The Standard in Information and Diagnostic Systems

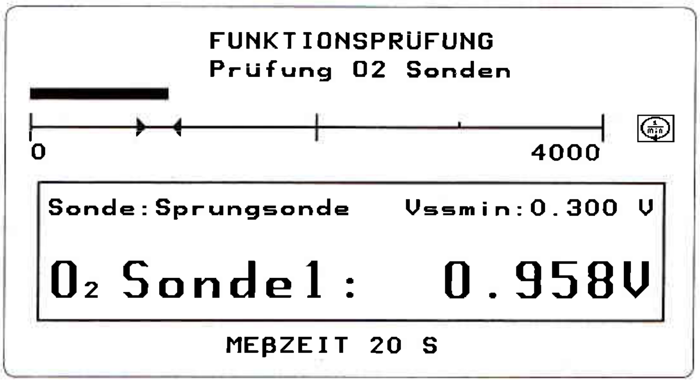
MODEL DGA 1800

Abgastestgerät

Otto- und Diesel

EOBD-AU Programme

AU Leitfaden 3



● BEDIENUNGSANLEITUNG

DGA 1800

DGA 1800 LF3 Softwareversion 4.58

AU Abgastestgerät

Part number : EAZ0007E01B Rev.:A

GEWÄHRLEISTUNGS- UND HAFTUNGSAUSSCHLUSS

Die Informationen in dieser Bedienungsanleitung wurden gewissenhaft und sorgfältig zusammengestellt. Der Inhalt oder Teile des Inhalts dieser Bedienungsanleitung:

- haben keinen Einfluß auf die Allgemeinen Geschäftsbedingungen des Kaufvertrages, Leasingvertrages oder Mietvertrages, auf dessen Grundlage das in dieser Bedienungsanleitung beschriebene Gerät bezogen wurde,
- erweitern in keiner Weise den Haftungsanspruch des Kunden oder Dritter.

AN DEN LESER

Bei der Zusammenstellung der in dieser Bedienungsanleitung enthaltenen Informationen wurde größten Wert auf deren Richtigkeit, Vollständigkeit und Aktualität gelegt. Wir behalten uns jedoch ausdrücklich das Recht vor, diese Informationen jederzeit und ohne vorherige Ankündigung zu ändern.

Lesen Sie diese Bedienungsanleitung sorgfältig durch, bevor Sie das Gerät installieren, warten oder betreiben. Beachten Sie insbesondere die Sicherheitsvorschriften und Warnungen.

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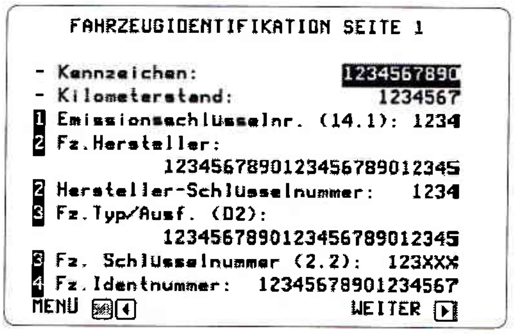
Inhaltsverzeichnis

Inhaltsverzeichnis



Beispiel FZ-Identifikationsseite G-Kat

Mit der Einführung des AU Leitfadens 3 sind einige grundsätzliche Änderungen in den DGA 1800 AU Programmen eingeführt worden:

Testreihenfolge

Die Reihenfolge der Tests in den OBD-AU Programmen wurde dem Leitfaden angepasst.

Solldatenvorgaben

Es dürfen nur noch die im Leitfaden angegebenen Solldaten als Standardwerte angezeigt werden. Der neue Standardsollwert für die Motortemperatur beträgt 60°C

Emmissionsschlüsselnummer

Diese Angabe muss aus dem Feld 14.1 des **neuen** KFZ Scheins übernommen werden. Es handelt sich um vier Stellen.
Im zur Zeit gültigen "**alten**" KFZ-Schein findet man diese Informationen im Feld 1. Es müssen zwei XX gefolgt von der 5. und 6. Stelle von Feld 1 eingegeben werden.

Kraftstoffart

Bei Fahrzeugen mit geregeltem oder ungeregeltem Katalysator muss die Kraftstoffart eingegegeben werden. Dies ist notwendig, damit vom Gerät die richtige Formel zur Lambdaberechnung angewendet wird.

Dieselfahrzeuge Erstzulassung

Es wird unterschieden, ob das Fahrzeug vor oder nach dem 1.6.2006 zugelassen worden ist. Ab dem 1.6.2006 gilt ein neuer Standardwert für die K-Werte: 1,5 anstelle von bisher 2,5.

Prüfbereitschaften Diesel-OBD

Die Prüfbereitschaften werden nur ausgelesen und im Ausdruck dokumentiert. Eine Bewertung wie in der Otto-OBD findet nicht statt.

Anzahl der Abgasstränge

Dies ist eine Kann-Bestimmung. Die neue LF3 Software führt den Anwender menügefüht durch die Abgasmessungen, wenn bei der Solldateneingabe 2 getrennte Abgasstränge eingegeben worden sind.

Nachweis/Protokollausdruck
Ab 2006 wird für die OBD-AU Fahrzeuge anstelle des bisherigen Protokollausdrucks ein Nachweis zur Vorlage bei der Hauptuntersuchung verlangt.
Dieser Nachweis enthält zusätzliche Infos zu den beseitigten Mängeln nach Nr. 6 der neuen AU-Richtlinie im Rahmen der AU. Der Punkt Sichtprüfung Bauteile entfällt hierbei.

AU Solldaten
Durch Einführung neuer Datenfelder für den Leitfaden 3 musste die Datenbankstruktur geändert werden. Neue Solldatendisketten gehören zum Lieferumfang der Leitfaden 3 Aufrüstung.
Das Verwenden alter AU-Solldatendisketten kann zur Falschanzeige von Daten und zu Programmabstürzen führen.

Anwahl eines Fahrzeugs mit Sollwerten aus dem Testerspeicher
Aufgrund der Änderungen für den Leitfaden 3 mussten im freien Fahrzeugtest die Funktion für den Testerspeicher entfernt werden.
Solldaten im freien Fahrzeugtest können jetzt nur noch auf der Standard-Solldatendiskette (STD-Diskette) gespeichert und abgerufen werden.
Bei Anwahl von "Fahrzeug mit Sollwerte" im Fahrzeugtestmenü kommt sofort die Aufforderung "Diskette ********.STD einführen".

Ladezeiten CAN-Adaptersoftware
In Verbindung mit der LF3 Software ist es nicht mehr notwendig zuerst die CAN Software zum Aufbau der Datenkommunikation an einen CAN-Fahrzeug zu laden. Dies geschieht automatisch.

EOBD-AU beenden/ausdrucken bei Fahrzeugen mit gespeichertem Fehlercode
Wird während einer OBD-AU angezeigt, dass Fehlercodes gespeichert sind, muss der Motor des Fahrzeugs solange weiter laufen, bis der Protokollausdruck/Nachweisausdruck beendet ist.
Es werden während des Ausdrucks noch Daten aus dem Steuergerät abgerufen.
Nur notwendig wenn Fehlercodes vorhanden sind!

Drehzahlüberwachung in der GKAT Regelkreisprüfung
Aufgrund einheitlicher Anforderungen der Gutachter RWTÜV und DEKRA muss jetzt während des gesamten Ablaufs der Regelkreisprüfung die Drehzahl überwacht werden. Gerät die Drehzahl während der Regelkreisprüfung außerhalb des in den Solldaten eingegebenen Drehzahlfensters startet die Regelkreisprüfung erneut. Dies wurde von den Gutachtern gewünscht, um eine Umgehung der Herstellervorschriften durch Antippen des Gaspedals zu verhindern.

```
PROGRAMM-MENÜ

1 Fahrzeugtest
2 Unbenutzt
3 AU nach § 47a StVZO
4 Sonderfunktionen
5 Meßparameter
6 Standby

ALLGEMEINE HILFE Shift ?
ZAHL AUSWÄHLEN
```

AU 2 für G-KAT Fahrzeuge mit OBD-System

Die AU II für Fahrzeuge mit geregeltem Katalysator und OBD-Diagnoseschnittstelle besteht aus den folgenden Programmteilen:

- Fahrzeugidentifikation
- Solldateneingabe
- Sichtprüfung
- Funktionsprüfung
- Protokollausdruck

```
AU PROGRAMME
AU nach § 47a StVZO

1 Otto ohne KAT
2 Otto mit UKAT
3 Otto mit GKAT
4 Otto mit GKAT und OBD
5 Diesel
6 Diesel mit OBD

DISKETTE LADEN
PROGRAMM-MENÜ ◄          ZAHL AUSWÄHLEN
```

AU Hauptmenü

Programmanwahl

Wählen Sie aus dem Programmmenü den Menüpunkt „AU nach § 47a StVZO“ an.

Wählen Sie aus dem AU-Hauptmenü das Programm „Otto mit G-KAT und OBD“ an. Es wird das Hauptmenü des Programms "G-Kat mit OBD" angezeigt.

```
MENÜ GKAT mit OBD

1 Fahrzeugidentifikation
2 Solldateneingabe
3 Sichtprüfung
4 Abgas- und Funktionsprüfung
5 Kontrollmodus GKAT mit OBD

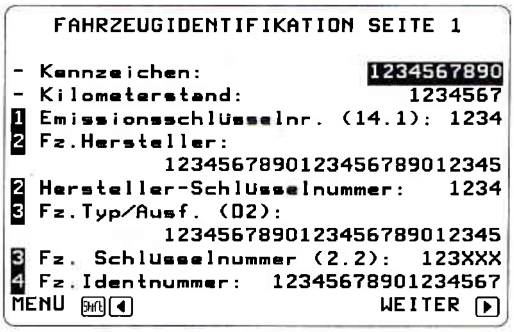
AU-PROGRAMME ◄          ZAHL AUSWÄHLEN
```

Hauptmenü GKAT mit OBD

Hauptmenü GKAT mit OBD

Vom EOBD-AU-Hauptmenü ausgehend können Sie alle zur Durchführung der AU erforderlichen Programmschritte anwählen. Starten Sie mit dem Programmpunkt "1 Fahrzeugidentifikation".

Die Menüpunkte können Sie jederzeit nochmals aufrufen, um z.B. Identifikations- oder Solldaten zu ändern oder, um die Messungen zu wiederholen.



Fahrzeugidentifikationsseite 1

Fahrzeugidentifikation

Voraussetzung für die AU ist eine den gesetzlichen Bestimmungen entsprechende Fahrzeugidentifikation vor jeder Messung. Die Identifikationsdaten können entweder manuell eingegeben werden oder werden größtenteils bei der Fahrzeuganwahl übernommen, wenn Sie mit den fahrzeugspezifischen AU-Solldaten arbeiten (siehe Kapitel „Allgemeine Programmhinweise zur AU/Diskettenfunktionen“).

Anwahl der Fahrzeugidentifikation

Wählen Sie den im Hauptmenü "G-Kat mit OBD" den Menüpunkt „Fahrzeugidentifikation“.

Eingabe der Identifikationsdaten auf Seite 1

Folgende Daten müssen zur Identifizierung des Fahrzeugs eingegeben werden:

- Kennzeichen
- Kilometerstand

Aus dem Kraftfahrzeugschein:

- Emmissionschlüsselnummer (vierstellig)
- Herstellerschlüsselnummer
- Fahrzeughersteller
- Fahrzeugtyp/Ausführung
- Fahrzeugschlüsselnummer (erste drei Ziffern)
- Fahrzeugidentnummer

Auf dem Bildschirm wird vor jeder Zeile die Feldnummer angegeben, in der die jeweiligen Daten im Kraftfahrzeugschein zu finden sind. Feldnummer für den neuen KfZ-Schein stehen in Klammern dahinter.

Fahrzeugidentifikationsseite 2

Eingabe der Identifikationsdaten auf Seite 2

Auf der Identifikationsseite 2 können Sie mit der Taste ☒ zwischen den Kraftstoffarten wählen:

- Benzin
- Flüssiggas
- Erdgas

Hinweis:
Beachten Sie zur Dateneingabe, wenn erforderlich, das Kapitel "Bedienung/Dateneingabe in den AU-Programmen“ in der Basisanleitung.

Weitergehen zur Solldatenseite 1

Drücken Sie die Pfeiltaste ⇨.

Rückkehr zum Menü „G-KAT mit OBD“

Drücken Sie die Tasten Shift und Pfeiltaste ⇦.

Hinweis:
Wird die Fahrzeugidentifikation erneut aufgerufen, werden - falls schon durchgeführt - das Ergebnis der Sichtprüfung und die Messergebnisse gelöscht.

```
SOLLDATEN SEITE 1

Einbauort Diagn. Schnittstelle:
123456789012345678901234567890123456
123456789012345678901234567890123456
12345678901234567890123456 78

Kond. Drehzahl          1/min:    *
Konditionierungszeit       s:     *
Anzahl der Abgasstränge    :     1X

MENÜ                         WEITER
```

Solldatenseite 1

Solldateneingabe

Das Programm „Solldateneingabe“ dient:

- zur Eingabe und Kontrolle der Solldaten des zu testenden Fahrzeugs
- zur Eingabe von Testbedingungen, die dem Messgerät eine Bewertung der Messergebnisse ermöglichen
- zur Anpassung des Prüfablaufs an den Fahrzeugtyp (z.B. Sprungsonde oder Breitbandsonde)

Die Solldaten bzw. Testbedingungen können entweder manuell eingegeben werden oder werden bei der Fahrzeuganwahl übernommen, wenn Sie mit den AU-Solldaten arbeiten. Die Solldateneingabe ist auf mehrere Bildschirmseiten verteilt.

Anwahl der Solldateneingabe

Vor der Solldateneingabe muss eine Fahrzeugidentifikation durchgeführt worden sein. Wählen Sie den Menüpunkt „Solldateneingabe“ im Menü „G-KAT mit OBD“ mit der Enter-Taste an. Bestätigen Sie die Anwahl durch Drücken der Pfeiltaste ⇨.

Durchführung der Solldateneingabe

Es erscheint zunächst die Solldatenseite 1, auf der entweder die Standardsollwerte oder die aus dem Speicher geladenen AU-Solldaten angezeigt werden. Prüfen Sie diese Werte noch einmal und passen Sie sie ggfs. den Herstellervorgaben an.

Hinweis:
Hinweise zur Dateneingabe finden Sie im Kapitel "Allgemeine Programmhinweise zur AU 2/Hinweise zur Dateneingabe“ in der Basisanleitung.

Hinweis:
Wird die Solldateneingabe erneut aufgerufen, werden das Ergebnis der Sichtprüfung und die Messergebnisse gelöscht.

Solldatenseite 1

Solldateneingabe Seite 1

Folgende Sollwerte bzw. Testbedingungen müssen eingegeben werden:

- Einbauort der Diagnoseschnittstelle (Info wird aus der Solldatendiskette ausgelesen, wenn mit Solldaten gearbeitet wird.)
- Konditionierungsdrehzahl und -zeit
- Anzahl der Abgasstränge

Eingabe von Konditionierungsdrehzahl und -zeit

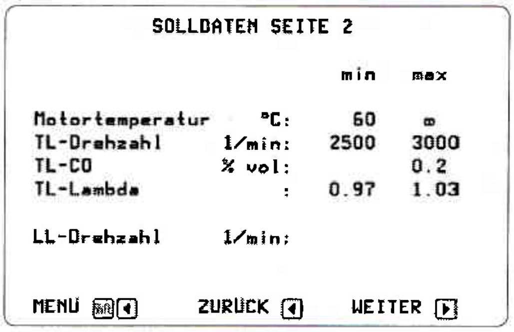
Die Konditionierung (Aufheizen des Katalysators) soll sicherstellen, dass während der Abgasmessung die optimale Arbeitstemperatur zur Schadstoffreduzierung erreicht ist und erhalten bleibt. In den AU-Solldaten des Fahrzeugherstellers ist angegeben, ob eine Konditionierung erforderlich ist. Mögliche Eingaben sind z.B. eine Konditionierungszeit von 180 Sekunden, in welcher der Motor bei 3000 Umdrehungen laufen muss.
Das Programm „Konditionierung" wird im späteren Programmablauf aktiviert, wenn Sie bei der Solldateneingabe einen Eintrag in der Zeile „Konditionierungszeit" machen.
Soll keine Konditionierung durchgeführt werden, muss in der Zeile „Konditionierungszeit" ein Stern stehen (Standardwert). Die Konditionierung wird daraufhin im Programmablauf übergangen.

Anzahl der Abgasstränge

Wählen Sie hier mit der Taste ☒ an, ob das Fahrzeug einen Abgasstrang oder 2 völlig getrennte Abgasstränge hat.
Wenn Sie "2" anwählen werden Sie im Laufe der AU Prozedur softwaregeführt aufgefordert die Abgasmessungen für das zweite System zu wiederholen.

Weitergehend zur Solldatenseite 2

Drücken Sie die Pfeiltaste ⇨.



Solldatenseite 2

Solldateneingabe Seite 2

Die Bildschirmseite „Solldatenseite 2“ kann nur von der Seite „Solldatenseite 1“ ausgehend aufgerufen werden.
Folgende Werte müssen eingegeben werden:

- Motortemperatur
- Teillastdrehzahl
- Teillast-CO
- Teillast-Lambda Min- und Max-Werte
- Leerlaufdrehzahl

Solldateneingabe Öltemperatur

Der gesetzlich vorgeschriebene Mindestsollwert für die Öltemperatur beträgt 60°C. Der Hersteller kann in seinen Sollwerten einen anderen Wert festlegen. Die Messung erfolgt ausschließlich über den Scanner basierend auf den Daten, die das Motorsteuergerät zur Verfügung stellt.

Rückkehr zur Solldatenseite 1

Drücken Sie die Pfeiltaste ⇦.

Weitergehen zur Solldatenseite 3

Drücken Sie die Pfeiltaste ⇨.

