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APPENDIX A. MEA-1500 COMPLETE CHECKOUT PROCEDURE

I N T R O D U C T I O N

HOW TO USE THE MANUAL

This Service Manual addresses the MEA-1500 and the MEA-1500-O-4 engine analyzer. Since the MEA-1500 is a Modular Engine Analyzer, the manual is broken out into 2 general parts. They are as follows:

Chapters 1 through 7 . . .	..consist of a complete manual for the MEA with no options installed.
Chapter 8 and above . . .	..are mini-service manuals on the individual option. i.e. the option chapters include theory, troubleshooting, calibration/ checkout, installation, and diagrams for everything involved with that option.

Most customer complaints pertain to a specific function of the Sun diagnostic analyzer not operating properly. Therefore, the Service Manual is divided into chapters that provide Theory of Operation, Service Calibration page usage (when applicable), Calibration (when applicable) and troubleshooting for the various functions of the tester.

Note: If the table of contents does not list a calibration procedure, service calibration usage notes, etc... this indicates there is no procedure applicable to that function.

IMPORTANT GUIDELINES FOR SERVICING "

A. ALWAYS verify that the main supply is operating within the specified tolerance (at the Board) before replacing any circuit board ! !

B. Verify that connectors to the boards are fully seated.

C. NEVER remove boards or disconnect a connector with power on!

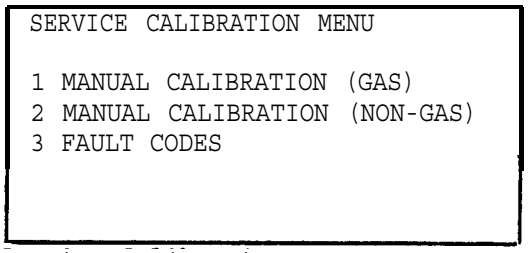
D. Make sure that you completely understand what the tester is suppose to do (you cannot fix it if it is not broken). Refer to Operators Manual, application notes & the flow diagrams for this type of information.

E. CONSULT the Service Bulletin Binder to see if this problem was identified earlier and instructions provided on how to correct it.

F. Use care when handling the circuit boards. Use anti-static bags when transporting the circuit boards.

HOW TO ACCESS THE SERVICE CALIBRATION PAGES

To gain access to the Service Calibration pages: Advance the Tester to the Self Calibration page & allow the parameters to calibrate. A "GOOD", "SERVICE REQUIRED" OR "NOT CALIBRATED" message will be displayed next to each parameter. With the Self Calibration page displayed, move selection #8 of SWl (SWl is located on the Digital Electronics board) to the "ON" position. After pressing "CONT" a menu will be displayed. the 5th selection will be "Service Menu". After selecting "5", a service menu will be displayed as follows:



Press the number on the Remote Control that corresponds to the Service Calibration page you want to access.

Service Calibration Menu page

Selection 1 (Manual Calibration [Gas]) is furthur explained in the BAR Chapters.

Selection 2 (Manual Calibration [Non-Gas]) is used to view the actual voltages to the MUX and an "unadjusted value". The unadjusted value is the actual calculated reading, disregarding the zero offset taken during self calibration. See example below.

	Measured Voltage	Unadjust Value
Readings during self calibration	-0.012	-0.1A
Correction factor	+0.012	+0.1 A
Corrected reading	— — -	0.0 A
Reading displayed in service cal page.	-0.012	-0.1A

On the Service Calibration page (non-gas), pressing the volt/ohms button toggles the volt ohms display, 1 toggles between amps scales, and 2 toggles between ohms scales.

To return to the Service Calibration Menu page from one of the Service Calibration pages press the menu button.

TRICK OF THE TRADE

Sun Electric uses numbers and letters to designate pins on connectors and circuit boards (Only numbers are used on the 72 pin Digital rack boards). The letters "G", "I", "O" and "Q" are not used. When counting, be sure to skip these letters. The following chart shows what letter will appear across from the numbers on the connector. To help retain these letter, remember the phrase "Gee I Ota Quit" (G,I,O, and Q).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	B	C	D	E	F	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	Z

LOGIC LEVEL DESIGNATIONS

Throughout the manual the terms "high" & "low" are used. Unless otherwise noted, the "high" is referring to a CMOS logic level high & a "low" is referring to a CMOS logic level low.

Signals that are active low or active on the falling edge are designated with an asterisk (*) following the signal name, i.e. ENGINE SYNC*, TIME PULSE*. Typically the text will differentiate between a level sensitive or edge sensitive signal.

The functional block diagrams use a bar ($\overline{\text{ENGINE SYNC}}$) over the signal's name to indicate that the signal is 'active low or on the falling edge.

OPEN COLLECTOR

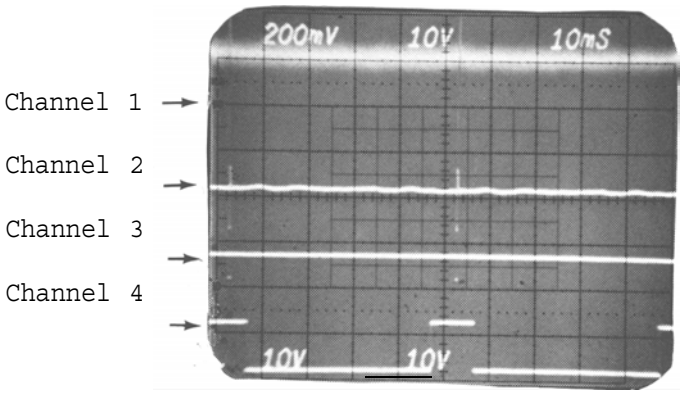
Some of the outputs are open collector. meaning that a pull-up resistor is used to "pull-up" the signal to Vcc. Usually the pull-up resistor is at the signal's destination board. The Open Collector outputs are designated on the diagrams with an O.C. marking at the edge connector. The technician should keep in mind the fact that open collector drive may be used. A broken wire between the source board and the destination board will cause the source board to appear to be defective. (The signal will not be pulled-up, thus it will appear that the source board is not outputting a signal).

INTERPRETATION OF OSCILLOSCOPE WAVEFORM FIGURES

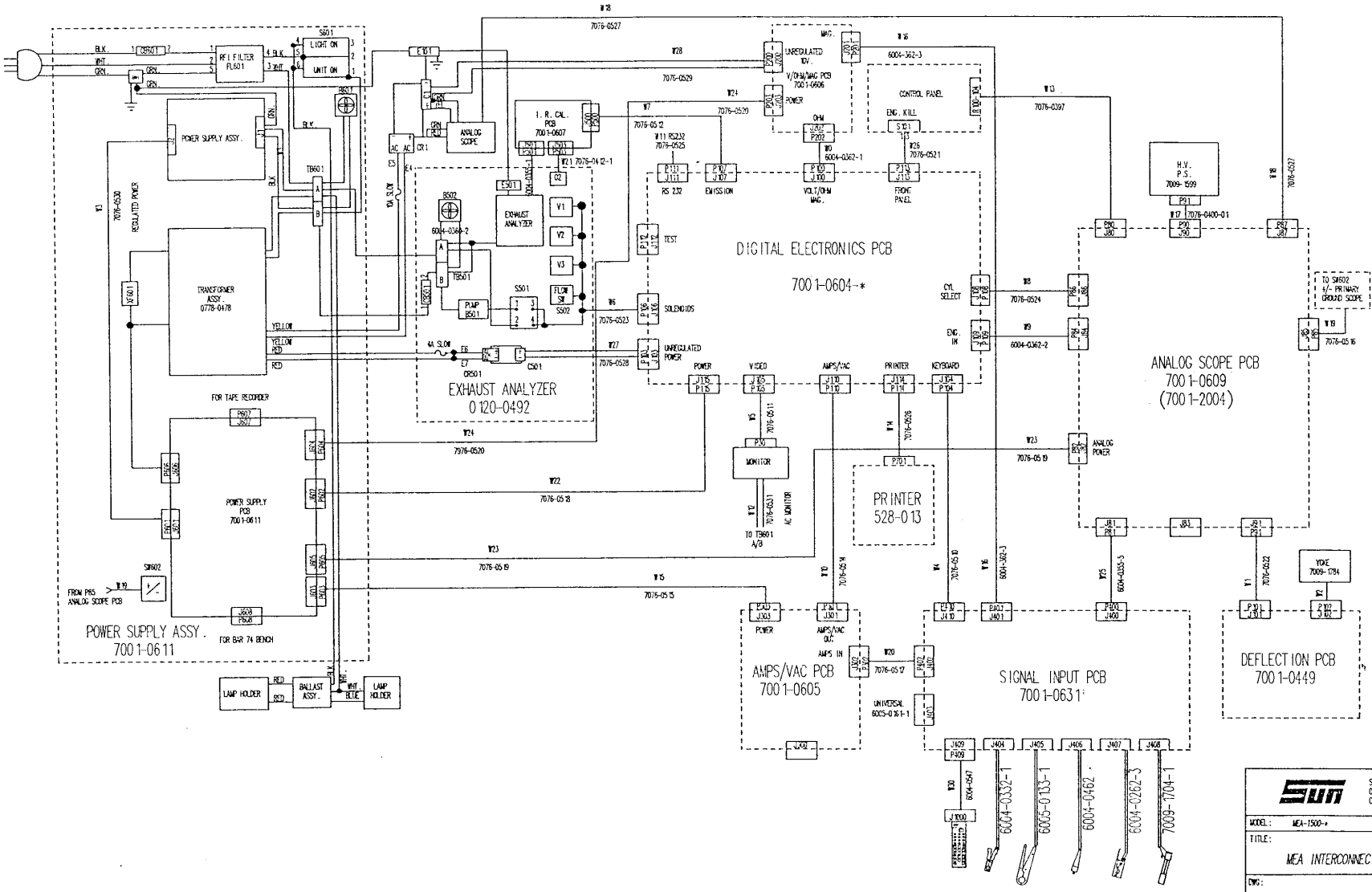
Many of the figures are pictures of Oscilloscope waveforms. These pictures were taken with the tester connected to a Simulator. The figures were included in the Service Manual to enhance the technician's overall understanding of how the electronics in the MEA-1500 work. They are not intended for a direct comparison to the tester you may be working on. This is due to the variables involved (Engine Rpm, Ignition type, etc. ..> affecting what the waveform will look like on the Oscilloscope.

The Oscilloscope model used to obtain the waveforms displays 4 channels, their volts per division & the horizontal sweep speed. The figure below shows the channels and their respective volts per division setting. The arrows on the picture show the ground point for each channel. The channels will always appear in the following order; channel 1 on top, channel 2 in the upper middle, channel 3 in the lower middle (when used), and channal 4 on the bottom (when used).

Channel 1 Volts/Div | Channel 3 Volts/Div | Sweep speed



Channel 2 Volts/Div | Channel 4 Volts/Div



SUN ELECTRIC CORPORATION One Sun Parkway Crystal Lake, Illinois 60014 U.S.A.	
MODEL: MEA-1500-*	
TITLE: MEA INTERCONNECTION DIAGRAM	
DWG:	PAGE: vi/vii
	5/89

CHAPTER 1

AC/DC POWER DISTRIBUTION

SECTION 1. AC THEORY OF OPERATION

SAFETY OBSERVE THE FOLLOWING SAFETY PRECAUTIONS WHEN WORKING WITH OR NEAR THE AC LINE VOLTAGE.

1. ALWAYS VERIFY.THAT THE TESTER IS "OFF" & THE LINE CORD IS UNPLUGGED FROM THE AC OUTLET BEFORE REMOVING WIRES FROM THE TERMINAL BLOCKS.

2. USE THE "ONE HAND RULE" (KEEP ONE HAND IN POCKET OR BEHIND BACK) WHEN WORKING WITH AC VOLTAGES.

Diagram 1-1 shows the AC power distribution for the tester. AC power enters the tester via the three conductor line cord. Many intermittent tester problems can be attributed to improper line voltage or a miswired AC outlet that the tester is connected to. If problems are experienced with the tester intermittently resetting (Resetting is defined as the tester returning to the Warm Up page unexpectedly) refer to the troubleshooting guide.

The black "hot" lead is connected to a RFI filter. The filter eliminates noise from the power line from entering the tester & also prevents tester AC noise from being transfered to the power line. Circuit breaker CB 601, main circuit breaker, located on the rear panel of the tester protects the tester when current in excess of 7 amps is drawn..

The power switch, also located on the rear panel of the tester, has three positions; ON / OFF / LIGHT ON. When in the ON position, power is applied to' the remainder of the tester and to the headsign lamp. In the LIGHT ON position, power is applied only to the headsign lamp. Terminal block 601 (TB601), located in the bottom right side drawer (inside) as viewed from the rear of the tester, is the main distribution point of the AC power. Most checks for AC Line voltage can be made at TB601. Generally the white wires with a black tracer and the black wires are the "hot" wires. Care should be exercised when reconnecting wires to the terminal block to prevent a direct short across the AC line.

AC power is applied to 5 components, they are the Cooling Fan, Flourescent ballast, T1 transformer, switching power supply, and the IR option if installed.

Refer to Diagram 1-1 for specific wiring connections and routing when trouble is experienced with the AC portion of the tester.

SECTION II. DC THEORY OF OPERATION

GENERAL OVERVIEW
Numerous low voltage AC & DC voltages are used throughout the MEA-1500 tester. The switching power supply assembly generates the basic supplies (5, 12, -12) to power the circuit boards.

The power supply board generates +17 volt regulated supply for the BAR 74 option, +15 volt regulated supply for the tape recorder on the bar 84 option, 30 volts DC to the analog scope board (which supplies the input to the high voltage (10.5 KV) supply for the analog scope), and -50 volts unregulated for the brightness control for the analog scope. In addition to generating these voltages, the power supply board is a distribution board for the three switching supplies and 9 VAC for the Mag/Volt/Ohm boards floating supply.

The +10 volt unregulated supply is not located on either of these two supplies. It is located on the top drawer of the analyzer and is used to power the yoke windings of the analog scope and the Europeon mag current source located on the Mag/Volt/Ohm board.

The remainder of the theory section provides theory of operation for each of the specific supplies. As with any piece of electronic equipment, power supply voltages should be checked (per checkout/calibration procedure) prior to replacement of any circuit board or before you perform checkout/calibration of the tester.

SWITCHING POWER SUPPLY ASSEMBLY (Reference diagram 1-1).
The Switching Power Supply assembly (located on floor of power supply drawer) receives its AC input voltage from terminal block 601. Protection for the supply is provided by a fuse F1.

Only one adjustment is avialable on Switching Power supply. This adjustment is used to adjust the +5 volt supply. The +12 and -12 volt supplies track the 5 volt supply. (i.e. when the +5 volt supply is adjusted down the +12 and -12 volt supplies will decrease also). The purpose for monitoring the +5 volt supply while adjusting, is that the tolerance of the +5 volt supply is much more critical than the +12 and -12 volt supplies.

12 VOLT SWITCHING SUPPLY
Referencing diagram 1-1, the +12 volt supply is used throughout the tester for the + (Vss+) supply on all Cmos logic. It is distributed (via the Power supply Board) to the following boards:

Digital Electronics Board	Analog Scope Board
Mag/Volt/Ohms Board	Deflection Board
Signal Input Board	CRT filament
Amps/Vacuum Board (optional)	Emisions Cal Board (optional)
BAR 74 (optional)	

-12 VOLT SWITCHING SUPPLY
Referencing diagram 1-1, the -12 volt supply is used throughout the tester for the - (Vss-) supply on all Cmos logic. It is distributed (via the Power Supply Board) to the following boards:

Digital Electronics Board	Analog Scope Board
Mag/Volt/Ohms Board	Deflection Board
Amps/Vacuum Board (optional)	Emisions Cal Board (optional)
BAR 74 (optional)	

5 VOLT SWITCHING SUPPLY

Referencing diagram 1-1, the +5 volt supply is used by the Mag/Volt/Ohm board to supply the switching device for the ohms ranging, and by the Digital Electronics Board to supply +Vss to all TTL logic.

10 VOLT UNREGULATED ANALOG YOKE SUPPLY

The 10 volt unregulated analog yoke supply is straightforward, with bridge rectifier CR1 providing rectification & capacitor Cl providing filtering.

ANALOG POWER SUPPLY BOARD (Reference Diagram l-l).

The analog power supply board (Located on the rear wall of the power supply drawer) receives miscellaneous AC voltages from Tranformer T1. These AC voltages are rectified, filtered and sometimes regulated, then distributed to their final destination.

UNREGULATED 30 VOLTS DC SUPPLY

The +30 unregulated DC supply provides the input voltage for the high voltage power supply which supplies the high voltage to the Analog scope. Referencing Diagram 1-1, Transformer T1 furnishes 25 volts AC to the Power Supply board. Rectifier CR2 provides full rectification and capacitor C8 and C9, filtering. The high voltage supply takes the 30 volts and steps it up to approximately 10.5 KV for the anode of the CRT, 250 volts for the accelerator grid & the focus grid.

REGULATED 17 VOLTS DC SUPPLY

The +30 unregulated DC supply provides the input voltage for regulator U2, which regulates to +17 volt. +17 is made availible for the Sun IR Bench on the BAR-74 option, if installed.

-50 VOLTS CRT BRIGHTNESS SUPPLY

The -50 volt brightness supply is obtained from the 50 volt AC tap from transformer T1. Rectifier CR1 and capacitor C3 provide full wave rectification and filtering. Zener diode CR5 regulates the supply to approximately -56 volts. Typically the supply will vary +/- 10 volts. Reference diagram 4-2 for the distribution of the -50 volts to the CRT control grid.

REGULATED 15 VOLTS DC SUPPLY

Referencing Diagram 1-1, Transformer T1 furnishes 18 volts AC to the Power Supply board. Rectifier CR3 provides full rectification and capacitor C4 filtering. Regulator U1 then regulates this DC voltage to +15. The +15 supply is made availible for the Tape Drive on the BAR-84 "I & M" option, if installed.

UNREGULATED 12 VOLTS FLOATING DC SUPPLY

Referencing Diagram 1-1, Transformer Tl furnishes 9.2 volts AC to the Mag/Volt Ohm Board. Rectifiers CR3, 4, 5, and 6 provide full wave rectification and capacitor C16 filtering. Regulator Q7 then regulates this DC voltage to +6 volts. The +12 and +6 volt supply is made availible for the Ohms constant current source.

SECTION III. POWER SUPPLY CHECKOUT AND CALIBRATION PROCEDURE

REQUIRED EQUIPMENT: Digital Multimeter
Nutdriver Set
Calibration Screwdriver
Phillips Screwdriver

The following procedure will verify proper operation and, if necessary, calibrate the MEA's D.C. Switching Power Supply.

1. Turn the Tester's power switch to the "OFF" position.

2. Remove the two 5/16" hex head screws which secure the MEA Power Supply Drawer, and pull the Power Supply Drawer out as far as it will go.

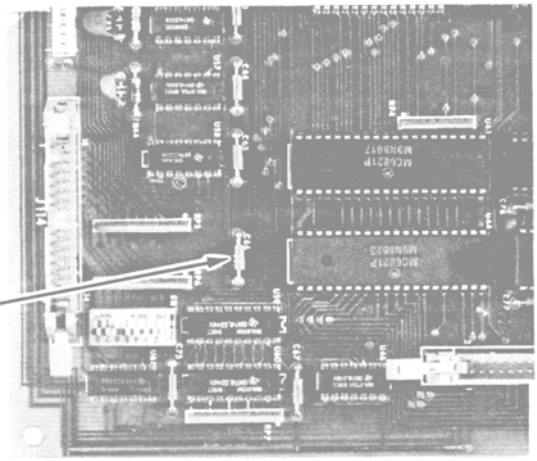
IMPORTANT: EXERCISE CARE WHEN WORKING NEAR THE POWER SUPPLY. HAZARDOUS VOLTAGES EXIST ON SOME OF THE VERTICAL HEATSINKS AND THE BOARD IN GENERAL

3. Remove two Phillips screws from unit's front drawer and pull front drawer out as far as it will go.

4. Turn the tester's power switch to the "ON" position.

5. Set the DMM to the 20 volt DC range.

6. Connect the DMM ACROSS capacitor C66 on the Digital Electronics Board. The DMM must read +4.9 to +5.10 volts. If not, adjust the 5V output pot (see NOTE) until DMM reads 5.0V +/-.05V. If unable to adjust within specification, replace the Power supply.



DIGITAL ELECTRONICS BOARD

NOTE : THERE ARE TWO DIFFERENT STYLES OF D.C. SWITCHING POWER SUPPLIES (#0532-0015). THE NEW STYLE HAS TWO BLACK VERTICAL HEATSINKS, ADJUST R48 FOR 5V OUTPUT CALIBRATION. THE OLD STYLE HAS TWO DIFFERENT TYPES OF HEATSINKS, ADJUST R3 FOR 5V OUTPUT CALIBRATION.

7. Connect the DMM's Black lead to ground.

8. Connect the DMM's Red lead to J107 pin 14(+12 volt supply) on the Digital Electronics Board #7001-0604. The DMM must read +10.5 to + 3.5 volts. If not, replace the power supply assembly.

9. Connect the DMM's Red lead to J107 pin 12(-12 volt supply) on the Digital Electronics Board #7001-0604. The DMM must read -13.5 to - 0.5 volts. If not, replace the power supply assembly.

NOTE : When the 5 volt supply is adjusted to +5.00 volts, using the 5V cal pot the +12 and -12 volt supplies will track proportionally. If the adjustment which makes the +5 volt supply correct causes either the +12 or -12 volt supplies to go out of specification, the supply must be replaced.

****

*** CALIBRATION COMPLETE ***
****

12/87

SECTION IV. POWER SUPPLY TROUBLESHOOTING

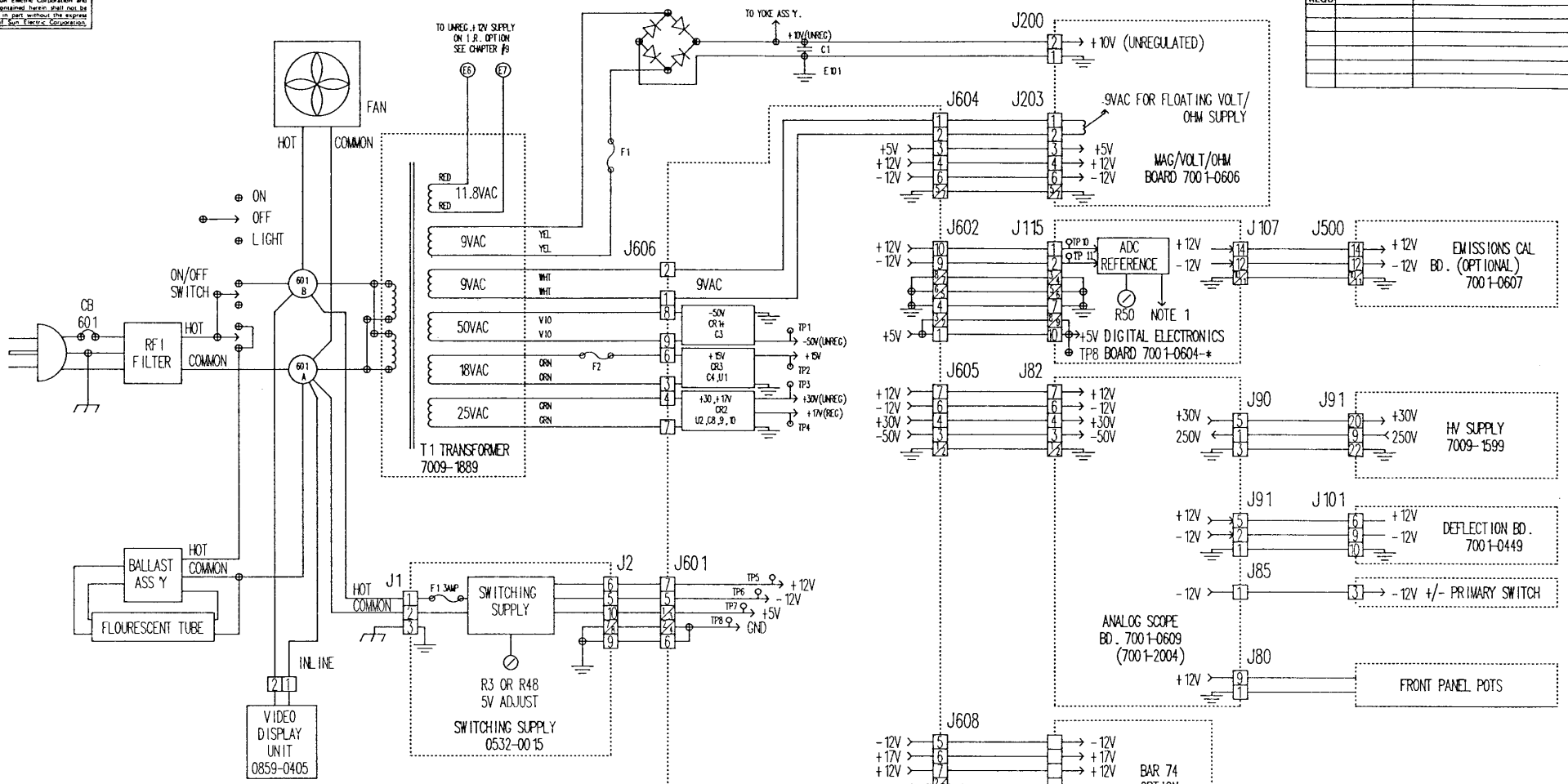
COMPLAINT	CORRECTIVE ACTION
I. ALL SWITCHING SUPPLIES (5, 12, -12) ARE MISSING NOTE: If only one supply is missing, refer to the complaint which addresses that supply.	1. Verify that the circuit breaker, located near the ON/OFF switch is not tripped. Press to reset. 2. Verify that the switching supply's fuse (Fl, 3 amp) is good. 3. Verify that 115 volts AC is available at the J1 of the Switching supply (pins 1&2], If not available, reference diagram 1-1 and verify connections to terminal block 601. If 115 AC volts is available at J1 ----------Substitute---------- A. Switching Supply ass'y 0532-0015 4. Refer to Theory of Operation and Functional Diagrams.
II. ONLY THE +5 VOLT SWITCHING SUPPLY IS MISSING	1. Power the tester down, disconnect J115 on the Digital Electronics board, then power the tester up and recheck the +5 V. If the +5V is now present; ----------Substitute---------- A. Digital Electronics Board 7001-0604 If the +5V is still missing, power the tester down, disconnect J203 on the Mag/Volt/Ohm board, then power power the tester up and recheck the +5 V. If the +5V is now present; ----------Substitute---------- A.Mag/Volt/Ohm Board 7001-0606 If the +5V is still missing; ----------Substitute---------- A. Switching Supply ass'y 0532-0015 2. Refer to Theory of Operation and Functional Diagrams.
111. THE +12 OR THE -12 VOLT SWITCHING IS MISSING, BUT NOT BOTH.	1. Power the tester down, remove connector J601 from the power supply board, then recheck the supply. "Supply voltage did not appear." ----------Substitute---------- A. Switching Supply ass'y 0532-0015

COMPLAINT	CORRECTIVE ACTION
111. (Continued)	"Supply voltage did appear. "A Board could be pulling the supply down. Check this by disconnecting the following connectors with power off, power up, and recheck the supply. A. J203 Mag/Volt/Ohm Board. B. J303 AMP Vacuum Board (if installed). C. J115 Digital Electronic Board. D. J82 Analog Scope Board. For items A & B, if supply returns when the connector is removed, suspect that board of pulling the supply down. For item C (Digital Electronics Board) If supply returns, reconnect J115, disconnect all other boards in which the missing supply is routed to. Replace the board that pulls the supply down. For item D (Analog Scope Board), If supply returns, reconnect J82 disconnect the following connectors with power off, power up, and recheck the supply. 1. J90 Analog Scope to HV power. 2. J91 Analog Scope to Deflection 3. J81 Analog Scope to Input. If supply returns, replace related component. If supply does not return, ----------Substitute ---------- A. Analog Scope Board 7001-0609 2. Refer to Theory of Operation & Functional diagrams.
IV. MISSING OR OUT OF DC TOLERANCE UNREGUALTED +10 YOKE/TIMING LIGHT SUPPLY .	1. Disconnect the Timing Light from the Input board and remeasure the supply. If the Supply is still missing; ----------Substitute---------- A. CR1, 30A Rectifier 0771-0412 B. Tl, Transformer 7009-1889 If the supply is now present: ----------Substitute---------- A. Timing Light Board 7001-0440 E.' Timing Light Cable 6004-0403-01 2. Refer to Theory of Operation & Functional Diagram #l-1.

COMPLAINT	CORRECTIVE ACTION
V. MISSING 9 VOLTS AC FOR OHMS CURRENT SOURCE.	1. Remove connector J203 from the Mag/Volt/ ohm board and recheck for 9 VAC. If voltage appears; ----------Substitute---------- A. Mag/Volt/Ohm Board 7001-0606 If Voltage did not appear; ----------Substitute---------- A. Tl, Transformer 7009-1889 2. Refer to Theory of Operation and Functional Diagram 1-1.
VI. MISSING OR OUT OF TOLERANCE -50 CRT BRIGHTNESS SUPPLY VOLTAGE. or NO BRIGHTNESS CONTROL	1. Typically the -50 volts will vary +/-10 volts. 2. Disconnect the connector from the CRT socket and measure from pin 6 (Green lead) to ground. Voltage should be between -15 to -30 volts depending on the position of the front panel brightness pot & the minimum brightness pot on the CRT Control bd. If voltage (-15 to -30) is present; the CRT is leaky (partially shorted) and pulling the supply down. Replace the CRT #0859-0066. If -15 to -30 VDC not present; Disconnect connector J606 on the Power Supply Board and measure for 50 Volts AC between pins 8 & 9. If the AC voltage is present; ----------Substitute---------- A. Power Supply Board 7001-0604. If the AC voltage is not present; ----------Substitute---------- A. T1 Transformer, 7009-1889 3. Refer to Theory of Operation and Functional diagrams.
VII. NO HIGH VOLTAGE (10.5 KV) TO ANALOG SCOPE.	1. Disconnect connector J91 from the High Voltage Power Supply and measure for 30 VDC between pins 20 & 22. If voltage is available; Substitute A. High Voltage Supply #7009-1599. If it is not available see Symptom VIII.

COMPLAINT	CORRECTIVE ACTION
VIII. MISSING UNREGULATED +30 VOLTS .	1. Disconnect J605 from the Power Supply Board, and recheck the voltage. If +30 volts is present; ----------Substitute---------- A. High Voltage Power Supply 7009-1599 B. Analog Scope Board 7001-0609. If +30 volts is not present; ----------Substitute---------- A. Power Supply Board 7001-0611 A. T1 Transformer, 7009-1889 2. Refer to Theory of Operation & Functional diagram 3-3.
IX. MISSING REGULATED +17 VOLTS .	1. If the +30 Volt supply is also missing, see Symptom VIII. This supply is not used unless a BAR-74 option is installed. If a problem is found with this supply see the BAR 84 Chapter.
x. MISSING REGULATED +15 VOLTS .	1. This supply is not used unless a BAR-84 option is installed. If a problem is found with this supply see the BAR 84 Chapter.
XI. AC RIPPLE IS OUT OF TOLERANCE ON THE +1OV YOKE/TIMING LIGHT SUPPLY.	1. ----------SUBSTITUTE---------- A. Cl, 50,000 mfd Capacitor 0679-0536 B. CR1, Rectifier 0771-0412

LIST OF MATERIAL			
QTY REQD	PART NO.	DESCRIPTION	ITEM NO.



NOTE 1: -7.2 - -7.6V SEE PAGE 2-3 FOR CHANGES TO ADC REFERENCE VOLTAGE CAL. AND CHECKOUT.

SYM	DATE	REVISIONS	ECN	APVL
	05/89			

(DO NOT SCALE) TOLERANCES (EXCEPT AS NOTED)
ANGLES ± DECIMALS .000 ± .001 .00 ± .010 .0 ± .1
FRACTIONS ±

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

TITLE: AC/DC DISTRIBUTION

MODEL: MEA-1500/ DIAGRAM 1-1

MAT'L AND/OR FINISH

DWG BY _____ / _____ ENG APVL _____ / _____

CHK BY _____ / _____ ENG APVL _____ / _____

SCALE | SHT OF | DWG SIZE D | DWG NO. | PAGE 1-9/1-10

SECTION I. COMPUTER AND RELATED HARDWARE THEORY OF OPERATION

The Digital Electronics Board is located in the center of the front drawer and contains a 6803 microprocessor (CPU) and its related support hardware. The CPU is supplied a 4 Mhz clock and communicates with various peripherals which are local to the Digital Electronic Board. See the associated paragraph for a description of each peripheral.

16K EPROM
The 16K EPROM contains the Program which the CPU executes upon power up. The EPROM is read by the CPU via the address and data buses.

COUNTER/TIMER
The counter timer is used by the CPU to time events in order to calculate reading to be displayed on the screen. Below is a list of events and their associated readings:

EVENT	READING
Time between ENGINE SYNC B* signals	RPM
Time High and Time low of DLYD DWELL*	Dwell
Time between ENGINE SYNC B* and TIME PULSE	Timing
Time between START CONV and END OF CONV	All analog voltages

MUX A/D CONVERTER
The MUX circuit is a multi-input switch which is selectable by the CPU. When the CPU wants a particular Voltage, that related Channel is selected, which applies the voltage to a comparator. The other input to the comparator is a calibrated ramp. When the ramp reaches the voltage of the input, the output of the Comparator changes states. This output (END OF CONV) is sent to the Counter/Timer. The Counter/Timer records the amount of time from the beginning of the ramp (START CONV) to the point where the ramp and the "+" input is equal. Since the CPU knows how fast the ramp is rising, the input voltage can be calculated. In order to calibrate the ramp, an ADC reference voltage is also available to the MUX (see ADC cal for further information).

The acceptable range of voltages that the Mux A/D can convert is +/-7.5 Volts. The boards prior to the Mux A/D condition voltages greater than +/-7.5 volts to a voltage that is within its conversion range.

INPUT/OUTPUT PORTS
The Digital 1/0, as the name implies, consists of input and output ports. The 1/0 is the computer's interface to the Digital signals that are used throughout the tester. The major functions are listed below. The specific individual functions are covered later when the Digital 1/0 has a role in processing of a signal. Digital 1/0 functions include:

1. Scanning the Remote Control, Engine Kill, Pump, and Low Flow switches.
2. Activating the span of the Emissions option when installed.
3. Ohmeter range selection via the Mag/Volt/Ohm board.
4. Ammeter range selection (100 or 1000 amp scale) via the Amp/VAC board.
5. Sensing end of conversion on the MUX circuit.
6. Sensing engine signals.
7. Control of the Scope functions and ranges.
8. Sensing the switches located on the Digital Electronics Board.

TROUBLE CODES

The Digital Electronic's Board has a built in diagnostic routine that records any errors encountered. If any errors are found, a code is stored in battery backed-up RAM. This ensures that the codes are present even if the unit has been powered down since the failure occurred. A description is displayed with the error code. See the related section of this manual for an explanation of parameters on each individual code.

The 40 and 50 series of troublecodes pertain to under and over range of a specific Mux channel. The last digit of these codes indicates which channel the problem exists on. See the Functional Block Diagram for a reference of what number applies to what channel, i.e. error 51 if an overrange on the C02 channel.

VIDEO GENERATOR AND VIDEO RAM

The video generator generates three signals to be sent to the monitor; the first of which is VIDEO. The Video Ram receives characters in digital form from the CPU. Each memory location corresponds to one character space on the VDU . When the CPU wants to write a character on the screen, it places the digital equivalent of the character into a RAM memory location. The Video Generator then reads this information and sends it to the VDU. The characters are formed in a 7 x 9 dot matrix. The screen format is 16 lines (rows) by 32 columns.

The other two signals generated are VERTICAL and HORIZONTAL SYNC. The horizontal sync is a 15.750 Khz signal used to reset the horizontal sweep of the VDU. The Vertical sync is a 50 or 60 Hz signal used to reset the vertical sweep of the VDU.

REMOTE CONTROL OPERATION

The computer, via the 1/0 ports, scans the Remote Control switches. To scan the matrix, the computer (via the 1/0 port) first takes the ACTIVATE A* drive line low. It then reads the logic levels on the 6 sense lines. Since the ACTIVATE A* line is the only drive line low at this time, only the switches connected to the ACTIVATE A* line can take their respective sense line low. Unless the sense lines are forced low by a closed switch, they are pulled high by pull-up resistors on the Digital Electronics Board. Thus, the sense lines represent the status of the switches connected to the ACTIVATE A* drive line at this time.

The computer then takes ACTIVATE B* and the status of the sense lines are read. This scanning process is continued until all of the rows of the matrix have been read. During tester operation, this process is continuously repeated to determine what button (switches) have been depressed.

ENHANCED ANALOG SCOPE

The MEA-1500 Serial "B" includes a new PINPOINT LAB SCOPE (Enhanced Analog Scope). To support this new feature, the MEA's Digital Electronics Board's (DEB Board's) firmware has changed. The new firmware alters the Option Switches such that the Enhanced Scope Option can be turned "ON" or "OFF". It is important to remember this fact if one is not able to evoke the Pin-Point Scope Mode. Shown in Figure 1. below is SW1 of the DEB Board and how options can be enabled or disabled by the switche settings.

OFF	SW1	ON
60 HERTZ DISPLAY	1	50 HERTZ DISPLAY
NO FOUR GAS	2	FOUR GAS INSTALLED
NO THREE GAS	3	THREE GAS INSTALLED
NO PRINTER	4	PRINTER INSTALLED
NO AMPS/VACUUM	5	AMPS/VACUUM INSTALLED
* NO ENHANCED SCOPE	6	ENHANCED SCOPE INSTALLED *
NO COIL "+"	7	COIL "+" INSTALLED
NO SERVICE MODE	8	SERVICE MODE

* SEE NOTES 1 AND 2

Figure 1.

NOTE : 1. Selection 6 on Firmware with a Revision of 3.0 or earlier will remain as OFF INCHES OF HG ON MILLIBAR VACUUM.

2. Selection 6 on Firmware with a Revision of 7.0 or later will now enable or disable the Enhanced Scope. Vacuum measurement will now be a selection from the Setup Menu, see VEHICLE SET-UP MENU below.

```
        VEHICLE SET-UP
ENTER NO. OF CYLINDERS X
ENTER NO. OF CYCLES    x
ENTER MAGNETIC OFFSET - X.X
SET VACUUM DISPLAY TYPE X
  (1=HG, 2=MBAR)
```

Xs are used to represent numbers that can be entered in VEHICLE SET-UP.

SECTION II. ADC CALIBRATION

The ADC REFERENCE voltage is used by the Digital Electronics board for Analog to Digital conversion. A ramp generator generates a calibrated ramp that is fed to a comparator for comparison to an analog signal. To properly calibrate this ramp, the ADC REFERENCE voltage must be calibrated. A known value must be fed into the comparator, and from the known, a conversion ramp can be generated that is linear not only in time but also in amplitude.

To do this , the battery voltage of 13 Volts is fed to the mux. By making the final result on the screen read the known by adjusting the ADC pot (R50), a true calibration of the ADC voltages takes place. Refer to the Volt/ Ohm Calibration procedure on page 6-4 to perform this calibration. **NOTE: AS BEFORE, IF THE ADC VOLTAGE HAS BEEN CALIBRATED, ALL MUX CHANNELS MUST BE RECALIBRATED .**

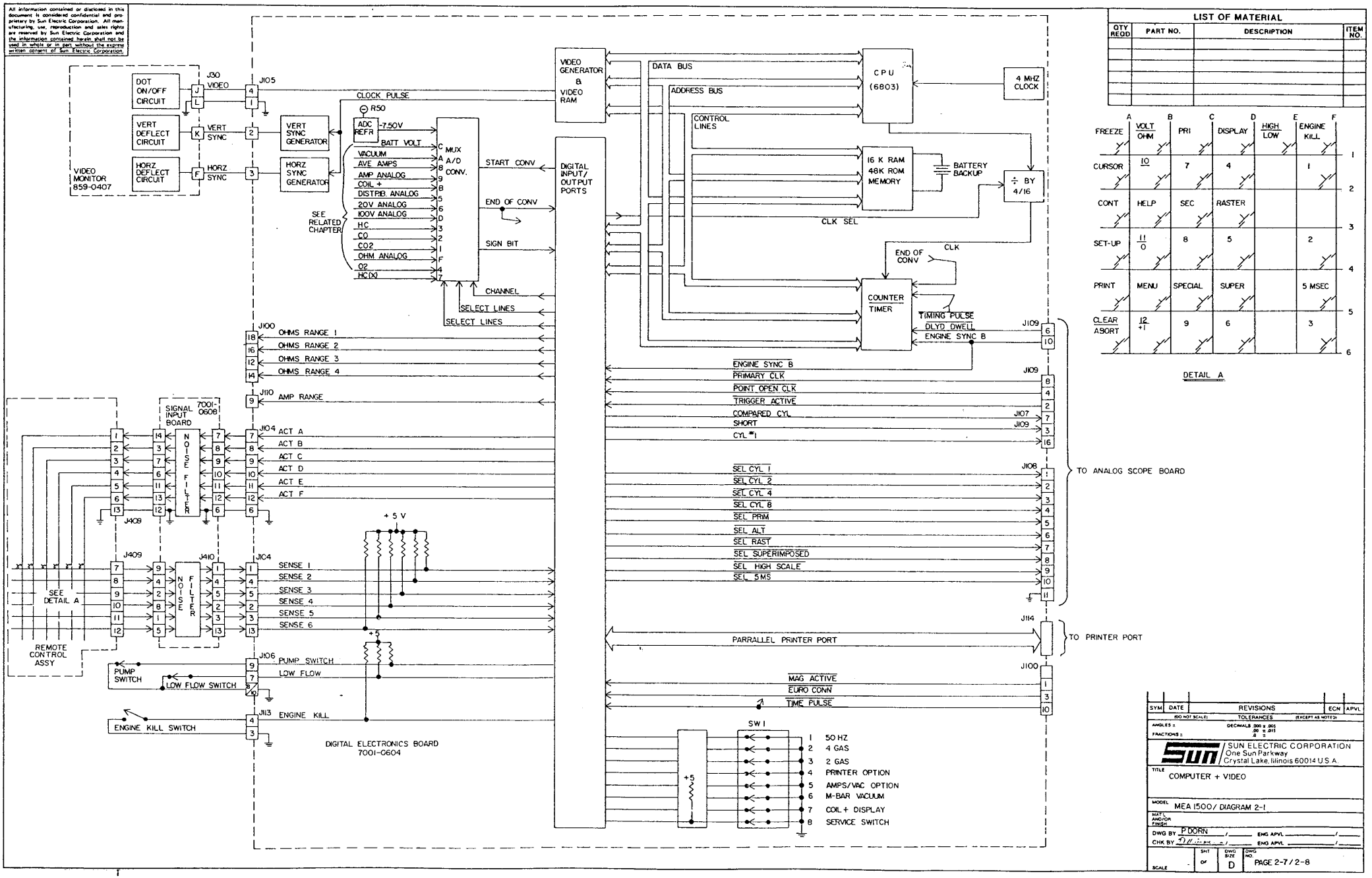
SECTION III. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. ERRATIC RESPONSE FROM REMOTE CONTROL.	1. ----------SUBSTITUTE---------- A. Membrane key pad #0552-0029 B. Digital Electronics Board 7001-0604 C. Remote Cable assembly 6004-0502 2. Refer to Theory of Operation & Functional Block 2-1.
II. NO RESPONSE FROM ONE OR MORE REMOTE CONTROL KEYS.	1. ----------SUBSTITUTE---------- A. Membrane key pad #0552-0029 B. Digital Electronics Board 7001-0604 C. Remote Cable assembly 6004-0502 2. Refer to Theory of Operation & Functional Block 2-1.
III. DIGITAL DISPLAY IS DARK .	1. If the fan does not run and the headsign does not light, verify that the Circuit Breaker on the rear of the tester is not "popped" and that AC line voltage is available at the AC outlet. 2. If a printer is present, turn the tester on and press the print button. If the Printer prints the Warm-up page, verify that the VDU is receiving AC voltage. If it is, ----------SUBSTITUTE---------- A. Video display Board, 0859-0511 B. Digital Electronics Board, 7001-0604 C. Video Display Unit, 7009-1592-01 If the Printer does not print, Verify that the DC Voltages are available to the Digital Electronics board. See Functional Block 2-1. If any supplies are missing, see Power Supply troubleshooting in Chapter 1. If all supplies are present; ----------SUBSTITUTE---------- A. Digital Electronics Board, 7001-0604

COMPLAINT	CORRECTIVE ACTION
111. (Continued)	3. If no Printer is available, verify that the VDU is receiving AC voltage. If AC voltage is present; ----------SUBSTITUTE---------- A. Video display board 0859-0511 B. Digital Electronics Board 7001-0604 C. Video Display unit 7009-1692-01 If no AC voltage is present, troubleshoot using Diagram 1-1. 4. Refer to Theory of Operation & Functional Block 2-1.
IV. TESTER JUMPS (RESETS) TO WARM-UP PAGE. or TESTER INTERMITTENTLY LOCKS UP.	1. Verify that the AC line voltage is within tolerance & confirm that no equipment that could cause voltage transients is connected on the same line. 2. Vehicle under test should have suppression spark plug wires. If "solid" wires are being used on engine, have mechanic try substituting suppression wires for the #1 spark plug wire & the coil wire. 3. Verify that the Power Supply voltages are set correctly. See Power Supply Calibration in Chapter 1. 4. If the unit in question has a boom, verify that the leads are routed as explained in the boom installation procedure. 5. Verify that the Ground Strap is intact from the Input Board to Ground. 6. Refer to Theory of Operation & Functional Block 2-1.
v. FAULT CODE 02 or FAULT CODE 03 DISPLAYED	1. If the Firmware is revision 1.0 (IC31) this is a normal condition, do not repair. 2. ----------SUBSTITUTE ---------- A. Digital Electronic Board 7001-0604.

N O T E S

==========.



LIST OF MATERIAL

QTY REQD	PART NO.	DESCRIPTION	ITEM NO.

	A	B	C	D	E	F	
FREEZE	VOLT OHM	PRI	DISPLAY	HIGH LOW	ENGINE KILL		1
CURSOR	10	7	4		1		2
CONT	HELP	SEC	RASTER				3
SET-UP	11 0	8	5		2		4
PRINT	MENU	SPECIAL	SUPER		5 MSEC		5
CLEAR ABORT	12 +1	9	6		3		6

DETAIL A

SYM	DATE	REVISIONS	ECN	APVL

TOLERANCES (DO NOT SCALE) (EXCEPT AS NOTED)
ANGLES ±
DECIMALS .000 ± .001, .00 ± .015, .0 ±
FRACTIONS ±

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

TITLE: COMPUTER + VIDEO

MODEL: MEA 1500/ DIAGRAM 2-1

MAT'L AND/OR FINISH

DWG BY P DORN / ENG APVL / /

CHK BY / ENG APVL / /

SCALE - SHT OF DWG SIZE D DWG NO. PAGE 2-7/2-8

CHAPTER 3
IGNITION PROCESSING AND CYLINDER SHORTING

SECTION 1. THEORY OF OPERATION

NOTE: The following text is used in conjunction with diagram 3-1.

GENERAL

The analog signals being generated from the engine under test must be converted to digital signals that can be interpreted by the MEA-1500's computer. Two of the most important signals for proper operation of the MEA-1500 are POINTS OPEN CLOCK* and ENGINE SYNC B* (typically abbreviated ENG SYNC B*).

The POINTS OPEN CLOCK* signal is generated by circuitry on the Analog scope board which detects when the firing voltage of each cylinder's spark plug exceeds a threshold voltage. The ENGINE SYNC B* signal, also originating on the Analog Scope board, is generated by circuitry that detects when the voltage of the #1 cylinder's spark plug exceeds a threshold voltage.

The following figures show the relationships between the primary waveform of the ignition system & the resulting POINTS OPEN CLOCK* & ENGINE SYNC B* signals for 8, 6 & 4 cylinder engines.

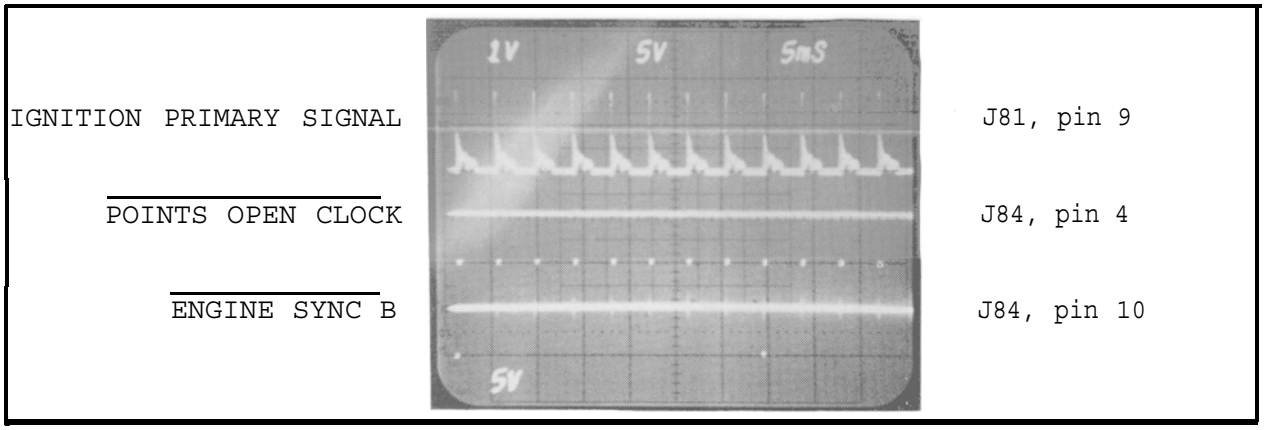


FIGURE 3-1 POINT OPEN CLOCK & ENGINE SYNC B (8 Cylinder Engine)

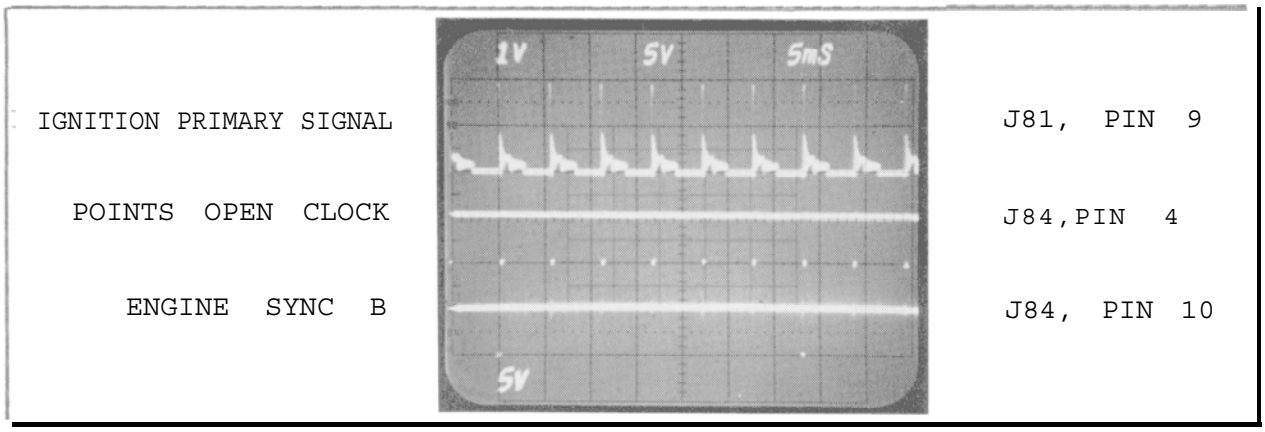


FIGURE 3-2 POINT OPEN CLOCK & ENGINE SYNC B (6 Cylinder Engine)

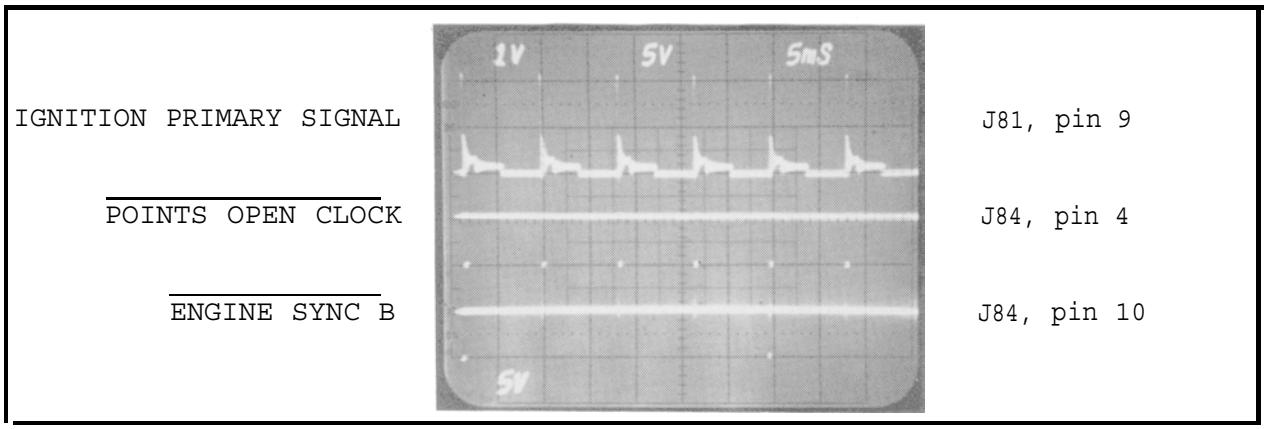


FIGURE 3-3 POINT OPEN CLOCK & ENGINE SYNC B (4 Cylinder Engine)

ENGINE SYNC A

The red trigger pickup is composed of a core material wrapped with several loops of wire. When the cylinder's spark plug that the trigger pickup is placed around (normally the engine's #1 cylinder's spark plug wire) fires, the magnetic flux induces a small voltage into the trigger pickup. This voltage passes through a Common mode rejection transformer and is then coupled to the Analog Scope Board at J81 Pin 13 via a 1:1 transformer on the Input board.

When the voltage from the trigger pickup exceeds the reference voltage of .09 volts ENGINE SYNC A goes high. When the input is less than the reference voltage ENGINE SYNC A is low. Therefore, with the input applied the output will produce a very narrow pulse from approximately +12 to O volts called ENGINE SYNC A.

ENGINE SYNC A is used to trigger the timing light, and to generate ENGINE SYNC B* if available.

TRIGGER AVAILABLE

The signal from the Trigger pickup is monitored by the Engine Sync Processor. If a signal is available, TRIGGER ACTIVE* will be low. If no trigger signal is available, TRIGGER ACTIVE* will be high. If this condition occurs, CYL #1* is used to generate ENGINE SYNC B*.

CYL #1

If the signal from the #1 pickup is not available, the computer makes up a #1 cylinder. The computer knows this by monitoring the TRIGGER AVAILABLE* signal.

ENGINE SYNC B

This signal can be generated from either ENGINE SYNC A or CYL #1*. ENGINE SYNC A is the preferred source. When #1 cylinder fires, the signal will go low for 0.7 mseconds, and is used for calculation of RPM if no POINTS OPEN CLOCK* is available.

PRIMARY (+) & (-) DRIVE

As Diagram 3-1 shows, there is a direct wire connection from the primary lead to the Input board. This primary is attenuated and sent to the Analog Scope Board as PRI (+) DRIVE and PRI (-) DRIVE. The primary clock processor is responsible for changing the noisy primary ignition signal into a clean digital logic signal. Its threshold are determined by two signals, 4 VOLT* and SHORT*. See Figure 3-4 the thresholds.

4VOLTS *	SHORT	HOLD THRESHOLD
HIGH	LOW	85 VOLTS
HIGH	HIGH	14 VOLTS
LOW	LOW	4 VOLTS
LOW	HIGH	4 VOLTS

FIGURE 3-4

PRIMARY (+) & (-) THRESHOLD

The primary voltage from the Blue lead is routed to the Input Board where it is attenuated and sent to the Analog Scope Board as PRIMARY (+) THRESHOLD and PRIMARY (-) THRESHOLD. If the voltage between these two leads is always less than 180 volts, 4 VOLTS* goes low, changing the threshold of the primary clock processor to 4 volts. If the voltage between these two signals goes above 180 volts, 4 VOLTS* stays high, and the Secondary clock processor triggers on 85 volts.

PRIMARY CLOCK

PRI CLK* is developed as described in PRIMARY (+) DRIVE, and is sent to the Digital Electronics Board for use in reading Distributor Resistance and timing of the CYL SHORT signal.

SECONDARY PATTERN

The signal from the secondary lead is filtered on the Input board and fed to the secondary processor on the Analog Scope board. If the signal was observed at J81 pin 9 it would be a secondary waveform with an amplitude of approximately 3 volts in the negative direction (Upside-down secondary waveform). The Secondary processing circuitry converts the secondary signal to a digital signal. The rising edges coincides with the firing of the spark plugs. The SECONDARY CYL CLK signal is fed to the Scope Clock Processor circuitry. See POINTS OPEN CLOCK for a further explanation.

POINTS OPEN CLOCK

The POINTS OPEN CLOCK* signal is derived from either the Secondary pickup or the primary lead. The Primary and secondary clock signals are "or'ted together, therefore the MEA-1500 is not Secondary preferred or forced primary. If one OR the other is available, Point open clock is developed. It is then routed to the Digital Electronic Board where it is used as the first source for engine RPM.

DELAYED DWELL

PRI CYL CLK is routed to a Delay Circuit where it is delay by 800 microseconds. This is done so that this signal does not happen at the exact point in time as ENGINE SYNC*, PRI CLK*, and PNTS OPEN CLK*, since the CPU is very busy during this time.

The DELAYED DWELL signal is routed to the Digital Electronics "board where its falling edge is used to trigger the distributor resistance readings and its duty cycle is used to determine dwell of the engine. (Dwell is the time that the ignition points are closed). Dwell is expressed as a percentage or in number of degrees of camshaft rotation.

For example: with an 8 cylinder engine, each cylinder will have 45 degrees (45 = 360/8) rotation of the camshaft. If the points are closed half the time, dwell = 22.5 degrees (22.5 = 45/2) or 50% of 45 degrees.

CYLINDER SHORTING--General

Cylinder shorting (power balancing) is used to determine the amount of power that is being contributed to the engine from each cylinder. By shorting out a cylinder (not allowing it to fire and contribute to engine performance) and watching the drop in RPM, it is possible to determine if the cylinder is contributing its "fair share" to overall engine performance. The greater the RPM drop, the greater the amount of power the cylinder was contributing to engine performance. If it was only contributing a small amount of power, indicating a problem, it will show up as a relatively small drop in RPM.

CYL SHORT

During power balancing, one cylinder is shorted and the RPM drop measured, then, the next cylinder in the firing order is shorted and its RPM drop is measured. The Digital Electronics board initiates shorting via the CYL SHORT signal and keeps track of which cylinder is being shorted. Figure 3-5 shows the relationship between the primary waveform, POINTS OPEN CLOCK*, CYL SHORT and ENGINE SYNC B*.

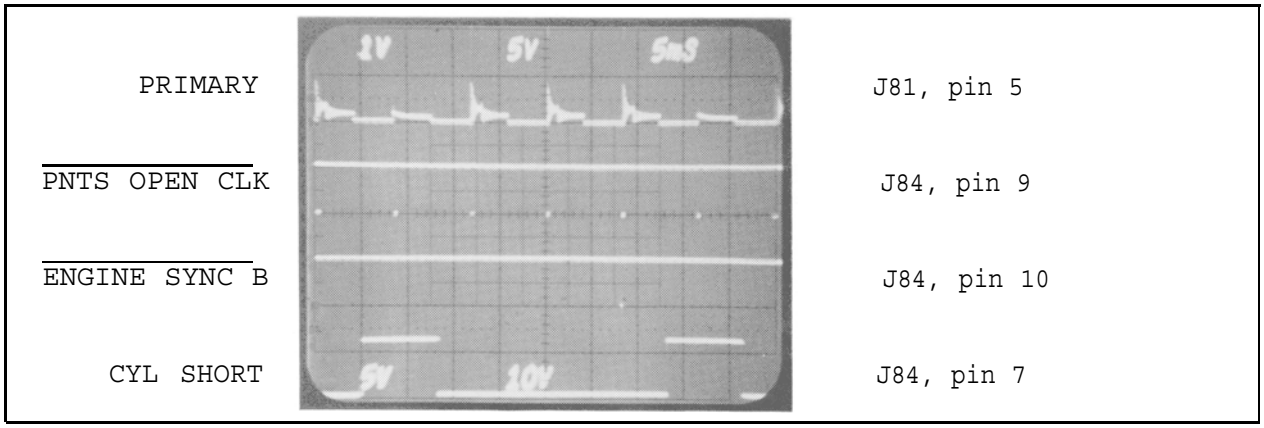


FIGURE 3-5 CYLINDER SHORTING

The SHORT signal will go high from approximately points close of the cylinder preceding the cylinder that it is going to be shorted and it will stay high until approximately points close of the cylinder that is shorted. Notice in Figure 3-5 that a small amount of voltage remains in the primary of the ignition system. It is this voltage that the tester is maintaining triggering with (producing POINTS OPEN CLOCK* with) during the time the cylinder is shorted.

The CYL SHORT signal goes to the cylinder shorting logic on the Analog Scope Board where it initiates turning on the shorting triac on the Input board. Referencing figure 3-6, the TRIAC GATE signal is simular to the CYL SHORT signal, with the signal being clamped at approximately 2 volts by the triac's gate.

The SHORT signal is also routed to the Primary Clock Processor where it is used to change the trigger threshold. This is to prevent the Primary Clock processor from losing trigger of the primary due to that cylinder being shorted.

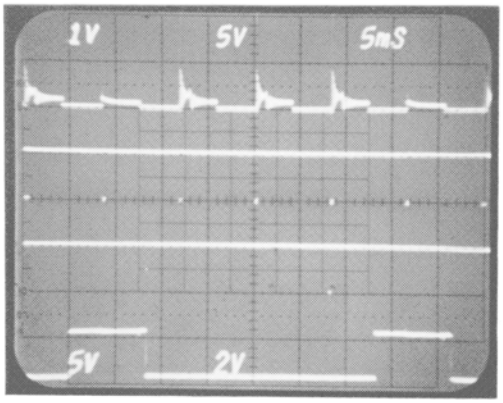
PRIMARY		J81, pin 5
PNTS OPEN CLK		J84, pin 9
ENGINE SYNC B*		J84, pin 10
TRIAC GATE		J81, pin 17

FIGURE 3-6 CYLINDER SHORTING

Normally the trigger threshold voltage of POINTS OPEN CLOCK* is at 85 volts. When a spark plug's firing voltage exceeds the 85 volts, the Primary Clock Processor on the Trigger board generates the falling edge of POINTS OPEN CLOCK*. When a cylinder is shorted, it produces less than 85 volts on the ignition primary. This can be seen in figure 3-6 (primary waveform). The SHORT* signal going to the Primary Processor lowers the trigger threshold voltage for POINTS OPEN CLOCK* from 85 volts to 4 volts for the cylinder that is shorted. Lowering the threshold voltage insures that the shorted cylinder is "counted".

