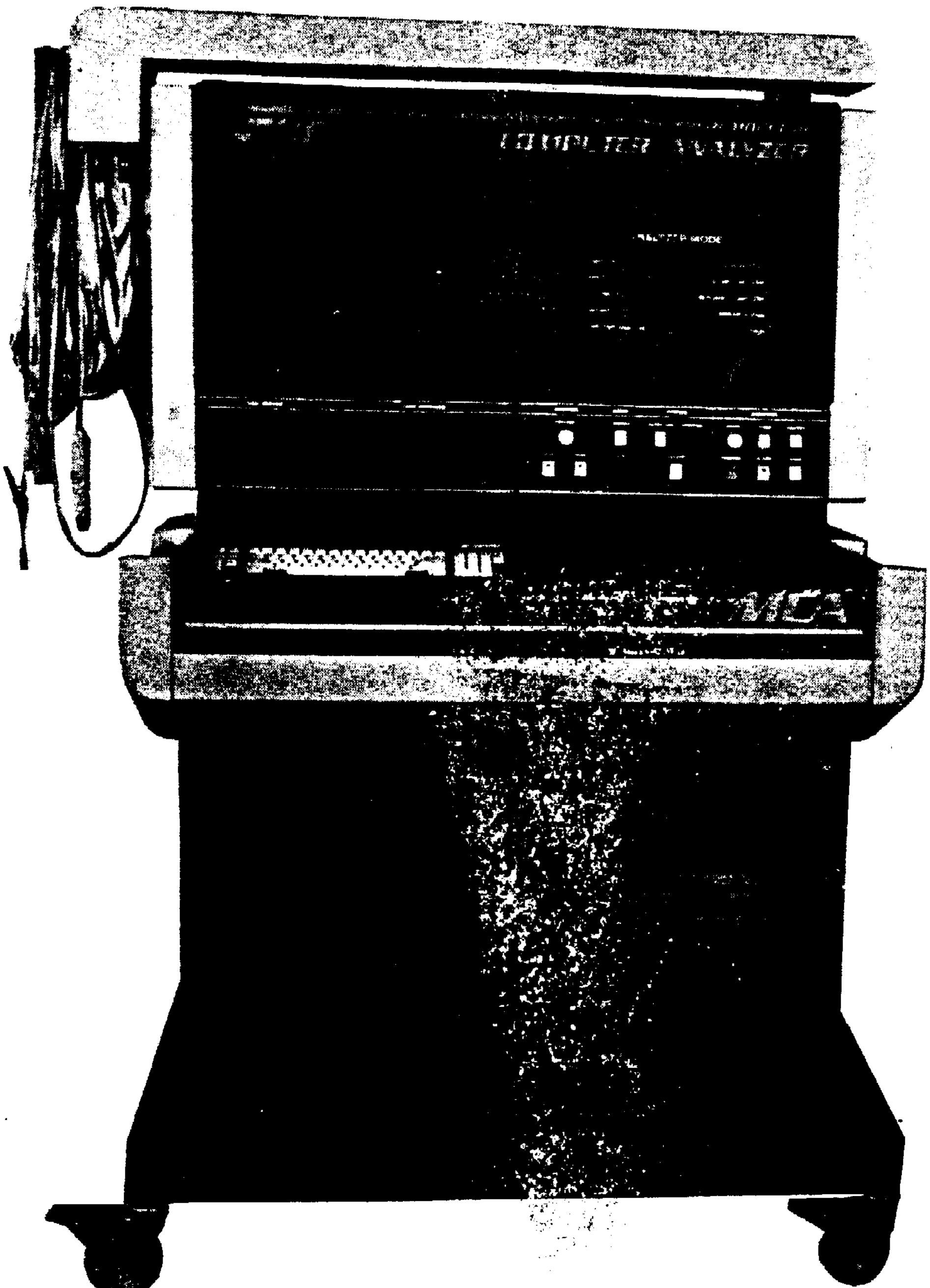
SUN ELECTRIC CORPORATION

MODEL

MCA-3000

MODULAR COMPUTER ANALYZER

Service Manual



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INTRODUCTION

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INTRODUCTION

HOW TO USE THIS MANUAL

This Service Manual discusses the Sun Modular Computer Analyzer Model MCA-3000 and **MCS-3000-3.** Unless otherwise noted the Sun Modular Computer Analyzer Model MCA-3000 is referred to as the Tester. Chapters 1 through 21 specifically describes the Model MCA-3000 (11OV) version of the Tester. Any Options will be explained in Chapters 22 and up. Whenever servicing a Tester refer to Appendix C for specific differences between the 110 Volt model and the model_ you are working on. Refer to the serial plate for model identification.

Since both versions of the Tester are functionally the same, Appendix C contains only the appropriate changes in installed unique parts and internal modifications required. As an example; when working on the Tester refer to Appendix C and/or the Table of Contents to check for possible changes on the function you are interested in. If no changes are listed, use the appropriate Chapter/Section within the main body of text.

Most customer complaints are attributed to a specific function of the Tester 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 that there is no procedure applicable to that function.

IMPORTANT GUIDELINES FOR SERVICING

A. ALWAYS verify that the main power supply is operating within the specified tolerance (at the Sun bus and Computer Module) before replacing any Circuit Board Assembly!!

B. Verify that connectors to the boards are fully seated and that the boards are fully seated in their respective card rack. In addition, verify that a connector keying pin has not come loose and lodged between pins, thereby inhibiting proper mating.

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

D. Make sure that you completely <u>understand what the Tester is suppose to do</u> (you cannot fix it if it is not broken). Refer to the Operator's Manual, application notes and 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.

G. Use Wrist Static Straps when Handling anys Printed Circuit Boards.

HOW TO ACCESS Calibration Diagnostics, **Gas** Cal and Development Aids Pages

To gain access to the **CALIBRATION DIAGNOSTICS** page (Figure **A)** from the SYSTEM CALIBRATION page press button “l” however; to access the GAS CALIBRATION page (Figure B) from the SYSTEM CALIBRATION page, press “CAL” button. To access the DEVELOPMENT AIDS page (Figure C) from the MAIN MENU:

1. Press button “O”

2. Immediately, hold down “CONTROL” and “SHIFT”.

3. and ess "6".

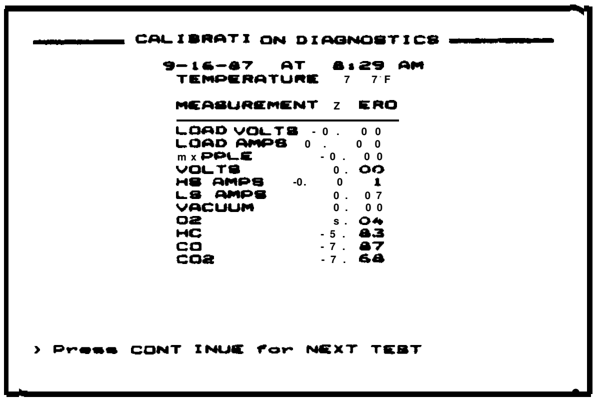


Figure A. Calibration Diagnostics Page.

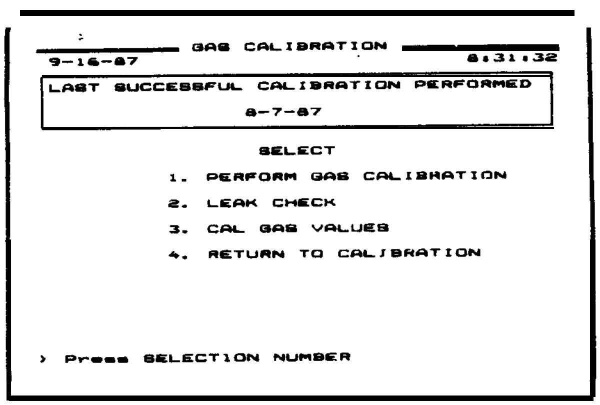


Figure B. Gas Calibration Page.

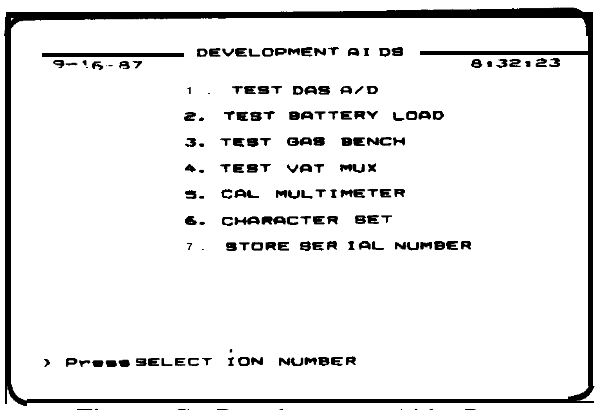


Figure C. Development Aids Page.

LOGIC LEVEL DESIGNATIONS

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

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.

A Functional block may use either an asterisk following the signal name or a bar over the signal's name (ENGINE SYNC) to indicate that the signal is active low or on the falling edge.

OPEN COLLECTOR OUTPUTS

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 CSR 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).

HANDLING OF MOS IC & OTHER STATIC SENSITIVE DEVICES

A majority of integrated circuits are high impedance devices. This characteristic makes them susceptible to damage by electrostatic charges. Large electrostatic charges can build up in low humidity environments which, if discharged through IC terminals, may permanently damage the device.

To eliminate needless failures, follow and use the following techniques when handling any circuit board, integrated circuit chip or any other static sensitive device:

1. Do not remove the printed circuit board from the static protection packaging until it is ready for use.
2. Never remove or insert boards under power.
3. The correct procedure for removal of Board's from card rack or main equipment is as follows
   A. E-quipment on which the repair is performed must be grounded.
   B. Wear wrist strap and connect wrist strap to equipment or any available nearest ground (wrist strap & ground cord art. included in field service kit).
   C. Touch the cage or any metal part of the equipment to neutralize static voltage differences.
   D. Always grasp the Board from two opposite edges using the forefingers.
   E. Place removed Board on grounded static dissipative mat (part of field service kit) when troubleshooting or software upgrading.
4. When inserting Boards into a card rack or into main equipment:
   A. Remove Board from original packaging on static" dissipative material. Save all packaging for possible reuse if required to ship defective Board.
   B. Install Boards into unit using rules 3A,3B,3C and 3D.
   C. Package defective Boards into a shielded bag and then return into a reusable container.

5. Package IC chips or any other static sensitive device in conductive foam or an equivalent static dissipative material which provides adequate static and physical protection.
6. Avoid any unnecessary contact with internal circuits.
7. Avoid setting Board's on static prone insulating surfaces such as paper, glass, rubber, and plastic.
8. Beware of friction generated static when:
   A. Wearing silk or nylon garments.
   B. Walking on carpets.
   C. Scuffing rubber sole shoes.

NOTE

Relative humidity has a direct bearing on the magnitude of possible static charge buildup; the lower the relative humidity the higher the charge and vice versa.

APPLICATION NOTES

The application notes are used in conjunction with the page flow diagram (page A-5/A-6) to give a brief description of the functions available for a particular page & what the Tester expects from the vehicle under test. The notes apply to both the MCA-3000 & MCA-3000-3.

PAGE	NOTES
WARM-UP	15 minute warm-up period is used to allow the Infrared Analyzer time to warm up. Warm-up period is dependent on the stability of the CO channel on the Infrared Analyzer. Warm-up period can be bypassed by pressing "FREEZE". If "FREEZE" is pressed prior to the "HC, CO, and C02 TIME UNTIL WARM-UP" prompt being displayed, the computer will not attempt to calibrate HC, CO or C02, and will use the in fromation from the last calibration. The message "TIME UNTIL WARM-UP NN:NN" CALIBRATED" will be displayed on the digital display unit next to these gases.
SELF CALIBRATION	CALIBRATED = Passed Self Calibration. Calibration constants (channel offsets) stored in RAM memory. TIME UNTIL WARM-UP NN.NN = Next to HC, CO, C02: CONTinue button was pressed before warm-up period was complete.
DIAGNOSTICS	Diagnostics page can be accessed only from the Self Calibration page. See MCA-3000 Operator's Manual for more information concerning the Diagnostics page.
PROGRAM SET-UP	When using an IS-1OOA use vehicle code 115 which is the code for a GM V8 engine with a -9.5 timing offset angle.

VISUAL CHECKS The operator/user can flag the following either good or bad by using the YES and NO keypads. The **good** items will appear in **GREEN** and the **bad** items in **RED** in reversed video. If no flag is made, the item is **not** seen on the printout.

Engine Oil	Drive Train
Trans. Oil	Suspension
Coolant	Brakes
Power Steering	Alignment
Brake Fluid	Frame
Window Washer	Exhaust
Belts	Gauges
Hoses	Lights
Air Filter	Wiper Blade
Battery Term.	Heater
Plug Wires	Air Cond.
PCV Valve	Tires

CRANKING Engine kill is automatically activated when the page is entered if the oil temperature is greater than 63 C. If less than 63 C, the operator is prompted to warm up the engine. When oil temperature reaches 65 C, the computer activates Engine Kill. This feature can be bypassed by pressing CONTinue.
The Tester forces primary triggering.
A starter draw of greater than -35 amperes required to begin the test.
Engine kill automatically released at the end of the test.
Cranking test VDU display and printout is provided in a three column format: MINIMUM-RESULTS-MAXIMUM where actual captured dynamic test data appears in the RESULTS column between the MINIMUM and MAXIMUM limits specified for the particular vehicle under test.

HIGH CRUISE RPM window of 2400 to 2600 rpm.

LOW CRUISE RPM window of 1400 to 1600 rpm.

IDLE TEST RPM window is +/- 50 rpm of the entered IDLE RPM form the VEHICLE SETUP Page.

FIRING KV RPM maintained Greater than 2000 rpm for 10 seconds--return to idle--press CONTinue to start test. During this test the magnitude of firing KV for all cylinders is captured. Low and High limits are loaded into the Tester from the LIMITS data disk.

TEST DATA REPORT KV CHANGE For the snap acceleration to be recognized, the snap must exceed 1500 rpm and the vacuum must drop to below 2"Hg if connected. Pressing CLEAR forces gathering of all new data starting at the firing KV test.
Minimum and maximum limits are loaded into the Tester from the LIMITS disk.
The computer forces primary triggering for snap acceleration. Primary must be Connected.

TEST DATA REPORT SPARK KV	Minimum and maximum limits for each cylinder are inputted from the LIMITS disk.
TEST DATA REPORT SPARK DURATION	Minimum and maximum limits are loaded in from the LIMITS disk.
POWER BALANCE	Manual power balancing is performed by pressing the number on the Remote Control keypad that corresponds to the cylinder selected to be shorted. Minimum and maximum limits are loaded in from the LIMITS disk.
TEST DATA CHANGE	Minimum and maximum limits are based on set offsets from the REPORT **HC** weighted average of the data acquired during the test.
ALL DATA PAGES	↑↑↑↑ Reading is **overscale.** ↓↓↓↓ Reading is **underscale.** RED Reading is over or under specification. GREEN Reading is within specifications.
DIGITAL MULTIMETER	Press UP/DOWN arrows on the keypad to locate selection press ENTER to make selection.
DYNAMIC KV	Press FREEZE to capture & freeze data (data can **only** be printed while it is frozen). Dynamic KV data is not used in the computer diagnostics at this time. If the Tester is gathering data the print screen command **will** be ignored until data acquisition is complete.
PRINT SCRN	Functions for all pages.

MCA-3000 BASIC SYSTEM OVERVIEW

NOTE

The following discussion is with reference to the basic MCA-3000 System Block Diagram of Figure D. Accessories, shipped as an integral part of the Tester, are not shown on the figure. Also, Board, PCB and circuit card assembly (CCA) are synonymous.

TURBO IBM XT* Compatible Computer PCB
The IBM XT* compatible computer PCB along with its installed Video Adapter, DAS (Data Acquisition System) Memory and **I/O-EEPROM-CLOCK** Board; functions as the "brain* of the Tester. Throughout the remainder of this manual this is referred to as the **Computer;** unless otherwise noted. Essentially, all other major assemblies, components and units of the Tester are under either direct or indirect control of the Computer. A more in-depth discussion of the Computer is given in Chapter 3 entitled "Single Board Computer **(SBC)** and Disk Drives".

With the exception of the DAS system; all intercommunication between the Computer and the Sun Bus occurs between the Computer Module 1/0 board and Bus Driver board installed on the Sun Bus backplane. The DAS Memory board functions to accept 16-bit **"RS232"** level data received from the DAS A/D (analog-to-digital) board installed on the Sun Bus backplane. The EGA Video Adapter functions to process Computer generated **control/signal** outputs in order to develop 6-bit TTL RGB (Red, Green, Blue) video/intensity output signals and horizontal and **vertical** output sync signals required to control operation of the 20" Color Display. For a more indepth explanation; refer to Chapter 5.

Dot **Matrix** Printer (AP-11OO)
Printer control/data signals are transferred between the Computer and Keyboard Arbitrator Board via the W29 34-pin flat ribbon cable assembly and between the Keyboard Arbitrator Board and Dot Matrix Printer via W23, a 25 conductor cable assembly. Point-to-point connection exists between the terminus on the Arbitrator Board. For a more indepth explanation, refer to Chapter 6.

Keyboard Arbitrator/ Keyboard/Remote Control Unit
The Keyboard Arbitrator Board functions to control passage of Keyboard and Remote Control Unit (**RCU**) selected control/signals between the Computer and the Keyboard or RCU. In the event **both** the Keyboard and RCU keys are operated simultaneously a contention situation exists however the Keyboard Arbitrator Board functions to prioritize operation such that the Keyboard **pre-empts** the RCU from operation and its transmission takes precedence over the RCU. For a more indepth explanation, refer to Chapter 4.

Disk Drives
A single 34 conductor flat ribbon type cable assembly functions to transfer control/data signals between the dual 3 1/2" Disk Drives and the Computer. This cable assembly performs the same functions for an optional 5 1/4" Disk Drive if installed. Read/write data to/ from the disk drives is in serialized form. **The** MCA-3000 program is **normally** loaded into the Tester from the top 3 1/2" Disk Drive. Upon powering up the system, specific vehicle limits and diagnostics data are loaded into the Tester from the bottom located 3 1/2" Disk Drive. The optional 5 1/4" Disk Drive is used to accommodate IBM XT * compatible programs i f desired. For a more indepth explanation, refer to Chapter 3.

Battery Load Unit
External battery load cables, connected at the rear of the Tester cabinet, are normally connected across the vehicle battery for testing purposes. The Battery Load Unit functions to supply computer controlled variable loads

● Trademark IBM

Battery Load Unit (continued)
(20A, 80A and lOOA) to the battery under test and route the sampled battery voltage /current/temperature to the VAT (volt ampere test) Board located on the Sun Bus backplane. For a more indepth explanation, refer to Chapter 3.

Filter Input Board
The Filter Input Board, installed at the top end of the boom, functions as a primary filter for all external vehicle signals monitored and sensed by the signal pickup leads. These Filtered signals are then routed via a multitude of cable assemblies to the appropriate Board located on the Sun Bus. The Filter Input board processes all vehicle tested signals except for the following battery load cable, amp probe signal and ALDL (assembly line diagnostic link) applied signals. The latter two are applied via the boom directly to the appropriate Board located on the Sun Bus.

IR Module
A conventional three channel (HC, CO and CO_2) Andros* IR bench is installed within this Tester. This bench operates to detect the concentration of Hydrocarbons (HC), Carbon Monoxide (CO) and Carbon Dioxide (CO_2) within the vehicle exhaust system. Additionally, a separately mounted oxygen (O_2) sensor detects the concentration level of expended oxygen within the vehicle's exhaust system. These analog signals, representing the individual gas concentrations, are routed via a 26 conductor axial cable assembly to the IR Interface Board located on the Sun Bus. Pneumatic solenoids, operated under control of the Computer via the Sun Bus; dictate the operational mode (vacuum, leak check, calibration, sample and zero hold) of the IR Module. For a more indepth explanation, refer to Chapter 17.

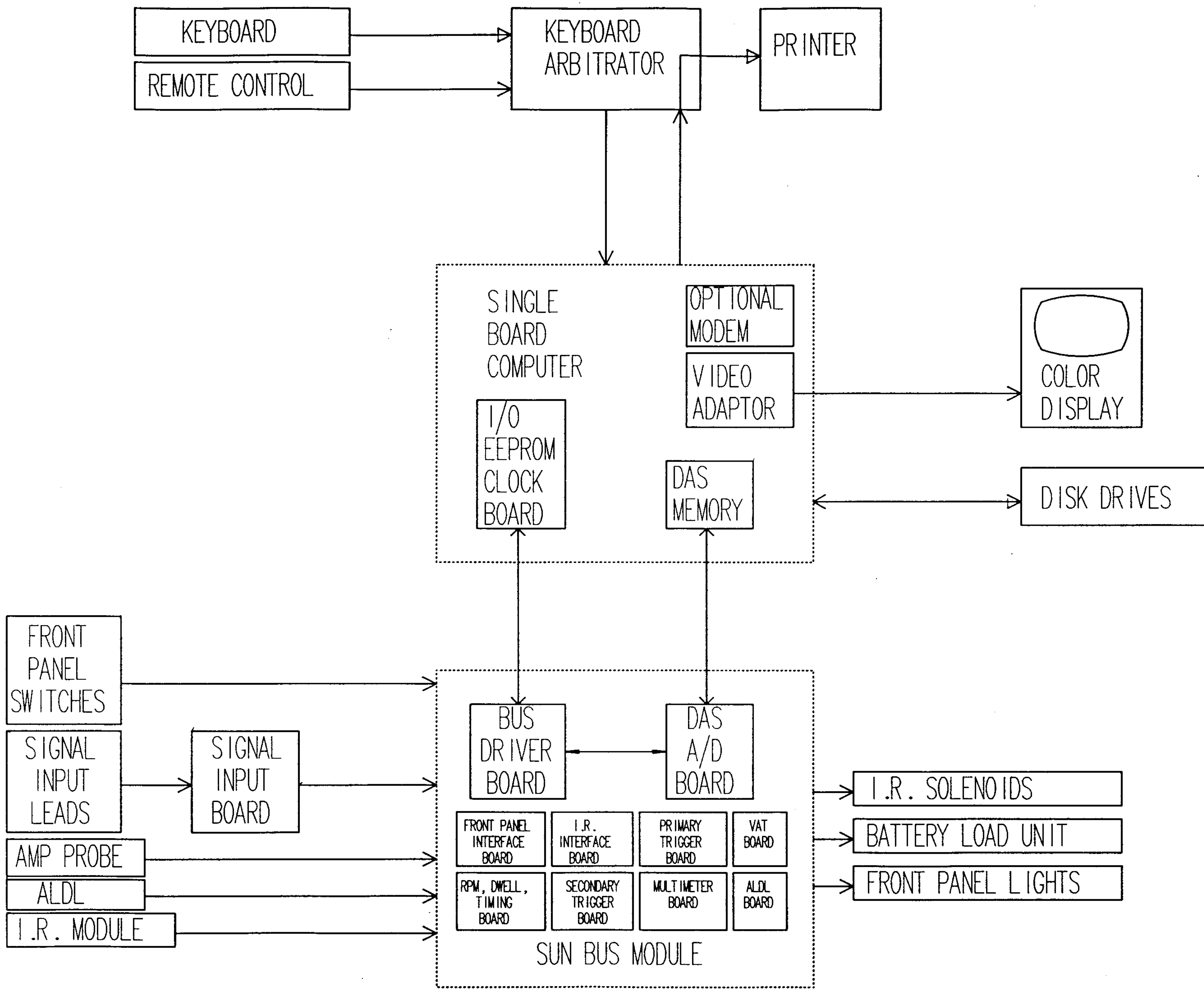
Front Panel Switches/Controls
Front panel switches and controls, operating under control of the Front Panel Interface Board (located on the Sun Bus), function to: apply/remove AC power, control Headsign lamp on/off operation, control IR pump on/off operation, vacuum pump on/off operation, vary amount of vacuum and hold vacuum, control speaker audio volume, force trigger operation, engine kill and control the overall operational mode of the Tester. Front panel lamps, also operating under control of the Front Panel Interface Board, indicate the mode and status of the Tester. For a more indepth explanation, refer to Chapter 20.

Analog Power Supply
The Analog Power Supply Assembly converts primary ac power into the required dc output voltages necessary to operate the Sun Bus. For a more indepth explanation, refer to Chapter 2.

Digital Power Supply
The Digital Power Supply Assembly converts primary ac power into the required dc output voltage necessary to operate the IBM XT Compatible Computer. For a more indepth explanation, refer to Chapter 2.

SYSTEM INTERCONNECTION
To assist the reader in understanding and more effectively and efficiently servicing and maintaining the MCA-3000, the in-depth MCA-3000 System Interconnection Diagram of Figure E is provided. Part numbers given on the diagram are for the standard 115Vac primary version of the Tester. Alternate part numbers can be found by referring to "Chapter 21. Parts" and to "Appendix C. Model Differences".

*Trademark Andros, Inc.



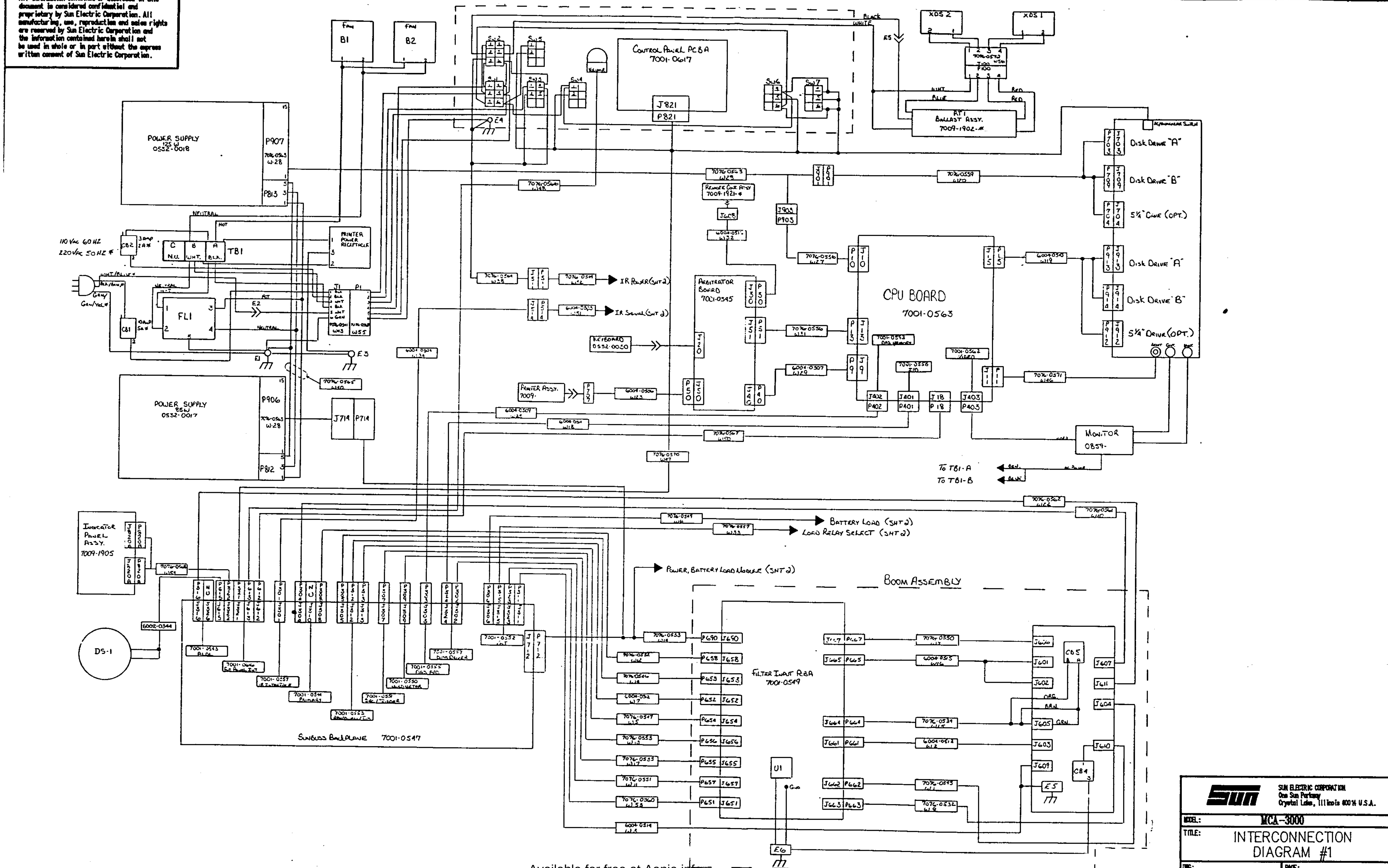
SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

MODEL: MCA-3000

TITLE: BASIC BLOCK DIAGRAM

DWG: i

PAGE: ix



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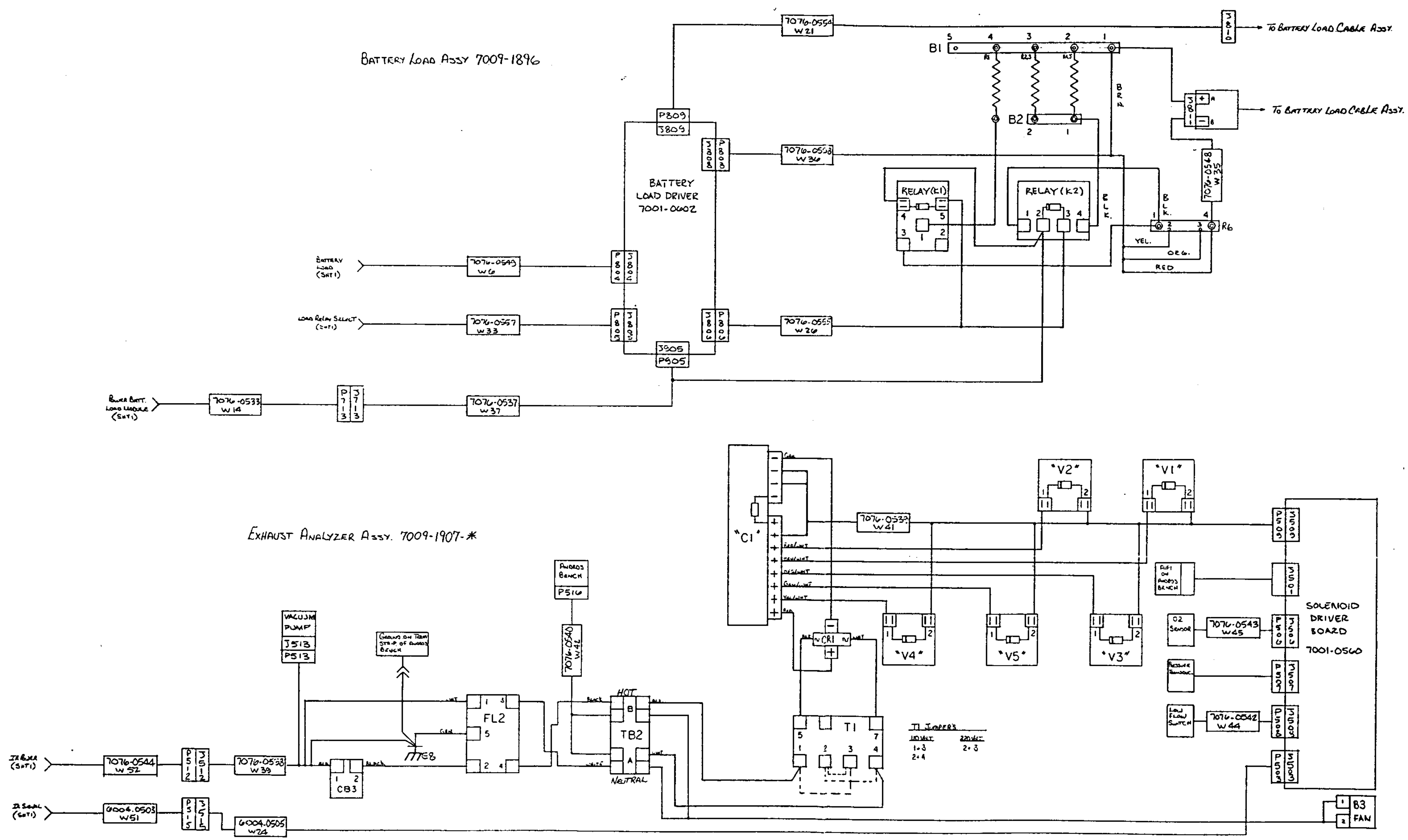
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

MODEL: MCA-3000

TITLE: INTERCONNECTION DIAGRAM #1

DWG: ii

PAGE: x



Sun

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Crystal Lake, Illinois 60014 U.S.A.

MODEL:	MCA-3000
TITLE:	INTERCONNECTION DIAGRAM #2
DWG: iii	PAGE: xi

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Chapter 1
AC POWER DISTRIBUTION

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CHAPTER 1

AC POWER DISTRIBUTION

SECTION I. THEORY OF OPERATION

WARNING Voltage Dangerous to Life is present in this equipment even with the POWER ON-OFF switch set to OFF! Use the "one hand rule" (keep one hand in pocket or behind back) when working with AC voltages. Always verify that the Tester is "OFF" & the primary input power cord is unplugged from the power source AC outlet before removing wires from terminal blocks and/or other terminations.

11OVAC Primary Power
Primary 11OV, 50/60 Hz, single phase ac input power (hot side) is applied to the Tester via the AC Power Cable assembly to terminal 1 of the main power circuit breaker CB1. Single phase ac input power neutral side is applied to terminal E2. The AC Power Cable assembly connector ground terminal (green wire) is connected directly to Tester chassis ground at terminal El. Connector J1 of W43 & W55 Wiring Harnesses then apply 11OV primary ac power to POWER ON/OFF and HEAD SIGN ON/OFF switches SW1 and SW2 respectively.

With both switches in their OFF position, the Tester is not operational. The Sun headsign is lit anytime the POWER ON/OFF switch is ON; regardless of HEADSIGN switch operating position. Also, the Sun Headsign is lit anytime the HEADSIGN switch is in its ON position; regardless of the Power ON/OFF switch position. The headsign lamp can only be turned off when both the POWER ON/OFF and HEADSIGN switches are OFF.

When the POWER ON/OFF switch is ON, primary input ac power is applied to the following termination points: terminals 3 and 6 of HEADSIGN switch SW2; terminal board TB1A,B; terminals 4 and 1 of IR PUMP switch SW3 and also to terminals 7 and 8 of connector P511.

TBIA and TBIB function as "hot" and "neutral" ac distribution points respectively. Hot ac from TBIA is routed to. axial fans B1 and B2, through circuit breaker CB2 terminals 1,2 to terminal 1 of IR PUMP switch SW3, through the L (line) and N (neutral) terminals of the bulkhead mounted receptacle and mating printer pendant cable assembly connector to the Printer, via AC Power Cable Assembly #6001-0151-01 to the Video Display Unit input power connector and also to terminals 1 and 2 of EMI line filter FL1.

Chassis ground for Printer power is supplied by wiring through the AC Power Cable Assembly to chassis ground point E3. Connector J511 ground is supplied through connector terminal 1 wiring connected to chassis ground point E4.

Output terminals 3,4 of line filter FL1 supply primary ac power via W40 Power SUpply Wiring Harness #7076-0565 to input power connectors J812 and J813 of Power Supply #1 and #2 respectively.

As previously noted, primary ac power is available at terminals 7,8 of P511 with the POWER ON/OFF switch SW1 ON, however ac power is present on terminal 3 and 6 of P511 only when I.R. PUMP switch SW3 is ON. Primary AC power, present at J511, is applied through W52 Wiring Harness #7076-0544 and W39 Wiring Harness wiring to the following: from terminals 3,6 of connector J512 via terminals 1,2 of connectors J513 to the IR pump; from terminal 7 of J512 to terminal 1 of EMI line filter FL2, from terminal 8 of J511 through terminals 1,2 of circuit breaker CB3 to terminal 2 of line filter FL2.

When ON/OFF switch SW1 and I.R. PUMP switch SW3 are ON; primary ac power is routed through FL2 and applied to terminal board TB2A (neutral) and TB2B (hot). Primary ac power neutral from TB2A is applied to terminals 2,4 of the step-down type solenoid transformer T1 0778-0476 while primary ac power hot from TB2B is applied to terminals 1,3 of T1. Primary ac power neutral/hot are applied through W42 IR Bench Power Wiring Harness 7076-0540 to terminals 2 and 1 of connectors J516 to the IR Bench 7049-0114-01. Primary ac power neutral/hot are also applied to terminals 1,2 respectively of Fan B3 0587-0504. 10VCT output from solenoid transformer T1 is applied to the AC input terminals of diode bridge CR1. When switches SW1 and SW3 are both ON, the IR emission module is fully operational with its IR pump operating.

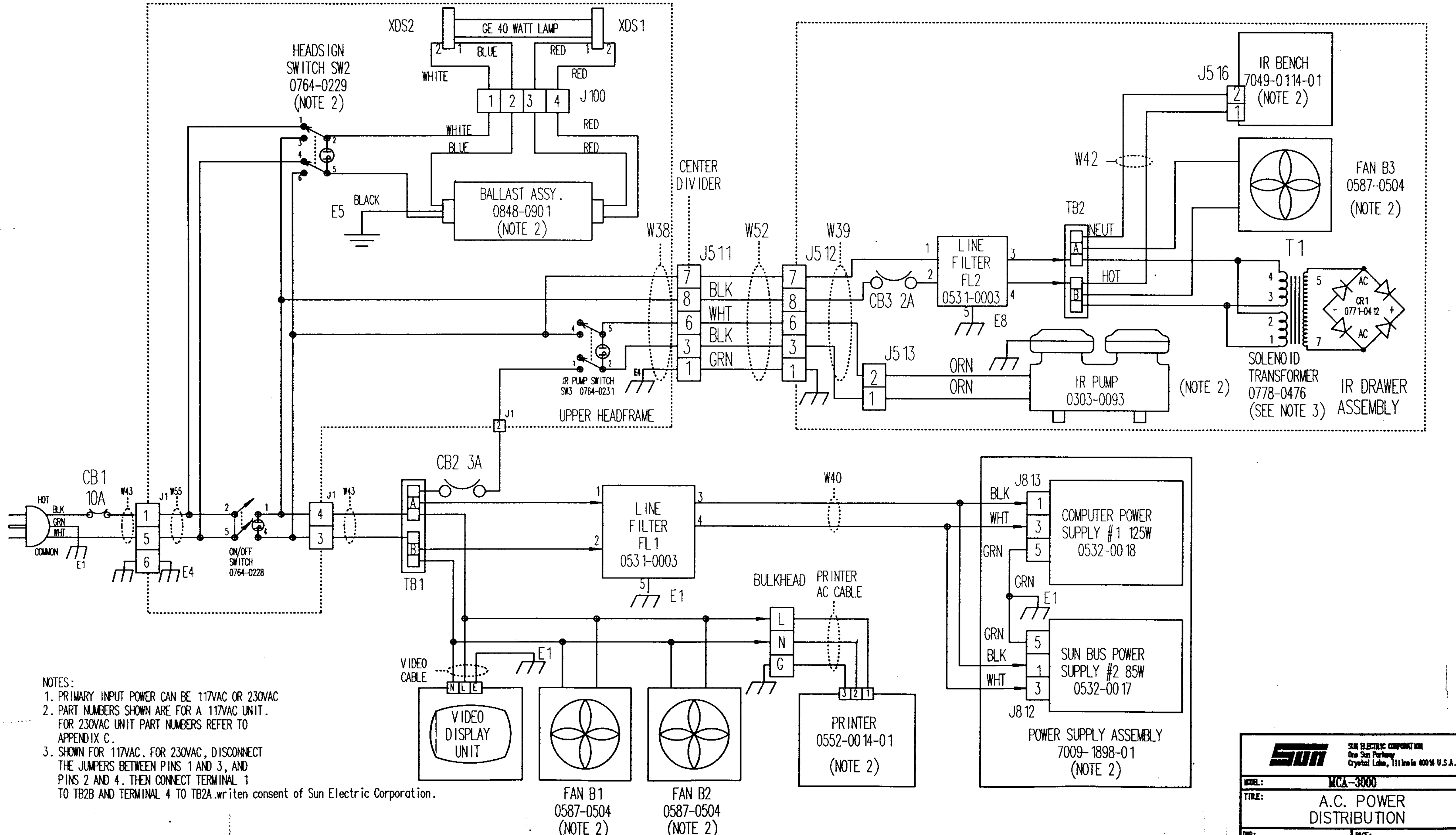
220VAC Primary Power

When the Tester is operated with 220V, 50/60 Hz, two phase ac primary input power; its electrical primary ac power distribution throughout the Tester is identical to that described for application of 11OVAC primary power. To accommodate the use of 220 V input power the following components required replacement or wiring change:

1. Ballast (220V) #0848-0906
2. Circuit breaker CB1 (5A) #1922-0112-08
3. Circuit breaker CB2 (2A) #1922-0112-05
4. Power cord (220V) #6001-0178
5. Axial fans (220V) #0587-0507-01
6. Vacuum pump (220V) #0303-0099
7. Solenoid transformer T1 (wiring change, see caution below)
8. SW2, Rocker, DPDT, 2-position, #0764-0230
9. SW3, Rocker, DPST, 2-position, #0764-0232

CAUTION

Prior to 220VAC power application, make certain that solenoid transformer primary terminals 1,3 and 2,4 are <u>disconnected</u> and terminals 2,3 are then <u>connected</u> and 1 and 4 are <u>connected to TB2B and TB2A</u> respectively. If this procedure is not followed, DAMAGE TO EQUIPMENT may result!



NOTES:
1. PRIMARY INPUT POWER CAN BE 117VAC OR 230VAC
2. PART NUMBERS SHOWN ARE FOR A 117VAC UNIT. FOR 230VAC UNIT PART NUMBERS REFER TO APPENDIX C.
3. SHOWN FOR 117VAC. FOR 230VAC, DISCONNECT THE JUMPERS BETWEEN PINS 1 AND 3, AND PINS 2 AND 4. THEN CONNECT TERMINAL 1 TO TB2B AND TERMINAL 4 TO TB2A.writen consent of Sun Electric Corporation.

SUN ELECTRIC CORPORATION
One Sun Parkway
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MODEL:	MCA-3000
TITLE:	A.C. POWER DISTRIBUTION
DWG: 1-1	PAGE: 1-3/1-4

CHAPTER 2

LOW VOLTAGE POWER DISTRIBUTION

SECTION 1. THEORY OF OPERATION

Tester internal DC operating voltages are supplied by the Computer Power SUpply and the Sun Bus Power Supply. These supplies, shown in the DC Power Functional Block Diagram 2-I, convert primary ac input power into the required dc output voltages necessary for Tester operation. An internal bridge rectifier CR1 also converts solenoid transformer 10Vac output power into +12Vdc unregulated power, filtered by Cl, required by IR Emission Module solenoid valves V1 through V5.

The Computer Power Supply #0532-0018 generates the required voltages necessary to operate the Computer Module and its loaded circuit card assemblies, both 3 l/2-inch disk drives, Battery Load Module, and one optional 5 l/4-inch disk drive, if installed. The Computer Module supplies +5Vdc to the Arbitrator Board which in turn supplies +5Vdc required by the Keyboard and Remote Control Unit.

The Sun Bus Power Supply #0532-()()17 generates the required voltages necessary to operate the Sun Bus backplane and its circuit board assemblies, Input Filter Assembly, control Panel Assembly, Indicator Lamp Panel, and Timing Light.

The IR Bench, converts AC power into +15Vdc required for operation of the bench. This is routed to the Solenoid Driver Board which in turn develops +7.5Vdc output required for operation of the Vacuum Transducer,

Computer Power Supply, #0532-0018, Power Distribution.
Computer Power Supply generated output DC voltages are present on connector J1 as follows:

PIN	NOMENCLATURE/VOLTAGE
6	Key
7	-12V
8	Common
9	-5V
10	Common
11	+12V Isolated Return
12	+12V isolated
13	Common
14,15	+12V
16,17	Common
18,19,20	+5V

Output DC voltages, present at the Computer Power Supply connector Jl, are routed through W28 Power Supply Secondary Wiring 7076-0563 connectors J901 and J903 and W27 Motherboard Power Wiring Harness connectors J903 and J1O to connector J1O located on the Computer Module. Low voltage dc present at J1O is as follows:

1	+5 v
2	Ground
3	+12V
4	-12V
5	-5V
6	Common
7	+5V

+5Vdc power from Computer Module connector J13 pin 5 is routed via W31 Keyboard Wiring Harness 7076-0556 to connector J51 located on the Arbitrator Board. Within this Board the +5Vdc power parallel branches to connectors J20 and J30. Pins 5 and 4 of the Keyboard connector, connected to J20, receive +5Vdc and ground respectively. +5Vdc and ground, present at connector J30 pins 7 and 8 respectively, are routed via W32 Remote Control Cable Assembly 6004-0516 connector J608 pins 7 and 8 to Remote Control Unit connector J1 pins 2 and 1 respectively.

+12V and +5V and associated grounds, present on the Sun Bus Power Supply connector Jl, are also routed via part of the W28 Wiring Harness (connectors J907 and J901) to connector P901. This power is then routed via connector J901 and J703, 709 and 704 to the top 3 1/2" Disk Drive, bottom located 3 1/2" Disk Drive and optional 5 1/4" Disk Drive if installed. Note that the pins on the Disk Drive Connector are Numbers the opisite off the connector. The following voltages and grounds are available at connector P703 and P709 of the respective 3 1/2" Disk Drive Assembly:

PIN	VOLTAGE
4	+12v
3	+12V Common
2	+5V Common
1	+5V

The following voltages and grounds are available at connector J704 of the 5 1/4" Disk Drive Assembly when installed:

PIN	VOLTAGE
1	+12V
2	+12V Common
3	+5V Common
4	+5V

Bridge rectifier CR1 supplies +12V unregulated power to one end of solenoid valves V1 thru V5. The IR Bench supplies +15V power via the IR Analyzer Cable Assembly 6004-0355-04 to pin 23 of Solenoid Driver Board connector J501. This +15Vdc power is further divided down internally within the Solenoid Driver Board to +7.5V required for operation of the Vacuum Transducer 7009-1910.

+12V isolated power, present at the Computer Power Supply connector Jl, pin 12, is routed through cable assembly connectors J714 and renamed 12V relay. From this point 12V relay power is passed through connectors J713 and J905 and applied to the Battery Load Board and also via ring lugs to solenoid valve control relays K1 pin 4 and K2 pin 2.

+12V relay power is present on terminal 4 of J905 while ground is located at terminals 1,2. Cabling from connector J714 supplies +12V relay power to the Sun Bus via J712 and to the Input Filter Assembly via connectors J690. The following voltages are applied to connector J712 of the Sun Bus:

PIN	VOLTAGE
1,5	Ground
2	+12V relay
4	-15V
6	+15V
8,10	+5V

Sun Bus Power Supply, #0532-0017, Power Distribution
The Sun Bus Power Supply generated output voltages are present on connector J1 as follows:

PIN,J1	PIN,J906	NOMENCLATURE/VOLTAGE
6	1	Key
7	2	No connection
8	3	Common
10	5	Common (15V isolated return)
11	6	-15V
12	7	15V isolated
13	8	Common
15	10	+15V
16,17	11,12	Common
19,20	14,15	+5V

The following voltages are applied, via W28 and W14 Wiring Harnesses, to connector J690 of the Input Filter Assembly located within the boom:

PIN	VOLTAGE
1	-15V
2	Ground
3	+15V
4	+12V relay

The Sun Bus Power Supply generated +5V, +15V and -15V power is routed, via W28 and W14 Wiring Harnesses, to Sun Bus backplane connector J712 pins 8,6 and 4 respectively. +5V, present on J712, is then routed to terminals A1,C1 of all digital bus J1OO Sun Bus connectors while +15V power, present on J712, is applied to terminals A2,C2 of all J1OO connectors. -15V, present on J712, is routed to terminals A3,C3 of all J100 connectors. Ground is available at A32/C32 of all J1OO connectors and also terminal A10/C10 of all analog bus J200 connectors.

Front Panel Interface Board J321 pin 5 supplies +12V power, via W47 Wiring Harness, to P821 pin 1 for application to one end of the MODE and STATUS indicating lamps DS1-5 located on the Control Panel Board 7001-0617. Front Panel Interface Board J321 pin 6 supplies +12V power to one side of Control Panel Assembly VACUUM HOLD, VACUUM ON/OFF and POWER ON/OFF switch-lamp assemblies SW6, SW7 and SW1 respectively. J321 pin 8 supplies ground via El to one side of SW1. J322 pin 11 supplies +12V power via W54 Wiring Harness and pin 6 of connectors J820A and J820B to one side of five indicating lamps (DS1-5) located on the Indicator Lamp Boards.

SECTION II. DC POWER CHECK-OUT/CALIBRATION

Computer Power Supply #0532-0018

1. **Connect** the DVM red lead to J1O pin 1 and the black lead to J1O pin 2, on the SBC (Single Board Computer) #7001-0563.

2. DVM should read +5.00 VDC +/-0.05. If not, adjust **R48** on the Computer Power Supply #0532-0018.

3. Move the red lead to pin 3 of J1O. DVM should read +13.00 VDC +/-2.0. If not, replace the Computer Power Supply #0532-0018.

4. Move the red lead to pin 4 of J1O. DVM should read -13.00 VDC +/-2.0. If not, replace the Computer Power Supply #0532-0018.

Sun Bus Power Supply #0532-0017

1. Insert the Card Extender #7001-0576 into a vacant backplane **slot.**

2. Connect the DVM red lead to pin Al of J1OO and the black lead to A32 of J1OO, on the card extender.

2. DVM should read +5.00 VDC +/-0.05. If not, adjust R48 on the Sun Bus Power Supply #0532-0017.

3. Move the red lead to pin A2 of J1OO. DVM should read +15.00 VDC +/-2.0. If not, replace the Sun Bus Power SUpply #0532-0017.

4. Move the red lead to pin A3 of J1OO. DVM should read -15.00 VDC +/-2.0. If not, replace the Sun Bus Power Supply #0532-0017.

" Check-Out/Calibration Complete "

SECTION III. LOW VOLTAGE DC TROUBLESHOOTING.

COMPLAINT	CORRECTIVE ACTION
I. **All Computer Power** Supply generated dc **output voltages missing** as checked at **J1/P907.**	1. Verify that circuit breaker CB1 (on rear panel) has not been "tripped". Reset if necessary. 2. Check that fuse F1 #0739-0555 (5 Amp, Figure 2-1) is good. Replace if defective. 3. Check for primary AC power between terminals 3 and 4 of line filter FL1. If present, then -----------------SUBSTITUTE--------------- A. Comptuer Power Supply. #0532-0018. If not present, refer to Chapter 1. AC Power. 4. Refer to Theory of Operation and Functional Diagrams
II. **All Sun Bus Power Supply generated dc output voltages missing as checked at J1/P906.**	1. Verify that circuit breaker CB1 (on rear panel) has not been "tripped". Reset if necessary. 2. Check that fuse F1 #0739-0026 (3 Amp, Figure 2-1) is good. Replace if defective. 3. Check for primary AC power between terminals 3 and 4 of line filter FL1. If present, then ----------------SUBSTITUTE---------------- A. Sun Bus Power Supply. #0532-0017. If not present, refer to Chapter 1, AC Power Distribution. 4. Refer to Theory of Operation and Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
III. One, or a combination of supplied voltages, missing from the Sun Bus Power supply.	1. With J712 (on the Sun Bus Backplane) pin 1 **as a ground check point, check for** presence of power supply voltages as noted: J712 pin 2 = +12V relay J712 pin 4 = -15V J712 pin 6 = +15V J712 pin 8 = +5V J712 pin 10 = +5V If any of the voltages are missing, then ----------------SUBSTITUTE----------------- A. Sun Bus Power Supply. #0532-0017.
IV. One, or **a combination of supplied voltages,** missing **from the Computer Power supply.**	1. **With** J1O (on SBC) **pin 2 as a ground check point, check for presence** of power supply **voltages as noted:** **J1O pin 1** = +5V **J1O pin 3** = +12 J1O pin 4 = -12V J1O **pin** 5 = -5V J1O **pin** 7 = +5V If any of the **voltages** are missing, then ----------------SUBSTITUTE----------------- A. Computer Power Supply .#0532-OO18.

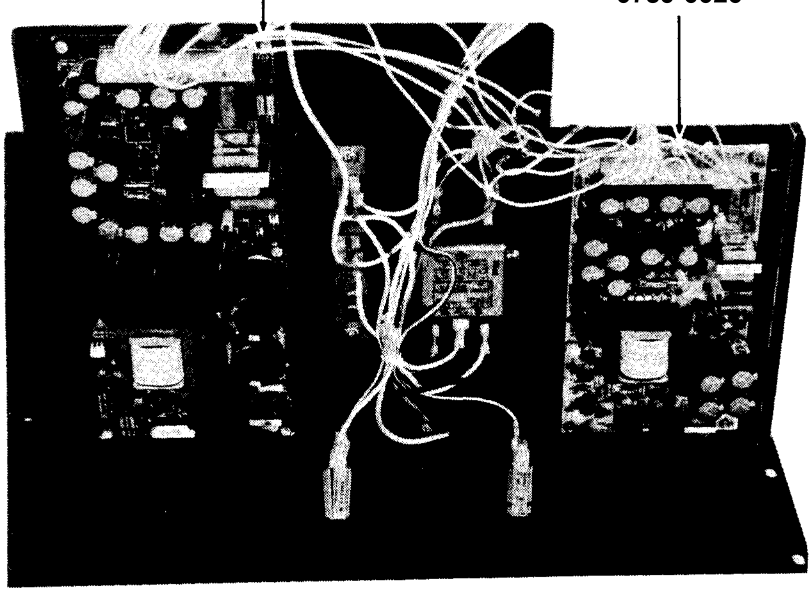
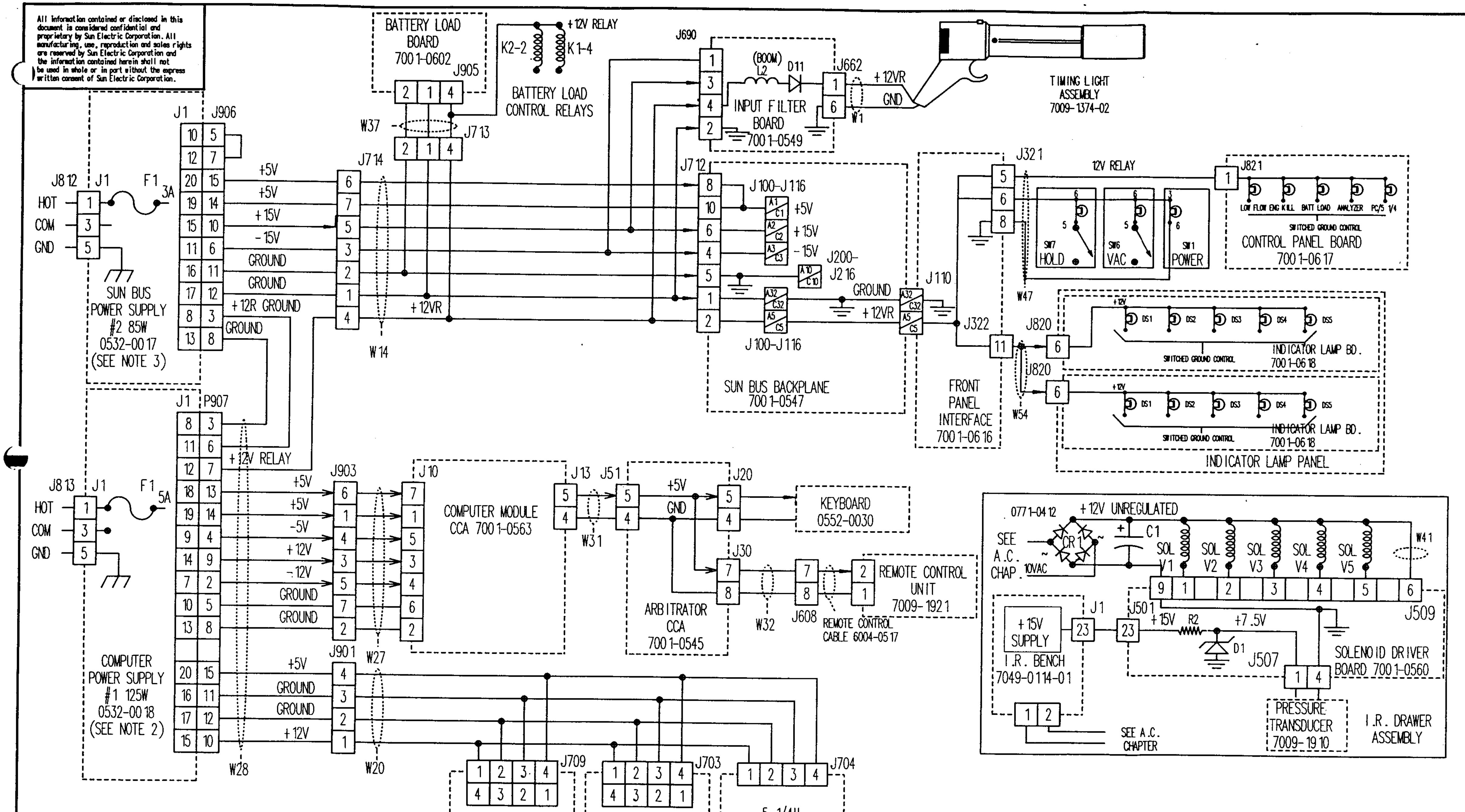


Figure 2-1. Power Supply Assembly, Fuse Location.



NOTES:
1. 110V model shown. 220V model is 7009-1904-02.
2. for 110V operation connect W1 to 110V terminal and make certain fuse F1 is 5.0A. For 230V operation connect W1 to 230VAC terminal and make certain fuse f1 is 2.5A.
3. For 110V operation connect W1 to 110VAC terminal and make certain fuse F1 is 3.0A. For 230VAC operation connect W1 to the 230VAC terminal and make certain fuse F1 is 1.5A.

Sun

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

MODEL:	MCA-3000
TITLE:	D.C. POWER DISTRIBUTION
DWG: 2-1	PAGE: 2-7/2-8

CHAPTER 3

SINGLE BOARD COMPUTER (SBC) & DISK DRIVES

GENERAL

The MCA-3000 was first released using an XT* compatible computer module and is referred to as SERIAL "A". In the last quarter of 1988 a SERIAL "B" MCA-3000 was introduced featuring a AT* compatible computer module, SERIAL "A" MCAS can be upgraded to the same level as a SERIAL "B" using KIT #120-0553-01. This chapter has been divided to cover both version, sections I - V will refer to the SERIAL "A" MCA, sections VI - XI will refer to the SERIAL "B" MCA. NOTE : Drives are handled differently between an XT* and an AT*, this is also covered in this chapter.

MCA-3000 SERIAL "A" GENERAL

The Computer Module Assembly, shown in Figure 3-1, contains a Single Board Computer (SBC) 7001-0563 which is physically, hardware and software compatible with the IBM PC XT*, with the added feature of dual processing speed. The SBC contains 640K RAM and 56K EPROM memory, two serial communication ports, one parallel port, floppy disk controller, a keyboard port, an 8-bit type 8088-2 microprocessor, a Direct Memory Access (DMA) controller, a timer, 8 levels of interrupt, a speaker port, a reset port and 8 expansion slots. The present version of the Tester has the following three Board's loaded into SBC expansion slots: EGA Video Adapter Board 7001-0562, DAS Memory Board 7001-0593 and I/O/EEPROM/Clock Board 7001-0558.

DISK OPERATING SYSTEM (DOS) BOOTUP

The Disk Operating System (DOS) is a set of programs contained on a single floppy disk which when properly loaded, tell the computer how to perform its many varied functions. Each time a Program Disk is inserted into the Disk Drive and either primary power is applied or the front panel RESET button is pressed; the DOS program is transferred, commonly called "loading" or "booted", from the floppy disk into computer memory.

The following sequence of events occurs during normal "booting" of the Disk Operating System:

1. After approximately 15 seconds, a "BEEP" is heard.

2. Immediately following the "BEEP", then

   "LOADING MCA MASTER PROGRAM
   ONE MOMENT PLEASE"
   appears on the VDU.

3. Nearly the same time the above prompt appears on the VDU, the print head returns to its "HOME" position (extreme left of travel).

4. After approximately 60 seconds, the TITLE PAGE appears, signaling a successful "bootup".

SECTION I. THEORY OF OPERATION

IBM XT * Compatible Computer PCB

A brief functional description for each of the expansion slot loaded Board's is given in the latter part of this section. The following text is given with respect to SBC Computer Block Diagram 3-1.

* Trademark of IBM

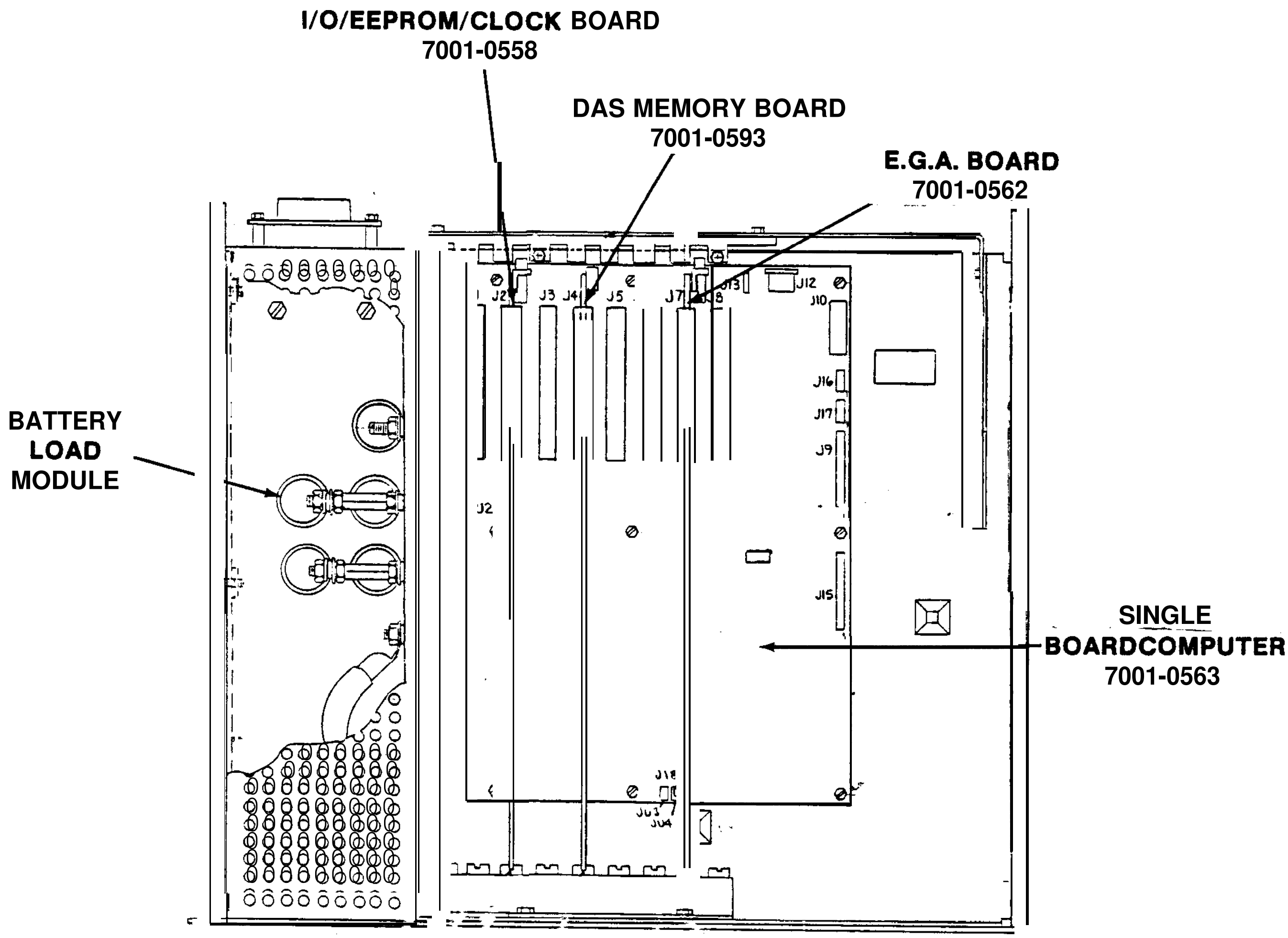


Figure 3-1. SBC Computer Module Parts Identification.

The type 8088 main CPU functions as the "brain" for the Tester. Operating under program control, this device performs the required arithmetic/control/manipulation of data received from the expansion slot Board's via the internal system and local buses. Data bits are transferred between the main CPU and various input/output ports via operation of interface devices. "Bus arbitration logic circuitry" functions as the principle transceiver for all system/local bus intercommunications. The type 8288 bus interface device controls data transfer to/from system RAM (640K). Bus Interface circuitry controls data transfer between the System Bus and the following: Floppy Disk Control port, Parallel Printer Port and two communication Serial Ports.

An interrupt signal, generated by an external peripheral device and applied to the main CPU, signifies that the device is ready to send or receive data. Multiple interrupts, referred to as vectored interrupts, occur when one or more peripheral devices interrupt one another. When the main CPU receives an interrupt it selects, or is vectored, to an appropriate subroutine servicing program required to perform the necessary task. The master/slave interrupt control circuits process up to eight vectored priority interrupts received from main CPU peripherals as noted below:

Interrupt	Use
0	Timer-Memory Refresh
1	Keyboard
2	----
3*	Serial 2*
4*	Serial 1*
5	BIOS Print Screen
6	Floppy Disk Controller
7	Printer

The type 8284 System Timing Logic circuitry provides command and control timing for the main CPU as well as controlling the Processing speed. This circuitry basically controls the memory read/write and I/O read/write command outputs. Control outputs from the System Timing Logic circuitry determine when the system bus is enabled onto the local bus and also determines the direction of data transfer. The Processing speed is controlled by software, or by reading the Keyboard. The SBC powers up in 4.77MHZ, but can be speed UP to 7.14MHZ by pressing CTRL, ALT,and F for Fast. In turn it can be Reset to 4.77MHZ by pressing CRTL, ALT, and R.

The type 8155H-2 Timer circuitry functions to generate accurate time delays under software control. One output drives an internal transistor (not shown) which in turn drives the J18 speaker port. The remaining outputs of the timer function to produce required delays after which generated interrupt signals are applied to the microprocessor.

Data bits are written into and read from RAM via operation of the type 8288 Bus Interface. Data storage location within the RAM's is determined by the status of applied RAM address bits. Memory write/read operations are controlled by the status of memory read/write control signals generated by the main CPU.

The Bus Interface device controls two-way data communications between the local bus and the Timer and EPROM's.

Program data bits are read from EPROM's whenever the main CPU generates a memory read control signal (not shown). Main CPU generated address bits determine the memory location of the extracted word. The EPROM's also contain the Basic Input/Output System (BIOS) which functions to provide device level control for the major I/O devices (peripherals) of the Tester. Software interrupts each access a different BIOS routine.

The Floppy Disk Control circuitry processes data bits and control signals received from the main CPU and produces the required read/write, disk drive select, head select, head directional control, and motor control outPut signals to the selected disk drive. The Floppy Disk Control circuitry also monitors disk drive generated control output signals such as: index, write protect and track zero. In summary, the Floppy Disk Control circuitry consists of all the logic circuitry used to perform the serial-to-parallel and parallel-to-serial data conversions required for normal disk drive control. This control circuitry also has control registers that determine the number of tracks and sectors required and the number of bytes per sector to be stored, thus the controller circuitry and BIOS determines the ultimate recording format.

If used, two Universal Asynchronous Receiver Transmitter (UART) convert parallel applied data bytes (each data byte consists of 8 parallel bits) to serialized form for transmittal from J16 COM1 and J17 COM2 ports respectively. These units may also convert serialized data received on the COM ports into an eight bit parallel output byte for transfer to the main CPU or by DMA to system RAM.

Bus Interface circuitry controls data transfer between the main CPU and the Keyboard, Printer and front panel mounted RESET switch. Connector J11 functions as the RESET switch port, either J12 or J13 serve as the Keyboard port and J9 is the Parallel Printer port.

Keyboard Port

Connector J13, functioning as a five pin port for the Keyboard, has the following pin/signal designations:

J13 Pin	Signal
1	+Clock
2	+Data
3	-Reset
4	Ground
5	+5V

See Chapter 4 for more in-depth details. Connector J12 is not used except to bypass to Remote Arbitrator in CPU Keyboard testing.

Parallel Printer Port

SBC connector J9 functions as a 34-pin parallel printer port for connection of the Printer. Proper operation of the Printer Port requires Jumper JU5 be installed. This port operates as Line Printer #1 (LPT1) in normal PC operation. Pin assignment for signal/control designations are as follows:

J9 Pin	Signal/Control
1	Strobe*
3	Data 0
5	Data 1
7	Data 2
9	Data 3
11	Data 4
13	Data 5
15	Data 6
17	Data 7
19	Ack*
21	Busy
23	PE (paper end)
25	Select
27	Auto Fdxt*
31	Ground
33	Chassis Ground
2-24(even pins)	Ground
26	Init*
28	Error*
30	Ground
34	SLCT IN*

Refer to Chapter 6 for more in-depth details.

Speaker Port

SBC connector J18 functions as an output speaker port for driving a Front Panel Interface Board amplifier and side mounted speaker. This four pin connector has the following pin assignment:

J18 Pin	Signal/Control
1	Data*
2	---
3	Ground
4	+5V

Speaker connection is between pins 1 and 4 of the connector. Also, a front panel mounted VOLUME control alters the audio level applied to the speaker. Refer to Chapter 20 for more in-depth details.

Reset Port

SBC two pin connector J11, connected to the front panel located normally open RESET switch, enables resetting of the computer from an external location. The SBC is automatically reset upon power application therefore a reset operation is not required. However; pressing of the RESET switch will reset the SBC at any other time. Pin assignment for connector J11 is as follows:

J11 Pin	Signal
1	Ground
2	Reset*

Expansion' Slots

Eight expansion slots, shown in Figure 3-1, are available on the SBC. Each expansion slot consists of a 62-pin connector having pin assignment and signal/control/voltage designations as noted below. Three expansion slot connectors (J1, J4 and J7) are used in the present version of the SBC; Slot Seven is reserved for the optional Modem. All processor memory cycles are 840ns in duration while 1/0 cycles are 1.05 microseconds. Memory refresh cycles occur approximately once every 15 microseconds.

J1-J8 Pin	Signal/Control/Voltage	J1-J8 Pin	Signal/Control/Voltage
B1	Ground	A1	I/0 Check*
B2	Reset	A2	D7
B3	+5V	A3	D6
B4	IRQ2	A4	D5
B5	-5V	A5	D4
B6	DRQ2	A6	D3
B7	-12V	A7	D2
B8	---	A8	D1
B9	+12V	A9	D0
B10	Ground	A10	1/0 Ready
B11	MEMW*	A11	AEN
B12	MEMR*	A12	A19
B13	IOW*	A13	A18
B14	IOR*	A14	A17
B15	DACK3*	A15	A16
B16	DRQ3	A16	A15
B17	DACK1*	A17	A14
B18	DRQ 1	A18	A13
B19	DACK0*	A19	A12
B20	Clock	A20	A11
B21	IRQ7	A21	A10
B22	IRQ6	A22	A9
B23	IRQ5	A23	A8
B24	IRQ4	A24	A7
B25	IRQ3	A25	A6
B26	DACK2*	A26	A5
B27	T/C	A27	A4
B28	ALE	A28	A3
B29	+5V	A29	A2
B30	Osc 14.3MHZ	A30	A1
B31	Ground	A31	A0

SIGNAL DESCRIPTIONS

RESET — This signal is system Reset.

IRQ2-7 — These signals are the interrupt request lines. IRQ2 has the highest priority; IRQ7 the lowest. The signal will be high until acknowledged by the interrupt service routine.

DRQ1-3 — These signals are DMA request lines. DRQ1 has the highest priority; IRQ3 the lowest. The signal will be high until the corresponding DACK line is received.

DACK0*-3* — These signals are the DMA Acknowledge lines. DAK0* is reserved for refresh, and a refresh cycle is indicated by DACK0* and MEMR*

SIGNAL DESCRIPTIONS (continued)

T/C	This indicates the DMA channel has reached its terminal count.
MEMW*	This signal indicates a MEMory Write.
MEMR*	This signal indicates a MEMory Read.
II OW*	This signal indicates a 1/0 Write.
I/ OR*	This signal indicates a 1/0 Read.
1/0 Ready	When this line is low, the current memory or 1/0 cycle will be extended in multiples of 210ns.
OSC	This is a 14.31838MHZ with a 50% duty cycle.
CLOCK	This is the 4.77Mhz or 7.15Mhz system clock. It has a 30% duty cycle.
AEN	When this line is high the DMA chip has control of the Bus.
I/OCheck*	This line is used to indicate that there is an error on a device in the expansion bus. the CPU will receive a NMI.
ALE	This signal is used to indicate when the address bus is valid. Processor addresses are latched on the falling edge.
DO-D7	These lines are the actual Data Bus
AO-A7	These lines are the actual Address Bus. For 1/0 operations, only AO-A9 are used.

Serial Communications Channels

The SBC contains two RS-232 type serial communications channels available at serial port connectors J16,17. The present version of the Tester however does not utilize these features. Switch SW1-4 being set to OFF enables the COM2 RS-232 serial port. Switch SW1-3 Being set to ON Disables the COM1 port.

Power Input

Power is supplied to the SBC via connector J1O which has the following pin assignment versus voltage/ground designation:

J1O Pin	Voltage/Ground
1,7	+5V, 3A Between 1 and 7
2	Ground
3	+12V, 50mA
4	-12V, 50mA
5	-5V, for expansion slots only.
6	Ground
8	Ground

Floppy Disk Control Port

SBC connector J15 functions as an 1/0 Floppy Disk Control Port for the installed 3 1/2-inch Floppy Disks and optional 5 1/4-inch Floppy Disk if present. Pin assignment for signal/control designations is as follows:

J15 Pin	Signal/Control
1-33 (odd pins)	Ground
6	Drive Select 3*
8	Index*
10	Drive Select O*
12	Drive Select 1*
14	Drive Select 2*
16	Motor*
18	Direction
20	Step
22	W Data (write data)
24	WE (write enable)*
26	Track 00*
28	WP (write protect)*
30	Read Data
32	Head Select

SBC SWITCH/JUMPER SETTINGS

When leaving the factory DIP switch SW1 positions 1, 2, and 3 are ON and position 4 is OFF. Since the BIOS EPROM, supplied with the board, is used; switch positions 1 & 2 must be ON thus indicating no monitor type. Switch position 3, being set to ON, disables operation of COM 1 port (J18). Switch position 4, being set to OFF, enables operation of COM 2 port (J17). Jumper J2 is installed thereby indicating installation of both 64K and 256K RAM's. Since jumper J4 is not present it indicates that EPROM type 2764 and 27128 are installed. With jumper J5 installed the printer parallel port J9 is enabled as LPT1.

SBC LOADED BOARDS

Three circuit card assemblies are presently loaded into SBC expansion slots; they are: DAS Memory Board 7001-0556, 1/0/ EEPROM/Clock Board 7001-0558 and Video Graphics Adapter Board 7001-0562. A brief functional description of each of these boards follows.

DAS Memory Board #7001-0556

The Data Acquisition System Memory Board converts RS-232 level 8-bit byte input digital signals, received from the DAS A/D Board located on the Sun Bus, into TTL level high order and low order 8-bit bytes suitable for storage within the 8K byte type RAM's located on the board. An on-board Microprocessor on the DAS A/D Board enables and addresses the appropriate selected RAM's for data storage (write operation) and/or a memory read operation. The digital stored data is read from RAM and processed by the SBC microprocessor for output to the Video Display Unit and Printer peripherals. See Chapter 8 for more in-depth details.

I/O,EEPROM,Clock Board #7001-0558

The 1/0 board has three main functions; namely:

1. Buffer all critical signals from the Tester computer bus to prevent loading problems and provide a hi-directional communications link from the computer to the Sun Bus. Refer to Chapter 7.

2* Provide a form of nonvolatile memory (Electrically Erasable Programable Read Only Memory EEPROM) that can be changed in the system. This Memory is nonvolatile and is used to store calibration information, customer custom messages, Screen Color, and Custom Report Format. When replacing the I/O-EEPROM-CLOCK board it maybe helpful to swap the EEPROM to prevent the loss of the customers preferences. If the EEPROM is the Problem, then the Preferences must be reprogrammed and a Gas Cal and Leak check must be performed.

   An on-board comparator, working in conjunction with an eight position DIP switch S3 and associated logic control circuitry, controls whether the following is a memory read or memory write operation. When computer supplied address bits A13-19 are identical to the present conditions of DIP switch S3, a memory select operation take place. Whether the subsequent operation is a read or write one is dictated by the status of the MEMR and MEMWR control signals produced by the computer and processed through the logic control circuitry.

3. Provide a battery backed up real-time clock. The crystal controlled *real* time clock circuitry functions to provide real time data (seconds, minutes, hours, day, month, year and day of week) required for Tester operation. A trimmer capacitor (C2, 36pf) enables fine tuning of the crystal oscillator frequency to exactly 32,768Hz prior to its input to the real time clock. After internal division the resultant output from the clock is 1Hz which is suitable for real time operation.

   Buffered data (BD0-3) and buffered address (BA0-3), along with SBC inputted and buffered input/output read (BI/ORD*) and buffered input/output write (BI/OWR*) control signals, determine whether a real-time read or write operation occurs. Real-time clock operation is enabled only when software controlled buffered address bits BA4-BA9 and BI/O match the settings SWB7-2 (111000) of DIP switch S1.

   A 3.6V battery and associated control circuitry function to supply power to the real-time clock in the event that the MCA is Turned OFF and +5v power is lost. This battery is designed to operate for 10 years before replacement.

Factory Dip Switch Settings

On leaving the factory, DIP switches SW1, SW2 & SW3 are preset as indicated below:

SWITCH	POSITION							
	1	2	3	4	5	6	7	8
Swl	ON	ON	ON	OFF	OFF	OFF	•	•
SW2	ON	ON	OFF	ON	ON	ON	OFF	OFF
SW3	ON	OFF	OFF	ON	ON	OFF	OFF	•

● DON'TCARE

Enhanced Graphics Adapter (EGA) Board #7001-0562

The Enhanced Graphics Adapter Board functions to interface the SBC with the Video Display Unit (TTL video levels). This board enables the production of monochrome quality text and high-resolution 16 color graphic displays on the VDU. Interfacing the EGA Board to the VDU is accomplished through the board's 9-pin female DB-9 connector J801 and the W30 Video Cable Assembly mating with VDU connector J403. Signal specifications and connector J801 pin out assignments are as follows:

J801 Pin	Name	Signal Specification
1	Ground	Common return for input signals.
2	Secondary red	33.3% Red gun control, positive TTL level.
3	Red	66.6% Red gun control, positive TTL level.
4	Green	66.6% Green gun control, positive TTL level.
5	Blue	66.6% Blue gun control, positive TTL level.
6	Secondary Green	33.3% Green gun control, positive TTL level.
7	Secondary Blue	33.3% Blue gun control, positive TTL level.
8	H Sync	Horizontal sync, negative TTL.
9	V Sync	Vertical sync, negative TTL.

The EGA Board is programmable relative to Video Display Unit raster and character parameters thereby enabling creation of customized graphics on the VDU. This board operates in either a low-resolution (40-character by 25-row) or high-resolution (80-character by 25-row) alphanumeric mode or one of 10 graphic modes. These 10 graphic modes are divided into one of four different resolution groups (medium-resolution, extended- medium-resolution, high-resolution and extended high-resolution) based upon the horizontal, vertical and color profile. The board contains 256K bytes of Dynamic display memory for storing information to be output to the VDU. The Tester is capable of producing 256 different character codes in 16 different colors using one type 2764 EPROM (erasable programmable read only memory) as a character generator. Refer to Chapter 5 for more in-depth detail.

SECTION II. DISK DRIVE THEORY OF OPERATION

GENERAL

Theory of operation for the Tester 3 l/2-Inch Disk Drives is divided into the following discussions: system operation, functional operation, DC power interfacing and electrical signal/control interfacing as shown in Diagram 3-2, page 3-20. Theory of operation for the optional 5 l/4-inch disk drive follows the 3 l/2-inch disk drive theory of operation.

Disks and Drives

The MCA-3000 uses 3 1/2" double sided, double density floppy disks. Storage space on any disk is measured in BYTES. Each disk has the ability to store up to 720K bytes of information (1K = 1024 Bytes). One byte of information is the equivalent of one character. Data is stored (written) on disks in circles, called TRACKS. The read/write head of the disk drive is able to move to any number of tracks to read (retrieve) or write (store) data on the disk. Tracks are also broken down, or divided, into SECTORS. MCA-3000 disks are FORMATTED or divided in the following manner:

1 character	=	1 byte
512 bytes	=	1 sector
9 sectors	=	1 track
80 tracks	=	1 side (double-sided)
2 sides	=	1 720K byte disk

512 bytes x9sectors/byte x80 Cracks/sector x2 sides/disk =737280 bytes/disk
737280 bytes/disk x 1024 bytes/Kbyte = 720 Kbyte/disk

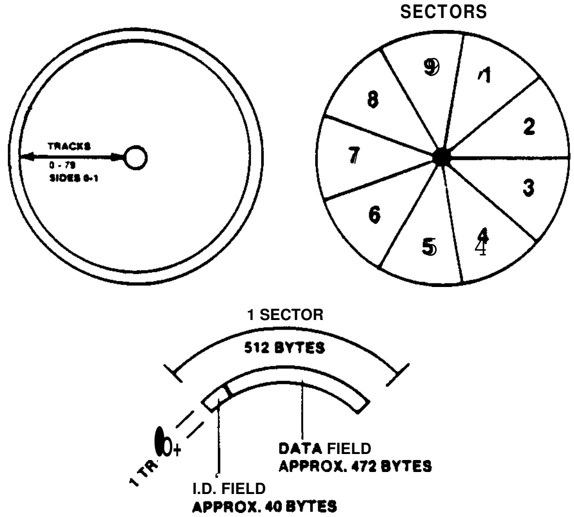


Figure 3-2. MCA-3000 disk

System Operation

Each 3 l/2-inch floppy disk drive consists of a floppy disk rotating mechanism, a read/write head, an actuator 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 medium (disk) inserted into the drive to the spindle, which is directly coupled to the DC brushless motor, which rotates it at 300 rpm. The positioning actuator moves the read/write head to the desired track. 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 SBC Floppy Disk Controllers.
2. Drive selection.
3. Index detection.
4. Head positioning actuator drive .
5. Spindle motor control.
6. Read/write.
7. Write protect.
8. Track 00 detection.
9. Drive ready detection.
10. Head selection.

The 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 follower is fitted in the lead screw groove on the stepping motor output shaft and, as the stepping motor rotates by 30 degrees, 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, with the slight offset, 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.

Functional Operation

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 ms 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.

DC Power Interfacing.

Primary Power Supply #1 (125 Watt) develops and supplies: +12Vdc, +5Vdc, +12V return and +5V return required to operate all installed flexible floppy disk drives. Power supply #1 output connector J1 pin assignment for the developed voltages and grounds are:

J1-15	+12V
J1-17	+12V return
J1-20	+5V
J1-16	+5V return

CAUTION Note that connectors P703 and P709 pins 1-4 connect to headers J703 and J709 pins 4-1 respectively. Although physical configuration of the connectors does not allow them to be installed incorrectly, when troubleshooting this portion of the circuitry, pay close attention to the method of connection. If the connector is offset by on pin the Power Supply will be shorted to ground, consequently shutting down.

Voltage and ground pin number assignment for W20 Wiring Harness, 3 1/2-inch Disk Drive, Power 7076-0559 connectors P703 and P709 are as follows:

PIN	VOLTAGE/GROUND
1	+5V
2	+5V return
3	+12V return
4	+12V

Voltage and ground pin number assignment for W20 Wiring Harness, 5 1/4-inch Disk Drive, Power 7076-0559 connector P704 is as follows (note voltage reversal):

PIN	VOLTAGE/GROUND
1	+12V
2	+12V return
3	+5V return
4	+5V

Electrical Signal/Control Interfacing

Overall control of Floppy Disk Drives installed within the Tester is governed by operation of Floppy Disk Controller U102 and Floppy Disk Controller U104 located on the SBC #7001-0563.

Electrical signal/control interfacing between SBC connector J15 and the signal/control interface connector of each disk drive is accomplished via a 34 conductor flat ribbon type cable assembly terminated in connectors P703, P704 and P709. Connector pin number and respective signal/control assignment is as follows:

NOTE

The following list is with respect to signal/control nomenclature at the SBC connector J15.

PIN	1/0	SIGNAL/CONTROL	PIN	1/0	SIGNAL/CONTROL
1-33*		Ground	20	o	Step
6	o	Drive Select 3*	22	0	Write Data
8	I	Index*	24	0	Write Enable*
10	o	Drive Select O*	26	I	Track 00*
12	0	Drive Select 1*	28	I	Write Protect*
14	0	Drive Select 2*	30	I	Read Data
16	0	Motor On*	32	o	Head Select
18	0	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 their 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 O-3*. These four separate input signal lines, Drive Select O to 3, are provided for connecting up to four disk drives to the SBC and multiplexing them. When the SBC Drive Select O output control signal is a logic "O" level, the top located 3 1/2 -inch Disk Drive is selected to be active. Drive Select 1 and Drive Select 2 function to activate the bottom 3 1/2-inch Disk Drive and 5 1/4-inch Disk Drive respectively. The activated Disk Drive front panel LED will light when its applied Drive Select is at a logic "O" level.

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 "l" level side O read/write head is selected and when at a logic "O", 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 "l" level, the read/write head moves from the center of the disk outward and conversely-if the signal is at logic "O" 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 input pulse signal moves the head one track position.

Write Enable* activates the internal write driver and data present on the write data line is written on the preselected side of the disk. When the line becomes logic "l" level the write driver is disabled and the read data logic circuitry is enabled. Read data is then made available for transfer to the SBC.

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 track on the rotating disk.

Track 00* — when at a logic "0" level, indicates 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 logical "1" but it sends a logical "0" (negative-going) output pulse during a read operation.

Write Protect* notifies the Tester of the insertion of a disk with the cover closing the write protect window into the drive. The signal goes to logical "1)''when a write-protected disk is inserted into the drive. When the signal is at logical "0", writing on the disk is inhibited even if the write gate line becomes active.

Optional 5 1/4-Inch Disk Drive Theory

The optional 5 1/4-inch disk drive is drive C when operating in the Analyzer mode and is activated when Drive Select 2 is asserted. When the front panel ANALYZER switch is in the down (PC 5 1/4) position it lights the front panel blue PC 5 1/4 indicator and changes the 3 1/2" drive to Drive C and the 5 1/4" drive to Drive A. This indicator is lit whenever the Tester computer, monitor and printer are being used in conjunction with the optional 5 1/4-inch disk drive and IBM compatible non-analyzer software.

SECTION III. DISK DRIVE CONFIGURATION

CONFIGURATION

Customizing the 3 1/2-Inch Disk Drives for operation within the Tester is performed by using shorting plugs J1-J4 and five jumper wires installed at precise locations on the Disk Drive Board as shown in Figure 3-3, Page 3-16.

NOTE — In-field removal and replacement of factory soldered jumper wires is prohibited. The following discussion is for use in making certain of shorting plug location/installation when removal and replacement of a disk drive is required. Dependent upon the removed disk drive previous installed location, jumper J1 (DS0-3) might not require relocation.

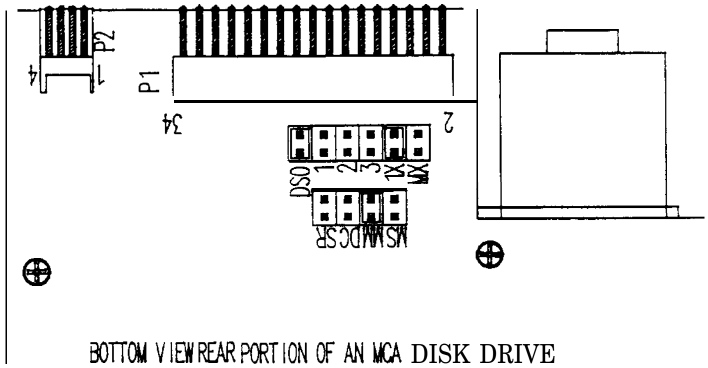


Figure 3-3. Shorting Pin locations

Shorting Plugs J1-J4

Installation of shorting plugs determine the operational condition to:

1. Select either disk drive one or disk drive two.
2. Start the spindle drive motor.
3. Output a READY signal to the Tester SBC. Since pin 34 of the W19 Disk Drive Cable Assembly 7076-0510 is not recognized by the SBC, this function is effectively disabled and therefore, no ready indication is available on the Disk Drive proper.

Drive Select DS0-3 (J1)

With two 3 1/2-inch disk drives installed within the Tester the disk drive located at the top installation position has its J1 shorting plug in the DS0 position while the bottom disk drive has its J1 shorting plug in the DS1 location. Thus, the top disk drive is selected when DS0 is a logic "0" and the bottom disk drive is selected when DS1 is a logic "0". When selected, input/output signals can be sent/received between the activated disk drive and SBC.

Mx, 1X (J2)

As shipped from the factory, shorting plug 1X is installed and MX is open. In this state, a given Disk Drive is accessed (selected for operation) only when its respective Device Select line DS0 or DS1 is an active logic low level.

Motor On Control Conditions MM, MS (Shorting Plug J3)

Operational control of the spindle motor on is determined by the installed position of J3. As shipped from the factory, J3 is installed in the MM position and MS is left open thus the spindle motor on/off state is controlled by the MOTOR ON signal.

Ready Signal Output Generation (Shorting Plug J4).

As previously noted, this Disk Drive output signal is <u>not</u> used by the Tester thus no further discussion is given.

Jumper Wires
The five Factory set jumper wire locations control the following functions:

1. Jumper wires IS and IU control the Drive's indicator LED lighting condition, causing the status of the drive's indicator LED to be on whenever the drive is selected.
2. Jumper wire FG, connects frame ground with signal ground.
3. Jumper wire MD, forces a normal motor off delay upon command from the SBC.
4. Jumper wire T1, provides approximately 3 second delay time select.

SECTION IV. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION

I. MCA does not initialize.

1. With the ON/OFF Switch "ON", are the cooling fans and Headframe Sign on ?

YES NO

- NO → See AC Power Distribution Functional Diagram 1-1.
- YES → After approximately 15 seconds, is a "BEEP" heard when powered up? **NOTE: Make sure the volume of the speaker is sufficient to be heard, turn the Front Panel Volume Control totally clockwise.**

  YES NO

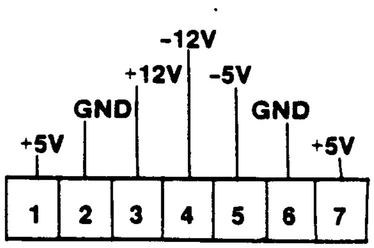
  - NO → Turn tester off and remove (unload) the following Boards from the SBC:
    DAS Memory #7001-0556,
    I/O, EEPROM, Clock #7001-0558, and
    EGA Board #7001-0562.
    Power up tester. Is a "BEEP" heard 15 seconds after power up?

    YES NO

    - NO → Are the supplied voltages present to the SBC? For pin-outs see figure 3-4

      YES NO

      - NO → Refer to Chapter 2, DC power.
      - YES → Replace SBC #7001-0563.
    - YES → Reinsert the above boards one at a time; powering up the tester between each board. When "BEEP" is no longer heard, replace the previously installed board.
  - YES → Continued on the next page.



ON J10 OF THE SBC.

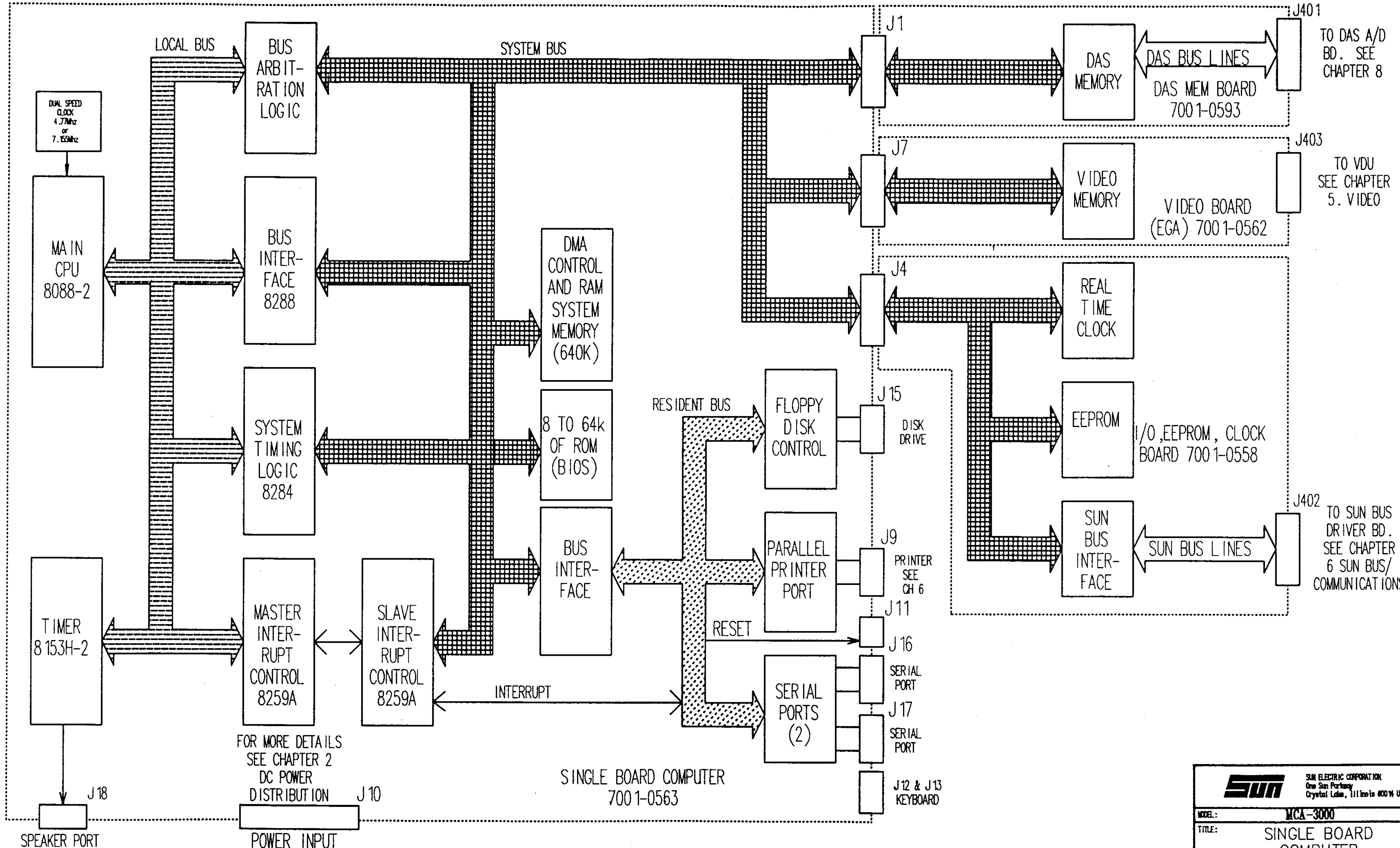
Figure 3-4.

COMPLAINT	CORRECTIVE ACTION
I. MCA does not initialize (continued).	If "LOADING MCA MASTER PROGRAM, ONE MOMENT PLEASE" is displayed, refer to Step 2. If "NON SYSTEM DISK OR DISK ERROR, REPLACE AND STRIKE ANY KEY WHEN READY" is displayed, refer to Complaint II. If a CURSOR (_) is displayed, refer to Complaint III. If VDU is blank, refer to Chapter 5, Section III. Troubleshooting. 2. Is an audio tone (continuous or pulsing) emitting from the tester ? YES NO Does MCA-3000 boot properly with Service Disk ? YES NO Replace disk Drive #0552-0024-01. Replace MCA-3000 Program Disk 0552-0938A02. Is the tone continuous ? YES NO (pulsing) Repair or Replace Remote Control Unit #7009-1921-01. Replace Keyboard #0552-0030. 3. Refer to Theory of Operation and Functional Diagram.
II. NON SYSTEM DISK OR DISK ERROR, REPLACE AND STRIKE ANY KEY WHEN READY is displayed.	1. Verify proper disk is being used in Drive "A". 2. Substitute the MCA-3000 Program disk with MCA-3000 test disk. Does the test disk boot properly ? YES NO Replace Disk Drive "A" #0552-0024-01. Replace MCA-3000 Program Disk #0552-0938A02. 3. Refer to Theory of Operation and Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
III. CURSOR (-) is flashing in upper left corner of VDU.	1. Verify the MCA-3000 Program disk is installed into Disk Drive "A" 2. Are supply voltages present at the disk drive ? YES → Replace Disk Drive "B" #0552-0024-01. NO → Refer to Chapter 2, DC Power. 3. Refer to Theory of Operation and Functional Diagram.
IV. VDU displays CHECK FOR PROPER DISK IN DRIVE B when entering vehicle code.	1. Verify that the proper disk is in drive "B". 2. Go to a different function which also uses Drive B using the appropriate disk i.e. STL or Communications, verify proper operation of Drive "B". Does Drive "B" function properly? YES → Replace previous Disk which did not work. NO → Refer to Chapter 2. DC Power. 3. Refer to Theory of Operation and Functional Diagram.

V. ANALYZER light does not light when ANALYZER switch is set to ANALYZER position.
 	
AND/OR
 	
PC 5 1/4" light does not light when ANALYZER switch is set to PC 5 1/4" position.
	1. Replace Lamp #0910-0056.
	
	2. Is +12V present at pin 1 of J821?
	YES → Shut off primary power to unit. Is There Continuity across ANALYZER switch SW8 contacts 8 and 9 for ANALYZER and contacts 7 and 8 for PC 5 1/4"?
	    YES → Replace Front Panel Interface Board 7001-0616.
	    NO → Replace ANALYZER switch #0689-0114.
	NO → Refer to Chapter 2, DC Power.
	
	3. Refer to Theory of Operation and Functional Diagram.

NOTES



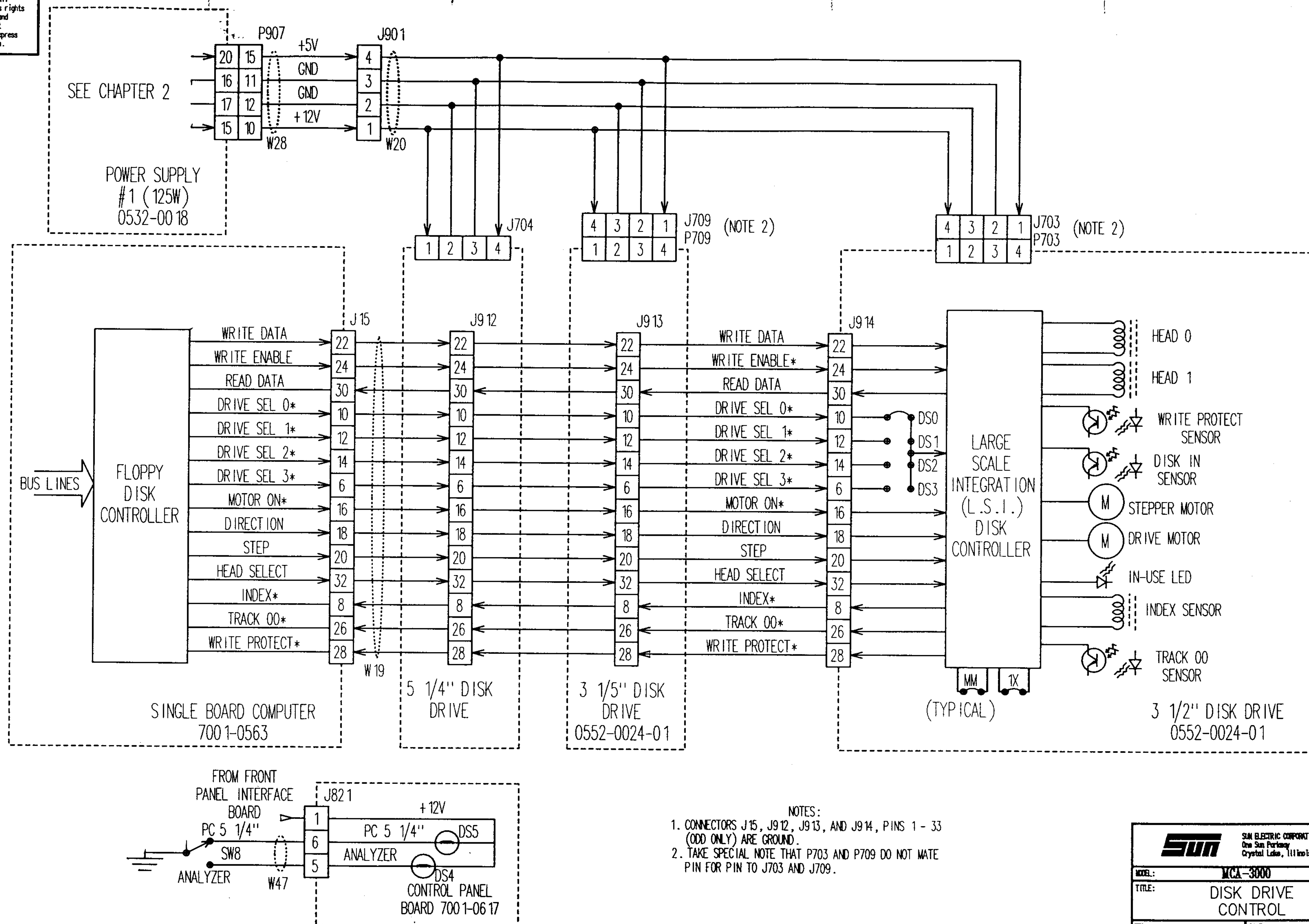
SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

MODEL: MCA-3000

TITLE: SINGLE BOARD COMPUTER

DWG: 3-1

PAGE: 3-21/3-22



NOTES:
1. CONNECTORS J15, J912, J913, AND J914, PINS 1 - 33 (ODD ONLY) ARE GROUND.
2. TAKE SPECIAL NOTE THAT P703 AND P709 DO NOT MATE PIN FOR PIN TO J703 AND J709.

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

MODEL:	MCA-3000
TITLE:	DISK DRIVE CONTROL
DWG: 3-2	PAGE: 3-23/3-24

GENERAL

The MCA-3000 Serial "B" uses a 80286 microprocessor based board (286 CPU Board) which is hardware and software compatible with an IBM AT*. Older Serial A MCA can be updated to the 286 CPU Board by installing Kit #0120-0553-01. This kit replaces the old computer drawer assembly of the Serial A MCA with a new computer drawer assembly featuring the 286 CPU Board.

The MCA's 286 CPU Board is employed using a Passive Backplane, meaning no active components are located on this board. The Passive Backplane is just copper traces and connectors, all other boards plug into this one and are interconnected to an AT style common bus. The 286 CPU Board is contained on a board that measures 4.8" by 13.5" (an industrial standard PC/AT card size). The 286 CPU Board plugs into one of the Passive Backplane's 12 slots, the same way as boards plugged into the MCA-3000'S SBC. This makes the MCA's 286 CPU Board easier to be replaced or swapped out for troubleshooting.

This section contains information on the computer and the disk drives circuitry. Some Problems, like software, are hard to distinguish between computer operation and Application software. For more information see the appropriate Chapters. Refer to the Table of Contents for there location.

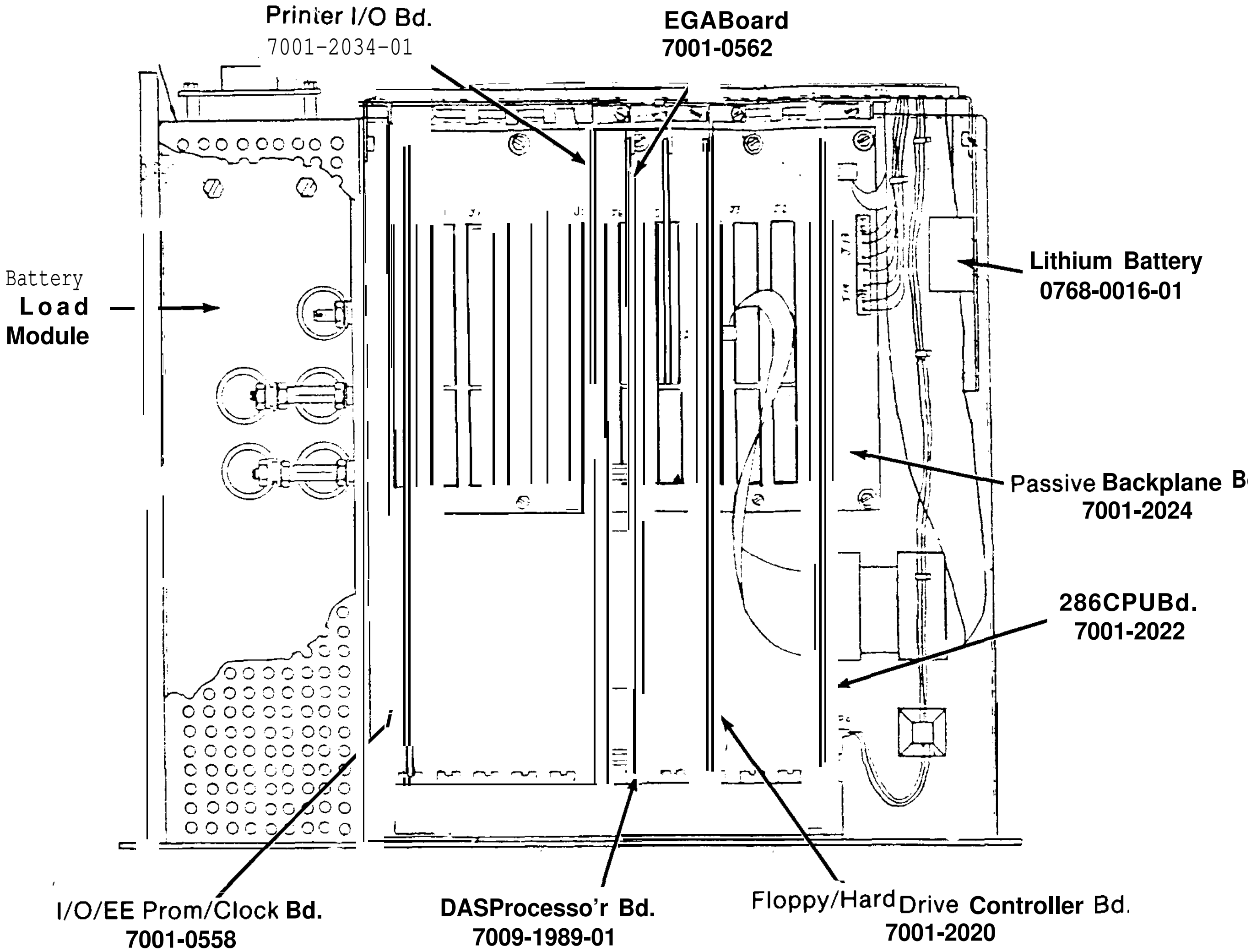


Figure 3-5. 286 CPU Computer Module Drawer Parts Identifications.

SECTION VII. Theory Of Operation

Contained in this section of text is a board by board description for all of the new or existing boards which have been modified for use in the 286 version of the MCA.

The 286 CPU Board, 7001-2022 is the brain of the MCA, used to control and process all the information collected by the MCA's SUN BUS. It contains 640K of RAM memory (512K on the 286 CPU board itself and another 128K on a Daughter board which plugs into the 286 CPU board).

This Board also contains ROM memory used for the system's BIOS (Binary Input Output System used to standardize software calls to hardware devices*such as the printer, EGA Board and Disk Drive Controller Board), and an AT Set-Up utility used for setting the 286 CPU's battery backed up Real Time Clock and defining system configuration stored in CMOS RAM memory.

The CMOS RAM memory is used to store such things as: type of floppy disk drive(s), type of hard drive(s), system memory and video type. For more detailed information see Section II, on AT Set-Up and Set-Up Procedure. Information on how to configure this board can be found at the end of this Chapter (configurations is a term used to describe how certain DIP switches and shorting jumpers are set on the various boards in the computer system, to enable desired functions for the unit to function as designed, these must be set properly).

The MCA's 286 CPU Board works in conjunction with other boards which are installed in the Passive Backplane Board to complete the computer drawer assembly.

Below is a list of boards also installed in the Passive Backplane Board:

Board Description	Part Number	Interface to
EGA Video Board	7001-0562	Video Display Unit
Serial & Printer 1/0 Board	7001-2034-01	Printer
Hard/Floppy Disk Controller Board	7001-2020	Floppy and Hard Drive
I/O/EEPROM/CLOCK Board	7001-0558	SUN BUS
DAS Processor Assembly	7009-1989-01	DAS A/D Board
Passive Backplane	7001-2024	All Other Boards

EGA Board, 7001-0562
The EGA (Enhanced Graphic Adapter) Board is used to generate the control signals used by the MCA's color monitor. For more information see Chapter 5 Video. For information on how to configure the EGA Board, see Appendix E. It is important to note which EGA board you have, for they can come in a variety of shapes and sizes.

Serial & Printer 1/0 Board, 7001-2034-01
This board is used to provide a parallel printer port which was contained on the SBC used in the XT compatible MCA. It also contains some features used by the TECH-10 option for the MCA (for more information see the Expertec chapter). For information on how to configure this board, see Appendix E.

Board Description (continued)

Hard/Floppy Disk Controller Board, 7001-2020
The Hard/Floppy Disk Controller Board is used to control the MCA's two 3 1/2" floppy drives (sometimes referred to as flex drives). It can also be used to control up to 2 Hard drives. For information on how to configure this board, see Appendix E.

I/O/EEPROM/CLOCK Board, 7001-0558
The I/O/EEPROM/CLOCK Board still carries on the same functions as it did in the XT based MCA version. Its the Input/Output port or bridge between the MCA's SUN BUS and the MCA's Computer section. The EEPROM portion is still used to provide storage for certain items (i.e. screen colors, Business Information and Gas Calibration constants). The CLOCK portion of this board is still used by the MCA's software instead of the Real Time Clock found on the 286 CPU Board. For more information see Chapter 7. SUN BUS/COMPUTER COMMUNICATIONS .

DAS MEMORY Board
The DAS MEMORY Board is still used to store continuous A/D conversion in RAM memory for the 286 CPU to access. The DAS MEMORY Board, 7001-2029-01 is a modified 7001-0593 DAS MEMORY Board. This one done to allow the new 286 CPU Board to address the RAM memory on the 7001-0593 properly. This modified DAS MEMORY Board will be used until such time, a new DATA ACQUISITION SYSTEM Assembly, 7009-1989-01 is available. This new DATA ACQUISITION SYSTEM Assembly will feature more available RAM memory (256K) and will offer greater flexibility for future developments. For details on how to modify the old DAS MEMORY Board, 7001-0593 into the interim DAS MEMORY Board, 7001-2029-01 see the Installation Instructions for the 286 Upgrade Kit in Appendix D. For more information about how the DATA ACQUISITION SYSTEM Assembly is used see Chapter 8. DAS SYSTEM.

Passive Backplane, 7001-2024
The Passive Backplane features 12 AT style expansion slots (an AT style expansion slot consist of two connectors, one 62 pin and the other 36 pin) and is used to interconnect all the other boards (i.e. 286 CPU, EGA Video Interface Board and I/O/EEPROM/CLOCK Board) together. It provides the distribution of DC power to all the expansion slots, along with the Data Bus, Address Bus and Control Bus. -

REMOTE/KEYBOARD ARBITRATOR Board, 7001-2021-01
The Remote/Keyboard Arbitrator Board (Arbitrator Board) has been redesigned for use with the 286 version of the MCA-3000. This was done because the 286 CPU understands a different set of make and break codes sent by the keyboard, this set of make and break codes did not support the dual inputs (keyboard and Remote). Early MCA keyboards are set up for communicating with an XT type computer, the new Arbitrator Board translates the XT key codes into AT codes used by the 286 CPU. The primary function of the Arbitrator Board, to select the priority between the Keyboard and Remote remains the same. Next, it is used to generate a Power Good Signal. This signal is used to initialize the 286 CPU on power up or hard reset. For information on how to configure this board, see Appendix E.

COMPUTER SYSTEM POWER UP.

Upon application of power, the CPU is not initialized, until a POWER GOOD signal is generated. The POWER GOOD signal is generated by the Arbitrator Board after the DC Switching Power Supply begins to output 5 volts. This is done to insure that the power from the DC Switching Power Supply has properly stabilized.

When the POWER GOOD line goes high, the CPU begins executing the program in ROM. This program is called BIOS, or Basic Input Output System. Under the direction of this program, the computer first performs a set of self-diagnostic routines and system initialization. If any problems are detected, diagnostics or configuration verification error message(s) will appear on the MCA'S monitor. For information regarding error message(s) see the Troubleshooting section. It is important to note the computer system's audible response during the self-diagnostic and system initialization phase, one "BEEP" indicates all is well, three "BEEPS" indicates NON-FATAL error(s) and the system continues to load software. However five "BEEPS" indicates a FATAL error, causing the system to halt or abort the loading of software. Refer to the troubleshooting section if more than one BEEP occurs.

After the computer system has completed self-Diagnostics and system initialization it will briefly hold with the following screen display before loading system software see Figure 3-6:

```
MAIN BOARD DIAGNOSTICS COMPLETE,
TEST AND INITIALIZE:
 DMA CONTROLLERS
'TIMER ZERO
'INTERRUPT CONTROLLERS
'MEMORY
CONVENTIONAL MEMORY TEST
00640 KB (*)
TOTAL MEMORY TEST 00640 KB
_KEYBOARD
PRESS <F1> IF HARDWARE SET UP IS
DESIRED
 SYSTEM SET FOR HIGH SPEED (**)
'FLEX DISK
'FIXED DISK
_COPROCESSOR NOT INSTALLED
```

FIGURE 3-6

* These numbers will toggle until the CPU detects the end of Conventional RAM memory, this number should equal 00640.

** This indicates the system is set for high speed, meaning the processor is using 10 MHz as its system clock speed.

The Service Technician has two service tools that can be accessed from this point. If F1 is pressed a "Setup Page" appears. This allow the technician to change the Setup program stored in battery backed up CMOS RAM memory located on the 286 CPU Board. The setup program is used to tell the computer what the current hardware setup is (i.e. Drive A & B = 720 K floppy or Type 3, or whether Disk O (the Hard Drive) is installed and what type. If no Hard Drive is installed Disk O = O.

If the "Control" and "D" keys are pressed simultaneously, the Flex Disk Diagnostic page will be displayed. This program is for use by the technician to diagnose errors in the floppy disk drive system and requires a blank disk. For more information on the usage of this page, refer to page 3-40

The CPU attempts to load a Disk Operating System from the Floppy Disk in Drive A. If no disk in present in Drive A, the following message will be displayed on the VDU:

```
ROM BASIC(INT 18H) IS NOT SUPPORTED
DISK ERROR, INSERT SYSTEM DISK
AND PRESS ANY KEY TO TRY AGAIN
```

To correct this problem, insert Master Program Disk in Drive A and press any key.

If a disk is present in Drive A and the Disk does not contain a Disk Operating System the following error message will be displayed on the VDU:

```
Non-System disk or disk error
Replace and strike any key when ready
```

To correct this problem, insert Master Program Disk in Drive A and press any key.

286 CPU Board

The 80286 Microprocessor performs arithmetic and control/manipulation of data received from the expansion slot Boards via the passive Backplane. To accomplish this, the CPU uses a local bus to communicate with the the interface circuitry. Data bits are transferred between the main CPU and various Boards via operation of these interface devices.

The 80286 CPU can be reset in one of two ways. The first method uses the RESET switch (located next to the 3 1/2" Drives), this method causes a COLD BOOT, the same as if the unit was just powered up. The second method is accomplished by pressing the "CONTROL", "ALT", and "DEL" keys simultaneously. This method is referred to as a WARM BOOT. The distinction between the two is that the WARM BOOT is accomplished via software and doesn't perform a memory test while the COLD BOOT is done through hardware and does execute the memory test. If the Computer is "LOCKED-UP", it may not be able to read the Keys, hence the WARM BOOT will not work.

286 CPU Board (continued)

DUAL SPEED CLOCK GENERATOR & POWER UP RESET GENERATOR VLSI circuity provides the CPU with the SYSTEM CLOCK and is derived by dividing a 20 MHz clock from a crystal oscillator. It is also used to generated the CPU's RESET signal from the POWER GOOD signal already discussed.

BUS ARBITRATION LOGIC is the principle transceiver for all system/local bus intercommunications. The BUS INTERFACE LOGIC controls data transfer to and from the system RAM (640K) as well as data transfer between the System Bus and the following: EGA Video Board, Serial/Parallel I/O board, Floppy/Hard Drive Controller Board, DAS Memory Board and I/O/EEPROM/CLOCK Board.

If any of the devices located on the System Bus want to communicate with the CPU is must generate an interrupt signal to signify it is ready to send or receive data. Multiple interrupts, referred to as vectored interrupts, occur when one or more peripheral devices interrupt one another. When the main CPU receives an interrupt it selects the appropriate subroutine to perform the necessary task. The MASTER/SLAVE INTERRUPT CONTROL CIRCUITS process up to sixteen priority interrupts received from peripheral devices as noted on the following page.

The SYSTEM TIMING LOGIC provides command and control timing for the main CPU as well as controlling the Processing speed. This circuitry basically controls the memory read/write and 1/0 read/write output commands. Control outputs from the SYSTEM TIMING LOGIC determine when the SYSTEM BUS and LOCAL BUS transfer data and the direction of data transfer.

Data. bits are written into RAM and read from ROM or RAM, via operation of the MEMORY CONTROL LOGIC. Data storage location within the RAM is determined by the status of applied RAM address bits. Memory write/read operations are controlled by the status of memory read/write control signals generated by the main CPU. Information is read from ROM whenever the main CPU generates a memory read control signal (not shown). Address bits generated by the CPU determine the memory location of the extracted word. Memory refresh cycles occur approximately once every 15 microseconds.

Level		Function
Microprocessor NMI		Parity or 1/0 Channel Check
Interrupt Controllers		
CTLR 1	CTLR 2	
IRQ 0		Timer Output 0
IRQ 1		Keyboard (Output Buffer Full)
IRQ 2---		Interrupt from CTLR 2
	IRQ 8	Real Time Clock Interrupt
	IRQ 9	Software redirected to INT OAH (IRQ 2)
	IRQ 10	Reserved
	IRQ 11	Reserved
	IRQ 12	Reserved
	IRQ 13	Co-Processor
	IRQ 14	Fixed Disk Controller
	IRQ 15	Reserved
IRQ 3		Serial Port 2 or 4
IRQ 4		Serial Port 1 or 3
IRQ 5		Parallel Port 2
IRQ 6		Diskette Controller
IRQ 7		Parallel Port 1

The ROM contains the Basic Input/Output System (BIOS), plus the 286 CPU SET-UP Program, and a Flex Disk Diagnostic Program. The BIOS provides device level control for the major 1/0 devices (peripherals) of the MCA. Each of the Software interrupts access a different BIOS routine.

The 286 CPU SET-UP Program is used to tell the CPU what devices are connected to the computer system. The Flex Disk Diagnostics are available for Troubleshooting the Floppy Drive.

The KEYBOARD CONTROLLER interfaces the Keyboard to the SYSTEM BUS. When a key is pressed, an interrupt is generated, and the CPU reads the KEYBOARD CONTROLLER to find out which key was pressed. For a better explanation of Keyboard Operation, refer to Chapter 4.

Under the direction of software, the CPU can activate the SPEAKER DRIVER. The output of this driver (BEEP) is routed to the Front Panel Interface Board where it is amplified. The amount of amplification is dependant on the position of the Front Panel Volume Control Potentiometer (for max volume turn Front Panel Volume Control Pot. fully clockwise).

Twelve expansion slots are available on the Passive Backplane Board. Each expansion slot consists of a 64-pin and a 36-pin connector having pin assignment and signal/control/voltage designations as noted on the next page.

AT STYLE BUS PIN ASSIGNMENTS

64-Pin	Signal/Control/Voltage	64-Pin	Signal/Control/Voltage
B1	Ground	Al	1/0 Check*
B2	Reset	A2	D7
B3	+5V	A3	D6
B4	IRQ2	A4	D5
B5	-5V	A5	D4
B6	DRQ2	A6	D3
B7	-12V	A7	D2
B8	---	A8	D1
B9	+12V	A9	DO
B1O	Ground	A1O	I/O Ready
B11	MEMW*	All	AEN
B12	MEMR*	A12	A19
913	IOW*	A13	A18
B14	IOR*	A14	A17
B15	DACK3*	A15	A16
B16	DRQ3	A16	A15
B17	DACK1*	A17	A14
B18	DRQ 1	A18	A13
B19	DACKO*	A19	A12
B20	Clock	A20	All
B21	IRQ7	A21	A1O
B22	IRQ6	A22	A9
B23	IRQ5	A23	A8
B24	IRQ4	A24	A7
B25	IRQ3	A25	A6
B26	DACK2*	A26	A5
B27	T/C	A27	A4
B28	ALE	A28	A3
B29	+5V	A29	A2
B30	Osc 14. 3MHZ	A30	Al
B31	Ground	A31	AO

36-Pin	Signal/Control/Voltage	36-Pin	Signal/Control/Voltage
cl	SBHE	D1	MEMCS16*
C2	LA23	D2	I/OCS16*
C3	LA22	D3	IRQ1O
C4	LA21	D4	IRQ11
C5	LA20	D5	IRQ12
C6	LA19	D6	IRQ13
C7	LA18	D7	IRQ14
C8	LA17	D8	DACKO*
C9	MEMR*	D9	DRQO
Clo	MEMW*	D1O	DACK5*
C11	D 8	D11	DRQ5
C12	D 9	D12	DACK6*
C13	D1O	D13	DRQ6
C14	D11	D14	DACK7*
C15	D12	D15	DRQ7
C16	D13	D16	+5 VDC
C17	D14	D17	MASTER*
C18	D15	D18	GROUND

S I GNAL DESCRIPTIONS ARE ON THE NEXT PAGE

SIGNAL NAMES AND DESCRIPTIONS

AO-A19	These lines are the actual Address Bus, used for both memory address locations and 1/0 address locations.
AEN	When this line is high the DMA chip has control of the Bus.
ALE	This signal is used to indicate when the address bus is valid. Processor addresses are latched on the falling edge.
BALE	Enables the Latched Address lines.
CLOCK	This is the 10.0Mhz or 8.0Mhz system clock. It has a 30% duty cycle.
DO-D15	These lines are the actual Data Bus
DACKO-7*	These signals are the DMA Acknowledge lines. DAKO* is reserved for refresh, and a refresh cycle is indicated by DACKO* and MEMR*
DRQO-7	These signals are DMA request lines. DRQO has the highest priority; DRQ7 the lowest. The signal will be high until the corresponding DACK line is received.
I/OCheck*	This line is used to indicate that there is an error on a device in the expansion bus. the CPU will receive a NMI.
I/OR*	This signal indicates a 1/0 Read, when low.
1/0 Rdy	When this line is low, the current memory or 1/0 cycle will be extended in multiples of 210ns.
1/0 CS16	Used in conjunction with LA17-23.
I /OW*	This signal indicates a 1/0 Write, when 10W.
IRQ2-15	These signals are the interrupt request lines. There are a total of 16 interrupt requests, the lower the number of the request the higher the priority. IRQ8 - IRQ15 are nested as IRQ2 and handled by the Slave Interrupt Controller. The interrupt request signals will be high until acknowledged by the interrupt service routine.
LA17-LA19	These lines are Latched address lines and allow the AT to access up to 16 Meg of RAM memory.
MASTER*	Used by DRQ to gain access.
MEMR*	This signal indicates a MEMory Read.
MEMCS16	Used in conjunction with LA17-23.
MEMW*	This signal indicates a MEMory Write.
Osc	This is a 14.31838MHZ with a 50% duty cycle.
Ows	Enables O Wait States, however the unit is used in the Turbo mode 1 Wait State is used to prevent the CPU from overrunning the RAM Memory.
RESET	This signal is system Reset.
REFRESH*	Indicates a Refresh cycle.
SBHE	Bus High Enable, enables the 8 high data bits
SMEMR*	This signal indicates a MEMory Read is in lower 1 Mbyte.
SMEMW*	This signal indicates a MEMory Write is in lower 1Mbyte.
T/C	This indicates the DMA channel has reached its terminal count.

SECTION 11X. 286 CPU SET-UP PROCEDURE

NOTE : 'L'he SET-UP Procedure is **used to store** system configuration information into battery back-up CMOS RAM Memory and set the CPU Board' s Real Time Clock, this information must be entered properly. Failure to do so can cause possible DAMAGE to the TECH-10 option's Hard Drive, **if** present.

1. Plug the unit into an AC outlet and turn the power "ON".

2. Wait until the unit has completed Level O Diagnostics and the screen prompt "PRESS Flu. Press "Fl" the following screen should appear:

Setup, Version 2.3

Device	Current settings	New settings
Date	...7-19-1988	
Time	.13.43.58	
Flexible disk A:	..720 KB, 3.5"	
Flexible disk B:	..720 KB.3.5°	
Fixed disk C:	.. Type 39	
Fixed disk D:	.. Not installed	
Conventional memory	.640 KB	
Extended memory	.0 KB	
Primary display	EGA/VGA graphics display	
Screen width	.80 Columns	
Math coprocessor	.. Not installed	

____________________ Date	Format for entry of date Month _ Day_ Year (Date will be set immediately)

↑ Move up a selection
↓ Move down a selection
↵ Enter the new setting

ESC Exit without changes

END Save **the changes and exit**

Figure 3-7. AT SETUP Screen

3. Using the Up and Down Cursor Keys position the highlighted area over the desired selection or device. Enter the correct information (see selection box in Figure **3-7)** from the keyboard and press the "ENTER" to change to the selection just entered. Listed below are the proper settings for each device in the MCA.

Date Enter the correct date if necessary using the Terminal's keyboard then press "ENTER".

Time Using the Terminal's keyboard enter the correct time (Hrs:min:sec) using Military time (example of Military time is 5:00 pm is noted 17:00.), if necessary. After the correct time is entered press "ENTER" to make the change.

Flexible disk A:
Using the Terminal's keyboard press **"3"** to enter the 720KB, 3.5" disk drive selection used by the Terminal.

Flexible disk B:
Using the Terminal's keyboard press "3" to enter the 720KB, 3.5" disk drive selection used by the Terminal.

Fixed disk C:
Enter "0" if no TECH-10 option is present, enter "39" to select Hard disk C: as a MiniScribe 3650 if TECH-10 option is present.

Fixed disk D:
Enter "O" (the number zero) to select Hard disk D: Not installed.

Conventional memory
Enter "640" to select 640 KB of RAM memory available to the CPU.

Extended memory
Enter "O" (the number zero) for the amount of Extended memory available to the Terminal's CPU.

Primary display
The Primary display should come up EGA/VGA graphics display due to switch settings scan done by the 286 CPU, if not, press "2" until it does.

Screen width
Enter "80" to select 80 columns wide.

Math coprocessor
This device setting first looks for the presence of the Math coprocessor, since no Math coprocessor is installed the setting is correct and does not need to be changed.

4. After all device settings are correct, press the "END" key (which is the "Review Back" key on the numeric keypad to the far right on the keyboard) to save the SET-UP selections in battery backed-up CMOS RAM. If all the settings are correct, press the "ESC" key to exit SETUP without changes.

****
* 286 CPU SET-UP PROCEDURE COMPLETE *
****

SECTION IX. 286 CPU DISK DRIVES

GENERAL

Theory of operation on Disk Drives is divided into two Sections, Drive interfacing and 3 1/2″ Floppy Disk Drive. Overall operation of the two 3 1/2″ Disk Drives is very similar to that described in the XT version of the MCA-3000. The main differences occur in how the Drives are interfaced to the CPU for selection. It is important to note that the drives used in the 286 version of MCA are different then that used in the 8088 version. The 286 CPU Board refers to the two 3 1/2″ floppy drives as flex drives.

DRIVE INTERFACE THEORY OF OPERATION.

The Disk Control circuitry on the Floppy/Hard Disk Controller Board processes data bits and control signals received from the main CPU and produces the required read/write, disk drive select, head select, head directional control, and motor control output signals to the selected disk drive. The Disk Control circuitry also monitors disk drive generated control output signals such as: index, wri te protect and track zero. In summary, the Disk Control circuitry consists of all the logic circuitry used to perform the serial-to-parallel and parallel-to-serial data conversions required for normal disk drive control.

This control circuitry also has control registers that determine the number of tracks and sectors required and the number of bytes per sector to be stored, thus the controller circuitry and BIOS determines the ultimate recording format.

FLOPPY DISK DRIVE THEORY OF OPERATION

GENERAL
Theory of operation for the MCA-3000'S 3 1/2-Inch Disk Drive (0552-0024-01) is divided into system operation and functional operation. Refer to Diagram 3-4, page 3-49 as you read this text.