Anwahlmöglichkeiten Solldatenseite 3

Solldateneingabe Seite 3

Die Bildschirmseite „Solldatenseite 3" kann nur von der Seite „Solldatenseite 2" ausgehend aufgerufen werden. Folgende Sollwerte müssen eingegeben werden:

- Unterstützte Regelsonde (Breitband- oder Sprungsonde)
- Sondenmessart (nur bei Breitbandsonde)
- Prüfdrehzahl für die Sondenprüfung

Messart für die angewählte Lambdasonde
Die Eingabemöglichkeiten sind davon abhängig, ob das Fahrzeug mit einer Sprungsonde oder einer Breitbandsonde ausgerüstet ist:

- Mindest-Spannungshub (Sprungsonde)
- Berechneter Lambdawert (Breitbandsonde)
- O2-Sondenstrom (Breitbandsonde)
- O2-Sondenspannung (Breitbandsonde)

Rückkehr zu den vorherigen Solldatenseiten

Drücken Sie die Pfeiltaste ⇦.

Identifikations- und Solldaten speichern

Nachdem alle Daten eingegeben und kontrolliert worden sind, empfiehlt es sich, die Identifikationsdaten zusammen mit den Solldaten durch Drücken der Taste ⊜ auf einer **JOB**-Diskette zu speichern.
Die Daten stehen dann bei der nächsten AU wieder zur Verfügung und brauchen nicht erneut eingegeben werden (s. Kapitel Diskettenfunktionen AU 2 im Basishandbuch).

Rückkehr zum Menü „G-KAT mit OBD“

Drücken Sie gleichzeitig die Tasten Shift und Pfeiltaste ⇦.

Weitergehend zur Sichtprüfung

Wenn Sie im AU-Programmablauf weitergehen möchten, können Sie direkt die Sichtprüfung anwählen. Drücken Sie hierzu die Pfeiltaste ⇨.

Es wird eine Autokalibration und eine HC-Restwerte Prüfung durchgeführt.

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MENÜ GKAT mit OBD

1 Fahrzeugidentifikation
2 Solldateneingabe
3 Sichtprüfung

AU-PROGRAMME ◄            ZAHL AUSWÄHLEN
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Hauptmenü GKAT mit OBD

Sichtprüfung

Das Programm „Sichtprüfung“ dient zur Beurteilung von Baugruppen, die einen Einfluss auf die Schadstoffzusammensetzung des Abgases haben. Die Beurteilung erfolgt durch eine Sichtprüfung, wobei das Fahrzeug, z.B. zur Prüfung der Abgasanlage (Auspuff, Katalysator und Lambdasonde) ggfs. angehoben werden muss oder die Prüfung über einer Grube erfolgen muss. Es brauchen nur solche Baugruppen beurteilt zu werden, die ohne Demontage sichtbar sind.

Anwahl der Sichtprüfung

Vor der Sichtprüfung müssen das Fahrzeug identifiziert und die Solldaten eingegeben worden sein. Sie können dann die Sichtprüfung im Menü „G-KAT mit OBD“ anwählen oder in der Solldatenseite 3 durch Anwahl von „Sichtprüfung" direkt zur Bildschirmseite "Sichtprüfung - Bauteile“ weitergehen.

```
SICHTPRÜFUNG BAUTEILE
Prüfung der schadstoffrelevanten
Bauteile einschließlich Auspuff-
anlage auf Vorhandensein, Vollstän-
digkeit, Dichtheit und Beschädigung,
soweit ohne Demontage sichtbar.
Prüfung des Tankdeckels und der
Verliersicherung oder
Sicherheitseinrichtung.
Ergebnis Sichtprüfung :
       nicht erforderlich - Nachweis

MENÜ SHIFT ◄               WEITER ►
```

Durchführung der Sichtprüfung für Nachweis

```
SICHTPRÜFUNG BAUTEILE
Prüfung der schadstoffrelevanten
Bauteile einschließlich Auspuff-
anlage auf Vorhandensein, Vollstän-
digkeit, Dichtheit und Beschädigung,
soweit ohne Demontage sichtbar.
Prüfung des Tankdeckels und der
Verliersicherung oder
Sicherheitseinrichtung.
Ergebnis Sichtprüfung :
       in Ordnung-Protokollausdruck

MENÜ SHIFT ◄               WEITER ►
```

Durchführung der Sichtprüfung für Protokollausdruck

Auswahl Protokollausdruck/Nachweis

WICHTIG!

Ab 1.1.2006 wird im Rahmen der Zusammenlegung von HU und AU der Protokollausdruck durch einen gedruckten Nachweis abgelöst. Für den Nachweis ist die Sichtprüfung Bauteile nicht mehr erforderlich. Es stehen daher drei Auswahlmöglichkeiten zur Verfügung:

- nicht erforderlich Nachweis

Anzuwenden ab 1.1.2006. Diese Anwahlmöglichkeit ist daher schon jetzt die Standardeinstellung. Es wird der neue Nachweis am Ende der AU ausgedruckt.

- in Ordnung Protokollausdruck

Es wird der herkömmliche Protokollausdruck am Ende der AU ausgedruckt.

- nicht in Ordnung Protokollausdruck

Es wird der herkömmliche Protokollausdruck am Ende der AU ausgedruckt.

Sichtprüfung durchführen

Die Baugruppen müssen am Fahrzeug beurteilt werden. Das Ergebnis muss in der Zeile „Ergebnis Sichtprüfung“ als „in Ordnung“ oder „nicht in Ordnung“ eingegeben werden.

Drücken Sie hierzu die Taste ☒.

Das Ergebnis der Beurteilung wird im Protollausdruck ausgewiesen.

Zurückgehen zum Menü „G-KAT mit OBD“

Drücken Sie gleichzeitig die Tasten Shift und Pfeiltaste ⇦.

Weitergehen zu den Messungen

Drücken Sie die Pfeiltaste ⇨.

```
MENU GKAT mit OBD

 1 Fahrzeugidentifikation
 2 Solldateneingabe
 3 Sichtprüfung
 4 Abgas- und Funktionsprüfung

AU-PROGRAMME ◄          ZAHL AUSWÄHLEN
```

Hauptmenü GKAT mit OBD

Funktionsprüfungen/Messungen

Einleitung

Die Funktionsprüfungen dienen zur Durchführung der für die AU 2 notwendigen Messungen und Prüfungen entsprechend den gesetzlichen Vorschriften. Die Prüfungen beinhalten folgende Tests:

- Sichtprüfung MI-Lampe
- Motorkonditionierung (Öltemp.-Messung)
- (ggf.) Kat-Konditionierung
- Teillast-Abgasmessung
- Leerlaufdrehzahlmessung
- Kontrolle der Prüfbereitschaften
- Lambdasondenprüfung (falls erforderlich)
- Kontrolle der Fehlerkodes
- Sichtprüfung MI-Lampe Status

Am Ende der Funktionsprüfungen ist das Druckerprogramm integriert.

Wiederholen der Funktionsprüfungen:
Achten Sie darauf, dass beim Wiederholen der Funktionsprüfungen der Scanner richtig angeschlossen und die Zündung eingeschaltet ist.

Funktionen/Messungen anwählen

Voraussetzung zur Anwahl des Messprogramms ist, dass zuvor die "Fahrzeugidentifikation", die "Solldateneingabe" und die "Sichtprüfung" durchgeführt wurden!
Wählen Sie den Menüpunkt "Abgas- und Funktionsprüfung" im Menü "GKAT mit OBD" an. Es besteht auch die Möglichkeit, auf der Bildschirmseite "Sichtprüfung" durch Anwahl von "Weiter" direkt zu den Funktionsprüfungen zu gehen.

Hilfetexte während der Messungen abrufen

Wurde eine Fahrzeugidentifizierung mit Hilfe der SUN AU-Solldaten durchgeführt, können auf vielen Bildschirmseiten fahrzeugspezifische Hilfetexte und Abbildungen abgerufen werden. Wenn Hilfetexte vorhanden sind, blinkt ein "?" in der linken oberen Ecke des Bildschirms.

Hinweis:
Diese Funktion steht erst dann zur Verfügung, wenn die Fahrzeughersteller geeignete Daten zur Verfügung gestellt haben.

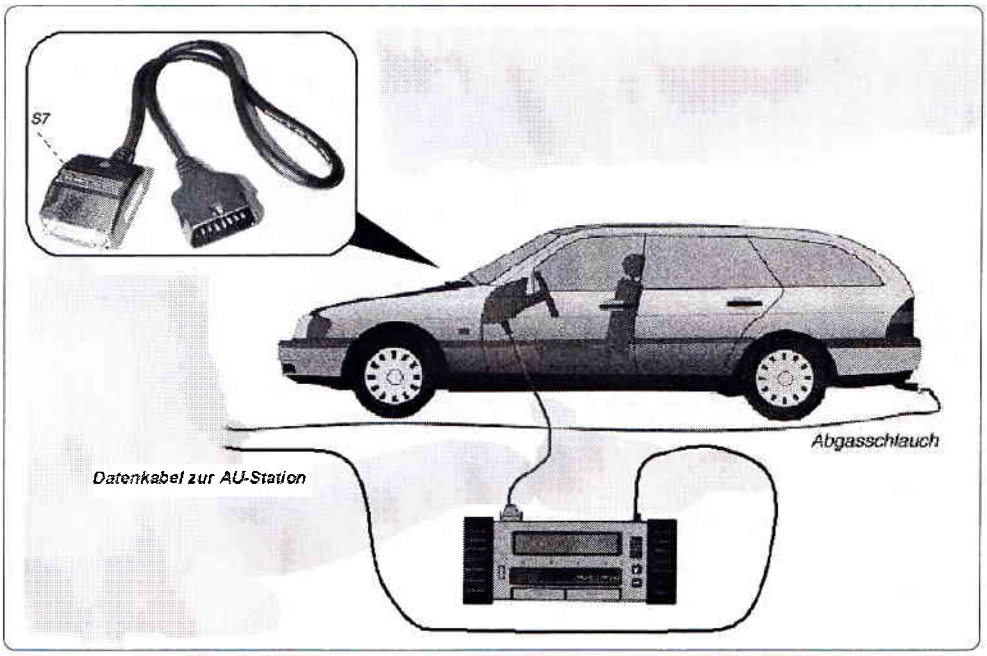
Aufnahme der Messwerte und Daten

Die Aufnahme der Messwerte bei einem EOBD Fahrzeug erfolgt ausschließlich über den Scanner und die OBD-Diagnoseschnittstelle. Nur die Abgasmeßsswerte werden auf herkömmliche Weise über das Auspuffendrohr gemessen.
Der erste Schritt der Funktionsprüfungen ist daher der Anschluss des Scanners an das Fahrzeug.

Scanner an das Fahrzeug anschließen

- Stellen Sie sicher, dass das Scannermodul mit der EOBD-Software im Scanner eingesteckt ist.

- Schließen Sie das Kommunikationskabel des Scanners an den seriellen Anschluss des Scanners an. Dieser Anschluss befindet sich rechts oben auf dem Scanner.



Erforderliche Anschlüsse

- Schließen Sie den 9-poligen Stecker des Kommunkationskabels an den seriellen Anschluss des DGA 1800 an. Der Anschluss befindet sich ganz rechts auf der Geräterückseite ("C").

- Schließen Sie das Diagnosekabel des Scanners an die OBD-Diagnosedose des Fahrzeugs an.
  Üblicherweise benötigen Sie hierzu das Adapterkabel mit dem DL 16 Diagnosestekker sowie den Identifizierungsschlüssel S7. Statt Stecker und Schlüssel kann auch der CAN-Adapter verwendet werden.

Scanner Bedienung

Nach dem Anschluss des Scanners an das Fahrzeug wird auf dem Scannerdisplay die Liste mit den Fahrzeugherstellern angezeigt.

```
-> ALFA/FIAT/LANCIA
   BMW
   CITROEN
   EOBD
```

Wählen Sie mit dem Rändelrad "EOBD" an. Bestätigen Sie die Anwahl durch Drücken der Y-Taste auf dem Scanner. Auf dem Scannerdisplay wird die EOBD Softwareversion angezeigt.
Der Scanner braucht jetzt nicht mehr bedient werden!

```
-> GENERERIC OBDII EOBD   (DEUTSCH)        V5.3

DRÜCKE Y FÜR WEITER.
N DRÜCKEN FÜR HILFE.
```

Sichtprüfung MI

Prüfen Sie, ob bei eingeschalteter Zündung (Motor AUS) die Motorkontrollleuchte im Armaturenbrett des Fahrzeugs leuchtet. Üblicherweise handelt es sich um ein gelb hinterleuchtetes Motorsymbol.

Hinweis:
Bei einigen Fahrzeugen erlischt die MI-Lampe wenige Sekunden nach dem die Zündung eingeschaltet wurde.

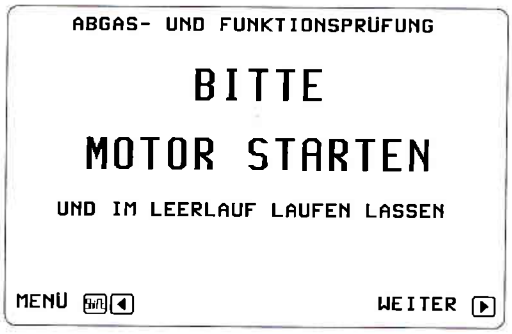
Wählen Sie durch Drücken der Pfeiltaste ⇦⇨, ob die MI-Lampe leuchtet oder nicht.

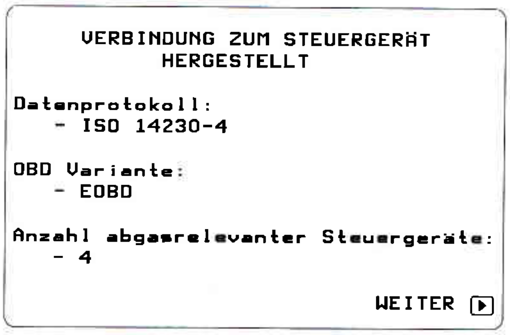
MI Beurteilung

Beurteilen Sie die MI-Lampe als fehlerhaft, wird nebenstehende Meldung angezeigt.

Stecken Sie die Abgassonde in den Auspuff bevor Sie durch Drücken der Pfeiltaste ⇨ zum nächsten Schritt weiter gehen.

MI fehlerhaft





Datenkommunikation zum Steuergerät wurde erfolgreich aufgebaut

Datenkommunikation aufbauen

Starten Sie den Motor sobald nebenstehende Meldung angezeigt wird und lassen Sie den Motor im Leerlauf laufen.
Drücken Sie die Pfeiltaste ⇨.

Das Abgasmessgerät versucht, über den Scanner eine Datenkommunikation zum Steuergerät des Fahrzeugs aufzubauen.
In dieser Zeit erscheint der Schriftzug „Bitte warten“ auf dem Bildschirm des Abgasmessgerätes. Der Kommunikationsaufbau dauert fahrzeugabhängig ca. 5 bis 10 Sekunden.

Nachdem die Kommunikation zwischen dem DGA und dem Scanner aufgebaut worden ist, wird auf dem Scannerdisplay:

„Kommunikation aufgebaut“

angezeigt. Die roten LEDs 1 und 2 auf der Frontseite blinken abwechselnd, wenn die Kommunikation zum Fahrzeug aufgebaut worden ist.
Das Abgasmessgerät wechselt zur nächsten Bildschirmseite. Das Datenprotokoll, mit dem das Steuergerät im Fahrzeug seine Daten ausgibt wird angezeigt. Dies ist eine Information, die im AU-Protokoll ausgedruckt wird.

Zusätzlich wird die Anzahl der gefundenen Steuergeräte angezeigt, die abgasrelevante Diagnosedaten liefern.

Weitergehen zur Motortemperaturmessung

Drücken Sie die Pfeiltaste ⇨.

Wiederholen des Kommunikationsaufbaus

Wenn es erforderlich sein sollte, können Sie auf dieser Bildschirmseite noch einmal den Aufbau der Datenkommunikation starten. Drücken Sie dazu die Taste "Wiederholen".

```
Steuergerät konnte nicht
erkannt werden.

Weiterer Ablauf des Verfahrens
nicht möglich.

WIEDERHOLEN        PROTOKOLLAUSDRUCK
```

Datenkommunikation zum Steuergerät konnte nicht aufgebaut werden.

Datenkommunikation wird nicht aufgebaut

Wenn nach einigen Sekunden kein Fortschritt im Programm zu erkennen ist, können Sie den Aufbau der Datenkommunikation erneut starten. Drücken Sie dazu die Taste "Wiederholen".

Wenn das Steuergerät nicht erkannt werden kann, erscheint ein Hinweis auf dem Bildschirm und ein weiterer Ablauf des Verfahrens ist nicht möglich.
Sie können hier die AU durch Drücken der Druckertaste protokolliert abbrechen oder durch Anwahl des Symbols „Wiederholen" versuchen, die Kommunikation neu zu starten. Folgen Sie den Anweisungen auf dem Bildschirm.

```
KOMMUNIKATIONSAUFBAU

- Zündung ausschalten und Scan Tool
  von der Diagnoseschnittstelle
  trennen.
- Scan Tool wieder an das Fahrzeug
  anschließen. PDL muss EOBD Start
  Display anzeigen.
- Motor starten und im Leerlauf
  laufen lassen.

                              WEITER
```

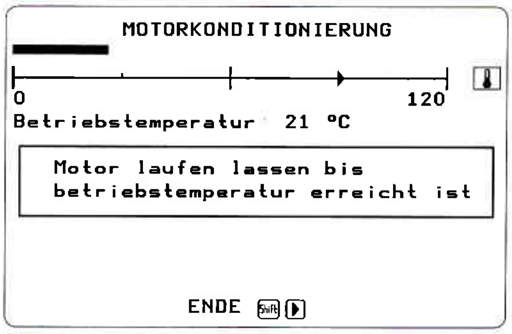
Prozedur zum erneuten Kommunikationsaufbau

Folgen Sie den Anweisungen auf dem Bildschirm. Prüfen Sie, ob Sie die Voraussetzungen zum Aufbau der Datenkommunikation erfüllt haben:

- Kommunikationskabel angeschlossen
- Diagnosekabel angeschlossen
- Zündung eingeschaltet
- Zeigt das Scanner Display das EOBD Menü
- Baudrate im Scanner 19200 Baud

Manuelles Einstellen der Baudrate 19200

Die Baudrate wird normalerweise automatisch gesetzt. Prüfen Sie im Problemfall die Einstellung im Scanner:
Hauptmenü / Anwendersetup / Kommunikationssetup / 19200 Baud / N-Taste

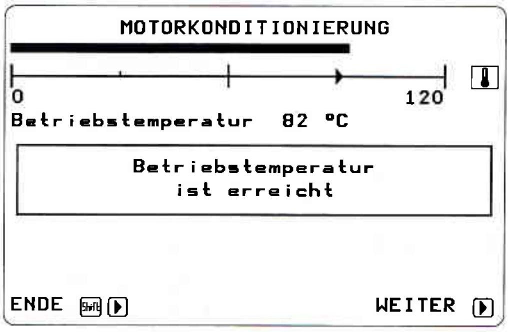


Motortemperatur noch nicht erreicht

Motortemperaturmessung

Die Anweisungen auf dieser Bildschirmseite dienen zur Prüfung, ob der Motor die in den Solldaten vorgegebene Betriebstemperatur erreicht hat. Die Messung erfolgt über den Scanner (PDL 1000/2000).