NOTE: If the shorted cylinder was not counted, the cylinder counter on the Digital Electronics board would not be incremented due to the missing POINTS OPEN CLOCK* signal. The end result would be that the engine would die because the tester continues to short the engine, shorting all the other cylinders when it is their turn to fire.

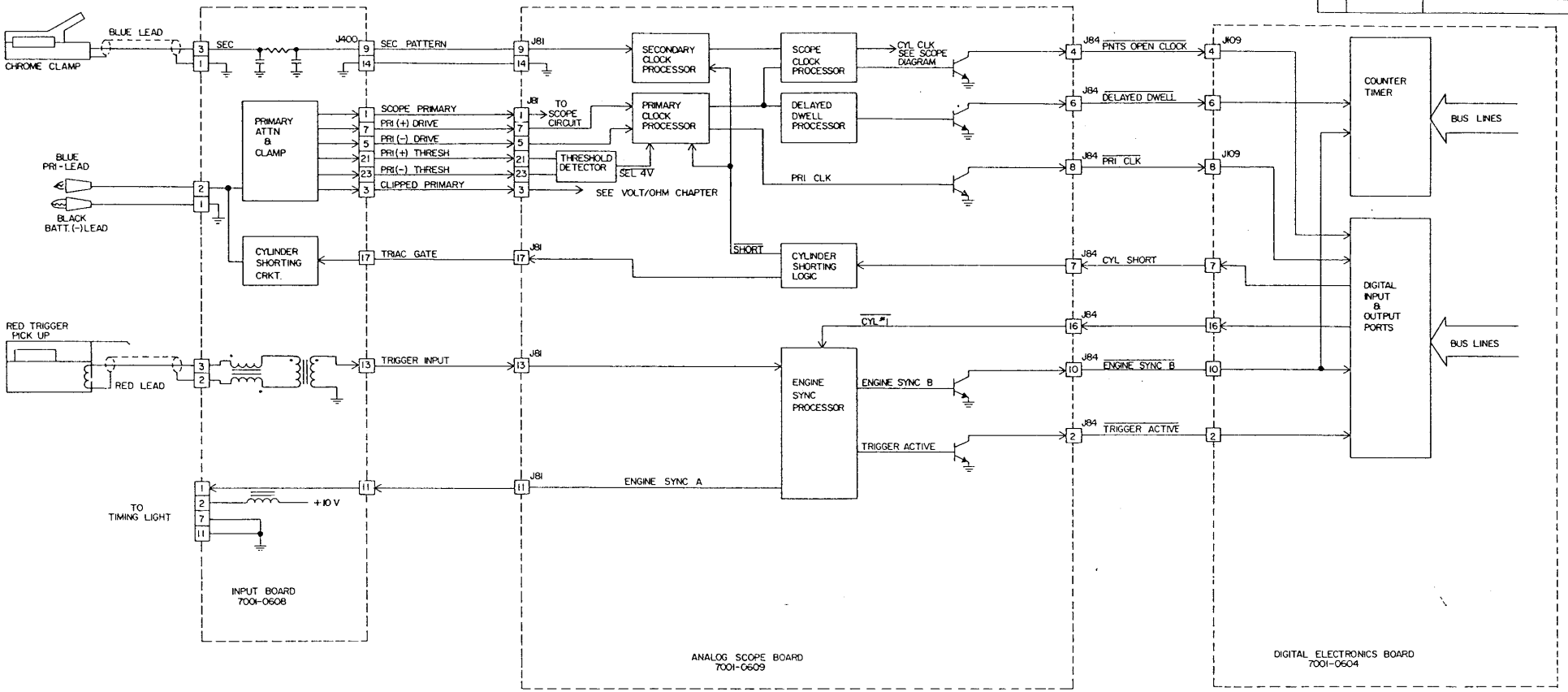
COMPLAINT	CORRECTIVE ACTION
I. NO RPM (TACH) READINGS. NOTE: Rpm can be derived from either the primary signal, the cylinder #1 signal, or the secondary signal.	1.Verify that the primary (-), Secondary ground leads, and the #1 Trigger lead are connected to a live ignition. 2.With an oscilloscope verify that the ENGINE SYNC A* signal & the POINTS OPEN CLOCK* signal is being output by the Analog Scope Board, pins 10 & 4 of J84 respectively (figure 3-1). If the above condition is met, replace the Digital Electronics Board (7001-0604) If the condition was not met and ENGINE SYNC* and/or CYLINDER CLOCK* was not output, verify Power supplies to the Analog Scope board (7001-0604). If power is OK replace the Board. 3. Refer to Theory of Operation & Functional Diagram.
11. TACH READINGS ARE INACCURATE OR UNSTABLE.	1. With an oscilloscope, verify that the ENGINE SYNC B* signal & the PNTS OPEN CLK* signal is stable (figure 3-1), Analog Scope Board, pins 10 & 4 of J84 respectively (figure 3-1). If the ENGINE SYNC* signal is unstable or erratic, verify that the red trigger clamp is not cracked or broken. Additionally, moving the trigger pick-up to a different position on the wire will sometimes alleviate the problem. If the ENGINE SYNC B* signal is still unstable after performing the above checks or the PNTS OPEN CLK* signal is unstable; ----------Substitute ---------- A. Analog Scope Board 7001-0609 If the ENGINE SYNC B* and the PNTS OPEN CLOCK* are present & stable; ----------Substitute ---------- A. Digital Electronic Board 7001-0604 2. Refer to Theory of Operation & Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
111. DWELL READINGS ARE ZERO, INACCURATE OR UNSTABLE.	1. Dwell readings are derived from the primary (-) signal. Verify that the blue booted & ground lead (black booted) leads are connected. 2. With an oscilloscope, verify that the DELAYED DWELL* signal is present and stable on pin 6 of J84 of the Analog Scope Board. Its duty cycle will vary proportional to the ignition dwell time. When connected to an IS-100A, duty cycle will be 50%. If the above conditions are met, replace ----------Substitute---------- A. Digital Electronic Board 7001-0604 If the conditions are not met, verify that a primary signal (figure 3-1) is available at pin 2 of the Trigger board. If it is not, verify continuity from the lead to pin 2. If Primary is available, replace the ----------Substitute---------- A. Analog Scope Board 7001-0609 3. Refer to Theory of Operation & Functional Diagram.
IV. ENGINE DIES DURING POWER BALANCE.	1. If the engine is running very poorly, shorting a cylinder that is contributing a large percentage of the power may cause the engine to die. Try power balancing at a slightly higher engine speed. 2. ----------Substitute---------- A. Analog Scope Board 7001-0609 B. Digital Electronic Board 7001-0604 C. Input Board 7001-0608 3. If a problem still exists after replacing the above boards, reference figure 3-6 and verify that CYL SHORT* is going low. (Informs Processor to lower its trigger threshold for the shorted cylinder). 4. Refer to Theory of Operation & Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
V. POWER BALANCE READINGS ARE UNSTABLE OR NOT REPEATABLE.	1. Verify that power balancing is appropriate for the vehicle being power balanced. Idle Speed Controls must be disabled for this test. 2. The engine's base speed should be steady prior to starting power balancing. If RPM is erratic, repeatability will be affected. Recommend that power balancing be tried at a slightly higher RPM.
VI. UNABLE TO START POWER BALANCE, CYLINDERS ARE NOT SHORTED.	1. Verify that the Primary (-) lead and the Ground lead are connected. 2. With an oscilloscope, verify that the CYL. SHORT* signal is present on pin 7 of J84 on the Analog Scope Board. It will only be present if cylinder shorting is currently being attempted. If the signal is not present; ----------Substitute---------- A. Digital Electronic Board 7001-0604 If the signal is present, ----------SUBSTITUTE---------- A. Analog Scope Board 7001-0609 B. Input Board 7001-0608 3. Refer to Theory of Operation & Functional Diagram.

LIST OF MATERIAL

QTY REQD	PART NO.	DESCRIPTION	ITEM NO.



SYM	DATE	REVISIONS	ECN	APVL

(DO NOT SCALE) TOLERANCES (EXCEPT AS NOTED)

ANGLES ± DECIMALS .XX ± .01, .XXX ± .015, 0 ±

FRACTIONS ±

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake Illinois 60014 U.S.A.

TITLE IGNITION PROCESSOR-
CYLINDER SHORTING
INTERCONNECTION DIAGRAM

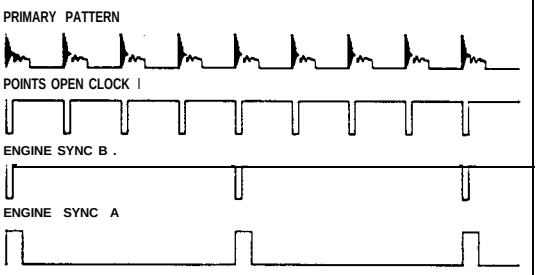
MODEL MEA 1500 / DIAGRAM 3-1

MAT'L AND/OR FINISH

DWG BY P. DORN, 11-16-85 ENG APVL ____/____

CHK BY D. Hunting Jr./____ ENG APVL ____/____

SCALE | SHT 1 OF | DWG SIZE D | DWG NO

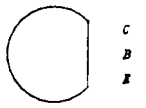


SIGNAL LOCATIONS

PRIMARY	R151
POINTS OPEN CLOCK *	Q7 COLLECTOR
ENGINE SYNC. B*	Q6 COLLECTOR
ENGINE SYNC. A	R205
CYL. SHORT *	R64
TRIAC GATE	D8
SLOW CLOCK	TPI
FAST CLOCK	TP2

POT ADJUSTMENTS

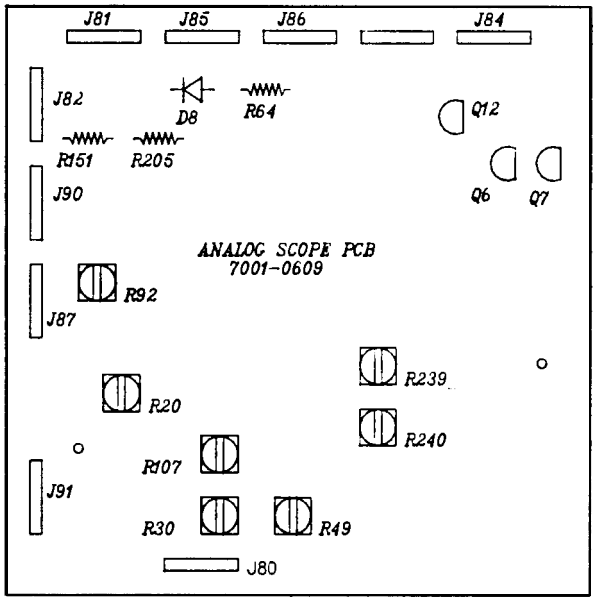
R20	PRIMARY GAIN
R30	RASTER LENGTH (2400)
R49	DISPLAY LENGTH (2400)
R92	MINIMUM BRIGHTNESS
R107	5 ms SWEEP
R239	DISPLAY LENGTH
R240	RASTER LENGTH



DIGITAL PCB 7001-0604 :

OFF	ON
160 HZ VIDEO	50 HZ VIDEO
2 NO 4 GAS	4 GAS INSTALLED
3 NO 2 GAS	2 GAS INSTALLED
4 NO PRINTER	PRINTER INSTALLED
5 NO AMP/VAC	AMPS/VAC INSTALLED
6 VACUUM "hg	VACUUM MILLIBAR
7 NO COIL +	COIL + INSTALLED
8 OPERATOR MODE	SERVICE MODE

CHECK 5 VOLT SUPPLY AT C66



MAG/VOLT/OHM PCB 7001-0606

R37	VOLT BALANCE
R100	100 VOLT ZERO
R101	OHMS ZERO
R102	20 VOLT ZERO
R111	OHMS ADJUST
R131	VOLTS GAIN

AMPS/VAC PCB 7001--0605

R28	VACUUM ZERO
R36	VACUUM GAIN
R42	AMPS GAIN
R43	AMPS ZERO

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A

MODEL: MEA 1500

TITLE: SIGNAL LOCATION AND WAVEFORM IDENTIFICATION

DWG: 3-2

PAGE: 3-11

CHAPTER 4

ANALOG SCOPE

SECTION I. THEORY OF OPERATION

GENERAL

The analog ignition scope of the MEA-1500 tester, which is located on the front left hand side of the tester, is used for displaying primary and secondary ignition waveforms, alternator ripple, and carburetor dwell.

The terms display, raster, superimposed and 5 Millisecond are used throughout this section. These terms refer to the different manner in which the ignition waveforms are displayed on the analog scope. The following four figures show

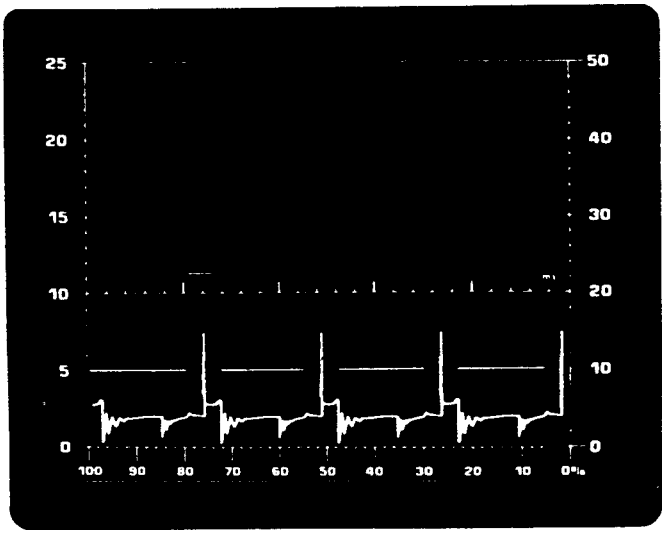


FIGURE 4-1 DISPLAY PATTERN

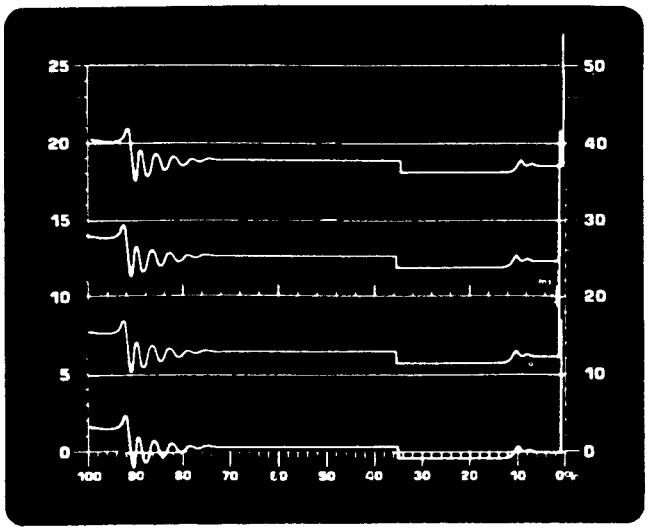


FIGURE 4-2 RASTER PATTERN

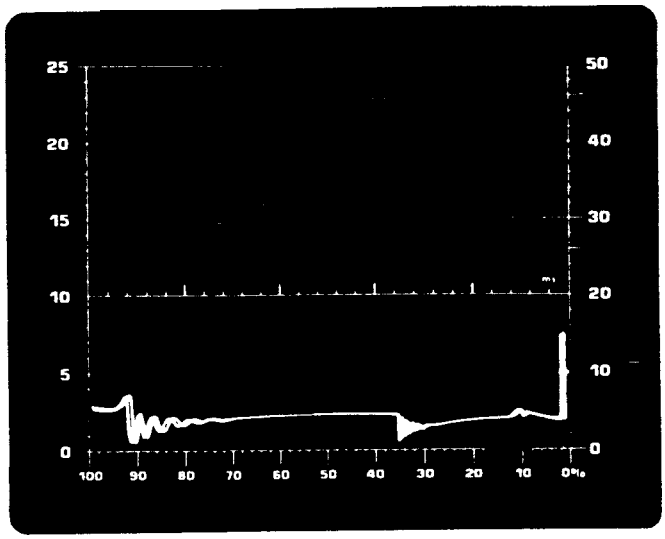


FIGURE 4-3 SUPERIMPOSED PATTERN

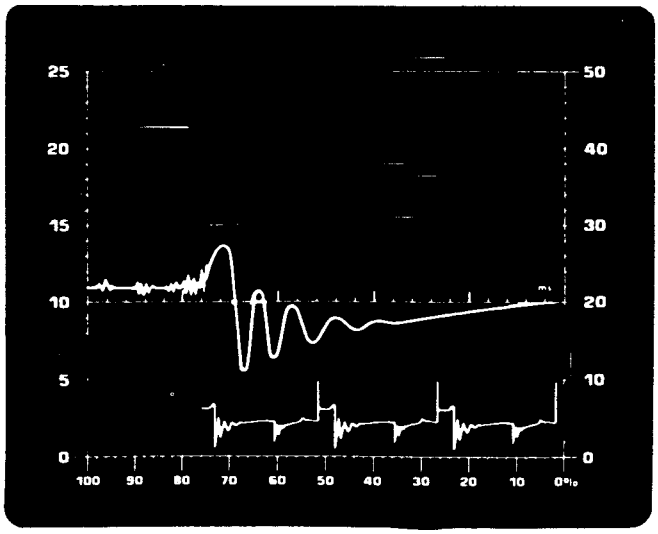


FIGURE 4-4 5 MSEC PATTERN

The analog scope (CRT) requires certain basic biasing voltages for proper operation and a means of deflecting the beam (trace) horizontally & vertically on the CRT. The first part of theory of operation provides these details. The second part deals with the signals that control the waveform (primary, secondary, etc.) that is displayed on the CRT and the manner (display, raster, superimposed) in which it is displayed.

CRT BIASING AND DEFLECTION

NOTE: The following text is used in conjunction with diagram 4-1.

BIASING

The filament, which is powered by 12 volts DC from power supply, heats the CRT's cathode, causing free electrons to be produced. These electrons are attracted away from the cathode by positive voltages on the accelerator grid and CRT face. On their way to the CRT face, the electrons are focused into a fine beam (trace) by the G4 focus grid. The face of the CRT is coated with green phosphor which glows when struck by the electron beam. With no external deflection or blanking, the beam will strike the center of the CRT, causing a bright dot to be produced. The electron beam can be deflected by magnetic means to any point on the CRT screen by the yoke & deflection circuitry.

The Power Supply Board 7001-0611, Analog Scope Board 7001-0609, and the high voltage power supply #7009-1599 are responsible for producing the DC voltages which bias the CRT. The Power Supply board provides +30 volts DC unregulated to power the high voltage power supply, -50 volt DC source (typically will vary +/- 10 volts) to control CRT brightness. The 12 volts DC source for the CRT filament enters the analog Scope Board at pin 7 of J101 and is applied directly to the CRT filament at pins 3 & 4.

The brightness of the trace is determined by the G1 control grid voltage. As the control grid voltage is made more negative with respect to the cathode, the trace becomes dimmer on the CRT face. As the control grid voltage is made less negative, the trace becomes brighter. The actual voltage applied to the control grid of the CRT is determined by a voltage divider primarily consisting of the front panel brightness control and the minimum brightness control (R92) on the Analog Scope board. Normally the control grid voltage will be between -10 & -30 volts DC, with the exact value depending upon the setting of the two controls.

The high voltage supply takes the +33 volts DC and steps it up to +250 Volts. for G2 accelerator grid voltage, and G4 focus grid voltage and to 10.5 KV for the CRT anode voltage.

A dot will be produced in the center of the CRT with these 6 voltages (filament, G1, G2, G4, cathode, and anode) applied to the CRT and no external deflection. The next step is to deflect the beam.

DEFLECTION

The yoke, horizontal & vertical deflection amplifiers cause the beam to be deflected. The yoke contains four separate windings. One pair deflects the trace vertically while the other pair deflects the trace horizontally. One lead of each of the four windings is connected to the +10 volts DC unregulated yoke supply. The deflection boards control the amount of yoke current through each winding by controlling the amount of current which flows through that winding to ground.

With no external deflection, a dot is produced in the center of the CRT. If current is allowed to flow in one winding of the horizontal pair, the beam is deflected from the center to the left. If the current is allowed to flow in the other horizontal winding, the beam is deflected from the center to the right. The same is true for the vertical pair of yoke windings except the beam is deflected up and down from the center of the CRT.

The Horizontal and Vertical Deflection circuits function identically except that the Horizontal Deflection circuit deflects the trace horizontally while the Vertical Deflection circuit deflects the trace vertically. Using discreet differential amplifiers and darlington configured transistors, the horizontal deflection circuit drives the horizontal yoke windings according to the horizontal sweep ramp coming from the Analog Scope board and the Vertical Deflection circuit drives the vertical windings according to the signal from the Analog Scope Board.

TRACE CONTROL

NOTE: The following text is used in conjunction with Diagram 4-2.

At the "heart" of the horizontal deflection circuitry is the slow sweep ramp generator & the fast sweep ramp generator on the Analog Scope Board. The fast sweep ramp generator is used to generate the sweep ramp for the raster & superimpose patterns (beam horizontally swept at a per cylinder rate) and the slow sweep ramp generator is used to generate the sweep ramp of the display pattern (beam horizontally swept once for all cylinders firing).

SLOW SWEEP RAMP (DISPLAY)
The operation of the slow sweep ramp and the display pattern will be discussed first. As shown in figure 4-5, the slow sweep ramp starts at 0 volts (equates to left side of CRT) and linearly increases to +5 volts (equates to right side of CRT) before being reset back to 0 volts to begin ramping up to +5 volts again.

The slow sweep ramp is applied to the sweep selector which routes either the slow sweep ramp or the fast sweep ramp to the output, depending on the selection made by the sweep select logic. If SEL 5 MSEC* and SEL RASTER* are both high, the default is Display (Slow Sweep).

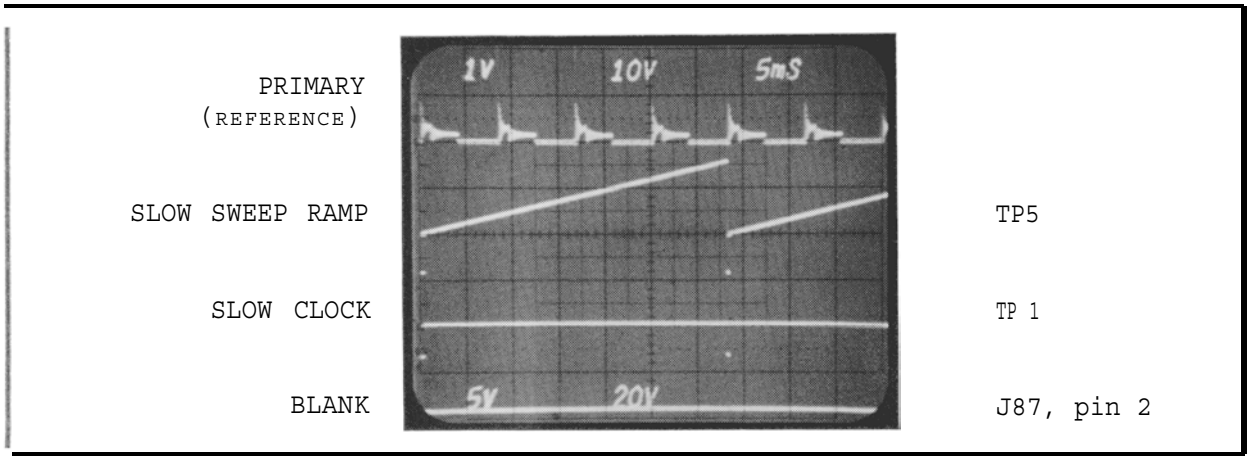


FIGURE 4-5

The HORIZONTAL SWEEP RAMP "A" (in this case slow sweep ramp) signal is routed from the Slow/Fast Sweep Select, to a variable gain buffer. The Length Pot on the front panel adjusts the gain, making the output voltage variable. If the output is adjusted larger, the sweep will go further to the right side of the screen. From the Buffer, the ramp is applied to the 5 MSEC sweep selector which routes either the output from the 5 millisecond generator or the HORIZONTAL SWEEP RAMP "A" signal to the output on Pin 4 of J91.

The HORIZONTAL SWEEP RAMP "B" (in this case slow sweep ramp) signal is routed to the Deflection board where the two horizontal deflection transistors (Q1 & Q2) are driven. With the ramp at 0 volts, Q2 is turned on, current flows through the horizontal winding it is connected to, causing the beam to be deflected to the left side of the CRT. As the ramp increases in the positive direction, Q2 conducts less, causing the beam to sweep towards the middle of the CRT. At approximately +2.5 volts, Q2 quits conducting & Q1 starts to conduct current through its yoke winding. As the sweep ramp voltage increases from +2.5 volts to +5 volts, Q1 conducts more, causing the beam to be swept from the center of the CRT to the right side of the CRT. The point at which Q2 turns OFF and Q1 turns ON is the crossover point. Potentiometer R12 on the Deflection board is adjusted until the crossover point is indistinguishable (no blank spot or bright spot in the horizontal trace).

At this point in time, the beam is on the right side of the CRT (assuming correct calibration of sweep length) and all cylinders have been displayed. The number one cylinder's spark plug fires, generating a SLOW CLOCK signal which is applied to the slow sweep ramp generator , which resets the slow sweep generator back to 0 volts (left side of CRT).

When the slow sweep generator is reset, the voltage goes from +5 to 0 volts very quickly and the trace is deflected from the right side of the CRT to the left side of the CRT (retrace). The beam is blanked during this retrace time to prevent the undesirable retrace line from being shown on the CRT.

BLANKING

The Blanking Logic is responsible for blanking the CRT during the retrace time. Blanking is accomplished by raising the cathode voltage to +12 volts, making the control grid more negative with respect to the cathode, turning the electron beam off.

The Engine Sync Generator outputs SLOW CLOCK (figure 4-5) which is applied to the Blanking logic. During the time that SLOW CLOCK is high, the BLANK* signal is taken low. This low is applied to the base of Q19, turning it on, which pulls the cathode up to +12 volts, thereby blanking the retrace line.

IMPROPER HORIZONTAL DEFLECTION SENSE

The analog scope incorporates protection circuitry which protects the CRT's phosphor from being "burned" by the electron beam sitting in one spot on the CRT face. This type of condition would occur if horizontal deflection (sweep) was lost. The current flowing through the horizontal yoke windings passes through a 1 ohm resistor on its way to ground (shown on diagram 4-2). The Analog Scope board's improper Blanking logic monitors this voltage (HORIZONTAL DEFLECTION SENSE Figure 4-6) to determine if horizontal deflection is present. If the signal is missing, the BLANK signal goes high (active), (resulting in the cathode going positive with respect to the G1 control grid) turning off the electron beam, protecting the CRT phosphor from being burned.

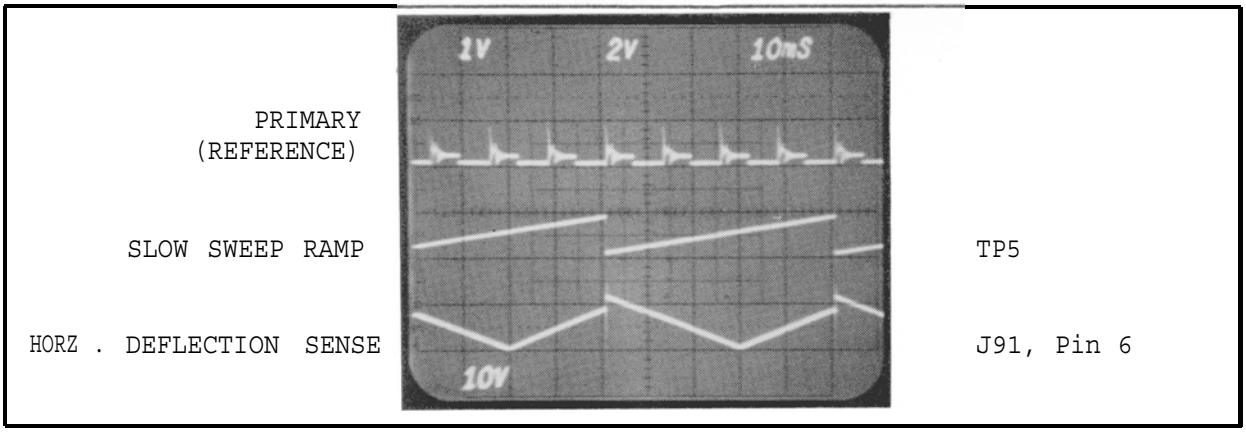


FIGURE 4-6

Now that the beam is being swept horizontally, the pattern that is to be displayed must be applied to the two vertical yoke windings for the beam to be deflected up & down. The Digital Electronic board selects which pattern is to be displayed. Present at the Analog Scope Board's input is the primary ignition pattern (figure 4-7), the engine's alternator output (figure 4-7), and the secondary ignition pattern (figure 4-7) from the secondary pickup.

The pattern that is to be displayed is controlled by the SELECT PRIMARY* (pin 5) and SELECT ALTERNATOR* (pin 6) control lines Digital Electronics Board. If neither of these two are low, Secondary is selected. If either is low that pattern will be displayed.

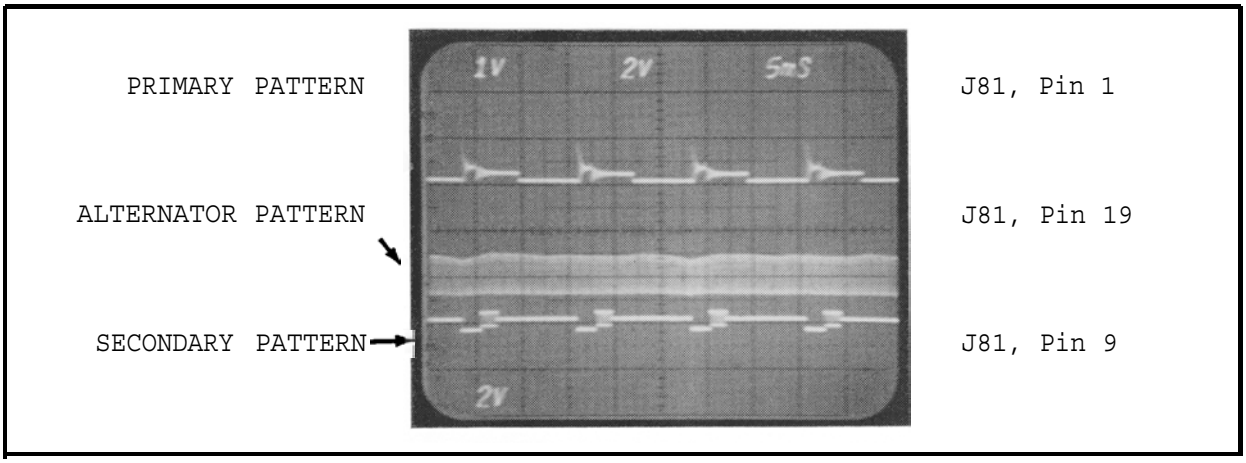


FIGURE 4-7

The signal that was selected, is amplified by the variable gain Vertical Buffer and then routed to the Deflection board which drives the two vertical deflection output transistors (Q13 & Q14), who in turn control the current in the vertical yoke windings, deflecting the beam vertically. Potentiometer R60 adjusts for crossover distortion. The vertical amplifier's crossover point (Q13 turning off & Q14 turning on) will be in the middle of the screen (vertically).

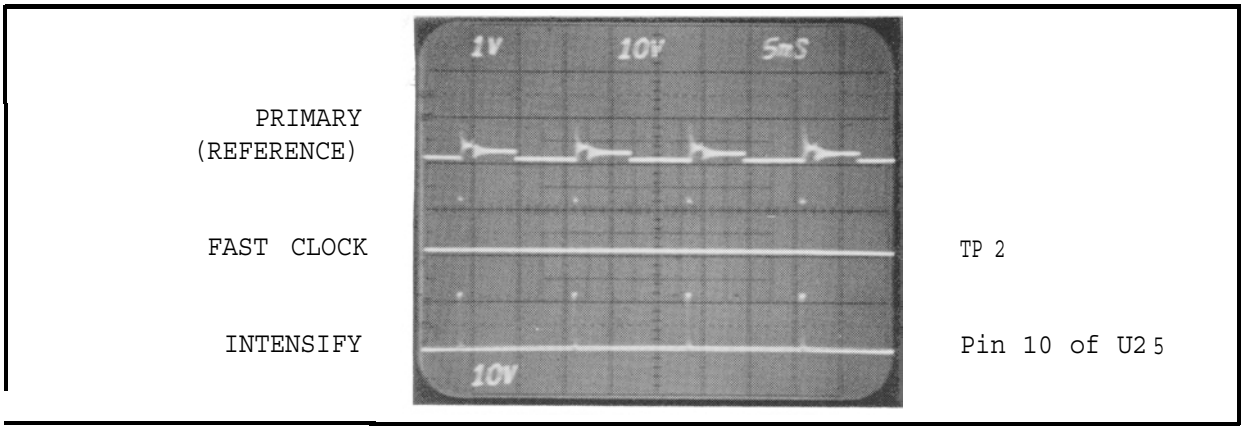


FIGURE 4-8

SECONDARY INTENSIFY

The secondary pattern has each firing line intensified (made brighter) to make it "stand out" from the remainder of the pattern. The intensification is the result of the secondary short store processor. The circuitry, when triggered by the active (rising edge) of FAST CLOCK applies a short positive pulse to the G1 control grid of the analog scope. During the duration of the pulse the grid is less negative with respect to the cathode causing the trace to increase in brightness (see figure 4-8).

FAST SWEEP RAMP (RASTER & SUPERIMPOSED)

Note: The following text assumes the reader has read the above text concerning the operation of the slow sweep ramp, deflection and blanking.

As shown in figure 4-9, the FAST SWEEP ramp starts at O volts (left side of CRT) and linearly increases to +5 volts (right side of CRT) before being reset to O volts. As shown, the sweep is being reset on a per cylinder basis.

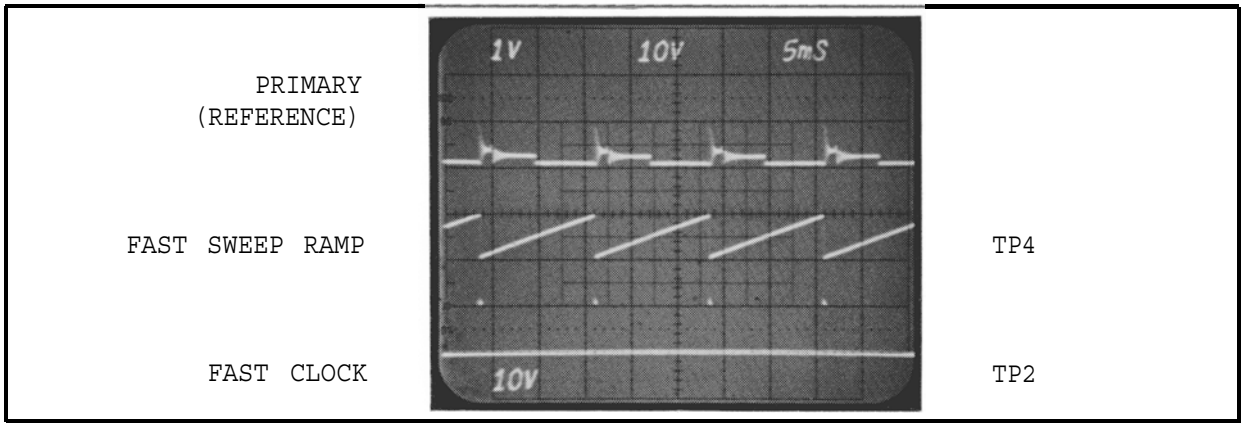


FIGURE 4-9

When in raster or superimposed the trace is swept across the CRT by the fast sweep ramp. Therefore, SELECT RASTER* (pin 7 of J86) on the Analog Scope board will be taken low by the Digital Electronic Board, routing the FAST SWEEP RAMP to the Buffer. From this point the operation of FAST SWEEP RAMP and SLOW SWEEP RAMP is the same as it applies to deflection. Blanking & resetting of the FAST SWEEP RAMP is different, since it happens on a per cylinder basis instead of once for all cylinders firing (distributor revolution).

RESETTING THE FAST SWEEP RAMP
The resetting of the FAST SWEEP RAMP is initiated by the FAST CLOCK signal which is routed to the Fast Sweep Ramp Generator where it resets the ramp to 0 volts (left side of CRT).

BLANKING THE RETRACE OF FAST SWEEP RAMP (RASTER & SUPERIMPOSED)
The FAST CLOCK (figure 4-9) signal from the OR gate is applied to the Blanking Logic. During the time that FAST Clock is high, the BLANK signal is taken high. From here blanking is accomplished the same as described in Slow Sweep Blanking.

SWEEP LENGTH CORRECTION
The sweep length correction circuitry on the Sweep board varies the input voltage to the slow and fast sweep ramp generators to maintain a constant (fixed) sweep length as the RPM varies. As the RPM increases, the period (time between firing lines) decreases.

The computer sets the output of a precision voltage divider with the SELECT 1, 2, 4, and 8 CYL* lines. (For a 6 CYL engine SELECT 2 & 4 CYL will go high) This can be thought of as a coarse setting. The frequency of the FAST CLOCK signal is converted to a voltage and applied to the precision voltage divider, whose output is applied to the sweep ramp generators. The length of the sweep ramp is now varied depending upon the voltage applied to it from the constant sweep length circuit.

NUMBER OF CYLINDERS	CONTROL LINES 8CYL	4CYL	2CYL	1CYL
12 CYLINDER	LOW	LOW	HIGH	HIGH
8 CYLINDER	LOW	HIGH	HIGH	HIGH
6 CYLINDER	HIGH	LOW	LOW	HIGH
5 CYLINDER	HIGH	LOW	HIGH	LOW
4 CYLINDER	HIGH	LOW	HIGH	HIGH
3 CYLINDER	HIGH	HIGH	LOW	LOW
2 CYLINDER	HIGH	HIGH	LOW	HIGH

TABLE 4-1 CYLINDER CONTROL LINE CONFIGURATION

COMPARE
Often times it is desirable to look at a particular cylinder's waveform close up. To do this, a number is pressed in the running test page and the cylinder of interest moves from the display pattern and appears in the middle of the CRT (See figure 4-10).

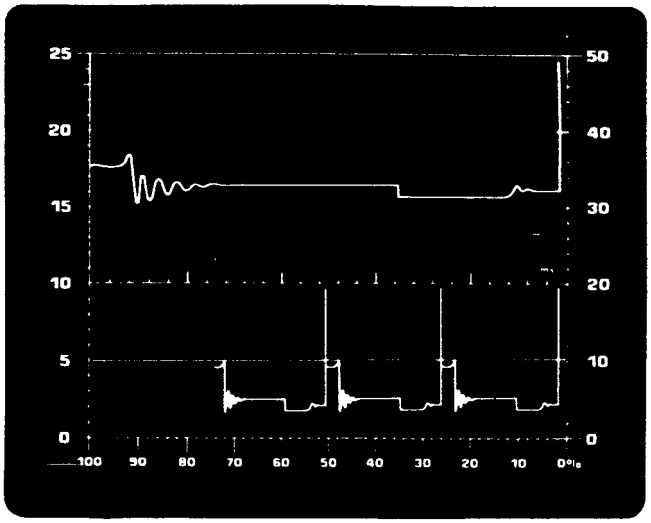


FIGURE 4-10

The COMPARED CYLINDER* signal (figure 4-11) from the Digital Electronics board is routed to the Vertical Buffer and controls which cylinder's waveform is moved up to the middle (midline) of the CRT. As shown in figure 4-11, the COMPARED CYLINDER* signal goes high from approximately points close of the cylinder that is going to be placed at midline to points close of the next cylinder. Additionally, COMPARED CYLINDER* is routed to the Sweep Select Logic to select FAST SWEEP RAMP. With the FAST SWEEP RAMP selected, the compared cylinder is displayed on a per cylinder basis at the midline of the CRT .

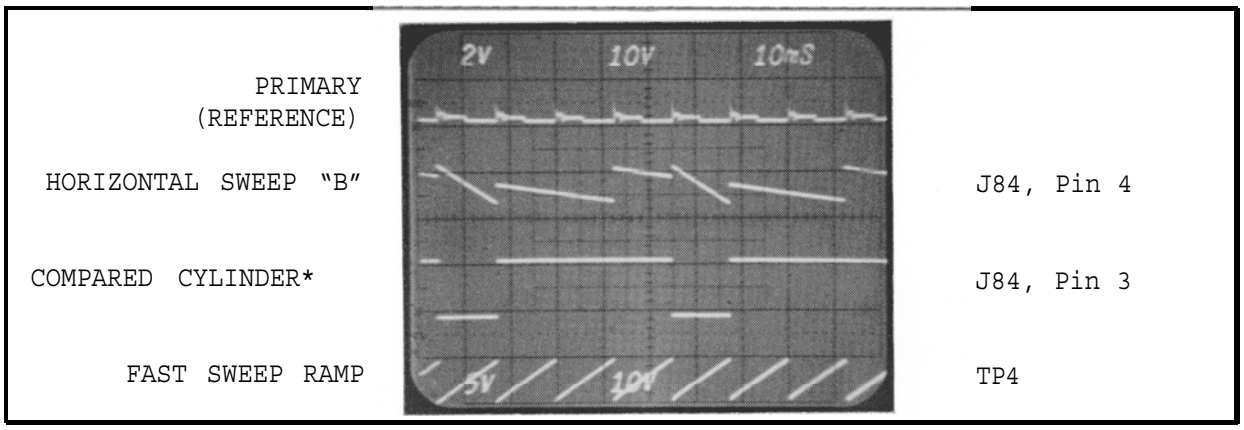


FIGURE 4-11

Figure 4-12 shows the blanking signal and the resulting horizontal deflection sense signals. Notice that the blanking signal blanks (is high) the beam's trace to and from the midline of the CRT.

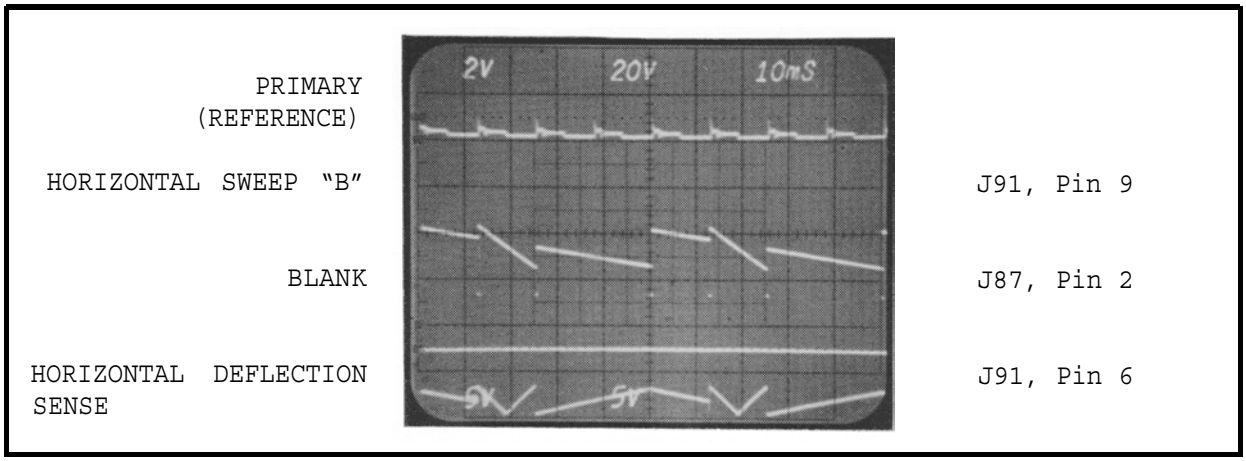


FIGURE 4-12

MASTER AND SUPERIMPOSED

As shown in figure 4-2, in the raster mode the cylinders are swept on a per cylinder basis and they are "stepped up" the CRT. The horizontal sweep is a result of the FAST SWEEP RAMP being used & the "stepping up" is a function of the raster generator. The raster generator applies a small "offset" voltage, in steps, to the Vertical Buffer, causing each cylinder's waveform to be shown above the last cylinder's waveform (figure 4-13).

This stepping action continues until the SLOW CLOCK signal (figure 4-13) resets the raster generator and the raster pattern back to the bottom of the CRT . The SLOW CLOCK signal occurs once per distributor revolution, therefore, the proper number of steps (number of cylinders) is insured.

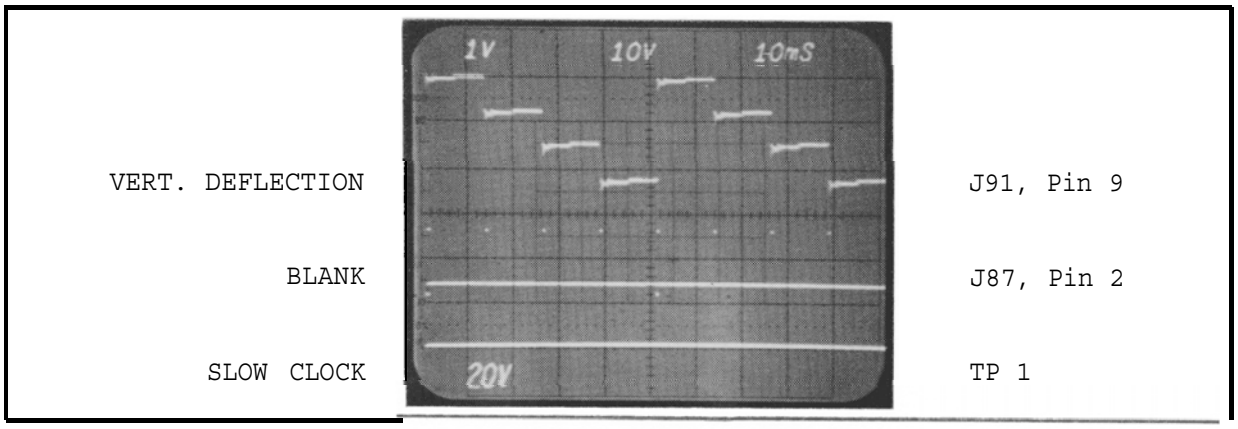


FIGURE 4-13

The BLANK* signal is used to increment the raster generator. Every time the retrace line is blanked, the raster generator is incremented to the next step voltage. The raster spacing control on the front panel is used to vary the amount of voltage between steps, thereby varying the distance between each cylinder's waveform shown on the CRT. The SELECT RASTER* control line is used to route the output of the raster generator through a FET switch (not shown on the diagram) to the input of the output amplifier. The RASTER GENERATOR is always generating the step voltage. The switch merely routes it to the input of the output amplifier.

When in superimposed mode (figure 4-3), a FET switch which applies the RASTER SPACING signal, is opened. This merely displays a Raster pattern, with no space between the cylinders.

5 MILLISECONDS (GENERAL)

The 5 millisecond sweep ramp generator is located on the Analog Scope Board. Whenever SEL 5 MSEC* goes low the 5 msec sweep is selected. In the 5 msec sweep mode, the cylinder selected is displayed at mid-screen, sweeping one time across the screen every 5 milliseconds. The only input into the 5 msec sweep generator is FAST CLK, which is used to trigger the beginning of the sweep.

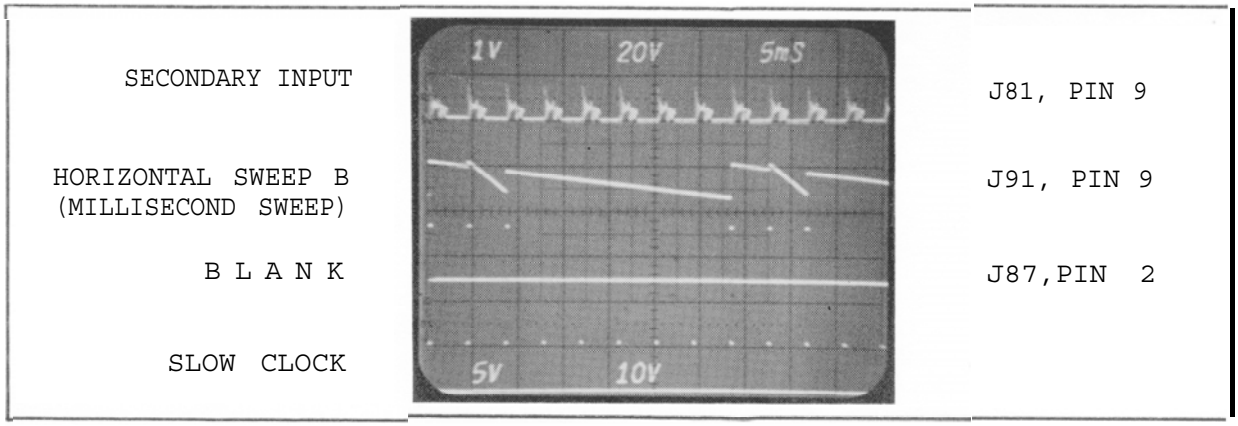


FIGURE 4-14 8 CYLINDER, 1200 RPM

The HORIZONTAL SWEEP "B" ramp is output to the Deflection board. Refer to Figure 4-14. Notice that the sweep ramp sweeps for a fixed 5 milliseconds (o to -5 volts), resets to 0 volts (the left side of the CRT), is blanked by the BLANK signal (portion of the third channel when it is high) and then starts slow sweeping again when the next trigger (firing line) occurs. Figure 4-15 shows the resulting display on the CRT.

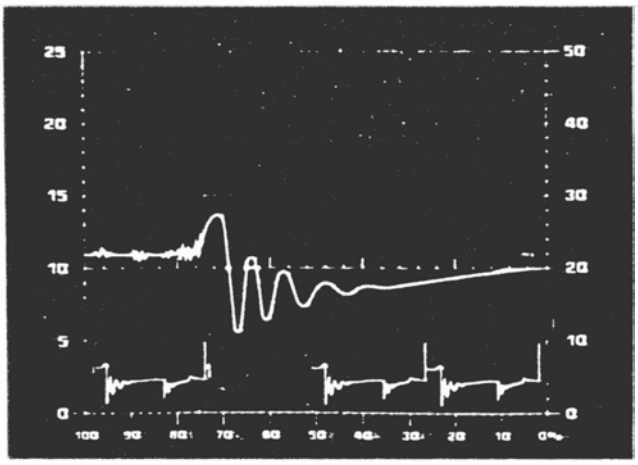


FIGURE 4-15
5 MSEC PATTERN AT 1200 RPM

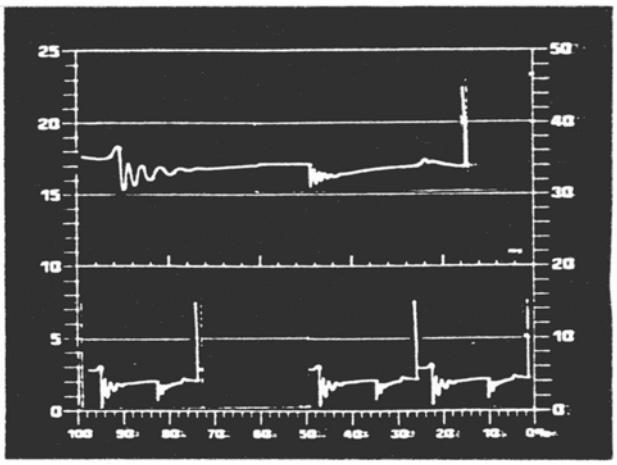


FIGURE 4-16
5 MSEC PATTERN AT 3600 RPM

As was shown in figure 4-15, the 5 millisecond sweep generator swept the full 25 milliseconds and was blanked until the next trigger occurred. In figure 4-16 the opposite condition exists. The sweep generator does not have time to sweep 5 milliseconds before the next trigger pulse occurs. As shown, the sweep ramp makes it to 4 milliseconds and is reset by the next trigger pulse. Figure 4-17 shows the resulting CRT display.

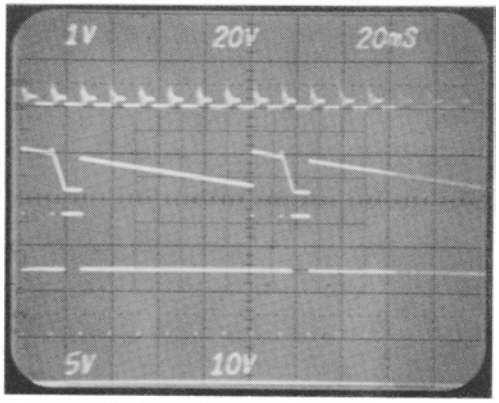
SECONDARY INPUT		J81, Pin 9
HORIZONTAL SWEEP B (MILLISECOND SWEEP)		J91, Pin 9
BLANK		J87, Pin 2
FAST CLOCK		TP2

FIGURE 4-17 8 CYLINDER, 3600 RPM

SECTION II. MEA-1500 with PIN-POINT LAB SCOPE CAPABILITIES

GENERAL

The PIN-POINT LAB SCOPE, adds a new dimension of testing capability for MEA owners. The PIN-POINT LAB SCOPE function adds a separate pin-point test mode with its own 5ms, 25ms and 100ms time sweep rates along with 5V, 25V and 50v vertical scales. All Pin-point Lab Scope settings appear on the MEA's monitor, and are entirely remote controlled.

This new function can be used to check a variety of input and output signals from electronic systems such as injector pulse widths and oxygen sensor waveforms. The Pin-point Lab Scope function is much like that of the Tektronix oscilloscope most of you carry in your service vehicle. Besides viewing the signal's waveform, the duty cycle and frequency of the incoming signal is displayed on the digital monitor where the dwell information is usually displayed.

WHAT IS REQUIRED

For any MEA-1500 to have Pin-point Lab Scope Capabilities, it must have a #7001-2004 Analog Scope Board and contain REV. 7.0 or greater firmware (U30 & U31) on the Digital Electronics Board. Other modifications may be required depending on the REV. level of other boards. The next few paragraphs outline which units have Pin-point Lab Scope Capabilities or what can be done to upgrade those that don't have this feature.

MEA-1500 Serial A units are not factory equipped with Pin-point Lab Scope capabilities. Serial A units can be upgraded with the Pin-point Lab Scope feature by installing Kit #1091-0031-02.

With MEA-1500 Serial B units, the Pin-point Lab Scope feature is installed at the factory as standard equipment.

On some MEA-1500 MB units, the Pin-point Lab Scope feature is standard equipment. However, early production of MEA-1500 MB units did not come with the Pin-point Lab Scope as standard equipment. These units can be upgraded by installing Kit #1091-0031-01

HOW TO USE THIS SECTION

This section deals only with the Pin-Point Lab Scope and its operation. For information about CRT Biasing, Deflection and Basic Ignition Scope operation, refer to Section I. However, the Checkout/Calibration and Troubleshooting sections are written to cover all types of MEA-1500s, with Pin-point Lab Scope or without Pin-point Lab Scope.

HOW TO ACCESS THE PIN-POINT LAB SCOPE MODE

NOTE : Remember to bring up the Pin-point mode the MEA must have Pin-point Lab Scope capabilities. Along with having this option enabled. To do this, switch #6 of SW1 of the DEB Board must be "ON") before powering up the MEA. Otherwise the MEA will not recognize the key selections to enter the Pin-Point Scope mode.

HOW TO ACCESS THE PIN-POINT LAB SCOPE MODE (continued)
To access the Pin-Point Lab Scope mode, press twice on the MEA's Remote Control "SPECIAL" key. You will notice that at the bottom of the MEA's Digital monitor that the Pin-Point Lab Scope parameters are displayed (see Figure 4-18) along with the DWELL line format being changed from:

"DWELL XXX.X % XXX.X DEG"
TO
"SPECIAL XXX.X % XXX.X HZ"

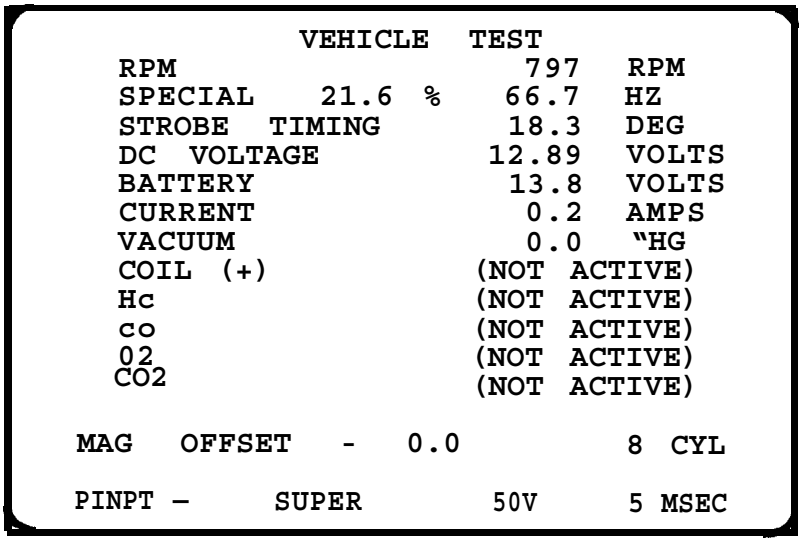


Figure 4-18. Digital Monitor page when in Pin-Point Lab Scope Mode.

If the frequency of the Pin-Point Scope signal exceeds 999 Hertz the MEA's digital display will show the frequency as "999 Hertz *"

Once in the Pin-Point Scope mode the scope is forced into the Raster Superimposed mode down towards the bottom of the CRT. The bottom line of the VDU will display information about the Pin-Point Scope mode such as vertical volt scale, time base scale and trigger mode.

NOTE : The line containing information about the Pin-Point Lab Scope parameters will only be displayed for 8 seconds before being removed from the screen. However selecting either the "DISPLAY" key or the "12 +/-" key will cause this information to be displayed for another 8 seconds.

SPECIAL: PIN-POINT SCOPE MODE FUNCTIONS

This section will list each of the Function Keys and the operation they do. To control the settings of the MEA's Pin-point Lab Scope, the MEA's Remote Control Assembly is used. By pressing certain selections on the keypad, different modes can be selected such as sweep length (5 ms, 25 ms and 100 ms) and vertical voltage scaling (5V, 25V and 50V). To see which keypad selections control the different modes see Figure 4-19 on the next page.

PINPOINT TEST MODE CONTROL

FUNCTION	KEY	SELECTIONS	NOTES
Select Pinpoint Test Mode	SPECIAL	1) Twice To Enter 2) Once To Exit	In the normal SUPERIMPOSED Mode, if the time between adjacent signals is less than 5 MSEC, multiple patterns will appear on the scope similar to DISPLAY Mode.
Select Vertical Scales	SCALE	5V 25V 50V	Trigger Voltage Threshold Minimums: 1v 5v 10v
Select Horizontal Sweep Rate	MSEC	5 MSEC 25 MSEC 100 MSEC	In the MSEC Mode, a full time period will be shown regardless of the number of pulses which may appear during that time,
Select Trigger Polarity	12 +/-	+: Amplitude or signal rising edge -: Decline or signal falling edge	The scope will not trigger on signals below O volts unless the polarity switch, on the rear of unit, is put in the Positive position; or the VOLT-OHM leads are reversed.

Figure 4-19. Pin-point Lab Scope Pinpoint Test Mode Controls.

SPECIAL: PIN-POINT SCOPE MODE FUNCTIONS (continued)

The SCALE key of the MEA' s remote is used to change the vertical volt scale sequentially from 5 Volts to 25 Volts to 50 volts. Each vertical volt scale has it own minimum trigger level they are as follows:

5 Volt Scale	1 volt Minimum Trigger
25 Volt Scale	5 volt Minimum Trigger
50 Volt Scale	10 volt Minimum Trigger

If the incoming signal does not exceed the minimum trigger level the scope will not trigger the sweep of the pattern across the face of the CRT.

The MSEC key is used to change the horizontal time base scale sequentially from 5 ms to 25 ms to 100 ms and then to NORMAL. The NORMAL time base is governed by the frequency of the incoming signal and is used to display one event based on the triggering value.

The SELECT TRIGGER POLARITY key is used to select which edge (rising or falling) the Pin-point Scope will begin to trace its pattern on the CRT. The "+" marking on the Digital Monitor indicates rising edge and the "-" marking indicates falling edge.

The Pin-point Lab Scope will not trigger on signals which stay below 0 Volts, unless the Vehicle Polarity Switch (located on the rear of the MEA's Power Supply Drawer) is placed in the POSITIVE position or by reversing the placement of the pinpoint leads.

THEORY OF OPERATION

The Theory of operation section is divided into two separate sections; one covering ANALOG PROCESSING and the other covering the DIGITAL CONTROL SIGNALS. The ANALOG PROCESSING section is about how the voltage, present on the MEA's pin-point volt/ohm leads, is processed by the MEA to produce the pattern on the ignition scope. The DIGITAL CONTROL SIGNALS section pertains to controls signals generated by the Digital Electronics Board to control pin-point lab scope. With all section of the PIN-POINT Scope mode refer to the Functional Block Diagram page 4-33/4-34.

ANALOG PROCESSING

The signal waveform that is displayed in the Pin-point Lab Scope mode is picked up using the MEA's existing flying Volt/Ohm leads. The signal is routed to the Input Filter Board where any common mode noise (noise common to both the + and - leads) is filtered out. After being filtered, the voltage signal is routed to the Mag/Volt/Ohm Board, where it is applied to the Floating Volt/Ohm processor. Here the signal is processed independently of chassis ground, to prevent any ground conflicts between the tester's earth ground and vehicle ground from the Black Battery lead and the Negative (Black) Volt/Ohm lead. From here the volt signal is applied to the 100 VOLT GAIN and GROUND ADJUSTER BLOCK; used for scaling, calibration and referencing the signal to chassis ground. The output of this block is called 100V ANALOG and is sent to the Digital Electronics Board at J100 Pin 11.

NOTE: The Floating Volt/Ohm Processor has an input impedance of 10 Megaohms, to prevent the loading of the circuit under test. This is required by many automobile manufacturers for testing of their Electronic Engine Control Systems.

On the Digital Electronics Board the 100V ANALOG signal has two paths. One going to the MUX A/D convertor, where it is converted from analog to digital for display on the MEA's VDU as the volt reading. The other path sends the 100V ANALOG signal to J84 pin 11 the ANALOG SCOPE BOARD, 7001-2004.

Once on the Analog Scope Board, the 100V ANALOG signal enters the PIN-POINT GAIN BLOCK. The PIN-POINT GAIN BLOCK is responsible for amplifying the 100V ANALOG signal for the correct scale set by the Digital Electronics Board (see Digital Control signals, page 4-16). The PIN-POINT GAIN BLOCK is also used to calibrate the Pin-point Lab Scope's vertical scale. The output of the of PIN-POINT GAIN BLOCK is called SPECIAL ANALOG.

The SPECIAL ANALOG signal branches off into two different paths. One path goes to the PRI/SPEC PATTERN SELECT LOGIC BLOCK. The PRI/SPEC PATTERN SELECT LOGIC BLOCK is used to select whether the Primary or Special signal is sent to the PATTERN SELECT BLOCK. The output of the PATTERN SELECT BLOCK is used to drive the vertical deflection circuit.