Disks and Drives
The MCA-3000 uses TWO 3 1/2″ double sided, double density floppy disk drive. Storage space on any disk is measured in BYTES. Each disk has the ability to store up to 720K bytes of information (1K = 1024 Bytes). One byte of information is the equivalent of one character. Data is stored (written) on disks in circles, called TRACKS. The read/write head of the disk drive is able to move to any number of tracks to read (retrieve) or write (store) data on the disk. Tracks are also broken down, or divided, into SECTORS. MCA disks are FORMATTED or divided in the following manner:

```
1 character = 1 byte
512 bytes   = 1 sector
9 sectors   = 1 track
80 tracks   = 1 side (double-sided)
2 sides     = 1 720K byte disk
```

512 bytes x9sectors/byte x80 tracks/sector x2 sides/disk =737280 bytes/disk
737280 bytes/disk x 1024 bytes/Kbyte = 720 Kbyte/disk

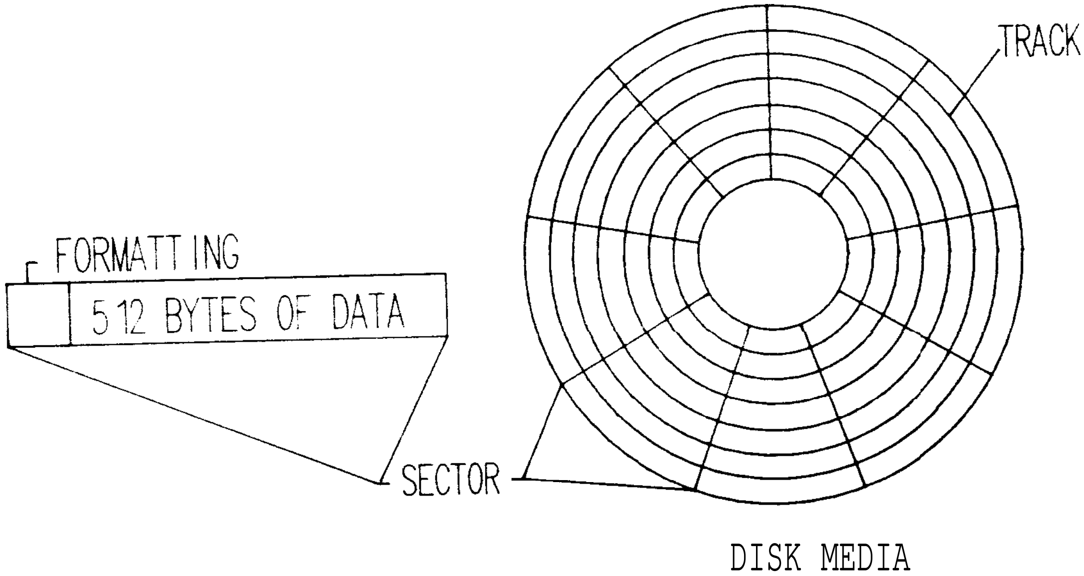


Figure 3-8. MCA-3000 disk

System Operation

Each 3 1/2-inch floppy disk drive consists of a floppy disk rotating mechanism, a read/write head, an actuator to position the read/write head on tracks, electronic circuits to read data, write data, and drive these components.

The rotation mechanism clamps the medium (disk) inserted into the drive to the spindle, which is directly coupled to the DC brushless motor, which rotates it at 300 rpm. The positioning actuator moves the read/write head to the desired track. 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 SBC Floppy Disk Controllers.
2. Drive selection.
3. Index detection.
4. Head positioning actuator drive .
5. Spindle motor control.
6. Read/write.
7. Write protect.
8. Track 00 detection.
9. Drive ready detection.
10. Head selection.

The 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 follower is fitted in the lead screw groove on the stepping motor output shaft and, as the stepping motor rotates 30x, the read/write head moves 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, with the slight offset, 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.

Functional Operation

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 ms 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 moves the read/write head to the desired track, selects an inward/outward direction first (dependent upon DIRection signal status). Next the head moves through use of the STEP signal. If access to a track location 2 or more tracks away is required, step pulses are continuously applied until the head moves to the desired track.

INPUT SIGNALS

DRIVE SELECT 1* and 2* are used in conjunction with MOTOR ON 1* and 2*. If MOTOR ON 1* and DRIVE SELECT 1* are low (active), Drive A is selected. The DRIVE SELECT 1* is connected to pin 12 of Drive A by twisting part of the ribbon cable. The twist interchanges pins 10 and 12 with pins 16 and 14, respectively. With a second Disk Drive installed, the DRIVE SELECT 2* and MOTOR ON 2* would be connected to the DS1 (pin 12) and MOTOR ON* (pin 16). This allows Drive B to be selected by making MOTOR ON 2* and DRIVE SELECT 2* active (low). Since the 286 CPU Board only requests the Floppy/Hard Disk Controller Board to select one drive at a time, all other control and data lines can be used for both drives.

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 input pulse signal moves the head one track position.

WRITE ENABLE* activates the internal write driver and data present on the WRITE DATA line is written on the pre-selected 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 SBC.

WRITE DATA is received by the disk drive whenever the WRITE ENABLE* (previously described) is a logic "O" level. This line is normally held at a logic "1" level.

Output Signals

INDEX* becomes a logic "O" 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 track on the rotating disk.

TRACK 00* when at a logic "O" level, indicates 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 logical "1" but it sends a logical "0" (negative-going) output pulse during a read operation.

WRITE PROTECT* notifies the Tester of the insertion of a disk with the cover closing the write protect window into the drive. The signal goes to logical "O''when a write-protected disk is inserted into the drive. When the signal is at logical "O", writing on the disk is inhibited even if the write gate line becomes active.

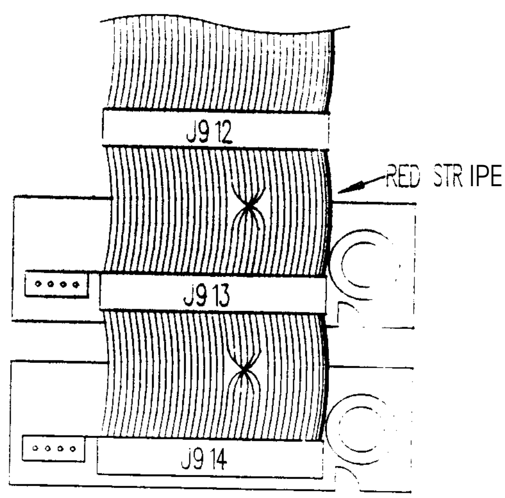


Figure 3-9. Floppy Drive Ribbon Cable and How its Used.

SECTION X. FLOPPY DRIVE CHECKOUT (FLEX DISK DIAGNOSTICS)

Tools Required: Scratch Disk

1. To start the test, simultaneously press the "Ctrl and D" keys when the "PRESS <Fl> IF HARDWARE SET UP IS DESIRED" message is displayed during Boot-up. In a few seconds the following screen should appear on the units VDU.

```
********** W A R N I N G **********

Diskette files on drives tested will be destroyed.
Insert write enabled double sided scratch diskette
into drive to be tested.
For testing the high capacity mode you must use a
high density media.

Depress ENTER key when ready to continue
```

2. Press "ENTER"

3. Press "T" once to select all tracks. (upper right corner of screen)

4. Press "F" twice to select 720 K disk. (upper right corner of screen)

5." Insert a Scratch disk into Drive A with the Write Enable tab closed.

6. Press ENTER twice to start the test. The following test will be performed: Reset Drives, Format, Write, Read and Verify, and Seek

   If any tests fail, an error will be indicated. If the Scratch disk is a KNOWN GOOD disk, the drive must be replaced. If the quality of the Scratch Disk is unknown, rerun the test with a different disk.

7. Press the "Down arrow" to highlight "Disk Change Line".

8. Press "ENTER" to start the test. Follow instructions on the bottom of the screen. If an error appears , either the Disk Drive or the Floppy/Hard Disk Controller are defective.

9. press the "Down Arrow" to select Disk Speed.

10. Press "ENTER" to start the test. The Disk Speed displayed on the bottom of the screen should be 200.0 ms +/- 3.0 ms. If it is not the Drive must be replaced.

```
****************************
* FLOPPY CHECKOUT COMPLETE *
****************************
```

COMPLAINT | CORRECTIVE ACTION

I. MCA does not initialize.

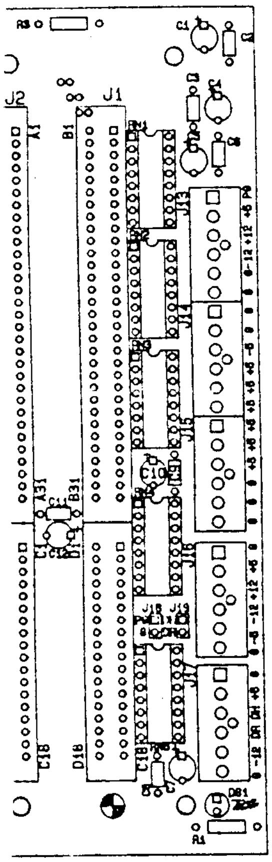


Figure 3-10.

With the ON/OFF Switch "ON", is the cooling fan running?

YES NO

NO → See AC Power Distribution Functional Diagram 1-1.

YES → After approximately 20 seconds after power up a "BEEP" should be heard. NOTE: **Make sure the Front Panel Volume Control is set fully clockwise for sufficient speaker volume.** Is the "BEEP" heard

YES NO

NO → Turn tester off and remove (unload) all the boards from the Backplane, **except the 286 CPU Bd, leave it in.** Turn the MCA "ON". Is a "BEEP" heard in 20 seconds after power up?

YES NO

NO → Are the supplied voltages present on the Passive Backplane? For pin outs see figure 3-?

YES NO

NO → Refer to Chapter 2, DC power.

YES → Replace 286 CPU #7001-2024.

YES → Reinsert the removed boards one at a time; powering up the tester between each board. When "BEEP" is no longer heard, check the configuration of the last board replaced. (see Appendix D) and try board again.

YES → How many beeps were heard?

1 3 5

5 → Refer to Complaint VI.

3 → Refer to Complaint XIV

1 → Is **"NON SYSTEM DISK OR DISK ERROR, REPLACE AND STRIKE ANY KEY WHEN READY"** displayed?

NO YES

YES → Refer to Complaint II.

NO → Continued on next page.

I. MCA does not initialize (continued).

```
Is "ROM BASIC(INT 18H) IS NOT SUPPORTED.
DISK ERROR.  INSERT SYSTEM DISK AND PRESS ANY
KEY TO TRY AGAIN." displayed?
NO   YES
|     |
|     Refer to Complaint III.
v
Is the VDU blank?
NO   YES
|     |
|     Refer to Chapter 5, Section III.
|     Troubleshooting of the Service Manual.
v
Is an audio tone emitting from the tester?
YES  NO
|     |
|     Does MCA boot properly with The DOS
|     System/Operating Disk installed?
|     YES  NO
|     |     |
|     |     Replace 286 CPU Board 7001-2022.
|     v
|     The Hard Drive (only if a TECH-10 option
|     is installed) must be repaired.  See
|     Chapter 23 on the MCA's TECH-10 option
|     for more information.
v
Is anything laying on the Keyboard of causing
a key to be held down?
YES  NO
|     |
|     Replace Keyboard #0552-0030.
v
Remove obstruction.

Refer to Theory of Operation and Functional
Diagram.
```

II. NON SYSTEM DISK OR DISK ERROR, REPLACE AND STRIKE ANY KEY WHEN READY is displayed.

```
This indicated that the a disk is inserted into
drive a: that does not contain DOS.  Is the
proper disk is being used in Drive "A"?
YES  NO
|     |
|     Insert such a Disk in Drive A and try
|     again.
v
Substitute the disk with an other disk
containing a DOS.  Does the MCA boot properly?
YES  NO
|     |
|     Disk Drive "A" #0552-0053.
v
Original disk does not contain DOS.
```

COMPLAINT	CORRECTIVE ACTION
III. The message "ROM BASIC(INT 18H) IS NOT SUPPORTED. DISK ERROR. INSERT SYSTEM DISK AND PRESS ANY KEY TO TRY AGAIN." appears in the upper left corner of VDU.	The Hard Drive is not operating properly, refer to Section V of Chapter 3.
IV. The MCA beeps 5 times on power up, and/or any of the following Error messages are displayed. System Port Error System ROM Error DMA Page Register Error Timer Error Refresh Error 0-64KB Ram Error Bus 8 - 16 Error Interrupt Controller Error 8742 Controller Error CMOS Ram Error Protected Mode Error (System Halt) NOTE; The system halts after five beeps or after any of the above are displayed on the MCA's VDU.	Check the Board Configurations for each of the boards installed. Are configurations set properly for each and every board? YES NO NO ↓ Set configurations properly and try again, reboot the system. YES ↓ Replace the 286 CPU Board, 7001-2022. Is the ERROR MESSAGE still occurring? YES NO NO ↓ Repair complete. YES ↓ Replace all other boards in the Passive Backplane one at a time and check for the ERROR MESSAGE after each replacement. If the ERROR MESSAGE stops, replace the board installed last. Refer to the Theory of Operation and Function Block Diagram.

COMPLAINT	CORRECTIVE ACTION

V. **"Primary CRT Error" is displayed The video monitor. Color/Mono switch is not correctly set.**

Check the position of the Color/Mono Switch (see configuration for location). Is the Color/Mono switch in the Color position?

YES NO

NO: Set switch to correct position and try to reboot system.

YES: Check 286 CPU Set-up. Is Set-up correct?

YES NO

NO: Correct Set-up problem (for information on 286 CPU Set-up Procedure see page 3-34)

YES: Check the configuration of the EGA Video Board (see the configuration section in Chapter 5 Video). Are the settings correct?

YES NO

NO: Correct configuration problems and try again, reboot the system.

YES:

------------------SUBSTITUTE--------------------

a. 286 CPU Board, 7001-2022

b. EGA Video Board, 7001-0562

Refer to the Theory of Operation and Functional Block Diagram.

COMPLAINT	CORRECTIVE ACTION

VI. **Any of the following message are displayed on the Terminal's CRT.**

x's are used to represent some hexadecimal number.

xxxxxx=Address of observed memory error

xxxx=Expected data

xxxx=Observed data

xxxxxx Memory Error Bit xxxx xxxx

xxxxxx Memory Error Address xxxx xxxx

xx0000 Memory Error Parity

Memory Address Error (System Halt)

Replace the 286 CPU Board. Did this correct the problem?

NO YES

YES: Problem corrected.

NO: Check the Board Configurations for each of the boards installed. are configurations are set properly for each and every board?

YES NO

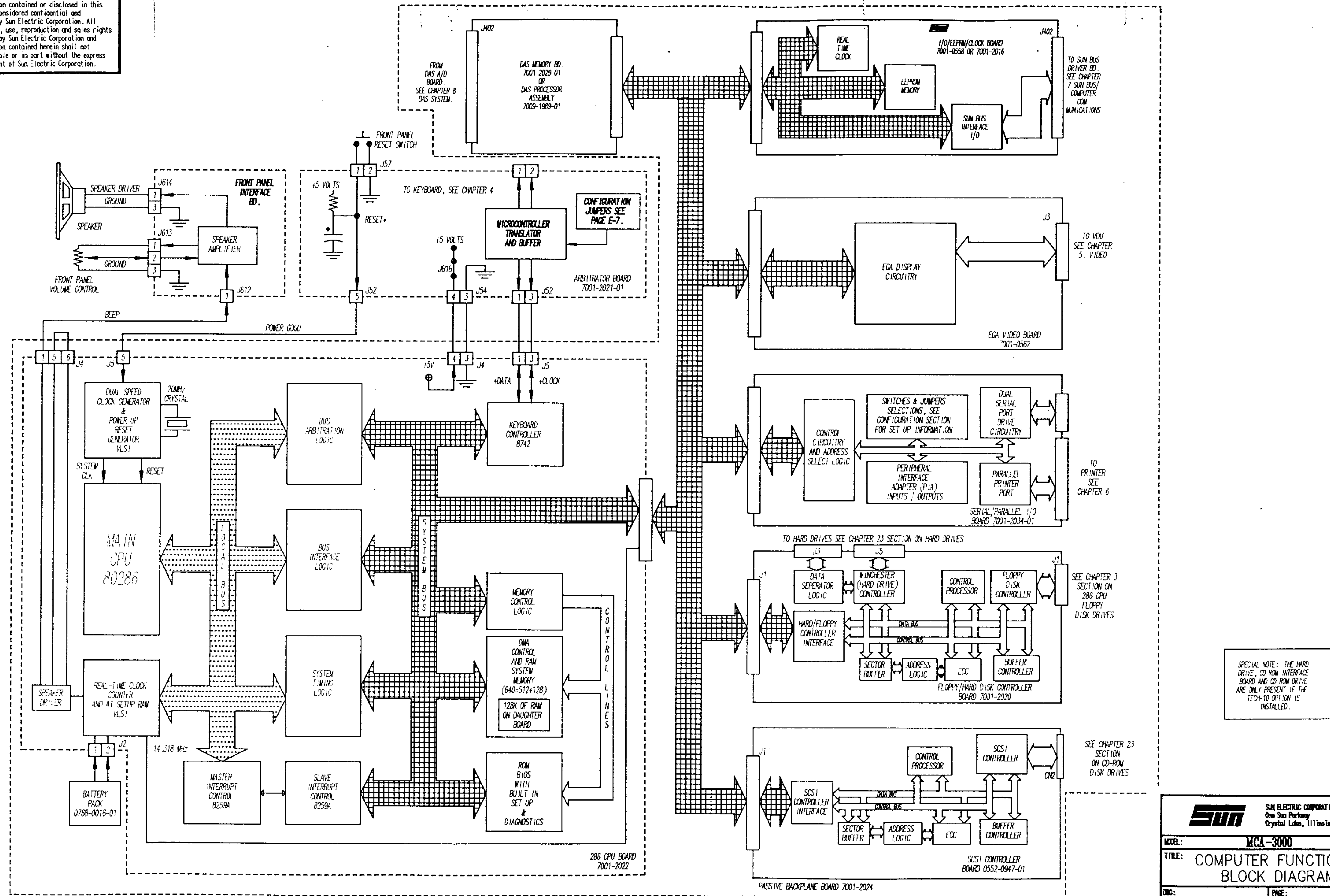
NO: Set configurations properly and try again.

YES: Replace all other boards in the Passive Backplane one at a time and check for the ERROR MESSAGE after each replacement. If the ERROR MESSAGE stops, replace the board installed last.

Refer to the Theory of Operation and Function Block Diagram.

COMPLAINT	CORRECTIVE ACTION
VII. "**Battery Power Lost (Run SETUP)" is displayed on CRT.	Is the Lithium battery is properly connected to the Terminals's 286 CPU Board at J2? YES NO NO: Reconnect the battery at connector J2 of the 286 CPU Board and rerun the 286 CPU Set-up Procedure (see page 2-8) YES: Disconnect Battery from 286 CPU Board and using a DVM measure the voltage across the Pins 1 and 2 of the Lithium battery. Is the voltage across the battery greater than 6.5 volts? YES NO NO: Replace Lithium battery pack, 0768-0016-01 and rerun Set-up. YES: Replace the 286 CPU Board, 7001-2022 Refer to the Theory of Operation and Functional Block Diagram.
VIII. "**Configuration not Set (Run SETUP)" is displayed on the Terminals's CRT.	Run Set-up Procedure (see page 3-34) and set unit accordingly. Reboot the Terminal.
IX. "**Time & Date not Set (Run SETUP)" is displayed on the CRT.	Run Set-up and set the time and date correctly. Reboot the Terminal and recheck. Is the message still present? YES NO NO: Turn the Power switch of, wait 5 minutes, then turn the terminal back on. is the message displayed? YES NO NO: Repair complete. YES: ----------------SUBSTITUTE---------------- a. Lithium Battery pack, 0768-0016-01 YES: -----------------SUBSTITUTE------------------ A. Lithium Battery pack, 0768-0016-01 B. 286 CPU Board, 7001-2022.

COMPLAINT	CORRECTIVE ACTION
X. "**Memory Size Error (Run SETUP)" is displayed on the CRT.	The detected and configured memory sizes do not agree. Run Set-up Procedure and check memory size. Is Memory Size set to 640KB? YES NO NO → Change to 640KB (see page 3-34). YES → Replace 286 CPU Board, 7001-2022
XI. "**Disk Configuration not correct" is displayed on the CRT.	The Disk configuration in CMOS and detected disk configuration do not agree. Run Set-up Procedure (see page 3-34). Is the setting for Drive A a TYPE 3? YES NO NO → Change setting for Drive A to type 3 and save changes (see page 3-34). YES → ------------------SUBSTITUTE------------------ a. 286 CPU Board, 7001-2022 b. Floppy/Hard Drive Controller Board,7001-2020 c. Disk Drive, 0552-0024-01
XII. **Check Keyboard (System Halt) is displayed on the CRT.	The keyboard does not function properly. Unplug the Keyboard Assembly. Does the system continue on and load software? NO YES YES → Replace Keyboard Assembly, 0552-0030. NO → ------------------SUBSTITUTE------------------ a. Arbitrator Board, 7001-2021-01 b. 286 CPU Board, 7001-2022 Refer to the Theory of Operation and Function Block Diagram.
XIII. XXX DAYS HAVE ELAPSED.. MESSAGE IS DISPLAYED WHEN LOADING THE EXPERTEC PROGRAM. NOTE: This will only occur if the TECH-10 option is present. XXX represent some number.	Using the Service Disk, check to see if the Expertec Validation check good or bad. BAD GOOD GOOD → Inform the customer that he must have the current CD ROM to operate his unit. BAD → Substitute the Serial/Parallel I/O board, 7001-2034-01.



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

MODEL:	MCA-3000
TITLE:	COMPUTER FUNCTIONAL BLOCK DIAGRAM
DWG: 3-3	PAGE: 3-47/3-48

CHAPTER 4

KEYBOARD/REMOTE CONTROL

SECTION I. KEYBOARD THEORY OF OPERATION

GENERAL

The Keyboard and Remote Control Unit (RCU) are the operator's interface to the computer. It is the avenue that the operator has at his fingertips that allows him to tell the computer what he requires. The Keyboard has its own microcontroller that is awaiting key presses from the operator and passes them onto the computer. On the way to the computer, it must go through the keyboard arbitrator, which allows the keyboard information to go to the Single Board Computer (SBC). Once the complete data for a single key stroke is received, the keyboard interface chip on the SBC generates an interrupt to the 8088 microprocessor. This causes the computer to execute a group of routines in a ROM chip on the SBC, if the main program recognizes the keystroke the computer will then execute the required program change due to that key stroke. It will also generate an audible click from the MCA's speaker if the computer is running Sun MCA software.

Since the Keyboard is an interrupt driven keyboard, the SBC does not have to spend time scanning for keyboard input and can be faster at displaying data or updating the screens.

The Remote Control Unit (RCU) uses the same path to the computer after the Keyboard Arbitrator. The RCU acts like the keyboard to the computer, therefore, either can be used to enter data or control the MCA's program. The purpose of the Arbitrator is to ensure that if a key is pressed on the RCU and the keyboard at the same time, only the first key stroke will get through. If they are really simultaneous, then the keyboard information will pass through and the remote information will be put on hold. After the keyboard is finished, then the microcontroller in the remote will send its data.

The Keyboard Assembly, Diagram 4-I, is basically comprised of a Microcomputer /Capacitance Detector Board, keyboard matrix unit and a 5-wire cable assembly. The Keyboard Board contains three status LED's for CAPS LOCK, NUMERIC LOCK and SCROLL LOCK thereby indicating which of the three modes is actively operational. This feature greatly minimizes the possibility of accidental entry of either false data or commands. Each LED alternately changes its operational state on successive depression (toggling) of its respective key. A Key press Click Speaker is also built in but is not currently enabled.

Interfacing the Keyboard to the Single Board Computer is accomplished by shorting (jumpering) pins A12 and B12 on the Keyboard Board.

The Keyboard uses a scanning system, Figure 4-3, whereby each key is individually checked for its operated /non-operated state. Scanning and detection is accomplished by the on-board capacitance detector (2) and microcomputer (1) working together. The capacitance detector uses 10 active drive lines and 12 active sense lines interfaced with the Keyboard capacitance -membrane .type key matrix.

Multiple-key rollover and a 16 character FIFO (first in-first out) register buffer results in high throughput. When held depressed, all data keys repeat.

Data transmission between the Keyboard and the Remote Arbitrator Board occurs on a common clock and data line. The clock line is controlled in either direction by the Keyboard during data transmission. The Keyboard will not transmit or receive data when the clock line is pulled low (logic O) by the Remote Arbitrator Board which uses the clock line as an inhibit to the Keyboard.

The data line is used both by the Keyboard and the Remote Arbitrator Board to transmit data. The format for the transmitted data byte consists of: 1 start bit (logic O), 8 data bits (least significant bit to most significant bit respectively), 1 odd parity bit and 1 stop bit (logic 1). Thus, a single keyboard generated character consists of 11 total bits.

Open collector type Hex inverter (U4), upon receipt of microcomputer LED control output signals, drives the three LED's while open collector Hex inverter (3) processes data/clock signals between the Keyboard Board and the external Remote Control Arbitrator Board.

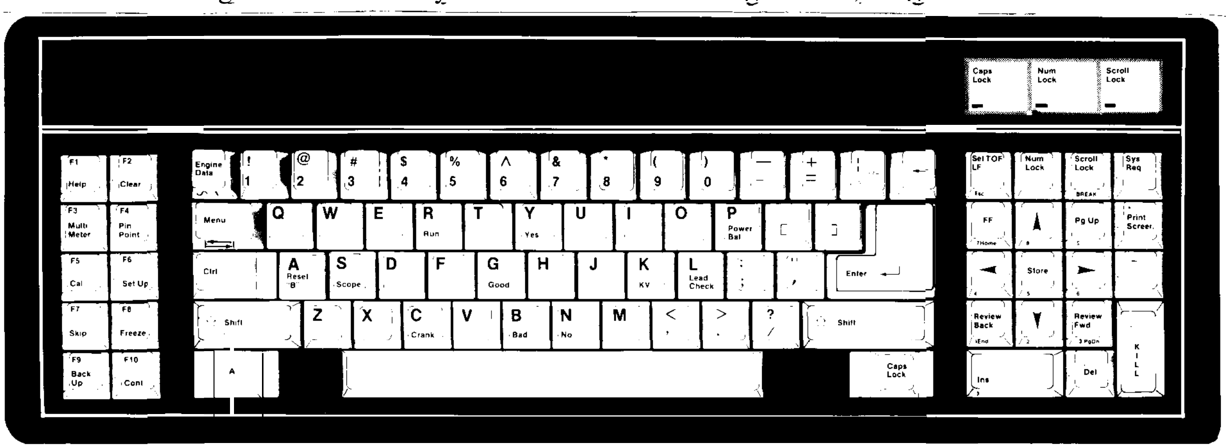
PAL U3, located on the Keyboard Arbitrator Board, functions as the contention controller for both the Keyboard and the Remote Control Unit in their communication with the Computer Module.

Keyboard Diagnostics

The Keyboard Board microprocessor performs a diagnostic self-test either upon Remote Keyboard Arbitrator Board power-up or after the Remote Keyboard Arbitrator Board pulls the clock line low for 500 microseconds minimum. During this self-test the microprocessor checks its data memory locations, does a checksum test of its program memory and checks for any stuck keys. If the diagnostic test was successful, the Keyboard transmits an AAH which is the first transmission following power Up of the Tester. If the diagnostic test was unsuccessful, the Keyboard transmits an 80H. In either case, following the diagnostic self-test, the Keyboard will begin normal operation.

Supporting Documentation.

Keyboard character array assignments are shown in Figure 4-1 while 8-bit IBM Hex-code assignment for each key is shown in Figure 4-2. A simplified schematic diagram of the Keyboard is shown in Figure 4-3, Page 4-3.



NOTE: Status LEDs for SCROLL LOCK, NUMERIC LOCK, and CAPS LOCK indicate immediately which mode the Keyboard is operating in.

Figure 4-1. Keyboard Character Array Assignments.

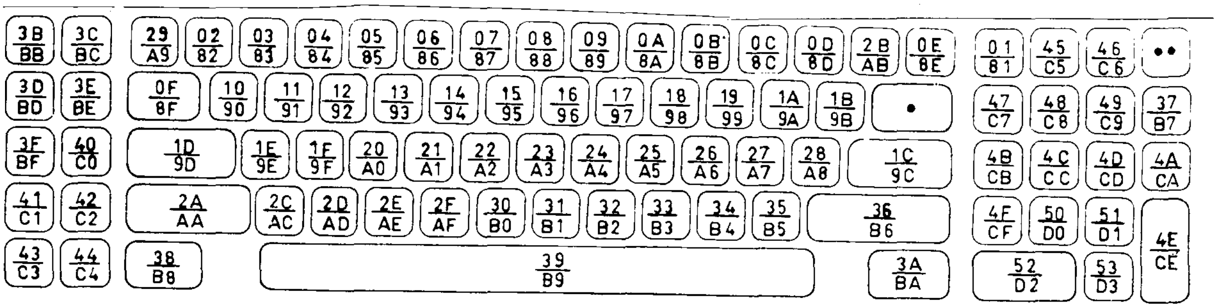
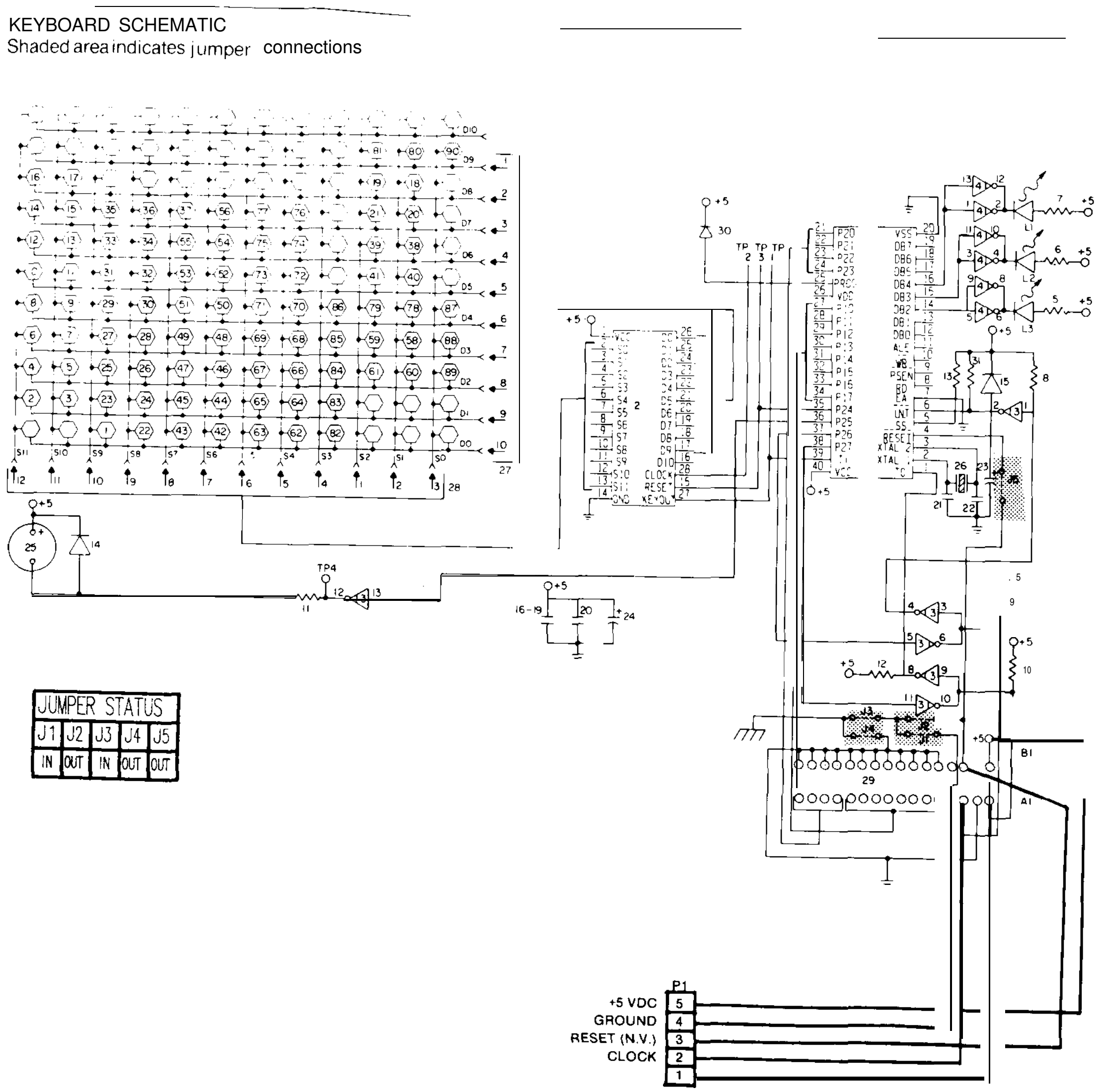


Figure 4-2. Keyboard 8-Bit Hex-Code Assignment.



NOTES:

1. Supply +5Vdc power measured at printed circuit board connector terminals.
2. IC packs have +5Vdc on Pin 4 and ground on Pin 7 unless otherwise noted

Figure 4-3. Keyboard Simplified Schematic Diagram.

SECTION II. RCU Theory of Operation

GENERAL

The Remote Control Unit Board microcontroller U1 (Functional Block Diagram 4-1, Page 4-7) scans the Remote Control Unit keyboard switches and senses which switch(es) have been pressed.

To scan the keyboard matrix, the microcontroller forces the ACTIVATE A* drive line (row) to a low level and then reads the logic levels present on the 6 sense lines (column). Since the ACTIVATE A* line is the only drive line low at this particular instant in time, only the switches (or jumpers) connected to the ACTIVATE A* line can take their respective sense line low. Unless the sense lines are forced low by a closed switch (or jumper), they are pulled high by pullup resistors R1 thru R6 on the Board. Thus, the sense lines represent the status of the keyboard switches connected to the ACTIVATE A* drive line at this moment in time.

The Board microcontroller then drives ACTIVATE B* low and the status of the sense lines are again read. This scanning process is continued until all of the rows/columns of the switch matrix have been read by the microcontroller. During Tester operation, this process is continuously repeated to determine what button [switch(es)] have been pressed.

When more than one keyboard keyswitch is closed at the same time the keyswitch D1-D6 diodes eliminate errors in the sensing matrix by preventing non-selected activate lines from being taken low via a low sense line and closed keyswitch.

Microcontroller port P2 functions as the port for transfer of bidirectional data/clock pulse signals between the Remote Control Unit Board and connector J30 of Remote Control Arbitrator Board. Control transistor Ql, when driven by a high level control voltage from microcontroller port P23, causes the SHIFT LED to light thus indicating shift mode operation. An internal RC network, connected to +5Vdc, forces a master reset of the microcontroller upon powering up of the Tester. After power-up, The Microcontroller will run a Self test, and if passed the revision level of the PAL is flash on the LED. i.e. Revision 1.2 would flash, pause, flash, flash.

SECTION III. Remote Keyboard Arbitrator Board Theory of Operation

GENERAL

Bi-directional transceivers, located on the Remote Control Unit Board and the Remote Control Arbitrator Board , control two-way communications over balanced transmission lines between the two boards. A Programmable Array Logic (PAL) controls two-way transmission of clock/data signals between the Key board/RCU and Computer Module and also controls intercommunication in the event contention (an attempt to simultaneously transmit data from both the Keyboard and RCU) occurs. W31, connected between Arbitrator Board connector J51 and Computer Module connector J13, functions to carry the data/clock signals between the two Board's. +5Vdc power is also supplied to the Arbitrator Board from the Computer Module via W31.

SECTION IV. CALIBRATION

GENERAL

Since the Key board /RCU/Keyboard Remote Arbitrator Board do not contain any adjustable controls; no calibration is required.

SECTION V. TROUBLESHOOTING

KEYBOARD TROUBLESHOOTING

NOTE

Prior to removal and replacement of the Keyboard, make certain jumpers J1 & J3 are installed and J2, J3 & J5 are not installed.

Since the Keyboard is a purchased item any operational malfunction dictates Keyboard unit removal and replacement.

RCU TROUBLESHOOTING

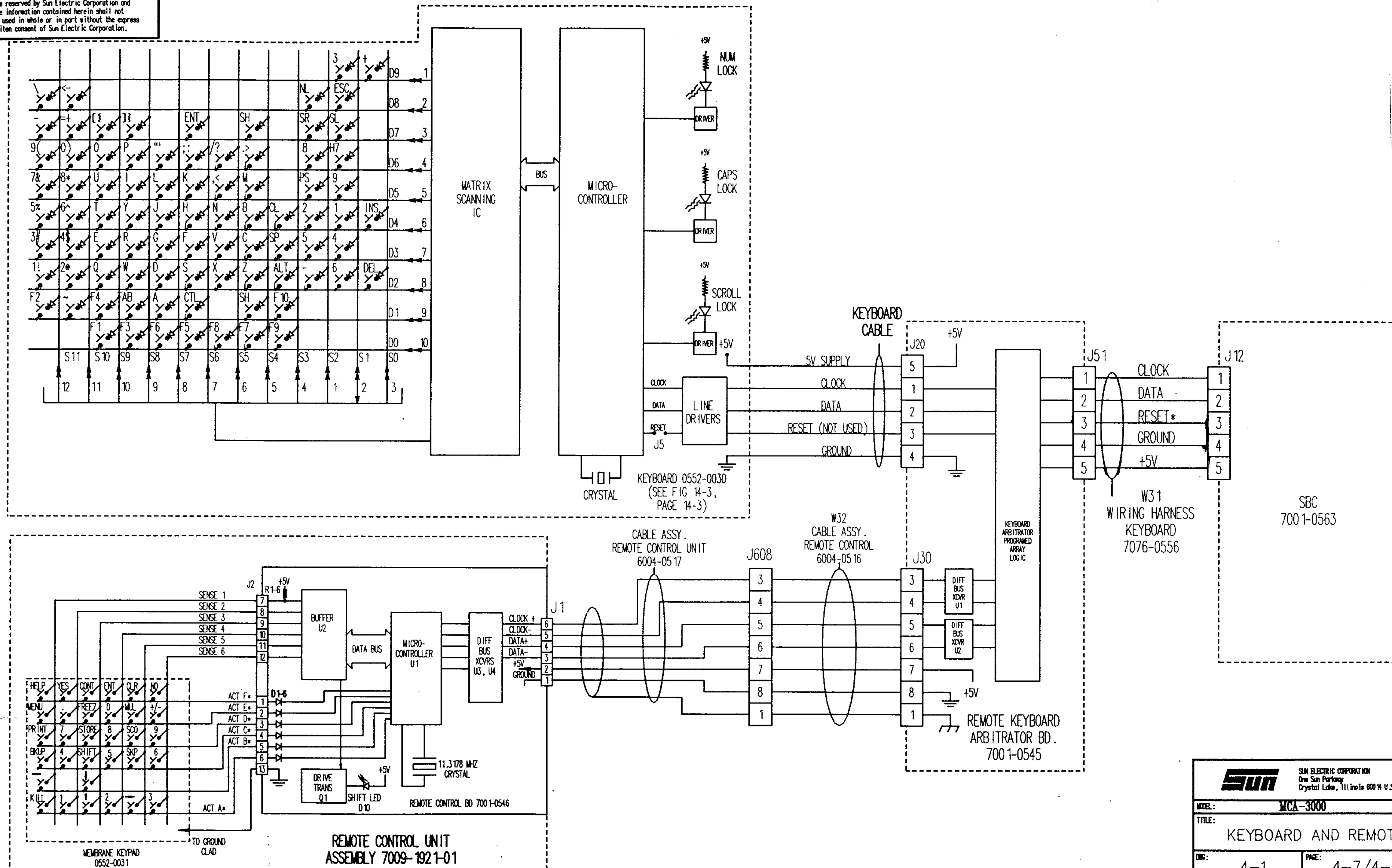
Troubleshooting of the Remote Control Unit is given in the following table.

COMPLAINT	CORRECTIVE ACTION
I. Single keyboard membrane switch inoperative.	1. Refer to functional block diagram 4-1, Page 4-7 and using DVM or equivalent, monitor for continuity between appropriate pins of J2 while depressing defective switch. Replace Keypad 0552-0031 if required.
II. One particular group of switches inoperative.	1. Refer to functional block diagram 4-1, Page 4-7 and using DVM or equivalent, monitor for continuity between appropriate pins of J2 while depressing defective switches. Replace keypad if required otherwise proceed to step 2. 2. If switches check out normal replace Remote Control Board 7001-0546.
III. All keypad switches inoperative.	1. Refer to functional block diagram 4-1, Page 4-7 and make continuity measurement between a few sample switch termination points on J2 while depressing the appropriate switch(s). If continuity is present, check for +5Vdc and ground between pins 2 and 1 of J1. If present, replace Remote Control Board 7001-0546. If not present, replace Remote Cable Assembly 6004-0517.
IV. SHIFT LED does not light when SHIFT switch is pressed; all other keypad functions are normal.	1. SHIFT control transistor/LED defective; replace Remote Control Board 7001-0546.

Keyboard Arbitrator Board Troubleshooting

Troubleshooting of the Keyboard Arbitrator Board is given in the following table.

COMPLAINT	CORRECTIVE ACTION
I. Unable to enter data from either the Keyboard or RCU.	1. Using DVM or equivalent, check for +5Vdc power between J51 pins 5,4. If not present, refer to functional block diagram of 4-1, Page 4-7 and monitor W31 Wiring Harness, Keyboard 7076-0556 for proper connection to Keyboard Arbitrator Board and also for continuity between terminating connector pins 4 and 5. Repair and/or replace defective wiring harness. If +5Vdc is present, replace Keyboard Arbitrator Board 7001-0545.
	2. Disconnect Keyboard pendant cable connector from Arbitrator Board connector J20 and connect to Computer connector J12. Disconnect Remote Control Unit (RCU) from connector J608 and connect to Computer connector J13. Attempt to enter data from both the Keyboard and RCU. If successful, replace Keyboard Arbitrator Board 7001-0545 however if not successful, replace Computer Module Board 7001-0563.
	3. Refer to Theory of Operation and Functional Block Diagram 4-1, Page 4-7.



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

MODEL:	MCA-3000
TITLE:	KEYBOARD AND REMOTE
DWG: 4-1	PAGE: 4-7/4-8

CHAPTER 5

VIDEO

GENERAL

The video display system in the McA-3000, consists of the following:

1. A 20" diagonal color monitor, 0859-0409
2. An Enhanced Graphic Adapter (EGA) Board, 7001-0562
3. Inter-connection cables, both AC power, #6001-0151-01 and video interface, #6004-0408.

Operation of the video display system can be compared to a closed-circuit television system. The color monitor is a self-contained unit requiring AC power (120VAC) from AC terminal block TB1 and the video control signals supplied by the EGA Board.

SECTION I. THEORY OF OPERATION

If the AC power from TB1 (see AC Power Distribution, Functional Block Diagram 1-1, Page 1-3/4) or the horizontal drive deflection signal is missing, the VDU will remain dark. All color video signals and sync control signals, generated by the EGA Board mounted within the Computer Module, are routed via a video cable assembly to the VDU's TTL interface Board's 9 pin D-Type connector as shown on Video Display System's Functional Block Diagram 5-1.

The COLOR MONITOR

The Color Monitor (VDU) used in the MCA-3000 is a custom built Color Monitor featuring a 20 inch diagonal CRT with a 0.31 mm pitch (or dot size, it can also be referred to as a pixel which stand for a picture element) with resolution capabilities of 1365 pixels (horizontal) by 870 pixels (vertical), but is limited to the resolution of the EGA standard of 640 pixels (horizontal) by 350 pixels (vertical). The color monitor is driven using 6-bit TTL RGB control signals from a EGA Board, located in one of the expansion slots on the SBC. The color monitor also features: operator adjustable brightness and contrast controls, a 115V/230V select switch, and a manual as well as automatic Degaussing circuitry. Degaussing is a process where both the CRT and surrounding frame are de-magnetized. This prevents stray magnetic deflection of the three electron beams which make up color display, thus effecting their color purity.

The color monitor is packaged using the following five circuit card assemblies:

1. Switched-mode power supply unit
2. Main chassis-d river /deflection
3. Tube base and video output assembly
4. TTL Interface
5. Degausse assembly

When viewed from the rear of the unit; the main chassis-driver/deflection Board is mounted on the chassis bottom, switched-mode power supply Board at the top-right side chassis (nearest the observer) and the Degausse Board mounted adjacent to the switched-mode power supply but farther away from the observer. The Degausse Board associated coil completely surrounds the outer periphery of the CRT face. The TTL Interface Board is mounted on the top-left side chassis while the Tube Base Board is mounted at the socket base of the CRT.

NOTE: Picture tube automatic degaussing operation occurs on powering up the Tester however, if desired a pushbutton mounted in the printer willallows for manual degaussing. Manual degaussing is required if color purity is poor, most likely caused by moving the tester and the effects of the earth's magnetic field or due to the magnetic effects created by turning the head frame sign "ON and OFF" with the tester on.

Operator Adjustment Controls

Front panel mounted BRIGHTNESS and CONTRAST controls serve to control the" brightness and contrast levels of the display. Adjustment of the BRIGHTNESS control allows the setting of the overall brightness of the displayed picture. Rotating the control clockwise increases the level of brightness while counterclockwise rotation decreases the picture brightness. This control is normally adjusted in conjunction with the CONTRAST control to acquire the most pleasing picture to the user's eye. Adjustment of the CONTRAST control alters the contrast setting between colors on the screen and background intensity.

NOTE When adjusting brightness and contrast controls, first set the Contrast Control fully counter-clockwise and adjust the Brightness Control so that retrace is not noticeable on the black backround. Next adjust the Contrast Control to obtain the best brown on the monitor.

COLOR VIDEO GENERATION

The MCA-3000'S color monitor functions similar to a TTL monitor. It uses the same methods to generate dots and also, utilizes the vertical and horizontal sync pulses in the same fashion. With a few exceptions, instead of having only one electron gun, the color monitor has three. One for each primary color, RED, GREEN, and BLUE, hence the term RGB. Each primary color gun is driven to four specific levels (0%, 33.37o, 66.67., and 100%) defined by two bits (see figure 5-l), a primary and a secondary bit for each primary color. By mixing the three different primary colors at different levels together, up to 64 different color and/or shades of colors can be obtained. Current MCA Master Program So ftw-are only uses 9 colors, they are:

Red	Green	Blue
Magenta	Cyan	Yellow
Brown	White	Black.

To generate the color Black all three of the primary colors are turned off (or at O%), to generate White all three primary colors are turned on (or at 1009’0).

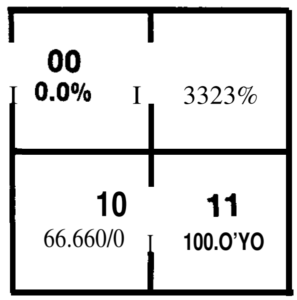


Figure 5-1, Primary Color, Two-Bit Color Selection

ENHANCED GRAPHICS ADAPTER (EGA) Board
The EGA Board plugs into one of the SBC eight expansion slots, where it receives both power and data from the SBC. The EGA Board is capable of driving several different type of monitors, to insure proper operation the EGA Board needs to be configured properly using DIP switches and jumper wires found on the EGA Board. See Section IV. Configurations, page 5-?, for switches and jumpers settings.

NOTE:

EGA Boards are made by a variety of manufactures, pay close attention to which board you have, when configuring the EGA Board.

The EGA Board’s functions has been broken into several different blocks. See the Functional Block Diagram of the Video Display System, pages 5-12/5-13.

ROM BIOS
A read only memory (ROM) Basic Input Output System (BIOS) module on the EGA Card is linked to the SBC’S own BIOS. This ROM BIOS contains character generators (information on the character set and how they are formed) and control code (the program instructions that makes the EGA Card function appropriately).

CRT Controller
The CRT Controller generates horizontal and vertical timing pulses, addressing for the regenerative buffer, cursor and underline timings, and refresh addressing for the 256K of dynamic RAM.

Sequencer
The Sequencer generates basic memory timings for the dynamic RAMs and the character clock for controlling regenerative memeory fetches. It allows the SBC’S processor to access memory during active displays intervals by inserting dedicated processor memory cycles periodically between the display cycles.

BIT MAP O-3
Contain a memory map of the display , broken down into (4) 64K blocks of the 256K of dynamic RAM, 4 separate planes or bit maps of the entire display screen. Each bit in a bit map, defines a portion of a pixel. One bit map for each primary color and one for their intensity. But the actual displayed color is generated in the Attribute Controller where the palette selection is added thus defining the pixel even further. There are (4) different palettes of 16 colors each in the total of 64 possible colors generated.

Graphics Controller
The Graphics Controller directs the data from the memory to the attribute controller and the processor. Other hardware facilities allow the processor to write 32 bits in a single memory cycle, (8 bits per plane) for quick color presetting of the display areas.

Attribute Controller
The Attribute Controller provides 4 color palettes of 16 colors, but the palette must be selected to use any of the 16 colors defined inside.

EGA OUTPUTS
The EGA Card generates signals to be processed by the color monitor and displayed on its CRT. Listed below are the signal's names and a brief description. More detailed information maybe found on Functional Block Diagram 5-1.

J801 Pin	Name Signal Specification
1	Ground Common return for input signals.
2	Secondary red 33.3% Red gun control, positive TTL level.
3	Red 66.6% Red gun control, positive TTL level.
4	Green 66.6% Green gun control, positive TTL level.
5	Blue 66.6% Blue gun control, positive TTL level.
6	Secondary Green 33.3910 Green gun control, positive TTL level.
7	Secondary Blue 33.3% Blue gun control, positive TTL level.
8	H Sync Horizontal sync, negative TTL.
9	V Sync Vertical sync, netgative TTL.

SECTION II. CHECK-OUT/CALIBRATION PROCEDURE

GENERAL

The video display unit contains preset adjustment controls, initially setup at the factory and normally do not require in-field adjustment. However, should in become necessary, details for adjusting these preset controls is described in the following paragraphs.

> CAUTION:
> TO PROTECT AGAINST ELECTRICAL SHOCK HAZARD AND TO PROTECT THE UNIT AGAINST SHORT CIRCUIT AND DAMAGE. USE ONLY AN INSULATED NON-METALLI TRIMMING TOOL TO MAKE ADJUSTMENTS TO THE PRESENT CONTROLS.

NOTE: Adjust only one control at a time and note carefully the effects of the adjustment before proceeding onto other adjustments. Take note of the original setting BEFORE adjustment in case the need arises to return to the original setting.

PRELIMINARY SET-UP

Advance to Typewriter mode and hold down the upper case letter "H" key to fill the entire screen area. Figure 5-3 on page 5-8 shows the location of all in-field adjustable preset controls. Figure 5-4 on page 5-9 a circle is used in the individual screen displays only to clearly illustrate the geometric effects of incorrect/correct control settings. Compare these illustrations to the current VDU display.

HORIZONTAL HOLD ADJUSTMENT, VR218

1. Insert MCA Master Program Disk and reset the MCA. This is done to apply a know video display format (TITLE PAGE).

2. Connect wire shorting link across diodes D290/291 to ground to temporarily interrupt the mixed sync information to the free-running oscillator. See Figure 5-2 below.

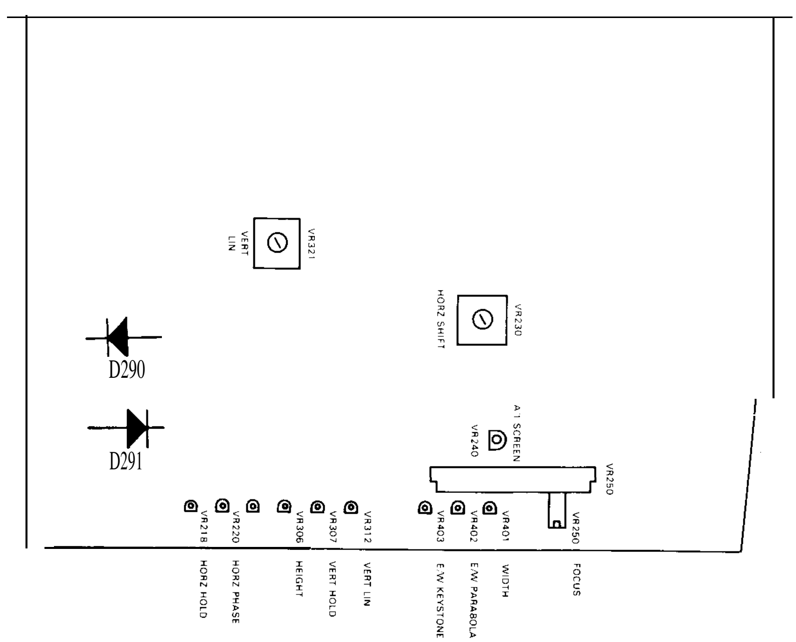


Figure 5-2, Location of Diodes D290 and D291.

3. Adjust preset control VR213 until the picture almost stabilizes as shown in Figure 5-4 on page 5-9, then remove wire shorting link. This procedure should result in a stable picture lock.

4. VERTICAL HOLD ADJUSTMENT Refer to Figure 5-4 and adjust VR307 until a stable picture lock occurs. For effective lock, VR307 should be set to the center of the locked picture range.

5. WIDTH ADJUSTMENT Refer to Figure 5-4 and adjust VR401 to effect the indicated picture width adjustment.

6. HORIZONTAL PHASE ADJUSTMENT This control adjusts the positioning of the video information relative to the raster in a line scan direction. Prior to attempting VR220 adjustment make certain that the following adjustment operations have been satisfactorily made:
   A) HORIZONTAL HOLD VR218 has been correctly set.
   B) Picture WIDTH preset control VR401 has been correctly set.
   Referring to Figure 5-4, adjust VR220 until the video information is correctly centered.

7. VERTICAL HEIGHT ADJUSTMENT Refer to Figure 5-4 and adjust preset control VR306 until the correct height set adjustment results.

8. VERTICAL LINEARITY ADJUSTMENT

NOTE: Best vertical linearity adjustment results are obtained by using a cross-hatch type grid display. If a cross-hatch generator is not on hand, see Preliminary Information on page 5-4.

   Refer to Figure 5-4 and adjust preset control VR312 until the entire video picture is linear in the vertical direction.

9. VERTICAL SHIFT ADJUSTMENT Adjustment of the vertical shift preset control VR321 controls positioning of the raster in the vertical direction. This control is adjusted until the displayed video picture is centrally positioned in the vertical direction. When used with the horizontal shift preset control VR230, preset control VR321 functions to centralize the displayed video picture on the screen.

10. HORIZONTAL SHIFT ADJUSTMENT Adjustment of the horizontal shift preset control VR230 controls positioning of the raster in the horizontal direction. This control is adjusted until the displayed video picture is centrally positioned in the horizontal direction. When used with the vertical shift preset control VR321, preset control VR230 functions to centralize the displayed video picture on the screen.

11. E/W (EAST/WEST) KEYSTONE ADJUSTMENT As shown in Figure 5-4, the displayed video picture should not appear "keystone shaped-with raster having non-t) arallel edges. Adjust VR403 until the lefthand and righthand vertical sides of the picture are parallel.

12. E/W PARABOLA ADJUSTMENT As shown in Figure 5-4, the picture should not appear "pin-cushioned, barrel-shaped or with raster having concave or convex picture edges". Adjust VR402 until the lefthand and righthand vertical sides of the picture are parallel.

13. FOCUS CONTROL ADJUSTMENT
    A) Set BRIGHTNESS control VR240 to most pleasant viewing level.
    B) Adjust FOCUS control VR250 until picture is sharply focused.

14. GRAY LEVEL ADJUSTMENT The following controls: VR901 (red black level), VR902 (green black level), VR903 (blue black level), are used when adjusting the color monitor's grey scale making sure the colors displayed are not tinted to one of the primary colors or derivatives there of.
    A) Adjust Brightness Control to mid-position.
    B) Adjust Contrast Control fully counter-clockwise.
    C) Remove 9-pin D-plug connector from the rear side of the monitor.
    D) Increase the Al control setting until the raster is just visible.

NOTE: If the raster is not shaded towards any particular color or combination of colors, then no further adjustment is required proceed to the SCREEN VOLTAGE ADJUSTMENT, step 15.

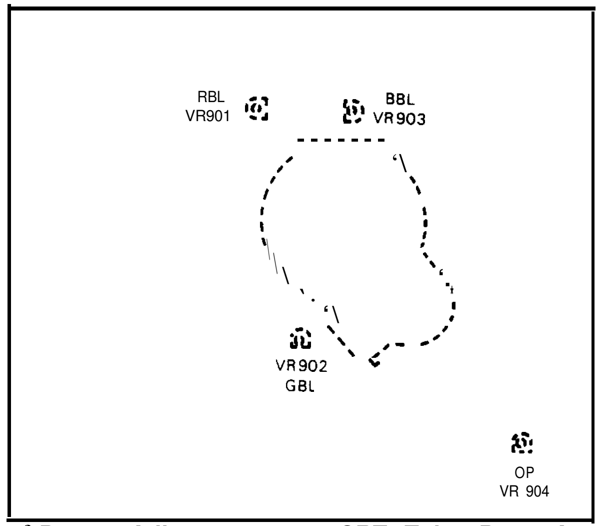
If the raster is shaded towards a primary or secondary color, then adjustments should be make to the appropriate black level preset to obtain a neutral (gray) raster.

EXAMPLE If the raster is shaded towards "RED" reduce the black level voltages on the green and blue guns by using VR902 and VR903 found on the CRT TUBE BASE ASSEMBLY Board. Access to VR901, VR902, VR903, and VR904 can be made through cut-out in the Board see figure 5-3 for position.

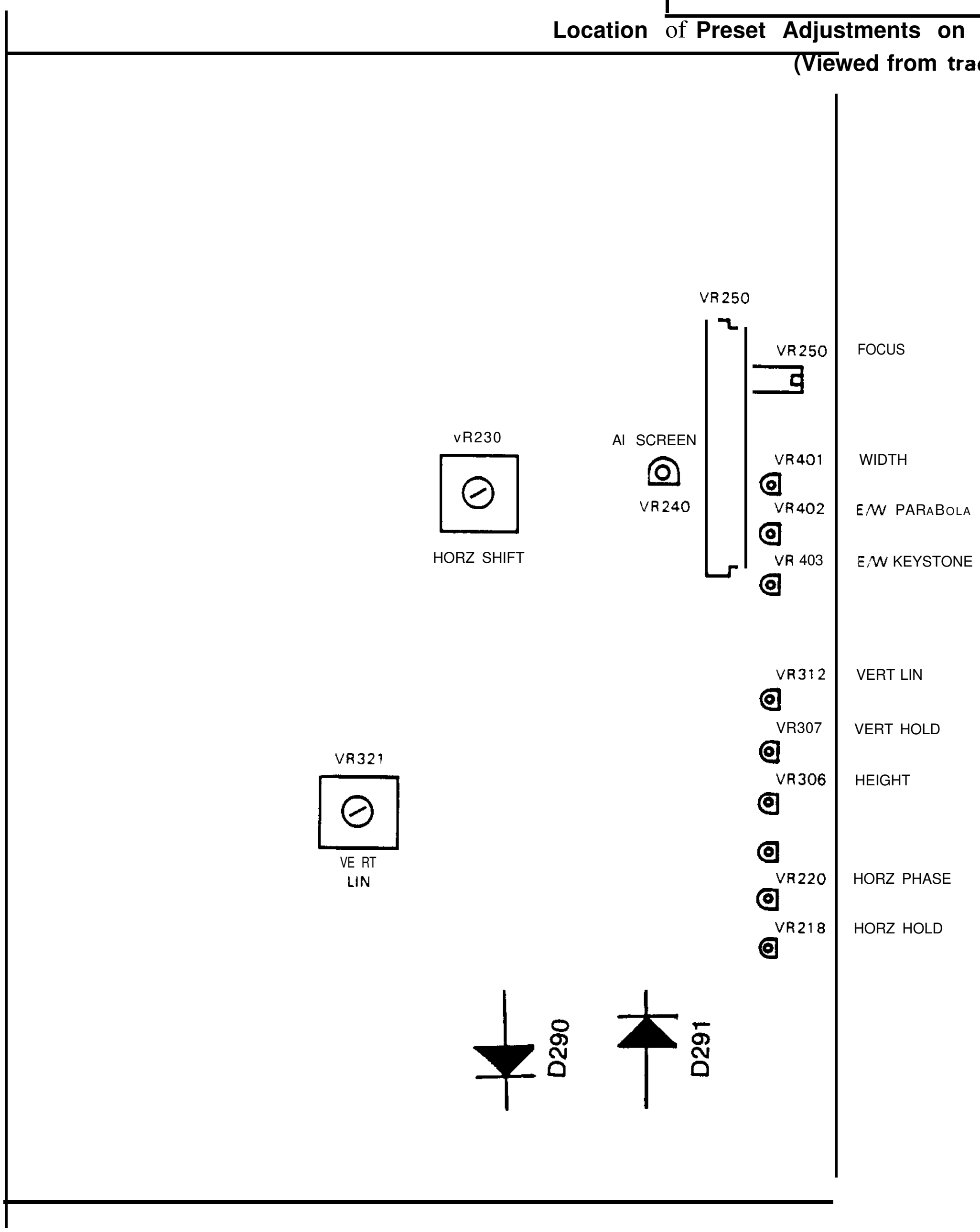
    E) Set the SCREEN VOLTAGE ADJUSTMENT, step 15.

15. SCREEN VOLTAGE ADJUSTMENT
For this adjustment it is necessary to fill the screen with the character upper case "H" using the typewriter mode.
    A) Set contrast fully counter-clockwise.
    B) Set brightness control to mid-position.
    C) Adjust VR250, so that the raster is only just extinguished.

****
* Check-Out/Calibration Complete *
****



Location of Preset Adjustments on CRT Tube Base Assembly PCB
(Viewed from track side)



Location of Preset Adjustments on Main PCB
(Viewed from component side)

Figure 5-3. Video Display Unit, Preset Control Location.

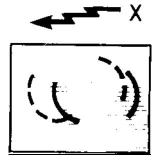
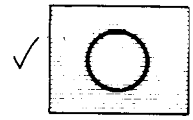
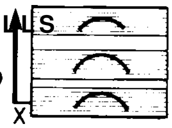
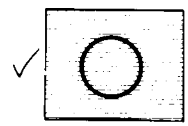
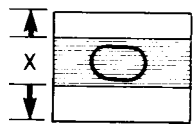
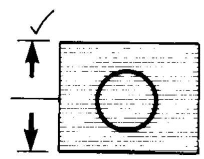
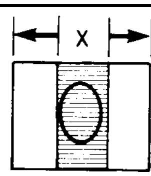
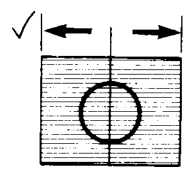
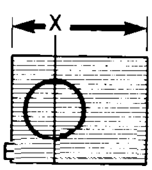
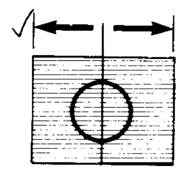
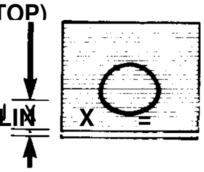
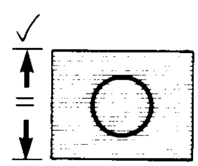
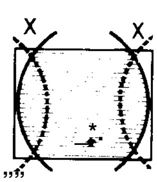
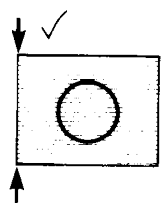
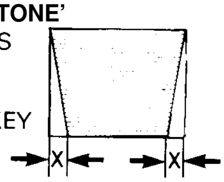
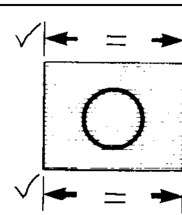
PRESET	WRONG X	RIGHT √
H. HOLD (LINE HOLD)	PICTURE BREAKS UP ADJUST H. HOLD 	 PICTURE LOCKED
V. HOLD (VERTICAL HOLD)	PICTURE ROLLS ADJUST V. HOLD 	 PICTURE LOCKED
HEIGHT	ADJUST HEIGHT 	 HEIGHT SET
WIDTH	ADJUST WIDTH 	 WIDTH SET
4. PHASE * HORIZONTAL PHASE)	PICTURE NOT CENTRAL ADJUST H. PHASE 	 PICTURE CENTRA PHASE SET
/. LIN * VERTICAL .INEARITY)	BOTTOM (OR TOP) OF PICTURE COMPRESSED ADJUST V. LIN 	 VERTICAL SCAN LINEAR V. LIN SET
:/W PARA * EASTAIVEST 'ARABOLA)	PICTURE 'BARREL SHAPED' OR 'PIN-CUSHION' SHAPED - ADJUST EMI PARA" 	 VERTICAL EDGES STRAIGHT E/W PARA SET
:/W KEY * EAST/WEST :EYSTON E)	PICTURE 'KEYSTONE' SHAPED, EDGES NOT PARALLEL ADJUST E/W KEY 	 PICTURE EDGES PARALLEL E/W KEY SET

TABLE OF PRESET ADJUSTMENTS

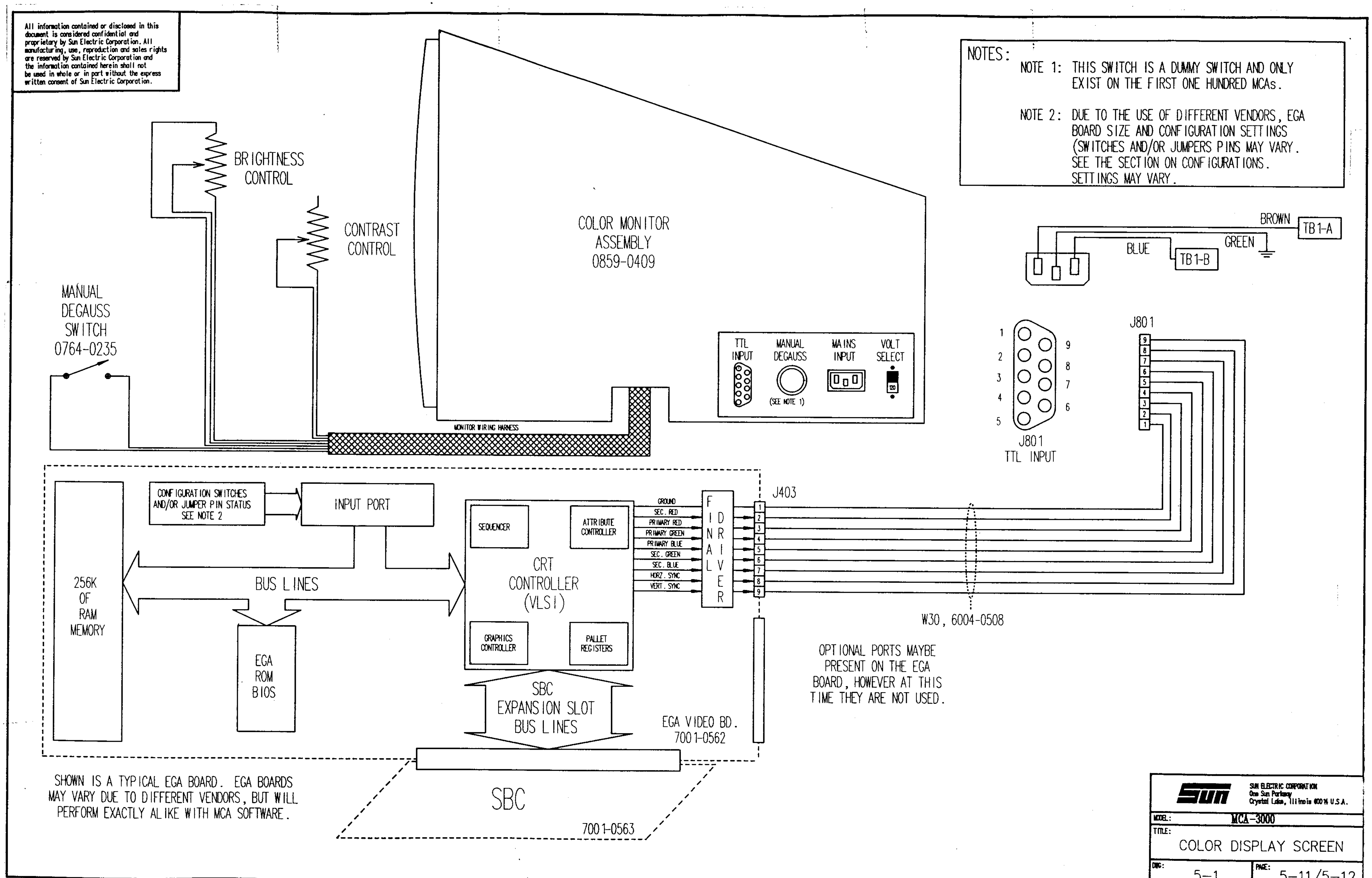
Figure 5-4. Video Display Right/Wrong Control Settings

SECTION III. TROUBLESHOOTING

GENERAL

Field on-site installation troubleshooting shall primarily consist of Switched-Mode Power Supply Board's, fuse Fl replacement and adjustment of variable preset controls discussed in Section II, Page 5-5.

COMPLAINT	CORRECTWE ACTION
1. Display completely dead.	1. If tester does not "Boot" properly, proceed to Chapter 3, Computer and Disk Drives. 2. Turn up Brightness. 1s a raster present ? YES NO Remove AC connector. Is there AC at cable end ? YES NO Refer to Chapter 1, AC Power. A) Check Fuse F1. Replace if necessary. B) Replace Monitor #0508-0409. Replace EGA Board #7001-0562. 3. Refer to Theory of Operation and Functional Diagram.
II. VDU resembles one of the examples in the WRONG column of the RIGHT/WRONG CONTROL SETTINGS, Figure 5-4, Page 5-9.	1. Proceed to page 5-5 and perform Check-out/Calibration. 2. ----------SUBSTITUTE----------------- A) EGA Board /}7001-0562. B) Monitor #0859-0409 or 0859-0411-01. 3. Refer to Theory of Operation and Functional Diagram.



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NOTES:
NOTE 1: THIS SWITCH IS A DUMMY SWITCH AND ONLY EXIST ON THE FIRST ONE HUNDRED MCAs.
NOTE 2: DUE TO THE USE OF DIFFERENT VENDORS, EGA BOARD SIZE AND CONFIGURATION SETTINGS (SWITCHES AND/OR JUMPERS PINS MAY VARY. SEE THE SECTION ON CONFIGURATIONS. SETTINGS MAY VARY.
BRIGHTNESS CONTROL
CONTRAST CONTROL
COLOR MONITOR ASSEMBLY 0859-0409
MANUAL DEGAUSS SWITCH 0764-0235
MONITOR WIRING HARNESS
TTL INPUT
MANUAL DEGAUSS
(SEE NOTE 1)
MAINS INPUT
VOLT SELECT
120
BROWN
TB1-A
GREEN
BLUE
TB1-B
J801
J801 TTL INPUT
CONFIGURATION SWITCHES AND/OR JUMPER PIN STATUS SEE NOTE 2
INPUT PORT
256K OF RAM MEMORY
BUS LINES
EGA ROM BIOS
SEQUENCER
ATTRIBUTE CONTROLLER
CRT CONTROLLER (VLSI)
GRAPHICS CONTROLLER
PALLET REGISTERS
SBC EXPANSION SLOT BUS LINES
GROUND
SEC. RED
PRIMARY RED
PRIMARY GREEN
PRIMARY BLUE
SEC. GREEN
SEC. BLUE
HORZ. SYNC
VERT. SYNC
FINAL DRIVER
J403
W30, 6004-0508
EGA VIDEO BD. 7001-0562
OPTIONAL PORTS MAYBE PRESENT ON THE EGA BOARD, HOWEVER AT THIS TIME THEY ARE NOT USED.
SBC
7001-0563
SHOWN IS A TYPICAL EGA BOARD. EGA BOARDS MAY VARY DUE TO DIFFERENT VENDORS, BUT WILL PERFORM EXACTLY ALIKE WITH MCA SOFTWARE.
SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.
MODEL: MCA-3000
TITLE: COLOR DISPLAY SCREEN
DWG: 5-1
PAGE: 5-11/5-12

SECTION V. CONFIGURATION

This Section will show how to configure each type of EGA Board used the the **MCA-3000.**

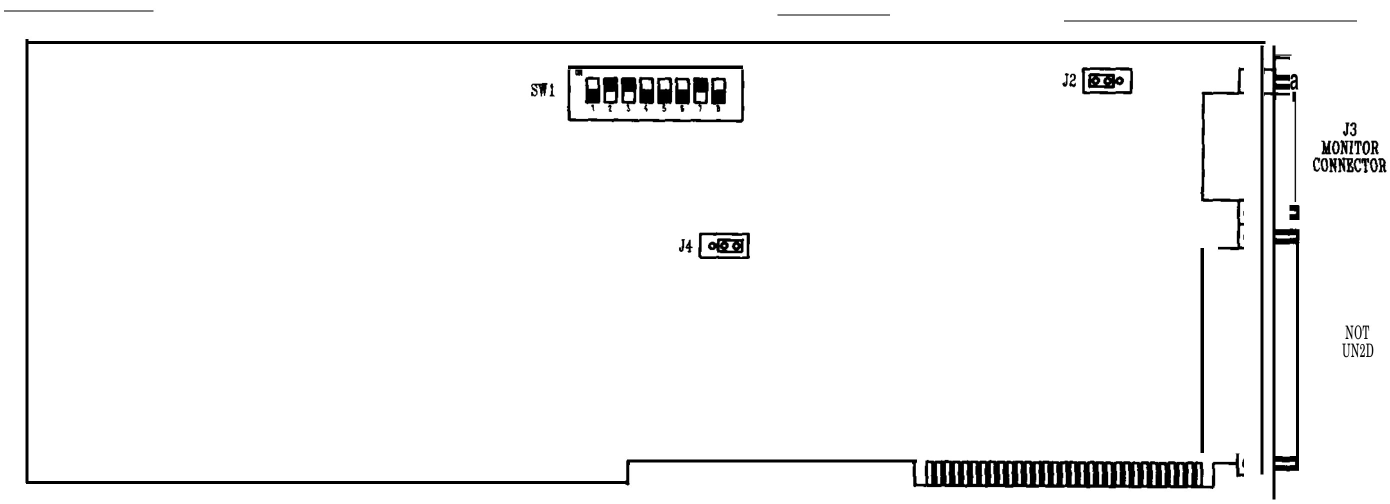


Figure 5-5, STB Multi-Res EGA Board.

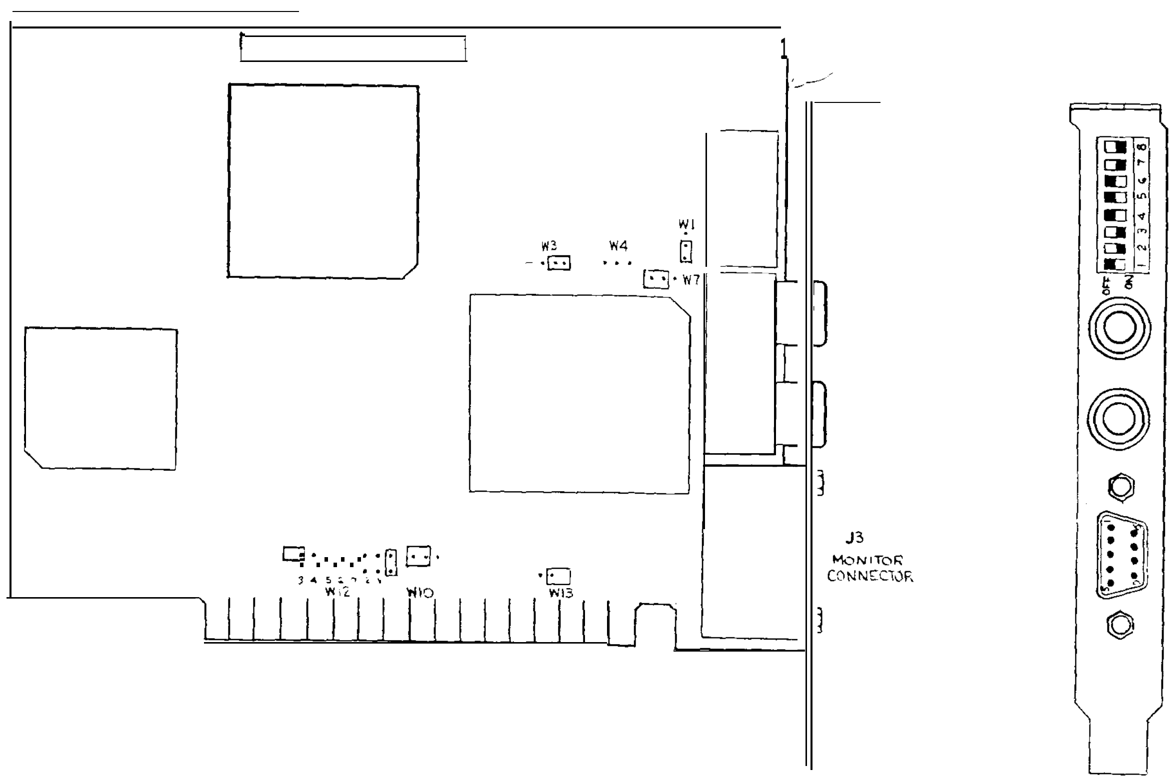


Figure 5-6, Everex EGA Board.

NOTES

CHAPTER 6

PRINTER MODEL AP-11OO

GENERAL

Test results and/or diagnostic messages are printed using the AP-11OO, an 80 column hi-directional, 7 X 9 (high speed draft), 9 x 9 (utility) or 17 x 17 (near letter quality) dot matrix, impact printer. This means that the printer uses a print wire (the dot) driven at an inked ribbon, against the paper (the impact) to form characters. The characters are created using dots in a 7 by 9 matrix, meaning that the characters are 7 dots wide by 9 dots high. The Printer is bidirectional, which means that the print head prints while moving in either direction, from home going right or from the right side on its way home. Printer speed is 160 CPS (characters per second) draft mode and spacing 6-6.5 CPI (characters per inch). When the operator/user selects the PRINT MENU page the following menu (Figure 6-1) is displayed on the Video Display Unit.

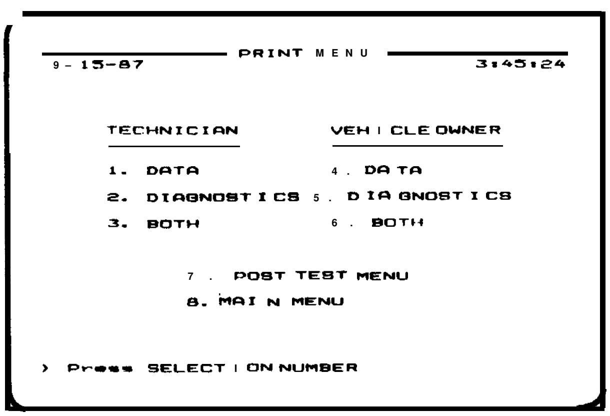


Figure 6-1. PRINT MENU Page

The operator/user then selects the desired function (l-8) by pressing the corresponding number on the keyboard or Remote Control Unit (RCU). As the selected information is being printed it may also be displayed on the Video Display Unit, but is not always necessary. To stop the printing operation the CLEAR button on the keyboard or the RCU is pressed.

If the operator/user only wants to print specific screens, the PRINT SCREEN button, located on either the Keyboard or RCU, is pressed. If this is the case, the operator/user would access the desired page and then press the PRINT SCREEN button. The standard BIOS Shift/Print Screen function is disabled within the MCA-3000'S software.

For the following text is meant to used in conjunction with Functional Block Diagram 6-1.

POWER

The Printer is supplied with primary **ac** power via its own power cord connected to a printer power panel receptacle. Power is applied only when the MCA AC SWITCH ON/OFF is set to the ON position. All other power required for Printer operation is supplied and generated by an AC/DC power supply located within the Printer. A Printer ON/OFF switch is located on the right-hand side near the rear of the unit.

PRINTER COMMUNICATION

The Printer communicates with the SBC via the Remote Arbitrator Board using a standard parallel interface, commonly called the Centronics Parallel Interface. Describe below are the signals used by the **Centronics** Parallel Interface.

Data

DATA is information sent to the Printer via the eight DATA lines (DATA 1-8). The format used is called ASCII (American Standard Code for Information Interchange). ASCII code is used to represent all the letters in the alphabet, both upper and lowercase, for numbers from O to 9, most punctuation marks, and some codes that control printer functions.

STROBE*

The STROBE* line is used to synchronize the Printer to the MCA-3000. When the STROBE* line is at a low level, the Printer reads all eight data lines.

Acknowledge

When the processing of this first byte of input data is completed, the BUSY signal is turned Off (becomes low) and a low level ACKNOWLEDGE* signal is sent from the Printer to the SBC to request the next data byte.

BUSY

The BUSY line, when high level, is used by the Printer to tell the MCA-3000 that it is busy and no more information should be sent from the SBC. The SBC stops sending information until the BUSY line again goes to its low level state.

Figure 6-2 shows the timing relationship between the above mentioned signals

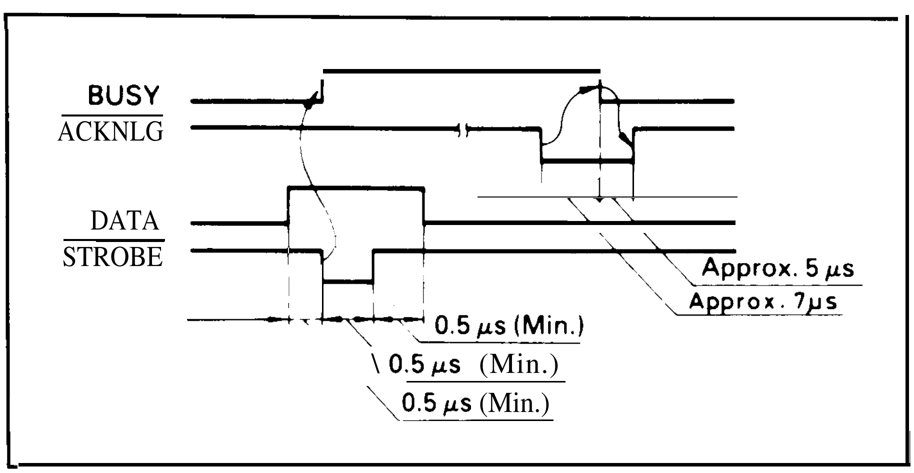


Figure 6-2. Parallel Interface Timing

Initialize*
The INIT line is used by the MCA-30 (MI to initialize the Printer. When the Tester is powered-up, the Printer initializes twice. The first initialization is inherent to applying AC power to the Printer while the second initialization is due to the SBC pulling the INIT line low. If the MCA-3000 does not power-up correctly, only one initialization will occur.

POWER OFF
If the MCA-3000 senses that BUSY and SELECT are both low; the message "Printer Off" is displayed on the Video Display Unit. This condition is existent only when the Printer does not have primary AC power applied.

SELECT
The Printer has two basic operational modes, Selected (on-line) and Not Selected (off-line), apparent to the SBC. To toggle between these two modes, the SELECT 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.

ALARM INDICATORS

Paper End
The AP-11OO printer is equipped with an alarm (tone and front panel lamp).
If the Printer runs out of paper, a high level PAPER END signal is generated which immediately causes the Printer front panel ALARM indicator to light and the Printer immediately stops printing. This action prevents possible damage to the printhead from printing directly onto the platen.

Drive Circuit Fault Alarm Circuit
This protective circuitry causes the AC fuse to open when a fault occurs in the printhead drive circuit, space motor drive circuit, line feed motor drive circuit, or their peripheral circuits thus preventing internal trouble.
NOTE: this alarm won't light the front panel indicator, but rather forces printer off.

Head Overheat Alarm Circuit
This circuitry protects the printhead coils by monitoring the head temperature using the built-in thermistor of the printhead. If continuous heavy duty printing continues for a long period of time, printhead temperature rises. When it rises to a predefine ,value a head overheat alarm is detected (ALARM indicator lights) and printing ceases until the head temperature is lowered below the alarm level after which the ALARM indicator goes out and printing resumes.

Control Switches

SET TOF (set top of form), LF (line feed) and FF (form feed) print function control buttons are located on the Keyboard while comparable TOF SET (top of form set), LINE FEED and FORM FEED buttons are physically located on the Printer.
NOTE: The Printer must be in the deselected mode (SEL light out) to operate the AP-11OO'S own front panel mounted LINE FEED, FORM FEED and TOF SET buttons. However when the printer is deselected the keyboard's own printer control keys cannot control the printer.

Control Switches (continued)

The keyboard SET TOF and Printer TOF SET buttons are functionally identical and operate to set the top of form to the current location of the printhead. Top of form is the first printing line on a page. To set the top of form, place the paper at top of form and press the TOF button once.

Pressing either The LF (line feed) button on the Keyboard or the LINE FEED button on the Printer results in Printer paper advancing one line. Holding either line feed button down results in continuous one line feed operations.

Pressing either the **FF** (form feed) button on the Keyboard or the FORM FEED button on the Printer results in Printer paper advancing to the next TOF (top of form) position.

SECTION I. THEORY OF OPERATION

SYSTEM OPERATION

Upon powering up the Tester the Printer is initialized (printhead travels rightward and then returns to the home position at the extreme left). If the AP-11OO'S internal computer does not see the printhead positioned at the left-hand margin position, an error message is relayed to the SBC. The MCA-3000'S SBC displays this error on the Video Display Unit during the warm-up page. After this error message is displayed, all subsequent commands to the Printer are ignored. As shown in the functional block diagram 6-1, Page 6-13/14; all interchange of data/control signals occur between the SBC and the Printer via the Remote Arbitrator Board #7001-0545. Each byte, composed of DATA 1-8 bits, leaves the octal latch U148 in parallel form, passes directly through the Remote Arbitrator Board and then to the Printer. The SBC'S parallel printer port controller produces printer command control/signal outputs and receives printer feedback signals also through the Remote Arbitrator Board.

Printer Internal Theory of Operation

The Printer CPU is the primary device for controlling operation of its peripheral circuits. The four 1/0 ports of the microprocessor are connected with the data bus (Port O), address bus (Port 2) and printer data bus (Port I,Port 3).

The program ROM (read only memory) is where the printer stores the control program. The microprocessor operates under control of this stored program.

The RAM stores data such as downloaded font and also, buffers print data received from the MCA-3000'S SBC. This RAM is battery backed-up and retains menu setup information as well.

The interface LSI **(MSM60201)** performs the following

1. Parallel interface function. The parallel interface function mode is selected when the level of the mode selection signal **(ISEL)** is high. In this mode, **IFD1** to 8 are used as an input port, and the parallel data received through the interface connector is latched in accordance with the application of the strobe signal (STROBE*) and is sent to the CPU in accordance with the RD* signal. In this mode, the interface LSI device also sends BUSY*, ACK, PE* and SELECT* signals to the Printer interface connector when the WR* signal is applied.

The interface LSI (MSM60201) performs the following: (continued)

2. Address decoder. The LSI internal address decoder decodes the address signal (A12 to A15) and sends the ROM SEL* signal.

The LSI motor control (MSM61048) performs the following functions:

1. Space motor speed control function. This accelerates and decelerates the space motor in accordance with commands from the microprocessor and controls the space motor speed in each printing mode.

2. Dot timing generation function. This generates the dot-on **timing** signal **(IPT*),** synchronized with the printing speed in accordance with output signals (PHASE **A,B)** of the encoder on the space motor, and sends this timing information to the microprocessor.

3. 1/0 ports. This LSI has a 12-bit output port and a 6-bit input port, and outputs control signals in accordance with the commands input from the microprocessor. The input port is also used to read information from the operation panel switches.

4. Address latch. The address latch latches the low-order 8 bits of the address (AO to A7). These bits are used as an address for read/write operations with peripheral devices.

5. Address decoder. The address decoder decodes the address signal (All to A15) and sends the RAM **SEL4*** signal.

Printer Initialization Occurs whenever power is turned on or whenever INIT* (initialize) signal is received from the SBC.

When resetting is completed, the program starts with mode setting of the CPU, Motor Control Logic, Interface LSI, memory (ROM and RAM) check, RAM initialization, and then the carriage going to the home (far left) position. The program finally establishes the interface signals (output of ACK, BUSY, etc.), lights the SELECT indicator and informs the Tester SBC that the Printer is ready for data reception by sending the appropriate low level BUSY signal. At this point Printer initialization is complete and the Printer is ready for dynamic operation.

Parallel Interfacing Control Address, data and control signals, from the SBC, are inputted into the Printer via connector CN1 and applied to the interface **LSI.** This information is latched only when the SBC generated STROBE* signal is low. The Printer BUSY signal is On (high) during processing of this data. The high level BUSY signal is also sent from the Printer to the SBC whenever data cannot be received by the Printer due to its receiving buffer register being full. When the processing of this first byte of input data is completed, the BUSY signal is turned Off (becomes low) and a low level ACKNOWLEDGE* signal is sent from the Printer to the SBC to request the next data byte.

SECTION II. MAINTENANCE

CLEANING

CAUTION Set AC Power switch to OFF prior to cleaning. Also, take care not to allow paper, lint, foreign particles, etc. to get inside the printer mechanism.

The Printer interior should be cleaned periodically at either 6 months or 300 operating hours, whichever occurs first. Approximately 6 minutes is required to complete the cleaning procedure.

REQUIRED EQUIPMENT:	
Cotton swabs	lint-free cloth
isopropyl alcohol	lubricating oil (Sun part #0681-0237)

1. Remove the top cover of the printer.
2. Remove printer paper and printer ribbon.
3. Using the cloth, wipe away any dust and dirt that may have accumulated in the exposed compartment. Also, using the alcohol, swabs, and cloth, wipe the printhead shaft clean.
4. Dampen the cloth with alcohol and wipe the bailing roller clean.
5. Apply a drop of oil the the printhead shaft. Move the printhead from end to end, spreading the oil into a thin coat, covering the printhead shaft.
6. Reinstall paper, ribbon, and cover.
7. Power the tester up and press the print button on the keyboard or the RCU.The printer should print the title page.
8. Remove paper lint and dust attached to Paper-End Sensor. See Figure 6-3.

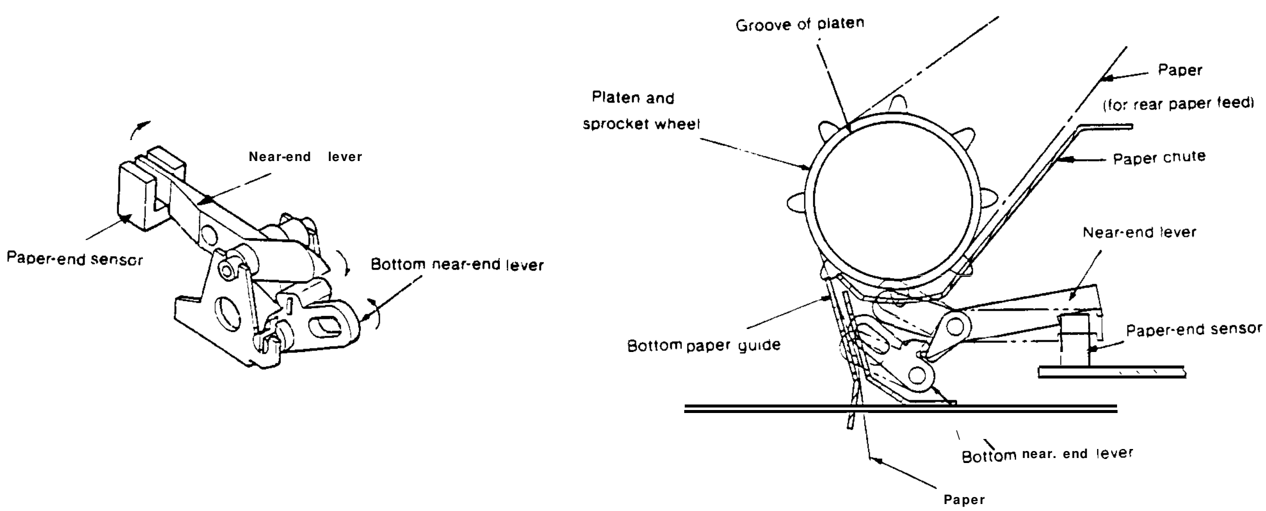


Figure 6-3 Paper-End Sensor

Cleaning and Lubrication Complete

SECTION III. ADJUSTMENT

HEAD-GAP ADJUSTMENT

REQUIRED EQUIPMENT: Thickness gauge set
Phillips screwdriver
Metal Rod appox. 0.04” in diameter (a straightened paper clip can be used)

Adjustment Procedure
Refer to Figure 6-3, Page 6-7 and perform adjustment as follows:

1. Turn the Printer AC POWER switch to OFF and remove the AC input plug from the AC receptacle.

2. Remove the access cover.

3. Remove the ribbon cartridge.

4. Set the adjusting lever to range 1.

5. Set the paper lock release lever rearward.

6. Insert a 0.019-inch (0.48-mm) thickness gauge between the platen and printhead. Make sure that the thickness gauge can be smoothly inserted if rubbed a little. Carry out this check at both the right and left end of the platen.

7. If gap adjustment is required, using the metal rod press down on the adjusting gear to disengage the gear from the adjusting lever and then adjust the gap by turning the adjusting screw with the screwdriver.

8. Move the adjusting lever from range "1" to “3” and then to “l” after completion of adjustment then check the gap between the platen and printhead again with the adjusting lever positioned to range “l”. The adjustment range is 0.016 to 0.02 inch (0.4 to 0.5 mm).

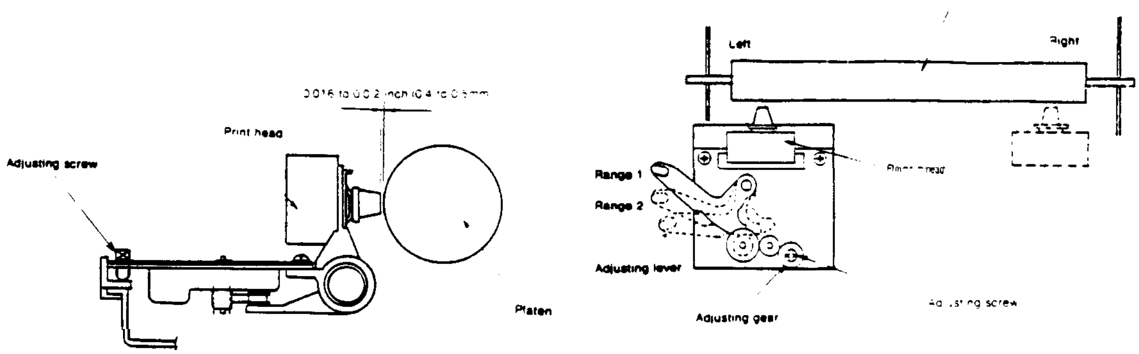


Figure 6-4. Head Gap Adjustment.

SECTION IV. PRINTER SETUP/SELF TEST

PRINTER SETUP PROCEDURE

To setup the Printer for use with the MCA-3000 perform the following:

1. Make sure that the Printer is OFF.

2. To initialize printer SETUP, Hold down the FORM FEED button and power up the Printer. The words "PRINT MENU?" should be printed.

3. Press the SELECT button. The printer will print one of the two option lists (see Figure 6-5). This list is how the printer was set when it left the fat-tory. You might have to change the factory setting to agree with the appropriate list below.

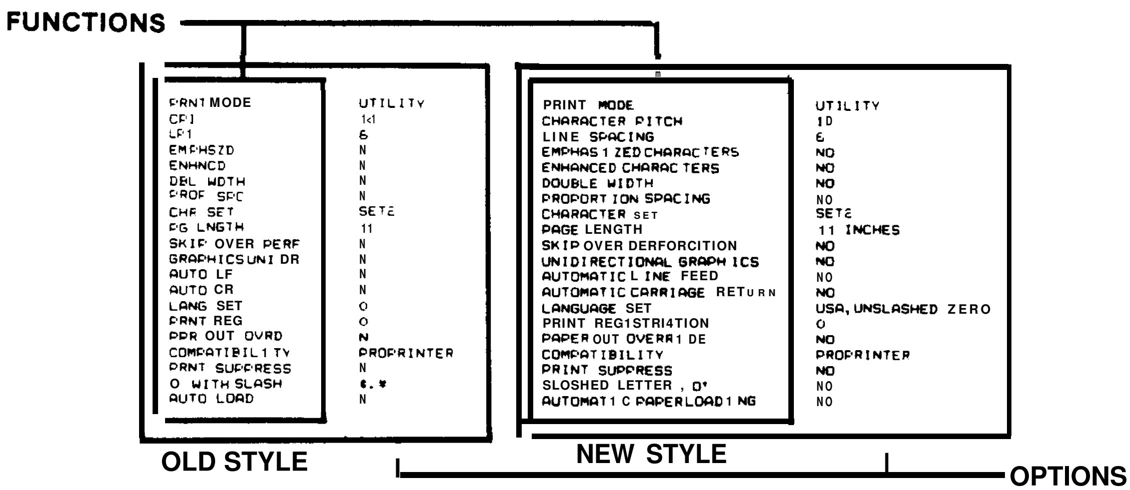


Figure 6-5. Printer Options

4. To set the options for each function as shown above, press the FORM FEED button to begin with the first function (PRNT MODE or PRINT MODE) and to move down the menu. Use the SELECT button to select the proper option (see appropriate Menu in Figure 6-5 for option settings). Figure 6-6 shows the Printer's control switches and their functions.

5. When all Functions are set to the proper Options, press the TOF SET button when to store these changes in the printer's battery backed up RAM memory.

6. Before checking printer operation, RESET the MCA-3000. This is done to down load the custom character set contained on the Master Program disk to the printer.

NOTE
Critical settings are:

AUTO LOAD . . . .N
COMPATIBILITY . . . . PROP RINTER
CHR SET. SET2

REFERENCE DIAGRAM FOR MENU SELECT

The following reference diagram (figure 6-6) provides information on using the Printer Menu Select mode and line feed feature.

MENU SELECT

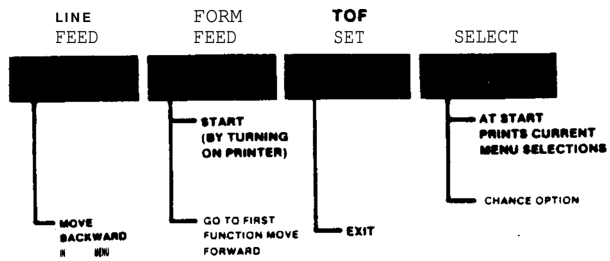


Figure 6-6. Reference Diagram

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

• Printer Setup Complete •
• ****************************

SELF TEST

Immediately following any/all Printer repair and/or adjustment procedures perform the following checkout procedures.

1. Turn OFF the Printer.
2. Load paper into the Printer.
3. Hold down the LINE FEED button while turning ON the Printer.
4. A test pattern (figure 6-6) similar to that below will printout. To stop the self test, turn OFF the Printer or press the SEL button to Select the Printer.

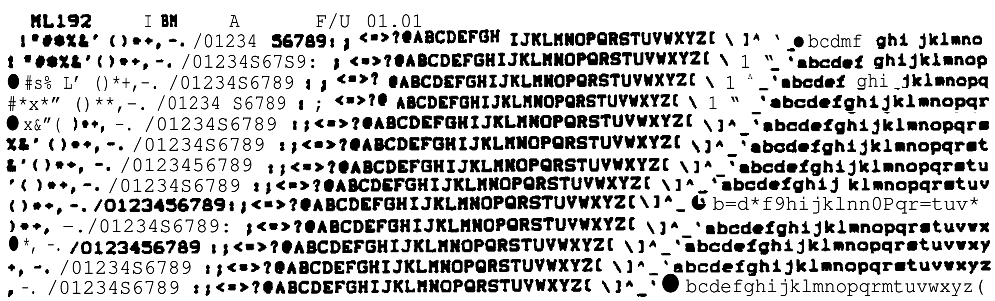


Figure 6-7. Self-Test Barber Pole Printout Example

Print Screen Integrity

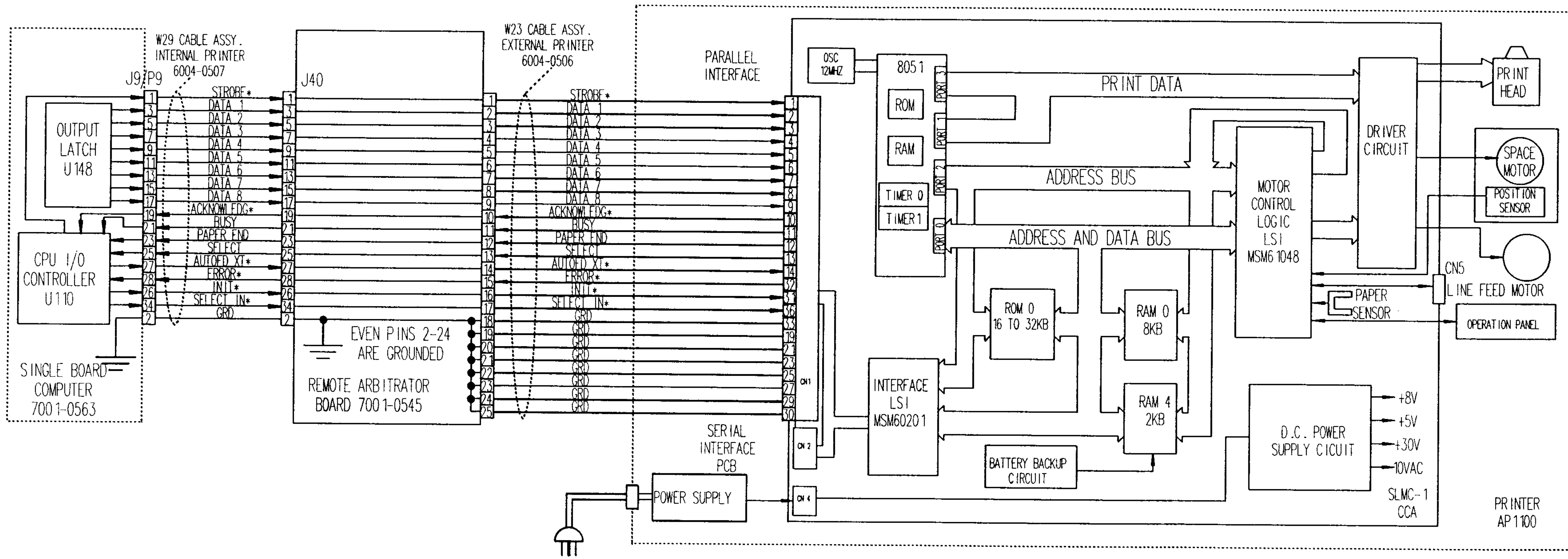
Check Printer printing accuracy/readability by commanding a print screen operation and checking the printout versus the Video Display Unit display.

SECTION V. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. **Carriage does not move when primary ac power is turned on.**	1. With data cable disconnected from rear of printer, can a Self Test be accomplished ? YES NO NO → Is there AC power at the 3 prong printer connector. YES NO NO → Refer to Chapter 1, AC Power. YES → a) Check Fuse F1 (1.5 amp)located on Motor Control Board. If fuse is blown, replace fuse. b) If fuse is not blown, replace printer AP-1100. YES → ----------------SUBSTITUTE-------------- A. SBC #7001-0563. B. Keyboard Arbitrator Board #7001-0545Printer C. Printer Cable Assm. (external) #6004-0506. D. Printer Cable Assm. (internal) #6004-0507. 2. Refer to Theory of Operation and Functional Diagram.
II. **Printer carriage homes properly but unable to print anything.**	1. Printer in deselect (off line) mode; press SELECT button and make certain SELECT indicator lights. 2. Check that the W23 External Printer Cable Assembly #6004-0506 is properly connected to both the Printer and Remote Arbitrator Board and from the Remote Arbitrator Board to the SBC inside the MCA. Reconnect if required. Continued

COMPLAINT	CORRECTIVE ACTION
II. Printer carriage homes properly but unable to print anything. (CONT)	3. Will printer perform Self Test ? YES NO NO → Replace Printer AP-1100. YES → ----------------SUBSTITUTE-------------- A. SBC #7001-0563. B. Keyboard Arbitrator Board #7001-0545Printer C. Printer Cable Assm. (external) #6004-0506. D. Printer Cable Assm. (internal) #6004-0507. 4. Refer to Theory of Operation and Functional Diagram.
III. Wrong characters are printed or some characters are not printed.	1. Interface cable assembly not connected properly. Reconnect if necessary. 2. Perform Printer Setup on page 6-8. 3. Will printer perform Self Test ? YES NO NO → Replace Printer AP-1100. YES → ----------------SUBSTITUTE-------------- A. SBC #7001-0563. B. Keyboard Arbitrator Board #7001-0545Printer C. Printer Cable Assm. (external) #6004-0506. D. Printer Cable Assm. (internal) #6004-0507. 4. Refer to Theory of Operation and Functional Diagram.
IV. Some dots are not printed.	1. Replace Printer AP-1100. 2. Refer to Theory of Operation and Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
V. Print is not dark enough.	1. If ribbon wear is evident, replace ribbon #0528-0995. 2. Check printhead range setting. If necessary, adjust per instructions on page 6-6. 3. Check Head Gap adjustment. If necessary, adjust per instructions on page 6-6. 4. Replace Printer AP-11OO. 5. Refer to Theory of Operation and Functional Diagram.
VI. Line **feed operation** not performed.	1. Replace Printer AP-11OO. 2. Refer to Theory of Operation and Functional Diagram.
VII. **Unable to command a line feed, form feed or set top of form from the Printer's front panel (with power on).**	1. Printer in select (on-line) mode. Press SELECT button and note that SELECT indicator lights thus indicating off-line operation. 2. If pressing buttons still does not result in Printer performing required function, replace Printer AP-11OO. 3. Refer to Theory of Operation and Functional Diagram.



SUN ELECTRIC CORPORATION, One Sun Parkway, Crystal Lake, Illinois 60014 U.S.A.	
MODEL:	MCA-3000
TITLE:	PRINTER
DWG: 6-1	PAGE: 6-13/6-14

CHAPTER 7

SUN BUS/COMPUTER COMMUNICATIONS

GENERAL

The purpose of the Sun Bus is to extend the Single Board Computer's (SBC) bus lines to allow communication with the Sun Bus Boards. Each of the Boards located on the Sun bus has the capability to communicate via the Sun Bus. The 1/0, EPROM, Clock Board, Sun Bus Backplane Board, and the Bus Driver Board are the boards primarily responsible for this communication. This communication can range from sending an address to a board, and receiving data in return, to actual hi-directional communication between one of the microprocessors on the Sun Bus and the Microprocessor on the SBC. Below, is a general description of the 1/0, Bus Driver, and Sun Bus Backplane board. After the general descriptions, an explanation of the communications will be given, along with an example.

SECTION I. THEORY OF OPERATION

I/O/EEPROM/CLOCK Board #7001-0558

The I/O/EEPROM/Clock Board basically controls the transfer and exchange of control/address/data between the Single Board Computer or SBC and the Sun Bus. It also functions as the real time clock source for the MCA-3000. The I/O/EEPROM/ Clock Board may be subdivided into 3 functional sections: (1) Input/Output control, (2) EEPROM type memory and (3) real time clock. For an Explanation of the EEPROM and Clock, Refer to Chapter 3.

Input/Output Control

When SBC address bits A2-A9 match the DIP switch S2 settings (11000100), the 1/0 function is activated. If READ/WRITE* is high, communication will be from the Sun Bus to the SBC. If READ/WRITE* is low, communication will be from the SBC to the Sun Bus. ADDRESS Bits AO and Al are use to determine whether the SUN BUS Address or the Data Bus is active.

BUS DRIVER Board #7001-0559

The Bus Driver Board functions to control the directional flow of both control and data signals between the Boards located on the Sun Bus and the I/O/EEPROM/Clock Board located on the SBC. on-board LED's LED1, LED2 and LED3 function to indicate the presence of +15v, -15V and +5V respectively on the SUN BUS Backplane.

The Bus Driver Board generates the Sun Bus signals which include: four address bits (OSBA0-3), eight bank select signals (SBBS0-7), eight data bits (OSBD0-7), Sun Bus read/write* signal (SBR/W*) and the output Sun Bus Acknowledge (OSBACK*) signal.

An on-board 3 to 8 line decoder operates on address bits SBA4-6, received from the 1/0 Board, to develop bank select signals SBBS0-7. These signals are then supplied to the Sun Bus via connector J103 and are used to select a board or a combination of boards for active communication with the SBC.

A hi-directional bus transceiver, hard-wired to operate in an I/O Board to Sun Bus unidirectional mode, processes applied address bits (SBAO-3,7) and SBACK* signal in order to generate On-Sun Bus address bits (OSBA0-3), Sun Bus write/read (SBR/W*) and Sun Bus acknowledge (SBACK*) signals. When SBR/W* is a high level; data is transferred from the Sun Bus to the 1/0 Board located on the Computer and conversely when it is a low level, data is transferred from the 1/0 Board to the Sun Bus.

SUN BUS BACKPLANE BOARD

The Sun Bus Card Rack, located to the right of the Printer, contains the Sun Bus Backplane board having 18 slots for installation of individual boards. All signal processing boards, front panel interface board, a data acquisition system analog-to-digital conversion board, assembly line diagnostic link board and bus driver board are presently installed in slots on the Backplane board. Figure 7-1, page 7-14, shows the Board's (boards) comprising the Sun Bus complement.

The Sun Bus functions to provide an analog and digital communications bus between installed Sun Bus boards as well as supply power to the individual installed boards. One connector (64 pins) serves as the digital and power supply bus while the other (32 pin) connector serves as the analog bus. All pins on the digital connectors are bussed while all but four (A11,C11,A12,C12) are bussed on the analog connector. An analog ground guard trace runs on either side of the sixteen analog A/D lines. 4.7K pullup resistors tied to +5VDC and 10K pulldown resistors tied to digital ground are provided for line termination on all of the computer communication and clock lines (SBA0-3, SBD0-7, SBBS0-7*, SBACK*, SBR*W, 1 MHZand 100 KHZ).

The following boards are mounted within the Backplane, for an overview on each board refer to page 7-10.

1. Primary Trigger Board #7001-0544
2. Secondary Trigger Board #7001-0551
3. Multimeter Board #7001-0550
4. RPM/Dwell/Timing Board #7001-0553
5. Bus Driver Board #7001-0559
6. Volt Amps Tester Board #7001-0552
7. IR Interface Board #7001-0557
8. DAS A/D Board #7001-0555
9. ALDL Reader Board 7001-0543
10. Front Panel Interface Board 7001-0616

The JIXX series connectors are considered the digital bus while the J2XX series connectors are the analog bus. All power, control, and signals, present on the analog/digital buses, are given on the following page.

DIGITAL BUS

JIXX PIN		JIXX PIN	
A1	+5V	c 1	+5V
A2	+15V	C2	+15V
A3	-15V	C3	-15V
A4	---	C4	---
AS	+12V (Relay)	C5	+12V (Relay)
A6	---	C6	---
A7	SBAO	C7	SBA1
A8	SBA2	C8	SBA3
A9	SBACK*	C9	SBR*W
AlO	---	C10	FLOWSTAT
A11	SBDO	C11	SBD1
A12	SBD2	C12	SBD3
A13	SBD4	C13	SBD5
A14	SBD6	C14	SBD7
A15	N.C.	C15	LOAD ENGAGE
A16	SBBSO*	C16	SBBS1*
A17	SBBS2*	C17	SBBS3*
A18	SBBS4*	C18	SBBS5*
A19	SBBS6*	C19	SBBS7*
A20	N.C.	C20	CYL CLK
A21	MS CLK	C21	CYL SHORT*
A22	DLYD DWELL	C22	ENGSYNC
A23	PRICLK	C23	CYL #1
A24	CYL SEL	C24	PEAK*
A25	1 MHZ	C25	VAC SEL*
A26	100 KHZ	C26	VAC HOLD*
A27	SPCLK1	C27	KILL SEL*
A28	SPCLK2	C28	KILL STAT*
A29	SPCLK3	C29	N.C.
A30	RESET*	C30	SDWL
A31	FORCE SEC*	C31	---
A32	GROUND	C32	GROUND

ANALOG BUS

J2XX PIN		J2XX PIN	
A1	ANALOG GROUND	c 1	ANALOG GROUND
A2	CH #7 SOLENOID DWELL	C2	CH #15
A3	CH #6 BOOM MUX	C3	CH #14
A4	CH #5 VOMMUX	C4	CH #13 AC VOLTS
A5	CH #4 BAT AMPS	C5	CH #12
A6	CH #3 BAT VOLTS	C6	CH #11
A7	CH #21R MUX	C7	CH #10
A8	CH#l SECONDARY	C8	CH #9 VAT MUX
A9	CH #O PRIMARY	C9	CH #8 DIST RES
A1O	ANALOG GROUND	C10	ANALOG GROUND
A11	N.C.		N.C.
A12	N.C.	C12	N.C.
A13	N.C.	C13	N.C.
A14	N.C.	C14	N.C.
A15	N.C.	C15	N.C.
A16	POINTS CLK	C16	N.C.

Digital Bus Signals/Sources

+5V (J1XX; AO1 and CO1)
+5 Volts is generated by Switching Power Supply #2, and supplies power to all the digital logic in the Sun Bus.

+15V (J1XX; A02 and **C02)**
+15 Volts is generated by Switching Power Supply #2. With the exception of the Vat Board, +15 volts is used to power +12 Volt regulators on the boards located on the Sun Bus. The +12 Volts is then used to power all of the CMOS logic on each individual Board.

-15V **(J1XX;** A03 and C03)
-15 Volts is generated by Switching Power Supply #2. With the exception of the Vat Board, -15 volts is used to power -12 Volt regulators on the boards located on the Sun Bus. The -12 Volts is then used to power all of the CMOS logic on each individual Board.

+12V (relay) **(J1XX;** A02 and **C02)**
+12 Volt Relay supply' is generated by Switching Power Supply #1, is used to power Relays and Lamps throughout the MCA-3000, and the Timing Light.

SBAO-SBA3 **(J1XX;** A07, C07, A08, C08)
Sun Bus Address Line. Asserted simultaneously with SBBSX* and SBR*W. Used for communication port decoding. Location-Bus Driver Board.

SBACK* **(J1XX;** A09)
Sun Bus Acknowledge is Low when data is written to the Sun Bus and stays low for approximately two microseconds. Data is guaranteed valid only on low to high transition and is present from approximately two microseconds before the low to high transition to approximately one microsecond after. This is ideal for latching data from the Sun Bus. Location-Bus Driver Board.

SBR*W (J1XX; C09)
Read* /Write goes high for Read from Sun Bus, low for Write to Sun BuS. The logic state is latched until the next Sun BUS operation occurs and controls direction of data flow on Sun BuS. Location-Bus Driver Board.

FLOWSTAT **(J1XX;** C1O)
Low Flow Status is normally low but goes high when there is insufficient gas flow through the IR Emissions Bench. When High, the front panel "LOW FLOW lamp should be lit to warn the operator that IR System Pneumatics may require service/maintenance. Location-IR Interface Board.

SBDS0-SBDS7 (J1xx; All, Cll, A12, C12, A13, C13, A14, and C14)
Sun Bus Data x (where x = O to 7) is a bidirectional tri-state data bus (eight lines numbered O through 7). They are normally high **(4.7K pullup,** 10K **pulldown).** On a <u>Write to the Sun Bus</u>, the data bus is activated approximately the same time SBACK* goes low and remains active for approximately three microseconds. On a <u>Read from the Sun Bus</u>, the Board selected by the address/bank select lines takes control of the data bus.
Generally, they provides data communication path between MCA-3000'S main processor and Sun Bus peripherals. Location-Bus Driver Board.

Digital Bus **Signals/Sources** (cent.~

LOAD ENGAGE **(J1XX; C15)**
Battery Loads Engaged goes high when the battery load is engaged. This indicates that potentially high currents are flowing in the battery and/or alternator field cables. This high also flags the Front Panel Interface Board warning lamp driver. Location-Volt Amp Tester Board.

SBBSO-SBBS7" **(J1XX,** All, **C11,** A12, C12, A13, C13, A14, and C14)
Sun Bus Bank Select x* (where x = O to 7) is output by Bus Driver Board, and is used to select a board or a combination of boards for active communication with the SBC. A chart showing the bank selects and there associated board follows:

SBBSO* Multimeter, ALDL, RPM/DWELL/TIMING, and DAS A/D
SBBS1* Primary and Secondary
SBBS2* **IR** Interface
SBBS3* VAT
SBBS4* BUS DRIVER Boom Mux
SBBS5* Front Panel Interface
SBBS6* N.U. for Future Expansion
SBBS7* N.U. for Future Expansion

CYL CLK **(J1XX;** C20)
Cylinder Clock. If PRIMARY is available and Trigger is in "AUTO" position, then CYL CLK is PRI CLK. If PRIMARY is not available then CYL CLK is generated from SECONDARY. CYL CLK is high from points open to shortly after (refer to PRI CLK) points closed if PRI CLK is present (points have definitely closed before PRI CLK falling edge). If PRI CLK absent, the falling edge is not guaranteed to occur after points closed event. CYL CLK is used by DAS A/D to set flags for KV readings and by Primary Board for timing and derivation of other signals. Location-Secondary Board.

MS CLK **(J1XX;** A21)
Millisecond Clock is high when spark plug fires (indicated by SECONDARY waveform) on a specific cylinder selected by software, and remains high for five milliseconds after the firing event. It is used to store data into DAS MEMORY Board's RAM during spark and firing KV, and spark duration and coil oscillation measurements. Location-Secondary Trigger Board.

CYL SHORT* **(J1XX; C21)**
Cylinder Short is normally high, but is active during power balance, cranking and engine kill. When active, it goes low from the falling edge of primary clock from the previous cylinder to the falling edge of primary clock of the cylinder being shorted. It can short any cylinder or cylinders desired and is software controlled from primary microcontroller. TRIAC GATE is used on Input Board to drive primary shorting circuitry. Location-Primary Board. See Chapter 9 Ignition Processing for more details.

DLYD DWELL **(J1XX;** A22)
Delayed Dwell is the Ignition primary signal that has been conditioned by a three stage filter. The duration of dwell is accurate, but its time relative position is Delayed by approximately 800 msec. DLYD DWELL maybe used for primary dwell measurement and during power balance testing to control cylinder shorting. Location-Primary Board.

Digital Bus Signals/Sources (cont.)

ENG SYNC (**J1XX;** C22)
Engine Sync is high for one millisecond when the red trigger clamp detects the firing of a cylinder. When clamped onto cylinder #1 spark plug wire, ENG SYNC signifies a cylinder #1 firing event. ENG SYNC Provides synchronization for CYL #1 and the Timing Light. It may also be used as a conversion trigger and/or a flag bit used in the A/D process. Location-Secondary Trigger Board.

PRI CLK (**J1XX;** A23)
Primary Clock is high from points open to about one millisecond after points closed (falling edge is triggered by same timing network that triggers DLYD DWELL falling edge). This is the only signal with a valid points open edge during cranking and power balance tests. When present, PRI CLK becomes CYL CLK. Primary is usually cleaner and more accurate than secondary. Location-Primary Board.

CYL #1 (**J1XX;** C23)
Cylinder #1 is high for one millisecond after the rising edge of ENG SYNC. If ENG SYNC not present, CYL #1 is synthesized from a 4-bit comparator/ counter combination which detects when the number of cylinder firings per full engine cycle is reached. The counter is clocked by CYL CLK and reset by falling-edge of CYL #1. Initial synchronization of CYL #1 is achieved with ENG SYNC, thus CYL #1 does not become valid until at least one valid ENGSYNC occurs.

CYL #1 is used heavily for engine cycle synchronization, also used for RPM calculations, power balance tests, data acquisition system analog-to-digital (DAS A/D) conversion for flags during KV reading and many other applications. Location-Secondary Trigger Board.

CYL SEL (**J1XX;** A24)
Cylinder Selected goes high from points open of selected cylinder to points open of next cylinder in the firing order. It is under software control of Primary Microcontroller and can select any cylinder or combination of cylinders. CYL SEL is derived from CYL CLK, and signals the start and end of the need to store data from the individually selected cylinder(s) into DAS MEMORY Board's RAM for digital oscilloscope display. Location- Primary Board.

PEAK* **(J1XX; C24)**
Peak Store* goes low 22 microseconds after spark firing (indicated by SECONDARY waveform), and stays low at least 80 microseconds during which SECONDARY peak is held. Peak* is used to flag DAS A/D that a valid peak SECONDARY KV signal is present. Location-Secondary Board.

1 MHZ **(J1xx; A25)**
1 Megahertz Clock is used. for various timing or counting functions and is generated by dividing down from 4 MHz crystal on Bus Driver Board. This clock pulse train is <u>not</u> synchronized with Sun Bus activity. Location-Bus Driver Board.

Digital Bus **Signals/Sources** (cent.~

VAC SEL **(J1XX; C25)**
Vacuum Selected is controlled by the front panel vacuum select switch. When this line is low the IR Emissions Drawer vacuum pump is activated. It remains low as long as switch is ON. When activated, the internal vacuum pump in IR Emissions Drawer is pneumatically connected to the vacuum fitting in boom. Location-Front Panel Interface Board. See Chapter 20 Front Panel Interface for more information. See Chapter 20 Front Panel Interface for more information.

100 KHZ **(J1XX,** A26)
100 Kilohertz Clock. Useful for varied timing or counting functions. Generated by dividing down from 1 MHz clock. Location-Bus Driver Board.

VAC HOLD* **(J1XX;** C26)
Vacuum Hold is controlled by the Front Panel Vacuum Select Switch. When this line is low the IR Emissions Drawer vacuum hold should be activated. It remains low as long as switch is ON. When activated, the Vacuum to the boom fitting is block off. Location-Front Panel Interface Board.

KILL SEL* **(J1XX; C27)**
Engine Kill Select is low when the front panel KILL switch is pressed and is used by the Primary Board to activate the Engine Kill circuit (presently shorts coil to ground). Location-Front Panel Interface Board.

KILL STAT* **(J1XX;** C28)
Engine Kill Status goes low whenever engine disabling circuitry is active. It may be activated either by the front panel KILL switch or by software demand, and indicates an engine kill situation. Location-Primary Board.

RESET* **(J1XX;** A30)
System Reset is normally high but goes low for 50 milliseconds following Tester powerup, resetting all Sun Bus boards to their known initial states. Location-Bus Driver Board.

FORCE SEC* **(J1XX;** A31)
Force Secondary is normally high level, but goes low when the front panel TRIGGER switch is pressed. This signal forces system triggering from the Preferred Secondary to Primary only.

GROUND **(J1XX;** A32 and C32)
Supplies ground to all board. This is the return path for the Power Supplies.

SDWL **(J1XX;** C30)
Solenoid Dwell, a digital clock pulse directly proportional to the duty cycle of the solenoid being measured. Location RPM/DWELL /TIMING Board.

SP CLK 1 and SP CLK 2 **(J1XX;** A27 and A28 respectively)
Special Clock 1 and Special Clock 2, are clock signals which are defined by software to be used as A/D conversion flags, when needed. Location RPM/DWELL/TIMING Board.

SP CLK 3 **(J1XX;** A29)
Special Clock 3 is a clock pulse who's interval is defined by software, to be used as a possible conversion flag, when needed. Location RPM/DWELL/TIMING Board.

Analog Bus Signals/Sources

ANALOG GROUND (**J2XX;** AO1 and CO1)
Supplies grounding for all analog signals.

CH #7 SOLENOID DWELL (**J2XX;** A02)
Solenoid Dwell is derived from the signal present on the Solenoid Dwell lead. It is filtered and reduced by a factor of three before being routed to the Sun Bus Backplane. This signal is used by the DAS A/D board for scope display. Location-RPM/Dwell/Timing Board

CH #15 **(J2XX; C02)**
Channel #15 of the MUX located on the DAS A/D Board. This Channel is not currently used, and is left open for future options.

CH #6 BOOM MUX (**J2XX;** A03)
Multiplexed Signals from Boom. Engine Vacuum, oil temperature, ambient temperature and coil + are multiplexed by the Bus Driver Board onto this analog channel. The Multiplexer is selected by writing a byte to a latch on the BUS DRIVER Board, with Bank Select 4 low and SBAO-3 all low

CH #5 VOM MUX (**J2XX;** A04)
This signal is used to multiplex the voltage, current, and resistance measurements made by the Multi meter Board. Location Multi meter Board.

CH #13 AC VOLTS (**J2XX;** C04)
AC VOLTS is Generated by the **Multimeter** Board, and contains the Analog voltage proportional to the RMS AC content of either the Pinpoint amps or volts lead. It can indicate AC current and Voltage measurements in the following **ranges:**

Volts: AC Range 1 0 to +/- 2 volts (**full** scale)
AC Range 2 2 to +/- 50 volts (full scale)

Amps: AC Range 1 0 to +/- 2 amperes (full scale)
AC Range 2 0 to +/- 7 amperes (full scale)

CH #4 BAT AMPS **(J2XX; A05)**
Battery Amps is an analog voltage proportional to the current sensed by the Amp Probe. This is an unfiltered signal and is used to read per cylinder data (i.e. charging system activity, individual cylinder compression and engine cranking verification). There are two ranges: O to 100 amperes and O to 1000 amperes. Range selected writing to bank select 3 address 00H. Data written selects **signal:** OOH-1OO amperes **full** scale, O1H-1OOO amperes full scale. Location-Volt Ampere Tester Board.

CH #12 **(J2XX; C05)**
Channel #12 of the MUX located on the DAS A/D Board. This Channel is not currently used, and is left open for future options.

BAT VOLTS (**J2XX;** A06)
Battery Voltage is an analog voltage proportional to the voltage sensed on either the Battery Clips or the Battery Clamps. Full scale is approximately 30 volts. Allows accurate battery voltage measurements (roughly within 10 millivolts). Location-Volt Amp Tester Board.

Analog Bus Signals/Sources (cont.)

CH #11 (J2XX; C06)
Channel #11 of the MUX located on the DAS A/D Board. This Channel is not currently used, and is left open for future options.

CH #2 IR MUX **(J2XX; A07)**
Multiplexed emissions module signals from IR Drawer. Signals correspond to HC, CO, **CO_2** and bench pressure. The multiplexer selected by writing to Bank Select 2, address 08H. Data written selects signal: OOH-HC, **01H-CO,** 02H-CO_2,03 H-O_2 05 H-bench pressure, 06 H-spare 1 and 07 H-spare 2. Used for **emissions** testing and bench calibration. **Location-IR** Interface Board.

CH #10 **(J2XX; C07)**
Channel #10 of the MUX located on the DAS A/D Board. This Channel is not currently used, and is left open for future options.

CH #1 SECONDARY (J2XX; A08)
This is the engine's secondary waveform scaled to 1.0 volt per 5 KV. The peak voltage is held for approximately 80 microseconds. This signal can be displayed on Video Display Unit during waveform diagnostics. Location-Secondary Trigger Board.

CH #9 VAT MUX **(J2XX;** C08)
Volt-Ampere Test MUX is an analog signal and can be any of the following: battery load voltage, battery load current, battery temperature and alternator ripple. The multiplexer may be selected by writing to Bank Select 3, address OIH. Data written selects signal: 00 H-load voltage, **01H-load** current, 02 H-battery temperature and 03 H-alternator ripple. It is used by electrical system software for system analysis. Location-Volt Amp Tester Board.

CH #O PRIMARY **(J2XX;** A09)
This is the engine's coil primary waveform divided by 50. The waveform peak which follows points open is held for 60 microseconds by a peak hold circuit. This Wave form can be displayed on Video Display Unit during waveform diagnostics. Location-Primary Board.

CH #8 DIST RES **(J2XX;** C09)
Distributor Resistance signal is the vehicle's primary voltage divided down to 1/3 it's original amplitude. This signal is then it is buffered and clipped to finally become the analog the **DIST** RES signal which is distributed on the analog portion of the SUN BUS. This signal then can be converted (A/D) after points closed (triggered by PTS CL K*) and the resultant value is displayed as PRI RES on the monitor. The point at which distributor resistance is sampled and the sampling time are both controlled by the primary microcontroller. Location-Primary Board.

ANALOG GROUND **(J2XX;** AlO and C1O)
Supplies a ground for all analog signals.

PTS CLK" **(J2XX;** A16)
Points Clock, is a digital signal generated on the PRIMARY Board. It is normally low and goes high for 200 microseconds after points closed has occurred. The falling edge is used to trigger Primary Resistance sampling for A/D conversion. Location PRIMARY Board.

SUN BUS Board FUNCTIONAL DESCRIPTION

A brief functional description of each of the mounted Sun Bus circuit card assemblies follows. Also, see page 7-14 for Board location.

ALDL Reader Board #7001-0543
This Board is the interface device which functions to control serialized communications between the Tester and the vehicle ALDL (Assembly Line Diagnostic Link). This Board is composed of the following major circuitry: four Green LED's which function as diagnostic indicators on powering up the Tester to indicate the operational status (error detection) of the ALDL, Red and Green LED's which function to indicate satisfactory battery polarity connection (Green) and incorrect battery polarity connection (Red), fused (1 ampere) mode selection circuitry which connects ground, 3.9K or 10K to the vehicle, Baud rate/ USART clock selection circuitry for governing speed of intercommunications, variable threshold Schmitt trigger circuitry- for detecting non-uniform amplitude received signals and ultimately developing a clean squared off version of the received signals, single/differential mode communication channels operating under microcontroller control and 12v power supply.

The four Green diagnostic LED's rapidly progress through a binary code sequence indicative of on-board circuitry status each time the Tester is powered up. Approximately one second after powering the Tester these LED's must all be lit to indicate a satisfactorily operating board. If any other LED illumination condition occurs it indicates a malfunctioning board.

The Red LED, when lit, indicates that the external battery connection is improper and must be reversed. The Green LED, when lit, indicates normal battery connection to the ALDL connector.

Primary Trigger Board #7001-0544
The Primary Trigger Board functions to process ignition system input signals and the primary sync pulse received from the vehicle under test.

SUN BUS BACKPLANE Board #7001-0547
The SUN BUS BACKPLANE Board provides two common busses, ANALOG and DIGITAL. Each Bus has it's own connector, the ANALOG BUS uses the J2XX connectors while the DIGITAL BUS uses the JIXX connectors. There are **18** slots or pairs of connectors.

Multimeter Board #7001-0550
The **Multimeter** Board processes typical **multimeter** input electrical signals /**properties**/ components such as: AC/DC volts, AC/DC amperes and Ohms. The analog DC voltage outputs from this Board are supplied as inputs via the Sun Bus to the DAS A/D Board for further processing and conversion to a digital output.

Secondary Trigger Board #7001-0551
The Secondary Trigger Board functions to basically process the vehicle under test secondary input and trigger pulses to generate various clock output **signals,PEAK** (store control), CYL #1, and ENG SYNC secondary outputs to the Sun Bus.

Volt Amps Tester Board #7001-0552

The Volts Amps Tester Board, operating under master computer control, produces Battery Load Driver Board output control signals which serve to control the 20A, 80A and lOOA loads applied to the battery. This board also generates a bias voltage required by the AMP probe Hall chip transducer and processes input voltage signals received from the AMP probe in order to generate a DC output voltage for application to the DAS A/D Board. Additionally, this board processes VCLIP or VCLAMP (connected directly across the battery under test) input signals in order to produce the following selected outputs: battery load voltage, battery load current, battery temperature and alternator ripple.