Lassen Sie den Motor laufen bis die Betriebstemperatur erreicht ist. Nach dem Erreichen der Temperatur wird eine entsprechende Meldung angezeigt.

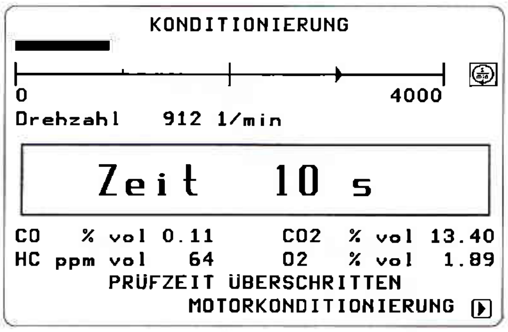


Motortemperatur erreicht

Weitergehen zum nächsten Test

Drücken Sie zum Weitergehen die Pfeiltaste ⇨. Nach ein paar Sekunden geht das Programm auch automatisch weiter.

Abhängig davon, ob Sie bei der Solldateneingabe einen Wert für die Konditionierungszeit eingegeben haben, geht das Programm weiter zur KAT-Konditionierung oder zur Teillastmessung.

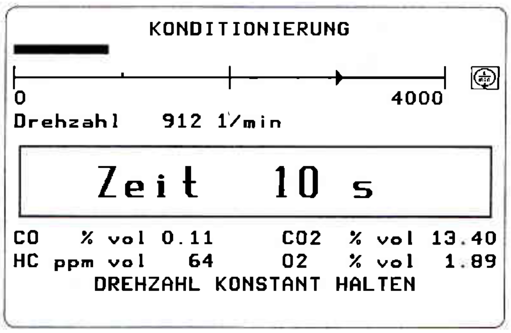


Beispiel für die Anzeige "Prüfzeit überschritten"

Prüfzeit überschritten:

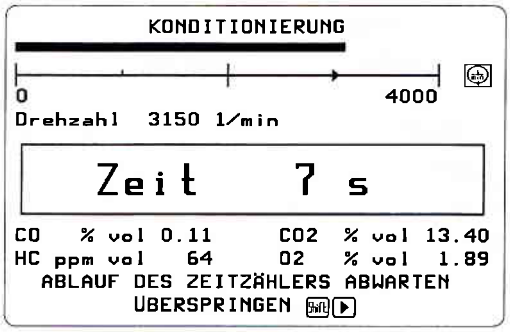
Nach dem Messen der Motortemperatur stehen dem Anwender 10 Minuten pro Testseite zur Verfügung, um die nachfolgenden Tests durchzuführen. Wird diese Zeit überschritten, erscheint der Hinweis "Prüfzeit überschritten" und das Messprogramm muss beginnend mit der Motortemperaturmessung wiederholt werden.

Kat-Konditionierung



Drehzahl nicht im Drehzahlfenster

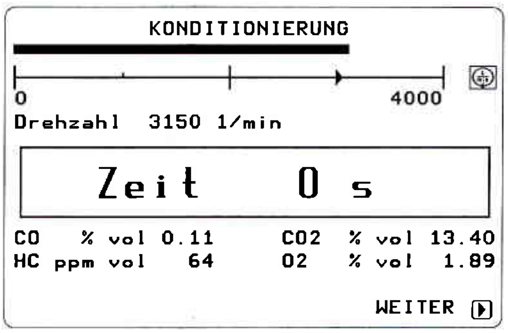
Hinweis zur KAT-Konditionierung
Die Bildschirmseite „KAT-Konditionierung“ erscheint nur, wenn bei der Solldateneingabe in der Zeile „Konditionierungszeit“ ein Wert eingegeben wurde (siehe Kapitel „Solldateneingabe/Eingabe von Konditionierungsdrehzahl und -zeit").
Die Konditionierung (Aufheizung des Katalysators) soll sicherstellen, dass während der Abgasmessung die optimale Arbeitstemperatur zur Schadstoffreduzierung erreicht ist und erhalten bleibt.



Drehzahl im Drehzahlfenster

Durchführung der Konditionierung

Zu Beginn der Konditionierung muss die Drehzahl in das bei der Solldateneingabe vorgegebene Drehzahlfenster gebracht werden. Andernfalls erscheint der Hinweis „Drehzahl konstant halten“. Befindet sich die Drehzahl im Fenster, startet ein Zeitzähler.
Wenn die Drehzahl das Drehzahlfenster verlässt, stoppt der Zeitzähler.
Nach Ablauf des Zählers muss auf die Leerlaufdrehzahl zurückgegangen werden. Die KAT-Konditionierung ist damit beendet.



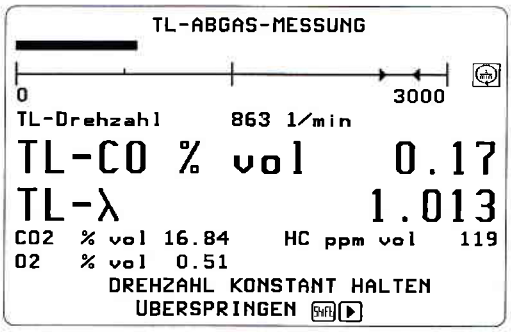
Konditionierung beendet

Weitergehen zur Teillastmessung

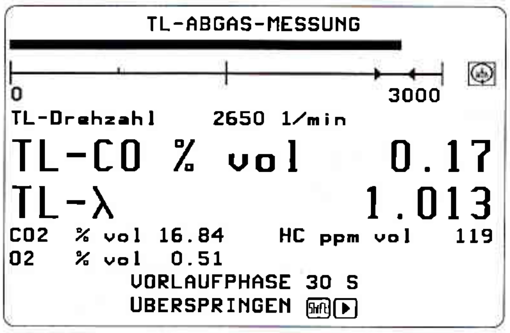
Drücken Sie die Pfeiltaste ⇨.

Messungen überspringen

Auf den Messseiten können Sie durch gleichzeitiges Drücken der Tasten Taste "Shift" und Pfeiltaste ⇨ den aktuellen Test überspringen. Das ist sinnvoll, um im Test weiterzukommen, wenn z.B. vom Fahrzeug keine Daten übertragen werden. Wenn Sie den Test überspringen gilt die AU grundsätzlich als nicht bestanden

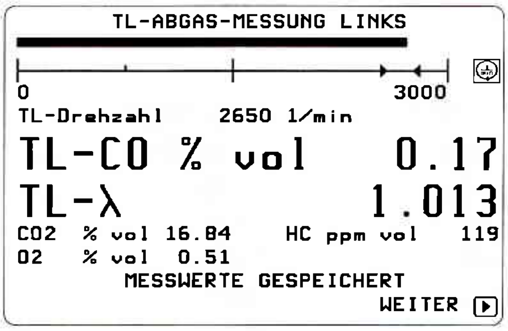


Drehzahl in das Drehzahlfenster bringen



30 Sekunden Messzeit

Hinweis zum Drehzahlfenster:
Verlässt die Drehzahl während der Messung das Drehzahlfenster, kann versucht werden innerhalb von ca. 3 Sekunden das Drehzahlfenster wieder zu erreichen. Wenn dies nicht gelingt, startet der Zeitzähler neu.



Messung beendet

Teillast-Abgasmessung

Die Teillast-Abgasmessung dient zur Messung des CO-Anteils und des Lambdawertes bei Teillastdrehzahl. Auf dem Bildschirm werden die Drehzahl, der CO-Messwert und der Lambdawert angezeigt. Als Zusatzinformationen werden CO2, O2 und HC angezeigt. Die Drehzahl wird über den Scanner ermittelt, die Abgasdaten über die Abgasmesssonde.

Testdurchführung

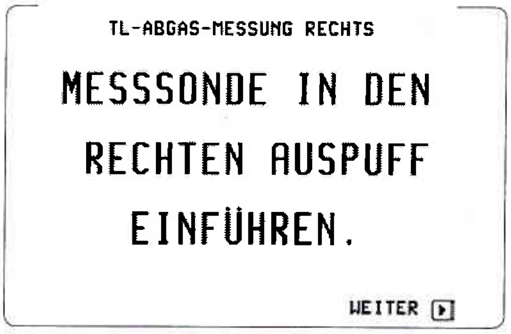
Zur Testdurchführung muss die Drehzahl in das vorgegebene Drehzahlfenster gebracht und dort stabil gehalten werden. Andernfalls erscheint die Meldung „Drehzahl konstant halten".

Befindet sich die Drehzahl im Fenster, läuft ein 30 Sekunden Zeitzähler ab. Während dieser Zeit prüft das Gerät selbständig, ob die Abgaswerte und die Teillastdrehzahl stabil sind und speichert sie. Werden innerhalb von 30 Sekunden keine stabilen Abgaswerte erkannt, erfolgt automatisch die Speicherung des letzten Messwertes.

Nach Ablauf der Messzeit erscheint auf dem Bildschirm der Hinweis „Messwerte gespeichert" und es kann wieder zum Leerlauf zurückgegangen werden.

Weitergehen zur Leerlaufmessung

Drücken Sie die Pfeiltaste ⇨.



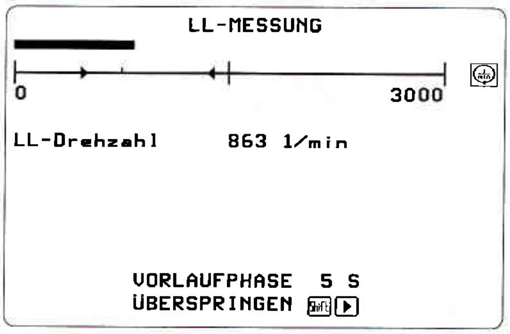
Zweites Auspuffsystem anwählen

Messung an zwei getrennten Auspuffsystemen

Haben Sie "2 Abgasstränge" bei der Solldateneingabe angewählt erkennen Sie an der Überschrift TL-Abgasmessung links oder rechts welche Messung gerade stattfindet.

Nach der Messung des ersten Systems wird die Anwahlmöglichkeit "2. Abgasstrang" angezeigt. Nach der Anwahl wird die nebenstehende Erinnerung angezeigt.

Zum Messen des zweiten Abgastrangs Sonde in das andere Auspuffsystem einführen und Pfeiltaste ⇨ anwählen.



5 Sekunden Messzeit

Leerlaufmessung

Auf der Bildschirmseite „Leerlaufdrehzahlmessung“ wird nur die über den Scanner gemessene Leerlaufdrehzahl bewertet. Die übrigen Anzeigen von CO, CO2, HC, O2 und Lambda dienen lediglich als Zusatzinformationen.

Durchführung der Messung

Zu Beginn der Messung sollten sich die Leerlaufwerte stabilisiert haben. Die Leerlaufdrehzahl muss sich in dem bei der Sollwerteingabe vorgegebenen Fenster befinden. Andernfalls erscheint die Meldung „Drehzahl konstant halten“.
Ist die Drehzahl im Fenster, läuft ein 5 Sekunden Zeitzähler ab. Innerhalb dieser Zeit prüft das Abgasmessgerät, ob die Leerlaufdrehzahl stabil ist und speichert sie. Es erscheint der Hinweis „Messwerte gespeichert“.

Hinweis:
Verlässt die Leerlaufdrehzahl das Fenster, wird der Zeitzähler neu gestartet.

Weitergehen zum Auslesen der Prüfbereitschaften

Drücken Sie die Pfeiltaste ⇨.

```
      ERGEBNIS PRUFBEREITSCHAFTTESTS
         Seite 1 (Steuergerät 1)
   ID                        Status   (n)iO
Komponenten umfassend  :   gesetzt      iO
Kraftstoff-System      :   gesetzt      iO
Verbrennungsaussetzer  :n.unterst.      iO
Abgasrückführung       :n.gesetzt      niO
O2-Sonden-Heizung      :   gesetzt      iO
O2-Sonden              :n.unterst.      iO
Klimaanlage            :   gesetzt      iO
Sekundärluft           :n.unterst.      iO

               SEITE 2 ▶
```

Beispiele Prüfbereitschaftstests (1)

```
      ERGEBNIS PRUFBEREITSCHAFTTESTS
         Seite 2 (Steuergerät 1)
   ID                        Status   (n)iO
Tankentlüftung         :n.gesetzt      niO
Katalysator-Heizung    :n.gesetzt      niO
Katalysator            :   gesetzt      iO

SEITE 1 ▲                       WEITER ▶
```

Beispiele Prüfbereitschaftstests (2)

Ergebnis Prüfbereitschaftstest

Die Prüfbereitschaft verschiedener abgasrelevanter Systeme wird vom Steuergerät ständig geprüft und gespeichert.
Diese Bildschirmseite zeigt die in der AU zu prüfenden Systeme an. Durch Drücken der Pfeiltasten können Sie zwischen den beiden Seiten mit den gelisteten Prüfbereitschaften wechseln.

Prüfbereitschaft nicht unterstützt

Modellspezifisch können bestimmte Prüfbereitschaften vom Fahrzeug nicht unterstützt werden. In diesem Fall wird **„n.unterst.“** in der entsprechenden Zeile angezeigt.

Prüfbereitschaft gesetzt

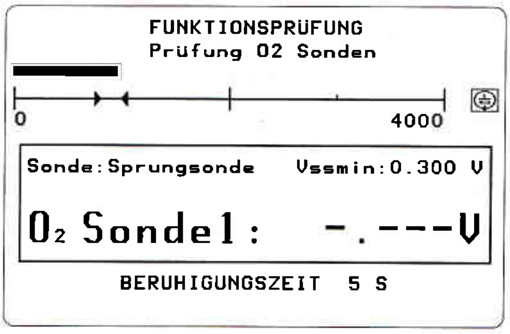
Die Anzeige **„gesetzt“** weist darauf hin, dass der Prüfbereitschaftstest für diese Baugruppe erfolgreich durchgeführt worden ist.
Wenn die unterstützten Prüfbereitschaften alle gesetzt sind, braucht kein Lambdatest durchgeführt werden. Der Lambdatest wird automatisch im Programm übergangen.

Prüfbereitschaft nicht gesetzt

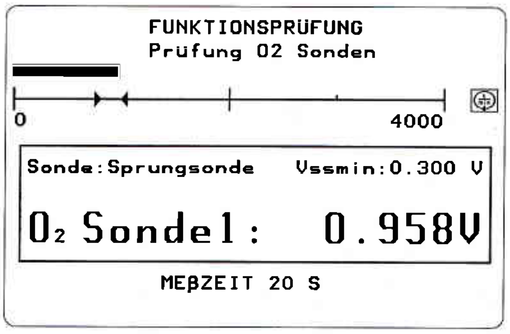
„N.gesetzt“ bedeutet, dass der Prüfbereitschaftstest für diese unterstützte Baugruppe nicht erfolgreich durchgeführt worden ist. Es ist ein Lambdatest erforderlich. Der Lambdatest wird automatisch vom Programm als letzter Funktionstest durchgeführt.

Prüfbereitschaftstest verlassen

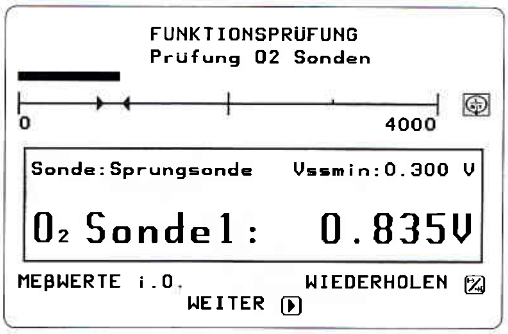
Sie können die Anzeige der Prüfbereitschaften durch Drücken der Pfeiltaste ⇨ auf der zweiten Seite verlassen. Hierdurch soll sichergestellt werden, dass auch wirklich alle Prüfbereitschaften angesehen wurden.
Das Programm geht abhängig vom Ergebnis der Prüfbereitschaftstest zur O2-Sondenprüfung oder zum Auslesen des Fehlerspeichers.



5 Sek. Beruhigungszeit



20 Sek. Messzeit



Messwerte gespeichert

Lambdasondenprüfung - Sprungsonde

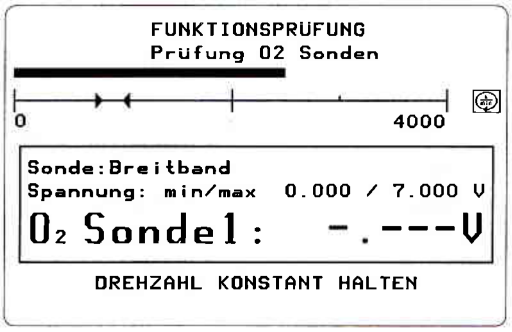
Lambdasondenprüfung nicht erforderlich
Wenn in den Prüfbereitschaftstests alle verfügbaren Prüfbereitschaften als gesetzt erkannt worden sind, braucht die Lambdasondenprüfung nicht durchgeführt zu werden. Das Programm überspringt die Prüfung automatisch geht direkt weiter zum Auslesen des Fehlerspeichers.