The second path of the SPECIAL ANALOG signal is routed to a threshold detector. If the amplitude of the SPECIAL ANALOG signal is greater than the threshold detector's trigger level setting, it is sent to the SPECIAL CLOCK PROCESSOR BLOCK. The trigger level setting of the threshold detector is set by the same signals that control the Pin-point gain block's gain control signals, see digital control signals page 4-16. If the threshold detector's trigger level setting are not met or exceeded the pattern will mistrigger. In the SPECIAL CLOCK PROCESSOR BLOCK the SPECIAL ANALOG signal is squared up into a digital pulse and sent to the PRI/SPEC CLOCK SELECT LOGIC BLOCK.

The PRI/SPEC CLOCK SELECT LOGIC BLOCK selects if either PRIMARY or SPECIAL CLOCK will be its output based on the state of DEB Board's control signals (DISPLAY O* and DISPLAY 1* , see Table 4-2 Digital Controls). The output of the PRI/SPEC CLOCK SELECT LOGIC BLOCK is used to calculate either DWELL (if PRIMARY CLOCK is its output) or DUTY CYCLE and FREQUENCY (if the SPECIAL CLOCK is its output). This calculation is done on the MEA's DEB Board for display on the MEA's VDU.

ANALOG PROCESSING (continued)

The output of the PRI/SPEC CLOCK SELECT LOGIC BLOCK is also used as FAST CLOCK. FAST CLOCK is used to start the beginning of a trace, by resetting the horizontal deflection circuit's ramp generator(s). Depending on what mode the MEA is in, see Section I.

DIGITAL CONTROL SIGNALS

The MEA's DEB Board is responsible for the control of the Analog Scope Board. This is accomplished by the microprocessor's use of an output port which sends control signals to the MEA's Analog Scope Board. Listed below are the names of these control signals and a brief explanation of their function and how it relates to the MEA's Pin-point Lab Scope option.

The control lines DISPLAY O* and DISPLAY 1* are used to select which analog input with be sent to the VERTICAL DEFLECTION circuitry. See Table 4-2 below for what states of these two control signals cause what analog signal to be used for vertical deflection.

INPUTS		
J108 pin6	J108 pin 5	
DISPLAY O*	DISPLAY 1*	VERTICAL OUTPUT USED
LOW	LOW	SECONDARY
LOW	HIGH	PRIMARY
HIGH	LOW	ALTERNATOR
HIGH	HIGH	SPECIAL or VOLTS

TABLE 4-2 DIGITAL CONTROL SIGNALS FOR VERTICAL OUTPUT.

+ TRIGGER SLOPE*

The + TRIGGER SLOPE* control line is an output of the DEB Board, on J109 pin 15. This signal controls which edge (rising or falling) of the Pin-Point Scope signal that the scope will be triggered on. When the signal is high, the scope will trigger on the signal's falling edge or - TRIGGER SLOPE. When the signal is low, the scope will trigger off the signal's rising edge or + TRIGGER SLOPE. This is done by taking the FAST CLOCK output of the PRIMARY/SPECIAL CLOCK SELECT LOGIC and apply to an Exclusive Or gate along with the + TRIGGER SLOPE* to start/reset the millisecond ramp generators.

MILLISEC SELECT & 25 MS/100 MS*

The MILLISEC SELECT and 25 MS/100 MS* control lines inform the Analog Scope Board whether to use the Programmable millisecond sweep generators or that of the engine dependent slow or fast sweep generators.

To better understand of how, both the MILLISEC SELECT and 25 MS/100 MS* lines are used to select which time ramp generators are used for Horizontal sweep see table 4-3 on the next page.

INPUTS		
25 MS/100 MS*	MILLISEC SELECT	TIME BASE RAMP USED
J109 pin 14	J108 pin 10	
LOW	LOW	ENG DEPENDENT
LOW	HIGH	5 ms sweep
HIGH	LOW	25 ms sweep
HIGH	HIGH	100 ms sweep

TABLE 4-3. TIME BASE RAMPS USED.

SELECT SPECIAL LOW*

The SELECT SPECIAL LOW* control line is used for setting the Pin-point Lab scope's vertical voltage scale to 5 volts by altering the gain of the PIN-POINT GAIN BLOCK. This along with the SELECT HIGH SCALE* control signal alters the gain of the PIN-POINT GAIN BLOCK to produce the 50 volt and 25 volt vertical voltage scales for the Pin-point Lab Scope, see table 4-4 below.

INPUTS FROM DEB TO PIN-POINT GAIN BLOCK		
J109 pin 17	J108 PIN 9	
SELECT SPECIAL LOW*	SELECT HIGH SCALE*	VERTICAL VOLT SCALE
LOW	LOW	25V
LOW	HIGH	50V
HIGH	LOW	5V

TABLE 4-4. VOLT SCALE SELECTION

SECTION III. ANALOG SCOPE CHECKOUT/CALIBRATION

REQUIRED EQUIPMENT: Calibration screwdriver #OOOl-0033 or equivalent IS-1OOA Ignition Simulator

NOTE:The analog scope checkout/calibration procedure consists of 6 separate checkout/calibration procedures. They can be performed sequentially for a complete checkout/calibration of the analog scope or any one out of the six can be performed individually. In all calibrations, an all CAPITOL BOLD letter pot description can be matched to the POT DESCRIPTION/LOCATION Diagram on the pull-out attached to the next page.

PRELIMINARY SETUP:

1. Turn tester "ON" and allow "Self Calibration" to complete.

2. Connect the tester leads to the IS- 1 OOA as follows:
   A. Place the red trigger pickup around the IS-1OOA trigger loop.
   B. Connect the blue secondary pattern lead to the calibrated secondary output of the IS-l OOA.
   C. Connect the primary lead (blue boot) to the negative side of the coil.
   D. Connect the red and black battery leads to 13 volts.
   E. Connect the green clamp around the current loop.

3. Set IS-l OOA as follows:
   A. 8 cylinder
   B. 1800 RPM
   C. Delta KV to the "OFF" position
   D. Spark Line Slope to the "OFF" position
   E. Ripple to the "OFF" position

4. Remove the two screws retaining the front C.C.A. drawer, and pull it open.

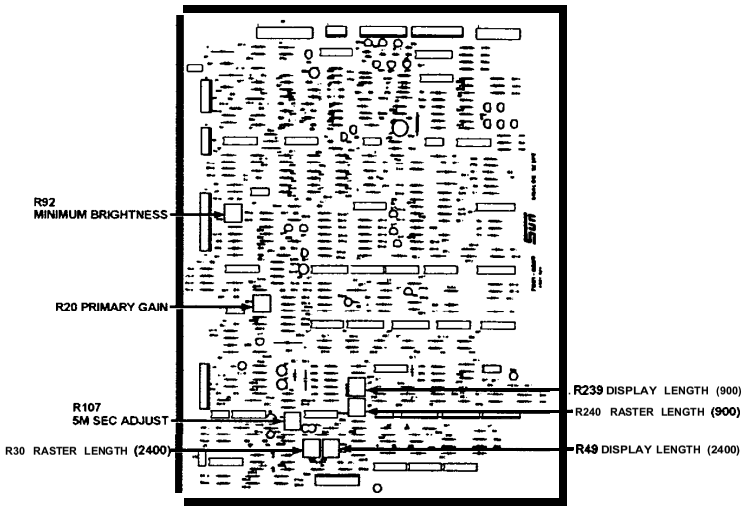
5. After the tester calibration is complete, using the remote, set the tester up as follows:
   A. Press "MENU" and select Number 1 (Vehicle Setup)
   B. Enter 8 cylinders
   C. Enter 4 cycle.
   D. Enter 0.0 timing offset

6. Press Cont. and select Number 2 on the remote (Vehicle Test).

   A. Press ESC
   B. Press HI/LO selection on the remote tester to display "25KV" on the bottom of the digital screen.
   C. Press RASTER to be displayed in the same manner.

7 Turn the IS-1OOA "power" and "ignition" switches to the "ON" position.

POT DESCRIPTION / LOCATION DIAGRAM



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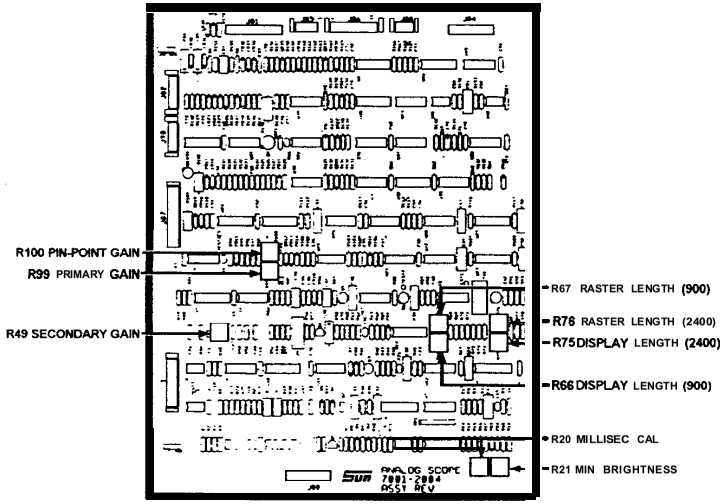

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MINIMUM BRIGHTNESS CHECKOUT AND CALIBRATION

PROCEED TO STEP 1 IF YOU HAVE ALREADY PERFORMED THE PRELIMINARY SETUP, IF NOT, PERFORM THE PRELIMINARY SETUP (PAGE 4-17) BEFORE PROCEEDING.

1. Turn IS-1OOA power "OFF".

2. Adjust the pattern VERTICALLY to be on the 0 KV line and HORIZONTALLY between the uprights.

3. Turn the front panel brightness control (☼) fully counterclockwise.

NOTE: In the following step the brightness of the trace is adjusted. You may not be able to obtain a dim trace as step 4 directs. If this is the case, adjust MINIMUM BRIGHTNESS to give a sharp trace without "blooming" when the front panel brightness pot is adjusted over its range.

4. The trace should be dim but visible, if not, adjust MINIMUM BRIGHTNESS on the Analog Scope Board until a dim but visible pattern is seen on the CRT.

5. Go to step 1 of "Trace Rotation" if you are doing a complete checkout/calibration, otherwise go to step 1 of the procedure you wish to perform.

****
*** CHECK OUT / CALIBRATION COMPLETE ***
****

TRACE ROTATION

PROCEED TO STEP 1 IF YOU HAVE ALREADY PERFORMED THE PRELIMINARY SETUP, IF NOT, PERFORM THE PRELIMINARY SETUP (PAGE 4-17) BEFORE PROCEEDING.

1. Using the front panel vertical position control (I), adjust the trace to the zero line of the CRT.

2. The trace should be level (not noticeable slanted), if not, loose the yoke on the rear of the CRT and rotate the yoke until the trace is level. Retighten the yoke and verify the trace is level.

3. Go to step 1 of "Crossover" if you are doing a complete checkout / calibration, otherwise go to step 1 of the procedure you wish to perform.

****
*** CHECK OUT / CALIBRATION COMPLETE ***
****

VERTICAL AND HORIZONTAL CROSSOVER DISTORTION CHECKOUT/ CALIBRATION

PROCEED TO STEP 1 IF YOU HAVE ALREADY PERFORMED THE PRELIMINARY SETUP, IF NOT, PERFORM THE PRELIMINARY SETUP (PAGE 4-17) BEFORE PROCEEDING.

NOTE : If an adjustment is necessary you must remove the tester's back panel.

1. There should be no distortion (bright spot or gap) in the horizontal center of the pattern. If there is distortion, adjust R12 (crossover distortion adjust) on the Deflection board (located inside the side panel) to eliminate the distortion.

2. Turn IS-100A power to"ON".

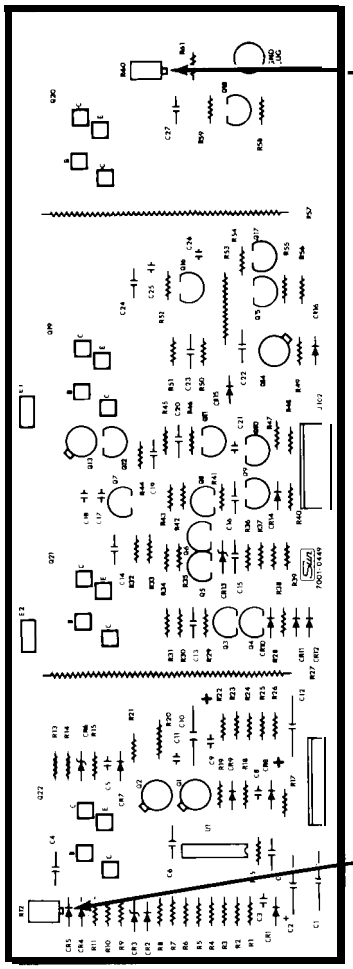
3. Turn the front panel raster spacing control ( ) counterclockwise until the raster lines are about 1/4" apart from each other.

4. Turn the front panel vertical control ( ) so the raster pattern is in the center of the CRT.

5. There should be no distortion in the vertical center of the CRT. If there is distortion, adjust R60 (crossover distortion) on the Deflection Board until it is eliminated.

6. Turn IS-100A Power to "OFF".

7. Go to step 1 of "Sweep Length" if you are doing a complete checkout/ calibration, otherwise go to step 1 of the procedure you wish to perform.



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*** CHECKOUT/CALIBRATION COMPLETE ***

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SWEEP LENGTH CHECKOUT/ CALIBRATION

PROCEED TO STEP 1 IF YOU HAVE ALREADY PERFORMED THE PRELIMINARY SETUP, IF NOT, PREFORM THE PRELIMINARY SETUP (PAGE 4-17) BEFORE PROCEEDING.

1. Turn the simulator's "RPM" switch to the 1200 RPM position and turn the POWER and IGNITION "ON".

2. Adjust the front panel length ( )& horizontal ( ) position controls until the trace is aligned between the vertical uprights and at the O KV line.

3. Press Display then number 2 on the remote to display a compared cylinder.

4. Turn the simulator's "RPM" switch to the 2400 RPM position.

5. If there is more than 1/4" change in the length of the display pattern, adjust **RASTER LENGTH (2400)** on the Analog Scope Board until the compared cylinder firing line aligns with the right upright.

6. Adjust **DISPLAY LENGTH (2400)** until the end of the display pattern aligns with the right upright.

7* Turn the simulator's "RPM" switch to the 600 RPM position and "Cylinder Select" to 4 Cyl.

8. Press Menu on the testers remote and select number 1 (Vehicle Setup), then enter 4 cyl., then press cont. to return back to the main menu, then press number 2 (Engine Test) then Number 2 on the remote to display a compared cylinder.

9. If there is more than 1/4" change in the length of the sweep, adjust **DISPLAY LENGTH (900)** on the Analog Scope Board the display pattern is aligned with the right upright.

10. Adjust RASTER LENGTH (900) on the Analog Scope Board until the compared cylinder firing line aligns with the right upright.

11. Repeat steps 1-9 until the sweep length changes less than 1/4".

12. Go to step 1 of the procedure you wish to perform.

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*** CHECKOUT/CALIBRATION COMPLETE ***

* *

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VERTICAL CHECKOUT/ CALIBRATION

PROCEED TO STEP 1 IF YOU HAVE ALREADY PERFORMED THE PRELIMINARY SETUP, IF NOT, PERFORM THE PRELIMINARY SETUP (PAGE 4-17) BEFORE PROCEEDING.

1. Turn off the IS-100A.

2. Align the 60HZ trace between the left and right uprights and at the 0 KV line.

3. Using the Remote Control Box of the tester, select PRI, DISPLAY, and push the HIGH/LOW selection to display 25V.

4. Make the following connections to the IS-100A:
   A. Connect the BATT. GRD. (Black Boot) to the GRD. side of the 13V supply.
   B. Connect the PRI. lead (Blue Boot) to the Positive side of the 13V supply .

5. Turn the IS-100A IGNITION switch to the "OFF" position and the POWER switch to the "ON" position.

6. The 60HZ trace should read 13 volts on the 25 volts scale +/- 0.2 volts. If not, adjust PRIMARY GAIN on the Analog Scope Board until the trace is at 13 volts.

****

*** CHECKOUT/CALIBRATION COMPLETE ***

****

09 /89

MILLISECOND SWEEP CHECKOUT/ CALIBRATION

PROCEED TO STEP 1 IF YOU HAVE ALREADY PERFORMED THE PRELIMINARY SETUP, IF NOT, PREFORM THE PRELIMINARY SETUP (PAGE 4-17) BEFORE PROCEEDING.

1. Press MENU on the testers remote to display the main menu and press number 1 (Vehicle setup). Enter 8 cylinders then press CONT. and then number 2 (Vehicle test). Now enter PRI., DISPLAY, HIGH scale to read 500V, 5 MSEC, and #5 on the remote.

2. Set IS-100A to 8 Cylinders, RPM's to "Variable RPM's" and adjust the Variable RPM knob on the simulator to read 3000 RPM's on the digital screen.

3. Adjust 5 MSEC on the Analog Scope Board so the #5 cyl. firing line in the 5 MSEC sweep position lines up with the right hand upright (5 MSEC).

****

*** CHECKOUT/CALIBRATION COMPLETE ***

****

09/89

SECONDARY GAIN CHECKOUT/ CALIBRATION

PROCEED TO STEP 1 IF YOU HAVE ALREADY PERFORMED THE PRELIMINARY SETUP, IF NOT, PREFORM THE PRELIMINARY SETUP (PAGE 4-17) BEFORE PROCEEDING.

1. Turn off the IS-100A.

2. Align the 60HZ trace between the left and right uprights and at the 0 KV line.

3. Using the Remote Control Box of the tester, select SEC, DISPLAY, and push the HIGH/LOW selection to display 25KV.

4. Ensure the Blue SECONDARY PATTERN lead is connected to the calibrated secondary output of the IS-100A.

5. Turn the IS-100A IGNITION switch to the "ON" position and the POWER switch to the "ON" position.

6. The firing lines of the display pattern should read 20KV on the 25KV scale +/- lKV. If not, adjust SECONDARY GAIN on the Analog Scope Board until the firing lines are at 20KV.

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*** CHECKOUT/CALIBRATION COMPLETE ***

* * * * * * * * * * * * * * * * * * *

09 /89

PIN-POINT LAB SCOPE GAIN CHECKOUT/ CALIBRATION

NOTE : IT IS IMPERATIVE THAT THE 5 MSEC CHECKOUT/ CALIBRATION BE PERFORMED BEFORE PROCEEDING WITH THE PIN-POINT LAB SCOPE GAIN CALIBRATION.

PRELIMINARY SETUP:

1. Perform Volt/Ohm Calibration and Checkout (found on page 6-4 and 6-5 of the MEA-1500 Service Manual) and make any adjust first before continuing with this procedure. Failure to do so, could cause improper calibration the next time the Volt/Ohm Calibration and Checkout Procedure is done.

2. Connect the Pinpoint Test Leads (Flying Volt/Ohm Leads) in the following manner: The RED lead to the negative Coil terminal on the IS-100A and the BLACK lead to Ground.

3. Turn the IS-100A "ON" and set RPM to "3600".

ADJUSTMENT PROCEDURE:

1. After performing the Volt/Ohm Calibration and Checkout Procedure (see page 6-4), enter Pinpoint Lab Scope mode by pressing the "ALT" keypad twice on the Remote.

2. Set the vertical volt scale to "25 V" on the Digital Display, by pressing the Remote's "SCALE" keypad until it is so.

3* Adjust PIN-POINT GAIN, on the Analog Scope Bd. until the section of the pattern as shown Figure 4-20 is at 13 volts +/- .50 volts.

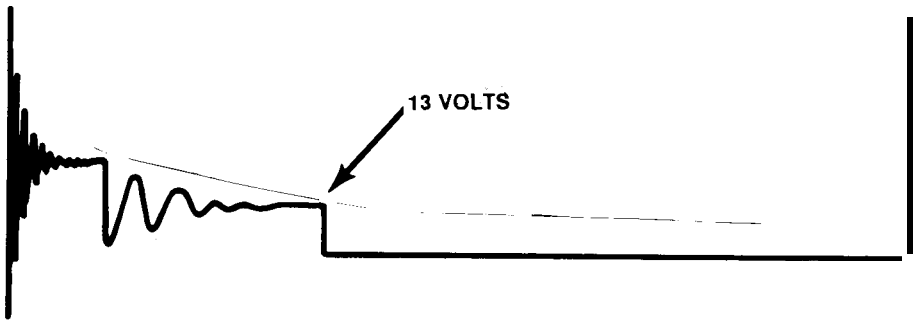


Figure 4-20. Dwell Section of pattern.

COMPLAINT	CORRECTIVE ACTION
I. NO TRACE OR PATTERNS ON THE ANALOG SCOPE. (IF ONLY ONE PATTERN IS MISSING, PROCEED TO THAT TROUBLESHOOTING COMPLAINT).	1. Check the position of the front panel brightness pot. Rotate fully clockwise for full brightness. 2. Check the position of the front panel vertical position control. Rotate fully clockwise to place the trace in the middle of the CRT. 3. Connect a jumper wire from the CRT side of the resistor in the yellow wire of the CRT yoke assembly to pin 2 of J115 (-12V) of the Digital electronic board. (This disables blanking on the CRT.) If a trace appears, see step 4. If a dot appears, see step 5. If nothing appears (no trace or dot), see step 6. 4. TRACE APPEARED, remove the lead from pin 7 and: ----------SUBSTITUTE ---------- A. Analog Scope Board B. Deflection Board 5. DOT APPEARS, If the dot is in the center of the CRT; A. Verify that the yoke supply voltage (10 volts unregulated) is available at the yoke. B. Verify that the yoke is not open. c. ----------SUBSTITUTE---------- Deflection Board D. Refer to theory of operation & functional diagram. If the dot is not in the center of the CRT, remove the ground lead on pin 7 & ----------SUBSTITUTE---------- A. Analog Scope Board B. Deflection Board C. Digital Electronic Board 6. NOTHING APPEARED (NO TRACE OR DOT) Verify the following: A. Filament lit, if it is not, trace the +12v supply using Diagrams 4-2 and 1-1. B. 30 volts DC present at J90, pin 4 on the Analog Scope Board.

COMPLAINT	CORRECTIVE ACTION
I. NO TRACE OR PATTERNS ON THE ANALOG SCOPE (continued). (IF ONLY ONE PATTERN IS MISSING, PROCEED TO THAT TROUBLESHOOTING COMPLAINT).	C. G1 control grid voltage (-12 to -50 volts DC) on pin 1 of in-line connector is present (variable by front panel brightness control). D. G2 Accelerator grid voltage and G4 Focus grid voltage, (250 volts DC) on pin 6 and 6 of the in-line connector are present. F. If the above voltages check ok, ----------SUBSTITUTE---------- A. High Voltage Power Supply B. CRT tube **7.** Refer to Theory & Functional diagrams.
11. MISSING OR IMPROPER "DISPLAY" PATTERN. or MISSING OR IMPROPER SUPER-IMPOSED PATTERN. or MISSING OR IMPROPER 5 MILLISECOND SWEEP.	1. ----------SUBSTITUTE---------- A. Analog Scope Board B. Digital Electronic Board 2. Refer to Theory of Operation & Functional diagrams.
III. MISSING OR IMPROPER RASTER PATTERN . (ALL OTHER PATTERNS NORMAL.)	1. If the raster pattern is always displayed as superimposed, verify that the voltage from the front panel pot (pin 7, J80) varies between 12 and O volts. 2. ----------SUBSTITUTE---------- A. Analog Scope Board B. Digital Electronic Board 3. Refer to Theory & Functional diagrams.
IV. SCOPE MISS-TRIGGERS.	1. Verify that the leads are hooked-up properly and that the vehicle under test does not have solid wires. Also check to to make sure t-hat the leads are not tie wrapped together. 2. Is the timing light flashing erratically, if so refer to the Timing Chapter 5 3. If it only occurs during compare, ----------SUBSTITUTE---------- A. Digital Electronics board

COMPLAINT	CORRECTIVE ACTION
IV. SCOPE MISS-TRIGGERS	4. ----------SUBSTITUTE---------- A. Analog Scope Board B. Input board
V. HORIZONTAL TRACE DOES NOT SWEEP FULL LENGTH OF CRT.	1. Check the position of the front panel pattern length and horizontal position controls. If one of these do not respond: ----------SUBSTITUTE---------- A. Related control Pot B. Analog Scope Board 2. If The trace if missing only on the right side: ----------SUBSTITUTE---------- A. Transistor Q21 B. Deflection Board 3. If The trace if missing only on the left side: ----------SUBSTITUTE---------- A. Transistor Q22 B. Deflection Board 4. Refer to Theory of Operation & Functional Diagrams.
VI. PATTERN LENGTH DOES NOT REMAIN CONSTANT OVER THE RPM RANGE. NOTE : DOES NOT APPLY TO 5 MILLISECOND SWEEP OR TO ANY OF THE PIN-POINT SCOPE FUNCTIONS.	1. Perform sweep length calibration per procedure. 2.----------SUBSTITUTE---------- A. Analog Scope Board B. Digital Electronics Bd 3. Refer to Theory of Operation & Functional Diagram.
VII. INDIVIDUAL PATTERN LENGTH (RASTER OR SUPERIMPOSED) IS NOT EQUAL TO DISPLAY PATTERN SWEEP LENGTH	1. Perform sweep length calibration per procedure. 2---------- Substitute---------- A. Analog Scope Board 3. Refer to Theory of Operation & Functional Diagrams.

COMPLAINT	CORRECTIVE ACTION
VIII. BRIGHT OR BLANK SPOT ON THE HORIZONTAL TRACE. or DISTORTION IN THE VERTICAL DISPLAY AT MID-SCALE.	1. Perform related crossover distortion calibration. 2.----------Substitute---------- A. Deflection Board 3. Refer to Theory of Operation & Functional Diagram 4-1.
IX. MISSING OR DISTORTED PATTERNS. [SECONDARY, PRIMARY OR ALTERNATOR]	1. Using an oscilloscope, verify that the missing signal is reaching the Analog Scope Board, that the appropriate select line(s) is correct and that the selected signal is being output to the Vertical Deflection board (see below).

SIGNAL	SIGNAL INPUT	SELECT SIGNAL (J86)	SIGNAL OUTPUT
PRIMARY	J81, PIN 1	SELECT PRIMARY*, pin 5	J91, pin 9
ALTERNATOR	J81, PIN 19	SELECT ALT*, pin 6	J91, pin 9
SECONDARY	J81, PIN 9	SEL PRI* & SEL ALT* high	J91, pin 9

2. If input signal is present and the corresponding select line is correct,

   ----------Substitute----------
   A. Analog Scope Board

3. If input signal is present and the corresponding line is not correct,

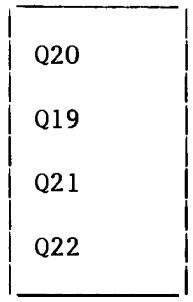
   ----------Substitute----------
   A. Digital Electronics Board

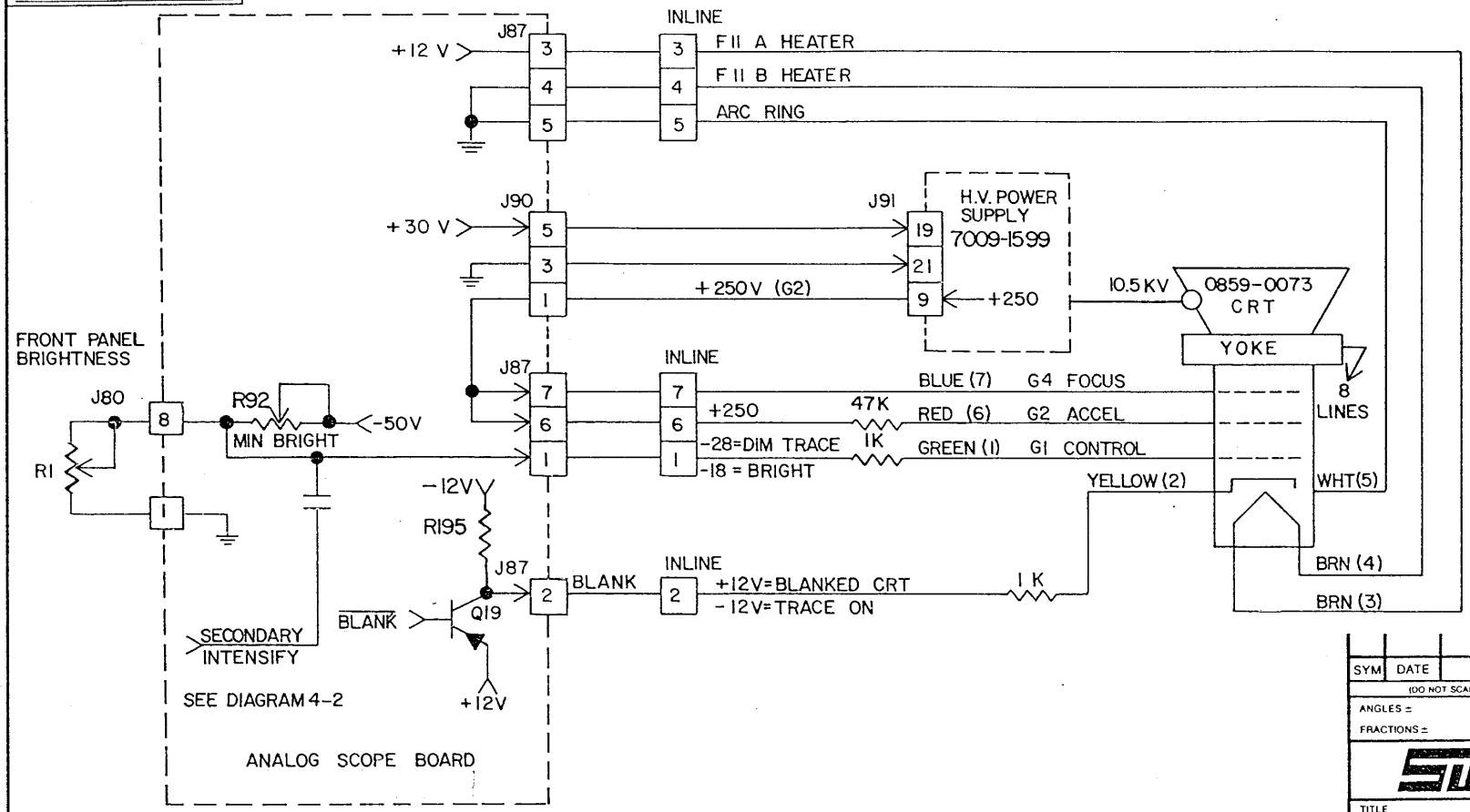
4. If input signal and output signal are present,

   ----------Substitute----------
   A. Deflection Board

5. Refer to Theory of Operation & Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
X. MISSING SCALE (25KV, 50KV, 25V, 500V)	1. Verify that J86, pin 9 (SELECT HIGH SCALE*) goes low to select 50KV and 500V. Also line should go high when 25KV and 25V are selected. If above conditions are not met, ----------Substitute---------- A. Digital Electronics Board If conditions are met, ----------Substitute---------- A. Analog Scope Board 2. Refer to Theory of Operation & Functional Diagram.
XI. AMPLITUDE OF THE FIRING LINES ARE QUESTIONABLE.	1. Perform Vertical calibration. 2---------- SUBSTITUTE---------- A. Analog Scope Board B. Input Board 3. Refer to Theory of Operation & Functional Diagram.
XII. SECONDARY FIRING LINES ARE NOT INTENSIFIED.	1.----------SUBSTITUTE---------- A. Analog Scope Board 2. Refer to Theory of Operation & Functional Diagram.
XIII. TRACE WILL NOT GO BELOW MID SCREEN. SCOPE TRIGGERS BUT NO PATTERN IS DISPLAYED (ONLY A STRAIGHT LINE)	l.----------SUBSTITUTE---------- A. Transistor Q19 B. Deflection Board C. Analog Scope Board 2. Refer to Theory of Operation & Functional Diagram .
XIV . PIN-POINT SCOPE SIGNAL NOT DISPLAYED ON SCOPE, YET DIGITAL DISPLAY SHOWS THAT THE MEA IS IN PIN-POINT SCOPE MODE .	1. Try Vehicle Polarity switch set to positive position (+). 2. Try different voltage scales. 3 .----------SUBSTITUTE---------- A. Pin-point Volt/Ohm leads B. Analog Scope Bd. C. Mag/Volt/Ohm Bd.

COMPLAINT	CORRECTIVE ACTION
xv. TRACE IS NOT DEFLECTED IN ONE DIRECTION.	1.----------SUBSTITUTE---------- A. Related Transistor, See Chart below B. Deflection Board c. Analog Scope Board
 SIDE VIEW OF DEFLECTION BOARD.	DIRECTION / TRANSISTOR UP — Q20 DOWN — Q19 LEFT — Q22 RIGHT — Q21
	2. Refer to Theory of Operation & Functional Diagram.
XVI. PRIMARY PATTERN IS INVERTED.	1. Verify the +/- switch on the back panel is in the proper position. 2. Refer to Theory of Operation & Functional Diagram.
XVII. PIN-POINT SCOPE MODE CANNOT BE ENTERED.	1. Is SW1 switch 6 on DEB Bd "ON". 2. Does DEB Bd. firmware support Enhanced Pin-point Scope (see page 2-3 for revisions listings. 3.----------SUBSTITUTE---------- Digital Electronics Board 4. Refer to Theory of Operation & Functional Diagram.
XVIII. MILLISECOND TIME BASE INACCURATE.	1. Perform 5 millisecond Calibration Procedure on page 4-18. 2.----------SUBSTITUTE---------- A. Analog Scope Bd. B. Digital Electronics Bd. 3. Refer to Theory of Operation & Functional Diagram.



SYM	DATE	REVISIONS	ECN	APVL

(DO NOT SCALE) TOLERANCES (EXCEPT AS NOTED)

ANGLES ± DECIMALS .000 ± .005
.00 ± .015
FRACTIONS ± .0 ±

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

TITLE
SCOPE BIASING

MODEL MEA 1500 / DIAGRAM 4-1

MAT'L AND/OR FINISH

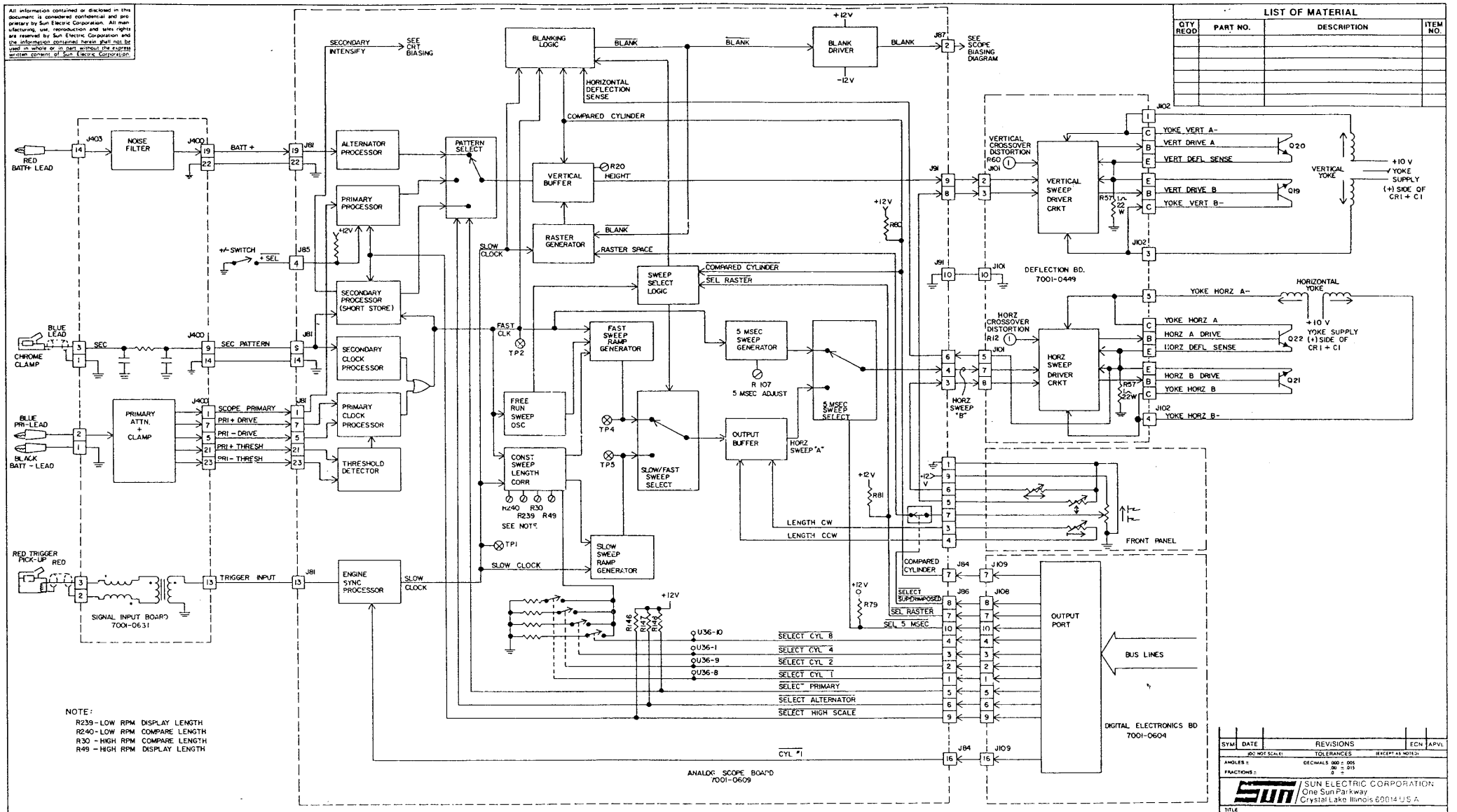
DWG BY P DORN / 11-16-86 ENG APVL ____ / ____

CHK BY D Kuiper / ____ ENG APVL ____ / ____

SCALE	SHT OF	DWG SIZE	DWG NO.
		B	PAGE 4-29/4-30

LIST OF MATERIAL

QTY REQD	PART NO.	DESCRIPTION	ITEM NO.



NOTE:
R239 - LOW RPM DISPLAY LENGTH
R240 - LOW RPM COMPARE LENGTH
R30 - HIGH RPM COMPARE LENGTH
R49 - HIGH RPM DISPLAY LENGTH

SYM	DATE	REVISIONS	ECN	APVL

DO NOT SCALE | TOLERANCES (EXCEPT AS NOTED)
ANGLES ± | DECIMALS .000 ± .005, .00 ± .015, .0 ±
FRACTIONS ±

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake Illinois 60014 U.S.A.

TITLE: SCOPE DEFLECTION

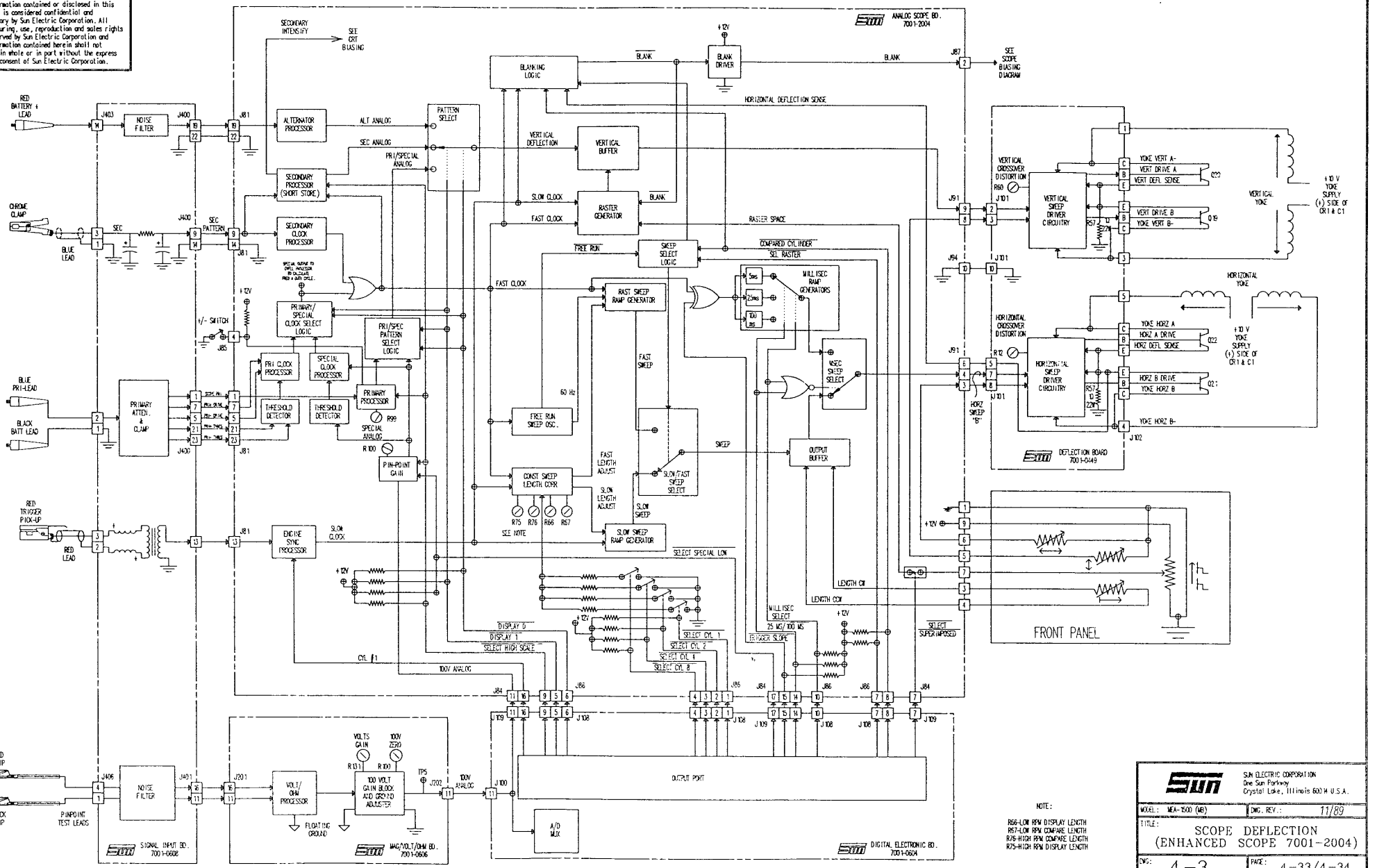
MODEL: MEA-1500 / DIAGRAM 4-2

MAT'L AND/OR FINISH

DWG BY _____ / _____ ENG APVL _____ / _____

CHK BY _____ / _____ ENG APVL _____ / _____

SCALE | SHT OF | DWG SIZE D | DWG NO.



SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

MODEL: MEA-1500 (MB)	DWG. REV.: 11/89

TITLE: SCOPE DEFLECTION (ENHANCED SCOPE 7001-2004)

DWG: 4-3	PAGE: 4-33/4-34

CHAPTER 5

STROBOSCOPIC & EUROPEAN TIMING

SECTION 1. THEORY OF OPERATION

NOTE: The following text is used in conjunction with Diagram 5-1, Pages 5-7/5-8.

GENERAL

Engine timing refers to the relationship between the spark plug firing and the position of the piston in the cylinder. If the piston is at TDC (Top Dead Center) when the spark arrives, timing is at TDC or O degrees. When the spark arrives before (in advance) the piston is at TDC, timing is advanced. When the spark arrives after the piston goes past TDC, timing is retarded.

The MEA-1500 can measure timing via the timing light (stroboscopic), the magnetic timing probe (Mag), the European timing pick-up (Euro Mag), or the LED timing connector (LED). Both mag timing connections and the LED timing are made at the universal lead, therefore only one can be present at a time. When any kind of mag timing is being used, the tester will automatically select and use the timing pulses from the mag probe. If no pulses are available from either mag hook-up, the tester uses the timing pulse from the Timing Light in computation of timing readings.

The CPU computes timing from the following two signals:
ENGINE SYNC B* - Occurs when the #1 spark plug fires, generated from the #1 Trigger Pick-up.
TIME PULSE* ---- Occurs when the #1 cylinder is at Top Dead Center (TDC), generated from either the timing light or one of the magnetic pickups.

7009-1704-01 (used for timing light connection),
7009-1576-01 (used for domestic magnetic probe connection)
6004-0396 (used for European diagnostic magnetic extender cable assembly connection and then ultimately one of six optional vehicle cable assemblies).

STROBOSCOPIC TIMING

The Timing Light (Strobe IV) receives approximately 10 volts DC, unregulated, from the power supply. The 10 volts is applied to the Timing Light board (inside the Timing Light) through a rocker type ON/OFF switch located on the top of the Timing Light. A DC to DC converter steps up the 13 volts to approximately 650 volts DC that is needed to flash the Xenon tube in the timing light.

The ENGINE SYNC A signal is routed to the Strobe IV Processing circuitry on the Timing board. The Strobe Timing Processing circuitry (one shot) issues the pulse which is used to trigger the flash of the Xenon tube and and to create the STROBE TIME PULSE* signal which is routed to the Mag/Volt/Ohm Board for use in computing timing readings.

NOTE: For a better explanation of the STROBE IV, refer to Its manual #0692-9142.

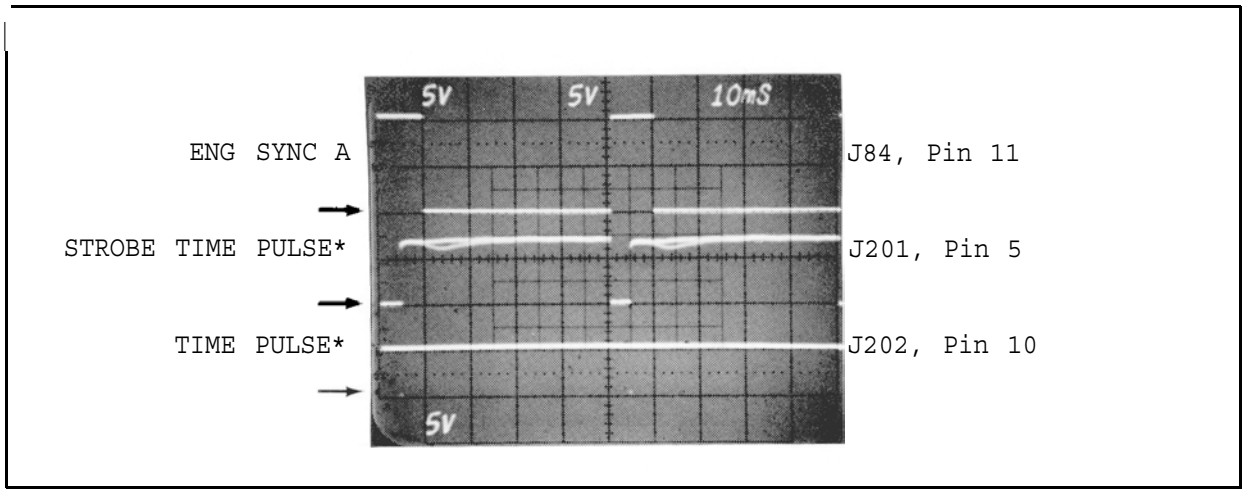


FIGURE 5-1 90 DEGREES ADVANCE

EUROPEAN TIMING

The pick-up for Timing on most European vehicles is built in at the factory. It is simply a coil of wire mounted near the Crankshaft pulley. This pulley has either one hole, two holes, one peg, or two pegs. The Mag/Volt/Ohm board supplies current to the probe, creating a magnetic field. When the hole or peg passes the coil of wire, the magnetic field is broken, creating a pulse on the EURO MAG + line.

The input stage provides a voltage gain to the AC portion of the EURO MAG + signal without gain to its DC component. This signal is then cleaned-up, and edge corrected to get a clean pulse for the System Detector. If the Vehicle under test is a Peg system, the TIME PULSE must be activated at the rising edge. This TIME PULSE signal is routed to the Digital Electronic Board for use in calculating timing.

Zero Crossing Detection

When using the magnetic probe; the point at which the generated signal "blip" crosses the DC voltage level, on which the signal is superimposed, is defined as the timing point for the engine.

A strobe type comparator is used as a crossing detector, thus allowing it to be enabled only during the time period that the probe input pulse occurs. The strobe pulse generation circuitry processes the internally generated setup pulse in order to develop a strobe pulse for application to the comparator. This allows for reliable output during the remainder of the cycle. To avoid spurious output oscillation due to ignition noise, coupling, etc., the Edge Correction circuit is strobed "On" only during the "blip" period.

Edge Correction-Crossing Detector

Because of the phase inversion in the transducer generated output signal between peg and slot systems, the crossing detector's output must be corrected to place the timing information on the falling edge of the output pulse. Operating the crossing comparator in the inverting mode and using positive feedback for hysteresis gives the proper output edge for the negative phase "blip".

Two threshold comparators are used to detect the first excursion from reference by the" blip" to start generation of the setup pulse and also to detect a point after reference crossing to end the setup pulse. Since peg and slot timing systems have an opposite polarity "blip", one initially going

positive while the other initially goes negative, the two comparators interchange their function.

PIN
SYSTEM

HOLE/SLOT
SYSTEM

Single/Double System Detection-Slot or Peg

A binary counter and a one-shot multivibrator , operating in the retriggerable mode, is used to determine whether the system under test is a single or double peg/slot system. Clocking the counter with the processed mag signal yields a binary count at the counter output. The counter is then cleared with the ENG SYNC A signal. For a single peg/slot system, the counter counts two mag pulses between each ENG SYNC A pulse, and for a double peg/slot system, the counter counts four mag pulses between each applied ENG SYNC A pulse. The counter output is used to clock multivibrator whose outputs are then used to turn On an appropriate analog switch. The operational status of the Detector dictates whether all mag pulses (single system) or the second of two pulses (double system) is selected.

Optical (Average Timing) Detection

Optical detection is similar to the single/double discussion given above. When a pulse occurs at the output of comparator, used to detect the optical system's input, a retriggerable one-shot multivibrator is used to defeat the single/double system detection circuit. Optical timing appears and functions as a double system, but all pulses are required for proper operation. A one-shot operates to allow all mag pulses (designated TIME PULSE) to pass to the System output.

OFFSET SELECTION

Most European manufacturers mount the magnetic pickup 20 degrees after TDC. Therefore, when the computer "sees" that the EURO CONN* line is low, it adds -20 degrees to the raw (uncorrected for offset) timing readings before they are displayed.

A few European auto manufacturers mount the pick up at TDC (O degrees) instead of at 20 degrees after TDC. On these vehicles, when the diagnostic cable is connected, pin 16 on the Timing board is taken low by a pin on the vehicle connector. The O DEGREE* line , which is active (low) on O degree system cars, IS routed to the Digital Electronic Board. When the computer sees the O DEGREE SYSTEM line high (it was inverted on the Timing board), it displays the timing readings without adding the -20 degrees offset.

If the MEA is connected to a domestic probe, EURO CONN* and O DEGREES* will be high, but MAG ACTIVE* will be low. This indicates that the CPU should use the offset angle that was enter in the set-up page. See Chart 5-1 for all possible combinations of these three signals.

SYSTEM	MAG ACTIVE*	EURO CONNECT*	O DEGREES*	OFFSET ANGLE
Domestic mag	LOW	HIGH	HIGH	ENTERED
20 degree european mag	LOW	LOW	HIGH	20 DEGREES
O degree european mag	LOW	LOW	LOW	O DEGREES
Stroboscopic	HIGH	LOW	HIGH	O DEGREES

In summary;. the computer uses ENG SYNC* and TIME PULSE* (which can be generated from the Timing Light, Domestic mag probe or the European pickup) to compute timing readings. The MAG ACTIVE*, O DEGREES, AND EURO CONN* signals inform the computer when to add the offset and informs the Timing Mode Select Circuitry which input to select.

SECTION II. STROBOSCOPIC TIMING

CALIBRATION AND CHECKOUT

Equipment Required: IS-100A
Calibration Screwdriver
Phillips Screwdriver

CHECKOUT

1. Connect MEA's trigger pick-up to the IS-100A.
2. Turn on both the IS-100A and the MEA.
3. Set IS-100A to 8 cylinders and 600 RPMs.
4. Set MEA's VEHICLE SET-UP page for 8 cylinders four cycle engine.
5. Turn on the MEA's timing light power switch.
6. Verify that the timing light flashes smoothly and does not mistrigger.
7. Set IS-100A'S cylinders switch to the TAU position. point the timing light at the window on the IS-100A.
8. Rotate timing advance knob counter clockwise until zero click is heard. The LEDs in the window on the IS-100A must read 00, this should agree with the timing reading displayed on the MEA's VDU.
9. Rotate timing advance knob fully clockwise, the IS-100A'S window display and the MEA's timing reading should be 60 degrees +/- 2 degrees. If out of specifications then proceed to adjustment procedure.

10. Turn timing light's power switch to the OFF position.

11. Remove black boot from the end of the timing light's barrel.

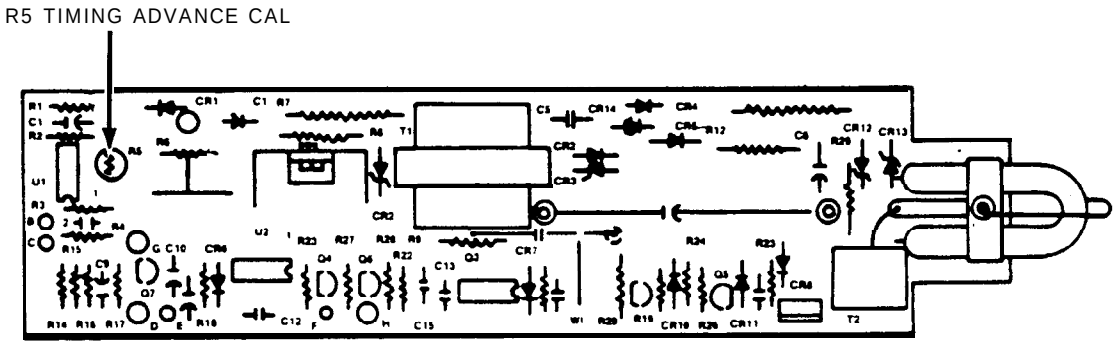
12. Remove two Phillips screws securing timing light barrel to handle.

13. Gently separate handle from barrel.

14. Remove two Phillips screws securing the timing light's pcb to the barrel housing.

15. Carefully slide the circuit Board out of the timing light's barrel housing.

16. Turn the timing light power switch back on.
NOTE : EXERCISE EXTREME CAUTION WITH TIMING LIGHT'S PCB REMOVED PROM HOUSING DUE TO HIGH VOLTAGE PRESENT ON THE PCB.



17. Rotate timing advance knob fully clockwise.

18. Adjust R5 on the timing light circuit board until IS-100A's window LEDs and MEA's timing display agree +/- 1.0 degrees of each other.

****
* **CALIBRATION COMPLETE** *
****

11/86

SECTION 111. TIMING TROUBLESHOOTING (STROBOSCOPIC & MAGNETIC)

Confirm that Power Supply voltages are correct before proceeding.

COMPLAINT	**CORRECTIVE ACTION**
I. Timing Light does not flash or flashes erratically.	1. Verify that RPM is displayed with only the Red #1 Trigger pick-up connected. If no RPM is displayed, see Chapter 3 "No Tach readings".

COMPLAINT	CORRECTIVE ACTION
I. (Continued)	2. Check operation of the Timing Light using the IS-100A. Use the Strobe IV manual for repair procedures. 3. ----------SUBSTITUTE---------- (A) Mag/Volt/Ohm board, 7001-0606 4. Verify that 10 volts is present between pins 11 and 2 of the Timing Light connector on the rear panel. 5. Refer to Theory of Operation and Functional Diagram 5-1.
II. Timing Light advance control has no effect.	1. Verify that the magnetic probe is not being used. (The advance is inhibited when the magnetic probe is receiving a signal). 2. Check operation of the Timing Light using the IS-100A. Use the Strobe IV manual for repair procedures. 3. Remove the Mag probe. If timing advance returns, replace the Mag Probe. #7009-1890 4. ----------SUBSTITUTE---------- (A) Mag/Volt/Ohm board, 7001-0606 5. Refer to Theory of Operation and Functional Diagram 5-1.
III. Timing Light readings are erratic or inaccurate.	1. Verify that RPM is stable with only the #1 Red Trigger lead connected. If unstable see Chapter 3. 2. Check operation of the Timing Light using the IS-100A. Use the Strobe IV manual for repair procedures. 3. Verify that the Red #1 Trigger pick-up is connected around the engine's #1 spark plug wire. 4. Perform Timing Light calibration. 5. ----------SUBSTITUTE---------- (A) Mag/Volt/Ohm board, 7001-0606 6. Refer to Theory of Operation and Functional Diagram 5-1.

LIST OF MATERIAL

QTY REQD	PART NO.	DESCRIPTION	ITEM NO.

UNIVERSAL LEAD
TO LED TIMING
J403
J401
OPT POWER
OPT IN
J201
+12 V
OPTICAL DETECTOR CIRCUIT
TP2
EUROPEAN CURRENT SOURCE
NOISE FILTER
0°
EURO CONN
TIME PULSE
MAG ACTIVE
EUR MAG +
MAG GND
DOM MAG
TP1
TP3
INPUT STAGE
ZERO CROSSING DETECTOR
EDGE CONNECT CIRCUIT
SINGLET DOUBLE PEG/HOLE SYSTEM DETECTOR
EUROPEAN CONNECT DETECTOR
MAG/VOLT/OHM BOARD 7001-0606
+10 V
J202
J201
J100
INPUT PORT
BUS LINES
J109
ENG SYNC B
COUNTER TIMER
DIGITAL ELECTRONICS BOARD 7001-0604

ADAPTER M.B. 1976 AND LATER 6004-0370
GROUND
COIL (-) KLI
EUR MAG LINE
SHLD
EUR MAG NEG
COIL (+) KLIS
BATT (+)

MAG PROBE 7009-1890

CABLE ASSY MAG TIMING ADAPTER VOLO 6004-0350
ADAPTER B.L.M.C. DB 6004-0351
ADAPTER CIT, REN, PEUG 6004-0352
ADAPT BMW 6004-0353
ADAPTER VW-AUDI WATER COOLED 6004-0354
ADAPTER VW 6004-0375
EUR IN
GND
EUROPEAN MAG EXTENDER CABLE ASSY. 6004-0396
RED TRIGGER PICK-UP 507-6
INPUT BD. 7001-0631
J81
TRIGGER INPUT
ENGINE SYNC PROCESSOR
ENG SYNC B
ENG SYNC A
J84
ANALOG SCOPE BOARD 7001-0609

J401
J408
NOISE FILTER
J400
ORN
STROBE TIME PULSE
BLU
CONT TSTR Q1
ONE SHOT MVB U2
PULSE AMPL TSTR Q6
0° SW
+VDC
+7.5 V
R5 100K
10K DEGREE ADVANCE CONTROL
TSTR Q4
LIGHT FIRE
DRVR CONT TSTR Q5
TRIG SCR 1
TRIG XMFR T2
BLK
+7.5 VDC
R6 250
ON/OFF SW S1
OSC NET T1, Q1
RECT/FLT. NET CR4, 5, 14, C8
+650 VDC
FLASHTUBE V1
ZENER FILTER REG CR3, C5
+7.5 VDC REG
FUSE 1A F1
BLK/WHITE
INPUT BOARD 7001-0631
PCB ASSEMBLY 7001-0440
TIMING LIGHT ASSEMBLY 7009-1704-01

SYM	DATE	REVISIONS 3-20	ECN	APVL

(DO NOT SCALE) TOLERANCES (EXCEPT AS NOTED)
ANGLES ±
FRACTIONS ±
DECIMALS .000 ± .001, .00 ± .015, 0 ±

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake Illinois 60014 U.S.A.

TITLE: TIMING DIAGRAM

MODEL: MEA 1500 / DIAGRAM 3-1
MAT'L AND/OR FINISH
DWG BY: R.K. / ENG APVL
CHK BY: / ENG APVL
SCALE | SHT OF | DWG SIZE D | DWG NO

CHAPTER 6

VOLT AND OHMS

SECTION I. OHMS THEORY OF OPERATION

NOTE: *The following text is used in conjunction with Volt/Ohms Diagram 6-1, Pages 6-25/6-26.*

G E N E R A L

The Volt/Ohms portion of MEA share part of their circuitry with each other. Thus both are calibrated in one procedure. This method insures proper calibration of both parameters.

O H M S

The Ohm circuit is capable of measuring resistances from O to 200K-ohms in four scales. Selection of scale ranges is done automatically by the Digital Electronics Board. Each range scale has its own constant current source. See Table 6-1 below for their value and range.

S C A L E	RANGE	CURRENT SOURCE
Rx 1	0 to 200 Ohms	10mA
Rxl0	200 to 2K Ohms	lmA
Rxl00	2K to 20K Ohms	100uA
Rxl000	20K to 200K Ohms	10uA

Table 6-1

The range scales are changed by taking one of the four SEL RANGE* signals logic low via output port on the Digital Electronics Board.

The Mag/Volt/Ohm board is supplied with 9.3 volts AC from the tester's main power supply transformer. The 9.3 volts AC is rectified and or regulated to create two floating supplies +6 volts regulated and +12 volts unregulated on the Mag/Volt/Ohm board. This power supply is **not referenced** to the MEA's chassis ground. It references its own (floating) ground on the Mag/Volt/Ohm board. This insures that no ground conflicts arise when taking measurements with the Volt/Ohms leads while the MEA's chassis ground lead (negative battery lead) is connected to the vehicle's ground.

NOTE: *If voltage measurements are made on the Mag/Volt/Ohm board during troubleshooting, such as checking the output of the floating power supplies. The floating ground on the Mag/Volt/Ohm board must be used.*

The unknown resistance is calculated by reading the voltage drop across it with one of the four constant current sources flowing through it. By applying part of OHM's LAW (resistance is equal to voltage divided by current) the Digital Electronic Board calculates the reading.

PINPOINT VOLTS
The voltmeter circuit has two ranges DC VOLTS LO O to ±20V called 20V ANALOG and DC VOLTS HI 20 to ±1OOV called 100V ANALOG. These two ranges are transparent to the operator for they are under selection by the Digital Electronics Board. The Digital Electronics Board chooses between the two by deciding which mux is converted for display.

Power for the volt circuit is the same floating supply as explained in the Ohms section.

BATTERY VOLTAGE
The battery voltage data is obtained from the battery lead connected to the positive terminal of the battery (and the ground lead). The Mag/Volt/Ohm Board processes the voltage, and outputs it as AVERAGE BATTERY VOLTAGE ANALOG (AV BAT VOLT ANLG). The AVERAGE BATTERY VOLTAGE ANALOG signal is routed to the Digital Electronics Board where it is read by the computer for display.

DISTRIBUTOR RESISTANCE
The distributor resistance is read in a static condition only (i.e. the engine is not running) AND is obtained from the MEA's primary minus lead which is connected to the negative side of coil.

The voltage present on the negative side of the coil is routed to the input board on J403 pin 2, fed into a clipping circuit, and output on J400 pin 3 to the Analog Scope Board. The clipped signal enters the Analog Scope Board on J81 pin 3, and is routed to the AVERAGE POINTS PROCESSOR to become AVERAGE POINTS VOLTAGE ANALOG. AV PTS VOLTS ANALOG is a D.C. voltage proportional to the voltage present at the negative side of the coil. It is then routed to the Digital Electronics Board at J109 pin 12, for conversion into the DIST. V. seen on the VDU.

The display is the voltage at the negative side of the coil with the engine not running. for a valid reading the Point must be closed or the Transistor must be on. Once the engine is running the VDU displays changes from DIST. V. to DWELL.