RPM/Dwell/Timing Board #7001-0553

The RPM/Dwell/Timing Board processes engine sync, monitors the vehicle under test distributor contact closure duration, RPM magnetic pickup device outputs and routes resultant output signals to the Sun Bus. Green LED 1 indicates the presence of a domestic type magnetic pickup, while red LED 2 indicates the presence of a European type magnetic pickup. When both F1 and F2 are lit simultaneously an optical type pickup is sensed. When only the red LED F3 is flashing it indicates the presence of a timing light. LED 4 indicates the presence of an “ES” signal (engine sync signal) and LED 5 indicates the application of a “TIME” pulse (input timing pulse).

DAS AID Board #7001-0555

The DAS A/D Board functions primarily as a data acquisition system (DAS) analog-to-digital (A/D) converter. This board, operating under control of its on-board microcontroller and various received clock pulses, converts received analog signal voltages into a 16-bit digital output. To select one of the multiplexer’s 16 channels is done by writing a byte to a latch on the BUS DRIVER Board along with BANK SELECT 4* low and SBA0-3 bits low. The developed A/D digital output signal is then level shifted to RS-232C specification prior to transmittal to the DAS Memory Board located on the Computer Module. Green LED 5 monitors +15V while green LED 6 monitors -15V power application to the board. Red LED 1, when lit, indicates the presence of a low level RAMEN* signal which is applied to the DAS Memory Board.

IR Interface Board #7001-0557

The IR Interface Board functions to process exhaust gas signals received from the IR Bench, by way of the Solenoid Driver Board. The IR Interface Board also produces output signals to the SOLENOID DRIVER Board which ultimately control the operation of various gas and vacuum control solenoid valves.

BUS DRIVER Board #7001-0559

The BUS DRIVER Board is used to receive and transmit data to and from the SUN BUS and the I/O/EEPROM/CLOCK Board. It decodes and buffers the SUN BUS ADDRESS lines and BANK SELECT lines. It is also receives the BOOM MUX signals; VACUUM, OIL, TEMPERATURE, Ambient Temperature and Coil + Average and unaveraged signals, it is here that these signals are multiplexed on the BOOM MUX line.

Front Panel Interface Board #7001-0616
Tester front panel switches and lamps are read and controlled by the Front Panel Interface Board. This board is comprised of three basic circuits: lamp/switch control, speaker control and power-on test. A front panel VOLUME control functions to control speaker output volume. The power-on test circuitry forces momentary lighting of the 10 control panel ANALYZER MODE lamps and the LOW FLOW, ENG KILL and BAT LOADSTATUS lamps upon powering up the Tester. The MODE ANALYZER and MODE PC 5 1/4 lamps are not tested by the power-on test circuitry. Internal switch control circuitry functions to produce low level KILL SELECT, VAC SEL, VAC HOLD, and FORCE output control signals to appropriate Board's located on the Sun Bus.

SINGLE BOARD COMPUTER TO SUN BUS COMMUNICATIONS
SBC to Sun Bus communications is primarily controlled by the MCA-3000'S SBC controlling operation of the I/O/EEPROM/Clock Board and Bus Driver Board.

NOTE Refer to -Diagram 7-1, entitled "Sun Bus/SBC Communications, Functional Block Diagram", as an aid in understanding the following text.

When SBC address bits A2-9 match the setting of DIP switch SW2 of the I/O/EEPROM/CLOCK Board, the comparator develops an Address Equal signal to the decoder. The status of address bits AO and Al and applied READ/WRITE* signal then dictates whether a Write Sun Bus Address, Write Sun Bus Data, Read Sun Bus Address, or Read Sun Bus Data output signal is generated. Generation of the Write Sun Bus Address and Write Sun Bus Data signals is required for the SBC to Sun Bus Communications to occur.

Sun Bus BANK SELECT O-7* output signals are developed by the 3 to 8 line decoder and applied to connector J103. These BANK SELECT signals are supplied to the Sun Bus Backplane for transfer to the various Board's located throughout the sun bus.

Data bus bits, received from the SBC, are processed through an octal bus transceiver and routed via the buffered data bus to two succeeding octal latches. With WRITE SUN BUS ADDRESS present, the address control octal latch passes SUN BUS ADDRESS bits to J401 pins 3 through 10. From this point the address bits are passed via interconnecting cabling W18 to connector J301 located on the Bus Driver Board.

Within the Bus Driver Board, SUN BUS Address bits SBA0-3 and SBA7 are applied to an address buffer while address bits SBA4-6 are supplied as inputs to the 3 to 8 Line Decoder for the bank selects. A Sun Bus Acknowledge (SBACK*) signal for a duration 2 microseconds is used to strobe data from the I/ C)/EEPROM/Clock Board, it is also supplied as an input signal to the address buffer. The address buffer then produces On-Sun Bus Address bits O-3 (OSBA0-3), Sun Bus Read/Write* and On-Sun Bus Ack* signals to Sun Bus Backplane connector J103. <u>When writing from the SBC to the sun bus</u>; SUN BUS READ/WRITE* is at a low level and when <u>reading from the sun bus to the SBC</u> it is a high level. The Sun Bus Read/Write* signal is also supplied as a directional control input signal to the Data Buffer. Buffered data bus bits are processed through the data flow control octal latch whenever the Write Sun Bus Data* signal is a low level. Octal latch output signals, are routed as sun bus data and made available at connector J401 for transfer via Sun Bus Data lines to connector J301 located on the Bus Driver Board.

When the Sun Bus Read/Write* signal, generated within the Bus Driver Board, is a low level; sun bus data bits are processed via the data buffer and renamed On-Sun Bus Data. These **On-Sus** Bus **Data0-7** signals are then supplied via Sun Bus Backplane connector J103 for application to remaining Board's within the sun bus.

NOTE A new address byte is not required for writing each data byte. An unlimited number of bytes of data may be written for any one address byte generated. Software control dictates the number of data bytes accompanying each address byte. Each New data byte is accompanied by a SBACK* used to strobe the data to the required board register.

SUN BUS TO SBC COMMUNICATIONS

Sun bus to **SBC** communications is possible only after a write operation has taken place. This is done to select the proper Bank Select, Address, and function. then the Sun Bus Read/Write* signal goes high. When Sun Bus Read/Write* is high, along with the proper bank and address signals. The requested data byte is placed on the SUN BUS, using On-Sun Bus DataO-7. This data byte is then buffered by the BUS DRIVER Board's Data Buffer. The direction of data through the BUS DRIVER Board's Data Buffer is defined by the Sun Bus Read/Write* signal, when logic low, data is buffered from I/O/EEPROM/CLOCK Board to SUN BUS. However if at logic high then data is buffered in the opposite direction or from SUN BUS **to** I/O/EEPROM/CLOCK Board. The ON-SUN BUS DATA byte is then latch by the I/O/EEPROM/CLOCK Board's Read Sun Bus Data Latch where it is held for the SBC to read through an 1/0 operation where the data byte is passed through an **octal** bus transceiver and routed via the data bus to connector **J1** for application to and processing by the SBC.

EXAMPLE

First the SUN BUS is written to, this sets up which function or parameter will be read. The data table would resemble the following:

Task	Bank Select	Address	SBDO	SBD1	SBD2	SBD3
Select VLOAD DATA	3	1	.-*	0	0	0

*unused

After the WRITE operation to select the function or parameter. The SUN BUS READ/WRITE* line goes high. Thus signaling a READ. Only this time SUN BUS DATA bits O-7 will by the actual data representing VLOAD data.

SECTION II. CALIBRATION

GENERAL

Calibration procedures for all variable controls located on the Boards within the Sun Bus are described within individual Chapter(s) of this manual.

SECTION III. TROUBLESHOOTING

As a result of design and manufacturing simplicity the Sun Bus Backplane Board (motherboard) should seldom, if ever, require replacement. This board contains six resistor packages (RP7-RP12), eighteen 64 pin digital bus connectors (J101-J118), eighteen 32 pin analog bus connectors (J201-J218) and a 12 pin power input connector (J712).

Troubleshooting of this board consists of monitoring J712 pins 8 & 10 for +5V, pin 6 for +15V, pin 4 for -15V and pin 2 for +12V relay power. Pins 1,3 and 5 are grounded. Also, using Extender Card 7001-0576 and monitor JIXX pins Al, A2, A3 and A5 for +5V, +15V, -15V and +12V relay respectively. The previous measurements are reasonable assurance that the necessary voltages are present on all loaded Boards.

It is also important to remember when troubleshooting the MCA's common bus setup or SUN BUS, that not only directly related board(s) can cause problems. But other unrelated board(s) can effect communication on the SUN BUS. This may cause other board(s) to given invalid data or not give data at all. Here are some tips to troubleshoot this possibility: "

1. Rule out obvious board(s) first, such as all directly related Circuit Board(s).

2. Verify that its not an 1/0 communications problem, substitute BUS DRIVER and I/ O/ EEPROM/CLOCK Boards.

3. Verify proper operation of the DAS A/D Board. If most of all the other parameters or muxs are "OK", then the DAS A/D Board is most likely good.

4. Reduce SUN BUS population to the minimum required for that function, such as directly related Board(s), BUS DRIVER Board and the DAS A/D Board.
   Does that correct the problem ?
   YES NO
   | |
   | Your problem is probably caused by one of the first
   | three steps. Go back and repeat them.

   One by one, reinstall the previously removed Boards. Check to see if the problem still exist after each board is reinstalled. When the problem reoccurs the board reinstalled last is the problem and needs to be replaced.

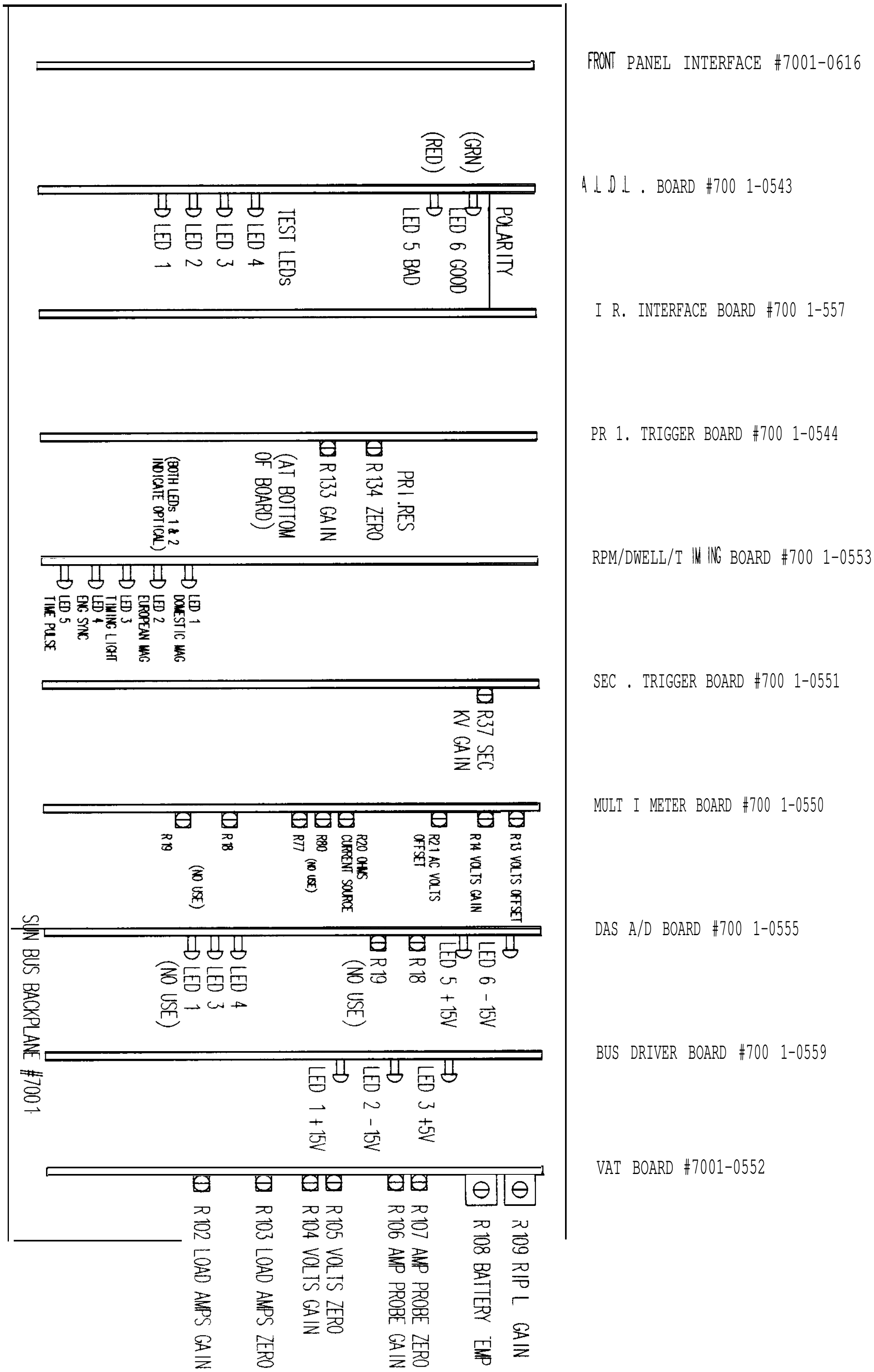
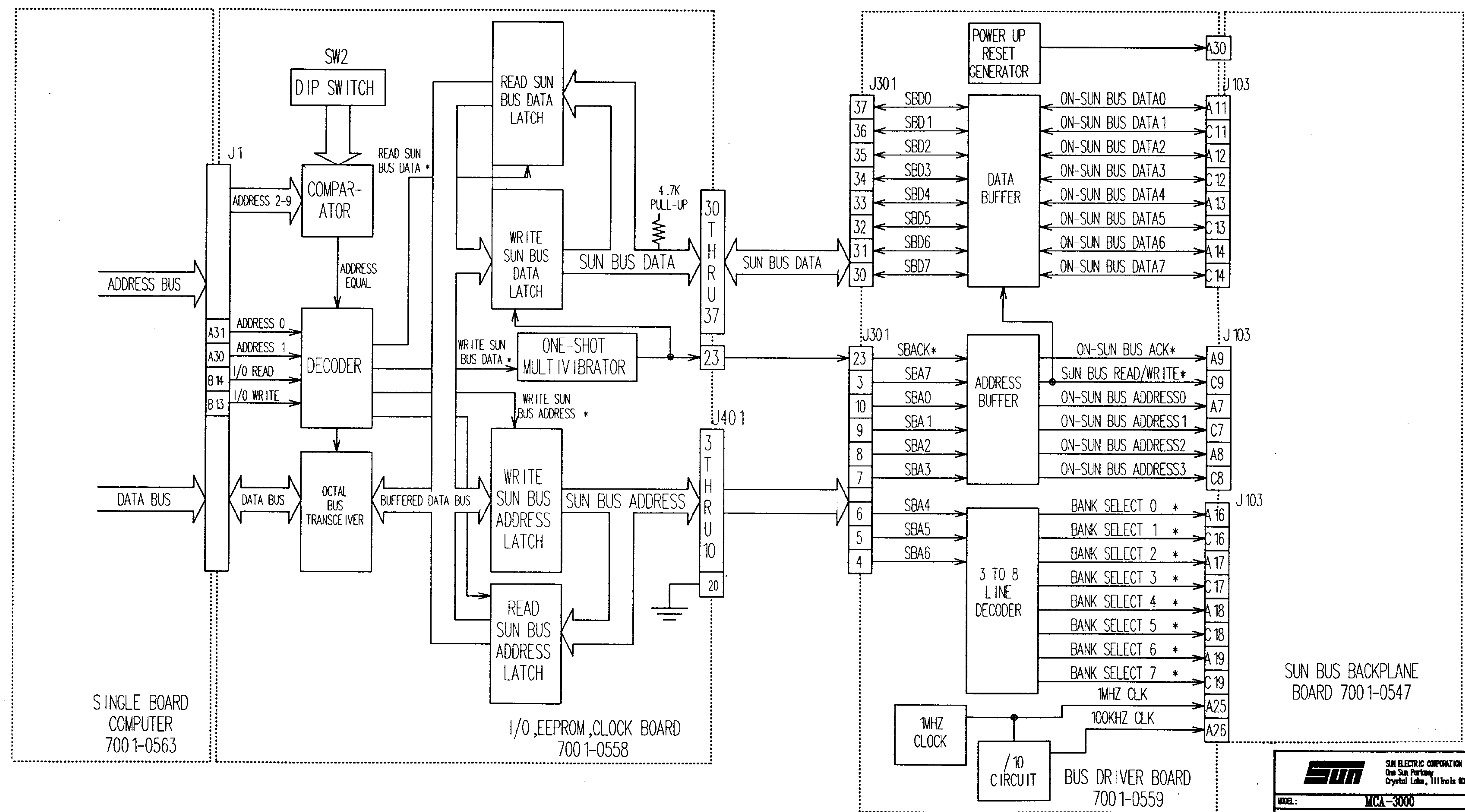


Figure 7-1. Sun Bus, Parts/Control Location.

NOTES



SUN ELECTRIC CORPORATION
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MODEL:	MCA-3000
TITLE:	SUN BUS/COMPUTER COMMUNICATIONS
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CHAPTER 8

DATA ACQUISITION SYSTEM (DAS)

GENERAL

The DAS system, shown in Diagram 8-1, Page 8-9/10, consists of the DAS A/D (Analog-to-Digital Converter) Board located on the Sun Bus and the DAS Memory Board located on the Single Board Computer (SBC). The DAS A/D Board converts analog signal inputs, sensed by external test leads, into a digital output. This digitized output signal, representative of the sampled analog input signal, is made available to the SBC in two different ways.

1. Individual conversions such as running page data, is sent to and latched by the I/O/EEPROM/CLOCK Board via the SUN BUS's BUS DRIVER Board. The I/O/EEPROM/CLOCK Board then makes available the DAS A/D Board's data to the SBC through its 1/0 function.

2. Continuous conversions is used in generating digitized scope patterns and gathering amps per cylinder data. The continuous A/D conversion data is sent from the DAS A/D Board to the DAS MEMORY Board were it is stored in RAM memory, which the SBC can address and read.

NOTE: It is important to remember that the SBC can perform memory read/write operations faster and with less overhead then SUN BUS 1/0 read/write operations. The DAS system makes use of this, through the DAS MEMORY Board, thus allowing the continuous converted data faster access to the SBC. This also alleviates a lot of system overhead required for a SUN BUS 1/0 operation.

Once the SBC has accessed the A/D conversion data, control and arithmetic calculation and processing on the digital data can occur at any time under the SBC's control. Results of these calculations and processing are then output at required times for display and/or printout.

SECTION I. THEORY OF OPERATION

16 Channel Multiplexer Analog Signal Input Sources

Analog DC signal inputs to the DAS A/D Board come from the various Board's located within the Sun Bus. The generated analog signals are applied to the analog bus portion of the Sun Bus and are ultimately applied to the DAS A/D Board card connector J204. All digital control signals applied to the DAS A/D Board are inputted from the Sun Bus and individual A/D conversions data (as ON-SUN BUS DATA) are available on card connector J104.

The following DC voltage input signals are applied to the 16 channel multiplexer:

Signal Name	Analog Channel
Primary	0
Secondary	1
IRMux	2
BAT Volts	3
BAT Amps	4
VOM Mux	5
BOOM Mux	6
Sol Dwell	7
DISTRES	8
VAT Mux	9
AC Volts	13

Note: Analog channels 10-12, 14 & 15 are not presently used.

PRIMARY/DIST RES Signal Processing

The Primary Board processes analog input signals sensed by the primary pickup and generates PRIMARY and DIST RES analog output signals. The PRIMARY DC analog output signal is routed on the SUN BUS to J204 pin A9 and into channel O of the 16 channel multiplexer located on the DAS A/D Board while the CLIPPED PRIMARY analog output signal is routed on the SUN BUS to J204 pin C9 and into channel 8 of the 16 channel multiplexer. The PRIMARY signal is used in creating the DIST RES signal which is used for measuring PRIMARY RESISTANCE and is also used in generating a digitized Primary scope pattern.

SECONDARY Signal Processing

The Secondary Board converts the secondary analog signal, from the secondary pickup, into a DC analog output signal which is routed on the SUN BUS to J204 pin A8 into channel 1 of the 16 channel multiplexer. This signal is used to measure Secondary KV and Spark KV and in generating a digitized Secondary scope pattern

IR MUX Signal Processing

The IR Interface Board processes HC, CO, C02, O2 gas concentration and IR PRESSURE analog signals received from the IR Module and generates a DC analog output IR MUX signal. This DC analog signal is then routed on the SUN BUS to J204 pin A7 and into channel 2 of the 16 channel multiplexer. At any instant in time, software control dictates which of the five input signals is made available on the IR MUX line for application to the 16 channel multiplexer. The IR MUX Signal is used for generating the exhaust emission readings

BAT VOLTS/BAT AMPS Signal Processing

Analog circuitry located within the VAT Board processes Clip or Clamp sensed battery voltage and generates a DC voltage output signal designated BAT VOLTS. This DC analog signal is then routed on the SUN BUS to J204 pin A6 and into channel 3 of the 16 channel multiplexer. A separate analog circuit, also located within the VAT Board, processes AMP probe Hall effect output and develops a DC analog signal output designated BAT AMPS. This DC analog signal voltage is then routed on the SUN BUS to J204 pin A5 and onto channel 4 of the 16 channel multiplexer.

VOM MUX Signal Processing
Analog circuitry, located within the **Multimeter** Board, processes VDC, VAC, AMPS DC, AMPS AC and ohms to generate a DC voltage output signal designated either VOM MUX or AC VOLTS/AC AMPS depending upon Pinpoint measurements software control. The VOM MUX DC voltage signal output is routed on the SUN BUS to J204 pin A4 and onto channel 5 of the 16 channel multiplexer. The AC VOLTS/AC AMPS signal, in reality a DC voltage signal, is routed on the SUN BUS to J204 pin C4 and onto channel 13 of the 16 channel multiplexer.

BOOM MUX Signal Processing
The Bus Driver Board processes the following analog input signals:

1. Oil temperature received from the oil temperature probe.
2. Ambient temperature, a dc analog voltage received from the ambient temperature sensor located within the Input Filter Board.
3. Vacuum, a dc analog voltage generated by the vacuum transducer located within the Input Filter Board.
4. Coil +, a analog voltage generated by the pickup clip connected to the coil primary + terminal.

The Bus Driver Board's on-board multiplexer, operating under software control, selects the desired input for outputting on the BOOM MUX line. This selected signal is then routed on the SUN BUS to J204 pin A3 onto channel 6 of the 16 channel multiplexer.

SOLINOID DWELL Signal Processing
The RPM Board receives a mixture control dwell (SDWL) input signal, sensed by the blue clip lead of the Volt/Ohm/Dwell Test Lead Assembly connected to the vehicle mixture control solenoid. Internal on-board analog circuitry produces an output SOL DWELL signal which is routed via the SUN BUS to J204 pin A2, and onto channel 7 of the 16 channel multiplexer.

VAT MUX Signal Processing
The VAT Board produces the following output signals to the DAS system:
VAT MUX Signals. The VAT Board receives the following input signals:

1. VLOAD (battery load voltage) from Battery Load Driver Board.
   ILOAD (battery load current) from Battery Load Driver Board.
   BATTEMP (battery temperature) from Battery Load Driver Board.
2. **BATRIPP** (battery ripple) sensed from V CLIP or V CLAMP
   RIPPWAV (ripple waveform) sensed from V CLIP or V CLAMP
   FLTRAMP (filtered high amperes) from Green Amps Probe.
   Analog circuitry on the VAT Board functions to process all three of these signals prior to their application as inputs to the on-board 8 channel multiplexer.
3. 15V located on-board the VAT Board but divided down to 7.5V prior to application to the on-board 8 channel multiplexer.

The on-board 8 channel multiplexer, operating under software control, selects one of the above mentioned eight input signals (highlighted) for outputting on the VAT MUX line. From this point the software selected signal is routed via the SUN BUS to J204 pin C8, and onto channel 9 of the 16 channel multiplexer.

DAS **A/D** Board Theory

The DAS A/D Board basically consists of the **following** functional circuitry:

1. 16 Channel Multiplexer
2. Sample and Hold Amplifier
3. 12 bit Analog-to-Digital Converter
4. Data Latch
5. Microcontroller
6. Trigger Multiplexer
7. Programmable Timer
8. Sun Bus Logic.
9. Flag Logic.

The DAS A/D Board 16-channel multiplexer, operating under channel select O-3 control signals developed from the microcontroller and its associated 1/0 expander, passes the selected mux signal to the sample and hold amplifier stage. This stage, operating under control of the analog-to-digital converter (ADC), functions to sample the applied mux signal and to store its peak value. The stored analog voltage is then applied to the analog-to-digital converter, which converts the **analog** voltage into a 12-bit digital output, having a value directly dependent upon the amplitude of the applied analog mux signal.

Trigger MUX

A/D conversion timimg is controlled by the microcontroller and associated 1/0 expander port by selecting either a conversion trigger **from** the conversion mux or a pre-defined time interval from the programmable timer. Conversion triggers available to the conversion **trigger mux are as** follows

Points CLK
CYL CLK
Selected CYL
Peak Store
MS CLK
Special Clock 1
Special Clock 2
Special Clock 3
Solenoid Dwell

After a A/D conversion, the 12-bit data is latched by a 16-bit latch, the other 4-bit data are used as flags. The flags are used to indicate when the conversion event occurred in relationship to certain engine events, they are:

CYL #l indicating the firing of cylinder #1.

CYL CLK indicating the firing of a cylinder, any cylinder.

SOL CLK indicating the beginning event of the mixture control solenoid.

SP CLK #3 (developed on the RPM/Dwell/Timing Board) which can assigned a Particular event, which is software selectable.

The DAS A/D Board also generates other signals for the DAS MEMORY Board to use. Such as:

ADDRESS WRITE (AWR), is the output signal of a ripple counter found on the DAS Memory Board, is used to increment the RAM ADDRESS GENERATOR on the DAS MEMORY Board used to assign memory address locations for the incoming data continuously converted from A/D. It is also used as a latch enable signal for the data latches used in latching data from the DAS A/D Board to DAS MEMORY Board. Is made available to the DAS MEMORY Board through J303 pin 42.

RESTART (RESTART) is used to reset the RAM MEMORY ADDRESS GENERATOR so that the DAS A/D Board can load (or wrap) data into the first RAM locations on the DAS MEMORY Board

The DAS A/D Board uses RS-232 communication levels (CMOS Logic levels and higher drive currents) to prevent noise being induced on the interface cable between the DAS A/D Board and the DAS MEMORY Board

DAS Memory Board Theory
Applied AD00-15 input bits, REN, AWR, and RESTART bits are level shifted downward to TTL level by memory interface logic. AD00-15 input bits are split into two separate bytes (8 bits = 1 byte). One called HIGH BYTE the other is called LOW BYTE. HIGH BYTE contains the status flags and A/D conversion data bits 8-11, whereas LOW BYTE containing A/D conversion data bits O-7. The HIGH BYTE and LOW BYTE data is then stored one on top of the other in the 128K of RAM located on the DAS MEMORY Board. It is important to remember that the SBC's processor's external data bus is only 8 bits wide, it is for this reason that the AD00-15 is divided into two separate bytes. The SBC can now access the conversion data stored in RAM by performing a memory read operation on the DAS MEMORY Board's 128K of RAM memory. The HIGH BYTE, LOW BYTE are then re-assembled back into one 16 bit word for the SBC's processor to deal with on it's own internal data bus.

SECTION II. CHECK-OUT

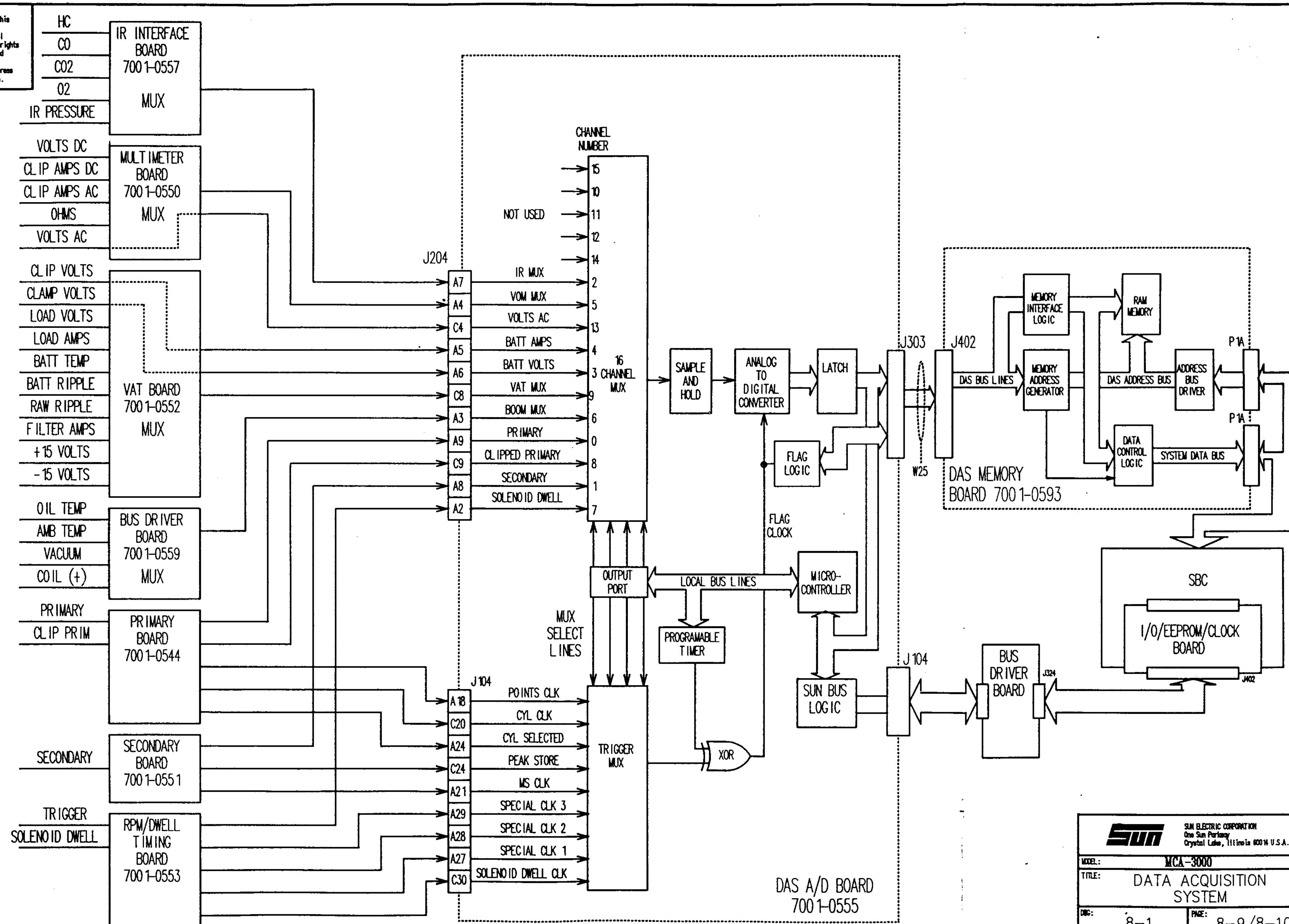
No calibration/adjustment is required. If the DAS System is not functioning properly, the result will be inaccurate or omitted readings on one or more channels. Therefore, if the individual functions of the MCA-3000 are checked and working properly it can be assumed the DAS System is also working properly.

SECTION III. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. DAS A/D Test page . IR MUX reading on VDU abnormal. All other DAS A/D Test page readings normal.	1.------------SUBSTITUTE ---------------------- A. IR Interface Board #7001-0557 B. DAS A/D Board #7001-0555 C. DAS Memory Board #7001-0593 2. Refer to Theory of Operation and Functional Diagram.
II. DAS A/D Test page VOM MUX reading on VDU abnormal. All other DAS AID Test page readings normal.	1.------------SUBSTITUTE ---------------------- A. Multimeter Board #7001-0550 B. DAS A/D Board #7001-0555 C. DAS Memory Board #7001-0593 2. Refer to Theory of Operation and Functional Diagram .
III. DAS A/D Test page AC VOLTS reading on VDU abnormal. All other DAS A/D Test page readings normal.	1. -------------SUBSTITUTE ------------------- A. Multimeter Board #7001-0550 B. DAS A/D Board #7001-0555 C. Memory Board #7001-0593 2. Refer to Theory of Operation and Functional Diagram.
IV. DAS A/D Test page BATT AMPS, BATT VOLTS and/or VAT MUX reading(s) on VDU abnormal. All other DAS A/D Test page readings normal.	1. --------------SUBSTITUTE ------------------- A. VAT Board #7001-0552 B. DAS A/D Board #7001-0555 C. Memory Board #7001-0593 2. Refer to Theory of Operation and Functional Diagram.
V. DAS A/D Test page BOOM MUX reading on VDU abnormal. All other DAS A/D Test page readings normal.	1. --------------SUBSTITUTE ------------------- A. Bus Driver Board #7001-0559 B. DAS A/D Board #7001-0555 C. Memory Board #7001-0593 2. Refer to Theory of Operation and Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
VI. DAS A/D Test page PRIMARY and/or **DISTRES** (clipped primary) reading(s) on VDU abnormal. All other DAS AID Test page readings normal.	1. --------------SUBSTITUTE ------------------- A. Primary Board #7001-0544 B. DAS A/D Board #7001-0555 C. Memory Board #7001-0593 2. Refer to Theory of Operation and Functional Diagram.
VII. DAS AID Test **page** **SECONDARY reading** on VDU abnormal. All other DAS **A/D** Test page readings normal.	1. --------------SUBSTITUTE ------------------- A. Secondary Board #7001-0551 B. DAS A/D Board #7001-0555 C. Memory Board #7001-0593 2. Refer to Theory of Operation and Functional Diagram.
VIII. DAS A/D Test page SOLENOID DWELL . reading on VDU abnormal. All other DAS A/D Test page readings normal.	1. " --------------SUBSTITUTE ------------------- A. RPM/Dwell/Clock Board #7001-0553 B. DAS A/D Board #7001-0555 C. Memory Board #7001-0593 2. Refer to Theory of Operation and Functional Diagram.

NOTES



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MODEL:	MCA-3000
TITLE:	DATA ACQUISITION SYSTEM
DWG: 8-1	PAGE: 8-9/8-10

CHAPTER 9

IGNITION PROCESSING & CYLINDER SHORTING

GENERAL

NOTE The following text is written with reference to the Ignition Processing & Cylinder Shorting Functional Block Diagram 9-1.

Vehicle generated analog signals must be converted into low level analog signals for A/D coversion and digital signals for processing by the RPM/Dwell/Timing Board. Two of the most important signals for proper operation of the Tester are: (1) CYLINDER CLOCK K--usu ally abbreviated CYL CLK and (2) ENGINE SYNC RONIZATION--usu ally abbreviated ENG SYNC.

The CYLINDER CLOCK signal is generated by detecting the primary firing voltage of each cylinder's spark plug (if primary is avalable). Secondary firing voltage is used in the absence of the primary signal or when the tester is forced into secondary triggering. The ENGINE SYNC signal is generated by detecting the firing current of the number 1 spark plug of the engine. Figures 9-1 shows a typical primary waveform and the resulting ENGINE SYNC and CYLINDER CLOCK signals for a 6 cylinder engine.

Primary — J206, pin A9.

Engine Sync — J108, pin C22.

Cyl Clock — J108, pin C20.

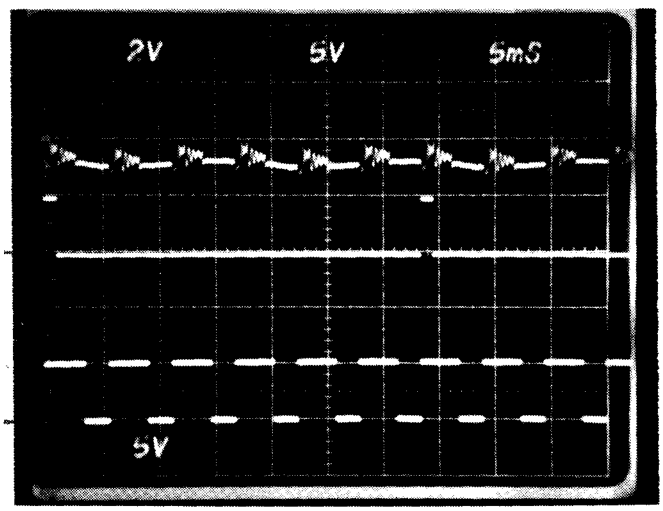


Figure 9-1. ENGINE SYNC and CYLINDER CLOCK (6 Cylinder Engine).

SECTION I. THEORY OF OPERATION

The Primary Board portion of this circuitry has seven main functions:

1. Provide a cylinder clock (CYL CLK) generated from the primary side of the vehicle's coil.
2. Provide a clock (DELAYED DWELL) that has the ignition distributor's dwell information.
3. Provide an analog signal (PRIMARY) for waveform analysis.
4. Provide a clock signal (DISTRES) that is suitable for triggering a measurement of the resistance (voltage) of the distributor points (see Chapter 14).

5. Provide a digital signal (POINTS CLOCK) that occurs at points close, to provide the correct timing to measure dynamic distributor resistance,
6. Provide a means (CYL SHORT or ENG KILL) for preventing the firing of the spark plugs by shorting across the engine's primary to ground.
7. Provide a clock signal (CYL SEL) for doing individual per cylinder test measurements.

The Secondary Board portion of this circuitry performs the following

1. Provides an analog signal (SECONDARY) for waveform analysis.
2. Produces a cylinder clock (CYL CLK) output from either the primary clock signal or a synthesized secondary clock.
3. Produces an engine sync (ENG SYNC) output pulse which is used by the RPM Board to generate RPM readings in the event the CYL CLK is not present. This signal is also used to synchronize Cylinder #1 and the cylinder counter and compute timing readings.
4. Generates a PEAK STORE output signal which can be used to flag the DAS (Data Acquisition System) A/D (Analog-to-Digital) Board that a valid secondary KV is present.

ENGINE SYNC (ENG SYNC)

The red trigger pickup is clamped around the engine's number 1 spark plug wire so that a voltage is induced into the windings of the trigger pickup each time the spark plug fires. An R-C filter network, located within the Input Filter Board #7001-0549, functions to reject noise i.e.: RFI (radio frequency interference) generated by the engine's ignition system. The Input Filter Board also provides high voltage isolation for the trigger signal via a 1:1 isolation transformer. The Secondary Trigger Board's #7001-0551 trigger processing circuitry transforms the applied signal into a digital output pulse (ENG SYNC). The rising edge of the ENG SYNC is the point at which the number 1 spark plug started to fire. ENG SYNC remains high for 1 millisecond. The ENG SYNC signal is routed to the RPM/Dwell/Timing Board #7001-0553, which uses this signal to synchronize the CYL CLK signal to its particular cylinder. Also, to develop RPM readings if the CYLINDER CLOCK signal is not present.

CYLINDER CLOCK

The CYLINDER CLOCK signal can be derived from either the primary (blue) clip lead that is connected to the (-) negative terminal of the coil or from the secondary (chrome) clamp that is connected around the coil secondary wire. On certain vehicles a special adapter (GM-HEI or Toyota- HEI adapter) is used instead of the chrome clamp around the coil wire.

SECONDARY CYLINDER CLOCK

The signal from the secondary pickup, chrome clamp or HEI adapter, is filtered by the filter network located on the Input Filter Board, then applied to the secondary processor located on the Secondary Trigger Board #7001-0551. The secondary clock processor converts the secondary input signal to the digital signal shown in Figure 9-3. Note the digital signal rising edges coincide with the firing of the spark plugs.

The SECONDARY CLOCK signal is applied to the cylinder clock select logic which outputs CYL CLK. If a PRIMARY CLOCK signal is not present, or the front panel Trigger Switch is on, the SECONDARY CLOCK is used to create CYL CLK. If PRIMARY CLOCK is available, CYL CLK is generated by PRIMARY CLOCK. Therefore, the tester will normally default to the PRIMARY CLOCK.

The CYL CLK output signal is processed by a 16 Bit Computer located within the RPM/Dwell/Timing Board to keep track of the cylinder that is firing. The CYL CLK signal is also applied to the 16 channel multiplexer located on the DAS A/D Board #7001-0555 where it is used as a conversion trigger to obtain relative compression, KV, and HC change per cylinder readings taken by continuous conversion mode of the DAS system. It is also routed to the CYL #1 logic on the Secondary Board where it is used to create CYL #1 if ENG SYNC is not available.

POINTS OPEN CLOCK

The POINTS OPEN CLOCK signal is applied to the trigger mux and used to trigger a voltage measurement for the PRI.RES (dynamic distributor resistance) reading. PRI.RES is measured in the cranking page therefore, the tester is using Primary CYL CLK as its trigger source (forced primary).
CYL CLK is applied to the primary microcontroller and delayed 750 microseconds. The resultant signal, renamed POINTS OPEN CLOCK, is driven high 750 after points close and remains high for 225 ms. The 750 ms delay insures that the readings are taken when the ignition points are closed.

PRIMARY CLOCK

The primary (blue) clip lead, connected to the negative (-) side of the engine's ignition coil, supplies the primary signal to the boom connector J61O. From this connector the primary signal is routed through an L-C filter network located on the Input Filter Board and sent to pin 4 of J308 on the Primary Board. The PRI signal is then simultaneously applied to the primary clock processor.

A delay circuit, located on the output side of the primary clock processing circuitry, functions to produce a DEL DWELL (delayed dwell) signal at pin A22 of J105. The developed PRI CLK signal is supplied to the Secondary Trigger Board's cylinder clock logic, while the DEL DWELL output signal is sent to the RPM/D well/Timing Board. PRIMARY CLOCK is used to generate CYL CLK on the RPM/Dwell/Timing Board. If the PRIMARY CLOCK is not available or the front panel TRIGGER switch is pressed, the SECONDARY CLK signal is then passed through the cylinder clock select circuitry and applied to the RPM/Dwell/Timing Board asCYL CLK.

The PRI CLK signal differs from the SEC CLK signal on the non-active edge of the signal. The PRI CLK non-active edge occurs when the ignition points close on testing of a conventional ignition system or when the transistor turns on when testing an electronic ignition system. The non-active edge of the SEC CLK occurs at a definite time interval after points open.

DELAYED DWELL

When the PRI signal is applied, the primary Board's primary clock processing circuitry and following delay circuit produces an output called DELAYED DWELL, which is delayed approximately 75o microseconds with respect to PRI CLK. The DELAYED DWELL output signal, J105 pin A22, is applied through pin A22 of J106 on the RPM/Dwell/Timing Board, where it is used in the computation of ignition's dwell time. The generated DELAYED DWELL signal's duty cycle is directly proportional to the dwell of the engine.

CYLINDER #1 (CYL #1)

High level for a one millisecond duration from rising edge of applied ENG SYNC pulse. If ENG SYNC is not present, CYL #1 is synthesized from a 4-bit comparator (PAL-U6) counter (U5) combination which detects when the number of cylinder firings per full engine cycle is reached. Counter U5 is clocked by CYL CLK and reset by the falling edge of CYL #1. Initial synchronization of CYL #1 is achieved with ENG SYNC; thus CYL #1 does not become valid until a valid ENG SYNC signal occurs. The CYL #1 signal is used for: engine cycle synchronization, RPM calculations, power balance tests and the DAS A/D system for flags during KV readings and scope display.

CYLINDER SHORTING-GENERAL

Cylinder shorting (power balancing) is used to determine how much power is being contributed to the engine from a particular cylinder. By shorting out a cylinder (not allowing it to fire and contribute to engine performance), and monitoring 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 amount of power the particular cylinder is contributing to overall engine performance. If it is only contributing a small amount of power, indicating a problem, it will show up as a relatively small drop in RPM.

CYL SHORT*

One function of the Primary microprocessor is to generate the CYL SHORT* (cylinder shorting) signal which is used for engine cylinder shorting. Under software control, two bytes are written to the microprocessor specifying which cylinder(s) to short. The micro monitors ENG SYNC and CYL CLK and when the correct cylinder is reached, CYL SHORT* goes low and the vehicle coil (-) terminal is shorted to ground. The cylinder must be shorted from "points closed" before it is supposed to fire to "points closed" after it should have fired.

ENGINE KILL-GENERAL

When the front panel ENGINE KILL button is pressed, a ground signal is converted to a high level output signal by the engine kill circuitry on the Primary Board. This high level signal is then applied to the gate lead of Triac Q1 thereby forcing it into a saturated operational state and connecting resistor R4 to a virtual ground potential. The conducting Triac maintains current flow through the ignitions system coil, thus preventing the primary winding magnetic field from collapsing. Therefore, when the points open it has a reduced effect due to the Triac maintaining most of the current flow and the spark plugs do not fire (engine ignition system is disabled).

ENGINE KILL*

The Primary Microprocessor can also kill the engine by shorting all of the cylinders or by operating under software control through the Sun Bus. To activate Engine Kill, the CYL CLK and CYL1 signals are not checked and the engine is killed immediately upon writing to the latch. The ENGINE KILL* signal, originated at the Primary Board, is routed to the gate lead of Input Filter Board **triac Q1** which functions as part of the engine kill shorting circuitry. This prevents the ignition from firing and the engine **will** cease to run. Diodes D1-D6 and 5 ohm resistor R4, shown connected in series with Triac **Q1,** leave enough voltage remaining on the PRI **line** to trigger the Tester thereby ultimately producing CYLINDER CLOCK* but not enough power for the engine to fire the spark plugs.

CYLINDER SELECT (CYL SEL)

During power balancing; one cylinder is shorted and the RPM drop is measured, then the next cylinder in the firing order is shorted and its RPM drop is measured. The Secondary Trigger Board initiates cylinder shorting by virtue of CYL CLK development. The Primary Processor Board keeps track of which cylinder is being shorted. Figures 9-2 shows the interrelationship between the CYL SELECTED, CYL CLK* and the PRI input signal for shorting one **cylinder** of a six cylinder **engine. Figure** 9-2 illustrates the interrelationship of CYL SHORT*, **TRIAC GATE,** and CYL CLK, with the third cylinder **shorted.**

Primary	J205, pin A09.
CYL CLK	J105, pin C20.
CYL SELECTED	J105, pin A24.
MS CLOCK	J105, pin A21.

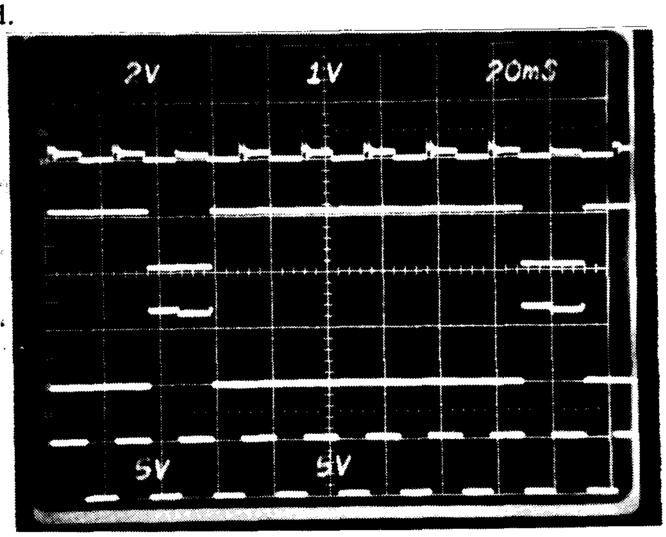


Figure 9-2. Six Cylinder; Engine showing Cylinder Selected.

Primary	**J205,** pin A09.
CYL Short*	J105, pin C21.
Triac Gate	J305, pin 4.
CYL CLK	J105, pin C20.

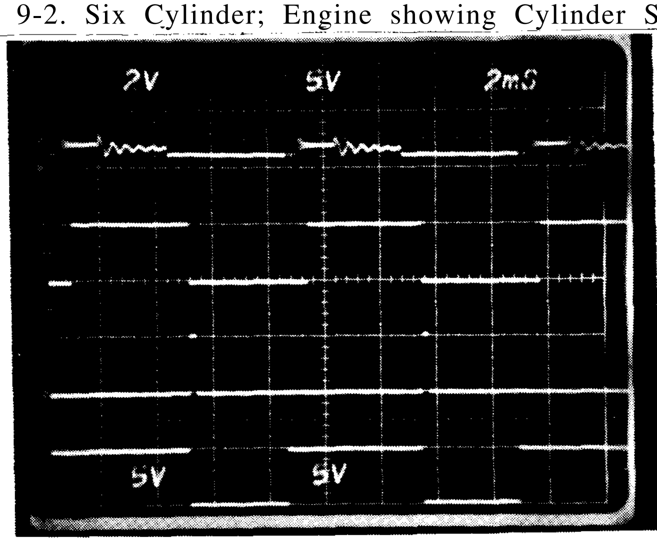


Figure 9-3. Six Cylinder Engine; Showing One Cylinder Shorted.

The Primary Board microprocessor is also used to generate a **signal** for performing per cylinder test measurements. Under software control, two bytes are written to the microprocessor telling it what cylinders are to be selected. By monitoring the ENG SYNC and CYL CLK lines it will change (CYL SELECTED) from a low level to a high level from "points open" of the selected cylinder to "points open" of the next cylinder in the firing order at which time the line will then go low again. Figures 9-5 and 9-6 shows clearly that for each shorted cylinder a small amount of voltage remains in the primary signal of the ignition system. This reduced voltage level is sufficient to maintain Tester triggering (generation of a CYLINDER CLOCK*) during the time that the cylinder is shorted.

The circuitry used to generate a PRI CLK and a DELAYED DWELL clock are almost identical to what has been used at Sun in the past. A positive-going primary input signal is applied to the Primary Board primary clock processor which operates at various threshold levels. The normal triggering thresholds are approximately 72 and 4.3 volts. These two thresholds (72V and 4.3 V), used on a normal running engine, are for purposes of detecting 'points open" and "points closed" respectively. The normal triggering thresholds, of approximately 72 and 4.3 volts, will be utilized if 4 VOLTS*, CYL SHORT* and ENG KILL* are high.

It becomes necessary to lower the threshold voltages due to a decrease in primary voltage, when shorting cylinders. If the tester is in the ENGINE KILL mode, the triggering thresholds will be 13.6 and 4.3 volts. Also, when an individual cylinder is shorted, during a power balance test, the threshold level becomes 13.6 and 4.3 volts. 13.6 volts is used to sense a "points open" while 2.8 volts is used to sense a "points closed" state during a shorted condition.

4 VOLTS*
When the 4 VOLTS* line from primary microcontroller is pulled low, the threshold level is adjusted to approximately 4.3 and 2.8 volts. 'The 4 VOLTS* line is pulled low for two conditions, they are; 1) When the DIL-180 (or future models of D.I.S. adapters) is in use (connected to) with the MCA-3000. A lower threshold is necessary due primary voltage drop in the DIL-180 circuitry. 2) When in the CRANKING page, during engine kill, if a particular ignition system's supply voltage is not adequate to produce a strong primary signal, the threshold will also be lowered

FORCED SECONDARY-CYL CLK GENERATION
The source of the CYL CLK signal can be from either the primary or the secondary of the engine's ignition system. Source selection is under either computer control or operator control. Operator depression of the front panel CONTROL TRIGGER switch forces selection of the SEC CLK for purposes of generating the CYL CLK. When operating on the cranking page, KV page, and Power Balance pages, the computer forces PRI CLK selection for generation of the CYL CLK through operation within the Secondary Trigger Board. When operating on the aforementioned pages, pressing of the CONTROL TRIGGER switch has no effect; the computer forces PRI CLK generation of the CYL CLK signal. On all other pages, the operator can select between the two trigger sources to maintain proper triggering. On a particular vehicle, primary triggering may work better than secondary or vice versa, thus, the CONTROL TRIGGER switch allows the operator to choose the trigger source that works the best.

FORCED SECONDARY-CYL CLK GENERATION (CONT)
When the FORCE SECONDARY* line is low the CYL CLOCK SELECT logic forces outputting of SEC CLK as the CYL CLK signal (Note: as explained previously, the software may force primary triggering even when front panel switch is in forced secondary mode). Conversely, when FORCE SECONDARY* is high, the select logic functions to pass PRI CLK as the CYL CLK output signal.

The 16 Bit Computer, located on the RPM/Dwell/Timing Board, processes the CYL #1 signal pulse along with the CYL CLK to generate an 8-bit byte (ADO-7) directly related to engine RPM measurements. This data word is then processed through a tri-state latch and made available to the Sun Bus on J106. From bus connector J106 the data bits are passed to the Bus Driver Board connector J103, where they are read by the SBC. For further explanation of the Sun Bus, refer to Chapter 7, Sun Bus/Computer Communications.

SOLENOID DWELL
NOTE: Refer to block diagram 9-2.
The Solenoid Dwell lead (volt/ohm/dwell lead #6004-0520) is used for sensing the duty cycle of carburetor mixture control solenoids and fuel injector solenoids. The results of the data collected are displayed in a percentage on the Pinpoint Page and used to determine the accuracy and efficiency of the fuel enrichment systems.

The analog signal picked up by the blue clip of the Volt/Ohm/Dwell Test Lead Assembly #6004-0520 is passed through boom connector J605 pin 3 to Input Filter Board, connector J664 pin 5. An L-C pad type filter, within the Input Filter Board, functions to filter out high frequency noise pulses riding on the sensed signal. The filtered output signal is then passed via connector J654 and W5 cable assembly and applied to connector J313 pin 9 located on the RPM/Dwell/Timing Board.

The applied signal is then divided down by a 3 to 1 voltage divider circuit, clamped to a maximum 12V amplitude by two diodes connected to +12V and -12V power. A buffer amplifier then routes the analog output signal via J211 pin A2 and the Sun Bus line to connector J204 pin A2 located on the DAS A/D Board.

Additionally, the buffered analog signal is processed by a comparator circuit which produces a digital SDWL (solenoid dwell) signal to the on-board microntroller and also to J106 pin C30. The RPM/Dwell/Timing Board's microcontroller processes the applied SDWL digital signal to develop the required duty cycle output data. The SBC can then read dwell from the Sun Bus.

The digital SDWL signal, present at JI06 pin C30, is routed via a Sun Bus line to J104 pin C30 of the DAS A/D Board and then to one input of the 8 channel trigger multiplexer. The solenoid dwell analog signal voltage available at J204 pin A2 is processed on channel 7 of the DAS A/D Board's 16 channel multiplexer as described in Chapter 8, Section I Theory of Operation.

IGNITION SCOPE THEORY.

The MCA has the ability to display a digital representation of the Primary and Secondary Ignition patterns, Alternator Ripple, and Special Patterns such as Solenoid Dwell or Injector Patterns. Ignition patterns can be displayed in one of five ways. They are the Conventional Display, Raster, and Superimposed, as shown in Figures 9-4 through 9-6 respectively, Single Cylinder, and Sequential cylinder.

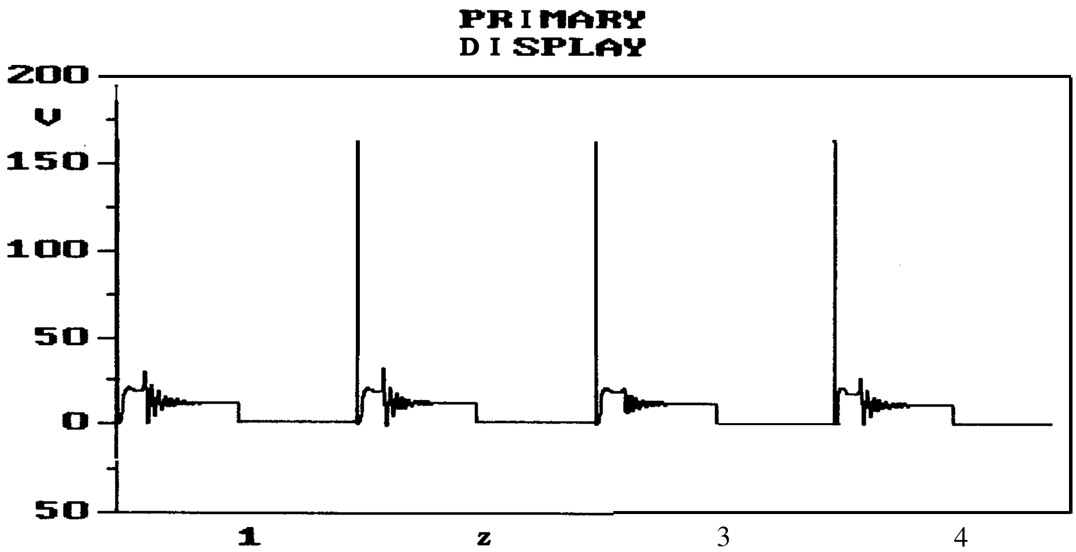


FIGURE 9-4

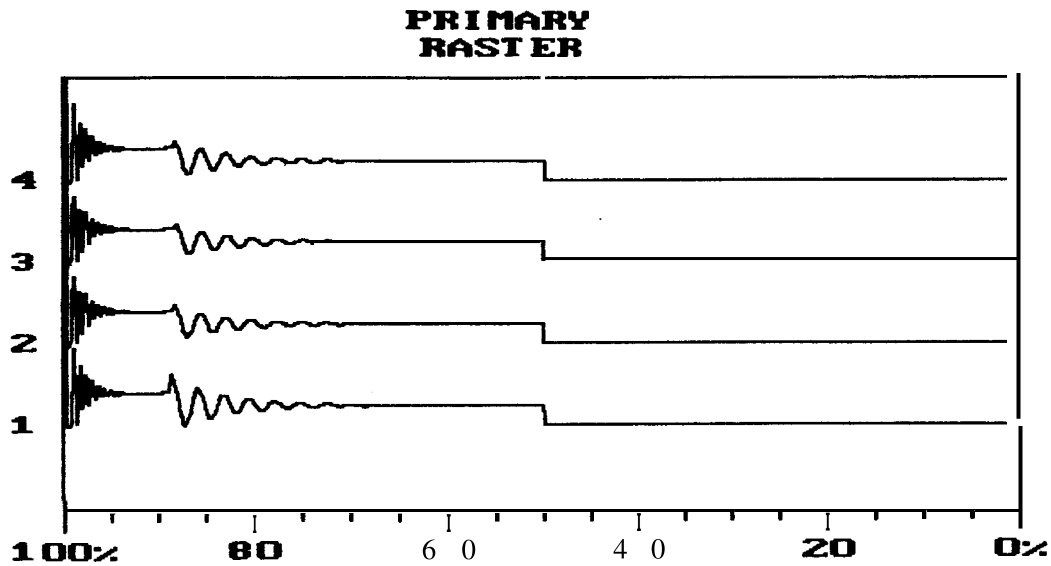


FIGURE 9-5

The display of these patterns is accomplished using the DAS system as described in Chapter 8. The displayed pattern is selected using the 16 Channel MUX located on the DAS A/D board. The trigger signals needed are chosen using the Trigger MUX located on the DAS A/D board.

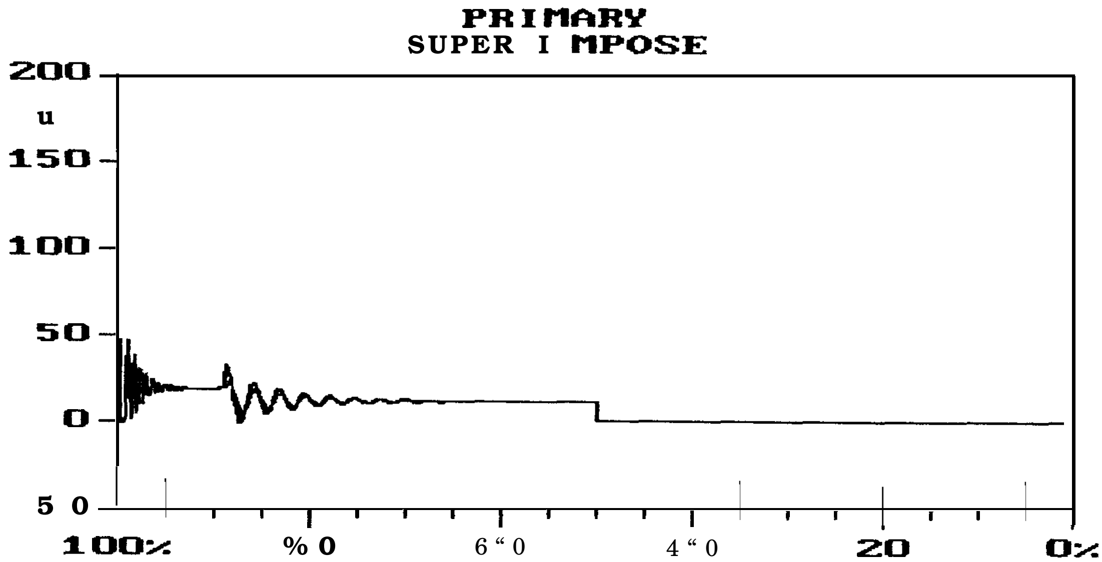


FIGURE 9-6

An example of this would be displaying the Secondary Raster Pattern. First the Single Board Computer, via the Sun BU S, configures the 16 Channel MUX to the Secondary Channel, and the Trigger MUX to capture ENG SYNC and CYL CLK. The Secondary Pattern is converter to a 12 bit digital input, and the trigger signals are then placed in the top 4 bits, or Flag Bits, of the 16 bit bus that is applied to the DAS Memory board.

The DAS Memory board then stores this 16 bit Bianary signal into the DAS Memory. When the SBC reads this Memory, the first 12 bits are used to determine how high the dot should be displayed at any given time. The Flag Bits are used to indicate when to reset the trace from the right side of the screen to the left side, when to move the pattern up a notch, and when to start at the bottom of the screen again.

Several other features that are new within the MCA-3000s Scope are the ability to store several seconds of scope patterns, digital readings for voltage, frequency, and Time, and selectable triggering voltage, sweep speed, and voltage scale in in the special patterns mode. This is possible because all the information of the Scope pattern is stored in digital form on the DAS Memory board. The Scope is not only a versatile ignition pattern storage scope, but also a full function lab scope.

SECTION III. KV CHECK-OUT/CALIBRATION

Check-out/Calibration Procedure

1. From the Main Menu, select #4 Pinpoint Tests. From the Pinpoint Tests Menu, select #3 Dynamic KV. The first page to appear should be "Dynamic Firing KV", if not, advance to "Dynamic Firing KV".

2. Connect the primary leads, blue and black (ground), to the IS-1OOA.

3. Connect the secondary lead to the calibrated secondary KV output terminal on the IS-1OOA.

4. Set the front panel ignition selector switch to AUTO.

5. Set the delta KV and spark line slope switches, on the IS-1OOA, to the OFF position.

6. Select 900 RPM on the IS-1OOA.

7. All the cylinders in the RESULTS column should read 20.0 KV. If not, adjust R37, on the Secondary Trigger Board #7001-0551, for 20.0 KV.

Calibration Complete

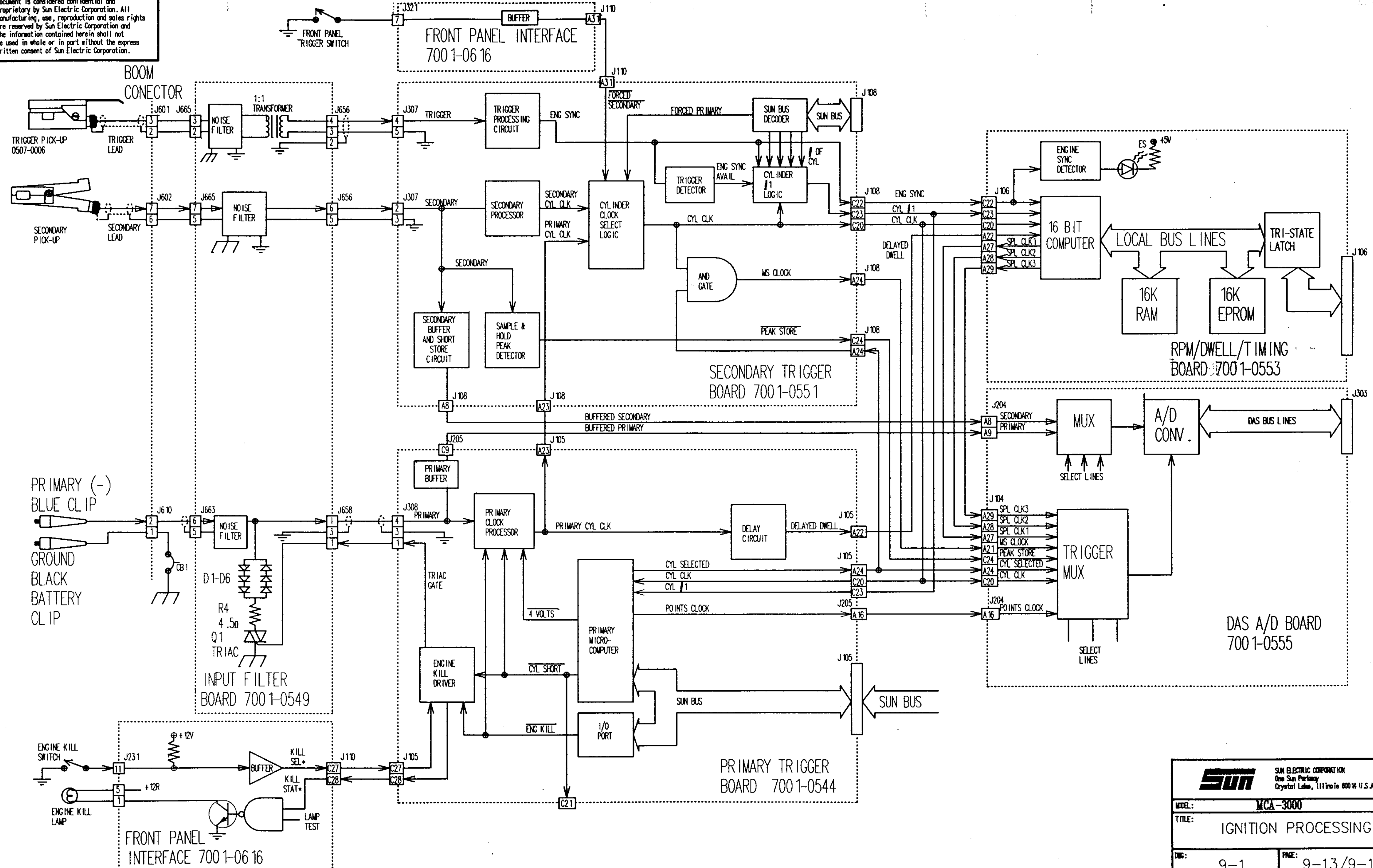
SECTION III. Ignition Processing and Cylinder Shorting Troubleshooting

Confirm that power supply voltages are correct before proceding.

COMPLAINT	CORRECTIVE ACTION
I. Trigger reads "SERVICE REQUIRED"	1. ------------SUBSTITUTE ------------ A. Secondary Trigger Board #7001-0551 B. RPM/Dwell/Timing Board #7001-0553 C. DAS A/D Board #7001-0555 2. Refer to Theory of Operation and Functional Diagram.
II. Primary reads "SERVICE REQUIRED"	1. ----------SUBSTITUTE --------------- A. Primary Trigger Board #7001-0544 B. DAS A/D Board #7001-0555 C. RPM/Dwell/Timing #7001-0553 2. Refer to Theory of Operation and Functional Diagram.
III. Secondary reads "SERVICE REQUIRED"	1. -----------SUBSTITUTE ---------------- A. Secondary Trigger Board #7001-0551 B. DAS A/D Board #7001-0555 C. RPM/Dwell/ Timing #7001-0553 2. Refer to Theory of Operation and Functional Diagram.

COMPLAINT	CORRECTIVE ACTION .
IV. Dwell reads zero, **or** is inaccurate or unstable.	1. Verify that the primary blue lead is connected to the negative side of the coil and that the tester's ground lead is connected to a good engine ground. **2.** With **all** leads connected, attempt an ENGINE KILL using front panel switch or keyboard. If engine dies (KILLS): ---------SUBSTITUTE ---------------- A, Primary Trigger Board #7001-0544 B. R.PM/Dwell/Timing Bd. #7001-0553 C. DAS A/D Board #7001-0555 If engine does not die (KILL): ---------SUBSTITUTE ---------------- A. Universal Harness #6005-0173 B. **Imput** Filter Board #7001-0549 C. Primary Trigger Board #7001-0544 D. RPM/Dwell/ Timing Bd. #7001-0553 E. DAS A/D Board #7001-0555 **3.** Refer to Theory of Operation and Functional Diagram.
V. Tachometer readings are inaccurate or unstable.	1. If leads are tie-wrapped together, noise may be introduced into a lead nearby. Cut tie-wraps and check for stable tach readings. **2.** Try switching the front panel "TRIGGER" switch into the Primary preferred position, the tester is less susceptible to noise when the tester is generating tach readings from the primary of the engine. **3.** Connect only the red trigger lead, if tach readings are unstable, then: ---------SUBSTITUTE ---------------- A. Trigger Pick-up #0507-0006 B. Trigger Lead # 6004-0262

COMPLAINT	CORRECTIVE ACTION
V. Continued	If tach readings are still unstable, then: ---------SUBSTITUTE ---------------- A. Secondary Trigger Bd. #7001-0551 B. RPM/Dwell/Timing Bd. #7001-0553 C. DAS A/D Board #7001-0555 D. Filter Imput Board #7001-0549 **4.** Refer to Theory of Operation and Functional Diagram.
VI. No Tachometer readings. (Assuming that the primary, secondary, and trigger leads are connected)	1.-------------SUBSTITUTE------------- A. RPM/Dwell/ Timing Bd. #7001-0553 B. DAS A/D Board #7001-0555 C. Sun Bus Driver board #7001-0559 D. I/O/EEPROM/CLOCK bd. #7001-0558 **2.** Refer to the Theory of Operation and Functional Diagrams.
VII. Engine dies during power balance test.	1. If engine is already running "rough", prior to power balancing, shorting a good cylinder may cause the engine to die. Try power balancing at a higher speed. 2.-------------SUBSTITUTE ------------- A. Primary Trigger Board #7001-0544 B. Secondary Trigger Bd. #7001-0551 C. DAS A/D Board #7001-0555 D. RPM/Dwell/Timing Bd. #7701-0553 **3.** Refer to Theory of Operation and Functional Diagrams.

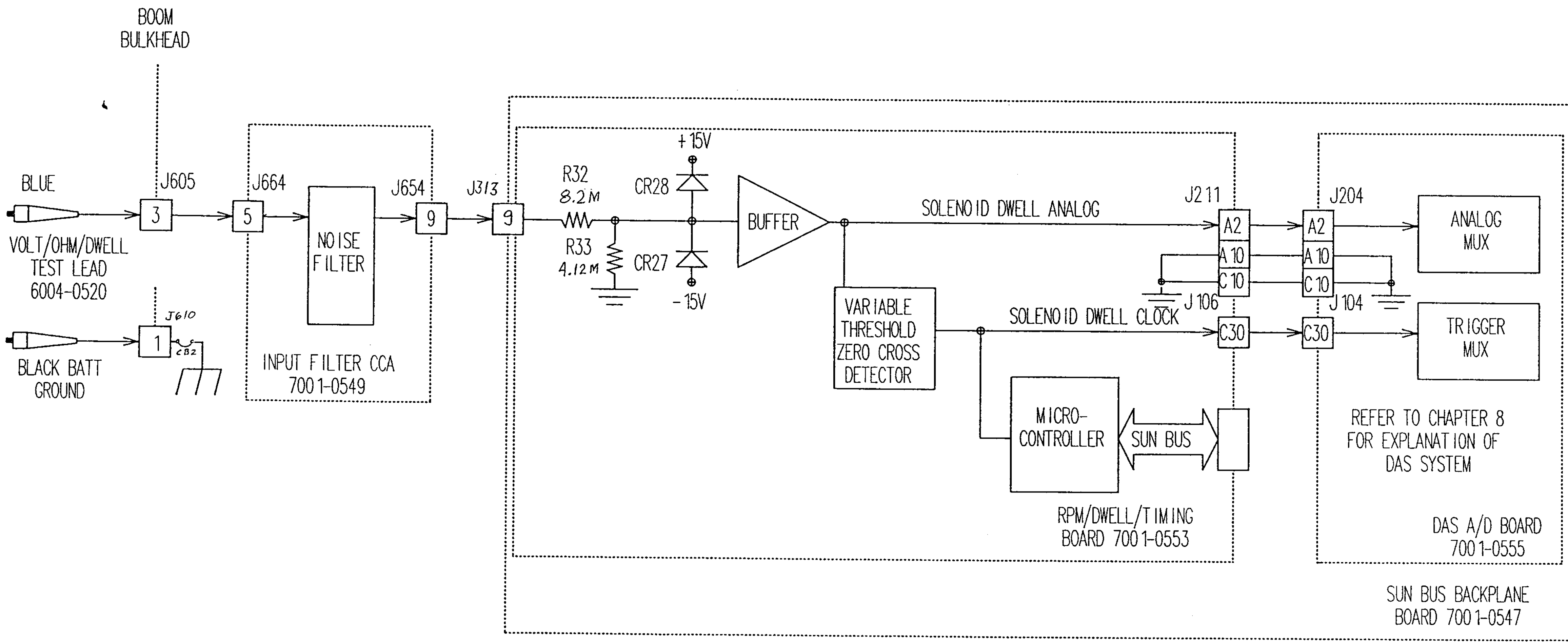


SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

MODEL: MCA-3000

TITLE: IGNITION PROCESSING

DWG: 9-1 | PAGE: 9-13/9-14



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

MODEL: MCA-3000

TITLE: SOLENOID DWELL

DWG: 9-2

PAGE: 9-15/9-16

B

CHAPTER 10

TIMING-STROBOSCOPIC & MAGNETIC

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 the piston is at TDC, timing is said to be advanced (or BTDC) and conversely when the spark arrives after the piston goes past TDC, timing is said to be retarded (or ATDC).

The MCA-3000 is capable of measuring timing via either the Timing Light (stroboscopic), a magnetic timing probe (monolithic), or Optical Timing..

When the timing light power switch is on, the MCA-3000 automatically selects and uses the timing information from the timing light advance circuitry. If the timing light is off, the MCA-3000 uses the timing signal that has the next highest priority. Timing priority, from highest to lowest, is Timing light, optical timing, European timing, and domestic mag timing.

The Timing is calculated using information from one of the above timing pickups and the Red Trigger Pick-up. With this information, the Microcontroller on the RPM/Dwell/Timing Board calculates The Timing reading and, on request, sends this information to the Single Board Computer (SBC).

SECTION I. THEORY OF OPERATION

STROBOSCOPIC TIMING LIGHT

The Timing Light (Diagram 10-1) receives +12VDC unregulated power (+12V Relay) from Power Supply #1 via the Input Filter Board. This +12V Relay power is applied through a rocker type ON/OFF switch S1 located on the top of the Timing Light and fuse F1 to terminal (+) located on the Timnig light Board. An internal DC to DC converter (comprised of free running oscillator Ql, step-up transformer Tl, half wave rectifiers CR2,3 and a filter network consisting of C3,4,5 & 7) steps up the applied +12VDC to approximately +450VDC that is needed to flash the Xenon filled flash tube VI. Potentiometer R3 controls the free-running frequency developed by oscillator Q1 while capacitor C4 functions as the trigger storage capacitor which is normally charged to an approximate +225VDC level.

The TRIGGER input pulse signal, generated by the Red Trigger Pickup connected to the vehicles #1 spark plug, is routed from the Input Filter Board to the Secondary Trigger Board where it is cleaned-up and output as ENGINE SYNC to the RPM/Dwell/Timing Board where it is routed to a 16 bit computer. The 16 bit computer uses it's internal A/D converter to measure the ADVANCE POT ANALOG voltage (with reference to V REF) and calculates the amount of delay between ENG SYNC and FLASH. This FLASH output pulse is then routed via the Input Filter Board to terminal T of the Timing Light Board where it triggers SCR1. This completes the ground path of T2, an autotransformer that steps approximately 225VDC to over 4000. volts. This 4000V Spike is routed to the small wire wrapped around the Flash tube. This Voltage Ionizes the Xenon gas in the tube, this drops the internal resistance of the tube. Causing momentary current saturation and discharges the main storage capacitor C2. When C2'S voltage drops below the ionization voltage of the tube, the flash will stop.

If the advance pot is in the "zero" position, then FLASH occurs at the same time as ENG SYNC. If the advance pot is turned just beyond the zero position, then FLASH will occur slightly before ENG SYNC (-20 Degrees), allowing retarded timing to be measured (see figure 6-l). If the advance pot is turned completely clockwise, then FLASH will occur 90 degree after ENG SYNC (see figure 6-2).

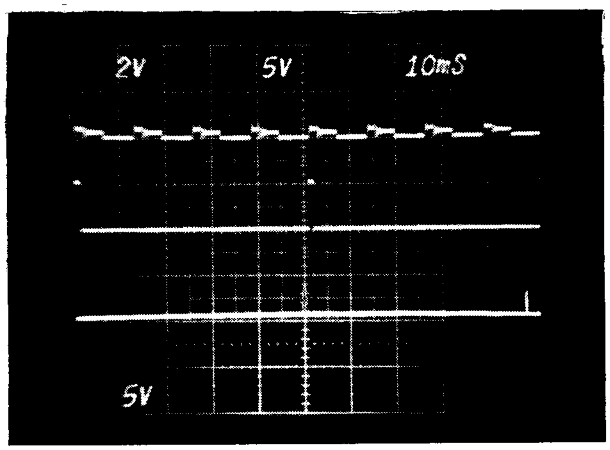
NOTE: For readings Between -20 and +6 degree,. Cylinder Clock Must be Present. If 'the Trigger Pick-up is the **only thing** connected to the engine the display will not read timing less than 6 degree.

The power to the timing light, after the On/Off switch, is routed back through the Input Filter Board and applied to the RPM/Dwell/Timing Board as a T/L ON signal. The on-board Micro-controller uses this signal to determine if the voltage from the advance pot is valid. If T/L **ON** is high, the reading from the Timing Light will be displayed.

PRIMARY

ENG SYNC

FLASH



J308, pin 4.

J108, pin C22.

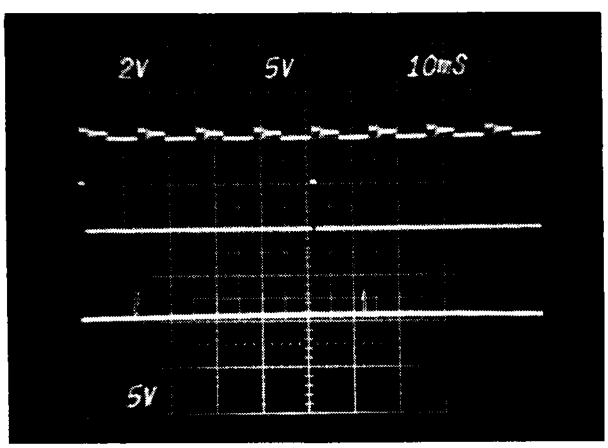
J305, pin 4.

Figure 10-1. Timing Degrees Retarded.

PRIMARY

ENG SYNC

FLASH



J308, pin 4.

J108, pin C22.

J301, pin 4.

Figure 10-2. 90 Degrees Advance.

MAGNETIC TIMING

Magnetic timing can be read from one of three ways, Domestic Mag timing, Europeon Mag timing, and Average (optical) timing. In order to calculate mag timing, two signals are needed, TIME PULSE and ENG SYNC. The delay between these signals is directly proportional to the timing of the vehicle under test. The following paragraphs explain how each type of timing gets from the vehicle to the TIME PULSE signal.

NOTE When the Timing light is on, the advance displayed will be from the timing light, and all magnetic timing signals will be ignored.

MAGNETIC TIMING-DOMESTIC

American automobile manufacturers made provisions for magnetic timing measurements in the early part of the 70s decade for use on the production line. A slot on the circumference of the vibration damper indicates the position of the #1 piston. The magnetic probe assembly holder is usually placed a specific 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 set away from TDC) is specified by the manufacturer. See the chart Below for typical readings.

GM	CHRYSLER	FORD		
		4 Cylinder	6 Cylinder	8 Cylinder
All Displacements	All Displacements	1.6 -68.0	3.8* V -309.0	All Displacements
-9.5	-10.0	1.9 -68.0	3.3 I -135.0	-135.0
		2.3 OHC -52.5	3.8" V -334.0	
		2.3 HSC -314.0	4.9 I -135.0	
		2.5 -68.0	3.0 V -233.0	
			2.8 V -135.0	

* For 3.8 Liter Engines: If model year is Early 82 use -309.0 degree Mag offset. For model year Late 82 and UP use --334.0 degree Mag offset.

Figure 10-1. Typical Magnetic Offset Angles.

The Tester "knows" the correct offset from the vehicle code previously entered on the Vehicle Identification 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 magnetic probe adapter is used to allow a proper fit of the magnetic probe into the probe holder on the vehicle. For stable readings, it is important that the magnetic probe be properly positioned in relationship to the slot on the vibration damper. The magnetic 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 small voltage "blip" is output via the Input Filter Board to the RPM/Dwell/Timing Board. The RPM/ Dwell/ Timing Board contains the electronics for squaring the blip. If no pulses are sensed from the European timing input, this squared-up signal is routed to an AGC (Automatic Gain Control) circuit and sent to the timing logic. If no pulse is present from the optical input, the timing logic routes the MAG PULSE signal out on the TIME PULSE line.

MAGNETIC TIMING--EUROPEAN

The European magnetic timing system utilizes a different approach than the Domestic magnetic timing system. The Timing pick-up is usually an integral part of the vehicle's engine. An extension cable and adapter cable (not supplied as a standard accessory, see Parts Chapter 21) is attached to the universal lead connector on the Tester and to the connector on the vehicle engine. The vibration damper can have a hole, a peg, 2 holes or 2 pegs. With the 2 hole or 2 peg system, one is used by the factory when the engine is built. The Timing Logic "knows" which system is connected by sensing the PEG and HOLE signals. When the hole(s) or peg(s) pass the pickup a "blip" is produced that is applied to the Input Filter Board which functions to filter extraneous noise from the signal pulse. The signal is then routed to the RPM/Dwell/ Timing Board.

Most European" manufacturers mount the magnetic pickup 20 degrees after TDC. Therefore, when the computer "sees" that European timing is being used, and the O DEGREE OFFSET* line is high, it adds -20 degrees to the raw (uncorrected for offset) timing readings before they are displayed.

A few European auto manufacturers mount the magnetic pickup at TDC (O degrees) instead of 20 degrees after TDC. On these vehicles, when the diagnostic cable is connected the O DEG* signal on pin 14 of connector J663 on the Input Filter Board is taken low by a pin on the vehicle connector. This signal is buffered and output to the Timing Logic as O DEGREES OFFSET*. If this signal is low, no offset will be added.

OPTICAL TIMING

Optical timing is used by some European manufacturers and consists of a LED and a Photo Diode mounted on the Vehicle. In order for this system to work properly, Power must be applyed to! the photo transistor. When the light from the Diode is allowed to shine on the photo transistor, OPTO IN is pulled Up to the supply voltage. When a peg interupts this light, the transistor turns off, allowing OPTO IN to go low instantaneously. This pulse is representative of Top Dead Center of cylinder #1.

TIMING OFFSET DETECTION

There are four modes of timing offset (see Below). The RPM/Dwell/Timing Board has 3 LEDs which indicate which of these offsets are being use. The 1/0 port on the RPM/Dwell/Timing Board is responsible for providing access to these signals for the SBC.

TIMING	LEDs ON	OFFSET
None	None	None
Timing Light	F3	Reading from Advance Pot
Optical Timing	F1 and F2	O Degrees
European Timing	F2	O OR -20 Degrees (depends on O DEG*)
Domestic Timing	F1	Offset from Vehicle Set-Up Page

ALSO, F4 indicates the presence of a TIME PULSE.
F5 indicates the presence of a ENGINE SYNC.

SECTION II. TIMING CHECKOUT. PROCEDURE

Tools Needed: IS-100A
Timing Light Adapter Cable #7076-0597
Mag Probe Amplifier Box #7009-1577-01

MAG TIMING **SYSTEM** (PROBE **AND** TESTER)

1. Advance tester to the COMPLETE TEST and enter vehicle code 115.

2. Depress the ENGINE DATA button and the ENGINE DATA page will be displayed.

3. Connect the red trigger lead and the blue booted (coil -) lead. Also, on the front panel of the MCA-3000 select AUTO triggering.

4. Set the IS-100A to 600 RPM (600 RPM/20 degrees advance).

5. The "TIMING ( )" line on the VDU will display an "M" in the parenthesis, when the Mag Probe is inserted in the IS-100A. NOTE: **TIMING LIGHT** MUST BE SWITCHED **OFF.**

6. The reading on the "TIMING (M)" line should be 10.5 +/-3.0 degrees. NOTE: This is due to code 115 having a -9.5 degree offset angle ie; 20 degrees (+) -9.5 degree = 10.5 degree. If not in tolerance, next perform NAG TIMING (PROBE ONLY) checkout.

MAG TIMING (PROBE **ONLY)**

1. Connect a know good Mag Amplifier Box #7009-1577-01 to the customers Mag probe #7009-1576.

2. Connect the remaining connector of the Mag Box to the IS-100A connector, labeled MAG PROBE.

3. Insert the end of the Mag Probe into the Mag Probe receptacle on the IS-100A.

4. Turn on the IS-100A and select TAU on the CYLINDER switch.

5. The decimal points in the advance window (red LEDs) should flash, indicating a good Mag Probe.

TIMING LIGHT (LIGHT **ONLY)**

1. Using the Timing light adapter #7076-0597, connect the timing light to the IS-100A.

2. Set the IS-100A'S CYLINDER switch to the TAU position and turn the AC power switch on.

3. Three indicators will verify proper Timing Light operation, they are:
    1. The Timing Light will flash at a constant rate.
    2. The decimal points in the advance window (red LEDs) will turn on when the advance pot is moved from the 0 degree detente.
    3. When the Timing Light is pointed in the Advance window and the advance pot is rotated, the numbers in the advance window will change at a random value.

STROBE TIMING SYSTEM (LIGHT AND TESTER)

1. Advance tester to the COMPLETE TEST and enter vehicle code 115.

2. Depress the ENGINE DATA button and the ENGINE DATA page will be displayed.

3. Connect the red trigger lead and the blue booted (coil -) lead.

NOTE: For readings between +10 and -6 degree, CYLINDER CLOCK Must be Present. If the Trigger Pick-up is the only thing connected to the engine the display will not read timing less then 6 degrees.

4. Set the IS-1OOA to 600 RPM. **Also,** on the front panel of the MCA-3000 select AUTO triggering.

5. The "TIMING ( )" line on the VDU will display a "L" in the parenthesis, when the Timing Light is switched on. **NOTE:** TIMING LIGHT MUST BE SWITCHED ON.

6. With the Timing Light flashing, adjust the advance pot for a 30 degree reading on the TIMING (L) line.

7. Next, flash the Timing Light into the advance window. The reading in the advance window should be 30.0 +/- 5.0 degrees.

•************************

• Checkout Complete •

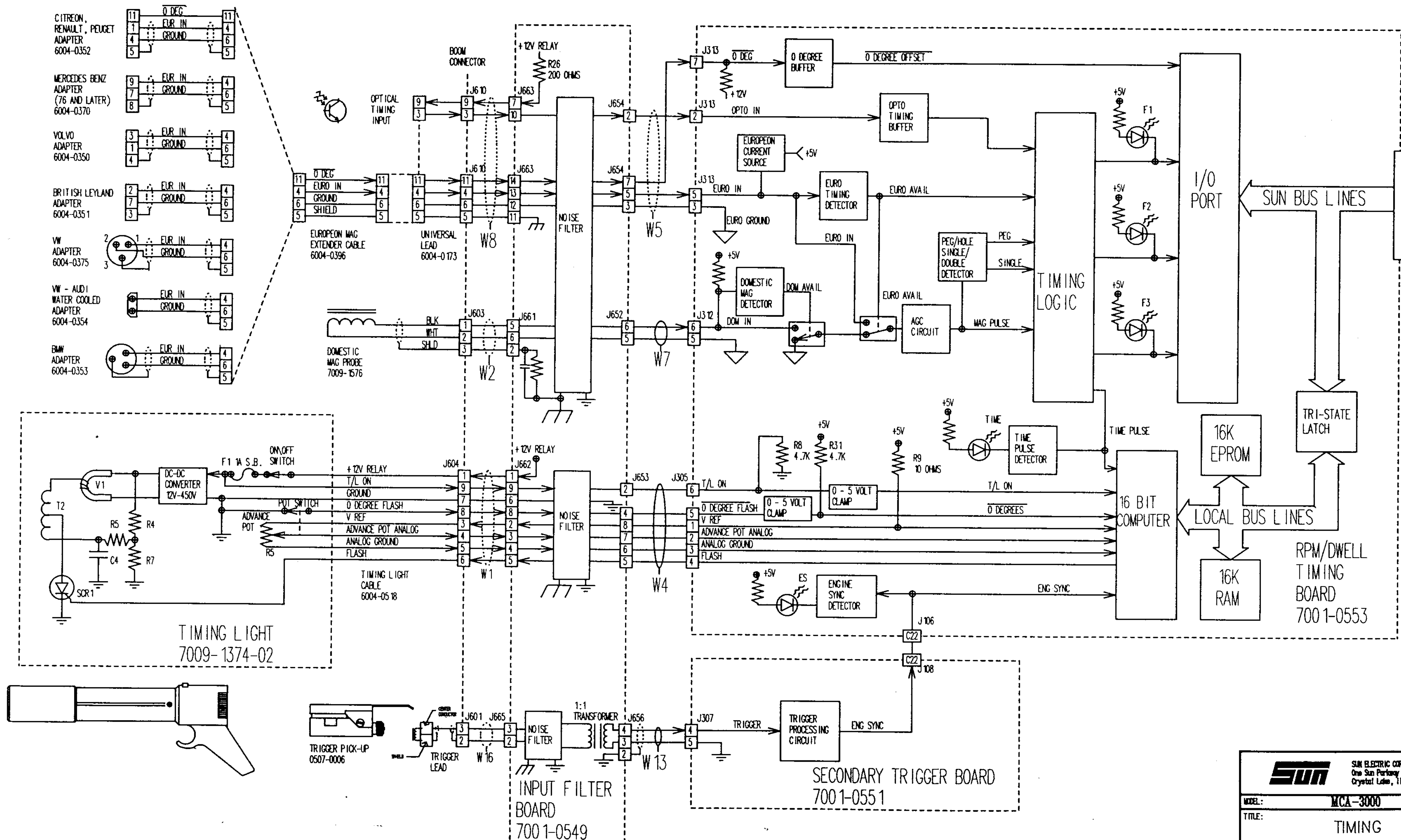
•************************

COMPLAINT	CORRECTIVE ACTION

1. Timing Light does not flash or flashes erotically.	1. Check on IS100A.
	2. Verify that RPM is displayed with only the red trigger lead connected.
	
	If no RPM is displayed, then
	---------SUBSTITUTE-----------
	A. Trigger pickup #0507-0006.
	B. Trigger lead #6004-0515.
	C. Secondary Trigger Board #7001-0551.
	D. RPM/Dwell/Timing Board #70014553.
	
	If RPM is displayed, verify the Timing Light using the IS-100A and the 7076-0597 T/L adapter cable.
	
	If the Timing Light funtions properly,
	A. Verify that +12V relay is present between pins 1 and 7 of the Timing Lights boom connector.
	B. ------------SUBSTITUTE--------------
	RPM/Dwell/Timing Board #7001-0553.
	
	If the Timing light does not function properly, then
	-----------SUBSTITUTE---- -----
	a) Timing Light Cable #6004-0518.
	b) Timing Light Board #7001-2044-01.
	
	3. Refer to Theory of Operation and Funtional Block Diagram.

II. Timing Light Advance Control has no effect.
 	
Note: The Primary Signal must be present for reading between -20 and +6 degrees.
	1. Verify the Timing Light using Check-out procedure on page 10-5.
	
	If the Timing Light functions properly on the IS-100A, then
	------- ------SUBSTITUTE---------- -----
	A. RPM/Dwell/Timing Board #7001-0553.
	B. Input Filter Board #7001-0549.
	
	If the Timing Light does not function properly, then
	------SUBSTITUTE------ -------
	a) Advance Pot #0685-0360.
	b) Timing Light Cable #60044518.
	
	2. Refer to Theory of Operation and Funtional Block Diagram.

COMPLAINT	CORRECTIVE ACTION
III. Timing Light Reading are inaccurate or erratic.	1. -------------SUBSTITUTE --------------------- A. RPM/Dwell/Timing Board #7001-0553. 2. Refer to Functional Block Diagram 10-1.
IV. Magnetic Timing Readings are inaccurate. or No Readings from the **Mag** Timing probe.	1. Verify the following mechanical **aspects:** A. The face of the Magnetic probe should be no more than 0.025" away from the vibration dampener surface. B. The slot on the **dapener** should pass across the entire face of the probe. C. The Probe holder should be perpendicular to the surface of the dampener pulley. D. The Dampener pulley should not have any deep dents, causing extra pulses. 2. Verify that the Timing Light is turned off. **3.** Verify that the Proper Mag Offset Angle is being used. **4.** Verify the Mag **proge** using the Check-out Procedure on page 10-5. If the Mag Probe functions properly, then --------------SUBSTITUTE ----------------- a) RPM/Dwell/Timing Board #7001-0553. b) Input Filter Board #7001-0549. 5. Refer to Theory of Operation and Functional Block Diagram.
V. European Timing Readings are inaccurate or No Readings from the European Timing Cable.	1. Verify symptom is present on more than one vehicle. 2. --------------SUBSTITUTE -------------------- A. RPM/Dwell/Timing Board #7001-0553. 3. Verify continuity from pin 5 of J313 to the associated pin of the adapter cable in use. 4. Verify continuity from pin 3 of J313 to the associated **pin** of the adapter cable in use. 5. Refer to Theory of Operation and Functional Block Diagram.



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MODEL: MCA-3000

TITLE: TIMING

DWG: 10-1

PAGE: 10-9/10-10

CHAPTER 11

AMPS

GENERAL
The MCA-3000 hae three separate methods of gathering Amp data, they are:

1. Probe Amps, which uses the MCA's green inductive Amp probe for gathering the Amp data from the vehicle. Probe **Amps is** used for such things as Relative Compression, Starter Draw, and Charging System Analysis. See Section 1, for more information.

2. Clamp Amps, which uses the MCA's Battery Load Cables and a current shunt (located in the VAT Module), for gathering **Amp** data from the vehicle's battery. See Section **IV,** for more information.

3. Clip Amps, which use the **MCA's** pin-point test leads and **a** current shunt (located on the Filter **Imput** Board) for gathering both **ac** and DC pin-point amp readings. Discussion of this parameter is not contain in this Chapter, but can be found in Chapter 12 **Multimeter.**

SECTION I. PROBE AMPS THEORY OF OPERATION

The Inductive Amp Probe uses a "HALL EFFECT Chip" to measure the magentic field created by the current flow through the wire that the **Amp** Probe surrounds. Direction of the current **flow** is indicated by the polarity of the output voltage or Amp Readings. Positive readings indicate alternator output or charging, Negative readings indicate a draw from the battery such as **starter** draw. To obtain proper polarity readings, probe orientation must be such that, if the **Amp** Probe is placed around the vehicle's negative battery cable an arrow on the **Amp** Probe itself must point away from the battery. If the Amp Probe is placed around the vehicle's positive cable, the arrow must point towards the battery. It is also important to keep the Amp Probe's jaws clean. Dirt and grim on the jaws prevent the jaws from totally closing, which causes the **Amp** readings to be inaccurate.

The Amp probes Hall effect chip (Diagram 11-1, Page 11-9/10) produces a voltage output signal that is directly proportional to the dc control current (I_c-, I_C+) passing through it times the magnetic field perpendicular to it. A constant biasing current is required by the Hall Effect Chip. The constant current source is supplied to the Amp probe from the VAT Board via the **Amp** Probe Assembly's lead. A bias adjustment potentiometer, located in the handle of the **Amp** probe allows us to adjust the Amp probe's symmetry by controlling a feedback current to the probe's constant current source. So that equal readings may be obtained in both positive **(+)** and negative (-) measurements. The symmetry adjustment must be made using an SRT-28 and a special adapter cable #6004-0533. For symmetry calibration procedure see Sun Service Bulletin #403.

The Amp probe Hall Effect generated output signals, **V_h+** and **V_h-,** are passed through W3 and applied directly to connector **J311** of the VAT Board #7001-0552 installed on the Sun BUS. The VAT Board has a Differential Amp block, which is where both AMP Zero (R107) and AMP Gain **(R106)** adjustments can be made, followed by a 10X gain and filter amplifier block that can be switched in or out. One output of the Xl **&** X1O gain amplifier is routed via a non-inverting buffer to the analog bus terminal **P207-A5.** This output signal is labeled RAW AMPS ANALOG and is applied via the Sun Analog Bus to connector **J207-A5** for eventual processing by channel #9 of the **DAS** A/D Board multiplexer.

An additional path from the gain block circuitry **is** applied through a high range integrating type filter averaging circuitry, which basically integrates the applied signal. The signal is then routed through the VAT MUX when the appropriate channel select signal, developed by the computer, is applied. From the VAT MUX, the integrated analog signal is processed by a non-inverting buffer and made available at the analog bus terminal **P207-C8.** This output signal is labeled VAT MUX, and is applied via the Sun Analog Bus to connector J204-c8 for processing by channel #4 of the **DAS A/D** Board. This channel is used for all ampere readings except for the Relative Compression readings.

There are three basic Amp Probe generated signals used in gathering data, they are:

1. RAW **AMPSD, scale 0-1000 Amps, is the** direct output **from the DIFF AMP Block, all other Probe Amp readings are derived from this. Raw Amps is used in a continuous conversion fashion for the purpose of obtaining AMPS PER CYLINDER data in the cranking test.**

2. **AVERAGE HI-RANGE AMPS**, scale 0-1000 **Amps,** is derivered from RAW AMPS after being filtered through an **RC** network, the output is then applied to the VAT MUX. Average Hi-range Amps is used for the starter draw reading.

3. FILTERED X1O AMPS, scale 0-100 amps, is derived from RAW AMPS after being filtered and amplified 10 times. It is used to obtain probe amp readings from 0-100 amps for things such as alternator output.

Relative compression readings are taken using the RAW AMPS ANALOG channel with readings being taken during the cranking test. The resultant readings are an indication of the mechanical soundness of the vehicle’s engine. A good cylinder will require more current to push the piston upward on its compression stroke than a cylinder that has a defect such as: bad valves, bad piston rings, etc.. The DAS system analog-to-digital conversion cycle of the applied RAW AMPS ANALOG signal is triggered (started) by application of the CYLINDER CLOCK (CYL CLK) signal. The CYLINDER CLOCK signal occurs at the peak of the compression stroke when the most current is being drawn.

AMPS SIGNAL SELECTION

Sun Bus Decode Logic processes computer output signals available on the SUN BUS, P107, to generate the required Amp gain select output signal. The GAIN Select **signals** are then processed by the RAW AMPS SELECT LOGIC circuitry which generates RAW AMPS and FILTERED X1O* outputs. When the RAW AMPS/ FILTERED X1O* signal is high, the raw amperes high range is selected and when FILTERED X1O* is low, the filtered amperes low range is selected. The low range provides readings from O to ±100 amperes while the high range provides readings from O to ±1000 amperes.

Scale ranging is controlled by the SBC (Single Board Computer) automatically, if the currently selected range is above or below two separate points (up scale at 95 amps and downscale at 85 amps). The SBC will select the appropriate scale by writing to the VAT Board on the SUN BUS, causing the appropriate scale to be selected.

Zeroing of the channel is controlled by adjustment of potentiometer R107 while a gain of approximately 350 is controlled by adjustment of variable resistor R106. See amps calibration procedure on Page 11-4 for adjustments of these two controls.

NOTE

The computer will fail amps *on the Self Calibration page if the mux channel output signal is greater than ±0.5 volts from zero. During Self Calibration, the zero offset of the average AMPS channel is read and stored in RAM memory. Before each ampere reading is displayed, the computer adjusts for this stored zero offset.*

The following chart illustrates some typical voltage readings and the scale selected. The Mux voltages are displayed on the Development Aids DAS A/D Test page.

Amperage Sensed	Scale (Gain)	Mux Voltage	Act ive Control Signal	
80.0	X1.0	0.4V	Raw Amps* (Low)	
80.0	X10.0	4.0V	Filtered X1O*(LOW)	
200.0	X1.0	1.0V	Raw Amps* (Low)	
200.0	X10.0	----	Filtered X1O*(LOW)	*

* This will cause the SBC to select AVERAGE HI AMPS from the **VAT MUX to** obtain the higher scale of filtered amps.

Normal starter current draw easily exceeds 100 amperes. Therefore, the computer forces the filtered high amps or RAW AMPS (O to ±1000 amperes scale) on the cranking page. On the other pages the computer selects the appropriate range.

SECTION II. PROBE AMPS CALIBRATION

REQUIRED EQUIPMENT

The following equipment is required to perform the amperes calibration procedure:

IS-1OO(A) Ignition Simulator	SRT-28
Calibration Screwdriver	Adapter Cable, #6004-0533

PRELIMINARY SETUP

Advance the Tester to the DEVELOPMENT AIDS menu. See the Introduction (Page ii) for specific instructions on how to access the DEVELOPMENT AIDS menu.

ADJUSTMENT PROCEDURE

1. Select #4, TEST VAT MUX, from the DEVELOPMENT AIDS menu.

2. Use Left/Right cursor to advance to HI AVE AMPS.

3. With Amp Probe disconnected from IS-1OOA, adjust R107 for 0.0 volts **±0.02** volts on the VAT VALUE line.

4. Press the BACK-UP key 3 times to return to the CALIBRATION page. Press the CLEAR key to re-perform the System Calibration.

5. When Calibration is complete, press the ENGINE DATA key and the ENGINE DATA page will be displayed.

6. Connect **Amp** Probe to the IS-1OOA'S current loop. Set. the simulator for +80 amps.

7 Adjust R106 on the VAT Board, until the AMPS line reads 80 amps **±2.0** amps.

8. Move the IS-1OOA'S polarity switch to the -80 **amps** position.

9. The display should read -80 amps **+/-2.0** amps. If not, perform amp clamp symmetry adjustment per Sun Service Bulletin #403 (use Adapter Cable #6004-0533).

10. Hold the IS-1OOA'S amp switch in the 200 amp position. The display should read 200 amps **+/-** 10 amps.

****

**** CALIBRATION COMPLETE ****

****

SECTION III. AMPS PROBE TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. Fails self calibration. NOT CALIBRATED is displayed on VDU.	1. Perform Amps Calibration, page 11-4. 2. ——SUBSTITUTE—— A. Current Pickup and Lead Assembly #6005-0171 and perform Amps calibration. B. VAT Board #7001-0552 and perform Amps calibration. C. DAS A/D Board #7001-0555. D. DAS Memory Board #7001-0593. 3. Refer to Theory of Operation and Amps Functional Block Diagram 11-1.
II. Amp readings are questionable and/or abnormal.	1. Verify that Amp probe jaws are closed properly and no excessive build-up is on the jaws. 2. Perform **Amps** Calibration-Page 11-4. 3. ——SUBSTITUTE—— A. Current Pickup and Lead Assembly #6005-0171 and perform **Amps** calibration. B. VAT Board #7001-0552 and perform Amps calibration. C. DAS **A/D** Board #7001-0555. D. DAS **Memory Board #7001-0593**. 3. Refer to Theory of Operation and **Amps** Functional Diagram 11-1.

SECTION IV. CLAMP AMPS THEORY OF OPERATION

Battery load current (I LOAD) is detected only when either or both **K1** and K2 is energized. When **K1** is energized, resistor **R1** (0.6 ohm) is selected thus resulting in 20A current flow through the shunt resistor R6 and load resistor RI. When K2 is energized, parallel connected resistors R2-R5 are connected in series with the shunt resistor, resulting in a resistance of 0.16 ohms and a load current of 80 amperes. When both **K1 and K2 are energized, the overall** resistance **total becomes 0.12 ohm and a total load current of 100 amperes** results. For a more in depth discussion on the Battery Load Circuit, see Chapter 16.

Current flow from the battery, produces a small voltage drop across shunt resistor R6 terminals 2 and 3. This sensed voltage, designated **+SHUNT** and -SHUNT respectively, is passed through w36 and made available at J808 pins 5 and 4. From this point the shunt sensed voltage signals are passed through Battery Load Driver Board coils L8 and L7, J804 pins 7 and 6, W6, J306 pins 4 and 5 and applied to amplifier u26 located on the VAT **CCA.** U26 produces a dc voltage output signal designated I LOAD which is applied as one input to the eight channel multiplexer **U17.**

When the appropriate channel select signals, as determined by software control, are applied; the 8 channel multiplexer passes the ILOAD analog output voltage signal through a voltage follower u24 and out to P207 pin c8. The analog output voltage signal is then routed via the Sun Bus and applied to channel 4 of the 16 channel multiplexer located on the DAS **A/D Board7001-0555. Refer to Chapter 8**, Section I Theory of Operation for additional signal processing.

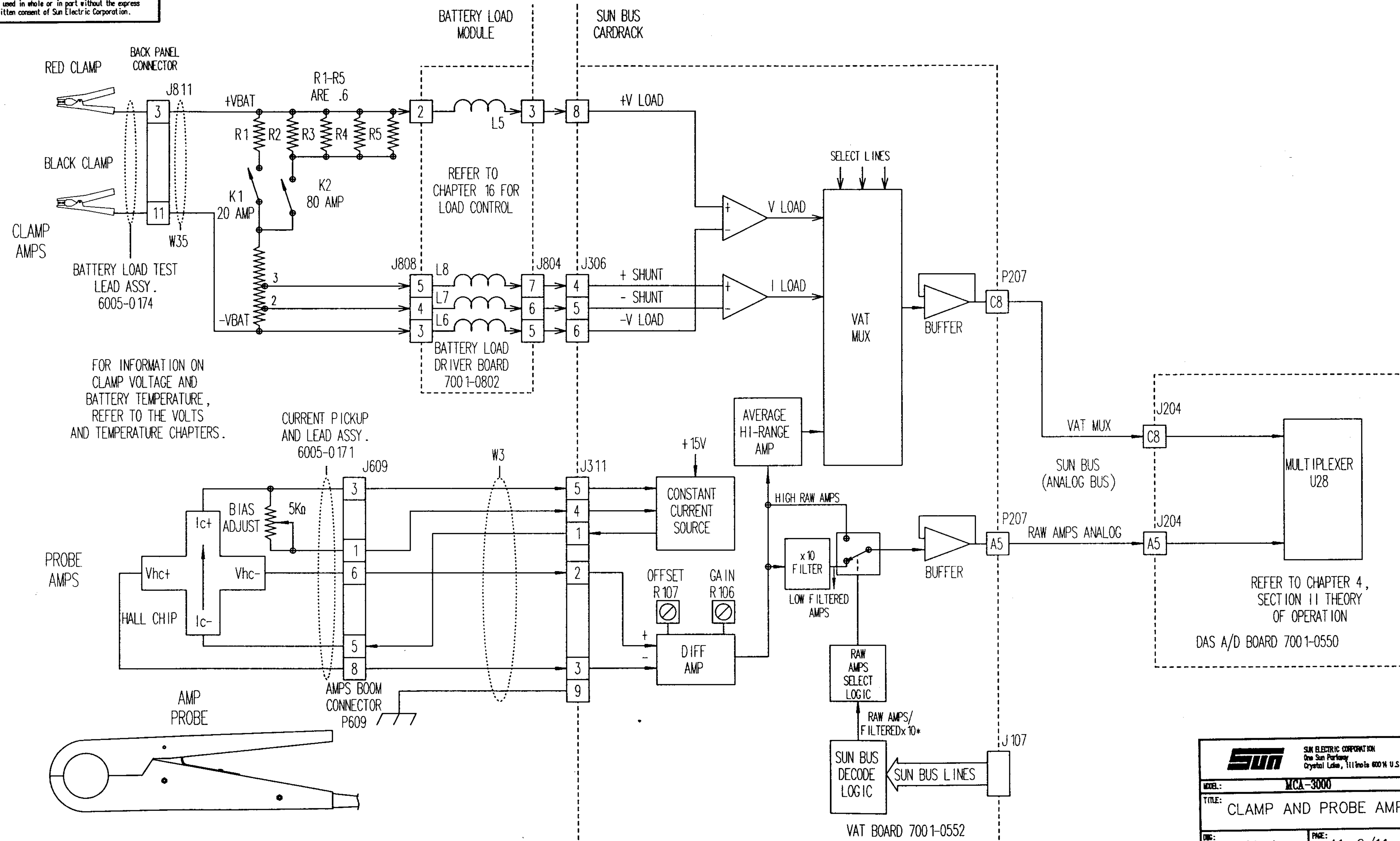
SECTION V. CLAMP AMPS CALIBRATION

Clamp Amps are not field adjustable.

SECTION VI. CLAMP AMPS TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. Unable to load battery to 20 ampere.	1. **Using test** meter, check for **+12V** relay at terminal 4 of K1. A. If not present, refer to Chapter 2 DC Power. b. If present, then -SUBSTITUTE 1. VAT Board #7001-0552. 2. Battery Load Driver Board #7001-0602. 3. Relay **K1** #0783-0326. 4. Resistor RI #0684-0622-01. 5. Resistor R6 #7076-0558, is part of Wiring Harness w36. **2.** Refer to Theory of Operation and Functional Diagram 16-1.
II. Unable to load battery to 80 ampere.	1. Using test meter, check for **+12V** relay at terminal 2 of K2. A. If not present, refer to Chapter 2, DC Power. B. If present, then **substitute** 1. VAT Board #7001-0552. 2. Battery Load Driver Board #7001-0602. 3. Relay K2 #0783-0324. 4. Resistor(s) R2-5 #0684-0622-01. 5. Resistor R6 #7076-0558, is part of Wiring Harness w36. **3. Refer to Theory of Operation and Functional** Diagram 16-1.
III. No indication of battery load current. Remaining indications are normal.	1. Using Functional Diagram 11-1, check continuity between terminal 2 of resistor R6 and J306 pin 4. If open, repair or replace parts as necessary. 2. Using Functional Diagram 11-1, check continuity between terminal 3 of resistor R6 and J306 pin 5. If open, repair or replace parts as necessary. 3. **SUBSTITUTE** **A. VAT Board #7001-0552.** **B. Battery Load Driver Board #7001-0802.**

NOTES



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MODEL: MCA-3000

TITLE: CLAMP AND PROBE AMPS

DWG: 11-1

PAGE: 11-9/11-10

CHAPTER 12

MULTIMETER

GENERAL

When Pin Point Tests have been selected from the main menu the Tester functions as a multimeter to enable testing of the following AC volts, DC volts, AC amperes, DC amperes, and resistance. The volt and ohm portion of the Tester, shown in Diagram 12-1, Page 12-9/10, share part of their circuitry with each other.

Many car manufacturers specify that a voltmeter with an input impedance greater than 10M ohms be used when taking voltage readings on the electronic control systems of the engine. The MCA-3000 meets this specification since the input impedance of the voltmeter circuitry exceeds 10M ohms.

Measurement ranges are as **follows:**

DC VOLTS	-50 to +50
DC AMPS	O to 6.5
OHMS	O to 200K
AC VOLTS	o to 40
AC AMPS	O to 6.5

SECTION I. THEORY OF OPERATION

OHMS

The ohms portion of the circuitry is capable of measuring resistances from O to 200K ohms in the following four separate scales. Range selection is performed automatically by the computer and is transparent to the operator.

1. 0 to 200 ohms
2. 200 to 2K ohms
3. 2K to20K ohms
4. 20K to 200K ohms

The **Multimeter** Board receives **+15Vdc** from Power Supply #2. A three terminal voltage regulator converts this **+15Vdc** into **+12Vdc** output for application to a DC/DC converter **(U25)** which converts **+12Vdc** into +5 VF(floating), **+15 VF(floating)**, and -15 **VF(floating)** output power when measured with respect to **0VF(floating).** This floating power and floating ground ensures that no ground conflicts can arise when taking measurements with the volt/ohm leads while the Tester chassis ground lead (negative battery lead) is connected to the vehicle's engine.

NOTE: If voltage measurements are made on the **Multimeter** Board during troubleshooting, such as checking the output of the DC/DC converter floating power supply, the floating ground **(0VF)** test point on the Multimeter board should be used.

The unknown resistance is measured by setting up a voltage divider with a Multimeter board precision resistor [200 ohm (R47), 2K ohm (R46), 20K ohm (R45), or 200K ohm (R44)] and measuring the dc voltage developed across the unknown resistor.

With a constant voltage applied to one end of the voltage divider network, comprised of the selected precision resistor and unknown resistor, the dc voltage across the unknown resistor is directly proportional to its ohmic value.

Tracing the current flow from the constant voltage source (+5VF) to floating ground (0VF) is as follows: from +5VF through a computer selected relay (K1-K4), selected multiplier resistor (R44-R47), series pass transistor Ql, closed contacts of relay KS, through the unknown resistor and then back through contacts of relay K5 to the floating ground.

The dc voltage developed across the unknown resistor is then sent to a Multimeter Board via J309 pins 1 &3. From the connector, the developed voltage is applied to a voltage divider and two amplifiers having separate gain factors. From these amplifiers the output signal is processed by hi/lo threshold detect stages. Output signals developed by the high/low threshold circuitry are processed within the on-board microcontroller which then produces the appropriate OHM1-OHM4 output select control signal to the required relay for internal connection of a specific value multiplier resistor in series with the unknown resistor.

The threshold output signals are also processed by the microcontroller which then develops a LOW/HI control signal which controls the operational status of analog switch U1O thereby selecting the low or high gain output signal. The selected DC VOLTS output signal is then applied as an input signal to the DAS A/D (Data Acquisition System Analog-to-Digital Converter) Board.

The DAS A/D Board developed output digital signal, representing the magnitude of the analog voltage across the unknown resistor, is then routed to the SBC for processing by the master microprocessor.

VOLTS DC

In this mode of operation, PINPTAMPS* is high, thus the dc voltage present at the Red and Black clip leads (designated VOLT/OHM (+) and VOLT/OHM (-)) is routed directly through normally closed contacts of relay K2 on the Input Filter Board, passed through the WI.7 and is made available at the input of the Low and High gain op amps located on the Multimeter Board. Whether the low gain (Xl) or high gain (X25) operational amplifier is selected is determined by the LOW/HI* signal from the on-board microprocessor. The status of the LOW/HI* gain signal is a direct result of the status of the threshold detector low/high output signals operating on the applied VOLTS DC signal. The DC VOLTS output is then converted into a digital signal by the DAS A/D Board, routed to the DAS Memory Board and processed by the master microprocessor for VDU display and Printer printout.

VOLTS AC
In this mode of operation PINPTAMPS* is a high level thus the test ac voltage is routed directly through the Input Filter Board and made available at the input of the low and high gain operational amplifiers located on the Multimeter Board. During this mode of operation only the stage with a gain of 1 is used thus its output ac voltage signal is capacitive coupled into the voltage input of a RMS to DC converter which converts the applied ac voltage into a dc voltage output. This dc voltage is then simultaneously applied to one input of an analog switch and to the non-inverting input of a following operational amplifier. The amplified dc voltage, present at the output of the gain amplifier, is then supplied as an input to the remaining input of the analog switch.

The threshold detector stages operate as previously described such that the on-board microprocessor develops the appropriate LOW/HI* control signal to the analog switch. When this signal is "high" the final gain stage (U17) of amplification is bypassed however when it is "low" the amplifier is inserted into the circuitry. The developed DC VOLTS output signal (representing the magnitude of the sampled AC voltage) is then processed by the DAS A/D Board, as covered in Chapter 8, Data Acquisition System.

AC/DC AMPERES
When performing either AC or DC amperage tests the Tester internal volt/ohm test circuitry functions in a manner similar to that previously described for voltage test measurement except as subsequently described.

In this mode of operation the Multimeter Board, operating under control of the Microcontroller, produces a lowlevelPINPOINT AMPS* output signal to energize control relay K1 located in the Input Filter Board. Transferred relay contacts connect a 1% precision resistor R24 and 8A circuit breaker CB5 in series with the external circuit under test. The voltage developed across this precision resistor is then sensed and processed in a manner identical to that for an unknown voltage test operation however the computer converts the processed data into a suitable amperage reading output for monitor display and printout. Circuit breaker CB5 protects the circuitry under test from a current overload in excess of 8 amperes.

SECTION II. CHECK-OUT/CALIBRATION PROCEDURE

1. Advance through SELF CALIBRATION.

2. From MAIN MENU page, select #4 PINPOINT TESTS and on to #2 MULTILETER.

3. Use the Up/Down cursor to select DC VOLTS, and press the ENTER key to display live DC VOLT readings (in box).

4. Connect BOTH the red booted and black booted Volt/Ohm lead to the (+) (red) lug on the IS-1OOA. Also, connect the black booted lead (battery -) from the Universal Lead assembly to the ground lug (lower left corner of IS-1 OOA).

5. Connect the DVM + (red) lead to TP4 and - (black) lead to GL1 (ground) on the **Multimeter** Board.

6. On the IS-1OOA, select the 13 volt position on the Volt/ohm selector switch, turn on the AC power switch, and turn off the Ripple switch.

7. DVM should read 0.00 VDC +/- 0.10, if not adjust R13.

8. Remove the Red and black pinpoint leads and short then together.

9. Connect red DVM lead to TP6 (black lead remains on GL1).

10. DVM should read 0.00 VDC +/-0.02, if not, adjust R21.

11. Return to SELF CALIBRATION (BACK-UP button 3 times).

12. When CALIBRATION is complete, return to MULTIMETER page, select VOLTS and press ENTER.

13. Connect the red and black pinpoint leads (separately) to the Volt/ohm lugs on the IS-1OOA, observe polarity.

14. On the IS-1OOA, turn Volt/ohm selector switch to 13 volts, AC power on, and Ripple off.

15. VDU should read 13.0 VDC +/-0.2 volts, if not adjust R14.

16. Short Volt/ohm leads together.

17. Use the Up/Down cursor to select OHMS and press ENTER.

18. VDU should read 0.00 ohms +/-0.02 ohms, if not refer to Section III, Troubleshooting.

19. Connect Volt/ohm leads to IS-1OOAS Volt/ohm lugs.

20. Turn IS-1OOAS AC power switch OFF and select 170 ohms on the Volt/ohm selector switch.

21. VDU should read 170 ohms +/-5 ohms, if not Adjust R20.

22. It is necessary to check the OHMS reading for each of the 4 scales. Use the Volt/ohm selector switch (IS-1OOA) to verify the following:

Switch position (IS- 1OOA)	VDU should read
5 ohms	5 +/-1 ohms
500 ohms	500 +/-50 ohms
5000 ohms	5000 +/-500 ohms
50K ohms	50K +/-5K ohms

[f the 50K Ohms scale is out of tolerance, try to adjust R95 for correct reading. However only Rev. G or greater **Multimeter** Boards have **R95.** If the adjustment can not be made within tolerance, then replace the **Multimeter** Board, 7001-0550 Rev. G or greater.

23. Turn off IS-1OOA and disconnect Volt/ohm leads.

24. Use the Up/Down cursor to select DC AMPS and press ENTER.

25. Using a DVM, measure resistance (ohms) between the 2 Volt/ohm leads. With .1 ohms precision resistor (on Imput Filter Board) applied accross Volt/ohm circuit, the reading should be less than 0.5 ohms.

26. Use the Up/Down cursor to select AC AMPS and press ENTER.

27. Using a DVM, measure resistance (ohms) between the 2 Volt/ohm leads. With .1 ohms precision resistor (on Imput Filter Board) applied accross Volt/ohm circuit, the reading should be less than 0.5 ohms.

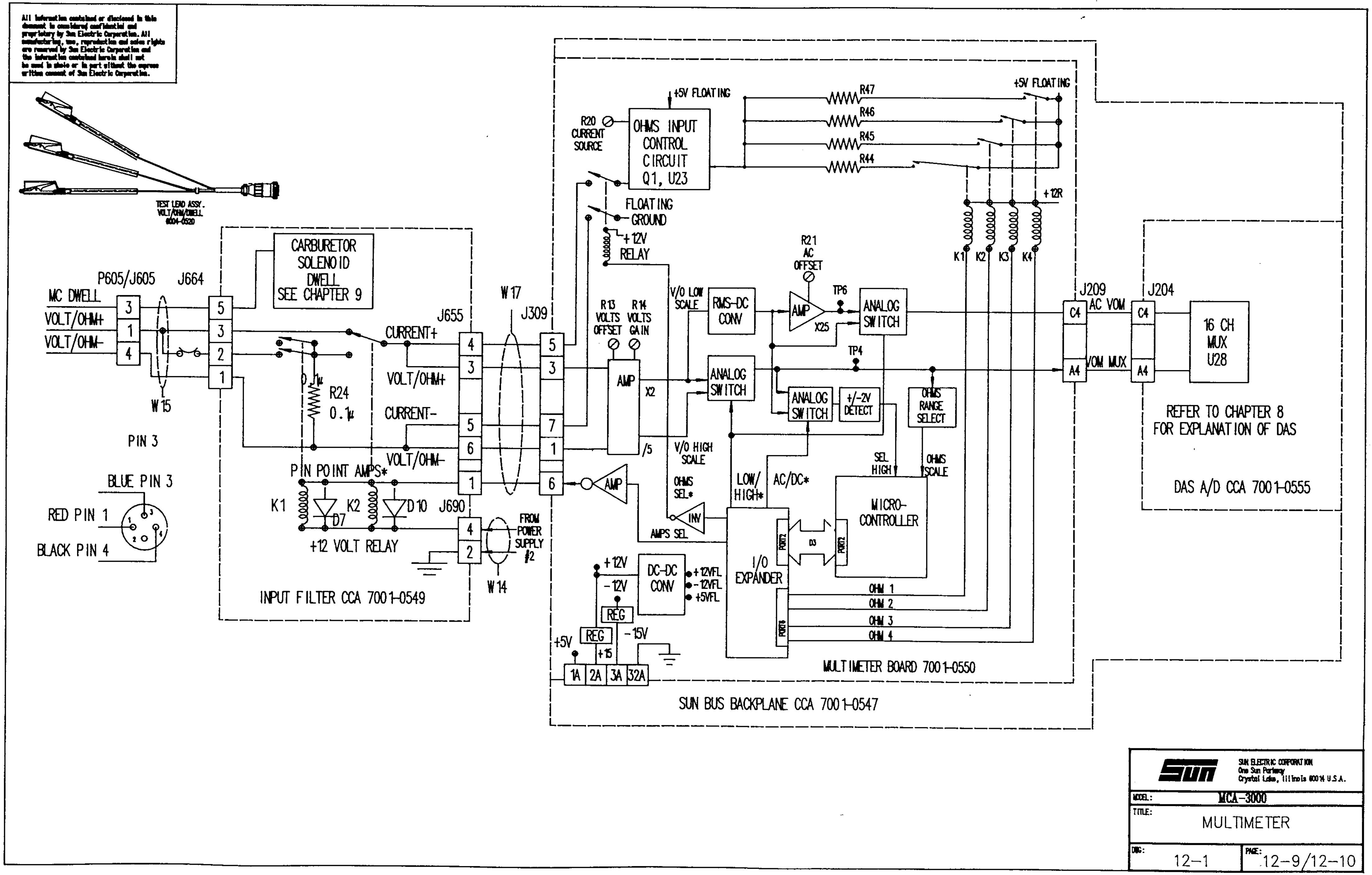
****
" Check-Out/Calibration Complete •
•*************************************

SECTION III. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. **Multimeter** fails self calibration.	1. Verify pinpoint leads are shorted at clip ends. 2. Using ohmmeter, check continuity of . pinpoint lead assembly #6004-0520. Replace or repair if necessary. 3. Verify +15 volts at J109 pin A2 of Sun Bus Board (using A32 for ground). If supply is missing, refer to Chapter 2. 4. With pinpoint leads shorted, remove J309 at **Multimeter** Board and check continuity between pins 3 and 7. If-open, refer to functional block diagram 12-1 to trace current paths. 5. Verify +12 volts at J690 pin 4 (using pin 2 as ground). If supply is missing, refer to Chapter 2. NOTE This is located in the Boom assembly. 6. If all above steps have been verfied, then --------------SUBSTITUTE ----------- A. **Multimeter** Board #7001-0550. B. Input Filter Board #7001-0549. C. DAS A/D Board #7001-0555. 7. Refer to Theory of Operation and Functional Diagrams.
II. **Multimeter** passes self calibration. DC volt readings are accurate and ohm readings are inaccurate.	1. Remove connector J309 from **Multimeter** Board. Check for continuity between pins 1 & 7 and 3 & 5. If open, then ---------------SUBSTITUTE------------------ A. **Multimeter** Board #7001-0550. 2. Refer to Theory of Operation and Functional Block Diagram.

COMPLAINT	CORRECTIVE ACTION
111. **Multimeter** passes self calibration but, AC Volts is inaccurate.	1. Verify circuit breaker CB5 has not been tripped. If so, reset (located on boom). 2. If all other Volts and Ohms are operating correctly, then ---------------SUBSTITUTE------------------ A. **Multimeter** Board #7001-0550. B. DAS A/D Board #7001-0555. 3. Refer to Theory of Operation and Functional Block Diagram
IV. DC Volts inaccurate, all other readings correct.	1. ----------------SUBSTITUTE----------------- A. **Multimeter** Board #7001-0550. 2. Refer to THeory of Operation and Functional Diagram.
v. AC or DC Current inaccurate, all other reading correct.	1----------------SUBSTITUTE ----------------- A. Multi”meter Board #7001-0550. 2. Refer to THeory of Operation and Functional Diagram.

NOTES



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TEST LEAD ASSY. VOLT/OHM/DWELL
MC DWELL
VOLT/OHM+
VOLT/OHM-
P605/J605
J664
W15
PIN 3
BLUE PIN 3
RED PIN 1
BLACK PIN 4
CARBURETOR SOLENOID DWELL SEE CHAPTER 9
CURRENT+
VOLT/OHM+
CURRENT-
VOLT/OHM-
R24 0.1µ
PIN POINT AMPS*
K1
D7
K2
D10
J690
+12 VOLT RELAY
INPUT FILTER CCA 7001-0549
J655
W17
J309
W14
FROM POWER SUPPLY #2
+5V FLOATING
R20 CURRENT SOURCE
OHMS INPUT CONTROL CIRCUIT Q1, U23
FLOATING GROUND
+12V RELAY
R47
R46
R45
R44
+12R
K1 K2 K3 K4
R21 AC OFFSET
R13 VOLTS OFFSET
R14 VOLTS GAIN
V/O LOW SCALE
RMS-DC CONV
AMP
X25
TP6
ANALOG SWITCH
TP4
X2
/5
V/O HIGH SCALE
ANALOG SWITCH
+/-2V DETECT
OHMS RANGE SELECT
SEL HIGH
OHMS SCALE
OHMS SEL*
LOW/ HIGH*
AC/DC*
INV
AMPS SEL
MICRO-CONTROLLER
I/O EXPANDER
PORT2
D3
PORT0
+12V
-12V
DC-DC CONV
+12VFL
-12VFL
+5VFL
REG
-15V
+5V
+15
1A 2A 3A 32A
OHM 1
OHM 2
OHM 3
OHM 4
MULTIMETER BOARD 7001-0550
SUN BUS BACKPLANE CCA 7001-0547
J209
AC VOM
VOM MUX
C4
A4
J204
16 CH MUX U28
REFER TO CHAPTER 8 FOR EXPLANATION OF DAS
DAS A/D CCA 7001-0555
SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.
MODEL: MCA-3000
TITLE: MULTIMETER
DWG: 12-1
PAGE: 12-9/12-10

CHAPTER 13

TEMPERATURE-OIL /AMBIENT/BATTERY

GENERAL
The MCA-3000 monitors three different temperatures, they are:

1. **Oil Temperature** - The Low Temperature Test Lead **#6004-0407** (temperature probe) is used to measure the oil temperature of the engine under test. Monitoring the temperature of the engine is useful for 3 reasons. They are; A) To verify the engine has reached operating temperature (more than 65C) to commence testing.
   B) To display a prompt indicating the engine under test is overheating (more than 11OC). C) To KILL (disable ignition) if the engine under test reaches a temperature of more than **115C.** The KILL, in option "C", will be overridden when the temperature falls below 105C or when the KILL button is depressed.

2. **Ambient Temperature - Ambiant** Temperature is sensed by an Ambient Temperature Sensor mounted on the Filter **Imput** Board #7001-0549 (mounted in the boom). **Ambiant** Temperature is continuously monitored and processed by the SBC to provide temperature compensation for Exhaust Emission (1. R.) Analyzer readings.

3. **Battery Temperature -** The Battery Temperature Sensor Assembly is contained in the jaws of the black Battery Test Clamp (assembly #6005-0174). A voltage is supplied to one lead of the temperature sensor and a current is an output of the other lead. This output current is dependent upon the sensed temperature. This is **useful** in determining if a good connection is made to the battery being loaded and also, to what capacity the battery should be tested.

SECTION I. THEORY OF OPERATION.

OIL TEMPERATURE
The Temperature probe, shown in Diagram 13-1, Page **13-7/8,** contains an internal thermistor which has a resistance that decreases as the temperature increases. The thermistor forms a voltage divider with resistors R7 and R8 connected to **+12V** and located on Input Filter Board #7001-0549. This circuitry arrangement creates a dc signal voltage which decreases as the temperature increases.

The output dc signal voltage, present at terminal 2 of J657, is then routed via **W11** to terminal 3 of J302 located on the Bus Driver Board #7001-0559. This analog signal is then processed by voltage follower U6 and applied to an eight channel multiplexer. operating under software control the 8 channel multiplexer passes the oil temperature out to a buffer and finally to **J203** pin A3.

The analog signal present at J203 pin **A3 is** routed via the Sun Bus to J204 pin A3 located on the DAS A/D Board #7001-0555 and designated BOOM MUX. The computer then reads and processes the digital oil temperature data for display on the VDU.

During self calibration, the computer reads the OIL TEMP ANALOG voltage. If the voltage exceeds 6.9 volts, the computer displays "SERVICE REQUIRED" message next to TEMP on the SELF CALIBRATION page.

Temperature readings can be displayed in either Centigrade (Celsius) or Fahrenheit as selected when in the "CHANGE UNITS" under the "UTILITIES" menu.