Testdurchführung
Auf der Bildschirmseite "Lambdasondenprüfung" wird die Motordrehzahl sowie die Lambdasondenspannung angezeigt. Alle Werte werden über den Scanner gemessen.
Wenn sich die Leerlaufdrehzahl im Drehzahlfenster befindet, läuft zunächst einmal ein 5 Sekunden Timer ab.
Nach Ablauf dieses Timers startet ein 20 Sekunden Timer, in der die eigentliche Messung des Lambdasondenhubs durchgeführt wird. Nach Ablauf des 20 Sekunden Timers werden die Messwerte gespeichert und die Mindestlambdaspannung in der Zeile „VSS Min“ angezeigt.

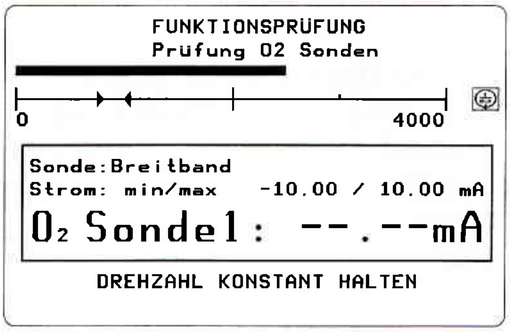
Zwei getrennte Abgassysteme prüfen
Hat das Fahrzeug zwei getrennte Abgassysteme, also 4 Lambdasonden, müssen zwei Prüfungen durchgeführt werden. Das Programm erkennt dies automatisch. Nach der Prüfung der ersten Sonde kann in diesem Fall "Nächste Sonde" angewählt werden.

Weitergehen zum Fehlerspeicherauslesen

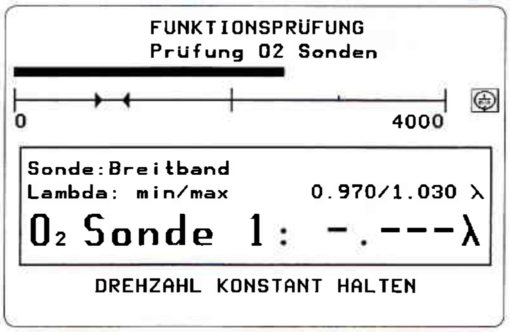
Drücken Sie die Pfeiltaste ⇨.



Breitbandsondenprüfung über Lambdaspannung



Breitbandsondenprüfung über Lambdastrom



Breitbandsondenprüfung über den berechneten Lambdawert

Lambdasondenprüfung Breitbandsonde

Lambdasondenprüfung nicht erforderlich

Wenn in den Prüfbereitschaftstests alle verfügbaren Prüfbereitschaften als gesetzt erkannt worden sind, braucht die Lambdasonden-Prüfung nicht durchgeführt zu werden. Das Programm überspringt die Prüfung automatisch und geht direkt weiter zum Auslesen des Fehlerspeichers.

Testdurchführung

Auf der Bildschirmseite "Lambdasondenprüfung" wird die Motordrehzahl sowie das bei der Solldateneingabe festgelegte Prüfkriterium angezeigt, also der berechnete Lambdawert, die Lambdaspannung oder der Lambdastrom. Alle Werte werden über den Scanner gemessen.

```
AUSLESEN DES FEHLERSPEICHERS

- Prüfung ob Fehlercodes
  vorhanden sind.

Anzahl der gespeicherten
Fehlercodes: Keine Fehlercodes
             in Speicher
             vorhanden.

                         WEITER
```

Auslesen des Fehlerspeichers, keine Kodes vorhanden

Fehlerspeicher auslesen

Nach dem Auslesen der Prüfbereitschaften bzw. Prüfen des O2-Sensors erfolgt das Auslesen des Fehlerspeichers des Steuergerätes. Die Anzahl der gespeicherten Fehlerkodes wird angezeigt.
Wenn keine Fehlerkodes vorhanden sind, können Sie direkt zum nächsten Programmschritt weitergehen.

```
AUSLESEN DES FEHLERSPEICHERS

- Prüfung ob Fehlercodes
  vorhanden sind.

Anzahl der gespeicherten
Fehlercodes: 5

                         WEITER
```

Auslesen des Fehlerspeichers, Kodes vorhanden

Anzeige der gespeicherten Fehlerkodes

Drücken Sie die Pfeiltaste ⇨. Die folgende Bildschirmseite zeigt Ihnen die P0-Codes und die Fehlercodeerklärung an.
Kodes, die mit P1... anfangen sind herstellerspezifisch und keine genormten Standardfehlerkodes. Die Kodes haben daher meistens keine Beschreibung in der AU-Prozedur.
Sind mehrere Fehlerkodes gespeichert, können Sie mit der Pfeiltaste ⇩ durch die Liste blättern.
Wenn keine Fehlercodes gesetzt sind, wird diese Bildschirmseite nicht angezeigt.

```
    FEHLERCODES IN SPEICHER
Code    Beschreibung
P0237:  Turbolader Druckgeber A,
        Spannung niedrig.

P0132:  Lambdasonde (Bank1, Sonde1)
        Spannung hoch.

       NÄCHSTE SEITE
                        WEITER
```

Anzeige der gespeicherten Fehlerkodes (Beispiel)

Weitergehen zur MI-Status Prüfung

Sie können diese Bildschirmseite durch Drücken der Pfeiltaste ⇨ verlassen. Das Programm geht weiter zur Bildschirmseite „Sichtprüfung MIL-Status".

```
SICHTPRÜFUNG MI

MIL Status = AUS
Überprüfen MI = AUS?

Bitte Taste drücken

NEIN                JA

ÜBERSPRINGEN
```

Sichtprüfung MIL bei laufendem Motor

Sichtprüfung MIL-Status

Auf dem Bildschirm erscheint der Hinweis „Bitte Motor starten". Befolgen Sie diese Anweisung. Es muss nun bei laufendem Motor noch einmal eine Sichtprüfung der MI-Lampe durchgeführt werden.

Prüfen Sie, ob die MI-Lampe jetzt aus ist. Bestätigen Sie dies durch Anwahl von „JA" oder „NEIN" durch Drücken der Pfeiltasten ⇦⇨.

Die Anwahl von „JA" oder „NEIN" hat keinen Einfluss auf den weiteren Ablauf, sondern auf die Beurteilung der AU-Prüfung im Protokollausdruck. Die nachfolgende Bildschirmseite zeigt Ihnen an, ob die MI-Lampe bzw. die Ansteuerung der MI-Lampe in Ordnung ist.

```
SICHTPRÜFUNG MI

Ergebnis:
MI-Lampe bzw. Ansteuerung
in Ordnung

WEITER
```

Ergebnis der MIL-Sichtprüfung o.k.

Weitergehen zur Ergebnisübersicht

Drücken Sie die Pfeiltaste ⇨. Das Programm geht weiter zur Ergebnisübersicht.

```
SICHTPRÜFUNG MI

Ergebnis:
MI Ansteuerung
In Ordnung.
Ein entsprechender
Fehlercode muß
vorhanden sein.

WEITER
```

Beispiel 1 MIL-Sichtprüfung fehlerhaft

```
SICHTPRÜFUNG MI

Ergebnis:
MI Ansteuerung
nicht in Ordnung
Anzeige defekt
(z.B. Leuchtmittel)

WEITER
```

Beispiel 2 MIL-Sichtprüfung fehlerhaft

```
ERGEBNISSEÜBERSICHT AU

Leerlaufdrehzahl                    i.O.
TL-Lambda und TL-CO                 i.O.
MIL Status                        n.i.O.
Ansteuerung MIL                     i.O.
Prüfbereitschafttests             n.i.O.
Prüfdrehzahl 02-Sensortest          i.O.
02-Sensortest                       i.O.
Fehlerspeicher                    n.i.O.

MESSUNGEN WIEDERHOLEN
FEHLERCODES                     AUSDRUCK
```

Ergebnisübersicht

```
ERGEBNISSEÜBERSICHT AU
Fehlercodes

Fehlercodes:
P0237: Turbolader Druckgeber A,
       Spannung niedrig.
P0132: Lambdasonde (Bank1, Sonde1)
       Spannung hoch.

MESSUNGEN WIEDERHOLEN
FEHLERCODES                     AUSDRUCK
```

Anzeige von Fehlercodes falls vorhanden

Anzeige der Ergebnisse/ Messungen wiederholen

Nach dem MI-Status wird zum Abschluss der AU die Bildschirmseite mit den Ergebnissen der Funktionstests angezeigt.
Falls Fehlerkodes vorhanden sind, können Sie diese durch Drücken der Pfeiltaste ⇩ aufrufen.

Durch Drücken der Taste Wiederholen haben Sie die Möglichkeit die Messungen zu wiederholen.

Weitergehen zum Protokollausdruck

Drücken Sie die Pfeiltaste ⇨ um zu den Vorbereitungsseiten für den Protokollausdruck weiter zu gehen.

```
VORBEREITUNG AUSDRUCK
Gesamtergebnis Prüfung :                 i.O.
Abweichungen/Erläuterungen :

123456789012345678901234567890123456
123456789012345678901234567890123456
123456789012345678901234567890123456

Prüfer     : 12345678901234567890
Plakette   : zugeteilt
Nächste AU: 12 / 2006

MENU                          AUSDRUCK
```

Vorbereitung Protokollausdruck

Protokollausdruck

Zur Komplettierung des AU-Programms müssen die Identifikationsdaten, die Solldaten, das Ergebnis der Sichtprüfungen, der Funktionstests und das Gesamtergebnis ausgedruckt werden.
Für den Ausdruck müssen der Name des Prüfers, die Gültigkeitsdauer der AU-Plakette und, wenn erforderlich, zusätzliche Erläuterungen eingegeben werden. Das Gesamtergebnis der Prüfung wird automatisch angezeigt.

Erläuterungen und Prüfername eingeben

Wenn erforderlich, können Sie zusätzliche Erläuterungen zum AU-Test eingeben.
Geben Sie den Prüfernamen ein. Der Prüfername bleibt bis zum Ausschalten des Geräts für alle weiteren AU's gespeichert, sofern er nicht verändert wird.

Plakette zuteilen

Es ist möglich, dass die AU-Prüfungen in Ordnung sind, die Plakette aber nicht zugeteilt werden kann. Dies ist z.B. der Fall, wenn das Fahrzeug mit rotem Kennzeichen ausgerüstet ist und die Plakette erst später zugeteilt werden kann. Über die Zuteilung der Plakette entscheidet einzig und allein der Prüfer.
Wählen Sie zwischen „Plakette zugeteilt“ und „Plakette nicht zugeteilt“ durch Drücken der Taste .

Gültigkeitsdauer der AU-Plakette

In der Zeile "Nächste AU" können Sie mit den numerischen Tasten die Gültigkeitsdauer der AU eingeben. Vorgegebener Standardwert ist das aktuelle Datum plus 2 Jahre.

```
VORBEREITUNG AUSDRUCK
Gesamtergebnis Prüfung :          i.O.
Abweichungen/Erläuterungen :

123456789012345678901234567890123456
123456789012345678901234567890123456
123456789012345678901234567890123456

Prüfer     : 12345678901234567890
Plakette   : zugeteilt
Nächste AU: 12 / 2006

BITTE WARTEN
```

Ausdruck in Arbeit

Protokollausdruck

Druckvorgang starten:
Setzen Sie den schwarzen Cursorbalken auf die Zeile „Protokollausdruck“ und bestätigen Sie die Anwahl durch Drücken der Pfeiltaste ⇨. Der Ausdruck erfolgt doppelt, so dass ein Exemplar für den Kunden und ein Exemplar für die Werkstatt zur Verfügung steht. Ein Beispiel finden Sie auf der nächsten Seite.
Manuelle Eingaben sind im Ausdruck mit "#" gekennzeichnet.

```
VORBEREITUNG AUSDRUCK
Anzahl der Ausdrucke :                  2x
Festgestellte Mängel nach Nr. 5 der
AU-Richtlinie wurden behoben: NEIN

Erkannte aber nicht behobene Mängel
nach Nr. 6 der AU-Richtlinie:
123456789012345678901234567890123456
123456789012345678901234567890123456
123456789012345678901234567890123456
123456789012345678901234567890123456
NÄCHSTES/VORHER. FELD ▲/▼
WEITER ▶
```

Vorbereitung Nachweis-Ausdruck

```
VORBEREITUNG AUSDRUCK
Anzahl der Ausdrucke :                  0x

MENU Shift ◀
```

Anwahl kein Nachweis-Ausdruck

Vorbereitung Ausdruck Prüfbescheinigung/Nachweis

Der Nachweis wird **ab 2006** der Standardausdruck sein. Die Entscheidung, ob ein Nachweis ausgedruckt wird oder ein herkömmlicher Protokollausdruck haben Sie in der Seite Sichtprüfung getroffen. Die Sichtprüfung Bauteile ist nicht Bestandteil eines Nachweises, wird nicht bewertet und nicht ausgedruckt.

Die Anwahl "nicht erforderlich - Nachweis" in der Sichtprüfung Bauteile hat dazu geführt, dass am Ende der AU auf der Seite "Vorbereitung Ausdruck" die Vorbereitungsseite für den Nachweis angezeigt wird.

Anzahl der Nachweise

Sie können durch Drücken der Taste ⊠ wählen, ob 0, 1, oder 2 Nachweise benötigt werden. Der Nachweis ist nur erforderlich, wenn das Fahrzeug für die Hauptuntersuchung (HU) zu einer Prüforganisation gefahren werden soll, also AU und HU nicht zur gleichen Zeit in ein und dem selben Betrieb durchgeführt werden.
Die Anwahl "0" wird benötigt wenn AU und HU gleichzeitig im gleichen Betrieb durchgeführt werden.

Mängelliste

Teil des Nachweises ist die Mängelliste. Es muss aus statistischen Gründen angegeben werden, ob Mängel nach Nummer 5 der AU-Richtlinie vor der Durchführung der AU-Prozedur beseitigt wurden. Wählen Sie hier "JA" oder "NEIN" durch Drücken der Taste ⊠ an.

Wenn Sie einen Nachweis ausdrucken, müssen Sie aus statistischen Gründen erkannte aber nicht behobenen Mängel nach Nummer 6 der AU-Richtlinie eintragen.

Weitergehen zum Protokollausdruck

Drücken Sie die Pfeiltaste ⇨ um zur nächsten Ausdruckseite weiter zu gehen.

```
VORBEREITUNG AUSDRUCK
Gesamtergebnis Prüfung :              i.O.
Abweichungen/Erläuterungen :

1234567890123456789012345678901234567890123456
1234567890123456789012345678901234567890123456
1234567890123456789012345678901234567890123456

Prüfer     : 12345678901234567890
Plakette   : zugeteilt
Nächste AU: 12 / 2006
        PRÜFER / PLAKETTE
ZURÜCK                          AUSDRUCK
```

Erläuterungen und Prüfername eingeben

Wenn erforderlich, können Sie zusätzliche Erläuterungen zum AU-Test eingeben.
Geben Sie den Prüfernamen ein. Der Prüfername bleibt bis zum Ausschalten des Geräts für alle weiteren AU's gespeichert, sofern er nicht verändert wird.

Plakette zuteilen

Es ist möglich, dass die AU-Prüfungen in Ordnung sind, die Plakette aber nicht zugeteilt werden kann. Dies ist z.B. der Fall, wenn das Fahrzeug mit rotem Kennzeichen ausgerüstet ist und die Plakette erst später zugeteilt werden kann. Über die Zuteilung der Plakette entscheidet einzig und allein der Prüfer.
Wählen Sie zwischen „Plakette zugeteilt“ und „Plakette nicht zugeteilt“ durch Drücken der Taste ☒.

Gültigkeitsdauer der AU-Plakette

In der Zeile "Nächste AU" können Sie mit den numerischen Tasten die Gültigkeitsdauer der AU eingeben. Vorgegebener Standardwert ist das aktuelle Datum plus 2 Jahre.

Nachweis ausdrucken

Starten des Druckvorgangs:
Drücken Sie die Taste "Drucken". Der Ausdruck erfolgt doppelt, so dass ein Exemplar für den Kunden und ein Exemplar für die Werkstatt zur Verfügung steht. Ein Beispiel finden Sie auf den folgenden Seiten.
Manuelle Eingaben sind im Ausdruck mit "#" gekennzeichnet.

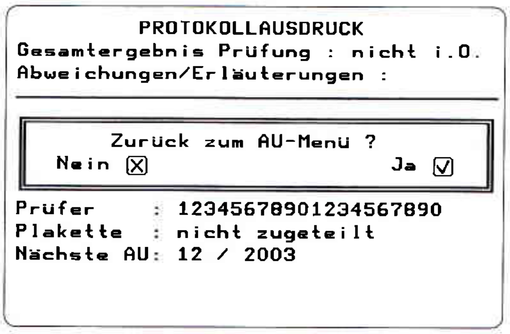
```
VORBEREITUNG AUSDRUCK
Gesamtergebnis Prüfung :              i.O.
Abweichungen/Erläuterungen :

1234567890123456789012345678901234567890123456
1234567890123456789012345678901234567890123456
1234567890123456789012345678901234567890123456

Prüfer     : 12345678901234567890
Plakette   : zugeteilt
Nächste AU: 12 / 2006

              BITTE WARTEN
```

Ausdruck in Arbeit



AU beenden

Beenden der AU GKAT mit OBD

Nach dem Protokollausdruck haben Sie die Möglichkeit durch Drücken der Tasten Shift und Pfeiltaste ⇦ die AU Prozedur zu verlassen. Es wird die Rückfrage "Zurück zum AU-Menü: Ja/Nein?" angezeigt.
Wenn Sie „JA“ anwählen, kehrt das Programm zum Menü „G-KAT mit OBD“ zurück. Es können dann einzelne Teile der AU wiederholt werden, eine neue AU durchgeführt werden oder zum Hauptmessbildschirm zurückgegangen werden.
Wenn Sie „NEIN“ wählen, kehrt das Programm zur Bildschirmseite „Protokollausdruck“ zurück und Sie können weitere Protokollausdrucke anfertigen.