SECTION II. SERVICE CALIBRATION PAGE USAGE

GENERAL
If needed, refer to the Introduction (page iv) for general information & specific instructions on how to access the MANUAL CALIBRATION (NON-GAS) page. To select OHMS one must press volt/ohm on the remote keypad.

UNADJUST VALUE
The UNADJUST VALUE reading is the current ohms reading based on the OHMS ANALOG channel. The reading displayed is uncorrected for *zero* offset. It is a representation of the OHMS ANALOG channel after conversion to Ohms. Without regard to the stored calibration constant gathered by the Digital Electronics Board during system calibration.

MEASURED VOLTAGE
The MEASURED VOLTAGE is to the left of the unadjust value on the OHMS line. It is the voltage presented to the mux select circuirty on the Digital Electronics Board at all times.

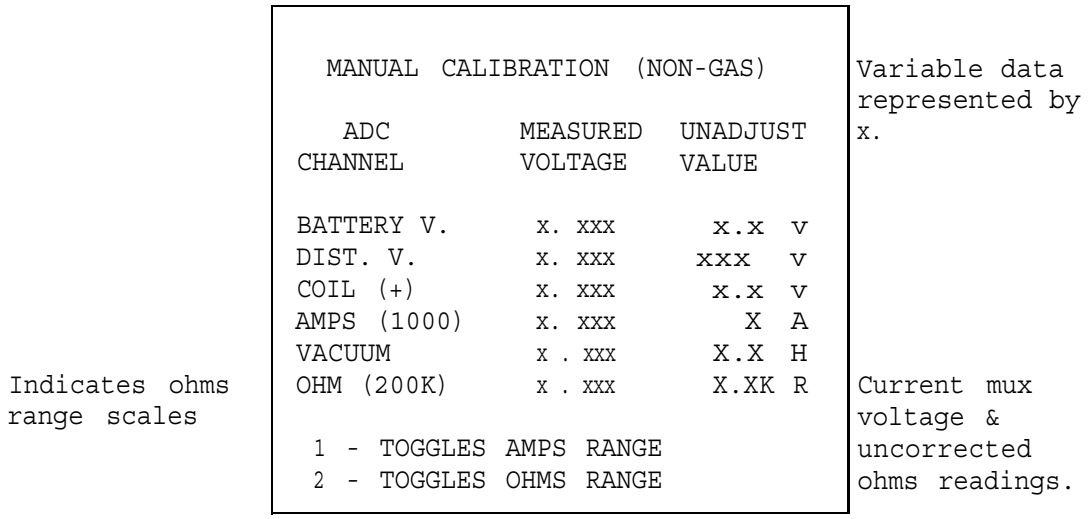


Figure 6-1
Service Calibration Page

OHMS

Pressing 2, Allows the forcing of the four possible ohms range scales (0-200 OHMS), (200-2K OHMS), (2K-20K OHMS), and (20K-200K OHMS). See the chart below *for* the resistances and their equivalent mux voltages.

RANGE	150 OHMS	1.5K OHMS	5K OHMS	50K OHMS
200	5.25 V	7.4 V *	7.4 V *	7.4 V *
2000	0.53	5.25 V	7.4 V *	7.4 V *
20K	0.05	0.53 V	1.75 V	7.4 V *
200K	0.00	0.05 V	0.17 V	1.75 V

* INDICATES OVERSCALE

Table 6-2
Resistance and Equivalent Mux Voltage

PINPOINT VOLTS

Depending on the adjustment of the Mag/Volt/Ohm board, with 13 volts in, the x20 mux voltage will be approximately 4.55 volts and the x100 mux voltage will be 0.91 volts.

BATTERY VOLTS

With 13 volts applied to the Battery leads, the Mux voltage will be 2.28 volts .

DISTRIBUTOR RESISTANCE

With 13 volts applied to the primary leads, the Mux voltage will be 6.50 volts .

GOOD SELF CALIBRATION LIMITS

All pinpoint zero voltages must be within 0.3 volt of 0.00 for a good to be displayed in the self cal page. The Distributor Resistance and Battery voltage reading have two windows that they can fall within, 0.00 ± 0.1 volts or 1.75 to 2.8 volts. This is to allow calibration while the leads are connected to a battery.

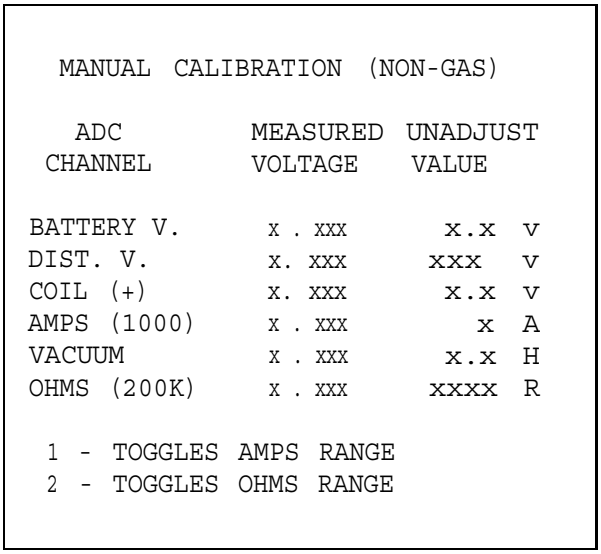


Figure 6-2
Service Calibration Page

SECTION III. MAG/VOLT/OHM CALIBRATION AND CHECKOUT

GENERAL

There are currently three Mag/Volt/Ohm Printed Circuit Boards. Refer to Table 6-3 below for the location of the correct procedures and figures:

SECTION	PCB	PROCEDURE	FIGURE
A	7001-0606	Page 6-5 to Page 6-7	Page 6-9
B	7001-2087-01	Page 6-11 to Page 6-14	Page 6-15
C	7001E9311-15	Page 6-17 to Page 6-19	Page 6-21

Table 6-3

A. MAG/VOLT/OHM PRINTED CIRCUIT BOARD 7001-0606 (refer to Figure 6-3)

REQUIRED EQUIPMENT:
IS-100A IGNITION SIMULATOR
CALIBRATION SCREWDRIVER
SPENCO HANDLE and SPANNER BIT #6
DIGITAL VOLTMETER

NOTES:

A. *When performing this procedure, use standard Anti-Static practices.*

B. *At no time during this procedure should the Battery Leads be used to connect the Pin-point Leads to the IS-100A.*

C. *Refer to Figure* 6-3 *on Page* 6-9 *for* Mag/VOLT/OHM *Board #7001-0606 for locations and descriptions of Test Points and Pot adjustments* as *outlined in this procedure.*

D. *Be sure to check the actual output of your IS-100A and adjust Voltage Gains accordingly.*

PRELIMINARY SETUP:

1. Remove the two Spanner screws securing the front drawer assembly of the MEA-1500 Tester.

2. Turn the MEA's power ON, short the PINPOINT LEADS together and proceed through SELF CALIBRATION. (If the MEA-1500 has a four gas option, a 15 minute warm-up is required.)

3. After completing SELF CALIBRATION, proceed to the VEHICLE TEST page by pressing CONT on the remote keypad.

4. Connect the Primary (Blue) and Battery (Red) clips to the IS-100A'S "+" output, and the Ground (Black) clip to the "-" output.

5. Turn the IS-1OOA'S power ON and set the Volt/ Ohm switch to 13 Volts.

6. Verify that Battery Volts read 13 Volts ± 0.2 Volts.

7. If the Voltage is within tolerence, go to the Volts Adjustment Procedure.

8. If the Voltage is not within tolerence:

   A. Adjust the **ADC REFERENCE** (Near J107, only pot on board) on the Digital Electronics Board until the screen reads 13 Volts.

   B. **WARNING: IF AN ADJUSTMENT IS MADE TO THE REFERENCE VOLTAGE, ALL MUX CHANNELS MUST BE RECALIBRATED. THESE INCLUDE, ALL FOUR GASSES, AMPS, VACUUM, VOLTS/ OHMS AND OIL TEMP. IF SO EQUIPPED.**

   c. Perform a System Calibration and then return to the Vehicle Test page.

VOLTS ADJUSTMENT PROCEDURE:

9. Locate the Mag/Volt/Ohm board, #7001-0606, and adjust R131, VOLTS GAIN POT to its maximum Clockwise position.

10. Connect both the Red and Black clips of the MEA's Pin-point Volt/ Ohm leads to the "+" output of the IS-1OOA. Set the Volt/ Ohm output of the IS-1OOA to 13 Volts, the Ripple and Power switches to the ON position.

11. Set the DVM to read DC Volts and connect the Red lead to the **BALANCE ZERO TP** (R99, closest to R63) and the Black lead to GROUND TP.

12. Adjust the R37, VOLT BALANCE POT on the Mag/Volt/Ohm board, #7001-0606, to read 0.000 Volts DC ± 0.005 Volts on the DVM.

13. Remove the Volt/ Ohm leads from the IS-1OOA and short them together. Be sure to return the Ripple switch to the OFF position before proceeding.

14. Connect the Red lead of the DVM to TP5, 100 VOLT ZERO TP and adjust R100 , 100 VOLT ZERO POT for 0.000 Volts DC ± 0.010 Volts.

15. Connect the Red lead of the DVM to TP9, 20 VOLT ZERO TP and adjust R101, 20 VOLT ZERO POT for 0.000 Volts DC ± 0.010 Volts.

16. Select Resistance by pressing the Volt/ Ohm key on the remote keypad.

17. Connect the Red lead of the DVM to TP6, OHMS ZERO TP and adjust R102, OHMS ZERO POT for 0.000 Volts DC ± 0.010 Volts.

18. Perform a System Calibration by Pressing Menu, #4 and #1 on the remote keypad.

19. After System Calibration is complete, return to the Vehicle Test page by pressing Menu twice and then #2 on the remote keypad.

21. Connect the black lead of the MEA-1500 Pinpoint leads to the "-" output of the IS-1OOA and the Red to the "+" output.

22. Adjust the R131, VOLTS GAIN POT until DC Volts on the Screen reads 13 volts ± 0.1 volts.

OHMS ADUSTMENT PROCEDURE:

23. Select Ohms by pressing Volt/Ohm on the remote keypad.

24. Set the IS-1OOA for 50K Ohms.

25. Adjust the Rll, OHMS GAIN POT for 50 K Ohms ± 0.2 K Ohms on the screen.

26. Remove the Volt/Ohm leads from the IS-1OOA and short them together.

27. Exit the Vehicle Test page and perform a System Calibration by pressing MENU, #4 and #1 on the Remote Keypad.

28. After the System Calibration is complete, return to the Vehicle Test page by pressing MENU twice and then #2 on the Remote Keypad and select resistance by pressing Volt/ Ohm on the remote keypad.

29. Connect the Volt/Ohm leads to the IS-1OOA

30. The MEA-1500 screen must read 50K ohms ± lk ohm. If not readjust the Rll, OHMS GAIN POT until it is within specifications. Then check the following readings:

RESISTANCE	LIMITS
5 ohms	4.75 to 5.25 ohms
50 ohms	47.5 to 52.5 ohms
150 ohms	142.5 to 157.5 Ohms
170 ohms	161.5 to 178.5 ohms
500 ohms	475 to 525 ohms
5K OhmS	4.75K to 5.25K Ohms
50K ohms	47.5K to 52.5K Ohms

Table 6-4
Resistance Scale Tolerances

31. Perform a System Calibration and make sure that VOLTS and OHMS read good on the display.

32. If the ADC REFERENCE pot was adjusted at the beginning of this procedure, precede to the appropriate sections of this manual to calibrate;

    1. Amps/ Vac
    2. Gasses
    3. Oil Temp.

****
*** CALIBRATION/CHECKOUT COMPLETE ***
****

NOTES

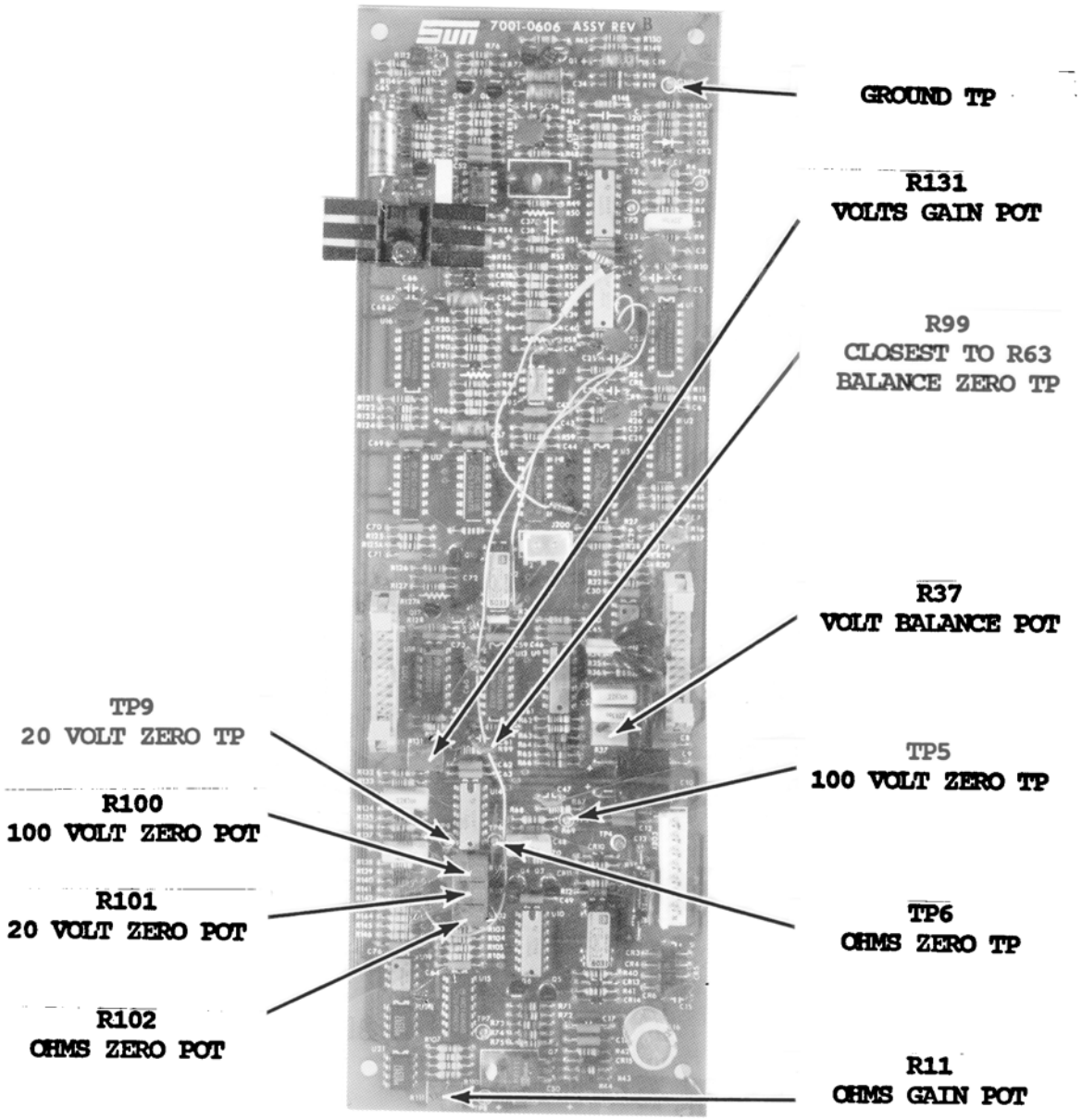


FIGURE 6-3

MAG/VOLT/OHM PRINTED CIRCUIT BOARD 7001-0606

B. MAG/VOLT/OHM PRINTED CIRCUIT BOARD 7001-2087-01 USED IN MEA-1500 SERIAL "C" OR LATER (Refer to Figure 6-5) on Page 6-15

EQUIPTMENT REQUIRED: IS-100A IGNITION SIMULATOR
CALIBRATION SCREWDRIVER
SPENCO HANDLE AND SPANNER BIT #6
DIGITAL VOLTMETER

NOTES:

A. *When performing this procedure,use standard Anti-Static practices.*

B. *At no time during this procedure should the Battery Leads be used to connect the Pin-point Leads to the IS-100A.*

c. *Refer to Figure 6-5, Page 6-15 for Mag/Volt/Ohm board, #7001-2087-01, for the locations and descriptions of Test Points and Pot Adjustments as outlined in this procedure.*

D. *Be sure to check the actual output of your IS-100A and adjust Voltage Gains accordingly.*

PRELIMINARY SETUP:

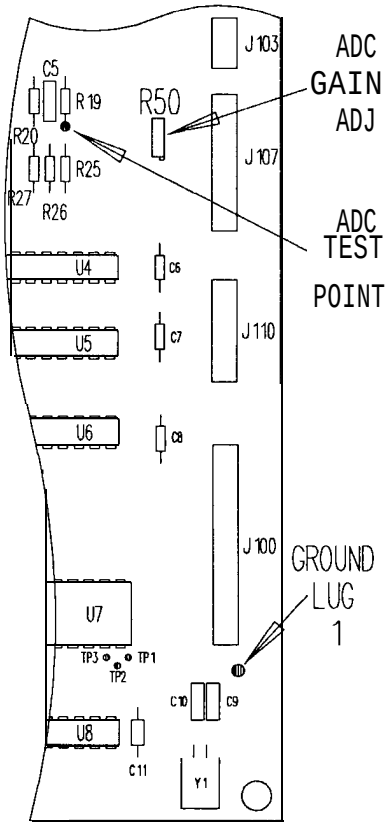


Figure 6-4
Digital Electronic Board
7001-0604

1. Remove the two Spanner screws securing the front drawer assembly of the MEA.

2. **Turn the MEA-1500 power *ON*,** short the **PINPOINT LEADS** together and proceed through **SELF CALIBRATION.** (If the MEA-1500 has a four gas option, a 15 minute warm-up is required.)

3. After completing **SELF CALIBRATION,** measure the **ADC VOLTAGE** at R-19 on the Digital Electronic Board (DEB). The test meter should read -7.5 VDC ± .03VDC. (Refer to Figure 6-4)

4. If the Voltage is within tolerance, go to the Volts Adjustment Procedure.

5. If the voltage is not within tolerance:
   A. Adjust the **ADC REFERENCE** on the Digital Electronics Board until the test meter reads -7.5 VDC ± .03VDC. (Refer to Figure 6-4)
   B. **WARNING: IF AN ADJUSTMENT IS MADE TO THE REFERENCE VOLTAGE, ALL MUX CHANNELS mMST BE RECALIBRATED. THESE INCLUDE ALL FOUR GASSES, AMPS, VACUUM, VOLTS/OHMS AND OIL TEMPERATURE, IF SO EQUIPPED.**
   C. Perform System Calibration and then return to VEHICLE TEST page.

VOLTS ADJUSTMENT PROCEDURE

6. Enter non-gas calibration page.

7. Short the battery and/or coil leads to the ground lead. Adjust the **R136 , ZERO BATT** and **R142, ZERO COIL** pots until the measured voltage on the screen is .000 ±.005 volts.

8. Place the Battery (Red) and Coil (Yellow) leads on the "+" terminal of the IS-100A and the ground lead on the "-" terminal. Set the IS-100A to 13 volts .

9. Measure the IS-100A voltage output using the external test meter and adjust the **R143, BATT GAIN** and **R141, COIL GAIN** pots until the unadjusted voltage values on the screen are the same as the voltage readings on the external test meter ±.1 volt.

10. Enter the TEST PAGE; the battery and coil voltages displayed should be the same as those displayed on the calibration page.

11. Switch the IS-100A to variable and ensure that the displayed voltages track the IS-100A output voltage as read on the external test meter.

12. Battery and Coil calibration is complete. Remove leads from IS-100A.

PIN POINT LEADS CALIBRATION

13. Set the Volt/Ohm output to 13 volts with the ripple OFF. Attach both volt/ohm pin point leads to the "+" terminal of the IS-100A.

14. Move the "-" ground lead of the external test meter to the ground lug on the board and the "+" lead to **STP9, BAL TP.**

15. Adjust **R95, BAL POT** until the external test meter reads 0 volts ±.001 volts.

16. Remove the volt/ohm pinpoint leads from the IS-100A but leave them shorted together. Return the external test meter to DC volts.

17. Place the "+" lead of the external test meter on **STP10, ZERO 100V TP** and adjust the **R138, ZERO 100V POT** to obtain a reading of 0 volts ± .001 Volt on the meter.

18. Place the "+" lead of the external test meter on **STP7, ZERO 20V TP** and adjust **R139, ZERO 20V POT** to obtain a reading of 0 volts **±** .001 volts on the meter.

19. Place the "+" lead of the external test meter on **STP8, ZERO OHMS TP** and adjust **R148, ZERO OHMS POT** to obtain a reading of 0 volts ± .001 volts on the meter.

20. Do a **SYSTEM CALIBRATION.**

21. When the calibration is complete, enter the test page. The displayed voltage reading should be 0 volts ± .01 volts.

OHMS ADJUSTMENT PROCEDURE

22. Switch to read ohms; the displayed ohms reading should be 0 Ω to .1 Ω.

23. Place the "+" volt/ohm pinpoint lead on the IS100A "+" terminal and the "-" lead on the IS-100A "-" terminal. Set the IS-100A to 13volts. Place the external test meter across the IS-100A output terminals.

24. Return the tester to read volts and adjust **R137, VOLTS GAIN** pot until the displayed volts reading is the same as the external test meter to the nearest .01 volt.

25. Switch the IS-100A to variable volts and check that the displayed voltage readings track the IS-100A output voltage.

26. Turn off the power to the IS-100A. Move the volt/ohm pin point leads from the "+" and "-" terminals in the lid of the IS-100A to the ALT.VOLTS/OHMS "+" and "-" posts .

27. Turn the ALT.VOLTS/OHMS switch to the 50k Ω position. Switch the tester to read ohms.

28. Adjust the R96, OHMS GAIN pot until the ohms reading displayed is **50 kΩ ±.2 kΩ.**

29. Remove the Volt/Ohm leads from the IS-100A and short them together.

30. Exit the Vehicle Test Page and perform a System Calibration.

31. After the System Calibration is complete, return to the vehicle test page and select resistance by pressing Volt/Ohm on the remote keypad.

32. Connect the Volt/Ohm leads to the IS-100A'S ALT.VOLTS/OHMS "+" and "-" posts .

38. Set the ALT.VOLTS/OHMS switch to the 50 k Ω position. The MEA-1500 screen **must read 50 kΩ ±1 kΩ.** If not readjust the OHMS GAIN pot R96until the reading is within specification. Then check the following readings:

RESISTANCE	LIMITS
5 ohms	4.75 to 5.25 ohms
50 ohms	47.5 to 52.5 ohms
150 ohms	142.5 to 157.5 OhmS
170 ohms	161.5 to 178.5 ohms
500 ohms	475 to 525 ohms
5K ohms	4.75K to 5.25K ohms
50K ohms	47.5K to 52.5K ohms

Table 6-6

39. Perform a System Calibration and make sure that the VOLTS and OHMS read good *on* the display.

40. If the ADC REFERENCE pot was adjusted at the beginning of this procedure, precede to the appropriate sections of this manual to calibrate:

1. Amps/Vat
2. Gasses
3. Oil Temp.

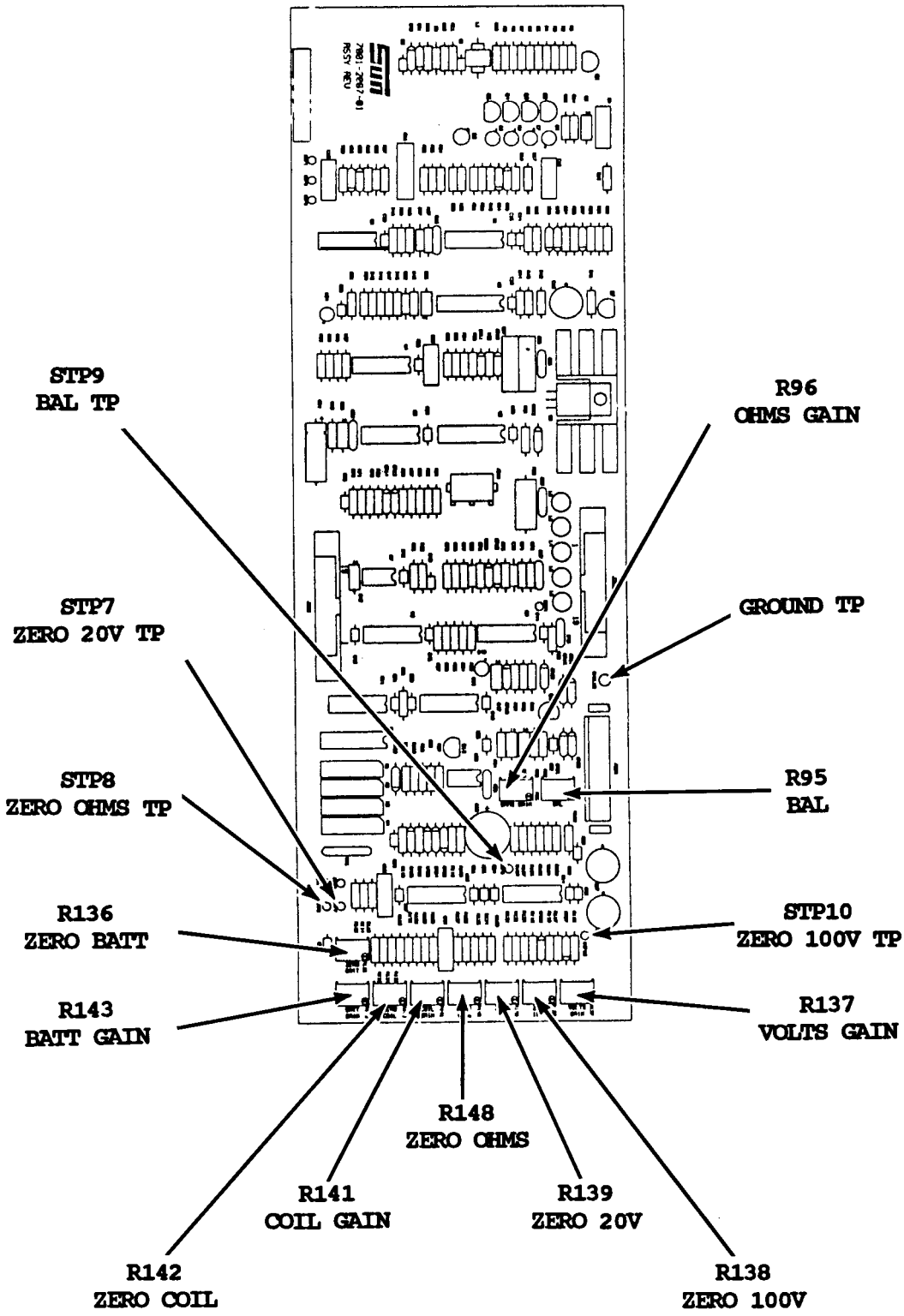


FIGURE 6-5

VOLT/OHM PRINTED CIRCUIT BOARD 7001-2087-01

C. MAG/VOLT/OHM PRINTED CIRCUIT BOARD 7001E9311-15 USED IN MEA-1500 MB (Refer to Figure 6-5)

REQUIRED EQUIPTMENT: IS-100A IGNITION SIMULATOR
CALIBRATION SCREWDRIVER
SPENCO HANDLE and SPANNER BIT #6
DIGITAL VOLTMETER

NOTES:

A. *When performing this procedure, use standard Anti-Static practices.*

B. *At no time during this procedure should the Battery Leads be used to connect the Pin-point Leads to the IS-100A.*

c. *Refer to Figure 6-5, Page 6-21 for Mag/Volt/Ohm board, #7001E9311-15, for the locations and descriptions of Test Points and Pot Adjustments as outlined in this procedure.*

D. *Be sure to check the* actual *output of your IS-100A and adjust Voltage Gains accordingly.*

PRELIMINARY SETUP:

1. Remove the two Spanner screws securing the front drawer assembly of the MEA-1500 MB Tester.

2. Turn the MEA-1500 MB power ON, short the PINPOINT LEADS together and proceed through SELF CALIBRATION. (If the MEA-1500 MB has a four gas option, a 15 minute warm-up is required.)

3. After completing SELF CALIBRATION, proceed to the VEHICLE TEST page by pressing CONT on the remote keypad.

4. Connect the Primary (Blue) and Battery (Red) clips to the IS-100A'S "+" output, and the Ground (Black) clip to the "-" output.

5. Turn the IS-100A'S power ON and set the Volt/ Ohm switch to 13 Volts.

6. Verify that Battery Volts read 13 Volts ± 0.2 Volts.

7. If the Voltage is within tolerence, go to the Volts Adjustment Procedure.

8. If the Voltage is not within tolerence:

   A. Adjust the **ADC REFERENCE** (only pot on the board) on the Digital Electronics Board until the screen reads 13 Volts.

   B. **WARNING : IF AN ADJUSTMENT IS MADE TO THE REFERENCE VOLTAGE, ALL MUX CHANNELS MUST BE RECALIB~TED. THESE INCLUDE, ALL FOUR GASSES, AMPS, VACUUM, VOLTS/ OHMS AND OIL TEMP. IF SO EQUIPPED.**

   c. Perform a System Calibration and then return to the Vehicle Test page.

VOLTS ADUSTJMENT PROCEDURE:

9. Locate the Mag/Volt/Ohm board, #7001E9311-15 used in the MEA-1500 MB, and adjust **R163, VOLTS GAIN POT** to its maximum Clockwise position.
10. Connect both the Red and Black clips of the MEA-1500MB Pin-point Volt/Ohm leads to the "+" output of the IS-1OOA. Set the Volt/Ohm output of the IS-1OOA to 13 Volts, the Ripple and Power switches to the ON position.

11. Set the DVM to read DC Volts and connect the Red lead to **BALANCE ZERO TP** and the Black lead to **GROUND TPO.**

12. Adjust **R178, VOLT BALANCE POT** and **R-142** on the Mag/Volt/Ohm board to read 0.000 Volts DC ± 0.005 Volts on the **DVM.**

13. Remove the Volt/Ohm leads from the IS-1OOA and short them together. Be sure to return the Ripple switch to the OFF position before proceeding.

14. Connect the Red lead of the **DVM** to **TP6, 100 VOLT ZERO TP** and adjust **R84, 100 VOLT ZERO POT** for 0.000 Volts DC ± 0.010 Volts.

15. Connect the Red lead of the DVM to **TP7, 20 VOLT ZERO TP** and adjust **R83 , 20 VOLT ZERO POT** for 0.000 Volts DC ± 0.010 Volts.

16. Select Resistance by pressing the Volt/Ohm key on the remote keypad.

17. Connect the Red lead of the DVM to **TP8, OHMS ZERO TP** and adjust **R82, OHMS ZERO POT** for 0.000 Volts DC ± 0.010 Volts.

18. Perform a System Calibration by Pressing Menu, #4 and #1 on the remote keypad.

19. After System Calibration is complete, return to the Vehicle Test page by pressing Menu twice and then #2 on the remote keypad.

20. Adjust the Variable Voltage Output of the IS-1OOA to 30 Volts.

21. Connect the Pinpoint leads to the output and adjust **R142** on the Mag/Volt/Ohm board, #7001E9311-15, until the screen reads 30 Volts.

22. Connect the black lead of the MEA's Pinpoint leads to the "-" output of the IS-1OOA and the Red to the "+" output.

23. Adjust **R163, VOLTS GAIN POT** until DC Volts on the Screen reads 13 Volts ± 0.1 volts.

24. Short ALL Universal leads together (Red, Green, Yellow and Black).

25. Adjust **R86, COIL + ZERO POT** for 0.00 Volts ± 0.01 on the screen.

26. Adjust **R85, BATTERY + ZERO POT** for 0.00 Volts ± 0.01 Volts on the screen.

27. Check that Distributor Volts are at approximately O Volts on the screen.

28. Remove the Volt/Ohm leads from the IS-1OOA and connect the Black lead of the Universal Harness to the "-" output, the Red, Green and Yellow to the "+" output.

29. Adjust **R81, COIL + GAIN POT** to read 13 Volts ± 0.01 Volts on the screen.

30. Adjust **R143, BATTERY + GAIN POT** to read 13 Volts ± 0.01 Volts on the screen.31. Check that Distributor Volts are at approximately 13 Volts on the screen.

32. Remove the Universal Harness and reconnect the Volt/Ohm leads to the IS-100A.

OHMS ADJUSTMENT PROCEDURE:

33. Select Ohms by pressing Volt/Ohm on the remote keypad.

34. Set the IS-100A for 50K Ohms.

35. Adjust the **R59, OHMS GAIN POT** for 50 K Ohms ± 0.2 K Ohms on the screen.

36. Remove the Volt/ Ohm leads from the IS-100A and short them together.

37. Exit the Vehicle Test page and perform a System Calibration, by pressing MENU, #4 and #1 on the Remote Keypad.

38. After the System Calibration is complete, return to the Vehicle Test page by pressing MENU twice and then #2 on the Remote Keypad and select Resistance by pressing Volt/Ohm on the remote keypad.

39. Connect the Volt/Ohm leads to the IS-100A

40. The MEA's screen must read 50K ohms ± 1K ohm. If not readjust the **R59, OHMS GAIN POT** until it is within specifications. Then check the following readings:

RESISTANCE	LIMITS
5 ohms	4.75 to 5.25 ohms
50 ohms	47.5 to 52.5 ohms
150 ohms	142.5 to 157.5 Ohms
170 ohms	161.5 to 178.5 Ohms
500 ohms	475 to 525 ohms
5K Ohms	4.75K to 5.25K Ohms
50K ohms	47.5K to 52.5K ohms

Table 6-5
Resistance Scale Tolerances

41. Perform a System Calibration and make sure that VOLTS and OHMS read good on the display.

42. If the ADC REFERENCE pot was adjusted at the beginning of this procedure, precede to the appropriate sections of this manual to calibrate:
    1. Amps/ Vac
    2. Gasses
    3. Oil Temp.

****
*** CALIBRATION/CHECKOUT COMPLETE ***
****

NOTES

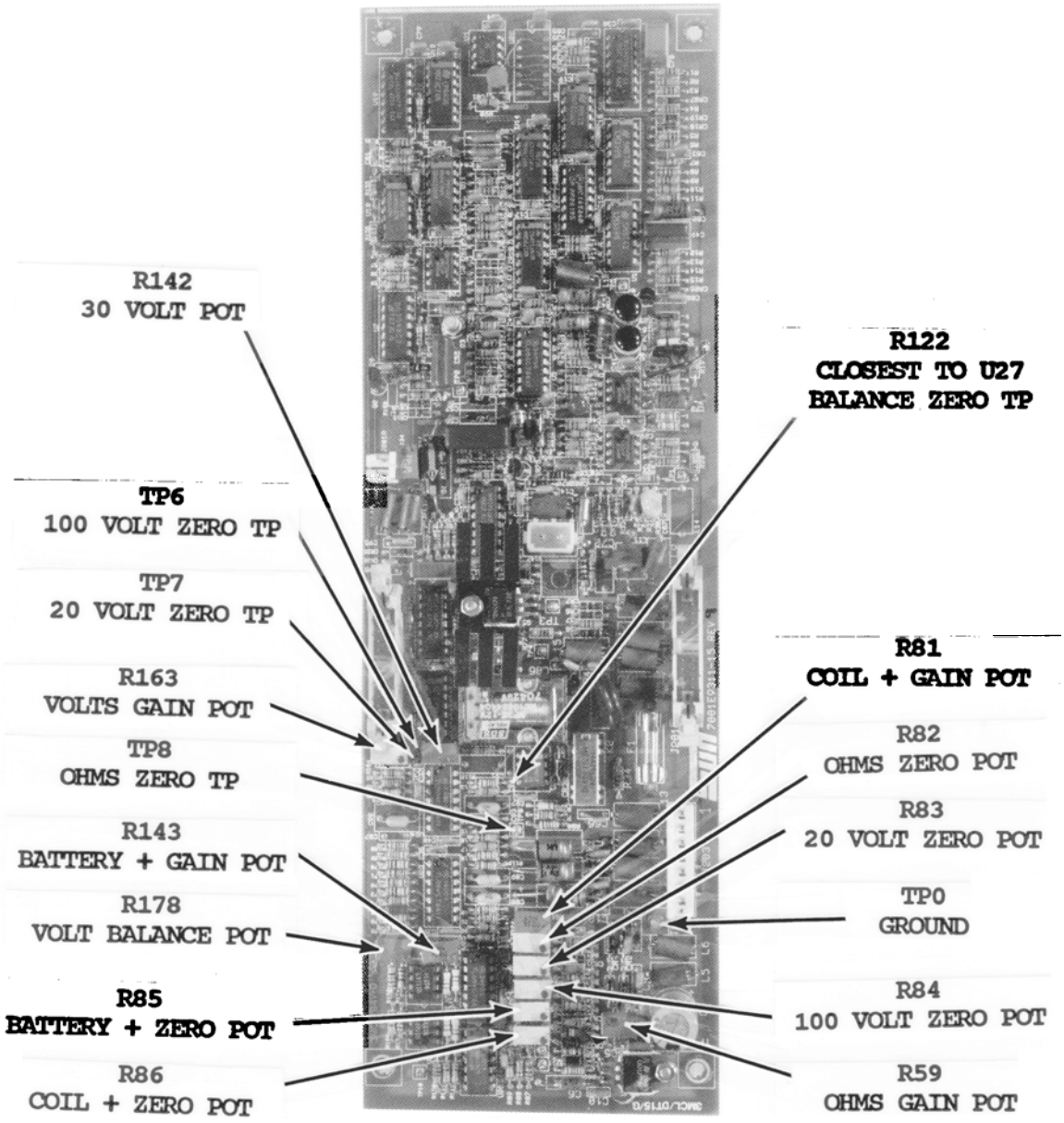


FIGURE 6-6

MAG/VOLT/OHM PRINTED CIRCUIT BOARD 7001E9311-15

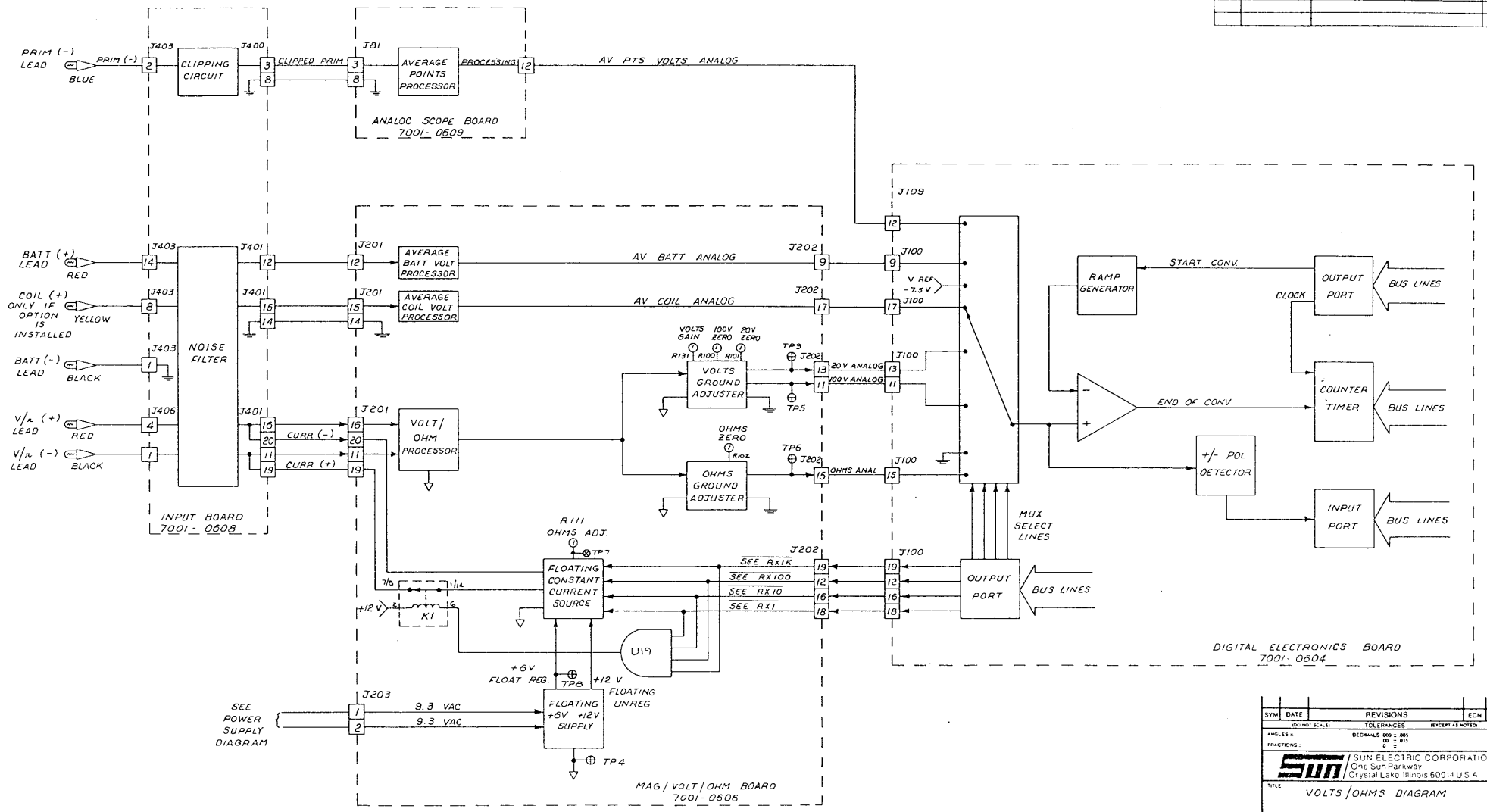
COMPLAINT	CORRECTIVE ACTION
I. OHMS SERVICE REQUIRED AND VOLTS SERVICE REQUIRED	1. Check Volt/Ohm Lead #6004-0462 for proper connection and continuity. If defective, replace. 2. Perform the Volt/Ohm Cal Procedure. 3. Verify Power Supply Voltages at S203 on the Mag/Volt/Ohm Board pin 3, +5V, pin 4, +12V, pin 6, -12V, use pin 5 for ground. 4. Verify 9.3VAC between pins 1 & 2 of J203. If supply is missing refer to chapter 1. 5. ----------SUBSTITUTE---------- A. Mag/Volt/Ohm Board #7001-0606, MEA-1500 #7001-2087-01, MEA-1500 #7001E9311-15, MEA-1500MB and calibrate volts/ohms. B. Digital Electronics Board #7001-0604-02, MEA-1500 #7001-0604-01, MEA-1500 MB. 6. Refer to Theory of Operation and Functional Diagram.
II. **OHMS READING ARE QUESTIONABLE. and/or VOLT READINGS ARE QUESTIONABLE.**	1. Perform Calibration procedure. 2. Verify any two other mux channels besides Volts or Ohms for proper calibration. If they are not calibrated, then perform ADC calibration in chapter 2. **NOTE:** *If this calibration is performed then the entire tester needs recalibrated.* If the two mux channels are OK, then ----------SUBSTITUTE ---------- A. Mag/Volt/Ohm Board #7001-0606, MEA-1500 #7001-2087-01, MEA-1500 #7001E9311-15, MEA-1500MB and calibrate volts/ohms. B. Digital Electronics Board #7001-0604-02, MEA-1500 #7001-0604-01, MEA-1500 MB. 3. Refer to Theory of Operation and Functional Diagram.

	COMPLAINT	CORRETIVE ACTION
III .	**BATTERY VOLTAGE IS QUESTIONABLE.**	1. Verify that the Battery leads are connected. A common mistake is to have the Volt/Ohm leads connected instead of the Battery leads. 2. ----------SUBSTITUTE---------- A. Universal Harness #6005-0161-01, MEA-1500 #6004E9310-32, MEA-1500 MB B. Mag/Volt/Ohm Board #7001-0606, MEA-1500 #7001-2087-01, MEA-1500 #7001E9311-15, MEA-1500MB. c. Digital Electronics Board #7001-0604-02, MEA-1500 #7001-0604-01, MEA-1500 MB. D. Input Board #7001-0631, MEA-1500 #7001-2002-01, MEA-1500 #7001E9311-20, MEA-1500 MB. 3. Refer to Theory of Operation & Functional Diagram.
Iv.	**DIST. V. IS NOT DISPLAYED**	1. Verify that the Engine is not running. Readings are static and will not be displayed with engine running. 2. Refer to Theory of Operation & Functional Diagram.
V.	**DISTRIBUTOR VOLT READINGS ARE INACCURATE**	1. If the primary pattern and Dwell are also inoperative, ----------SUBSTITUTE---------- A. Universal Harness #6005-0161-01, MEA-1500 #6004E9310-32, MEA-1500 MB. B. Input Board #7001-0631, MEA-1500 #7001-2002-01, MEA-1500 #7001E9311-20, MEA-1500 MB **c.** Analog Scope Board #7001-0609, MEA-1500 #7001-2004, MEA-1500 MB 2. Connect the primary lead to the 13 volt supply on the IS-100A and the black volt lead to ground.

	COMPLAINT	CORRECTIVE ACTION
v.	**DISTRIBUTOR VOLT READINGS ARE INACCURATE (continued)**	If the dist. resistance reading reads 13 volts there is currently no problem with this unit. If the dist. resistance reading is O or inaccurate, ----------SUBSTITUTE---------- A. Analog Scope Board #7001-0609, MEA-1500 #7001-2004, MEA-1500 MB B. Digital Electronics Board #7001-0604-02, MEA-1500 #7001-0604-01, MEA-1500 MB 3. Refer to Theory of Operation & Functional Diagram.

LIST OF MATERIAL

QTY REQD	PART NO.	DESCRIPTION	ITEM NO.



SYM	DATE	REVISIONS	ECN	APVL

TOLERANCES (DO NOT SCALE) EXCEPT AS NOTED

ANGLES ± DECIMALS .000 ± .005 .00 ± .015 .0 ±

FRACTIONS ±

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake Illinois 60014 U.S.A.

TITLE: VOLTS/OHMS DIAGRAM

MODEL: MEA 1500 / DIAGRAM 6-1

MAT'L AND/OR FINISH

DWG BY R.K. / ENG APVL /

CHK BY Dimmick / ENG APVL /

SCALE | SHT OF | DWG SIZE D | DWG NO. | PAGE 6-27/6-28

CHAPTER 7

SPARE PARTS

TABLE OF CONTENTS

PICTORIAL PARTS
- LEADS AND ACCESSORIES 7-1
- FRONT VIEW EXTERNAL 7-2
- REAR VIEW EXTERNAL 7-3
- POWER SUPPLY DRAWER 7-4
- FRONT DRAWER 7-5
- REAR VIEW INTERNAL 7-5

PARTS LISTING 7-6

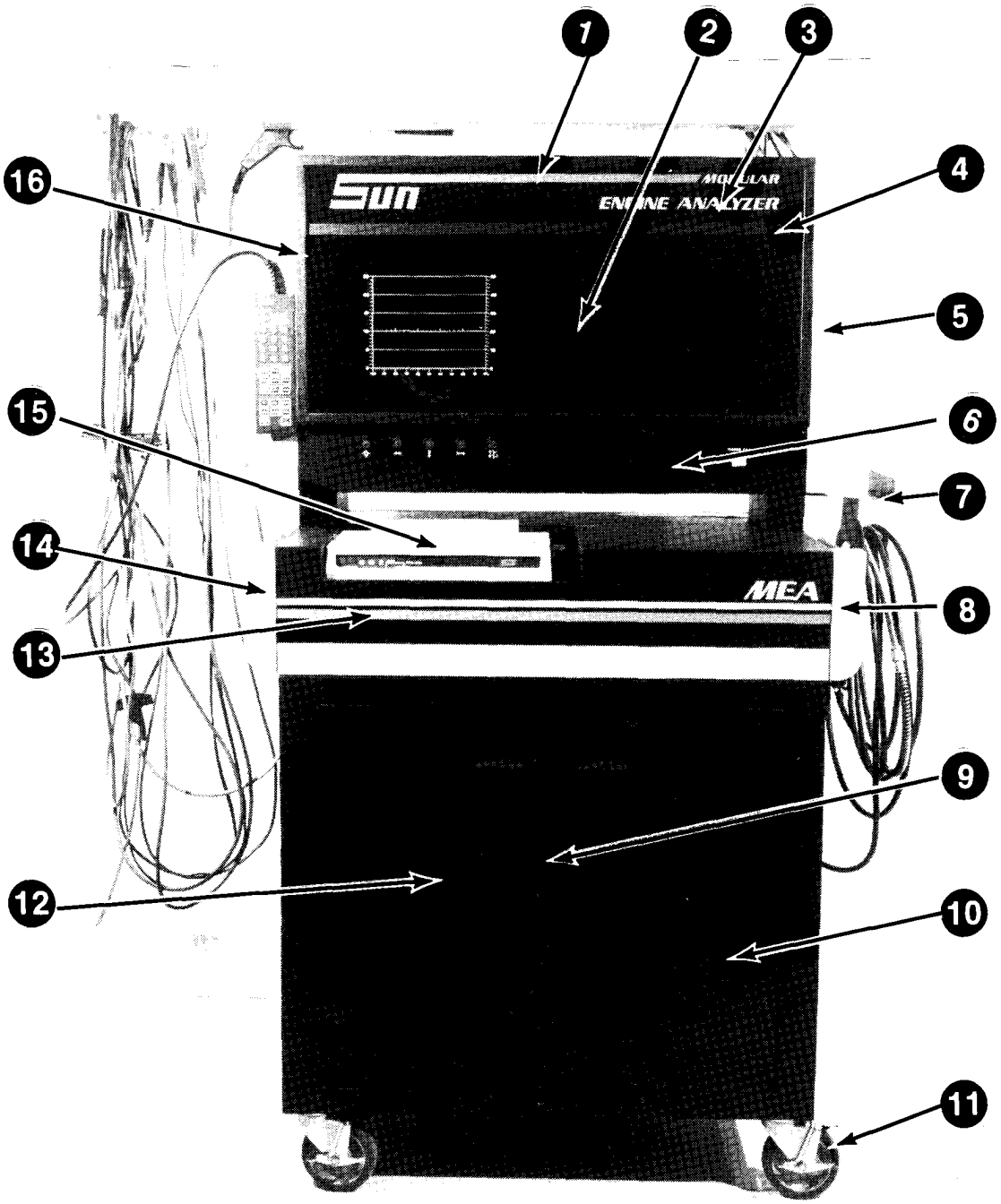
LEADS AND ACCESSORIES

1. Trigger Lead 6004-0262-03	6. Remote Control Assy . .7009-1892
1a.Trigger Pick-up 0507-0006	6a.Cable (plastic case) .6004-0547
2. Pattern Lead 6004-0332-01	6b.Keypad Kit 0120-0518
2a.Pattern Pick-up 1747-0101	6c.Plastic housing, fr **.7054-o102
2b.GM HEI adaptor . . . 1747-0102	6d.Plastic housing, rr **.7054-0103
2c.Adapter Lead 6002-0048	6e.Corner Caps (4) 0720-0025
2d.Toyota HEI adaptor . . 1747-0103	6f.Magnet(plastic Case)..0865-0112
3. Amp Lead Assy. (option) .6005-0133-01	7. Vacuum Hose (option) ..6006-0007
3a.Current Lead 6004-0254-01	8. Mag Probe (option) . . .7009-1890
4. Universal Cable 6005-0161-01	9. Timing Light Assv 7009-1704-01
4a.Coil "+" Lead. (option).6005-0172	9a.Timing Light Cable . . 6004-0403-01
4b. Clip 0672-0003	9b.On/Off Switch 0764-0207
4c.Boot, Black 0190-000 1	9c.Knob Assy 7009-1063
4d.Boot, Red 0190-0002	9d.Timing Light board . . 7001-0440
4e.Boot, Blue 0190-0003	9e.Fuse 1A,Slo-blo 0739-0040
4f.Boot, Yellow 0190-0016	9f.Timing Light Adv. Pot..0685-0360
5. Volt/Ohm Lead . . . 6004-0462	10.Insulating Pliers . . . 0002-1028
5a.Clip . . . . . 0672—0029	11.Ignition Coil Adapters .3676-0501
5b.Red Boot 0809-0031	12.Resistance Test Probe..4344-0000
5c.Black Boot 0809-0032	13.Test Lead Assy (2) 6005-0067

CABLES UNIQUE TO MEA-1500 MB

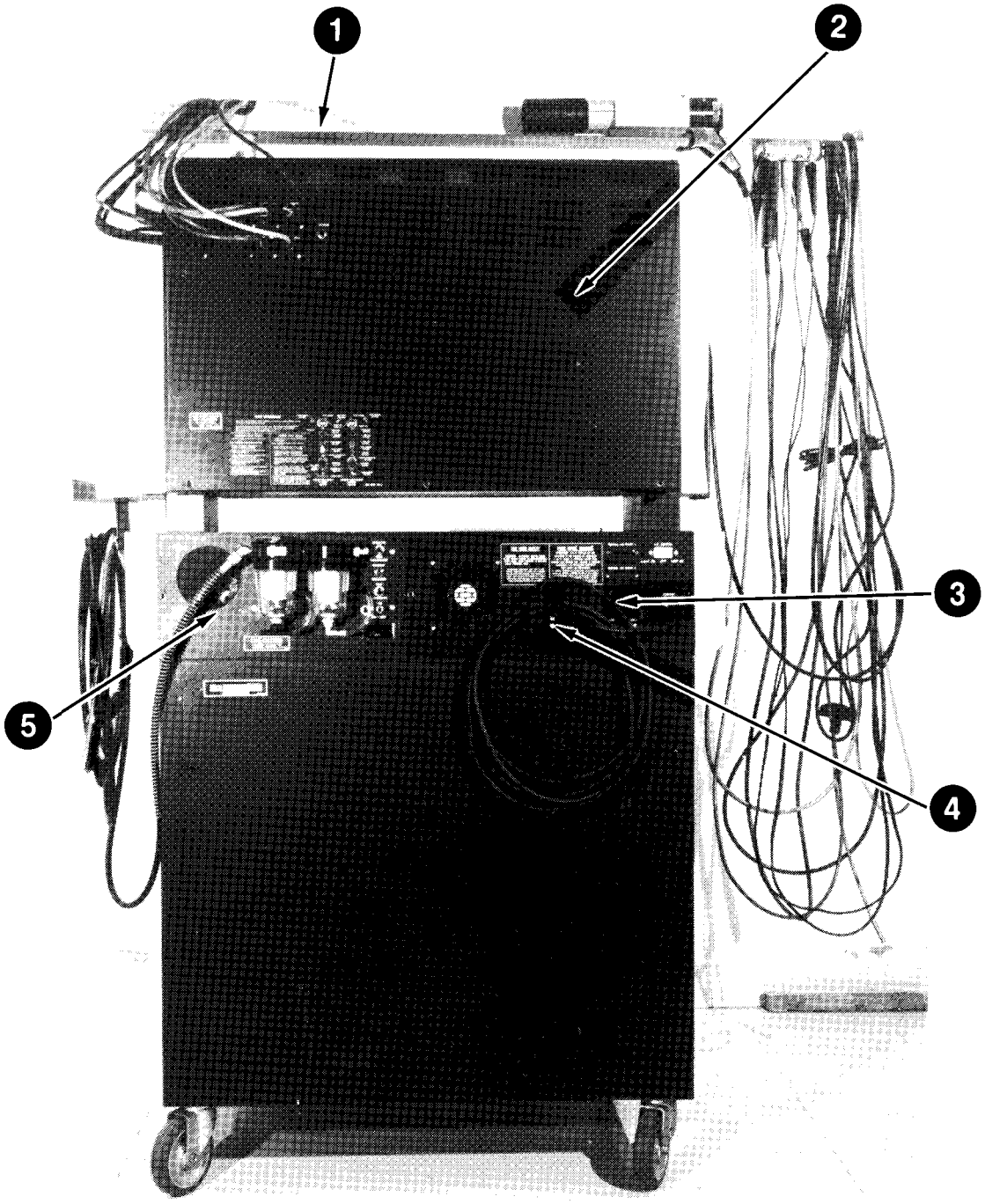
Cable, Universal Extention	6004E9311-35
Cable, Universal Harness	6004E9310-32
Cable, Oil Temp. Extention	6004E9310-42
Cable , Oil Temp. Probe	6004E9310-37
Cable, MB Diagnostic	6004e9016-00
Cable , MB Adapter	6004e9017-00

** The remote control metal case and cable assembly (metal) are no longer available. If a metal case or lead are damaged, a new plastic remote control assembly (7009-1892) is required.