AMBIENT TEMPERATURE

Ambient temperature is sensed by an ambient temperature sensor **which is** mounted on the Input Filter Board #7001-0549. This sensor functions within the +5 to +300 degree Fahrenheit range and develops 10mv/degree Fahrenheit change. For example; at **+74F** the sensor develops 0.74 volt output which is applied to J657 pin 1.

The AMB TEMP ANALOG signal voltage is routed via **W11** and applied to J302 pin 4 on the Bus Driver Board #7001-0559, through amplifier U6 and applied to the 8 channel multiplexer. When operating under software control such that the AO-2 signals are appropriate; the applied analog signal is then processed within the eight channel multiplexer and amplified by 1 via the voltage follower U2 and made available on the BOOM MUX output at J203 pin A3.

The Sun Bus Transfer then supplies the ambient temperature analog dc signal to J204 pin A3 located on the DAS A/D Board #7001-0555 and applied to channel 6 of the 16 channel multiplexer. From this point the ambient temperature analog dc signal voltage is processed within the DAS A/D Board .

Refer to Chapter 8, Section I, Theory of Operation for additional discussion relative to the complete DAS System and its method of signal acquisition and processing.

BATTERY TEMPERATURE

The temperature sensor assembly, contained within the black clamp of the Battery Load Test Lead Assembly #6005-0174, produces an output current dependent upon the sensed temperature. **+15V** power is supplied to the sensor assembly via resistor R74 located on the VAT Board #7001-0552. The produced -TEMP signal is routed through J81O pin 13, J809 pin 4, through coil L4, J804 pin 9, W6, J306 pin 2 and developed across TEMP CAL potentiometer R108 located within the VAT Board .

The **-TEMP** signal, developed across R108, is processed through voltage follower (buffer) U20 and then applied as one input to the following eight channel multiplexer U17. When software control channel select lines AO-2 are of a specific status the battery temperature signal **(-TEMP)** is processed by voltage follower (buffer) U24 and routed via P207 pin C8 and J204 pin C8 (as the Vat Mux) and applied as one input to the 16 channel multiplexer U28 located on the DAS A/D Board 7001-0555.

Refer to Chapter 8, Section I Theory of Operation for additional **discusson** relative to the complete DAS system and its method of signal acquisition and processing.

SECTION II. TEMPERATURE CHECK-OUT AND/OR CALIBRATION

AMBIENT TEMPERATURE CHECK-OUT PROCEDURE

Operational calibration of the ambient temperature sensor consists only of testing its readout accuracy. Testing involves comparing the output of the sensor to the ambient temperature displayed on a digital thermometer. Assuming a thermometer test instrument having an accuracy of 2F, the ambient temperature sensor output readings should be within **+/-4F** of the test instrument reading.

• ************************
• **Check-Out Complete** •
• ************************

BATTERY TEMPERATURE CALIBRATION PROCEDURE

To properly adjust the battery temperature TEMP CAL potentiometer R108, proceed as follows:

1. Access MAIN MENU page. ·

2. Press "O", and immediately after press Control, Shift, and 6 at the same time, to access DEVELOPMENT AIDS page.

3. Press "4" to access VAT TEST page.

4. Use right arrow (-->) key to arrive at TEMP selection.

NOTE: Prior to performing step 5 allow sufficient time for the black clamp of the Battery Load Test Lead Assembly #6005-0174 to reach ambient temperature as measured by an accurate standard thermometer.

5. Connect test meter (+) and (-) test leads between P207 pin C8 and C1O respectively of VAT Board . Set test meter to monitor VDC.

6. Adjust VAT Board potentiometer R108 until it reads correct voltage as noted in following temperature/voltage tabulation; e.g.: measured voltage must be +7.92 for 20 degree C.

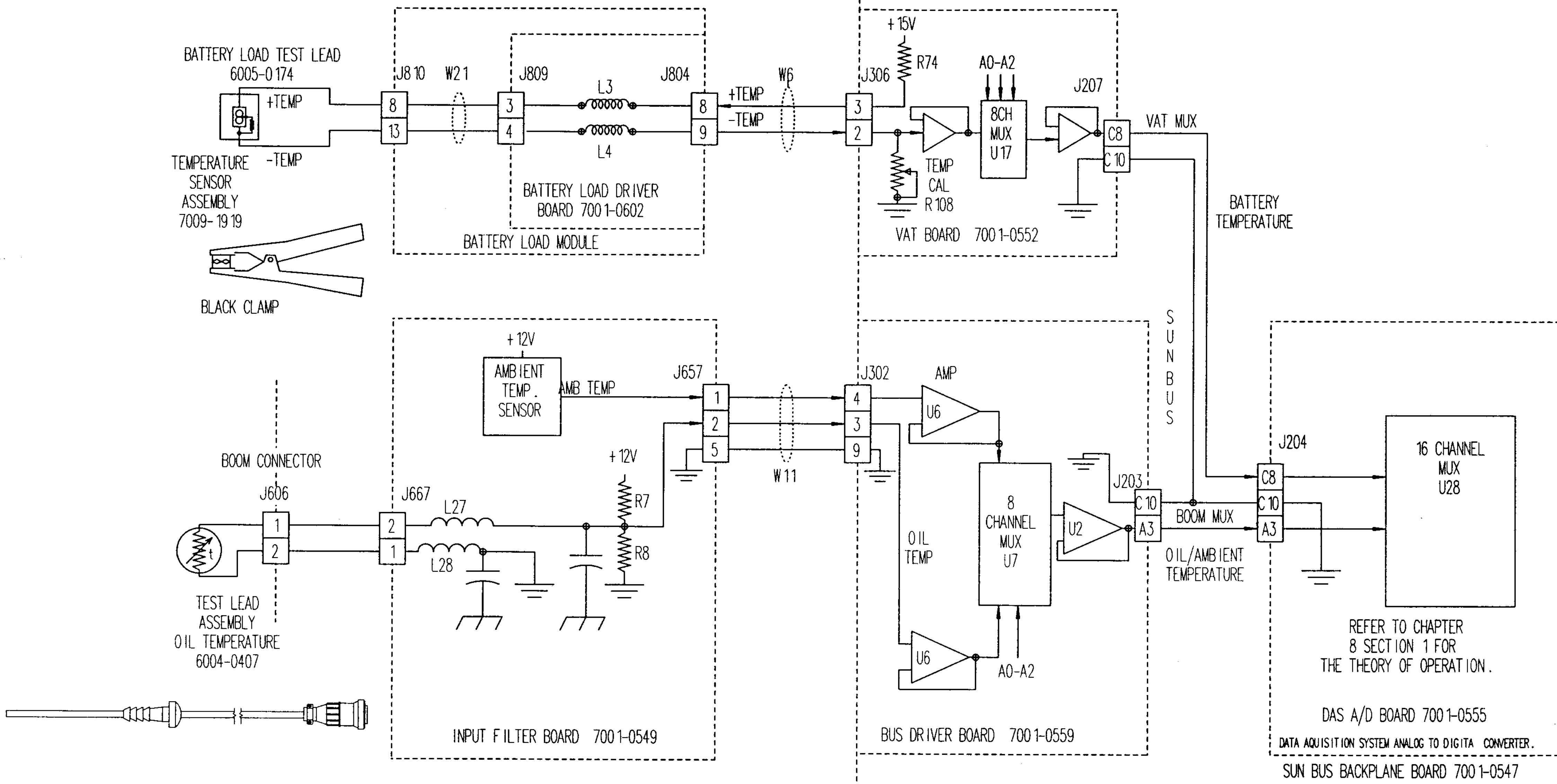
TEMP (C)	TEMP (F)	VOLTS	TEMP (C)	TEMP (F)	VOLTS
10	50.0	7.64	27	80.6	8.12
11	51.8	7.67	28	82.4	8.15
12	53.6	7.70	29	84.2	8.17
13	55.4	7.73	30	86	8.20
14	57.2	7.75	31	87.8	8.23
15	59.0	7.78	32	89.6	8.26
16	60.8	7.81	33	91.4	8.29
17	62,6	7.84	34	93.2	8.31
18	64.4	7.87	35	95	8.34
19	66.2	7.89	36	96.8	8.37
20	68.0	7.92.	37	98.6	8.40
21	69.8	7.95	38	100	8.43
22	71.6	7.95	39	102	8.46
23	73.4	8.01	40	104	8.48
24	75.2	8.03	41	106	8.51
25	78.3	8.09	42	108	8.54

SECTION III. TEMPERATURE TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. Ambient temperature abnormal; oil temperature indication normal.1	1. Monitor ambient temperature sensor by connecting DVM between J657 pin 1 and ground point J656 pin 5. The reading should be directly related to ambient room temperature (10mv/degree F); e.g.: if room is at 74 degrees F the meter should read 0.74V. If not, then ----------------SUBSTITUTE--------------------- A. Filter Imput Board #7001-0549 If reading is normal proceed to step 2. 2. Connect DVM between J302 pins 4 and 9 (ground) and check for same reading obtained in step 1. If present, then -----------------SUBSTITUTE-------------------- B. Bus Driver Board 7001-0559 If not present, repair W11 Wiring Harness VAC/Oil/Temperature #7076-0551.
II. Oil temperature abnormal, ambient temperature indication normal.	1. Using DVM, check that resistance between pins 1 and 2 of Low Temperature Test Lead Assembly 6004-0407 is from 30K to 350K ohms. Resistance should be approximately lOOK ohms at 77 degrees F. If not, then -----------------SUBSTITUTE-------------------- A. Temperature Test Lead Assembly #6004-0407 If resistance is normal, proceed to step 2. 2. Connect DVM across J657 pin 2 and J656 pin 5 (ground) and note that meter indicates approximately +6.1Vdc at room temperature. If not, then -----------------SUBSTITUTE-------------------- A. Input Filter Board #7001-0549 If present, proceed to step 3.

COMPLAINT	CORRECTIVE ACTION
II. Oil temperature abnormal, ambient temperature indication normal. (CONT')	**3. Connect DVM across J302 pin 3 and pin 9 (ground) and** note that meter indicates voltage obtained in step 2. If present, then -----------------SUBSTITUTE-------------------- A. Bus Driver Board #7001-0559 But if not present, repair **W11** Wiring Harness, VAC/Oil/Temperature #7076-0551. 4. Refer to Theory of Operation and Functional Block Diagram 13-1.
III. Battery temperature abnormal. Oil & ambient temperatures normal.	1. Refer to Section V and **re-calibrate** battery temperature. 2. Disconnect Battery Load Test Lead Assembly and check for **+15V** as measured between J81O pin 8 and analog ground. If present, then -----------------SUBSTITUTE-------------------- A. Temperature Sensor Lead Assembly #7009-1919 But if not present, proceed to step 3. 3. Check for **+15v** at J306 pin 3 on VAT Board . If present, then -----------------SUBSTITUTE-------------------- A. Battery Load Driver Board #7001-0602 and/or repair W6, W21 cable assemblies. If not present, then -----------------SUBSTITUTE-------------------- A. VAT Board #7001-0552. 4. Refer to temperature/volt Table above and check for correct voltage at P207 pin **C8.** If present, proceed to Chapter 8, DAS Troubleshooting guide, If not present, proceed to step 5.

COMPLAINT	CORRECTIVE ACTION
III. Battery temperature abnormal. Oil & ambient temperatures normal. (CONT')	**5.** Check for correct voltage at ambient temperature at J306 pin 2 (voltage should be approximately same as at P207 pin C8). If normal, then -----------------SUBSTITUTE------------------- A. VAT Board #7001-0552 If not normal, proceed to step 6. 6. Check for correct voltage at ambient temperature at J81O pin 13 (voltage should be approximately the same as at P207 pin C8). If not normal, then -----------------SUBSTITUTE------------------- A. Temperature Sensor Lead Assembly #7009-1919 But if normal, then -----------------SUBSTITUTE------------------- A. Battery Load Driver Board #7001-0602 and/or repair W21 cable assembly. 7. Refer to Theory of Operation and Functional Block Diagram 13-1.



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

MODEL:	MCA-3000
TITLE:	OIL, AMBIENT, AND BATTERY TEMPERATURE
DWG: 13-1	PAGE: 13-7/13-8

CHAPTER 14

VOLTS

GENERAL

The MCA-3000 has several method of reading volts. They include:

Voltage	Source leads
Primary resistance	Primary - lead & battery ground
Coil + Voltage	Primary + lead & battery ground
Ripple Voltage	Battery volt clips
Battery Voltage (Clips)	Battery volt clips
Battery Voltage (Clamps)	Battery volt clamps
Pinpoint Voltage (multimeter)	Pinpoint leads

All of these voltage will be discussed in this chapter with the exception of Pinpoint volts, which is discussed in Chapter 12. This Chapter is broken down into 2 parts, Primary and Battery volts,

SECTION I. VOLTAGE and RIPPLE THEORY OF OPERATION

GENERAL

Primary Voltage Theory of Operation is divided into two parts; namely: PRI.RES (distributor resistance) and Coil + voltage. Primary and Distributor Resistance are used interchangeably throughout this chapter. The following paragraphs provide a functional description of each of these subjects.

DYNAMIC PRIMARY DISTRIBUTOR RESISTANCE (PRI.RES)

Dynamic Primary Distributor Resistance is the voltage developed across the points when the points are closed. With electronic ignition systems it is the voltage developed across the transistor when the transistor is turned on. Dynamic distributor resistance is obtained during the cranking test. As the engine is cranking the voltage across the points (when they are closed) is read by the computer.

The COIL- (PRIMARY-) signal voltage is sensed by the blue Universal Test Lead clip attached to the vehicle coil- terminal. This analog signal is passed through the W8 cable assembly to a noise filter located on the Input Filter Board #7001-0549. From this point the filtered analog signal voltage is routed via the W12 cable assembly to J308 pin 4 located on the Primary Processor Board #7001-0544.

Two diodes, connected to +/-12V, function to clip the applied analog signal voltage to a maximum swing of +/-12V prior to its application to the amplifier stage. The clipped and amplified output signal from the amplifier is routed through J206 pin C9 and J204 pin C9 and applied to one input of the 16 channel multiplexer located on the DAS A/D Board #7001-0555. Refer to Chapter 8, Section I, for Theory of Operation concerning the DAS system.

A conversion clock (POINTS CLOCK) is developed by the primary microprocessor. The CYL CLK signal is used by the primary microprocessor to form POINTS CLOCK. The delayed (750 ms) POINTS CLOCK signal ensures that the dynamic distributor resistance measurements are taken while the distributor points are closed.

Figure 9-4 shows the interrelationship between the POINTS CLOCK signal and the PRIMARY OUT signal being applied to pin A9 of J204 located on the DAS A/D Board.

Primary — J205, pin A9.

Delay Dwell — J105, pin A22.

PRI CLK — J205, pin A16.

CYL CLK — J105, pin C20.

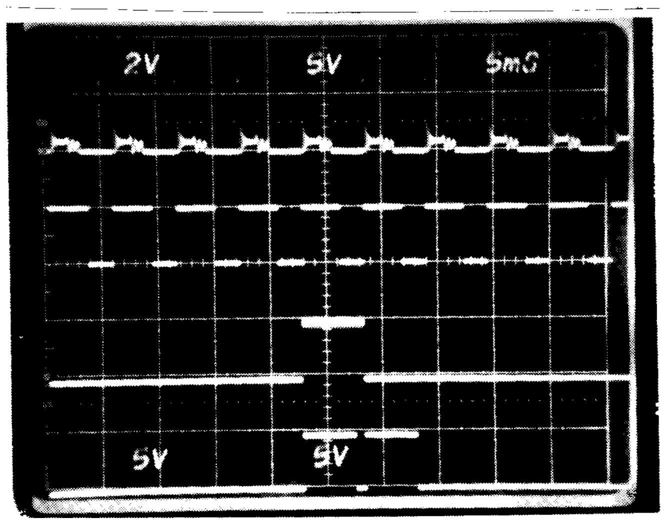


Figure 14-1. POINTS CLOCK and PRI OUT Signal **Interrelationship.**

COIL+ VOLTAGE THEORY OF OPERATION

The COIL+ signal voltage is sensed by the yellow Universal Test Lead clip attached to the vehicle coil+ terminal. This analog signal is passed through the W8 cable assembly to a noise filter located on the Input Filter Board #7001-0549. From this point the filtered analog signal voltage is routed via the **W11** cable assembly to J302 pin 6 located on the Bus Driver Board #7001-0559.

The voltage divider comprised of resistors R35 & R29 function to divide the input applied signal by a factor of 3. Two diodes **(CR3, CR4),** connected to **+/-12V,** function to clip the divided down analog signal voltage to a maximum swing of **+/-12V** prior to its application to the following buffer. One output signal of the buffer is developed across load resistor R14 and applied to one input of the following multiplexer as an unfiltered coil+ signal (unused at time of publication). The remaining output signal of the buffer amplifier is filtered by the RC combination of R31 and **C32** with its filtered signal being applied to a different input of the multiplexer and used for coil+ voltages.

Sun Bus line status being processed through the Sun Bus logic circuitry produces output select line signals which in turn function to select which of the 8 multiplexer input signals is selected for output through the following buffer to J203 pin A3. This signal is then routed via J204 pin A3 and applied to one input of the 16 channel multiplexer located on the DAS A/D Board #7001-0555. Refer to Chapter 8, Section I, for theory of operation concerning the DAS system.

CLIP/CLAMP VOLTS GENERAL
Battery voltage input data, as shown in Battery Voltage Functional Block Diagram 14-2, is obtained from either the Red/Black clamps of the Battery Load, Test Lead Assembly 6005-0174 or Red/Black clips of the Universal Test lead Assembly 6005-0173 when connected across the positive and negative terminals of the battery. There is currently three uses for the input voltage. They are Battery Volts, Ripple Volts, and Ripple Pattern. Each will be discussed in more detail following the. Clip and Clamp theory.

CLAMP PICKUP
+VBAT and -VBAT sensed battery voltage, picked up by the Red/Black clamps, is routed via W21 and applied to J809 terminals 1 and 2 of the Battery Load Driver Board 7001-0602. The Battery Load Driver Board functions to filter the applied battery voltage input and outputs it on J804 pins 1 and 2 "as +VCLAMP and -VCLAMP. These voltages are then routed through W6 and applied to J306 pins 10 and 9 of the VAT (Volts Amperes Tester) Board 7001-0552.

Operating under software control the sun bus logic controls transistor Q2 into saturation thus energizing both clip/clamp select relays K1 and K2. In this state, the +VCLAMP and -VCLAMP voltages are passed through the relays and applied to a differential amplifier. R105 functions as the zero adjust control while R104 serves as the gain control. BATVOLTS (battery volts) output, generated by the differential amplifier, is applied through J207 pin A6 and the Sun Bus to J204 pin A6 on the DAS A/D Board 7001-0555. For a further explanation of the DAS system refer to Chapter 8.

CLIP PICKUP
Sensed battery voltage, picked up by the Red/Black clips of the Universal Test Lead Assembly 6005-0173, is routed via W8 applied to J663 terminal 2. The black clip lead is terminated via circuit breaker CB2 terminals 1 and 2 to ground thereby functioning as an overload device. The Noise filter on the input board functions as an LC filter and as a high voltage protector. The filtered output, present at J651 terminals 2 and 4 and labeled as +VCLIP and -VCLIP respectively, is routed via W53 to J323 terminals 3 and 1 of the VAT Board.

At initial powerup of the Tester, the clip/clamp select relays K1 and K2 are not energized and clip lead input voltage is passed onto the differential amplifier. Except when functioning with the battery load cable connected; software maintains the relays in their de-energized state thus the clip lead pickup voltage is processed by the DAS A/D Board as previously described for clamp pickup mode operation.

BATTERY VOLTS
Battery volts are measured as mentioned previously under "Clip/Clamp Volts" and are processed via J 204 pin A6 of the DAS A/D Board. For a further explanation of the operation of the DAS system refer to chapter 8.

RIPPLE VOLTS
The Input voltage from the selected leads is routed to the Ripple AMP as -VCLIP and +VCLIP signals through K1 and K2. Ripple gain potentiometer R109 Controls the Gain for this stage. The ac component of the alternator input signal is coupled via capacitor C18 and applied as a RIPPLE PATTERN to one input of an 8 channel multiplexer while the second amplifier output is applied to a rectifier filter network. The negative and positive rectified output from the filter network, designated RIPPLE VOLTS, is applied as another input to the 8 channel multiplexer. The DAS system then reads the RIPPLE VOLTS signal and displays it as Alternator Ripple. For a further explanation of the DAS system refer to Chapter 8.

RIPPLE PATTERN
The RIPPLE PATTERN signal as described in Ripple Volts is read by the DAS system and can be displayed as a ripple pattern in the Scope functions of the MCA-3000. For a further explanation of the DAS system and the Scope Pattern funtion, refer to Chapter 8.

SECTION II. VOLTS and RIPPLE CHECK-OUT/CALIBRATION

Required Equipment: IS-lOOA Calibration Screwdriver
Card extender Board #7001-0576

1. With tester OFF, remove Primary Processor Board #7001-0544 and insert card extender. Insert Primary Board into card extender and power up tester.

2. Advance to COMPLETE TEST and enter code 115.

3. Depress ENGINE DATA key to display ENGINE DATA page.

4. With all leads disconnected, COIL +, PRI. RES, VOLTS, and RIPPLE should read 0.0 +/- 0.2 volts.

5. If the COIL + or RIPPLE do not read 0.0 +/-0.2 volts, precede to Section HI, Troubleshooting (no adjustment). If the PRI. RES and/or VOLTS do not read 0.0 +/- 0.2 volts, precede to next step.

6. For PRI. RES zero, adjust R134, on the Primary Processor Board #7001-0544, for 0.0 +/-0.2 volts.

   For VOLTS, adjust R105, on the VAT Board #7001-0552, for 0.0 +/-0.2 volts.

7. Connect the following:
   A. Yellow booted lead (coil +) to 13 volt output lug.
   B. Blue booted lead (coil -) to 13 volt output lug.
   C. Red booted lead (battery +) to 13 volt output lug.
   D. Black booted lead (battery -) to ground lug.

8. Set the Volt/Ohm selector switch to 13 volts, turn the Ripple switch off, and the AC power switch on.

8. The COIL +, PRI. RES, and VOLTS should all read 13.0 volts +/- 0.2 volts (IS-1 OOA).
   If not within limits:
   Adjust R133, on the Primary Processor Board #7001-0544, for 13.0 +/-0.2 volts on the PRI. RES line.

   Adjust R104, on the VAT Board #7001-0552, for 13.0 +/-0.2 volts on the VOLTS line.

   COIL + is unadjustable, precede to Section III, Troubleshooting.

9. With leads connected, turn on the Ripple switch (IS-1 OOA).

10. Adjust R109 for 1.50 +/-0.1 volts on the RIPPLE line,

• ************************************
• **Check-Out/Calibration Complete** •
• ************************************

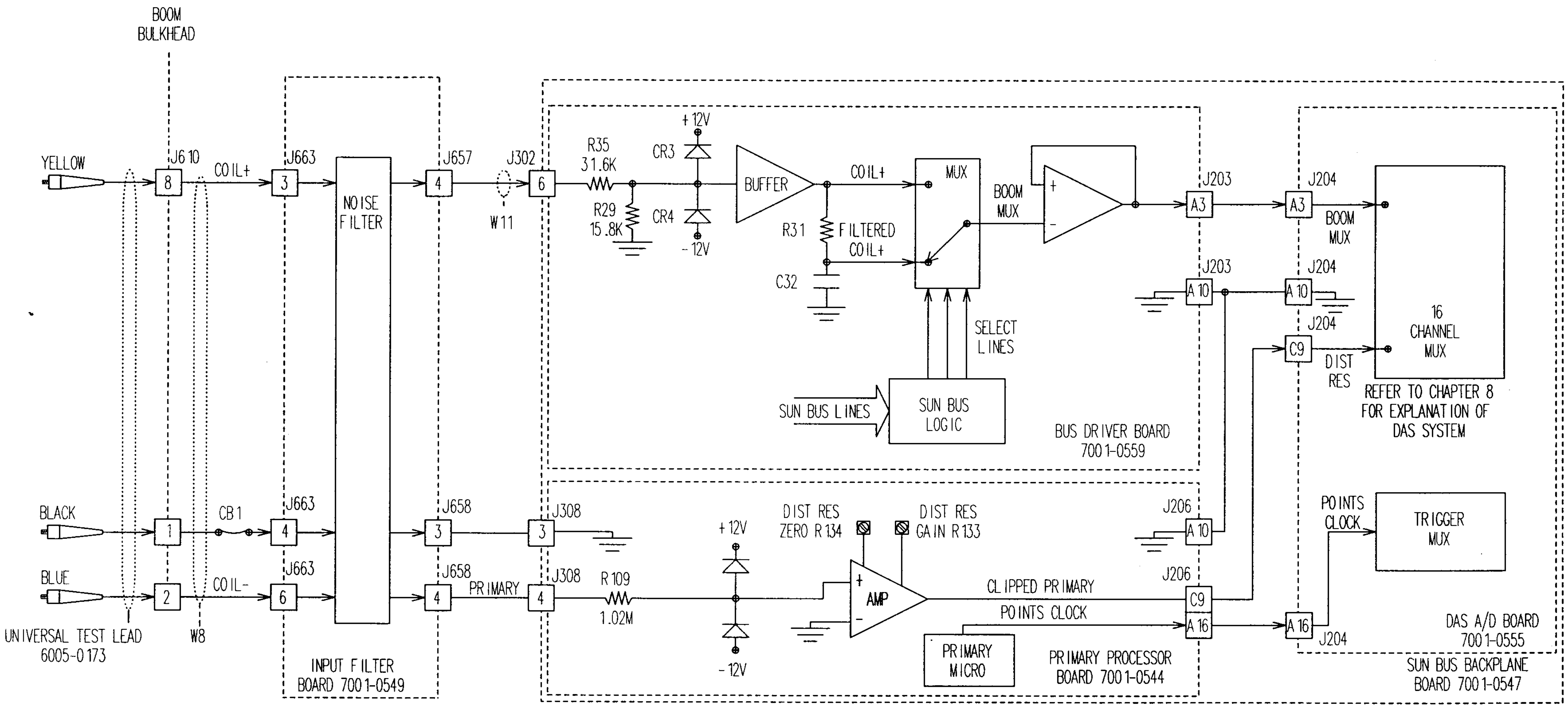
SECTION III. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. Abnormal COIL+ voltage on VDU, with +13V (IS-1OOA) applied between Coil+ lead and ground.	1. Check for +13V (IS-1OOA) at connector J302 pin 6. If not present, then: -------------SUBSTITUTE -------------------- A. Input Filter Board #7001-0549. B. Universal Lead Assm. #6004-0173
	2. Check interconnecting wire. If present, proceed to step 3.
	3. -------------SUBSTITUTE -------------------- A. Bus Driver Board #7001-0559.
	4. Troubleshoot DAS System as directed in Chapter 8.
	5. Refer to Theory of Operation and Functional Block Diagrams.

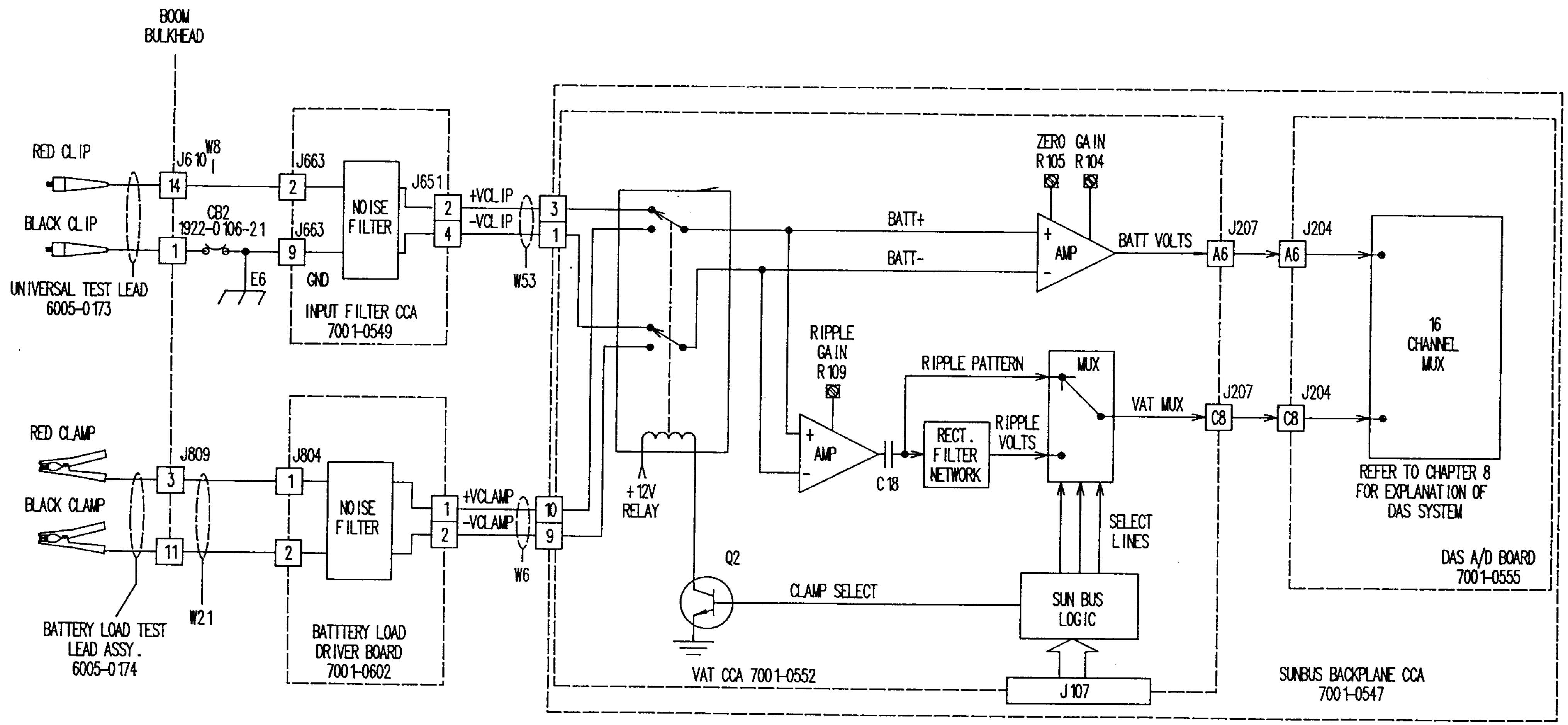
COMPLAINT	CORRECTIVE ACTION
II. Distributor resistance reading will not zero on VDU.	1. Calibrate per procedure on page 14-3. **2. .... SUBSTITUTE ....** **A. Primary Processor Board #7001-0544.** **B. Input Filter Board #7001-0549.** **3. Refer to Theory of Operation and Functional Block Diagram.**
III. Distributor resistance reading abnormal with calibrated voltage source (+13V) applied between blue clip lead and ground.	1. **Check for +13V at J308** pin 4. If not present, then .... SUBSTITUTE A. Input Filter Board #7001-0549. B. Universal Lead Assm. #6005-0173. If present, proceed with step 2. 2. Check for +4.09V at J206 pin C9. If not present, then SUBSTITUTE A. Primary Processor Board #7001-0544. If present, then SUBSTITUTE A. DAS AID Board #7001-0555. Also, refer to Chapter 8, DAS. 5. Refer to Theory of Operation and Functional Block Diagram.
IV. Abnormal battery volts when using battery load cables. Battery volts normal when using battery volt clip leads.	1. Check for 13 volts (IS-1OOA) between pins 3 and 1 of J323. If present, then SUBSTITUTE A. VAT Board #7001-0552. If not, then SUBSTITUTE A. Input Filter Board #7001-0549. 2. Refer to Theory of Operation and Functional Block Diagram.

COMPLAINT	CORRECTIVE ACTION
V. Abnormal battery volts when using clip leads of Universal Test Lead Assembly. Battery volts normal when using clamps of Battery Load, Test Lead Assembly.	1. Check for 13 volts (IS-1OOA) between pins 9 and 10 of J306. If present, then ....SUBSTITUTE.................. A. VAT Board #7001-0552. If not, then ....SUBSTITUTE.................. A. Battery Load Driver Board #7001-0602. 2. Check for continuity between terminals 1 and 2 of CB2. If not present, reset/replace CB2. If present, proceed to step 3. 3. Refer to Theory of Operation and Functional Block Diagram.
VI. Abnormal battery volts when using either red /black clamps or red/black clips.	1. Perform clip/clamp volt calibration, Section II. 2. .-..-.=--=.- -SUBSTITUTE.======-======.=.======= A. VAT Board #7001-0552.
VII. Battery ripple in excess of .12 on VDU or abnormal ripple wave form. Battery volts indication normal (ripple switch off, IS-1OOA).	1. Refer to Section II, and readjust R109 as directed. 2. .==.-==..= SUBSTITUTE . ... -------- A. VAT Board #7001-0552. 3. Refer to Theory of Operation and Functional Block Diagram.
VIII. Ripple waveform and battery ripple both abnormal.	1. Refer to Section II, Calibration readjust as directed. 2. ....sUBSTITUTE.......................... A. VAT Board #7001-0552. B. Imput Filter Board #7001-0549. C. Universal Test Lead #6005-0173. 3. Refer to Theory of Operation and Functional Block Diagram.

NOTES



SUN ELECTRIC CORPORATION One Sun Parkway Crystal Lake, Illinois 60014 U.S.A.	
MODEL:	MCA-3000
TITLE:	COIL +/DISTRIBUTOR RESISTANCE
DWG: 14-1	PAGE: 14-9/14-10



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One Sun Parkway
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MODEL: MCA-3000

TITLE: CLIP/CLAMP VOLTS AND RIPPLE

DWG: 14-2

PAGE: 14-11/14-12

CHAPTER 15

VACUUM

GENERAL

NOTE: For information on "Pressure" (Emissions Module) see Chapter 17.

A test of intake manifold vacuum is a valid test of the functioning of an engine's mechanical system. Normal intake manifold vacuum, at idle, varies from 15 to 22 inches of mercury (hg) for most vehicles. The MCA-3000 has the ability to use the vacuum information to diagnose vehicle problems. Also, an important feature of the MCA-3000's Vacuum System, is the "HOLD" capability. This mode allows the operator to apply a vacuum to a vacuum controlled device and check its holding capabilities.

SECTION I. THEORY OF OPERATION

The pressure transducer, located on the Input Filter Board #7001-0549, generates an output voltage directly proportional to the pressure (vacuum) exerted upon it. A perfect vacuum is O psia (pounds per square inch absolute) while atmospheric pressure at sea level is approximately 14.7 psia.

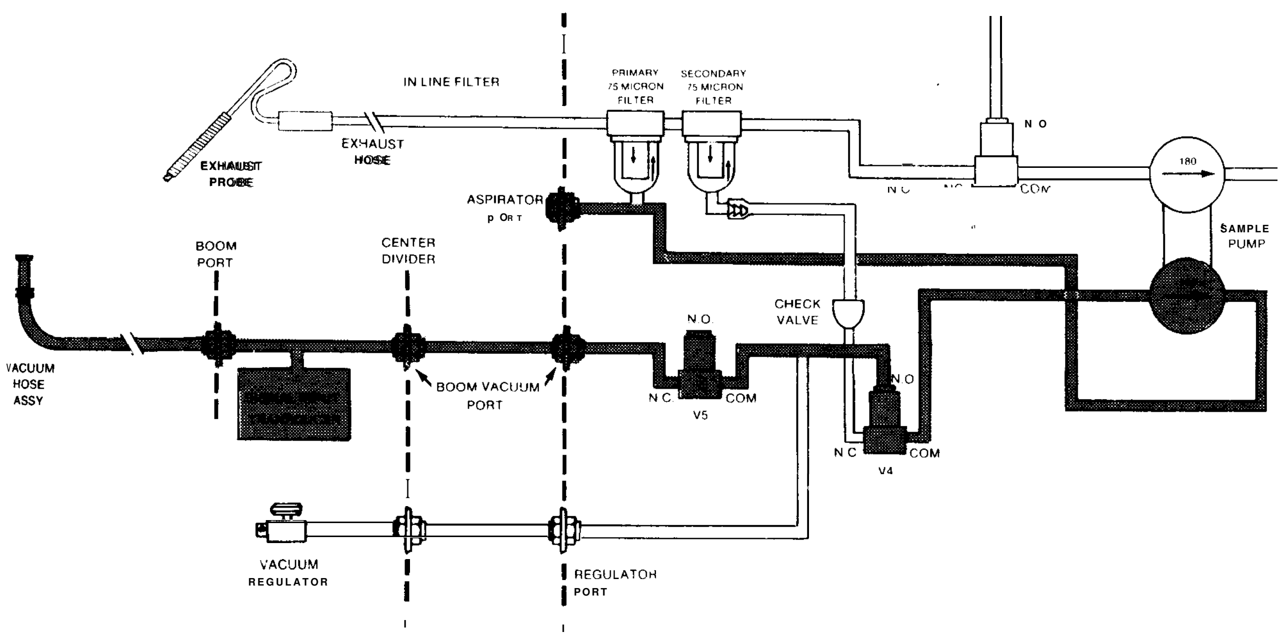


FIGURE 15-1. Vacuum System (pneumatics)

When VACUUM ON/OFF switch SW6, shown in Diagram 15-1, Page 15-5/6 is ON; a ground signal is processed through the Front Panel Interface Board, IR Interface Board and Solenoid Driver Board resulting in the energization of vacuum control solenoids V4 & V5. With the IR pump switch ON and V4 & V5 energized; a vacuum is applied to the boom test lead and regulated by the variable air bleed of the vacuum regulator. With the VACUUM ON/OFF switch ON and HOLD switch in the activated position; a ground signal is passed through the Front Panel Interface Board and processed by logic circuitry within the IR Interface Board to effectively cutoff current conduction of transistor Q5. With Q5 cutoff, vacuum control solenoid valve V5 is de-energized thus holding the previously drawn vacuum within the pneumatic system.

Operation of the front panel Vacuum Regulator control is an adjustable vacuum leak that varies the amount of vacuum drawn by the vacuum pump, which is made available to the boom vacuum port(shown and described in Chapter 18). As the applied pressure decreases (vacuum increasing); the developed transducer output voltage decreases.

The vacuum signal processing circuitry, contained within the Input Filter Board, amplifies the output from the transducer and provides the zero offset adjustment (R20) and gain adjustment (R23). The processed analog VAC (vacuum) output signal is routed to the Bus Driver Board #7001-0559 where it is processed through a buffer, eight channel multiplexer and succeeding buffer follower and made available, under software control, as a BOOM MUX output signal on terminal J203 pin A3 of the analog bus.

This analog signal is then applied, via the analog Sun Bus, to the DAS (Data Acquisition System) A/D (Analog-to-Digital) Board #7001-0555 where it is converted to digital data. The computer then reads and interprets the applied digital data for application to the Video Display Unit and Printer. For more information on the DAS System see Chapter 8.

SECTION II. CALIBRATION

SELF CALIBRATION

During Self Calibration the computer converts and stores the voltage present on the analog VAC channel as the "vacuum zero". All measurements are displayed using the stored "zero" reference. A NOT CALIBRATED message is displayed on the Calibration Complete page if the "zero" limits are exceeded. Satisfactory vacuum calibration limits are from -0.2 to +0.2 volts.

CALIBRATION/CHECK-OUT

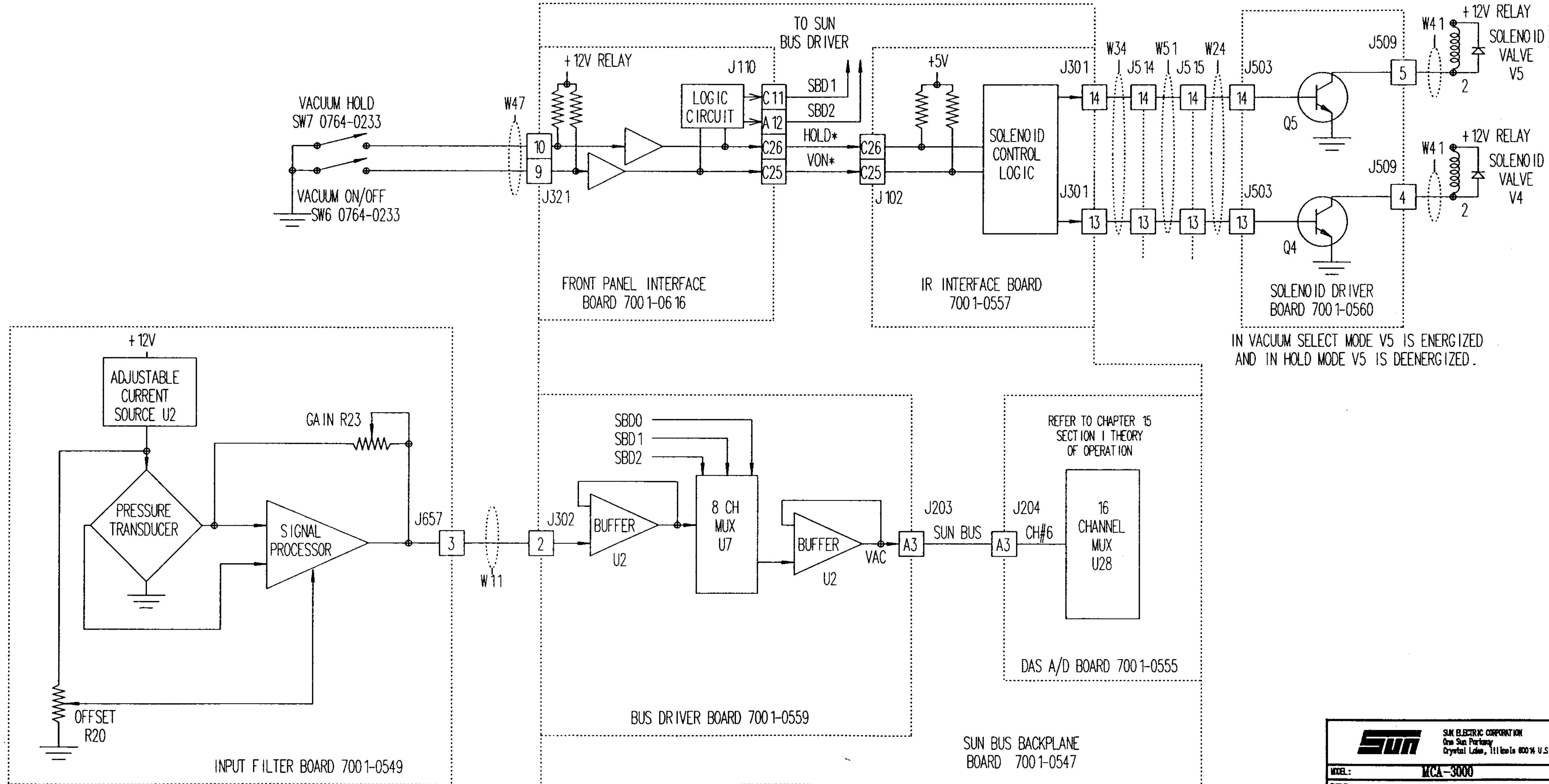
Required equipment: Mity-Vac or equivalent Calibration screwdriver

1. Remove boom housing.
2. Advance to ENGINE DATA page.
3. Connect a DVM to Test Point 1, on the Input Filter Board (located in boom), and ground lug and select a 10V or greater range.
4. DVM should read 0.0 volts +/- 0.1 volt, if not adjust Offset variable resistor R20 until the DVM indicates 0.0 +/-0.1.
5. Connect the DVM to pin 3 of connector J657.
6. Apply a vacuum of 20 inches of Hg to P2 of pressure transducer with vacuum source (Mity-vat).
7. DVM should read +3.80 volts +/- 0.01 volts, if not adjust gain variable resistor R23 until the DVM indicates +3.8 (+/- 0.01) volts. Remove vacuum source to allow calibration.
8. Return to SELF CALIBRATION page and advance tester through SELF CALIBRATION.
9. Go to PINPOINT MENU and return to option #1 "ENGINE DATA", apply 20" Hg to vacuum line and check VDU for 20" +/- 0.5".

****
* Calibration Complete *
****

SECTION III. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. **No vacuum indication on VDU although system appears to be drawing a vacuum in external** vacuum port **on** boom.	1. Solenoid valve V5 and vacuum pump operating normally but electronic circuitry appears abnormal. Check for variable **dc** voltage at P302 pin 2 of Bus Driver Board as front panel VACUUM REGULATOR control is rotated. If present, then -----------------SUBSTITUTE-------------------- A. Bus Driver Board #7001-0559. 2. If not present, check for variable voltage at J657 pin 3 and if not present, then ---------------SUBSTITUTE--------------------- A. Input Filter Board #7001-0549. 3. If present, check and/or replace **W11** Temperature, Oil, Vacuum Wiring Harness #7076-0551.
II. **Unable to draw any** kind **of vacuum with IR PUMP and VACUUM** ON/OFF **switches On.**	1. Refer to Pneumatic Diagram 18-4, Page 18-11/12, and check for excessive kinking or sharp bends in vacuum tubing. **Also** check for foreign particle, dust, dirt causing internal blockage within tubing or pump valves. Remove/replace tubing as required. 2. Solenoid valve V5 not operated. Check for **+12V** power across solenoid winding and if not present, refer to Theory of Operation and Functional Block Diagram 15-1, Page 15-5/6 and perform standard signal tracing techniques. 3. Solenoid valve V4 not operated. Check for **+12V** power across solenoid winding and if not present, refer to Theory of Operation and Functional Block Diagram 15-1, Page 15-5/6 and perform standard signal tracing techniques.
III. **Unable to vary** amount of vacuum while rotating Vacuum Regulator control; vacuum amount **stays fixed.**	1. Vacuum regulator defective -----------------SUBSTITUTE-------------------- A. Vacuum Regulator Assembly #7009-1430. B. Rubber Seal for above assembly #0400-0601.



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MODEL: MCA-3000

TITLE: VACUUM FUNCTIONAL BLOCK

DWG: 15-1

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CHAPTER 16

BATTERY LOAD CIRCUITRY

SECTION I. THEORY OF OPERATION

OPERATIONAL OVERVIEW

The battery load circuitry, basically comprised of the Battery Load Module (with Battery Load Driver Board #7001-0602), VAT Board //7001-0552, DAS A/D Board #7001-0555 and the Computer Module, functions to monitor: battery voltage, battery temperature present at the negative terminal of the battery and battery load current. With the exception of the Battery Load Module, this circuitry is also used to monitor the battery voltage whenever the Universal Test Lead Assembly, 6005-0161, red and black clips are connected across the battery terminals. Load Amps and Temperature are discussed in chapters 11 and 13, respectively. Likewise, the Battery volts function is discussed in Chapter 14, only the load volts funtion will be discussed in this Chapter. Note that load volts are not used for any reading displayed on the screen, but merely for diagnostic purposes during battery loading.

LOAD VOLTAGE

Battery load voltage (+V LOAD and -V LOAD), present across the load resistors, is passed through Battery Load Driver Board coils L5 and L6, J804 pins 3 and 5, w6, J306 pins 8 and 6 and then applied to an amplifier whose output is designated V LOAD (load voltage) and applied to the eight channel multiplexer to be processed by the DAS system. For a further explanation of how the DAS system works refer to Chapter 8, Theory of Operation.

BATTERY LOAD

The MCA-3000 has the capability of applying a 20, 80, or 100 amp load via Load resistors Rl through R5. These loads are accomplished by turning on relays Kl and K2 located in the Battery Load module. When Kl is energized, resistor Rl (0.6 ohms) is selected thus resulting in a 20A current flow through shunt resistors R6 and R1. When K2 is energized, parallel connected resistors R2-R5 are connected in series with the shunt resistor, resulting in a total resistance of 0.16 ohms and load current of 80 amperes. When both Kl and K2 are energized, the total resistance becomes 0.12 ohms and a total load current of 100 amperes results. These current ratings are based on a 12 volt battery under test. The actual current will decrease as battery voltage drops.

Relay Kl is energized whenever 20 or 100 Amp load has been selected by the Single Board Computer. This is accomplished by communicating with the Vat Board via the Sun Bus. The SUN Bus decode logic pulls K1* low, and the Programmable Timer is set for the length of time the load is required. At this point the load is ready to be applied, but is not applied until LOAD* is pulled low, activating the timer, pulling ENABLE* low. Since both inputs of the NOR gate are low, the output (20A LOAD) is high. This high is then routed via J315-7 to the Battery Load Driver Board where it is inverted and output a 20A LOAD*. This low supplies the ground path for Kl, energizing it, and applying a 0.6 ohm load to the battery.

This load is applied until the timer runs out. Note that If the timer is not loaded with a time, it will automatically time out after 63 seconds. This is selected using Jumper 1, which is normaly in position 2. When the Timer runs out, ENABLE* goes high, preventing the relays from turning on.

Relay K2 is energized whenever 80 or 100 Amp load has been selected by the Single Board Computer. This is accomplished by communicating with the Vat Board via the Sun Bus. The SUN Bus decode logic pulls K2* low, and the Programmable Timer is set for the length of time the load is required. At this point the load is ready to be applied, but is not applied until LOAD* is pulled low, activating the timer, pulling ENABLE* low. Since both inputs of the NOR gate are low, the output (80A LOAD) is high. This high is then routed via J315-1 to the Battery Load Driver Board where it is inverted and output a 80A LOAD*. This low supplies the ground path for K2, energizing it, and applying a 0.16 ohm load to the battery.

When both the K1* and RELAY K2* signals are low level, K1 and K2 are both energized and a 100 amp load is applied to the battery. When either relay is engaged, LOAD ENGage is high on the Sun Bus indicating a load is being applied. This LOAD ENGage signal will inform the Front Panel Interface Board, therefore lighting the load light on the front panel.

SECTION II. BATTERY LOAD CHECKOUT

Equipment required: Fluke 77 DVM or equivalent

1. Access the Development Aids page (see page ii in the Introduction for instructions on how to gain access).

2. Connect the DVM, on ohms scale, accross the Black and Red Battery Load Clamps.

3. From the Development Aids menu, select #2 Test Battery Load.

4. Move cursor to 20 Amp load, press #1 and set timer for 20 seconds.

5. Press Enter and; The relay will click, Load light will light, SET and STATUS adjacent to the 20 A LOAD will shift to ON, and the LOAD ENGAGED will also shift to ON.

6. DVM should read 0.6 ohms +/-0.3 ohms.

7. Remove the a 20 Amp Load by pressing Enter.

8. DVM should read infinite ohms.

9. Repeat steps 4 & 5 for the 80 amp load.

10. DVM should read 0.16 ohms +/-0.1 ohms.

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

* Checkout Complete *

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

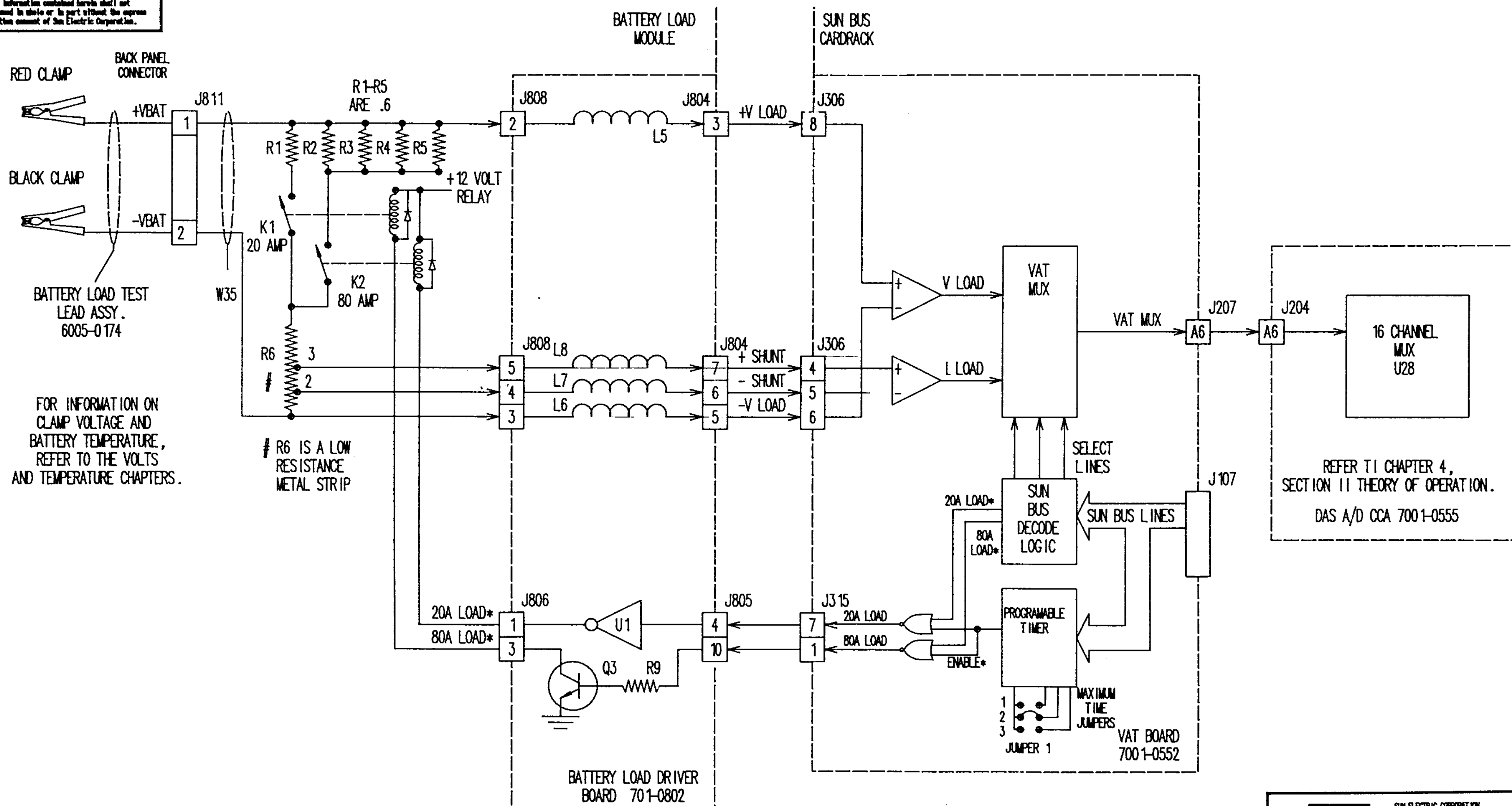
SECTION III. BATTERY LOAD CIRCUITRY TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION

I. Unable to load battery to 20 ampere.	1. Is +12V relay present at terminal 4 of K1?
	YES → Does 20A LOAD* on J806-1 go low during loading?
	  YES → Susbstitute 20 Amp Relay 0783-0326.
	  NO → Does 20A LOAD on J805-4 goes high during load?
	    YES → Sustitute Battery Load Driver Board 7001-0802.
	    NO → Substitute Vat Board #7001-0552
	NO → Refer to Chapter 2, DC Power.
	
	2. Refer to theory of operation and Funtional Block Diagram.

II. Unable to load battery to 80 ampere.	1. Is +12V relay present at terminal 4 of K2?
	YES → Does 80A LOAD* on J806-3 go low during loading?
	  YES → Susbstitute 80 Amp Relay 0783-0324.
	  NO → Does 80A LOAD on J805-10 goes high during load?
	    YES → Sustitute Battery Load Driver Board 7001-0802.
	    NO → Substitute Vat Board #7001-0552
	NO → Refer to Chapter 2, DC Power.
	
	2. Refer to theory of operation and Funtional Block Diagram.

NOTES



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

MODEL: MCA-3000

TITLE: BATTERY LOAD CIRCUITRY

DWG: 16-1

PAGE: 16-5/16-6

CHAPTER 17

EXHAUST EMISSIONS-HC/CO/CO_2/O_2

SECTION I. HC/CO/CO_2 AND PRESSURE THEORY OF OPERATION

GENERAL

NOTE
The term "analyzer" is used throughout this chapter when referring to the Infrared Gas Analyzer.

The Exhaust Analyzer Assembly located at the rear righthand side of the MCA-3000 and the IR Interface Board installed within the Sun Bus makeup the four-gas analyzer used in the MCA-3000. Its purpose is to measure the concentrations of Hydrocarbons (HC), Carbon Dioxide (CO_2), Oxygen (O_2) and Carbon Monoxide (CO) emitted from the exhaust of an automobile. An Andros Model 256B three-gas analyzer is presently being used in the MCA-3000 along with an oxygen sensor. The oxygen sensor is physically positioned between the sample side exhaust OUT port of the IR pump and the dual input ports to the IR Bench.

The pneumatic system associated with the analyzer is controlled by five solenoid valves operating in five different modes:

1. Zero/Vat Hold Mode - used whenever gas measurements are not required. In this mode no exhaust gases are drawn into the exhaust sample hose. This reduces the amount of moisture that can condense in the filter bowls. In all modes the primary filter bowl is connected to the aspirator port and moisture is being drained from it. Also, used to "Hold" source vacuum in boom vacuum line.
2. Sample/Leak Check "C" mode - used to sample exhaust gases. In this mode vehicle exhaust or calibration gases are drawn into the filter bowls by both sides of the vacuum pump. This allows for the fastest response time and is also the mode most likely to cause moisture to accumulate in the filter bowls.
3. Calibration/Leak Check "A" mode - this mode is used to allow a calibration gas to flow from the CAL PORT to the IR bench and the oxygen sensor.
4. Leak Check "B' mode - this mode is used to perform a leak check on the pneumatics by letting the calibration gas flow to the LEAK CHECK PORT. From the LEAK CHECK PORT, through an external adapter, it is introduced into the sample hose. If the correct concentration is not measured then a pneumatic leak is present. An in-depth discussin of the leak check mode is provided in Chapter 18 Pneumatics & Leak Detection.
5. Vacuum mode - this mode is used to allow a vacuum to be drawn on the boom vacuum port.

See Chapter 18 for a more in depth discussion on the Pneumatics System.

In-depth details of the inner-workings of the Analyzer are not discussed within this Service Manual; instead a general overview is given. If more information is desired on the Analyzer, refer to the Integration Interface Manual for the 200 Series Gas Analyzer (#0692-9149) which is available to Sun Personel through the Training/Documentation group located at Crystal Lake.

HC/CO/CO_2 AnalyzerChannels.
The Analyzer uses a metallized ceramic heater as the source of infrared energy which then passes through a motor-driven rotating filter wheel. The rotating filter wheel contains integral HC, CO, CO_2 and reference filters. The filter wheel also has a portion that does not allow passage of infrared energy thus its is called the dark portion of the wheel. The signal developed at the Dark Level Test Point is shown in Figure 17-1. As the filter wheel rotates, infrared energy from the source passes through each filter in succession, creating a sequential train of output pulses, each having a specifically different wavelength. The developed pulse train is as follows:

|---|
->DARK-->REFERENCE-->$C0_2$-->HC-->CO-->-

From the filter wheel the infrared energy passes through the sample cell which contains the sample gases to be measured. The higher the sample gas concentration in the sample cell the less infrared energy is received by the infrared detector located at the end of the sample cell. This detector converts the received infrared energy into a voltage output signal which is amplified by the Cooler/Preamp board and the pulse train decoded by the Processor board of the Analyzer.

Each sampled gas has its own output test points shown in Figure 17-2. These test points are located on the Processor board (top board) of the Analyzer.

The stability of the filter wheel motor drive frequency is of particular importance to the accurate operation of the Analyzer. The DC motor in the Analyzer spins the filter wheel at 95 Hz. With t-he filter wheel rotating at 95 Hz, the dark pulse occurs at every 10.5 millisecond interval. The Processor board uses the pulse created from the 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.

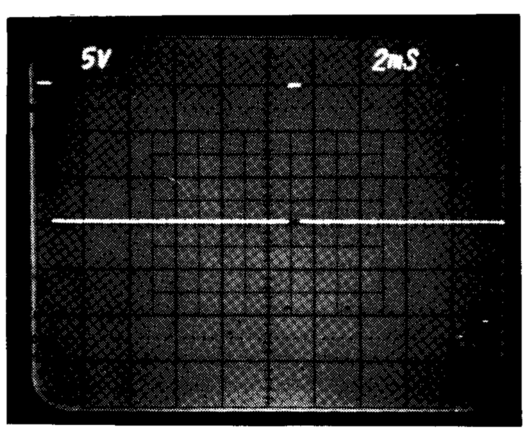


Figure 17-1. Dark Level Test Point (DLTP) Signal Waveform.

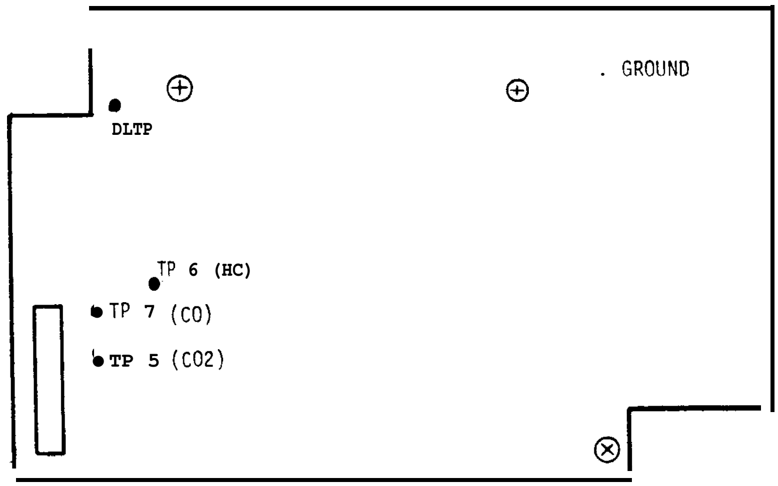


Figure 17-2. Gas Channel Test Point Location.

SIGNAL ROUTING FROM THE ANALYZER TO THE COMPUTER
These DC voltages could be measured at TP7,TP6 & TP5 either with a DVM or an Oscilloscope. From the Analyzer the DC analog voltage outputs are routed via ribbon cable to connector J501 of the Solenoid Driver Board (refer to IR Emission Functional Block Diagram 17-1). This board contains the HC, CO and CO_2 GAIN potentiometers, which are located in the feed back loop of the final output amp of the I.R. bench. From the Solenoid Driver Board the three gas sample DC analog voltage signals are supplied as inputs to the IR Interface Board. Additionally, an oxygen sample signal voltage, pressure (vacuum) analog signal voltage and low flow status signal are also routed as inputs to the IR Interface Board. The Analyzer HC, CO and CO_2 gas sample analog signals and the pressure (vacuum) sample analog signal are all buffered by voltage followers and applied as inputs to the I.R. multiplexer. An oxygen (O_2) sample analog signal is integrated then amplified and also applied as an input to the I.R. multiplexer. The I.R. multiplexer output signal is then buffered and made available as an output signal on the Sun Bus J202 pin A7.

From the IR Interface Board the software selected analog signal is applied as one input to a 16 channel multiplexer located on the DAS A/D (Data Acquisition System Analog-to-Digital) Board. This data is then subsequently read and processed by the DAS System. For a more in-depth discussion of the DAS system; refer to Chapter 8, Section I. Theory of Operation.

CALIBRATION POTS
Each of the three gas sample channels (HC,CO,CO_2) has a gain potentiometer (R3, 4 and 5 respectively) located on the Solenoid Driver Board. These gain potentiometers are used to set the output voltage of each channel to match the gas concentration.

IN-DEPTH CIRCUIT ANALYSIS
A 120/240 volt transformer Tl, followed by a bridge rectifier CR1, and a large filter capacitor Cl, supply an unregulated 12 volts DC to the solenoid valves V1-V5 used to control gas flow. The output from the bridge rectifier measures approximately 13.5 volts with no solenoid valves energized and approximately 11.0 volts with four solenoid valves energized.

The solenoid valves are controlled by the IR Interface Board operating through the Solenoid Driver Board. Transistors Q1 through Q5, located on the Solenoid Driver Board, turn the solenoid valves on and off. Transistor Q6 functions to turn relay RLY1 on the Solenoid Driver Board on and off thus changing the gain of the HC channel and providing a high scale HC range.

The Solenoid Driver Board is primarily used to interconnect: the I.R. Interface Board, Andros IR Bench, oxygen sensor, pressure sensor, low flow switch and the five solenoid valves V1-V5. The Solenoid Driver Board also contains three variable resistors R3-R5 required to adjust the gain for the HC, CO and CO_2 signals respectively. Resistor R2 and zener diode D1 regulate the +15V supply, from the Andros Bench, to approximately +7.5V for use by the pressure tranducer.

Analog generated signals, representing HC, CO, CO_2 and pressure, are applied through the Solenoid Driver Board to the IR Interface Board, where they are buffered or amplified and multiplexed by an 8 channel multiplexer, into one analog IR MUX output signal which is made available at J202 pin A7. The HC, CO, $C0_2$ and pressure signals are buffered and slightly filtered but are not amplified. Test points TP1-TP3 are provided for the HC, CO and $C0_2$ signals respectively.

The oxygen signal is amplified (integrated) and heavily filtered by a capacitor and then further amplified and inverted providing an overall gain of approximately 500. The amplified oxygen signal is available at test point TP4 located on the IR Interface Board.

WARMUP

The Warm-up page is displayed immediately following the Title Page. The overall time duration of the warm-up is 15 minutes after the Tester is turned on. The I/O, EPROM, CLOCK Board keeps track of warm-up time if power is not removed from tester and MCA-3000 software is used.

SECTION II. $HC/CO/CO_2$ CALIBRATION

COARSE (HARDWARE) GAS BENCH CALIBRATION

CRITICAL NOTES 1. The following gas calibration procedure assumes the use of a low scale calibration gas: Propane **(HC)** of 600ppm, CO of **1.6%** and CO_2 of 11.0% or a high scale calibration gas: Propane (HC) of **3000ppm,** CO of 8.0% and CO_2 of 13.0% All gas concentrations must be within +/-2%. If any other concentration of calibration gas is used, the following calibration values are not correct.

2. Adjustment of the calibrated gas bottle flow regulator must be made such that exhaust port gas flow and calibrated gas bottle gas flow are identical, prior to the start of the calibration procedure. See set-up procedure listed below.

3. Normal operation during calibration depends on the use of the standard exhaust probe. Use the small tube antidilution probe for short periods of time and never during calibration.

Setting Flow Rate on Calibration Gas Bottle
The following set-up procedure should be used to set the flow rate for the gas bottle regulator used during calibration. If the customer does not have the gas calibration kit, the CSR'S equipment must be used.

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

2. With the I.R. pump on, advance the tester to the DEVELOPEMENT AIDS menu and select #3 TEST GAS BENCH. Use the Left/Right cursor to select the ZERO mode and record the flow rate on the flow meter for future reference.

3. Use the Left/Right cursor to select the CAL mode.

4. If using customers cal gas tank and regulator:

   A. Remove the acorn lock nut from the regulator to gain access to the flow rate adjustment screw.

   B. Turn the adjustment screw counterclockwise (using 3/16" hex wrench) until there is no more drag felt on the screw. The regulator should now be shut off (no flow).

   c. Open the gas calibration bottle valve completely. The regulator gauge will indicate the amount (pressure) of cal gas remaining in the tank. The flow meter should still indicate zero.

   D. Turn the adjustment screw clockwise, watching the flow meter, until the flow matches the amount recorded in step #2.

   E. Reinstall acorn lock nut over the adjusting screw and tighten. Close cal gas bottle valve.

Setting Flow Rate on Calibration Gas Bottle (CONT)

5. If the customer does not have Gas Calibration Kit #0121-0446-01:

   A. Connect the technicians cal gas bottle to the cal gas port on the rear of the tester.

   B. Open the gas bottle valve and adjust the regulator assembly to match the testers flow recorded in step #2.

   c. Close the gas bottle valve.

•**********************
• Set-Up Complete “
•**********************

Calibration Procedure

1. Turn the Tester on and allow it to warmup for 15 minutes.

2. Press MENU to access the MAIN MENU page. Press the “O” key. Immediately after pressing "0", press CONTROL, SHIFT, and 6 at the same time, to access the DEVELOPMENT AIDS menu.

3. Select TEST GAS BENCH from the DEVELOPMENT AIDS menu.

4. Using the arrow keys; select the SAMPLE mode.

5. Plug the end of the exhaust sample hose and note that the front panel LOW FLOW indicator lights. [f it does not, troubleshoot and repair before preceding.

6. Using the arrow keys; select ZERO mode.

7. On the Solenoid Driver Board, rotate variable resistors R3 (HC SPAN), R4 (CO SPAN), and R5 ($C0_2$ SPAN) fully counterclockwise.

8. Connect DVM to TP1 and ground on the Solenoid Driver Board. Adjust R31, labeled HC on the Andros bench until the DVM reads 0.0 volts +/-0.2 volts.

9. Connect DVM to TP2 and ground on the Solenoid Driver Board. Adjust R28, labeled CO on the Andros bench until the DVM reads 0.0 volts +/-0.2 volts.

10. Connect DVM to TP3 and ground on the Solenoid Driver Board. Adjust R34, labeled $C0_2$ on the Andros bench until the DVM reads 0.0 volts +/-0.2 volts.

11. Using the arrow keys; select the CAL mode.

Coarse (Hardware) Gas Bench Calibration Procedure (continued)

12. Connect the calibration gas bottle to the gas input CAL PORT located on the rear of the IR Emission Module.

13. Open the valve on the calibration gas bottle.

14. Reconnect the DVM to TP1. Rotate variable resistor R3, labeled HC SPAN on the Solenoid Driver Board, clockwise until the DVM reads:

    1.8 +/- 0.1 volts for low scale gas, or

    7.99 +/- 0.1 volts for high scale gas.

15. Reconnect the DVM to TP2. Rotate variable resistor R4, labeled CO SPAN on the Solenoid Driver Board, clockwise until the DVM reads:

    3.85 +/- 0.1 volts for low scale gas, or

    8.94 +/- 0.1 volts for high scale gas.

16. Reconnect the DVM to TP3. Rotate variable resistor R5, labeled CO_2 SPAN on the Solenoid Driver Board, clockwise until the DVM reads:

    7.19 +/- 0.1 volts for low scale gas, or

    7.72 +/- 0.1 volts for high scale gas.

17. Close the valve on the calibration gas bottle.

18. Using the arrow keys; select the ZERO mode.

19. Connect the DVM to TP1. Adjust R31, labeled HC on the Andros bench, unti I the DVM reads between -1.0 volts +/-0.1 volts.

20. Connect the DVM to TP2. Adjust R28, labeled CO on the Andros bench, until the DVM reads between -1.0 volts +/-0.1 volts.

21. Connect the DVM to TP3. Adjust R34, labeled $C0_2$ on the Andros bench, until the DVM reads between -1.0 volts +/-0.1 volts.

22. Using the MENU and BACKUP keys; access the SYSTEM CALIBRATION page.

23. Perform a System Calibration.

24. Perform a Fine (software) gas calibration.

****

• Coarse (Hardware) Calibration Complete •

• ***

Fine (Software) Gas Calibration

The following discusson describes a Tester SELF (SOFTWARE) Gas Calibration.

1. Turn the tester ON and allow the software to boot up. If Tester is already On, press MENU, BACKUP and/or CO NTinue keys as required to reach the title page.

2. Press CONTinue key to precede to the SYSTEM CALIBRATION page.

3. Wait until the Tester has completed its warmup time then press the "CAL" key to progress to the GAS CALIBRATION menu page where the propane correlation factor (propane equivalency factor, PEF), HC, CO, and $C0_2$ gas tag values are entered.

4. To change the displayed HC, CO and $C0_2$ concentration, press #3 CAL GAS VALUES. Pressing the CLEAR key allows for the setting of new cal gas values. To change any number, merely press the desired arithmetic value keys and then press ENTER. If the displayed value is acceptable and change is not desired, press ENTER only.

5. To change the PEF press "O" from the GAS CALIBRATION menu. **NOTE:** The selection "O" is not visible in the GAS CALIBRATION menu and is to be used **by Sun Electric personnel only.** Enter the PEF, if different, and press ENTER. This will return you to the GAS CALIBRATION menu.

6. Select #1, PERFORM GAS CALIBRATION.

   NOTE: Make certain that the valve on the calibration gas bottle is closed prior to continuing.

7. ZERO READINGS IN PROGRESS is then displayed on the VDU screen and approximately 15 seconds later the "ATTACH GAS BOTTLE AND CLOSE VALVE" message appears. Once the bottle is connected, with valve closed, the "OPEN VALVE ON CALIBRATION GAS BOTTLE" is displayed.

8. Open the calibration gas bottle valve and note that a GAS CALIBRATION IN PROGRESS message appears on the VDU screen.

9. Approximately 30 seconds later a screen prompt indicates to close the calibration gas bottle valve.

10. At this time, the newly calculated zero and gain values, and the date of the calibration (if Successful) are stored in the EEPROM on the 1/0, EEPROM, CLOCK Board.

11. Proceed with LEAK CHECK.

12. With the calibration gas bottle valve closed, and the bottle attached to the GAS CAL PORT located on the rear of the IR Emission Module, select #2 LEAK CHECK.

13. The VDU prompt then directs the operator to interconnect the gas exhaust probe to the LEAK CHECK PORT using an Exhaust Probe Adapter #7009-1700 supplied as part of the Tester accessories.

14. The VDU prompt then dictates that the gas bottle valve be opened after which the screen displays “LEAK CHECK IN PROGRESS”. After approximately 30 seconds the VDU screen prompt dictates that the calibration gas bottle valve be closed and either a “LEAK CHECK PASSED” or “LEAK CHECK FAILED” message appears on the VDU screen.

15. Presuming that the Tester has passed the leak check; press CONTinue to access the SYSTEM CALIBRATION page otherwise refer to Chapter 18 entitled “Pneumatics” and proceed to troubleshoot the pneumatic portion of the Tester.

• **

• **Fine (Software) Calibration Complete** •

• **

SECTION 111. HC /CO /CO_2 & Pressure Troubleshooting

COMPLAINT	CORRECTIVE ACTION
I. **HC, & or CO, & or** CO_2 fails self calibration.	1. Proceed to Diagnostics Aids page (HC, CO, CO_2). See the Introduction chapter (page ii) if Instructions are needed on how to access the Service Calibration pages. A. Verify that the ZERO voltages are -1.0 volts ± 0.1 volt. If out of tolerance, adjust per IR calibration procedure on page 17-6. If unable to adjust properly, refer to Complaint II.
II. **Unable to adjust** Zero or Gas Span voltages while on the HC/CO/CO_2 Service Calibration page.	1. Verify that the cursor is on the parameter (zero or gain) being adjusted. Use the arrow cursor positioning keys as required to select the appropriate function. 2. Check for voltage change at test points on the IR bench (HC-TP6, CO-TP7 and CO_2-TP5). For example: rotate the HC zero pot R31 on the bench while monitoring TP6 and note that a voltage change occurs. If the voltage changes at the test point, but not on the Video Display Unit, refer to step 3. If no change occurs, refer to step 4. 3. Check connections from IR Bench through Solenoid Driver Board to IR Interface Board. -----------------SUBSTITUTE----------------- B. Solenoid Driver Board 7001-0560. C. IR Interface Board 7001-0557. 4. No change at test points on IR Bench, then -----------------SUBSTITUTE------------------ A. I.R. Bench #7049-0114-01. 5. Refer to Theory of Operation and IR Emission Functional Block Diagram 17-1.
III. **Questionable exhaust emission readings.**	1. Perform leak check, refer to page 18-4. 2. Perform gas calibration, refer to page 17-5. 3. Refer to Theory of Operation and IR Emission Functional Block Diagram 17-1.

COMPLAINT	CORRECTIVE ACTION
IV. Tester fails to warm up.	1. Turn the Tester on and allow the IR bench to warmup for 15 minutes. If the CLEARING GASES for RE-CAL...ONE MOMENT message is not displayed after 15 minutes, override the internal timer by pressing the CO NTinue key. If the CLEARING GASES for RE-CAL...ONE MOMENT message is displayed see Step 3. If message is not displayed, then ------------------SUBSTITUTE------------------- (A) Solenoid Driver Board 7001-0560. (B) IR Interface Board 7001-0557. (C) Check connections of cable assemblies.
	2. Refer to Theory of Operation and IR Emission Functional Block Diagram 17-1.
	3. CLEARING GASES for RE-CAL...ONE MOMENT message is displayed after manually pressing CO NTinue key. (A) Monitor TP7 on the Andros Bench with an oscilloscope. If stable, refer to Step 5 however if signal varies more than 60 mv over 30 seconds replace IR Bench 7049-0114-01.
	4. Refer to Theory of Operation and IR Emission Functional Block Diagram 17-1.
	5. Stable signal at TP7: -----------------SUBSTITUTE-------------------- (A) Solenoid Driver Board 7001-0560. (B) IR Interface Board 7001-0557. (C) Check and repair/replace defective interconnecting cable assembly(s).
	6. Refer to Theory of Operation and IR Emission Functional Block Diagram 17-1.

SECTION IV. OXYGEN (0_2) THEORY OF OPERATION

GENERAL

The oxygen content of the exhaust sample from the engine under test is measured by an 0_2 sensor cell. The cell outputs a DC voltage in the millivolts range when exposed to atmospheric oxygen. Typically the voltage is 10 millivolts +/-5 millivolts when exposed to atmospheric oxygen (20.8%). As the oxygen content of the exhaust sample decreases, the cell's DC output voltage decreases. The output of the 0_2 sensor is very stable throughout its life. Its output voltage becomes very unstable when it is at the end of its life therefore, re-calibration of the sensor is not recommended: onlv its replacement.

The electrical output signal from the 0_2 sensor cell is routed via W45, to the Solenoid Driver Board #7001-0560, and then via W24 and W34 to the IR Interface Board #7001-0557. This signal is then integrated and amplified and applied to an eight channel multiplexer. Software control functions to select the appropriate sensed gas (HC, CO, $C0_2$ or 0_2) inputted to the I.R. multiplexer for routing to the DAS system for application to a 16 channel multiplexer for further selection and processing by the computer. For more information on the DAS System, see Chapter 8, Section I., Theory of Operation.

SECTION V. OXYGEN CALIBRATION

During Self Calibration, the Tester computer commands a pneumatic system Zero mode operation wherein only oxygen enters the IR Bench. The computer then reads the zero voltage of the 0_2 analog channel. Any zero offset is corrected for by the computer before 0_2 readings are displayed. The computer also reads the zero voltage of the HC, $C0_2$ and CO gases during self calibration.

Mechanical calibration is not required. If 02 will not calibrate or the readings are questionable, refer to Section VI, Troubleshooting

****
• **Calibration Complete** •
•**************************

SECTION VI. OXYGEN TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. O_2 fails self calibration, NOT CALIBRATED displayed.	1. If 0_2 sensor was just installed, allow sensor to be exposed to atmospheric oxygen for 15 minutes and then re-calibrate.
	2. Calibrate per procedure on page 17-11.
	3. --------------SUBSTITUTE ----------------- (A) O_2 Sensor #7049-0004 and calibrate. (B) Solenoid Driver Board #7001-0560. (C) IR Interface Board #7001-0557.
	4. Refer to Theory of Operation and IR Emission Functional Block Diagram 17-1.

SECTION VII. LOW FLOW THEORY OF OPERATION

LOW FLOW

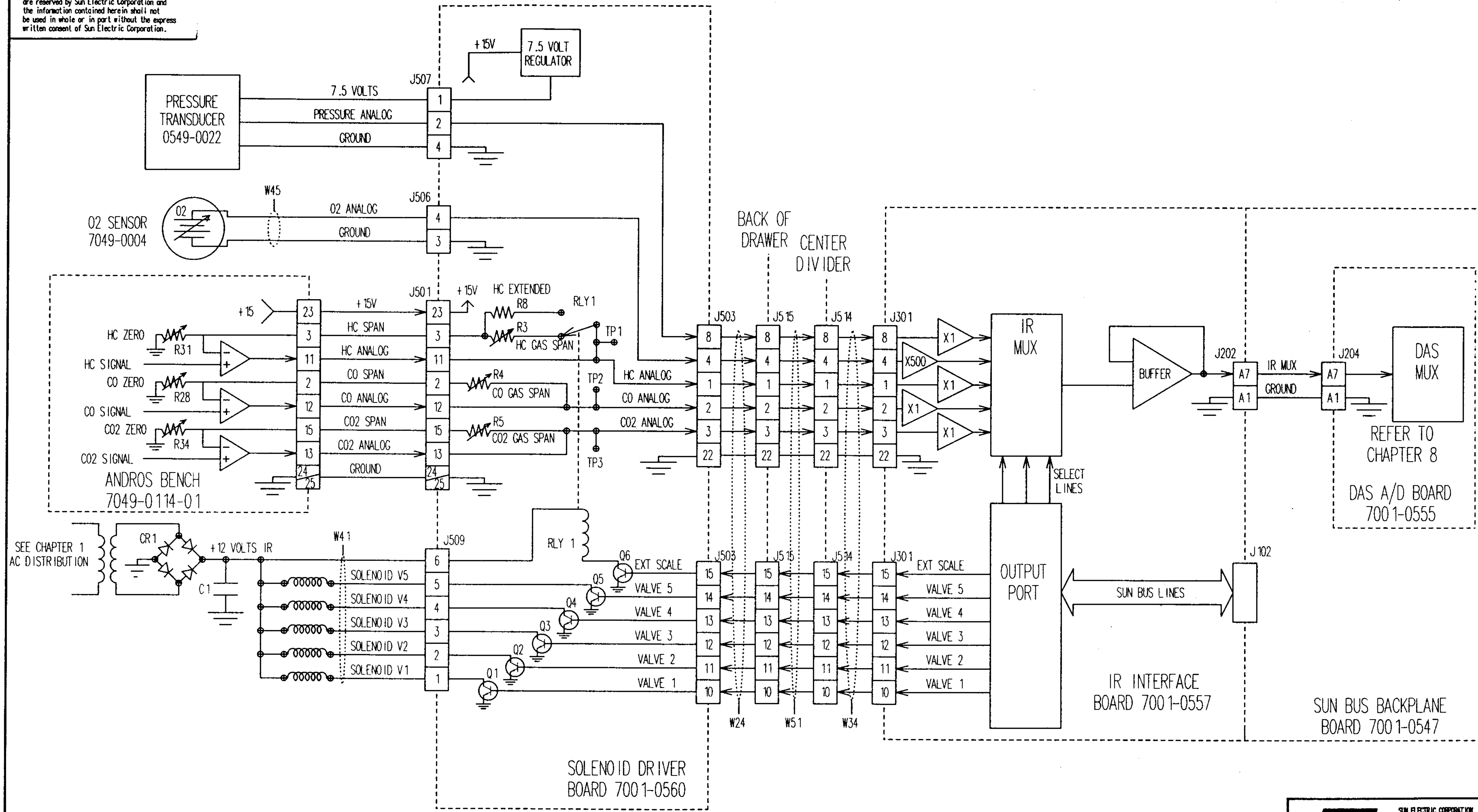
The low flow switch, installed within the Exhaust Analyzer Assembly, informs the computer and controls operation of the front panel LOW FLOW lamp whenever the pneumatic system is restricted. The most typical restriction results from infrequent changing of the primary and secondary filter elements.

With the system operating normally, pressure from the vacuum pump's exhaust port keeps the Low Flow switch closed. Whenever a low flow condition occurs the pressure output from the vacuum pump decreases and the switch opens.

SECTION VIII. LOW FLOW TROUBLESHOOTING

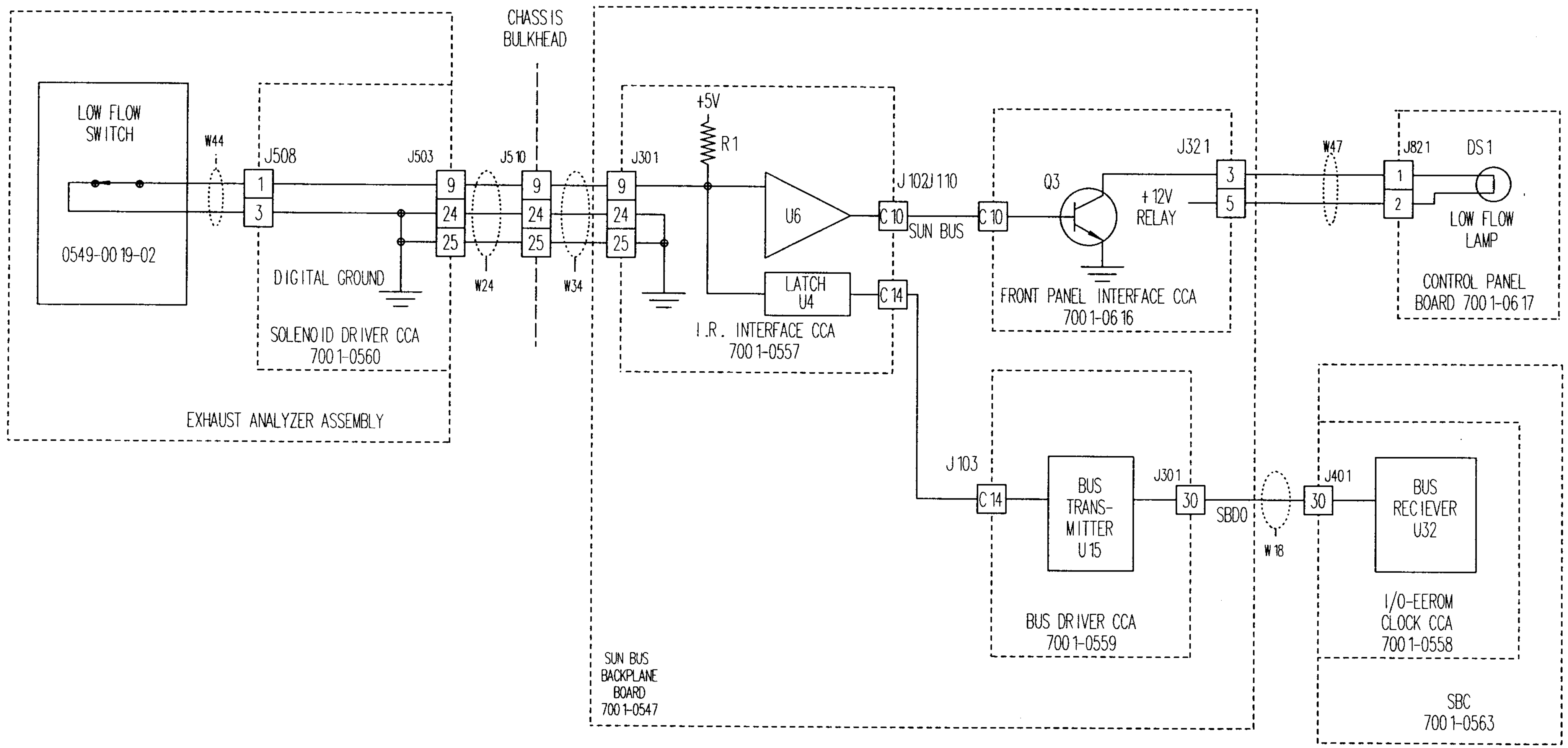
COMPLAINT	CORRECTIVE ACTION
I. LOW FLOW lamp does not light when pneumatic blockage occurs. LOW FLOW message flashes on Video Display Unit.	1. Check for virtual ground at J321 pin 3. If present, replace LOW FLOW lamp. If not present, proceed to step 2. 2. Check for high level signal between J102-C1O and J102-A32 (ground). If not present, then ----------------SUBSTITUTE-------------------- A. IR Interface Board #7001-0557. If present, then ----------------SUBSTITUTE-------------------- A. Front Panel Interface Board #7001-0616. 3. Refer to Theory of Operation and Functional Block Diagram 17-2.
II. LOW FLOW message does not flash on Video Display Unit but LOW FLOW lamp lights. Video Display Unit functioning normally.	1. Check for high logic level signal at J301 pin 30. If not present, then -----------------SUBSTITUTE-------------------- A. Bus Driver Board #7001-0559. If present, proceed to step 2. 2. Check for high logic level signal at P1A pin 2. If not present, then -----------------SUBSTITUTE-------------------- A. 1/0 Board #7001-0558. If present, proceed as directed in step 3. 3. Refer to Theory of Operation and Functional Block Diagram 17-2.

COMPLAINT	CORRECTIVE ACTION
III. The LOW FLOW message does not flash on the VDU nor does the LOW FLOW indicator light when a pneumatic system **low flow condition occurs.**	1. Using test meter, check for +5Vdc between J301 pin 9 and pin 24 (ground). If present, then -----------------SUBSTITUTE-------------------- A. IR Interface Board #7001-0557. If not present, proceed with step 2. 2. Check for +5Vdc directly across terminals of low flow switch. If reading is normal, then -----------------SUBSTITUTE--------------------- A. Low Flow Switch #0549-0019-02. 3. Refer to Theory of Operation and Functional Block Diagram 17-2.



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

MODEL:	MCA-3000
TITLE:	INFRARED EMISSION
DWG: 17-1	PAGE: 17-15/17-16



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

MODEL: MCA-3000

TITLE: LOW FLOW

DWG: 17-2

PAGE: 17-17/17-18

CHAPTER 18

PNEUMATICS

GENERAL

The Solenoid Driver Board, operating under control of the IR Interface Board located on the Sun Bus, controls the energizing/de-energizing of the five pneumatic system solenoid control valves V1-V5. Figure 18-1 illustrates solenoid valve location within the Emission Module compartment.

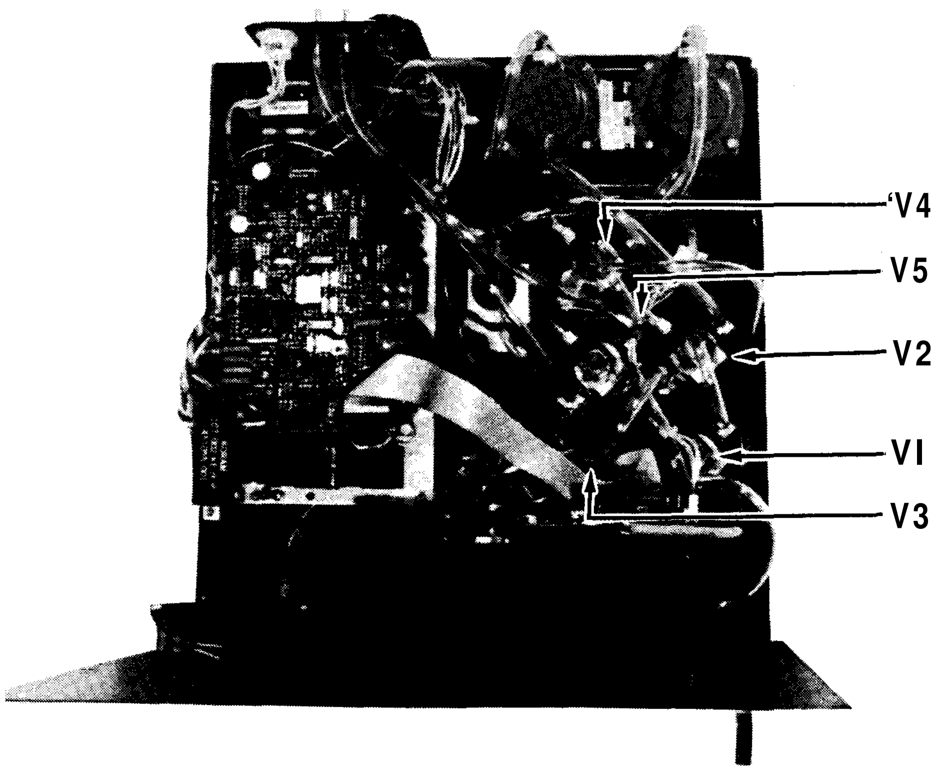


Figure 18-1. Solenoid Valve V1-V5, Location Diagram.,

When a valve is energized its N. C.(normally closed) and COM (common) ports are effectively opened and connected together and when the valve is de-energized its N. O.(normally open) and COM ports are connected. Reverse biased diodes, connected across the coil winding of each solenoid valve, function to dissipate the inductive "kick" of solenoid de-energization. Configuration of the solenoid valves during specific operational modes is shown in Diagrams 18-1 through 18-5, Pages 18-5 through 18-14.

SECTION I. PNEUMATICS THEORY OF OPERATION

CALIBRATION MODE

This mode is used to allow a calibration gas to flow from the CAL PORT to the I.R. Bench and also through the 0_2 sensor.

When conducting an external gas calibration mode of operation, Diagram 18-2, Pages 18-9,10; solenoid valve V2 is energized while V1,3,4 & 5 are de-energized. With VI de-energized the gas sample probe pneumatic portion is isolated from input to the IR Bench and therefore the aspiration side of the pneumatics is unnecessary.

External gases (from a calibrated gas source) are inputted at the Tester calibration gas port. From this port the gases are passed through N.C. to COM ports of energized V2 and the COM to N.O. ports of de-energized solenoid valve V3, N.O. to COM ports of de-energized solenoid valve V1 to the .180" intake side of the pump. From the output .180" side of the pump the calibrated gases are routed through an oxygen (02) sensor and applied to the two intake sides of the IR Bench. Calibrated gases, from the pump output, are also passed through a flow restrictor and applied to the low flow switch. From the oxygen sensor the calibrated gases are also applied through a flow restrictor to a pressure transducer. After gas evaluation within the IR Bench it is exhausted into the surrounding atmosphere through the gas exhaust port.

SAMPLE MODE

This mode is used to sample vehicle exhaust gases. In this mode vehicle exhaust gases are drawn into the primary/secondary filter bowls by both sides of the vacuum pump. This allows for the fastest response time and also the mode most likely to cause moisture to accumulate in the filter bowls.

When operating in the gas sample mode, Diagram 18-4, Pages 18-11,12; the exhaust sample probe is inserted within the vehicle exhaust pipe and exhaust gases are tested and evaluated. While in this operational mode, solenoid valves V1 & V4 are energized while solenoid valves V2,3 & V5 are de-energized.

Vehicle gases are picked Up by the sample probe, passed through the 75 micron primary filter, 8 micron secondary filter, N.C. and COM ports of energized solenoid valve Vl, .180" section of the pump and then simultaneously routed to the oxygen (02) sensor and through a flow restrictor to the low flow switch. From the oxygen sensor the gases take a two-way path: (1) through a flow restrictor to a pressure transducer and (2) directly to the two intake orifices of the IR Bench. After IR Bench processing and evaluation they are vented through the Tester gas exhaust port to the surrounding atmosphere.

VACUUM MODE

This mode is used to allow a vacuum to be drawn on the boom located VACUUM port. When performing a vacuum check, Diagram 18-2, Pages 18-7,8; solenoid valve V5 is energized while solenoid valves V1-V4 are de-energized. The de-energized status of VI isolates the exhaust sample path from the vacuum path while the operational status of V2 isolates the external calibration gas port from the exhaust sample path through the pump. The output of the .180" side of the sample pump is applied to the aspirator on the primary filter. The aspirator and the check assembly are responsible for removing water from the primary filter, without diluting the exhaust sample with air. For proper operation the "small end" of the aspirator must be connected to the output of the sample pump. The intake of the .180" section of the pump is used to provide the vacuum for the "vacuum source" mode. In the "vacuum source" mode, solenoid valves V4 and V5 switch the intake of the sample pump to the vacuum connector on the boom. The vacuum regulator "bleeds off" excess vacuum, allowing the vacuum source to become adjustable. The signal input vacuum transducer, located on the Input Filter Board, monitors the vacuum magnitude for eventual display on the VDU. When the vacuum source mode is not selected, the sample pump's intake becomes a simple vent to the atmosphere. Additionally, the operational status of the solenoid valves block the engine vacuum (from boom connector), allowing the Tester to display conventional engine vacuum.

The operational pump "draws" a vacuum from the boom vacuum port through the pneumatic system to the aspirator port in the following manner: boom vacuum port, center divider boom vacuum port, chassis boom vacuum port, N.C. to COM port of energized solenoid valve V5, N.O. to COM port of de-energized solenoid valve V4 to the .180" section of the pump. From the output of the .180" side of the pump to the primary filter aspirator and then out the base located aspirator port.

ZERO HOLD MODE

The zero mode is used whenever gas measurements are not required. In this mode no exhaust gases are drawn into the exhaust probe and sample hose thus reducing the amount of *moisture* that can condense in the filter bowls. In all modes of operation the primary filter bowl is connected to the aspirator port and moisture is being drained from it.

When operating in the zero hold mode, Diagram 18-1, Pages 18-9/10; the vehicle gas input sample pathway is cutoff, external calibration gas pathway is cutoff and the boom vacuum pathway is also cutoff via the operation of solenoid valves VI-5. In this operational mode all solenoid valves are de-energized thus their N.O. to COM ports are connected together. V1 isolates the vehicle incoming gas sample from the IR Bench, V2 isolates the external gas calibration port and V5 isolates the boom vacuum port.

During the zero portion of this operational mode, ambient air passes through V2, V3 and Vl, then through the pump and the oxygen sensor to the I.R. Bench for zeroing and finally out the gas exhaust port. Simultaneously with the above action; valves V4 and V5 and the remaining part of the pump function to further aspirate water and other finite particulate matter from the primary filter thus readying the filter for later sample gas input.

The hold portion of this operational mode functions to de-energize all solenoid valves thus enabling monitoring of the created vacuum and checking for possible leakage.

SECTION II. LEAK DETECTION THEORY OF OPERATION

BAR 84 specifications require that the operator have a means of testing the portion of the sample system which is normally exposed to less than atmospheric pressure. The Leak check hardware of the Tester checks the integrity of the sample handling system by drawing a few seconds of calibrated gas, applying a vacuum and then monitoring the concentration for decay. If decay in gas concentration occurs it indicates a dilution and thus a leak in the pneumatic system.

LEAK CHECK MODE

This mode is used to perform a leak check on the pneumatics system of the Tester by letting calibration gas flow from a calibration gas bottle into the CAL PORT, then out the LEAK CHECK PORT and into the Leak Check Adapter. The calibration gas is then introduced into the I.R. Bench via the exhaust probe and sample hose. After gas is introduced into the I.R. bench, the valves are placed in the sample mode while the I.R. Bench monitors the gas concentration for a decay on the HC (hydrocarbons) channel. If the sampled gas concentration is less than required, a leak must be present in the pneumatic system.

A O to 15 psia (pounds per square inch absolute) pressure transducer, mounted to the left of and immediately adjacent to the Solenoid Driver Board, is used to monitor the pressure in the sample handling system during testing to compensate for a near, but not actual, low flow condition or altitude correction. See Chapter 17 for more information.

NOTE

> A pressure less than 14.7 psia shall be considered a vacuum. The remaining portion of the following text uses the word "vacuum" to indicate a pressure of less than 14.7 psia.

Leak check theory is covered in three separate modes namely: Leak Check A, B & C. The following discussions describe the theory of operation during each of the modes.

Leak Check A Mode

When performing Leak Check A, Diagram 18-2, Pages 18-5,6; solenoid valves V1 and V3 are de-energized while v2 is energized. In this mode, with the solenoid valves in their stated operational condition and the cal gas bottle disconnected, air flows normally through the cal gas port. Directed by prompts on the VDU, the operator connects the cal gas bottle with the valve closed. At this point, the Low Flow switch senses a low flow condition and software control then forces operation into the Leak Check B Mode.

Leak Check B Mode

When performing Leak Check B, Diagram 18-3, Pages 18-7,8; solenoid valves Vl, V2, & V3 are energized thereby connecting their normally closed (N. C.) and common (COM) ports. In this mode, with the cal gas bottle connected and the the leak check adapter disconnected, air flows normally through the exhaust probe and hose. Directed by prompts on the VDU, the operator connects the leak check adapter to the leak check port and the exhaust probe. Connecting the leak check adapter once again creates a low flow condition and the VDU (under software control) prompts the operator to open the cal gas bottle valve. Cal gas now passes through the cal gas port, through energized solenoids (V2 & V3), and out leak check port. From this point the cal gas passes through the externally connected leak test adapter, exhaust probe, 75 micron primary filter, 8 micron secondary filter, energized solenoid valve VI, pump, 0_2 sensor, I.R. Bench and finally out the EXHAUST PORT. After 10 seconds, if the gas concentration sensed by the I.R. bench is not at least 2/3 the gas concentration that was entered in the CAL GAS VALUES page (via the GAS CALIBRATION MENU), leak check is aborted and LEAK CHECK FAILED appears on the VDU. If after 10 seconds the gas concentration is more than 2/3 of what was entered, a peak HC (hydrocarbons) reading is stored in internal memory and Leak Check C Mode is initiated (under software control).

Leak Check C Mode

When performing Leak Check C, Diagram 18-4, Page 18-8,9; solenoid valves V2 & V3 are de-energized while V1 & V4 are energized. In this operational state, the solenoid valves function to trap the previously inputted calibration gas. Solenoid valve V2 is de-energized which halts the flow of gas from the bottle while, V3 is also de-energized which traps the gas in the Sample Mode. This results in a vacuum being created in the sampling system. If the gas sample concentration decays by more than 20'% of peak (highest concentration sampled during Leak Check B), after a short sampling period, LEAK CHECK FAILED appears on the VDU. If the sampled gas does not decay more than 20'%, sampling continues. Next, after a more lenghtly period, if the gas concentration does not decay by more than 37% of the peak reading (taken during Leak Check B), finally software judges the system to be near leak free. At this point, LEAK CHECK PASSED message appears on the VDU.

Operational Sequence
The following procedure outlines the operational steps required to perform a leak check:

NOTE
Make certain that the EXHAUST PORT and calibration gas bottle source flow rates are identical. Flow rates are critical for accurate leak test results!

Setting Flow Rate on Calibration Gas Bottle
The following set-up procedure should be used to set the flow rate for the gas bottle regulator used during calibration. If the customer does not have the gas calibration kit, the CSR's equipment must be used.

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

2. With the I.R. pump on, advance the tester to the DEVELOPEMENT AIDS menu and select #3 TEST GAS BENCH. Use the Left/Right cursor to select the ZERO mode and record the flow rate on the flow meter for future reference.

3. Use the Left/Right cursor to select the CAL mode.

4. If using customers cal gas tank and regulator:

   A. Remove the acorn lock nut from the regulator to gain access to the flow rate adjustment screw.

   B. Turn the adjustment screw counterclockwise (using 3/16" hex wrench) until there is no more drag felt on the screw. The regulator should now be shut off (no flow).

   C. Open the gas calibration bottle valve completely. The regulator gauge will indicate the amount (pressure) of cal gas remaining in the tank. The flow meter should still indicate zero.

   D. Turn the adjustment screw clockwise, watching the flow meter, until the flow matches the amount recorded in step #2.

   E. Reinstall acorn lock nut over the adjusting screw and tighten. Close cal gas bottle valve.

5. If the customer does not have Gas Calibration Kit #0121-0446-01:

   A. Connect the technicians cal gas bottle to the cal gas port on the rear of the tester.

   B. Open the gas bottle valve and adjust the regulator assembly to match the testers flow recorded in step #2.

   C. Close the gas bottle valve.

• *******************

* **Set-Up Complete** •

•*******************

LEAK CHECK PROCEDURE

1. Access the SYSTEM CALIBRATION page.

2. Press CAL pushbutton to obtain GAS CALIBRATION MENU page.

3. Press #3 to enter CAL GAS CONCENTRATION AND and enter in the correct values.

4. Press CONTinue to return to the GAS CALIBRATION MENU page.

5. Press #2 for LEAK CHECK and follow prompts.

6. As directed by VDU prompt; attach gas bottle and close valve.

7. Connect exhaust probe to LEAK CHECK PORT using a Leak Test Exhaust Probe Adapter Assembly.

8. Open valve on calibration gas bottle and note that VDU display reads "LEAK CHECK IN PROGRESS.

9. Close valve on calibration gas bottle and note that VDU display reads either "LEAK CHECK PASSED" or "LEAK CHECK FAILED". A "LEAK CHECK FAILED" message indicates a leakage in the pneumatic system requiring maintenance prior to placing the Tester back in service.

NOTE

Procedural steps 4 & 5 are referenced to Leak Check A Mode Diagram 18-2, Page 18-11/12 while steps 6 & 7 are related to Leak Check B Mode Diagram 18-3, Page 18-13/14. Diagram 18-4, Page 18-15/16 supports Leak Check Mode C.

****

* **Leak Check Complete** *

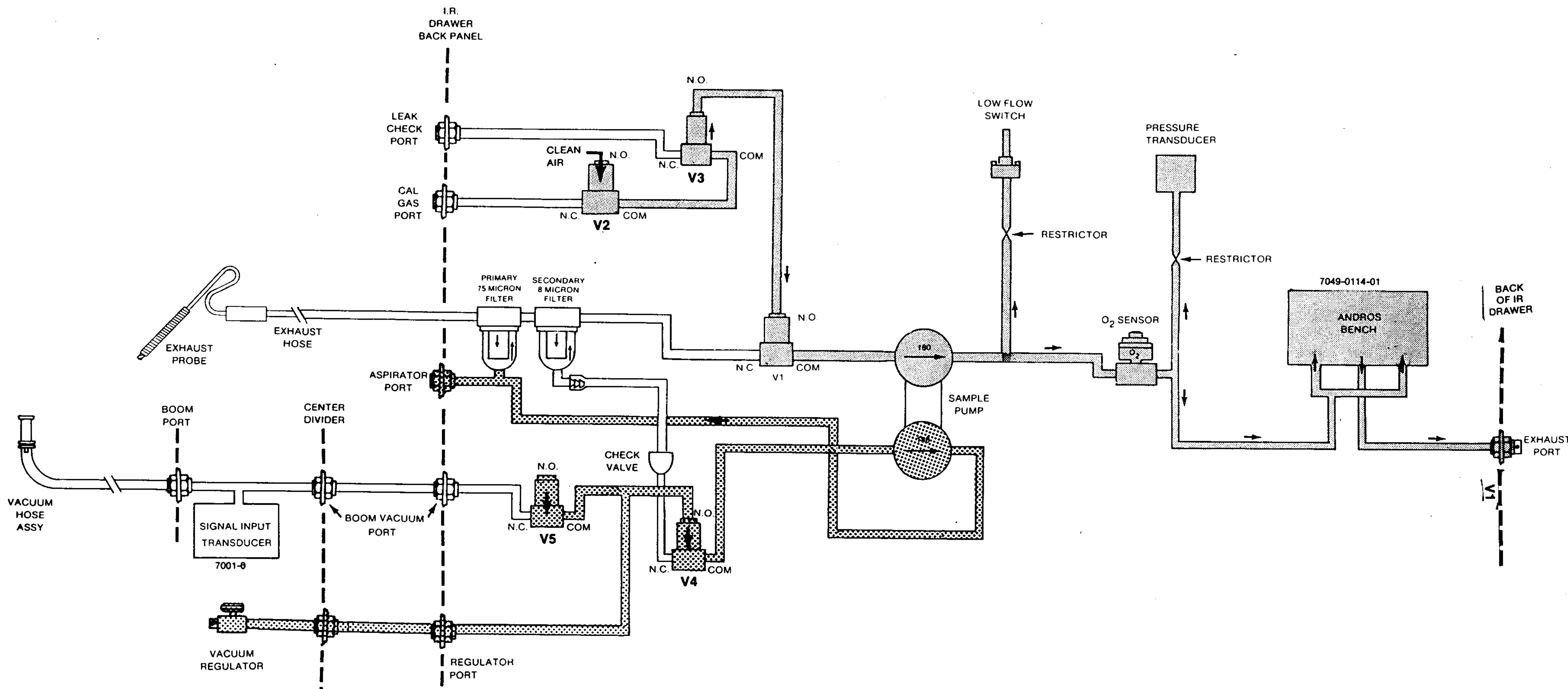
****

SECTION III. PNEUMATICS TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. **Unable to manually regulate vacuum when in VACUUM mode.** Vacuum is **present but it is a constant value.**	1. Vacuum regulator #7009-1430 defective; replace. 2. Refer to Theory of Operation and Vacuum Mode **Configuration Pneumatic Diagram 18-5.**
II. **Unable to obtain any vacuum when operating in VAC mode. Vacuum pump operating normally.**	1. **Solenoid valve(s) V4 & V5 not energized. Check for presence of virtual ground at J509 pins 4 & 5. If not present, then** **-----------------SUBSTITUTE--------------------** **A. Solenoid Driver Board #7001-0560.** If present, proceed to step 2. 2. Check V4 & V5 coils for approximately 16 ohms resistance. If open or shorted, then -----------------SUBSTITUTE-------------------- A. Defective solenoid valve(s) V4 or V5 #0304 -0040. 3. Check for +15Vdc at pin 2 of V4 & V5. If not present, refer to Chapter 17 Theory of Operation and Functional Block Diagram 17-1 and Pneumatic Diagram 18-5.
111. **Abnormal gas values obtained during Calibration mode** operation. Pump operating normally.	1. **Solenoid valve V2 not energized. Check for presence of virtual ground at J509 pin 2. If** not present, then -----------------SUBSTITUTE-------------------- A. Solenoid Driver Board #7001-0560. B. Solenoid V2 #0304-0039. If present, proceed to step 2. 2. Check pneumatic system hoses for obstructions. Repair if necessary. 3. Refer to Chapter 17 Theory of Operation and Functional Block Diagram 17-1 and Pneumatic Diagram 18-4.

COMPLAINT	CORRECTIVE ACTION
IV. Abnormal vacuum when operating in SAMPLE mode.	**1. Check solenoid valve V4 coil for approximately 16 ohms resistance. If open or shorted, then** **----------------SUBSTITUTE-------------------** **A. Solenoid Valve V4 #0304-0040.** 2. Check pneumatic system hoses and ports for obstructions. Repair if necessary. 3. Check Vacuum Pump for sufficient "draw", clean and repair as needed. 4. Refer to AC Power Distribution Diagram 1-1, Chapter 17 Theory of Operation and Infrared Emission Diagram 17-1.

NOTES



SOLENOID TRUTH TABLE

MODE	V1	V2	V3	V4	V5
ZERO & VAC HOLD	N.O.	N.O.	N.O.	N.O.	N.O.

N.O. = SOLENOID DE-ENERGIZED
N.C. = SOLENOID ENERGIZED

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

MODEL: MCA-3000

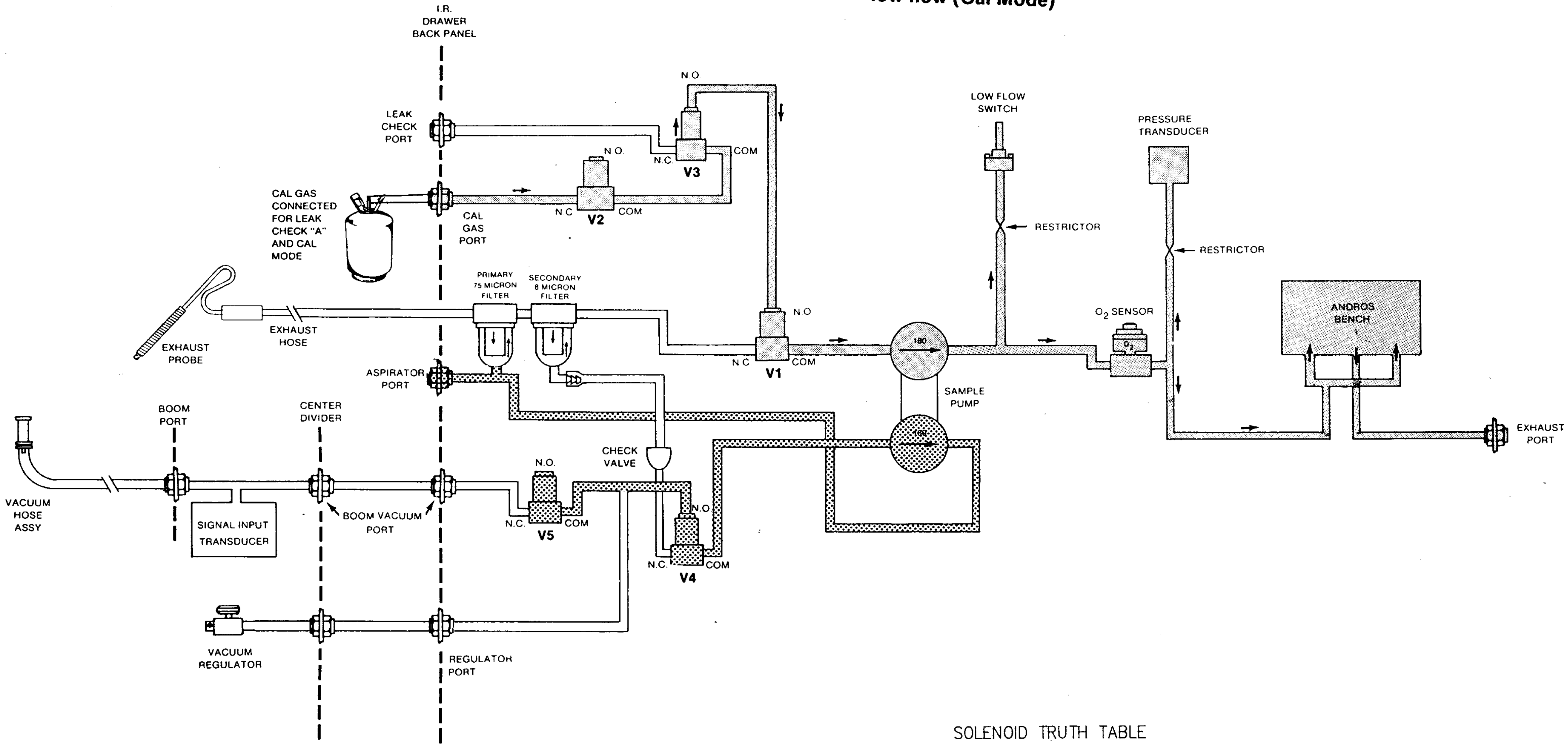
TITLE: PNEUMATIC DIAGRAM, ZERO/VAC HOLD MODE CONFIGURATION

DWG: 18-1

PAGE: 18-11/18-12

CALIBRATION/LEAK CHECK A

Connect cal gas—valve closed, look for low flow (Cal Mode)



SOLENOID TRUTH TABLE

MODE	V1	V2	V3	V4	V5
CAL & LEAK CHECK "A"	N.O.	N.C.	N.O.	N.O.	N.O.

N.O. = SOLENOID DE-ENERGIZED
N.C. = SOLENOID ENERGIZED

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

MODEL: MCA-3000

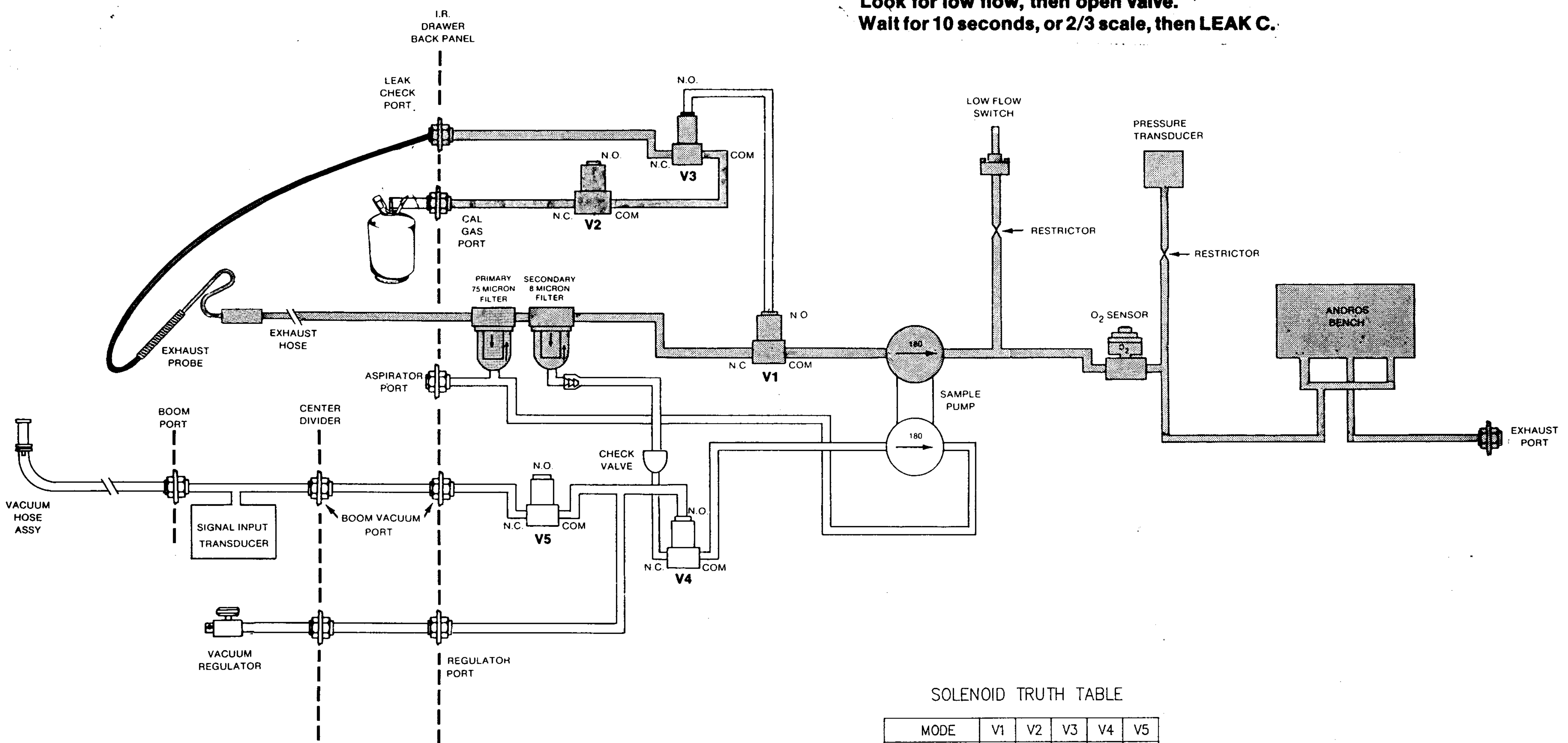
TITLE: PNEUMATIC DIAGRAM, CALIBRATION/LEAK CHECK "A" MODE CONFIGURATION

DWG: 18-2

PAGE: 18-13/18-14

TELEDYNE POST N79497

LEAK B Connect leak check adapter
(Leak Check Mode)
Look for low flow, then open valve.
Wait for 10 seconds, or 2/3 scale, then LEAK C.



SOLENOID TRUTH TABLE

MODE	V1	V2	V3	V4	V5
CAL & LEAK CHECK "B"	N.C.	N.C.	N.C.	N.O.	N.O.

N.O. = SOLENOID DE-ENERGIZED
N.C. = SOLENOID ENERGIZED

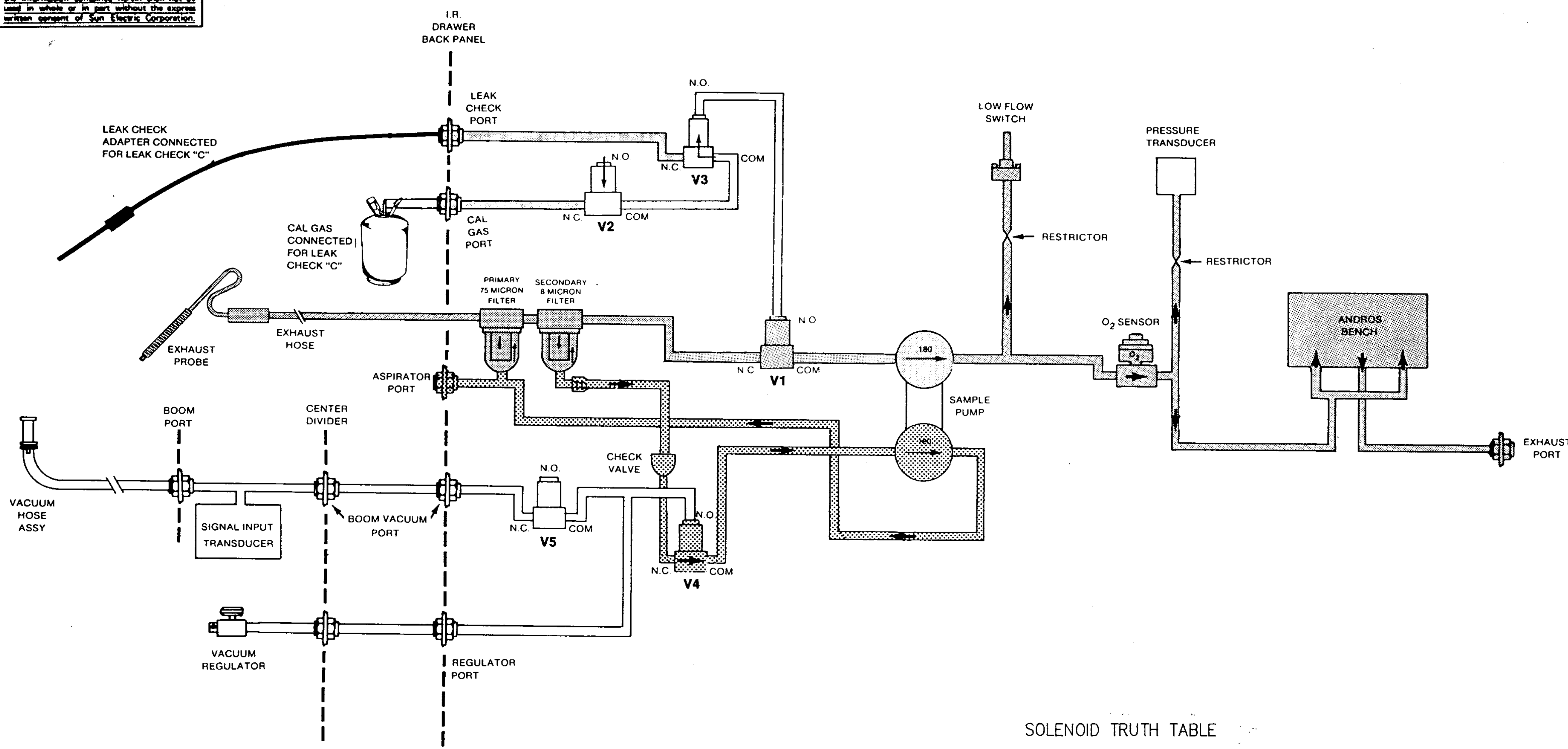
Sun
SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

MODEL: MCA-3000

TITLE: PNEUMATIC DIAGRAM LEAK "B" CALIBRATION MODE CONFIGURATION

DWG: 18-3

PAGE: 18-15/18-16



SOLENOID TRUTH TABLE

MODE	V1	V2	V3	V4	V5
SAM & LEAK CHECK "C"	N.C.	N.O.	N.O.	N.O.	N.O.

N.O. = SOLENOID DE–ENERGIZED
N.C. = SOLENOID ENERGIZED

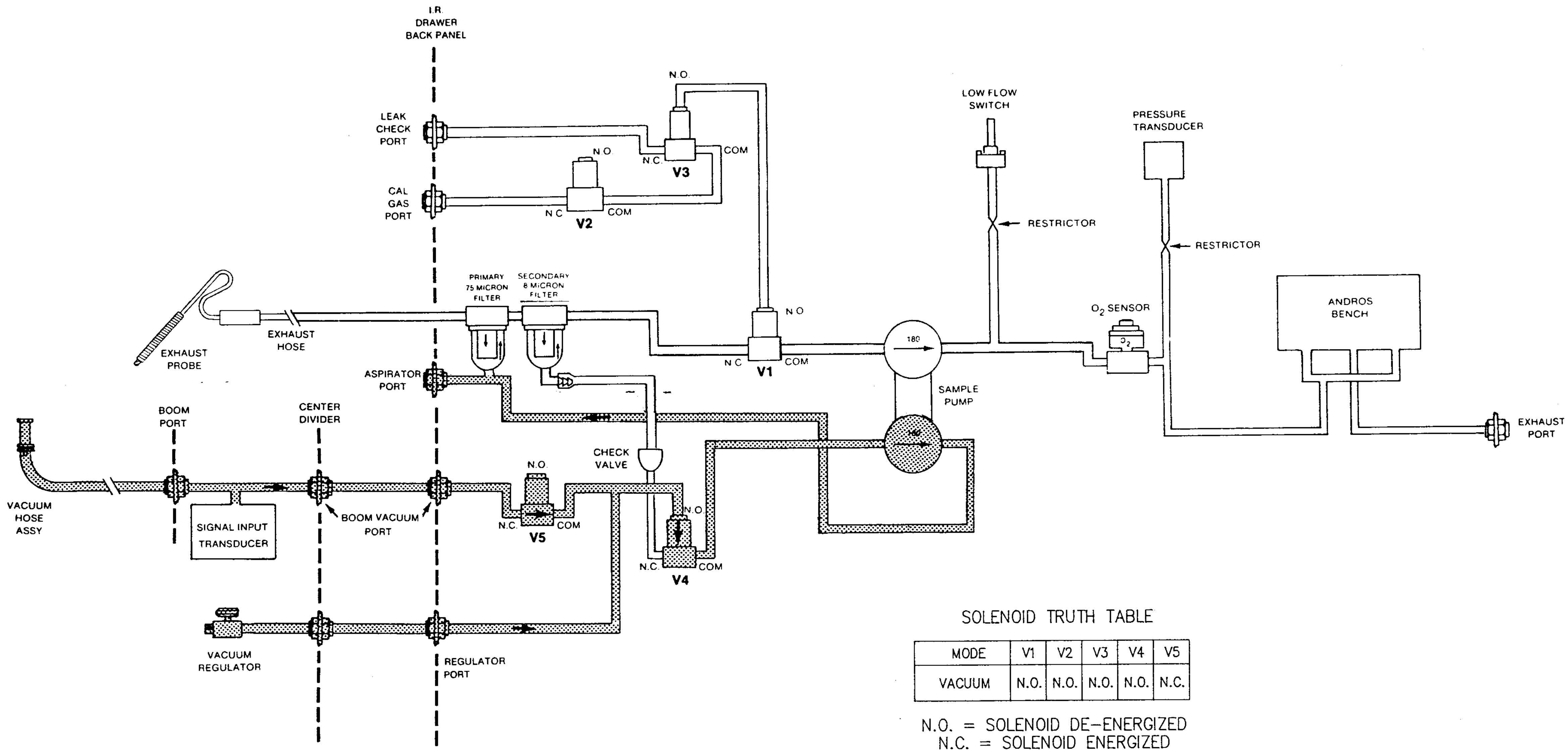
NOTE: If vacuum function is front panel selected, V1-V3 do not change operational state; however if vacuum mode is software selected, V1-V3 change states.

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

MODEL: MCA-3000

TITLE: SAMPLE MODE/LEAK C MODE CONFIGURATION

DWG: 18-4 PAGE: 18-17/18-1



SOLENOID TRUTH TABLE

MODE	V1	V2	V3	V4	V5
VACUUM	N.O.	N.O.	N.O.	N.O.	N.C.

N.O. = SOLENOID DE-ENERGIZED
N.C. = SOLENOID ENERGIZED

NOTE: If vacuum function is front panel selected, V1-V3 do not change operational state; however if vacuum mode is software selected, V1-V3 change states.

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

MODEL: MCA-3000

TITLE: PNEUMATIC DIAGRAM, VACUUM MODE CONFIGURATION

DWG: 18-5

PAGE: 18-19/18-20

CHAPTER 19

ALDL

GENERAL

The ALDL Reader Board #7001-0543, shown in Diagram 19-1, is a microcontroller based board which mounts into the MCA's SUN BUS. This Board is designed to interface, the many different vehicle manufactures on-board computer systems with the MCA-3000 through a variety of serial communication ports or ALDLs (Assembly Line Diagnostic Link). This function provides the MCA-3000 with the ability to display information from the vehicle's sensors, as seen by the vehicle's on-board computer. The MCA's ALDL function also provides diagnostics used to pinpoint possible on-board computer system failures. The ALDL function requires specialized software, tailored specifically to a certain type of system for a particular make and model automobile.

The MCA-3000'S ALDL function is capable of communicating with both Uni-directional and Bi-directional on-board computer systems. The ALDL Board has the ability to communicate at any rate, from 1 to 19.2K baud (bits per second), using logic levels of 2 to 20 volts which is under software control. The 8749H microcontroller has an extensive library of command utilities within its EPROM. Specialized software routines, for communicating with various automobiles, are downloaded to an external static RAM chip from the SUN BUS for execution by the microcontroller.

TYPES OF ON-BOARD SYSTEMS

On-board computer systems have changed since their early beginnings, all systems started out being dumb or with no communications later they were up-graded to uni-directional systems. Uni-directional 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 MCA's ALDL function was designed to be able to listen to this serial data, interpret the data, and display it on the monitor. In addition to being able to handle newer systems as they appear.

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). However 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), Chryslers output O volts (low) and +5 volts (high).

BI-DIRECTIONAL COMMUNICATIONS or BI-COM.

Beginning in 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. 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.

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 other 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 ALDL function is not present, then the ECM continues with it's normal routines until it is time to check the ALDL connector again. If the ALDL function is present, it informs the ECM of it's presence and what data it requires. The ECM sends back the appropriate data the ALDL function 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 (main), while all the other control 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 MCA'S ALDL function is present or not. If present, the ALDL function 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 MCA-3000'S ALDL function 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 and later model on-board computers. This system does not poll it's ALDL like GM's does, but requires that the MCA-3000'S ALDL function 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 ALDL function can then 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 ALDL function 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 MCA's ALDL READER Board.

The vehicle's on-board computer begins sending numbers which represent sensors. When the number of the sensor that the ALDL function wants to read is sent, the MCA's ALDL function 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 ALDL function 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 MCA's ALDL function decodes the data for display.

Both the GM and Chrysler BI-COM systems use O volt (low) and +5 volts (high). However, the BI-COM portion of the MCA-3000 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 ALDL function pull-up their data stream signal. Currently only certain Chrysler carbureted vehicles require this. How this is done is discussed in further detail on page 19-6.

SECTION I. THEORY OF OPERATION

ERROR CODES

Upon power-up or software reset (causing the SUN BUS to reset), the microcontroller performs an extensive self-test. Four green status LED's (LED1-4) are grouped together at the top of the ALDL board. If there are any faults (errors) discovered by this self-test, an error code is displayed on these status indicators. The displayed error codes are given in four-bit binary: MSB (most significant bit) on the left (LED1) when facing the component side of the board. A "l" signifies a lit LED while a O indicates that the LED is out.