Scanner vom Fahrzeug abklemmen

Schalten Sie nach Beendigung der AU-Prüfungen die Zündung aus.
Ziehen Sie das OBD-Adapterkabel aus der OBD-Diagnosesteckdose des Fahrzeugs.

Beispielausdrucke

DGA-1800
X4.52 Leitf V3
AU nach § 47a StVZO
G-KAT mit OBD
PDL-1000 OBD PRIMARY V5.3
Datum: 08. April 2005 Zeit: 12:45

1
2
3
4
5
6
7
8

- Kennzeichen	:	ME-FW 567
- Kilometerstand	:	123456
1 Emissionsschlüsselnummer	:	1234
2 Fahrzeug Hersteller	:	VW
2 Hersteller Schlüsselnr.	:	1234
3 Fahrzeugtyp/Ausführung	:	Passat
3 Fahrzeug Schlüsselnummer	:	123XXX
4 Fahrzeugidentnummer	:	ABCDEFG1234567890
- Kraftstoffart	:	BENZIN

Soll/Ist-Vergleich	min	ist	max	
Motortemperatur [°C]	60	69		iO
Auspuff links				
TL-Drehzahl [1/min]	1800	2921	3000	iO
TL-CO-Wert [% vol]		0.00	0.20	iO
TL-Lambda-Wert	0.970	1.000	1.030	iO
Auspuff rechts				
TL-Drehzahl [1/min]	1800	2407	3000	iO
TL-CO-Wert [% vol]		0.00	0.20	iO
TL-Lambda-Wert	0.970	1.000	1.030	iO
LL-Drehzahl [1/min]	750	897	980	iO

Prüfbereitschafttests	ECU1	ECU2	ECU3	ECU4	ECU5	ECU6
Komponenten umfassend	ges					
Kraftstoff-System	ges					
Verbrennungsaussetzer	ges					
Abgasrückführung	nunt					
O2-Sonden-Heizung	ges					
O2-Sonden	ges					
Klimaanlage	nunt					
Sekundärluft	nunt					
Tankentlüftung	ges					
Katalysator-Heizung	nunt					
Katalysator	ges					

Unterstützt: 11101100101
Gesetzt: 00000000000

Alle Systemtests durchgeführt.

GKAT mit OBD Protokollaus-

Fehlerspeicher
Anzahl der Fehler: 0

Bewertung

Sichtprüfung Bauteile	:	in Ordnung #
Sichtprüfung MIL	:	in Ordnung #
Soll/Ist-Vergleich	:	in Ordnung
Fehlerspeicher	:	in Ordnung
Ansteuerung MIL	:	in Ordnung #
Status MIL	:	in Ordnung

OBD-INFO:
- OBD Version : - EOBD
- Protokoll : - ISO 14230-4

Gesamtergebnis : in Ordnung

Plakette nach Anlage IXa zugeteilt. #

ABWEICHUNGEN/ERLÄUTERUNGEN

1234
abcd
ABCD

Kontrollnummer nach § 47b	:	9
Prüfer	:	WEGENER
Nächste AU	:	4 / 2007

Unterschrift der verantwortlichen Person: ....

Hinweise zum Ausdruck

*
Messwert nicht aufgenommen oder fehlerhaft.

#
Manuell eingegebener Wert.

Beispielausdrucke

DGA-1800
X4.52 Leitf V3
Nachweis der AU
G-KAT mit OBD
PDL-1000 OBD PRIMARY V5.3

Datum: 08. April 2005 Zeit: 12:56

1
2
3
4
5
6
7
8

- Kennzeichen	:	ME-FW 567
- Kilometerstand	:	123456
1 Emissionsschlüsselnummer:		1234
2 Fahrzeug Hersteller	:	VW
2 Hersteller Schlüsselnr.	:	1234
3 Fahrzeugtyp/Ausführung	:	Passat
3 Fahrzeug Schlüsselnummer:		123XXX
4 Fahrzeugidentnummer	:	ABCDEFG1234567890
- Kraftstoffart	:	BENZIN

Soll/Ist-Vergleich	min	ist	max	
Motortemperatur [°C]	60	84		iO
TL-Drehzahl [1/min]	1800	2261	3000	iO
TL-CO-Wert [% vol]		0.00	0.20	iO
TL-Lambda-Wert	0.970	1.000	1.030	iO
LL-Drehzahl [1/min]	720	748	850	iO

Prüfbereitschafttests	ECU1	ECU2	ECU3	ECU4	ECU5	ECU6
Komponenten umfassend	ges					
Kraftstoff-System	ges					
Verbrennungsaussetzer	ges					
Abgasrückführung	nunt					
O2-Sonden-Heizung	nges					
O2-Sonden	nges					
Klimaanlage	nunt					
Sekundärluft	nunt					
Tankentlüftung	nges					
Katalysator-Heizung	nunt					
Katalysator	nges					

Unterstützt: 11101100101
Gesetzt: 00001100101

Nicht alle Systemtests durchgeführt.

O2-Sonden Prüfung	min	ist	max	
Unterstützte Regelsonde:	Breitbandsonde			
Drehzahl [1/min]:	720	744	850	iO
Sonde 1 [mA]:	-0.120	-0.007	0.120	iO

Fehlerspeicher
Anzahl der Fehler: 0

Bewertung		
Sichtprüfung MIL	:	in Ordnung #
Soll/Ist-Vergleich	:	in Ordnung
Prüfung O2 Sonden	:	in Ordnung
Fehlerspeicher	:	in Ordnung
Ansteuerung MIL	:	in Ordnung #
Status MIL	:	in Ordnung

OBD-INFO:
- OBD Version : - EOBD
- Protokoll : - ISO 14230-4

Gesamtergebnis : in Ordnung

Plakette nach Anlage IXa zugeteilt. #

Mängel nach Nr.5 der AU Richtlinie (Mängel-Nr.813) :

Festgestellte Mängel wurden behoben: [ ] ja

[X] nein

Erkannte aber nicht behobene Mängel nach Nr.6 der AU-Richtlinie:

ABWEICHUNGEN/ERLÄUTERUNGEN

Kontrollnummer nach § 47b	:	9
Prüfer	:	WEGENER
Nächste AU	:	4 / 2007

Unterschrift der verantwortlichen Person: ....

GKAT mit OBD Nachweis

Hinweise zum Ausdruck

*
Messwert nicht aufgenommen oder fehlerhaft.

#
Manuell eingegebener Wert.

```
MENÜ GKAT mit OBD

1 Fahrzeugidentifikation
2 Solldateneingabe
3 Sichtprüfung
4 Abgas- und Funktionsprüfung
5 Kontrollmodus GKAT mit OBD

AU-PROGRAMME ◄               ZAHL AUSWÄHLEN
```

Hauptmenü "GKAT mit OBD"

```
GKAT MIT OBD KONTROLLMODUS
                        LL          TL
Drehzahl 1/min         825        2750
λ                    1.005       1.006
CO       % vol        0.05        0.03
CO2      % vol        8.02        7.99
HC     ppm vol           6          11
O2       % vol        0.10        0.11

Wcv 0.0000    Ocv 0.0175    Hcv 1.7261
K      3.5    K1       6

MENÜ ◄                        AUSDRUCK
```

Kontrollmodus

Kontrollmodus GKAT mit OBD

Der Kontrollmodus ist ein vom Gesetzgeber gefordeter Programmteil. Er ermöglicht dem Prüfer die Kontrolle des im AU-Programm ermittelten Lambdawertes mit Hilfe der "Brettschneider"-Formel.

Das Programm "Kontrollmodus" kann nur aufgerufen werden, wenn **vorher** eine AU 2 GKAT mit OBD durchgeführt worden ist.

Ist das der Fall, kann der Kontrollmodus aus dem Hauptmenü "GKAT mit OBD" angewählt werden.

Der Bildschirm zeigt alle zur Berechnung notwendigen Daten.

Die Daten bestehen zum einen aus Messwerten, die während der AU Tests gemessen wurden, zum anderen aus Konstanten, die zur Lambdaberechnung nach der "Brettschneider"-Formel benötigt werden.

Hinweis:
Beachten Sie bei der Berechnung, dass HC in ppm (parts per million) gemessen wird, aber als Prozentwert in die Formel eingesetzt werden muss, z.B. 20 ppm = 0.0020%.

Kontrollmodus-Werte drucken

Die Messwerte, die Konstanten und die Identifizierungsdaten des Fahrzeugs können durch Drücken der Druckertaste ausgedruckt werden.

Kontrollmodus verlassen

Durch Drücken der Pfeiltaste "⇦" kann der Kontrollmodus wieder verlassen werden. Das Programm geht zum Menü GKAT mit OBD zurück.

AU 2 für Diesel Fahrzeuge mit OBD-System

Die AU Dieselfahrzeuge und OBD-Diagnoseschnittstelle besteht aus den folgenden Programmteilen:

- Fahrzeugidentifikation
- Solldateneingabe
- Sichtprüfung
- Funktionsprüfung
- Protokollausdruck

AU Hauptmenü

Programmanwahl

Wählen Sie aus dem Programmmenü den Menüpunkt „AU nach § 47a StVZO“ an.

Wählen Sie aus dem AU-Hauptmenü das Programm „Diesel mit OBD“ an. Es wird das Hauptmenü des Programms "Diesel mit OBD" angezeigt.

Hauptmenü Diesel mit OBD

Hauptmenü Diesel mit OBD

Vom EOBD-AU-Hauptmenü ausgehend können Sie alle zur Durchführung der AU erforderlichen Programmschritte anwählen. Starten Sie mit dem Programmpunkt "1 Fahrzeugidentifikation".
Die Menüpunkte können Sie jederzeit nochmals aufrufen, um z.B. Identifikations- oder Solldaten zu ändern, oder, um die Messungen zu wiederholen.

Fahrzeugidentifikationsseite 1

Fahrzeugidentifikation

Voraussetzung für die AU ist eine den gesetzlichen Bestimmungen entsprechende Fahrzeugidentifikation vor jeder Messung. Die Identifikationsdaten können entweder manuell eingegeben werden oder werden größtenteils bei der Fahrzeuganwahl übernommen, wenn Sie mit den fahrzeugspezifischen AU-Solldaten arbeiten (siehe Kapitel „Allgemeine Programmhinweise zur AU/Diskettenfunktionen“).

Anwahl der Fahrzeugidentifikation

Wählen Sie den im Hauptmenü "Diesel mit OBD" den Menüpunkt „Fahrzeugidentifikation“.

Eingabe der Identifikationsdaten auf Seite 1

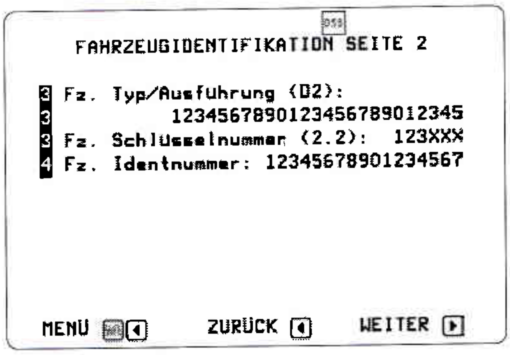
Folgende Daten müssen zur Identifizierung des Fahrzeugs eingegeben werden:
- Kennzeichen
- Kilometerstand

Aus dem Kraftfahrzeugschein:
- Erstzulassung
- Emmissionschlüsselnummer (vierstellig)
- Herstellerschlüsselnummer
- Fahrzeughersteller

Auf dem Bildschirm wird vor jeder Zeile die Feldnummer angegeben, in der die jeweiligen Daten im Kraftfahrzeugschein zu finden sind. Feldnummer für den neuen KfZ-Schein stehen in Klammern dahinter.

Dieselfahrzeuge Erstzulassung

Es wird unterschieden, ob das Fahrzeug vor oder nach dem 1.6.2006 zugelassen worden ist. Ab dem 1.6.2006 gilt ein neuer Standardwert für die K-Werte: 1,5 anstelle von bisher 2,5.



Fahrzeugidentifikationsseite 2

Eingabe der Identifikationsdaten auf Seite 2

Aus dem Kraftfahrzeugschein:

- Fahrzeugtyp/Ausführung
- Fahrzeugschlüsselnummer (erste drei Ziffern)
- Fahrzeugidentnummer

Hinweis:
Beachten Sie zur Dateneingabe, wenn erforderlich, das Kapitel "Bedienung/Dateneingabe in den AU-Programmen“ in der Basisanleitung.

Weitergehen zur Solldatenseite 1

Drücken Sie die Pfeiltaste ⇨.

Rückkehr zum Menü „Diesel mit OBD“

Drücken Sie die Tasten Shift und Pfeiltaste ⇦.

Hinweis:
Wird die Fahrzeugidentifikation erneut aufgerufen, werden - falls schon durchgeführt - das Ergebnis der Sichtprüfung und die Messergebnisse gelöscht.

Hauptmenü Diesel mit EOBD

Solldateneingabe

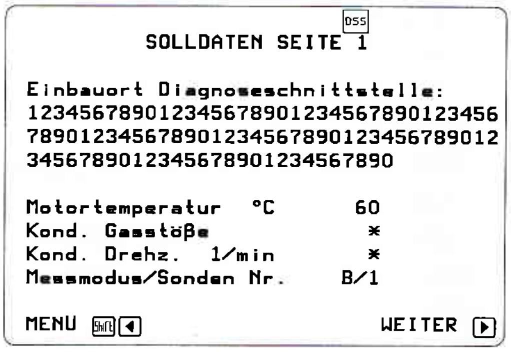
Das Programm „Solldateneingabe" dient:

- zur Eingabe und Kontrolle der Solldaten des zu testenden Fahrzeugs
- zur Eingabe von Testbedingungen, die dem Messgerät eine Bewertung der Messergebnisse ermöglichen
- zur Anpassung des Prüfablaufs an den Fahrzeugtyp

Die Solldaten bzw. Testbedingungen können entweder manuell eingegeben werden oder werden bei der Fahrzeuganwahl übernommen, wenn Sie mit den AU-Solldaten arbeiten. Die Solldateneingabe ist auf mehrere Bildschirmseiten verteilt.

Anwahl der Solldateneingabe

Vor der Solldateneingabe muss eine Fahrzeugidentifikation durchgeführt worden sein. Wählen Sie den Menüpunkt „Solldateneingabe" im Menü „Diesel mit OBD" mit der Enter-Taste an. Bestätigen Sie die Anwahl durch Drücken der Pfeiltaste ⇨.



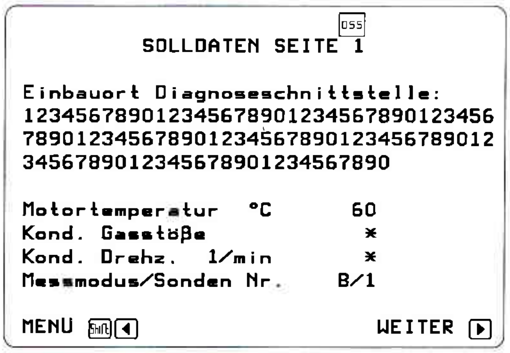
Solldatenseite 1

Solldateneingabe durchführen

Es erscheint zunächst die Solldatenseite 1, auf der entweder die Standardsollwerte oder die aus dem Speicher geladenen AU-Solldaten angezeigt werden. Prüfen Sie diese Werte noch einmal und passen Sie sie ggfs. den Herstellervorgaben an.

Hinweis:
Wird die Solldateneingabe erneut aufgerufen, werden das Ergebnis der Sichtprüfung und die Messergebnisse gelöscht.

Hinweis:
Hinweise zur Dateneingabe finden Sie im Basishandbuch im Kapitel "Allgemeine Programmhinweise zur AU 2/Hinweise zur Dateneingabe".



Solldatenseite 1

Solldateneingabe Seite 1

Folgende Sollwerte bzw. Testbedingungen müssen eingegeben werden:

- Einbauort der Diagnoseschnittstelle (Info wird aus der Solldatendiskette ausgelesen, wenn mit Solldaten gearbeitet wird.)
- Motortemperatur
- Konditionierungsdrehzahl und -zeit
- Messmodus und Sondenart

Solldateneingabe Öltemperatur

Der gesetzlich vorgeschriebene Mindestsollwert für die Öltemperatur beträgt 60°C. Der Hersteller kann in seinen Sollwerten einen anderen Wert festlegen. Die Messung erfolgt ausschließlich über den Scanner basierend auf den Daten, die das Motorsteuergerät zur Verfügung stellt.

Konditionierungsgasstöße

Die Konditionierungsgasstöße dienen zur Beseitigung von Ablagerungen und Rückständen im Verbrennungsraum und in der Abgasanlage. Einige Fahrzeughersteller haben die Konditionierungsgasstöße als festen Bestandteil in die Diesel-AU aufgenommen (z.B. BMW und Mercedes). In den Sollwerten ist die Anzahl der Gasstöße und die Prüfdrehzahl angegeben.
Grundsätzlich ist das Durchführen von Konditionierungsgasstößen auch an Fahrzeugen ohne Sollwertvorgabe empfehlenswert.
Ist der Eintrag für die Anzahl der Gasstöße ein Stern, wird das Konditionierungsprogramm im Programmablauf übergangen.

Meßmodus (A, B)
Die richtige Anwahl des Meßmodus ist erforderlich, um ein aussagefähiges Meßergebnis zu erhalten.
Der Meßmodus wurde vom Hersteller fahrzeugspezifisch ermittelt und muß in den Sollwerten angegeben werden.
Im Meßmodus "B" arbeitet das Meßsystem mit einer stärkeren Dämpfung (Hartrigde) als in Modus "A". Die Meßrate ist kleiner und der Trübungsmeßwert somit unterschiedlich zum Modus "A" .
Der gewählte Modus wird im Ausdruck protokolliert.