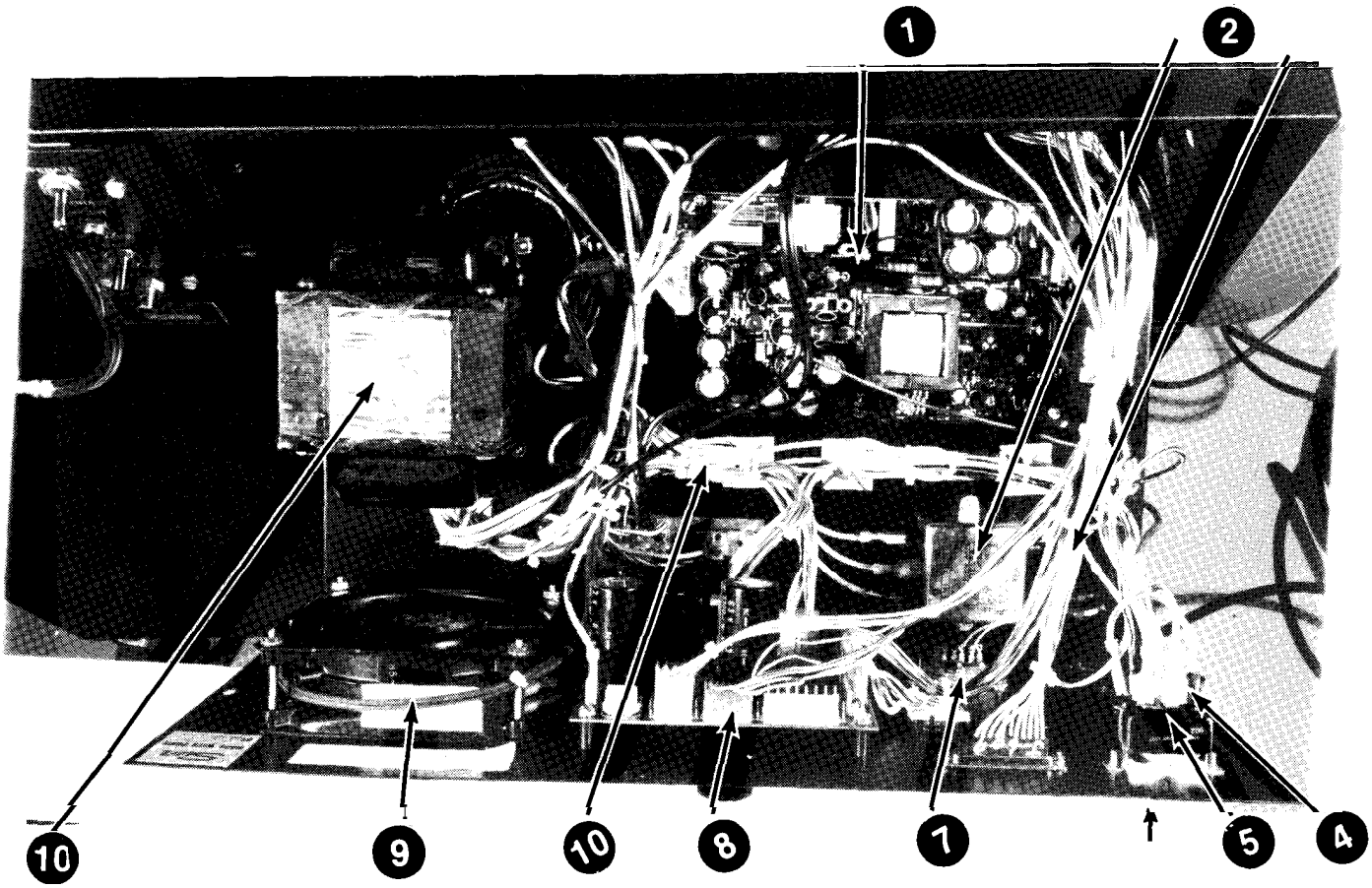
FRONT VIEW (EXTERNAL)

1. Head Sign 7030-0161
2. Graticle 7045-0090
2a. Graticule, Anti-Glare 7045-0090-01
2b. Graticule MB Only 7045-0090-02
3. Lamp, fluorescent 30".3000-0001-01
4. Retainer Bar 7024-0444
4a. Retainer Plastic. ..7032-0151
5* Panel, side dress 7005-0783
6. Front Drawer Assy . . . See page 7-5
7. Hanging Bracket 7020-1818
8. Handle Side Panel,L..7009-1882-02
9. Cabinet, C-34 . . . . N/A
10. Door, Right side . . . 7020-1827-02
10a.Hinge Pin, Top 7024-0452
11. Caster, with brake . .3645-0025
11a.Caster 3645-0009
12. Door, Left side . . .7020-1827-01
12a.Hinge Pin, bottom 7024-0453
12b.Catch, Magnetic 2397-0203
12c.Bushing, Hinge pin . 1489-0504
13. Headframe, Lower . . . 7020-1816-02
14. Handle Side Panel, R. .7009-1882-01
15. Printer . . . . . see pg 11-9
15a.Tray, Printer . . . 7018-0245
16. Headframe, Upper 7020-1816-01



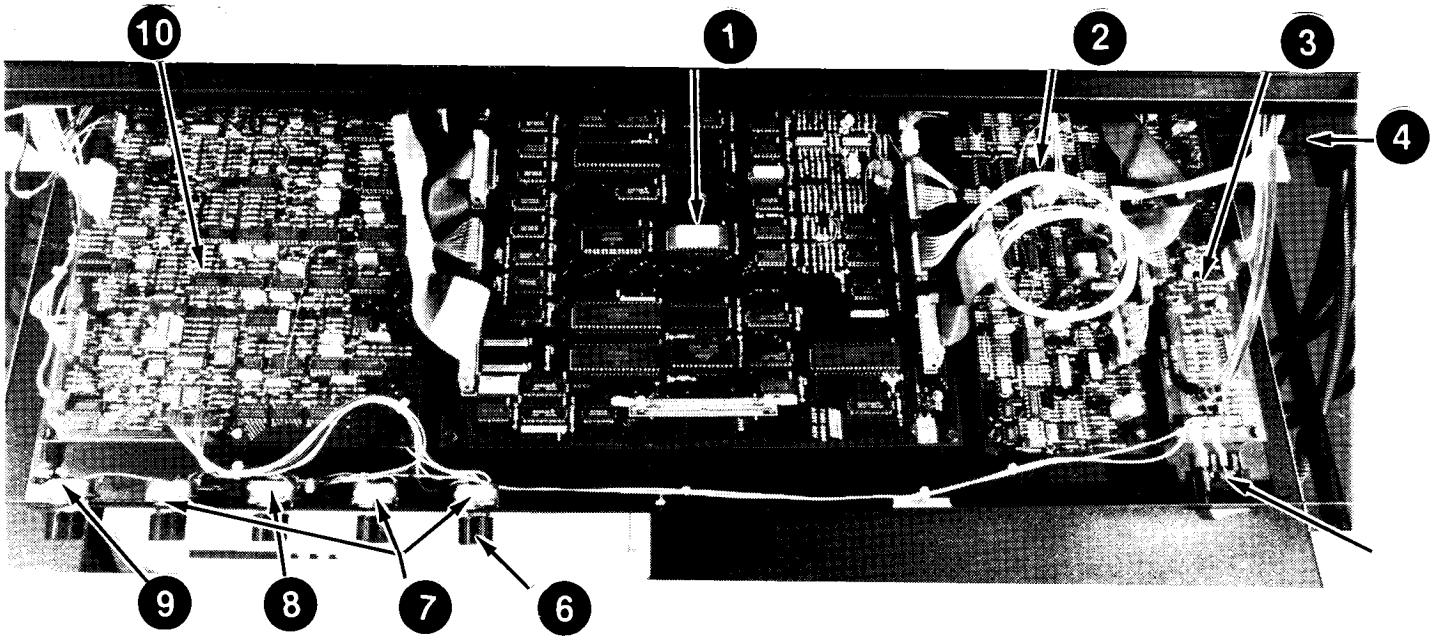
REAR VIEW (EXTERNAL)

1. Boom Assy . . . . .see pg 10-4
2. Rear Panel 7020-1812
2a. Screws, Rear Panel . . 0610-0163
3. Power Supply Drawer . . see pg 7-4
3a. Screws, P.S. Drawer 0410-0063
4. A.C. Hanger Bracket 2161-0005-03
5. IR Option Drawer Assy...see pg 9-20
5a. Screws, IR Drawer . .0410-0063
5b. Cover Plate, No IR Opt. .7005-0796



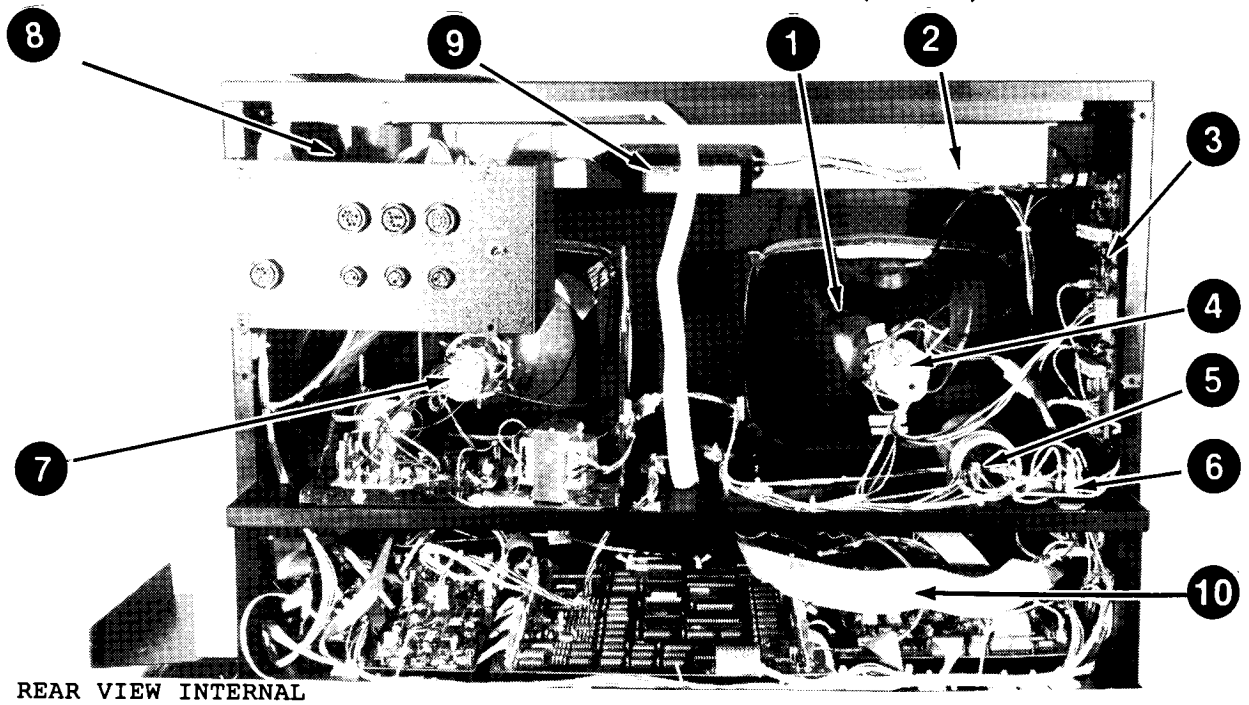
POWER SUPPLY DRAWER

1. Switching Power Supply.0532-0015
1a. Fuse F.B. 3A/250V 0739-0026
1b. Screws, 6x32, 3/8 Hex. .0403-1341-06
2. Filter, RF 0531-0003
3. Varistor Assy 7009-1320-01
4. Circuit Breaker (7A). ..1922-0105-23
5. Switch, Rocker 0764-0209
6. A.c. Power Cord 6001-0154
6a. A.C. Plug 0825-0020
7. Switch, (+/-) 0764-0119
8. Power Supply Board . . .7001-0611
8a. Screws, 6x32 3/8 Hex.403-1341-06
9. Fan Axial. 0587-0504
10. Fuse, FB 3A/250V . . . 0739-0026
11. Transformer 7009-1889



FRONT DRAWER

1. Digital Board MB Only 7001-0604-01
la.Digital Board 702l-O6O4-O2
2. Mag/ Volt/ Ohm MB Only 7001E9311-15
2a.Mag/ Volt/ Ohm Board. ..7001-0606
2b.Mag/ Volt/ Ohm Board 7001-2087-01
3. Amps/Vat. board (opt) ..7OOl-O6O5
4. I/R Cal. Board (opt) ...7001-0607
5. Switch, Rocker (mom.) ..0764-0219-02
6. Knobs (5) 0758-0183-01
7. Var. Resistor, 10K (3).0685-0430-01
8. Var. Resistor, 10K (1).0685-0430-03
9. Var. Resistor, 250K 0685-0430-02
10. Analog Scp. Enhanced 7001-2004
10a. Analog Scope board. ..7001-0609
11. Ser I.F. (DL100) Bd. ..7OO1-0639



REAR VIEW INTERNAL

1. Analog Scope CRT(12) . .0859-O073
2. High Voltage supply . .7009-1599
3. Deflection Board 700l-O449
3a.Transistors(4)2N5885..0776-0265
3b.Mica Washers . . .O776-O9O5
3c.Screws, 6-32 X 3/4 0406-0144
4. Deflection Yoke Assy. .7009-1784
5. Cap. 50,000 mfd . . . 0679-0536
6. Rectifier, Bridge (30A)0771-0412
7. Digital Monitor Assy. .7001-1692-Ol
8. Input Board. 7OOl-O63l
8a.Input Board w/Fuse 7001-2002-01
8b.Input board MB OnlY 7001E9311-20
8c.Fuse, 250V, 5A 0739-0104
8d.Oil Temp MB Only 7009E9314-20
9. Ballast Assy . . .7009-l888-Ol
10. Cable (W25, Input Bd. to Analog scope Bd.) 6004-0355-05

DESCRIPTION	PART#	COMMENTS
Adapter, GM HEI	1747-0102	
Adapter, Ignition Coil	3676-0501	
Adapter, Lead HEI	6002-0048	
Adapter, Toyota HEI	1747-0103	
Ballast Assy.	7009-1888-01	Headframe Sign
Board, Amp/Vat (Optional)	7001-0605	In Front Drawer
Board, Analog Scope	7001-0609	In Front Drawer
Board, Analog Scope (Enhanced)	7001-2004	In Front Drawer
Board, Deflection	7001-0449	On Side Panel
Board, Digital Electronics	7001-0604-02	In Front Drawer
Board, Digital MB Only	7001-0604-01	
Board, I/R Cal. (Optional)	7001-0607	Right Side Wall
Board, Mag/Volt/Ohm	7001-0606	Front Drawer Assy.
Board, Mag/Volt/Ohm	7001-2087-01	
Board, Mag/Volt/Ohm MB Only	7001E9311-15	
Board, Oil Temp MB Only	7009E9314-20	
Board, Power Supply	7001-0611	Power Supply Drawer
Board, Signal Input	7001-0631	Upper Left Rear of tester
Board, Signal Input	7001-2002-01	
Board, Signal Input MB Only	7001E9311-20	
Board, Timing Light	7001-0440	In T/L
Bracket, A.C. Cable	2161-0005-03	On Power Supply Drawer
Bracket, Hanging	7020-1818	T/L & Leads(No Boom Option)
Bracket, Timing Light	7020-0848-06	With Boom Option
Cable, A.C. Power	6001-0154	Power Supply Drawer
Cable, Amp Probe Assy. Opt.	6005-0133-01	
Cable, Coil + Opt	6005-0172	
Cable, Current Lead	6004-0254-01	Green Lead
Cable, MB Adapter MB Only	6004E9017-00	
Cable, MB Diagnostic MB Only	6004E9016-00	
Cable, Oil Temp Probe MB Only	6OO4E931O-37	
Cable, Oil Temp. Ext. MB Only	6OO4E931O-42	
Cable, Pattern	6004-0332-01	Blue Lead
Cable, Remote (metal case)	6004-0502	
Cable, Remote (plastic case)	6004-0547	
Cable, Timing Light	6004-0403-01	
Cable, Trigger	6004-0262-03	Red Lead
Cable, Universal	6005-0161-01	
Cable, Universal Ext. MB Only	6OO4E931O-35	
Cable, Universal MB Only	6OO4E931O-32	
Cable, Volt/Ohm	6004-0462	
Cable Assembly	6004-0355-05	Input bd to Analog scope bd
Cap. 50,000mf	0679-0536	Yoke Supply
Caster	3645-0009	c-34
Caster W/Brake	3645-0025	c-34
Catch, Magnetic	2397-0203	Cabinet
Circuit Breaker (7A)	1922-0105-23	Power Supply Drawer
Clip, Alligator	0672-0029	Volt/Ohm lead
Clip	0672-0003	Universal lead
Corner protectors	0720-0025	On Remote Control Metal Box
Cover Plate, without I/R Opt.	7005-0796	
CRT, Analog Scope (12”)	0859-0073	Picture Tube

DESCRIPTION	PART#	COMMENTS
Door , Left Side	7024-1827-01	Cabinet
Door, Right Side	7020-1827-02	Cabinet
Fan, Axial	0587-0504	In Power Supply Drawer
Filter, RF	0531-0003	In Power Supply Drawer
Fuse, 1A Slo-Blo	0739-0040	In Timing light
Fuse, 3A/250V	0739-0026	On Switching Supply
Fuse, 5A/250V	0739-0104	Sig Input Bd (7001-2002-01)
Graticule	7045-0090	
Graticule, Anti-Glare	7045-0090-01	
Graticule MB Only	7045-0090-02	
Headframe, Lower	7020-1816-0	
Headframe, Upper	7020-1816-01	
HeadSign	7030-0161	Sun Version
Headsign Retainer (frtpnl)	7024-0444	
High Voltage Power Supply	7009-1599	High Voltage Supply
Hinge Pin, Bottom	7024-0453	Cabinet
Hinge Pin, Bushing	1489-0504	Nylon for Cabinet
Hinge Pin, Top	7024-0452	Cabinet
Hose, Vacuum Assy.	6006-0007	External Test Hose
Insulator Boot, Black	0809-0032	Volt/Ohm lead
Insulator Boot, Black	0190-0001	Universal lead
Insulator Boot, Blue	0190-0003	Universal lead
Insulator Boot, Red	0809-0031	Volt/Ohm lead
Insulator Boot, Red	0190-0002	Universal lead
Insulator Boot, Yellow	0190-0016	Universal lead
Kit, 4-Gas	120-492-1	Optional
Kit, Amp/Vacuum	120-495	Optional
Kit, Boom	120-496	Optional
Kit, Coil (+) Voltage	120-497	Optional
Kit, Keypad	0120-0518	On Remote Control
Kit, Mag Timing	120-494	Optional
Kit, Printer Accessory	120-500	Optional
Knob, Front Panel Control	0758-0183-01	5 used
Knob, T/L Advance	7009-1063	Includes decal
Lamp, fluorescent 30”	3000-0001-01	Head Sign light
Mag Probe	7009-1890	Optional
Magnet	0865-0112	For Plastic Remote
Mica Washers	0776-0905	For Transistors
Monitor, Digital	7009-1692-01	VDU (With AC Connector)
Monitor, Digital	0859-0407	VDU (Without AC Connector)
Video Sweep Board	0859-0511	
Panel, Lower Left Side	7009-1827-01	Handle included
Panel, Lower Right Side	7009-1882-02	Handle included
Panel, Rear	7020-1812	
Panel, Side Dress	7005-0783	
Pick-up, Pattern	1747-0101	
Pick-up, Trigger	0507-0006	
Pliers, Insulated	0002-1028	Accessory
Plug, A.C. Cable	0825-0020	Replacement

DESCRIPTION	PART #	COMMENTS
Pot , Front Panel	0685-0430-01	Horz. , Length, Raster
Pot , Front Panel	0685-0430-02	Brightness
Pot , Front Panel	0685-0430-03	Vertical
Pot ., T/L Adv.	0685-0360	Timing Light
Printer, Optional	AP-1OOOR	Rebuilt Printer
Printer, Optional	AP-1OOO	New Printer
Probe, Resistance	4344-0000	Accessory
Rectifier, Bridge,30A	0771-0412	Yoke Supply
Remote Back (Plastic) **	7054-0103	
Remote Control Assy.	7009-1892	
Remote Front (Plastic) **	7054-0102	
Retainer, Bar	7024-0444	
Retainer, Plastic Washer	7032-0151	Holds bar to headframe
Screws, #6-32 x 3/8	0403-1361-06	For Remote (6 used)
Screws, #6-32 x 3/8	0403-1341-06	For Circuit Boards
Screws, #8-32 x 3/4	0408-0077	Retainer screws
Screws, 6-32 x 3/4	0406-0144	
Screws, I/R Drawer	0410-0063	
Screws, P.S. Drawer	0410-0063	
Screws, Rear Panel	0610-0163	
Screws, Tamper proof	0410-0133	Front Drawer
Switch, Keypad (Remote)	0552-0014	YES-BACKUP-NO Ser B & later
Switch, Rocker	0764-0207	Timing Light Power
Switch, Rocker	0764-0209	Main Power
Switch, Rocker (SPDT)	0764-0219-02	Engine Kill, Front Panel
Switch, Slide (+/- Grd.)	0764-0119	Ground Ref. Switch
Switching, Power Supply	0532-0015	Power Supply Drawer
Test lead Assy	6005-0067	6" Male/Female (Fasten)
Timing Light Assy.	7009-1704-01	
Transformer, T1	7009-1889	In Power Supply Drawer
Transistors(4) 2N5885	0776-0265	Deflection Board
Tray, Printer	7018-0245	Removable Tray
Varistor Assy.	7009-1320-01	On E.M.I. Filter and I.R. Pump Switch
Washer, Plastic	4003-0003-03	Front Drawer
Yoke, Deflection Assy.	7009-1784	Scope

** The remote control metal case and cable assembly (metal) are no longer available. If a metal case or lead are damaged, a new plastic remote control assembly (7009-1892) is required.

CHAPTER 8

AMPS/VACUUM OPTION

SECTION 1. AMPS THEORY OF OPERATION

The Amp probe senses the current drawn from the battery (- readings) and current returned to the battery from the charging system (+ readings). The orientation of the Amp probe is important. The arrow on the Amp probe should point away from the negative terminal of the battery when the probe is placed around the negative (ground) cable. When the Amp probe is placed around the positive cable (if more than one cable is coming from the battery, the clamp should go around all of them) the arrow should point towards the positive terminal of the battery. If the clamp is oriented the wrong way, the charging current will be displayed as negative and the current drawn out of the battery will be displayed as positive.

The Amp probe contains a Hall chip which produces a voltage that is proportional to amplitude and the polarity of the magnetic flux around the current carrying wire(s). Biasing for the Hall chip and processing of the voltages from the Amp probe is provided by the Amps/vat Board located to the right of the Mag/Volt/Ohm Board in the front drawer assembly.

The Amp probe contains a "symmetry" adjustment. This adjustment is used to produce a symmetrical swing (+ and -) around zero. The symmetry adjustment must be made using an SRT-28. Refer to the SRT-28 instructions for information on how to calibrate the Amp probe or reference Service Bulletin #403.

The Amps/Vat Board has fixed gain circuitry that can be switched between xl and x10. The computer controls the xl and x10 gain circuitry via the SELECT 1000/100A* (SEL 1000/100A*)line. When the SELECT 1000/100A* line is low, the x10 gain is selected. The x10 range provides readings from 0 to 100 amps. When the SELECT 1000/100A* line is high, the xl range is selected. The xl range provides readings from 0 to 1000 amps.

The zero of the amps channel is adjusted with R43. The gain is adjusted with R42. See the amps calibration procedure on page 8-3 for the adjustment procedure of these two pots. It is important to note that the computer will fail amps on the Self Calibration page if the amps channel is greater than approximately +/- 14 amps. When the computer goes through Self Calibration the zero offset of the AVERAGE AMPS ANALOG channel is read and stored in RAM memory. Before test readings are displayed, the computer adjusts for the zero offset.

The chart on the next page shows some typical voltage readings and the scale selected. The Mux voltages are displayed on the Manual Calibration (NON GAS) page.

AMPERAGE SENSED	SCALE (GAIN)	Mux VOLTAGE	SCALE SELECT LINE SELECT 1000/100AMP*
80 AMPS	100	5.6 V	LOW
80 AMPS	1000	0.56 V	HIGH
200 AMPS	1000	1.4V	HIGH

This tester employs auto ranging to select what gain is being used. This is done by the Digital Electronics Board by monitoring the Avg Amps Analog chanel. If Avg Amps Analog exceeds a certain point the Digital Electronics Board forces SEL, 1000/100A* high changing X10 to Xl.

The output of the xl & x10 gain circuitry is routed to the Mux ADC via two channels. One output of the xl & x10 gain circuitry is fed through a filter before going to the Mux ADC. This channel is called AVERAGE AMPS ANALOG (AVG AMP ANLG). The AVERAGE AMPS ANALOG channel provides an average output voltage of the currents sensed. This channel is used for all amp readings at this time. There is however, a RAW AMPS ANALOG (RAW AMPS ANLG) channel which is routed to the Digital Electronics Board but is not used at this time.

SECTION 11. AMPS SERVICE CALIBRATION PAGE USAGE

If needed, refer to the Introduction (page iii) for general information & specific instructions on how to access the Manual Calibration (NON-GAS) page.

MANUAL CALIBRATION (NON-GAS)

ADC CHANNEL	MEASURED VOLTAGE	UNADJUST VALUE
BATTERY V.	x.xxx	x.x v
DIST. V.	x.xxx	xxx v
COIL (+)	x.xxx	x.x v
AMPS (loo)	x. xxx	x.x A
VACUUM	x. xxx	x.x H
DC V. (X20)	x . xxx	xxx v
DC V. (X1OO)	x.xxx	x.x v

1 - TOGGLES AMPS RANGE
2 - TOGGLES OHMS RANGE

Variable data represented by X.

Current mux voltage & uncorrected amp readings.

Depressing 1 toggles amps range from one scale to the other.

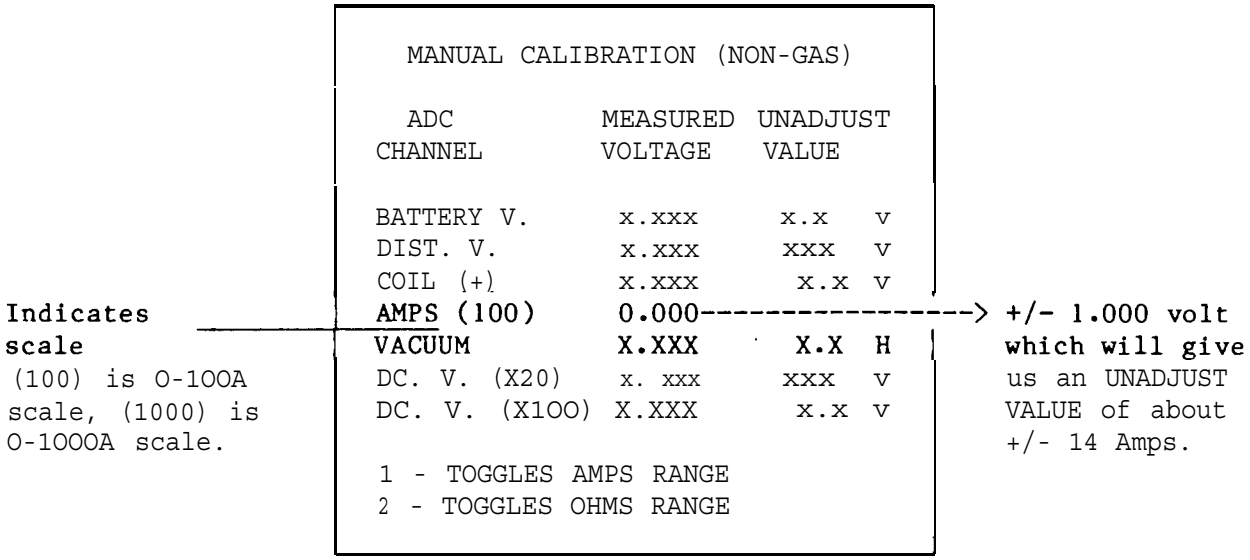
MANUAL CALIBRATION (NON-GAS) PAGE

UNADJUST VALUE
The UNADJUST VALUE reading is the current amps reading based on the AVERAGE AMPS ANALOG channel. The reading displayed is uncorrected for zero offset. And is a representation of AVERAGE AMPS ANALOG after conversion to Amps. Without regard to the stored calibration constant gathered by the Digital Electronics Board during self calibration.

MEASURED VOLTAGE
The MEASURED VOLTAGE is to the left of the unadjust value on the AMPS line. It is the voltage presented to mux select circuitry on the Digital Electronics Board at all times.

TOGGLES AMPS RANGE
Allows the forcing of the two possible amp scales (O-100A) or (O-1000A), while we are in the MANUAL CALIBRATION (NON-GAS) PAGE.

GOOD AMP CALIBRATION LIMITS



SECTION III. AMPS CALIBRATION

REQUIRED EQUIPMENT: IS-100(A) Ignition Simulator
Calibration Screwdriver

1. Open main drawer and turn dip switch #8 of SW1 to the "on" position.

2. Proceed to the MANUAL CALIBRATION (NON-GAS) page. NOTE: See introduction (page iii) for specific instructions on how to access MANUAL CALIBRATION (NON-GAS) page.

3. Adjust R43 on the AMP/VAC Board (//7001-0605) until the MEASURED voltage reads 0.000 volts +/- .005.

SEE PAGE 8-7 FOR POSITIONING 0F R42 AND R43

4. Turn IS-100(A) "on" and allow 5 minute warm up. Connect the green Amps probe #6005-0133-01 to IS 100(A)'S current loop. Set IS 100(A) for 80 amps.

5. Adjust R42 on the Amps/Vat Board #7001-0605, until the tester's UNADJUST VALUE reads 80.0 amps +/- 1.0 amp on the O to 100 amp scale. (O to 100 amp scale is determined by (100) next to the word AMPS on the MANUAL CALIBRATION (NON-GAS) page.)

6. Move the ISl00(A) Amps polarity switch to the opposite position. UNADJUST VALUE must read -80 amps +/- 5.0 amps. If the reading is out of tolerance, recalibrate amps probe using SRT-28.

7. Hold ISl00(A) amp switch in the 200 amp position. The UNADJUST VALUE must be 200 amps +/- 10 amps. (Amp scaling must change from 0-100A scale (100) to 0-1000A scale (1000).

****

*** CALIBRATION COMPLETE ***

****

SECTION IV. AMPS TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
1. Fails Self Calibration Tester displays, SERVICE REQUIRED or "****" are displayed instead of readings.	1. Verify Power Supply Voltages at J303 on the Amps/Vat Board pin 1 -12V, pin 2 12V, pin 4 is ground. If Supplies are missing see Section 1-4. If Supplies are present go to next step. 2. Monitor Amps channel in MANUAL CALIBRATION (NON-GAS) page, while performing wiggle test on Amps probe's lead. If Amps channel readings vary excessively replace lead #6004-0254-01. If Amps channel readings remain steady proceed to next step. 3. A. Perform Amps Calibration, page 8-3. 4. ----------SUBSTITUTE---------- A. Amps probe #6005-0133-01 and perform Amps calibration. B. Amps/Vat board #7001-0605 and perform Amps and Vacuum calibration. C. Digital Electronics Board #7001-0604 5. Refer to Theory of Operation and Functional Diagram #8-1.

COMPLAINT	CORRECTIVE ACTION
II. Tester fails to recognize Amps/Vacuum Option.	1. Check status on option select switch #5 SW1 (on D.E.B.) should be "on". ----------SUBSTUTITE---------- 2. Digital Electronics Board #7001-0604 3. Refer to Theory of Operation and Functional Diagram #8-1.
III. Amp readings are questionable.	1. Verify that Amp probe jaws are closing properly and no excessive build-up is on the jaws. 2. Perform Amps Calibration -- Page 8-3. 3. Verify any two other mux channels besides Amps or Vacuum for proper calibration. If they are not calibrated, perform ADC calibration page 2-3. NOTE : If this calibration is performed the entire tester needs recalibrated. If the two mux channels are good, proceed to step 1 of complaint I, "Fails Self Calibration." 4. Refer to Theory of Operation and Functional Diagrams #8-1.

SECTION V. VACUUM THEORY OF OPERATION

The pressure transducer on the Amps/Vacuum Board outputs a voltage that is proportional to the pressure applied to it. A perfect vacuum is O PSIA (pressure per square inch absolute) and atmospheric pressure at sea level is approximately 14.7 PISA. As the applied pressure decreases (vacuum increasing) the output voltage decreases. The vacuum processing circuitry (represented by the VAC PROCESSOR block) amplifies the output from the transducer and provides the zero adjustment R28, and the gain adjustment R36. The VACUUM ANALOG (VAC ANLG) signal is routed to the Digital Electronics Board for signal conversion.

During Self Calibration the computer converts and stores the voltage present on the Vacuum analog channel as the "vacuum zero". All measurements are displayed using the stored "zero" as a reference. A Service required message will be displayed on the Self Calibration page if the "zero" limits are exceeded. The limits must be between 3.5 to 6.0 volts with atmospheric pressure applied to the transducer for an acceptable zero to be stored.

This tester can be selected to display in two different units of measurement, inches of mercury and millibars. This selection can be made using switch #6 of dip switch package SW1 on the Digital Electronics Board. "OFF" being inches of mercury, and "ON" being millibars.

SECTION VI. VACUUM SERVICE CALIBRATION PAGE USAGE

If needed, refer to the Introduction (page III) for general information & specific instructions on how to access the Service -Calibration pages. The Vacuum portion of the MANUAL CALIBRATION (NON-GAS) page is discussed below.

```
    MANUAL CALIBRATION (NON-GAS)

     ADC          MEASURED  UNADJUST
  CHANNEL         VOLTAGE    VALUE

  BATTERY V.       x.xxx      x.x  v
  DIST. V.         x.xxx      xxx  v
  COIL (+)         x.xxx       x.x v
  AMPS (l00)       x. xxx      x.x A
  VACUUM           x.xxx       x.x H
  DC V. (X20)      x.xxx      xxx  v
  DC V. (X100)  X.XXX          x.x v

   1 - TOGGLES AMPS RANGE
   2 - TOGGLES OHMS RANGE
```

Variable data represented by X.

Current mux voltage & uncorrected vacuum readings. Character next to unadjust value on vacuum line indicates unit of measurements, H for inches of mercury and M for millibars.

MANUAL CALIBRATION (NON-GAS) PAGE

UNADJUST VALUE

The UNADJUST VALUE reading is the current vacuum reading based on the VACUUM ANALOG channel. The reading displayed is uncorrected for zero. It is a representation of VACUUM ANALOG after conversion to inches of mercury. But without regard to the stored calibration constant gathered by the Digital Electronics Board during self calibration.

MEASURED VOLTAGE

The MEASURED VOLTAGE is to the left of the unadjust value on the VACUUM line. It is the voltage present at the mux select circuitry on the Digital Electronics Board at all times.

GOOD SELF CALIBRATION LIMITS

```
   MANUAL  CALIBRATION  (NON-GAS)

    ADC          MEASURED  UNADJUST
  CHANNEL        VOLTAGE    VALUE

  BATTERY V.      x. xxx      x.x   v
  DIST. V.        x. xxx      xxx   v
  COIL (+)        x.xxx        x.x  v
  AMPS (l00)      x. xxx       X.X  A
  VACUUM          x.xxx ----------------->
  DC. V. (X20)    x. xxx      xxx   v
  DC. V. (X100)  x.xxx         x.x  v

  1 - TOGGLES AMPS RANGE
  2 - TOGGLES OHMS RANGE
```

MEASURED VOLTAGE MUST BE BETWEEN 3.500 TO 6.000V AT ATMOSPHERIC PRESSURE TO CALIBRATE.

SECTION VII. VACUUM CALIBRATION

REQUIRED EQUIPMENT: Vacuum source (MIGHTY VAC or equaivalent.)
Calibration screwdriver

1. Advance the tester to the "MANUAL CALIBRATION (NON-GAS)" page. See the Introduction (page v) for specific instructions on how to access the Service Calibration pages.

2. Verify that the vacuum's measured voltage is 4.750 +/- 0.200 volts.

3. Connect Vacuum Source to MEA's vacuum line.

4. Apply 20.0" of mercury to MEA's vacuum line, as read on the vacuum standard gauge. The vaccum should read 20" +/-0.3". If O" and 20" are both accurate, calibration is complete. If either are out of specs, proceed.

5. Adjust R28 on Amps/Vat Board #7001-0605 until "MEASURED VOLTAGE" reads 0.000 volts +/-0.000 volts.

6. Remove vacuum from MEA's vacuum line.

7. Adjust R36 until "MEASURED VOLTAGE" is 3.8000 +/-0.010 volts.

8. Readjust R28 until "MEASURED VOLTAGE" reads 4.750 volts +/-0.010 volts.

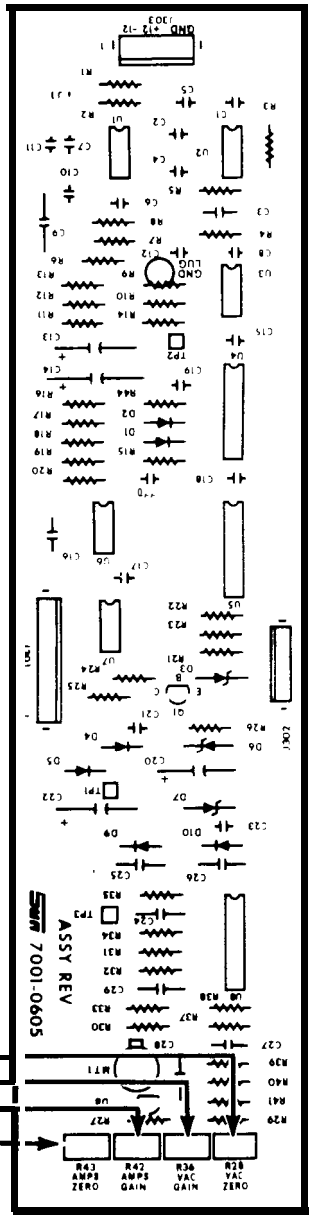
9. To repeat system calibration press "MENU" twice. Select CALIBRATION MENU by pressing "4". To perform SYSTEM CALIBRATION press "l" on remote. Unit should now be performing SYSTEM CALIBRATION or self calibration.

10. Repeat the procedure starting at step 1 until both the O" and 20" tolerances are met.

* *

* **CALIBRATION COMPLETE** *

****

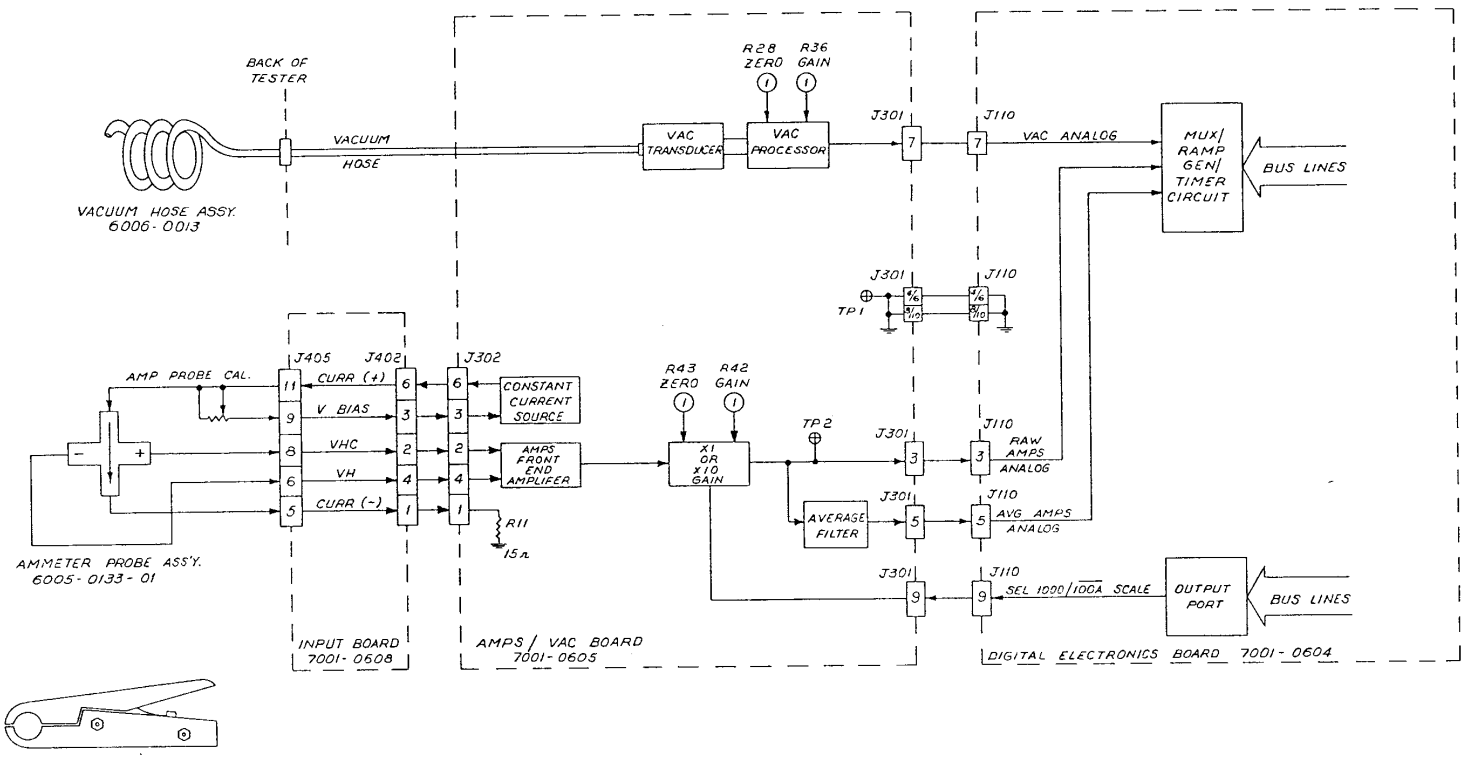


SECTION VIII. VACUUM TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. Vacuum fails self calibration. Tester displays, SERVICE REQUIRED or "****" instead of readings.	1. Verify that there is no vacuum present at tester's vacuum line. 2. Verify Power Supply Voltage at J303 on the Amps/Vat Board pin 1 -12V, pin 2 12V, pin 4 is ground. If Supplies are missing see Section 1-4. If Supplies are present go to next step. 3. Perform Vacuum calibration. 4. ----------SUBSTITUTE---------- A. Amps/Vat Board #7001-0605 and perform Vacuum calibration. B. Digital Electronics Board #7001-0604 5. Refer to Theory of Operation & Functional Diagram #10.
II. Vacuum readings Inaccurate.	1. Check for Vacuum leaks (i.e. cracks in Vacuum Line) from tester's Vacuum Line end to termination of Vacuum Line at Amps/Vat Board. 2. Perform Vacuum calibration. 3. If cannot calibrate: ----------SUBSTITUTE---------- A. Amps/Vat Board #7001-0605 and perform Amps and Vac calibration. B. Digital Electronics Board #7001-0604 4. Refer to Theory of Operation & Functional Diagram #10.

LIST OF MATERIAL

QTY REQD	PART NO.	DESCRIPTION	ITEM NO.



SYM	DATE	REVISIONS	ECN	APVL

(DO NOT SCALE) TOLERANCES (EXCEPT AS NOTED)

ANGLES ± DECIMALS .000 ± .005 .00 ± .015 .0 ±

FRACTIONS ±

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake Illinois 60014 U.S.A.

TITLE: AMP/VACUUM OPTION

MODEL: MEA 1500/DIAGRAM 8-1

MAT'L AND/OR FINISH:

DWG BY: R. K. / ENG APVL: /

CHK BY: D. Weisberg / ENG APVL: /

SCALE | SHT OF | DWG SIZE D | DWG NO. PAGE 8-9/8-10

Model: Kit #0120-0495

Assembly & Installtion Instructions

The installation of Kit #0120-0495 provides the MEA-l5OO with the Amps/Vacuum Option and is only available as a Field Installation item.

PARTS LIST

QTY	PART NUMBER	DESCRIPTION
1	7001-0605	Amps/Vacuum, C.C.A.
5	N/A	Screws, 6-32 by 3/8" Hex
1	7076-0514	Wiring Harness, Amps/Vacuum, W1O
1	7076-0515	Wiring Harness, Amps/Power, W15
1	7076-0516	Wiring Harness, Amps Input, W20
40"	0669-0229	Hose, Vacuum 3/16" I.D.
1	2209-0002	Nipple, Hose
2	0409-0029	Nut, Hex 3/8"
2	0603-0010	Washer, Lock, Ext. 3/8"
8	5878-0015	Strap, Cable
1	6007-0007	Hose Assembly, Vacuum
1	6005-0133-01	Test Lead Assembly, Current
1	2894-0501	Tee Assembly, Hose
1	0669-0623	Hose Rubber, 6"
1	0669-0733	Hose Rubber, 6"
1	0669-0734	Hose Rubber, 6"

REQUIRRD TOOLS

FLAT SCREWDRIVER
NUT DRIVER SET

INSTALLATION PROCEDURE

1. Remove the two front panel screws holding the C.C.A. "drawer" in place and pull out the drawer.

2. Remove all the test leads from the input board on the rear of the tester and remove the nine screws securing the rear panel.

3. Remove the two screws holding the Power Supply "drawer" (located in the lower right hand side of the tester as viewed from the rear) in place and pull it open.

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4. As you are facing the front of the tester, mount the Amps/Vat board (p/n 7001-0605) to the right hand side of the Volt/Ohm/Mag board (p/n 7001-0606), with the Cal Pots to the front, and secure into place using the provided hardware.

5. Remove W1O from the parts package and connect P301 to J301 on the Amps/Vat Board and P11O to J11O on the Digital Electronics Board.

6. Remove W15 from the parts package and connect P303 to J303 on the Amps/Vat Board. Route W15 down to the Power Supply Shelf and connect P603 to J603 on the Power Supply Assy.

7. Remove W20 from the parts package and connect P302 to J302 on the Amps/Vat Board. Route W15 up to the Input Board and connect P402 to J402 on the Input Board.

8. Remove the black plug, located near the Input Board. Place the 3/8" lock washer over the nipple and insert through the hole from the inside. Install and tighten the 3/8" hex nut supplied.

9. Connect the supplied Vacuum Hose (p/n 0669-0229) to the vacuum transducer on the board and route it through the tester along the digital side of the tester and up to the Input Board at the rear of the tester. DO NOT cut the hose to length. Push the hose over the vacuum nipple.

10. Position the vacuum hose and wiring/ribbon harnesses to the rear of the main C.C.A. drawer and then to the out sides of the tester allowing enough slack so the drawers open and close with no binding or pulling and secure them with cable straps and ties provided.

11. Turn switch #5 of SWl on the Digital Electronics Board (p/n 7001-0604) to the "ON" position to activate the Amps/Vat option.

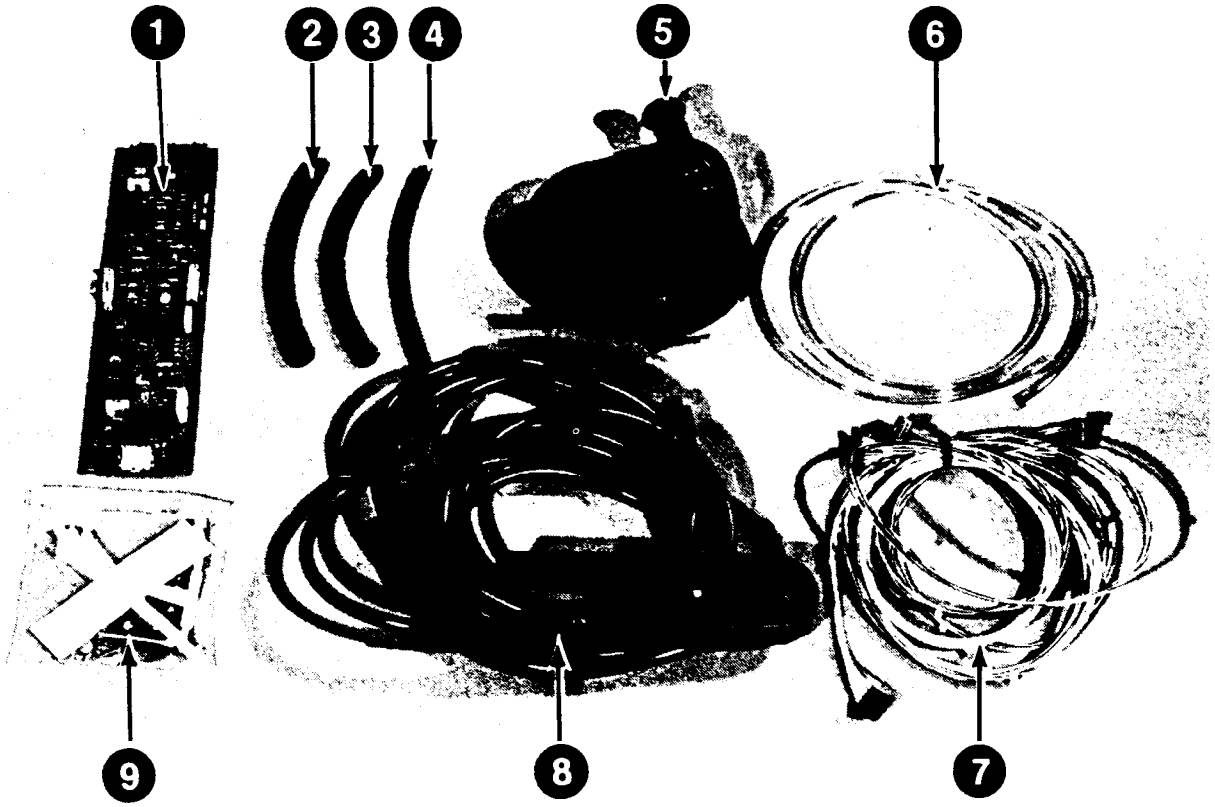
12. Push in both drawers and re-install the hold down screws. Then re-install the rear panel and hook up the leads.

13. Remove the Vacuum Hose Assembly (p/n 6007-0007) and the Current Tester Lead Assembly (p/n 6005-0133-01) from the parts package and install them on the tester.

CHECK OUT PROCEDURE ——————————————————————————————

Refer to Chapter 8 of the MEA-1500 Service Manual for complete checkout and calibration procedure.

****
*** INSTALLATION COMPLETE ***
****



AMPS VACUUM OPTION (0120-0495)

1.	AMP/VAC BOARD 7001-0605	8B .	SPRING 0711-0224
2.	HOSE O669-O623	8C.	CONNECTOR, 14PIN 4162-O8O6
3.	HOSE 0669-0733	8D.	PINS, MALE 4162-0926
4.	HOSE 0669-0734	8E .	PINS, FEMALE 0676-0022
5.	HOSE ASSEMBLY 6006-0007	9.	HARDWARE PACKET . . . . . N/A
6.	HOSE, 3/36" ID. (40'').. .0669-0229	9A.	TEE ASSEMBY 2894-O5O1
7A.	WIRING HARNESS, TO DEB.7076-0514	9B .	CABLE TIE, SWALL . . 5878-OO15
7B.	WIRING HARNESS, POWER..7076-0515	9C.	WASHER 3/8" EXT. LOCK..O6O3-OO1O
7C.	WIRING HARNESS, INPUT. .7076-0516	9D.	NUT, HEX 3/8" 0409-0029
8.	AMP LEAD 6005-0133-01	9E.	NIPPLE, HOSE 2209-0002
8A.	CABLE 6OO4-O254-O1		

CHAPTER 9

BAR-80 EXHAUST EMISSIONS 0PTION--HC/CO/C02/O2

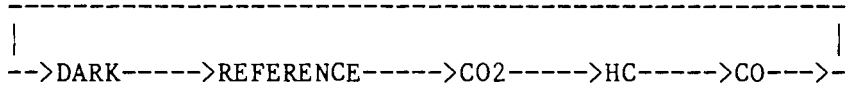
SECTION 1. THEORY OF OPERATION

NOTE 1: The following text is used in conjunction with diagram 9-1.
NOTE 2: The terms "analyzer" & "bench" are used interchangeably throughout this chapter when referring to the Infrared gas Analyzer.

GENERAL

The Infrared Analyzer used in the MEA-1500's BAR-80 option is a three gas analyzer (HC, CO & C02) made by Andros Analyzers Incorporated. The in depth details of inter-workings of the analyzer will not be discussed, instead a general overview will be given. If more information is desired on the Analyzer, refer to the Integration Interface Manual. The manual is available to Sun CSR'S through the Training/Documentation group located at Crystal Lake.

The Analyzer uses a metalized ceramic heater as the source of infrared energy. The infrared energy passes through a rotating filter wheel. The rotating filter wheel contains the HC, CO, C02 & Reference filters. The filter wheel also has a portion that does not allow infrared energy to pass through. This portion is called the dark portion of the wheel. As the filter wheel rotates, infrared energy from the source passes through each filter in succession, creating a sequential train of pulses, each of a specific wave length. The pulse train is as follows:



After the filter wheel the infrared energy passes through the sample cell. The sample cell contains the gases to be measured. The higher the gas concentration in the sample cell the less energy that is received by the detector. The detector converts the infrared energy to a voltage. This voltage is amplified by the Cooler/Preamp board and the pulse train decoded by the Processor board of the analyzer.

Each gas has its own output. The output test points are given below. These test points are located on the Processor board (top board) of the analyzer. With no gas going through the analyzer, the output of the analyzer channels will be zero volts. When spanned, the Full Scale output of the analyzer is 10 volts DC.

HC --- TP6
CO --- TP7
C02 --- TP5

The stability of the motor frequency is of particular importance to the operation of the analyzer. The DC motor in the analyzer spins the filter wheel at 95 Hz. With the filter wheel rotating at 95 Hz, the dark pulse will be at every 10.5 milliseconds. The processor board uses the pulse created from dark portion of the filter wheel to decode the pulse train. This dark level pulse can be observed at the Dark Level Test Point (DLTP) located on the processor board. The figures on the following page show the DLTP signal and the gas channels output test points.

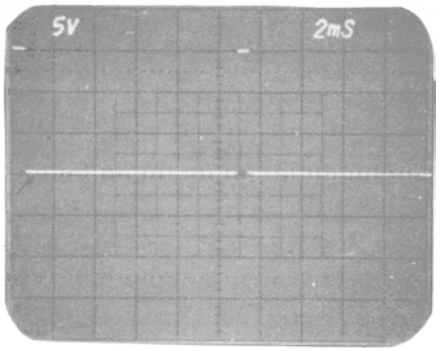
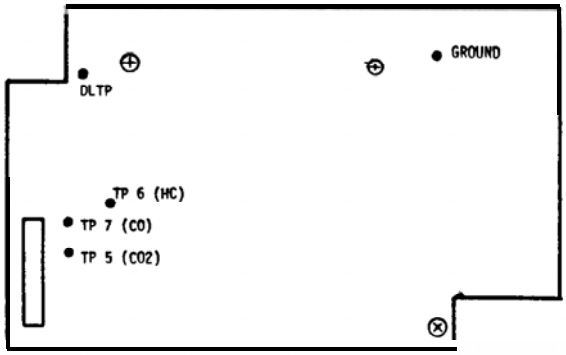


FIGURE 9-1 DARK LEVEL TEST POINT SIGNAL



TOP VIEW OF
ANDROS ANALYZER

FIGURE 9-2 GAS CHANNEL & DLTP TEST POINT LOCATION

SIGNAL ROUTING FROM THE ANALYZER TO THE COMPUTER

As an example, assume the analyzer was being spanned, all channels would be at 10 volts. These DC voltages could be measured at TP7, TP6 & TP5 with a DVM or an Oscilloscope. From the analyzer the signals (DC analog voltages) are routed to the Emissions Calibration board. The Emission Calibration board divides the CO and C02 voltage output of the analyzer by 2. This scales down the analyzer output voltages to within the +/-7.5 volt range of the Mux A/D. The signals are routed to the Digital Electronic Board where the voltage is converted and read by the MUX A/D (for better understanding of the MUX circuit see Chapter 2). The HC channel is routed directly to the Digital Electronic board, where it is not only fed directly to the MUX but also is divided by 2 to create the extended HC scale. This scale is used in the manual power balance page.

SPAN

When the computer goes through the Self Calibration page it checks the zero of each of the three gas channels and the full scale output of each channel. SPAN* causes the output channels of the bench to go to their full scale output (lo volts). The computer energizes SPAN* via Digital 1/0 port on the Digital Electronics Board. When the SPAN* is active (low), the analyzer goes to full scale voltage.

HC change readings are taken from the engine under test during power balancing. HC change readings are the difference between the HC readings with the cylinder shorted and the same cylinder not shorted. The air/fuel mixture is not burned with the cylinder shorted. This raw air/fuel mixture might cause the normal HC channel to overrange. To prevent this overrange, the computer uses the HC REL channel during the powerbalance test.

The computer takes a base HC reading before any of the cylinders are shorted. It is from this "base" reading that the amount of change is calculated.

CALIBRATION POTS

Each gas channel (HC,C0,C02) has a zero pot and a full scale pot and a Cal pot. The C02 also has a coarse adjustment for each of these. The zero pots are used to set the zero voltage of each gas channel and the Full scale pots are used to set the output voltage of each channel to 10 volts when the analyzer is electrically spanned. The Cal pot is used to compensate for the differences in optics from one analyzer to the next analyzer and requires adjustment when the Infrared analyzer is replaced and a different analyzer is installed into the tester. Therefore, there are two infrared calibration procedures; one for use when the infrared analyzer is changed (Long procedure) & one for use when adjusting or checking the accuracy of the analyzer (Short procedure).

There is no VCAL pots on this tester, all gas calibration is done in software, automatically during the gas calibration routine.

02

The 02 reading is obtained from a self contained 02 sensor. The characteristics of the 02 sensor are much like a variable battery. The more oxygen present the higher the output voltage. Nominal output voltage with 20.8% oxygen is 7 to 10 millivolts. With no oxygen present the output is approximately O millivolts. This voltage is routed to the Cal board where it is amplified and output to the Digital Electronic Board. Nominal voltage at this point for 20.8% oxygen is 5 volts. On the Digital Electronic the signal is routed to the Mux A/D circuit for conversion to a Digital signal.

WARM-UP

When the MEA-1500 is powered up, the Warm up page is displayed. The length of the warm up period is 15 minutes. All tests except Gas Readings can be performed during this period. Going back to the menu page will display how much time is left of the 15 minutes.

GAS CALIBRATION

The following text explains the step by step description of the internal workings during the GAS CAL page. The gas tag values of the tri-blend gas must be entered into the analyzer under the calibration menu prior to this test.

1. All solenoids are turned off to allow sampling from the zero port.
2. After 15 seconds, the 02 span (20.8%) voltage is stored. It is normally 5 volts. The acceptable window is 5.0 +/- 2.0 volts.
3. HC/CO/C02 zero voltages are stored. They should normally be 0.00 volts. The acceptable window is from -2.0 to +2.0 volts.
4. Electrical span of the bench is activated.
5. Electrical span voltages for the HC/CO/C02 channels are stored. The span is normally 5.00 volts (10.00 volts at the bench). The acceptable window for all three channels is from +3.0 volts to +7.0 volts (at the main board).
6. Solenoid V3 is turned on to allow internal cal gas to flow through the bench.

7. After 15 seconds. the channel voltages are read. and a gas correction factor is caculated for each channel. If the output of the channel deviates more than 3% from what was expected, as based on the entered gas tag value and the corresponding look up table value, then calibration is failed. A failed channel is forced to read O.
8. With gas still flowing, the 02 voltage is measured and stored. It is nominally 0.00 volts. The acceptable window is from -2.0 to +2.0 volts.
9. Calculations are stored in the non-volatile, non-protected RAM memory.
10. Non-protected checksum is re-calculated and updated.

LEAK TEST

The following text explains the step by step description of the internal working during the LEAK TEST page. To perform a leak test (Option 7), a leak test adapter hose must be connected from the leak test port to the tip of the sample probe, and the Cal Gas Tank must be connected with the proper flow adjusted. NOTE- Flow rates are critical!!

1. Cal gas solenoid V3 is turned "on" to allow direct flow of cal gas into the bench. See LEAK CHECK A diagram.
2. After a stabilization period, the resulting channel readings are stored.
3. Solenoid V3 is released and solenoids V2 and V4 are energized to allow gas flow out the leak test port, through the leak test adapter, thru the sample handling system and into the bench. The concentration will be read and displayed by the "Upper" heading. The highest concentration level read is displayed by the "Peak" heading. See LEAK CHECK B diagram.
4. After a stabilization period, V2 de-energized, trapping the cal gas. If the sample system has "no leaks the reading will stay the same and the leak check will pass. If the system has a leak, fresh air will be drawn in and the sample will be diluted. If this dilution is greater than 3%, the gas reading will be displayed in the "Lower" space and leak check will fail.

SECTION 11. HC/CO/C02 SERVICE CALIBRATION PAGE USAGE

```
        MANUAL CALIBRATION (GAS)

  GAS    MEASURED    UNADJUSTED
CHANNEL  VOLTAGE    CONCENTRATION

  HC       x.xxx         xxxx PPM
  co       x.xxx         xxx  %
  C02      x.xxx         xxx  %
  02       x.xxx         xx.x %

SELECTED  SOLENIOD  CONFIGURATION
   1 ZERO GAS    4 SAMPLE
   2 CAL GAS     5 LEAK CHECK
   3 SPAN
```

Variable data is represented by X

(2) HC/CO/C02/02 SERVICE CALIBRATION PAGE

The Service Calibration page allows the CSR to monitor the mux voltages of the 4 gas channel, and force the pneumatics into any of 4 configurations. This is accomplished by pressing the number diplayed in front of the configuration wanted. The unadjusted concentration reading is only displayed

on selections 1, 3, and 5, and is the calculated value of the gas reading, disregarding any zero offset that was read during calibration.

MEASURE VOLTAGE

The Measure voltage readings are the current voltages on their respective input channel on the MUX A/D. They will range from O volts to 5 volts depending on the concentration of gas in the analyzer. With no gas in the analyzer they should be at O volts, as the gas concentration in the analyzer increases the voltages will increase, with Full scale being approximately 5 volts. This would be 10 volts on the output test points on the analyzer (voltage is divided by 2).

1 ZERO

During ZERO the pneumatics are configured to draw clean air, as shown on page 9-11. The readings displayed indicate the unadjusted value. The ZERO voltages are the current mux readings with clean sample being drawn through the bench. The voltages for HC, CO, and C02 must be between +2.00 and -2.00 volts, and 02 must be 5.00 +/-1 volt in order to pass self calibration.

2 CAL GAS

During CAL GAS the pneumatics are configured to draw gas in from the Gas Cal port as shown on page 9-16. The readings displayed indicate the unadjusted value of the gas present at the Gas Cal port.

3 SPAN

During SPAN the pneumatics are configured to draw clean air, as shown on page 9-17. The SPAN voltages is what the respective Mux channel went to when the analyzer is being spanned. All voltages must be 5.00 +/- 2.0 in order to pass Self Calibration. Being able to have the computer force the analyzer to a SPAN condition is useful for troubleshooting. With the SPAN flashing, the computer should have taken the SPAN* line low going to the analyzer. If the analyzer did not span (go to full scale) it is a simple matter of taking a few voltage measurements to find out where the problem lies.

4 SAMPLE

During SAMPLE the pneumatics are configured to draw from the exhaust sample hose , as shown on page 9-15. The voltage and unadjusted concentration of the gas available at the end of the probe is displayed.

5 LEAK CHECK

During LEAK CHECK the pneumatics are configured from the exhaust sample hose, as shown on page 9-18. This selection does not perform a complete leak check.

SECTION III. 4-GAS CALIBRATION/CHECKOUT PROCEDURE

This procedure includes Manual Calibration, Customer gas calibration, and Leak test. If only one of these procedures are needed, perform the Set-up and that procedure. If more than one is needed the set-up must only be done before the first one. The entire procedure should be used for unit setup, I/R Kit Installation, preventive maintenance calls, and all unit repair relating to the Infrared function of the MEA-1500.

REQUIRED EQUIPMENT:	Calibration Screwdriver 0-50 SCFH Flow Meter (p/n 7009-1731) Tri-Blend Gas, 2% tolerance Phillips Screwdriver

SET-UP

The following set-up procedure should be used to set the flow rate for the gas bottle used during calibration. If the customer does not have the gas calibration kit, the CSR'S tank must be used. The flow rate of calibration gas is very critical.

1. Attach the flow meter (p/n 7009-1731) over the exhaust port at the rear of the tester so all the holes of the exhaust port are completely covered by the flow meter hose.

2. Remove customer calibration gas bottle from calibration port nipple if connected.

3. With the I/R pump "ON" and the tester in the Service/Gas Calibration page, press #2 "Cal Gas", and record the flow rate displayed on the flow meter for future reference.

4. Connect gas bottle to cal port nipple.

5. If using the customers Cal gas Tank,
   A. Remove the acorn nut from the regulator to gain access to the flow rate adjustment hex nut.
   B. Turn the hex nut counterclockwise (using a 3/16" hex wrench) until there is no more drag on the hex bolt. The regulator should now be shut off so there is no flow.
   C. Open the gas calibration bottle completely (counterclockwise). The regulator gage should indicate the amount of pressure of the contents in the bottle and the flow meter should indicate zero flow.
   D. Turn the hex nut clockwise watching the flow meter until the flow matches that recorded in step 3. Reinstall the acorn nut over the hex nut adjuster bolt.
   E. Turn the gas off, using the tank valve.

NOTE: When the regulator gage reads 50psi. or less, it is time to replace the bottle.

6. If the customer does not have the gas calibration kit, P/N 0121-0446-01,
   A. Connect the Technician's gas bottle to the gas cal input port on the tester.
   B. Turn the tank on and adjust the regulator assembly to match the testers flow recorded in step 3.
   C. Turn the Gas off using the tank valve.

7. Proceed to the Calibration menu, and press "4" to enter the Set Tag Value page. Enter the Hexane/Propane factor and the gas tag values from the Cal Gas tank being used.

MANUAL CALIBRATION PROCEDURE (COARSE ADJUSTMENT)

The set-up procedure should be performed prior to this procedure.

1. Turn the MEA-1500 power switch to the "ON" position and allow it to warm up for a minimum of 15 minutes. When warm up is complete, enter the service menu, gas calibration page. (Refer to the Introduction on how to access the service page, if necessary).

2. Enter the CALIBRATION MENU and select #4 on the remote, "SET GAS TAG VALUES". Enter the Hexane/Propane Ratio and the Gas Tag Values. The Hexane/Propane Ratio can be located on the bench if there is no tag on the rear of the tester. The Gas Tag Values should be entered directly from the gas bottle label. The tester will do the HC calculations automatically.

3. Press Menu twice, select "SERVICE MENU", then #1 "MANUAL CALIBRATION (GAS)". "1 Zero Gas" will be flashing.

4. With the "1 Zero Gas" flashing, adjust the HC(R3), CO(R9), and C02(R6) Zero voltage readings for O +/- 0.020 volts using the zero adjustment pots located on the Calibration Board (p/n 7001-0607) which is located on the right hand side of the tester inside the main C.C.A. drawer. For set up and 02 sensor replacement only, adjust the 02 Mech. span pot (R11) for 5.000 volts +/- 0.020.

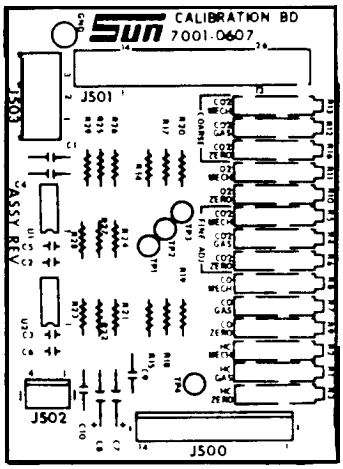


FIGURE 9-3

NOTE: The pots are grouped in sets of three. Starting at the bottom of the board with HC, CO, C02 fine adjustment, 02, and C02 course adjustment. The C02 course adjustments (R16, R12 and R13) are only adjusted when a new bench is installed or the C02 fine adjustments are at the end of their adjustment. If either one of these symptoms occur, set the C02 fine adj. pots to midscale (20 turn pots), adjust the C02 course adjustment to approximately the specified reading and then adjust the C02 fine adj. pots to the calibrated specification.

5. Press the number 2 on the Remote and listen for the gas calibration solenoid to energize. "2 Gas Cal" will be flashing on the CRT. Turn on the gas bottle. Calibration gas will now flow through the unit. With the pump "ON" adjust the gas concentrations shown on the CRT to the calculated HC (adjusted by Rl) and tag values of CO (adjusted by R7) and C02 (adjusted by R4) using the "Gas Span" pots. Adjust the 02 voltage reading (R1O) for 00.000 +/- 0.020 volts. This adjustment of 02 is only done on set up or replacement of the 02 sensor. Turn off the gas.

6. Press the number 3 on the Remote. The gas calibration solenoid will de-energize and #3 "SPAN" will flash on the CRT. Adjust HC(R2), CO(R8), C02(R5), and 02(R11) span voltages for 5.000 +/- 0.020 volts, using the "Mech Span" pots located on the Calibration board (p/n 7001-0607).

7. Press the number 4, then the number 5 on the keyboard and listen for the audible click to signify the solenoids are being energized.
NOTE : The MEA must be advanced through SYSTEM CALIBRATION after any adjustments have been made.

CUSTOMER GAS CALIBRATION

The Set-up procedure must be performed prior to this procedure.

1. Proceed to the Calibration menu, and press "2" to enter the GAS CALIBRATION page.

2. Connect the Cal Gas tank (adjusted during set-up) to the Cal Port on the rear of the tester.

3. Turn the Cal Gas Tank ON and press "CONT".

4. After approximately 90 seconds the display should read Calibration complete. If calibration fails consult the Trouble Shooting Guide.