ERROR CODE	DESCRIPTION
1111	Error in internal RAM
0111	Error in bank 7 of external Data RAM (lst 2K)
1000	Error in bank 6 of external Data RAM
1001	Error in bank 5 of external Data RAM
1010	Error in bank 4 of external Data RAM
1o11	Error in bank 3 of external Data RAM
1100	Error in bank 2 of external Data RAM
1101	Error in bank 1 of external Data RAM
1110	Error in bank O of external Data RAM
0110	Error in external PROGRAM RAM. A six (0110) will be displayed for any of the 8 banks, O-7 which have a RAM test error. This code will flash six times, this signals the end of test errors to be displayed.

NOTE: The error display is initially blanked before anything on the board is initialized and blanked again after all error codes have been displayed. Error codes are displayed for two seconds and separated by a one second blanking. After all self-testing has been satisfactorily completed, all four LED'S are lit. However, during dynamic operational testing, the two low order LED's flicker normally when reading 80/160 baud GM data streams.

MODE CONTROL is an output from the ALDL READER Board, which places a certain resistance value on pin 4. of J611 (boom connector). This resistance value is made available to the vehicle's ALDL connector, setting up a voltage divider inside the vehicle's on-board computer system. The on-board computer system monitors this voltage divider and when the voltage dividers exceeds a certain point, the on-board system is placed in a specific mode of operation. This mode of operation is used for such things as; allowing the system to send trouble codes or information from the vehicle's sensors as seen by the computer. For specifics resistance values, and their responses pertaining to different manufactures, see the chart on next page.

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.

POWER SUPPLY
The ALDL Reader Board receives it's power from Power Supply #1, through the SUN BUS. The SUN BUS supplies the ALDL Reader with +5 volts and +/-15 volts, the ALDL Reader then regulates the +/- 15 volts to create +/-12 volts supplies.

PROGRAM LOADING

NOTE: Only MCA-3000 STL software will function in the MCA-3000. STL and DL-1OO software will not be recognized by the MCA-3000.

The MCA's ALDL function can be entered by selecting "#6" from the MCA's Main Menu page. The VDU will then prompt the operator to insert the MCA's STL software into Drive B and press "RETURN". The MCA software is loaded from the Disk Drive B, through the SBC, and on to the 1/0 portion of the I/O/EEPROM/CLOCK Board. From here the data is transferred to the SUN BUS via the SUN BUS DRIVER Board. Once on the SUN BUS, the ALDL READER Board recognizes its BANK SELECT and prepares to receive incoming data. The incoming data is stored in external RAM memory. Once stored in RAM, the memory is treated as if it were ROM memory, because it is only read from. The instructions that were downloaded into the external RAM are executed by the micro-controller to gather data from signals entering the ALDL READER Board from an on-board computer system. The gathered data is then returned to the SBC, via the SUN BUS and it's 1/0 communication capabilities, where it is ready for display on the VDU.

The MCA's ALDL function also provides the operator with a sophisticated inter-active diagnostic tool to guide the operator through the volumes of the vehicle's manufacturers troubleshooting logic trees. This is provide through special MCA diagnostic software tailored for each system and year.

To exit from the MCA's ALDL function, just press the "E" (for EXIT) key on the Keyboard. This will cause the MCA to return control back over to the SBC and resume function as an engine anaylzer.

VEHICLE INTERFACE CIRCUITRY
The MCA-3000'S ALDL function must be able to interface with many types of on-board computer systems present and future. The following text will describe the interface curcuitry and should be used in conjunction with the Functional Block Diagram, 19-1 page 19-11/12.

BATTERY voltage signal, when present at pin 6 of J611, is used to energize RELAY K3. The state of RELAY K3 determines the communication voltage levels or VSYS (for Vehicle System Voltage) of the hi-directional portion of the ALDL READER Board. In it's de-energized state, 5 volts is selected for VSYS which is supplied via the SUN BUS. However if K3 is energized the vehicle's own battery voltage is used for communication. The BATTERY signal is also applied to circuitry which senses it's polarity. Proper polarity is indicated by a lit green LED and improper polarity is indicated by a lit red LED.

BI-DIR A and BI-DIR B (pins 7 & 8 of J611 respectively) are used for hi-directional communications between the ALDL READER Board and the vehicle's on-board computer system. A USART (Universal Synchronous Asynchronous Receiver Transmitter) is used to transform serial data, received from the vehicle's on-board computer, into parallel data used by the micro-controller. Also, for taking parallel data, from the micro-controller, and converting it into serial data to be sent to the vehicle's on-board computer. When transmitting data from the ALDL READER Board to a vehicle's on-board system, two push/pull drivers are used. One designated PUSH/PULL DRIVER A for the BI-DIR A line and the other PUSH/PULL DRIVER B for the BI-DIR B line. The Push/Pull Drivers utilize VSYS (vehicle system voltage) for communication voltage levels. Both are monitored by a current overload detector. If the detector sees a current overload condition, it informs the micro-controller. Hence, the micro-controller stops communicating to prevent possible damage to either the ALDL READER Board or the on-board computer system.

Due to the characteristics of some electronic ignition systems, it may be necessary to utilize battery voltage for VSYS (vehicle system voltage), rather then the +5 volts supplied by the Sun Bus. To allow certain systems to be recognized (such as some "87" Chrysler cabureted ignition systems) a pull-up resistor R54 is used to bring the BI-DIR A line to the VSYS (vehicle) system voltage level.
R54 (pull-up resistor) is enabled via Transistor Q2 activated through one of the micro-controller's 1/0 expander ports under software control. BI-DIR B line also utilizes a pull-up resistor (R55), which is capable of pulling the BI-DIR B line up to 5 volts which is directly controlled by the TXD/RXD (TRANSMIT/RECEIVE) SELECT LOGIC. The TXD/RXD SELECT LOGIC is also used to select which of the two hi-dir lines we are communicating (TXD and RXD)on

There are three different forms of received data presented to the USART:

- Type 1. Serial data on the BI-DIR A line.
- Type 2. Serial data from the BI-DIR B line after subtracting half of whatever VSYS is.
- Type 3. The difference between the BI-DIR A signal and the BI-DIR B signal voltage.

The TXD/RXD SELECT LOGIC is used to select RECEIVE A (BI-DIR A) or RECEIVE B (BI-DIR B), which will be feed into the USART. This is controlled by a signal called A*B. When low, RECEIVE A signal becomes RXD to the USART, when high the RECEIVE B signal is used as RXD to the USART.

RELAY K1 also plays an important part in RECEIVE DATA selection. This relay is used to switch between RECEIVE DATA type 2 or type 3 (as described above). K1 is controlled by a signal called A/AB DIFF*, an output of the micro-controller. When high, either types 1 or 2 (as described above) are available, depending on whether A or B is selected by the TXD/RXD SELECT LOGIC. But if A/AB DIFF* is low, type 3 (as described above) is then available on the RECEIVE A line.

NON-USART SIGNAL PROCESSOR

The NON-USART SIGNAL PROCESSOR is used to receive uni-directional serial data from either pins 1 or 5 of J611 the MCA-3000'S boom connector. Selection between pin 1 or 5 is accomplished through RELAY K4. This relay is controlled by a signal from the micro-controller's 1/0 expander called SLOW DATA l/SLOWDATA 5* (SD1/SD5*). When SD1/SD5* signal is low, DATA STREAM 5 or data present on pin 5 of J611 will be feed into the NO N-USART SIGNAL PROCESSOR. If SLOW DATA l/SLOW DATA5* signal is high, RELAY K4energizes causing DATA STREAM 1 (the data present on pin 1 of J611) to be feed into the NON-USART SIGNAL PROCESSOR. The NON-USART SIGNAL PROCESSOR is basically a variable threshold detector used to create a clean DATA STREAM signal half the size of the incoming DATA STREAM, independent of the vehicle's communication voltage levels. The output of the NO N-USART SIGNAL PROCESSOR is fed into an input port of the micro-controller's 1/0 Expander. Here it is prepared by the micro-controller to be passed via the SUN BUS and on to the SBC for interpretation and display.

SECTION II. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. **MCA won't load ALDL software.**	1. Is the MCA in the On-Board Computer Analyzer Mode ?

YES NO

Return the MCA to it's main menu. Press "6" on the keyboard. Does the screen look like the one below ?

```
———————— SUN TEST LINK ————————

Insert Test Link Program Disk in drive B



> Press ENTER when ready
```

YES NO

Try a new MCA MASTER PROGRAM DISK.

Re-insert the MCA's LIMITS Disk into Drive "B" and try to load a vehicle code. Can a code be entered ?

YES NO

Refer to Chapter 3, Section III, Troubleshooting on page 3-14.

Drive B is functioning properly try a different ALDL disk. If this disk works, replace the other disk.

Power down the MCA and observe LEDs 1-4 on the ALDL Board. Check for error codes from the self-test started upon power-up. See chart on page 19-4 for error code(s). Are their any error code(s) ?

YES NO

------------SUBSTITUTE-------------

1. I/O EEPROM CLK Bd, 7001-0558
2. SUN BUS DRIVER Bd, 7001-0559
3. ALDL READER Board, 7001-0543

NOTE: Remember any board on the SUN BUS can cause I/O errors. See Chapter 7 for more information.

Replace ALDL READER Board, 7001-0543

2. Refer to Theory of Operation and Functional Diagram.

COMPLAINT	CORRECTIVE ACTION
II. MCA won't read vehicle's data stream.	1. Verify that the proper TEST LINK Disk has and engine selections have been made for the vehicle under test.

2. Verify proper connection between the MCA's ALDL Interface Cable/Adapter (required on some bi-directional vehicle systems) and the vehicle under test.

3. Check continuity of ALDL Interface Cables and Adapters. See Function Block Diagrams page 19-11/12 for pin-outs. Is the Interface Cable or Adapter open ?

YES NO

NO →

------------SUBSTITUTE-------------

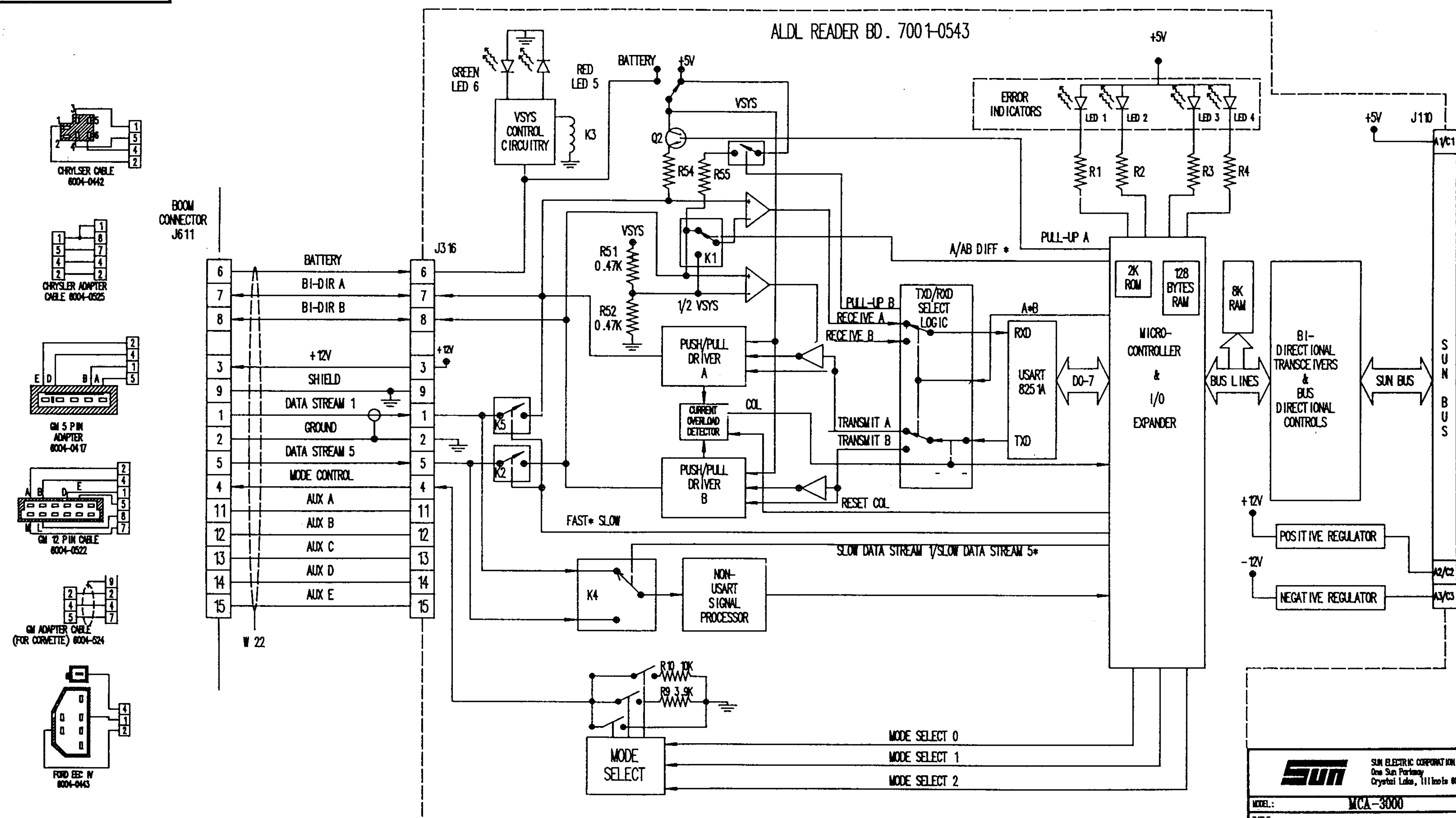
1. The ALDL Board 7001-0543.
2. The BUS DRIVER Board 7001-0559.
3. The I/O EEPROM CLOCK Board, 7001-0558.

YES →

Replace the defective Interface Cable and/or Adapter.

4. Refer to Theory of Operation and the Functional Diagrams.

NOTES



SUN ELECTRIC CORPORATION
One Sun Parkway
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MODEL:	MCA-3000
TITLE:	A.L.D.L.
DWG: 19-1	PAGE: 19-11/19-12

CHAPTER 20

FRONT PANEL SWITCHES/LAMPS

SECTION 1. THEORY OF OPERATION

GENERAL

Tester front panel switch and lamp operational status is primarily monitored and controlled through operation of the Front Panel Interface Board (7001-0616) located on the Sun BUS. This board is essentially comprised of three basic operational circuits: power-on test, lamp/switch control and speaker control. The Front Panel Lamp/Switch Interfacing Functional Block Diagram 20-1, Page 20-7/8 will assist the reader in understanding this Chapter.

POWER-ON TEST CIRCUITRY.

Upon power application a RESET* signal from the BUS DRIVER Board goes low and remains low for approximately 50 milliseconds. When low; this signal resets the MCA'S SUN BUS logic circuitry (only) to a known initialized state.

The Power-On Logic circuitry produces a negative-going 4-5 second long P.O.TEST* (poweron test*) output pulse. During this time the negative-going P.O.TEST* (poweron test*) signal is present, the lamp control circuitry functions to light the following front panel lamps:

SCOPE
ON-BOARD COMPUTERS
COMMUNICATIONS
OTHER
DIAGNOSTICS
COMPLETE TEST
RAPID TEST
SYSTEM TEST
PINPOINT TESTS
SYMPTOMS ANALYSIS
ENGINE KILL
BATTERY LOAD
LOW FLOW

NOTE

With the I.R. PUMP switch OFF, the LOW FLOW lamp will remain lit.

The SUN BUS can also be RESET by signals sent by the I/O/EEPROM/CLOCK Board under software control. This software SUN BUS RESET is defined by the MCA's Master Program software.

LAMP/SWITCH CONTROL CIRCUITRY.

This circuitry can be further subdivided into three basic functional circuits:

1. ENGINE KILL, BATTERY LOAD and LOW FLOW lamp control circuitry.
2. TRIGGER, ENGINE KILL, VACUUM ON/OFF and VACUUM HOLD switch monitoring control circuitry.
3. Control Panel/Indicator Panel lamp control circuitry.

ENGINE KILL. BATT LOAD. LOW FLOW Lamp Control. Whenever the engine kill circuitry is activated (either by ENGINE KILL front panel button is pressed or by a software demand) the KILL SEL* signal is a low level. This signal is processed by the INDEPENDENT LAMP DRIVERS circuitry, which applies a virtual ground to the ENG KILL lamp causing it to light. For further discussion of ENGINE KILL see Chapter 9. Whenever battery loads relays are engaged, a LOAD ENG signal (pin C15) from the VAT Board goes high. This signal is then sent via the SUN BUS to the Front Panel Interface Board, where after passing through an inverter and into the INDEPENDENT LAMP DRIVERS circuitry. The INDEPENDENT LAMP DRIVERS circuitry applies a virtual ground to the BATTERY LOAD lamp causing it to light. When lit, this lamp indicates that potentially high currents are flowing through the MCA's Battery Load Test cables. For further discussion of LOAD ENG see Chapter 16. Whenever insufficient exhaust gas flows through the IR bench the normally low level LOW FLOW input signal (pin C1O) goes to a high level. The LOW FLOW signal is applied to the Front Panel Interface Board, there it is plassed through an inverter and into the INDEPENDENT LAMP DRIVERS circuitry. The INDEPENDENT LAMP DRIVERS circuitry applies a virtual ground to the front panel LOW FLOW lamp, causing it to light. For further discussion of LOW FLOW see Chapter 17.

TRIGGER SWITCH SW5. ENGINE KILL SWITCH SW4. VACUUM ON/OFF SWITCH SW6. VACUUM HOLD Switch SW7 and Switch Monitoring Control Circuitry. This circuitry consists of pullup resistors (R5-8, R13) connected to a +12V relay power source and then followed by non-inverting buffers. The pullup resistors and buffer amplifiers working together supply normally high level FORCE SECONDARY* (Trigger), KILL SEL*, VAC SEL* and VAC HOLD* output signals via connector J11O and through the Sun Bus to appropriate Board's for further processing. Any of the above mentioned manually activated front panel switches applies a ground through its non-inverting buffer amplifier U6 to connector J11O.

Control Panel/Indicator Panel Lamp Control Circuitry. Following powerup and during dynamic operation this control circuitry operates under control of information made available to the Front Panel Interface Board via the SUN BUS. After this portion of the Front Panel Interface has been properly addressed, Sun Bus Data bits SBDO-3 assume varied status, which are used by the SUN BUS and LAMP DRIVER circuitry to produces the appropriate low level output signal(s) or virtual ground which cause the appropriate lamp(s) to light. The following table shows the status of SUN BUS DATA bits SBD0-3 required to light the Indicator or Control Panel Lamp(s).

SBD3	SBD2	SBD1	SBDO	LAMPS LIT
0	0	0	0	COMPLETE TEST
0	0	0	1	RAPID TEST -
0	0	1	0	PINPOINT TESTS
0	0	1	1	SCOPE FUNCTIONS
0	1	0	0	SYSTEMS TEST
0	1	0	1	SYMPTOMS ANALYSIS
0	1	1	0	DIAGNOSTICS
0	1	1	1	ON-BOARD COMPUTERS
1	0	0	0	COMMUNICATIONS
1	0	0	1	OTHER
1	0	1	0	COMPLETE TEST & PINPOINT TESTS
1	0	1	1	COMPLETE TEST & SCOPE FUNCTIONS
1	1	0	0	RAPID TEST & PINPOINT TESTS
1	1	0	1	RAPID TEST & SCOPE FUNCTIONS

SPEAKER CONTROL CIRCUITRY.
On-board transistors Q14,15 and an operational amplifier, interconnected to a front panel mounted VOLUME control VR1 and speaker, function together to emit audible tones whenever keyboard data is entered when using MCA software. SBC speaker signal is processed via Q14, one part of U5, through the volume control, remaining amplifier U5 and driver transistor Q15 to the speaker. The external VOLUME control permits the user to adjust the emitted audio to the desired level.

NON-FRONT PANEL INTERFACE BOARD CONTROLLED SWITCHES & LAMPS

NOTE

The following control panel switches are not controlled by operation of the Front Panel Interface Board: POWER ON/OFF, CONTROL HEADSIGN and CONTROL I. R. PUMP. The following control panel lamps are not controlled by operation of the FPI: MODE ANALYZER and MODE5 1/4.

POWER ON/OFF. CONTROL HEADSIGN and CONTROL I. R. PUMP Switches.
Once the Tester is properly installed and interconnected to primary ac power, the CONTROL HEADSIGN switch can be used to light the Sun headsign irrespective of the POWER ON/OFF switch position. Primary ac power is applied to the Tester whenever the CONTROL ON/OFF switch is set to its "ON" position, this will also cause the headsign to light even with the CONTROL HEADSIGN switch "OFF". AC power is applied to the I.R. Emission Pump whenever the I.R. PUMP and CONTROL ON/OFF switches are both ON. Integrally mounted lamps are lit when the switches are in their ON position. For more information see Chapter 1.

DISK DRIVE COMPARTMENT MOUNTED SWITCHES/CONTROLS.
The following disk drive compartment mounted switches/ contrdols are not controlled by the Front Panel Interface Board: BRIGHTNESS CONTROL, CONTRAST CONTROL, ANALYZER/PC 5 1/4 switch and RESET switch.
Operation of these switches/controls is described in subsequent paragraphs.

BRIGHTNESS/CO NTRAST controls. These controls, are wired to the Video Display Unit. They function to vary the brightness level and adjust the contrast between colors on the screen and the background intensity respectively. For more information see Chapter 5

ANALYZER/PC 5 1/4 Switch. When this switch is in the ANALYZER position, the MODE ANALYZER indicator lamp is lit showing that the MCA'S SBC is being used for vehicle analysis. However, when the switch is in its down position; the MODE PC 5 1/4 indicator lamp is lit thus indicating that the MCA's SBC is being used in conjunction with the optional 5 l/4-inch Disk Drive (if present) and can run IBM compatible software for the 5 l/4-inch Disk Drive. For more information see Chapter 3.

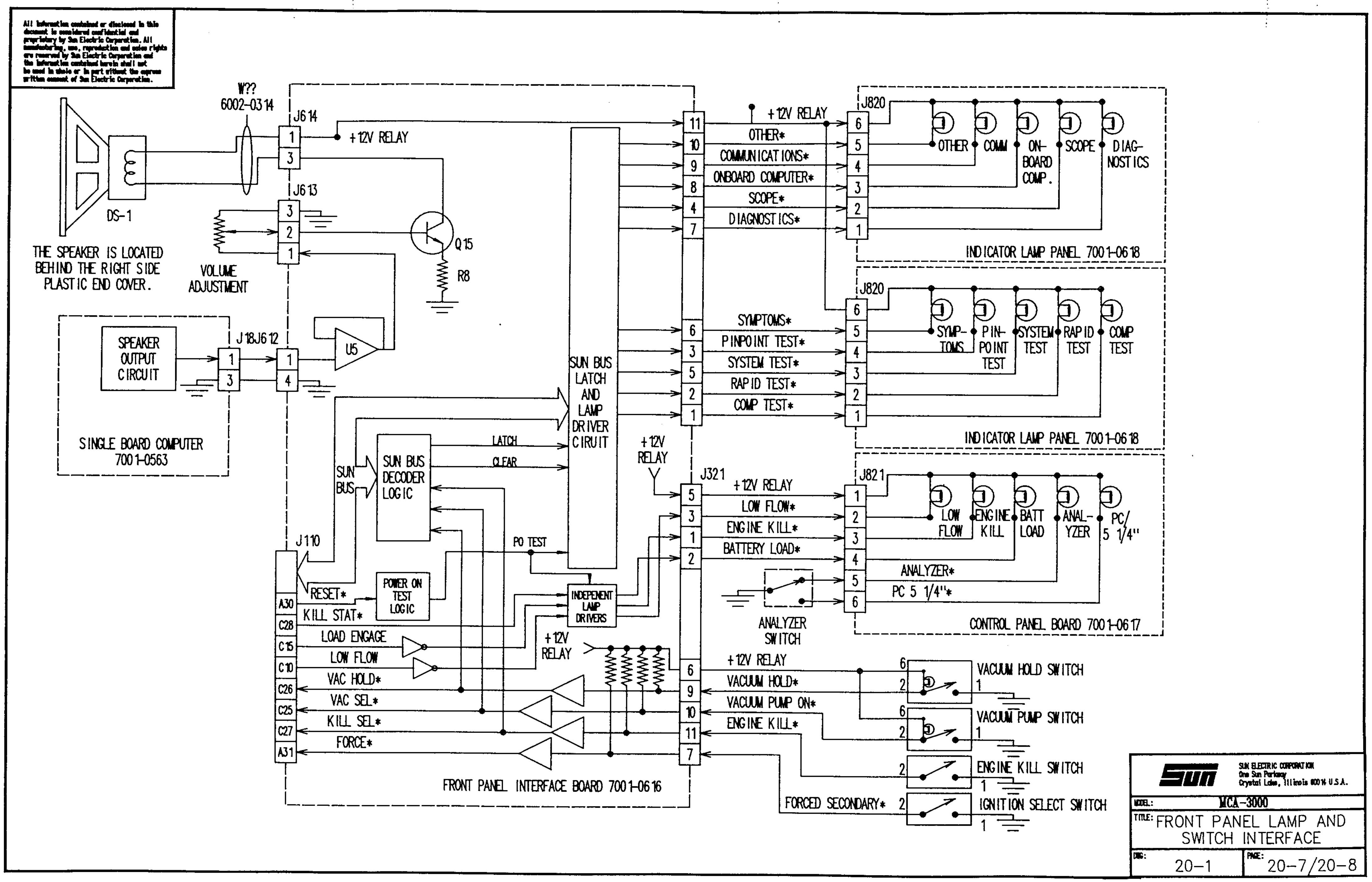
RESET Pushbutton. Momentary depression of this pushbutton switch forces the MCA's SBC to reset. This will cause a resetting of the MCA to its program starting location, thus causing the tester to reboot. For more information see Chapter 3.

SECTION II. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. Control panel and Indicator Lamp Panel lamps do not light for 4-5 seconds upon powering up Tester.	1. Verify SUN BUS power supplies +5V pin A1, +15V pin A2, -15V pin A3 12V RELAY pin A5, and pin A32 for GRD. This can be done using any J100 series connector on the SUN BUS. Are any supplies missing ? NO YES YES → Then refer to chapter 2 for information on troubleshooting the power supplies. NO → Ground pin A30 on the SUN BUS. Does the MCA now perform lamp power on test ? YES NO NO → Replace Front Panel Interface Board 7001-0616. YES → Replace Bus Driver Board, 7001-0559. 2. Refer to Theory of Operation and Functional Diagram of Functional Block Diagram 20-1.
II. Unable to adjust speaker audio level.	1. Shut off primary power to the MCA and check resistance across volume control VR1. Is reading 10K ohms ? YES NO NO → Replace VR1, 0685-0373. YES → Check resistance across speaker DS-1. Is ohm readings 8 ohms ? YES NO NO → Replace speaker DS-1, 0514-0305. YES → Replace Front Panel Interface Bd. 7001-0616 2. Refer to Theory of Operation and Functional Diagram of Functional Block Diagram 20-1.

COMPLAINT	CORRECTIVE ACTION
III. No speaker audio regardless of volume control setting.	1. Check wiring harnesses W50 between SBC J18 and Front Panel Interface Bd. J612, W48 between volume control VR-1 and Front Panel Interface Bd J613 and 6002-0344 between speaker DS-1 and Front Panel Interface Bd. J614. Are wiring harnesses connected and are good ? YES NO NO: Correct wiring harness fault. YES: Shut off primary power to the MCA and check resistance across volume control VR1. Is the ohm reading open ? NO YES YES: Replace volume control VR-1, 0685-0373 NO: ---SUBSTITUTE--- 1. Front Panel Interface Bd. 7001-0616. 2. SBC, 7001-0563. 3. Speaker DS-1, 0514-0305. 2. Refer to Theory of Operation and Functional Diagram of Functional Block Diagram 20-1.
IV. Control Panel and Indicator Lamp Panel lamps do not light under software control.	1. Power down the MCA then back up. Did the MCA perform a POWER-ON LAMP TEST ? YES NO NO: Check SUN BUS power supplies, +5V pin A1, +15V pin A2, -15V pin A3 12V RELAY pin A5, and pin A32 for GRD. This can be done using any J100 series connector on the SUN BUS. Are any supplies missing ? NO YES Then refer to chapter 2 for information on troubleshooting the power supplies. YES: Replace Front Panel Interface Bd. 7001-0616. 2. Refer to Theory of Operation and Functional Diagram of Functional Block Diagram 20-1.

NOTES



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W??
6002-0314
J614
+12V RELAY
J613
DS-1
Q15
R8
THE SPEAKER IS LOCATED BEHIND THE RIGHT SIDE PLASTIC END COVER.
VOLUME ADJUSTMENT
SPEAKER OUTPUT CIRCUIT
J18
J612
U5
SINGLE BOARD COMPUTER 7001-0563
SUN BUS LATCH AND LAMP DRIVER CIRUIT
SUN BUS
SUN BUS DECODER LOGIC
LATCH
CLEAR
PO TEST
J110
RESET*
KILL STAT*
POWER ON TEST LOGIC
INDEPENENT LAMP DRIVERS
LOAD ENGAGE
LOW FLOW
VAC HOLD*
VAC SEL*
KILL SEL*
FORCE*
A30
C28
C15
C10
C26
C25
C27
A31
+12V RELAY
FRONT PANEL INTERFACE BOARD 7001-0616
OTHER*
COMMUNICATIONS*
ONBOARD COMPUTER*
SCOPE*
DIAGNOSTICS*
J820
OTHER
COMM
ON-BOARD COMP.
SCOPE
DIAG-NOSTICS
INDICATOR LAMP PANEL 7001-0618
SYMPTOMS*
PINPOINT TEST*
SYSTEM TEST*
RAPID TEST*
COMP TEST*
SYMP-TOMS
PIN-POINT TEST
SYSTEM TEST
RAPID TEST
COMP TEST
INDICATOR LAMP PANEL 7001-0618
J321
LOW FLOW*
ENGINE KILL*
BATTERY LOAD*
J821
LOW FLOW
ENGINE KILL
BATT LOAD
ANAL-YZER
PC/ 5 1/4"
ANALYZER*
PC 5 1/4"*
ANALYZER SWITCH
CONTROL PANEL BOARD 7001-0617
VACUUM HOLD*
VACUUM PUMP ON*
ENGINE KILL*
FORCED SECONDARY*
VACUUM HOLD SWITCH
VACUUM PUMP SWITCH
ENGINE KILL SWITCH
IGNITION SELECT SWITCH
SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.
MODEL: MCA-3000
TITLE: FRONT PANEL LAMP AND SWITCH INTERFACE
DWG: 20-1
PAGE: 20-7/20-8

CHAPTER 21

PARTS

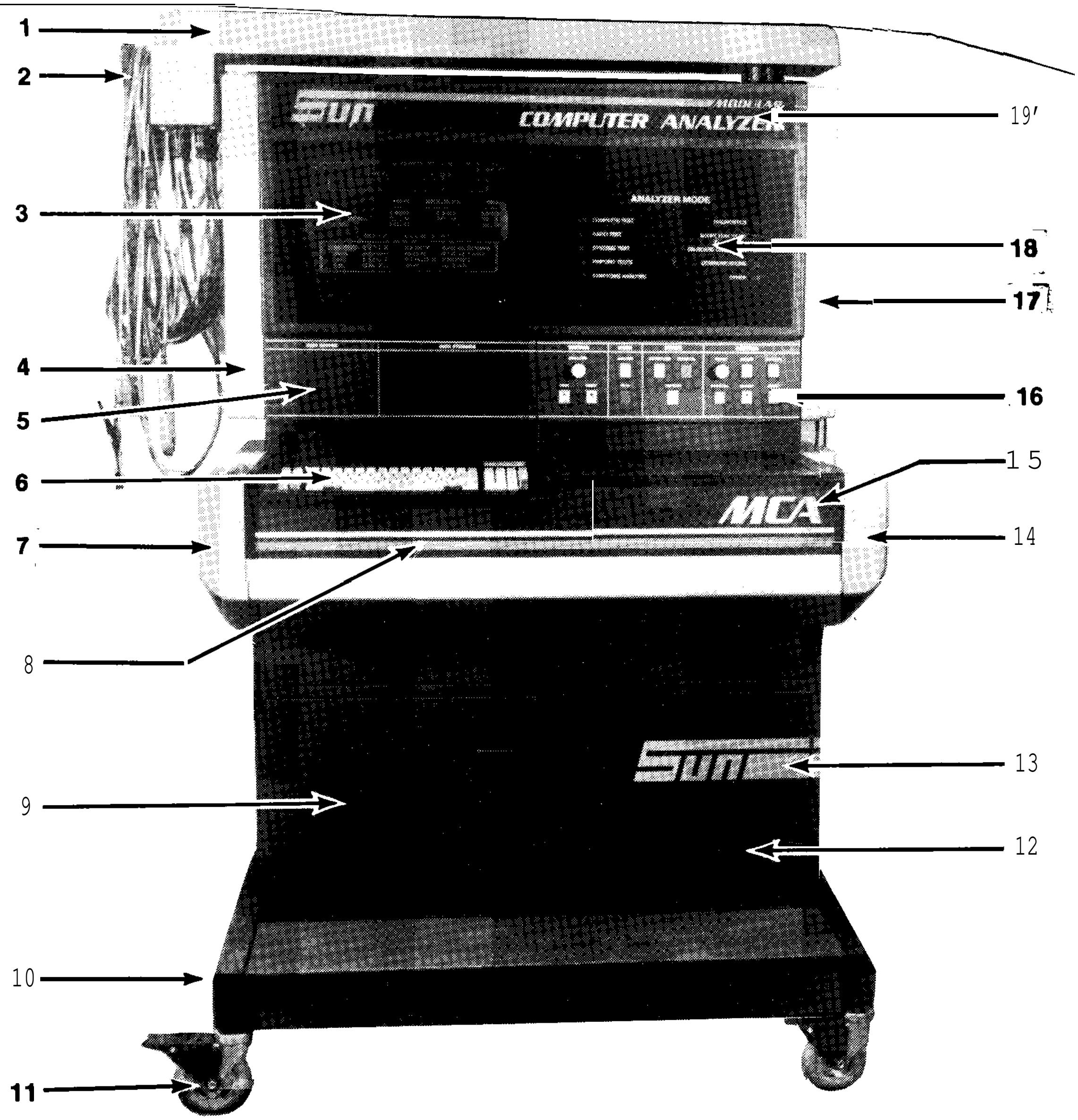
The parts chapter is divided into two sections. The first lists the parts by pictorial and the second lists the parts by description. Both sections contain the same information. They are presented in different formats to allow quick and accurate identification of the desired part.

Table of Contents

Pictorial Views

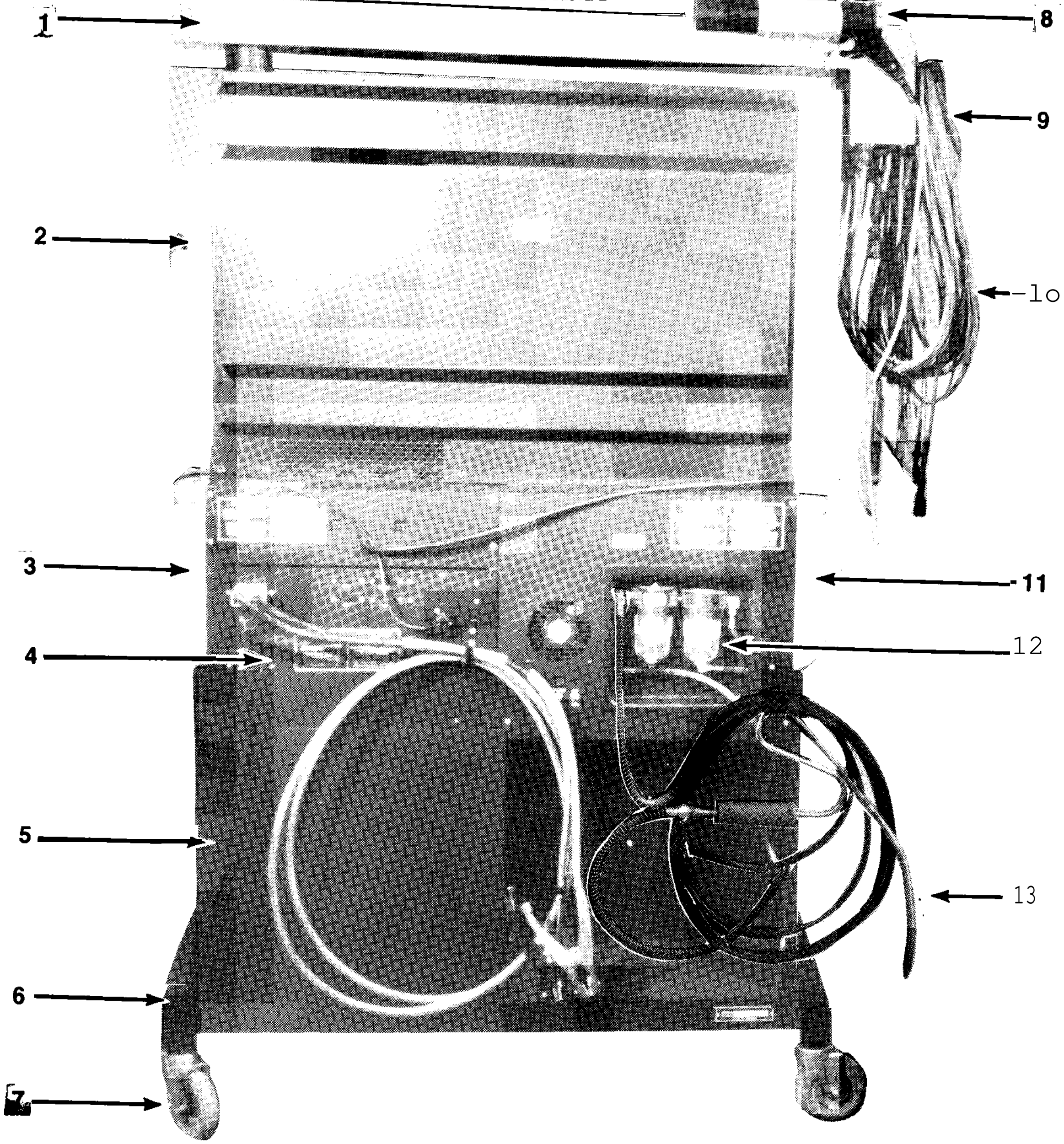
PARTS BY CATEGORY

FRONT VIEW PARTS DIAGRAM



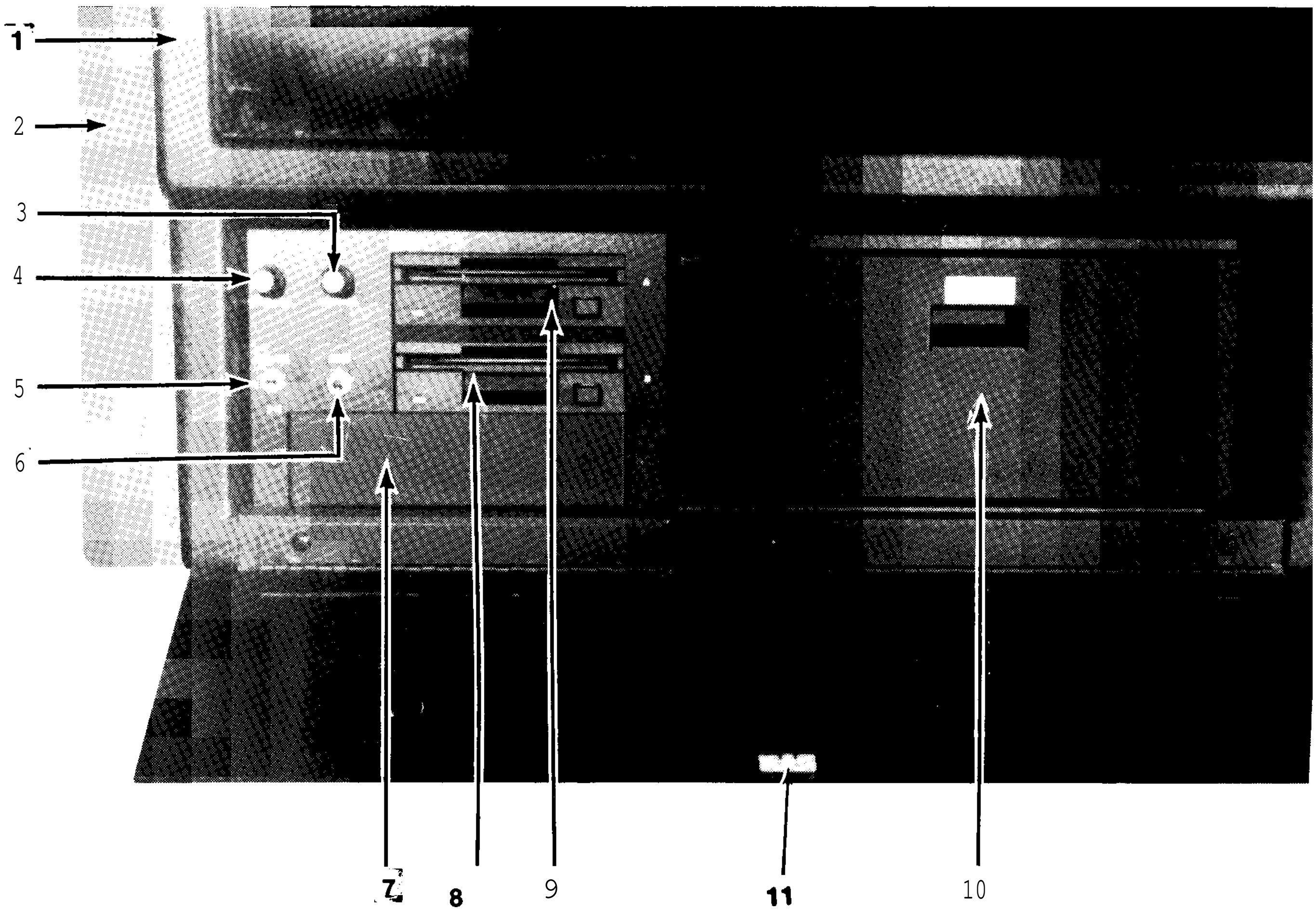
1.	Boom Weld Assy	See Pg 21-3
2.	Cable Manag. Cover..	7054-0106
	Connector Plate	7003-0572
3.	Monitor Color	0859-0409
	Filter Plexiglass...	7030-0163
4.	L.H. Upper Cover	7054-0090
5.	Door, Disk Drive	7009-1917
	Latch Set	5666-0032
6.	Keyboard Ashy	0552-0030
7.	L.H. Lower Cover	7054-0092
8.	Front Trim Panel	7054-0096
	Label, Front Panel..	0682-0715
9.	C39 L.H. Door	7020-1821-01
10.	Cabinet Weld Assy...	7020-1820
11.	Caster with brake...	3645-0042-02
	Caster W/O brake	3645-0042-01
12.	R.H. Door Assy	7020-1821-02
13.	Sun Label	0753-0137-01
14.	R.H. Lower Cover	7054-0093
15.	Label, Front Panel..	0682-0715
16.	Control Panel	7005-2232
	On/Off SW1	0764-0228
	Trigger SW5	0764-0226
	Headsign SW2 11OV..	0764-0229
	I.R. Pump SW3 11OV.	0764-0231
	Kill SW4	0764-0227
	Vac ON/OFF SW6	0764-0233
	Vac Hold SW7	0764-0233
	Vac Regulator	7009-1430
	Washer, Vac Reg...	0400-0601
	Knob, Vac Reg	0758-0189
	Cap, Vac Reg	0758-0190
	Volume Control Pot.	0685-0373
	Knob Vol Control..	0758-0189
	Cap Knob Vol Ctrl.	0758-0190
17.	R.H. Upper Cover...	7054-0091
18.	Filter Plexiglas. . .	7030-0163
19.	Headsign	7030-0164
	Retainer, Headsign.	7054-0100
	Fluorescent Lamp...	0848-0904

REAR VIEW PARTS



1.	Boom Weld **Assy**	7020-1873
	Input Filter PCB...	7001-0549
	Circuit Breaker CB2	1922-0106-21
	Circuit Breaker CB5	1922-0112-11
	Boom Cover	7054-0104
	Cover, Cable Manag.	7054-0106
2.	**R.H.** Top Cover **Assy**	7054-0091
3.	**R.H.** Lower cover...	7054-0093
4.	Label, Safety	0682-0724
5.	Battery Load Lead..	6005-0174
6.	C39-G	7010-0719
	Cabinet Weld **Assy..**	7020-1820
	Left Door **Assy**	7020-1821-01
	Right Door **Assy**	7020-1821-02
	R.H. Door Bracket..	7012-1058-01
	L.h. Door Bracket..	7012-1058-02
	Magnetic Catch	0865-0109
	Graphic Label . . .	0753-0137-01
7.	Caster W/O Lock	3645-0042-01
	Caster With Lock...	3645-0042-02
8.	Timing Light	7009-1374-02
	Timing Light PCB...	7001-0117
	Timing Light Cable.	6004-0518
9.	Cover, Cable	7054-0106
10.	Mag Timing Probe...	7009-1576
	Volt/Ohm/Dwell Lead	6004-0520
	Trigger Lead	6004-0262
	Pattern Lead	6004-0496
	Universal Lead	6005-0173
	Temperature Lead...	6004-0407
	Ammeter Lead	6005-0171
	Vacuum Hose	6006-0003
11.	**L.H.** Lower Cover...	7054-0092
12.	See **I.R.** Parts Picture	
13.	Exhaust Probe	7009-1869
	Exhaust Probe A.D..	7009-1506

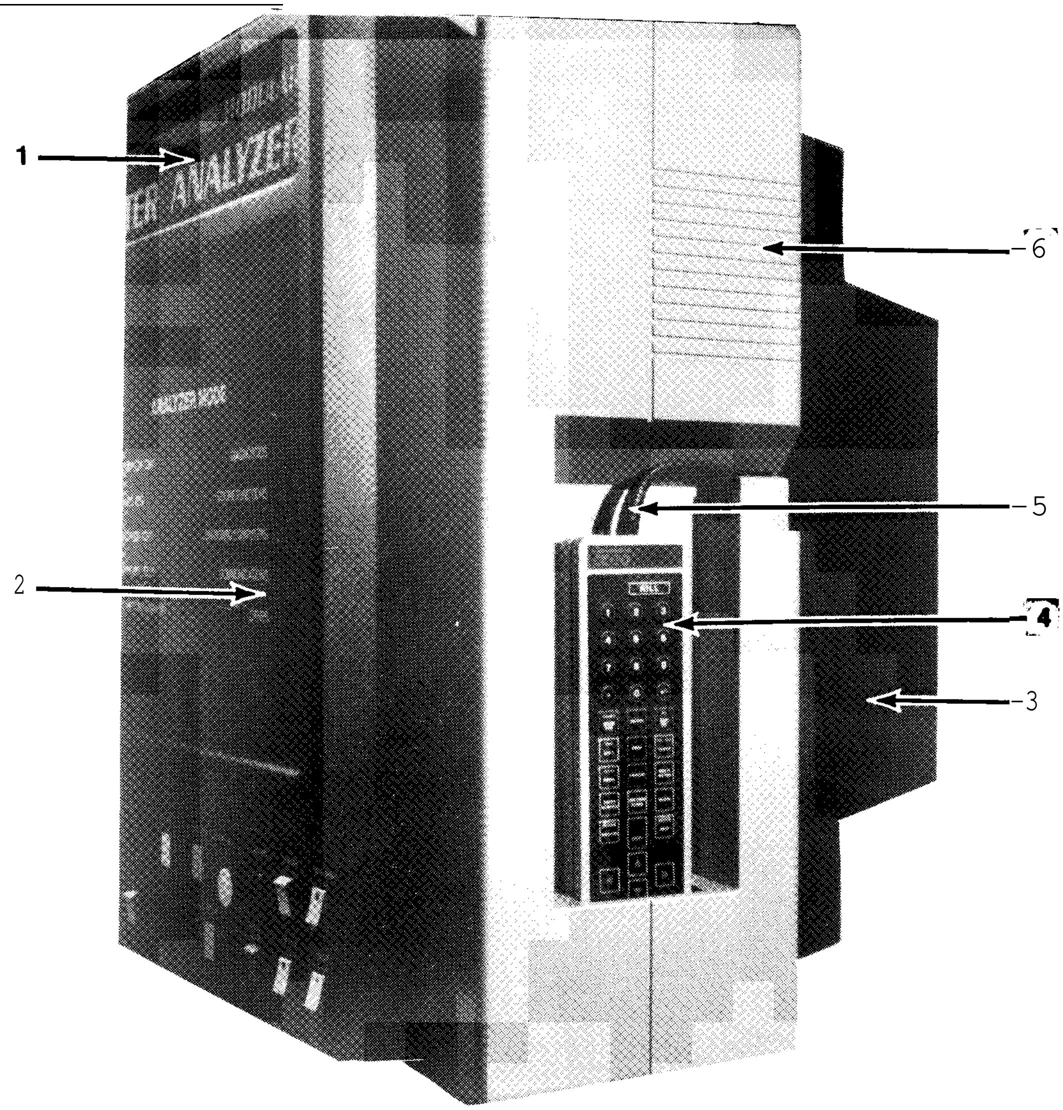
DISK DRIVE AREA PARTS



1. Front Panel 7054-0101
2. L.H. Upper Cover... 7054-0090
3. Contrast Knob . . . . -
4. Brightness Knob . . . . . -
5. PC/5 1/4 SW 0689-0114
6. Reset SW 0799-0233
7. Plate, Blank Cover. 7003-0573

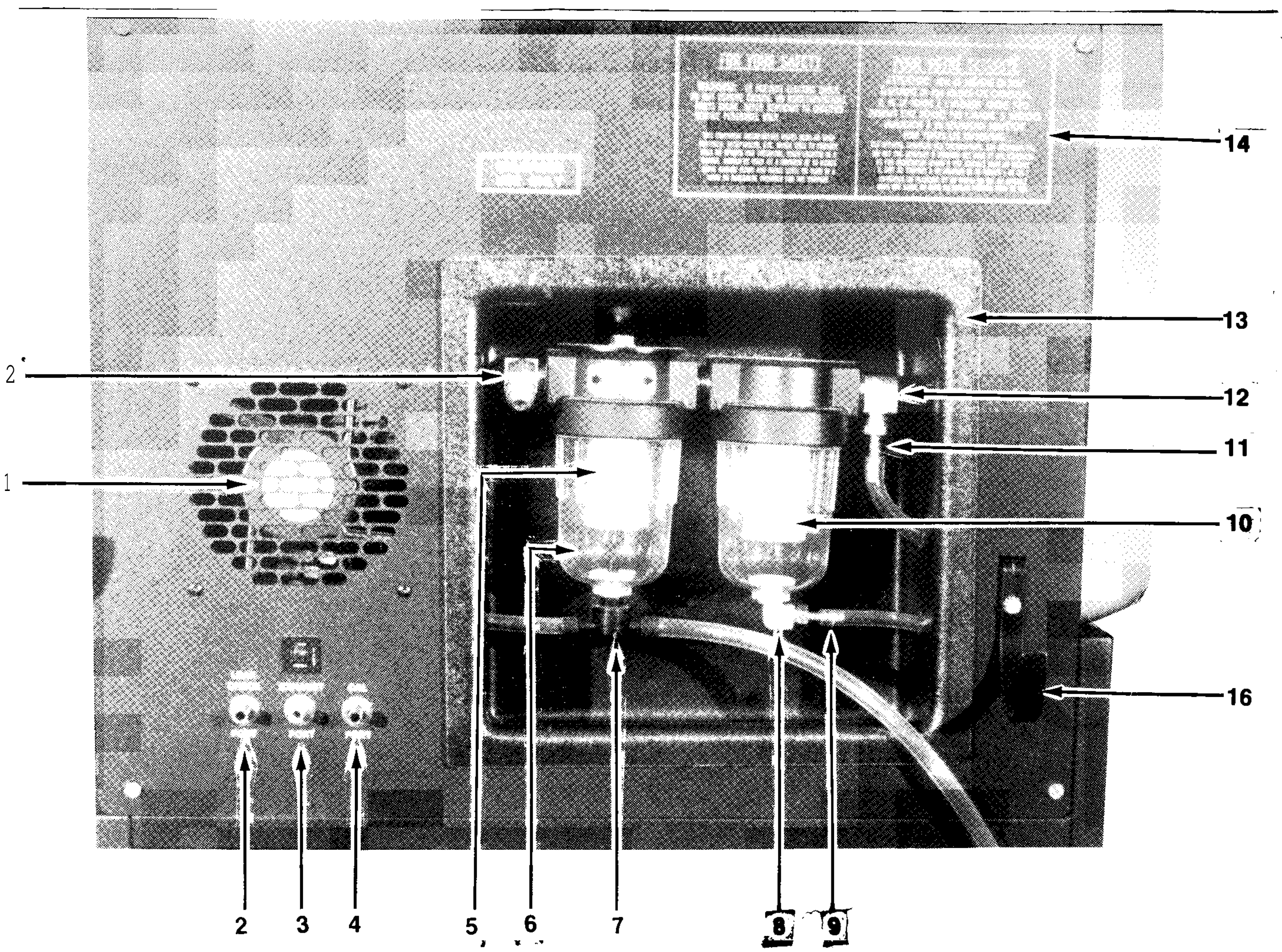
8. Disk DriveB: 0552-0024-01
9. Disk Drive A: 0552-0024-01
10. Drawer Ashy 7009-1901
    Drawer Weld Ass 7020-1842
    Rubber Malt 7019-0065
    Partition 7005-2253
    Slide 0109-0010
    Disk Divider 0621-0218
11. Latch Set 5666-0032

RIGHT SIDE PARTS



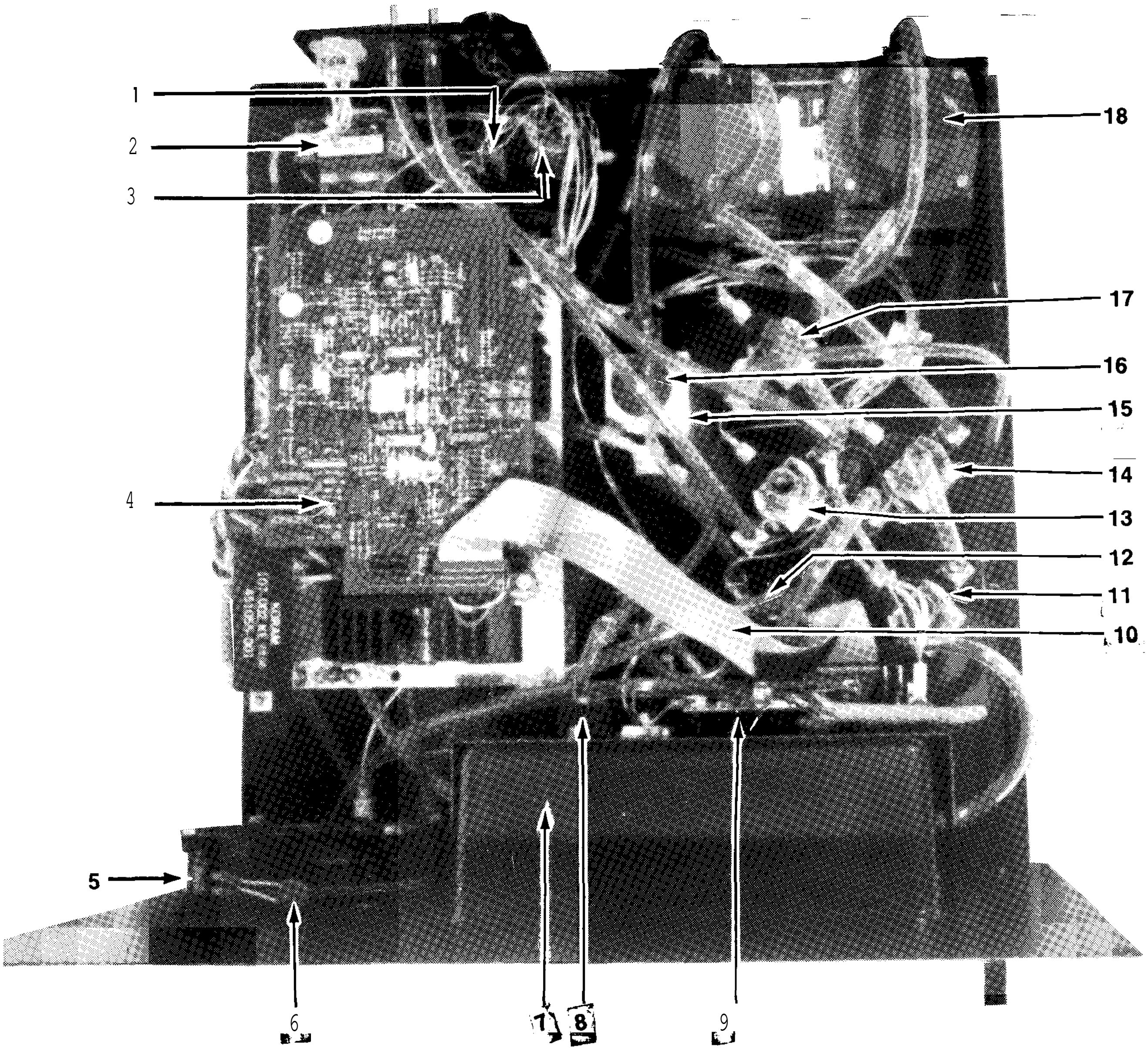
1. Headsign 7030-0164
   Headsign Retainer.. 7054-0100
2. Filter Plexiglass.. 7030-0163
3. Rear Cover 7054-0105
4. Remote Control Asm. 7009-1921-02
   Sun Logo label 0682-0701
   Case Front 7054-0102
   Case Back 7054-0103
   Keypad 0552-0031
   Remote PCB 7001-0546
   Magnet 2" X 2"..... 0865-0112
5. Cable, Remote 6004-0517
6. R.H. Upper Cover... 7045-0091

FILTER DRAWER COVER PARTS



1. Fan Axial 11OV 0587-0504
   " " 220V 0587-0507-01
2. Nipple, Hose 2209-0001
   Washer Flat 3/8''... 0400-0004
   Lockwasher 3/8'' 0602-0035
   Nut , Hex 3/8'' 0409-0020
3. Nipple, Exhaust 7016-0005
   Nut, Hex 7/16'' 0407-0216
4. Same as Item 2
5. Filter 75 Micron... 0301-0926
6. Bowl 0301-0931
7. Aspirator .0.. .00.. . 7009-0728
8. Adapter, Elbow 0647-0044
9. Adapter, Pipe to Hose 3/16" 0647-0069
10. Filter 8 Micron 0301-0908
11. Adapter Pipe to Hose 1/4" 0647-0146
12. Adapter, Elbow 0647-0083
13. Panel Recessed 7005-2023-03
14. I.R. Weld assy 7020-1819
    Label, Safety 0682-0724

1. R. DRAWER PARTS

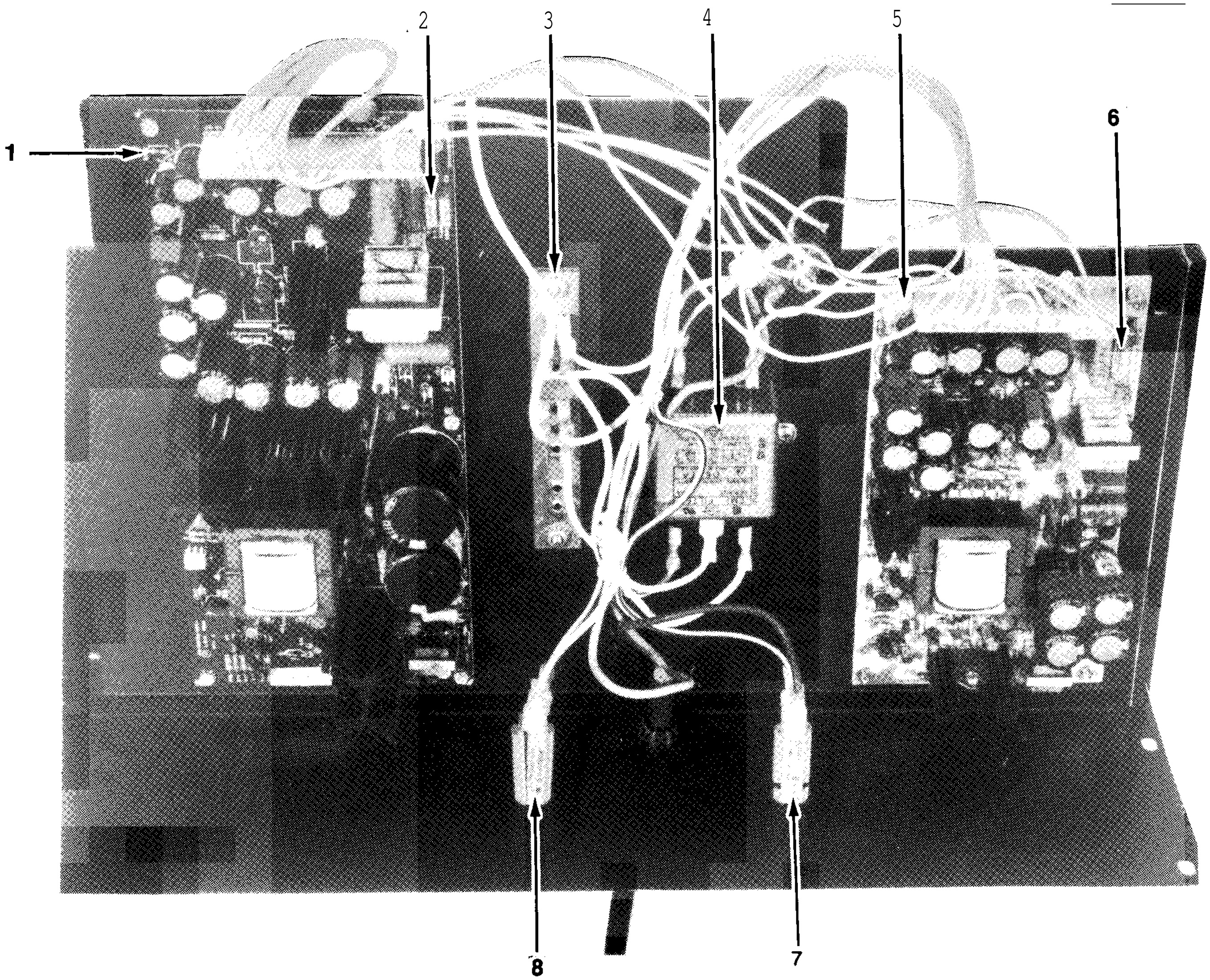


1. Bridge Rectifier . . . 0771-0412
2. Transformer T1 0778-0476
3. Capacitor 8000 **Mfd.** 0679-0541
   Bracket, Cap Mount. 0679-0904
4. **I.R.** Bench Andros.. 7049-0114-01
   Flexible Mount 0561-0139
5. Axial Fan 110V 0587-0504
   " " **220V.....** 0587-0507-01
6. Varistor 110V 0749-0207
   " 220V 0749-0214
7. Panel Recessed 7005-2023-03
8. Pressure Transducer 7009-1910
9. Solenoid Driver **PCB** 7001-0560
10. **I.R.** Cable 6004-0505
11. Solenoid Vi 0304-0040
    Diode Ashy 7009-1486-03
12. Low **FLow** SW 0549-0019-02
13. Solenoid **V5** 0304-0040
14. Solenoid **V2** 0304-0039
15. Block 02 Mount 7002-0207
16. 02 Sensor 7049-0004
17. Solenoid **V4** 0304-0040
18. Vacuum Pump 110V... 0303-0093
    " " 220V... 0303-0099
    Connector Body 2Pin 4162-0307
    Contact Socket 4162-0557

PARTS NOT SHOWN

Hose 3/16″ I.D 0669-0229
Hose 1/4″ I.D 0669-0220
Hose Tee 0647-0107
Restrictor Pressure Transducer
. . . . 3841-0101-02
Restrictor Low Flow
. .. . 3841-0101-06

POWER SUPPLY DRAWER PARTS

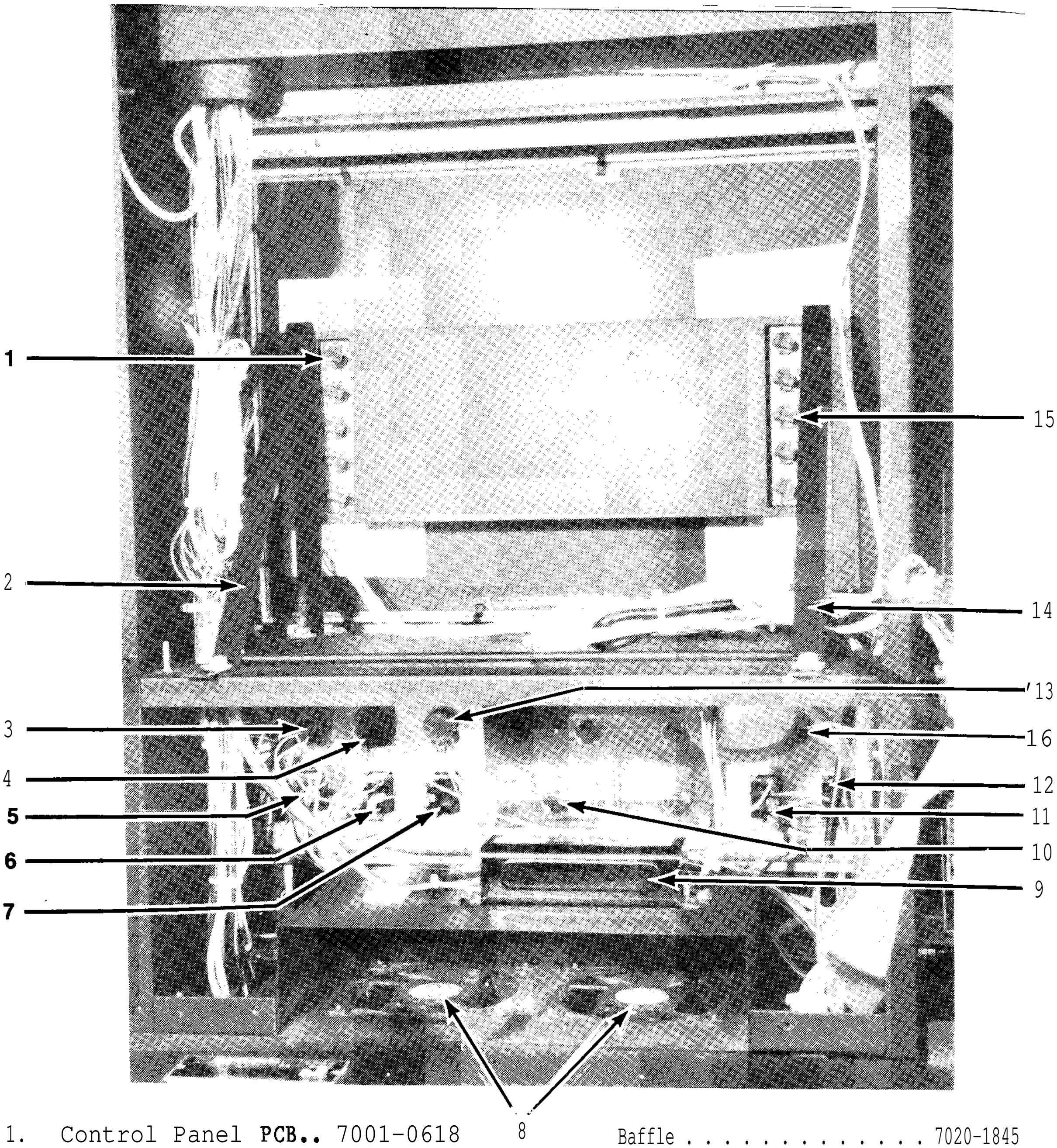


1. Power Supply #1 0532-0018
2. Fuse 5A 110V Line. 0739-0055
3. Terminal Strip TB1. 7008-0318
   Insulator Strip 7031-0180
4. EMI Filter **FL1** 0531-0003
5. Power Supply #2 0532-0017
6. Fuse 3A 110V Line. 0739-0026
   "1.5A 220V Line. 0739-0095
7. CB1 10A 110V Line.. 1922-0112-13
   " 5A 220V Line.. 1922-0112-08
8. CB2 3A 110V Line... 1922-0112-06
   " 2A 220V Line... 1922-0112-05

PARTS NOT SHOWN

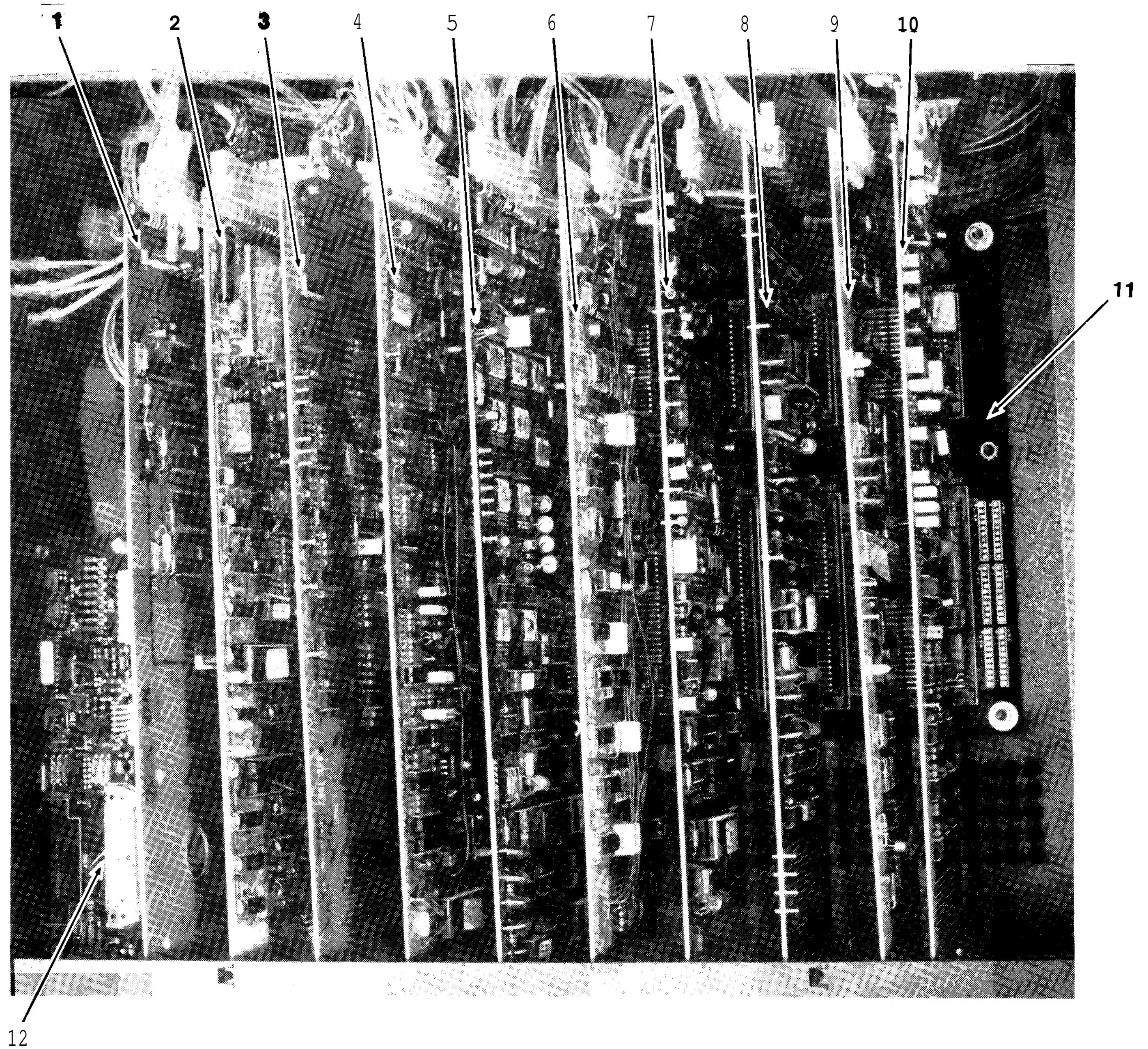
P.S. Drawer Weld Assy.. 7020-1834
Slide, Drawer 7024-0462
A.C. Power Cable 110V.. 6001-0177
" " " 220V. . 6001-0178
Bushing, Power Cable... 2035-0008
Replacement **A.C.** Plug... 0528-0020

REAR CONTROL PANEL PARTS



1. Control Panel **PCB..** 7001-0618
   Lamp 0910-0056
   Socket 0909-0045
   Baffle 7020-1841
2. Indicator Weld Asm. 7020-1840
3. Headsign SW2 110V.. 0764-0229
4. Trigger **SW5** 0764-0226
5. On/Off **SW1** 0764-0228
6. **I.R.** Pump SW3 110V. 0764-0231
7. Engine Kill **SW4** 0764-0227
8. Axial Fan 110V 0587-0504
9. Ballast 110V 0848-0901
10. Control Panel **PCB..** 7001-0617
    Lamp 0910-0056
    Socket 0909-0045
    Baffle 7020-1845
11. Vac On/Off **SW6** 0764-0233
12. Vac Hold **SW7** 0764-0233
13. Volume Pot 10K 0685-0373
    Knob 0758-0189
    Cap, Knob 0758-0190
14. Indicator Weld Asm. 7020-1840
15. Control Panel **PCB..** 7001-0618
    Lamp 0910-0056
    Socket 0909-0045
    Baffle 7020-1841
16. Vac Regulator 7009-1430
    Washer, Vac Reg... 0400-0601
    Knob, Vac Reg 0758-0189
    Cap, Vac Reg 0758-0190

SUN BUS MODULE



1. Front Panel Int. PCB.. 7001-0616
2. ALDL PUB 7001-0543-01
3. I.R. Interface PCB 7001-0557
4. Primary Trigger PCB... 7001-0544
5. RPM/Dwell/Timing PCB.. 7001-0553
6. Secondary Trigger PCB. 7001-0551
7. Multimeter PUB 7001-0550
8. DAS A/D PUB 7001-0555
9. BUS Driver PUB 7001-0559
10. VAT PUB 7001-0552
11. SUN BUS Backplane PCB. 7001-0547
12.* Remote Arbitrator PCB. 7001-0545

* NOT PART OF THE SUN BUS

DESCRIPTION	PART NUMBER	QTY .	COMMENTS
ACCESSORIES			
ALDL LEADS & DISK & MCA DISKS	0120-0517	1	
ALDL CABLE GM 5 PIN	6004-0417	1	
ALDL CABLE CHRYSLER	6004-0442	1	
ALDL CABLE FORD	6004-0443	1	
ALDL CABLE GM 12 PIN	6004-0522	1	
ALDL ADAPTER GM BICOM	6004-0525	1	
ALDL ADAPTER CHRYSLER BICOM	6004-0524	1	
DISK DIVIDERS	0621-0218	10	
DISK KIT MCA MASTER PROGRAM	7009-1944A20	1	
DISK KIT MCA LIMITS DIAG.	7009-1944A21	1	
DISK KIT MCA STORAGE	7009-1944A01	1	
DISK MCA ALDL GM MONITOR	7009-1944A19	1	
DISK MCA ALDL FORD MONITOR	7009-1944A18	1	
COMMUNICATIONS KIT	0120-0520	OPTIONAL EQUIPMENT	
MODEM PCB	0552-0047	1	
PHONE JACK CONNECTOR	4162-0496	1	
CABLE ASSY, MODEM	6004-0536	1	MODEM TO JAC CON
CABLE ASSY, PHONE	6004-0484	1	JAC TO WALL JAC
PLATE JAC MOUNT	7003-0590	1	
DISK, COMMUNICATIONS	0552-0938-23	1	
IBM DOS PACKAGE	0552-0050	1	
MOUNT, CABLE TIE	5878-0902	1	
CABLE TIE SMALL	5878-0015	1	
GAS CALIBRATION KIT	0120-0522	OPTIONAL	
GAS REGULATOR	0131-0024	1	
ADAPTER, PIPE TO HOSE	0647-0070	1	
HOSE, 1/4" ID POLY.	0669-0220	18"	
CAL GAS TANK	0271-0041	1	SUPPLIED LOCALLY
UNIT ACCESSORIES			
REMOTE CONTROL ASSY	7009-1921-02	1	MCA-3000-G
SUN LOGO LABEL	0628-0701	1	MCA-3000-1
MAG TIMING PROBE ASSY	7009-1576	1	
TIMING LIGHT ASSY	7009-1374-02	1	
EXHAUST PROBE ASSY	7009-1869	1	
LEAK ADAPTER ASSY	7009-1700	1	
EXHAUST PROBE UNDILUTED ASSY	7009-1506	1	
LEAK ADAPTER UNDILUTED	7009-1730	1	
EXHAUST HOSE	3988-0216	1	
PRINTER POWER CABLE	0662-0230	1	
PRINTER DATA CABLE	6004-0506	1	
VOLT/OHM/DWELL TEST LEAD	6004-0520	1	
TRIGGER LEAD	6004-0262	1	
TEMPERATURE TEST LEAD	6004-0407	1	
PATTERN LEAD ASSY	6004-0496	1	
BATTERY LOAD LEAD ASSY	6005-0174	1	

DESCRIPTION	PART NUMBER	QTY .	COMMENTS
UNIT ACCESSORIES CONTINUED			
UNIVERSAL LEAD ASSY	6005-0173	1	
AMMETER LEAD ASSY	6005-0171	1	
VACUUM HOSE ASSY	6006-0003	1	
TEE, HOSE	0647-0170	1	
HANGER	2161-0023	2	
PATTERN PICKUP	1747-0101	1	CHROME CLAMP
TRIGGER PICKUP	0507-0006	1	RED CLAMP
HEI PICKUP	1747-0102	1	
JUMPER LEAD ASSY	6002-0346	1	
MAG TIMING ADAPTER FORD	7054-0056	1	
MAG TIMING ADAPTER CHRYSLER	7054-0057	1	
MAG TIMING ADAP. FORD 2300	7054-0060	1	
MAG TIMING ADAP. CHRY 1977	7054-0062	1	
HOSE, POLY 1/4″ ID	0669-0220	32"	
HOSE, RUBBER	0669-0623	1	
HOSE, RUBBER	0669-0733	1	
HOSE, RUBBER	0669-0734	1	
COIL TERMINAL ADAPTER	0552-0043	1	
GM EXT. COIL ADAPTER	0552-0044	1	
GM MICROPAC COIL ADAPTER	0552-0045	1	
SIDE TERMINAL CHRG,BOOST	0552-0046	1	
FILTER 8 MICRON	0301-0908	1	
FILTER 75 MICRON	0301-0926	1	
BANNER	0693-1339	1	
BOOM ASSY.			
WELD ASSY BOOM	7020-1843	1	
CONNECTOR PLATE	7003-0572	1	
COVER, BOOM	7054-0104	1	
COVER CABLE MANAGEMENT	7054-0106	1	
FILTER, INPUT PCB	7001-0549	1	
CB2 MAIN GROUND C. B.	1922-0106-21	1	
CB1 PINPOINT AMPS	1922-0112-11	1	
VACUUM HOSE, LONG	0669-0229	107″	
VACUUM HOSE, SHORT	0669-0007	5"	
TEE, HOSE	2209-0002	1	
COMPUTER MODULE ASSY.			
WELD ASSY. COMPUTER MODULE	7020-1830	1	
SLIDE, COMPUTER MODULE	7024-0458	2	
BRACKET PCB	7012-1142	1	
GUIDE PC BOARD	5398-0613	9	
PCB SUPPORT	7012-1090	1	
HOUSING PCB	7004-0396	1	
CPU PCB	7001-0563	1	SBC
PCB STANDOFF	0429-0038-02	9	
VIDEO PCB, EGA	7001-0562	1	EGA COLOR PCB
1/0 EEPROM CLOCK PCB	7001-0558	1	
DAS MEMORY	7001-0593	1	

DESCRIPTION	PART NUMBER	QTY.	COMMENTS
BATTERY LOAD ASSY.	7009-1896	1	
BATTERY LOAD DRIVER PCB	7001-0602	1	
RELAY K1 25A	0783-0326	1	
RELAY K2 80A	0783-0324	1	
K1 DIODE ASSY.	7009-1486-01	1	SURGE SUPPRESSION
K2 DIODE ASSY.	7009-1486-02	1	SURGE SUPPRESSION
R1-R5 0.6 OHM	0684-0662-01	5	WIRE RESISTOR
SHUNT RESISTOR R6	0744-0120	1	PART OF W36
BUSS BAR B1 5 POS.	7024-0455-02	1	UPPER BAR
BUSS BAR B2 2 POS.	7024-0455-01	1	LOWER BAR
BATTERY LOAD CONNECTOR	4162-0475	1	J811
CONTACT PIN	4162-0635	2	J811
REDUCING BUSHING	4162-0643	2	J811
COVER BATTERY LOAD	7014-0177	1	
CONTROL PANEL ASSY.			
PANEL, CONTROL	7005-2232	1	
LIGHT BAFFLE WELD ASSY.	7020-1845	1	
CONTROL PANEL CCA.	7001-0617	1	
BULB SOCKET	0909-0045	5	
LAMP	0910-0056	5	
On/Off SW1	0764-0228	1	
HEADSIGN SW2 110V	0764-0229	1	
" " 220V	0764-0230		
I.R. PUMP SW3 110V	0764-0231	1	
" " " 220V	0764-0232		
KILL SW4	0764-0227	1	
TRIGGER SW5	0764-0226	1	
VAC ON/OFF SW6	0764-0233	1	
VAC HOLD SW7	0764-0233	1	
VAC REGULATOR	7009-1430	1	
WASHER, VAC REG.	0400-0601	1	
KNOB, VAC REG.	0758-0189	1	
CAP, VAC REG.	0758-0190	1	
VOLUME CONTROL POT	0685-0373	1	
KNOB VOL CONTROL	0758-0189	1	
CAP KNOB VOL CTRL.	0758-0190	1	
DISK DRIVE ASSY.			
WELD ASSY. DISK DRIVE	7024-1839	1	
DISK DRIVE	0552-0024-01	2	MUST SET A OR B
FOAM TAPE	7020-0502	9"	BETWEEN DRIVES
DRIVE MOUNT BRACKET	7012-1093	2	
COVER PLATE 5 1/4 DISK	7003-0573	1	
RESET SWITCH	0779-0233	1	
ANALYZER / PC 5 1/4 SW.8	0689-0114	1	OPTIONAL USE

DESCRIPTION	PART NUMBER	QTY .	COMMENTS
DISK STORAGE ASSY.			
DISK STORAGE WELD ASSY.	7020-1842	1	
SLIDE, DRAWER	0109-0010	2	
RUBBER MAT	7019-0065-10	2	
PARTITION, STORAGE DRAWER	7005-2253	1	
DRAWER MOUNT	7005-2220	1	
EXHAUST ANALYZER ASSY.			
WELD ASSY IR SHELF	7020-1819	1	
SLIDE, IR SUPPORT	7024-0440	2	
SLIDE, STOP	7012-1053	1	
MOUNT, FILTER ASSY	7012-0844	1	MAIN FILTER
MOUNT, SWITCH LOW FLOW	7012-0808	1	
PUMP, VACUUM 110V	0303-0093	1	
" " 220V	0303-0099		
Connector Body 2 Pin	4162-0307	1	PUMP CONNECTOR
Contact Socket	4162-0557	2	FOR ABOVE
TRANSDUCER ASSY.	7009-1910	1	PRESSURE TRANS.
FILTER ASSY.	7009-1895	1	
FILTER ASSY 75 MICRON	0301-0128	1	
BOWL	0301-0931	1	
HEAD SEAL O RING	0617-0199	1	
CENTER POST	0301-0932	1	
SHROUD	0301-0933	1	
WING NUT	0301-0940	1	
FILTER ELEMENT 75 MIC.	0301-0926	1	
FILTER ASSY 8 MICRON	0301-0123-02	1	
BOWL	0301-0931	1	
HEAD SEAL O RING	0617-0199	1	
CENTER POST	0301-0932	1	
WING NUT	0301-0940	1	
CAP END	0301-0934	1	
PLUG, BOTTOM	0647-0138	1	
FILTER ELEMENT 8 MIC.	0301-0908	1	
NIPPLE CLOSE 1/4 NPT	4982-0306	1	
ASPIRATOR ASSY	7009-0728	1	
ELBOW ADAPTER 90 DEGREE	0647-0083	2	BRASS FITTINGS
ELBOW ADAPTER	0647-0044	1	PLASTIC
ADAPTER PIPE TO HOSE	0647-0146	1	1/4" HOSE
ADAPTER PIPE TO HOSE	0647-0069	1	3/16" HOSE
ELBOW PIPE TO TUBE	0647-0137	1	BRASS
TEFLON TAPE	0682-0246		
PRESSURE SWITCH	0549-0019-02	1	LOW FLOW SWITCH
OXYGEN SENSOR	7049-0004	1	
BLOCK, 02 SENSOR	7002-0207	1	
IR BENCH	7049-0114-01	1	ANDROS BENCH
MOUNT, RESILIENT	0561-0139	4	
LABEL, CORRELATION	4600-0183	1	
SOLENOID DRIVER PCB	7001-0560		
VALVE, SOLENOID V3	0304-0039	1	
VALVE, SOLENOID v1,2,4,5	0304-0040	4	
DIODE ASSY	7009-1486-03	5	SURGE SUPPRESSION

DESCRIPTION	PART NUMBER	QTY .	COMMENTS
EXHAUST ANALYZER CONTINUED			
FAN, AXIAL 110V	0587-0504	1	
" " 220V	0587-0507-01		
VARISTOR 110V	0749-0207	1	
" 220V	0749-0214		
CAUTION, FAN LABEL	0682-0294	1	
EM1 FILTER FL2	0531-0003	1	110V
RECTIFIER BRIDGE	0771-0412	1	
TRANSFORMER T1	0778-0476	1	
CAPACITOR, FILTER C1	0679-0541	1	8000 MFD. 30V
CAP. BRACKET	0679-0904	1	
CIRCUIT BREAKER CB3	1922-0112-05	1	
PANEL, RECESSED FILTER	7005-2023-03	1	
HOSE, 1/4″ I.D.	0669-0220	122″	
HOSE, 3/16″ I.D.	0669-0229	74 1/2″	
HOSE, 5/16″ I.D.	0669-0231	11"	
HOSE, TEE	0647-0107	1	
RESTRICTOR, FLOW	3841-0101-02	1	PRESSURE TRANS
RESTRICTOR, FLOW	3841-0101-06	1	LOW FLOW SWITCH
VALVE, CHECK	4015-0022	1	
FINAL ASSEMBLY			
WELD ASSY, BASE	7020-1832	1	
WELD ASSY, HEADFRAME	7020-1844	1	
WELD ASSY, KEYBOARD BRACKET	7020-1828	1	LEFT
WELD ASSY, KEYBOARD BRACKET	7020-1829	1	RIGHT
WRITING SURFACE COVER	7054-0094	1	TOP PLASTIC
WRITING SURFACE PLATE	7003-0568	1	METAL SUPPORT
COVER, UPPER LEFT	7054-0090	1	
COVER, UPPER RIGHT	7054-0091	1	
COVER, LOWER LEFT	7054-0092	1	
COVER, LOWER RIGHT	7054-0093	1	
EXTRUSION FRONT	7054-0097	1	WRITING SURFACE
EXTRUSION RIGHT	7054-0098	1	TRIM ON RIGHT
EXTRUSION LEFT	7054-0099	1	TRIM ON LEFT
HANDLE	7024-0450	2	
PIN, HANDLE	7024-0461	4	
BRACKET, ARBITRATOR MT.	7012-1070	1	
ARBITRATOR PCB	7001-0545	1	
BRACKET, PCB STABILIZER	7012-1048	1	SUN BUS CARD SUP
FAN, AXIAL 110V	0587-0504	2	ABOVE POWER SUP.
" " 220V	0587-0507-01		
FILTER AIR	0301-0131	2	FOAM FILTER
SPEAKER, DS1	0514-0305	1	RIGHT SIDE MOUNT
MONITOR 19″ COLOR	0859-0409	1	
FRONT PANEL ASSY.	7054-0101	1	
DISK DRIVE DOOR ASSY	7009-1917	1	
PLEXIGLASS FILTER	7030-0163	1	
HEADSIGN SUN MCA-3000	7030-0164	1	
RETAINER, TINNERMAN	7054-0100	12	

DESCRIPTION	PART NUMBER	QTY .	COMMENTS
FINAL ASSY. CONTINUED			
FOAM TAPE	0861-0152	6"	
RTV ADHESIVE	0621-0573		
INDICATOR PANEL ASSY.			
INDICATOR PANEL WELD ASSY	7020-1840	1	
LIGHT BAFFLE	7020-1841	2	
INDICATOR LAMP CCA.	7001-0618	2	
BULB SOCKET	0909-0045	5	
LAMP	0910-0056	5	
POWER SUPPLY ASSY.			
WELD ASSEMBLY, POWER SUPPLY	7020-1834	1	
SLIDE, POWER SUPPLY	7024-0462	2	
POWER SUPPLY 85 WATTS	0532-0017	1	SUN BUS SUPPLY
POWER SUPPLY 125 WATTS	0532-0018	1	COMPUTER SUPPLY
CIRCUIT BREAKER CB1 10A	1922-0112-13	1	
CIRCUIT BREAKER CB2 3A	1922-0112-06	1	
EMI FILTER FL1	0531-0003	1	
FRONT PANEL ASSY.			
PRINTER ASSY AND ACCESSORIES			
PRINTER AP11OO	7009-1933-01	1	
LABEL SUN	0682-0700	1	
LABEL BLANK	0682-0700-01	1	MCA-3000-G
RIBBON, PRINTER	0528-0995	1	
PLATEN KNOB	0528-1016	1	
FUSE 1.0 A	0528-1002	1	
FUSE 1.5 A	0528-1001	1	
FUSE .63 A FOR 220V	0528-1037		
POWER CABLE, PRINTER	0662-0230	1	
DATA CABLE, PRINTER	6004-0506	1	W23
PAPER, CASE	0528-1011-01	1	DOUBLE SHEET
REFLECTOR ASSY.			
RELECTOR WELD ASSY.	7020-1835	1	
LAMP HOLDER	0848-0903	2	
FLUORESCENT TUBE	0848-0904	1	PURCHASE LOCALLY
BALLAST RAPID START 11OV	0848-0901	1	
" " " 220V	0848-0906		

DESCRIPTION	PART NUMBER	QTY .	COMMENTS
SUN BUS ASSY.			
ALDL READER PCB.	7001-0543-01	1	
PRIMARY PCB	7001-0544	1	
SUN BUS BACKPLANE PCB	7001-0547	1	
MULTIMETER PCB	7001-0550	1	
SECONDARY TRIGGER PCB	7001-0551	1	
AMPS/BATTERY/VOLTS PCB	7001-0552	1	VAT BOARD
RPM/DWELL/TIMING PCB	7001-0553	1	
DAS A/D PCB	7001-0555	1	
IR INTERFACE PCB	7001-0557	1	
BUS DRIVER PCB	7001-0559	1	
FRONT PANEL INTERFACE PCB	7001-0616	1	
TIMING LIGHT ASSY	7009-1374-02	1	
CABLE ASSY	6004-0518	1	
TIMING LIGHT PCB	7001-0117	1	
FLASH TUBE	1677-0011	1	
SPACER	7028-0014	2	PCB STANDOFF
SCREW #6-32 X 1/4″	0406-0005	2	P ANHEAD
LENS HOLDER	7054-0021-01	1	
LENS OBJECTIVE	0391-0007	1	
REFLECTOR TUBE	7015-0059	1	WHITE TUBE
ROCKER SWITCH	0764-0207	1	
TIMING POT WITH SWITCH	0685-0360	1	
PLATE, POT MOUNTING	7003-0341	1	
TUBE, GRAY LIGHT HOUSING	7059-0406	1	
SCREW #6-32 X 1/4″	0406-0134	4	FLATHEAD
HOUSING ASSY.	7059-0511	1	RT.& LT. HANDLE
SCREW	0610-0161	1	#8 X 5/8"
SCREW	0610-0162	1	#8 X 1"
KNOB ASSY	7009-1063	1	
SET SCREW	0686-0022	2	#6-32 X 1/8″
OVERLAY PLATE	4055-0187	1	
FUSE HOLDER	1417-0025	1	
FUSE 1A	0739-0040	1	SLOW-BLOW
REMOTE CONTROL ASSY	7009-1921-02	1	MCA-3000-G
REMOTE UPPER CASE	7054-0102	1	
REMOTE LOWER CASE	7054-0103	1	
KEYPAD, REMOTE	0552-0031	1	
LABEL, SUN LOGO	0628-0701	1	NOT MCA-3000-G
REMOTE CABLE ASSY.	6004-0517	1	
PCB, RE11OTE	7001-0546	1	
SCREW 6-32 X 1/2″	0403-1361-08	4	ROUNDHEAD
SCREW 6-32 X 3/8″	0403-1361-06	1	ROUNDHEAD
MAGNETIC TAPE 2 X 2"	0865-0112	2	

NOTES

CHAPTER 22

COMMUNICATIONS

GENERAL

Communications for the MCA is accomplished via an optional Communications kit 0120-0520. The option at the time of issue is Dos based and not integrated into the MCA'S main program. The purpose of the communications package is to allow the user access to on-line data bases. These data bases operated by FORD (Oasis) and other bulletin board services provide a means of getting a wealth of information about a vehicle or product problem. This information is more current than the latest service bulletins for the product as all the latest changes are imputed to these systems be for it is ever mailed. The future uses of this package are limited only by the imagination of the people developing the data bases.

SECTION I. THEORY OF OPERATION

The MCA-3000 Communicates via a Modem. A Modem is a Modulator Demodulator and works through changing computer data into audio signals, transmitted on the telephone lines. These signals can be picked Up by another Modem and converted back into digital data for the computer at the other end.

The Modem resides in slot J5 of the Single Board Computer (SBC) This Modem is considered an internal modem as it is connected to the computers expansion slot. The modem has several functions, which are described below, along with diagram 22-1 at the end of this chapter:

This modem is intelligent in that it has a microcontroller (Micro) which receives the data from the SBC, to be transmitted to the remote computer. This Micro controls the operation of a built in dialer, that can dial calls with either a pulse dial like rotary telephones or it can dial using Touch-Tone dialing or Dual-Tone-Multi-Frequency (D TMF). DTMF is the default dialing mode but is selectable by the communications software. The micro receives commands from the communications program to dial numbers or perform other functions. This modem is fully Hayes comparable, what this means is that it uses the same commands and instructions as the Hayes brand of Modems. The micro has 4K Bytes of ROM to retain the program necessary to operate the modem and uses a Universal Asynchronous Receiver Transmitter (UART) to translate the parallel data from the SBC into serial data at a specific Baud rate.

The UART also is responsible for converting serial data from the Modem signal processing chip set into parallel data for the SBC. The modem's Baud rate is programmable for 300, 1200 and 2400 bits per second, which automatically shifts speed to agree with the modem it is communicating with and informs the Micro so it can change the UART's speed. The output is isolated via an isolation transformer as required by FCC regulations. Only the WALL connector on the modem is currently used and the PHONE connector is unused. In other applications a telephone is connected to the modem at the PHONE connector.

During the dialing sequence the speaker allows you to hear the dialing, the tone at the other end, or if a wrong number you may hear a person speaking. After communications has started the speaker is be turned off. The software for the MCA communications is designed for text communications with standard services such as Oasis and The Source. When communicating with these services the text will be displayed.

SECTION II. TROUBLESHOOTING

During the boot of the communications software the modem will be put through a self test if this test passes the modem is probably OK. If it fails recheck installation (NOTE: a copy of the installation instructions is included in appendix D) and configuration of the select switches, per the installation instructions. Normal configuration of the switches has them all set OFF see figure 1.

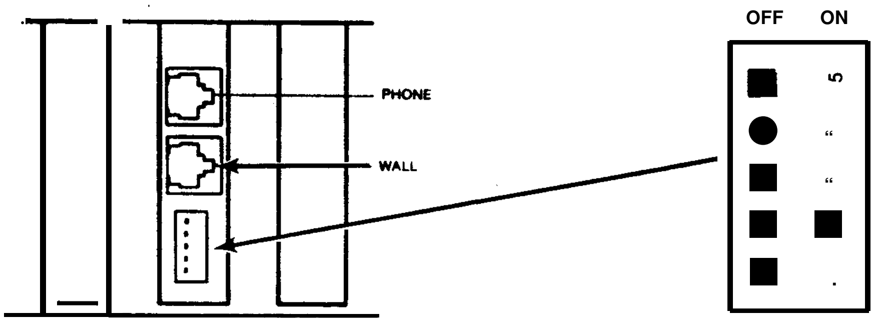


FIGURE 22-1. MODEM CONFIGURATION

The only switch that may not be right for all installations is switch 5. The switch is normally set to OFF (pointing to the left). The OFF setting of switch 5 indicates that the modular connectors you are using are type RJ11, RJ14, RJ41S, and RJ45. These connectors are standard on single and two-line phones that do not have a light to indicate that one line is occupied. If your telephone is attached to a multiple-line system (sometime called a "key" system), you may still be able to connect your modem. Most telephone systems of this type use the RJ12 or RJ13 connector, which the modem can accept when switch 5 is ON. If you know that the customers telephone has this type of connector, set switch 5 to ON. It is a good idea to set the switch to OFF and if problems arise try switch ON.

If the computer is locking-up or resetting it is important to check the setting of SW1 on the SBC. This DIP switch must be set with SW1-1, SW1-2, and SW1-3 each ON, SW1-4 should be OFF. See figure 2 for this configuration.

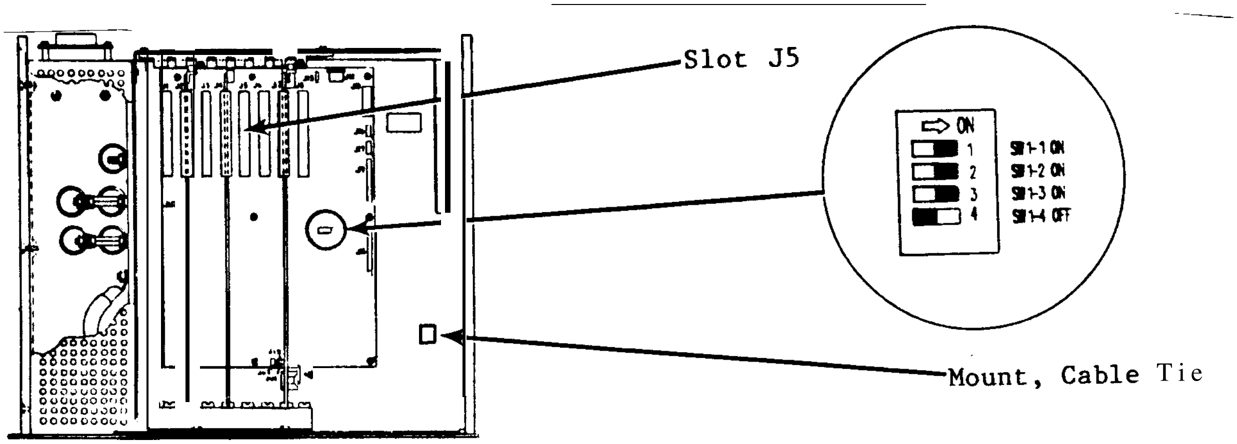
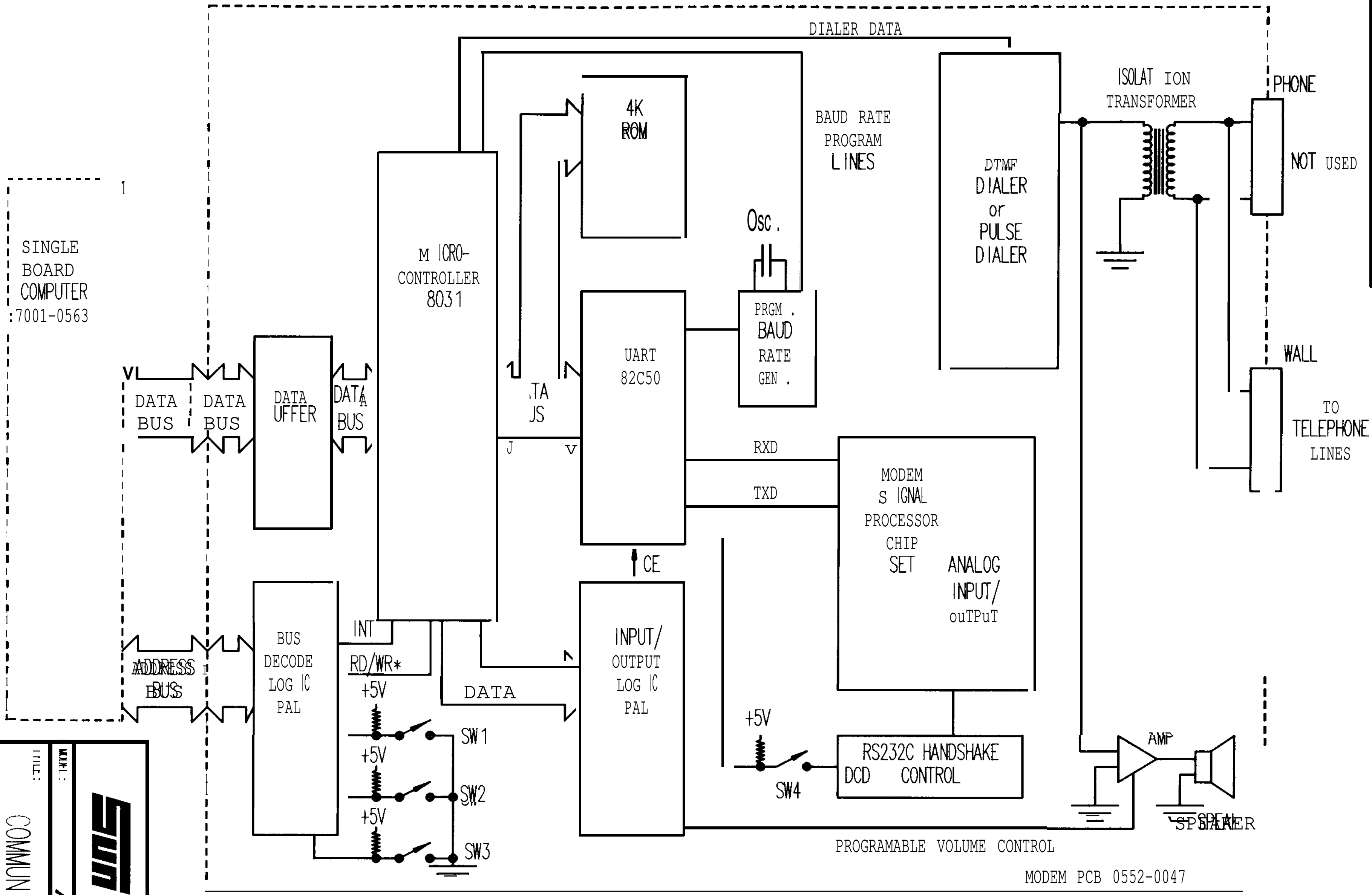


FIGURE 22-2. SBC CONFIGURATION SWITCH SW1



SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014

TITLE: COMMUNICATIONS KIT

DWG: 22-1

PAGE: 2-3

NOTES

CHAPTER 23

TECH-10 OPTION & GM EXPERTEC SOFTWARE

GENERAL

The Tech-10 Option, provides the MCA-3000 with the proper hardware (i.e. a Hard and CD-ROM Drive) to allow it to run General Motor's Expertec software. Expertec is a proprietary database program from GM containing the latest in vehicle information (i.e. Technical Service Bulletins, Tune-Up Specs, ECM information and even NON-GM vehicle Tune-Up specifications.) The Expertec system provides all this information to the mechanic, quickly and easily, at the touch of a few keys.

The TECH-10 option can only be installed in MCA-3000s which have the 286 CPU Computer Module installed. Do not attempt to install this option in a MCA-3000 which does not have the 286 CPU Computer Module installed.

Sun Electric supplies the hardware to run Expertec, and is responsible for the distribution of the Expertec software for GM. The Expertec software is provided and maintained by General Motors. The software is not sold to the customer, the customer pays for a license subscription. This means the customer does not own the software, instead he/she pays for a license to use the software. Each CD-ROM disk is only good for a certain amount of time, after this time period the software will cease to function. Instead it will display the following error message:

XXX Days have elapsed since your last update
TECH 10 will not continue until the system is updated.
Please contact your service representative
to install a new system

NOTE: The "XXX" represents some numerical value , which may change in the future without notice.

Since the TECH-10 consists of two different subassemblies (the Hard Drive and CD-ROM Drive) and the software which runs it, this Chapter will contain separate sections for all three. Each section will contain its own General Introduction, Theory of Operation, Checkout Procedures and Troubleshooting pertaining to the Hardware and Software which make up the TECH-10 option.

SECTION 1. THE TECH-10'S HARD DRIVE

GENERAL

The TECH-10 option features a Hard Drive. The Hard Disk drive is similar to a Floppy Disk Drive. The differences are that the Hard Disk Drive contains several Disks stack one over the other and can not be easily removed. The Hard Drive spins its disks at 3600 RPMs versus 300 RPMs for the floppy drive. , The Hard Drive's Read/Write Heads fly over disks not actually touching them, versus the Floppy Drive's Read/Write heads which actually makes contact with the disk material. Since it is never removed, the disk is made of a rigid material, hence the Term "Hard Drive" was given to it. Other terms used for the Hard Drive are Fixed Disk, meaning the disk is fixed in one position or permanently attached. Still another term used is Winchester Drive for Hard Drive, this term goes back to the days of the first hard drive , where part of its specification were the same as the name of a popular rifle from Winchester.

Because the Hard Drive disks are fixed, the accuracy and repeatability are much greater, thus allowing greater density of information, i.e. number of tracks and sectors, to be greatly increased.

HARD DRIVE TO 286 CPU INTERFACE

The Hard Disk Control circuitry is contained on the Floppy/Hard Disk Controller Board, 7001-2020. It is used to process data bits and control signals received from the 286 CPU to produce the required read/write, disk drive select, head select, head directional control, and motor control output signals. The Hard Disk Control circuitry also monitors disk drive generated output signals such as: INDEX* , SEEK COMPLETE* and TRACK ZERO*. In summary, the Hard Disk Control circuitry consists of all the logic circuitry used to perform the serial-to-parallel and parallel-to-serial data conversions required for normal Hard disk drive operation.

This control circuitry also has control registers that determine the number of tracks and sectors required and the number of bytes per sector to be stored, thus the controller circuitry and controller BIOS determine the ultimate recording format.

Storage space on any disk (Floppy or Hard) is measured in BYTES. The Current Hard Drive (MiniScribe 3650) has the ability to store up to 43 Megabytes of information (1 Mega Byte + 1,024,000 Bytes). One byte of information is the equivalent of one character. Data is stored (written) on the hard disk the same as in the floppy disk, in concentric circles using a serial format. These circles are called TRACKS. A CYLINDER is one track on each surface of the disks. Each read/write head is able to move to any CYLINDER to read (retrieve) or write (store) data on the disk. CYLINDERS are also divided into SECTORS. The MiniScribe 3650 Hard drive is FORMATTED, or divided, in the following manner:

1 character	= 1 byte
512 bytes	= 1 sector
17 sectors	= 1 track
6 tracks	= 1 cylinder
820 cylinder	= 1 formatted drive

512 bytes/sector x 17 sectors/track x 6 tracks/cylinder x 820 cylinders/drive =42,823,680 bytes/formatted drive

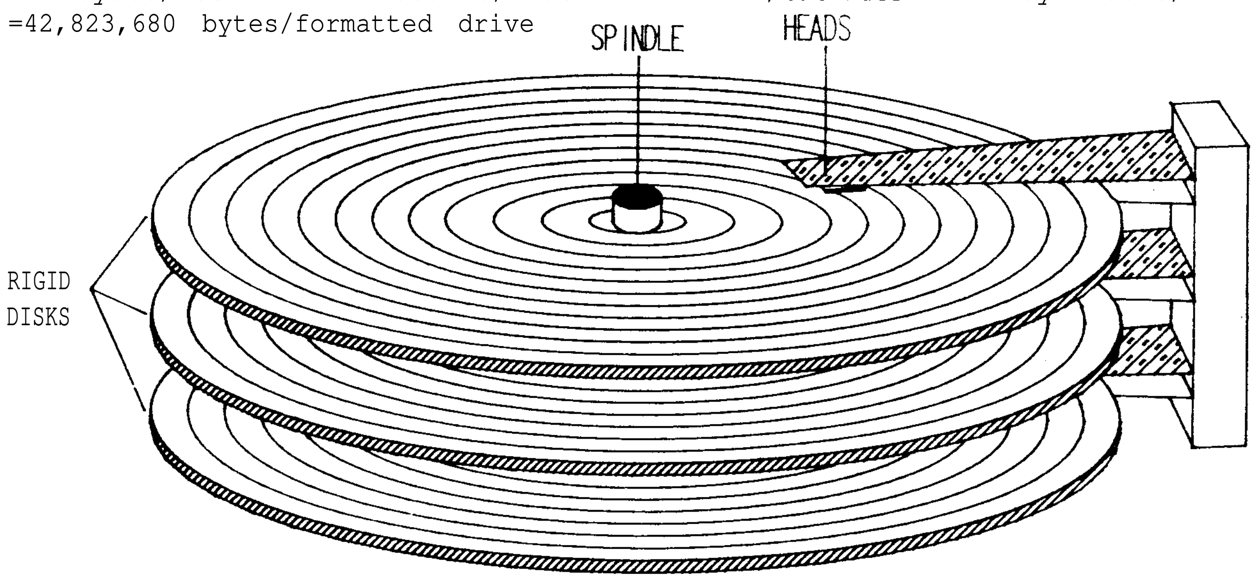


Figure 23-1. TECH-10 Hard Drive

In order to make the Hard Drive usable by the Computer, it must be formatted. To do this, each sector must have a header written on it that indicates what track it is on, and what sector number it is. This is called Low Level Formatting, and is done at the factory. Currently only 820 cylinders are low level formatted. If any sectors are defective, they are noted and are disregarded. If a drive fails in the field, you will use the Service Disk to perform this function (low level format). Next, the Hard Drive must be Partitioned.

Since PC DOS 3.3 can only look at 32.5 Megabytes on one drive, the physical hard drive must be divided into several logical drives. A logical drive means that the CPU's logic interprets the large drive as several smaller drives. The current Hard Drive is divided or "Partitioned" into 3 logical drives, C: (16.67 Meg), D: (16.67 Meg), and E:(9.31 Meg). Since the program has the ability to switch between drives, this does not effect operation of the program. Partitioning is also done at the factory, but may be required in the field to repair a hard drive. This can be done using the T-10/TECH-10 Service Disk's selection #2 COMPLETE RE-FORMAT OF HARD DRIVE. For more information regarding the Service Disk see "How to Use the Service Disk," page 23-29. Finally the Disk Drive must be High Level Formatted using PC DOS 3.3

High Level Formatting consists of reading all the sectors of a Logical Drive and writing a File Allocation Table(FAT). This FAT file is written to the drive and contains information on the number of Bytes that are used, Hidden Files, Directories, and where each file is located. This is also done at the factory, but may need to be done in the field for repair of the Hard drive using the DOS Format command. Since the Hard Drive has already been partitioned, all three logical drives are formatted individually.

NOTE: If Low Level Formatting, Partitioning, or High Level Formatting are done to a drive that contains any files, ALL THE FILES WILL BE LOST!

After the Hard disk is High Level formatted, other files must be moved onto the Hard drive, such as COMMAND.COM, IBMDOS, CONFIG.SYS, AUTOEXEC.BAT and so on. For a better explanation of these files, refer to the Chapter 3. Computer, Section I. Theory of Operation.

If a Sector becomes defective and can no longer be read, an error may be displayed when reading the file that includes that sector. To verify if a sector is bad, the DOS "CHKDSK" utility is used. To run this, type CHKDSK from the drive you want to check. If a CHKDSK/F is typed, the disk will be checked and any bad sector will be disabled. Then the defective file must be rewritten to the disk.

FRONT PANEL LED

The MiniScribe 3650 Hard drive uses a Tricolor LED. When operating normally, the LED should emit a continuous GREEN light. The Drive's LED will flash RED if a problem exists. And finally, the LED has an "AMBER" shade indicating the Read/Write Heads are parked off the loading zone away from the data tracks (this is true, only if a special jumper configuration exists). We DO NOT use this special jumper configuration, therefore you should never see the AMBER.

CONTROL SIGNALS

The control lines used to control the Hard Drive are similar to those of a Floppy Drive. The exception being that the Hard Drive's motor runs continuously at 3600 RPM, therefore, the MOTOR ON* signal is not required. Several new Signals have also been added, such as WRITE FAULT*, SEEK COMPLETE*, READY*, and three HEAD SELECT lines. The Data is also routed through a separate ribbon cable and is read from a pair of lines that are the compliments of each other.

The WRITE FAULT* line is used by the Drive to indicate that the data written to the drive failed.

SEEK COMPLETE* is used by the Hard Drive to indicate that the selected head has reached the desired cylinder and the motor speed is stabilized at 3600 RPM.

READY* is used by the Hard Drive to inform the Controller that its Disks and spindle are up to speed.

HEAD SELECT 0, 1, and 2 are used to select which of the 6 heads are to be used for the current Read or Write command. These 3 signals are used as a binary number, HEAD SELECT 0 is the "2 " digit (1), HEAD SELECT 1 is the "2 " digit (2), and HEAD SELECT 2 is the "2 " digit (4).

The MFM (Modified Frequency Modulation) READ DATA, and MFM WRITE DATA lines are the actual data transferred between the Drive and the Controller. This data travels in differential pairs, and is read by taking the difference between the two lines. This is done for noise immunity and speed.

WRITTEN GATE* is low when valid data is to be written on the disk. The Hard Disk Controller Card takes this line high when a WRITE FAULT is detected. This line is also used with special circuitry to insure that nothing is written on the disk during system power up.

TRACK 000*, this line is taken low when the Read/Write heads are positioned over the outermost cylinder

WRITE FAULT* is taken low when a write error occurs. While this signal is low the command in process aborts and no other disk command can be executed.

INDEX* is used to indicate the start of a track and will pulse once on each revolution, it is also used to control sector placement of each track.

STEP* , this control line is used along with DIRIN* to position the read/write heads over the proper cylinder. When the STEP* line goes low the read/write heads move in the direction indicated by DIRIN*.

DSO* and DS1*, these lines are used to select which drive is active if the Drives are Daisy chained together.

DIRIN*, this line is used to specify in which direction the Read/Write Heads will move , and is used in conjunction with the STEP* control signal.

SECTION II. HARD DRIVE CHECKOUT AND REPAIR

Tool Required: T-10/TECH-10 Service Disk
Disk Manager Disk

1. Turn the Power switch ON and allow the Computer to Boot-up.

2. If the MCA booted from the Hard Drive, Press "2" to select DOS. If the Computer will not boot from the Hard Drive, Refer to the Troubleshooting Section. Symptom 111 of the Hard Drive section.

3. Type "CHKDSK C:" at the DOS prompt and Press "ENTER".

4. If any errors are found, the question "Convert lost chains to files?" will appear. Answer "N" and press "ENTER" and proceed to steps 5 and 6. If any errors occur do a high level re-format, and reload the files as outlined on page 23-29.

5. Repeat steps 4 and 5, this time using "CHKDSK D:"

6. Repeat steps 4 and 5, this time using "CHKDSK E:"

7. Insert the T-10/TECH-10 Service Disk into drive A. Type "A:" to change the drive from D to A and when the A prompt appears, type "MENU". When the menu screen appears, select "1. Hard Disk Diagnostics". Refer to page 23-29 on Service Disk usage.

8. Follow the instructions on the screen and insert the Disk Manager Disk in Drive B: and Press enter. After this is done, the MCA/TECH-10 will ask you to select 1 or 2 for # of hard drives, select #1 and press enter. Next you will be asked to use the parameters at the top of the screen. Type "Y" for yes and press enter.

9. Press "F1" to run all tests. If an error is indicated press "F10" for repair procedures. NOTE : If Track 819 fails this is normal, since this track is not formatted.

10. Press "F2" to select "RUN INDIVIDUAL TESTS".

11. Press "F6" to select "VERIFY MEDIA" The MCA/TECH-10 will prompt You and ask "Do you have a DISK MANAGER flaw map on disk?". Enter "N" for NO and press enter. If an error is indicated, press "F10" for repair procedures. NOTE : If Track 819 fails this is normal, since this track is not formatted.

*************** *****************
* HARD DRIVE CHECKOUT COMPLETE *
****

SECTION III. HARD DRIVE REFORMATTING PROCEDURE

Tools Required: Customer's DOS Startup/Operating disk
T-10/TECH-10 Service Disk
Disk Manager Disk
Current Expertec CD

Note: This Procedure can be started at Low Level Formatting, High Level Formatting, or file loading, BUT IT MUST BE FOLLOWED TO THE END NO MATTER WHERE IT IS STARTED.

LOW LEVEL FORMATTING

NOTE: THIS WILL DESTROY ALL DATA ON THE HARD DRIVE, IF ANY FILES ARE STORED ON THE HARD DRIVE AND ARE NOT BACKED UP, DO SO AT THIS TIME. ALL FILES NEEDED FOR EXPERTEC ARE EITHER CONTAINED ON THE SERVICE DISK OR ON THE CD ROM.

1. During Boot-up, Press "F1" to enter set up. Verify that the correct TYPE is displayed for the Hard Drive (MiniScribe 3650 and 3675 = Type 39). See Chapter 3 for more information on 286 CPU Set-Up procedure if necessary.

2. Insert The customer DOS Startup/Operating System disk into drive A: and exit the set up page, by pressing the REVIEW/BACK UP (END) Key.

3. Enter the correct Time and Date if necessary and Press "ENTER"

4. Insert the Service Disk into Drive A:, at the A> prompt type "MENU" and press "ENTER"

5. Press the "2" key to select the "2. COMPLETE RE-FORMAT OF HARD DRIVE".

6. If You wish to continue, press any key. This process will take about 8 minutes.

7. When Low Level formatting is complete, perform steps 1 through 6 of High Level Formatting Procedure.

HIGH LEVEL FORMATTING

1. Insert the DOS Startup/Operating disk on Drive A, and press RESET.

2. Enter the correct Time and Date if necessary and Press "ENTER"

3. At the A: prompt type "FORMAT C:" and press "Enter". Answer "Y" to "Are You Sure?".

4. Repeat Step 3 with "FORMAT E:"

5. Repeat Step 3 with "FORMAT D:"

6. Insert the T-10/TECH-10 Service Disk into Drive A, type "MENU" and press "ENTER", and proceed to Installation of Operating System Files on the next page.

INSTALLATION OF OPERATING SYSTEM FILES

NOTE : If this is being done without High Level Formatting as described above , errors will appear like "unable to to create directory" This is normal since the subdirectories already exist. The files will still be loaded properly.

1. Press "3" to select "3. Install Operating System Files on Hard Drive" from the main menu of the T-10/ TECH-10 Service Disk. Refer to Service Disk usage if more information is required.

2. You will be instructed to insert the DOS start-up disk in drive A and hit any key. The MCA/TECH-ill will begin to load the DOS files from Drive A to Drive C and D (this will take approximately 2 minutes).

3. When this is complete, you will be instructed to remove the DOS disk and insert the T-10/TECH-10 service disk and "Strike any key". The T-10 will now load batch files and device drivers necessary for the operation of the MCA's TECH-10 Option.

4. When complete, remove the disk from drive A, and press the RESET switch. This should display the pre boot menu. Next the Installation of Expertec files MUST be done next.

INSTALLATION OF EXPERTEC FILES

NOTE : If this is being done without High Level Formatting as described above , errors will appear like "unable to to create directory" This is normal since the subdirectories already exist. The files will still be loaded properly.

1. Press "4" to select "4. Install Expertec files on Hard Drive" from the main menu of the T-10/TECH-10 Service Disk. Refer to Service Disk usage for more information, if necessary.

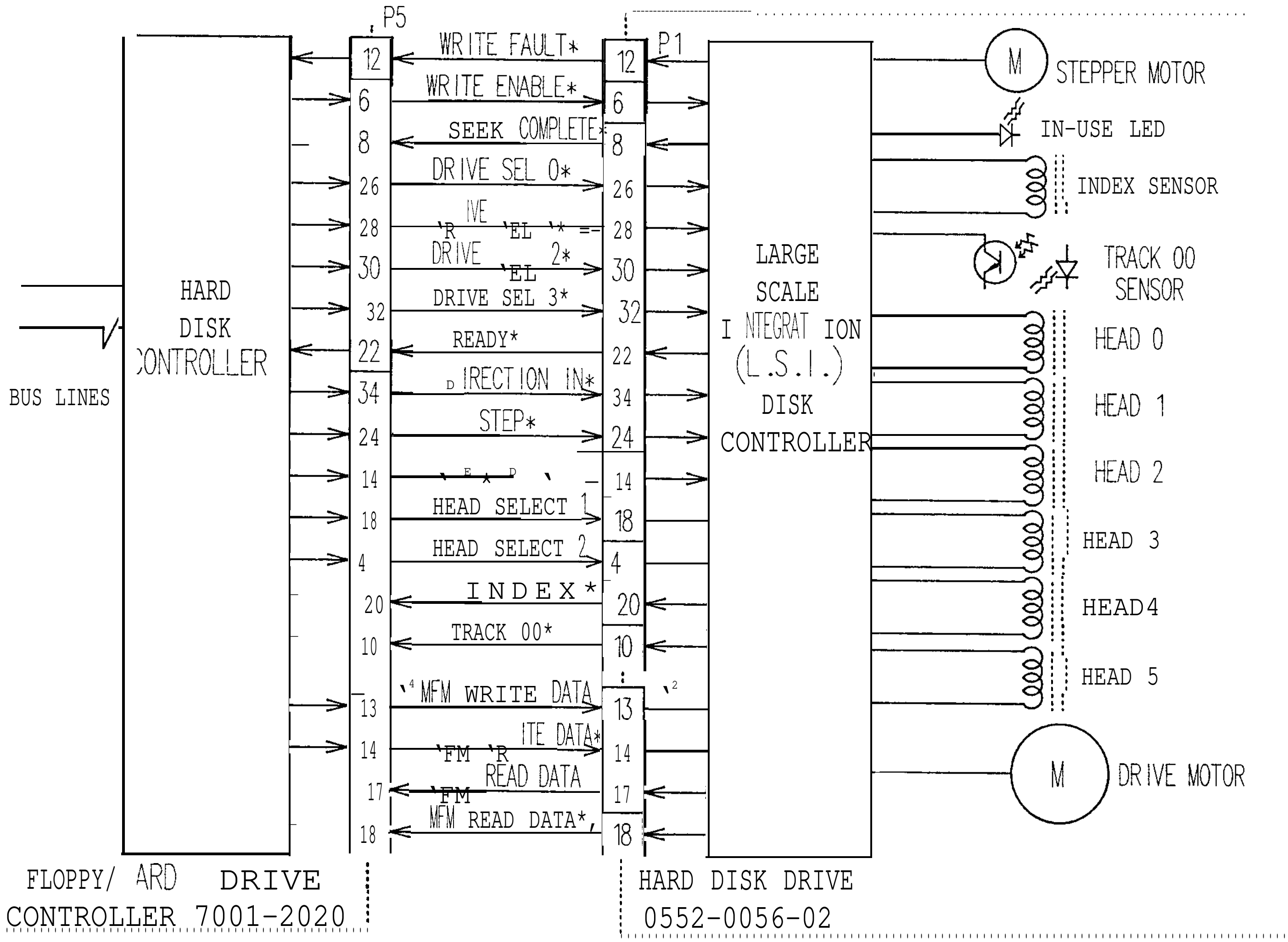
2. You will be instructed to insert the (the latest) Expertec CD in the CD ROM drive and hit any key. The MCA/TECH-10 will begin to load the Expertec files from CD ROM Drive to Drive E (this will take approximately 2 minutes).

3. When this is complete, "D:\>" will be displayed and you will be instructed to remove the disk from Drive A: and reset the Computer. The MCA's TECH-10 option is now functional

```
***********************************
* HARD DRIVE REFORMATTING COMPLETE *
*  AND FILE INSTALLATION COMPLETE  *
***********************************
```

COMPLAINT	CORRECTIVE ACTION
I. NON SYSTEM DISK OR DISK ERROR, REPLACE AND STRIKE ANY KEY WHEN READY is displayed.	Remove any disk from Drive A: and reboot. Does message reappear? YES → Using the Setup Procedure on page 3-34 Verify the SET-UP. Is it correct? NO → The disk in Drive A: does not have the DOS system installed on it. Boot from Drive C: Then, using DOS commands run the program in Drive A. Using the Setup Procedure on page 3-34 Verify the SET-UP. Is it correct? YES → Using the Service Disk and the customers copy of DOS, reinstall the DOS SYSTEM, and reboot. NO → Correct and reboot. Using the Service Disk and the customers copy of DOS, reinstall the DOS SYSTEM, and reboot. Does the message reboot? YES → Using the Service Disk, Reinstall the complete Hard Drive, and reboot. NO → The system is corrected. Using the Service Disk, Reinstall the complete Hard Drive, and reboot. If the symptom is still present substitute the Hard Drive 0552-0056-02.
II. NCB Error. Contact your Service Representative is displayed when loading Expertec software.	This indicates that the clock on the Parallel/Serial I/O Interface Board is not functioning. Using the Service Disk Verify the Software Clock. Does it read properly? YES → Reinstall the files on the hard drive using the procedure on page 23-7. NO → Replace Parallel/Serial Board 7001-2034-01

COMPLAINT	CORRECTIVE ACTION
III. Error message displayed that a file has failed to load.	Run the File Installation part of the Hard Drive Reformatting procedure. Note that the message "Unable to create directory" will be displayed. Does the message still appear? YES → Perform the Hard Drive Reformatting Procedure from High Level Reformatting through File installation. NO → Repair is complete.
IV. XXX DAYS HAVE ELAPSED . . . Message is displayed when loading the Expertec Program X's represent some some number.	Using the Service Disk, verify if the Expertec Validation checks good or bad. BAD → Substitute the Serial/Parallel I/O board, 7001-2034-01 GOOD → Inform the customer that he must have current CD ROM to operate his unit.
V. ROM BASIC (INT 18H) Disk 0 Error	Is LED flashing RED on Hard Disk? NO → Ensure Data & Control cables are making good contact. Does problem still exist? YES → Replace Hard Drive, 0552-0056-02 Ensure Data & Control cables are making good contact. Does problem still exist? YES → Perform a High Level reformat of drives C/D/E and reload files. Does problem still exist? NO → Correct Problem. Perform a High Level reformat of drives C/D/E and reload files. Does problem still exist? YES → Perform a Low & High level reformat or drives C/D/E and reload files. Does problem still exist? NO → Problem resolved. Perform a Low & High level reformat or drives C/D/E and reload files. Does problem still exist? YES → Substitute the Floppy/Hard Drive Controller Board (7001-2020). If problem still exists, replace the Hard Disk Drive (0552-0056-02) NO → Problem resolved.



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

MODEL: MCA/TECH-10

TITLE: HARD DISK DRIVES

DWG: 23-1 PAGE: 23-10

SECTION VI. COMPACT DISK READ ONLY MEMORY DRIVE (CD ROM)

GENERAL

The CD ROM (Compact Disk Read Only Memory) Drive is similar to a Hard Drive. The exceptions are that the CD ROM Drive uses an optical means of data storage, the Hard Drive uses magnetic method. The CD ROM Drive is only capable of being read from, it can not currently be written to by the hardware available. The Compact Disks (CD) are mass duplicated much like a ROM chip. The CD ROM Drive is sometimes referred to as Optical drive.

The CD ROM Drive makes use of the popular Audio CD player technology. The Audio CD Player is capable of holding up to one hour of music in a digital coded format. Based on the same Audio CD technology, a computer CD ROM can hold up to 550 Mega Bytes. This is equivalent to more than 762 Disks (using 720K bytes 3 1/2" disk), or almost 190,000 pages of text. Since the CD ROM and the Audio CD Player use the same technology, the CD ROM Drive also supports audio capability (some of the first ones however did not, because of the availability of the CD-ROM Drives with audio capability). This allows the hardware to be flexible to any future uses of audio output.

The CD ROM is a "Smart Device" and is interfaced to the CPU board using a Small Computer System Interface, or SCSI (pronounced "scuzzy"). The SCSI interface is contained on the SCSI Interface Board, and actually sets up a small network between the computer and the CD ROM Drive. This network is similar to a computer bus system, and contains Data, Address, Arbitration, and Control Lines, and Parity Checks.

Since the CD ROM Drive can not be written to in the field and it is not as fast as the Hard Drive, it is used to transport a program from the manufacturer to the customer. The program can be run from the CD ROM Drive, or to increase speed, some programs may be copied from the CD ROM Drive to the Hard Drive upon installation of the Expertec software. Only the data files are accessed from the CD ROM. To the Computer the CD ROM Drive looks like any other drive and will be set up as the F: drive.

SECTION VII. THEORY OF OPERATION

The control circuitry on the SCSI Interface Board processes data and control signals received from the main CPU and produces the required interface signals to communicate with the CD ROM Drive.

This interface (SCSI) consists of an Initiator and a Terminator. The SCSI Interface Board is the Initiator, and initiates all communication between the Drive and itself. The Drive is the Terminator, and is where the control signals terminate. The CD-ROM Drive also has a Termination Board mounted on the back. This board is used to supply Termination (pull-up) Resistors for all Data Lines. The SCSI interface is capable of handling up to 8 devices in series, with the final device containing the Termination Resistors. Since the MCA's TECH-10 option only has one SCSI device (the CD-ROM Drive), it contains the Termination Board.

The CD ROM Board receives its commands from the SCSI interface, and retrieves the information from the Compact Disk. All control of the Disk rotation and Head movement is done by the CD ROM Drive's on-board computer logic.

In order for this communication to take place both the CD ROM and SCSI controller Board must be configured properly. If they are not, the drive will not respond to the SCSI controller and an error message:

"No valid CD-ROM device drivers selected"

will be displayed during boot-up. For configuration information, refer to Appendix D.

The CD ROM Disk is made of a Polycarbonate material, coated with an aluminum plating. The information is contained on a continuous spiral track that runs from the center of the disk to the outer diameter. The spacings on this spiral is 1.6 Microns, or 16,000 Tracks per inch. The spiral is made up of Lands and Pits. The Land is where the aluminum surface is intact. The Pit is where the disk is actually transparent.