Meßsonde
Um korrekte Meßergebnisse zu erhalten, muß die richtige Sonde angewählt und verwendet werden:
1 Auspuffendrohr bis 70 mm Durchmesser = PKW-Sonde (10 mm Innendurchmesser)
2 Auspuffendrohr über 70 mm Durchmesser = LKW-Sonde (27 mm Innendurchmesser)

Anwahl von Meßmodus / Meßsonde
Die Anwahl des Meßmodus und der Meßsonde erfolgt durch Drücken der Taste ☒ .
Die Wahl wird im Ausdruck protokolliert!

Weitergehen zur Solldatenseite 2
Drücken Sie die Pfeiltaste ⇨.

Solldatenseite 2

Solldateneingabe Seite 2

Die Bildschirmseite „Solldatenseite 2“ kann nur von der Seite „Solldatenseite 1“ ausgehend aufgerufen werden.
Folgende Werte müssen eingegeben werden:

- Leerlaufdrehzahl
- Abregeldrehzahl
- Abregelzeitraum
- Messzeitanteil Tx
- Trübungswert k
- Anzahl der Abgasstränge

LL-Drehzahl (Leerlaufdrehzahl)
Die Leerlaufdrehzahl muß vom Fahrzeughersteller in den Sollwerten angegeben werden.

AR-Drehzahl (Abregeldrehzahl)
Die Abregeldrehzahl muß vom Fahrzeughersteller in den Sollwerten angegeben werden.

AR-Zeit (Abregelzeitraum)
Der Abregelzeitraum muß vom Fahrzeughersteller in den Sollwerten vorgegeben werden. Sie gibt an, wie lange das Gaspedal bei der Abregeldrehzahlmessung durchgetreten werden muß. Es ist eine Eingabe bis 5.0 Sekunden möglich.

Trübungswert (k-Wert)
Der Trübungswert "k" muß in Verbindung mit dem Meßmodus vom Fahrzeughersteller vorgegebenen werden. Sind keine Sollwerte vorhanden, ist im Meßmodus "B" ein k-Wert von max. 2,5 1/m vom Gesetzgeber vorgeschrieben.

Anzahl der Abgasstränge
Wählen Sie mit der Taste an, ob das Fahrzeug einen Abgasstrang oder 2 völlig getrennte Abgasstränge hat.
Wenn Sie "2" anwählen werden Sie im Laufe der AU Prozedur softwaregeführt aufgefordert die Abgasmessungen für das zweite System zu wiederholen.

Meßzeitanteil tx

Der Meßzeitanteil muß vom Fahrzeughersteller in den Sollwerten angegeben werden. Er gibt an, wie lange der Motor bei den Beschleunigungsmessungen auf der Abregeldrehzahl gehalten werden muß.

Grundsätzlich ist die vom Gesetzgeber vorgeschriebene Haltezeit von einer Sekunde im Gerät vorprogrammiert. Der Fahrzeughersteller hat dies in seiner Sollwertvorgabe zu berücksichtigen (z.B. Sollwert 0,5 = 1,5 tx).

Hinweis:
Die Bildschirmseite kann nur verlassen werden, wenn plausible Eingaben in allen Feldern gemacht werden.

Umschalten zwischen den Solldatenseiten 1 + 2

Zwischen den Solldatenseiten 1 und 2 kann mit den Pfeiltasten entsprechend den Bildschirmanweisungen umgeschaltet werden.

Identifikations- und Solldaten speichern

Nachdem alle Daten eingegeben und kontrolliert worden sind, empfiehlt es sich, die Identifikationsdaten zusammen mit den Solldaten durch Drücken der Taste ⊖ auf einer **JOB**-Diskette zu speichern.

Die Daten stehen dann bei der nächsten AU wieder zur Verfügung und brauchen nicht erneut eingegeben werden (s. Kapitel Diskettenfunktionen AU 2 im Basishandbuch).

Weitergehend zur Sichtprüfung

Wenn Sie im AU-Programmablauf weitergehen möchten, können Sie direkt die Sichtprüfung anwählen. Drücken Sie hierzu die Pfeiltaste ⇨.

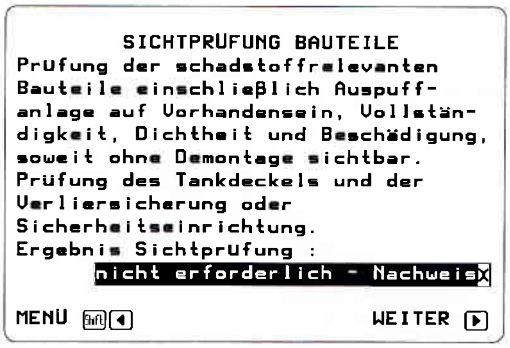
Hauptmenü Diesel mit EOBD

Sichtprüfung Bauteile

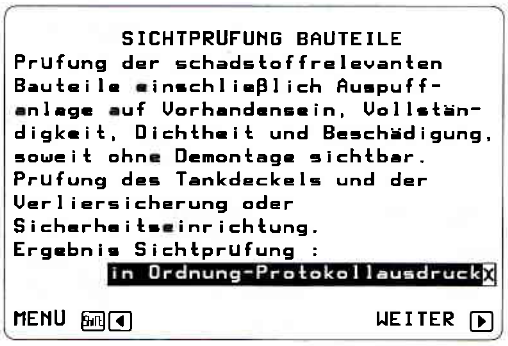
Das Programm "Sichtprüfung Bauteile" dient zur Beurteilung von Baugruppen, die einen Einfluß auf die Schadstoffzusammensetzung des Abgases haben.
Die Beurteilung erfolgt durch eine Sichtprüfung, wobei das Fahrzeug z.B. zur Prüfung der Abgasanlage (Auspuff, Katalysator und Lambdasonde) gegebenenfalls angehoben werden muß oder die Prüfung über einer Grube erfolgen muß.
Es brauchen nur solche Baugruppen beurteilt werden, die ohne Demontage sichtbar sind.

Anwahl der Sichtprüfung

Vor der Sichtprüfung muß das Fahrzeug identifiziert und die Solldaten eingegeben worden sein. Das Programm "Sichtprüfungen" erreicht man anschließend durch Eingabe einer "3" im Menü "Diesel mit OBD" oder durch Befolgen der "Weiter"-Anweisungen in der "Solldaten-eingabe".



Durchführung der Sichtprüfung für Nachweis



Durchführung der Sichtprüfung für Protokollausdruck

Auswahl Protokollausdruck/Nachweis

WICHTIG!

Ab 1.1.2006 wird im Rahmen der Zusammenlegung von HU und AU der Protokollausdruck durch einen gedruckten Nachweis abgelöst. Für den Nachweis ist die Sichtprüfung Bauteile nicht mehr erforderlich. Es stehen daher drei Auswahlmöglichkeiten zur Verfügung:

- nicht erforderlich Nachweis
Anzuwenden ab 1.1.2006. Diese Anwahlmöglichkeit ist daher schon jetzt die Standardeinstellung. Es wird der neue Nachweis am Ende der AU ausgedruckt.

- in Ordnung Protokollausdruck
Es wird der herkömmliche Protokollausdruck am Ende der AU ausgedruckt.

- nicht in Ordnung Protokollausdruck
Es wird der herkömmliche Protokollausdruck am Ende der AU ausgedruckt.

Durchführung der Sichtprüfung

Die Baugruppen müssen am Fahrzeug beurteilt und das Ergebnis durch Betätigen der Taste [X] eingeben werden.

Hinweis:
Wird die Sichtprüfung erneut aufgerufen, wird das Ergebnis der vorherigen Sichtprüfung gelöscht und muß neu eingegeben werden. Die Ergebnisse der Messungen werden ebenfalls gelöscht.

Weitergehen zur Sichtprüfung MI

Durch Drücken der Pfeiltaste "rechts" kann zur Fortsetzung der AU 2 mit dem Programm "Sichtprüfung MI" fortgefahren werden.

Hauptmenü Diesel mit OBD

Funktionsprüfungen/Messungen

Einleitung

Die Funktionsprüfungen dienen zur Durchführung der für die AU 2 notwendigen Messungen und Prüfungen entsprechend den gesetzlichen Vorschriften. Die Prüfungen beinhalten folgende Tests:

- Sichtprüfung MI-Lampe
- Motorkonditionierung (Öltemp.-Messung)
- Leerlaufdrehzahlmessung
- Abregeldrehzahlmessung
- (Konditionierungsgasstößen (falls erforderlich)
- Beschleunigungsmessungen
- Kontrolle der Prüfbereitschaften
- Kontrolle der Fehlerkodes
- Sichtprüfung MI-Lampe Status

Am Ende der Funktionsprüfungen ist das Druckerprogramm integriert.

Funktionen/Messungen anwählen

Voraussetzung zur Anwahl des Messprogramms ist, dass zuvor die "Fahrzeugidentifikation", die "Solldateneingabe" und die "Sichtprüfung" durchgeführt wurden!

Wählen Sie den Menüpunkt "Abgas- und Funktionsprüfung" im Menü "Diesel mit OBD" an. Es besteht auch die Möglichkeit, auf der Bildschirmseite "Sichtprüfung" durch Anwahl von "Weiter" direkt zu den Funktionsprüfungen zu gehen.

Wiederholen der Funktionsprüfungen:
Achten Sie darauf, dass beim Wiederholen der Funktionsprüfungen der Scanner richtig angeschlossen und die Zündung eingeschaltet ist.

Aufnahme der Messwerte und Daten

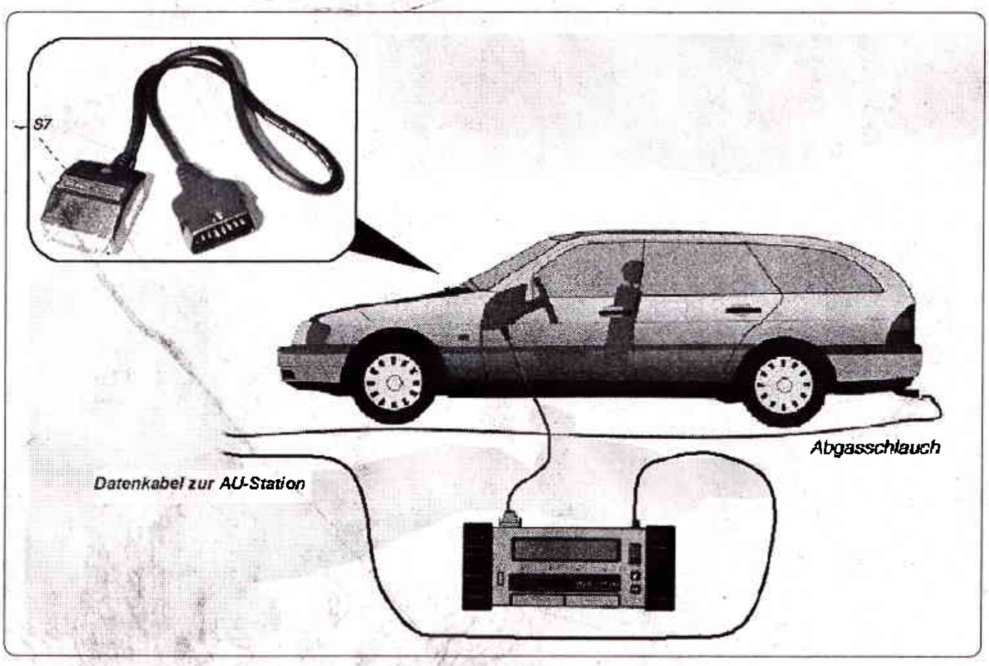
Die Aufnahme der Messwerte bei einem EOBD Fahrzeug erfolgt ausschließlich über den Scanner und die OBD-Diagnoseschnittstelle. Nur die Abgasmeßsswerte werden auf herkömmliche Weise über das Auspuffendrohr gemessen.
Der erste Schritt der Funktionsprüfungen ist daher der Anschluss des Scanners an das Fahrzeug.

Scanner an das Fahrzeug anschließen

- Stellen Sie sicher, dass das Scannermodul mit der EOBD-Software im Scanner eingesteckt ist.

- Schließen Sie das Kommunikationskabel des Scanners an den seriellen Anschluss des Scanners an. Dieser Anschluss befindet sich rechts oben auf dem Scanner.

- Schließen Sie den 9-poligen Stecker des 'Kommunkationskabels an den seriellen Anschluss des DGA 1800 an. Der Anschluss befindet sich ganz rechts auf der Geräterückseite ("C").



erforderliche Anschlüsse

- Schließen Sie das Diagnosekabel des Scanners an die OBD-Diagnosedose des Fahrzeugs an.
  Üblicherweise benötigen Sie hierzu das Adapterkabel mit dem DL 16 Diagnosestekker sowie den Identifizierungsschlüssel S7. Statt Stecker und Schlüssel kann auch der CAN-Adapter verwendet werden.

Scanner Bedienung

Nach dem Anschluss des Scanners an das Fahrzeug wird auf dem Scannerdisplay die Liste mit den Fahrzeugherstellern angezeigt.

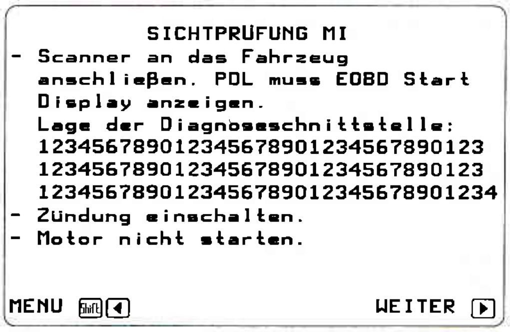
```
-> ALFA/FIAT/LANCIA
   BMW
   CITROEN
   EOBD
```

Wählen Sie mit dem Rändelrad "EOBD" an. Bestätigen Sie die Anwahl durch Drücken der Y-Taste auf dem Scanner. Auf dem Scannerdisplay wird die EOBD Softwareversion angezeigt.

Der Scanner braucht jetzt nicht mehr bedient werden!

```
-> GENERERIC OBDII EOBD   (DEUTSCH)        V5.3

DRÜCKE Y FÜR WEITER.
N DRÜCKEN FÜR HILFE.
```



Sichtprüfung MI-Lampe

MI Beurteilung

MI fehlerhaft

Sichtprüfung MI-Lampe

Prüfen Sie, ob bei eingeschalteter Zündung (Motor AUS) die Motorkontrollleuchte im Armaturenbrett des Fahrzeugs leuchtet. Üblicherweise handelt es sich um ein gelb hinterleuchtetes Motorsymbol.

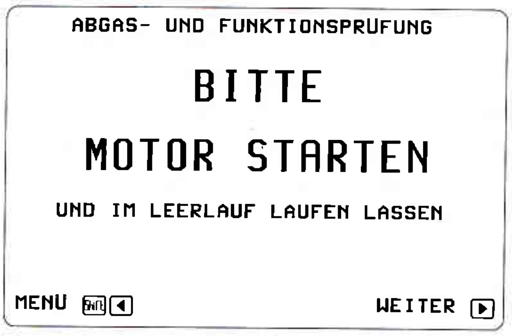
Hinweis:
Bei einigen Fahrzeugen erlischt die MI-Lampe wenige Sekunden nach dem die Zündung eingeschaltet wurde.

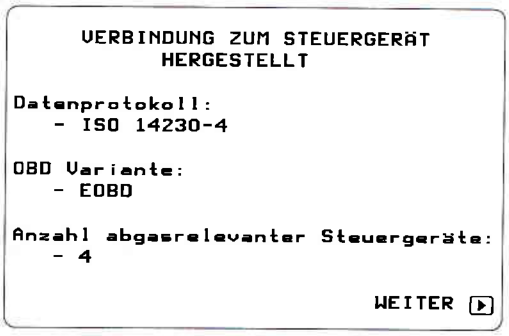
Wählen Sie durch Drücken der Pfeiltaste ⇦⇨, ob die MI-Lampe leuchtet oder nicht.

Beurteilen Sie die MI-Lampe als fehlerhaft, wird nebenstehende Meldung angezeigt.

Weitergehen zum Aufbau der Datenkommunikation

Drücken Sie die Pfeiltaste ⇨.





Datenkommunikation zum Steuergerät wurde erfolgreich aufgebaut

Datenkommunikation aufbauen

Starten Sie den Motor sobald nebenstehende Meldung angezeigt wird und lassen Sie den Motor im Leerlauf laufen.
Drücken Sie die Pfeiltaste ⇨.

Das Abgasmessgerät versucht, über den Scanner eine Datenkommunikation zum Steuergerät des Fahrzeugs aufzubauen.
In dieser Zeit erscheint der Schriftzug „Bitte warten“ auf dem Bildschirm des Abgasmessgerätes. Der Kommunikationsaufbau dauert fahrzeugabhängig ca. 5 bis 10 Sekunden.

Nachdem die Kommunikation zwischen dem DGA und dem Scanner aufgebaut worden ist, wird auf dem Scannerdisplay:

„Kommunikation aufgebaut“

angezeigt. Die roten LEDs 1 und 2 auf der Frontseite blinken abwechselnd, wenn die Kommunikation zum Fahrzeug aufgebaut worden ist.
Das Abgasmessgerät wechselt zur nächsten Bildschirmseite. Das Datenprotokoll, mit dem das Steuergerät im Fahrzeug seine Daten ausgibt wird angezeigt. Dies ist eine Information, die im AU-Protokoll ausgedruckt wird.

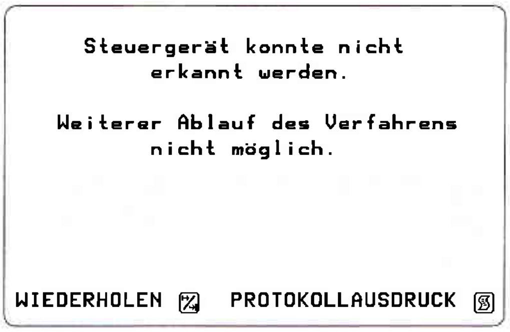
Zusätzlich wird die Anzahl der gefundenen Steuergeräte angezeigt, die abgasrelevante Diagnosedaten liefern.