LEAK TEST

The Set-up procedure must be performed prior to this procedure.

1. Proceed to the Calibration menu, and press "3" to enter the LEAK CHECK page.

2. Connect the Cal Gas tank (adjusted during set-up) to the Cal Port on the rear of the tester.

3. Turn the Cal Gas Tank ON.

4. Connect the Leak Check Adaptor from the Exhaust probe to the LEAK CHECK PORT on the rear of the tester.

5. Press "CONT"

7. After approximately 90 seconds, the display should read LEAK CHECK PASSED. If the Leak Check fails consult the Trouble Shooting Guide.

****

*** CALIBRATION/CHECKOUT COMPLETE ***

****

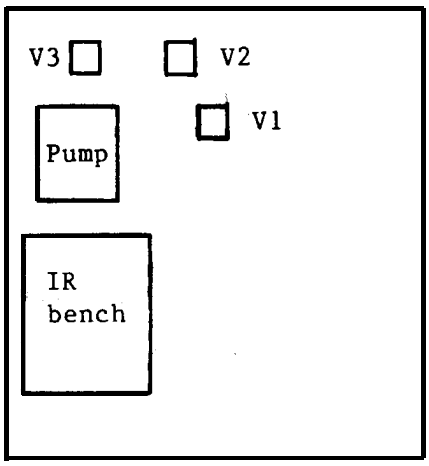
02/87

SECTION IV. EXHAUST EMISSIONS TROUBLESHOOTING

Confirm that Power Supply voltages are correct before proceeding.

COMPLAINT	CORRECTIVE ACTION
I. HC, &/or CO, &/or C02 &/or 02 FAILS SELF CALIBRATION.	1. Proceed to Fault code page and troubleshoot per fault code complaints below.
II. FAULT CODE 71 PRESENT. or FAULT CODE 72 PRESENT. or FAULT CODE 73 PRESENT.	1. Verify that the ZERO voltages are O volts +/- 2 volts. If out of tolerance, adjust per IR calibration procedure on page 9-6. If you cannot adjust, see complaint "VII. Unable to adjust zero or Span voltages".
111. FAULT CODE 74 PRESENT.	1. Verify that the unadjusted 02 reading in the Sevice Cal page is 5 +/- 2 volts. If out of tolerance, and the 02 sensor has not been replaced recently, ----------Substitute---------- A. 02 sensor 7049-0004, and recalibrate after a 15 minute stabilization period. If out of tolerance, and the 02 sensor has just been replaced recently perform the calibration procedure on page 9-6. If you cannot adjust, see complaint "Unable to adjust zero or Span voltages".
IV. FAULT CODE 81 PRESENT. or FAULT CODE 82 PRESENT. or FAULT CODE 83 PRESENT.	1. Verify that the SPAN voltages are 5 volts +/- 2 volts. If out of tolerance, adjust per IR calibration procedure on page 9-6. If you cannot adjust, see complaint "VII. unable to adjust zero or Span voltages" If span voltages are near zero volts see,"Span voltages read O or near O volts".
v. FAULT CODE 91 PRESENT. or FAULT CODE 92 PRESENT. or FAULT CODE 93 PRESENT.	1. Perform calibration Procedure on page 9-6. This code indicates that the span voltage minus the zero voltage is not 5 +/- 0.5 volts.
VI. FAULT CODE 101 PRESENT. or FAULT CODE 102 PRESENT. or FAULT CODE 103 PRESENT.	1. Perform calibration Procedure on page 9-6. This code indicates that the voltage on the gas channel was higher than the software look-up table will allow. Entering the Service Cal Page will set this code. If present, press Clear.

COMPLAINT	CORRECTIVE ACTION
VII. UNABLE TO ADJUST ZERO OR SPAN VOLTAGES WHILE IN THE SERVICE PAGE.	1. Check for voltage change at test points on the bench (HC-TP6, CO-TP7 C02-TP5). (EAMPLE: Turning the HC zero pot, R15, on the Emissions Calibration board while monitoring TP6 on the IR bench, you should see a corresponding voltage change). If the voltage changes at the bench test points but not on the VDU, check connections from bench to Emissions Calibration board. ----------SUBSTITUTE---------- A. Digital Electronics Board 7001-0604 B. Calibration Baord 7001-0607 C. Andros bench #7049-0114-01 If the voltage does not change at the test points, check connections between Calibration bd and IR bench. ----------SUBSTITUTE---------- A. Andros bench #7049-0114-01 B. Calibration Board 7001-0607 3. Refer to Theory of Operation and Functional Diagram.
VIII. ALL SPAN VOLTAGES ARE AT OR NEAR O VOLTS.	1. Verify that AC is available to the bench. 2. Verify that $\overline{\text{SPAN}}$ on the collector of Q4 on the Digital Electronic Board is low when Span is Flashing on the Gas Cal Page. If $\overline{\text{SPAN}}$ is low, ----------SUBSTITUTE---------- A. Andros bench #7049-0114-01 If $\overline{\text{SPAN}}$ is not low, ----------SUBSTITUTE---------- A. Digital Electronics Board 7001-0604 3. Refer to Theory of Operation and Functional Diagram.
IX. QUESTIONABLE EXHAUST EMISSION READINGS.	1. Perform Leak Check, see page 9-8. 2. Perform gas calibration, see page 9-6. 3. Refer to Theory of Operation, Functional Diagram, and pneumatic diagrams.

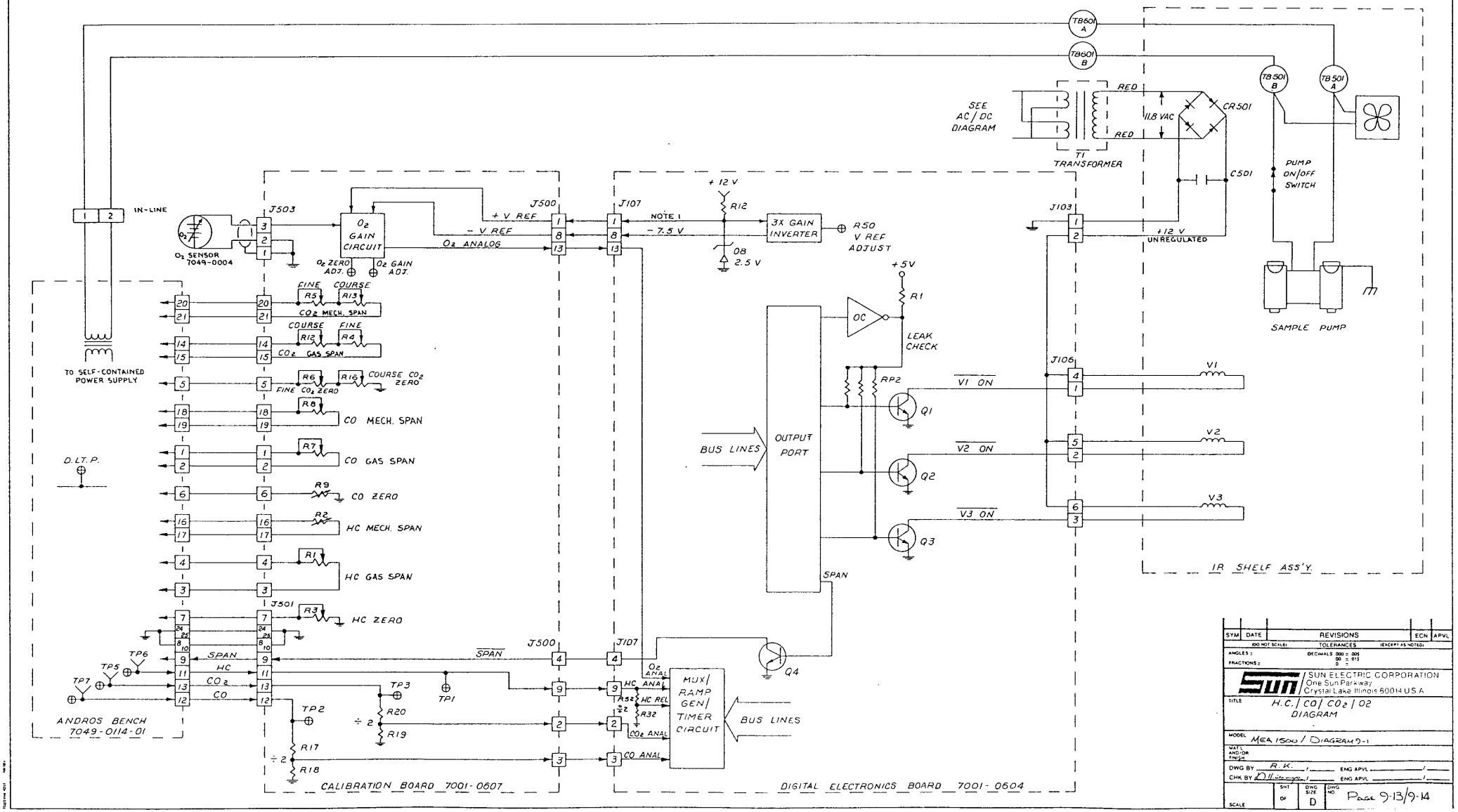
COMPLAINT	CORRECTIVE ACTION
X. ERRANEOUS HC CHANGE DATA ON POWER BALANCE PAGE.	1. ----------SUBSTITUTE---------- A. Digital Electronics Board 7001-0604 2. Refer to Theory of Operation and Functional Diagram.
XI. PNEUMATIC SYSTEM FAILS THE LEAK CHECK.	1. Check for excessive leaks in the sample handling system. Particularly the sample probe & filter bowls. See page 9-18 for solenoid configuration during a Leak Check. 2. Refer to Theory of Operation and Functional Diagram.
XII. PNEUMATICS FLOW IS NOT CORRECT.  **4-GAS DRAWER ASSEMBLY**	1. If this is a new set-up, verify that the hose loop has been removed from the 02 block and that the T-fitting from the Low flow Sensor is connected to the rear of the block and the restrictor from the pump is connected to the front of the 02 block. 2. Verify that the solenoid signals configure properly in Sample, Zero, and Cal positions. If any Solenoid control lines are not correct, ----------SUBSTITUTE---------- A. Digital Electronics Board 7001-0604 If all soleniod control lines are good, follow flow to the incorrect solenoid and ----------SUBSTITUTE---------- V1 & V2 = 0304-0040 V3 = 0303-0039 5. Refer to Theory of Operation and Functional Diagram.
XIII. FAULT CODE 51, 52, 53 OR 54 IS PRESENT.	1. This indicates that the channel has been over-ranged. Reset the code and verify the problem is still present. 2. Perform calibration Procedure on page 9-6.
XIV. FAULT CODE 41, 42, 43 OR 44 IS PRESENT.	1. This indicates that the channel has been Under-ranged. Reset the code and verify the problem is still present. 2. Perform calibration Procedure on page 6-9.

N O T E S

NOTE 1:
+2.5 V REV. F OR EARLIER
+10 V REV. G OR LATER

LIST OF MATERIAL

QTY REQD	PART NO.	DESCRIPTION	ITEM NO.



SYM	DATE	REVISIONS	ECN	APVL
		DO NOT SCALE! TOLERANCES (EXCEPT AS NOTED)		

ANGLES ±
FRACTIONS ±
DECIMALS .000 ± .005
.00 ± .015
.0 ±

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake Illinois 60014 U.S.A.

TITLE: H.C./CO/CO2/O2 DIAGRAM

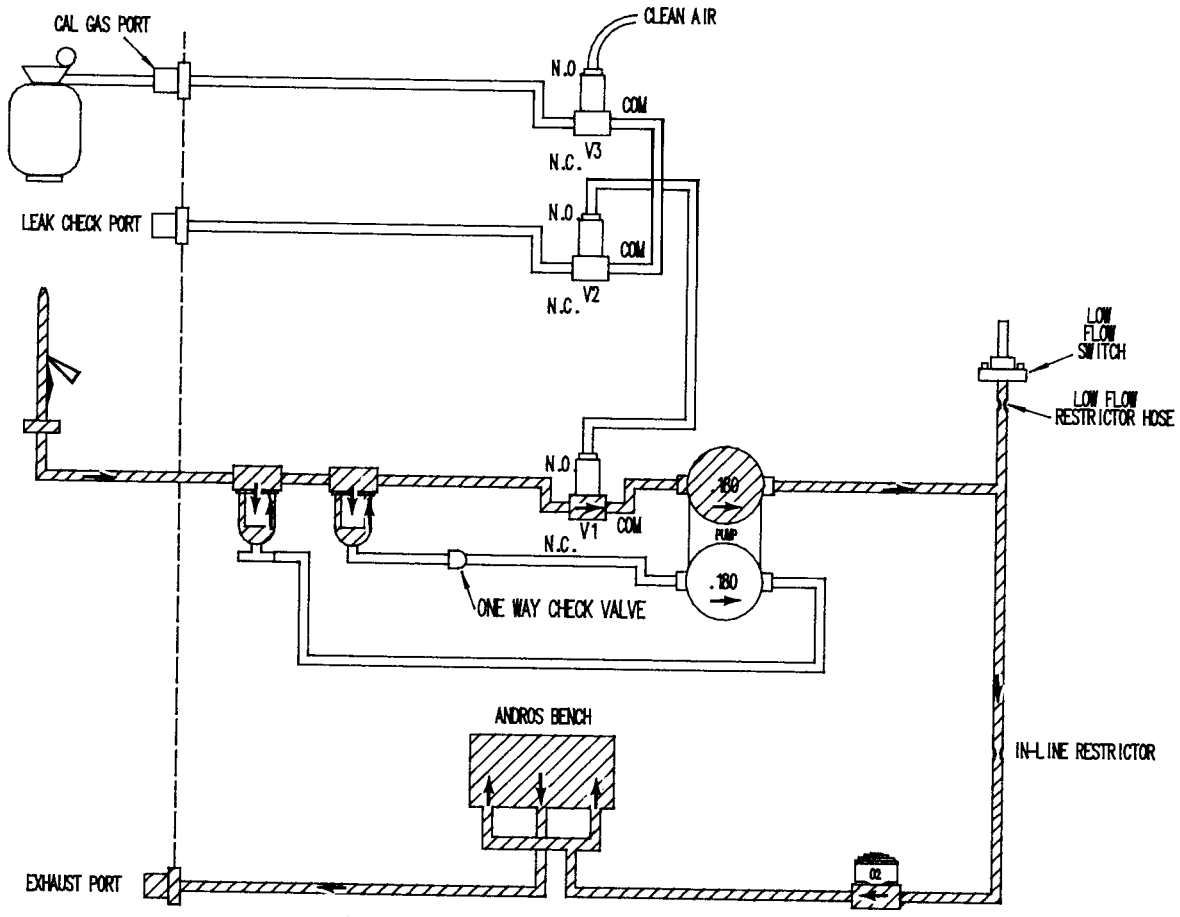
MODEL: MEA 1500 / DIAGRAM 9-1

MATL. AND/OR FINISH:

DWG BY R.K. / ENG APVL

CHK BY D.Wiegman / ENG APVL

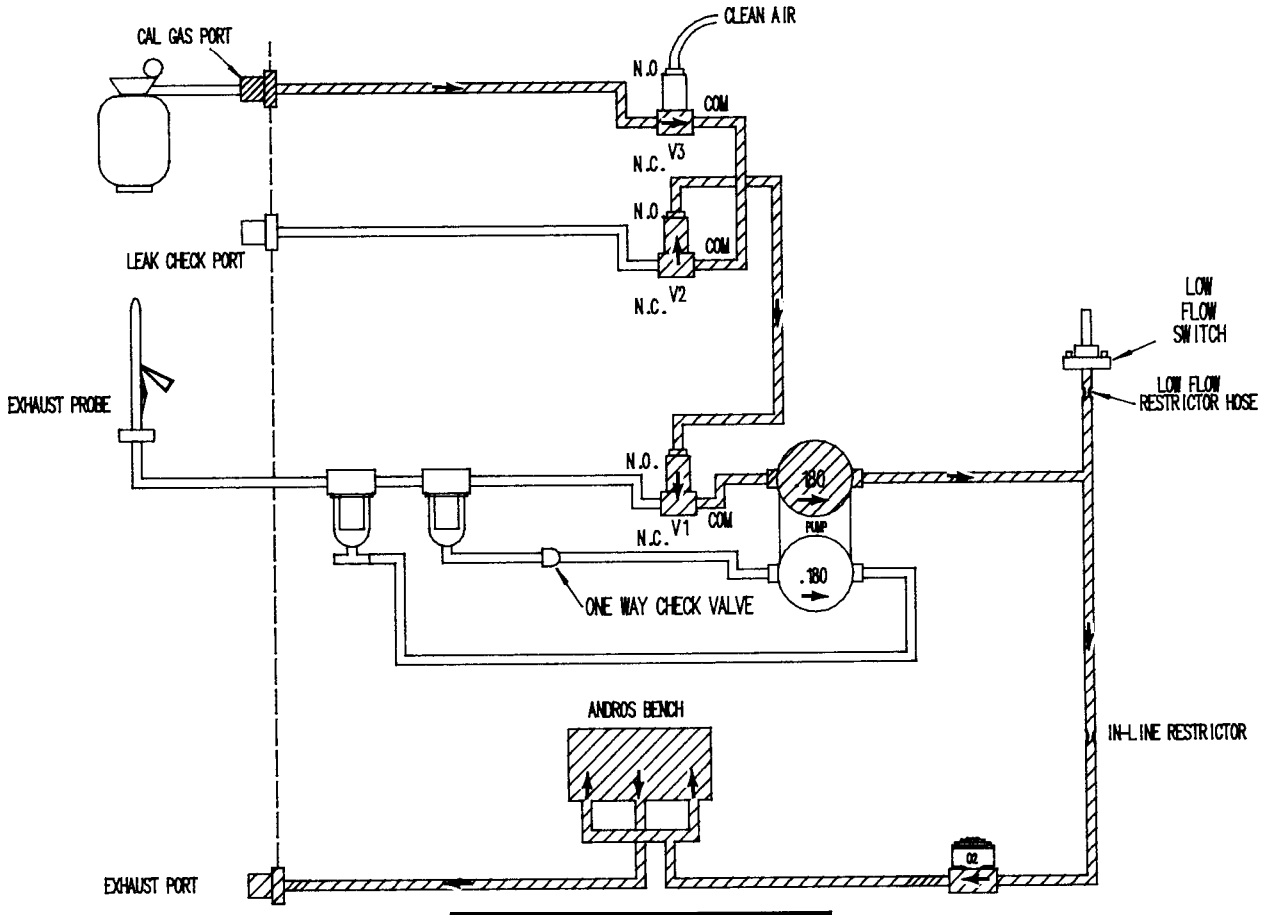
SCALE | SHT OF | DWG SIZE D | DWG NO. | Page 9-13/9-14



SAMPLE MODE		
SOLENOID	STATE	ACTIVE PORT
V1	ON	N.C.
V2	OFF	N.O.
V3	OFF	N.O.

SAMPLE MODE

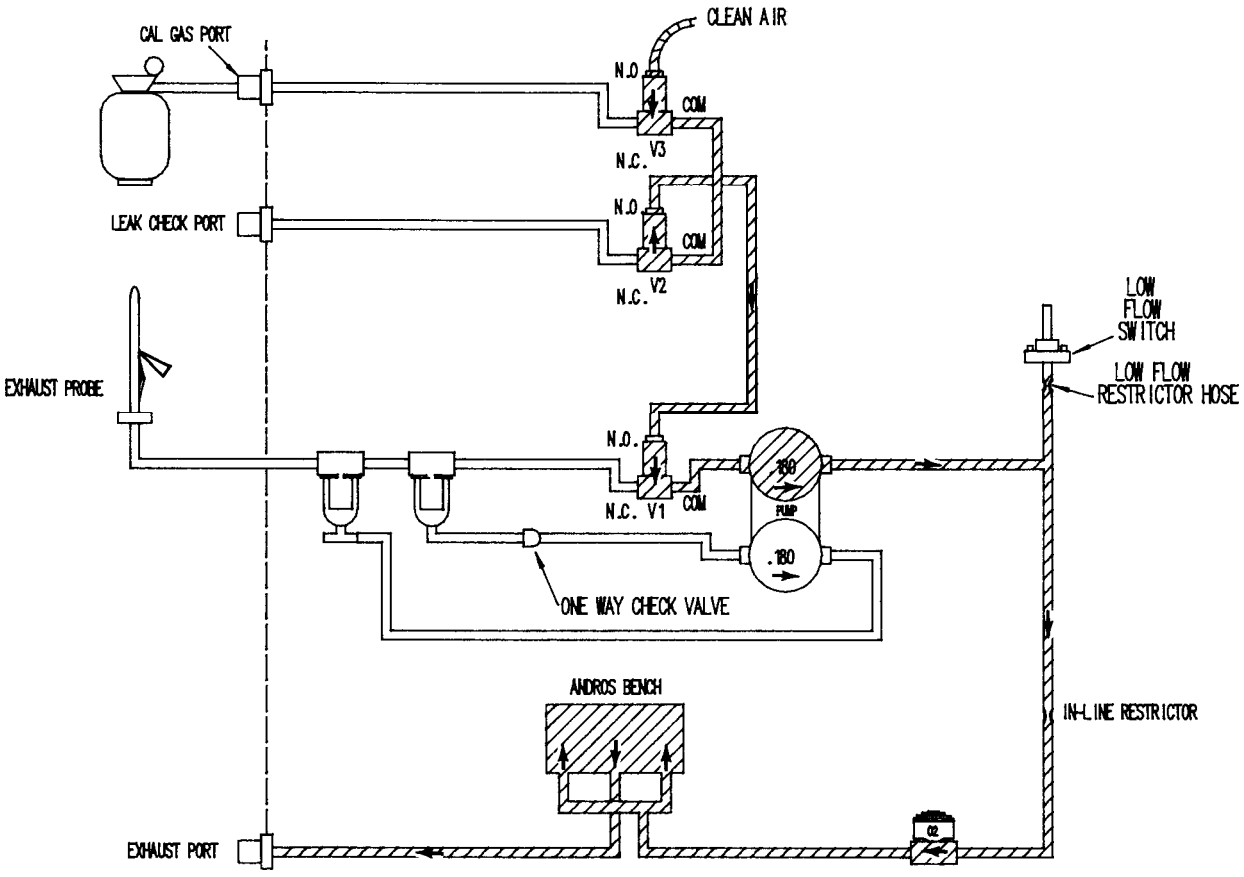
During the sample mode, the exhuast gasses are drawn from the vehicles exhaust pipe, through the primary and secondary filters, 02 sensor, and Andros Bench. This mode is used in the vehicle test and power balance pages, and can also be forced by pressing "4" in the Manual Calibration (Gas) page.



GAS CAL MODE		
SOLENOID	STATE	ACTIVE PORT
V1	OFF	N.O.
V2	OFF	N.O.
V3	ON	N.C.

CAL MODE

During the cal mode, the Calibration Gas is drawn from the Cal Gas Tank (if installed), and pumped through the 02 sensor, and Andros Bench. This mode is used in the Gas Calibration page, and can also be forced by pressing "2" in the Manual Calibration (Gas) page.



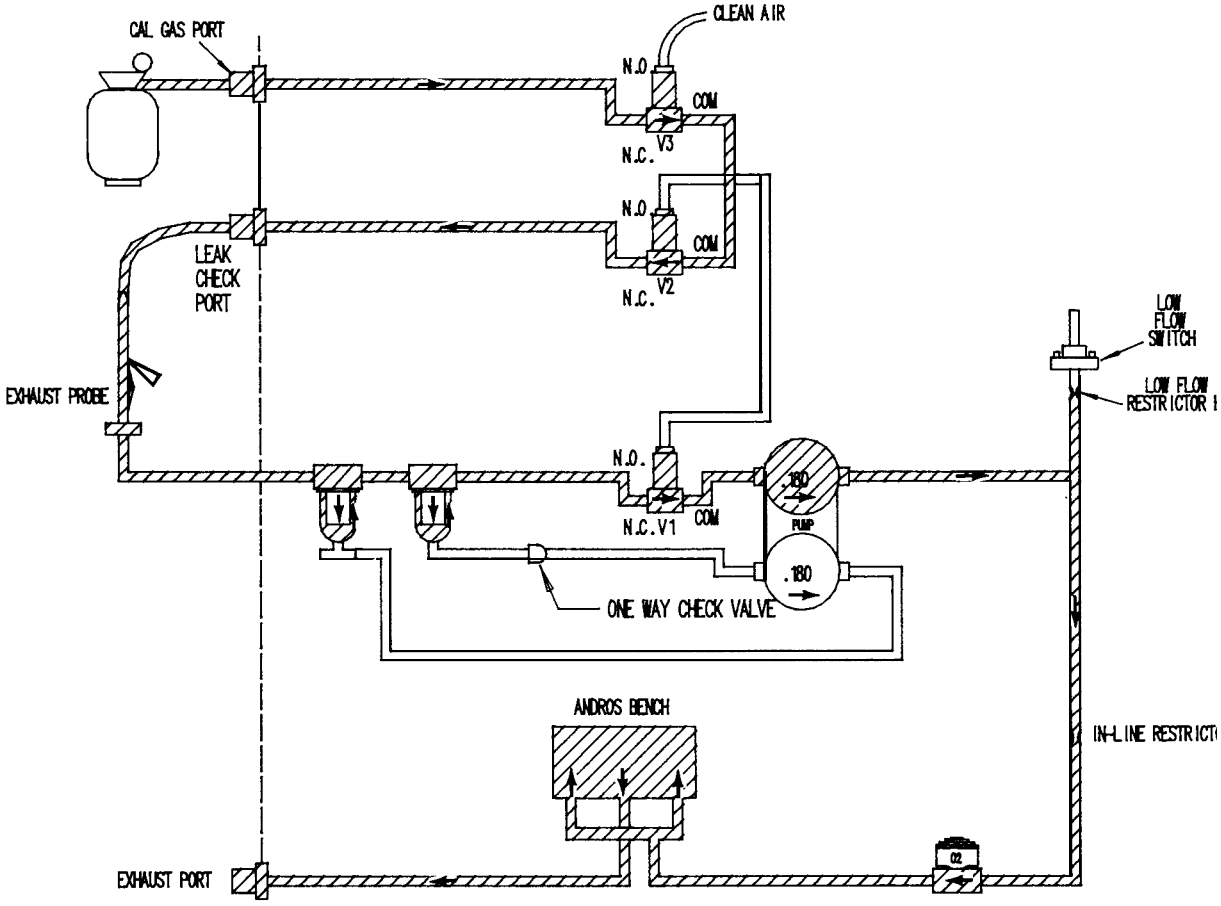
N.O. = NORMALLY OPEN

N.C. = NORMALLY CLOSED

LEAK CHECK "A" AND ZERO MODE		
SOLENOID	STATE	ACTIVE PORT
V1	OFF	N.O.
V2	OFF	N.O.
V3	OFF	N.O.

ZERO MODE & LEAK CHECK A

During the zero mode, clean air is drawn from the Normally Open port of V3 and pumped through 02 sensor, and Andros Bench. This mode is used in the Gas Calibration page, System Calibration page, and during the first stage of the leak check. It can also be forced by pressing "1" or "3" in the Manual Calibration (Gas) page.



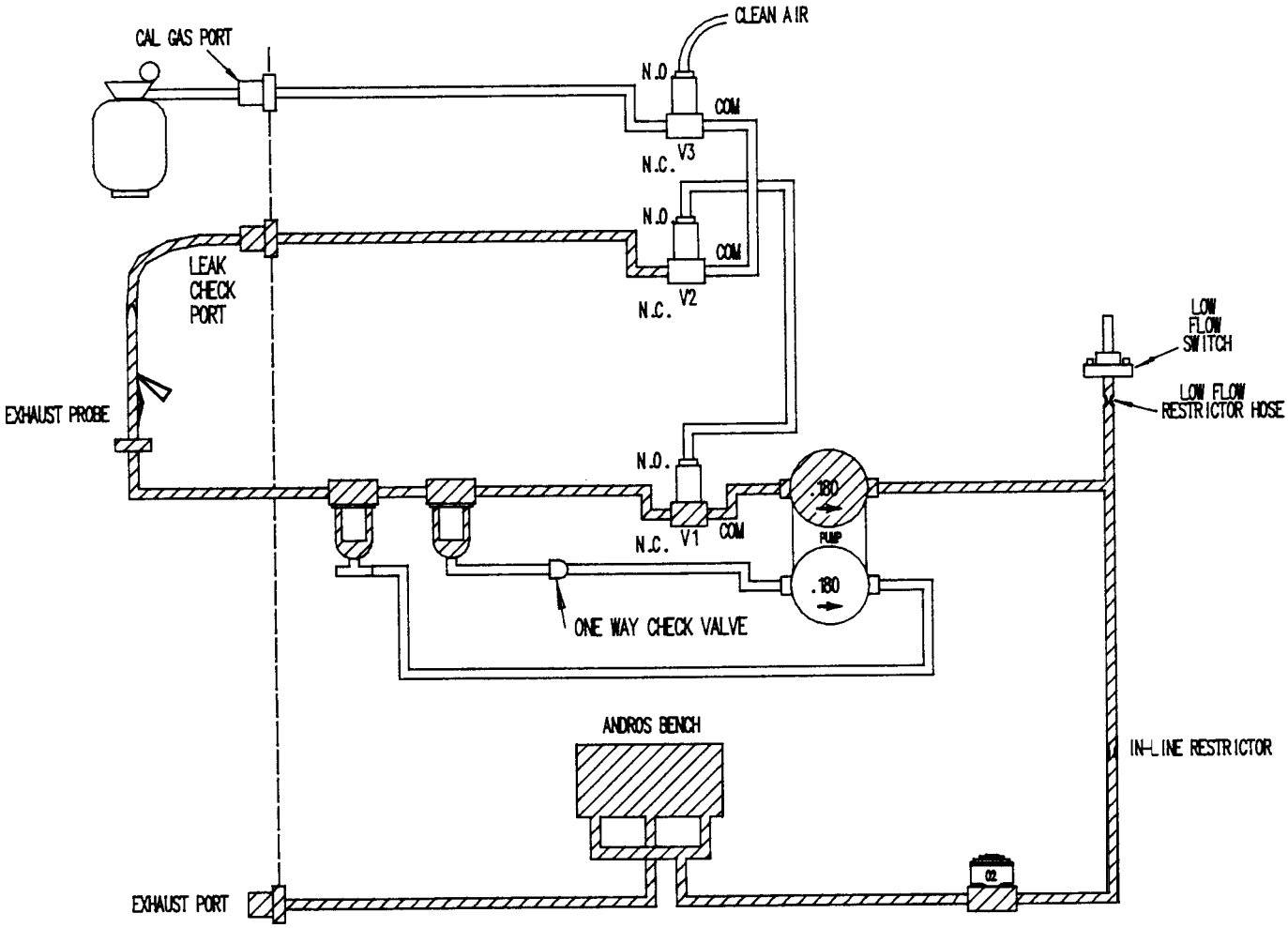
N.O. = NORMALLY OPEN

N.C. = NORMALLY CLOSED

LEAK CHECK "B" MODE		
SOLENOID	STATE	ACTIVE PORT
V1	ON	N.C.
V2	ON	N.C.
V3	ON	N.C.

LEAK CHECK B

During the leak check B mode, the Calibration Gas is drawn from the Cal Gas Tank (if installed), through the Exhaust hose, primary and secondary filters, 02 sensor, and Andros Bench. This mode is used during the second stage of leak check and can also be forced by pressing "5" in the Manual Calibration (Gas) page.



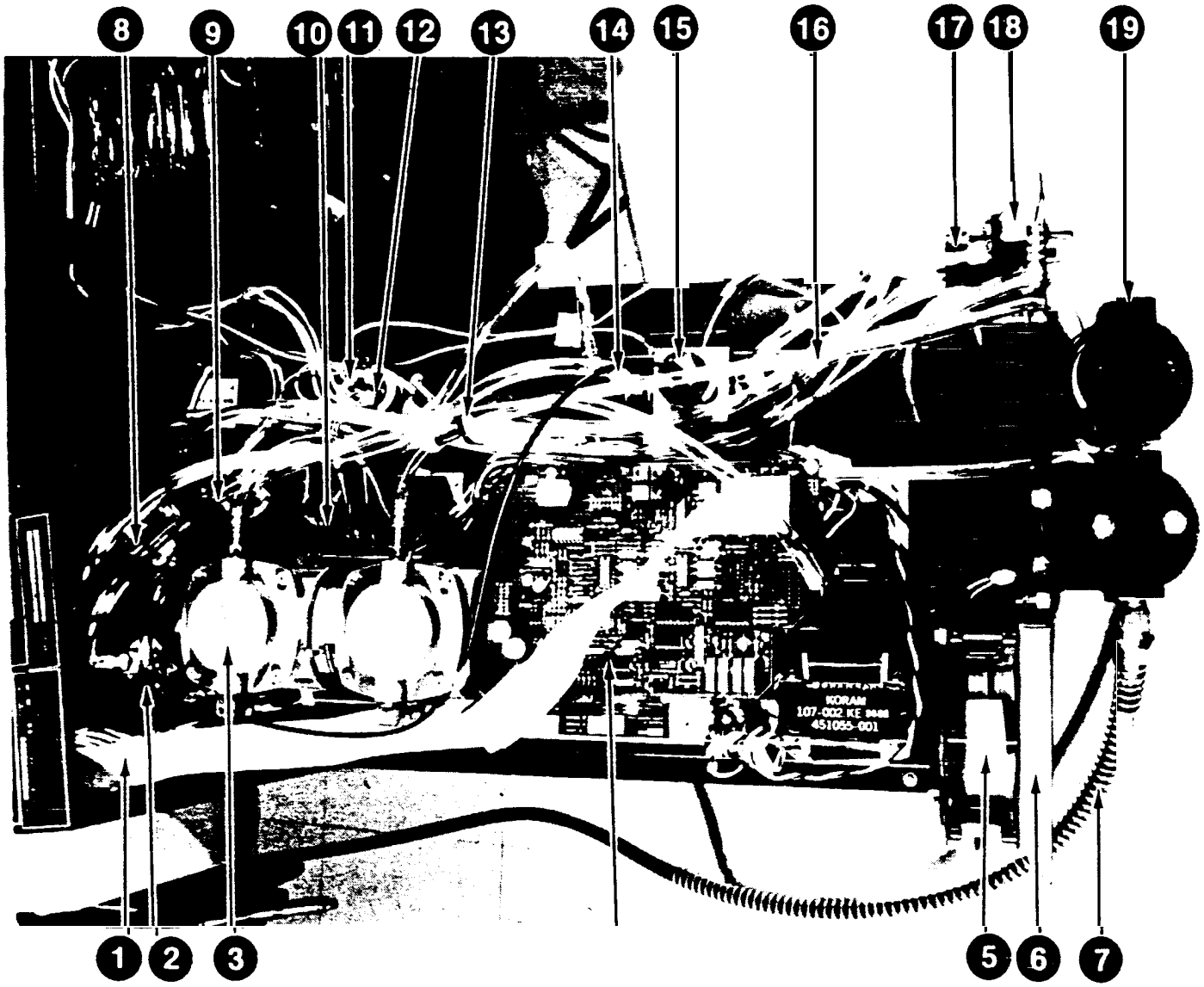
N.O. = NORMALLY OPEN

N.C. = NORMALLY CLOSED

LEAK CHECK "C" MODE		
SOLENOID	STATE	ACTIVE PORT
V1	ON	N.C.
V2	OFF	N.O.
V3	OFF	N.O.

LEAK CHECK C

During the leak check C mode, the Calibration Gas is trapped in the Sample' system, if no leaks are present. This mode is used during the third stage of the leak check and can also be forced by pressing "4" in the Manual Calibration (Gas) page.



4-GAS DRAWER

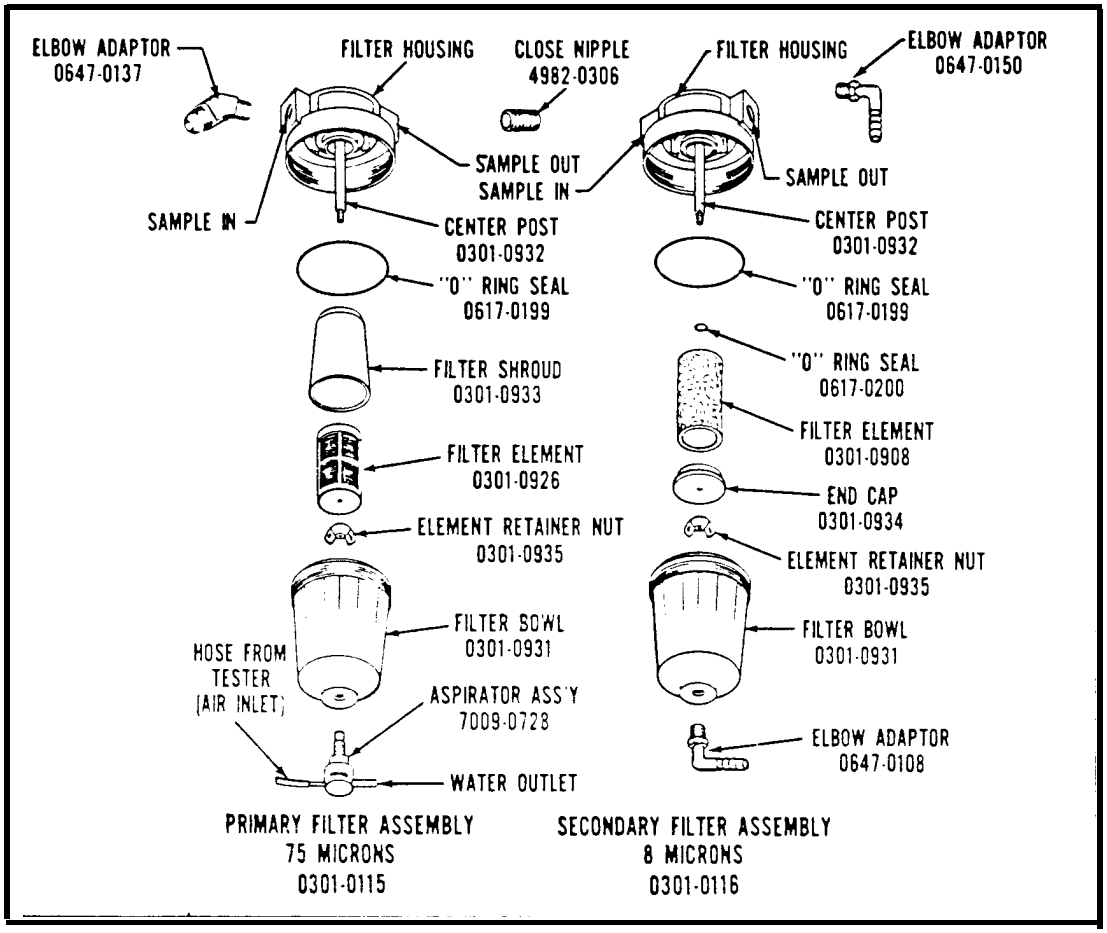
1 Ribbon Cable Assy..6004-0355-Ol
2. Solenoid (V3) 0304-O039
2a. Diode Assy 7009-1486-03
3. Pump, I/R O303-oo93
3a. Reed valve 0303-0913
3b. Gasket O303-O909
3C. Diaphram 0303-0907
4. Andros Bench 7O40-Oll4-Ol
4a. Chopper Motor 0120-0482
5. Fan, Axial 0587-0504
6. Air Filter O3Ol-Ol26
7. Hose, Exhaust . . . 3988-O2l6
8. Solenoid (V2) 0304-0040
8a. Diode Assy 7009-1486-03
9. Solenoid (Vi) O3O4-OO4O
9a. Diode Assy 7OO9-1486-O3
10. Switch, Low Flow . . . O549-OO19-O2
11. Rectifier O771-0412
12. Capacitor, 8000mfd ..O60541541
13. Check Valve . . . 4Ol5-OO22
14. Restrictor 384l-Ol10
15. Oxygen Sensor 7049-OOO4
16a. Hose, 1/4" 0669-0220
16b. Hose, 3/16" 0669-0229
16c. Hose 0669-0231
17. Circuit Breaker (5A) ..1922-O1O5-21
18. Switch, Toggle 0689-0065
19. Bowls and filters . . . ..Next Page

NOT SHOWN

I/R. Cal. C.C.A 7001-0607
Probe, undiluted 7009-1506
Probe Tip 7015-OO8l
Probe assembly . ..7OO9-l869
Calibration Kit . . . . Next Page

GAS CALIBRATION KIT (0120-0446-01)

1. CASE. SAMPLE GAS 1655-1655
1A. Washer 1/4" flat. . . .0400-0020
1B. Washer 1/4" lock 0604-0014
1C. Screws, 1/4"-20x1/2...0675-0033
2. Probe, Undiluted . . . 7009-1506
3. Gas Regulator 0131-0024
4. Elbow, pipe to hose. .0647-0070
5. Adjustment Tool 0001-0029
6. Hose, 1/4" (25") 0669-0220
7. Leak Check Adaptor (sm).7009-1730
8. Leak Check Adaptor. (lg).7009-1700
9. Label, Gas Installation.0682-0578-01
10. Gas Tank, (local) 0271-0027



CHAPTER 10

BOOM KIT OPTION

SECTION 1. THEORY OF OPERATION

GENERAL

The BOOM KIT OPTION #0120-0496 provides the customer with a convenient method of lead management for his MEA. It promotes lead care and ease of connection. Pick-up hangers located on the bottom side of the boom end, prevent damage to the pick-ups from falling to the floor. When the leads are hung in an orderly fashion connection is expedited, since you don't waste time untangling leads.

The wires in the boom must be routed, as explained in the installation instruction, to provide ignition noise isolation for the leads which are not ignition system related. By separating the leads non-ignition signals such as amps and volt/ohms are kept clean of extraneous RF noise generated by the vehicle ignition system under test.

SUN ELECTRIC CORPORATION

Model: Kit #0120-0496

Assembly & Installation Instructions

The installation of Kit #0120-0494 provides the MEA-1500 with the Boom Option and is only available as a Field Installation item.

PARTS LIST

QTY	PART NUMBER	DESCRIPTION
1	7014-0180	Boom Cover
1	7020-1825	Boom Housing
1	7012-0848-06	Timing Light Bracket
2	0813-0041	Handle, Bow
4	0410-0122	Screw, #10-32 by 3/8" Hex
1	0686-0091	Screw, 1/4-20 by 3/8" Socket Cap
5	0610-0095	Screw, TF #8 by 3/8"
4	0616-0003	Nut, Keps 1/4"-20
4	0603-0030	Washer, Lock #10 Ext.
2	0501-0065	Grommet,1/2 Rubber
1	0663-0819	Ground Strap, 21"
12	5878-0010	Wire Ties
12	5878-0902	Cable Mounts
1	1243-0800-05	Identification Plate
1	0119-0255	Literature Kit

REQUIRED TOOLS

1/4" SOCKET SET
NUT DRIVER SET
DIGITAL MULTIMETER
ALLEN WRENCH SET

INSTALLATION PROCEDURE

1. Turn the tester power "OFF", and unplug from the A.C. outlet.
2. Disconnect all test leads from the unit and remove the thirteen screws securing the rear panel of the unit.

Printed in U.S.A.

3. Remove the Black plug located on top right side of Tester.

4. Remove the Boom Housing from the package. Insert Screw (p/n 0686-0091) into the Boom Housing shaft(upper hole if 2 are present) and tighten until it bottoms out.

5. Insert the shaft of the Boom Housing into the Boom opening uncovered in step 3. Push down on the Boom Housing until it bottoms out.

6. Insert the Grommets into the "half moon" shaped openings at the rear, swivel end of the boom.

7. Install the chrome Bow Handles to the end of the boom using the hardware provided.

8. Install one each of the 1/4" keps nuts provided, (p/n 0616-0003), to the ground stud on the boom and on the underside of the top portion of the host tester and tighten securely. Now install the Ground Strap (p/n 0663-0819) to the weld stud in the Boom Housing and route it through the Boom Shaft, attaching the other end of the Ground Strap to the weld stud in the tester headframe and secure tightly with the remaining two 1/4" keps nuts.

9. Using a Digital Multimeter, measure the resistance between the Boom's ground stud and the tester's weld stud. The resistance should be less than 1 ohm. I-f the resistance is higher, correct the problem before proceeding.

10. Re-install the unit's rear panel.

11. Reconnect all Test Leads.

12. Route the tester leads through the Boom Housing with the Trigger, Pattern, and Universal leads grouped together and routed through one of the half moons of the boom and on one side of the center wall, and all other test leads routed through the other half moon of the boom and on the opposite side of the center wall.

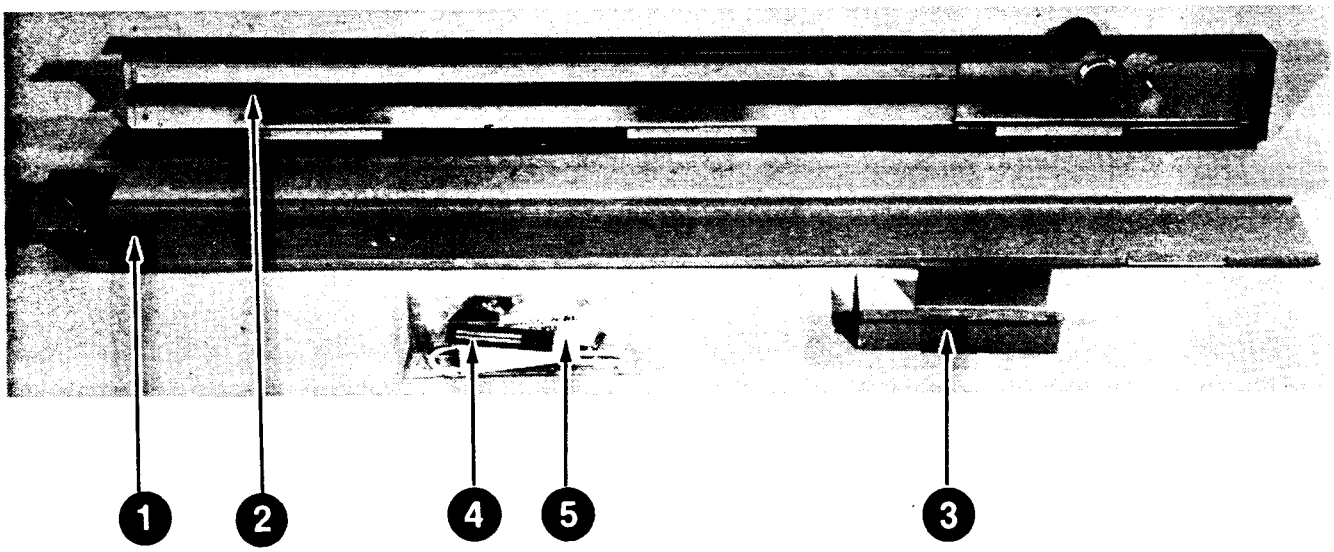
13. Using Wire Ties and Cable Mounts, secure all the leads in the Boom Housing to the **outside walls.**
    NOTE: EXTEND THE BOOM TO THE FAR RIGHT HAND SIDE BEFORE WIRE TIEING THE LEADS.

14. Mount the Boom Cover and the Timing Light Bracket to complete the Boom Assembly using the 5 Screws (p/n 0610-0095) provided.

15. Affix the provided Option Kit Identification Plate to the MEA-1500 next to its Serial Plate or any other Option Kit I.D. Plate already present at that location.
    NOTE: Make sure the surface is clean and free of dirt!

****

*** INSTALLATION COMPLETE ***
****



BOOM KIT (0120-0496)

1. BOOM COVER 7014-0180
2. BOOM HOUSING 7020-1825
3. TIMING LIGHT BRACKET.7012-0848-06
4. BOW HANDLES.(2 USED).0813-0041
5. HARDWARE PACKET . . . . . N/A
5A.SCREW,#10-32 X 3/8"..0410-0122
5B.SCREW, 1/4" X 3/8"...0686-0091
5C. SCREW, #8 X 3/8" 0610-0095
5D.NUT, KEPS 1/4-20.....0616-0003
5E.WASHER, #10 EXT.LOCK.0603-0030
5F.GROMMET, 1/2 0501-0065
5G.GROUNG STRAP 0663-0819
5H.WIRE TIES 5878-0010
51.CABLE MOUNTS 5878-0902

CHAPTER 11

PRINTER OPTION

SECTION I. PRINTER THEORY OF OPERATION

GENERAL
The optional Printer (AP-1000) and the hardware installation Kit #0120-0500, provides the customer with the ability to have a hard copy of test results displayed on the VDU. The printer is a impact dot matrix printer, this means that it uses a print wire (the dot) driving (the impact) an inked ribbon against the paper, forming dots. The characters are created using dots in a 7 by 9 format. This means that the characters are 7 dots wide by 9 dots high. The printer is bidirectional, which means the print head prints while moving in either direction, from home going right or from the right side on its way home. This gives the printer better speed, 120 CPS (characters per second) to be precise. The character spacing is set at 8.5 CPI (characters per inch).

POWER
The printer is supplied l17vac from the terminal strip located in the Power Supply drawer. Power is applied only when the MEA's power switch is ON. All power supplies for the printer are developed internally. An ON/OFF switch is also provided on the printer, located on the right-hand side, towards the back.

PRINTER
This printer communicates with the Digital Electronics Board through a parallel port. The data is sent to the printer via the 8 DATA lines. The STROBE* line is used to synchronize the printer to the MEA. When the Strobe* line goes low, the printer reads all 8 data lines.

RESET
The RESET line is used by the MEA to reinitialize the printer. When the tester is powered-up, the printer initializes twice. The first initialization is inherent to applying power to the printer. The second initialization is due to the CPU pulling the RESET line high. If the MEA does not power-up correctly, only one initialization will occur.

BUSY
The BUSY line is used by the Printer to tell the MEA that it is busy and no more information should be sent. The MEA stops sending information until the BUSY line goes low again.

PAPER OUT
If the printer runs out of paper, a photosensor is activated. The printer immediately pulls the PAPER OUT signal High. When the MEA senses this High signal, an "out of paper" message is displayed and printing is interrupted.

POWER OFF
If the MEA senses that BUSY and SELECT are both low, the message "Printer Off" is displayed. This condition is only possible when the printer does not have power applied.

SELECT
The printer has two basic modes, Selected and Not Selected. To toggle between these modes, the SEL button is pressed. If printing is attempted when the printer is not selected, (sensed by SELECT being low) a message is displayed at the bottom of the screen and printing is aborted.

CONTROLS AND INDICATORS
There are four control switches on the front of the MEA's optional printer. They are, in order from left to right, LINE FEED, FORM FEED, TOF SET, and SEL. In addition, there are three indicator LEDs. In order, from left to right they are SEL LIGHT, ALARM, and POWER. In the normal condition the red light should be off, and the two green lights should be on.

POWER LIGHT
This indicates the printer is "ON" and has power.

SEL BUTTON
See SELECT on previous page.

SEL LIGHT
This LED indicates if the printer is on or off line. The LED being "ON" means the printer is selected. The LED being "OFF" means their is no communication going on between the printer and the MEA's Digital Electronics Board.

TOF SET BUTTON
This switch is used for setting where the first line of print will appear. To set the top of form, place the paper at top of form and press the TOF button once.

FORM FEED
Is used to make the printer feed the paper to the next top of form. The same can be accomplished by pressing the print button on the remote twice quickly.

SECTION 11. CLEANING AND LUBRICATION

REQUIRED EQUIPMENT: Cotten swabs
Isopropyl alcohol
lint-free cloth
Singer sewing machine oil

1. Remove the top cover of the printer.

2. Remove the printer paper and printer ribbon.

3. Using the alcohol, swabs, and cloth, wipe the printhead shaft clean. Wipe away any dust and dirt that may have accumulated in the exposed compartment.

4. Dampen the cloth with alcohol and wipe the bailing roller clean.

5. Apply a small drop of oil on the printhead shaft. Move the printhead from end to end, spreading the oil into a thin coat, covering the printhead shaft.

6. Re-install the paper, ribbon, and cover.

7. Power the tester up and press the PRINT button. The printer should print the Title page.

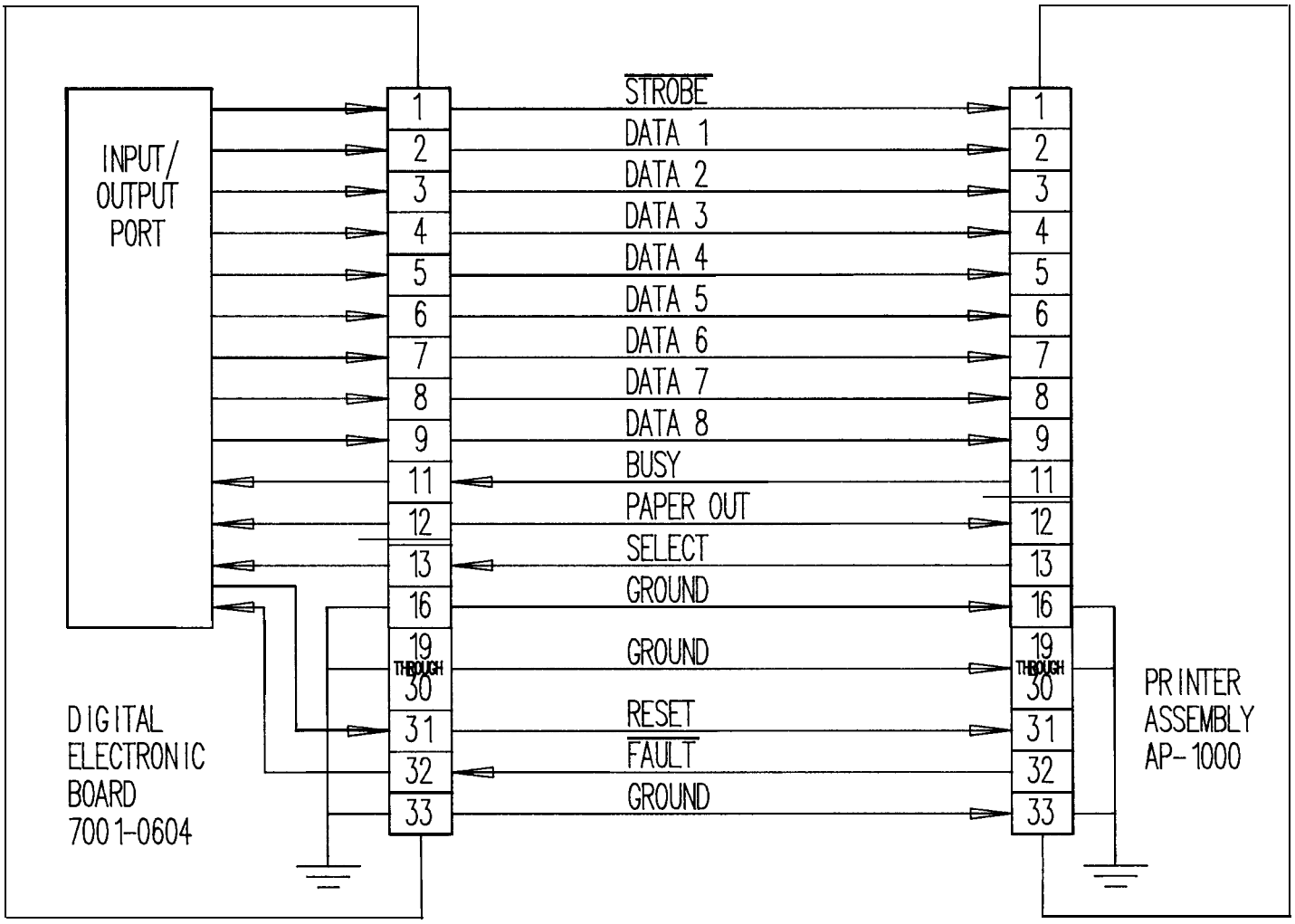
****
*** CLEANING AND LUBRICATION COMPLETE ***
****

11/86

COMPLAINT	CORRECTIVE ACTION
I. ERROR CODE 31 DISPLAYED or PRINTER OUT OF PAPER MESSAGE IS DISPLAYED	1. If the fault code is present, but the printer prints, clear the fault code. It was set by the customer but no problem currently exists. 2. Verify that the paper is properly installed, see operators manual. 3. With paper properly installed, and power applied, measure the voltage on pin 6 of U60 on the Digital electronic board. If the signal is High, ----------SUBSTITUTE---------- A. Digital Electronics Board 7001-0604 If the signal is Low, ----------SUBSTITUTE---------- A. Printer Assembly AP-1000(R) 4. Refer to Theory of Operation and Functional Diagram.
11. ERROR CODE 32 DISPLAYED or PRINTER MALFUNCTION MESSAGE IS DISPLAYED	1. If the fault code is present, but the printer prints, clear the fault code. It was set by the customer but no problem currently exists. 2. Perform the Cleaning and lubrication procedure. 3. If the Alarm light comes on when printing is attempted, ----------SUBSTITUTE---------- A. Printer Assembly AP-1000(R) 4. Turn the printer's power switch off, press and hold the LF button in while turning the power switch on. If the printer prints the self test, ----------SUBSTITUTE---------- A. Digital Electronics Board 7001-0604 If the printer doesn't print the selftest ----------SUBSTITUTE---------- A. Printer Assembly AP-1000(R) 5. Refer to Theory of Operation and Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
111. ERROR CODE 33 DISPLAYED or PRINTER OFFLINE MESSAGE IS DISPLAYED	1. If the fault code is present, but the printer prints, clear the fault code. It was set by the customer but no problem currently exists. 2. If the SEL light is OFF, press the SEL button, and attempt printing again. 3. If the message is displayed measure the voltage on pin 4 of U60 on the Digital electronic board. If the signal is High, ----------SUBSTITUTE---------- A. Digital Electronics Board 7001-0604 If the signal is Low, ----------SUBSTITUTE---------- A. Printer Assembly AP-1000(R) 4. Refer to Theory of Operation & Functional Diagram.
IV. ERROR CODE 34 DISPLAYED or PRINTER IS OFF MESSAGE IS DISPLAYED	1. If the fault code is present, but the printer prints, clear the fault code. It was set by the customer but no problem currently exists. 2. Verify that the POWER light is ON when the power switch is on. If the Light is ON, and the message still appears when the print button is pressed, ----------SUBSTITUTE---------- A. Printer Assembly AP-1000(R) B. Digital Electronics Board 7001-0604 If the Light is OFF, verify the following A. 117VAC is present at the AC plug at the rear of the printer. B. The Primary fuse, located inside the printer just above the power switch, is good (1.5 amp). C. The Secondary fuse, located inside the printer on the main Board is good (1.0 amp). If all the above checks are good, ----------SUBSTITUTE---------- A. Printer Assembly AP-1000(R) 3. Refer to Theory of Operation & Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
V. PRINTING IS TOO LIGHT OR INACCURATE.	1. Verify that the paper thickness lever, located to the left of the ribbon, is set for the number of sheets currently installed. 2. ----------SUBSTITUTE---------- B. Printer Ribbon 0528-0995 3. Refer to Theory of Operation & Functional Diagram.



SUN ELECTRIC CORPORATION

Model: Kit #0120-493

Assemby & Installtion Instructions

The installation of Kit #0120-0493 provides the MEA-1500 with the Printer Option and is only available as a Field Installation item.

PARTS LIST —

QTY	PART NUMBER	DESCRIPTION
1	0528-0013	Printer
1	0528-0995	Printer Ribbon
1	0528-0994	Printer Paper
1	7076-0526	Wire Harness, Printer, W14
1	6001-0176	Wiring Harness, Power, A.C.
2	0408-0077	Printer Mounting Screws,#8-32, 3/4"
2	0400-0162	Washer, Flat #8
2	0407-0002	Keps Nuts, Hex #8-32 Acorn
8	5878-0012	Wire Ties
5	5878-0902	Cable Mounts
1	1243-0800-02	Identification Plate

REQUIRED TOOLS ——————————

FLAT SCREWDRIVER
PHILLIPS SCREWDRIVER
NUT DRIVER SET
SCREW STARTER
1/4" SOCKET SET

INSTALLATION PROCEDURE ——————————

1. Turn tester "OFF" and remove AC plug from the outlet.

2. Press down on the rear of the printer shelf (located just below the analog scope controls). Remove the shelf by pulling foward and lifting. Remove the two nuts exposed on the bottom of this shelf, and remove the cover plate of the shelf. Discard this cover.

3. Loosen the cover plate located on the lower lefthand corner of the rear wall of the printer paper compartment.

4. Remove the printer from its packing.

5. Remove the top cover of the printer by lifting the backside and pivoting it forward.

6. Remove the cardboard retainer that keeps the printhead in place.

7. Place the printer on the printer shelf. Using the two screws, flat washers and acorn keps nuts supplied, mount the printer on the shelf removed in step 2. (See Figure 1)

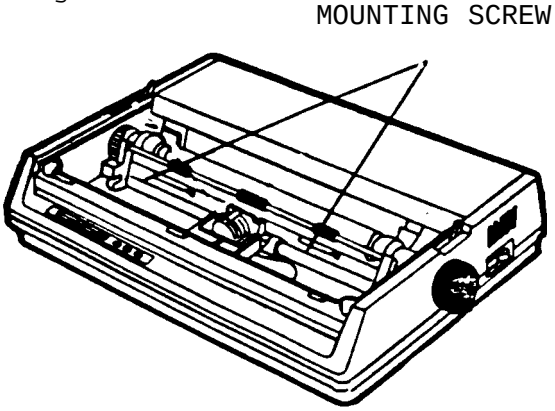


Figure 1

8. Remove the two screws holding the Power Supply "drawer" (located in the lower right hand side of the tester as viewed from the rear) in place and pull it open.

9. Remove the two phillips screws retaining the front C.C.A. drawer, and pull it open.

10. Turn switch number 4 of SW-1 on the Digital Electronics Board (p/n 7001-0604) to the "ON" position to activate the printer option.

11. Route the small end of the ribbon cable supplied (#7076-0526), and route the "Fast-on" end of the AC cable supplied (#6001-0176), through the hole in the rear of the paper compartment and into the power supply compartment then push the small cover plate down to the two cables and tighten the screw.

12. From the rear of the tester, route the ribbon cable up through the front hole of the compartment ceiling, into the front drawer compartment.

13. From the front of the tester, route the ribbon cable along the side of the Analog scope board, then across the front to connector J114 on the Digital Electronic Board making sure to connect the red stripped side of the ribbon cable to pin 1 of J114.

NOTE: Leave enough slack in the cable to allow the sliding of the drawer.

15. From the rear of the tester, install the White wire (or the Black wire with the White designation) of the AC cable to the left hand terminal of the AC Terminal Block.

16. From the rear of the tester, install the Black wire of the AC cable to the center terminal of the AC Terminal Block.

17. From the rear of the tester, install the Green wire of the AC cable to the Ground Stud, located just below the host testers AC cable.

19. Place the printer paper, supplied, in the paper tray.

20. Connect the AC and Ribbon cable to the rear of the Printer. Taking Care not to pinch the cables, set the Printer/Shelf Assembly in place.

21. Attach a cable mount to the rear paper tray wall at the printer tray cut away. Strap the two cables to the mount. (By mounting the cable mount as such , the printer and tray may be removed from the tester after disconnecting the ribbon and AC Cables without removing any cable ties.)