These Land and Pits on the Compact Disk are read by use of a Laser Source (diode) being aimed at the disk surface. If the disk surface is reflective (land), the laser is reflected to a laser sensitive transistor. This turns the transistor on and outputs a low on the collector. If the Disk surface does not reflect (pit) the laser light to the transistor, the transistor stays off, leaving a high at the collector. Refer to Figure 23-2.

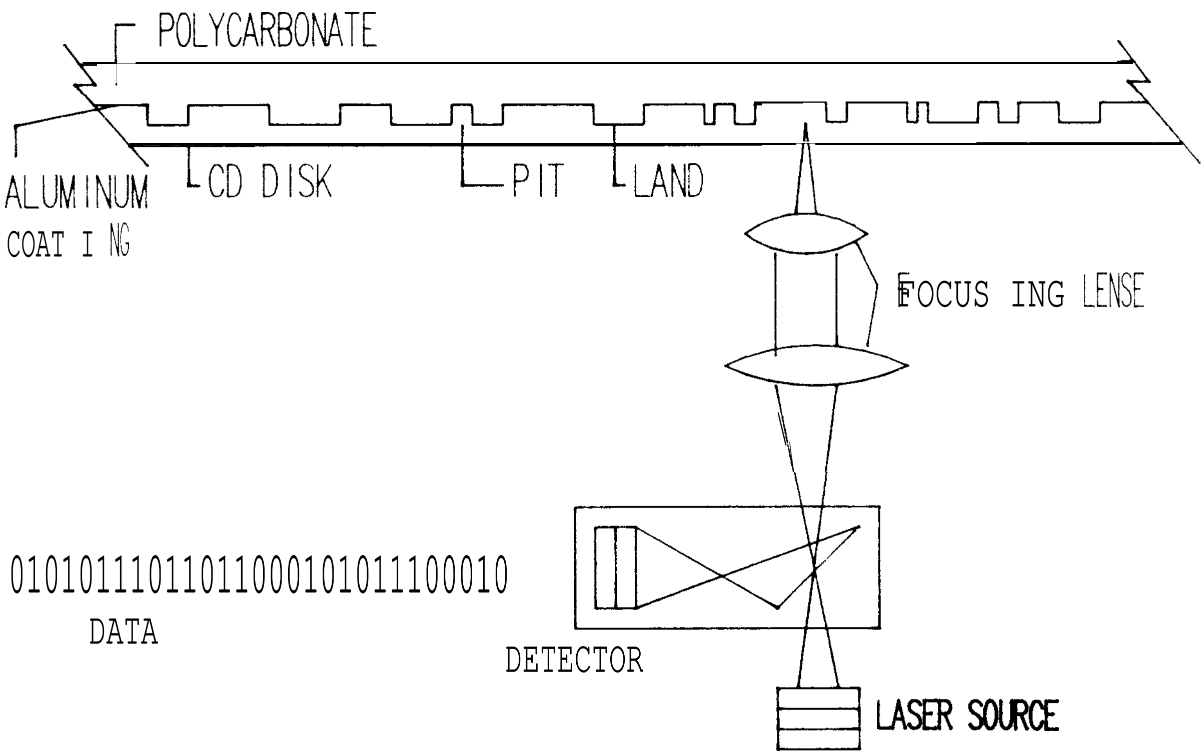


FIGURE 23-2. CD ROM DRIVE PICKUP DEVICE

The disk surface is made up of about 4,464,000,000 spots which can be either a land or a pit. As the disk spins over the laser pick-up assembly, these spots are transformed into highs (1s) and lows (0s). These 1s and 0s (bits) are then sent in 14 bit bytes to the CD ROM's processor board at a rate of 150 kbytes/second, transformed into 8 bytes and sent to the SCSI Controller Board.

Like the Hard drive, the CD ROM disk is formatted in a manner which allows the control circuitry to find a specific sector in the disk. The format (as shown in Figure 23-3) starts with 12 sync bytes that are used to control the speed of the disk. As the Laser Pickup moves further out on the disk, the motor spins slower to keep the same frequency of data. The next section of the format is the 4 bytes ID section, which is used by the controller to find a particular sector on the disk. Immediately following is the 2048 bytes of actual user data. To verify that the data read from the disk is correct, the final 288 bytes are used for error detection.

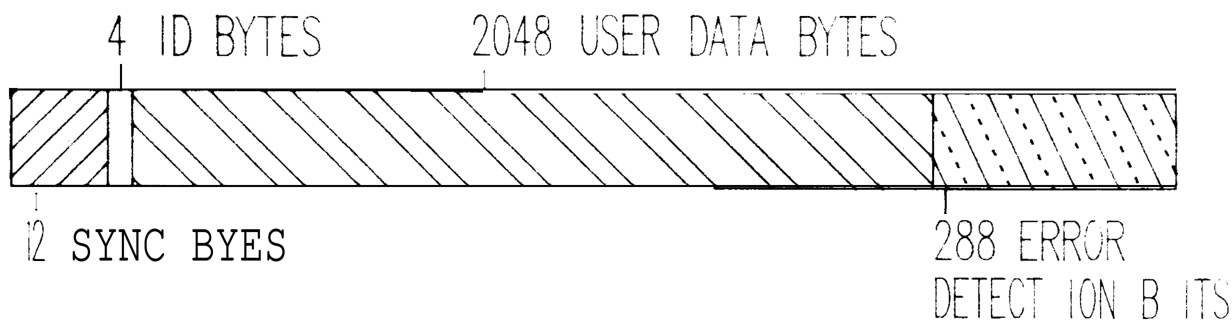


Figure 23-3. Format of a Sector.

Power On Sequencing

In order to operate the CD ROM drive, the CPU must load a Driver program into the CPU's system memory (part of the CONFIG.SYS file). This program includes information on what drive specifier (i.e. Drive F:) the CD ROM will reside at, how to interface with the SCSI Controller Board, and what the specifics of the CD ROM are.

This information is loaded into RAM by the CONFIG.SYS file and an EXPERTEC.BAT file located on the hard drive. If these files do not include the proper commands, the CD ROM Drive will not operate. Refer to page 23-19 for more information on DOS.

The CONFIG.SYS file is used by the CPU to determine how its peripheral devices are configured. This file must include the following information:

```
DEVICE=\TOSCD.SYS /D:MSCD001
LASTDRIVE=Z
```

The DEVICE=\TOSCD.SYS informs the CPU that the information regarding the TOSCD (Toshiba Compact Disk) is located in the root directory (\) and is called TOSCD.SYS. The /D:MSCD001, again, indicates the drive name is MSCD001 (Mass Storage Compact Disk 001). The LASTDRIVE=Z informs the CPU to allow any drive name between A and Z. We will configure our CD ROM as F:

The EXPERTEC.BAT file, found in the root directory of drive E:, must contain:

```
\MSCDEX.EXE /d:MSCD001 /M:8
```

This loads the program "MSCDEX.EXE" and specifies that the Device Name (/d:) is MSCD001 (Mass Storage Compact Disk 001). The /M:8 reserves 8 K of memory for the CD ROM to use as a scratch pad. This driver is also loaded when the CD ROM Sampler Disk Selection is made from the Service Disk.

SECTION 11X. CHECKOUT

Tools required: Sampler CD ROM (]552-0951-01

1. Turn the Computer "ON"

2. Press "2" to select DOS. Note that the Driver program for the CD ROM is installed. If an error is indicated, refer to Complaint II on page 23-15.

3. Insert the Service Disk in Drive A:

4. Mount the Sampler CD ROM into a Carrier and insert it into the CD ROM Drive. The disk should be pulled into the drive. If it does not, refer to Complaint III on page 23-15.

5. From the D:\DOS> prompt, type "A:"

6. From the A:\> DOS prompt type "MENU" and press ENTER.

7. Press "6" to select CD ROM SAMPLER PROGRAM.

8. If the message "Invalid Drive" appears, refer to Complaint II on page 23-15.

9. A "Discovery System" logo should move onto the screen from the bottom. If an error is displayed, refer to Complaint II on page 23-15.

10. Insert an earphone in the Audio Jack of the CD ROM Drive. Audio should be heard.

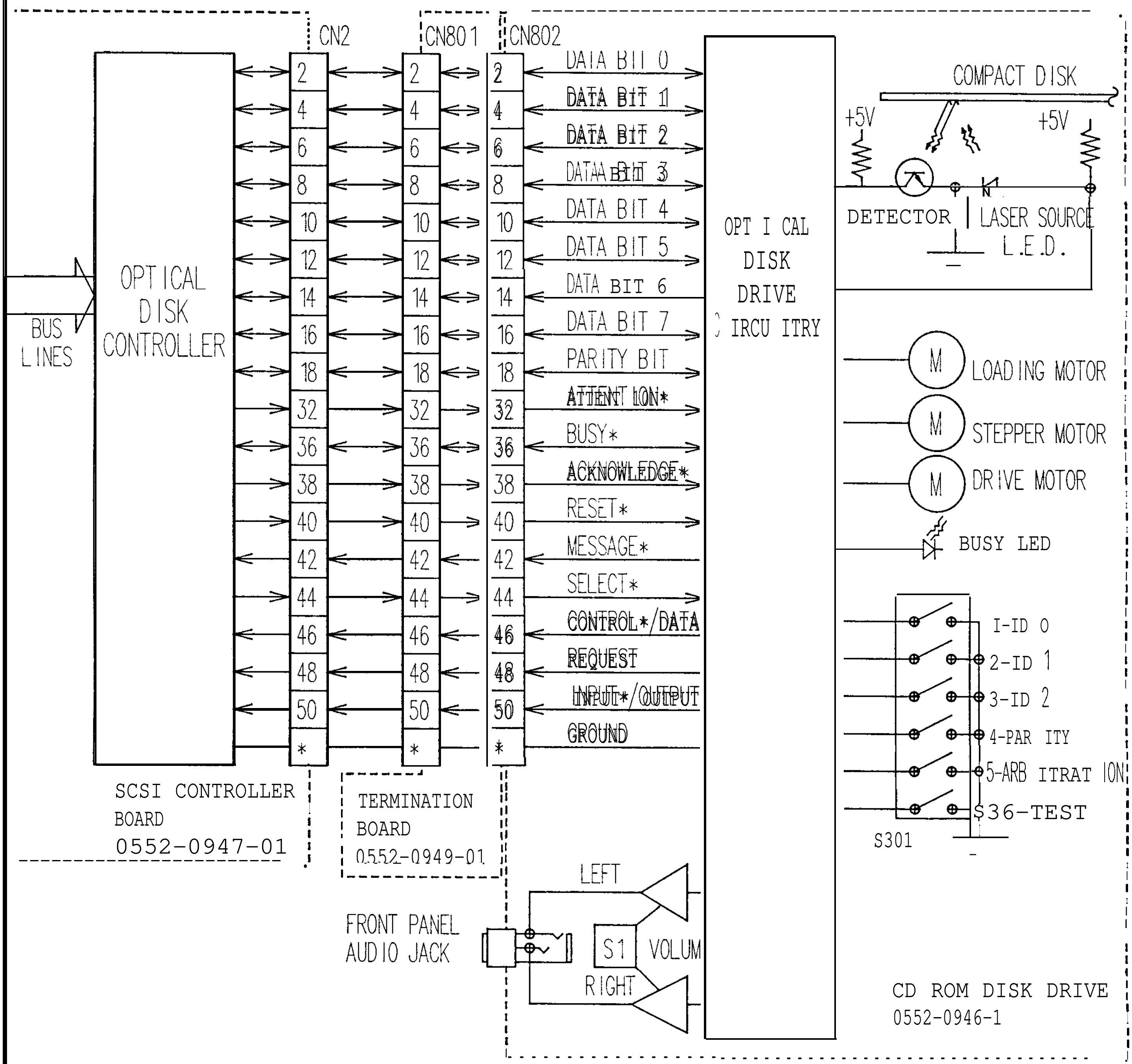
11. Press "RESET."

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

SECTION IX. TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. Won't read information from the CD ROM.	Perform the Checkout Procedure on page 23-14 and proceed to relative complaint.
II. CDR 101 error is displayed on the screen when accessing the CD ROM	Verify that a CD ROM Disk is installed into the CD ROM Drive and press "R" to retry. If the symptom persists, replace the CD ROM Drive 0552-0946-01
III. "No valid CD-ROM device drivers selected" is displayed during boot up. OR "Invalid Drive" message is displayed during checkout.	Verify that the SCSI Controller Board and CD-ROM Drive are configured per Appendix D. From the DOS Prompt, type "DIR/W C:". Are the files "TOSCD.SYS" and MSCDEX.EXE YES NO NO: Using the Service Disk, reinstall all files. YES: From the Dos Prompt, type "TYPE C:\CONFIG.SYS". Are the following lines included in the file? "DEVICE=\TOSCD.SYS /D:MSCD001" "LASTDRIVE=A" YES NO NO: Using the Service Disk, reinstall all files. YES: Is voltage at the power connector of the CD ROM drive as follows: Pin 3 to Pin 4, +5 Volts +/- 0.2 Pin 2 to Pin 1, +12 Volts +/- 0.5 YES NO NO: Troubleshoot accordingly. YES: ---------------SUBSTITUTE--------------- a. SCSI Controller Board, 0552-0947-01 b. CD ROM Drive, 0552-0946-01 c. 50 Pin Ribbon Cable, 0552-0950-01

COMPLAINT	CORRECTIVE ACTION
IV. CD ROM Disk does not load into CD ROM	Is voltage at the power connector of the CD ROM drive as follows: From Pin 3 to Pin 4, +5 Volts +/- 0.2 From Pin 2 to Pin 1, +12 Volts +/- 0.5 YES → SUBSTITUTE the CD ROM Drive 0552-0946-01 NO → Trouble shoot accordingly.
V. XXX Days have elapsed MESSAGE IS DISPLAYED WHEN LOADING THE EXPERTEC PROGRAM. X's represent some number.	Using the Service Disk, verify if the Expertec Validation checks good or bad. BAD → Substitute the Serial/Parallel I/O board, 7001-2034-01. GOOD → Inform the customer that he must have the current CD ROM to operate his unit.



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

MODEL: MCA/TECH-10

TITLE: CD ROM DRIVE

DWG: 23-2

PAGE: 23-17

NOTES

SECTION XI. APPLICATIONS SOFTWARE

GENERAL

This section explains how software is used in the MCA-3000/TECH-10. It is divided into three different sections:

1. "TECH-10 Power-Up"
2. "Disk Operating System"
3. "Expertec Technical Information System"

This is meant to be an overview of how the' software works and what it does. It also contains information on Directory and File structure of the Hard Drive.

MCA-3000/TECH-10 POWER-UP

When the MCA-3000/TECH-10 is first turned on with no disk in Drive A, the unit loads a pre-boot program (from the hard drive "C:") which writes the pre-boot menu (shown below) and monitors the keyboard for the selection.

```
Please select one of the following:

1 Expertec Technical Service Information System       V1.0
2 Disk Operating System

Your Selection:
```

This pre-boot program is located in the boot sector of Drive C. From here the operator can select either Expertec (provided Expertec has already been installed) or DOS. At this point, DOS has not yet been loaded. This occurs only after a selection has been made from the pre-boot menu. It is important to note that since DOS has not yet been loaded into system memory that the printer has not yet been initialized, and is not on line to print. The printer will be initialized after a selection is made from the pre-boot menu. This small pre-boot program contains a timer. If no selection is made from the pre-boot menu for 30 minutes, it will automatically attempt to load selection #1 (Expertec).

SECTION XII. DISK OPERATING SYSTEM (DOS)

This section explains what DOS (Disk Operating System) is how to use it along with how DOS is loaded. It will also explain its Directory and File Structure and show you what files and directories are where.

NOTE : DOS is copyrighted and is not to be copied or used without a registered copy. To do so is punishable by a $10,000.00 fine and/or ten years in prison.

WHAT IS DOS?
DOS is a set of files which define how data can be moved around in the computer between its devices (devices refers to such things as the keyboard and monitor, its drives both floppy and Hard and the printer to name a few) to perform useful tasks i.e. store files on disk and how data is displayed on the monitor.

It acts as a Traffic Cop directing data to its various devices. It also offers a command **set** (a set of instructions) by which, tasks **can** be performed. When it is first turned "ON", the MCA/TECH-10's computer knows just enough information from its ROM BIOS to perform self **diagnostics and** simple hardware initialization of the CPU board itself. After this has been done, it then looks for a disk in Drive A. If a disk is in Drive A, it attempts to load the Disk Operating System from the boot sector. If no disk is in Drive A, it looks for a Hard Drive. If a Hard Drive is present it loads from its boot sector.

When DOS is loaded into system memory (RAM), it is done in different layers. The first layer consists of a file called PCBIO.COM which initializes and defines the resident drivers for such things as the communication ports (both serial and parallel) and drives the console (the keyboard & monitor). These things are standard for most IBM compatible units. Next, the CONFIG.SYS file is used to load any nonresident drivers. In the case of the MCA/TECH-10 it is used to load the device driver for CD-ROM Drive. All these drives are loaded into RAM memory and stay resident for the system to use.

Next PCDOS.COM is loaded. This file also stays resident in RAM, and is used to interrupt commands from the DOS kernel and call on the ROM BIOS to execute the commands. This is done to take a high level code and convert it to executable machine code, which the CPU understands. The DOS kernel is a set of high level instructions by which all things are done.

NOTE : The PCBIO.COM and PCDOS.COM files can not be seen, when a directory (see DOS commands) is listed. This is because of a special attribute byte contained in the file making it a hidden file.

For the operator to interface with the DOS kernel, a file **called** COMMAND.COM is loaded into RAM memory (it also stays resident). This COMMAND.COM file is used to interrupt commands from the operator to the DOS kernel. The COMMAND.COM file contains a set of internal commands by which the operator can copy , move or display files. DOS also features a set of external commands which <u>are not contained in COMMAND.COM.</u> To execute these files you must be in the directory which contains them or have a path statement (see PATH Command) which searches that directory to run them. Examples of such commands: FORMAT, XCOPY and CHECK DISK (see DOS commands for an explanation of what they do).

COMMAND.COM then looks for and loads an AUTOEXEC.BAT file and by this action, command of the computer is turned over to you the operator.

The AUTOEXEC.BAT file is used to automatically load user defined application software. Upon the completion of this a DOS prompt appears. The DOS prompt indicates the currently selected drive. However in the TECH-10 the AUTOEXEC.BAT file has changed the DOS **prompt to also include the current** d i re c to ry .

DOS and DRIVES

DOS needs a way of identifying drives, so that data can be moved between them. Each drive has its own Drive Specifier. The first floppy drive in any system is referred to as Drive A. In a one drive system such as the T-10, the drive can be referred to as Drive A or B. This is done to make the disk copy procedure easier to follow. The first Hard drive in any system can be referred to as Drive C. The Hard Drive in the TECH-10 is divided into three smaller ones called Drive C, Drive D and Drive E. This is done in part, because of DOS's inability to handle Hard Drives larger than 32 Megabytes. The Hard Drive used in the TECI-I-10 is a 42.5 Megabyte Drive and therefore is divided.

To change between which Drive is active, the operator must type at the DOS prompt, the letter of the new Drive, followed by a colon (:) and the ENTER key. Example to change from Drive C to Drive A the operator must do the following

    C:\>A (ENTER)

this will cause the DOS prompt to change from C:\> to A:\>

DOS Directory Structure

DOS uses a Directories Structure so that information can be divided into small logical pieces, which makes them easier to organize. Each disk can be divided into Directories. Each disk starts with a ***root*** directory, other directories can be added, as sub-directories of the root. To make a new directory, type MD at the DOS Prompt (example D\>:MD NEWDIR then "ENTER")

DOS File Structure

All DOS file names consist of 2 parts, the file name and an extension separated by a period. Example: COMMAND.COM. The File name portion can be up to 8 characters in length with file extension being a maximum of 3 characters in length. Some characters are exempt from use in both the file name and extension. They are: "/\[]:;<>+=., if you try to use these characters in a DOS file name, you will receive an invalid file name message from DOS.

File names should usually represent what the file does or pertains to. This makes them easier to find. You can not have 2 file names identical to each other.

Contained in each file is an attribute byte, which defines whether or not the file can be seen (called hidden files such as PCBIO.COM & PCDOS.COM) or read and write (called normal files) to or just read (Archival files)

DOS COMMANDS

DOS commands are given after the prompt (i.e. C:\> or A:\>) and whatever is not found in RAM resident COMMAND.COM is assumed to be the name of a file on the default disk and DOS will search for it under one of the three names:

If you type C:\>BOOK

DOS will look for in this order: BOOK.COM (COMMAND)
BOOK.EXE (EXECUTE)
BOOK.BAT (BATCH)

The first file found will be read into the computer's memory and the command processor will start the program running. If the file is not found, COMMAND.COM will issue a statement indicating it could not find the file.

SYNTAX

DOS commands are issued in an orderly or systematic manner which is commonly referred to as "syntax". If a string of DOS commands are not entered properly, COMMAND.COM will promptly notify you and the DOS command will not be executed. Directly related to this "orderly and systematic" requirement is a forbidden character set that cannot be used in path names and file names. This character set basically consists of punctuation characters used by DOS to execute its functions.

WILDCARDS

In some DOS commands you can use **wildcards.** A **wildcard** is like a joker in a card deck because it can stand for any character or group of characters. The ? represents any <u>single</u> character. **? =** any character in a string. The * represents any group of characters. ***.*** = **any** file and ext.

The following is a list of commonly used DOS commands with a brief explanation of each. You may not find it necessary to use all these commands however, they are included for your information. For more information regarding these commands and other refer to the DOS Reference Manual which comes with every TECH-10.

The [] indicates optional parts of the basic command and the <> indicate the name of files or directories.

COMMAND	SYNONYM	ACTION
CHANGE DIRECTORY Example: **C:\>CD** [PATH] Result: **C:\>PATH**	CD	Changes current directory of the specified or default drive, or displays the current directory path of a drive.
CHECK DISK C:\>[PATH]CHKDSK **C:\>[PATH]CHKDSK[PATH]FILENAME [.ext]**	CHKDSK	Analyzes the directories, files, and the File Allocation table on the designated or default drive and produces a disk and memory status report.
CLEAR SCREEN **C:\>CLS**	CLS	Clears the video screen and sets prompt at upper left corner of screen.
DATE **C:\>DATE [mm-dd-yy]:[dd-mm-yy]** **[yy-mm-dd]**	NONE	Permits you to enter or change the date known to the system.

COMMAND	SYNONYM	ACTION
DELETE C:\>DEL [D:][PATH]FILENAME.[EXT]	DEL	This command deletes specified files. If a drive specifier is not used, DOS will assume the default drive. CARE MUST BE TAKEN WHEN USING THE DELETE COMMAND.
DIRECTORY C:\>DIR[d:][path] [filename[.ext]] [/w][/p]	DIR	Lists either all the directory entries, or only those for specified files. If a drive specifier is not used. DOS will list directory for the drive you are in. /w = wide list without file date (size & date). /p = pauses list when it fills the CRT, pressing any key will list more.
ERASE C:\>[d:][path] filename[.ext]	NONE	Erases the specified file. If the drive specifier is not specified, the default drive is assumed.
FORMAT C:\>[d:][path]FORMAT d:[/s][/1] [/8][/V][/B][/4]	NONE	Initializes the disk in the designated drive to a recording format acceptable to DOS; analyzes the entire disk for any defective tracks; and prepares the disk to accept DOS files by initializing the directory File Allocation Table, the system loader. CAUTION:Please beware that formatting destroys all data on the disk. Because of this, you should be very careful before you decide to format any disk, particularly a fixed disk (Hard Drive).
MAKE DIRECTORY C:\>md [d:]path	MD	Creates a subdirectory on the specified disk. If you do not specify a drive, DOS assumes the default drive.
PATH C:\>PATH [[d:]path[[;[d:]path]]]	NONE	Searches specified directories for commands or batch files that were not found by a search of the current directory. Typing PATH with no parameters displays the current DOS path.
REMOVE DIRECTORY C:\>RD[d:]path	RD	Removes a subdirectory from the specified disk. The directory must be empty before it can be removed with the exception of the "." and ".." entries.
TIME C:\>TIME [hh:mm:[:ss[.xx]]]	NONE	Permits you to enter or change the time known to the system.
TREE C:\>[path]TREE [d:][/F]	NONE	Displays all of the directory paths found on the specified drive, and optionally lists the files in the root directory and each subdirectory.

SECTION XIII. TECH-10 Logical Drives and Directory Structures

Drive C:\>

Logical Drive C is used as the Boot Drive. It contains a small program (in the boot sector) which writes a pre-boot message to the screen and monitors the keyboard for a selection of either 1 (for Expertec) or 2 (for DOS) by the use of BIOS calls. It should be noted, that if no selection is made from the pre-boot screen for 30 minutes, the unit will automatically select 1 or Expertec. This is also where the TECH-10'S DOS boot files (2 of which are hidden, see DOS) are located, along with the 3 files (CONFIG.SYS, TOSCD.SYS and MSCDES.EXE) used to control the CD ROM Drive. Also contained on this Drive are 2 BATCH files used to load either Expertec or DOS from the pre-boot screen program. Listed below is a directory of C Drive.

```
 Volume in drive C has no label
 Directory of  C:\

COMMAND  COM     25307   3-17-67  12:00p
CONF I G SYS       128   9-26-88  12:06p
EXPER    BAT        66  10-26-88   2:04p
DOS      BAT        66  10-26-88   2:04p
TOSCD    SYS      6316   8-03-88   3:47p
MSCDEX   EXE     14313   8-03-88   3:47p
         6 File(s)  1653'3648 bytes free
```

DRIVE D:

D:\>

Drive D is used to contain two Directories, one for DOS and the other called UTIL (for Utilities). See Directory of D Drive below.

```
 Volume in drive D has no label
 Directory of D:\

DOS          (DIR}        10-24-88   2:07p
UTIL         (DIR)        10-24-88   2: 13p
LOADCD   BAT          44  10-13-88   3:20p
         3 File(s)   16068608  bytes  free
```

The contents of Drive D (continued)

D: \DOS>
The DOS directory of Drive D contains all the external commands or applications of DOS. To use these external DOS applications, you must either be in that directory (D:\DOS>) or be pathed (for more information on pATH see DOS commands 23-22 thru that directory. Listed below are the contents of the DOS directory on Drive D. NOTE : The format of this directory is different, it was selected to be wide (DIR/W) to take up less space. NOTE: DO NOT RUN BASIC OR BASICA, THEY REQUIRE A BASIC ROM TO BE PRESENT. THIS IS NOT SUPPORTED.

Volume in drive D has no label
Directory of D: \DOS

.		..		COMMAND	COM	ANS I	SYS	APPEND	EXI
ASS I GN	COM	ATTRIB	EXE	BACKUP	COM	BAS I C	COM	BASICA	COI
CHKDSK	COM	COMP	Corn	COUNTRY	SYS	DEBUG	COM	DISKCOMP	COI
DISKCOPY	COM	DISPLAY	SYS	DRIVER	SYS	EDL I N	COM	FASTOPEN	EXI
FDISK	COM	FIND	EXE	FORMAT	COM	GRAFTABL	COM	GRAPHICS	COM
JOIN	EXE	KEYB	Corn	KEYBOARD	SYS	LABEL	COM	MODE	COI
MORE	COM	NLSFUNC	EXE	PRINT	COM	PRINTER	SYS	RECOVER	COI
REPLACE	EXE	RESTORE	COM	SELECT	Corn	SHARE	EXE	SORT	EXE
SUBST	EXE	SYS	COM	TREE	Corn	VDISK	SYS	XCOPY	EXE
EGA	CPI	LCD	CP I	4201	CP I	5202	CP I	BAS I C	PIE
BAS I CA	PIF	MORTGAGE	BAS						

52 File(s) 16019456 bytes free

D:\UTIL>
The UTIL directory is used for special utility programs which offers extra functions to the TECH-10. Such as the background program which parks the Hard Drive's Read/Write Heads if no hard drive activity has been seen for 10 seconds, or blank the monitor's screen if there is no keyboard activity for 30 minutes. Listed below is the UTIL directory of Drive D.

```
 Volume in drive D has no label
 Directory of D:\UTIL

.              {DIR)      10-24-88    2: 19p
..             (DIR)      10-24-88    2:19p
PRNKEYS  COM        651    9-27-88    3:52p
        3 File(s)   1601'3456 bytes free
```

E:\>
The E Drive is exclusively reserved for Expertec files from GM. Its roots directory consists of 3 sub directories and 1 batch file used to run Expertec. Listed below is the directory of E Drive.

```
 Volume in drive E has no label
 Directory of E:\

EXPERTEC BAT        116    3-26-88   11:36a
EXINSTAL BAT         61   10-26-88    2:04p
EXPERTEC       (DIR)      10-28-88    5:06p
MENUSRC        (DIR)      10-28-88    5:06p
WORK           (DIR)      10-28-88    5:06p
        5 File(s)    8028160  bytes  free
```

SECTION XIV. Expertec Technical Service Information System

This will explain the basics of how the TECH-10 works with Expertec *. First we must understand what Expertec is. Expertec is a customized Data Base from General Motors, it is used to supply the Automotive Service Technician with the latest vehicle service information possible at the touch of a few keys. Expertec contains GM Technical Service Bulletins and Vehicle Specification for both GM products and non-GM products.

TECH-10 EXPERTEC INSTALLATION

For now, the TECH-10 comes from the factory with the Expertec Data Base not yet installed, it is to be installed at the customers site by the customer. This requires the customer to follow the TECH-10 Expertec Installation Procedure that comes with the unit; in the future the unit may come with Expertec installed. But for now, it requires the customer to first load DOS from the pre-BOOT menu by selecting 2 (this loads DOS into system memory) and changing the Drive A.

To change to Drive A, type the following:

A: (ENTER)

Then insert the special Install Disk in Drive A and the Expertec CD-ROM into the CD-ROM Drive.

Then type.

install (ENTER) at the DOS prompt A:\>

This will cause the TECH-10 to automatically load the appropriate Expertec files onto the Hard Drive. Once completed the operator will be prompted to reset (reboot) the TECH-10 in order to use Expertec.

The Expertec Selection

NOTE : For Expertec to load, the <u>Expertec CD-ROM MUST be present in the CD-ROM Drive.</u>

When the Expertec selection is made from the pre-boot menu, the TECH-10 first loads its Disk Operating System or DOS along with special drivers for the CD-ROM from Drive C. Upon completion of this, it loads special utility programs which monitor the keyboard for activity. If no hard drive activity is detected for 10 seconds, this program parks the read/write heads of the Hard Drive to prevent the possibility of any head crashes, should the unit be moved. This is also used to protect the TECH-10'S monitor from burning its phosphor. If no keyboard activity is seen for 30 minutes the monitor is blanked and can easily be restored by pressing any key on the keyboard.

The Expertec Selection (continued)

After the TECH-10 has loaded its utilities programs it begins to load Expertec. During the loading of Expertec, it does a verification check via the MCA's 1/0 Board (7001-2034-01) located in the computer drawer assembly. If the verification check is good, Expertec will finish loading and display its menu screen. If problems arise with the verification check, error or other messages will be displayed on the TECH-10'S monitor. See the Troubleshooting Section of this Chapter.

The Expertec Data Base is contained in part on the TECH-10'S Hard Drive with most of it on the TECH-10'S CD-ROM Drive. The TECH-10'S Hard Drive is divided into three separate logical drives, called C:, D: and E: (see Logical Drives and Directory Structures pages 23-24 thru 23-25).

For information on how to run the Expertec Technical Information System refer to the User's Reference Manual. This Reference Manual is supplied by General Motors.

The DOS Selection

When the DOS selection is made from the pre-boot menu, the TECH-10 loads DOS from its Hard Drive. This can be used by its operator for running other PC DOS based software. It can also be used by Sun's Service Technician to support their Service Tools; The Disk Manager Service Disk (used to diagnose problems on the Hard Drive) and the T-10/TECH-10 Service Disk (used for purposes of adjusting the video monitor, all the way through reconstructing the Hard Drive).

NOTES

SECTION XV. T-10/TECH-10 SERVICE DISK

What is the T-10/TECH-10 SERVICE DISK? The T-10/TECH-10 SERVICE DISK is a special Service tool for the Expertec products which we (Sun Electric Corporation) produce. This special Service tool can be used for Low Level Formatting and Partitioning for the TECH-10'S Hard Drive. It is also used to install some of the files required by Expertec. And finally, can be used to verify if the Expertec Validation process is functioning correctly or not. It is important for you to know how to use this service tool. The following text will describe how to use this Service Disk and what it does.

BEFORE YOU START THE T-10/TECH-10 SERVICE DISK

Before you start the T-10/TECH-10 SERVICE DISK you must first boot up DOS (Disk Operating System). This can be done in one of two different ways, the 1st method is to use the TECH-10'S own Hard Drive which contains DOS. To use this method, make sure no disk is present in the MCA's Drive A, then either turn the MCA "ON" (provided it was not on before) or RESET the MCA using the RESET switch located next to the MCA's two 3 1/2" floppy drives. The MCA/TECH-10 unit will after system self tests and initialization, load and display the pre-boot menu shown below:

```
1 Expertec Technical Service Information System          V1.0
2 Disk Operating System

Your selection:
```

To load the Disk Operating System selection press "2" on the MCA's keyboard. Once the DOS is loaded, the units screen will clear and the following DOS prompt will appear:

D/>

To run the T-10/TECH-10 SERVICE DISK you must change the DOS prompt to A/>. To do this type "A: [ENTER]", this will change the DOS prompt to A/>. Now proceed to STARTING THE T-10/TECH-10 SERVICE DISK (see Page 23-30). NOTE : If this method does not work (load DOS) then used method #2.

METHOD #2 FOR BOOTING DOS

The 2nd method of booting DOS, is to place the Customer's 3 1/2" DOS Startup/Operating Disk (this is provided with each TECH-10 unit) in the MCA's Drive A and either power up the unit (provided it was not already "ON") or to press the MCA'S RESET switch located to the left of the two MCA 3 1/2" floppy drives. After the unit has been turned "ON" or RESET the MCA/TECH-10 will load the DOS from Drive A. Once DOS is loaded you will be prompted on the MCA's monitor for the current date, like below:

```
Current date is Wed 11-02-1988
Enter new date (mm-dd-yy):_
```

The date should already be correct, to proceed past this press the keyboard's "[ENTER]" key. The unit will then prompt you for the current time, like below:

```
Current time is 9:47:42.55
Enter new time
```

NOTE : Time is displayed in military format based on 24 hrs instead of 12 hrs using AM or PM.

This should also be correct. To proceed past this press the keyboard's "[ENTER]" key. NOTE: If the current DATE or TIME is not correct, run SETUP, see page 3-34.

After you have proceeded past the current time the following will appear on the MCA's ❑onitor:

```
The IBM Personal Computer DOS
Version 3.30   (C)Copyright International Business Machine Corp. 1981, 1987
               (C)Copyright Microsoft Corp. 1981, 1986

A>_
```

STARTING THE T-10/TECH-10 SERVICE DISK

After DOS has been loaded and you have either of the following DOS prompts A/> (when booted from the Hard Drive) and A> (when booted from the Drive A with the customer's DOS Startup/Operating Disk). Insert the T-10/TECH-10 Service Disk into Drive A of the MCA. Type "menu [ENTER]", this will cause the following screen to appear (see below). This screen lists the various functions that the Service Disk can perform. Each one of these functions will be described as to what it does and when to use it in the text following the Service Disk menu screen.

```
                    T-10 / TECH-10 SERVICE DISK MENU

                    1. RUN HARD DRIVE DIAGNOSTICS

                    2. COMPLETE RE-FORMAT OF HARD DRIVE

                    3. INSTALL OPERATING FILES ON HARD DRIVE

                    4. INSTALL EXPERTEC FILES ON HARD DRIVE

                    5. PARK HEADS ON HARD DRIVE FOR RELOCATION

                    6. RUN CD ROM SAMPLER PROGRAM

                    7. MONITOR ADJUSTMENT

                    8. EXPERTEC VALIDATION CHECK

                    9. EXIT TO DOS

SELECT A NUMBER
```

To run or perform any of the above items, just enter the appropriate number for that selection.

WHAT EACH TEST ITEM DOES AND WHEN TO USE IT

1. RUN HARD DRIVE DIAGNOSTICS

This selection is used to prompt the Service Technician through the process of starting the Disk Manager Disk's Diagnostics (for more information on Disk Manager Diagnostics see page 23-34).

When to use this selection, 1. RUN HARD DRIVE DIAGNOSTICS selection should be used check for the proper operation of the Hard Drive. If a problem with the Hard Drive is suspected (i.e. constant file corruption, DOS reporting errors evolving the Hard Drive and a Hard Drive that won't boot).

2. COMPLETE RE-FORMAT OF HARD DRIVE

This selection is used to perform a Low Level Format of the Hard Drive and is responsible for partitioning it into three different logical drives, called C, D and E.

NOTE : IT IS IMPORTANT TO NOTE THAT RUNNING THIS SELECTION WILL DESTROY ALL FILES PRESENT ON THE HARD DRIVE.

When to use this selection, 2. COMPLETE RE-FORMAT OF HARD DRIVE selection should be used to prepare a Hard Drive from scratch (not yet Low Level Formatted) or if major file corruption has occurred and it is not being fixed by reinstalling the files over the top of the already present files. This is to be used as a last resort.

3. INSTALL OPERATING FILES ON HARD DRIVE

This selection is used to create subdirectories and place certain files (i.e. PRNKEYS, COM, DOS and the Pre-Boot Menu program along with other files provided by Sun Electric) into these subdirectories.

NOTE ; Do not be concerned with the DOS error message "Unable to create directory", this message means the directory already exists on the Hard Drive and cannot be created again.

When to use this selection, 3. INSTALL OPERATING FILES ON HARD DRIVE selection should be used if file corruption is suspected or after a Low Level or High Level Format has been done to the TECH-10 Hard Drive.

4. INSTALL EXPERTEC FILES ON HARD DRIVE

This selection is used to create subdirectories for Expertec and place certain files into theses subdirectories.

When to use this selection, 4. INSTALL EXPERTEC FILES ON HARD DRIVE selection should be used if Expertec file corruption is suspected or after Low Level or High Level Formatting has been done to the TECH-10'S Hard Drive. Failure to do install Expertec files on the Hard Drive after formatting (low level or high level) will end up with Expertec unable to run.

WHAT EACH TEST ITEM DOES AND WHEN TO USE IT (continued)

5. PARK HEADS ON HARD DRIVE FOR RELOCATION

This selection is used to relocate the Hard Drive's Read/Write heads away from any Hard Drive cylinders which may contain data to prevent possible data damage. It should also be noted, that a special RAM resident program also parks the Read/Write heads when their is no keyboard activity for longer than 10 seconds if Expertec has been loaded.

When to use this selection, the 5. PARK HEADS ON HARD DRIVE FOR RELOCATION selection should be used just before the unit is moved long distances. After parking the heads the unit should be powered down and not used again otherwise the heads will need re-parked. This can also be accomplished if the Expertec Technical Service Information System is load and the keyboard is left alone for greater than 10 seconds.

6. RUN CD ROM SAMPLER PROGRAM

This selection is used to load in the special device drivers (see page 23-13 for more information) for the CD-ROM Drive after it has booted DOS off of the Hard Drive. It then automatically prompts the Service Technician to insert the CD-ROM Sampler Disk and begins to run it.

When to use this selection, 6. RUN CD ROM SAMPLER PROGRAM selection should be used to verify proper operation of the CD-ROM Drive. If the TECH-10 is having problems with the CD-ROM accessing data, the Sampler disk may be inserted and the 6. RUN CD ROM SAMPLER PROGRAM selection made. If the CD-ROM Sampler works the problem is not in the CD-ROM Drive itself. Refer to CD-ROM Checkout procedure page 23-14 for more details.

7. MONITOR ADJUSTMENT

This selection is used mostly for the T-10 Terminal and its multisync monitor. It provides an additional menu (see below) from which selections can be made to provide special screens in which to adjust the T-10's monitor. The EGA CROSS HATCH pattern screen can be used for most MCA monitor adjustments.

MONITOR ADJUSTMENT MENU

1. FREQUENCY TO VOLTAGE ADJUSTMENT
2. EGA CROSS HATCH PATTERN
3. CGA CROSS HATCH PATTERN
4. RETURN TO MAIN MENU

SELECT A NUMBER

8. EXPERTEC VALIDATION CHECK

This selection is used to verify if the Expertec validation process is working correctly. After making the selection of this test, it will report its results PASS or FAIL. If the unit PASSES, this function is working properly. If the unit FAILS, firsts check the date on the CD-ROM to see if it has expired. If the CD-ROM has not expired then replace the Printer 1/0 Board, #7001-2034-01.

NOTE : This test does require the CD-ROM Disk to be installed in the CD-ROM Drive, in order to work properly.

When to use this selection, 8. EXPERTEC VALIDATION CHECK selection should be used whenever the Expertec Validation process is suspect for Expertec not loading Usually error messages will be displayed.

9. EXIT TO DOS

This selection is used to exit the T-10/TECH-10 Service Disk program. It will return you to the point of entry. It is to be used when you have completed using the Service Disk.

SECTION XVI. HOW TO USE THE DISK MANAGER SERVICE DISK

WHAT IS DISK MANAGER

The Disk Manager Disk is a software package, that can be used to Low Level Format , Diagnose Hard Drive problems or to park the Read/Write Heads of the Hard Drive(s). However, it is provided to Field Service as a diagnostic tool only, it is not to be used to perform a Low Level Format, partitioning of the Hard Drive or parking the Read/Write Heads of the Hard Drive. Use only the T-10/TECH-10 Service Disk Low Level Format, partitioning or parking of the TECH-10'S Hard Drive. Failure to use only the T-10/TECH-10 Service Disk for partitioning and low level format will end up with an improperly partitioned Hard Drive in which Expertec * will not work. Disk Manager is a copyrighted software and is not to be copied in any form.

DISK MANAGER DIAGNOSTICS (a file call diag.com on the Disk Manager Disk) is a software utility that provides you with a comprehensive test for the TECH-10'S hard drive subsystem. This utility performs exhaustive disk controller tests, disk drive tests, and provides clear error detection, error isolation, and corrective action information.

With DISK MANAGER DIAGNOSTICS, you have the capability to scan the TECH-10'S Hard Drive to identify any flaws that have occurred on the disk surface after the initial installation.

HOW TO START DISK MANAGER'S DIAGNOSTICS

To access the Disk Manager's Diagnostics use the T-10/TECH-10 Service Disk, see page 23-30 for more information. After the Service Disk's selection menu appears on the unit's monitor (see Service Disk Selection Menu below):

T-10 / TECH-10 SERVICE DISK MENU

1. RUN HARD DRIVE DIAGNOSTICS
2. COMPLETE RE-FORMAT OF HARD DRIVE
3. INSTALL OPERATING FILES ON HARD DRIVE
4. INSTALL EXPERTEC FILES ON HARD DRIVE
5* PARK HEADS ON HARD DRIVE FOR RELOCATION
6. RUN CD ROM SAMPLER PROGRAM
7. MONITOR ADJUSTMENT
8. EXPERTEC VALIDATION CHECK
9. EXIT TO DOS

SELECT A NUMBER

To make HARD DRIVE DIAGNOSTICS selection run, press 1 (You do not press have to press ENTER after the selection). You will be prompted to insert Disk Manager Disk into Drive B of the MCA and strike any key when ready. Pressing any key will cause the Disk Manager's Diagnostic to be loaded into system memory. After the Disk Manager's Diagnostic software is loaded the following screen will appear:

DISK MANAGER DIAGNOSTICS 1.08 SERIAL NO. 01929573
COPYRIGHT (C) ONTRACK COMPUTER SYSTEMS INC. 1986-1988

This utility provides you with a comprehensive test for your hard disk subsystem. DISK MANAGER DIAGNOSTICS will perform exhaustive disk controller and disk drive tests, providing clear error detection, error isolation, and corrective action information. To begin testing, select the drive number to be tested:

Select drive (1 or 2) >1

Select which drive (either 1 or 2) is to be tested. In the case of the TECH-10 only one drive is present, press "1 [ENTER]" (THIS REPRESENTS [ENTER] the ENTER key and is used throughout the rest of this text). In order to do the Diagnostics the program reads and displays the parameters of the selected Hard Drive (see next page).

For the Mini Scribe model 3650 Hard Drive being used in the TECH-10, the screen display should be as shown below:

DRIVE ONE Parameters:
CURRENT DEFAULT SIZE . . . .   42.8 MEGABYTES 820 CYLINDERS 6 HEADS

Do you wish to use these parameters? (y/n) _

If the DRIVE ONE parameters agree with the ones shown above, press Y [ENTER]. This will cause the Disk Manager Diagnostic software to advance to its main diagnostic menu (shown on the next page). If the DRIVE ONE parameters do not agree with the ones shown above, abort Disk Manager Diagnostics and completely **re-format** Hard Drive using T-10/TECH-10 Service Disk (see T-10/TECH-10 Service Disk Usage page 23-29.

Disk Manager Diagnostic Main Menu

DISK MANAGER DIAGNOSTICS 1.08 SERIAL NO. 01929573
COPYRIGHT (C) ONTRACK COMPUTER SYSTEMS INC. 1986-1988

F2. RUN INDIVIDUAL TESTS

F3. REPEAT THE TESTS

F4 . ALLOW C.E. CYLINDER WRITES

F5. STOP ON ERROR

F6. SELECT DRIVE TWO

F7. FORMAT C.E. CYLINDER

F8. DISPLAY ALL DISK PARAMETERS

F9. COLOR ON/OFF

Use the function keys to select an option.

Press Esc to terminate program.

To select one of the Diagnostic Test press the appropriate Function key (located on the left hand side of the unit's keyboard) for that test.

Disk Manager Diagnostics should be used when problems are encountered with using the TECH-10 option and it is believed to be related to the Hard Drive Subsystem (consisting of the Hard Drive, its cables both Control and Data and the Floppy/Hard Drive Controller Board). Use Disk Manager's Diagnostics to pin-point or isolate the problem.

SECTION XVII. DISK MANAGER DIAGNOSTICS OPERATING INSTRUCTIONS

- WARNING -

DISK MANAGER DIAGNOSTICS does have the ability to perform initialization and write functions on your hard disk. DISK MANAGER DIAGNOSTICS makes every effort to ensure that these operations occur ONLY on the Customer Engineer (C.E.) cylinder, which is not normally used to store data. However, since the intent of a diagnostic is usually to operate on a machine suspected of having a malfunction, it is always advisable to BACK-UP ANY VALUABLE DATA prior to running any of the write tests.

WHAT EACH SELECTION DOES

F1 -RUN ALL TESTS
This option will execute all the tests in the Test Menu in the order shown below.

DISK MANAGER DIAGNOSTICS 1.08 SERIAL NO. 01929573
COPYRIGHT (C) ONTRACK COMPUTER SYSTEMS INC. 1986-1988
TESTING DRIVE ONE

F1. CONTROLLER TESTS

F2. SEEK TESTS

F3. RANDOM READ TESTS

F4. READ/WRITE TESTS

F5. ECC READ/WRITE TESTS

Special Note: If selection F4 from Disk Manager's Diagnostic Main Menu is not selected these two options will not appear. See F4 ALLOW C.E. CYLINDER WRITES for more info.

CYLINDER 819 WILL BE USED FOR WRITING. IS THIS OKAY? (Y/N)

F2 - RUN INDIVIDUAL TESTS
This option lets you select and execute one test from a Test Menu (see Test Menu above).

F3 - REPEAT THE TESTS
This option lets you loop on an individual test, or on multiple tests. Use this option to help detect intermittent failures. To loop on an individual test, select F3 and then F2. You will then select the specific test from the Test Menu. To loop on all tests, select F3 and then F1.

F4 - ALLOW C.E. CYLINDER WRITES
This selection may cause damage to some of the files on the Hard Drive, for why see WARNING below. This option will permit the diagnostics software to actually write to the Hard disk. The Customer Engineer (C.E.) cylinder is a reserved cylinder that is not normally used by DOS .

WARNING! DISK INSTALLATIONS THAT USE A "DRIVE-SPLIT" MECHANISM SHOULD NEVER USE THIS FUNCTION, BECAUSE A C.E. CYLINDER WRITE TO THE FIRST LOGICAL DRIVE WILL WRITE TO THE SECOND LOGICAL DRIVE RATHER THAN THE ACTUAL C.E. CYLINDER.

F5 - STOP ON ERROR
Select this option to halt the diagnostic on any error. This option should be selected whenever tests are done using loops or multiple trials.

F6 - SELECT DRIVE TWO
In a multiple hard disk drive subsystem, use this option to select the alternate drive to be tested. If drive 2 is selected, this function key will let you re-select drive 1.

F7 - FORMAT C.E. CYLINDER
This option will permit the diagnostic to actually format one disk cylinder. The Customer Engineer (C.E.) cylinder is a reserved cylinder that is not normally used by DOS. Use this option to verify formatting capability prior to initial disk installation, or to test the write/read capability of the disk subsystem in an existing installation.

WARNING! DISK INSTALLATIONS THAT USE A "DRIVE-SPLIT" MECHANISM SHOULD NEVER USE THIS FUNCTION, BECAUSE A C.E. CYLINDER WRITE TO THE FIRST LOGICAL DRIVE WILL WRITE TO THE SECOND LOGICAL DRIVE RATHER THAN THE ACTUAL C.E. CYLINDER.

CAUTION: THIS OPTION SHOULD ONLY BE SELECTED IF YOU SUSPECT A WRITE FAILURE IN THE SUBSYSTEM.

F8 - DISPLAY ALL DISK PARAMETERS

This option will display the active disk drive parameters. If you are experiencing difficulty in executing the diagnostic, use this option to check your disk configuration file. If changes are necessary, change the appropriate parameters using the screen prompts, or select a new configuration file as described in Step 2 of this section. For what's normal for the TECH-10'S Hard Drive see the Hard Disk parameters below:

DISK MANAGER DIAGNOSTICS 1.08 SERIAL NO. 01929573
COPYRIGHT (C) ONTRACK COMPUTER SYSTEMS INC. 1986-1988

PARAMETERS	DRIVE ONE	DRIVE TWO
SETUP TYPE	39	0
MEGABYTES	42.8	10.6
CYLINDERS	820	306
HEADS	6	4
REDUCED WRITE CURRENT	0	0
WRITE PRE-COMP	820	128
ECC CORRECTION SPAN	0	0
CONTROL BYTE	0	0
STANDARD TIME OUT	0	0
FORMAT DRIVE TIME OUT	0	0
CHECK DRIVE TIME OUT	0	0
LANDING ZONE	820	305
SECTORS PER TRACK	17	17

Press F1 to modify DRIVE ONE　　　Press F2 to modify DRIVE TWO
Press F10 to return to main menu.

If the above parameters differ from the ones being displayed on your unit, the unit may have been improperly prepared. Use T-10/TECH-10 Service Disk selection 2. COMPLETE RE-FORMAT OF HARD DRIVE. NOTE : Check 286 CPU Set-Up for Drive 0 = type 39 (see page 3-34).

F9 - COLOR ON/OFF

Use this option to select either monochrome or color displays.

THE INDIVIDUAL TEST MENU

This Test Menu is used to execute each test selection individually and monitor its results. Shown below is how the Test Menu should appear when accessed, after that each selection is described by what it does.

DISK MANAGER DIAGNOSTICS 1.08 SERIAL NO. 01929573
COPYRIGHT (C) ONTRACK COMPUTER SYSTEMS, INC. 1986-1988
TESTING DRIVE ONE

```
F1.  CONTROLLER TESTS

F2.  SEEK TESTS

F3.  RANDOM READ TESTS

F4.  READ/WRITE TESTS

F5.  ECC READ/WRITE TESTS

F6.  VERIFY DISK MEDIA

F7.  RETURN TO MAIN MENU
```

Special Note: If selection F4 from Disk Manager's Diagnostic Main Menu is not selected these two options will not appear. See F4 ALLOW C.E. CYLINDER WRITES for more info.

Use the Function keys to select a test.

The function keys active in the TEST MENU are described below:

F1 - CONTROLLER TESTS
This option performs an exhaustive test of the hard disk controller card. This test may be performed with the disk drive either connected or disconnected from the Controller. Fault isolation is to the Controller card as a unit.

F2 - SEEK TESTS
This option performs in-out, harmonic and random seek tests on the disk drive. Fault isolation is to the suspect device. This test is used to test the Drives Read/Write Head movement it does not destroy data integrity.

F3 - RANDOM READ TESTS
This option performs a random read of the disk to test the overall health of the disk subsystem. This test is used to test the Drives Read/Write Head's read performance, it does not destroy data integrity.

The function keys active in the TEST MENU are described below (continued):

F4 - READ/WRITE TESTS
This option performs write, read and compare operations on the C.E. cylinder of the disk. The C.E. cylinder must be formatted prior to executing this test. Fault isolation is to the suspect device.

CAUTION: THIS OPTION SHOULD ONLY BE SELECTED IF YOU SUSPECT A WRITE FAILURE IN THE SUBSYSTEM.

F5 - ECC READ/WRITE TESTS
Error Correction Code (ECC) tests force data errors on the C.E. cylinder of the disk, and test the controller's error detection (correction) capability. The C.E. cylinder must be formatted prior to executing this test. (Main Menu options F4 and then F7 must be selected). Fault isolation is to the suspect device.

CAUTION: THIS OPTION SHOULD ONLY BE SELECTED IF YOU SUSPECT A WRITE FAILURE IN THE SUBSYSTEM.

F6 - VERIFY DISK MEDIA
This option lets you scan the disk for media defects. This test executes a non-destructive scan, in that it does not write to the disk surface. Upon completion of the scan activity, you will have the option of examining the list of defects found. If new defects are detected, use DISK MANAGER to de-allocate them.

NOTE ; THIS TEST OPTION IS NOT EXECUTED WHEN F1 (RUNNING ALL TESTS) IS SELECTED FROM THE MAIN MENU. SELECT THIS OPTION SEPARATELY. YOU CANNOT SCAN A DISK SURFACE THAT IS NOT INITIALIZED.

F7 - RETURN TO MAIN MENU
From the Main Menu, additional options can be selected, or the diagnostic can be terminated.

ERROR DETECTION AND OPERATOR ACTIONS

CAUTION: ALWAYS POWER-OFF THE COMPUTER AND ANY EXTERNAL POWER SUPPLIES BEFORE WORKING ON THE DISK SUBSYSTEM. FAILURE TO DO SO MAY RESULT IN PERSONAL INJURY AND/OR DAMAGE TO THE DISK SUBSYSTEM!

When the diagnostic detects an error within the disk subsystem, an appropriate message is displayed. By depressing the F10 key, a more descriptive error message is displayed, providing the recommended corrective action.

In some cases, fault isolation to the specific device (controller, command cable, data cable, or drive), cannot be accurately defined. For example, a faulty data cable can cause one to suspect the controller and/or the drive to be defective. The diagnostic will identify the recommended order of investigation in such cases.

Occasionally, the disk subsystem will fail to operate through no fault of its own. The following shows some system-level failures that, when resolved, could restore the disk subsystem to operation:

Problem:

1. DOS will not boot from hard disk, or
2. Diagnostic will not load, or
3. Diagnostics load but will not run

Check:

1. Check proper connection of all external' cables (keyboard, monitor, disks).
2. Check proper seating of all card assemblies in the system.
3. Run system-level diagnostics (normally provided with the computer) via the MCA's CPU Power on Self Tests.

- NOTICE -

DISK MANAGER DIAGNOSTICS is intended to diagnose any detectable problem with your hard disk subsystem. In order to accomplish this, DISK MANAGER DIAGNOSTICS uses hard disk functions which are not normally used in the course of system operation. These "diagnostic" functions are NOT necessarily supported by all computer/controller combinations. Therefore, if your system appears to be working without any problems and DISK MANAGER DIAGNOSTICS indicates that a diagnostic function is failing, the possibility exists that your computer/controller simply does not support the diagnostic function itself.

If you have any question regarding Disk Manager's Diagnostic functions not being supported by the TECH-10 hardware please contact Technical Support for verification.

NOTES

SIMU-TECH OPTION

GENERAL

SIMU-TECH is an all new service tool designed specifically for performing testing and fault diagnosis of the onboard computer system and its input and output devices. Simu-Tech allows the operator to "T" into the vehicle's on board computer through a POD. It is described as an intelligent Breakout Box.

The SIMU-TECH Option consists of four circuit boards and interconnection cables. Optional components include all vehicle interface cables. This chapter is configured as follows:

Section I. An explanation of the power supplies.
Section II. A list of the boards and a general description of each.
Section III. Funtional Block Diagram of unit and Cables.
Section IV. Installation Instructions with parts list.

SECTION I. POWER SUPPLY THEORY OF OPERATION

This Section includes the purpose of the power supply, the input and output functions and its operational characteristics.

The battery of the vehicle under test supplies voltage for the relays in the POD (12R). The internal circuitry of the POD is powered by a regulated +5, +17.6 and a -12 vdc output. The two boards receive power from the computer backplane.

Referring to Figure 1-1, when the POD (remote "T" box) is hooked up, it is connected directly to the battery. For safety reasons, there must be no current flowing to prevent arcing when hooking up to battery. The Power box provides this safety factor. To allow current to flow the push button must be pressed. CR25 provides rectification and polarity input protection. If the battery leads were inadvertently reversed, CR25 would remain reverse biased preventing the unit from being energized.

The TMS and Acquisition Boards are plugged into the Host's computer backplane. They are powered by the Host's switching power supply +5,-5,+12 and -12 volts. The Acquisition board has a DC TO DC converter allowing 12 volts to be stepped upto 17.6 volts. For protection the Pod board has micro fuses for each of the voltages being supplied from the Acquisition board.

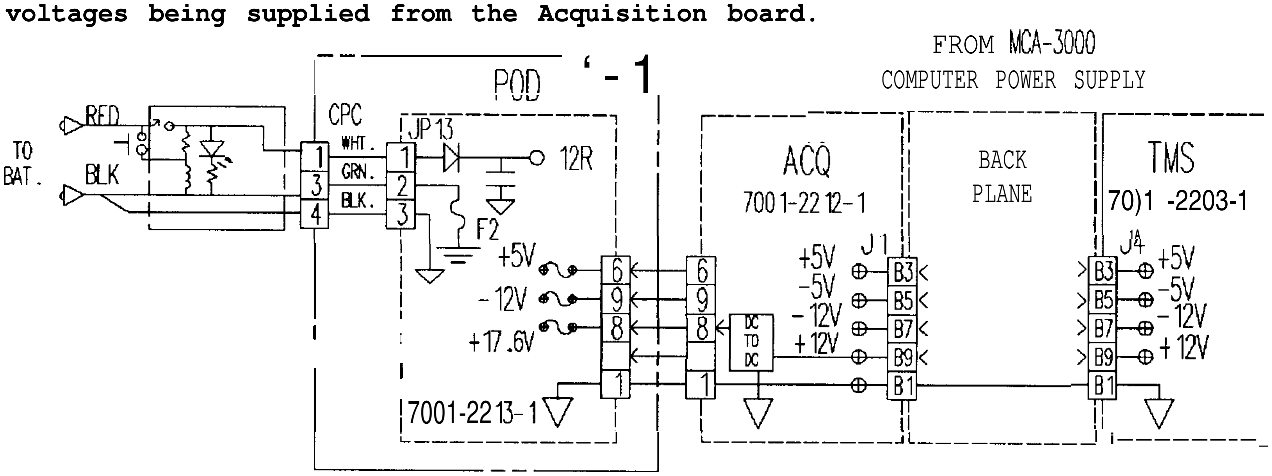


Figure 1-1. Power Supply Diagram

POWER SUPPLY TROUBLESHOOTING

COMPLAINT	CORRECTIVE ACTION
I. **POWER LED will not light when the POWER ON button is depressed.**	Are the twin flex leads from the Pod connected t(a good 12 volt battery? YES — NO NO: Connect twin flex leads to a good 12 volt output. YES: Using a DVM, is there 12 volts at the input of the Power Box? YES — NO NO: Replace the twin flex lead assembly and check for normal operation. YES: Replace Battery Box/Lead Refer to Theory of Operation and Figure 1-1.
II. **TMS HARDWARE FAILURE**	Has unit been Setup per the Installation Instruction? YES — NO NO: Exit to DOS, and type "C:", Press "ENTER", Type "CD CONNECT", Press "ENTER", Type "CNCT \SETUP" and Press "ENTER". Configure the setup page as outlined in the installation instructions YES: TMS board not being recognized, Reseat it and Try it again. If it still doesn't work, replace it.

SECTION II. SIMU-TECH THEORY OF OPERATION

The SIMU-TECH accessory consists of four circuit boards and interconnection cables. Optional components include all vehicle interface cables. A list of the boards and a general description of each follows:

TMS CPU BOARD - This board is mounted in the host tester's PC Backplane and acts as an interface between the PC bus and the local SIMU-TECH bus. It also contains its own Ram Memory for storing data from the vehicle.

DATA ACQUISITION BOARD - This board is also mounted in the PC Backplane. It performs four basic functions as listed below:

1. Convert the Serial Port Data from the TMS board into a twisted pair output to the Pod board. This is done to eliminate noise problems.
2. Supply power to portions of the Pod Board. The +5V and -12V from the PC Backplane are simply routed through this board to the pod, however, the +12 volt supply is converted into a +17.6V supply. This supply is used to power the MUX chips on the Pod. This is necessary because the input voltage from the vehicle can read up to 16 volts, and a MUX must never have more voltage at the input than it is supplied.

3. A/D conversion of the MONITOR line is performed and the information is transferred to the TMS CPU Board via the Local Bus Lines.
4. A full floating DMM is used to read volts, ohms, or amps from the POD. This reading can be from either the Volt/Ω Leads or from switching in many of the connections on J1 and J2. The ground reference of this DMM can be switched between five sources; Black Volt/Ω lead, Common Ground of the Vehicle (J1-21), one side of either IAC motor winding (J1-35,J1-39), or vehicle ground (Black Battery Lead).

POD BOARD - This board is responsible for interfacing with the connections between the Vehicle and its Computer. There are seven types of input/output channels. They are as follows:

1. INJECTORS - These channels are input from the vehicle computer. They can be monitored (Scope Pattern), or the output can be connected to either the DMM (Resistance Readings), or to a High Current Source which is monitored to give a Current reading.
2. ANALOG INPUTS - These channels are for sensors from the vehicle that output an analog voltage proportional to the function they are monitoring (i.e. Throttle Position Sensor). The Pod can monitor this voltage, or output a simulated voltage to the Vehicle Computer to simulate a different condition for diagnostic purposes.
3. SOLENOIDS & RELAYS - These channels are used to interface with the solenoids and relays under the hood which are controlled by the Vehicle Computer. The Pod can monitor this reading, or supply a Medium Current Supply which is monitored to give a Current reading.
4. IAC MOTOR - This connection is used to test the IAC (Idle Air Control) motor on the Vehicle. These channels can be monitored, allow the windings to be connected across the DMM, or drive the IAC motor using an on board Stepper Driver. This is used to either automatically control the speed of the engine, or test the IAC Motor.
5. SUPPLY VOLTAGES - This input is used to monitor the voltages supplied either to the Vehicle's Computer from the vehicle or from the Vehicle's Computer to a sensor, solenoid, or relay. Pin 21 is used as a ground when using the DMM on the inputs.
6. GROUNDS - These connections "T" into the ground connections to the Vehicles Computer. They can either be monitored in the normal sweep test, or a conditional test can be run to flow 500mA through them to determine if they can handle the current they must carry.
7. MONITOR ONLY - These channels are used for miscellaneous inputs from either the vehicle or the Vehicle's Computer. They to not break the connection between the vehicle and its computer, but merely tap into them and monitor their status.

Each Vehicle Interface Cable connects between the Vehicle's Computer and the underhood wiring harness. They are wired to connect the correct type of signals to the proper channels on the Pod Board. Additionally, the Pod board performs the following functions:

1. Monitors the Harness ID lines to determine which harness is connected. The ID is "Wired" into the cable by connecting any or all of the HARNESS ID lines to the Ground pin (J2-2) The Harness ID lines are pulled up to +5V. The current Cable IDs are as follows:

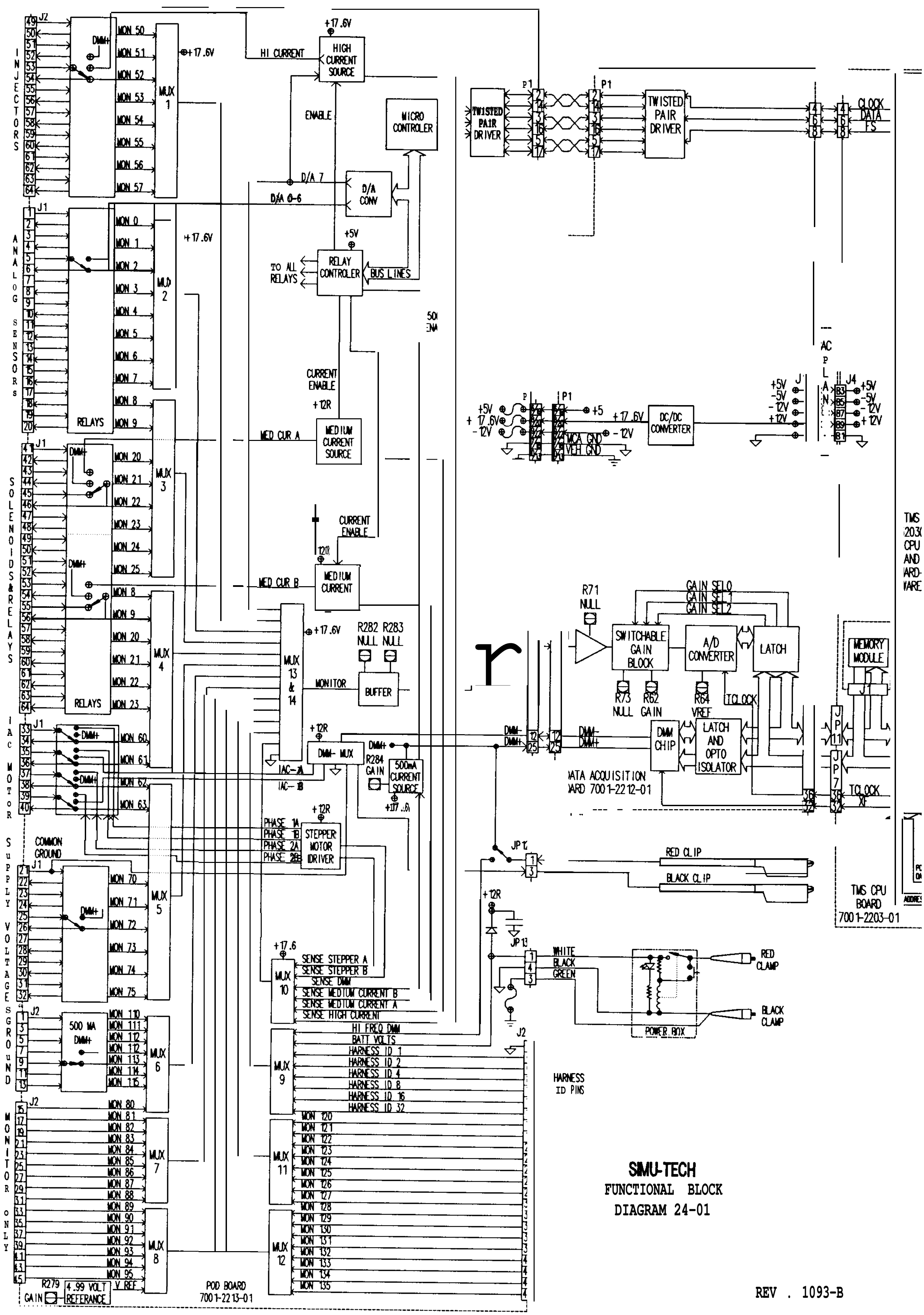
CABLE	ID NUMBER	J2 PINS CONNECTED TO J2-2 4	6	8	10	12	14
FM 01	15					x	x
FM 02	23				x		x
FM 03	10	x		x		x	x
GM 01	1		x	x	x	x	x
GM 03	3			x	x	x	x
GM 04	4	x	x		x	x	x
GM 05	5		x		x	x	x
GM 06	6	x			x	x	x
GM 07	7				x	x	x
GM 08	11			x		x	x
GM 10	9		x	x		x	x
CR 01, 1A, 1B	12	x	x			x	x
CR 02	13		x			x	x
TY 01	14	x				x	x
TY 02	22	x			x		x
TY 03	16	x	x	x	x		x
TY 04	17		x	x	x		x
TY 07	20	x	x		x		x
TY 08	21		x		x		x
	HEX VALUE	1	2	4	8	16	32

2. Receives Battery voltage from the battery leads and uses it to supply power to the relays located on the Pod Board. This voltage is also routed to a monitor channel on the MUX and can be read at any time by clicking on the Battery symbol in the lower right corner of the screen.
3. Monitors up to 96 inputs by way of the 12 Pre-MUX chips routed into a final MUX. This final MUX is software calibrated using one channel of the D/A converted to supply a programmable voltage. One input is also connected to ground to determine the zero offset of the entire circuit.

Calibration is done by selecting Calibration from System Administration Menu. There are two types of Calibration, INTR (Internal) and DVOM. These calibrations store the Zero and Span voltages of both the Monitor and DMM, respectively. Note that since power is supplied from both the Hosts tester and the Battery Leads, the battery leads must be connected to 13 volts during calibration. The normal zero readings are between 1 and 3 Ω.

A self test is also available, also selected from the System Administration Menu. The Battery leads must also be connected during this test. If they are not, the DMM OPEN reading will fail when the leads are shorted. This test should be run with the DMM leads shorted. The final test (Closed Loop Pod Tests) should not be run. The proper equipment is not available in the field and the unit will lock up.

POWER BOX BOARD - This Board is responsible for allowing a no spark hook up to the battery. Once the battery is connected, the button on the box is pressed, enegizing a relay that supplies power to the box.



SIMU-TECH
FUNCTIONAL BLOCK
DIAGRAM 24-01

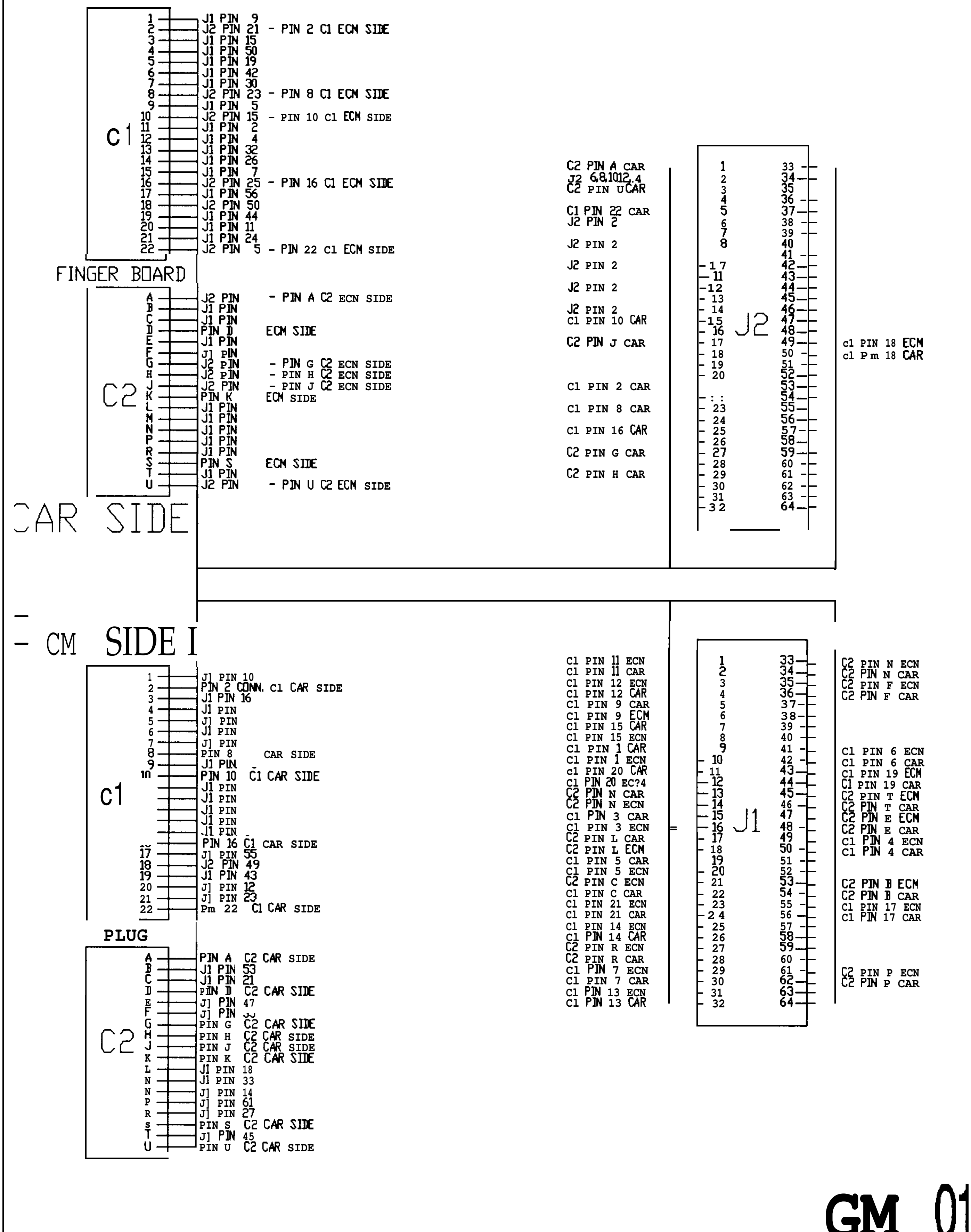
REV . 1093-B

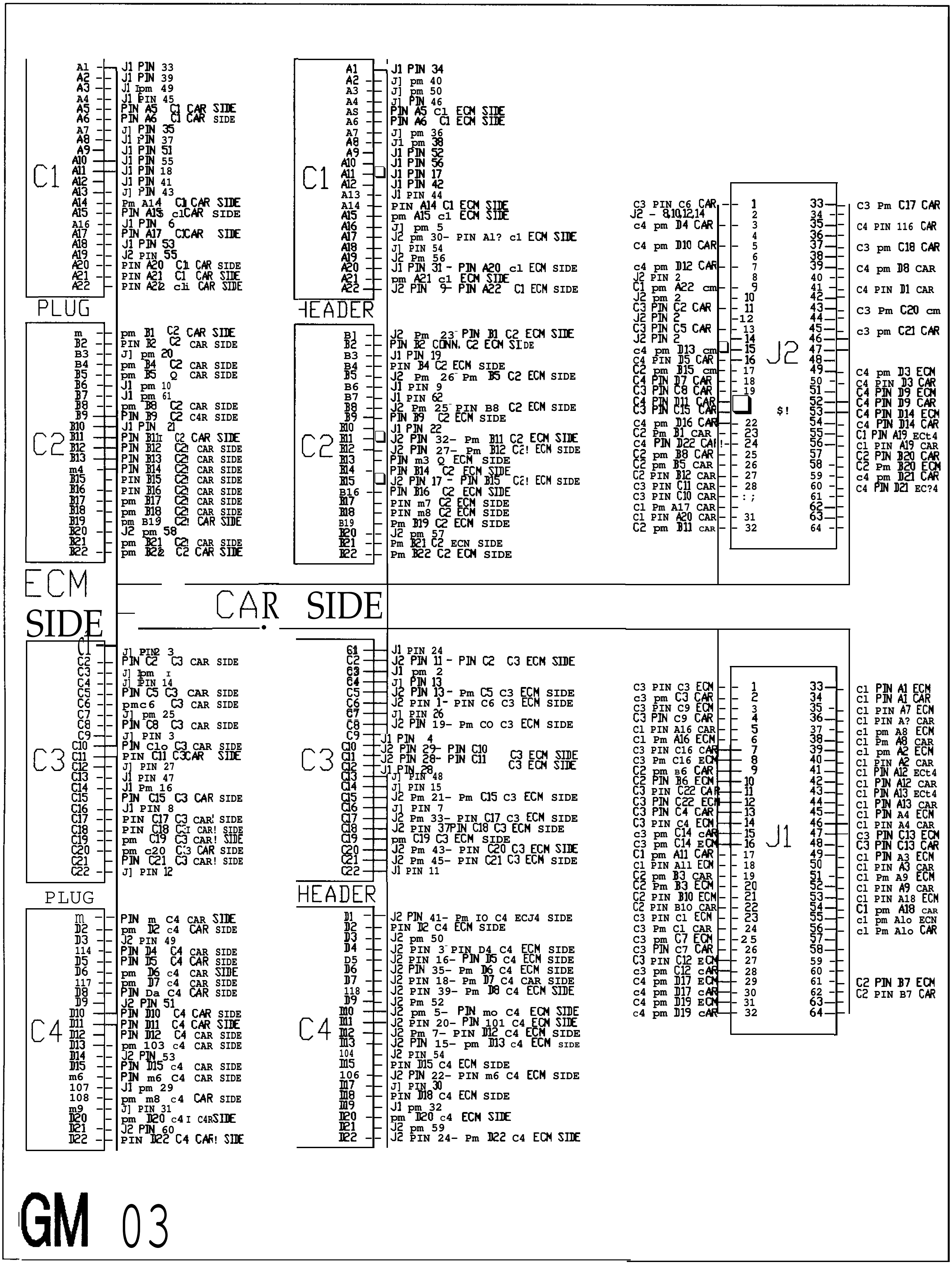
SECTION III.

This section contains an interconnection diagram for all cables that are complete as of the day of publication. This information should be used to identify cable problem. If the customer complains that a reading is not correct on an ’83 GM, and it uses GM 01 Cable, you can determine which pin of the vehicle the reading is taken on and check the continuity of that wire.

These diagrams include:

GM 01	**GM 03**	**GM 04**	**GM 05**	**GM 06**	**GM 07**
GM 08	**FM 01**	**FM 02**	**FM 03**	**CR 1A & 1B**	**CR 02**
TY 02	**TY 04**	**TY 07**			


FINGER BOARD
C1
C2
CAR SIDE
CM SIDE
PLUG
J1
J2
J1 PIN 9
J2 PIN 21 - PIN 2 C1 ECM SIDE
J2 PIN 23 - PIN 8 C1 ECM SIDE
J2 PIN 15 - PIN 10 C1 ECM SIDE
J2 PIN 25 - PIN 16 C1 ECM SIDE
J2 PIN 5 - PIN 22 C1 ECM SIDE
J2 PIN - PIN A C2 ECN SIDE
J2 PIN - PIN U C2 ECM SIDE
PIN 2 CONN. C1 CAR SIDE
PIN 10 C1 CAR SIDE
PIN 16 C1 CAR SIDE
Pm 22 C1 CAR SIDE
PIN A C2 CAR SIDE
PIN U C2 CAR SIDE
GM 01



C1
PLUG
A1 J1 PIN 33
A2 J1 PIN 39
A3 J1 Ipm 49
A4 J1 PIN 45
A5 PIN A5 C1 CAR SIDE
A6 PIN A6 C1 CAR SIDE
A7 J1 PIN 35
A8 J1 PIN 37
A9 J1 PIN 51
A10 J1 PIN 55
A11 J1 PIN 18
A12 J1 PIN 41
A13 J1 PIN 43
A14 Pm A14 C1 CAR SIDE
A15 PIN A15 c1CAR SIDE
A16 J1 PIN 6
A17 PIN A17 C1CAR SIDE
A18 J1 PIN 53
A19 J2 PIN 55
A20 PIN A20 C1 CAR SIDE
A21 PIN A21 C1 CAR SIDE
A22 PIN A22 c1i CAR SIDE
C1
HEADER
A1 J1 PIN 34
A2 J1 pm 40
A3 J1 pm 50
A4 J1 PIN 46
AS PIN A5 C1 ECM SIDE
A6 PIN A6 C1 ECM SIDE
A7 J1 pm 36
A8 J1 pm 38
A9 J1 PIN 52
A10 J1 PIN 56
A11 J1 PIN 17
A12 J1 PIN 42
A13 J1 PIN 44
A14 PIN A14 C1 ECM SIDE
A15 pm A15 c1 ECM SIDE
A16 J1 pm 5
A17 J2 pm 30- PIN A1? c1 ECM SIDE
A18 J1 PIN 54
A19 J2 Pm 56
A20 J1 PIN 31 - PIN A20 c1 ECM SIDE
A21 pm A21 c1 ECM SIDE
A22 J2 PIN 9- PIN A22 C1 ECM SIDE
C2
m pm B1 C2 CAR SIDE
B2 PIN B2 C2 CAR SIDE
B3 J1 pm 20
B4 pm B4 C2 CAR SIDE
B5 pm B5 Q CAR SIDE
B6 J1 pm 10
B7 J1 pm 61
B8 pm B8 C2 CAR SIDE
B9 PIN B9 C2 C4R SIDE
B10 J1 PIN 21
B11 PIN B11 C2 CAR SIDE
B12 PIN B12 C2 CAR SIDE
B13 PIN B13 C2 CAR SIDE
m4 PIN B14 C2 CAR SIDE
B15 PIN B15 C2 CAR SIDE
B16 PIN B16 C2 CAR SIDE
B17 pm B17 C2 CAR SIDE
B18 pm B18 C2 CAR SIDE
B19 pm B19 C2 CAR SIDE
B20 J2 pm 58
B21 pm B21 C2 CAR SIDE
B22 pm B22 C2 CAR SIDE
C2
B1 J2 Pm 23- PIN B1 C2 ECM SIDE
B2 PIN B2 CONN. C2 ECM SIDE
B3 J1 PIN 19
B4 PIN B4 C2 ECM SIDE
B5 J2 Pm 26 Pm B5 C2 ECM SIDE
B6 J1 PIN 9
B7 J1 PIN 62
B8 J2 Pm 25 PIN B8 C2 ECM SIDE
B9 PIN B9 C2 ECM SIDE
B10 J1 PIN 22
B11 J2 PIN 32- Pm B11 C2 ECM SIDE
B12 J2 PIN 27- Pm B12 C2! ECM SIDE
B13 PIN m3 Q ECM SIDE
B14 PIN B14 C2 ECM SIDE
B15 J2 PIN 17 - PIN B15 C2! ECM SIDE
B16 PIN B16 C2 ECM SIDE
B17 PIN m7 C2 ECM SIDE
B18 PIN m8 C2 ECM SIDE
B19 Pm B19 C2 ECM SIDE
B20 J2 pm 57
B21 Pm B21 C2 ECN SIDE
B22 Pm B22 C2 ECM SIDE
ECM SIDE
CAR SIDE
J2
C3 PIN C6 CAR 1
J2 - 8,10,12,14 2
c4 pm D4 CAR 3
4
C4 pm D10 CAR 5
6
c4 pm D12 CAR 7
J2 PIN 2 8
C1 pm A22 cm 9
J2 pm 2 10
C3 PIN C2 CAR 11
J2 PIN 2 12
C3 PIN C5 CAR 13
J2 PIN 2 14
c4 pm D13 cm 15
C4 PIN D5 CAR 16
C2 pm B15 cm 17
C4 PIN D7 CAR 18
C3 PIN C8 CAR 19
C4 PIN D11 CAR
C3 PIN C15 CAR
C4 pm D16 CAR 22
C2 Pm B1 CAR 23
C4 PIN D22 CAR 24
C2 pm B8 CAR 25
C2 pm B5 CAR 26
C2 PIN B12 CAR 27
C3 PIN C11 CAR 28
C3 PIN C10 CAR
C1 Pm A17 CAR
C1 PIN A20 CAR 31
C2 pm B11 CAR 32
33 C3 Pm C17 CAR
34
35 C4 PIN 116 CAR
36
37 C3 pm C18 CAR
38
39 C4 pm D8 CAR
40
41 C4 PIN D1 CAR
42
43 C3 Pm C20 cm
44
45 c3 pm C21 CAR
46
47
48
49 C4 pm D3 ECM
50 C4 PIN D3 CAR
51 C4 PIN D9 ECM
52 C4 PIN D9 CAR
53 C4 PIN D14 ECM
54 C4 PIN D14 CAR
55 C1 PIN A19 ECt4
56 C1 PIN A19 CAR
57 C2 PIN B20 CAR
58 C2 pm B20 ECM
59 c4 pm D21 CAR
60 C4 PIN D21 EC?4
61
62
63
64
$!
C3
PLUG
C1 J1 PIN 3
C2 PIN C2 C3 CAR SIDE
C3 J1 Ipm 1
C4 J1 PIN 14
C5 PIN C5 C3 CAR SIDE
C6 pmc6 C3 CAR SIDE
C7 J1 pm 25
C8 PIN C8 C3 CAR SIDE
C9 J1 PIN 3
C10 PIN C10 C3 CAR SIDE
C11 PIN C11 C3CAR SIDE
C12 J1 PIN 27
C13 J1 PIN 47
C14 J1 Pm 16
C15 PIN C15 C3 CAR SIDE
C16 J1 PIN 8
C17 PIN C17 C3 CAR! SIDE
C18 PIN C18 C3 CAR! SIDE
C19 pm C19 C3 CAR! SIDE
C20 pm c20 C3 CAR SIDE
C21 PIN C21 C3 CAR! SIDE
C22 J1 PIN 12
C3
HEADER
C1 J1 PIN 24
C2 J2 PIN 11 - PIN C2 C3 ECM SIDE
C3 J1 pm 2
C4 J1 PIN 13
C5 J2 PIN 13- Pm C5 C3 ECM SIDE
C6 J2 PIN 1- PIN C6 C3 ECM SIDE
C7 J1 PIN 26
C8 J2 PIN 19- Pm CO C3 ECM SIDE
C9 J1 PIN 4
C10 J2 PIN 29- PIN C10 C3 ECM SIDE
C11 J2 PIN 28- PIN C11 C3 ECM SIDE
C12 J1 PIN 28
C13 J1 PIN 48
C14 J1 PIN 15
C15 J2 Pm 21- Pm C15 C3 ECM SIDE
C16 J1 PIN 7
C17 J2 Pm 33- PIN C17 C3 ECM SIDE
C18 J2 PIN 37PIN C18 C3 ECM SIDE
C19 pm C19 C3 ECM SIDE
C20 J2 Pm 43- PIN C20 C3 ECM SIDE
C21 J2 Pm 45- PIN C21 C3 ECM SIDE
C22 J1 PIN 11
J1
C3 PIN C3 ECM 1
c3 pm C3 CAR 2
C3 PIN C9 ECM 3
C3 PIN C9 CAR 4
C1 PIN A16 CAR 5
C1 Pm A16 ECM 6
C3 PIN C16 CAR 7
C3 Pm C16 ECM 8
C2 pm B6 CAR 9
C2 PIN B6 ECM 10
C3 PIN C22 CAR 11
C3 PIN C22 ECM 12
C3 PIN C4 CAR 13
C3 PIN C4 ECM 14
c3 pm C14 CAR 15
C3 pm C14 ECM 16
C1 pm A11 CAR 17
C1 PIN A11 ECM 18
C2 pm B3 CAR 19
C2 Pm B3 ECM 20
C2 PIN B10 ECM 21
C2 PIN B10 CAR 22
C3 PIN C1 ECM 23
C3 Pm C1 CAR 24
C3 pm C7 ECM 25
C3 PIN C7 CAR 26
C3 PIN C12 ECM 27
c3 pm C12 CAR 28
C4 pm D17 ECM 29
c4 pm D17 CAR 30
C4 pm D19 ECM 31
c4 pm D19 CAR 32
33 C1 PIN A1 ECM
34 C1 PIN A1 CAR
35 C1 PIN A7 ECM
36 C1 PIN A? CAR
37 c1 pm A8 ECM
38 C1 Pm A8 CAR
39 c1 pm A2 ECM
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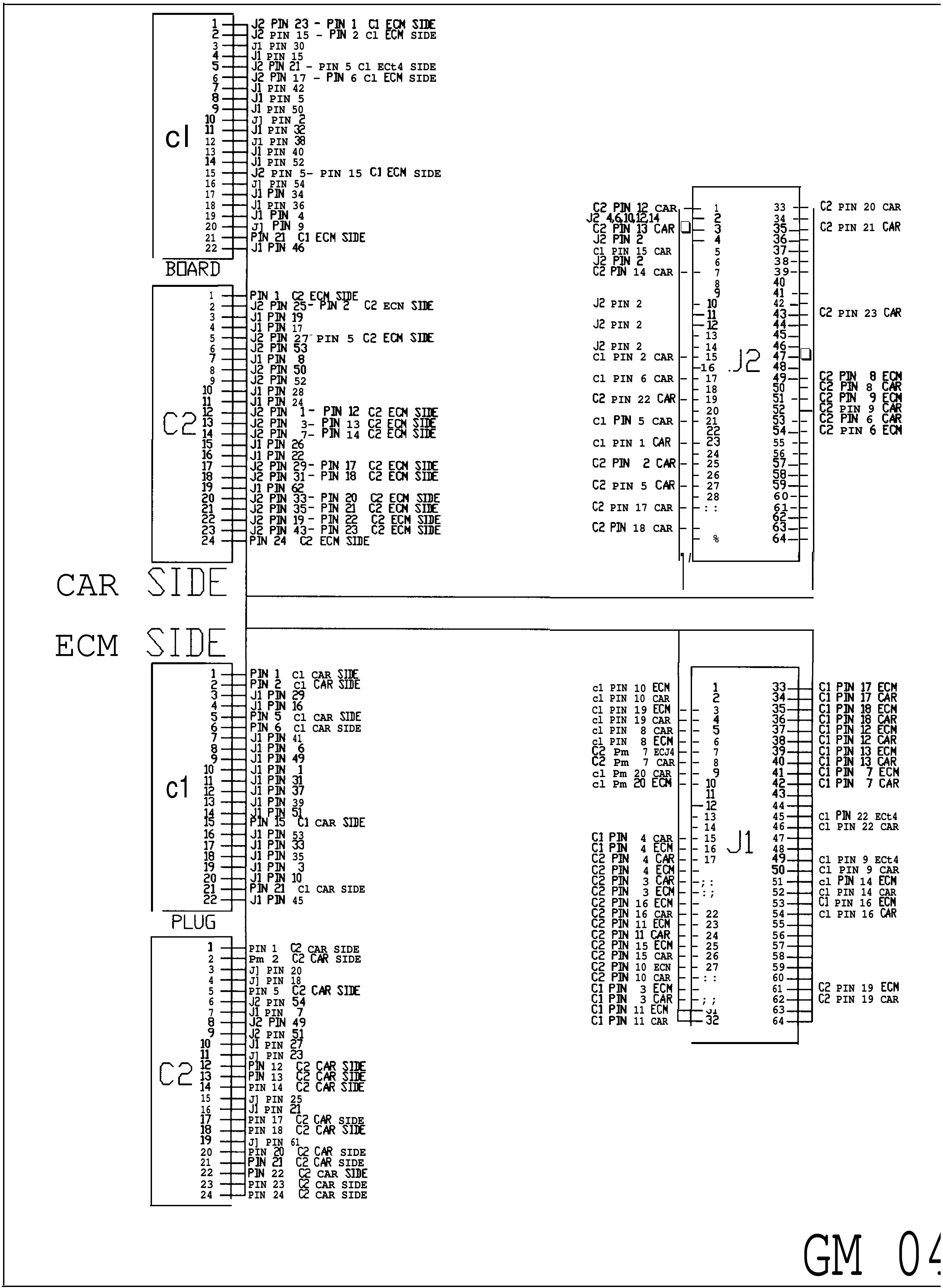
41 C1 PIN A12 ECt4
42 C1 PIN A12 CAR
43 C1 PIN A13 ECt4
44 C1 PIN A13 CAR
45 C1 PIN A4 ECM
46 C1 PIN A4 CAR
47 C3 PIN C13 ECM
48 C3 PIN C13 CAR
49 c1 PIN A3 ECM
50 C1 PIN A3 CAR
51 C1 Pm A9 ECM
52 C1 PIN A9 CAR
53 C1 PIN A18 ECM
54 C1 pm A18 CAR
55 c1 pm Alo ECN
56 c1 Pm Alo CAR
57
58
59
60
61 C2 PIN B7 ECM
62 C2 PIN B7 CAR
63
64
C4
PLUG
m PIN m C4 CAR SIDE
D2 pm D2 c4 CAR SIDE
D3 J2 PIN 49
114 PIN D4 C4 CAR SIDE
D5 PIN D5 C4 CAR SIDE
D6 pm D6 c4 CAR SIDE
117 pm D7 c4 CAR SIDE
D8 PIN Da C4 CAR SIDE
D9 J2 PIN 51
D10 PIN D10 C4 CAR SIDE
D11 PIN D11 C4 CAR SIDE
D12 PIN D12 C4 CAR SIDE
D13 pm 103 c4 CAR SIDE
D14 J2 PIN 53
D15 PIN D15 c4 CAR SIDE
m6 PIN m6 C4 CAR SIDE
107 J1 pm 29
108 pm m8 c4 CAR SIDE
m9 J1 PIN 31
D20 pm D20 c4 I C4RSIDE
D21 J2 PIN 60
D22 PIN D22 C4 CAR! SIDE
C4
D1 J2 PIN 41- Pm IO C4 ECJ4 SIDE
D2 PIN D2 C4 ECM SIDE
D3 J2 pm 50
D4 J2 PIN 3 PIN D4 C4 ECM SIDE
D5 J2 PIN 16- PIN D5 C4 ECM SIDE
D6 J2 PIN 35- Pm D6 C4 ECM SIDE
D7 J2 PIN 18- Pm D7 C4 CAR SIDE
118 J2 PIN 39- Pm D8 C4 ECM SIDE
D9 J2 Pm 52
D10 J2 pm 5- PIN mo C4 ECM SIDE
D11 J2 PIN 20- PIN 101 C4 ECM SIDE
D12 J2 Pm 7- PIN D12 C4 ECM SIDE
D13 J2 PIN 15- pm D13 c4 ECM SIDE
104 J2 PIN 54
D15 PIN D15 C4 ECM SIDE
106 J2 PIN 22- PIN m6 C4 ECM SIDE
D17 J1 PIN 30
D18 PIN D18 C4 ECM SIDE
D19 J1 pm 32
D20 pm D20 c4 ECM SIDE
D21 J2 pm 59
D22 J2 PIN 24- Pm D22 c4 ECM SIDE
GM 03



c1
BOARD
C2
CAR SIDE
ECM SIDE
c1
PLUG
C2
J2
J1
J2 PIN 23 - PIN 1 C1 ECM SIDE
J2 PIN 15 - PIN 2 C1 ECM SIDE
J1 PIN 30
J1 PIN 15
J2 PIN 21 - PIN 5 C1 ECt4 SIDE
J2 PIN 17 - PIN 6 C1 ECM SIDE
J1 PIN 42
J1 PIN 5
J1 PIN 50
J1 PIN 2
J1 PIN 32
J1 PIN 38
J1 PIN 40
J1 PIN 52
J2 PIN 5- PIN 15 C1 ECM SIDE
J1 PIN 54
J1 PIN 34
J1 PIN 36
J1 PIN 4
J1 PIN 9
PIN 21 C1 ECM SIDE
J1 PIN 46
PIN 1 C2 ECM SIDE
J2 PIN 25- PIN 2 C2 ECN SIDE
J1 PIN 19
J1 PIN 17
J2 PIN 27- PIN 5 C2 ECM SIDE
J2 PIN 53
J1 PIN 8
J2 PIN 50
J2 PIN 52
J1 PIN 28
J1 PIN 24
J2 PIN 1- PIN 12 C2 ECM SIDE
J2 PIN 3- PIN 13 C2 ECM SIDE
J2 PIN 7- PIN 14 C2 ECM SIDE
J1 PIN 26
J1 PIN 22
J2 PIN 29- PIN 17 C2 ECM SIDE
J2 PIN 31- PIN 18 C2 ECM SIDE
J1 PIN 62
J2 PIN 33- PIN 20 C2 ECM SIDE
J2 PIN 35- PIN 21 C2 ECM SIDE
J2 PIN 19- PIN 22 C2 ECM SIDE
J2 PIN 43- PIN 23 C2 ECM SIDE
PIN 24 C2 ECM SIDE
C2 PIN 12 CAR
J2 4,6,10,12,14
C2 PIN 13 CAR
J2 PIN 2
C1 PIN 15 CAR
J2 PIN 2
C2 PIN 14 CAR
J2 PIN 2
J2 PIN 2
J2 PIN 2
C1 PIN 2 CAR
C1 PIN 6 CAR
C2 PIN 22 CAR
C1 PIN 5 CAR
C1 PIN 1 CAR
C2 PIN 2 CAR
C2 PIN 5 CAR
C2 PIN 17 CAR
C2 PIN 18 CAR
C2 PIN 20 CAR
C2 PIN 21 CAR
C2 PIN 23 CAR
C2 PIN 8 ECM
C2 PIN 8 CAR
C2 PIN 9 ECM
C2 PIN 9 CAR
C2 PIN 6 CAR
C2 PIN 6 ECM
PIN 1 C1 CAR SIDE
PIN 2 C1 CAR SIDE
J1 PIN 29
J1 PIN 16
PIN 5 C1 CAR SIDE
PIN 6 C1 CAR SIDE
J1 PIN 41
J1 PIN 6
J1 PIN 49
J1 PIN 1
J1 PIN 31
J1 PIN 37
J1 PIN 39
J1 PIN 51
PIN 15 C1 CAR SIDE
J1 PIN 53
J1 PIN 33
J1 PIN 35
J1 PIN 3
J1 PIN 10
PIN 21 C1 CAR SIDE
J1 PIN 45
PIN 1 C2 CAR SIDE
PIN 2 C2 CAR SIDE
J1 PIN 20
J1 PIN 18
PIN 5 C2 CAR SIDE
J2 PIN 54
J1 PIN 7
J2 PIN 49
J2 PIN 51
J1 PIN 27
J1 PIN 23
PIN 12 C2 CAR SIDE
PIN 13 C2 CAR SIDE
PIN 14 C2 CAR SIDE
J1 PIN 25
J1 PIN 21
PIN 17 C2 CAR SIDE
PIN 18 C2 CAR SIDE
J1 PIN 61
PIN 20 C2 CAR SIDE
PIN 21 C2 CAR SIDE
PIN 22 C2 CAR SIDE
PIN 23 C2 CAR SIDE
PIN 24 C2 CAR SIDE
c1 PIN 10 ECM
c1 PIN 10 CAR
c1 PIN 19 ECM
c1 PIN 19 CAR
c1 PIN 8 CAR
c1 PIN 8 ECM
C2 PIN 7 ECM
C2 PIN 7 CAR
c1 PIN 20 CAR
c1 PIN 20 ECM
C1 PIN 4 CAR
C1 PIN 4 ECM
C2 PIN 4 CAR
C2 PIN 4 ECM
C2 PIN 3 CAR
C2 PIN 3 ECM
C2 PIN 16 ECM
C2 PIN 16 CAR
C2 PIN 11 ECM
C2 PIN 11 CAR
C2 PIN 15 ECM
C2 PIN 15 CAR
C2 PIN 10 ECM
C2 PIN 10 CAR
C1 PIN 3 ECM
C1 PIN 3 CAR
C1 PIN 11 ECM
C1 PIN 11 CAR
C1 PIN 17 ECM
C1 PIN 17 CAR
C1 PIN 18 ECM
C1 PIN 18 CAR
C1 PIN 12 ECM
C1 PIN 12 CAR
C1 PIN 13 ECM
C1 PIN 13 CAR
C1 PIN 7 ECM
C1 PIN 7 CAR
C1 PIN 22 ECM
C1 PIN 22 CAR
C1 PIN 9 ECM
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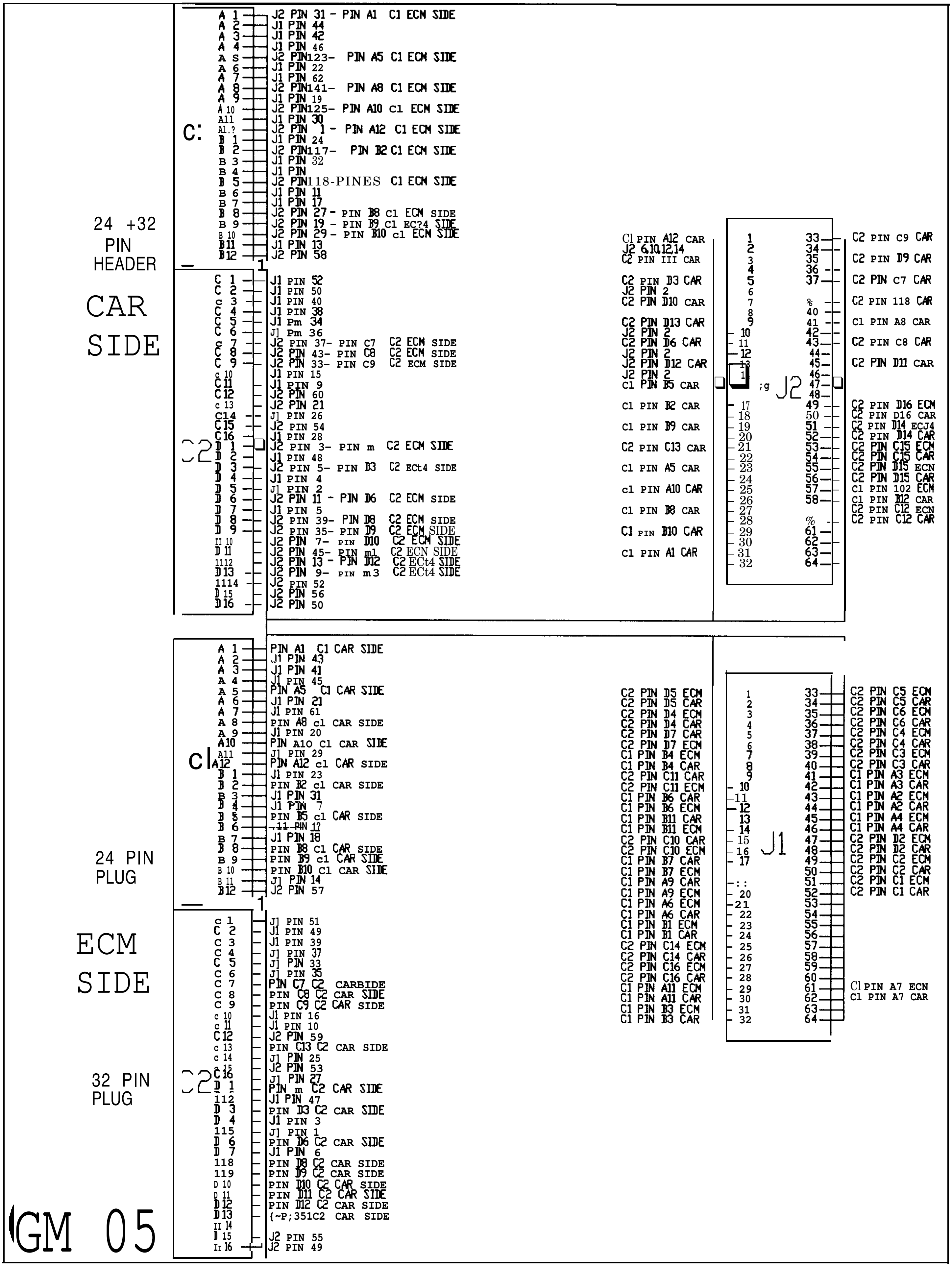
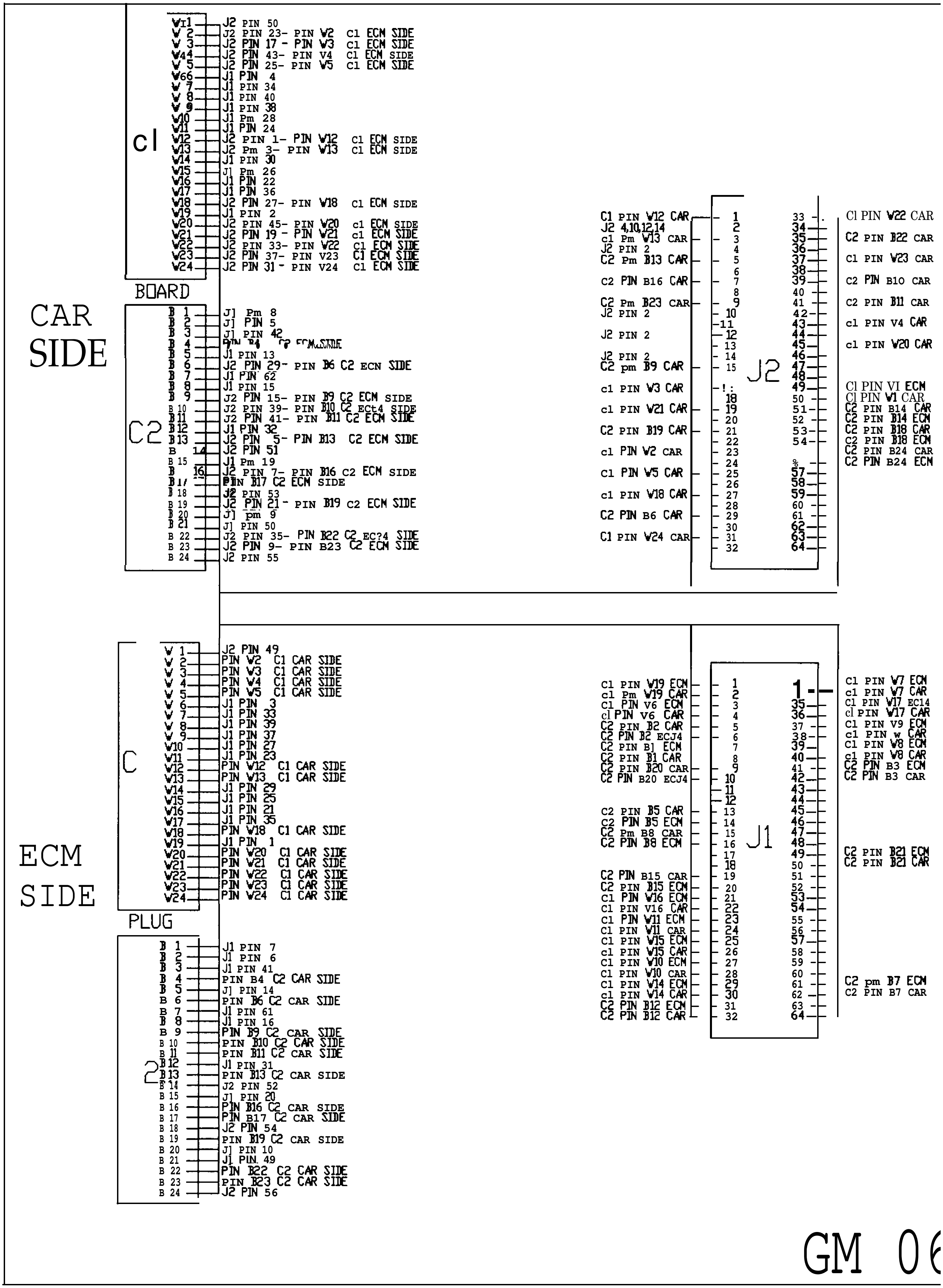
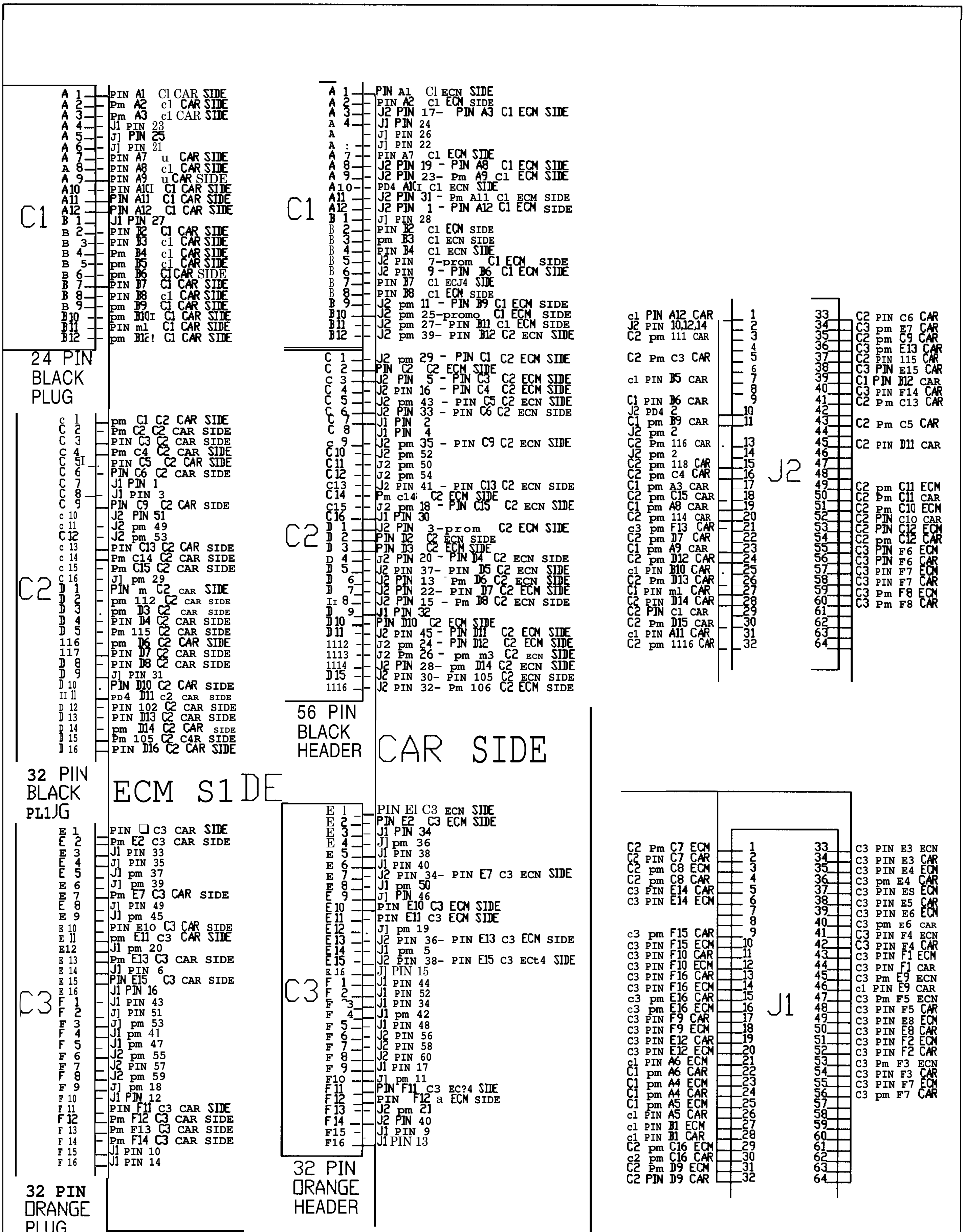
C2 PIN 19 ECM
C2 PIN 19 CAR

GM 04



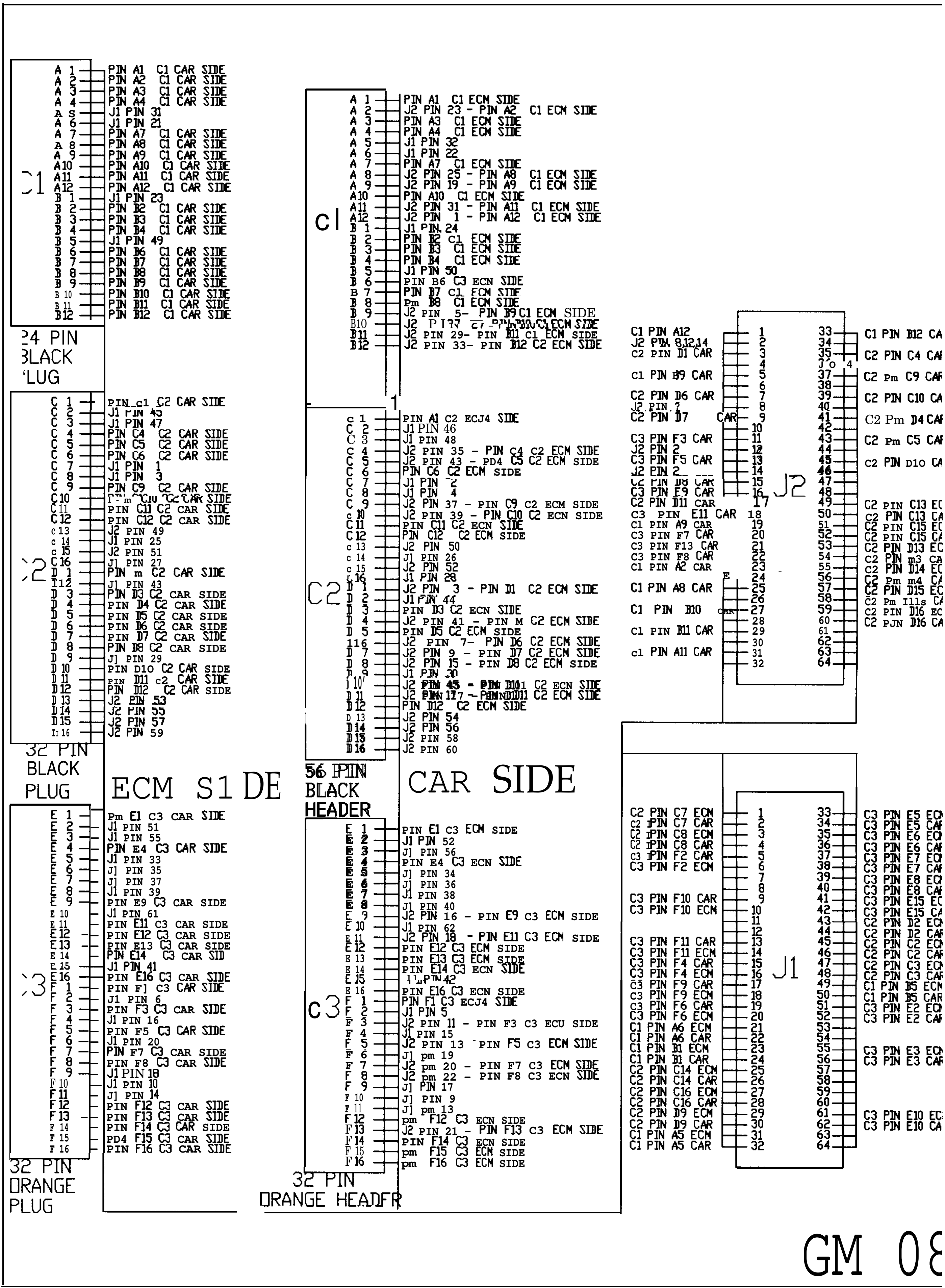
24 +32
PIN
HEADER
CAR
SIDE
C1
A 1 J2 PIN 31 - PIN A1 C1 ECM SIDE
A 2 J1 PIN 44
A 3 J1 PIN 42
A 4 J1 PIN 46
A S J2 PIN123- PIN A5 C1 ECM SIDE
A 6 J1 PIN 22
A 7 J1 PIN 62
A 8 J2 PIN141- PIN A8 C1 ECM SIDE
A 9 J1 PIN 19
A 10 J2 PIN125- PIN A10 c1 ECM SIDE
A11 J1 PIN 30
A1.? J2 PIN 1 - PIN A12 C1 ECM SIDE
B 1 J1 PIN 24
B 2 J2 PIN117- PIN B2 C1 ECM SIDE
B 3 J1 PIN 32
B 4 J1 PIN
B 5 J2 PIN118-PINES C1 ECM SIDE
B 6 J1 PIN 11
B 7 J1 PIN 17
B 8 J2 PIN 27 - PIN B8 c1 ECM SIDE
B 9 J2 PIN 19 - PIN B9 C1 EC?4 SIDE
B 10 J2 PIN 29 - PIN B10 c1 ECM SIDE
B11 J1 PIN 13
B12 J2 PIN 58
C2
C 1 J1 PIN 52
C 2 J1 PIN 50
C 3 J1 PIN 40
C 4 J1 PIN 38
C 5 J1 Pm 34
C 6 J] Pm 36
C 7 J2 PIN 37- PIN C7 C2 ECM SIDE
C 8 J2 PIN 43- PIN C8 C2 ECM SIDE
C 9 J2 PIN 33- PIN C9 C2 ECM SIDE
c 10 J1 PIN 15
C11 J1 PIN 9
C12 J2 PIN 60
c 13 J2 PIN 21
C14 J] PIN 26
C15 J2 PIN 54
C16 J1 PIN 28
D 1 J2 PIN 3- PIN m C2 ECM SIDE
D 2 J1 PIN 48
D 3 J2 PIN 5- PIN D3 C2 ECt4 SIDE
D 4 J1 PIN 4
D 5 J] PIN 2
D 6 J2 PIN 11 - PIN D6 C2 ECM SIDE
D 7 J1 PIN 5
D 8 J2 PIN 39- PIN D8 C2 ECM SIDE
D 9 J2 PIN 35- PIN D9 C2 ECM SIDE
II 10 J2 PIN 7- PIN D10 C2 ECM SIDE
D 11 J2 PIN 45- PIN m1 C2 ECN SIDE
1112 J2 PIN 13 - PIN D12 C2 ECt4 SIDE
D13 J2 PIN 9- PIN m3 C2 ECt4 SIDE
1114 J2 PIN 52
D 15 J2 PIN 56
D16 J2 PIN 50
C1 PIN A12 CAR
J2 6,10,12,14
C2 PIN III CAR
C2 PIN D3 CAR
J2 PIN 2
C2 PIN D10 CAR
C2 PIN D13 CAR
J2 PIN 2
C2 PIN D6 CAR
J2 PIN 2
J2 PIN D12 CAR
J2 PIN 2
C1 PIN B5 CAR
C1 PIN B2 CAR
C1 PIN B9 CAR
C2 PIN C13 CAR
C1 PIN A5 CAR
c1 PIN A10 CAR
C1 PIN B8 CAR
C1 PIN B10 CAR
C1 PIN A1 CAR
J2
C2 PIN C9 CAR
C2 PIN D9 CAR
C2 PIN C7 CAR
C2 PIN 118 CAR
C1 PIN A8 CAR
C2 PIN C8 CAR
C2 PIN D11 CAR
C2 PIN D16 ECM
C2 PIN D16 CAR
C2 PIN D14 ECJ4
C2 PIN D14 CAR
C2 PIN C15 ECM
C2 PIN C15 CAR
C2 PIN D15 ECN
C2 PIN D15 CAR
C1 PIN 102 ECM
C1 PIN B12 CAR
C2 PIN C12 ECN
C2 PIN C12 CAR
24 PIN
PLUG
ECM
SIDE
32 PIN
PLUG
C1
A 1 PIN A1 C1 CAR SIDE
A 2 J1 PIN 43
A 3 J1 PIN 41
A 4 J1 PIN 45
A 5 PIN A5 C1 CAR SIDE
A 6 J1 PIN 21
A 7 J1 PIN 61
A 8 PIN A8 c1 CAR SIDE
A 9 J1 PIN 20
A10 PIN A10 C1 CAR SIDE
A11 J] PIN 29
A12 PIN A12 c1 CAR SIDE
B 1 J1 PIN 23
B 2 PIN B2 c1 CAR SIDE
B 3 J1 PIN 31
B 4 J1 PIN 7
B 5 PIN B5 c1 CAR SIDE
B 6 J1 PIN 12
B 7 J1 PIN 18
B 8 PIN B8 C1 CAR SIDE
B 9 PIN B9 c1 CAR SIDE
B 10 PIN B10 C1 CAR SIDE
B 11 J1 PIN 14
B12 J2 PIN 57
C2
C 1 J] PIN 51
C 2 J1 PIN 49
C 3 J1 PIN 39
C 4 J] PIN 37
C 5 J] PIN 33
C 6 J] PIN 35
C 7 PIN C7 C2 CARBIDE
C 8 PIN C8 C2 CAR SIDE
C 9 PIN C9 C2 CAR SIDE
c 10 J1 PIN 16
c 11 J1 PIN 10
C12 J2 PIN 59
c 13 PIN C13 C2 CAR SIDE
c 14 J] PIN 25
c 15 J2 PIN 53
C16 J] PIN 27
D 1 PIN m C2 CAR SIDE
112 J1 PIN 47
D 3 PIN D3 C2 CAR SIDE
D 4 J1 PIN 3
115 J] PIN 1
D 6 PIN D6 C2 CAR SIDE
D 7 J1 PIN 6
118 PIN D8 C2 CAR SIDE
119 PIN D9 C2 CAR SIDE
D 10 PIN D10 C2 CAR SIDE
D 11 PIN D11 C2 CAR SIDE
D12 PIN D12 C2 CAR SIDE
D13 {~P;351C2 CAR SIDE
II 14
D 15 J2 PIN 55
I1 16 J2 PIN 49
C2 PIN D5 ECM
C2 PIN D5 CAR
C2 PIN D4 ECM
C2 PIN D4 CAR
C2 PIN D7 CAR
C2 PIN D7 ECM
C1 PIN B4 ECM
C1 PIN B4 CAR
C2 PIN C11 CAR
C2 PIN C11 ECM
C1 PIN B6 CAR
C1 PIN B6 ECM
C1 PIN B11 CAR
C1 PIN B11 ECM
C2 PIN C10 CAR
C2 PIN C10 ECM
C1 PIN B7 CAR
C1 PIN B7 ECM
C1 PIN A9 CAR
C1 PIN A9 ECM
C1 PIN A6 ECM
C1 PIN A6 CAR
C1 PIN B1 ECM
C1 PIN B1 CAR
C2 PIN C14 ECM
C2 PIN C14 CAR
C2 PIN C16 ECM
C2 PIN C16 CAR
C1 PIN A11 ECM
C1 PIN A11 CAR
C1 PIN B3 ECM
C1 PIN B3 CAR
J1
C2 PIN C5 ECM
C2 PIN C5 CAR
C2 PIN C6 ECM
C2 PIN C6 CAR
C2 PIN C4 ECM
C2 PIN C4 CAR
C2 PIN C3 ECM
C2 PIN C3 CAR
C1 PIN A3 ECM
C1 PIN A3 CAR
C1 PIN A2 ECM
C1 PIN A2 CAR
C1 PIN A4 ECM
C1 PIN A4 CAR
C2 PIN D2 ECM
C2 PIN D2 CAR
C2 PIN C2 ECM
C2 PIN C2 CAR
C2 PIN C1 ECM
C2 PIN C1 CAR
C1 PIN A7 ECN
C1 PIN A7 CAR
GM 05

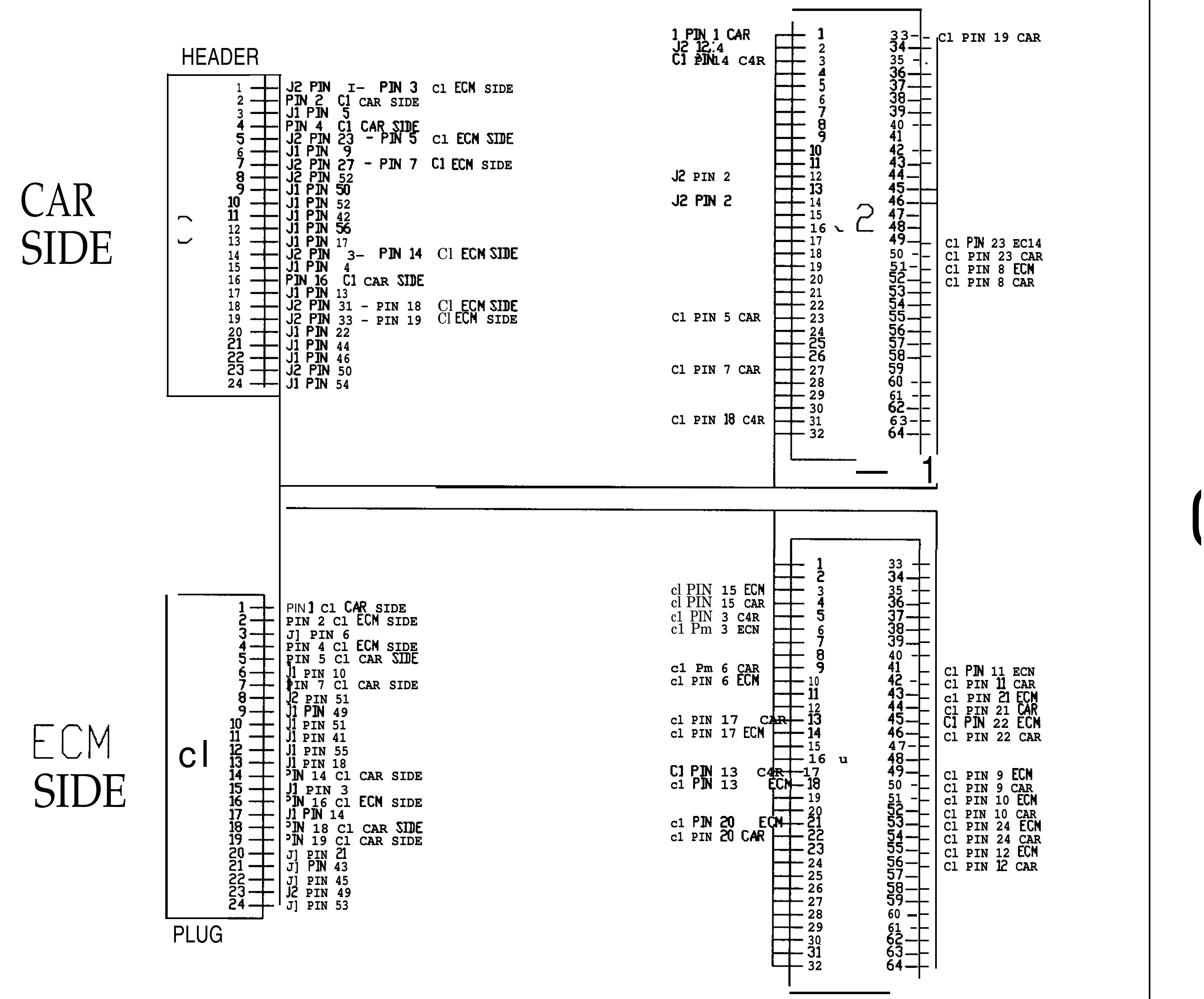

CAR SIDE
C1
BOARD
C2
V1 - J2 PIN 50
V2 - J2 PIN 23- PIN V2 C1 ECM SIDE
V3 - J2 PIN 17 - PIN V3 C1 ECM SIDE
V4 - J2 PIN 43- PIN V4 C1 ECM SIDE
V5 - J2 PIN 25- PIN V5 C1 ECM SIDE
V6 - J1 PIN 4
V7 - J1 PIN 34
V8 - J1 PIN 40
V9 - J1 PIN 38
V10 - J1 Pm 28
V11 - J1 PIN 24
V12 - J2 PIN 1- PIN V12 C1 ECM SIDE
V13 - J2 Pm 3- PIN V13 C1 ECM SIDE
V14 - J1 PIN 30
V15 - J1 Pm 26
V16 - J1 PIN 22
V17 - J1 PIN 36
V18 - J2 PIN 27- PIN V18 C1 ECM SIDE
V19 - J1 PIN 2
V20 - J2 PIN 45- PIN V20 C1 ECM SIDE
V21 - J2 PIN 19 - PIN V21 C1 ECM SIDE
V22 - J2 PIN 33- PIN V22 C1 ECM SIDE
V23 - J2 PIN 37- PIN V23 C1 ECM SIDE
V24 - J2 PIN 31 - PIN V24 C1 ECM SIDE
B1 - J1 Pm 8
B2 - J1 PIN 5
B3 - J1 PIN 42
B4 - PIN B4 C2 ECM SIDE
B5 - J1 PIN 13
B6 - J2 PIN 29- PIN B6 C2 ECN SIDE
B7 - J1 PIN 62
B8 - J1 PIN 15
B9 - J2 PIN 15- PIN B9 C2 ECM SIDE
B10 - J2 PIN 39- PIN B10 C2 ECt4 SIDE
B11 - J2 PIN 41- PIN B11 C2 ECM SIDE
B12 - J1 PIN 32
B13 - J2 PIN 5- PIN B13 C2 ECM SIDE
B14 - J2 PIN 51
B15 - J1 Pm 19
B16 - J2 PIN 7- PIN B16 C2 ECM SIDE
B17 - PIN B17 C2 ECM SIDE
B18 - J2 PIN 53
B19 - J2 PIN 21 - PIN B19 C2 ECM SIDE
B20 - J1 pm 9
B21 - J1 PIN 50
B22 - J2 PIN 35- PIN B22 C2 EC?4 SIDE
B23 - J2 PIN 9- PIN B23 C2 ECM SIDE
B24 - J2 PIN 55
J2
1 - C1 PIN V12 CAR
2 - J2 4,10,12,14
3 - C1 Pm V13 CAR
4 - J2 PIN 2
5 - C2 Pm B13 CAR
7 - C2 PIN B16 CAR
9 - C2 Pm B23 CAR
10 - J2 PIN 2
12 - J2 PIN 2
14 - J2 PIN 2
15 - C2 pm B9 CAR
17 - C1 PIN V3 CAR
19 - C1 PIN V21 CAR
21 - C2 PIN B19 CAR
23 - C1 PIN V2 CAR
25 - C1 PIN V5 CAR
27 - C1 PIN V18 CAR
29 - C2 PIN B6 CAR
31 - C1 PIN V24 CAR
33 - C1 PIN V22 CAR
35 - C2 PIN B22 CAR
37 - C1 PIN V23 CAR
39 - C2 PIN B10 CAR
41 - C2 PIN B11 CAR
43 - C1 PIN V4 CAR
45 - C1 PIN V20 CAR
49 - C1 PIN V1 ECM
50 - C1 PIN V1 CAR
51 - C2 PIN B14 CAR
52 - C2 PIN B14 ECM
53 - C2 PIN B18 CAR
54 - C2 PIN B18 ECM
55 - C2 PIN B24 CAR
56 - C2 PIN B24 ECM
ECM SIDE
C1
PLUG
C2
V1 - J2 PIN 49
V2 - PIN V2 C1 CAR SIDE
V3 - PIN V3 C1 CAR SIDE
V4 - PIN V4 C1 CAR SIDE
V5 - PIN V5 C1 CAR SIDE
V6 - J1 PIN 3
V7 - J1 PIN 33
V8 - J1 PIN 39
V9 - J1 PIN 37
V10 - J1 PIN 27
V11 - J1 PIN 23
V12 - PIN V12 C1 CAR SIDE
V13 - PIN V13 C1 CAR SIDE
V14 - J1 PIN 29
V15 - J1 PIN 25
V16 - J1 PIN 21
V17 - J1 PIN 35
V18 - PIN V18 C1 CAR SIDE
V19 - J1 PIN 1
V20 - PIN V20 C1 CAR SIDE
V21 - PIN V21 C1 CAR SIDE
V22 - PIN V22 C1 CAR SIDE
V23 - PIN V23 C1 CAR SIDE
V24 - PIN V24 C1 CAR SIDE
B1 - J1 PIN 7
B2 - J1 PIN 6
B3 - J1 PIN 41
B4 - PIN B4 C2 CAR SIDE
B5 - J1 PIN 14
B6 - PIN B6 C2 CAR SIDE
B7 - J1 PIN 61
B8 - J1 PIN 16
B9 - PIN B9 C2 CAR SIDE
B10 - PIN B10 C2 CAR SIDE
B11 - PIN B11 C2 CAR SIDE
B12 - J1 PIN 31
B13 - PIN B13 C2 CAR SIDE
B14 - J2 PIN 52
B15 - J1 PIN 20
B16 - PIN B16 C2 CAR SIDE
B17 - PIN B17 C2 CAR SIDE
B18 - J2 PIN 54
B19 - PIN B19 C2 CAR SIDE
B20 - J1 PIN 10
B21 - J1 PIN 49
B22 - PIN B22 C2 CAR SIDE
B23 - PIN B23 C2 CAR SIDE
B24 - J2 PIN 56
J1
1 - C1 PIN V19 ECM
2 - C1 Pm V19 CAR
3 - C1 PIN V6 ECM
4 - C1 PIN V6 CAR
5 - C2 PIN B2 CAR
6 - C2 PIN B2 ECM
7 - C2 PIN B1 ECM
8 - C2 PIN B1 CAR
9 - C2 PIN B20 CAR
10 - C2 PIN B20 ECM
13 - C2 PIN B5 CAR
14 - C2 PIN B5 ECM
15 - C2 Pm B8 CAR
16 - C2 PIN B8 ECM
19 - C2 PIN B15 CAR
20 - C2 PIN B15 ECM
21 - C1 PIN V16 ECM
22 - C1 PIN V16 CAR
23 - C1 PIN V11 ECM
24 - C1 PIN V11 CAR
25 - C1 PIN V15 ECM
26 - C1 PIN V15 CAR
27 - C1 PIN V10 ECM
28 - C1 PIN V10 CAR
29 - C1 PIN V14 ECM
30 - C1 PIN V14 CAR
31 - C2 PIN B12 ECM
32 - C2 PIN B12 CAR
33 - C1 PIN V7 ECM
34 - C1 PIN V7 CAR
35 - C1 PIN V17 ECM
36 - C1 PIN V17 CAR
37 - C1 PIN V9 ECM
38 - C1 PIN V9 CAR
39 - C1 PIN V8 ECM
40 - C1 PIN V8 CAR
41 - C2 PIN B3 ECM
42 - C2 PIN B3 CAR
49 - C2 PIN B21 ECM
50 - C2 PIN B21 CAR
61 - C2 pm B7 ECM
62 - C2 PIN B7 CAR
GM 06