Weitergehen zur Motortemperaturmessung

Drücken Sie die Pfeiltaste ⇨.

Wiederholen des Kommunikationsaufbaus

Wenn es erforderlich sein sollte, können Sie auf dieser Bildschirmseite noch einmal den Aufbau der Datenkommunikation starten. Drücken Sie dazu die Taste "Wiederholen".

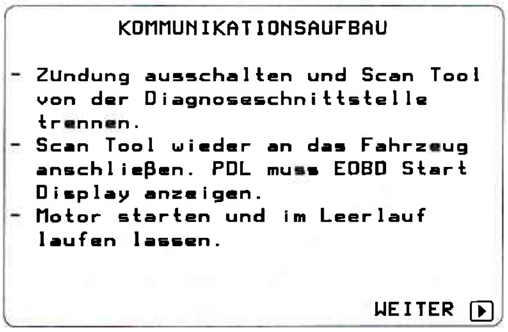


Datenkommunikation zum Steuergerät konnte nicht aufgebaut werden.

Datenkommunikation wird nicht aufgebaut

Wenn nach einigen Sekunden kein Fortschritt im Programm zu erkennen ist, können Sie den Aufbau der Datenkommunikation erneut starten. Drücken Sie dazu die Taste "Wiederholen".

Wenn das Steuergerät nicht erkannt werden kann, erscheint ein Hinweis auf dem Bildschirm und ein weiterer Ablauf des Verfahrens ist nicht möglich.
Sie können hier die AU durch Drücken der Druckertaste protokolliert abbrechen oder durch Anwahl des Symbols „Wiederholen“ versuchen, die Kommunikation neu zu starten. Folgen Sie den Anweisungen auf dem Bildschirm.



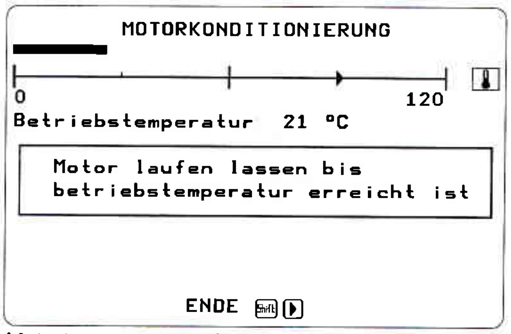
Prozedur zum erneuten Kommunikationsaufbau

Folgen Sie den Anweisungen auf dem Bildschirm. Prüfen Sie, ob Sie die Voraussetzungen zum Aufbau der Datenkommunikation erfüllt haben:

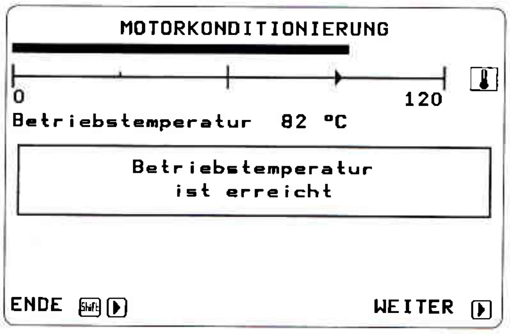
- Kommunikationskabel angeschlossen
- Diagnosekabel angeschlossen
- Zündung eingeschaltet
- Zeigt das Scanner Display das EOBD Menü
- Baudrate im Scanner 19200 Baud

Manuelles Einstellen der Baudrate 19200

Die Baudrate wird normalerweise automatisch gesetzt. Prüfen Sie im Problemfall die Einstellung im Scanner: Hauptmenü / Anwendersetup / Kommunikationssetup / 19200 Baud / N-Taste



Motortemperatur noch nicht erreicht



Motortemperatur erreicht

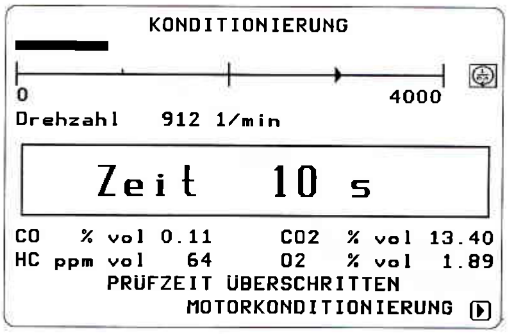
Motortemperaturmessung

Die Anweisungen auf dieser Bildschirmseite dienen zur Prüfung, ob der Motor die in den Solldaten vorgegebene Betriebstemperatur erreicht hat. Die Messung erfolgt über den Scanner (PDL 1000/2000).

Lassen Sie den Motor laufen bis die Betriebstemperatur erreicht ist. Nach dem Erreichen der Temperatur wird eine entsprechende Meldung angezeigt und das Programm geht nach einigen Sekunden automatisch weiter zu den Drehzahlmessungen.

Weitergehen zum nächsten Test

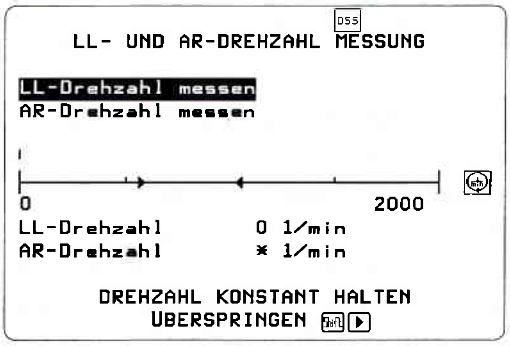
Drücken Sie zum Weitergehen die Pfeiltaste ⇨. Nach ein paar Sekunden geht das Programm auch automatisch weiter zur Leerlaufmessung.



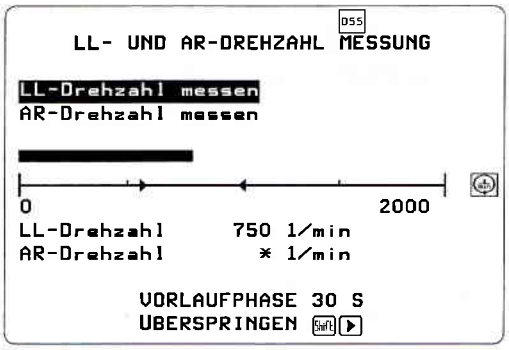
Beispiel für die Anzeige "Prüfzeit überschritten"

Prüfzeit überschritten:

Nach dem Messen der Motortemperatur stehen dem Anwender 10 Minuten pro Testseite zur Verfügung, um die nachfolgenden Tests durchzuführen. Wird diese Zeit überschritten, erscheint der Hinweis "Prüfzeit überschritten" und das Messprogramm muss beginnend mit der Motortemperaturmessung wiederholt werden.



Leerlaufdrehzahl nicht im Fenster



Leerlaufdrehzahl wird gemessen

Leerlaufdrehzahlmessung

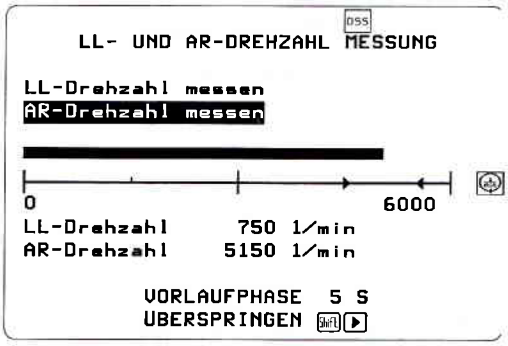
Auf dieser Bildschirmseite können sowohl die Leerlaufdrehzahl als auch die Abregeldrehzahl gemessen werden.
Die aktive Drehzahlmessung ist mit einem Leuchtband hinterlegt.

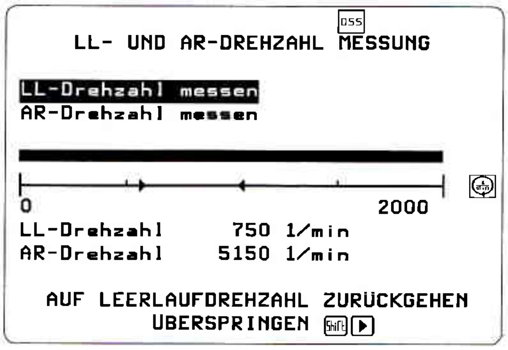
Messung durchführen

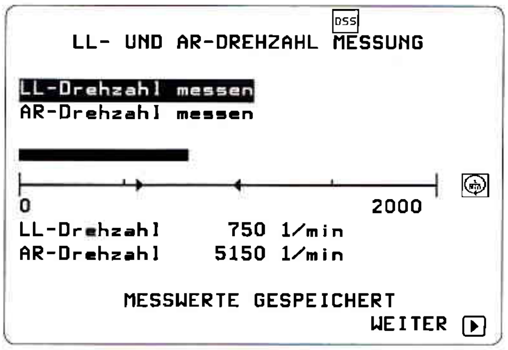
Die Leerlaufdrehzahl muß in das, durch die Sollwerte vorgegebene, Drehzahlfenster gebracht werden. Ist diese Bedingung erfüllt, läuft ein 30-Sekunden Zeitzähler ab. Während dieser Zeit sucht der DGA 1800 nach einem stabilen Drehzahlwert und speichert ihn ab.

Hinweis:
Verläßt die Drehzahl das Drehzahlfenster, beginnt der Zeitzähler nach Rückkehr ins Fenster erneut zu zählen.

Nach dem Speichern des Leerlaufmeßwertes springt das Leuchtband automatisch auf die Position "Abregeldrehzahl", und das Programm fordert dazu auf, die Drehzahl in das Abregeldrehzahlfenster zu bringen.







Abregeldrehzahlmessung

Durchführung der Messung

Nachdem der Leuchtbalken auf die Position "Abregeldrehzahl messen" gesprungen ist, muß das Gaspedal bis zum Anschlag durchgetreten und entsprechend der angezeigten Vorlaufphase gehalten werden. Die Zeit wurde bei der Sollwerteingabe "Seite 2" in der Zeile "Abregelzeitraum" vorgegeben.
Nach Ablauf der Vorlaufphase muß wieder zum Leerlauf zurückgegangen werden.
Es erscheint die Meldung "Meßwerte gespeichert", und die Drehzahlmessungen sind beendet.

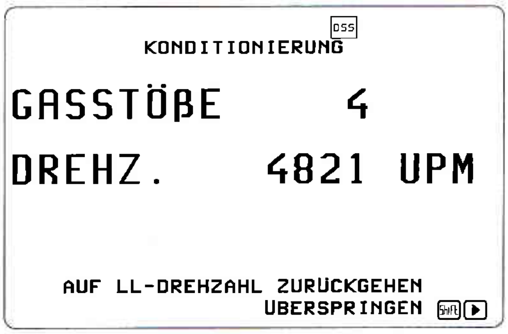
Weitergehen zum nächsten Test

Drücken Sie zum Weitergehen die Pfeiltaste ⇨.
Abhängig davon, ob Sie bei der Solldateneingabe einen Wert für die Konditionierungsgasstöße eingegeben haben geht das Programm weiter zu den Konditionierungsgasstößen oder den Beschleunigungsmessungen.

Hinweis:
Es ist nur dann möglich, zum nächsten Test weiterzugehen, wenn die Drehzahlen in den Fenstern gespeichert werden konnten. Ist dies nicht möglich, muß zuerst die Fehlerursache beseitigt werden.

Drehzahl in Drehzahlfenster bringen

Bild 107.10



Konditionierung beendet

Konditionierungsgasstöße

Das Programm "Konditionierungsgasstöße" erscheint nur, wenn auf der "Solldatenseite 1" ein Wert (> 0) in der Zeile "Kond. Gasstöße" eingegeben worden ist.

Durchführung der Konditionierung

Die Anzahl der erforderlichen Gasstöße wird auf dem Bildschirm angezeigt.
Das Gaspedal muß bis zum Anschlag durchgetreten werden. Nach dem Erreichen der Abregeldrehzahl (-10%) erscheint die Meldung "Auf Leerlaufdrehzahl zurückgehen", und die Drehzahl muß wieder zurückgenommen werden.
Dieser Vorgang muß entsprechend der Anzahl der verlangten Gasstößen wiederholt werden.

Weitergehen zum nächsten AU Test

Durch Drücken der Pfeiltaste "⇨" kann mit der "Meßkopfkalibration" fortgefahren werden.

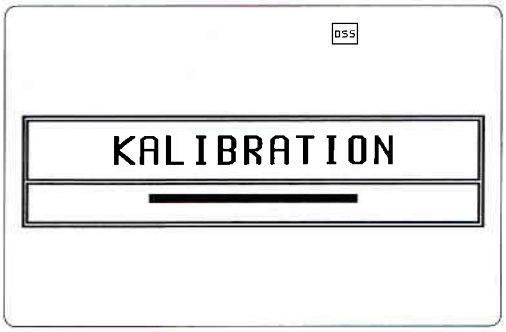
Messungen überspringen

Auf den Messseiten können Sie durch gleichzeitiges Drücken der Tasten Taste "Shift" und Pfeiltaste ⇨ den aktuellen Test überspringen. Das ist sinnvoll, um im Test weiterzukommen, wenn z.B. vom Fahrzeug keine Daten übertragen werden.
Wenn Sie den Test überspringen, gilt die AU grundsätzlich als nicht bestanden.

Meßkopfkalibration

Vor den Beschleunigungsmessungen zur Ermittlung des Trübungsmeßwertes muß der Dieselmeßkopf kalibriert werden. Dies ist erforderlich, da das optische Meßsystem des Meßkopfes ggf. durch vorangegangene Messungen verschmutzt ist. Die Kalibration läuft automatisch ab. Es müssen lediglich die beiden Bildschirmanweisungen am Fahrzeug ausgeführt werden.

Hinweis:
Stellen Sie nicht den Motor ab, dies unterbricht die Datenkommunikation zum Scanner

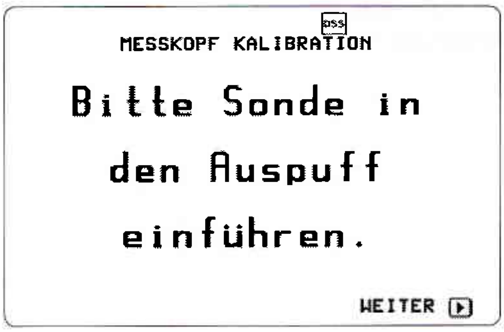


Kalibration durchführen

- Die Kalibration läuft selbstständig ab. Der Ablauf kann auf dem Bildschirm verfolgt werden.
- Das Programm geht **automatisch** weiter zu den Beschleunigungsmessungen.

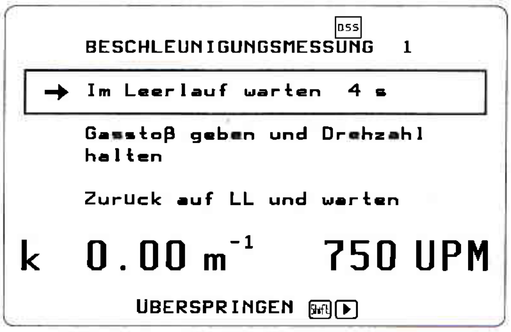
Kalibration fehlerhaft

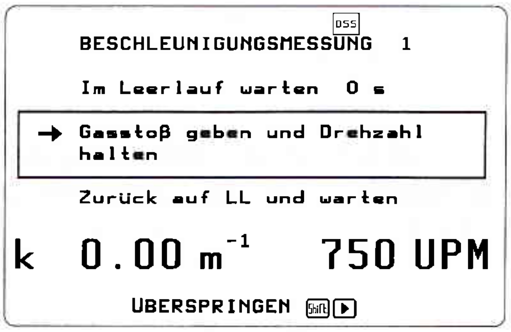
Ist die Kalibration fehlerhaft, erscheint ein Hinweis auf dem Bildschirm. In diesem Fall muß das Meßsystem des Dieselmeßkopfes gereinigt und die Kalibration wiederholt werden (s. Kapitel "Wartung des Dieselmeßkopfes" in der Basisbedienungsanleitung).

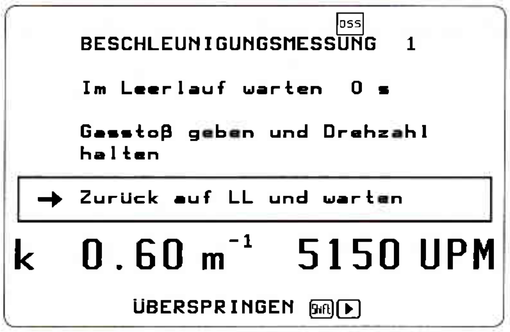


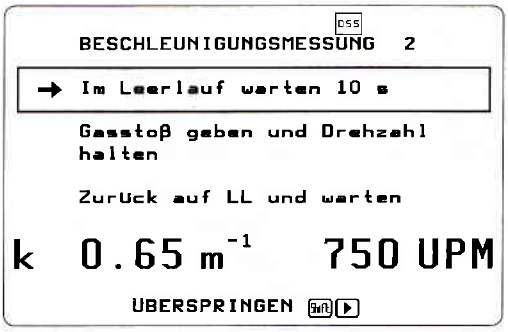
Weitergehen zum den Beschleunigungsmessungen

Nach der Messkopfkalibration werden Sie aufgefordert die Messonde in den Auspuff zu stecken. Befolgen Sie diese Anweisung.
Durch Drücken der Pfeiltaste "⇨" kann dann mit den "Beschleunigungsmessungen" fortgefahren werden.









Beschleunigungsmessungen

Das Programm "Beschleunigungsmessung" dient zur Messung des Trübungswertes "k" während der Beschleunigung des Motors.
Es müssen den gesetzlichen Vorschriften entsprechend mindestens vier Beschleunigungsmessungen durchgeführt werden.
Die erste Messung wird nicht beurteilt. Sie dient dazu, das Auspuffsystem freizublasen und für die 2. Messung die gleichen Voraussetzungen herzustellen, die anschließend für die Messung 3 und 4 vorherrschen werden.