22. Using the remaining cable mounts and ties, tie the cables down as required.

23. Push in both drawers and re-install the hold down screws.

24. Refer to the Operators Manual for instructions on paper and ribbon installation.

25. Re-install the rear panel and the test leads.

26. Affix the provided Option Kit Identification Plate to the MEA-1500 next to its Serial Plate or any other Option Kit I.D. Plate already present at that location. **NOTE:** Make sure the surface is clean and free of dirt!

CHECK OUT PROCEDURE

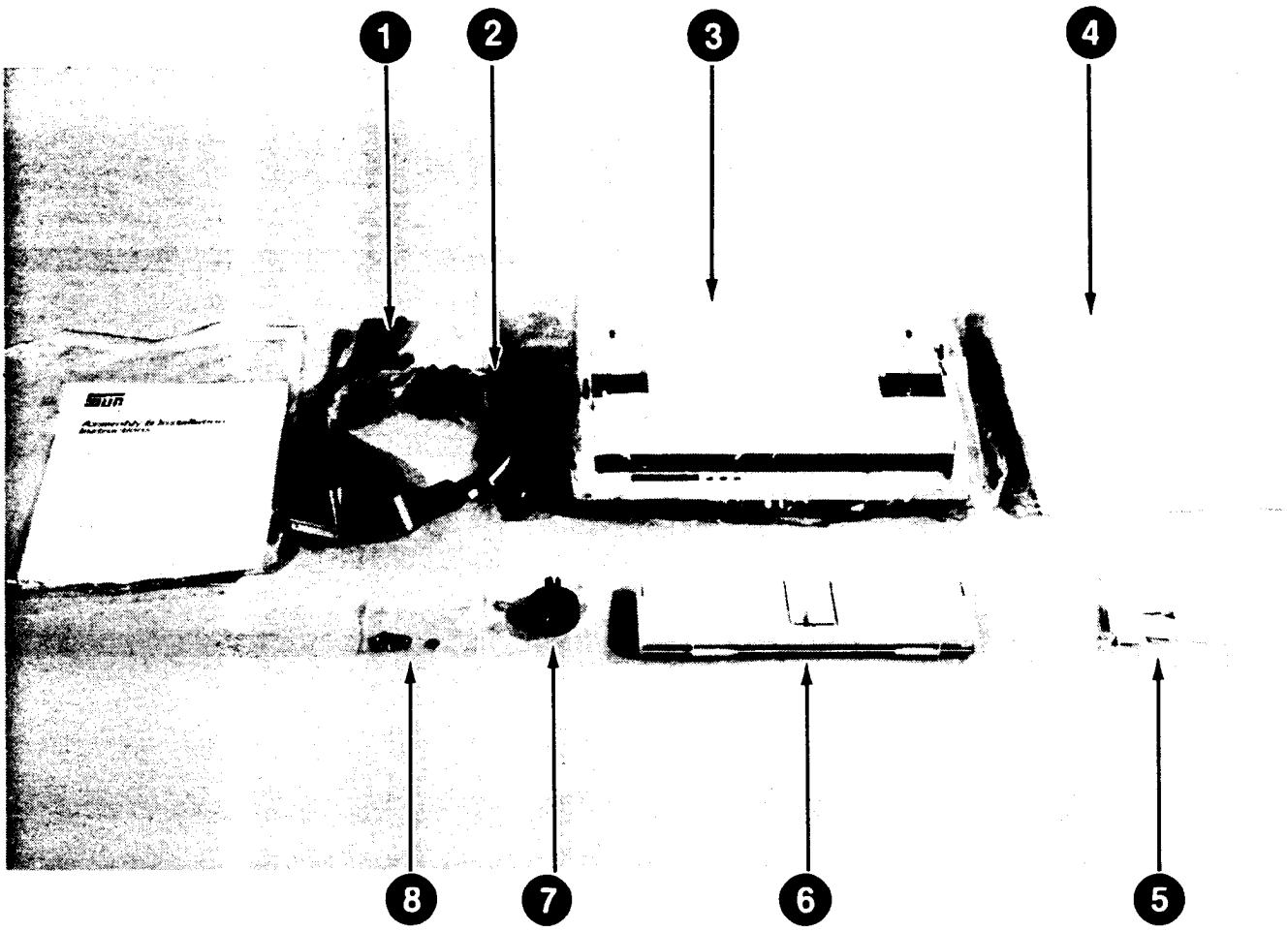
1. Power-up the host tester.

2. Turn the Power switch of the printer (located on the right hand side) to the "ON" position. The Printhead should move to the home positon.

3. Press the "Print" button on the Remote Control. The copyright page should be printed.

****

*** INSTALLATION COMPLETE ***
****



PRINTER INSTALLATION KIT (0120-0500)

1. RIBBON CABLE 7076-0526
2. AC CORD 6001-0176
3. PRINTER (NEW) AP-1000
3A. PRINTER (REBUILT) . ..AP-1OOOR
3B. PRINTER RIBBON 0528-0995
4. PAPER, FAN FOLD 0528-0994-01
5. TIEDOWN PACKET . . . . . N/A
5A. CABLE MOUNT 5878-0902
5B. WIRE TIES 5878-0012
6. PAPER GUIDE.(INCL. W/PRINTER)
7. KNOB 0528-1003
8. HARDWARE PACKET . . . . . N/A
8A. SCREWS,#8-32x3/4 . . 0408-0077
8B. WASHERS, #8 0400-0162
8C. NUT,#8-32 HEX 0407-0002

NOTE : The AP-1000 printer is not part of KIT #0120-0500. But is needed if the MEA-1500 is to have the printer option.

CHAPTER 12

MAGNETIC TIMING OPTION

SECTION 1. THEORY OF OPERATION

GENERAL

The mag timing kit consists of a magnetic timing probe and 4 Adaptors. Unlike the other options, Mag timing does not have an enable switch on the Digital Electronics Board.

NOTE: The following text is used in conjunction with Diagram 5-1, Pages 5-7/5-8.

When the magnetic probe (mag probe) is being used, the tester will automatically select and use the timing pulses from the mag probe. If no pulses are available from the mag probe, the tester uses the timing pulse from the Timing Light in computation of timing readings.

The Digital Electronic Board computes timing from two signals, (1) ENGINE SYNC B* which occurs when the #1 spark plug fires and (2) TIME PULSE* - which represents the position of the piston in the cylinder. The CPU uses the time between the falling edges of these two signals to calculate timing.

MAGNETIC TIMING -- DOMESTIC

The car manufacturers made provisions for magnetic timing measurements in the early 70's. A slot on the circumference of the vibration damper indicates the position of the #1 piston. The holder for the magnetic probe is usually placed a set number of degrees away from TDC. With the holder mounted at a position other than TDC, measurements with a Timing Light are not interfered with.

Each manufacturer mounts (offsets) the magnetic probe holder a different number of degrees from TDC. The offset angle (number of degrees the probe holder is off from TDC) is specified by the manufacturer. General Motors typically uses -9.5 degrees, Chrysler -10.0 degrees, Ford -135 degrees. These are some typical offsets, the car manufacturers do use other offsets than the ones mentioned above.

Figure 5-2 shows the location of a magnetic probe holder. Notice that it is past TDC by 9.5 degrees. The computer must add -9.5 degrees to compensate for the probe holders location {9.5 (+) -9.5 = 0 or TDC}.

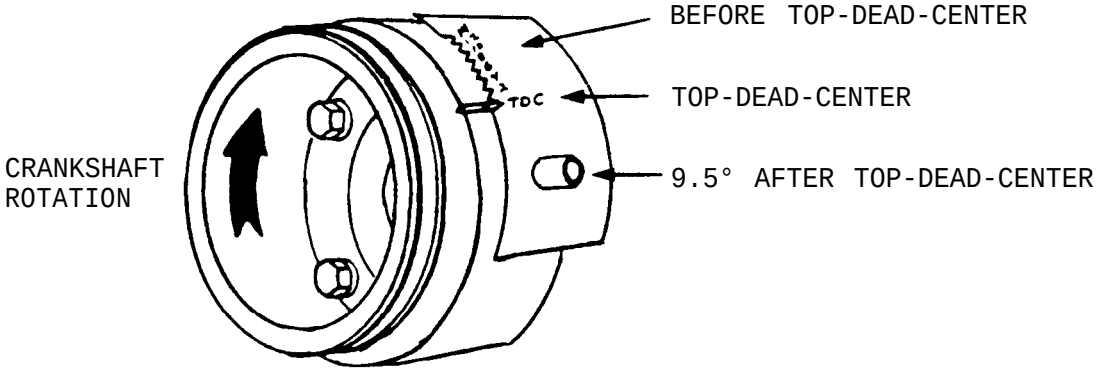


FIGURE 12-1

The correct offset angle is entered on the set-up page. Before the magnetic timing readings are displayed, the offset angle is added to the "raw" timing readings to get the correct timing of the engine.

A mag probe adapter is used to allow a proper fit of the magnetic probe into the probe holder on the vehicle. It is important that the magnetic probe be properly positioned in relationship to the slot on the vibration damper for stable readings. The mag probe adapter provides this function.

The magnetic probe is a passive probe, meaning it contains a magnet and a coil of wire. As the slot on the vibration damper passes by the probe, a blip is output to the Mag/Volt/Ohm board, where it is further squared up, zero cross detected, and applied to the single/double peg/hole detector. This activates the MAG ACTIVE* signal, removing the timing light signal from one side of the OR gate. This allows the mag pulse to pass to the Digital Electronics Board, where it is compared to ENG SYNC b* to obtain "raw" timing readings. Before the reading is displayed, the computer adds the offset angle of the engine to the raw reading to obtain the correct reading.

SECTION 11. MAGNETIC TIMING CHECKOUT

REQUIRED EQUIPMENT: IS-100(A) Ignition Simulator

1. Advance the tester to the "SET-UP" page.
2. Set-up for and 8 cylinder, 4 cycle, 0.00 degree offset angle.
3. Advance the tester to the "ENGINE TEST" page.
4. Connect the Red trigger pickup from the tester around the trigger loop on the Ignition Simulator.
5. Set the Ignition Simulator to 600 RPM. (600 RPM / 20 degrees advance)
6. Insert the mag probe from the tester into the mag probe hole in the Ignition Simulator.
7. The Display should read 20 degrees +/- 3 degrees.

*** * * * * * * * * * * * * ***
*** CHECKOUT COMPLETE ***
*** * * * * * * * * * * * * ***

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COMPLAINT	CORRECTIVE ACTION
1. MAGNETIC TIMING READS O DEGREES, IS ERRATIC OR INACCURATE.	1. Verify the following mechanical aspects: A. The face of the magnetic probe must be no more than 0.025" away from the vibration damper surface. B. That the slot on the vibration damper passes across the entire probe face. C. That the probe holder is properly aligned for the magnetic probe to be positioned correctly. D. That the vibration damper does not have deep dents. (The dent may cause an extra pulse) . 2. Verify that the Timing Light functions correctly. If not functioning correctly See page chapter 5. 3. ----------SUBSTITUTE---------- A. Magnetic probe 7009-1890 B. Mag/Volt/Ohm Board 7001-0606 C. Digital Electronics Board 7001-0604 4. Refer to Theory of Operation and Functional Diagram.

SUN ELECTRIC CORPORATION

Model: Kit #0120-0494

Page: 1 of 1

Assembly & Installation Instructions

The installation of Kit #0120-0494 provides the MEA-1500 with the Magnetic Timing Option and is only available as a Field Installation item.

PARTS LIST

QTY	PART NUMBER	DESCRIPTION
1	7009-1890	Probe Assembly, Mag Timing
1	7054-0056	Adapter, Monolithic Probe (Ford)
1	7054-0057	Adapter, Monolithic Probe (Chrysler)
1	7054-0060	Adapter, Monolithic Probe (Ford 2300 CC)
1	7054-0062	Adapter, Monolithic Probe (Chrysler 1977)
1	1243-0800-03	Identification Plate
1	0119-0259	Literature Kit

REQUIRED TOOLS

IS-100A

INSTALLATION PROCEDURE

1. Connect the Mag Probe provided in the kit to the existing Universal Harness.

2. Affix the provided Option Kit Identification Plate to the MEA-1500 next to its Serial Plate or any other Option Kit I.D. Plate already present at that location. NOTE: Make sure the surface is clean and free of dirt!

CHECK OUT PROCEDURE

Refer to Chapter 12 of the MEA-1500 Service Manual for the checkout procedure.

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*** INSTALLATION COMPLETE ***

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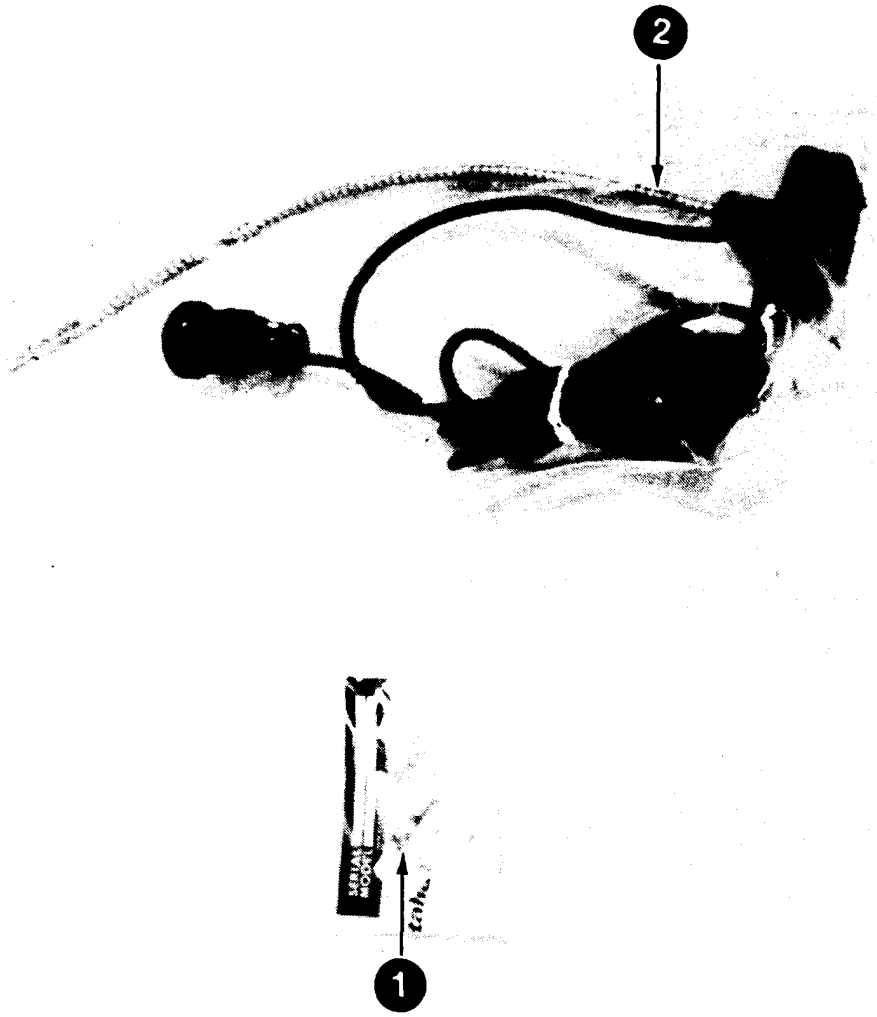


MAGNETIC TIMING OPTION (0120-0494)

1. ACCESSORY PACKET . . . . . N/A
1A. ADAPTOR, FORD 7054-0056
1B. ADAPTOR, CHRYSLER 7054-0057
1C. ADAPTOR, FORD 2300CC 7O54-0060
1D. ADAPTOR, CHRYSLER '77...7054-0062
2. PROBE, TIMING 7009-1890
2A. CONNECTOR, 4 PIN 4162-0604
2B. PIN, MALE 4162-0924

CHAPTER 13

COIL "+" VOLTAGE OPTION

SECTION I. THEORY OF OPERATION

GENERAL
The COIL "+" option consists of a twinflex lead which is substituted for the Primary (-) lead. The option is enabled by dip switch #7 on the Digital Electronics Board.

NOTE: The following text is used in conjunction with diagram **6-1.**

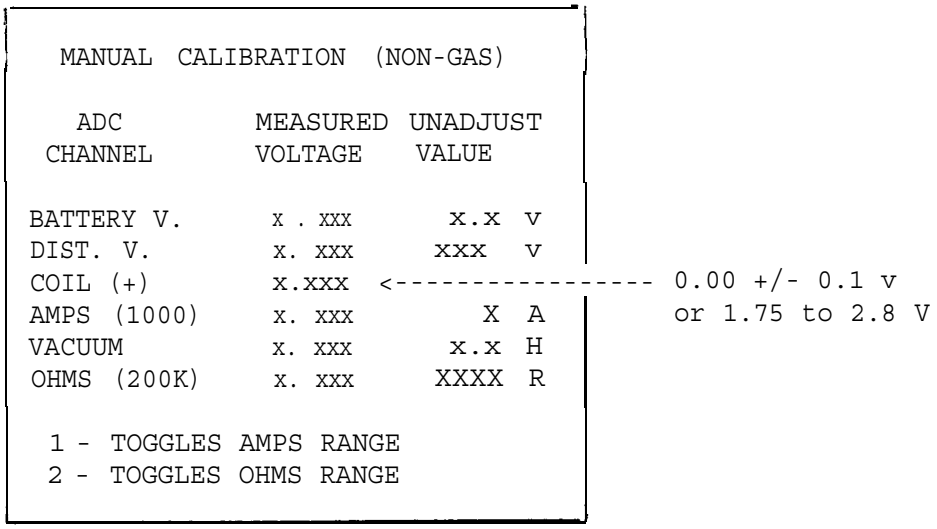
COIL "+" VOLTAGE
The coil voltage data is obtained from the Yellow boot lead that is connected to the positive terminal of the Coil (and the **ground lead).** The Mag/Volt/Ohm Board processes the voltage, and outputs it as AVERAGE COIL VOLTAGE ANALOG (AV COIL ANLG). The AV COIL ANALOG signal is routed to the Digital Electronics Board where it is read by the computer for display.

SECTION 11. SERVICE CALIBRATION PAGE USAGE

GENERAL
If needed, refer to the Introduction (page iv) for general information & specific instructions on how to access the MANUAL CALIBRATION (NON-GAS) page. To select OHMS one must press volt/ohm on the remote keypad.

UNADJUST VALUE
The UNADJUST VALUE reading is the current COIL + reading based on the AV COIL ANALOG channel. The reading displayed is uncorrected for zero offset. It is a representation of the AV COIL ANALOG channel after conversion to volts, without regard to the stored calibration constant gathered by the Digital Electronics Board during system calibration.

MEASURED VOLTAGE
The MEASURED VOLTAGE is to the left of the unadjust value on the COIL + line. It is the voltage presented to the mux select circuitry on the Digital Electronics Board at all times.



BATTERY VOLTS

With 13 volts applied to the Battery leads, the Mux voltage will be 2.28 volts.

GOOD CALIBRATION LIMITS

The Coil + voltage reading must fall within a window of 0.00 +/- 0.1 volts or 1.75 to 2.8 volts. This is to allow calibration while the leads are connected to a Vehicle.