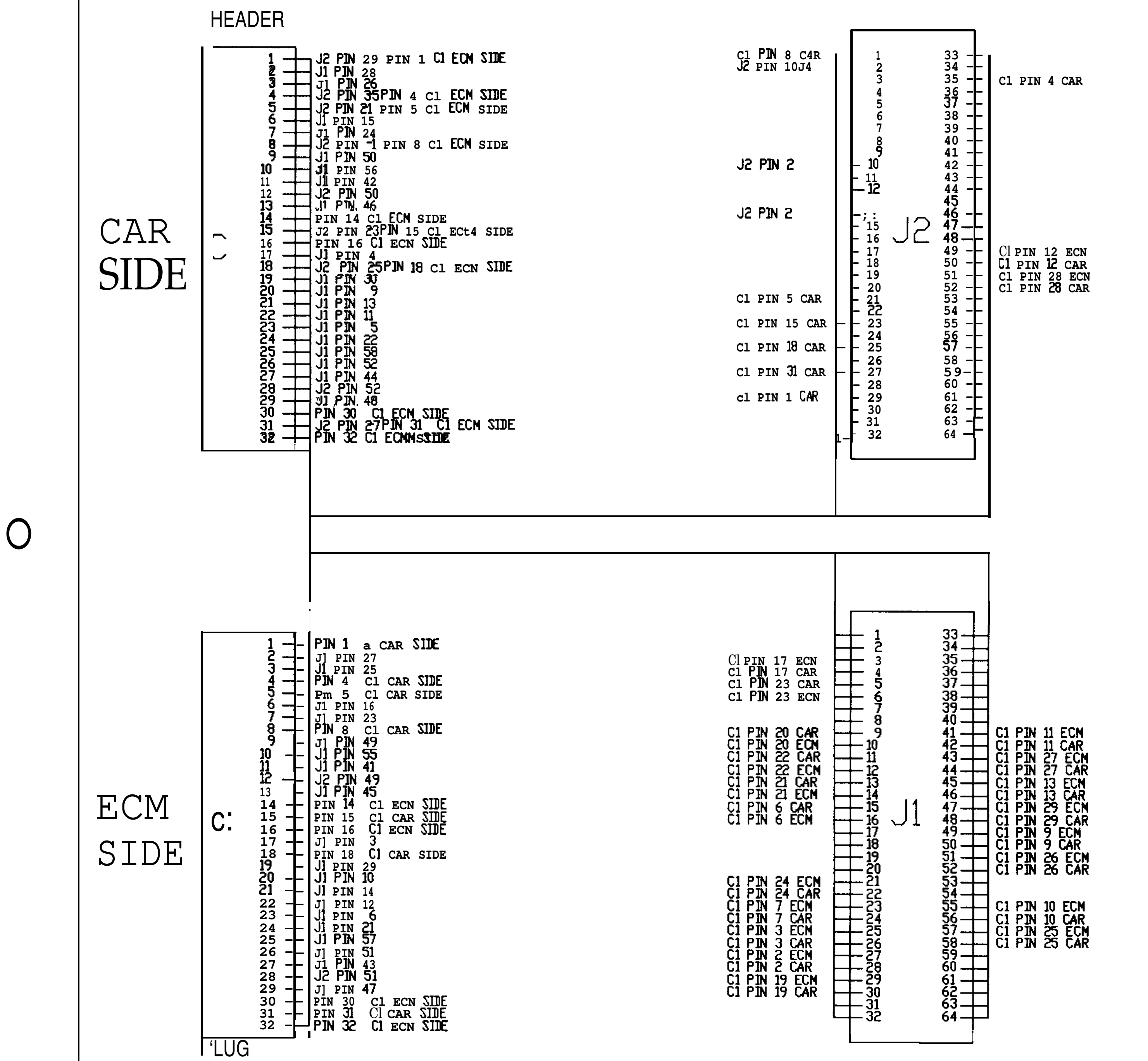
C1
24 PIN
BLACK
PLUG
C2
32 PIN
BLACK
PLUG
ECM SIDE
C3
32 PIN
ORANGE
PLUG
C1
56 PIN
BLACK
HEADER
C2
CAR SIDE
C3
32 PIN
ORANGE
HEADER
J2
J1

GM 07


C1
24 PIN
BLACK
PLUG
C2
32 PIN
BLACK
PLUG
C3
32 PIN
ORANGE
PLUG
ECM SIDE
C1
C2
56 PIN
BLACK
HEADER
C3
32 PIN
ORANGE HEADER
CAR SIDE
J2
J1
GM 08


HEADER
CAR
SIDE
J2 PIN 1- PIN 3 C1 ECM SIDE
PIN 2 C1 CAR SIDE
J1 PIN 5
PIN 4 C1 CAR SIDE
J2 PIN 23 - PIN 5 C1 ECM SIDE
J1 PIN 9
J2 PIN 27 - PIN 7 C1 ECM SIDE
J2 PIN 52
J1 PIN 50
J1 PIN 52
J1 PIN 42
J1 PIN 56
J1 PIN 17
J2 PIN 3- PIN 14 C1 ECM SIDE
J1 PIN 4
PIN 16 C1 CAR SIDE
J1 PIN 13
J2 PIN 31 - PIN 18 C1 ECM SIDE
J2 PIN 33 - PIN 19 C1 ECM SIDE
J1 PIN 22
J1 PIN 44
J1 PIN 46
J2 PIN 50
J1 PIN 54
1 PIN 1 CAR
J2 12.4
C1 PIN 14 C4R
J2 PIN 2
J2 PIN 2
C1 PIN 5 CAR
C1 PIN 7 CAR
C1 PIN 18 C4R
C1 PIN 19 CAR
C1 PIN 23 EC14
C1 PIN 23 CAR
C1 PIN 8 ECM
C1 PIN 8 CAR
ECM
SIDE
c1
PLUG
PIN 1 C1 CAR SIDE
PIN 2 C1 ECM SIDE
J1 PIN 6
PIN 4 C1 ECM SIDE
PIN 5 C1 CAR SIDE
J1 PIN 10
PIN 7 C1 CAR SIDE
J2 PIN 51
J1 PIN 49
J1 PIN 51
J1 PIN 41
J1 PIN 55
J1 PIN 18
PIN 14 C1 CAR SIDE
J1 PIN 3
PIN 16 C1 ECM SIDE
J1 PIN 14
PIN 18 C1 CAR SIDE
PIN 19 C1 CAR SIDE
J1 PIN 21
J1 PIN 43
J1 PIN 45
J2 PIN 49
J1 PIN 53
c1 PIN 15 ECM
c1 PIN 15 CAR
c1 PIN 3 C4R
c1 Pm 3 ECN
c1 Pm 6 CAR
c1 PIN 6 ECM
c1 PIN 17 CAR
c1 PIN 17 ECM
C1 PIN 13 C4R
c1 PIN 13 ECM
c1 PIN 20 ECM
c1 PIN 20 CAR
C1 PIN 11 ECN
C1 PIN 11 CAR
c1 PIN 21 ECM
C1 PIN 21 CAR
C1 PIN 22 ECM
C1 PIN 22 CAR
C1 PIN 9 ECM
C1 PIN 9 CAR
c1 PIN 10 ECM
C1 PIN 10 CAR
C1 PIN 24 ECM
C1 PIN 24 CAR
C1 PIN 12 ECM
C1 PIN 12 CAR

FM 01


HEADER
CAR SIDE
1 J2 PIN 29 PIN 1 C1 ECM SIDE
2 J1 PIN 28
3 J1 PIN 26
4 J2 PIN 35PIN 4 C1 ECM SIDE
5 J2 PIN 21 PIN 5 C1 ECM SIDE
6 J1 PIN 15
7 J1 PIN 24
8 J2 PIN -1 PIN 8 C1 ECM SIDE
9 J1 PIN 50
10 J1 PIN 56
11 J1 PIN 42
12 J2 PIN 50
13 J1 PIN 46
14 PIN 14 C1 ECM SIDE
15 J2 PIN 23PIN 15 C1 ECt4 SIDE
16 PIN 16 C1 ECN SIDE
17 J1 PIN 4
18 J2 PIN 25PIN 18 C1 ECN SIDE
19 J1 PIN 30
20 J1 PIN 9
21 J1 PIN 13
22 J1 PIN 11
23 J1 PIN 5
24 J1 PIN 22
25 J1 PIN 58
26 J1 PIN 52
27 J1 PIN 44
28 J2 PIN 52
29 J1 PIN 48
30 PIN 30 C1 ECM SIDE
31 J2 PIN 27PIN 31 C1 ECM SIDE
32 PIN 32 C1 ECM SIDE
C1 PIN 8 C4R
J2 PIN 10J4
J2 PIN 2
J2 PIN 2
C1 PIN 5 CAR
C1 PIN 15 CAR
C1 PIN 18 CAR
C1 PIN 31 CAR
C1 PIN 1 CAR
J2
C1 PIN 4 CAR
C1 PIN 12 ECN
C1 PIN 12 CAR
C1 PIN 28 ECN
C1 PIN 28 CAR
O
ECM SIDE
C:
1 PIN 1 a CAR SIDE
2 J1 PIN 27
3 J1 PIN 25
4 PIN 4 C1 CAR SIDE
5 Pm 5 C1 CAR SIDE
6 J1 PIN 16
7 J1 PIN 23
8 PIN 8 C1 CAR SIDE
9 J1 PIN 49
10 J1 PIN 55
11 J1 PIN 41
12 J2 PIN 49
13 J1 PIN 45
14 PIN 14 C1 ECN SIDE
15 PIN 15 C1 CAR SIDE
16 PIN 16 C1 ECN SIDE
17 J1 PIN 3
18 PIN 18 C1 CAR SIDE
19 J1 PIN 29
20 J1 PIN 10
21 J1 PIN 14
22 J1 PIN 12
23 J1 PIN 6
24 J1 PIN 21
25 J1 PIN 57
26 J1 PIN 51
27 J1 PIN 43
28 J2 PIN 51
29 J1 PIN 47
30 PIN 30 C1 ECN SIDE
31 PIN 31 C1 CAR SIDE
32 PIN 32 C1 ECN SIDE
'LUG
C1 PIN 17 ECN
C1 PIN 17 CAR
C1 PIN 23 CAR
C1 PIN 23 ECN
C1 PIN 20 CAR
C1 PIN 20 ECM
C1 PIN 22 CAR
C1 PIN 22 ECM
C1 PIN 21 CAR
C1 PIN 21 ECM
C1 PIN 6 CAR
C1 PIN 6 ECM
C1 PIN 24 ECM
C1 PIN 24 CAR
C1 PIN 7 ECM
C1 PIN 7 CAR
C1 PIN 3 ECM
C1 PIN 3 CAR
C1 PIN 2 ECM
C1 PIN 2 CAR
C1 PIN 19 ECM
C1 PIN 19 CAR
J1
C1 PIN 11 ECM
C1 PIN 11 CAR
C1 PIN 27 ECM
C1 PIN 27 CAR
C1 PIN 13 ECM
C1 PIN 13 CAR
C1 PIN 29 ECM
C1 PIN 29 CAR
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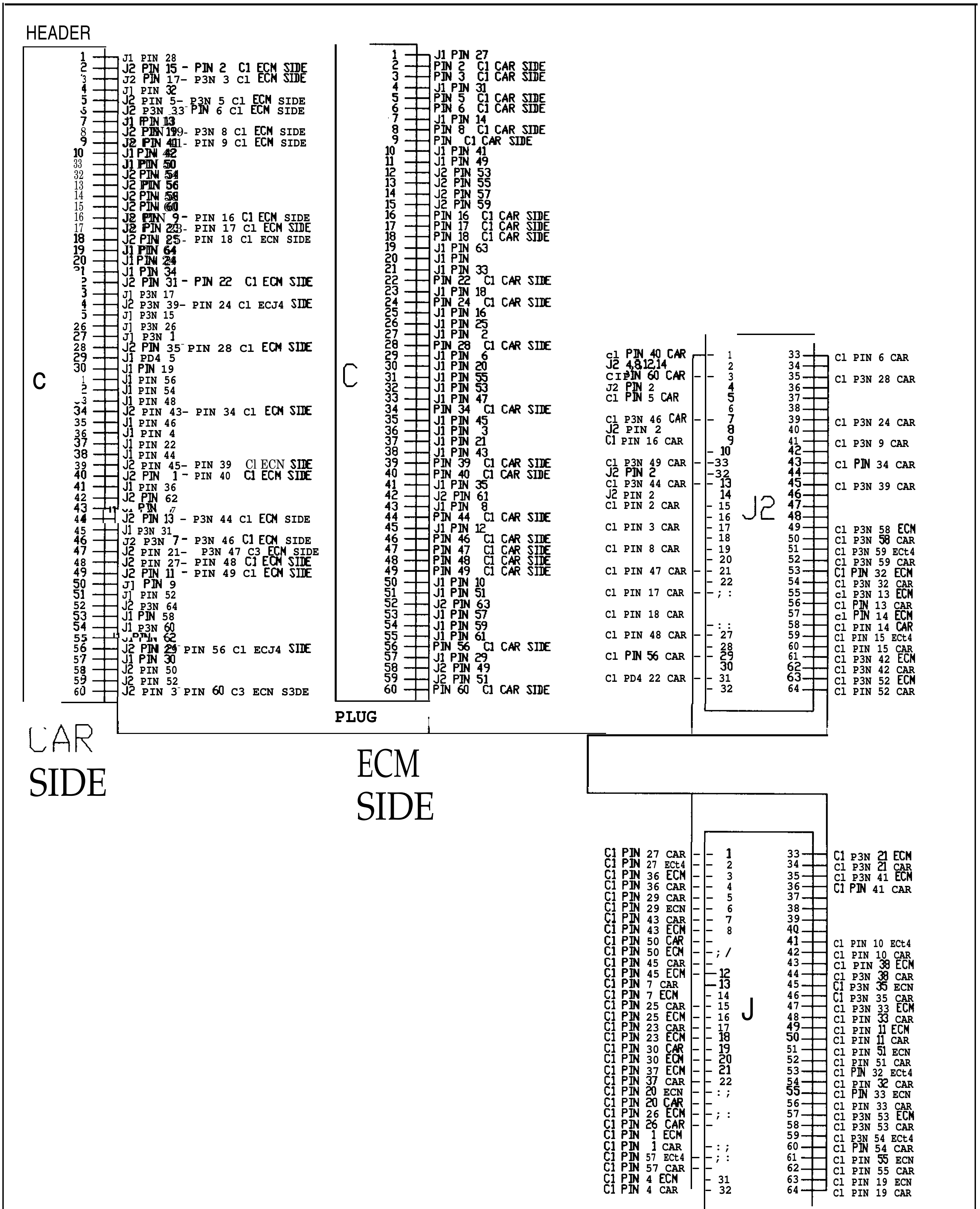
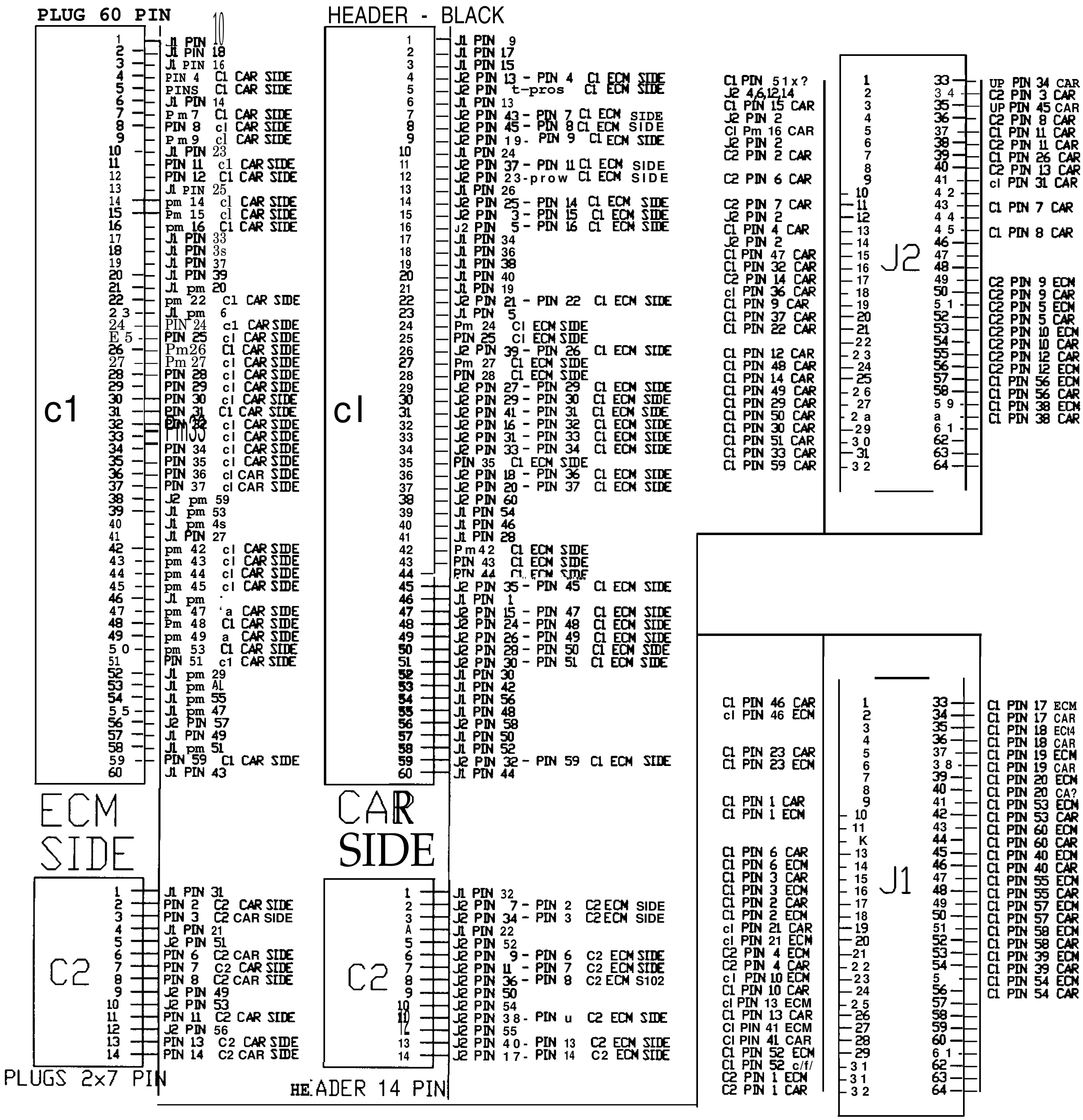
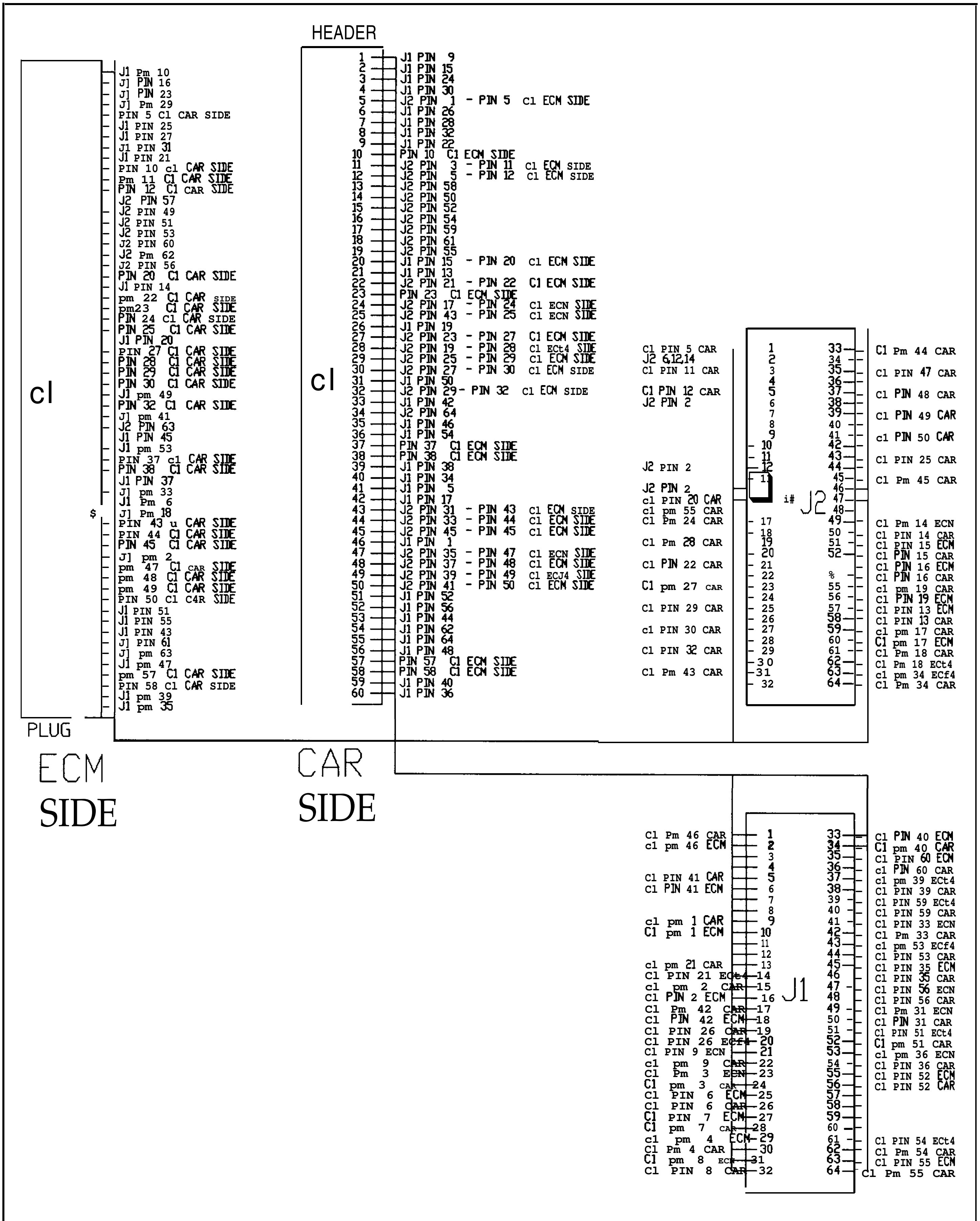
C1 PIN 26 CAR
C1 PIN 10 ECM
C1 PIN 10 CAR
C1 PIN 25 ECM
C1 PIN 25 CAR



FM 03

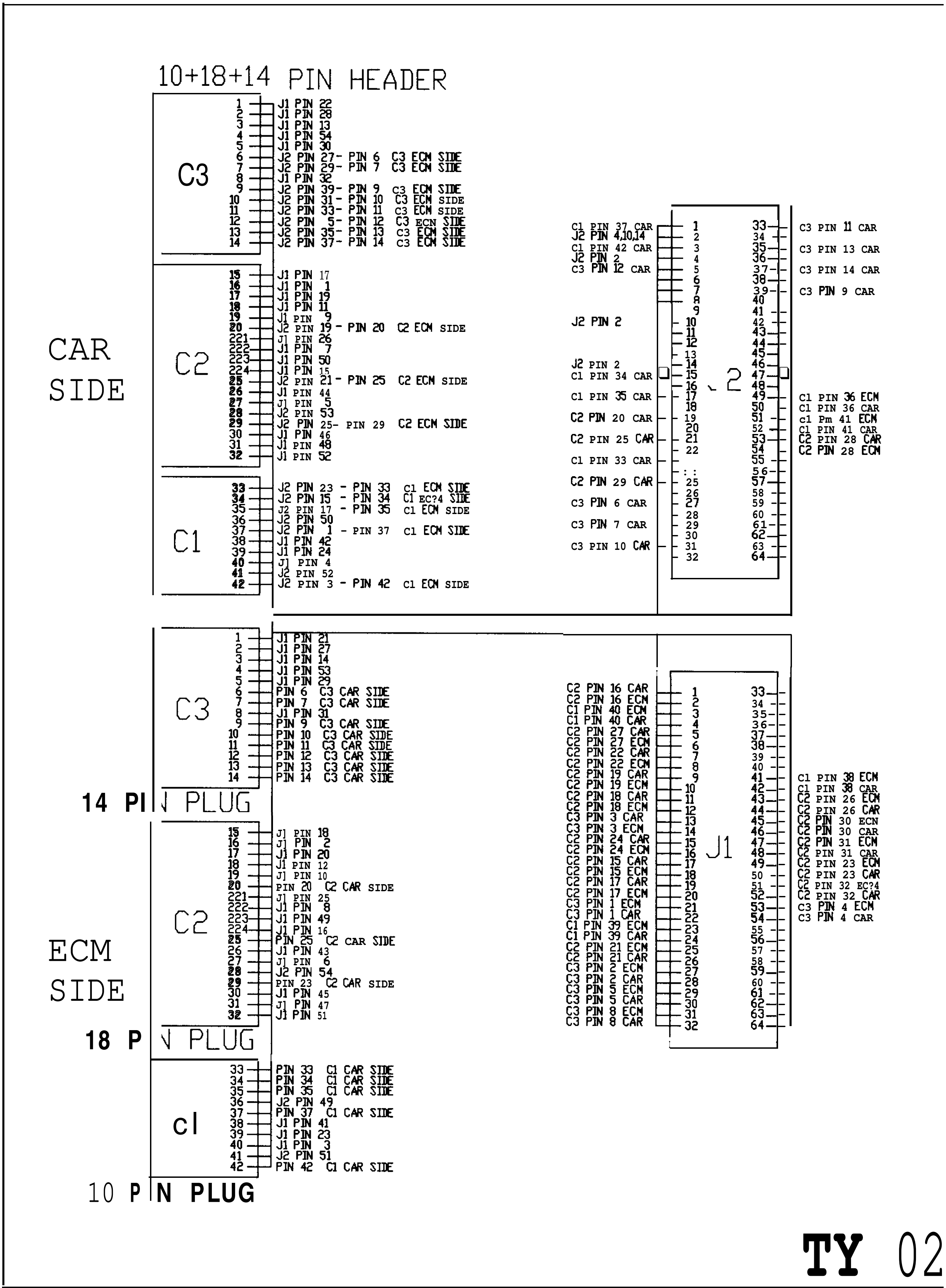

PLUG 60 PIN
HEADER - BLACK
C1
ECM SIDE
CAR SIDE
C2
PLUGS 2x7 PIN
HEADER 14 PIN
J2
J1

CR 1A & CR 1B



HEADER
PLUG
C1
ECM SIDE
CAR SIDE
J1 Pm 10
J] PIN 16
J] PIN 23
J] Pm 29
PIN 5 C1 CAR SIDE
J1 PIN 25
J1 PIN 27
J1 PIN 31
J1 PIN 21
PIN 10 c1 CAR SIDE
Pm 11 C1 CAR SIDE
PIN 12 C1 CAR SIDE
J2 PIN 57
J2 PIN 49
J2 PIN 51
J2 PIN 53
J2 PIN 60
J2 Pm 62
J2 PIN 56
PIN 20 C1 CAR SIDE
J1 PIN 14
pm 22 C1 CAR SIDE
pm23 C1 CAR SIDE
PIN 24 C1 CAR SIDE
PIN 25 C1 CAR SIDE
J1 PIN 20
PIN 27 C1 CAR SIDE
PIN 28 C1 CAR SIDE
PIN 29 C1 CAR SIDE
PIN 30 C1 CAR SIDE
J1 pm 49
PIN 32 C1 CAR SIDE
J] pm 41
J2 PIN 63
J1 PIN 45
J1 pm 53
PIN 37 c1 CAR SIDE
PIN 38 C1 CAR SIDE
J1 PIN 37
J] pm 33
J1 Pm 6
J] Pm 18
PIN 43 u CAR SIDE
PIN 44 C1 CAR SIDE
PIN 45 C1 CAR SIDE
J] pm 2
pm 47 C1 CAR SIDE
pm 48 C1 CAR SIDE
pm 49 C1 CAR SIDE
PIN 50 C1 C4R SIDE
J1 PIN 51
J1 PIN 55
J1 PIN 43
J] PIN 61
J] pm 63
J1 pm 47
pm 57 C1 CAR SIDE
PIN 58 C1 CAR SIDE
J1 pm 39
J1 pm 35
1 J1 PIN 9
2 J1 PIN 15
3 J1 PIN 24
4 J1 PIN 30
5 J2 PIN 1 - PIN 5 C1 ECM SIDE
6 J1 PIN 26
7 J1 PIN 28
8 J1 PIN 32
9 J1 PIN 22
10 PIN 10 C1 ECM SIDE
11 J2 PIN 3 - PIN 11 C1 ECM SIDE
12 J2 PIN 5 - PIN 12 C1 ECM SIDE
13 J2 PIN 58
14 J2 PIN 50
15 J2 PIN 52
16 J2 PIN 54
17 J2 PIN 59
18 J2 PIN 61
19 J2 PIN 55
20 J1 PIN 15 - PIN 20 C1 ECM SIDE
21 J1 PIN 13
22 J2 PIN 21 - PIN 22 C1 ECM SIDE
23 PIN 23 C1 ECM SIDE
24 J2 PIN 17 - PIN 24 C1 ECN SIDE
25 J2 PIN 43 - PIN 25 C1 ECN SIDE
26 J1 PIN 19
27 J2 PIN 23 - PIN 27 C1 ECM SIDE
28 J2 PIN 19 - PIN 28 C1 ECt4 SIDE
29 J2 PIN 25 - PIN 29 C1 ECM SIDE
30 J2 PIN 27 - PIN 30 C1 ECM SIDE
31 J1 PIN 50
32 J2 PIN 29 - PIN 32 C1 ECM SIDE
33 J1 PIN 42
34 J2 PIN 64
35 J1 PIN 46
36 J1 PIN 54
37 PIN 37 C1 ECM SIDE
38 PIN 38 C1 ECM SIDE
39 J1 PIN 38
40 J1 PIN 34
41 J1 PIN 5
42 J1 PIN 17
43 J2 PIN 31 - PIN 43 C1 ECM SIDE
44 J2 PIN 33 - PIN 44 C1 ECM SIDE
45 J2 PIN 45 - PIN 45 C1 ECM SIDE
46 J1 PIN 1
47 J2 PIN 35 - PIN 47 C1 ECN SIDE
48 J2 PIN 37 - PIN 48 C1 ECM SIDE
49 J2 PIN 39 - PIN 49 C1 ECJ4 SIDE
50 J2 PIN 41 - PIN 50 C1 ECM SIDE
51 J1 PIN 52
52 J1 PIN 56
53 J1 PIN 44
54 J1 PIN 62
55 J1 PIN 64
56 J1 PIN 48
57 PIN 57 C1 ECM SIDE
58 PIN 58 C1 ECM SIDE
59 J1 PIN 40
60 J1 PIN 36
J2
C1 PIN 5 CAR
J2 6,12,14
C1 PIN 11 CAR
C1 PIN 12 CAR
J2 PIN 2
J2 PIN 2
J2 PIN 2
c1 PIN 20 CAR
c1 pm 55 CAR
C1 Pm 24 CAR
C1 Pm 28 CAR
C1 PIN 22 CAR
C1 pm 27 CAR
C1 PIN 29 CAR
c1 PIN 30 CAR
C1 PIN 32 CAR
C1 Pm 43 CAR
C1 Pm 44 CAR
C1 PIN 47 CAR
C1 PIN 48 CAR
C1 PIN 49 CAR
c1 PIN 50 CAR
C1 PIN 25 CAR
C1 Pm 45 CAR
C1 Pm 14 ECN
C1 PIN 14 CAR
C1 PIN 15 ECM
C1 PIN 15 CAR
C1 PIN 16 ECM
C1 PIN 16 CAR
c1 pm 19 CAR
c1 PIN 19 ECM
C1 PIN 13 ECM
C1 PIN 13 CAR
c1 pm 17 CAR
C1 pm 17 ECM
C1 Pm 18 CAR
C1 Pm 18 ECt4
c1 pm 34 ECf4
C1 Pm 34 CAR
J1
C1 Pm 46 CAR
c1 pm 46 ECM
C1 PIN 41 CAR
C1 PIN 41 ECM
c1 pm 1 CAR
C1 pm 1 ECM
c1 pm 21 CAR
C1 PIN 21 ECt4
c1 pm 2 CAR
C1 PIN 2 ECM
C1 Pm 42 CAR
C1 PIN 42 ECM
C1 PIN 26 CAR
C1 PIN 26 ECf4
C1 PIN 9 ECN
c1 pm 9 CAR
C1 Pm 3 ECN
C1 pm 3 CAR
C1 PIN 6 ECM
C1 PIN 6 CAR
C1 PIN 7 ECM
C1 pm 7 CAR
c1 pm 4 ECM
C1 Pm 4 CAR
C1 pm 8 ECM
C1 PIN 8 CAR
C1 PIN 40 ECM
C1 pm 40 CAR
C1 PIN 60 ECM
c1 PIN 60 CAR
c1 pm 39 ECt4
C1 PIN 39 CAR
C1 PIN 59 ECt4
C1 PIN 59 CAR
C1 PIN 33 ECN
C1 Pm 33 CAR
c1 pm 53 ECf4
C1 PIN 53 CAR
C1 PIN 35 ECM
C1 PIN 35 CAR
C1 PIN 56 ECN
C1 PIN 56 CAR
C1 Pm 31 ECN
C1 PIN 31 CAR
C1 PIN 51 ECt4
C1 pm 51 CAR
c1 pm 36 ECN
C1 PIN 36 CAR
C1 PIN 52 ECM
C1 PIN 52 CAR
C1 PIN 54 ECt4
C1 Pm 54 CAR
C1 PIN 55 ECM
C1 Pm 55 CAR

CR 02


10+18+14 PIN HEADER
CAR SIDE
C3
C2
C1
J1 PIN 22
J1 PIN 28
J1 PIN 13
J1 PIN 54
J1 PIN 30
J2 PIN 27- PIN 6 C3 ECM SIDE
J2 PIN 29- PIN 7 C3 ECM SIDE
J1 PIN 32
J2 PIN 39- PIN 9 C3 ECM SIDE
J2 PIN 31- PIN 10 C3 ECM SIDE
J2 PIN 33- PIN 11 C3 ECM SIDE
J2 PIN 5- PIN 12 C3 ECN SIDE
J2 PIN 35- PIN 13 C3 ECM SIDE
J2 PIN 37- PIN 14 C3 ECM SIDE
J1 PIN 17
J1 PIN 1
J1 PIN 19
J1 PIN 11
J1 PIN 9
J2 PIN 19 - PIN 20 C2 ECM SIDE
J1 PIN 26
J1 PIN 7
J1 PIN 50
J1 PIN 15
J2 PIN 21 - PIN 25 C2 ECM SIDE
J1 PIN 44
J1 PIN 5
J2 PIN 53
J2 PIN 25- PIN 29 C2 ECM SIDE
J1 PIN 46
J1 PIN 48
J1 PIN 52
J2 PIN 23 - PIN 33 C1 ECM SIDE
J2 PIN 15 - PIN 34 C1 EC?4 SIDE
J2 PIN 17 - PIN 35 C1 ECM SIDE
J2 PIN 50
J2 PIN 1 - PIN 37 C1 ECM SIDE
J1 PIN 42
J1 PIN 24
J1 PIN 4
J2 PIN 52
J2 PIN 3 - PIN 42 C1 ECM SIDE
C1 PIN 37 CAR
J2 PIN 4,10,14
C1 PIN 42 CAR
J2 PIN 2
C3 PIN 12 CAR
J2 PIN 2
J2 PIN 2
C1 PIN 34 CAR
C1 PIN 35 CAR
C2 PIN 20 CAR
C2 PIN 25 CAR
C1 PIN 33 CAR
C2 PIN 29 CAR
C3 PIN 6 CAR
C3 PIN 7 CAR
C3 PIN 10 CAR
J2
C3 PIN 11 CAR
C3 PIN 13 CAR
C3 PIN 14 CAR
C3 PIN 9 CAR
C1 PIN 36 ECM
C1 PIN 36 CAR
C1 PIN 41 ECM
C1 PIN 41 CAR
C2 PIN 28 CAR
C2 PIN 28 ECM
ECM SIDE
J1 PIN 21
J1 PIN 27
J1 PIN 14
J1 PIN 53
J1 PIN 29
PIN 6 C3 CAR SIDE
PIN 7 C3 CAR SIDE
J1 PIN 31
PIN 9 C3 CAR SIDE
PIN 10 C3 CAR SIDE
PIN 11 C3 CAR SIDE
PIN 12 C3 CAR SIDE
PIN 13 C3 CAR SIDE
PIN 14 C3 CAR SIDE
14 PIN PLUG
J1 PIN 18
J1 PIN 2
J1 PIN 20
J1 PIN 12
J1 PIN 10
PIN 20 C2 CAR SIDE
J1 PIN 25
J1 PIN 8
J1 PIN 49
J1 PIN 16
PIN 25 C2 CAR SIDE
J1 PIN 43
J1 PIN 6
J2 PIN 54
PIN 23 C2 CAR SIDE
J1 PIN 45
J1 PIN 47
J1 PIN 51
18 PIN PLUG
PIN 33 C1 CAR SIDE
PIN 34 C1 CAR SIDE
PIN 35 C1 CAR SIDE
J2 PIN 49
PIN 37 C1 CAR SIDE
J1 PIN 41
J1 PIN 23
J1 PIN 3
J2 PIN 51
PIN 42 C1 CAR SIDE
10 PIN PLUG
C2 PIN 16 CAR
C2 PIN 16 ECM
C1 PIN 40 ECM
C1 PIN 40 CAR
C2 PIN 27 CAR
C2 PIN 27 ECM
C2 PIN 22 CAR
C2 PIN 22 ECM
C2 PIN 19 CAR
C2 PIN 19 ECM
C2 PIN 18 CAR
C2 PIN 18 ECM
C3 PIN 3 CAR
C3 PIN 3 ECM
C2 PIN 24 CAR
C2 PIN 24 ECM
C2 PIN 15 CAR
C2 PIN 15 ECM
C2 PIN 17 CAR
C2 PIN 17 ECM
C3 PIN 1 ECM
C3 PIN 1 CAR
C1 PIN 39 ECM
C1 PIN 39 CAR
C2 PIN 21 ECM
C2 PIN 21 CAR
C3 PIN 2 ECM
C3 PIN 2 CAR
C3 PIN 5 ECM
C3 PIN 5 CAR
C3 PIN 8 ECM
C3 PIN 8 CAR
J1
C1 PIN 38 ECM
C1 PIN 38 CAR
C2 PIN 26 ECM
C2 PIN 26 CAR
C2 PIN 30 ECN
C2 PIN 30 CAR
C2 PIN 31 ECM
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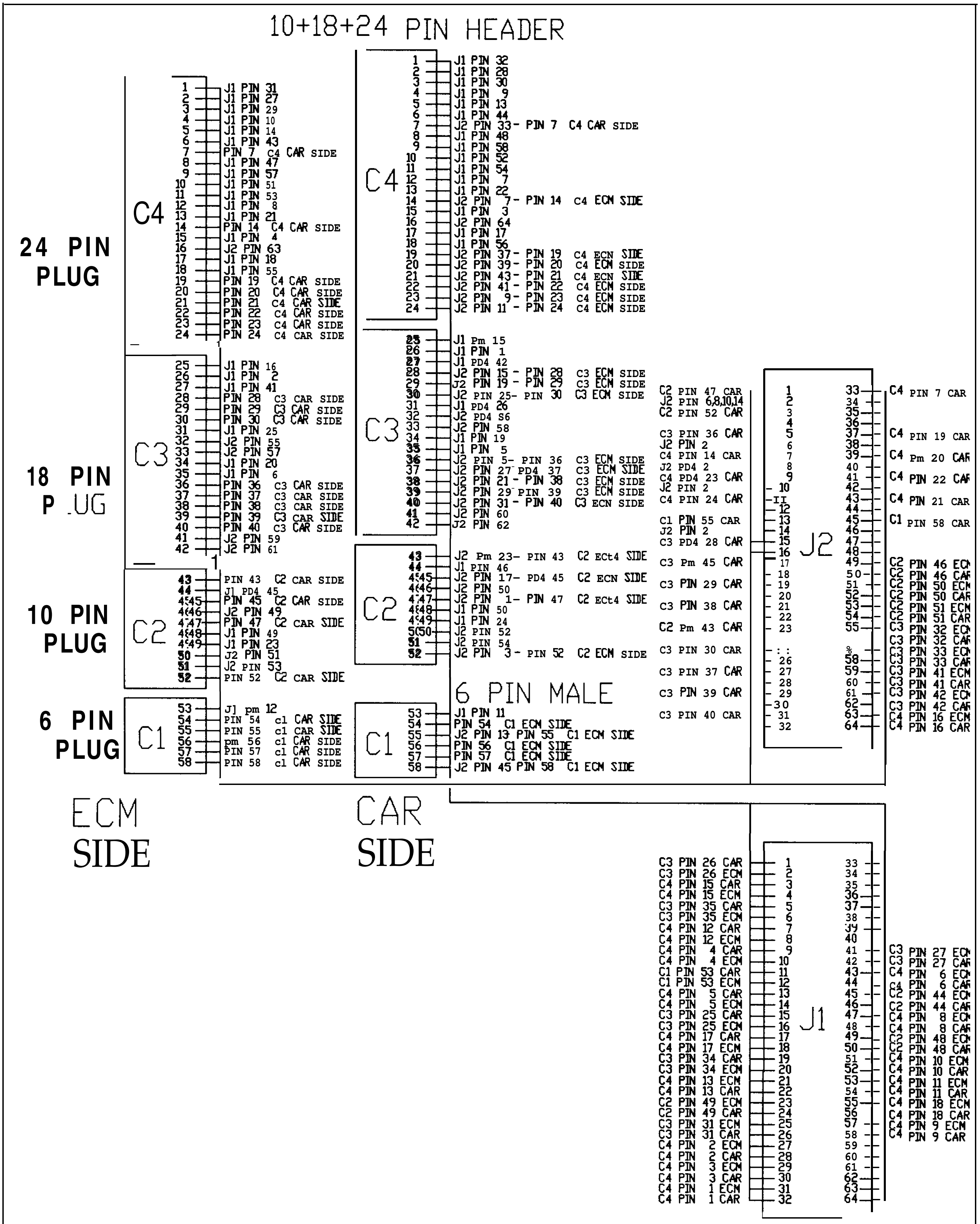
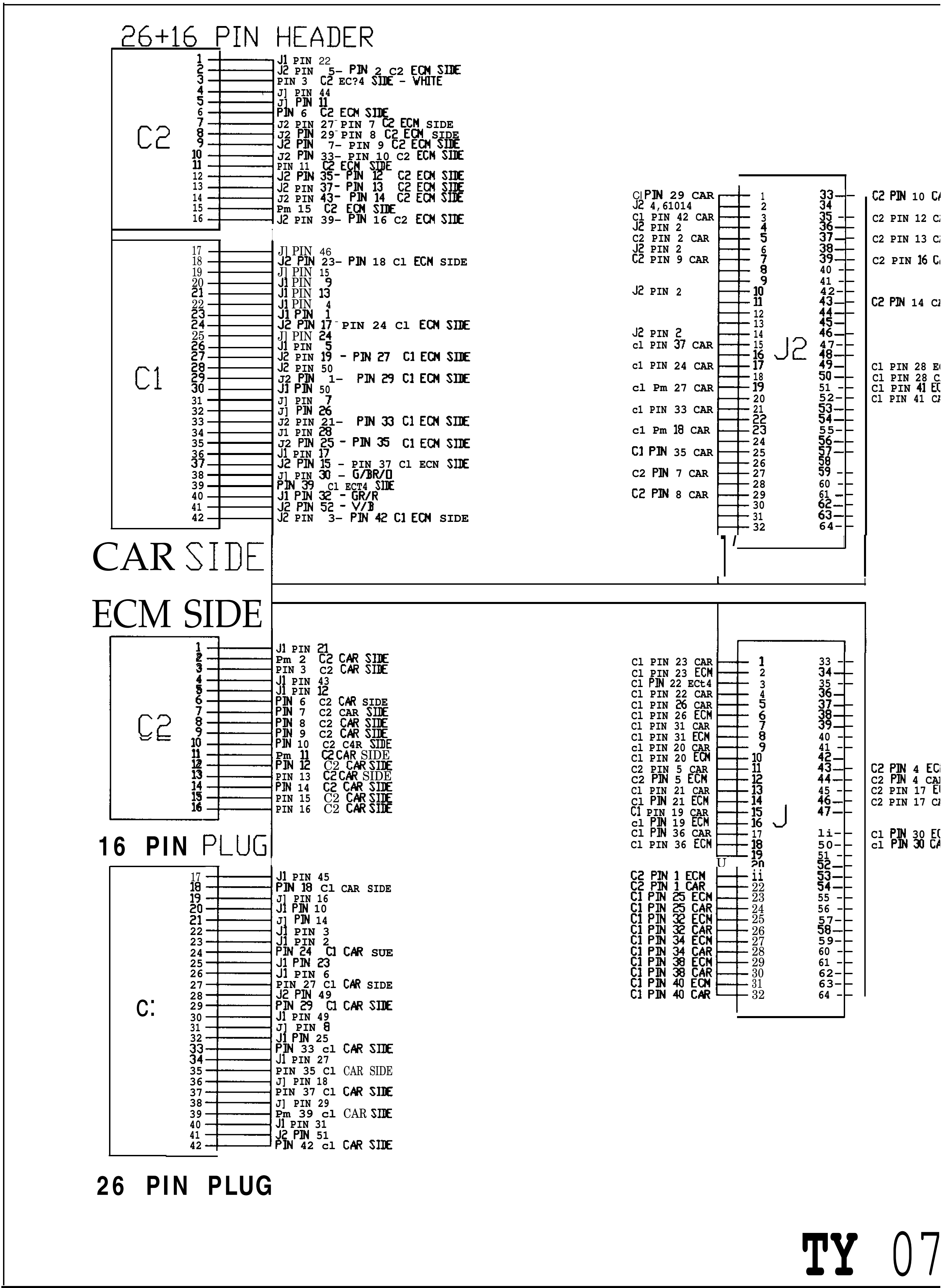
C2 PIN 32 EC?4
C2 PIN 32 CAR
C3 PIN 4 ECM
C3 PIN 4 CAR
TY 02



10+18+24 PIN HEADER
24 PIN PLUG
18 PIN PLUG
10 PIN PLUG
6 PIN PLUG
ECM SIDE
CAR SIDE
C4
C3
C2
C1
J2
J1
6 PIN MALE
1 J1 PIN 31
2 J1 PIN 27
3 J1 PIN 29
4 J1 PIN 10
5 J1 PIN 14
6 J1 PIN 43
7 PIN 7 C4 CAR SIDE
8 J1 PIN 47
9 J1 PIN 57
10 J1 PIN 51
11 J1 PIN 53
12 J1 PIN 8
13 J1 PIN 21
14 PIN 14 C4 CAR SIDE
15 J1 PIN 4
16 J2 PIN 63
17 J1 PIN 18
18 J1 PIN 55
19 PIN 19 C4 CAR SIDE
20 PIN 20 C4 CAR SIDE
21 PIN 21 C4 CAR SIDE
22 PIN 22 C4 CAR SIDE
23 PIN 23 C4 CAR SIDE
24 PIN 24 C4 CAR SIDE
25 J1 PIN 16
26 J1 PIN 2
27 J1 PIN 41
28 PIN 28 C3 CAR SIDE
29 PIN 29 C3 CAR SIDE
30 PIN 30 C3 CAR SIDE
31 J1 PIN 25
32 J2 PIN 55
33 J2 PIN 57
34 J1 PIN 20
35 J1 PIN 6
36 PIN 36 C3 CAR SIDE
37 PIN 37 C3 CAR SIDE
38 PIN 38 C3 CAR SIDE
39 PIN 39 C3 CAR SIDE
40 PIN 40 C3 CAR SIDE
41 J2 PIN 59
42 J2 PIN 61
43 PIN 43 C2 CAR SIDE
44 J1 PD4 45
45 PIN 45 C2 CAR SIDE
46 J2 PIN 49
47 PIN 47 C2 CAR SIDE
48 J1 PIN 49
49 J1 PIN 23
50 J2 PIN 51
51 J2 PIN 53
52 PIN 52 C2 CAR SIDE
53 J1 pm 12
54 PIN 54 c1 CAR SIDE
55 PIN 55 c1 CAR SIDE
56 pm 56 c1 CAR SIDE
57 PIN 57 c1 CAR SIDE
58 PIN 58 c1 CAR SIDE
1 J1 PIN 32
2 J1 PIN 28
3 J1 PIN 30
4 J1 PIN 9
5 J1 PIN 13
6 J1 PIN 44
7 J2 PIN 33 - PIN 7 C4 CAR SIDE
8 J1 PIN 48
9 J1 PIN 58
10 J1 PIN 52
11 J1 PIN 54
12 J1 PIN 7
13 J1 PIN 22
14 J2 PIN 7 - PIN 14 C4 ECM SIDE
15 J1 PIN 3
16 J2 PIN 64
17 J1 PIN 17
18 J1 PIN 56
19 J2 PIN 37 - PIN 19 C4 ECN SIDE
20 J2 PIN 39 - PIN 20 C4 ECM SIDE
21 J2 PIN 43 - PIN 21 C4 ECN SIDE
22 J2 PIN 41 - PIN 22 C4 ECM SIDE
23 J2 PIN 9 - PIN 23 C4 ECM SIDE
24 J2 PIN 11 - PIN 24 C4 ECM SIDE
25 J1 Pm 15
26 J1 PIN 1
27 J1 PD4 42
28 J2 PIN 15 - PIN 28 C3 ECM SIDE
29 J2 PIN 19 - PIN 29 C3 ECM SIDE
30 J2 PIN 25 - PIN 30 C3 ECM SIDE
31 J1 PD4 26
32 J2 PD4 56
33 J2 PIN 58
34 J1 PIN 19
35 J1 PIN 5
36 J2 PIN 5 - PIN 36 C3 ECM SIDE
37 J2 PIN 27 PD4 37 C3 ECM SIDE
38 J2 PIN 21 - PIN 38 C3 ECM SIDE
39 J2 PIN 29 PIN 39 C3 ECM SIDE
40 J2 PIN 31 - PIN 40 C3 ECN SIDE
41 J2 PIN 60
42 J2 PIN 62
43 J2 Pm 23 - PIN 43 C2 ECt4 SIDE
44 J1 PIN 46
45 J2 PIN 17 - PD4 45 C2 ECN SIDE
46 J2 PIN 50
47 J2 PIN 1 - PIN 47 C2 ECt4 SIDE
48 J1 PIN 50
49 J1 PIN 24
50 J2 PIN 52
51 J2 PIN 54
52 J2 PIN 3 - PIN 52 C2 ECM SIDE
53 J1 PIN 11
54 PIN 54 C1 ECM SIDE
55 J2 PIN 13 PIN 55 C1 ECM SIDE
56 PIN 56 C1 ECM SIDE
57 PIN 57 C1 ECM SIDE
58 J2 PIN 45 PIN 58 C1 ECM SIDE
C2 PIN 47 CAR 1
J2 PIN 6,8,10,14 2
C2 PIN 52 CAR 3
4
C3 PIN 36 CAR 5
J2 PIN 2 6
C4 PIN 14 CAR 7
J2 PD4 2 8
C4 PD4 23 CAR 9
J2 PIN 2 10
C4 PIN 24 CAR 11
12
C1 PIN 55 CAR 13
J2 PIN 2 14
C3 PD4 28 CAR 15
16
C3 Pm 45 CAR 17
18
C3 PIN 29 CAR 19
20
C3 PIN 38 CAR 21
22
C2 Pm 43 CAR 23
C3 PIN 30 CAR
C3 PIN 37 CAR 26
27
C3 PIN 39 CAR 28
29
C3 PIN 40 CAR 30
31
32
33 C4 PIN 7 CAR
37 C4 PIN 19 CAR
39 C4 Pm 20 CAR
41 C4 PIN 22 CAR
43 C4 PIN 21 CAR
45 C1 PIN 58 CAR
49 C2 PIN 46 ECM
50 C2 PIN 46 CAR
51 C2 PIN 50 ECM
52 C2 PIN 50 CAR
53 C2 PIN 51 ECM
54 C2 PIN 51 CAR
55 C3 PIN 32 ECM
C3 PIN 32 CAR
C3 PIN 33 ECM
58 C3 PIN 33 CAR
59 C3 PIN 41 ECM
60 C3 PIN 41 CAR
61 C3 PIN 42 ECM
62 C3 PIN 42 CAR
63 C4 PIN 16 ECM
64 C4 PIN 16 CAR
C3 PIN 26 CAR 1
C3 PIN 26 ECM 2
C4 PIN 15 CAR 3
C4 PIN 15 ECM 4
C3 PIN 35 CAR 5
C3 PIN 35 ECM 6
C4 PIN 12 CAR 7
C4 PIN 12 ECM 8
C4 PIN 4 CAR 9
C4 PIN 4 ECM 10
C1 PIN 53 CAR 11
C1 PIN 53 ECM 12
C4 PIN 5 CAR 13
C4 PIN 5 ECM 14
C3 PIN 25 CAR 15
C3 PIN 25 ECM 16
C4 PIN 17 CAR 17
C4 PIN 17 ECM 18
C3 PIN 34 CAR 19
C3 PIN 34 ECM 20
C4 PIN 13 ECM 21
C4 PIN 13 CAR 22
C2 PIN 49 ECM 23
C2 PIN 49 CAR 24
C3 PIN 31 ECM 25
C3 PIN 31 CAR 26
C4 PIN 2 ECM 27
C4 PIN 2 CAR 28
C4 PIN 3 ECM 29
C4 PIN 3 CAR 30
C4 PIN 1 ECM 31
C4 PIN 1 CAR 32
41 C3 PIN 27 ECM
42 C3 PIN 27 CAR
43 C4 PIN 6 ECM
44 C4 PIN 6 CAR
45 C2 PIN 44 ECM
46 C2 PIN 44 CAR
47 C4 PIN 8 ECM
48 C4 PIN 8 CAR
49 C2 PIN 48 ECM
50 C2 PIN 48 CAR
51 C4 PIN 10 ECM
52 C4 PIN 10 CAR
53 C4 PIN 11 ECM
54 C4 PIN 11 CAR
55 C4 PIN 18 ECM
56 C4 PIN 18 CAR
57 C4 PIN 9 ECM
58 C4 PIN 9 CAR

TY 04



26+16 PIN HEADER
C2
J1 PIN 22
J2 PIN 5- PIN 2 C2 ECM SIDE
PIN 3 C2 EC?4 SIDE - WHITE
J] PIN 44
J] PIN 11
PIN 6 C2 ECM SIDE
J2 PIN 27 PIN 7 C2 ECM SIDE
J2 PIN 29 PIN 8 C2 ECM SIDE
J2 PIN 7- PIN 9 C2 ECM SIDE
J2 PIN 33- PIN 10 C2 ECM SIDE
PIN 11 C2 ECM SIDE
J2 PIN 35- PIN 12 C2 ECM SIDE
J2 PIN 37- PIN 13 C2 ECM SIDE
J2 PIN 43- PIN 14 C2 ECM SIDE
Pm 15 C2 ECM SIDE
J2 PIN 39- PIN 16 C2 ECM SIDE
C1
J] PIN 46
J2 PIN 23- PIN 18 C1 ECM SIDE
J] PIN 15
J1 PIN 9
J1 PIN 13
J1 PIN 4
J1 PIN 1
J2 PIN 17 PIN 24 C1 ECM SIDE
J] PIN 24
J1 PIN 5
J2 PIN 19 - PIN 27 C1 ECM SIDE
J2 PIN 50
J2 PIN 1- PIN 29 C1 ECM SIDE
J1 PIN 50
J] PIN 7
J] PIN 26
J2 PIN 21- PIN 33 C1 ECM SIDE
J1 PIN 28
J2 PIN 25 - PIN 35 C1 ECM SIDE
J1 PIN 17
J2 PIN 15 - PIN 37 C1 ECN SIDE
J] PIN 30 - G/BR/O
PIN 39 C1 ECT4 SIDE
J1 PIN 32 - GR/R
J2 PIN 52 - V/B
J2 PIN 3- PIN 42 C1 ECM SIDE
CAR SIDE
ECM SIDE
J2
C1 PIN 29 CAR
J2 4,61014
C1 PIN 42 CAR
J2 PIN 2
C2 PIN 2 CAR
J2 PIN 2
C2 PIN 9 CAR
J2 PIN 2
J2 PIN 2
c1 PIN 37 CAR
c1 PIN 24 CAR
c1 Pm 27 CAR
c1 PIN 33 CAR
c1 Pm 18 CAR
C1 PIN 35 CAR
C2 PIN 7 CAR
C2 PIN 8 CAR
C2 PIN 10 C
C2 PIN 12 C
C2 PIN 13 C
C2 PIN 16 C
C2 PIN 14 C
C1 PIN 28 E
C1 PIN 28 C
C1 PIN 41 E
C1 PIN 41 C
C2
J1 PIN 21
Pm 2 C2 CAR SIDE
PIN 3 C2 CAR SIDE
J1 PIN 43
J1 PIN 12
PIN 6 C2 CAR SIDE
PIN 7 C2 CAR SIDE
PIN 8 C2 CAR SIDE
PIN 9 C2 CAR SIDE
PIN 10 C2 C4R SIDE
Pm 11 C2 CAR SIDE
PIN 12 C2 CAR SIDE
PIN 13 C2 CAR SIDE
PIN 14 C2 CAR SIDE
PIN 15 C2 CAR SIDE
PIN 16 C2 CAR SIDE
16 PIN PLUG
C:
J1 PIN 45
PIN 18 C1 CAR SIDE
J] PIN 16
J1 PIN 10
J] PIN 14
J1 PIN 3
J1 PIN 2
PIN 24 C1 CAR SUE
J1 PIN 23
J1 PIN 6
PIN 27 C1 CAR SIDE
J2 PIN 49
PIN 29 C1 CAR SIDE
J1 PIN 49
J] PIN 8
J1 PIN 25
PIN 33 c1 CAR SIDE
J1 PIN 27
PIN 35 C1 CAR SIDE
J] PIN 18
PIN 37 C1 CAR SIDE
J] PIN 29
Pm 39 c1 CAR SIDE
J1 PIN 31
J2 PIN 51
PIN 42 c1 CAR SIDE
26 PIN PLUG
J
C1 PIN 23 CAR
C1 PIN 23 ECM
C1 PIN 22 ECt4
C1 PIN 22 CAR
C1 PIN 26 CAR
C1 PIN 26 ECM
C1 PIN 31 CAR
C1 PIN 31 ECM
c1 PIN 20 CAR
C1 PIN 20 ECM
C2 PIN 5 CAR
C2 PIN 5 ECM
C1 PIN 21 CAR
C1 PIN 21 ECM
C1 PIN 19 CAR
c1 PIN 19 ECM
C1 PIN 36 CAR
C1 PIN 36 ECM
C2 PIN 1 ECM
C2 PIN 1 CAR
C1 PIN 25 ECM
C1 PIN 25 CAR
C1 PIN 32 ECM
C1 PIN 32 CAR
C1 PIN 34 ECM
C1 PIN 34 CAR
C1 PIN 38 ECM
C1 PIN 38 CAR
C1 PIN 40 ECM
C1 PIN 40 CAR
C2 PIN 4 EC
C2 PIN 4 CA
C2 PIN 17 E
C2 PIN 17 C
C1 PIN 30 E
c1 PIN 30 C
TY 07

SUN ELECTRIC CORPORATION

Field Installation Instructions

INSTALLATION MUST BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL ONLY

INSTALLATION OVERVIEW:

Simu-Tech option for the MCA-3000 (B) provides the MCA with additional diagnostic capabilities by way of an intelligent breakout box. Two circuit boards are added to the computer section of the unit. Once installed, an Interface Box (Pod) is connected and software is installed.

PREREQUISITES:

1. Harddrive Kit 1091-0199-01 or MDSHDCD kit.
2. Serial Port Extension kit 1095-0040-01
3. Menu Version 2.20 or above.
4. Simu-Tech Software Disk Pack.

NOTE: *FOR THIS KIT TO BE INSTALLED, THE CUSTOMER MUST HAVE A LICENSED VERSION OF MS-DOS OR IBM PC-DOS VERSION 3.3 OR HIGHER AND MAKE IT AVAILABLE TO YOU FOR THE INSTALLATION. IF THE CUSTOMER DOES NOT HAVE A LICENSED COPY OF DOS, THEN YOU CANNOT CONTINUE.*

PARTS LIST:

PART NUMBER	DESCRIPTION
Two Board Set:	
7001-2203-01	TMS Board (Dig.Proc.)
7001-2212-01	Acquisition Board
6004-0757-01	Ribbon Cables (2)
6004-0756-01	Battery Lead
7009-2328-01	DVOM Probe cable
0552-0089-01	Mouse and software driver
0610-1311-06	Screws, sheet metal (2)
0692-2026-01	Installation Instructions

PART NUMBER	DESCRIPTION
7009-2327-01	Interface Box (POD)
6004-0755-01	Pod Cable
4162-7030-01	Housing, Connector
0404-0071	Screws, #6x3/4° (2)
0616-0010	Nuts, #6 (2)
0400-0027	Washers, #6 (2)
7001-2213-01	Pod Board
5398-0613	Circuit Card Guides (2)

REQUIRED TOOLS:

COMPLETE SUN ISSUED TOOL KIT, IS-100A, ANTI-STATIC KIT

PROCEDURE:

NOTE: *USE STANDARD ANTI-STATIC PROCEDURES WHILE PERFORMING THIS PROCEDURE.*

1. **Turn off tester and remove power plug from the wall.**

2. **Remove the 4 Hex screws securing the Computer Drawer Assembly.**

3. **Carefully slide the Computer Drawer Assembly out from the MCA. Do not slide it so far out that the Drawer assembly is no longer supported by its side rails.**

4. **If a SCSI Board is installed in this MCA-3000, and it is a Future Domain Brand Board, change the jumper configuration as shown below. (NOTE:** *IF SCSI IS TOSHIBA, proceed to step 5)*

   W-1 Shorted (jumper in) **W-2 Open (jumper out)**

5. **Reconfigure the circuit boards in the computer rack so there are 3 adjacent open slots in the backplane.**

6. **Place the two circuit card guides in the rear of the Compute drawer in the holes corresponding to the outer two of the three slot from etep 5, i.e., the middle slot will not have a card guide.**

7. **Install the two boarde connected by already installed ribbon cables keeping the middle slot open between the two boards. Use care when installing.**

8. **Ensure dip switch setting on the TMS board are 1-5 = ON / 6-10 = OFF .**

9. **Remove one of the D-Shell plates on the Computer Drawer.**

10. **Disassemble the housing on the end of the Pod cable and route the cable through the opening. Reassemble the housing and connect it to the Data Acquisition board. Secure by tightening the two screws.**

11. **Secure second housing (approx. 24 inches up the cable) to rear panel where it runs thru the 34 pin cutout, using hardware on the housing. Ensure that the end of the housing sits on the lip of the D-shell hole, and does not slide into the opening.**

12. **Verify that there are no washers on the screws securing the 9-pin serial cable to the rear of the computer drawer. If there ie, remove them, as they can prevent the mouse from making contact with the connector.**

13. **Remove mouse from box and connect it to serial port on rear of computer drawer. Note:** *The adapters included with the mouse* **are** *not used.*

14. **Plug the unit in, and turn it on**

15. Using your DVM (Digital Voltmeter), check the following Power Supply voltages: +5V *0.05 V, +12V *1.2 V and -12V *1.2 V at the MCA Computer's Passive Backplane Board (see Figure 1 for locations where to measure Power Supply voltages). If the +5V is out of tolerance, adjust R48 on Computer Power Supply until reading is within tolerance.

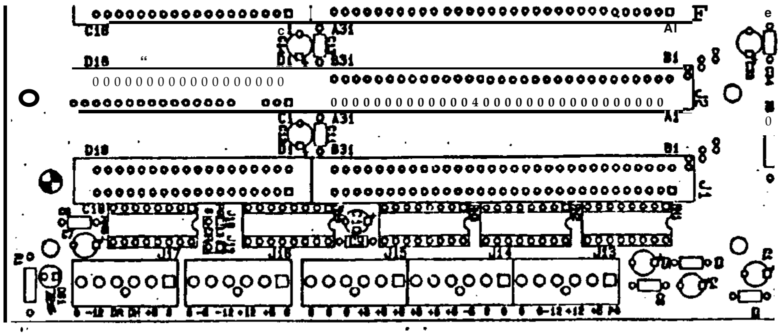


Figure 1. **Computer Power Supply**

16. Select "Disk Operating System" from the main menu.

17. Insert mouse Utilities disk in drive A: and type:
"COPY A:MOUSE.COM D:\UTIL" and press ENTER.
When complete, the screen message should be "1 file copied".

18. Insert Simu-Tech Installation Disk 1 of 3, type "A:INSTALL" and press ENTER. Follow the prompts to load Simu-Tech software from all three disks.

19. Type "SUNMENU" and press ENTER. The Blue background Sunmenu should appear.

20. Select "Simu-Tech" from the menu. The Logitech Mouse driver Window should appear followed by "Mouse Driver Installed". If an error is reported, verify connections at serial port board.

21. The screen should display:
"WELCOME TO SIMUTECH. SYSTEM SETUP WILL FOLLOW."

22. Use mouse to click on $\boxed{\text{OK}}$. The Setup Configuration Page should be displayed.

23. Use the mouse to modify the lower section of the screen to match the information below by clicking until the correct entry appears in the window.

DISPLAY	VGA		POINTER	MOUSE3
ELEVATION	m 5[illegible]0	(OR YOUR ELE.)	HARDwARE	FULL
TMS-ADDR	C800		TMS-I/O	F-0220

24. **When complete use the mouse to click on OK .**
n

25. **The screen will indicate "NOT CALIBRATED", click on** $\boxed{\text{OK}}$

26. **Unit should initialize SIMU-TECH title screen.**

CHECKOUT PROCEDURE:

27. **Connect POD battery clips to IS-1OOA + and - battery lugs and select 13 volts and turn on IS-1OOA.**

28. **Using mouse, click once to go to "HOMEVIEW" page. Move the pointer to the battery symbol in the lower right corner of the screen and click. The IS-1OOA'S 13 Volt Supply reading will be displayed. Click again to remove subscreen.**

29. **From HOMEVIEW screen, use mouse to click on "SYSTEM ADMINISTRATION"**

30. **Click on "CALIBRATION" . The DVOM window should be light; click on "CALIBRATE" to activate. Follow screen instructions and click on "OK".**

31. **Results should be 1 to 3Ω, Click on "OK". Click on "SYSTEM ADMINISTRATION" .**

32. **Click on "CALIBRATION", and "INTR" for internal calibration; click on "CALIBRATE" to activate. Results should be 2 to 3.5Ω, Click on "OK".**

33. **On HOME VIEW page, click on "SYSTEM ADMINISTRATION''and click on "HARDWARE TEST".**

34. **Repeat steps 29 through 33.**

35. **Short the DVOM leads on the Pod.**

36. **PerfOrm tests 1 through 9 by clicking on "RUN TEST", selection will be activated with highlight bar, results will be displayed when "RUNNING" turns to PASS, click on "RUN TEST" to activate next selection.**

NOTE: *Do not run test 10. You do not have the proper equipment to run this test, and a lockup will result.*

37. *Once Test* **#9 is** *complete and all tests have passed, click on "RETURN" (upper left corner).*

****
*** INSTALLATION/CHECKOUT COMPLETE ***
****

APPENDIX A

SOFTWARE OVERVIEW

General The Appendix A is brief explanation of the program contained on the Master Program Disk of the MCA-3000'S software. It is divided into nine main sections which include; Menus, Dedicated Keys, Complete Test, Rapid Test, Systems Test, Pinpoint Test, Scope Functions, On-board Computers, and Utilities.

Menus The Main Menu provides the starting point for all analyzer test sequences. The Main Menu immediately follows the "Warm-up" page or can be accessed at any time by depressing the "MENU" key on the keyboard or the "Menu" key on the Remote Control Unit. Various other Menus are also utilized throughout the program to direct the user to any desired point. For example; If the operator were in the "Starting System Test" in the "Engine Systems Tests" program, and depressed the "Menu" key, the "Systems Tests Menu" will be displayed on the VDU. By depressing the "Menu" key again will return the operator to the "Main Menu". Refer to flow charts following this text.

Dedicated Keys Various Keyboard buttons allow the user direct access to certain functions and program pages. This is a useful and time saving feature which can be use to access a page, directly, while in a different part of the program. Some of these keys are:

Engine Data	Multimeter
KV (Dynamic KV)	Power Balance
Menu	CAL (Calibration)
Lead Check	Crank (Cranking)
RUN (Running)	SCOPE

Complete **Test** The Complete Test will provide the operator with a comprehensive vehicle analysis. The data can be viewed in three different formats: Minimum Data Mode, Comparison Mode, and Maximum Data Mode. In all three modes, the amount of data captured is identical. Each mode of operation is unique in its approach to displaying the data. The variation offers the operator flexibility when conducting a test.

Minimum Data Mode displays only the information needed to obtain diagnostics in the complete test. Upper and lower limits nor comparison of other cylinders are displayed. For example, in the Cranking Page only temperature and a count down timer are visible to the operator.

Maximum Data Mode allows the operator to perform an in-depth analysis of the engine system or analysis of an individual area of choice. Upper and lower limits are displayed in red along with a yellow arrow indicating whether the result is above or below the specified limit.

Comparison Mode presents all the displayed data in a side by side format with related data grouped together. This allows the operator to compare data from several areas at the same time, which will assist in identifying trouble areas that may have developed.

Selecting the operation mode can be done in any page. Before, during or after a Complete Test has been accomplished the operator may use the left/right cursor buttons to select modes. This allows the operator to collect data in one mode and review or display the data- in a different mode.

Rapid Test The Rapid Test allows the user to determine overall engine condition quickly, with basic diagnostics. By stepping through an abbreviated version of the Complete Test, the MCA-3000 will develope basic diagnostics in a shorter period of time.

Systems Tests **The Engine Systems Tests allows the user to analyze a** specific system on the automobile. Engine System Tests include; Starting, Charging, Fuel/Emissions, and Cylinder and Power Contribution. Access to the Engine Systems Tests is gained through the. Main Menu. Once completed, the tests are followed by a dedicated Systems Post Test Menu.

Pinpoint Test The Pinpoint Tests **allow** the user to isolate a problem in a system of an automobile, troubleshoot a component of an automotive system, and adjust the initial setting of various engine systems. Included in the Pinpoint Tests are; Engine Data (which can be accessed by its own dedicated key), **Multimeter** (dedicated key), Dynamic KV (dedicated key), Scope Functions (dedicated key), Manual Power Balance (dedicated key), Adjustment Sequence, and Battery Test. **Also,** the Vehicle I.D. can be changed and the Main Menu can be accessed.

Scope Functions In the Scope Functions section the user will have the ability to view traditional oscilloscope patterns which are generated digitally by the MCA-3000. Access can be gained through the Main Menu or by depressing the dedicated SCOPE button on the keyboard or the remote control **unit.** The digital Scope Function section will display; ignition primary pattern, ignition secondary pattern, pinpoint waveform, and alternator ripple pattern. Each pattern can be displayed with various grid, time, and voltage parameters by utilizing the pop-up menus within the scope section.

On-board **Computers** After selecting the on-board Computers function from the Main Menu, a message on the VDU will prompt the operator to install a special program disk. This disk will display pages and required operations which are very similar to what are utilized in the STL-3003, DL-1OO (MEA-1500), and the SUN-1805 **Z(-9).** Entry to the on-board Computers functions can only be accessed through the Main Menu and its program disk must be booted up after making the selection from the Main Menu. The On-board Computers program can be exited by pressing the "E" key. It is not necessary to reset the computer, such as on the STL-3003. The "E" key will return the operator to the Main Menu of the **MCA-3000's** Master Program.

Utilities The program contained in this section, will allow the operator to alter colors and in formation on the programed pages. Also included in this function are the ability to; set th-e systems internal real time clock, use the keyboard as a full function typewriter, and use the keyboard as a full function calculator. The Utilities selection is divided into six parts, which include:

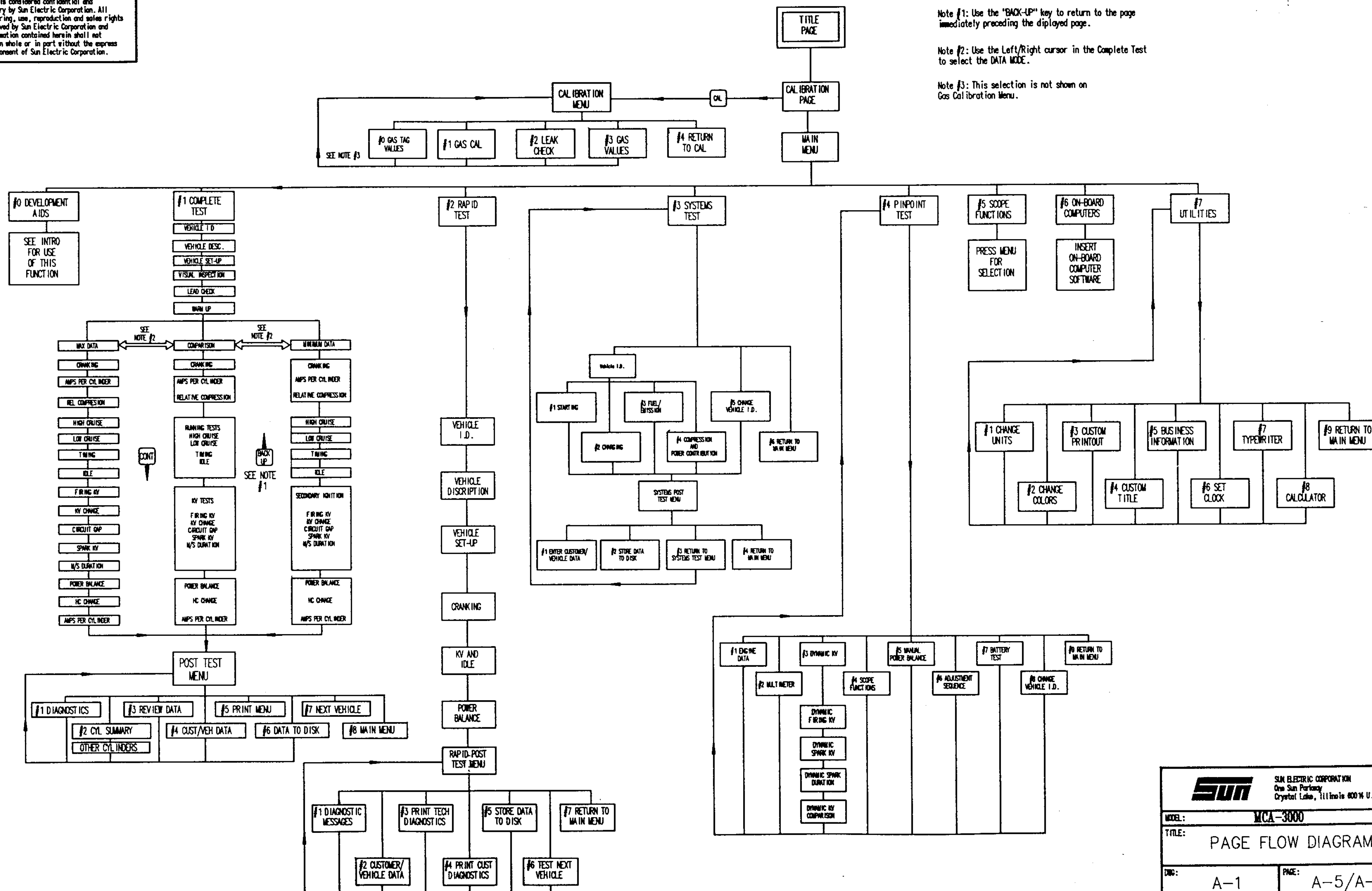
1. Change Units - Which includes changing the units of Dwell, Vacuum, Temperature, and MC Dwell Scale.
2. Change Color - Individual items on the displayed pages can have their color modified for ease of viewing.
3. Customize Printout - The operator can enter service specials or messages to be printed on the customers print-out.
4. Customize Title Screen - This selection enables the operator to personalize the title screen on the MCA-3000. The shop title or a message can be entered, which will be displayed at the bottom of the Title Page.
5. Business Information - which may include the name, address, and phone number, can be entered to be printed on the customers print-out.
6. Set System Clock - This selection enables the user to set the MCA-3000S internal time/date clock.
7. Typewriter - This selection allows the operator the option of using the keyboard, monitor, and printer as a full function typewriter.
8. Calculator - This selection allows the operator the option of using the keyboard and monitor as a full function calculator.
9. Return to Main **Menu.**

NOTES

Note #1: Use the "BACK-UP" key to return to the page immediately preceding the diployed page.

Note #2: Use the Left/Right cursor in the Complete Test to select the DATA MODE.

Note #3: This selection is not shown on Gas Calibration Menu.



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

MODEL: MCA-3000

TITLE: PAGE FLOW DIAGRAM

DWG: A-1 | PAGE: A-5/A-6

APPENDIX B

Access time	The time required to get a byte from memory.
Acoustic Coupler	A device for connecting a computer with a telephone receiver for data transmission over phone lines.
Address	A number that indicates the location of a byte of information in computer memory.
Alphanumeric	A set of all alphabetic and numeric characters.
Amplitude Modulation	.4 mode of transmission where the 1's and O's in a data stream are differentiated by varying the amplitude of the carrier signal.
Analog signal	A continuous electrical signal representing a condition (such as temperature or the position of game control paddles). Unlike a digital signal, which is discrete, an analog signal can be any frequency or amplitude.
Applications Software	Computer programs written to perform actual tasks such as accounts receivable or payroll.
Arithmetic Logic Unit (ALU)	The element in a central processing unit that carries out all arithmetic and logic operations, as well as data manipulations.
Artificial Intelligence	The ability of a machine to imitate certain human activities such as problem solving, decision making, perception and learning, such as Diagnostics.
ASCII	American Standard Code for information interchange. Set of digital codes for all alpha-numeric and control codes.
ASCII keyboard	A keyboard that contains keys for all ASCII character sets and transmits the standard code for each keypress.
Assembler	A program that converts the assembly language source code into binary code for execution. Acts as a compiler for assembly language.
Assembly language	Nothing more than machine language translated into mnemonic codes that are much easier for programmers to remember than 8-bit binary strings. The code for a jump to another location in Z80 machine language, for example, is 1100011. In assembly language, this instruction is simply JMP.
Audit Trail	The log of transactions generated by a program, such as accounts payable, for purposes of security and error detection.

Asynchronous Transmission — Transmission in which time intervals between transmitted characters may be of unequal length. Transmission is control-led by start and stop bits at the beginning and end of each character

Auto Answer — A feature in modems allowing the device to answer an incoming call from over the phone lines without requiring a telephone receiver or operatior intervention.

Auto Dial — Same as above, except with dialing instead of answering.

Bandwidth — The range of frequencies available for signaling; the difference expressed in Hertz between the highest and lowest frequencies of a band.

BASIC — Beginners All-purpose Symbolic Instruction Code. Developed at Dartmouth College as a simplified and interactive version of FORTRAN. This language was used to provide students ready access to a powerful computer from numerous locations across the campus. It quickly became and remains the most popular language for microcomputers.

Band — A measure of the rate at which digital data is transmitted in bits per second; typically ranges up to 19,200 baud (19.2K baud).

Bell 103 — AT&T modem providing asynchronous originate/answer transmission at speeds to 300 bps.

Bell 212 — AT&T modem providing full-duplex asynchronous or synchronous data transmission at speeds to 1200 bps on the dial network.

Bisynchronous Transmission (BSC) — An IBM communications protocol which uses a defined set of control characters for synchronized transmission of binary coded data between stations in a data communications system.

Bidirectional printing — A feature of some computer printers; indicates that a printer prints from left to right, and then continues from right to left with no carriage return. Procedure continues until entire document is printed. Speeds up the printing process.

Bit — Acronym for Binary Digit. Represents either of two binary states - 1 or O. Bits are usually grouped for easier operator manipulation. See byte below.

BPS (Bits Per Second) — Unit of data transmission rate.

Boot — A program used to start the computer, usually by clearing the memory, checking devices and loading the operating system into internal RAM from internal or external memory.

Bubble Memory — A type of memory device using discrete, microscopic magnetic cells in an aluminum garnate substrate.

Buffer A storage device used to compensate for a difference in rate of data flow or event timing when transmitting data from one device to another.

Bus A conductor that carries heavy current to be distributed to several other circuits and so places different components on different circuit boards. In a computer, carries signals to and from the microprocessor (which may be on one circuit board) and other component boards such as memory, 1/0 controllers, disk drives, etc. Popular standard buses are S-1OO and IEEE 696, Multibus, IEEE 488, S-50, and the new MCA-3000 Sun Bus.

Advantages are that the computing system is modular; expansion is simplified; there is a potential for a greater variety of hardware from a variety of manufacturers; and there is thus more competition in marketing and developing boards.

Byte A group of bits, usually eight, universally used to represent a character. There are two nibbles in a byte.

C BASIC A popular compiled BASIC language for 8080, 8085, and Z80 microprocessor computers. Much faster in execution than the more popular interpreter BASIC. This high-level language is not interactive.

Carrier A continuous frequency capable of being either modulated or impressed with a signal.

Carrier Detect Same as Received Line Signal Detector, RS-232 interface modem signal that indicates to attached terminal that the modem is-receiving a signal from the remote modem.

Character set The total number of alphanumeric, special and punctuation characters available on a terminal or printer.

Chip An integrated circuit etched on a small piece of silicon which is very cheap to mass produce and is more reliable and uses less power than conventional discrete circuits. Chips are commonly sized anywhere from 1/8-inch to 3/4-inch square in surface area. They can contain anywhere up to tens of thousands of transistors or other circuit elements. One chip may contain the central processing unit (CPU) of a computer or memory that stores up to 256,000 separate bits of information.

Circuit board **Microcomputers are made of one or more circuit boards, each a flat fiberglass board on which chips and other components are linked together by wires layered on the surface of the board.**

Clock Shorthand term for the source(s) of timing signals used in synchronous transmission. More generally the source(s) of timing signals sequencing electronic events.

COBOL Acronym for Common Business Oriented Language. A high-level language with **Engligh-like** words popular for business programming applications.

Compiler A program that converts high-level language into the binary code required by the computer. Compiled instructions are known as the "object code."

Command An order to the computer in the form of words and numbers typed on a keyboard, words spoken into a microphone, position of a game paddle or joystick, etc.

Computer A general-purpose computing system whose minimum configuration is a CPU, memory, and input/output (1/0) capability.

Computer system A complete computer setup, including CPU, memory, input and output (1/0) devices, and software.

Conditioning The addition of equipment to a leased voice-grade telegram channel to provide minimum values of line characteristics required for data transmission.

Console The part of a computer used for communication between the operator and the computer.

Controller A piece of hardware that usually monitors an input/output device(s).

CP/M Abbreviation for Control Program for Microcomputers. A single-user operating system for 8080, 8085, and Z80 microcomputers; all of which may utilize the S-1OO bus.

CPU Abbreviation for Central Processing Unit. Part of the computer responsible for processing, storing and retrieving data from memory.

CR(Carriage Return) A format effecter which moves the active position of the same line.

Crosstalk Interference caused by the transfer of electrical energy from one telephone line to another.

CRT Cathode ray tube. This is the most common form of a computer display screen. It may be a television set or a video monitor, or slightly modified versions of these display devices.

Current Loop Method of interconnecting terminals and transmitting signals, whereby a mark (binary 1) is represented by current on the line and space (binary O) is represented by the absence of current.

Cycle Redundancy Check(CRC)	A method of error detection whereby an equasion known to both sender and receiver is used to "add up" the bits in a transmitted block. Errors are detected by comparing the values gained from the equation to see if they are equal.
Daisywheel printer	An impact printer whose printing element resembles a daisy flower, with 96 or more single-character-slug spokes radiating from a central hub.
Database	Systematic organization of data files for easy access, retrieval and update.
Data Integrity	A performance measure based on the rate of undetected errors.
DBMS	Data Base Management System.
DCE (Data Communications Equipment)	The equipment that provides the functions required to establish, maintain and terminate a data transmission connection; e.g. a modem.
Dedicated	Assigned exclusively to one task.
Demodulation	The process whereby an analog signal, such as is transmitted over the phone lines, is converted into a digital signal so that the computer can manipulate it.
Descenders	The portion of lower-case characters (**g,j,p,q** and y) that descends below the base line of other characters.
Dibit	A group of two bits. The four possible states for a dibit code are 00, 01, 10 and 11.
Digital	In data communications, the signal which the computer manipulates within its own confines. Modems must convert this into analog to transmit it over the phone lines.
Digitizer	Device used to convert analog information into digital equivalents. .
DIP (Dual In-Line Package)	An electronic component package characterized by two rows of external connecting pins which are inserted into the holes of the printed circuit board.
Disk	A flat, circular magnetic storage device that is rotated like a phonograph record. To differentiate between the audio and computer media, spelling is differentdisc or audio, disk for computers.
Diskette	A term often used to identify a "floppy disk" magnetic storage disk.
Display	A computer output device designed to show alphanumeric **and/or** graphics data. In personal computing, the display is usually a TV-like video screen, but it can be a printout from a hard copy printer.

Documentation	Written computer or program instructions; a user or operator manual.
DOS	Disk Operating System. Tells the central processor how to communicate with all the peripherals connected to a computer. Used on computers that require a disk drive as a very important peripheral. Well-known systems are CP/M, MS-DOS, the UCSDP-system and UNIX.
Dot matrix	A means by which printed characters are formed using a matrix of small dots. The matrix is fixed and defined as so many dots wide by so many dots high. Typical matrices are 5x7,7x9,7x12, and soon.
Double-density	A technique used to double the amount of data that can be stored on a single magnetic medium.
DTE (Data Terminal Equipment)	The equipment acting as data source, data sink or both.
DTR (Data Terminal Ready)	Physical modem interface control signal from data terminal, indicating to the modem that the terminal is ready for transmission.
Dual-intensity	Indicates the ability of a terminal or printer to produce characters in regular as well as highlighted or bold formats.
Dumb Terminal	A computer terminal, usually comprising a keyboard and video monitor, which has little or no computational power of its own, but which allows remote data entry and access to a mainframe computer.
Editor	A computer program used to permit entry of text into a computer system.
Electronic Industries Association (EIA)	An organization which establishes the standard for electrical interface equipment. (Often, RS232 ports on the back of computers are labelled "EIA".)
EPROM	Acronym for Erasable Programmable Read-Only Memory; a type of computer memory device that can be used to store data within a computer for instant access. Can be erased by ultraviolet light and reprogrammed. A nonvolatile memory that retains programmed-in data even when no power is applied. See also PROM and ROM.
Equalization	The process which conditions a particular line in order to transmit signals correctly.
ESC (Escape)	A control character which is used to provide additional control functions. It alters the meaning of a limited number of continuously following bit combinations.

External Memory — Information storage devices such as cassette tape, floppy disk and hard disk drivesplus the media used to record the information. Also known as mass or removable memory.

Field — The number of character spaces reserved in a data file for a specific piece of data.

File — A logical block of information designated by name and considered as a unit by the user it may be physically divided into records.

Firmware — A computer program or software stored permanently in PROM or ROM orsemi-permanently in EPROM.

Floppy disk — A magnetic medium used for mass storage of data. Flexible disks are available in 8, 5-1/4 and 3-112-inch sizes; hard- and soft-sector formats. This term is used to describe the magnetic disk medium and its protective jacket.

FORTRAN — Acronym for **FORmula** Translator, a high level programming language developed for mathematical operations required by scientists and engineers.

Frequency Modulation — A method of transmission whereby 1's and O's are differentiated by varying the frequency of the signal.

Frequency Shift Keying (FSK) — Also called frequency shift signaling. A method of frequency modulation in which frequency is made to vary at significant instants by smooth as well as abrupt transitions. Typically, a data '1' bit is represented as one frequency and a data 'O' as another frequency.

Full duplex — A communication mode in which data can be transmitted and received simultaneously.

Half duplex — A communication mode in which data can be transmitted and received, but not simultaneously.

Handshaking — Exchange of predetermined signals between two devices for purposes of control.

Hard copy — Output, from a computer, that has been printed on paper.

Hard disk — A mass-storage magnetic medium that uses a rigid-material disk for mass storage of data. Usually nonremovable, hard-disk systems are faster and can store many times more data than is possible on same-size floppy disks. The disk itself is housed in a hermetically sealed enclosure, along with the read/write head, to insure against contamination.

Hardware — Describes all items in a computer system that are not software: circuit boards, integrated circuits, transistors, discrete components, etc. See also software.

Hard-wired — Used to describe system components that function as a result of being soldered into the system rather than being connected through software.

Header — The control information prefixed in a message text, e.g. source or destination address, sequence number or message length or type.

Hertz(Hz) — A measure of frequency or bandwidth. The same as cycles per second.

Hexadecimal — Frequently abbreviated "hex," this numbering system, popularly used in the computer world, uses a base-16 format. Hex numbers count up from O to 9 numerically and continue through the letters A through F to represent the full 16 numerals possible. Hex numbers are usually tagged with the suffix "H" to distinguish them from other numbers.

High-level language — Any human-like programming language that is relatively easy for the computer user to learn and use. Examples include BASIC, COBOL, FORTRAN, PASCAL, PL/1, APL, etc.

Host Computer — A computer which can be accessed over the phone lines or acts as the master in a multiprocessor environment.

High resolution — A term used to describe the ability of a video terminal to display highly detailed graphics.

Impact printer — Any printer in which characters are transferred to paper by striking through an inked ribbon, as in a typewriter.

Instruction — A single command within a computer program.

Interface — An electronic or software device used to mate a computer and its peripherals with the outside world.

1/0 — Input/Output. Refers to the paths by which information enters a computer system (input) and leaves the system (output). Traditional input device is a keyboard although some computer systems utilize joysticks, a mouse, touch sensitive screens, or other similar devices. The usual output devicer on modern computers is a video screen or a printer.

ISAM — Indexed Sequential Access Method. A method or organizing data files for easy and rapid access.

Keypad — A calculator-style arrangement of numeric and arithmetic keys.

Kilobyte — Term used to denote "1OOO bytes" or 1K (precisely 1024 bytes).

Leased Line — A telephone line reserved for the exclusive use of a leasing customer without interexchange switching arrangements. Also called a Private Line.

Letter-quality — A term used to indicate fine quality printing from a formed-character printer, such as the daisy wheel and thimble.

Library	**A collection** of computer programs, or subroutines, **usually** on cassette tape or floppy disk.
Line Driver	**A signal converter which conditions digital signal to ensure reliable transmission over an extended distance.**
Line Turnaround	**A reversing of transmission direction from sender to** receiver or vice versa when using a half-duplex circuit.
Load	**A term that indicates the transfer of data from a storage location, such as a disk or tape, into a computer.**
Location	**The actual, physical place in the computer's memory where a particular item(s) can be addressed.**
Logic	Term used to describe that part of the computer's circuitry that makes decisions (e.g. compares two numbers and decides which is greater).
Logical Operator	**Logic symbol in programming.**
LRC (Longitudinal Redundancy Check	**An error detection** scheme in which the check character consists of bits calculated on the basis of odd and even parity on all the characters of the block.
Machine language	**The internal language of a computer as represented by bynary numbers.**
Magnetic Bubble	**A magnetic "domain" created in a thin layer of substrate sandwiched between two thin chips. The domains appear to be bubbles, and the appearance of a bubble is** used to signify a binary digit much the same way that the presence or absence of current is similarly used. Bubble memories are faster than tapes or disks but slower than RAM or ROM; like disks, however, information in a bubble memory is non-volatile it remains even when the power is turned off. Bubble memories are often used to emulate a disk drive in main memory, speeding access to information.
Mainframe	The box that holds the computer's main memory, associated controllers, CPU and logic components. Also used to distinguish very large computers from **minis** and micros.
Mark	Presence of signal. In telegraph communication, a mark represents the closed condition or current flowing. A mark inpulse is equivalent to a binary 1.
Megabyte	A term used to indicate millions of bytes, 1 megabyte (lMb) = 1,048,576 bytes or 1048 kilobytes (1 OOOK).
Megahertz	A unit of electrical frequency equal to 1 million cycles per second (lMHz).

Memory	One of the main features of a computer is its ability to store and retrieve very quickly enormous amounts of information. There are several kinds of memory. See RAM, ROM, EPROM.
Menu	**A common device used** in many applications programs that allows the user to choose a command or function from a list that appears on the screen.
Microcomputer	An integrated complete small computer system built around a microprocessor (CPU), memory and input/output interfaces, and containing a power supply. All personal computers are microcomputers.
Microprocessor	The brain of any computer. Performs all of the mathematical and logical operations necessary for the functioning of a computer system (see CPU).
Modem	Acronym for MOdulator/DEModulator; a device used to interface a computer with a telephone line, converting digital information into analog form and vice versa.
Modem Eliminator	A device which **intefaces** between a local terminal that normally requires a modem and the computer near it that also expects to connect to a modem. Functions as an imitation modem in both directions.
MP/M	Abbreviation for Multiprogramming control Program for Microprocessors; a multiple-user version of the **CP/M** operating system. See also **CP/M.**
Multi-processing	Used to describe a small computer that has more than one microprocessor, which allows the processing of more than one command at a time.
Multi-user system	A computer system that allows more than one terminal or computer to access the CPU and input/output devices. Allows concurrent use of the sample applications program or database.
Network	A group of computers that communicate over telephone lines, radio or microwaves; a multi-user system that may or may not be multi-processing.
Nibble	A block of data representing half a byte, usually 4 bits.
Number crunching	Performance of complex numerical operations or arithmetic-intensive computation by computer.
Object code	The binary code produced by an assembler or compiler program; it can usually be executed directly by the CPU when loaded into the computer. See also a source code.
Octal	A numbering system in which only eight digits, O thru 7, are used. Sometimes used in microcomputers. Octal numbers are usually tagged with the suffix **"o"** to distinguish them from decimal and hexadecimal numbers.

On-line — A phrase used to indicate any device directly connected by a computer.

Operating system — A program or collection of programs used to manage the hardware and logical functions of a computer system.

Overstriking — The ability of a hard-copy printer to strike a character more than once to produce boldface.

Parallel Transmission — Byte-wide data transmission that allocates a data line for each bit in a word. Transmission is usualy unidirectional.

Parity Check — Addition of noninformation bits to data, making the number of ones in a byte (bit group) either always odd or always even. This permits detection of errors in blocks that have a single error.

Pascal — A high-level programming language named after Blaise Pascal. May become the most popular language for sophisticated programmers.

Peripheral — Any device that connects to and is controlled by a computer, such as a terminal, printer, modem, etc.

Personal Computer — A low-cost very compact computer designed for the individual user without requiring access to a large computer.

Pixel — Picture element. Refers to the smallest single screen element directly addressable by a computer. The smaller the pixel size, the more pixels to a screen, and thus the finer the graphics resolution.

Phase Modulation — One of three ways of modifying a sine wave signal to make it 'carry' information. The sine wave or 'carrier' has its phase changed in accordance with the information to be transmitted.

Polling — Means of terminal control on a multidrop line by sequential inquiry.

Port — An interface on a computer configured as data terminal equipment and capable of attaching a modem for communication with a remote data terminal.

Portability — In software, the ability to use a program in more than one computer environment; in hardware, the ability to transport a computer easily and use it en-route.

Program — A list of user-specified instructions that tells a computer to perform a specific processing task. Programs can be written in machine language, assembly language, and high-level language.

Programming language	**Any language used to write a computer program (see above).**
PROM	Acronym for Programmable Read-Only Memory; a permanent storage device that can be programmed by the device manufacturer, supplier, or user. See also EPROM and ROM.
Protocol	**A formal set of conventions governing the formatting and relative timing of message exchange between two communicating systems.**
Quad-density	A term used to specify the data storage density of a computer disk system. Quad-density systems can store up to four times the data that can be stored on single-density disks. Double-sided, double-density disks are quad-density disks.
Queue	A waiting line or area.
RAM	Acronym for Random-Access Memory. A volatile type of temporary storage device that can be written to by the user. Any data byte stored in RAM can be directly retrieved simply by entering its address. Data store in RAM is irretrievably lost when power is shut down.
Randon Access	**Addressable memory, i.e. memory that can be accessed at any point using addresses.**
Read/Write	A term used to indicate that the user can read data from and write data into memory, which can be RAM, tape, or disk.
Real Time	**Immediate and concurrent response, processing or programming.**
Response time	The elapsed time between the generation of the last character of a message at a terminal and the receipt of the first character of the reply. It includes terminal delay and network delay.
Resolution	**Refers to either the number of scanning lines on a video display terminal or the number of pixels addressable on the display screen (see pixel).**
Reverse video	**A term** used to indicate, in some video terminals, the ability to display black characters on a white (or green) background.
RF Modulator	Converts a standard, non-broadcast, computer video signal into a modulated radio frequency signal that can be sent through a television set's antenna and thereby displayed with acceptable quality.

RGB — A form of color video signal (Red, Green, Blue), distinctly different from the composite color video used in standard television sets. Can be displayed only on a color monitor that has a separate electron gun for each of these primary colors. Ordinary color television sets use only one gun. RGB displays are noted for their crisp, bright colors and high resolution.

Ring Indicator — Modem interface signal defined in RS-232 which indicates to the attached data terminal equipment that an incoming call is present.

ROM — Acronym for Read-only Memory. A permanent data storage device that, once programmed, cannot be reprogrammed. The user can only read what is in ROM; he cannot write to it. This type of memory is nonvolatile. See also EPROM and PROM.

RS-232C — Interface between data terminal equipment and data communication equipment employing serial binary data interchange.

Scrolling — The ability to move text displayed on a video terminal's screen up and down and, in some cases, left and right.

Sector — A section of a storage disk's track.

Semiconductor — A substance, usually some form of silicon, that is between an electrical conductor and an insulator. Used to make components such as transistors, resistors, etc.

Sequential Access — A method of scanning data in which files or blocks of data are accesssed in order.

Serial — A type of input or output utilizing an established protocol, writing, and information format so that data is submitted one bit at a time.

Serial port — An input/output port in a computer through which data is transmitted and received one bit at a time. In most cases in personal computers, serial data is passed through an RS232C serial interface port.

Single-sided — A phrase used to indicate that only one side of a disk is accessible by the disk drive for storage and retrieval of data.

Source code — A text file of a program in a high-level language. This source program is then submitted to an assembler or compiler for translation into a form usable by the computer.

Sort — To arrange data in sequential order, usually alphabetically or numerically; a common program application.

Space	Absence of signal. In telegraph communications, a space represents the open condition or no current flowing. A space impulse is equivalent to a binary O.
Start Bit	In asynchronous transmission, the first bit or element in each character, normally a space, which serves to prepare the receiving equipment for the reception and registration of the character.
Stop Bit	In start-stop transmission, the last bit or element in each character, normally a mark, to which is assigned a minimum duration, during which the receiving equipment is returned to its rest condition in preparation for the reception of the next character.
Superconductor	A material that offers almost no resistance to the passage of electrical current.
Synchronous Transmission	Transmission in which the data characters and bits are transmitted at a fixed rate with the transmitter and receiver synchronized. Synchronous transmission eliminates the need for start and stop bits.
Syntax	A set of grammatical rules that define how a programming language must be written to be properly executed in a computer.
Teletext	Information transmission through a television set. This information is usually maintained on a computer that allows two-way interaction by linking the computer and the user through telephone lines.
Teletypewriter (TTY)	A computer typewriter that is fast becoming obsolete.
Telex (Teleprinter Exchange)	A teleprinter dial network offered by Western Union and the International Record Carriers. Uses baudot code.
Terminal	Simply, a computer without a CPU; usually used as a remote workstation allowing input and output to and from a central CPU.
Tractor feed	A mechanical device in hard-copy printers used to insure accurate positioning and moving of fan-fold paper through the mechanism. Sprockets in the printer engage the holes along the sides of the paper. A must-have item in high speed printing where accuracy in alignment is a necessity, such as in the printing of thousands of mailing labels.
Trunk	A single circuit between two points, both of which are switching centers or individual distribution points. A trunk usually handles many channels simultaneously.

Turnkey Complete. A turnkey system is usually put together by an OEM or systems house from several different manufacturers' equipment. This system is composed of fully-compatible hardware, software and peripherals, installed and well documented.

Voice-Grade Line A telephone line primarily used for the transmission of the voice. The range is from 300-3400 Hertz. It is also sometimes used for analog data transmission.

Volatile storage Refers to a memory device that loses data programmed into it when power is removed or interrupted. See RAM.

WATS (Wide Area Telephone Service) A service provided by telephone companies in the United States that permits a customer to make calls to or from telephones in specific zones for a flat monthly charge. The monthly charges are based on size of the zone instead of number of calls.

Word A unit of information within the computer's memory. A word is usually composed of eight or 16 bits in micros, 32 bits in mainframes.

Word processor A computer/software system designed for writing and editing letters, reports, or any other word-intensive document.

Write protection A phrase indicating that data cannot be written onto or erased from a storage disk. For an 8-inch disk to be write protected an adhesive tab must be removed from its protective jacket; for a 5-1/4 inch disk, the tab must be placed on the jacket. For a 3 1/2" disk, the window must be closed.

X-OFF (Transmitter Off, DC3) The communication control character used to instruct a terminal to suspend transmission.

X-ON (Transmitter On, DC1) The communication control character used to instruct a terminal to start or resume transmission.

NOTES

APPENDIX C

MODEL DIFFERENCES

SECTION I. ITEMIZED DIFFERENCES

GENERAL
Major differences between the Model MCA-3000 (110V), Model MCA-3000-3 (220V), and the model MCA-3000-G versions of the Tester are noted in the following table.

PART NUMBER	DESCRIPTION	MCA-3000	MCA-3000-3	MCA-3000-G
0587-0504	Fan, Axial (Qty 2)	x		x
0587-0507-01	Fan, Axial (220V-Qty 2)		X	
0682-0721	Label, Printer Outlet (220V)		X	
0764-0229	Switch, Rocker, DPDT, SW2	X		X
0764-0230	Switch, Rocker, DPDT SW2 (220V)		X	
0764-0231	Switch, Rocker, DPST SW3	X		X
0764-0232	Switch, Rocker, DPST SW3 (220V)		X	
1243-0803	Plate, Identification	X		
1243-0804	Plate, Identification (220V)		X	
1243-0834	Plate, Identification (Atlas)			X
1243-0834	Plate, Identification (Rot)			X
1922-0112-04	Circuit Breaker, 1 Ampere		X	
1922-0112-05	Circuit Breaker, 2 Ampere	X		X
1922-0112-06	Circuit Breaker Pump, 3A	X		X
1922-0112-08	Circuit Breaker 5A		X	
1922-0112-13	Circuit Breaker, 10 Ampere	X		X
6001-0177	Cable Assy, AC Power (110V)	X		X
6001-0178	Cable Assy, AC Power (220V)		X	
6004-0360	Cable Assy, Fan Power	X		X
6004-0360-01	Cable Assy, Fan 110V (Qty 2)	X		X
6004-0458-01	Cable Assy, Fan 220V (Qty 2)		X	
7009-1896	Battery Load Assembly	X		X
7009-1897-02	Vacuum Pump Assy (220V)		X	
7009-1898-01	Power Supply Assy	X		X
7009-1898-02	Power Supply Assy (220V)		X	
7009-1902-01	Ballast Assy	X		X
7009-1902-02	Ballast Assy (220V)		X	
7009-1903-01	Front Panel Assy	X		
7009-1903-02	Front Panel Assy (220V)		X	
7009-1903-03	Front Panel Assy (ATLAS)			X
7009-1903-04	Front Panel Assy (Rotunda)			X
7009-1904-01	Control Panel Assy, 110V	X		X
7009-1904-02	Control Panel Assy, 220V		X	
7009-1907-01	Exhaust Analyzer Assy	X		X
7009-1907-02	Exhaust Analyzer Assy (220V)		X	
7014-0170	Cover, Battery, Connector		X	
7014-0171	Cover, Battery CPC Corm.		X	
7030-0164	Headsign (Sun)	X	X	
	Headsign (Atlas)			X
	Headsign (Rotunda)			X
7049-0120	Analyzer, Exhaust (220V)		X	

PART NUMBER	DESCRIPTION	MCA-3000	MCA-3000-3	MCA-3000-G
7091-0169-01	Unit Packaging & Accessories	X		
7091-0169-02	Unit Packaging & Accessories		x	
7091-0169-03	Unit Packaging & Accessories			x

APPENDIX D

CHECK-OUT PROCEDURES AND INSTALLATION INSTRUCTIONS

GENERAL

This Appendix will be used to file the Check-Out Procedures and Installation Instructions for the MCA-3000 and its options. It is advised that you keep this updated with the latest and greatest in Installation Instructions for your own reference. Below you will find a list, which contains the Installation Instructions which are currently available.

SUN ELECTRIC CORPORATION

Model: KIT# 120-0553-01
MCA-3000

Field Installation Instructions

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL

INSTALLATION OVERVIEW:
This kit updates the MCA's XT* computer module by replacing the computer drawer assembly with an IBM AT* compatible based computer drawer assembly. This greatly increase the operating speed of the MCA.

PARTS LIST --

PART NUMBER	DESCRIPTION	QTY
0403-1451-8	Screw, #8 (for Computer Drawer slide)	1
0664-0090	Wire Jumper, 2.5"	1
0776-0254	Transistor, 2N6427	1
N/A	Arbitrator Assembly, includes	1
7001-2021-01	Keyboard/Remote Arbitrator Board	1
7012-1070	Arbitrator Bracket	1
7009-1976	Computer Drawer Assembly, includes:	1
7001-2024	Passive Backplane board	1
7001-2022	286 CPU board	1
7009-1989-01	DAS Processor Assembly	1
7001-2034-01	Serial/Parallel 1/0 board	1
7001-2020	Hard/Floppy Disk Controller board	1
7076-0621	Computer Power Supply Wiring Harness, W27	1
6004-0570	Floppy Disk Drive Data Cable, W19	1
N/A	Printer Data Cable, W29	1
7076-0622	CPU to FPI Wiring Harness, W50	1
6004-0568	CPU to Arbitrator Bd. Wiring Harness, W31	1
N/A	Battery Pack	1
7020-1839	Disk Drive Mounting Bracket Assembly	1
5878-0015	Wire Ties	10
0119-0294-01	Literature Kit	1
0692-1650-01	Installation Instructions	1
0682-0724	Caution Label	1
N/A	Shipping Label	1

REQUIRED TOOLS --

COMPLETE SUN ISSUED TOOL KIT IS-100A

INSTALLATION INSTRUCTION PRELIMINARY CHECKOUT

NOTE : USE STANDARD ANTI-STATIC PROCEDURES WHILE PERFORMING THIS PROCEDURE.

1. Verify with the MCA's Operator that the unit is functioning normal, if not, make any and all repairs before starting the installation of this kit. If the unit is functioning normal, continue on.

* AT &XT is a registered trademark of IBM Corporation

COMPUTER DRAWER UPDATE PROCEDURE

2. Turn "OFF" the tester and remove the AC cord from the power outlet.

3* Remove the screws which secure the computer drawer.

4. Carefully slide the computer drawer all the way out from the MCA. Use care not to let the drawer fall.

5. Disconnect the following connectors from the Single Board Computer:

Wiring Harness	Connector to be removed:
Speaker Harness, W50	J18
Reset Wiring Harness, W46	J11
Printer Cable, W29	J9
Disk Drive Cable, W19	J15
Keyboard Wiring Harness, W13	J13

6. Disconnect the following connectors from boards which populate the SBC:

Wiring Harness	Name of PCB connected to:	Connector to be removed:
Video Harness	EGA Board	J403
DAS Interface Cable, W50	DAS Memory	J401
SUN BUS Cable, W25	I/O/EEPROM/CLOCK	J402

7. Remove the Writing surface cover and disconnect connectors P306 and P315 from the VAT Board.

8. Disconnect in-line connectors J903 from P713, power lead from Power Supply Drawer Assembly.

9. Unfasten, remove and/or cut all cable mounts and/or cable ties securing Wiring Harnesses or Cables.

10. Remove the Remote Control Unit's connector J608 from the rear of the MCA's Computer Drawer Assembly.

11. Carefully remove the Computer Drawer Assembly from the MCA. Place the Drawer where it can be easily accessed and as close to the new Computer Drawer Assembly as possible (certain items need to be transferred from the old to the new).

12. Remove the Lead Hanger from the old Computer Drawer Assembly and attach it to the new Computer Drawer Assembly.

13. From the old Computer Drawer Assembly, remove the EGA Board and install it in the new Computer Drawer Assembly in slot J7 the 6th from the left.

14. If the MCA is not equipped with a modem kit, proceed to step 15. If the MCA is equipped with the Communications option, disconnect the plug in phone jack from the back of the Modem PCB. Remove the Modem PCB and the associated harness, connectors and cover plate, and reinstall them in the new Drawer Assembly. Install the Modem PCB in slot J2 the 11th slot from the left.

15. From the old Drawer Assembly, remove the I/O/EEPROM/CLOCK Board and modify per the procedure below.

MODIFYING I/O/EEPROM/CLOCK BOARD PROCEDURE

16. On the I/O/EEPROM/CLOCK Board, cut pin 11 of U16, as close to the board as possible. Bend the just cut pin, up (see Figure 2).

17. Using a soldering iron, carefully solder the jumper wire supplied from pin 10 of U4 to pin 11 of U16 (see Figure 2). NOTE : TOO MUCH HEAT USED WHEN SOLDERING THIS JUMPER WIRE, CAN DAMAGE THE ICS INVOLVED.

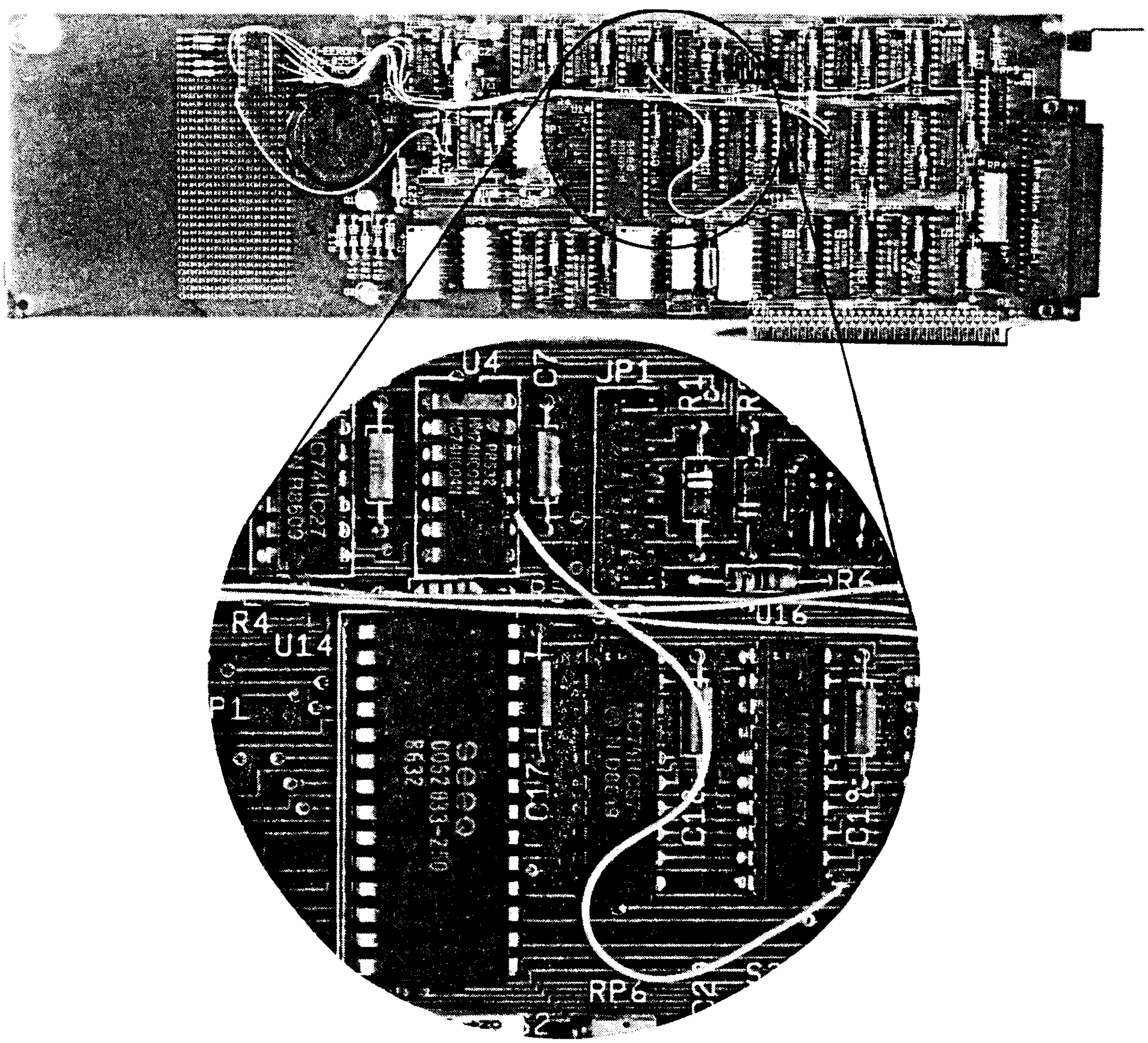


Figure 2. Modifying the I/O/EEPROM/CLOCK Board

18. Reinstall the modified I/O/EEPROM/CLOCK Board in the new Drawer Assembly in slot J8, the 5th one from the left.

19. Remove the rails from the old Drawer Assembly and reinstall them on the new Drawer Assembly. Use the new screw, #0403-1451-08 to secure the Computer Drawer's left hand rail (as viewed from the rear of the drawer) innermost mounting hole instead of the screw used on the old Computer Drawer Assembly (see figure 3).

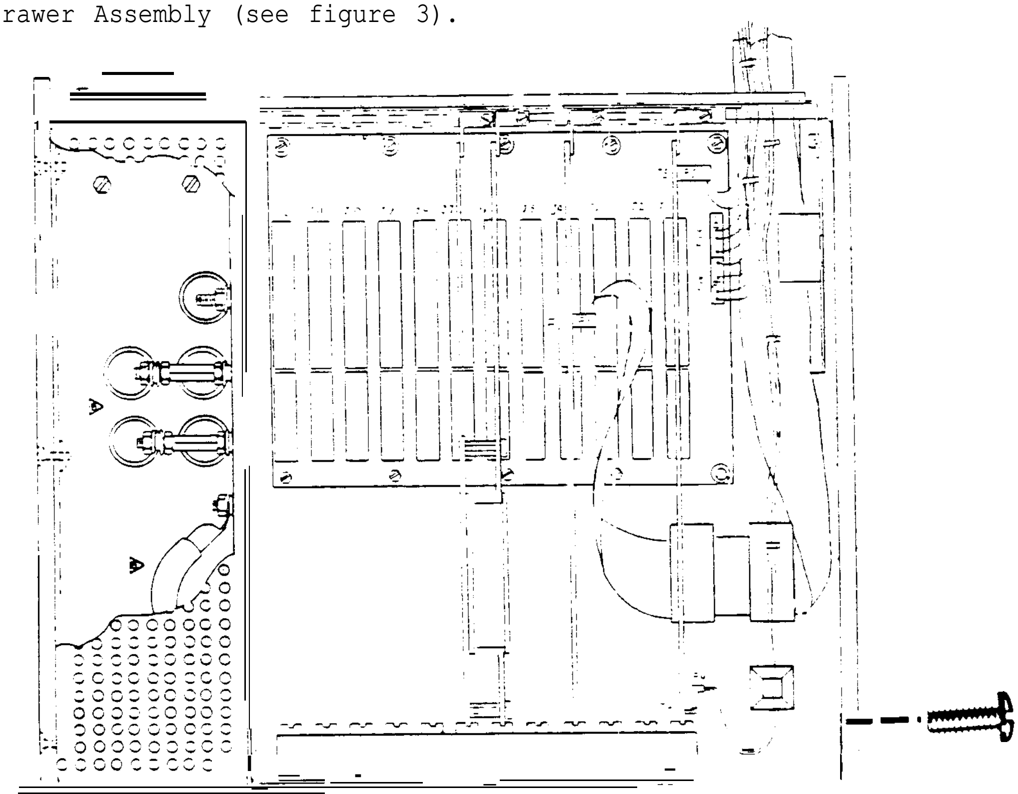


Figure 3. Location of new screw, #0403-1451-08

20. Remove the four screws which secure the Battery Load Module's protective screen.

21. Remove both connectors J811 and J810 (used for the Battery Load Leads) from the rear of the Computer Drawer Assembly's Load Module.

22. Remove the 2 screws which secure the Battery Load Module to the Computer Drawer Assembly.

23. Remove the Battery Load Module from the old Drawer Assembly and install it in the new Computer Drawer Assembly using the old hardware (use the proper socket along with both extensions from your /4" Drive set to make it easier to reach the nuts).

24. Install both connectors J811 and J810 (used for the Battery Load Leads) in their proper location of the new Computer Drawer Assembly.

25. Install the Battery Load Module's Protective Screen using the four screws from step 25.

26. Line up the new Computer Drawer Assembly and start to insert the drawer into the MCA'S headframe, so that it will be supported by its rails.

27. Reconnect connectors P305 and P315 from the Battery Load Module to the VAT Board located in the SUN BUS, also connect J713 to P713 leading to the Power Supply Drawer.

, 28. Reconnect the following wiring harnesses to the following connectors:

Wiring Harness	Name of PCB connected to:	Connector to be removed:
Video Harness	EGA Board	J403
* DAS Interface Cable, W50	DAS Memory	J402
* SUN BUS Cable, W25	I/O/EEPROM/CLOCK	J401

* Attach Data Ribbon Cable to the boards such that the Red stripe is on top.

29. Connect CPU Power Wiring Harness, W27 to connectors J903 to J903 the in-line Power to CPU connector

30. Reinstall the RCU Cable on the new Computer Drawer Assembly, using the same hardware used to mount it in the old Computer Drawer Assembly.

31. Disconnect the AP-11OO'S printer cable from the Arbitrator's bulkhead connector, J707 and unplug the MCA's Keyboard from J20.

32. Using 3/16" Nut Driver, remove the studs which secure J707 to the MCA's bulkhead. "

33. Disconnect RCU Wiring Harness, W32 (Arbitrator to Rear of Computer Drawer Assembly) from connector P30 of the Arbitrator Board.

34. Remove the Arbitrator Board (along with Wiring Harness W31) and mounting bracket by removing the two keps nuts underneath the bracket. NOTE: Removal of the 4 SUN BUS boards on the left will make changing the Arbitrator Assembly easier. Complete removal is not necessary, enough lead length is there to lay the boards on the SUN BUS.

35. Remove Wiring Harness W29 (Printer Harness from SBC to Arbitrator Board) and discard it.

36. Install the new Remote Keyboard Arbitrator Board (7001-2021-01) and its mounting bracket. Make sure the Keyboard connector on the Arbitrator aligns properly with its opening before finally securing in place.

37. Connect the Remote Control Unit's Wiring Harness, W32 connector P30 to J53 of the new Arbitrator Board.

38. Find D shaped connector P40 of the new Wiring Harness, W29 and place in printer connector opening of the MCA. Secure P40 in place using mounting hardware from step # 37, then reconnect the AP-11OO printer.

39. Reinstall the 4 SUN BUS boards with the exception of the Front Panel Interface Board. Completely remove the Front Panel Interface Board from the MCA.

MODIFYING THE FRONT PANEL INTERFACE BOARD PROCEDURE

40. **Desolder** Transistor, Q14 from the Front Panel Interface Board. NOTE: TO MUCH HEAT CAN CAUSE DAMAGE TO THE BOARD, SO USE CARE WHEN RESOLDERING AND SOLDERING ON THIS BOARD.

41. Install new Transistor, Q14 (Sun part number 0776-0254) such that the Collector of the new transistor is in the upper most hole location for Q14 , the Base is in the hole farthest to the right and the Emitter of the transistor is in the lower floor, as shown in Figure 4.

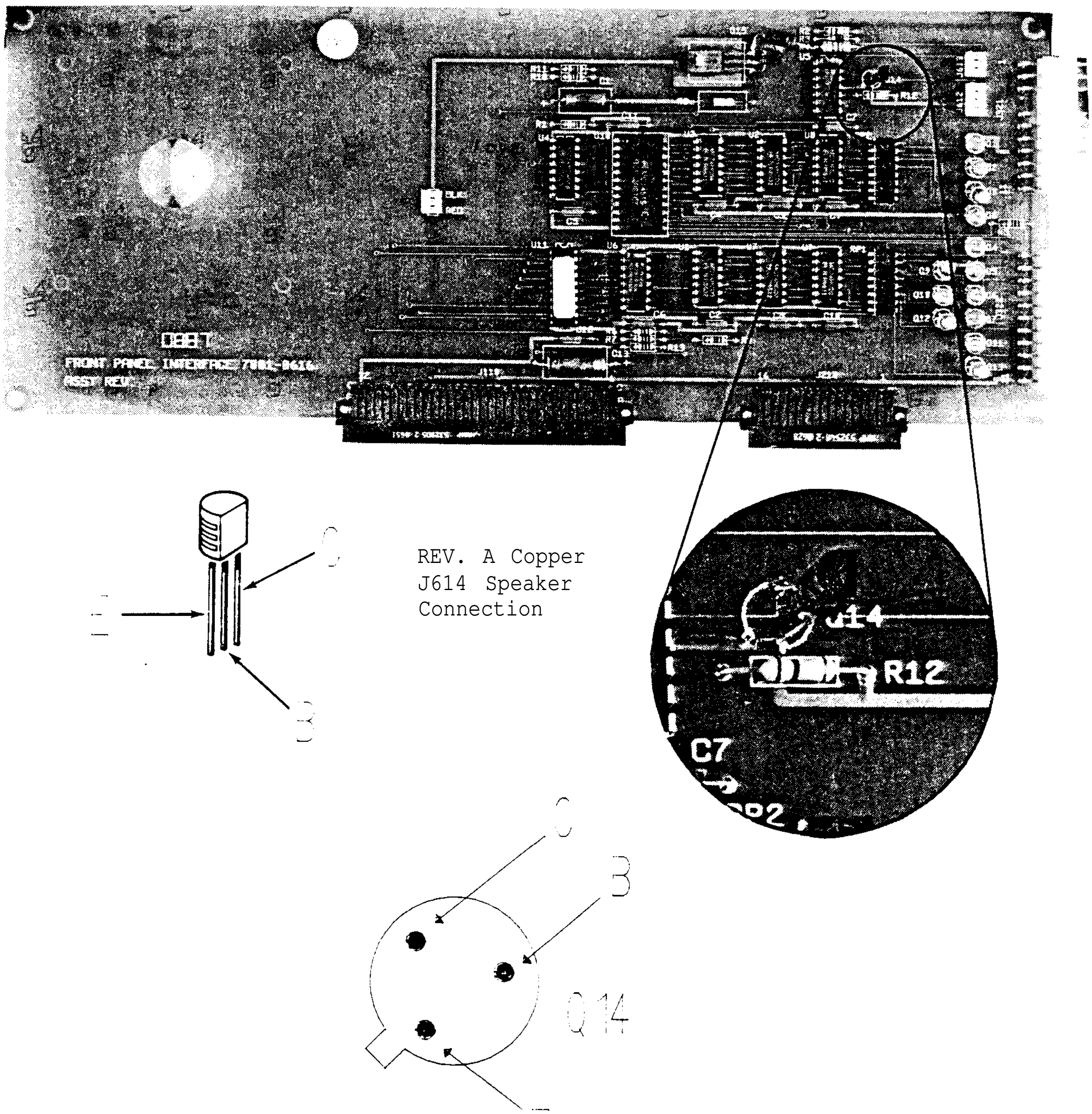


Figure 4. Placement of new Transistor, Q14

42. Reinstall the just modified Front Panel Interface Board into the SUN BUS.

43. Find CPU to Front Panel Interface Wiring Harness, W50 (marked P18 and P612 on the ends) and discard it.

44. Route Wiring Harness, W50 and connect P54 from the new Computer Drawer to the Remote Keyboard Arbitrator Board's J54 and then connect P612 to the Front Panel Interface Board's J612.

45. Route and connect P11 (previously connected to the old SBC for RESET) to J57 of the new Arbitrator Board.

46. Route and connect P52 from the New Computer Drawer to J52 on the Arbitrator Board such that the red stripe on the cable is towards the front of the MCA.

MODIFYING THE FLOPPY DRIVES PROCEDURE

47. Remove the back cover of the MCA 3000.

48. Observing proper orientation, disconnect the ribbon cable from the two 3 1/2" Disk drives.

49. Observing proper orientation, disconnect the power cable from the two 3 1/2" Disk drives.

50. Remove the two screws from the rear of the Drive Assembly Bracket which secure it to the unit and on some units the two screws which secure it in the front.

51. Remove the mounting hardware for the following Controls:

    Brightness Control Potentiometer
    Contrast Control Potentiometer
    Reset Switch
    Analyzer/PC 5 1/4" Switch

52. Pull the drive assembly out through the back of the MCA.

    NOTE : The Drive Assembly Bracket may become caught on one of the screws securing the monitor, removing the screw will make it easier for you to remove and reinstall the Drive Assembly Bracket.

53. Remove the eight mounting screws that hold the two 3 1/2" disk drives in place then remove the two 3 1/2" disk drives.

54. Remove both the drives from their mounting plates.

55. Identify which type of drive is used, either the MF353AF-12U or the MF353B-12UJ. The drives model number is marked on the same side as the disk eject button.

56. Set the configuration jumper pins (located on the bottom of the disk drive assembly) accordingly, for the proper model drive on the next page.

For Model MF353FA-12U Drives

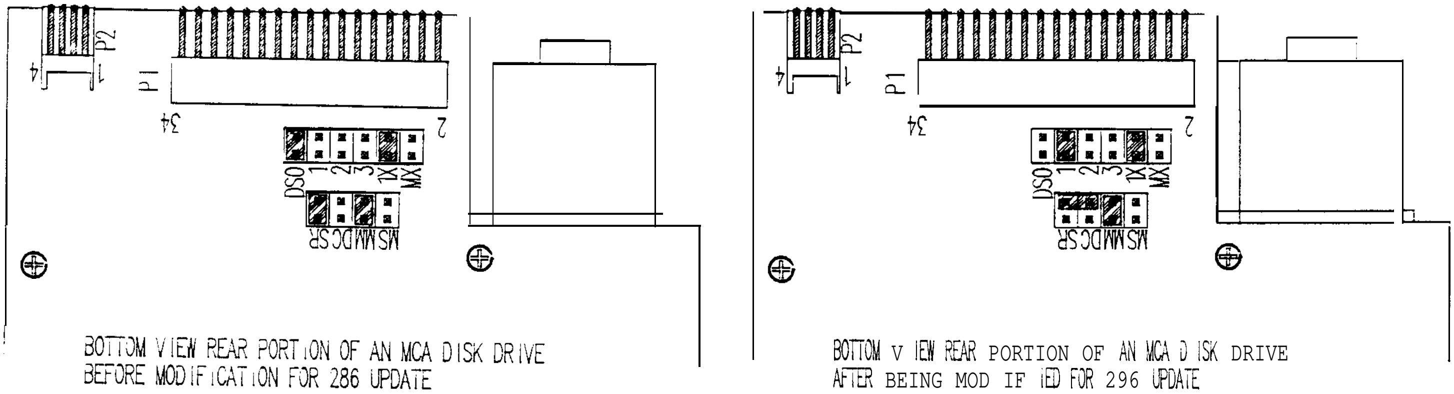


Figure 5. Shorting pin configuration for Model MF353FA-12U Disk Drive

Move SR shorting pin so that it placed across both SR and DC markings (see Figure 5).