SECTION III. Coil + CHECKOUT

REQUIRED EQUIPMENT: IS-100A

1. Proceed to the VEHICLE TEST PAGE.
2. Connect the Yellow booted COIL + lead to the + VOLT/OHM lug of the IS-100A.
3. Connect the Black booted Battery (-) lead to the - VOLT/OHM lug of the IS-100A.
4. Turn the IS-100A power switch to the ON position, and the VOLT/OHMS switch to the 13V position.
5. Verify that the COIL + Voltage reads 13 +/- 0.2.

```
* * * * * * * * * * * * * * * * * * * * *
*  CALIBRATION/CHECKOUT  COMPLETE  *
* * * * * * * * * * * * * * * * * * * * *
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SECTION IV. COIL + TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. COIL + SERVICE REQUIRED.	1. Verify that the Yellow Booted COIL + lead was disconnected during calibration 2. ----------SUBSTITUTE---------- A. Mag/Volt/Ohm Board #7001-0606 and calibrate volts/ohms. B. Digital Electronics Board 7001-0604. 3. Refer to Theory of Operation and Functional Diagram.
11. COIL + READINGS ARE INACCURATE.	1. Perform the ADC calibration. Note that The complete tester must be recalibrated If the ADC voltage is adjusted. 2. Refer to Theory of Operation and Functional Diagram.
111. COIL + READINGS ARE AT OR NEAR O VOLTS.	1. Using an Ohm Meter, verify continuity of Coil + lead. 2. ----------SUBSTITUTE---------- A. Mag/Volt/Ohm Board #7001-0606 B. Digital Electronics Board 7001-0604. c. Input Board #7001-0608. 3. Refer to Theory of Operation & Functional Diagram.

SUN ELECTRIC CORPORATION

Model: Kit #0120-497

Assembly & Installation Instructions

The installation of Kit #0120-0497 provides the MEA-1500 with the Coil "+" Option and is only available as a Field Installation item.

PARTS LIST

QTY	PART NUMBER	DESCRIPTION
1	6005-0172	Coil "+" Lead Assembly
1	1243-0800-06	Plate, Identification
1	0119-0258	Literature Kit

REQUIRED TOOLS

PHILLIPS SCREWDRIVER
PIN EXTRACTOR (AMP #0305183-R)

INSTALLATION PROCEDURE

1. Turn tester "OFF" and remove AC plug from the outlet.
2. Remove the Universal lead from the tester.
3. Remove the two screws and the strain relief from the 14 pin Universal connector.
4. Unscrew the back cover of the 14 pin connector.
5. Using the pin extractor, remove pin 2 and discard the Blue Primary wire.
6. Feed the Twin flex cable through the back cover of the 14 pin connector.
7. Insert the Blue Booted side of the Twinflex cable into pin 2.
8. Insert the Yellow Booted side of the Twinflex cable into pin 8.
9. Re-assemble the 14 pin connector and attach it back to the Input Board.
10. Unscrew the two screws holding the front C.C.A. drawer in place and pull it open.
11. Turn switch number 7 of SWl located on the Digital Electronics Board (p/n 7001-0604) to the "ON" position to activate the Coil "+" option.

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12. Affix the provided Option Kit Identification Plate to the MEA-1500 next to its Serial Plate or any other Option Kit I.D. Plate already present at at that location. **NOTE:** Make sure the surface is clean and free of dirt!

CHECK OUT PROCEDURE

Refer to Chapter 13 of the MEA-1500 Service Manual for checkout and Calibration procedures.

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*** INSTALLATION COMPLETE ***
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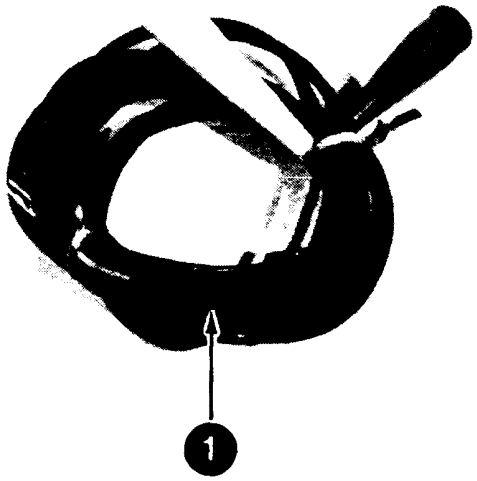


COIL (+) VOLTAGE OPTION (0120-0497)

1.	COIL (+) LEAD	6005-0172
1A.	CLIP	0672-0003
1B.	BOOT, YELLOW	0190-0016
1C.	BOOT, BLUE	0190-0003

SECTION I. THEORY OF OPERATION

GENERAL

The DATA LINK-1OO or DL-1OO is an option for the MEA-1500, which provides the MEA with the ability to interface with on-board computer systems used in vehicles. This allows the MEA to display information from the vehicle's on-board computer as seen from the vehicle's sensors about engine performance and operation. This DL-1OO has only one mode, it is referred to as the "MONITOR MODE". Only vehicle data can be displayed, the DL-1OO is not capable of diagnostics, as the STL and MCA'S ALDL units are.

The DL-1OO is only available by ordering //0120-0511. This Kit contains the necessary parts for installation. For more information on installation, see the installation instructions pages 14-23 thur 14-25.

The DL-1OO is capable of testing both uni-directional and hi-directional on-board computer systems. However the DL-1OO does require special software (it is not compatible with either STL or MCA ALDL software). Vehicle interface cables are interchangeable between the STL, MCA'S ALDL and the DL-1OO.

The Circuitry of the DL-1OO consists of the following:

-CPU Board	contains the main microprocessor, RAM and ROM memory, and associated interface circuitry to interface with the Bi-Com Board, MEA's Digital Electronic Board, the Disk Interface Board, and Uni-directional communication capable vehicles.
-Bi-Com Board	contains a microprocessor, RAM and ROM memory, and the associated interface circuitry to interface with the Main CPU board and Bi-directional communications capable vehicles.
-Serial Interface Board	contains a serial port which connects into the Digital Electronics Board (DEB Board) bus lines, allowing the DL-1OO'S CPU board and the MEA-1500's DEB board to communicate with each other.
-Disk Interface Board	contains a Floppy Disk Controller, 128K of RAM, and the associated control circuitry.

The Main CPU communicates with the MEA-1500's computer via the Serial Interface Board. Information that is sent between these two boards consists of video information from the DL-1OO to the MEA and controls information from the MEA-1500 to the DL-1OO. This information consists of what buttons on the remote were pressed or other commands from the MEA-1500.

POWER SUPPLY

The DL-1OO uses the MEA-1500's Switching power supply's +5v, +12v and -12v supplies. This is accomplished by "T-ing" into Connector J604 on the Power Supply Distribution Board.

PROGRAM LOADING

The DL-100 function is accessed by pressing the appropriate selection on the MEA's main menu page. This option is only available when a Rev. 2.0 OR later EPROM is installed on the DEB board (this EPROM comes standard with a 0120-0511 Kit). If a Rev. 2 or later EPROM is installed and the DL-100 is not present, a "(NOT ACTIVE)" message will be displayed. If the DL-100 is installed but not operational, a "(SERVICE REQUIRED)" message will be displayed. If the DL-100 is selected and the DL-100 is operational, the customer is instructed to insert a disk and Boot-up occurs. During boot-up of the DL-100, it reads the EPROM and follows the instructions found there. They include just enough information to find the Disk Operating System (Sundial) on the Disk inserted in the Disk Drive and load it into RAM memory located on the CPU Board. The Operating System for the BI-Com board is also loaded at this time. If this can not be accomplished, the beeper will beep. The CPU then follows the instruction contained in the operating system to load the actual Program (RTS, Run Time System) from the disk. RTS is the language interpreter (i.e. BASIC), is used to run the actual program.

The ROM located on the CPU Board contains no information about interfacing with cars, only enough information to send the "Insert Disk" to the MEA-1500 for display, and to load the Program from the Disk.

COMPUTER CIRCUITRY

The circuitry on the CPU Board consists of a self contained computer. To interface the required amount of memory, Bank Switching of the Disk Interface Board's 128K of RAM memory. Under this system, only one 16K block of the available 128K is allowed to respond at any given time. If a different memory segment is required, the current segment is deselected and the new segment is enabled. The new memory segment (bank) then responds to the same memory space.

The Peripheral Interface Adapter (PIA) is used by the CPU to input and output digital signals. To the CPU, the PIA appears as memory locations. The reading of one of these locations allows the CPU to determine if any given input pin is at a logic high or logic low. Writing to one of the PIA's memory locations allows the CPU to set any given output pin to either a logic high or a logic low.

PIA OUTPUTS

SEL O and SEL 1 - These signals assist in the control of the memory bank selection of the RAM on the Disk Interface Board.

BEEPER DRIVE - This signal is used to control the audible beeping device. The signal is applied to an AMP, which in turn drives the beeper. A Beep is issued to give the operator feedback each time a key has been pressed and accepted, during testing indicating the VDU is being updated, or during boot-up to indicate that the Bi-Com board did not load properly.

MODE CONTROL LINES - These signals are used to control transistors which change the resistance from pin 4 of the Vehicle Connector to ground. One of the lines forces a direct connection to ground through a high-power Darlington pair that is constructed out of two discrete transistors (Q1 and Q2). The second mode control line controls transistor (Q3) which places a 10K resistor between pin 4 of the Vehicle Connector and ground. The third mode control line places a 3.9K resistor between pin 4 of the Vehicle Connector and ground, thus placing some GM Fuel Injection vehicles into a mode known as the Fuel Back-Up Mode.

This mode causes the vehicle's on-board computer system to use certain fixed parameters except for throttle position and distributor pulses.

VEHICLE TYPE	ON PIN 4	RESULTS FROM THE VEHICLE'S COMPUTER
GM	Ground =	Check Engine Light Mode (flashes trouble code(s) using Check Engine Light)
	10K =	Monitor Data Mode (outputs engine parameter data)
	3.9K =	Fuel Back-Up Mode (force some Fuel Injection systems to input fixed parameters)
Ford	Ground =	Sends trouble codes
Chrysler	Ground =	Enables ATM Emulation Test Mode Trouble Codes are sent by using the ignition key, Key ON Key OFF Key ON Key OFF Key ON
	Ground/Open =	Is used on hi-directional on-board systems to indicate what sensor is ready to be read.

These control lines are tested by the Service Test Disk when performing a Vehicle 1/0 Loop-back Test with the exception of the 3.9 K Mode.

DATA STREAM SELECT is used to select the valid data stream for the vehicle being tested. The selected channel is inputted to the CPU via the PIA.

PIA INPUTS

Vehicle data that is present on the selected input line is read via this input. The CPU synchronizes to this data stream, decodes it and uses the information for display on the Monitor page.

RESET SWITCH

The Reset switch is a normally open push-button switch, and is located on the front panel. When pressed, the switch pulls the RESET* line low. This forces the Reset Generators on the CPU and BI-COM boards to pulse the RES* line low. In turn the 6809 microprocessors are reset, thus causing the rebooting of the disk.

DISK DRIVE INTERFACE

Interface to the disk drive is done by the Disk Drive Interface Board. This board is used for three major functions which are under control of the main CPU . A brief description of these functions follows:

Floppy Disk Controller-This component is responsible for all the input and output signals to and from the disk drive. The CPU communicates with the' Controller to get certain information. The Floppy Disk Controller then controls the functions of the Disk drive to find the track and sector, then reads it. This information is read in a serial fashion and then presented to the DMA controller. The detail of handling the Disk Drive are performed completely by the controller. The output of the controller is very similar to an output from a Memory Chip.

Dynamic RAM Controller-This component is responsible for refreshing the contents of the Dynamic RAM every 2 milliseconds. This is done without interfering with reading from and writing to the memory by the CPU. If the RAM is not refreshed, the information stored there will be lost. This controller is also responsible for controlling the bank selecting scheme which is used to select 16K blocks of the 128K RAM memory located on the Disk Controller Board. Because the 6809 CPU can only directly access 64K of memory, the 128K must be broken down into 16K blocks which are switched in, one at a time. This allows 128K of memory to be available to the CPU, but uses only 16K of it's memory space.

DMA Controller-This Component is responsible for interfacing the selected 16K of RAM to either the CPU Board or the Floppy Disk Controller. To maximize the data handling speed of the floppy disk controller, a Direct Memory Access (DMA) technique is used. While in DMA mode, the DMA Controller takes the information (BITS) from the Floppy Disk Controller and pokes them into memory locations via the Dynamic RAM Controller. When the DMA transfer is complete, access to the RAM memory is returned to the CPU.

DISK DRIVE

The 3 1/2-inch floppy disk drive consists of a floppy disk rotating mechanism, a read/write head, an adductor to position the read/write head on tracks, electronic circuits to read and write data, and to drive these components.

The rotation mechanism clamps the disk inserted into the drive to the spindle, which is directly coupled to the DC brushless motor, and rotates it at 300 rpm. The positioning adductor moves the read/write head to the desired track of the medium. Reading and writing can then occur after a settling delay.

The electronic circuits driving the individual mechanisms of the disk drive are located on a single Board which consists of the following circuitry:

1. Line drivers and receivers that exchange signals with the Computer Module Floppy Disk Controllers.
2. Drive selection.
3. Index detection.
4. Head positioning adductor drive .
5. Spindle motor control.
6. Read/write.
7. Write protect.
8. Track 00 detection.
9. Drive ready detection.
10. Head selection.

The Circuit Board for the spindle motor consists of a motor drive circuit, speed sensor and Hall element sensor.

Rotation Mechanism

The disk rotation mechanism uses a DC brushless direct-drive motor to directly rotate the spindle at 300 rpm.

Positioning Mechanism

The read/write head is positioned as subsequently described. A carriage assembly needle is fitted in the lead screw groove on the stepping motor output shaft and, as the stepping motor rotates by 30x, the read/write head moves by one track in the specified direction, thus positioning the read/write head.

Read/Write Head

The head consists of a read/write head block and erase head block (tunnel erase) that erases data on both sides of each track. The two heads, facing each other over a disk, are attached to a soft circular gimbal spring and each head closely follows the disk surface so as to obtain the greatest read signals from the contacting disk.

Power On Sequencing

No read/write operation can occur during the time period before control signals are stabilized immediately following DC power turn on. The disk drive ready state is established within a maximum 600 milliseconds after application of the MOTOR ON signal.

The read/write head may be positioned on an incorrect track of the disk after application of Tester AC power (Disk Drive DC power applied), so before starting a read/write operation the Tester forces performance of a step out operational sequence until a TRACK 00 signal is detected, thus correctly positioning the head at a known track.

Positioning Operation

The "seek operation" which moves the read/write head to the desired track selects an inward/outward direction first (dependent upon DIRection signal status) and then commands the head to move through use of the STEP signal. If access to a track location two or more tracks away from the existing head track position is required, step pulses are continuously applied until the head moves to the desired track.

Electrical Signal/Control Interfacing

Overall control of Floppy Disk Drive is governed by operation of Floppy Disk Controller located on the Disk Interface Board. Electrical signal/control interfacing is accomplished via a 34 conductor flat ribbon type cable assembly. Connector pin number and respective signal/control assignment are as follows:

NOTE The following list is with respect to signal/control nomenclature for Wiring Harness, W35 between the Disk Interface Board and the Disk Drive Assembly.

PIN	I/O	SIGNAL/CONTROL	PIN	I/O	SIGNAL/CONTROL
1 - 3 3 * *		Ground	20	O	Step
6	O	Drive Select 3*	22	O	Write Data
8	I	Index*	24	O	Write Enable*
10	O	Drive Select O*	26	I	Track 00*
12	O	Drive Select 1*	28	I	Write Protect*
14	O	Drive Select 2*	30	I	Read Data
16	O	Motor On*	32	O	Head Select
18	O	Direction			

** All odd numbered pins. Pins 2,4 and 34 are not used.

With reference to the Interface connector located on each Floppy Disk Drive assembly there are 10 active input signals applied to the disk drive and four disk drive output signals generated. A functional description of each of these input/output signals is subsequently given.

Input Signals.

Drive Select 0-3* are four separate input signal lines, Drive Select 0 to 3, are provided for connecting up to four disk drives and multiplexing them. It is for this reason that the DRIVE SELECT on the drive must be set properly, or at DS0 for the Disk Interface to select or use the installed disk drive. The Disk Interface Board selects the proper drive by taking the DS0* line low. More then one method for implementing drive selection (on the disk drive itself) varies between manufacturers of the drive. See Configuration for more information.

Side One Select is used to select which of the two sides of the disk is to be read from or written to. When at a logic "1" level side 0 read/write head is selected and when at a logic "0", side 1 read/write head is selected.

Direction Select controls the inward/outward direction the read/write head moves when an input step signal pulse (described below) is applied. When the signal is at a logic "1" level, the read/write head moves from the center of the disk outward and conversely if the signal is at logic "0" level the head moves inward.

Step is a pulsed signal which moves the read/write head in the direction, either inward or outward, as defined by the Direction Select signal. Each pulse moves the head one track position.

Write Enable* controls the the internal write driver. When low, data present on the write data line is written on the preceded side of the disk. When the line becomes logic "1" level the write driver is disabled and the read data logic circuitry is enabled. Read data is then made available for transfer to the CPU.

Write Data is received by the disk drive whenever the write enable (previously described) is a logic "0" level. This line is normally held at a logic "1" level.

Motor On*, when a logic "0" level, starts the spindle drive motor. When the line goes to a logic "1" level, it stops the drive motor from operation.

Output Signals

Index* becomes a logic "0" level output pulse each time the disk make one complete revolution but then returns to a logic "1" level. This output signal signifies the start of a sector on the rotating disk.

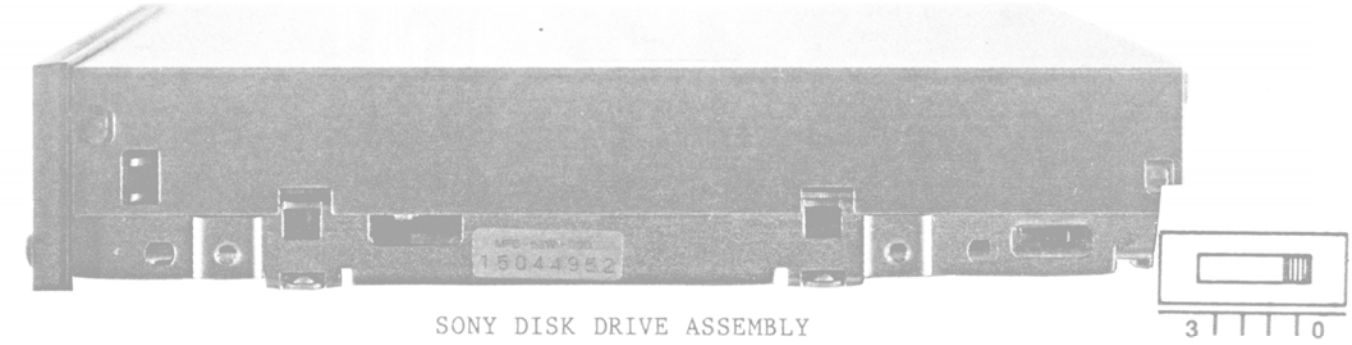
Track 00* becomes a logic "0" level to indicate that a read/write head of the selected disk drive is positioned on track 00.

Read Data transmits the data that is detected by the read/write head on the disk. The read data line is normally logic "1" but it sends a logic "0" (negative-going) output pulse during a read operation.

Write Protect* notifies the CPU of the insertion of a disk without a write protect notch into the drive. The signal goes to logic "0''when a write-protected disk is inserted into the drive. When the signal is at logic "O", writing on the disk is inhibited even if the write gate line becomes active.

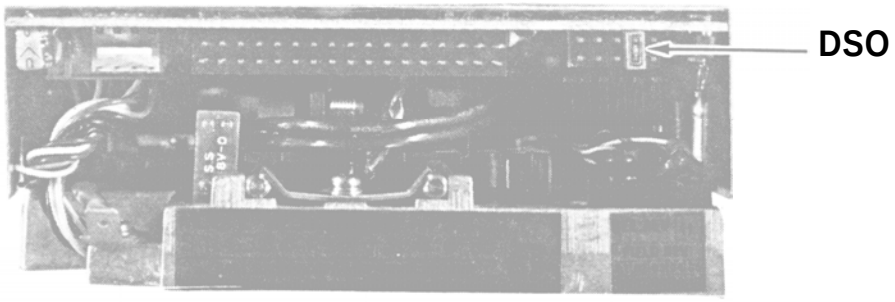
CONFIGURATION

Customizing the 3 l/2-Inch Disk Drives for operation within the Tester is dependent upon the drive's manufacturer. Sony drive selection is determined by using a DRIVE SELECT slide switch (see figure below for correct setting).



SONY DISK DRIVE ASSEMBLY

However Mitsubishi drives use shorting pins located on the rear of the disk drive assembly, by placing the shorting pin in the DSO location (as shown below) the drive is configured properly for use by the DL-100.



MITSUBISHI DISK DRIVE ASSEMBLY

COMMUNICATION BETWEEN THE MEA-1500 AND THE DL-100

The communication port between the MEA-1500 and the DL-100 is a serial port, data is exchanged bit by bit between the MEA and DL-100'S CPU. However this port is NOT an RS232C serial port, but is instead an RS422 port. The RS422 serial port uses a differential drive scheme for transmitting and receiving data. This means that two lines are required for transmitting data, called TXD and TXD*, and two for receiving data, called RXD and RXD*. The TXD and TXD* signals are created by feeding the data to be transmitted into a differential amplifier. The differential amp has two outputs, one being the transmit data and the other being the inverse of transmit data. On the receiving end the RXD and the RXD* signals are applied to a comparator which checks both the RXD and RXD* lines for a difference. If a difference is sensed an output is produced which is the data being received. The communication levels used by the RS422 port are 5 volts rather then 12 volts used by RS232 ports. The RS422 port offers better noise immunity and faster data transfer rates. The RS422 port between the MEA and DL-100 is operating at 9600 baud. The fast data transfer rate (baud) is required in order to be able to keep the video controller (located on the DEB Board, 7001-0604) up-dated. The video controller creates the TTL video signals used by the MEA's monitor.

The RS422 Serial port in the DL-100 is contained on the CPU Board. Whereas the MEA's Serial port is on a Serial Interface board 7001-0639, which plugs into J112 of the DEB Board. The Serial Interface board, 7001-0639 has two serial ports, J700 and J701. Both serial ports are wired together pin for pin, when trying to communicate with a specific device through the serial port. The MEA must address that specific device. On power-up the MEA address the Serial Interface Board in Jl12 of the MEA's DEB Board. If the Serial Interface Board does not respond, the MEA assumes that the DL-100 is not present. When the main menu page is displayed "DATA LINK (NOT ACTIVE)" can be seen. However, if the Serial Interface Board does respond, communication between the MEA and the DL-100 is established. The DL-100 then reports back to the MEA on its status. If the DL-100 does not report it's status to the MEA, the MEA assumes that there is a problem. When the main menu is displayed, "DATA LINK (SERVICE REQ)" will be displayed.

RS422/232 SERIAL I/0 PORT TEST
Testing the MEA's RS422 Serial Port is possible by sending data out and receiving it back. Use the following procedure to perform the test.

RS422 SERIAL 1/0 PORT TEST PROCEDURE

EQUIPMENT REQUIRED

SERIAL LOOP-BACK ADAPTER 6004-0541

RS422/232 SERIAL 1/0 PORT TEST

1. Advance the MEA into the SERVICE MENU page by placing the "SERVICE SWITCH" (DIP SWITCH #8 on the DEB Board) in the "ON" position. Re-select "MENU" on the Remote Control Assembly

2. Connect the MEA Serial Loop-back Adapter, #6004-0541, to serial port #2 on the back panel of the tester.

3. Once the SERVICE MENU page is displayed, select the RS422 1/0 PORT SELF TEST by pressing "5" on the Remote Control Assembly The test will begin automatically. If the port passes, communication from the Serial Interface Board to the point of loop-back is OK. If the port fails, then communication does not exist, replace the Serial Interface Board #7001-0639.

4. Connect the MEA Serial Loop-back Adapter, #6004-0541, to serial port #1 on the back panel of the tester. Select RS232 1/0 PORT Self Test. If the port passes, communication from the Serial Interface Board to the' point of loop-back is OK. If the port fails, then communication does not exist, replace the Serial Interface Board #7001-0639.

NOTE: At this time, Serial Port #1 (RS232) is not used.

****
CHECKOUT COMPLETE
****

VEHICLE INTERFACE

The interface to the vehicle's computer is done via the appropriate vehicle interface cable and an adapter cable, if needed. The following four interface cables and two special adapter cables (used to support certain BI-COM capable vehicles) are currently available:

GM 5-pin	6004-0417	
GM 12-pin	6004-0522 *	"87" Corvettes requires adapter cable #6004-0524.
Ford EEC IV	6004-0443	
Chrysler TBI	6004-0442	requires BI-COM Adapter Cable #6004-0525

* This Cable Assembly has been changed to support both unidirectional and BI-COM systems

For pinouts of these cables see Diagram 14-1.

TYPES OF ON-BOARD SYSTEMS

On-board computer systems have changed since their early beginnings, all systems started out being uni-directional only. This means that communication only goes one way, serial data is sent from the vehicle's on-board computer to be received by an ALDL tester. But as automotive electronic technology advanced, so did the communication methods between vehicle and tester. Thus the advent of hi-directional on-board systems. These systems can not only send serial data but also listen and then act upon received serial data. The following text explains in detail how all this occurs.

The Automobile Manufacturers started using on-board systems which could output serial data as early as 1980. Most post 1980 Chrysler, Ford, and GM systems are capable of sending trouble code(s) stored in the on-board computer's memory. GM's on-board systems are capable of sending data about the engine parameters that the system monitors. Chrysler and Ford's on-board systems are able to start certain test sequences, then send serial data about the results. The DL-1OO was designed to be able to listen to this serial data, interpret the data, and display it on the VDU of the host tester.

Beginning with some 1986 models, GM started using a different type of on-board computer system. These systems differ from their older unidirectional counterparts in the fact that instead of just outputting serial data, they can also listen to serial data. This form of communication . is referred to as **BI-DIRECTIONAL COMMUNICATIONS** or **BI-COM.** Data can be exchanged in either direction on one line. Chrysler also introduced a similar on-board system in 1987. We will refer to the earlier systems as being unidirectional, for they can only send data. The data transfer rates of these BI-COM systems have greatly improved. On GM systems the data transfer rate (baud) is 8192 compared with earlier unidirectional systems that use 160 baud.

UNIDIRECTIONAL SYSTEMS

The vehicle under test outputs digital data in the form of voltage levels that represent logic highs and lows. The engine data is encoded by varying the amount of time that is spent in the high and low states. The voltages which represent a logic high and a logic low varies depending upon the vehicle type. Most GM vehicles output O volts (low) and +12 volts (high). There is at least one Chevette engine that outputs O volts (low) and +5 volts (high). Ford specifies 1 volt (low) and +12 volts (high), Chrysler output O volts (low) and +5 volts (high).

UNIDIRECTIONAL SYSTEMS (continued)

The signal from either pins 1 and/or 5 are then applied to the Main CPU Board's "Variable Threshold Input Processors". The Two Variable Threshold Input Processors are identical, and independently process the signals entering in on either pins 1 and/or 5. The input processors sense the high and low voltage extremes of the incoming digital signal and selects a trigger threshold at the mid-point of the peak-to-peak extremes. The output of the input processor is a clean digital signal (O to +12 volts) that is independent of the vehicle's output voltage levels. The selected vehicle interface cable routes the unidirectional data stream to either pin 1 or 5 of the DL-1OO'S Vehicle Connector, depending on the vehicle, or the BI-COM data line to pins 7 and/or 8.

The two digital data lines from the dual variable threshold input processor (at O to +12 volt levels) are applied to a logic level switching circuit where the active line is transformed into digital signals of TTL levels (Ov to +5V). The signals are "wire-or'd" together before being read-in by the CPU via the PIO.

The DL-1OO will "beep", indicating that data is being received from the vehicle or up-dating the DL-1OO. The absence of a digital Data Stream is indicated when there is no "beep". The exact definition and appearance of the vehicle's data stream varies depending upon the vehicle type. For troubleshooting purposes it is generally safe to assume that if the DL-1OO is beeping, then a data stream is present.

Pin 4 of the DL-1OO'S Vehicle Connector J1OOO is an output that the DL-1OO, used to place the on-board computer system in an appropriate mode of operation for testing (MODE CONTROL). Some vehicles require that this pin be grounded to request the sending of a data stream, others require that a resistance of 10K to ground be present to request the sending of the data stream. When in the "10K to ground" mode, the 10K resistor forms a voltage divider with a similar resistor in the vehicle's on-board computer. This voltage divider results in a voltage of about 6 volts on the Mode Control line. Refer to the chart on page 14-3 for each vehicle's requirements regarding the mode control signal.

BI-DIRECTIONAL SYSTEMS

General Motors Systems

General Motors has two types of BI-DIRECTIONAL systems, both systems use faster data transfer rate or baud rate of 8192 baud verses 100 - 160 baud of most of their uni-directional systems. The first one consists of an ECM (Electronic Control Module), which is hi-directional and uses the 8192 baud rate. This system polls the vehicle's ALDL (Assembly Line Diagnostic Link) to see if any test equipment is connected. If the DL-1OO is not present, then the ECM continues with it's normal routines until it is time to check the ALDL connector again. If the DL-1OO is present on the ALDL, the DL-1OO informs the ECM of it's presence and what data it requires. The ECM sends back the appropriate data the DL-1OO requested and returns to it's normal routines. This procedure is repeated continuously.

The second General Motors system is more complex, instead of just having an ECM it also has a Body Control Module, or BCM. The BCM is the master, while all the other modules are slaves. Together they form a Local Area Network system, or LAN. This LAN is responsible for the inter-sharing of vehicle information relating to other module's data and functions. Some modules make information requests of other modules by sending a device or module code followed by what type of information is being requested. This system polls it's ALDL connector much like the first GM system described above to sense if the DL-100 is present or not. If present, the DL-100 informs the BCM of it's presence and what data it requires. The request is passed throughout the LAN, to gather the data. The gathered data is then placed on the LAN for the DL-100 to read.

GM also has another system which resembles their Unidirectional ECM systems with one exception. Instead of using 160 baud rate, this system employs the faster data rate of 8192 like the hi-directional systems but, without hi-directional capabilities.

Chrysler

Chrysler also uses hi-directional capabilities on some of their 1987 model on-board computers. This system does not poll it's ALDL like GM's does, but requires that the DL-100 make it's presence known to the vehicle's on-board system through the ALDL. This is done by sending the hexadecimal number "C", or 1100 in binary to wake-up the on-board computer. After the on-board computer is awake, the DL-100 can ask for trouble codes by sending a number at 61 times a second. The vehicle's on-board computer will answer by sending trouble codes. The DL-100 can also ask for data from the vehicle's sensors by placing the vehicle's on-board computer in ground mode and using the mode control from the DL-100'S Main CPU Board.

The vehicle's on-board computer starts sending numbers which represent sensors. When the number of the sensor that the DL-100 wants to see is sent, the DL-100 releases the mode control ground. The vehicle's on-board computer recognizes this, and starts to send data representing the selected sensor. This test can be done with the engine either off or running. A third method is used to create a "monitor" page where all the sensor's data is displayed and updated. The DL-100 uses a baud rate of 7812 to send the address of memory locations in the vehicle's computer. These memory locations contain data pertaining to such things as RPM and coolant temperature. The vehicle's computer sends back the contents of the addressed memory location, the DL-100 decodes the data for display.

Both the GM and Chrysler BI-COM systems use 0 volt (low) and +5 volts (high). However, the BI-COM portion of the DL-100 can also support systems that use +12 volts (high).

Not all BI-COM vehicle's data streams can be seen so easily, some require that the DL-100 pull-up their data stream signal. Currently only certain Chrysler carbureted vehicles require this. How this is done will be discussed later.

SIGNALS & DESCRIPTION
This section discusses the signal names and their descriptions, which are used for the Bi-directional communication.

PULL-UP
When high it enables a pull-up resistor on the BI-COM Board. This pull-up resistor is used to pull-up the vehicle's output data stream coming in on the BI-DIR A line to either 12 volts or 5 volts, depending on the status of SEL 12V/5V*. Without this pull-up resistor it would look as if the vehicle's on-board computer was not outputting data. At this time only some Chrysler carbureted engines require a pull-up resistor, but others vehicles and/or manufacturers may follow.

SEL 12V/5V*
Due to possible future Auto Manufacturers electronic design criteria, it may be necessary to be able to talk with both CMOS (12 volts) and TTL (5 volts) logic levels. This signal is responsible for switching the pull-up resistor (R20) and both push/pull drivers (A and B) voltage to the appropriate voltage for the vehicle under test. At present, General Motors uses TTL logic levels for hi-directional communications, whereas their slow data stream vehicles (1985 and earlier with exceptions) primarily use CMOS logic levels. Chrysler uses TTL logic levels at present.

TRANS DATA A
TRANS DATA A is the data sent to the vehicle's on-board computer system(s) through the BI-DIR A line by use of push/pull driver A located on the BI-COM Analog Board.

TRANS DATA B
TRANS DATA B is similar to TRANS DATA A, but controls push/pull driver B to communicate through the BI-DIR B line.

LISTEN A
LISTEN A is a control signal that makes the push-pull driver (which is used to send data from the DL-100 to the vehicles on-board computer) transparent to the vehicles incoming data stream.

LISTEN B
LISTEN B is similar to LISTEN A, but controls LISTEN/SWITCH B instead.

C.O.L.
Current OverLoad informs the BI-COM Board CPU that a current exceeding 300 milliamps has been detected flowing from one of the push/pull drivers. The current through the push/pull drivers is measured by monitoring the voltage across R42 and R41 for push/pull driver A, and R39 and R38 for push/pull driver B. If C.O.L. goes high then all buffers (tri-state) are placed in their high impedance state to prevent possible damage.

RECEIVED DATA
REC DATA is serial data received from the vehicle under test, this signal is used by the BI-COM Board to obtain information about the vehicle under test. The BI-COM section has two hi-directional lines, but we have three possible combinations of REC DATA that the DL-100 is able to listen to. They are; BI-DIR A, BI-DIR B, and the difference between BI-DIR A and B. This means that we must have some method of selecting what we are listening to. This is done by the DATA SELECT LOGIC which is fed into a buffer op amp before becoming REC DATA.

DATA SELECT LOGIC
The DATA SELECT LOGIC receives control signals (SEL DATA A and SEL DATA B) from the Versatile Interface Adapter (V.I.A.) to select what will be used to make-up the RECEIVED DATA signal. The DATA SELECT LOGIC can select between either BI-DIR A, BI-DIR B, or the difference between BI-DIR A signal and BI-DIR B signal as RECEIVED DATA.

SEL DATA A
SELECT DATA A is a control signal that selects BI-DIR A to be outputted as REC DATA.

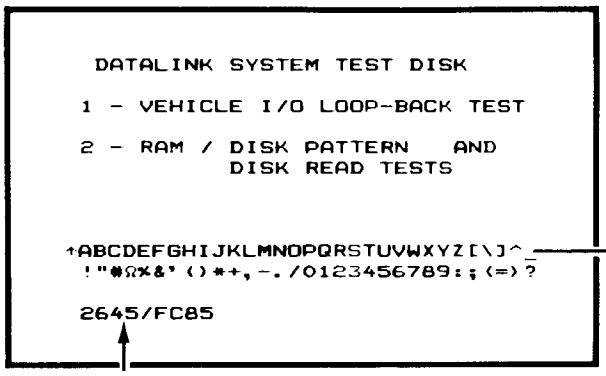
SEL DATA B
SELECT DATA B is a control signal that selects BI-DIR B to be outputted as REC DATA.

If both SEL DATA A and B are high, the difference between BI-DIK A and B from the the vehicle's on-board computer is used as REC DATA.

MODE SEL 0, and MODE SEL 1
These signals are used to control what is present on pin #4 of the Vehicle Connector from the BI-COM Board only. Currently, only the 3.9K mode or the fuel back-up mode is supported by software. More possible combinations could be decoded as the need arises.

SERVICE TEST DISK THEORY OF OPERATION

The 0552-0937A-04 Service Test Disk performs two individual tests; Vehicle 1/0 Loop-back test, and Ram/Disk Pattern and Disk Read tests. The troubleshooting section makes extensive use of these tests to isolate faults. Both of these tests are explained in the text which follows. After the Service Test Disk is loaded, the VDU will display:



NOTE: This set of characters , represents the set,which the printer can create and maybe appear different when the ones displayed on the VDU.

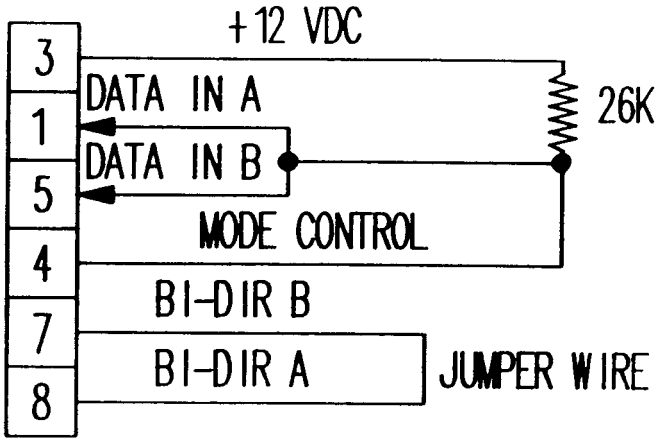
These two HEXADECIMAL numbers represents the checksums for the EPROMS on the CPU Board and the BI-COM Board.

To select either of the tests shown above, press the number just to the left of that Test's Title.

TEST 1 - VEHICLE 1/0 LOOP-BACK TEST

This test provides an easy means to verify operation of the DL-100'S input and output circuitry that is used to communicate with the vehicle.

NOTE : The test requires that a **MODIFIED** (see Service Bulletin - 581 for specific information) 6004-0454 Vehicle 1/0 Test Adapter be connected to the DL-100'S vehicle connector prior to the test being started. The connector's schematic is presented below;



VEHICLE 1/0 LOOP-BACK ADAPTER SCHEMATIC

This test operates by using the mode control signal of the CPU Board at pin 4 of the DL-100'S rear panel vehicle connector to generate one of three voltages. The voltage generated at any point is under test software control. The voltage changes that are available are 0 volt, +4 volts, and +12 volts.

These voltages are returned to the DL-100 via pins 1 and 5 of the DL-100'S vehicle connector. These two pins are the pins that are normally used to return the data stream from the vehicle.

The DL-100 makes the +12 volt supply available at the vehicle connector to power the TLK-4 telemetry adapter. The loop-back connector uses this supply to pull the two input channels up to +12 volts. If the test software requires to set the input channel voltages at ground (0 volt), it commands the mode control line to be taken to ground by the Darlington transistor pair. If the test software wants to set the input voltage at 4 volts, it turns on the transistor that grounds the mode control line via a 10K resistor. The 10K resistor and the 26K resistor in the test adapter form a voltage divider that sets the +4 volt level.

The loop-back test performs testing in 10 separate phases, each phase is known as a test "STATE". If a failure(s) is detected, the DL-100 presents the number(s) of the the state(s) that have failed. The following state table presents the details of each of the 10 states. This chart is drawn out as a state diagram on the following page.

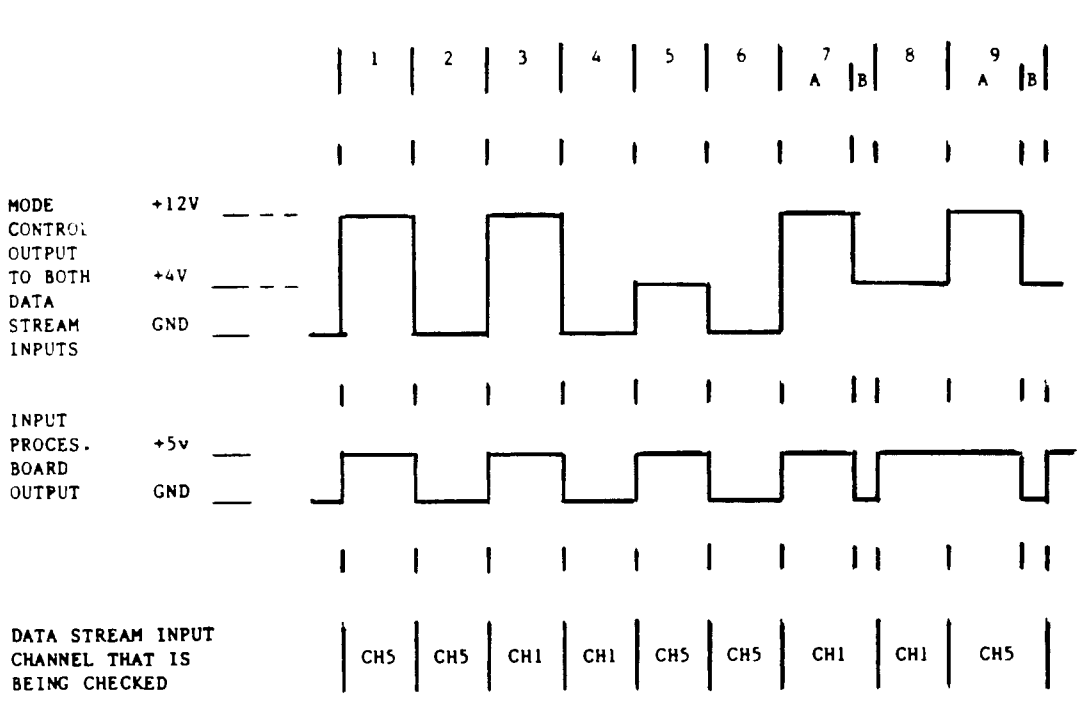
STATE#	MODE LINE	INPUT CHANNEL	EXPECTED RETURN AT THE CPU BOARD
1	+12V	PIN 5	+12v (HIGH)
2	Ov	PIN 5	OV (LOW)
3	+12V	PIN 1	+12v (HIGH)
4	Ov	PIN 1	OV (LOW)
5	+4V	PIN 5	+12v (HIGH)
6	Ov	PIN 5	OV (LOW)
7A	+12V	PIN 1	+12v (HIGH)
7B	+4V	PIN 1	OV (LOW)*
8	+4V	PIN 1	+12v (HIGH)
9A	+12V	PIN 5	+12v (HIGH)
9B	+4V	PIN 5	OV (LOW)*

10A Serial data is sent from pin 8 through the loop-back adapter into pin 7 where the BI-COM Analog Board is reading it.

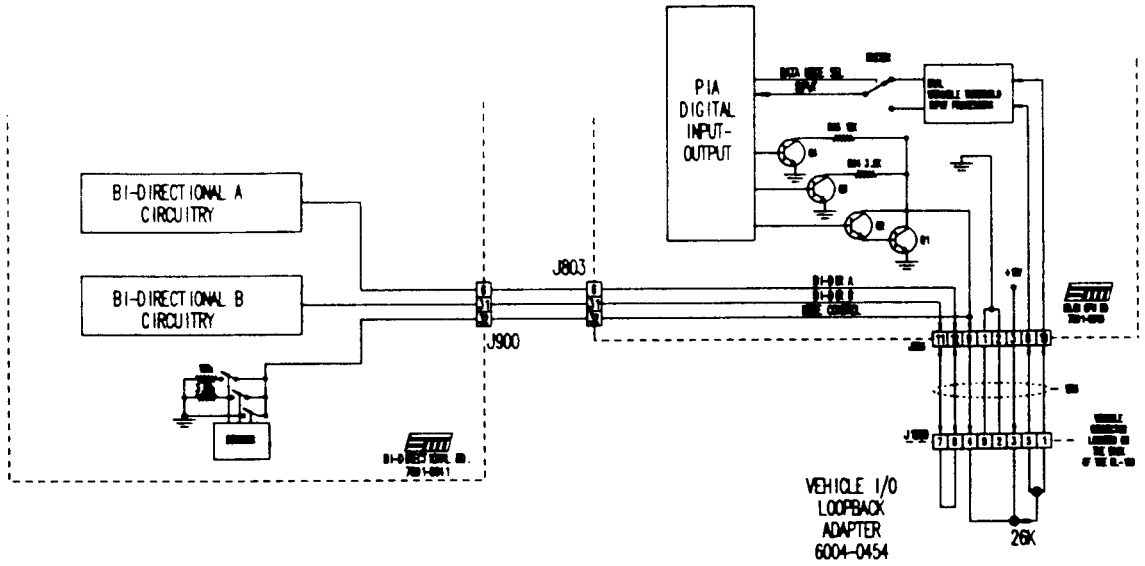
10B Serial data is sent from pin 7 through the loop-back adapter into pin 8, where the BI-COM Analog Board is reading it.

* - The expected low in the "B" phase of state 7 and 9 exists for only 250 ms. It is a test of the variable threshold seeking ability of the Input Processor Board.

VEHICLE I/O LOOP BACK TEST STATE DIAGRAM



Notes: Channel 5 equals pin 5
Channel 1 equals pin 1
Each state normally lasts approximately 1/2 second
State 10 is not shown on this Diagram, for it involes the BI-COM Digital & Analog Boards only. See Service Disk Theory of Operation for more information on State 10.



LOOPBACK DIAGRAM

The state diagram (on page 14-15) shows the voltages present during each state of the Service Test Disk's Vehicle 1/0 Loop-back Test. The top waveform is generated by the Mode Control line (on the CPU Board), under the direction of the test software. This same waveform is delivered to the two data stream inputs (on the Input Processor Board), J1 pins 1 and 5, by the Vehicle 1/0 Test Adapter via the Vehicle Connector. At each state, the test software checks to see if the expected voltage is returned to the CPU Board. If error(s) occurs, the test software displays all of the errors on the host tester's VDU. State 10 checks the BI-COM capabilities by sending out data on one line and into the other, then reversing the process. If the DL-100 is not functional causing the BI-COM Board not to upload the BI-COM portion of the Service Test Disk, "BIDIRECTIONAL LOOP-BACK TEST NOT PERFORMED" will be displayed on the VDU:

NOTE : The expected returns, at the CPU Board,in states 7B and 9B are false states. The expected logic low exists for only 250 milliseconds. The low exists for the period of time it takes the Input Processor Board to lower its trigger threshold from +6 volts to +2 volts, in response to the drop of the "high" input from +12 volts to +4 volts.

2. The RAM/DISK PATTERN AND DISK READ TESTS are used to check the operation of the DATA LINK's RAM memory, disk drive, and/or that of a particular disk. To select this test press "2" on the remote keypad. The first part of this test is the RAM TEST. The Ram Test checks certain kill memory locations by writing data to, then reading from the same memory locations that were just written to. Comparing the written data verses the data read verifies the RAM memory tested is functioning. Not all RAM memory locations are check, it is possible to pass this test and still have a RAM memory failure. If a RAM memory failure is detected it will be displayed on the VDU. If the RAM memory test passes, a "TEST COMPLETE" message will be displayed for a few seconds.

2. **The RAM/DISK PATTERN AND DISK READ TESTS (continued)**
The DL-100 automatically proceeds to the DISK PATTERN TEST, where a prompt is given on how to proceed. After the test is initiated you should listen for a "buzzing" from the disk drive. The "buzzing" sound in made by making the head position stepper motor seeking specific tracks. If a specific track can not be found, the test will stop and a number will be displayed representing where the failure occurred. If all tracks are found, the test advances automatically onto the next step. The next step is the DISK READ TEST where we sequentially check each sector by track (a block) on both sides of the disk. As each block is checked, the display shows a number which represents the total number of blocks of data on a particular disk. When the number reaches 2560 and stops then the drive and disk have passed the read test. If the number of blocks does not reach 2560 then a read error has been detected at the block number indicated on the VDU.

SECTION II. DL-100 CHECKOUT

EQUIPMENT REQUIRED

VEHICLE 1/0 LOOP-BACK ADAPTER	6004-0454
SERVICE TEST DISK	0552-0937A-04

The DL-100'S Service Test Disk contains two separate tests; VEHICLE 1/0 LOOP-BACK TEST and RAM/DISK PATTERN AND DISK READ TEST. Either test can be individually selected from the DATA LINK SYSTEM TEST DISK menu once the Service Test Disk is booted.

The Troubleshooting Section makes extensive use of these test procedures in isolating faults. If you have been directed to perform the Checkout Procedure by the Troubleshooting Section, perform the procedure as directed, then use the failure which occurs (if any) in the step of Troubleshooting Section which requested the test.

NOTE : The theory of operation for the Service Test Disk is explained on Page 14-13.

DL-100 CHECKOUT PROCEDURE

1. VEHICLE 1/0 LOOP-BACK TEST

   A. Advance the MEA into the DATA LINK mode and insert the Service Test Disk into the DL-100. Once the disk boots, the Service Test Disk Menu will be displayed on the screen.

   B. Install the Vehicle 1/0 Loop-back Adapter #6004-0454 into the Vehicle connector on the rear of the DATA LINK. Select test number "1", VEHICLE 1/0 LOOP-BACK TEST, from the Service Test Disk Main Menu. The DL-100 will immediately begin the loop-back test. The Loop-back test adapter must have been previously installed, or the test will fail.

   c. If the DL-100 passes, the tester will present a "Test Complete" message. If any portion of the test fails, the failure(s) will be displayed on the screen.

1. VEHICLE 1/0 LOOP-BACK TEST (continued)

D. To return to the main menu, press the "MENU" button on the Remote Control.

2. RAM/DISK PATTERN AND DISK READ TESTS

A. Return to the System Test Menu and select test number 2, RAM/DISK PATTERN AND DISK READ TESTS. The test will immediately begin by performing the RAM memory test segment. If it does not, try again by pressing the RESET switch and selecting test number 2. If the DL-100 still fails to perform the RAM TEST, refer to the Troubleshooting Section.

B. If the disk boots and the RAM TEST passes, the test sequence will automatically proceed to the DISK PATTERN AND DISK READ test.

c. The DL-100 will then perform the "DISK PATTERN" portion of the test which commands the drive to alternately seek the outer and inner tracks, several times. This should result in a "buzzing" of the drive as the head positioning stepper motor is used. If a seek error is detected, the test will halt and the number of the block that the drive was unable to seek will be displayed. If an error is detected, proceed to the Troubleshooting Section.

D. Following the DISK PATTERN TEST, the system will begin the DISK READ portion of the test. This test sequentially checks each block of data on the disk. As the blocks are read, the VDU displays the number of blocks read. There are 2560 blocks on each disk. If a read error occurs, the test is halted and cannot be continued. Refer to the troubleshooting guide. This test can be used two ways. First to check for a possible hardware problem, and secondly to verify a particular disk. This is done by using a known good disk (such as your Service Disk) for the READ portion of the test. If the disk passes, the problem is not likely to be in the hardware. Repeat the READ portion of the test using the disk in question. If this disk fails, the problem is in the disk.

****

*** CHECKOUT COMPLETE ***

****

COMPLAINT	CORRECTIVE ACTION
I. DL-100 is not recognized by the MEA on the MAIN MENU page.	1. Verify that U31, on the MEA's DEB Bd. is 0773-0616-01 REV 2.0 or later. A. If not replace U31 with 0773-0616-01 REV 2.0 or later 2. Refer to the Theory of Operation and Functional Diagram 14-1.
11. In Program Menu page next to Selection 5. DATA LINK "(SERVICE REQ)" is displayed.	1. Is W30 (DL-100 to MEA Wiring Harness) connected to both the MEA and DL-100. YES NO | Correct fault and recycle the unit (OFF then ON). Is power present in the DL-100 at J801. For +5V pin 12, -12V pin 11 and +12V pin 13. YES NO | 1. Check for connection of J604 to P604 of the Power Supply Bd. 7001-0611 (located in the MEA's Power Supply Drawer). 2. Verify MEA power supply, see page 1-4. 3. Ohm out W30, see Functional Block Diagram for pin-outs. Perform RS422 SERIAL 1/0 LOOP-BACK TEST see page 14-8 for procedure. Did it PASS ? PASS FAIL | 1. Replace Serial Interface Bd. 7001-0639. 2. Replace DEB Bd. 7001-0604. ----------SUBSTITUTE---------- 1. Serial Interface Bd 7001-0639. 2. Main CPU Bd 7001-0640. 3. Bi-Directional Bd 7001-0641. 2. Refer to the Theory of Operation and Functional Block Diagram 14-1.

COMPLAINT	CORRECTIVE ACTION
111. "DATA LINK (NOT ACTIVE)" is displayed. NOTE: THIS IS NORMAL FOR AN MEA WHICH DOES NOT HAVE THE DL-100 OPTION BUT HAS U31 EPROM REV. 2.0 OR LATER ON THE D.E.B. BOARD .	1. Verify that Serial Interface Bd. 7001-0639 is installed in J112 of the MEA's Digital Electronics Bd. A. If the Serial Interface Bd is not installed, install it. B. If the Serial Interface Bd is installed, then replace it. 2. Refer to the Theory of Operation and Functional Block Diagram 14-1.
IV. Display reads "PLEASE BE SURE DISK IS INSERTED" with a Disk in the Disk Drive.	1. Verify that the Disk in the Drive is a DATA LINK Disk. **NOTE : THE DL-100 IS ONLY ABLE TO READ IT'S OWN SPECIAL DISK, STL OR MCA ALDL SOFTWARE WILL NOT WORK IN THE DL-100.** A. If the Disk is not a DATA LINK Disk, then insert a DATA LINK Disk and try again, B. If the Disk is a DATA LINK Disk, perform a DISK READ TEST on the DATA LINK Disk, one page 14-18 for procedure. 1. If the DL SERVICE Disk won't boot go to Complaint XI. 2. If the Data Link Disk passes the read test, try re-booting it again. 3. If the Data Link Disk fails the read test, order a replacement disk per Disk Replacement Policy. 2. Refer to the Theory of Operation and Functional Block Diagram.
V. WON'T READ NEW HIGH SPEED AND/OR BI-DIRECTIONAL DATA STREAMS . NOTE : THESE TYPES OF SYSTEMS ARE SPECIALLY NOTED BY HAVING ( ) AROUND THE NUMBER USED TO SELECT THEM FROM OTHER ENGINES OR FUEL DELIVERY TYPES DISPLAYED ON THE VDU.	1. Verify that the proper diagnostic cable and adapter cables are used, also verify continuity. Refer to the functional block diagram for pin outs. 2. Verify power supplies on the BI-COM Board as follows: A. +12 Volts across C6. B. -12 Volts across C8. C. +5 volts across Cll. 3. Verify proper connection of wire harness from BI-COM Bd to Main CPU Board.

COMPLAINT	CORRECTIVE ACTION
v. WON' T READ NEW HIGH SPEED AND/OR BI-DIRECTIONAL DATA STREAMS (continued).	4. Perform a Vehicle Loop-Back test and observe the VDU for state(s) that FAIL. **NOTE: USE ONLY VEHICLE LOOP-BACK ADAPTER THAT HAS 6 PINS INSTEAD OF 4** A. If no FAILED states are displayed; proceed to step 5. B. If any FAILED state(s) except 10 are displayed then proceed to it's appropriate Complaint. c. If FAILED state 10 is displayed on the VDU then: --------SUBSTITUTE------- 1. BI-COM Board. 7001-0641 2. Main CPU Board. 7001-0640 Repeat Vehicle Loop-Back Test after each substitution to verify which Board caused state 10 to FAIL. 5. Refer to the Theory of Operation and the Functional Block Diagram 14-1.
VI. WON'T UPLOAD BI-CCM SOFTWARE. NOTE: THIS IS INDICATED BY A BEEP MAINTAINED FOR ABOUT 3 SECONDS SHORTLY AFTER UPULOADING HAS BEGUN.	1. Verify power supplies on the BI-COFM Board as follows: A. +12 Volts across C6. B. -12 Volts across C8. C. +5 volts across C1l. 2. Verify proper connection of wire harness from BI-COM Bd going to Main CPU Board. 3. ----------SUBTITUTE---------- 1. BI-COM Board. 7001-0641 2. Main CPU Board. 7001-0640 4. Refer to the Theory of Operation and the Functional Block Diagram 14-1.
VII. FAILURE WAS DETECTED IN ANY OF STATES, 1 THROUGH 9.	1. Is 12 Volts Present at pin 3 of the Vehicle connector? YES NO | | | Trace Voltage using Diagram 14-1. | ----------SUBSTITUTE---------- A. Main CPU Board 7001-0640 2. Verify W33 Wiring Harness 3. Refer to the Theory of Operation and the Functional Block Diagram 14-1.
VIII. RAM FAILURE WAS DETECTED.	1. ----------SUBSTIUTE---------- A. Disk Interface Board 7001-0519 2. Refer to the Theory of Operation and the Functional Block Diagram 14-1.

COMPLAINT	CORRECTIVE ACTION
IX. DISK PATTERN TEST FAILS.	1. This test should be performed using the service disk. If it fails on a customers disk re-check using the service disk. 2. ----------SUBSTITUTE---------- A. Disk Drive Assembly 0552-0024 B. Disk Interface Board 7001-0519 C. Main CPU Board 7001-0640 3. Refer to the Theory of Operation and the Functional Block Diagram 14-1.
x. DISK READ TEST FAILS.	1. This test should be performed using the service disk first. Does it Fail on the service disk? YES NO | | | Replace Disk that Test failed on. ----------SUBSTITUTE---------- A. Disk Drive Assembly 0552-0024 B. Disk Interface Board 7001-0519 C. Main CPU Board 7001-0640 2. Refer to the Theory of Operation and the Functional Block Diagram 14-1.
XI. DISK WON'T BOOT. BE SURE THE DISK IS AN DATA LINK DISK.	1. Try a different disk. Did that DISK boot ? YES NO | | | ----------SUBSTITUTE---------- | A. Disk Drive Assembly 0552-0024 | B. Disk Interface Bd. 7001-0519 | C. Main CPU Board 7001-0640 Perform a Disk Read Test on the suspected disk. What were the results of the test ? PASS FAIL | | Replace Disk per Disk Replacement Policy. 2. Refer to the Theory of Operation and the Functional Block Diagram 14-1.

SUN ELECTRIC CORPORATION

Model: KIT# 120-511 DL-100

Field Installation Instructions

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL

INSTALLATION OVERVIEW

The installation of the Data Link-100 (DL-100) into the MEA-1500 involves the installation of an additional PCB in the MEA-1500, several wiring harnesses, a new EPROM to the MEA's Digital Electronics Board, and the main DL-100 unit itself.

Before beginning the installation, it is important that you verify that the MEA-1500 is operational. Turn the unit ON and allow the tester to complete warm-up (if required). Proceed to the calibration page. If any of the parameters fails to calibrate, correct this condition before proceeding with the installation of the DL-100.

NOTE: If the MEA-1500's Remote Control does not have a backup selection, Kit # 0120-0518 should be installed to add this feature to the MEA's Remote Control.

PARTS LIST

DESCRIPTION	PART NUMBER	QUANTITY
DATA LINK ASSEMBLY	7009-1940	1
PCB, SERIAL ADAPTER	7001-0639	1
MEA ADAPTER HARNESS	7076-0595	1
EPROM U31	0773-0616-01	1
MOUNTING BRACKETS	7012-1157	2
SCREWS, BLACK #8-32x3/8	0403-1423-06	4
WASHER, FLAT #8	0400-0162	4
WASHER, SPLIT #8	0604-0059	4
STUD, EXTENSION	4162-0602	1 set
INTERFACE HARNESS	7076-0592-01	1
DISKETTE KIT, GM MONITOR	7009-1943-01	1
DISKETTE KIT, CHRY. MONITOR	7009-1943-03	1
DISKETTE KIT, FORD MONITOR	7009-1943-02	1
CABLE MOUNTS	5878-0902	4
CABLE STRAPS	5878-0010	8
LITERATURE KIT	0119-0272	1

Printed in U.S.A.

TOOLS REQUIRED

Nut Driver set	Screwdriver, Phillips
Spenco #10 Driver	Screwdriver, Regular

POWER SUPPLY DRAWER

1. Turn the MEA-1500 "Off" and disconnect the A.C. power cord from the outlet.

2. Remove the two screws that secure the Power Supply Drawer and pull the drawer out approximately 6".

3. Using a small screwdriver, remove the cover over "Serial 1/0 Port 2" on the back of the MEA-1500 in the Power Supply Drawer.

4. Using the Stud Extension hardware supplied, mount Serial Port J61O, which is part of the MEA Adapter Harness #7076-0595, into the vacant "Serial 1/0 Port 2" location. Position the **wide part of the Serial Port connector towards the top.**

5. Remove connector P604 from the Power Supply Board #7001-0611. In it's place install connector P604A (keyed) of the MEA Adapter Harness #7076-0585. Note that connector P604A is a 9 pin, while connector J604 on the Power Supply Board has 7 pins. Verify proper mating and alignment of these connectors. Plug P604 into connector J604A of the MEA Adapter Harness.

6. Remove the two screws that secure the Main Drawer and slide it out. Route the remaining connector of the MEA Adapter Harness (P700) up through the headframe access hole and into the MEA's Front Main Drawer. Pull the remaining slack of the MEA Adapter Harness up into the Main Drawer.

7. Using a wire tie, tie the MEA Adapter Harness away from the Switching Power Supply, preferably along the right side of the Power Supply drawer with the other power supply wires. Close the Power Supply Drawer and secure it using the original hardware, taking care not to pinch any wires in the process.

MEA-1500 FRONT MAIN DRAWER

8. Using a small screwdriver or I.C. Puller, remove EPROM U31 from the Digital Electronics Board #7001-0604. In it's place install EPROM U31 #0773-0616-01 that is supplied with the kit. Make sure that the notch on the EPROM aligns with the notch screened on the circuit board.

9. Install the Serial Adapter Board #7001-0639 that is supplied with the kit into location J112 on the Digital Electronics Board with the components facing the front of the tester. Make sure that it is correctly and fully seated. **NOTE: The cable locks on the J112 connector have no effect on the securing of the 7001-0639 Bd. Take care not to damage any of the components if the cable locks are locked!**

MEA-1500 FRONT MAIN DRAWER (continued)

10. Plug connector P700 of the MEA Adapter Harness (coming from the Power Supply Drawer) into connector J700 (top connector) of the Serial Adapter Board.

11. Close the Main Drawer but do not secure it at this time.

DATA LINK INSTALLATION

12. From the front of the MEA-1500, slide the DL-1OO into the space underneath the MEA's Main Drawer. Slide the unit all the way back until the "ears" of the DL-1OO rest against the MEA Headframe Supports.

    NOTE : If the rear of the DL-1OO interferes with the Serial Tags of any of the MEA-1500's Option Kits, it may be necessary to relocate the Serial Tags.

13. On the left and right sides of the DL-1OO, towards the rear, install the two Mounting Brackets and Hardware that are supplied with the kit so that the Brackets butt-up against the rear of the MEA Headframe Supports.

14. Connect the P61O end of the Interface Harness #7076-0592-01 to Serial Port 2 on the rear panel of the Power Supply Drawer (both ends are keyed and will only go on one way). Connect the other end of the Interface Harness, P801 to the Serial Port on the rear of the DL-1OO. Gather the slack (if any) and secure the harness to the back of the MEA using Cable Anchors and Cable Straps.

15. If the MEA-1500 has a date code on the serial tag prior to 0887,(lst four numbers) Kit #120-0518 will be necessary to operate the DL-1OO.

CHECKOUT PROCEDURE

1. Plug the MEA-1500 into an A.C. outlet and turn the tester on. Allow the tester to warm-up, (if required).

2. While the tester is warming-up, perform the power supply calibration procedure on page 1-4 of the MEA-1500 Service Manual. Make adjustments if necessary.

3. After warm-up (if required), perform checkout procedure. Refer to Chapter 14 of the MEA-1500 Service Manual for complete instructions.

*** * * * * * * * * * * * * ***

*** INSTALLATION COMPLETE ***
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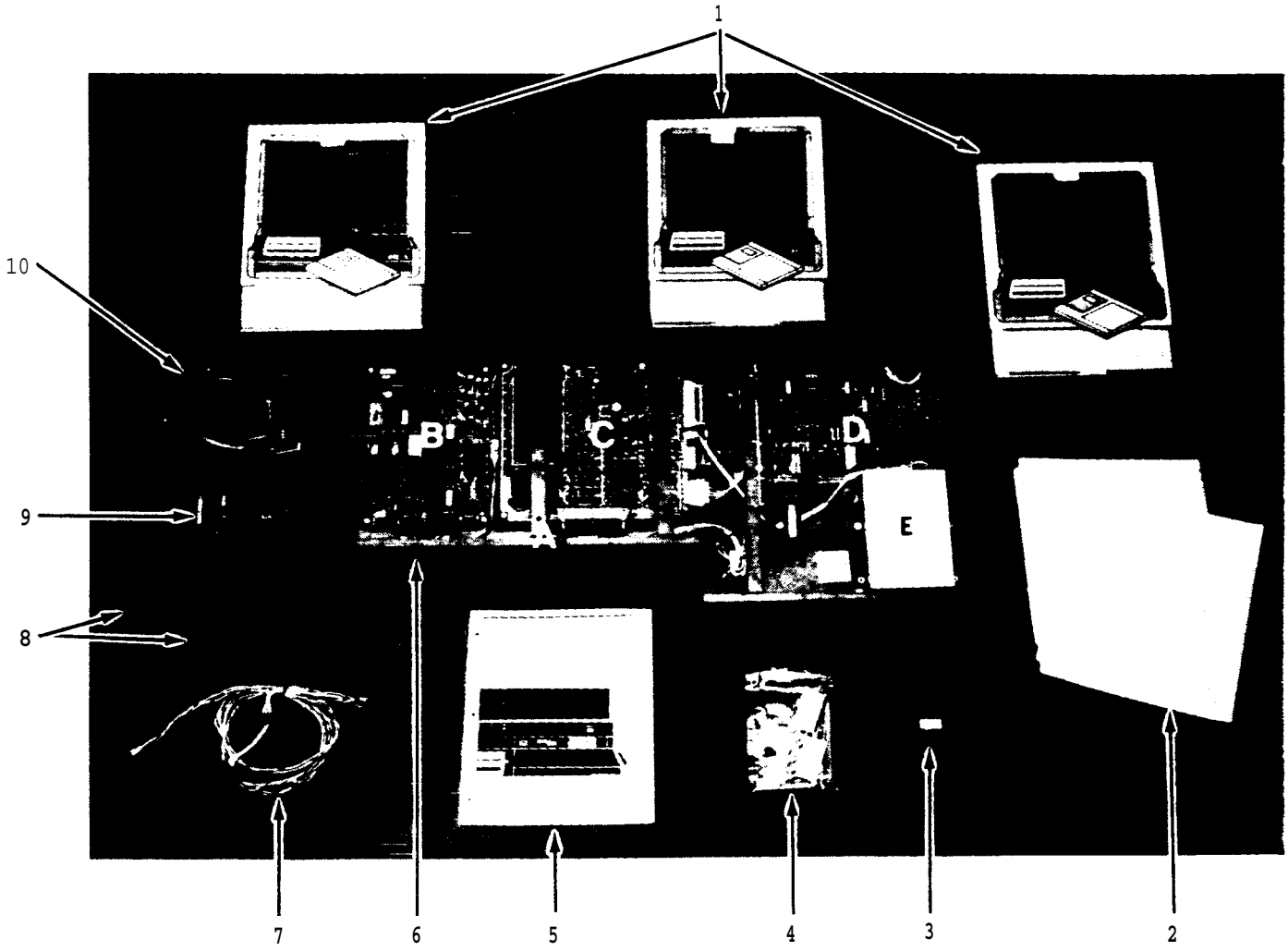
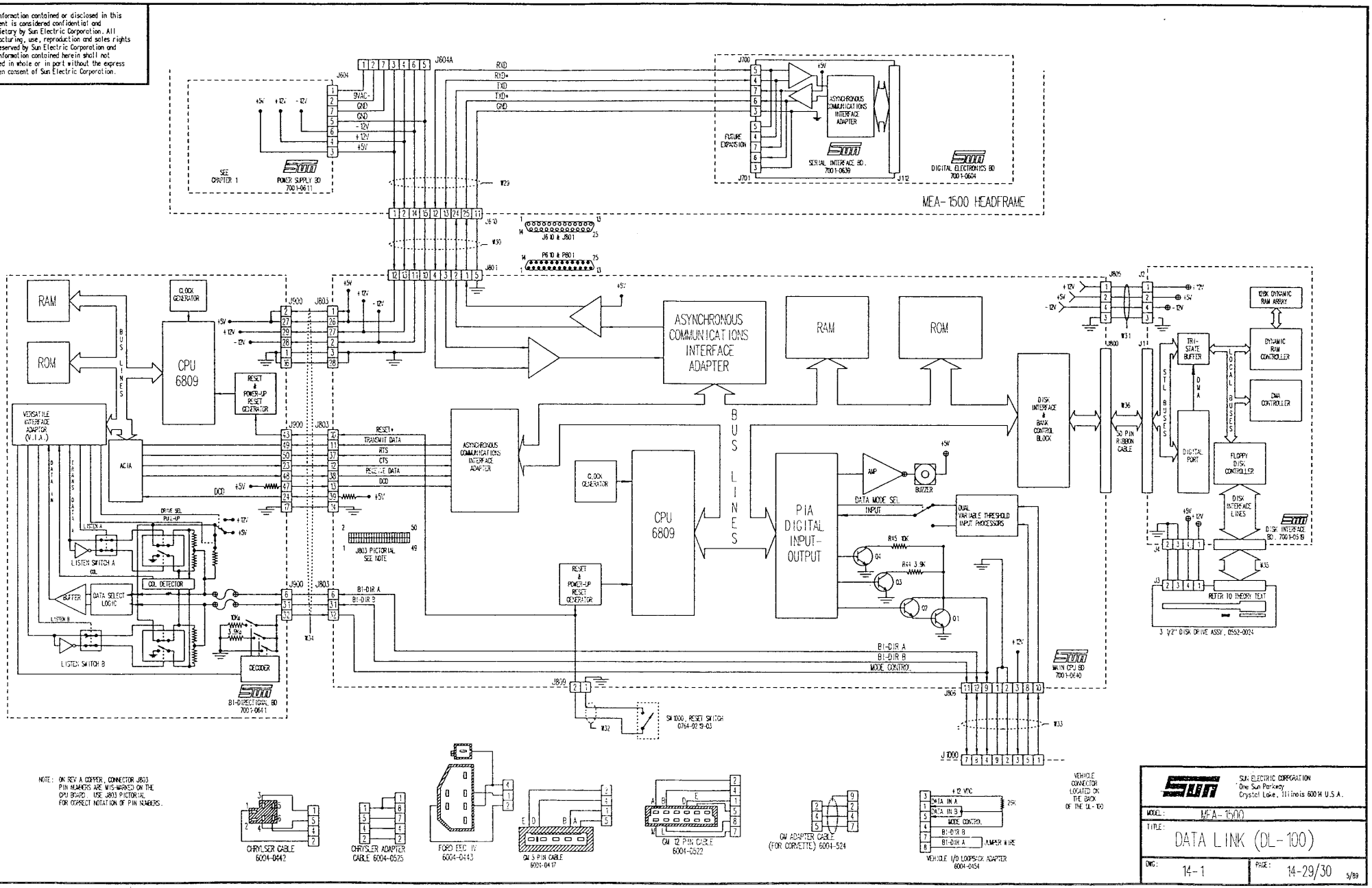
NOTES



DATA LINK-1OO OPTION, (0120-0511)

ITEM	DESCRIPTION	PART NUMBER
1.	GM Software	7009-1493-Ol
1A.	Ford Software	7009-1493-02
1B.	Chrysler Software	7009–1493-03
2.	Disk Holders	.0692-1301
3.	EPROM, U31	0773-0616-01
4.	Hardware Kit	N/A
4A.	Screws, #8-32x3/8	.0403-0423-06
4B.	Washer, Flat #8	.0400-O162
4C.	Washer, Split #8	.0604-0059
4D.	Stud, Extension	.4162-0602
4E.	Cable Mounts	.5878-0902
4F.	Cable Straps	.5878-OO10
5.	Operator Ins	.0692-1489
5B.	Installation Ins	.0692-1490
6.	DATA LINK-1OO	.N/A
6A.	Weld Assembly	7020-1873
6B.	Bi-Directional Bd.	7OO064141
6C.	Disk Interface Bd.	7001-05l9
6D.	CPU Board	7001-0640
6E.	Disk Drive Assy	0552-O024
6F.	Drive Access Door	0621-0221
6G.	Access Door Knob	0813-O046
6H.	Access Door Spring	0771-0239
6I.	Reset Switch	.O764-O2l9-O3
6J.	W31, Disk Inter Pwr.	7076-0591
6K.	W32, Reset	7076-0593
6L.	W33, Vehicle Input	7076-0594
6M.	W34, Bi-Dir Harness.	7076-0596
6N.	W35, Disk Data	6004-0444-02
60.	W36, Disk Int	6004-0445-02
7.	W29, Power Supply.	7076-0595
8.	Mounting Brackets.	7Ol2-1157
9.	Serial Interface Bd.	7001-0639
10.	W30, Ext. Cable	.7076-0592-Ol
10A.	Service Cable, 48"	7076-0592
	Service Disk	0552-0937A-04
	Remote Mod Kit	0120-05l8

NOTES



NOTE: ON REV A COPPER, CONNECTOR J803 PIN NUMBERS ARE MIS-MARKED ON THE CPU BOARD. USE J803 PICTORIAL FOR CORRECT NOTATION OF PIN NUMBERS.

CHRYSLER CABLE 6004-0442

CHRYSLER ADAPTER CABLE 6004-0525

FORD EEC IV 6004-0443

GM 5 PIN CABLE 6004-0417

GM 12 PIN CABLE 6004-0522

GM ADAPTER CABLE (FOR CORVETTE) 6004-524

VEHICLE I/O LOOPBACK ADAPTER 6004-0454

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

MODEL: MEA-1500

TITLE: DATA LINK (DL-100)

DWG: 14-1

PAGE: 14-29/30

5/89

CHAPTER 15

MEA-1500 M/B (Mercedes Benz)
DIFFERENCES & CALIBRATION

SECTION I. THEORY OF OPERATION

The MEA-1500 M/B is very similar to the MEA 1500. For this reason, the original manual can be used for the majority of the troubleshooting and calibration. Only the differences are explained in this chapter. The following is a general explanation of the changes.

1.MAG/VOLT/OHM BOARD	Accommodates the new oil temperature function. Due to the new layout of this board a new calibration procedure is needed for the Mag/Volt/Ohm Board. Refer to SECTION II for this procedure. Refer to Chapter 6, page 6-6 for the troubleshooting procedure.
2.SIGNAL INPUT BOARD	Accommodates cross-coil shorting.
3.ANALOG SCOPE BOARD	Revised triggering threshold voltages, and cross-coil shorting.
4.DIGITAL ELEC BOARD	New firmware for the oil temperature, and improved noise filtering.

OIL TEMPERATURE

The MEA-1500 M/B is equipped with a oil temperature probe to measure the oil temperature of the engine under test. Oil temperature is an important addition to the unit to insure proper adjustment of the engine at the recommended operating temperature. The temperature probe contains an internal thermistor which has a resistance that decreases as the temperature increases.

From the rear of the tester, the probe lead is routed through the rear panel connector that is soldered onto the Oil Temperature Filter Board. The signal then moves through a iron-core transformer where noise is limited, and tapped to ground through capacitors. The signal is then divided down with resistors on the Mag/Volt/Ohm board to create an output voltage which decreases as the temperature increases. The signal (Oil Temp Sign.Out) then enters the Digital Board to be converted and read. Readings will be displayed in Centigrade (Celsius) and only displayed on the Vehicle Test Page and Service Calibration Page. Refer to SECTION II for the calibration and SECTION 111 for the troubleshooting procedures. Functional Block Diagram located on page 15-7.

CROSS COIL SHORTING

The MEA-1500 M/B also uses “Cross Coil Shorting” to short the cylinders during power balance. This method is required by Mercedes Benz. When cross-coil shorting occurs, the short is transferred from the negative side of the coil to the positive side, instead of going to chassis ground. The Digital Board controls an Opto-Isolator U1 (located on the Signal Input Board), to turn on Ql, a SCR (Silicon Controlled Rectifier) which initiates the cross coil shorting. The SCR receives its power from the primary signal. Refer to page 15-5 for the Functional Block Diagram.

NEW LEADS

Six new leads have been added to the MEA-1500 M/B. The oil temperature probe and extension cable diagram can be found on page 15-7. The other four leads which are all referenced to the universal harness are located on page 15-5. Two of the four leads have special screw-on connectors for the Mercedes Benz vehicle terminal.

REQUIRED EQUIPMENT:	IS-100A IGNITION SIMULATOR CALIBRATION SCREWDRIVER SPENCO HANDLE and SPANNER BIT #10 DIGITAL VOLTMETER

PRELIMINARY SETUP:

1. Remove the two Spanner screws securing the front drawer assembly of the MEA and slide drawer out slowly. Turn MEA's power on.
2. Proceed to the MANUAL CALIBRATION (NON-GAS) page. **NOTE: See introduction (page iii) for specific instructions on how to access MANUAL CALIBRATION (NON-GAS) page.**

VOLTS ADJUSTMENT PROCEDURE:

1. Short Volt/Ohm leads together, and locate the Mag/Volt/Ohm board.

2. Set the DVM to D.C. voltage scale and connect the DVM'S red lead to TP6 located between R163 and R142, and black lead to the Ground Lug TPO. Adjust R84 (100V ZERO) on the Mag/Volt/Ohm Board until D.C. Voltage on the DVM is 0.000 +/- O.O1OV.

3. Connect the DVM's red lead to TP7 and the black lead to Ground Lug. Adjust R83 (20V ZERO) on the Mag/Volt/Ohm Board until D.C. voltage on the DVM is 0.000 volts +/- 0.010 volts.

4. Connect both the RED and BLACK clips of the MEA's Volt/Ohm leads to the + volt output on the IS-100A. Set IS-100A volt output to 13 volts. Adjust R178 (VOLT BALANCE) on the Mag/Volt/Ohm Board until D.C. V. (X100)'S MEASURED VOLTAGE is 0.000 +/-0.010 volts

5. Connect the black lead of MEA's Volt/Ohm leads to the - volt output on the IS-100A. Leave the red lead connected to the + volt output on the IS-100A. Adjust R142 (VOLTS GAIN) until D.C. V. (X100)'s UNADJUST VALUE is 13 volts +/- .10 volts.

6. Adjust R163 until (X20's) UNADJUST VALUE equals 13.0 volts +/- 0.10 volts.

COIL +, BATTERY +, DISTRIBUTOR RESISTANCE ADJUSTMENT PROCEDURE

1. Short all Universal Multimeter leads (Red,Black,Green,Yellow) together.

2. Adjust R86 (COIL + MEASURED VOLTAGE) to read O volts +/- 0.01.

3. Adjust R85 (BATTERY + MEASURED VOLTAGE) to read O volts +/- 0.01.

4. Check that Distributor voltage (UNADJUST VALUE) is approximately O volts.

5. Connect the Black lead to ground on the IS100A, and the Red, Yellow and Green lead to the + voltage terminal. Set IS100A to 13 volts.

6. Adjust R81 (coil + voltage) for UNADJUST VALUE to read 13v +/- 0.01.

7. Adjust R143 (battery voltage) for UNADJUST VALUE to read 13v +/- 0.01.

8. Check that the Distributor voltage reads 13 volts +/- 0.5.

OHMS ADJUSTMENT PROCEDURE

1. Short Volt/Ohm leads together.

2. Connect the DVM'S red lead to TP8 and the black lead to Ground. Adjust R82 (OHMS ZERO) on the Mag/Volt/Ohm Board until the D.C. voltage for ohms on the DVM is 0.000 +/- 0.010 volts.

3. Turn IS-100A power switch to the off position, and remove power cord from the A.C. wall socket.

4. Connect Volt/Ohm leads to IS-100A resistance output terminals. Set IS-100A for 150 ohms.

5. Select Ohms by pressing "VOLT/OHM". Check that the ohms read 150 ohms +/- 1 ohm. Adjust R59 if necessary.

6. Remove Volt/Ohm leads from IS-100A and short the red and black end together.

7. Exit MANUAL CALIBRATION (NON-GAS) page and proceed through SYSTEM CALIBRATION.

8. Enter the VEHICLE TEST page by pressing "MENU", which will bring you to the CALIBRATION MENU. Selecting "MENU" again will bring you to the PROGRAM MENU. Select "2" to enter us into the VEHICLE TEST page. To display RESISTANCE press "VOLT/OHM" on the remote keypad.

9. Reconnect Volt/Ohm leads to the IS-100A resistance output terminals.

10. Set IS-100A'S resistance output to 150 ohms, MEA should display 150 ohms +/- 1.0 ohms. Readjust R59 if necessary.

11. Set IS-100A'S resistance output to 5, 50, 150, 170, 500, 5K, 50K ohms, MEA should display all readings within 5 %. If these parameters cannot be satisfied repeat procedure starting with step 1.

12. After calibration note that the Volts and Ohms read "GOOD".

OIL TEMPERATURE CALIBRATION PROCEDURE

1. Adjust R134 on the Mag/Volt/Ohm Board to display the current temperature of the surrounding area. The reading will be in Centigrade (Celsius), so use the chart on the following page to adjust for the correct temperature.
   To convert from Fahrenheit to Centigrade use the following formula:
   C = (F - 32) / 1.8

TEMP (CELSIUS)	TEMP (F)	TEMP (CELSIUS)	TEMP (F)
10	50	27	80.6
11	51.8	28	82.4
12	53.6	29	84.2
13	55.4	30	86
14	57.2	31	87.8
15	59	32	89.6
16	60.8	33	91.4
17	62.6	34	93.2
18	64.4	35	95
19	66.2	36	96.8
20	68	37	98.6
21	69.8	38	100
22	71.6	39	102
23	73.4	40	104
24	75.2	41	106
25	78.3	42	108

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*** CALIBRATION/CHECKOUT COMPLETE ***

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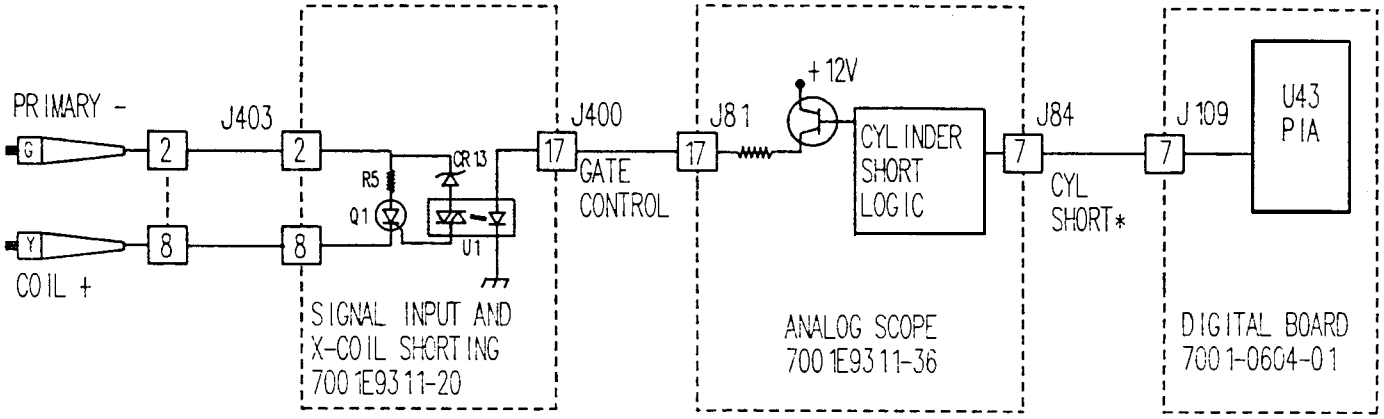
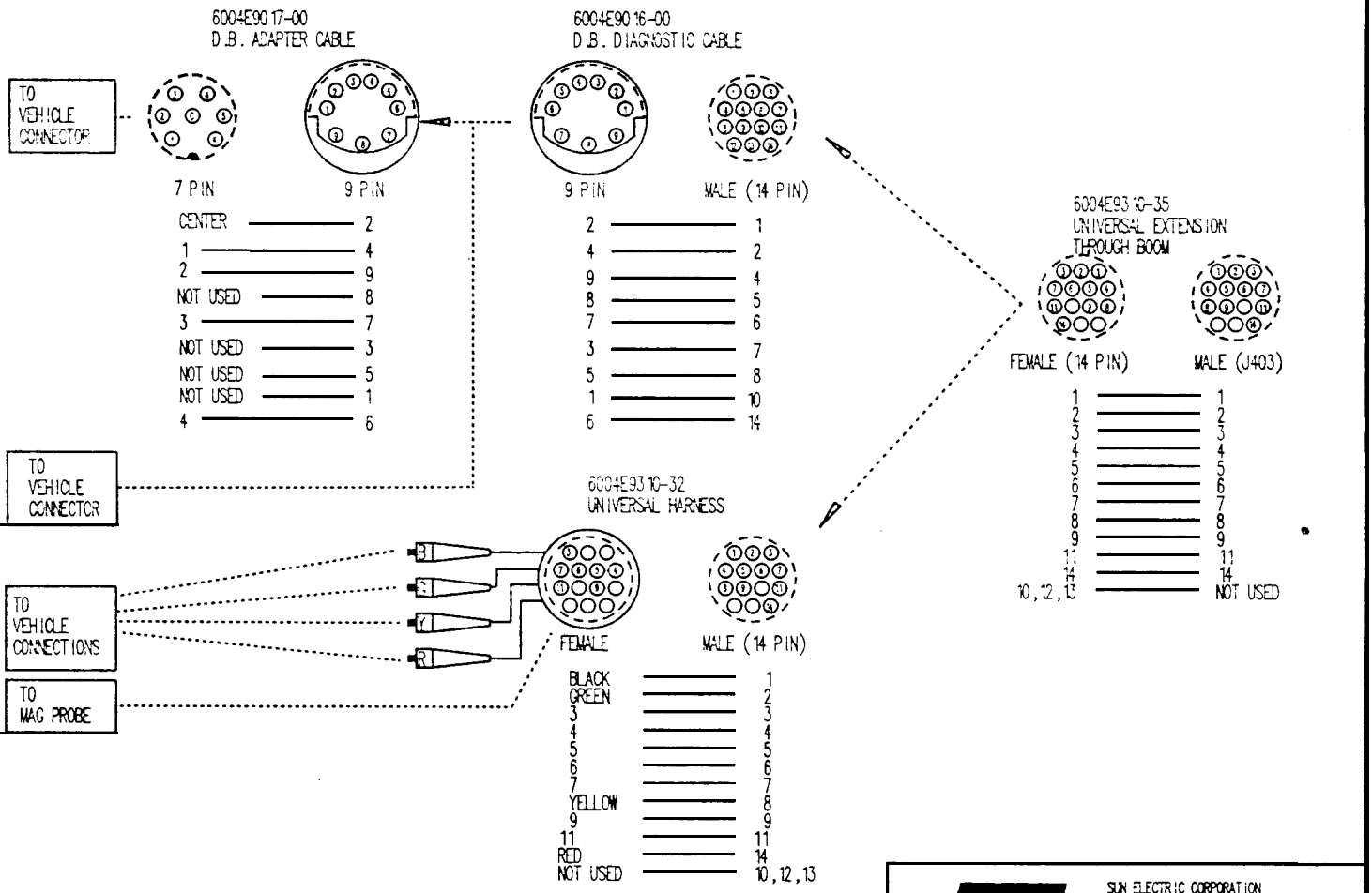
SECTION III. OIL TEMPERATURE TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. OIL TEMPERATURE ABNORMAL.	1. Using DVM, check that resistance between pins 1 and 2 of Oil Temperature Test Lead Assembly 6OO4E931O-37 is from 30K to 350K ohms. Resistance should be approximately lOOK ohms at 77 degrees Fahrenheit. If not, then ----------SUBSTITUTE---------- A. Temperature Test Lead Assembly #6004E9310-37 If resistance is normal, proceed to step 2. 2. Using DVM, check that resistance between pins 1 and 2 of J 201A on the Mag/Volt/Ohm Board is from 30K to 350K ohms. If not, then ----------SUBSTITUTE---------- A. Oil Temp Filter Board #7009E9314-20 If resistance is normal, then ----------SUBSTITUTE---------- A. Mag/Volt/Ohm Board #7001E9311-15 B. Digital Electronics Board #7001-0604-01





SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

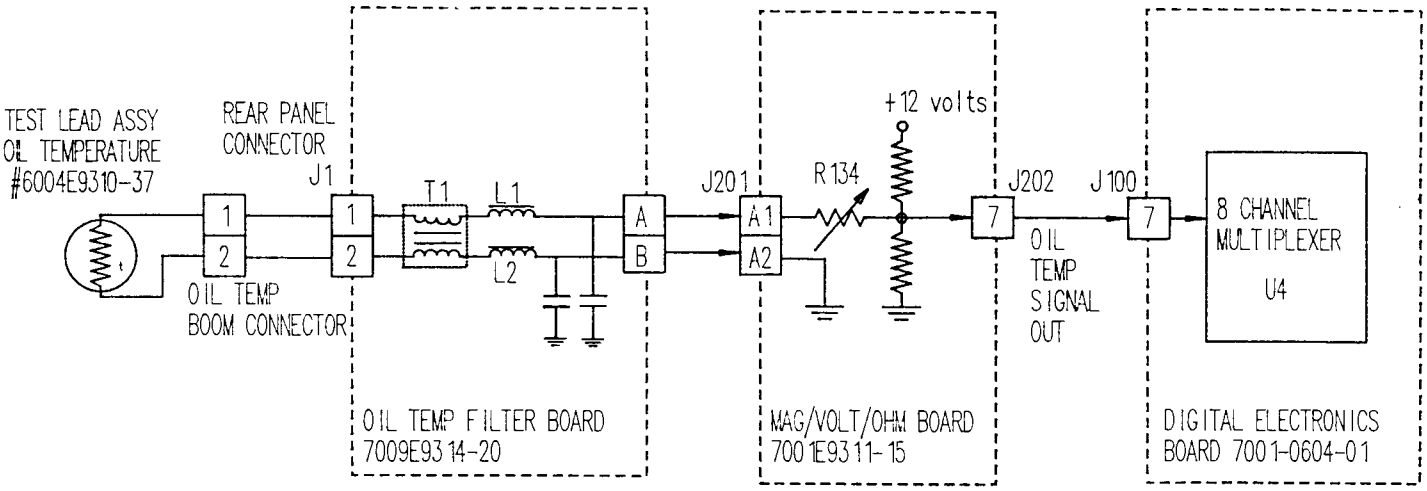
MODEL: MEA-1500 M/B

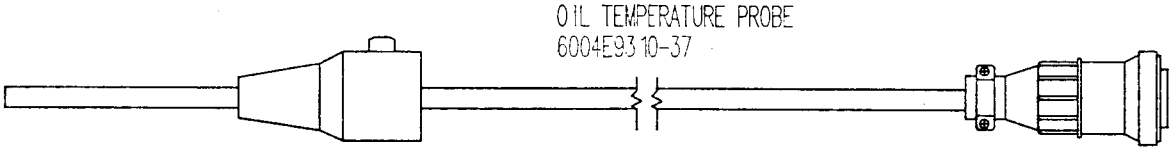
TITLE: CROSS-COIL SHORTING & CABLE PIN-OUTS

DWG: 15-1

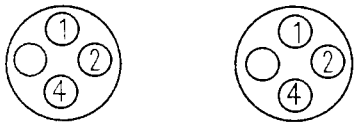
PAGE: 15-5

NOTES





6004E9310-42
OIL TEMP. EXTENSION CABLE
THROUGH BOOM



1	1
2	2
3	NOT USED
4	4

SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

MODEL: MEA-1500 M/B

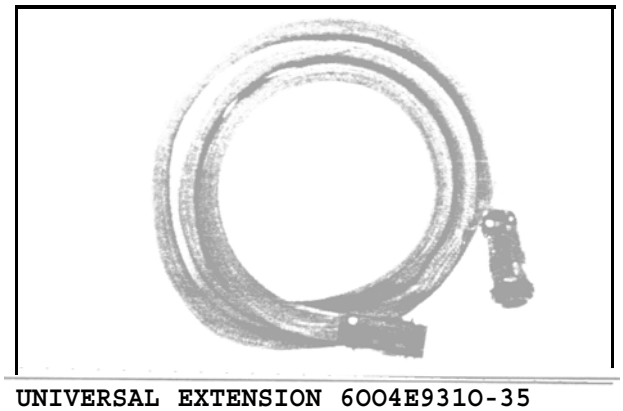
TITLE: OIL TEMPERATURE FLOW DIAGRAM

DWG: 15-2

PAGE: 15-7

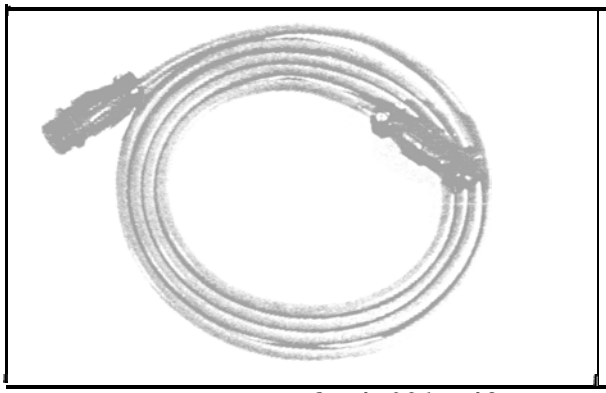
NOTES

DESCRIPTION	PART NUMBER
DIGITAL ELECTRONICS BOARD	7001-0604-01
MAG/VOLT/OHM BOARD	7001E9311-15
SIGNAL INPUT BOARD	7001E9311-20
ANALOG SCOPE BOARD	7001E9311-36
OIL TEMP FILTER BOARD/with CABLE	7009E9314-20
GRATICULE	7045-0090-02

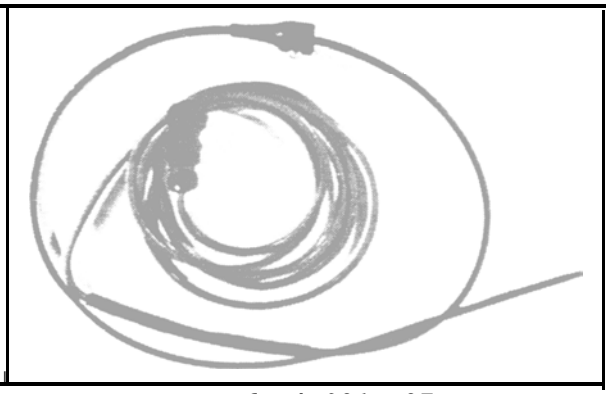


UNIVERSAL EXTENSION 6004E9310-35

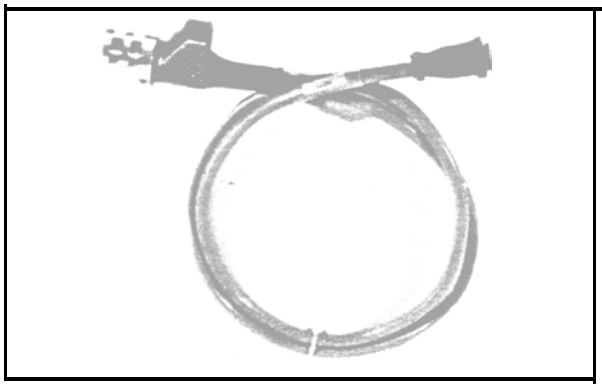
UNIVERSAL HARNESS 6004E9310-32



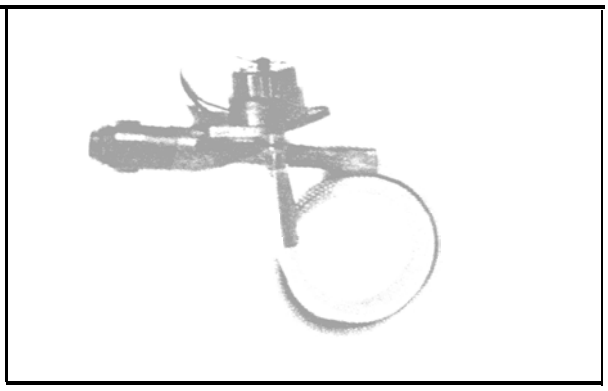
OIL TEMP EXTENSION 6004E9310-42



OIL TEMP PROBE 6004E9310-37



D.B. DIAGNOSTIC CABLE 6004E9016-00



D.B. ADAPTER CABLE 6004E9017-00

NOTES

APPENDIX A

MEA-1500 CHECKOUT

The following out-of-box checkout procedure is written for the field technician and is to be performed upon tester set-up or when ever any of the options are installed. If the tester that you are checking does not have all the options, you may not see all of the displays as indicated in this procedure. All of the tolerance values have been calculated by considering several factors; such as assembly line and field calibration equipment accuracy, and product specifications. The tolerance values listed must be followed EXACTLY. If trouble is encountered, refer to the MEA-1500 Service Manual pertaining to the particular problem.

EQUIPMENT REQUIRED:

IS-100A Ignition Simulator
Data Link Test Disk #0552-0937A04
Vehicle 1/0 Loop Back Adapter #6004-0454
Vacuum Source - Mity-Vac #0303-1012

PRELIMINARY SET-UP

1. Turn the tester "ON" and allow a 15 MINUTE WARMUP. Short the VOLT/OHM leads together and allow "Self Calibration" to complete. Verify all items calibrate successfully. If not, refer to the appropriate section of the MEA-1500 Service manual.

2. Verify that the Headsign light and the rear panel cooling fans are operational.

3. Check for +5VDC (+.15 /-.05) at C66 of the Digital Electronics Board. If a Data Link is installed, check the 5V supply at J805 pin 2 on the Disk Interface Board (reference J805 pin 3 for ground).

4. Connect the tester leads to the IS-100A as follows:

   A. Place the red trigger pickup around the IS-100A trigger loop.
   B. Connect the blue secondary pattern lead to the calibrated secondary output of the IS-100A.
   C. Connect the primary lead (blue boot) to the negative side of the coil.
   D. Connect the red (+) and black (-) battery leads to the 13V battery posts.
   E. Connect the green amp clamp around the current loop.
   F. Connect COIL + (yellow boot) to the 13V positive side of coil.

5. Set IS-100A as follows:

   8 cylinder
   1200 RPM
   Delta KV to the "OFF" position
   Spark Line Slope to "OFF" position
   Ripple to the "OFF" position

6. After the tester calibration is complete, set the tester up as follows:

   A. Press "MENU" and select Number 1 (Vehicle Set-up)
   B. Enter 8 cylinders
   C. Enter 4 cycle
   D. Enter 0.0 timing offset

7. Connect the VOLT/OHM (pinpoint) leads to the red and black battery posts (13V) on the IS-100A.

8. Press CONT and select Number 2 on the remote (Vehicle Test).

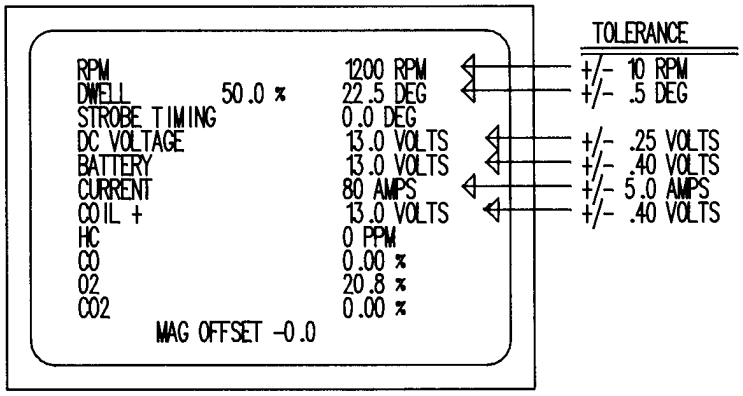
   A. Press SEC.
   B. Press the SCALE selection on the remote to display "25KV" on the bottom of the diqital screen.

9. Use the front panel Scope Control Pots to correctly position the trace and control the brightness.

10. Turn the IS-100A "Power" and "Ignition" switches to the "ON" position.

11. On the Digital Monitor you should see the following approximate readings:

* **BE SURE TO CHECK THAT YOUR IS100(A) IS SET TO 13V. IF NOT, COMPARE THESE READINGS ACCORDINGLY.**



12. Press the "SEC" and "SCALE" buttons on the remote until the monitor indicates SECONDARY DISPLAY 25KV.

13. On the analog scope, all eight cylinders should be in the DISPLAY mode with the firing lines approximately 20KV on the 25KV scale.

14. While in the DISPLAY mode, verify the use of the COMPARED CYLINDER function by using the appropriate number keys to bring a selected cylinder to mid-screen.

15. Press the "PRI" and "SCALE" buttons on the remote until the monitor indicates PRIMARY DISPLAY 500V.

16. Verify Primary pattern is present and that all 8 firing lines are approximately 180V on the 500V scale.

17. Verify the RASTER and SUPERIMPOSED modes by pressing the "RASTER" and "SUPERIMPOSED" buttons. Also, while in the RASTER mode, verify the use of the front panel pot to control raster spacing.

18. Verify the Millisecond Sweep function by pressing the "MSEC" button on the remote.

19. Verify the SPECIAL function by pressing the "SPECIAL" key and placing the "RIPPLE" switch of the IS-100A in the ON position, checking to see ripple on the scope.

POWER BALANCE AND ENGINE KILL

1. With the ignition portion of the simulator operating, press MENU to display the Program Menu. Select #3 "Power Balance Test" and press CONT to begin the Automatic Power Balance.

2. An audible difference should be noticed in the operation of the simulator, although no RPM difference may be noticed.

3. When test is complete, press the ENGINE KILL button on the Remote and on the front panel. The simulator's ignition should be rendered inoperable, although no RPM difference may be noticed.

4. Manually perform a power balance by selecting a cylinder on the remote and check to see that gas readings appear on the screen.

OHMS, VACUUM, AND DISTRIBUTOR VOLTS

1. Select the Vehicle 'Test page by pressing "MENU" and number 2 on the remote.

2. Rotate the Volt/Ohm Selector switch on the IS-100A, to the 150 ohm position. Press the Volt/Ohm button on the MEA-1500's remote control. The "Resistance" line should read 150 ohms +/- 5.0.

3. Connect the Vacuum Source (Mity-Vac #0303-0102) to the vacuum hose and pump the handle to obtain a 20"hg reading on the Mity-Vac. The VACUUM should read 20.0 +/- 2.0"hg.

4. Turn "OFF" the simulator's IGNITION SWITCH (leave Power switch "ON") and remove the red trigger pick-up from the trigger loop of the IS-100A. Rotate the Volt/Ohm selector switch on the IS-100A to the 13V position. Connect the blue booted primary lead to the 13 volt output lug, leaving the ground connected. The DIST. VOLTS line should read 13.0 +/- 0.4 volts.

STROBOSCOPIC TIMING CHECKOUT

To further check out the Stroboscopic timing, perform the following procedure:

1. Reconnect the Red Trigger pickup to the trigger loop.

2. Turn on the MEA's timing light power switch.

3. Verify that the timing light flashes smoothly and does not mistrigger.

4. Set IS-100A'S cylinders switch to the TAU position.

5. Rotate timing advance knob counter clockwise until zero click is heard.

6. Point the timing light at the window on the IS-100A. The LEDs in the window on the IS-100A must read 00, this should agree with the timing reading displayed on the MEA's VDU.

7. Rotate the timing advance knob fully clockwise, the IS-100A'S window display and the MEA's timing reading should be 60 degrees +/- 2 degrees.

MAGNETIC TIMING CHECKOUT

1. Turn the timing light power switch to the "OFF" position.

2. Set the Ignition Simulator to 600 RPM (600 RPM / 20 degrees advance).

3. Insert the mag probe from the tester into the mag probe hole in the Ignition Simulator.

4. The MEA Magnetic Timing Display should read 20 degrees +/- 1.0 degree.

AP-1000 PRINTER CHECKOUT

1. Press "Print" on the MEA Remote Control and the printer should print any page the MEA Digital Screen is displaying at that time.

2. Press the "Print" button twice to force a form feed.

DL-100 CHECKOUT PROCEDURE

1. Using the Remote, advance the MEA into the DATA LINK mode (selection 5 of the main menu) and insert the Service Test Disk into the DL-100. "Once the disk boots, the Service Test Disk Menu will be displayed on the screen.

2. Install the Vehicle 1/0 Loop-back Adapter (p/n 6004-0454) into the Vehicle connector on the rear of the DATA LINK. Select test number "1", VEHICLE I/0 LOOP-BACK TEST, from the Service Test Disk Main Menu. The DL-100 will immediately begin the loop-back test. The loop-back adapter must have been previously installed, or the test will fail.

3. If the DL-100 passes, the tester will present a "Test Passed" message. If any portion of the test fails, the failure(s) will be displayed on the screen.

4. Press "Continue", then select #2 on the remote. If the RAM TEST passes, the screen will display "TEST PASSED" very briefly and proceed into "TCR SYSTEM TEST". Use the Test Disk or the customer Disk to count the blocks on the Disk and press continue, as indicated. If all is good, the screen will display "BLOCK 2560 TEST PASSED".

FOUR GAS OPTION CHECKOUT

1. Verify the pneumatics pump is operational and the stabilization period (5 min.) is complete (PUMP STABILIZATION should not be flashing on monitor).

2. Close off the end of the sample hose to verify Low Flow circuit is operational. "Low Flow " should flash on the bottom of the monitor when this is done.

3. Perform the "Customer Gas Calibration" as outlined in the Service Manual (Be sure to set cal gas flow rate).

4. Perform the "Leak Test" as outlined in the Service Manual.

ENHANCED SCOPE CHECKOUT

1. Turn the tester on and allow the tester to complete "WARM UP".

2. Advance to the Vehicle Test page by pressing continue after the calibration is complete.

3. Connect the RED lead of the PINPOINT VOLT/OHM leads to the - side of the coil on the IS100A and the BLACK lead to ground. Set the # of CYLS to 4, the RPM to 600, and the ignition switch to "ON".

4. The tester will operate the same as before except if the SPECIAL PINPOINT MODE is entered. To enter the PINPOINT MODE, press the "SPECIAL" key TWICE and verify that the following occurs:

   A. The Scope switches to the "SUPERIMPOSED" mode.

   B. The scope displays a PRIMARY pattern (this is an input of the PINPOINT LEADS).

   c. The normal "DWELL" Line on the Scope Display, will be replaced by: "SPECIAL" 50 % 40 Hz.

NOTE: The bottom line of the V.D.U. will indicate that PINPOINT mode has been selected and will display the current Voltage Scale and Sweep Time. To the right of the PINPOINT message on the V.D.U., A + o r - will appear. This screen will be visible for about 8 Seconds.

5. When in the SPECIAL PINPOINT MODE, verify that the following functions operate properly:

   A. The HI/LO key on the remote sequentially changes the the FULL SCALE VOLTAGE from 5 to 25 to 50 VOLTS.

   B. The MSEC key on the remote sequentially changes the FULL SCALE TIME from NORMAL to 5 MSEC to 25 MSEC to 100 MSEC.

   c. The (+/-) key on the remote changes the direction of trigger from the rising edge to the falling edge. The active trigger direction will be displayed at the bottom of the Video Display Unit.

6. To exit from the "SPECIAL PINPOINT" mode, press the Special key on the remote.

****

*** CHECKOUT COMPLETE ***

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