Set the Drive Select shorting pin on both the A and B Drives to DS1 (see Figure 5).

For Model MF353B-12UJ

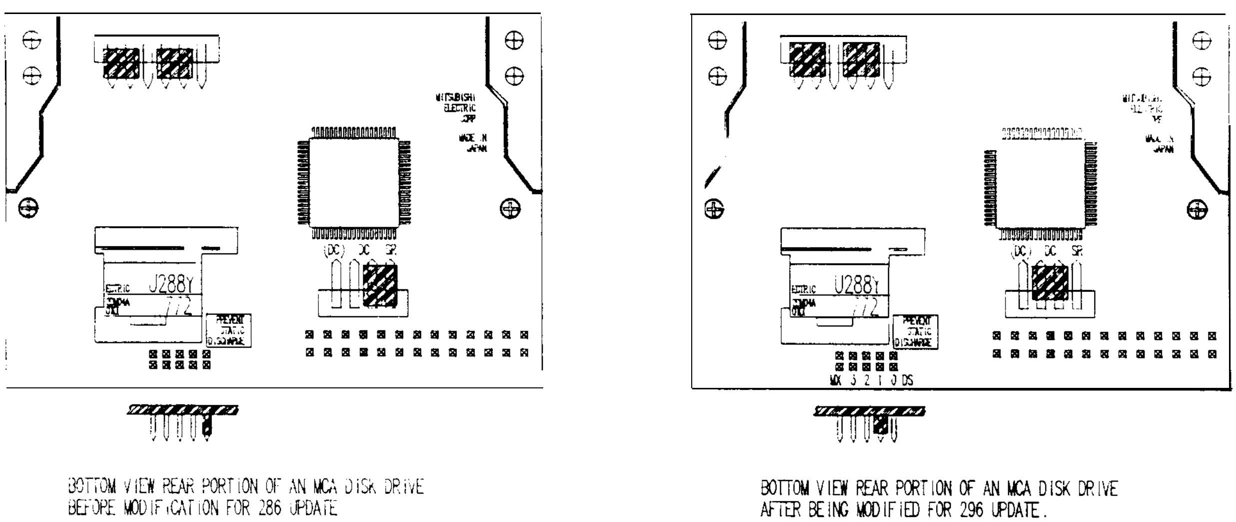


Figure 6. Shorting pin configuration for Model MF353B-12UJ Disk Drive.

Move shorting pin between the DC and SR pins and place on the middle two pins (see Figure 6).

Set the Drive Select shorting pin on both the A and B Drives to DS1 (see Figure 6).

57. Remount the drives on their individual mounting plates and secure in place.

58. Check the foam between the drives. If two pieces of foam where used, remove both of them and replace them with one piece of foam (#0720-0517) towards the front of the drives. For more information see Service Bulletin #599.

59. Reinstall the two 3 1/2" disk drives into the new Disk Drive Mounting Bracket, //7020-1839 provided with the smaller box of Kit 120-0553-01. Make sure that both drives are in their proper location of the Disk Drive Mounting Bracket (bottom drive is Drive B, top drive is Drive A).

60. If the TECH 10 option is to be installed at the same time as this Kit, proceed to install the TECH-10 Option Kit now. When done installing the TECH-10 Option Kit return to this procedure and complete the rest of the steps stating with step 66.

61. Adjust Drive B, so that it is flush with the front of the Disk Drive Mounting Bracket and secure in place using the four screws removed in step 54.

62. Adjust the top 3 1/2" drive (Drive A) until it fits in the front opening correctly and secure in place using only four of the screws removed in step 58.

63. Remove the old Disk Drive Ribbon Cable, W19 and discard.

64. Route the new Floppy Disk Drive Ribbon Cable with three connectors marked , P912, P913 and P914 from the new Computer drawer, to the Disk Drive Assembly. Route these cables the same as the discard W19 cable and secure in place using flat cable anchor under the monitor assembly.

65. Connect the new Disk Interface Cable W19, such that the middle connector, J913 is attached to Drive A. Make sure that the red stripe is on the right hand side as viewed from the rear of the drive assembly (see Figure 7). Connect J914 to Drive B,

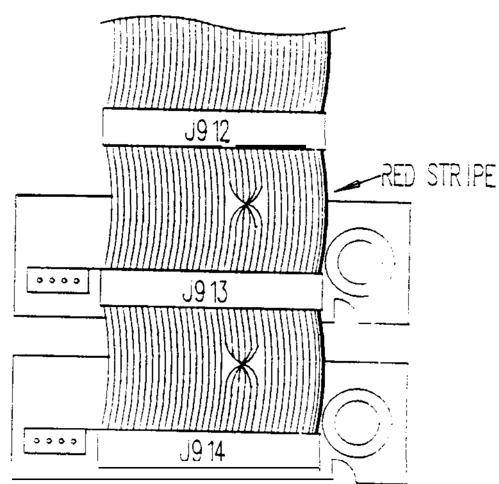


FIGURE 7. W19, Disk Interface Cable connections to Mitsubishi Drives.

66. Reinstall the Disk Drive Assembly Bracket into its proper location inside the MCA. DO NOT YET SECURE IT IN PLACE.

67. Reinstall the RESET switch.

68. Reconnect the two Power Connectors J703 and J709 to their appropriate connector on the two 3.5" drives.

69. **Re-check** all connections, to make sure that EVERYTHING has been connected properly per Figure 8 MCA 286 Interconnection Diagram.

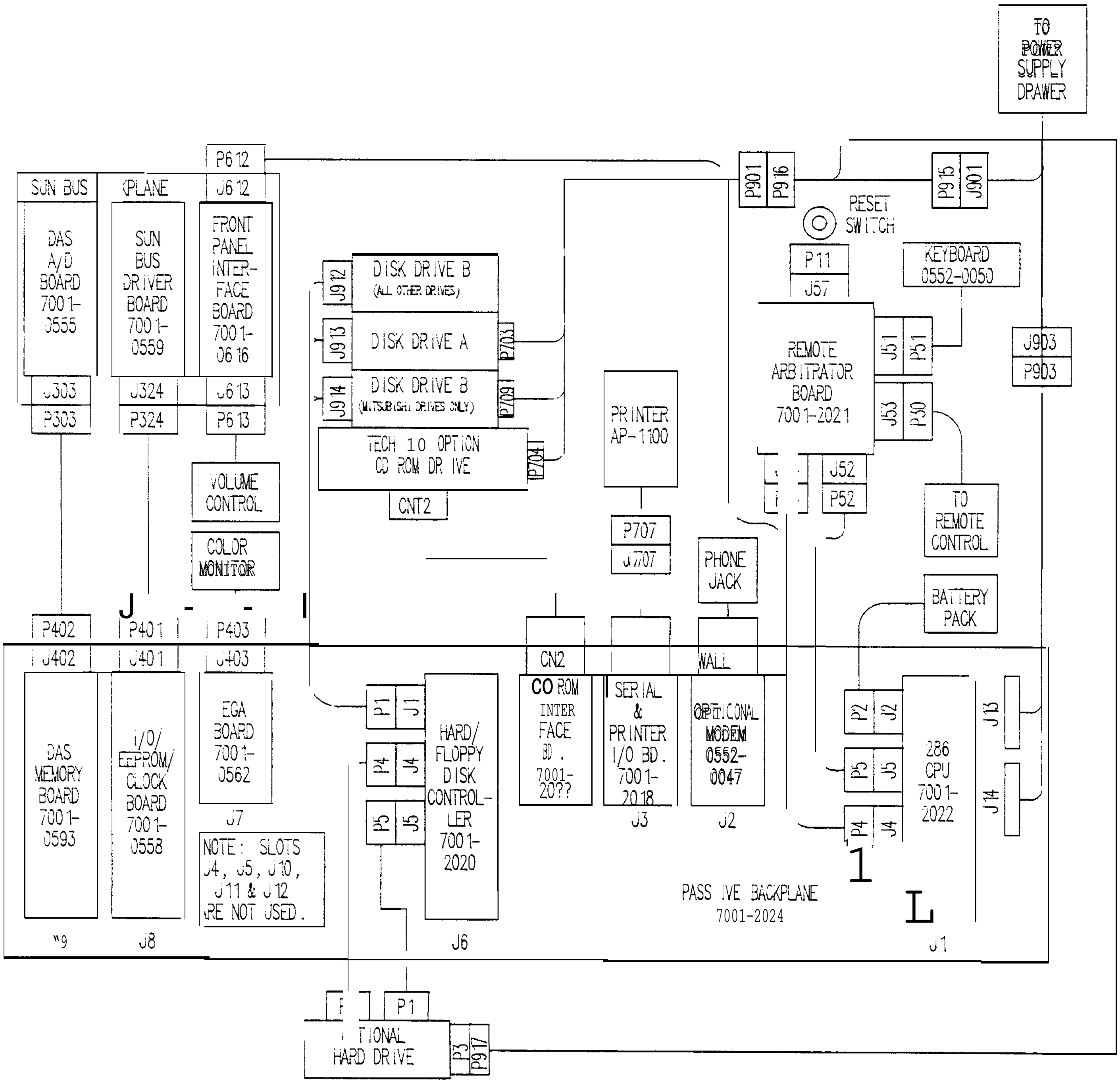


Figure 8. MCA286 Interconnection Diagram

COMPUTER SET-UP PROCEDURE

NOTE 1: IT IS VERY IMPORTANT THAT THIS PROCEDURE IS FOLLOWED TO THE LETTER, OTHERWISE POSSIBLE DAMAGE CAN OCCUR.

NOTE 2: The SET-UP Procedure is used to store system configuration specification into battery back-up CMOS RAM Memory and set the CPU Board's Real Time Clock, these specifications must be entered properly.

70. Plug the MCA into an AC outlet and turn the power "ON".

71. Wait until the MCA has completed Level O Diagnostics and the screen prompt "SET-UP Flu. Press "Fl" the screen should appear as shown in Figure 9.

Setup. Version 2.3

Device	Current settings	New settings
Date	7-19-1988	
Time	13:43:58	
Flexible disk A:	720KB. 3.5"	
Flexible disk B:	720KB. 3.5"	
Fixed disk C:	Type 39	
Fixed disk O:	Not installed	
Conventional memory	640 KB	
Extended memory	o KB	
Primary display	EGA/VGA graphics display	
Screen width	80 Columns	
Math coprocessor	Not installed	

— Date

Format for entry of date
Month _ Day _ Year
(Date will be set immediately)

↑ Move up a selection
↓ Move down a selection
↵ Enter the new setting

ESC Exit without changes
END Save the changes and exit

Figure 9. New CPU SET-UP Screen

72. Using the Up and Down Cursor Keys position the highlighted area over the desired selection or device. Enter the correct information (see Figure 9) from the keyboard and press the "ENTER" to change to the selection just entered. Listed below are the proper setting for each device for the MCA.

Date
Enter the correct date if necessary using the MCA's keyboard then press "ENTER".

Time
Using the MCA's keyboard enter the correct time (Hrs:min:sec) using Military time (example of Military time is 5:00 pm is 17:00.), if necessary. After the correct time is entered press "ENTER" to make the change.

Flexible disk A:
Using the MCA's keyboard press "3" to enter the 720KB, 3.5" disk drive selection used by the MCA.

Flexible disk B:
Using the MCA's keyboard press "3" to enter the 720KB, 3.5" disk drive selection used by the MCA.

COMPUTER SET-UP PROCEDURE (continued)

Fixed disk C:
Enter "0" (the number zero) to select Hard disk C: Not installed.

NOTE : If the TECH-10 option was installed along with this kit enter "39" to select Hard disk C:

Fixed disk D:
Enter "0" (the number zero) to select Hard disk D: Not installed.

Conventional memory
Enter "640" to select 640 KB of RAM memory available to the CPU.

Extended memory
Enter "O" (the number zero) for the amount of Extended memory available to the MCA's CPU.

Primary display
The Primary display should come up EGA/VGA graphics display due to switch settings scan done by the SBC, if not, press "2" until it does.

Screen width
Enter "80" to select 80 columns wide.

Math coprocessor
This device setting first looks for the presents of the Math coprocessor, since no Math coprocessor is installed the setting is correct and does not need to be changed.

73. After all device setting are correct, press the "END" key (which is the "Review Back" key on the numeric keypad to the far right on the keyboard) to save the SET-UP setting in battery backed-up CMOS RAM. If all the setting are correct press the "ESC" key to exit SET-UP without changes.

74. After completing the SET-UP, install the new MCA Master Program disk into drive A and reboot the MCA by pressing the "RESET" button just to the left of the 3.5" disk drives. The MCA should boot up as normal. However all software will run at a much faster speed (watch the Title screen page), then proceed to the Checkout Procedure.

CHECKOUT PROCEDURE

75. Install the Limits and Diagnostics disk in drive B:.

76. Verify that the printer is turned on.

77. Turn Volume Control Knob fully clockwise.

78. Turn on the power switch. After approximately 20 seconds a "BEEP" should be heard, if not verify Front Panel Interface connectors see Figure 7 page 9. After approximately 60 seconds, the TITLE PAGE appears, signaling a successful "boot-up".

79. Press "CONTINUE" to advance to the calibration page.

80. Press "CONTINUE'" to proceed to the MAIN MENU.

CHECKOUT PROCEDURE (continued)

81. Press "4" (PINPoINT TESTS).

82. Press "8" (VEHICLE I.D.).

83. Press "2" (ENTER VEHICLE CODE).

84. Enter "115" as the vehicle code and press "ENTER".

85. The VDU will say "Loading Vehicle Specifications" and return to the pinpoint menu, if the program does not load the specifications, check that the limits disk is in the lower drive.

86. From the "PINPOINT TESTS" menu press "1" (ENGINE DATA).

87. Connect the following leads to a IS-1OOA:
YELLOW COIL+ to the VOLTS/OHMS red terminal.
BLACK BATTERY VOLTS LEAD to Ground.
RED BATTERY VOLTS LEAD to VOLTS/OHMS red terminal.
BLUE PATTERN LEAD to the calibrated coil output.
BLUE PRIMARY LEAD to the coil- terminal.
RED TRIGGER PICKUP on trigger loop.
GREEN AMP PROBE on amp loop.

88. Set the IS-1OOA to the following settings:
Volts/Ohm switch "13V"
Cylinders to "8"
RPM/Timing to "600"
Ripple "OFF"
Delta KV "OFF"
Power "On"
Ignition "On"

89. Set MCA-3000 to the following settings:
VAC. Source "OFF"
Pump "ON"
Trigger Mode "AUTO"

Continue on to the next page

CHECKOUT PROCEDURE (continued)

90. The simulators data should appear on the VDU and be in a continuous update, unless "FREEZE" is pressed.

The following readings should be displayed:
RPM 600 +/- 10 RPM
Dwell % 50.0 +/- 0.9 %
Coil+ 13.0 +/- 0.2 v.
Pri. Res 0.01 to 0.50 V.
This reading may be unstable due to timing errors in the IS-1OOA.

volts 13.00 +/- 0.2 v.
Amps 80 +/- 5 A.
Ripple 0.00 +/- 0.20 v.

HC **** O +/- 10 PPM requires full warm-up
co **** Until warmed up 0.00 +/- 0.20% requires full warm-up
02 **** 20.8 +/- 0.2%
CO2 **** 0.00 +/- 0.20 % requires full warm-up

Pinpoint Dwell 0.00 %
Vac "Hg 0.0"
Temp degree C Current air temp

91. If any of the above values are out of specification, consult the service manual for appropriate actions to remedy the problem.

97. Press "SCOPE" and the secondary raster pattern should be displayed.

92. Press "CONTINUE" and the primary raster pattern should be displayed.

93. Disconnect all leads and turn off IS-1OOA. Press the "CAL" key and then "CLEAR" the tester will recalibrate and display all items "CALIBRATED". If the 15 minute timer for gas calibration has not timed out wait until it has before continuing on then press "CLEAR" again and everything including the gasses will display "CALIBRATED".

94. Press "PRT SC" the printer should respond by printing the calibration page status in the wide format used by the MCA, if not troubleshoot per chapter 6 of the service manual.

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

95. Secure the Disk Drive Mounting Bracket Assembly using the two screws previously used to fasten it.

96. Secure all cables and wiring harnesses using the wire ties and cable anchors provided with this kit.

97. Reattach the MCA's rear cover panel and secure in place using the same hardware removed it step 52, then proceed to the next page.

98. Install the following kits:

1095-0012-01 (RPM/DWELL/TIMING Impedance Kit)
109S-OO13-O1 (DAS A/D 4.0 Update Kit)
1095-0014-01 (ALDL Board 4.0 Update Kit)

The Installation Instructions for all three kits mentioned above are attached.

NOTE : 4.0 refers to the revision of the Master Program Disk.

99. Reinstall the MCA's writing surface and secure in place.

100. Slide the Computer Drawer Assembly completely closed and secure using the screws removed in step 3.

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

MATERIAL RETURN PROCEDURE

NOTE : IT IS OF THE UTMOST IMPORTANCE THAT THE COMPLETE OLD COMPUTER DRAWER ASSEMBLY BE RETURN TO CRYSTAL LAKE TOTALLY INTACT. FAILURE TO DUE SO, WILL RESULT IN CHARGE BACKS TO YOUR REGION.

101. Using the same box that the kit was shipped in, re-pack the box with ALL OF THE ITEMS LISTED BELOW.

RETURN ITEMS LIST

1. Complete Computer Drawer Assembly this includes:
   Computer Drawer Sheet metal
   SBC complete (including all I.C.)
   Remote Keyboard Arbitrator Board, 7001-0545
   The three discarded Wiring Harnesses

102. Seal the box and affix the provided shipping label to the box.

103. Ship box back to Crystal Lake **A.S.A.P.**

Field Installation Instructions

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL

INSTALLATION OVERVIEW

This kit updates the MCAS RPM/DWELL/TIMING Board's Special pattern lead's input impedance to 10 Mega ohms, such that it can be used with on-board computer system measurements.

PARTS LIST

PART NUMBER	DESCRIPTION	QTY
0773-0661-01	EPROM, U26	1
0773-0661-02	EPROM, U27	1
1670-8256	Resistor, R32 8.25 megaohms	1
1670-4126	Resistor, R33 4.12 megaohms	1
0860-0048	Capacitor, C6 10 picofarads	1
0694-0484	Label, (imprint 7001-0553 REV. G)	1
0692-1661-01	Installation Instructions	1

REQUIRED TOOLS

COMPLETE SUN ISSUED TOOL KIT IS-100A

INSTALLATION INSTRUCTION PRELIMINARY CHECKOUT

NOTE : USE STANDARD ANTI-STATIC PROCEDURES WHILE PERFORMING THIS PROCEDURE.

1. Verify with the MCA's Operator that the unit's RPM/DWELL/TIMING functions are operating normally, if not, make any and all repairs before starting the installation of this kit. If the units RPM/DWELL/TIMING functions are operating normally, continue on.

2. Remove the MCA's writing surface and remove the RPM/DWELL/TIMING Board from the MCA's SUN BUS.

3. Locate and Remove resistor, R102 on the RPM/DWELL/TIMING Board (see Figure 1).

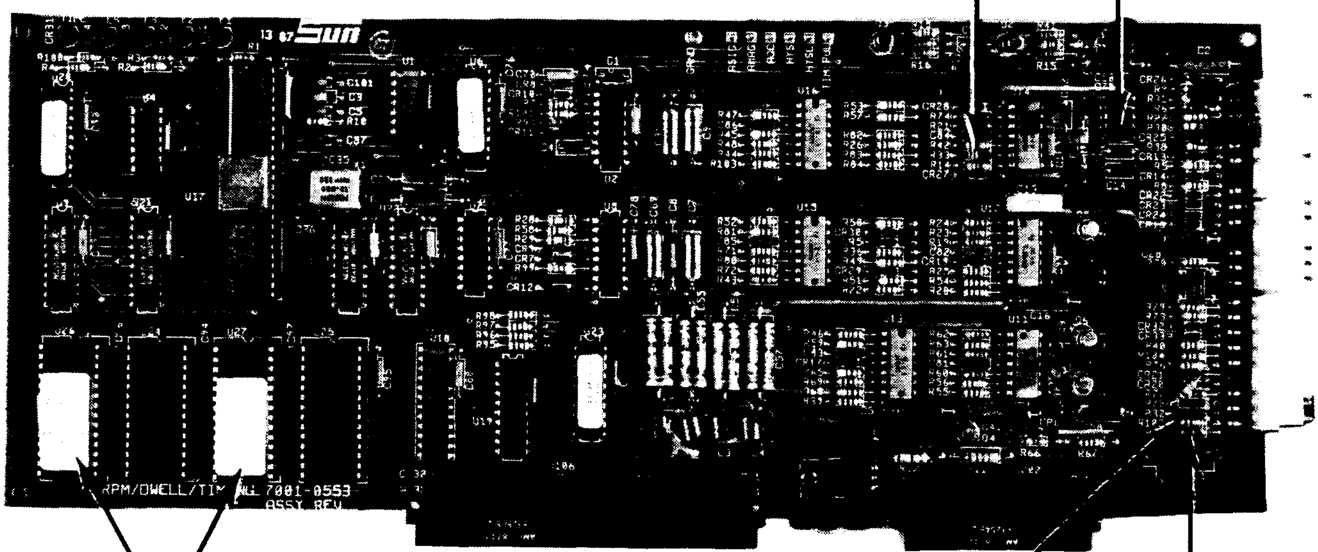
4. Remove resistor R32 and replace using resistor #1670-8256, a 8.25 megaohm 1/4 watt resistor (see Figure 1).

5. Remove resistor R33 and replace using resistor #1670-4126, a 4.12 megaohm 1/4 watt resistor (see Figure 1).

6. Remove capacitor C6 and replace using capacitor #0860-0048, a 10 picofarad 1000 volt capacitor (see Figure 1).

REPLACE R33 WITH NEW RESISTOR #1670-4126, AN 4.12 MEGOHM RESISTOR.

REPLACE C6 WITH NEW CAPACITOR #0860-0048, A 10 PICOFARAD CAP.



REPLACE U26 & U27 WITH NEW EPROMS REV. 1.0

REPLACE R32 WITH NEW RESISTOR #1670-8256, AN 8.25 MEGOHM RESISTOR.

REMOVE AND DISCARD R102.

Figure 1. How to Modify the RPM/DWELL/TIMING Board.

7. Using a small standard slot screwdriver, carefully pry EPROMs U26 and U27 from the RPM/DWELL/TIMING Board.

8. Replace EPROMs U26 and U27 with new EPROMS U26 and U27 marked with Rev. 1.0 on both.

9. Attach new label, 0694-0484 over the RPM/DWELL/TIMING Boards part number and revision ID stamp (see Figure 1).

10. Reinstall the just updated RPM/DWELL/TIMING Board back into the MCA's SUN BUS reconnect connectors P313, P312 and P305.

11. Enter a vehicle description code and advance the unit to the scope mode by pressing the Scope HOT key.

12. Press the "CONT" key until PINPOINT pattern is displayed across the top of the MCA's VDU.

13. Attach the Blue Pinpoint lead to the negative side of the IS-1OOAS ignition coil and observe the displayed pattern. The pattern should resemble a primary pattern, if not verify proper installation of the components in this kit. If they are properly installed, they replace the RPM/DWELL/TIMING Board with a new one REV. G or greater.

14. Reinstall the MCA's writing surface and secure.

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

SUN ELECTRIC CORPORATION

Model: 1095-0013-01
DAS A/D Update Kit

Page:

Field Installation Instructions

THIS PROCEDURE IS TO BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL ONLY

This Kit updates the MCA-3000'S DAS A/D Board to improve the Digital Scope operation by eliminating missing patterns during first pattern store/review cycle.

PARTS LIST
Verify that the all the components listed below are contained in the box.

QTY	PART NUMBER	DESCRIPTION
1	0773-0581-02	Micro Controller, Version 0.2
1	0692-1662-01	Installation Instructions
1	0694-0484	Label, 7001-0555 Rev. J

REQUIRED TOOLS

Small Screw Driver or I.C. Puller
Spanco driver #8.

GENERAL INSTRUCTIONS AND INFORMATION

1. Verify, with the operator, that the MCAS Digital Scope function works properly with the old software installed.

2. Remove the writing surface of the MCA-3000.

3. With the AC power "OFF", locate and remove the DAS A/D Board from the Sun Bus Card Rack.

4. Remove U4 and replace it with the 0773-0581-02 supplied, noting proper orientation of Pin 1.

5* Place the label (7001-0555 Rev J) supplied with the Kit over the part number of the DAS A/D Board.

6. Re-insert The DAS A/D board into the Sun Bus.

CHECKOUT

7. Insert Version 4.0 Master Program disk into Drive **A.**

8. Turn the **MCA** on.

9. Verify proper operation of machine using the Check Out Procedure found in the Service Manual. **If** any problems are found troubleshoot per the Service Manual.

10. Reinstall the Writing surface cover.

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

Field Installation Instructions

THIS PROCEDURE IS TO BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL ONLY

This Kit updates the MCA-3000'S ALDL board from a 7001-0543 to a 7001-543-01. This is required to make the board compatible with 4.0 Master Program disks. The update consists of replacing U6 (Micro Controller) with a new version 0.3 Micro Controller.

PARTS LIST

Verify that the all the components listed below are contained in the box.

QTY	PART NUMBER	DESCRIPTION
1	0773-0581-08	Micro Controller, Version 0.3
1	0692-1663	Installation Instructions
1	0694-0484	Label, 7001-0543-01 Rev. A

REQUIRED TOOLS

Small Screw Driver or I.C. Puller
Spanco driver #8.

GENERAL INSTRUCTIONS AND INFORMATION

1. Verify, with the operator, that the ALDL function works properly with the old software installed.

2. Remove the writing surface of the MCA-3000.

3. With the AC power "OFF", locate and remove the ALDL Board from the Sun Bus Card Rack.

4. Verify that the board is a Rev. K or later. If it is not, the board must be replaced with a new 7001-0543-01.

5. Remove U6 and replace it with the 0773-0581-01 supplied, noting proper orientation of Pin 1.

6. Place the label (7001-0543-01) supplied with the Kit over the part number of the ALDL Board.

7. Re-insert The ALDL board into the Sun Bus.

CHECKOUT

8. Insert Version 4.0 Master Program disk into Drive **A** and any of the new STL disks (marked with an orange dot) into Drive B.

9. Turn the MCA on, and proceed to the main menu.

10. Select "6. On-Board Computers".

11. If the STL menu is displayed, the update is complete.

12. If any error Messages are displayed, verify proper installation of U6. If U6 is oriented and installed properly, replace the ALDL board with a 7001-0543-01.

13. Reinstall the Writing surface cover.

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

SUN ELECTRIC CORPORATION

Model: TECH-10 Option for the MCA-3000

Page: PAGE 1 OF 4

Field Installation Instructions

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL

INSTALLATION OVERVIEW

The TECH-10 Option for the MCA-3000, provides the MCA with GM's EXPERTEC Database. NOTE : FOR THIS KIT TO BE INSTALLED, THE MCA MUST BE A SERIAL "B" OR A SERIAL "A" THAT HAS BEEN UPDATED WITH A #120-0553-01 CPU UP GRADE KIT.

PARTS LIST

PART NUMBER	DESCRIPTION	QTY
0403-1351-04	Screw, 6-32 x 1/4	8
0406-0124	Screw, Machine 6-32 x 5	2
0616-0006	Keps Nut, 6-32	2
0692-1657-01	Installation Instructions	1
5878-0015	Cable Tie	8
5878-0902	Cable Mount	4
6004-0571	Cable, Hard Drive Control *	1
6004-0572	Cable, Hard Drive Data *	1
6004-0581-01	Cable, CD ROM Drive	1
7076-0663-01	Wiring Harness, W67 Hard Drive Power	1
0610-1411-06	Hold-down screw, SCSI Interface Bd.	1
1091-0003-01	Hard Drive, Miniscribe 3650, Formatted	1
1091-0002-01	CD ROM Drive, Toshiba 3101B	1
0552-0050	IBM PC DOS 3.3 Software	1
0692-1664-01	Operators Manual (from GM)	1

* NOTE: On some units these cables may already be installed in the Computer Drawer Assembly.

REQUIRED TOOLS

COMPLETE SUN ISSUED TOOL KIT

INSTALLATION INSTRUCTIONS

NOTE : USE STANDARD ANTI-STATIC PROCEDURES WHILE PERFORMING THIS PROCEDURE.

1. Remove the 4 Hex screws securing the Computer Drawer Assembly.

2. Carefully, slide the Computer Drawer Assembly out from the MCA, be careful not to slide so far out that the Drawer assembly is no longer supported by its rails.

* GM is a registered trademark of General Motors .

3. Remove the Hex screws which secure the MCA's rear cover. Then remove the rear cover.

4* Remove the two screws retaining the rear of the Disk Drive Bracket.

5. Open the Disk Drive Door in the front of the MCA-3000. If there are two screws in the upper corners of the drive bracket, remove them.

6. Carefully slide the Disk Drive Bracket Assembly from the MCA-3000 by sliding it back and lifting it out, and lay it in the back of the MCA such that the connected cables are not damaged.

7. Remove the front cover on the lower slot of the Drive Bracket.

8. Place the two screws and Keps Nuts in the existing holes. These are for cosmetic reasons.

NOTE : If a MCA-3000 CPU upgrade is being installed, start the instructions here.

9. Using a screwdriver, pry the ribbon cable anchor from the rear of the bracket.

10. Install the Optical Disk Drive (CD ROM) through the front of the bracket, into the lower position of the Disk Drive Bracket. Secure it using 4 of the 0403-1351-04 Screws (6-32x1/4), inserted from the sides. Note the front of the drive should line up with the front of the bracket before tightening and the screws should be in the lower holes of the Drive.

11. Reinsert the Disk Drive Bracket into the MCA, but do not reinstall the screws that retain it.

12. Insert the Termination Board supplied with the Optical Drive into the 50 Pin connector on the rear of the drive.

13. Check the Dip switch settings on the Optical Drive Controller Board to insure that they are set proper according to Figure 1.

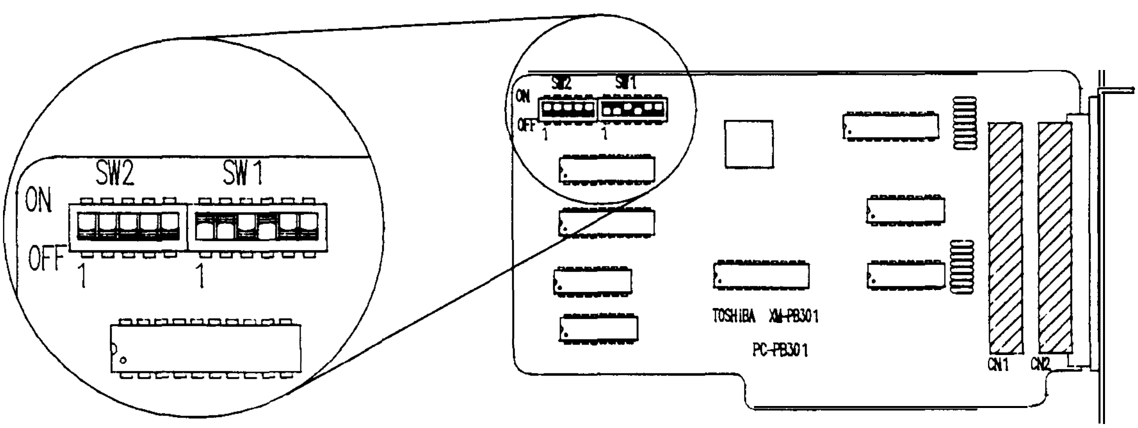


Figure 1. Dip Switch settings for Optical Drive Controller Board.

14. Insert One end of the 50 pin Ribbon Cable supplied into connector CN2 of the Optical Drive Controller Board.

15. Route the 50-pin Cable through the front opening, and insert the Optical Disk Controller Board into Slot J10 of the Passive Backplane Board.

16. Route the other end of the 50 pin cable up through the head frame and across to the Optical Disk Drive, inserting it into the 50 pin connector of the Termination Board mounted on the rear of the Optical Drive.

17. Locate P704, a 4-pin connector by the Disk Drives and insert it into the power connector of the Optical Drive.

18. Connect J917 of the Power Supply Harness to J3 of the Hard Disk Drive.

19. Connect P1 of the 34 pin Ribbon Cable to J1 of the Hard Disk Drive.

20. Connect P2 of the 10 pin Ribbon Cable to J2 of the Hard Disk Drive.

21. Mount the Hard Disk Drive to the Bracket located in the right side of the Computer Drawer as viewed from the rear, using 4 of the 0403-1351-04 Screws (6-32x1/4) supplied. The front of the Hard Drive should face the rear and the bottom should face the right.

22. Route the 34 pin ribbon cable from the Hard Disk Drive under the boards in the Passive Backplane to J5 of the Floppy/Hard Drive Controller.

23. Route the 10 pin ribbon cable from the Hard Disk Drive under the boards in the Passive Backplane to J4 of the Floppy/Hard Drive Controller.

24. Locate J901/P901, a 4-pin connector above the Computer Drawer. Disconnect it, and insert P915 of the Power Supply Cable supplied into P901, and P916 into J901.

NOTE : If the MCA-3000 CPU update is being installed in conjunction with this kit, return to the other procedure now.

25. Reinstall the 4 screws retaining the Disk Drive Bracket.

26. Reinstall all connectors to the two 3 1/2″ drives, verifying proper orientation.

27. Apply Cable mounts and cable ties as necessary.

28. Reinstall the Rear Panel.

29. Gently push the Computer Drawer back in and install screws.

30. Attach Expertec decal to the front of the Disk Drive Access Door, just above the bottom line using the words DISK DRIVES for centering position.

****
* Hardware Installation Complete *
****

Proceed to the CHECKOUT PROCEDURE on the next page.

CHECKOUT PROCEDURE

31. Make sure that the Master Program disk is not in Drive A and turn the MCA "ON". Unit should boot from newly installed Hard Drive and display the following:

Please select one of the following:

1 Expertec Technical Service Information System
2 Disk Operating System

Your selection:

32. Enter selection "2" and watch the MCA's display screen:

It should display the following:

Please select one of the following:

1 Expertec Technical Service Information System
2 Disk Operating System

Your selection: 2
Toshiba XM-2000/XM-3000 series MSCDEX device driver Version 1.01 (CSIXA-001)
(C) Copyright Toshiba Corporation 1987
*** Number of the installed Toshiba CD-ROM drives: 1

then the screen clears and this is displayed

D:\DOS>

If not, then see the troubleshooting section of your Service Manual.

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

SUN ELECTRIC CORPORATION

Model: MCA-3000

CHECK-OUT PROCEDURES

THIS PROCEDURE IS TO BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL ONLY

This procedure should be used whenever setting up a MCA-3000, and should never be performed more than once on any given unit. If any parameter is found not to fall within these specifications, they should be reported on the Quality Control Questionnaire.

Tools Required: IS-100A Calibration Gas and Flow Gauge 12 Volt Car Battery Digital Volt Meter Vacuum Gauge

1. Unbox tester and cabinet per Installation Instructions 0692-1507.
2. Plug the unit in, install the Master Program disk in drive A: and the Limits disk in drive B:.
3. Turn on the headsign switch. The headsign should light; if not check out the problem per chapter 1 of the MCA service manual.
4. Verify that the printer is turned on.
5. Turn on the power switch. After approximately 15 seconds a "BEEP" will be heard, then "LOADING MCA MASTER PROGRAM ONE MOMENT PLEASE" will appear on the VDU and the print head will return to its "HOME" position (extreme left of travel). After approximately 60 seconds, the TITLE PAGE appears, signaling a successful "bootup". If this does not happen troubleshoot the problem following the procedures in chapter 3 of the MCA service manual.
6. Turn the printer off, hold down the "FORM FEED" button and turn the power back on. The printer should print "PRINT MENU?". Press the "SELECT" button and the printer menu should be printed.
7. Compare this menu with the menus shown at the top of page 2. If it is not setup properly, refer to the procedure in the Service Manual chapter 6.
8. Press the RESET button next to the disk drives to REBOOT.

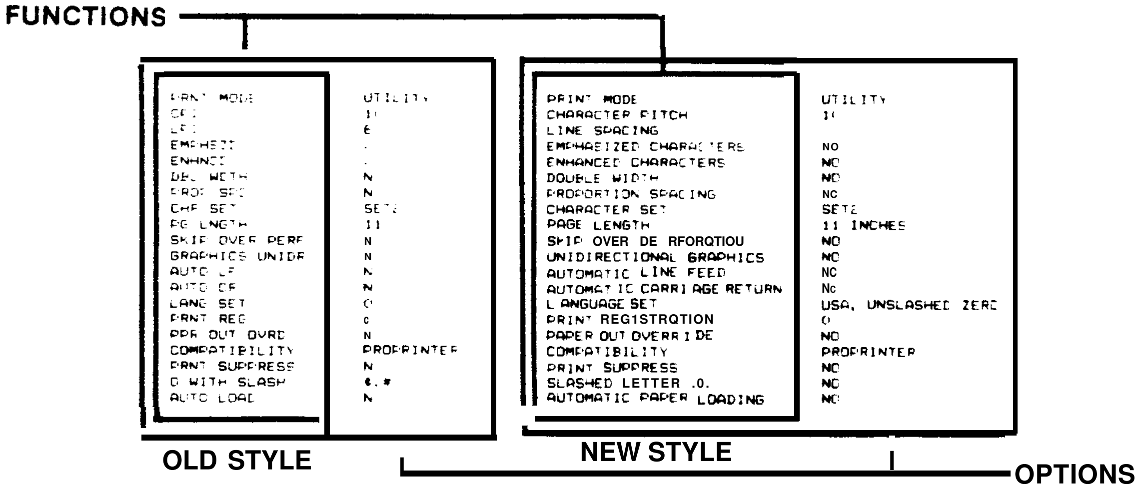


Figure 1. Printer Menus.

9. After pressing reset in step-6 the computer will restart as in step-5. Press "CONTINUE" on the Keyboard to advance to the calibration page.

10. Press "CONTINUE" on the Remote control to proceed to the MAIN MENU.

11. Press "4" (PINPOINT TESTS).

12. Press "8" (VEHICLE I.D.).

13. Press "2" (ENTER VEHICLE CODE).

14. Enter "115" as the vehicle code and press "ENTER".

15. The VDU will say "Loading Vehicle Specifications" and return to the pinpoint menu. If the program does not load the specifications, check that the limits disk is in the lower B drive. If the disk is there checkout the problem using chapter 3 of the service manual.

16. From the "PINPOINT TESTS" menu press "1" (ENGINE DATA).

17. Connect the following leads to a IS-100A:
YELLOW COIL+ to the VOLTS/OHMS red terminal.
BLACK BATTERY VOLTS LEAD to Ground.
RED BATTERY VOLTS LEAD to VOLTS/OHMS red terminal.
BLUE PATTERN LEAD to the calibrated coil output.
BLUE PRIMARY LEAD to the coil- terminal.
RED TRIGGER PICKUP on trigger loop.
GREEN AMP PROBE on amp loop.
MAG PROBE in mag output hole.

18. Set the IS-100A to the following settings:
Volts/Ohm switch "13V"
Cylinders to "8"
RPM/Timing to "600"
Ripple "OFF"
Delta KV "OFF"
Power "On"
Ignition "On"

19. Set MCA-3000 to the following settings:
VAC. Source "OFF"
Pump "ON"
Trigger Mode "AUTO"

20. The following readings should be displayed:

RPM	600 +/- 10 RPM
Timing (M)	10 +/- 0.5 Degrees
"Dwell %	50.0 +/- 0.9 %
Coil+	13.0 +/- 0.2 v.
Pri. Res	0.01 to 0.50 v.
This reading may be unstable due to timing errors in the IS-100A.	
volts	13.00 +/- 0.2 v.
Amps	80 +/- 5 A.
Ripple	0.00 +/- 0.20 v.
HC ****	0 +/- 10 PPM requires full warmup.
co **** Until warmed up	0.00 +/- 0.20% requires full warmup.
02 ****	20.8 +/- 0.2%
CO2 ****	0.00 +/- 0.20 % requires full warmup.
Pinpoint Dwell	0.00 %
Vac "Hg	0.0"
Temp degree C	Current air temp

21. Turn on the Timing light. The Timing indicator should change to (L). Set the IS-100A Switch to TAU and aim the light at the LED display on the IS-100A.

22. Adjust the timing light advance knob to read 0.0 Degrees on the MCA display, the IS-100A LED display should be 0 +/- 1 Degree.

23. Adjust the timing light advance knob to read 30.0 Degrees on the MCA display, the IS-100A LED display should be 30 +/- 3 Degrees.

24. Turn off the timing light.

25. Set Ripple switch to "ON". Ripple should read 1.55 +/- 0.50

26. Change the AMPs Polarity switch on the IS-100A, the Amps reading should be of the opposit polarity and within +/- 5 Amps.

27. Connect Standard Vacuum Gauge to the Boom Vacuum Hose.

28. Turn on the Vacuum source switch, and compare the vacuum readings with the vacuum gauge as you adjust the vacuum regulator.

29. Adjust the vacuum regulator to 19" Hg. and compare the readings between the meter and the display they should be within +/-2"Hg.

30. Turn on the Hold switch and turn off the pump. The vacuum should remain constant for 15 seconds without dropping more than 1"Hg.

31. Turn off the Hold and the vacuum should drop, turn on the Pump and adjust the regulator for 0" Hg.. Disconnect the standard vacuum gauge from the Boom vacuum hose.

32. Turn off ignition on IS-100A and press the MULTIMETER key on the Remote control.

33. Use the UP and DOWN arrows to select VOLTS and Press Continue.

34. Connect the Pinpoint Leads to the Volts/Ohms connectors of the IS-1OOA and set the Ripple switch to OFF.

35. The volts reading should be 13.0 +/- 0.2V.

36. Switch the Ripple on and select AC Volts on the MCA.

37. The AC Volts value should be 0.75 +/- 0.2V.

38. Select OHMS on the Multimeter display and switch the IS-1OOA from 13V to 5 ohms. The display should read 5 ohms +/- 1 ohm.

39. Rotate the IS-1OOA Volt/Ohm switch to 50 ohms. The display should read 50 ohms +/- 2 ohms.

40. Rotate the IS-1OOA Volt/Ohm switch to 5 Kohms. The display should read 5 Kohms +/- 0.2 Kohms.

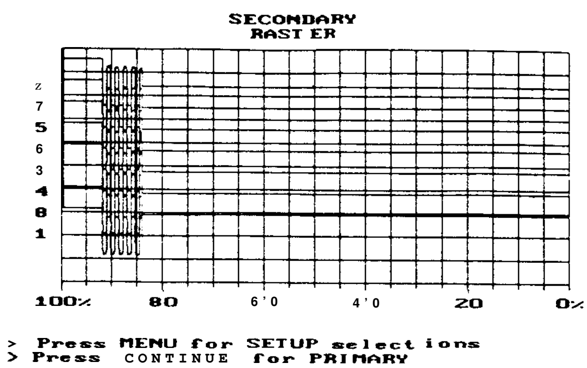
41. Rotate the IS-1OOA Volt/Ohm switch to 50 Kohms. The display should read 50 Kohms +/- 2 Kohms.

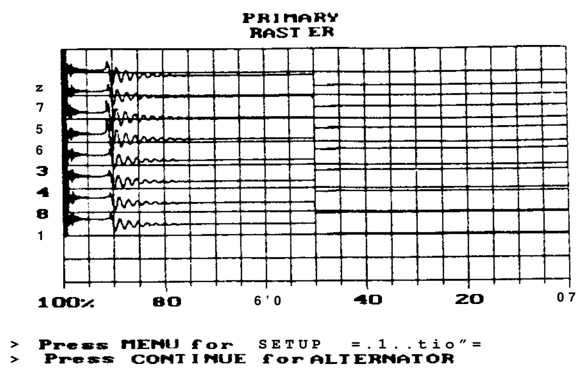
42. Select DC Amps on the Multimeter display and remove the Pinpoint leads from the IS-1OOA. Connect a DVM to the Pinpoint leads and set DVM to 200 Ohms range. The DVM should read between 0.1 and 0.4 ohms

43. Select AC Amps on the Multimeter display. The DVM should read between 0.1 and 0.5 ohms.

44. If any of the above values are out of specification, consult the service manual for appropriate actions to remedy the problem.

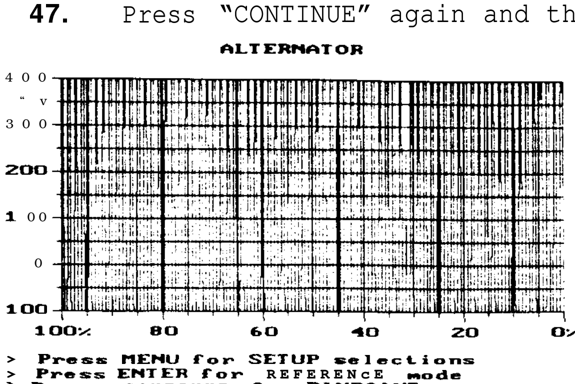
45. Press "SCOPE" and the secondary raster pattern should be displayed.

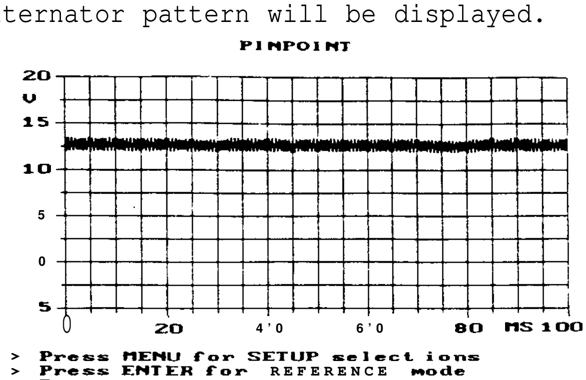




46. Press "CONTINUE" and the primary raster pattern should be displayed.

47. Press "CONTINUE" again and the alternator pattern will be displayed.





48. Connect the Blue Pinpoint dwell lead to the Volts terminal and Press "CONTINUE". This will display the pinpoint pattern of volts ripple. If this still does not work consult the appropriate chapters of the repair manual.

49. Press "CONTINUE" until Secondary Raster reapears Press "MENU" a pop up menu will be displayed select Display using the up and down arrows and press "CONTINUE" the display will change to a Secondary Display pattern. The KV should be approximately 20Kv +/- 4Kv. Use the up and down arrows to raise or lower the display on the voltage grid to allow measurement of the KV.

50. Press "PINPOINT" on the keyboard this should display the "PINPOINT TESTS" menu, press 7 and connect the battery load leads to a charged 12 V. battery.

51. Select "AMP HOUR RATING" by pressing the right arrow key.

52. Press "CONTINUE" and the next page will prompt for the amp hour rating and minimum battery voltage. Enter 40 for the amp hour and leave the voltage at 12.4 V. and press "ENTER" twice and press "CONTINUE". The VDU will display the "BATTERY TEST" page with the time remaining and battery temperature. Follow the prompts and the battery test will start. If not consult the appropriate chapters of the service manual for troubleshooting.

53. Disconnect all leads and turn off IS-1OOA. Press the "CAL" key and then "CLEAR" the tester will recalibrate and display all items "CALIBRATED". If the 15 minute timer for gas calibration has not timed out, wait until it has before continuing on, press "CLEAR" again and everything including the gasses will display "CALIBRATED".

54. Press "PRT SC" the printer should respond by printing the calibration page status in the wide format used by the MCA. If not troubleshoot per chapter 6 of the service manual.

55. Press "CONTINUE" and then "PINPOINT" then select "l''(engine tests).

56. Connect calibration gas to the sample hose and apply the correct flow amount of the gas. The HC, CO, CO_2 and O_2 rereadings should be normal and equal to the tag values of the bottle (remember the propane value must be multiplied by the correlation factor of the bench to get the HC value to be displayed on the VDU). If the readings are not close then a gas calibration will be required or it will be necessary to do a leak check.

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

SUN ELECTRIC CORPORATION

Model: MCA-3000

Page: 1 OF 2

Field Installation Instructions

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED SUN SERVICE **PERSONNEL** .

The installation of the MCA-3000 can be made easier by following these installation instructions in sequence.

PARTS LIST

QTY	PART NUMBER	DESCRIPTION
* 1	C-39 OR C-39/G	Cabinet
1	MCA 3000	Modular Computer Analyzer

* (THIS IS OPTIONAL, UNIT MAY BE UTILIZING A HEAD SUSPENSION KIT)

REQUIRED TOOLS

9/16" Box End or Crescent Wrench   5/16" Nut Driver
Small Flat Blade Screwdriver

INSTALLATION PROCEDURE

1. Remove MCA-3000 from the box.

2. If the MCA-3000 is being mounted on a HSK, refer to the instructions included in the HSK carton.

3. Place the MCA-3000 on the Cabinet and secure using the the four **9/16"bolts,** and flat washers found in the C-39.. Two can be accessed through the right drawer, one through the left drawer, and one from the rear.

4. Lift the printer cover located on the left-hand side of the tester as viewed from the front.

5. Place paper stack (supplied) in the printer compartment and slide it to the rear.

6. Install the printer interface and power cables (supplied) to the connectors located on the right-hand wall of the printer compartment.

7. Remove the Printer (P/N AP-1100) from its box and place it on the work area (right front) of the MCA.

8. Connect the AC power and the Printer interface cables to the rear of the printer and slide the Printer forward against the Printer stop. Route cables so they do not interfere with paper supply.

9. Remove the shipping retainer from the printer carriage as shown in the "IMPORTANT NOTICE" enclosed.

10. Install the Printer ribbon onto the print carriage and load the paper into the Printer. If necessary, refer to the operator manual for assistance in loading ribbon and paper.

11. Replace the Printer's dust cover and turn the Printer power switch to the "ON" position. Lower the printer compartment cover.

12. Remove the Keyboard from its box and plug its cable into the Keyboard connector located on the righthand wall of the printer compartment.

13. Place the Keyboard into the rack above the printer.

14. Install the Remote Control in the remote control pocket located on righthand side of the tester. Connect the cable to the remote control connector located on the rear center of the tester.

15. Install the two Cable Hangers (U-shaped) to the back of tester using two 5/8" hex head screws to secure.

16. Slide open Infra-Red Module drawer on right side of tester (viewed from the rear). Locate Oxygen Sensor from the accessories bag and screw into mounting block (located in the middle of drawer). FINGER TIGHT ONLY! Locate the cable from the Solenoid Driver Board mounted on the back of the Infra-Red Module drawer, and insert its 1/4" plug into top of O_2 Sensor.

17. Connect the clear Plastic 1/4" Hose (32" in length), to the aspirator fitting of the primary bowl, down to the drain fitting located at base of the Cabinet.

18. Attach all Tester Leads along with vacuum hose, to their prospective connectors located on the boom of the MCA.

19. On units utilizing the C-39/G Cabinet, place the two rubber mats provided at base of unit (one on front ledge and the other in the gas bottle compartment at rear of unit.

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

SUN ELECTRIC CORPORATION

Model: MCA-3000

Field Installation Instructions

INSTALLATION SHOULD BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL.

The installation of the Communications Kit 0120-0520 can be made easier by following the installation instructions in sequence.

PARTS LIST

STY	PART NUMBER	DESCRIPTION
1	0552-0047	Modem PCB.
1	4162-0496	Connector, Telephone Jack
1	6004-0536	Cable assy, Modem
1	0552-0938-23	Diskette, Communications
1	6004-0484	Cable assy, Telephone
1	7003-0590	Plate, Modem outlet
1	0610-1311-06	Screw, #6 x 3/8″, Hex
2	0616-0006	Nuts , #6 Keps
1		IBM Disk Operating System Package
1	0692-1506	Installation Instructions
1	5878-0902	Mount, Cable Tie
1	5878-0015	Cable Strap

REQUIRED TOOLS

Small Flat Blade Screwdriver
11/32″ Nut Driver
5/16″ Nut Driver
1/4″ Nut Driver
6" Diagonal Cutters

INSTALLATION PROCEDURE

1. Turn off MCA and disconnect the A.C. Power cord from the wall.

2. Remove the screws from the Computer Module panel on the rear of the tester.

3. Pull the Computer Module drawer outward being careful to not pull harnesses off the PCB in the Module.

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4. Check the switch settings of the Computer PCB's SW1-3 must be on see figure 1.

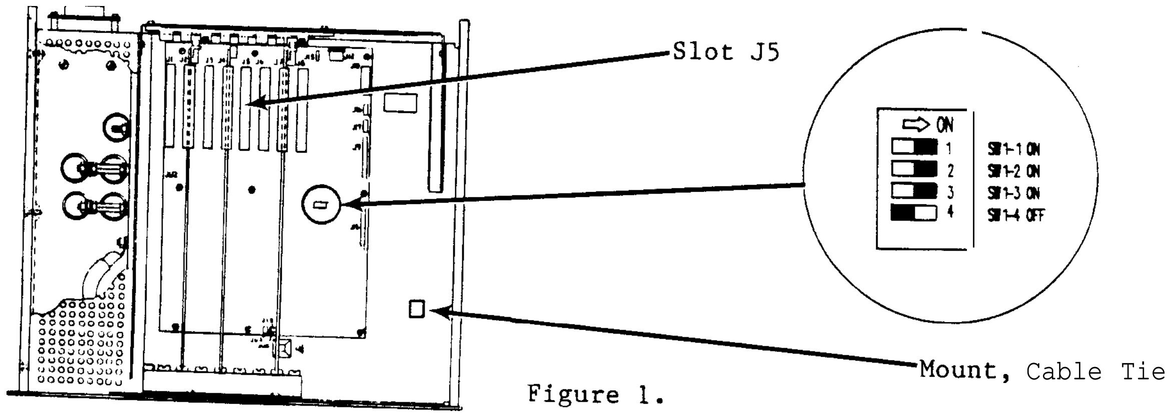

Figure 1.

5. Remove the Modem PCB (0552-0047) and Static bag from Kit box.

6. Ground yourself to the testers chassis and remove the Modem PCB from the static bag and check the DIP switch settings of the PCB, they should all be off see Figure 2.

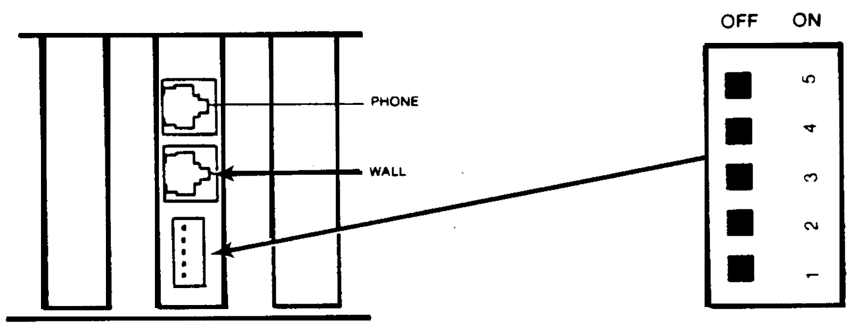

Figure 2.

7. Install the Modem PCB in the slot J5 shown in Figure 1.

8. Install retaining screw (0610-1311-06) in the PCB end bracket and SBC Computer card retainer.

9. Install the Modem Cable assy. (6004-0536) to the Modem PCB WALL RJ11 connector shown in Figure 2.

10. Connect the RED, YELLOW, GREEN and BLACK wires to the respective screw terminals of the Telephone Jack connector (4162-0496).

11. Remove the large hole cover on the back panel of the computer module and install the Modem Outlet Plate (7003-0590) using the same hardware that was used to retain the plug see Figure 3.

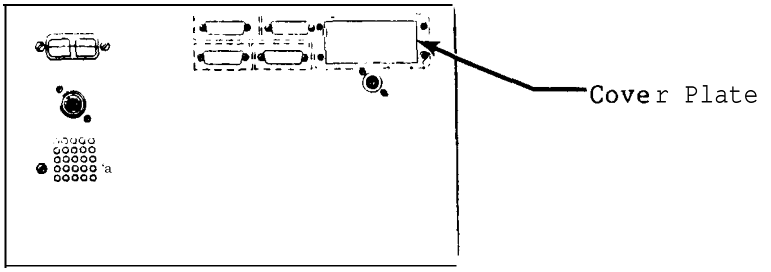

Figure 3.

12. Install the Modem Jack to the Modem Outlet plate using the two #6-32x 1 3/8" (0403-1341-22) screws, **two washers (0400-0378-03)** and two #6 KEPS nuts (0616-0006).

13. Install Cable tie mount as shown in Figure 1. Install cable tie in mount and around Modem cable.

14. Slide the Computer Module back into the Headframe and replace all hardware.

15. Install the Telephone Cable (6004-0484) to the Modem Jacks RJ11 connector.

16. Connect the other end of the Telephone Cable to the Customers Telephone outlet Jack on the wall Figure 4.

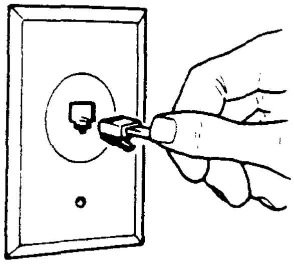

Figure 4

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

CHECKOUT PROCEDURE

1. Install Communications disk (0552-0938-23) in drive A:, Plug in tester and turn on.
2. The tester screen will be blank while the CPU is performing it's self test. Following this The screen will go BLUE and inform you that the program is loading and running a modem self test. If the self test is OK the modem should work.

SUN

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Assembly & Installation Instructions

INSTALLATION SHOULD BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL ONLY.

NOTE: SUN ELECTRIC CORPORATION disclaims all responsibility and liability if installation is attempted by other than SUN personnel.

The Head Suspension Kit provides the necessary hardware for suspension mounting the MCA-3000 from an overhead "T." beam. These instructions present the basic layout and dimensions needed to correctly position the "I" beam and assemble the kit. The dimensions for the optimum "I" beam location are based upon a conventional 12′ x 24′ service bay. The attachment points of the "I" beam to the building depend upon local codes and the particular building.

PARTS LIST

ITEM	QUAN.	PART NO.	DESCRIPTION
1	1	7020-1878	Suspension Base Weld Assy.
2	2	7020-1876	Suspension Tube Weld Assy.
3	2	7012-1171	Suspension Bracket, Left and Right
4	2	0401-0378	Stop Spacer
5	1	7020-1879	Suspension Top Beam Assy.
6	1	7024-0486	Block, Collar
7	4	0675-0460	Bolt, 1/2″-13 x 9"
8	4	0675-0444	Bolt, 1/2"-13 x 5 1/2"
9	2	0675-0428	Bolt, 1/2″-13 x 3"
10	4	0675-0152	Bolt, 1/2"-13 x 4"
11	18	0400-0161	Washer, Flat 1/2"
12	14	0407-0081	Nut, 1/2″-13
13	14	0604-0035	Washer, Split Locking 1/2"
14	2	0401-0377	Bracket Spacer
15	1	7020-1877	Head Support Tube
16	2	7009-1948	End Cover Assembly Top Beam
17	4	7009-1949	End Cover Assembly, Suspension Base
18	4	0403-1711-08	Bolt, 3/8″-16 x 1/2"
19	2	0686-0034	Screw, Socket Head 1/4″-20 x 3/4"
20	2	0400-0200	Washer, Flat 5/8" O.D.
21	1	0686-0115	Screw, Socket Head 5/16″-18 X 1"
22	1	7012-1169	Stop Bracket
23	2	7009-1079-3	Trolley Assembly
24	2	7012-1162	Trolley stop
25	4	0616-0008	Keps nut, 3/8" x 16
26	4	0604-0024	Split Lock washers, 3/8"
27	8	0400-0136	Flat Washers, 3/8"
28	4	0675-0102	Bolt 3/8 x 16 x 1"
29	1	0692-1530	Installation Instructions

REQUIRED TOOLS --

9/6″ Wrench
Drill Bits
3/4″ Wrench
Drill
1/4″ Hex Wrench

SUGGESTED BEAM LOCATIONS --

Figure 1 shows a typical overhead beam locations with approximate dimensions for a two bay facility. The following are the approximate dimensions used.

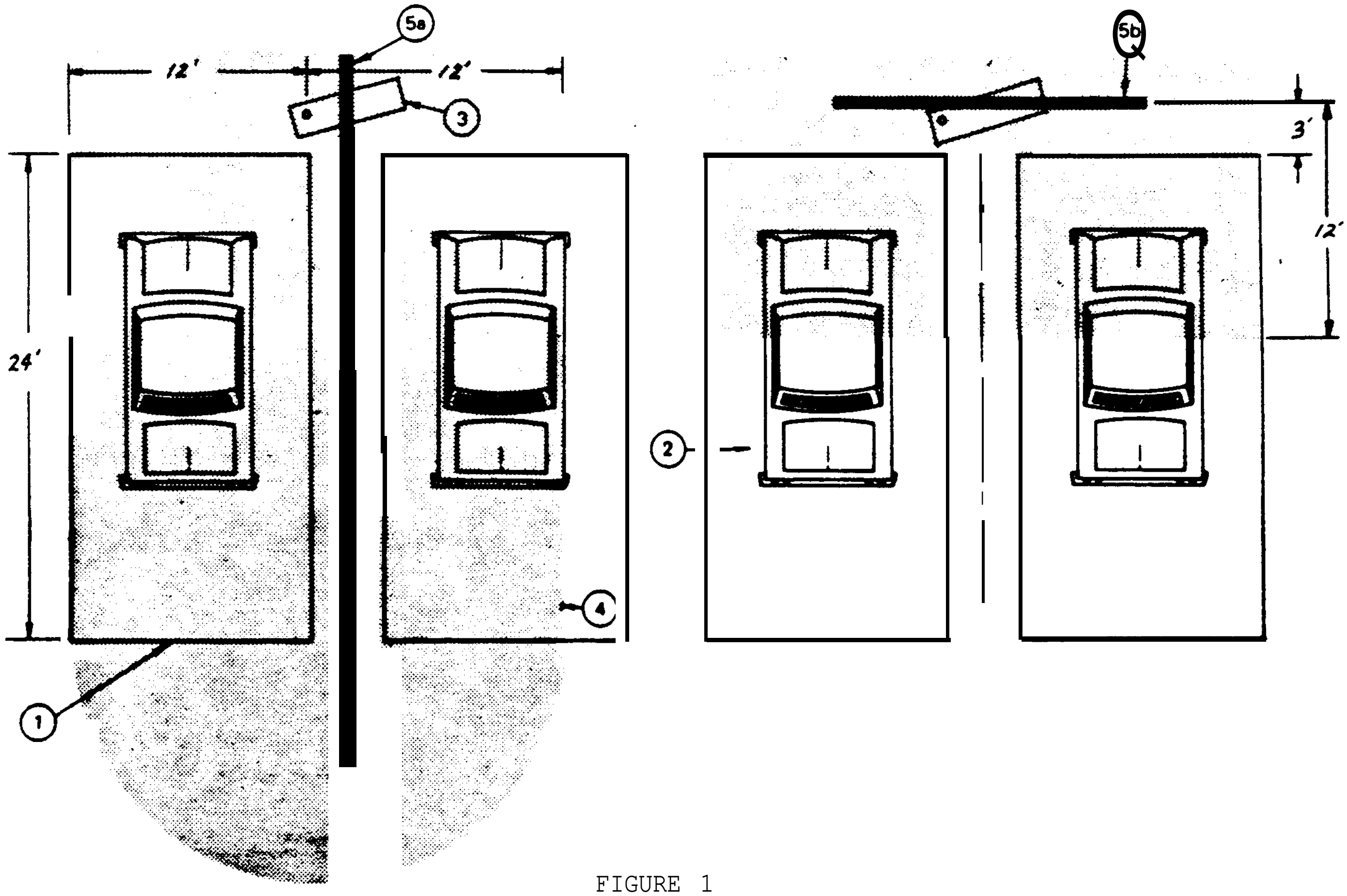

FIGURE 1

1. Two 12 x 24 foot adjacent bays with a 4 foot space between bays.

2* 80″ x 220″ vehicles (typical).

3. Tester shown approximately 38"x18".

4. Usable tester lead connection area is a 12′ radius about tester, shaded area, in illustration (boom length plus test leads extended to their maximum length).

5a. 30 foot long (approximate) "I" beam* centered between bays.

5b. 16 foot long (minimum) "I" beam* located 3 feet from front of bays. Beam extends across front of both bays.

* Sun does not supply the "I" beam or beam mounting hardware or installs the beam. Beam must be obtained locally and its installation in the building must conform to local building codes.

HANGING RECOMMENDATIONS AND ALLOWABLE LOADING ON THE BEAM ---------------------

The HSK-40 is designed for use with a standard 5" I beam with a 3" flange **width.** This typical beam weighs approximately 10 pounds per foot **of** length. .4 larger beam may be used. However, it will then be necessary to shim the trolley to accommodate the greater flange width. The height at which the beam should be mounted above the floor is determined by the following but should not exceed 140″ from floor to bottom of flange: See Figure 2

1. The writing surface of the tester should be approximately 43.5″ off the floor (or as desired), for best viewing angle and operation of the controls.

2. The dimension between the bottom of the beam and the top of the tester is determined by the length of the support tube. The Head Support Tube must be cut to obtain the desired floor to tester height. The recommended height can be achieved by measuring the distance in inches from the bottom of the beam to the floor and subtract 82″ from this number, the result of this will be the cut length of the Tube.

Distance from bottom of
beam . . . .120″
subtract . . . .-82°
Tube length 38"

The beam should be supported **by** sufficient hangers to handle the load and prevent bending of the beam. When using the standard 5", 10 lb. per foot beam, do not exceed 10 feet between supports.

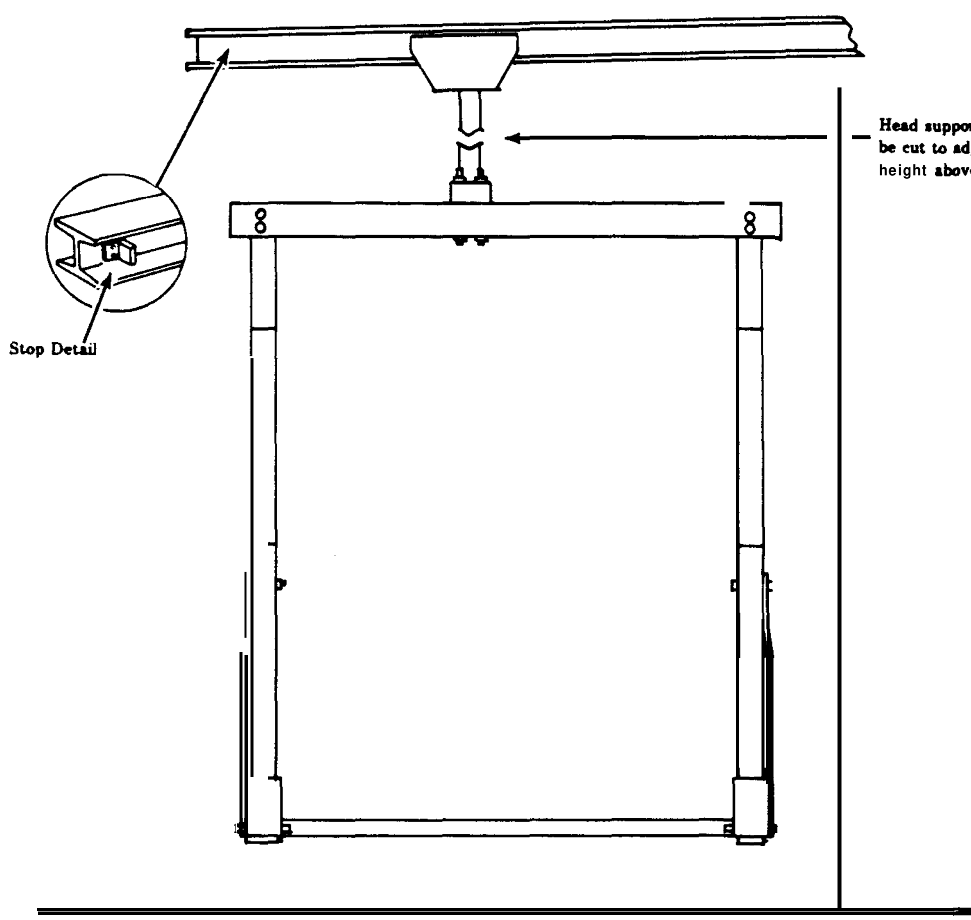

FIGURE 2

The load on the hangers may be calculated by adding the weight of the beam, the suspension kit, the weight of the testers and accessories and the weight of any other equipment to be hung on the beam.

A typical installation must be designed to support:

30 feet of beam at 10 lbs. per foot		300 lbs.
Head Suspension Kit		100 lbs.
MCA-3000 and accessories		600 lbs.
	Total	1000 lbs.

The installation MUST also provide for positive stops on the ends of the beam. Any addition or change to building structure must adhere to local building codes.

INSTALLATION PROCEDURE

ASSEMBLY OF THE HEAD SUSPENSION KIT

1. Determine proper length of head support tube (item 15) and cut it to proper length.

2. After the head support tube has been cut to proper length, drill two holes in the upper end as shown in Figure 3. NOTE that the holes must be in line with the two holes located on the bottom of the tube.

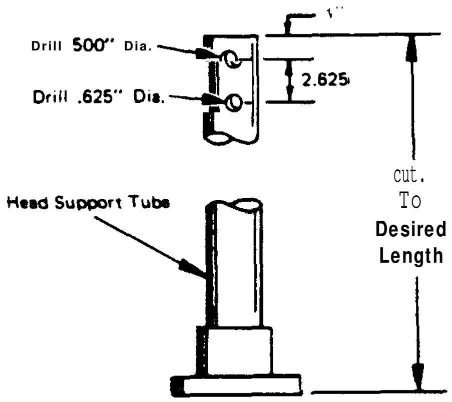

FIGURE 3

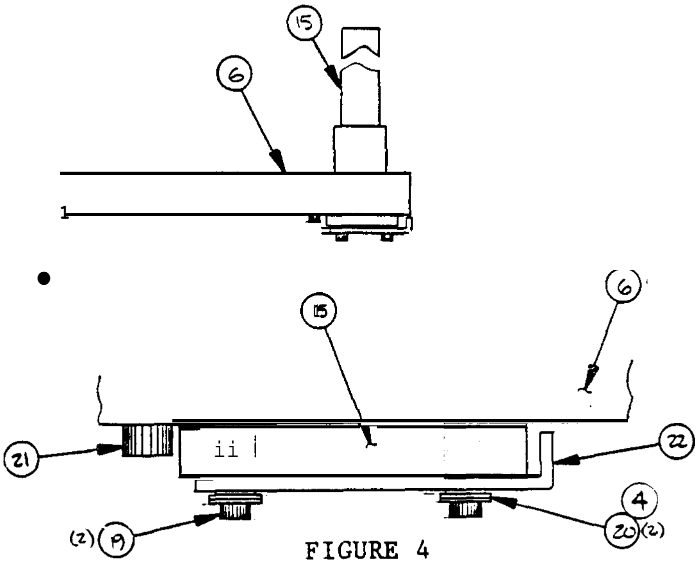

FIGURE 4

3. Apply grease to the unpainted bearing surfaces of the tube collar and flange, and place the Collar Block in proper position over the collar and swivel plate as shown in Figure 4.

4. Using Item 19, 20, and 22, mount the Rotational Stop to the bottem end of the Tube, as shown in Figure 4.

5. Insert the Stop Bolt Item 21 into the Collar Block item 6 as shown in Figure 4.

6. Drill two 7/16″ holes in the each end of the I-beam as shown in Figure 2.

7. Using the items 11, 12, 13, 14, and 15, mount the end stops on each end of the I-Beam. See Figure 2.

8. Assemble the Trolley item 23 to the head support tube as shown in Figure 5. Do not fully tighten bolts.

NOTE If an "I" beam with a flange width greater than 3 inches is used. it will be necessary to shim at point "A" in Figure 5 to retain the trolley assemblies in a parallel position. Use longer bolts if required.

9. With trolley hanging on beam, plumb head support tube and tighten both assembly bolts securely.

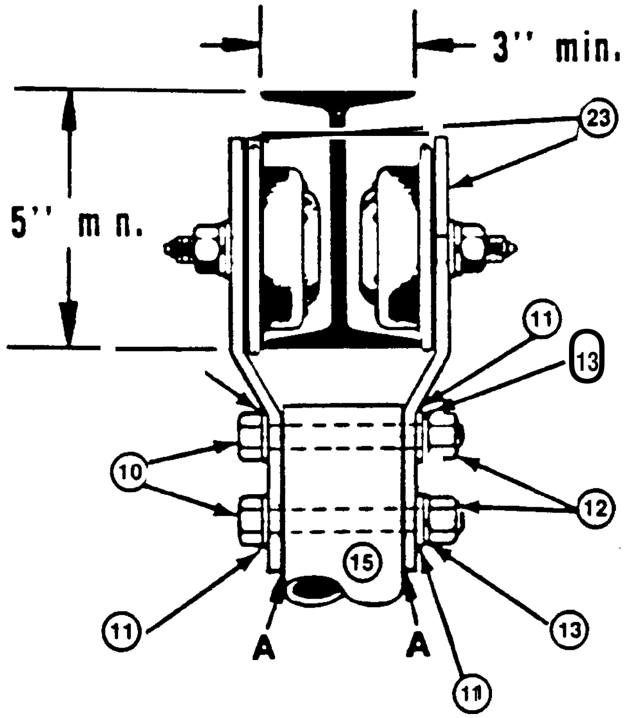

FIGURE 5

10. Position the MCA-3000 on the Base Weld Assy. and align the mounting holes in the bottom of the MCA with those in the Base. Install 4 bolts item 18 into MCA.

11. Lower the MCA with Base Weld Assy on to its back and install the two Suspension Tube Weld Assy. item 2 into the holes in the Base. Return the MCA to the upright position.

12. Install the two Suspension Brackets item 3 to the Suspension Tubes and Base using a 3"bolt item 9 in the tube and a 4" bolt item 10 in the base Please pay attention to the positioning of the offsets and bends in the brackets and tubes as shown in Figure 6 and make sure to install the spacer item 14 between the Bracket and the Base.

13. Place Top Suspension Beam item 5 over both Suspension tubes with the welds up and the larger portion of the offset facing the front. Place the four 9" bolts in place and fix in place using items 11, 12, and 13.

14. Raise the MCA and HSK frame up until it is the same height as the bottom of the Collar Block suspended from the beam. Line up the holes and insert the four 5 1/2" bolts and fasten in place using items 11, 12, and 13.

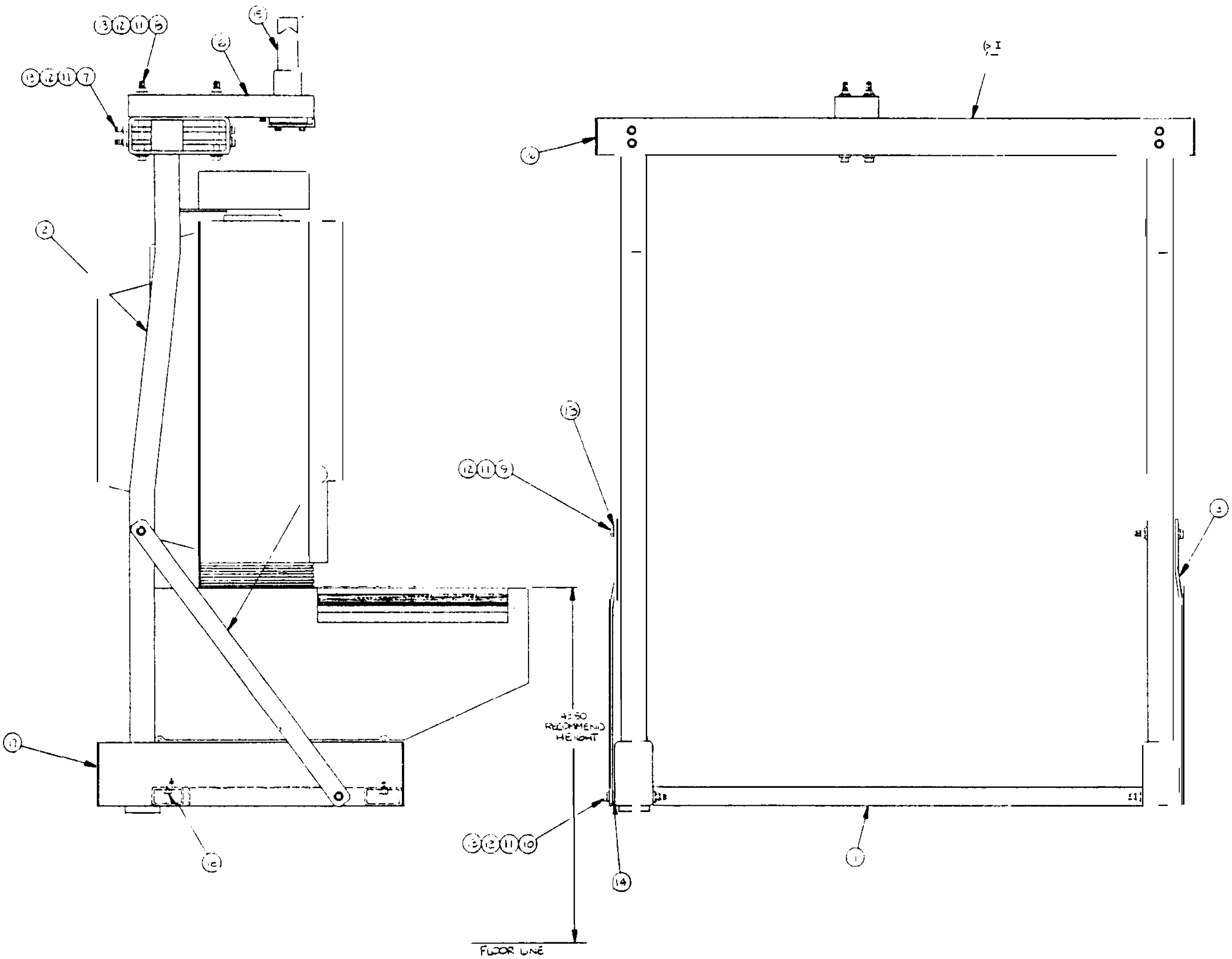

Figure 6

ELECTRICAL SERVICE ---

Provisions should be made for supplying 117V AC power to the tester throughout its full travel length. This may be a single outlet centrally located, or an automatic return reel type retriever.

SUN ELECTRIC CORPORATION

Model: KIT 0120-0541
MCA 3000
Ventilation Cover

Page:

Assembly & Installation Instructions

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL

The installation of kit 0120-0541 provides the MCA 3000 with a vent cover to prevent debris from being pulled into the unit. This cover is installed over the vent in the rear of the Computer Module Drawer.

PARTS LIST

QTY	PART NUMBER	DESCRIPTION
1	7014-1103	COVER PLATE
2	0403-1441-08	SCREW, 8-32 x 1/2

REQUIRED TOOLS

Complete Sun Issued Tool Kit

INSTALLATION INSTRUCTIONS

1. Refer to Figure 1 (see page 2) to locate vent in Computer Module Drawer on rear of the MCA 3000.

2. Place vent Cover Plate over the vent holes and secure in place with the screws provided.

k********************
* INSTALLATION COMPLETE *
****

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0692-1611 (8830)

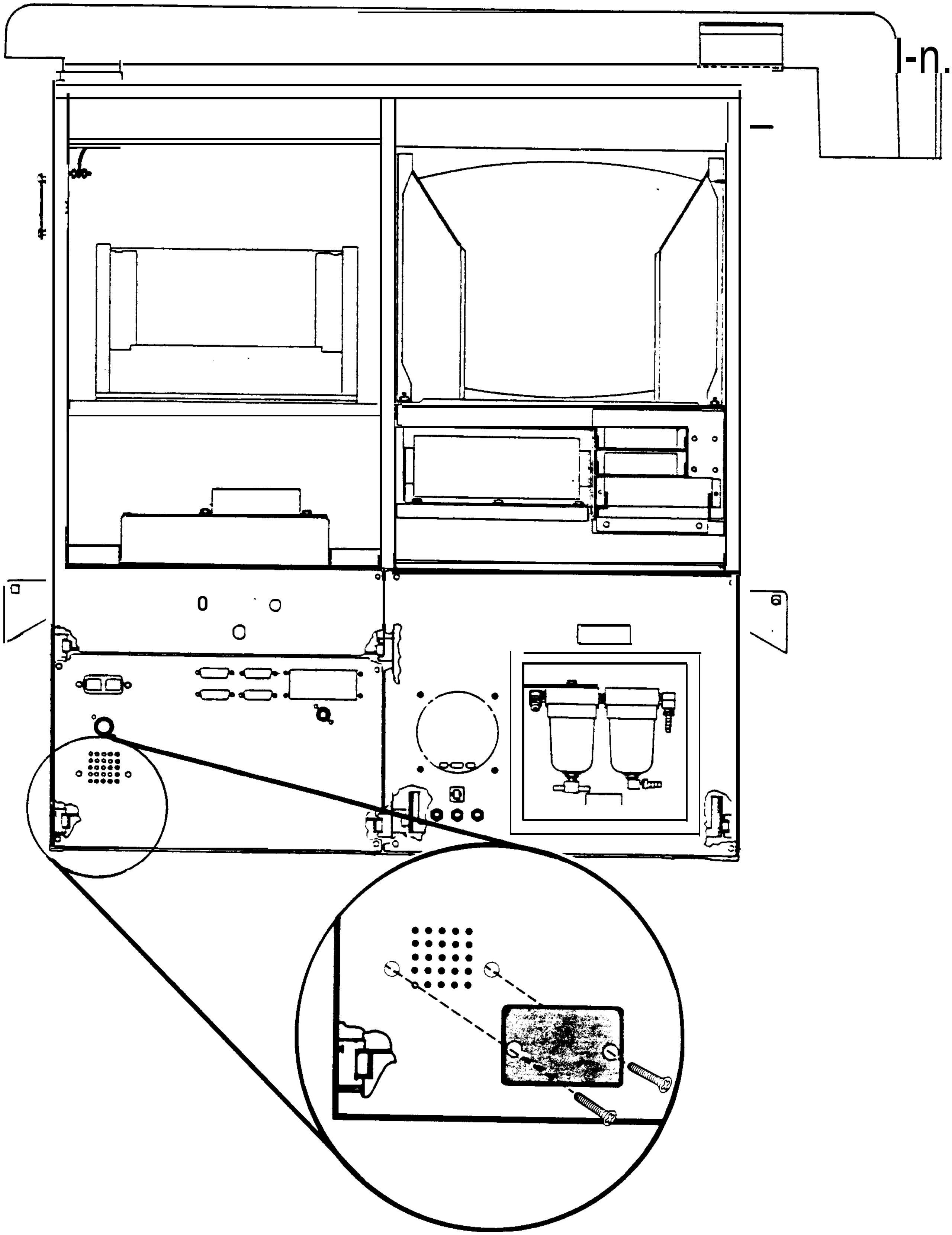

Figure 1. VENT COVER LOCATION

Mode/:	KIT 0120-0542 **MCA 3000** Timing Light Bracket
Page:	PAGE 1 of 1

SUN ELECTRIC CORPORATION

Assembly & Installation Instructions

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED SUN SERVICE PERSONNEL.

The installation of kit **0120-0542** provides the MCA 3000 with a bracket connected to the top of the Boom, to hold the Timing Light in its place.

PARTS LIST

QTY	PART NUMBER	DESCRIPTION
1	7012-1184	BRACKET, TIMING LIGHT
2	0403-1411-12	SCREW, 8-32 X 3/4 HEX WASHER
3	0692-1612	INSTALLATION INSTRUCTIONS

REQUIRED TOOLS

Complete Sun Issued Tool Kit

INSTALLATION INSTRUCTIONS

1. Remove the two screws on-top of the Boom as shown in Figure 1.
2. Align the new Timing Light Bracket over the two holes with the tab hanging over the existing bracket.
3. Insert the two new screws, 0403-1411-12 into the holes and secure.

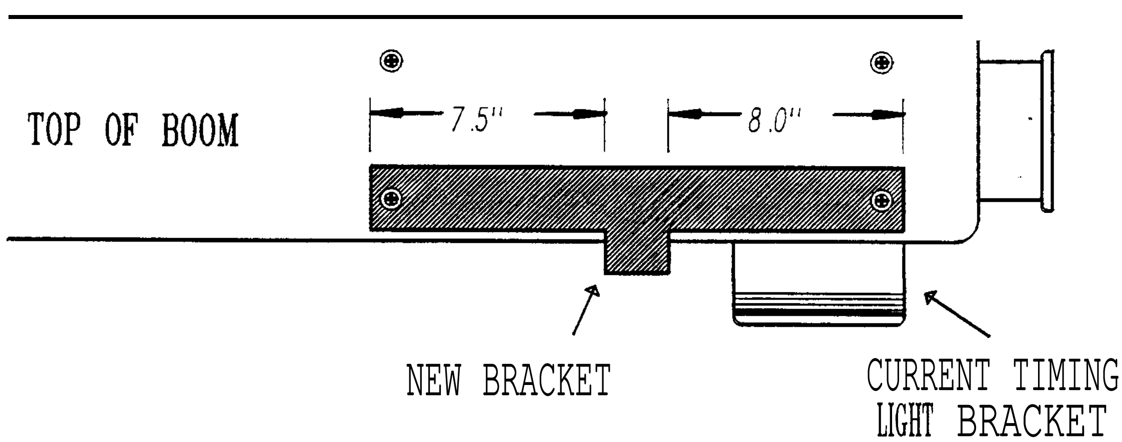

FIGURE 1 TIMING LIGHT **BRACKET** MOUNTING **POSITION**

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0692-1612. (8840)

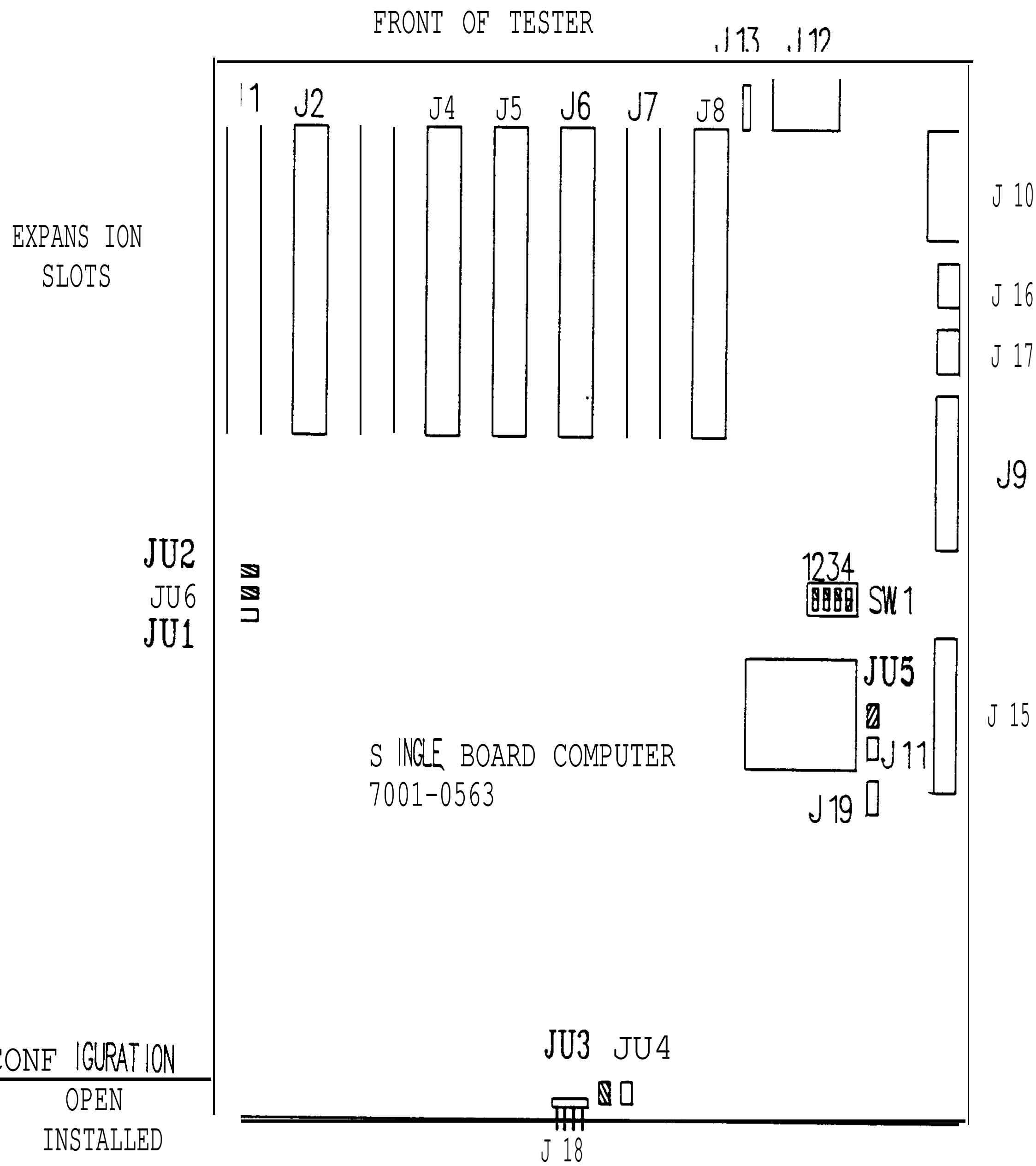
APPENDIX E. CONFIGURATION

GENERAL

This Appendix contains pictorial views of all the components (i.e. Printed Circuit Boards and Subassemblies) related to the MCA-3000 (both Serial "A" & "B") and its TECH-10 Option. The pictorial views show how each board must be set or configured for the MCA-3000 and/or its TECH-10 Option to function properly. It is very important when troubleshooting to first verify that all boards or subassemblies are configured properly, otherwise conflicts/problem(s) may arise.

SINGLE BOARD COMPUTER BOARD (8088)

The MCA-3000 Serial "A" has only one approved Single Board Computer, this board was produced by Faraday.



JUMPER	CONFIGURATION
JU1	OPEN
JU2	INSTALLED
JU3	INSTALLED
JU4	OPEN
JU5	INSTALLED
JU6	INSTALLED*

* - JU6 IS ONLY ON LATER REVISION BOARDS

Figure E-1. SBC, 7001-0563

I/O/EEPROM/CLOCK BOARD

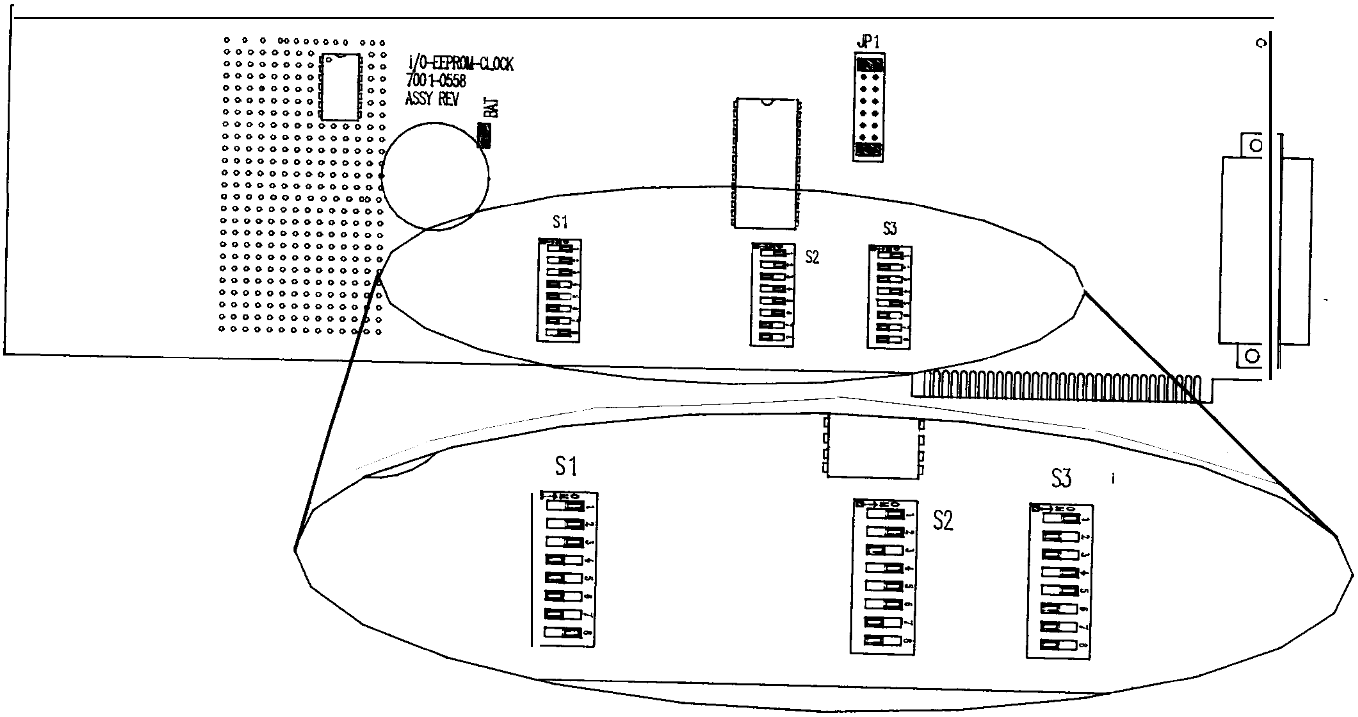


Figure E-2. I/O/EEPROM/CLOCK Board, 7001-0558 or 7001-2016

DAS PROCESSOR ASSEMBLY

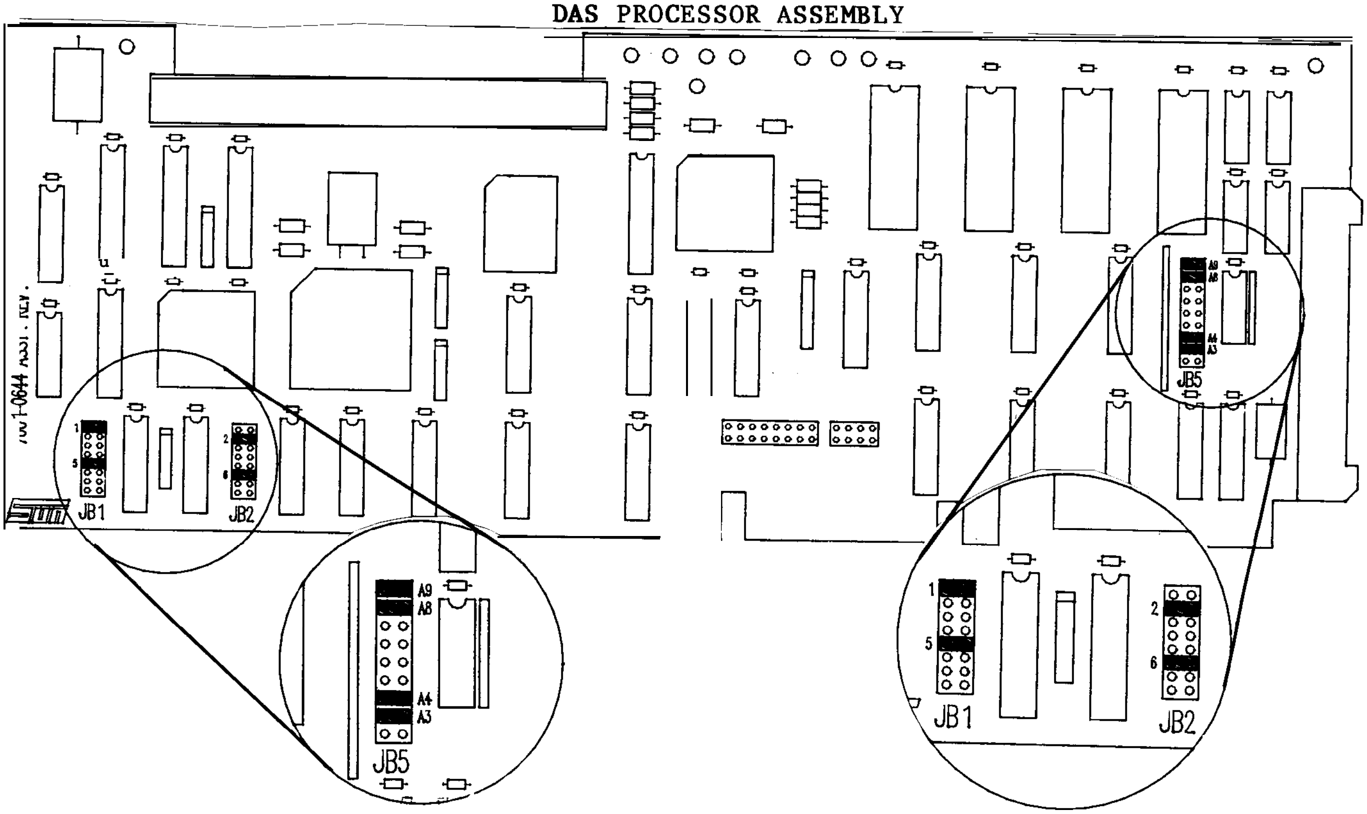


Figure E-3. DAS Processor Assembly, **7009-1989-01**

EGA VIDEO BOARD

There are currently 3 different EGA Video Board approved for use in the MCA. Configuration for these three boards are shown below.

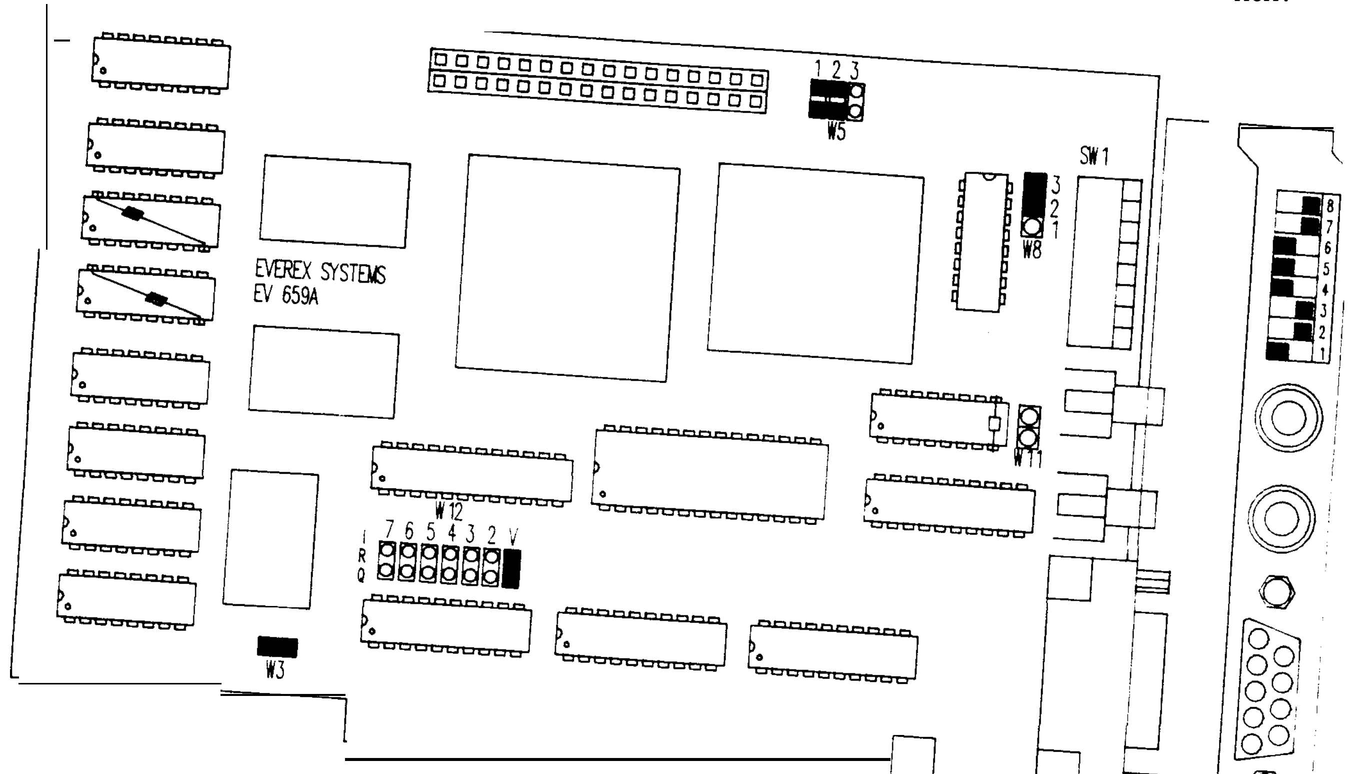


Figure E-4 . Everex System's EV-659A EGA Video Board

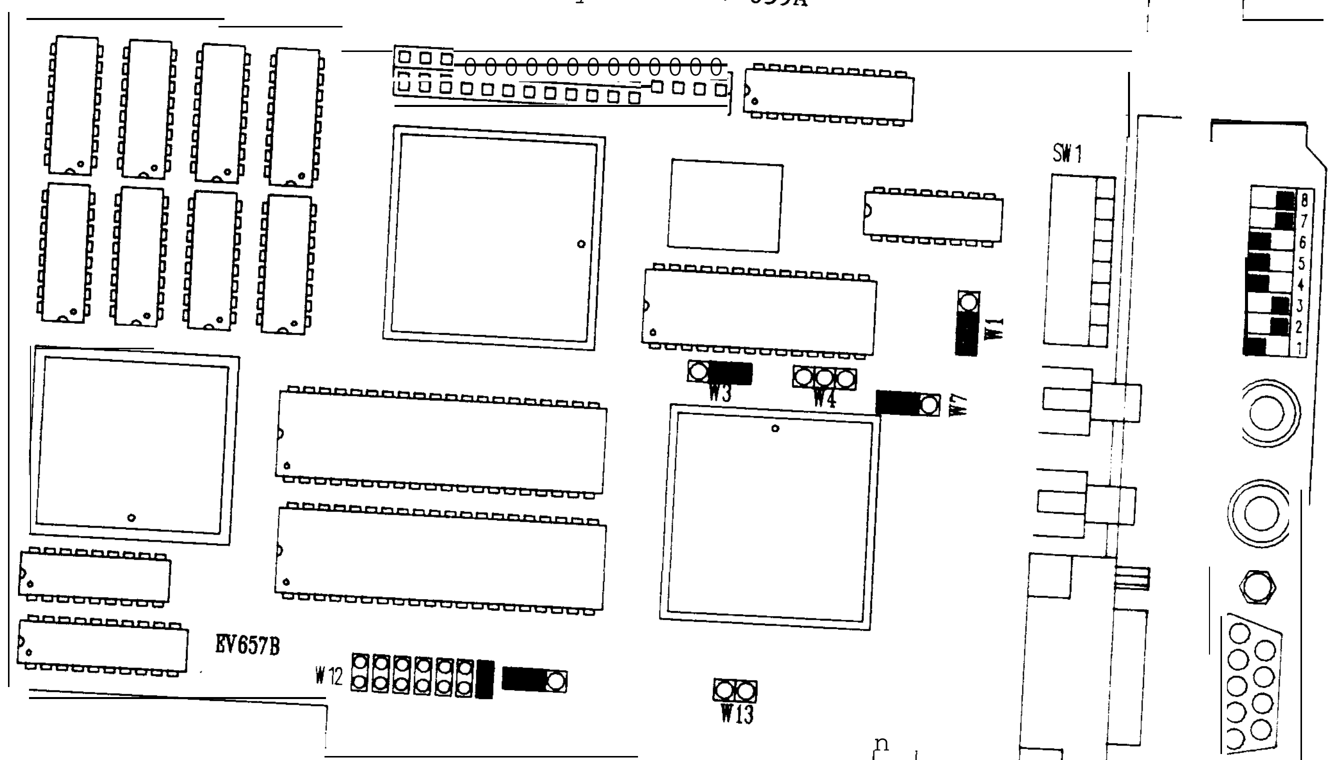


Figure E-5. Everex Systemfs EV-657B EGA Video Board

EV-657B EGA Video Board

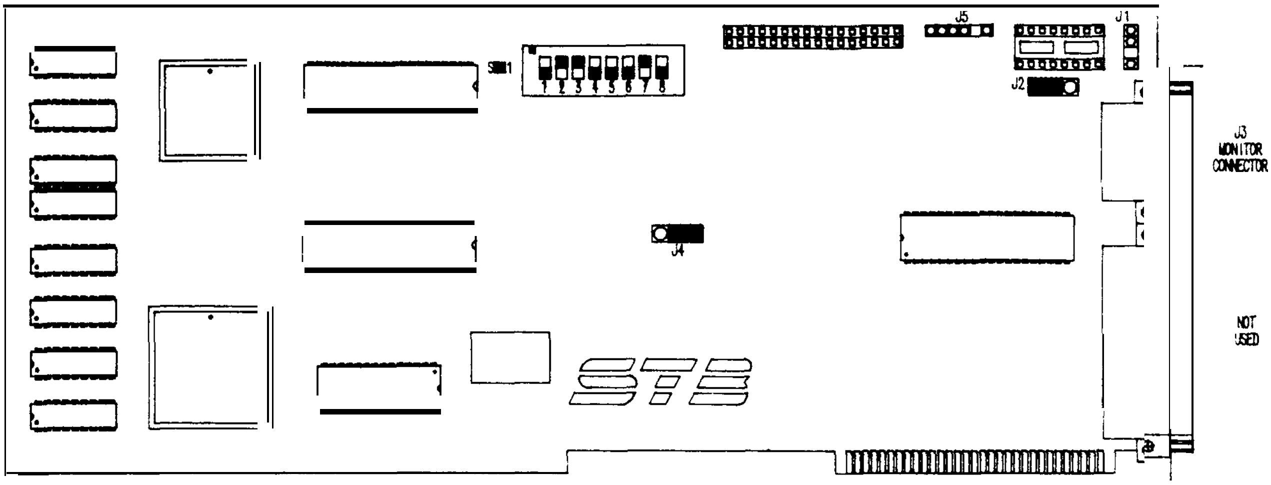


Figure E-6. STB Video Board

286 CPU BOARD

Currently only the NCR 80286 CPU board is approved for use in the MCA-3000 Serial "B".

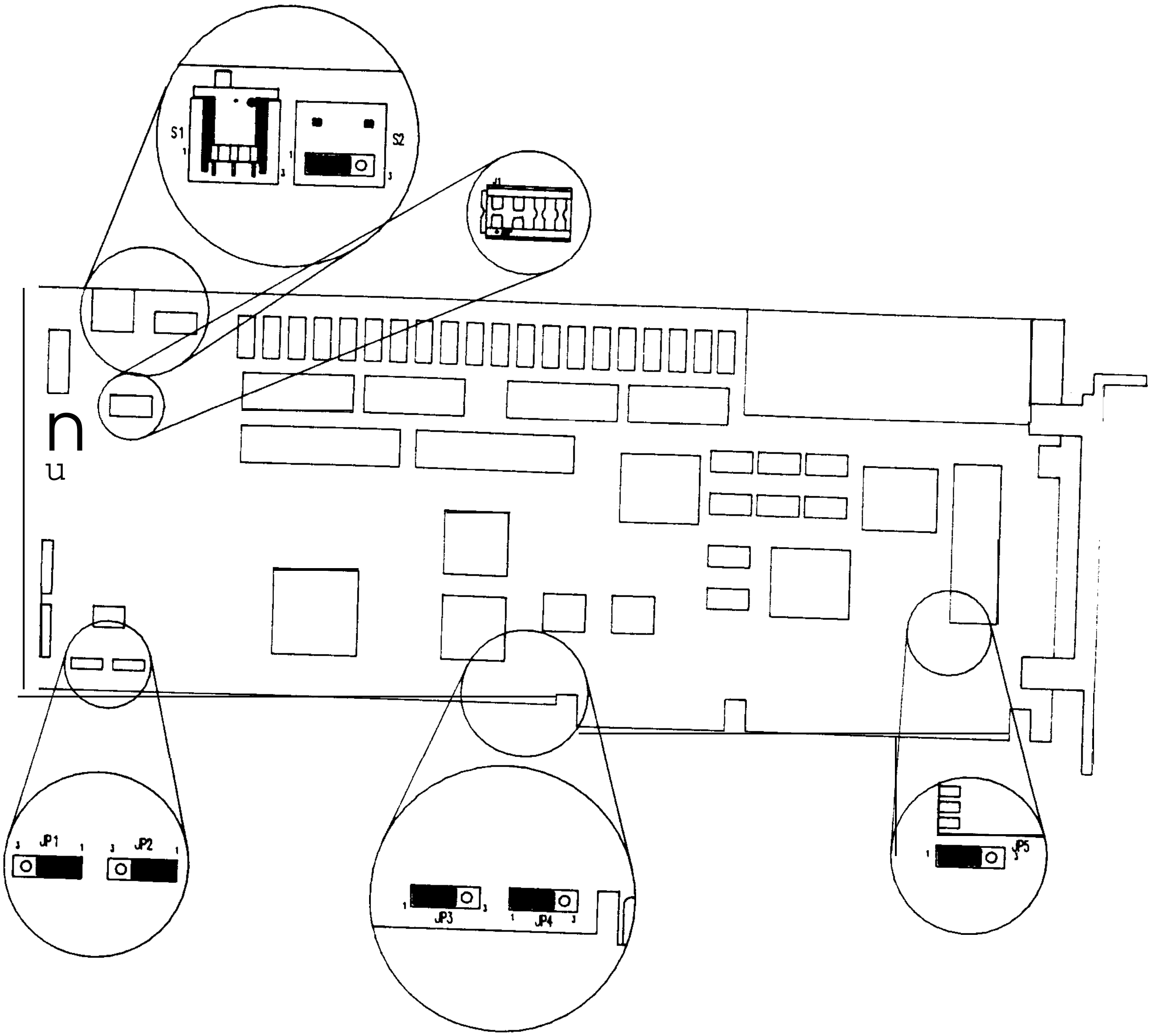


Figure E-7. NCR 286 CPU BOARD, 7001-2024

ARBITRATOR BOARD

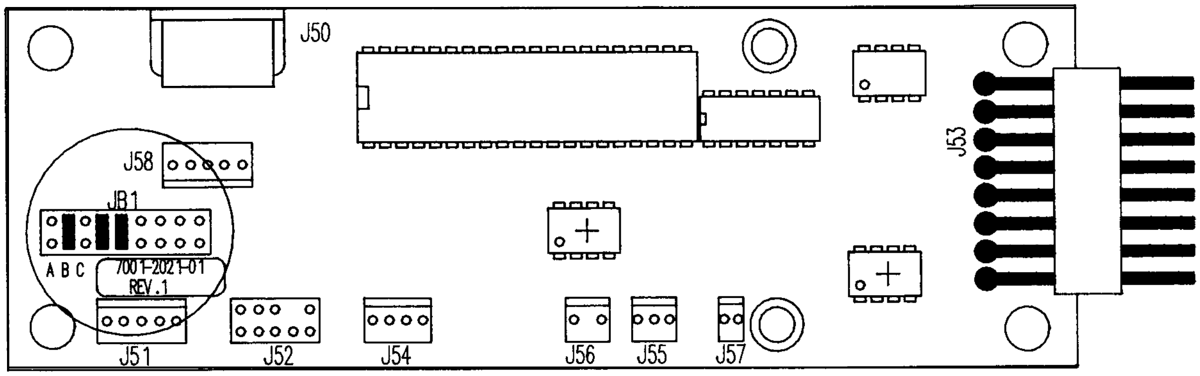


Figure E-8. ARBITRATOR BOARD, 7001-2021-02

PARALLEL/SERIAL 1/0 BOARD

Currently only the Everex EV-170 1/0 board is approved for use in the MCA.

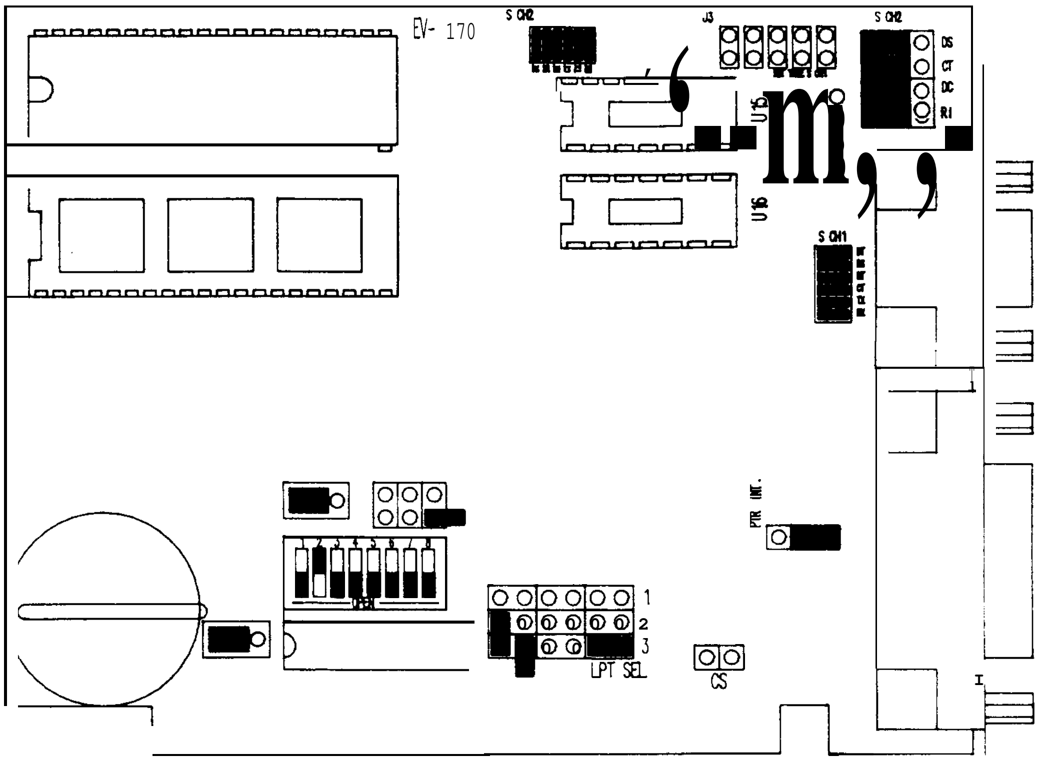


Figure E-9. EVEREX EV-170 Serial/Parallel 1/0 Board 7001-2034-01

FLOPPY/HARD DRIVE CONTROLLER BOARD

Currently only the WD-1003 Controller Board is approved for use in the MCA-3000 Serial "B" units.

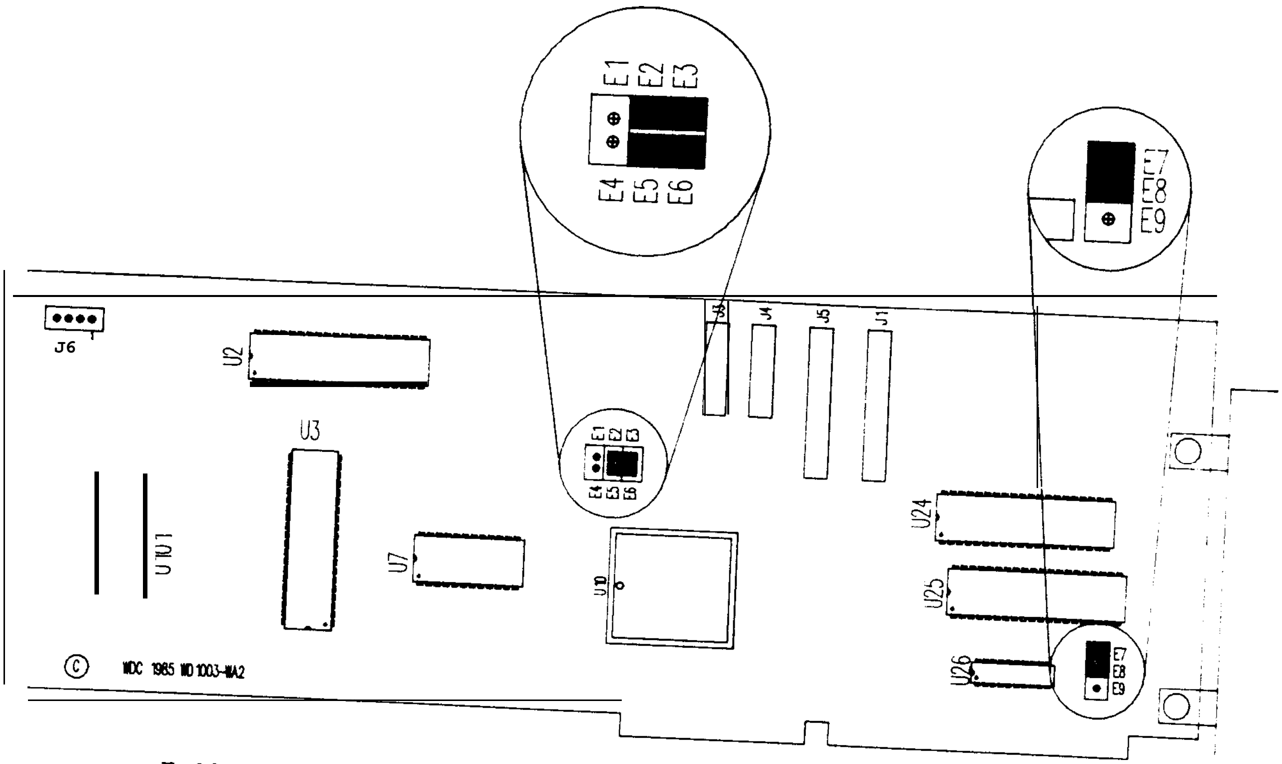


Figure E-10. WD-1003-WA2 Floppy/Hard Drive Controller Board 7001-2020.

SCSI CONTROLLER BOARD CONFIGURATION.

Currently only the TOSHIBA XM-PB301 SCSI Controller Board is approved for the MCA/TECH-10. Customizing this part for operation within the Terminal is performed by use of two DIP (Dual In-line Pin) Switches. The switches on the SCSI Controller can be access from the top of the board located in the Passive Backplane.

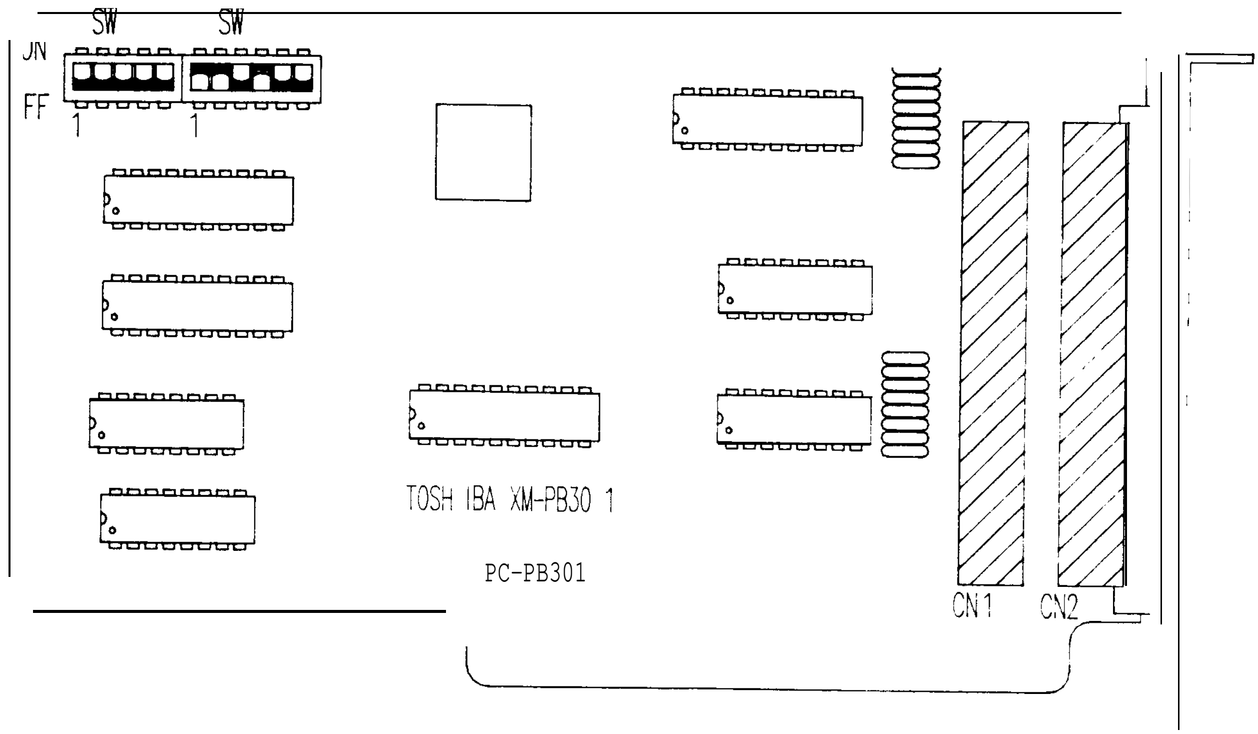


Figure E-n. Toshiba XR-PB301 SCSI Controller Board.

FLOPPY DISK DRIVE CONFIGURATION

CONFIGURATION

Currently, there are 2 Floppy Drives approved for use in the MCA. Configuration settings of the 2 approved drives also differ depending on which type of CPU (either 8088 or 80286) is used. Customizing this 3 1/2-Inch Disk Drives for operation within the Tester is performed by use of either of jumpers.

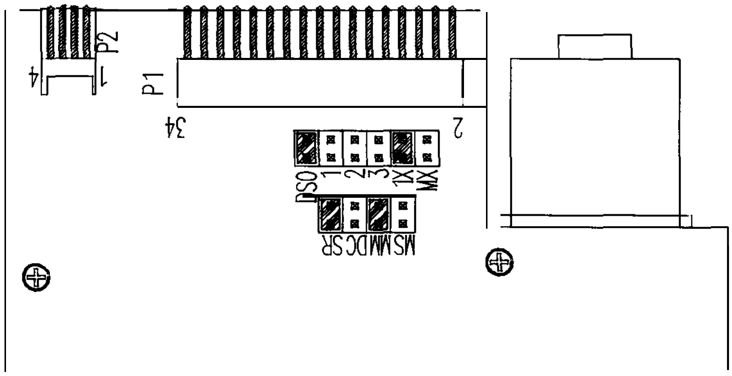


Figure E-12. Mitsubishi Model MF353FA Disk Drive set for uses with a 8088 CPU.

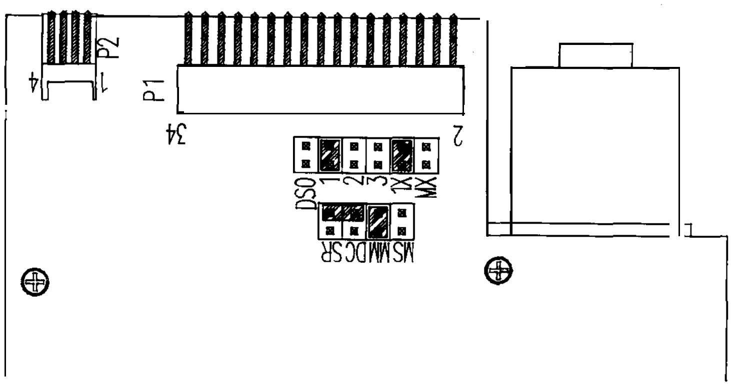


Figure E-13. Mitsubishi Model **MF353FA** Disk Drive set for uses with a 286 CPU.

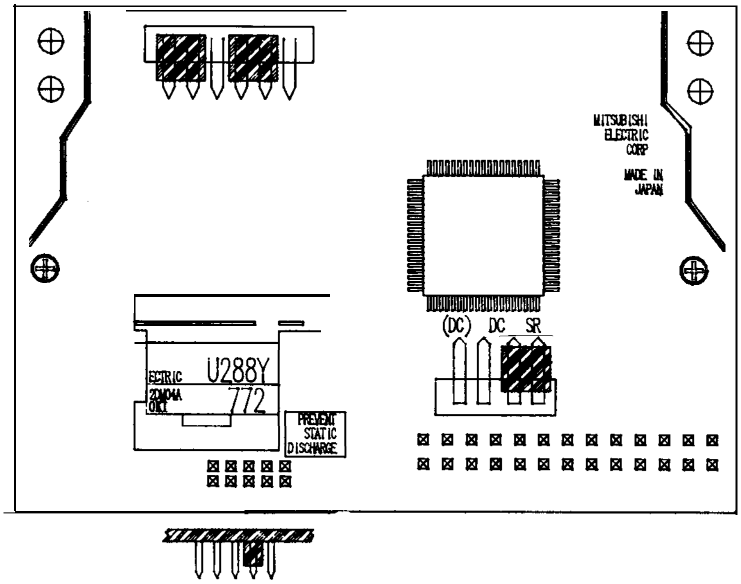


Figure E-14. Mitsubishi Model MF353B-12UJ Disk Drive set for use with an 8088 CPU.

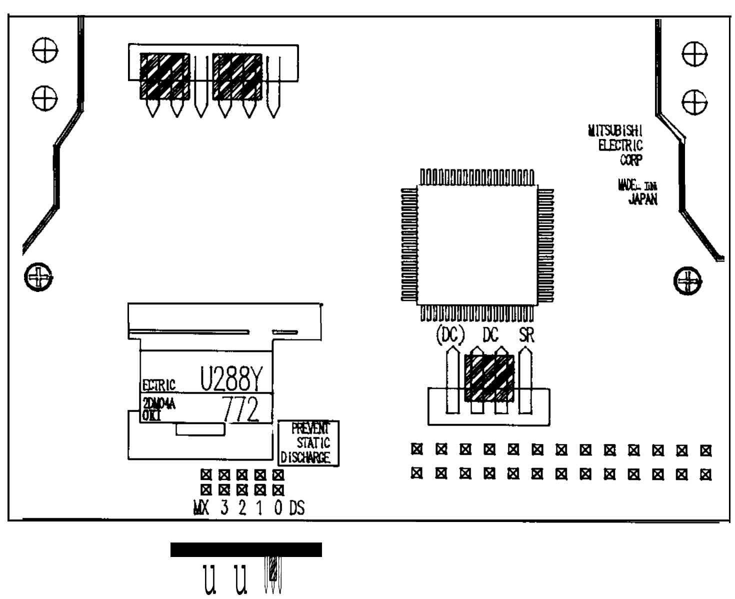


Figure E-15. Mitsubishi Model MF353B-12UJ Disk Drive set for use with an 286 CPU.

HARD DISK DRIVE CONFIGURATION

Currently there is **only 2** Hard Disk Drives approved for use in the MCA/TECH-10 . They both are manufactured by MiniScribe and are **physically** identical to each other and are also configured the same. Customizing these Hard Disk Drives for operation within the Tester is performed by **use of** Jumpers. These Jumpers should always be in the position shown below and are accessed from the rear of the drive.

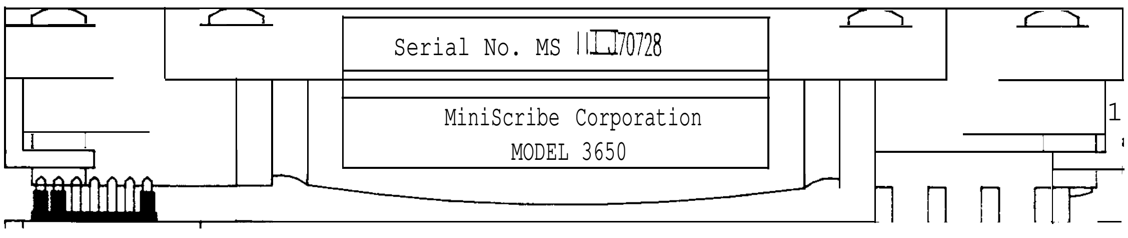


Figure E-16. MiniScribe 3650 and 3675 Hard Drives rear view.

CD ROM DRIVE CONFIGURATION.

Currently only the TOSHIBA Model XM-3101 CD ROM is approved for the MCA/TECH-10. Customizing these parts for operation within the unit is performed by use of a DIP (Dual In-line Pin) Switches. The switches on the CD ROM Drive can be accessed on the rear of the drive.

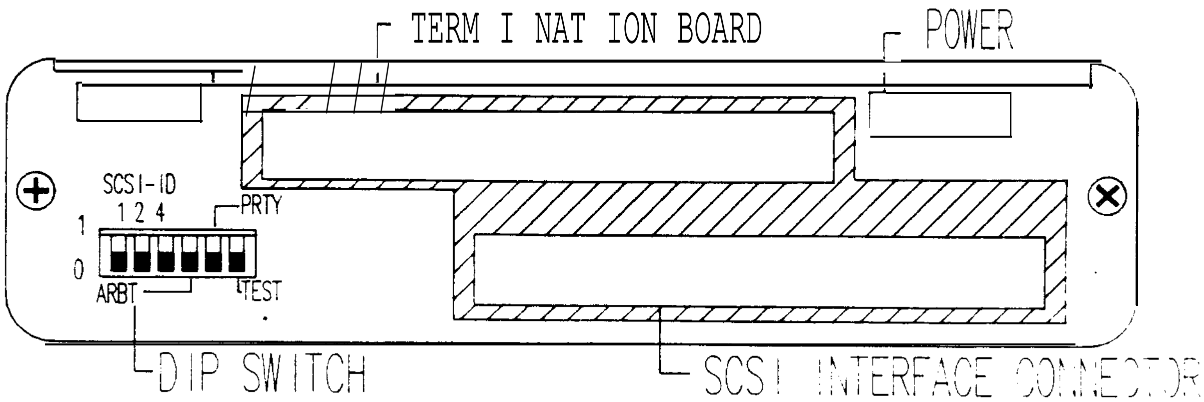


Figure E-17. Toshiba XM-3101 CD ROM Drive rear view.

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TECHNICAL FEEDBACK FORM

Instructions: If an error is found in the Service Manual that affects its technical accuracy, note it in the space below. Give acomplete and accurate description of the error. When practical, send inacopy of thepage with the error noted.

Mail to: **Sun Electric Corporation**
Training/Documentation
One Sun Parkway
Crystal Lake, Illinois 60014

Manual Name: ____________________ Manual Part Number: ____________

Section: ____________________ Page: ____________________

FSR: ____________________ Employee Number: ____________

Region: ____________________

Sun Electric Corporation

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