Durchführung der Beschleunigungsmessungen

- Der Motor muß zunächst 5 Sekunden im Leerlauf laufen. Ein Zeitzähler zeigt den Ablauf an.
- Wenn die Anweisung "Gasstoß geben" auf dem Bildschirm markiert wird, muß das Gaspedal bis zum Vollastanschlag durchgetreten werden. Es muß solange gehalten werden, bis die Anweisung "auf Leerlaufdrehzahl zurückgehen und warten" auf dem Bildschirm markiert wird. Die Haltezeit wurde in der "Sollwerteingabe" vorgegeben (Meßzeitanteil tx).
- Nach der Rückkehr zum Leerlauf wird der gespeicherte Trübungswert blinkend angezeigt.
- Anschließend wird der Text "Im Leerlauf warten" markiert und ein 15 Sekunden Zeitzähler läuft ab.

Die zuvor beschriebene Meßprozedur muß anschließend noch dreimal wiederholt werden. Nach der vierten Messung erfolgt ein Hinweis darauf, daß die Meßdaten gespeichert sind, und das Programm geht automatisch zur Bildschirmseite mit den Meßergebnissen weiter.

Beachten Sie bitte folgenden Hinweis.

Mehr als vier Beschleunigungsmessungen erforderlich:
Zur korrekten Einhaltung der AU Vorschriften müssen drei aufeinander folgende Messungen durchgeführt werden, bei denen:

- **die Bandbreite des k-Wertes nicht größer als 0,5 1/m sein darf**
- **der gemessene Trübungsmittelwert nicht höher als der vorgegebene Sollwert sein darf.**

Das Programm fordert aus diesem Grund so oft eine neue Beschleunigungsmessung, bis diese Bedingungen erfüllt werden.

So kann es, abhängig vom Zustand des Fahrzeugs vorkommen, daß **mehr als die vier Standardmessungen** durchgeführt werden müssen.
Sollte nach einer akzeptablen Anzahl von Gasstößen, der gewünschte k-Wert nicht erreicht werden, so muß die Messung abgebrochen und die Ursache für das zu starke und unregelmäßiges Rußen des Motors beseitigt werden.
Wählen Sie in diesem Fall "Überspringen" an.

BESCHLEUNIGUNGSMESSUNGEN

MESSSONDE IN DEN
RECHTEN AUSPUFF
EINFÜHREN.

WEITER

Messung an zwei getrennten Auspuffsystemen

Haben Sie "2 Abgasstränge" bei der Solldateneingabe angewählt, werden Sie nach dem ersten Satz Beschleunigungsmessungen aufgefordert die Messsonde in das Auspuffrohr des anderen Systems zu stecken.
Nach Anwahl von "Weiter" müssen Sie die Beschleunigungsmessungen für das zweite Auspuffsystem wiederholen.

```
ERGEBNIS PRUFBEREITSCHAFTTESTS
   Seite 1 (Steuergerät 1)
  ID                       Status  (n)iO
Komponenten umfassend   :  gesetzt   iO
Kraftstoff-System       :  gesetzt   iO
Verbrennungsaussetzer   :n.unterst.  iO
Abgasrückführung        :n.gesetzt  niO
O2-Sonden-Heizung       :  gesetzt   iO
O2-Sonden               :n.unterst.  iO
Klimaanlage             :  gesetzt   iO
Sekundärluft            :n.unterst.  iO

             SEITE 2 ▶
```

Beispiele Prüfbereitschaftstests (1)

```
ERGEBNIS PRUFBEREITSCHAFTTESTS
   Seite 2 (Steuergerät 1)
  ID                       Status  (n)iO
Tankentlüftung          :n.gesetzt  niO
Katalysator-Heizung     :n.gesetzt  niO
Katalysator             :  gesetzt   iO

SEITE 1 ▲                     WEITER ▶
```

Beispiele Prüfbereitschaftstests (2)

Ergebnis Prüfbereitschaftstest

Die Prüfbereitschaft verschiedener abgasrelevanter Systeme wird vom Steuergerät ständig geprüft und gespeichert.
Diese Bildschirmseite zeigt die in der AU zu prüfenden Systeme an. Durch Drücken der Pfeiltasten können Sie zwischen den beiden Seiten mit den gelisteten Prüfbereitschaften wechseln.

Prüfbereitschaft nicht unterstützt
Modellspezifisch können bestimmte Prüfbereitschaften vom Fahrzeug nicht unterstützt werden. In diesem Fall wird „**n.unterst.**“ in der entsprechenden Zeile angezeigt.

Prüfbereitschaft gesetzt
Die Anzeige „**gesetzt**“ weist darauf hin, dass der Prüfbereitschaftstest für diese Baugruppe erfolgreich durchgeführt worden ist.

Prüfbereitschaft nicht gesetzt
„**n.gesetzt**“ bedeutet, dass der Prüfbereitschaftstest für diese unterstützte Baugruppe nicht erfolgreich durchgeführt worden ist.
Hinweis:
Die Prüfbereitschaften werden nur Ausgelesen und im Ausdruck dokumentiert. Eine Bewertung findet nicht statt.

Prüfbereitschaftstest verlassen

Sie können die Anzeige der Prüfbereitschaften durch Drücken der Pfeiltaste ⇨ auf der zweiten Seite verlassen. Hierdurch soll sichergestellt werden, dass auch wirklich alle Prüfbereitschaften angesehen wurden.
Das Programm geht weiter zum Auslesen des Fehlerspeichers.

Fehlerspeicher auslesen

```
AUSLESEN DES FEHLERSPEICHERS

- Prüfung ob Fehlercodes
  vorhanden sind.

Anzahl der gespeicherten
Fehlercodes: Keine Fehlercodes
             in Speicher
             vorhanden.

                       WEITER
```

Auslesen des Fehlerspeichers, keine Kodes vorhanden

Nach dem Auslesen der Prüfbereitschaften erfolgt das Auslesen des Fehlerspeichers des Steuergerätes. Die Anzahl der gespeicherten Fehlerkodes wird angezeigt.
Wenn keine Fehlerkodes vorhanden sind, können Sie direkt zum nächsten Programmschritt weitergehen.

Anzeige der gespeicherten Fehlerkodes

```
AUSLESEN DES FEHLERSPEICHERS

- Prüfung ob Fehlercodes
  vorhanden sind.

Anzahl der gespeicherten
Fehlercodes: 5

                       WEITER
```

Auslesen des Fehlerspeichers, Kodes vorhanden

Drücken Sie die Pfeiltaste ⇨. Die folgende Bildschirmseite zeigt Ihnen die P0-Codes und die Fehlercodeerklärung an.
Kodes, die mit P1... anfangen sind herstellerspezifisch und keine genormten Standardfehlerkodes. Die Kodes haben daher meistens keine Beschreibung in der AU-Prozedur.
Sind mehrere Fehlerkodes gespeichert, können Sie mit der Pfeiltaste ⇩ durch die Liste blättern.
Wenn keine Fehlercodes gesetzt sind, wird diese Bildschirmseite nicht angezeigt.

```
     FEHLERCODES IN SPEICHER
Code   Beschreibung
P0237: Turbolader Druckgeber A,
       Spannung niedrig.

P0132: Lambdasonde (Bank1, Sonde1)
       Spannung hoch.

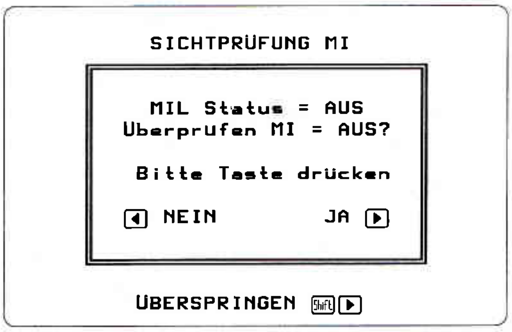
        NÄCHSTE SEITE
                       WEITER
```

Anzeige der gespeicherten Fehlerkodes (Beispiel)

WICHTIG:
Lassen Sie den Motor bis zur Beendigung des Protokollausdrucks laufen, wenn Fehlerkodes im Steuergerät gespeichert sind.
Die Kodes werden für den Ausdruck während des Druckens aus dem Steuergerät ausgelesen.

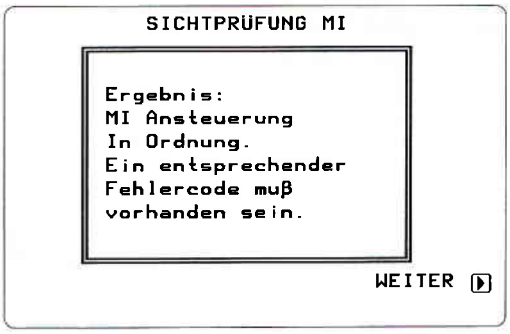
Weitergehen zur MI-Status Prüfung

Sie können diese Bildschirmseite durch Drücken der Pfeiltaste ⇨ verlassen. Das Programm geht weiter zur Bildschirmseite „Sichtprüfung MI".



Sichtprüfung MIL bei laufendem Motor

Ergebnis der MIL-Sichtprüfung o.k.



Beispiel 1 MIL-Sichtprüfung fehlerhaft

Beispiel 2 MIL-Sichtprüfung fehlerhaft

Sichtprüfung MIL

Auf dem Bildschirm erscheint der Hinweis „Bitte Motor starten“. Befolgen Sie diese Anweisung. Es muss nun bei laufendem Motor noch einmal eine Sichtprüfung der MI-Lampe durchgeführt werden.

Prüfen Sie, ob die MI-Lampe jetzt aus ist. Bestätigen Sie dies durch Anwahl von „JA“ oder „NEIN“ durch Drücken der Pfeiltasten ⇦⇨.

Die Anwahl von „JA“ oder „NEIN“ hat keinen Einfluss auf den weiteren Ablauf, sondern auf die Beurteilung der AU-Prüfung im Protokollausdruck. Die nachfolgende Bildschirmseite zeigt Ihnen an, ob die MI-Lampe bzw. die Ansteuerung der MI-Lampe in Ordnung ist.

Weitergehen zur Ergebnisübersicht

Drücken Sie die Pfeiltaste ⇨. Das Programm geht weiter zur Ergebnisübersicht.

ERGEBNISSEÜBERSICHT - MESSWERTE

Messung		1	2	3
LL-Drehz.	1/min	750	750	750
AR-Drehz.	1/min	5150	5150	5150
Beschl.zeit	s	1.62	0.82	0.54
Trübung k	1/m	0.00	0.00	0.00

Trübungsmittelwert	1/m	0.00
Bandbreite	1/m	0.00

WEITER

Ergebnisübersicht Beschleunigungstests

ERGEBNISSEÜBERSICHT AU

Leerlaufdrehzahl	i.O.
Abregeldrehzahl	i.O.
Freie Beschleunigungen	n.i.O.
Bandbreite der k-Werte	i.O.
MI Status	n.i.O.
Ansteuerung MI	i.O.
Prüfbereitschafttests	i.O.
Fehlerspeicher	n.i.O.

MESSWERTE MESSUNGEN WIEDERH.
FEHLERCODES AUSDRUCK

Ergebnisübersicht zweite Seite

ERGEBNISSEÜBERSICHT AU
Fehlercodes

Fehlercodes:
P0237: Turbolader Druckgeber A, Spannung niedrig.
P0132: Lambdasonde (Bank1, Sondel) Spannung hoch.

MESSUNGEN WIEDERHOLEN
ÜBERSICHT AUSDRUCK

Anzeige von Fehlercodes falls vorhanden

Anzeige der Ergebnisse/ Messungen wiederholen

Nach dem MI-Status werden zum Abschluss der AU die Bildschirmseiten mit den Ergebnissen der Funktionstests angezeigt.

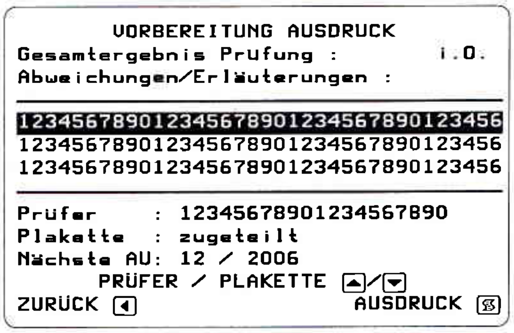
Durch Drücken der Pfeiltaste ⇨ oder der Pfeiltaste ⇦ können Sie zwischen den beiden Ergebnisseiten wechseln.

Durch Drücken der Taste Wiederholen haben Sie die Möglichkeit die Messungen zu wiederholen.

Weitergehen zum Protokollausdruck

Drücken Sie die Pfeiltaste ⇨ um zu den Vorbereitungsseiten für den Protokollausdruck weiter zu gehen.

WICHTIG:
Lassen Sie den Motor bis zur Beendigung des Protokollausdrucks laufen, wenn Fehlerkodes im Steuergerät gespeichert sind.
Die Kodes werden für den Ausdruck während des Druckens aus dem Steuergerät ausgelesen.



Vorbereitung Protokollausdruck

Vorbereitung Protokollausdruck

Zur Komplettierung des AU-Programms müssen die Identifikationsdaten, die Solldaten, das Ergebnis der Sichtprüfungen, der Funktionstests und das Gesamtergebnis ausgedruckt werden.
Für den Ausdruck müssen der Name des Prüfers, die Gültigkeitsdauer der AU-Plakette und, wenn erforderlich, zusätzliche Erläuterungen eingegeben werden. Das Gesamtergebnis der Prüfung wird automatisch angezeigt.

Erläuterungen und Prüfername eingeben

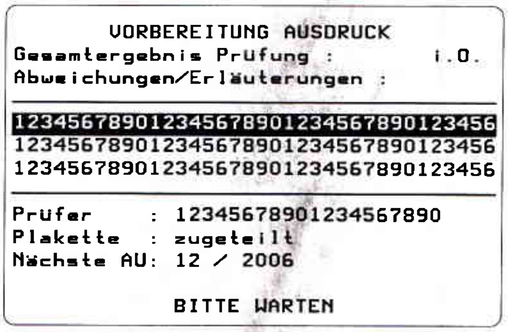
Wenn erforderlich, können Sie zusätzliche Erläuterungen zum AU-Test eingeben.
Geben Sie den Prüfernamen ein. Der Prüfername bleibt bis zum Ausschalten des Geräts für alle weiteren AU's gespeichert, sofern er nicht verändert wird.

Plakette zuteilen

Es ist möglich, dass die AU-Prüfungen in Ordnung sind, die Plakette aber nicht zugeteilt werden kann. Dies ist z.B. der Fall, wenn das Fahrzeug mit rotem Kennzeichen ausgerüstet ist und die Plakette erst später zugeteilt werden kann. Über die Zuteilung der Plakette entscheidet einzig und allein der Prüfer.
Wählen Sie zwischen „Plakette zugeteilt“ und „Plakette nicht zugeteilt“ durch Drücken der Taste ☒.

Gültigkeitsdauer der AU-Plakette

In der Zeile "Nächste AU" können Sie mit den numerischen Tasten die Gültigkeitsdauer der AU eingeben. Vorgegebener Standardwert ist das aktuelle Datum plus 2 Jahre.



Ausdruck in Arbeit

Protokollausdruck

Druckvorgang starten:
Drücken Sie die Taste "Drucken". Der Ausdruck erfolgt doppelt, so dass ein Exemplar für den Kunden und ein Exemplar für die Werkstatt zur Verfügung steht. Ein Beispiel finden Sie auf den folgenden Seiten.
Manuelle Eingaben sind im Ausdruck mit "#" gekennzeichnet.

```
          VORBEREITUNG AUSDRUCK
Anzahl der Ausdrucke :                2X
Festgestellte Mängel nach Nr. 5 der
AU-Richtlinie wurden behoben: NEIN

Erkannte aber nicht behobene Mängel
nach Nr. 6 der AU-Richtlinie:
123456789012345678901234567890123456
123456789012345678901234567890123456
123456789012345678901234567890123456
123456789012345678901234567890123456
     NÄCHSTES/VORHER. FELD ▲/▼
            WEITER ▶
```

Vorbereitung Nachweis-Ausdruck

```
          VORBEREITUNG AUSDRUCK
Anzahl der Ausdrucke :                0X






             MENU Shift ◀
```

Anwahl kein Nachweis-Ausdruck

Vorbereitung Ausdruck Prüfbescheinigung/Nachweis

Der Nachweis wird **ab 2006** der Standardausdruck sein. Die Entscheidung, ob ein Nachweis ausgedruckt wird oder ein herkömmlicher Protokollausdruck haben Sie in der Seite Sichtprüfung getroffen. Die Sichtprüfung Bauteile ist nicht Bestandteil eines Nachweises, wird nicht bewertet und nicht ausgedruckt.

Die Anwahl "nicht erforderlich - Nachweis" in der Sichtprüfung Bauteile hat dazu geführt, dass am Ende der AU auf der Seite "Vorbereitung Ausdruck" die Vorbereitungsseite für den Nachweis angezeigt wird.

Anzahl der Nachweise

Sie können durch Drücken der Taste ☒ wählen, ob 0, 1, oder 2 Nachweise benötigt werden. Der Nachweis ist nur erforderlich, wenn das Fahrzeug für die Hauptuntersuchung (HU) zu einer Prüforganisation gefahren werden soll, also AU und HU nicht zur gleichen Zeit in ein und dem selben Betrieb durchgeführt werden.
Die Anwahl "0" wird benötigt wenn AU und HU gleichzeitig im gleichen Betrieb durchgeführt werden.

Mängelliste

Teil des Nachweises ist die Mängelliste. Es muss aus statistischen Gründen angegeben werden, ob Mängel nach Nummer 5 der AU-Richtlinie vor der Durchführung der AU-Prozedur beseitigt wurden. Wählen Sie hier "JA" oder "NEIN" durch Drücken der Taste ☒ an.

Wenn Sie einen Nachweis ausdrucken, müssen Sie aus statistischen Gründen erkannte aber nicht behobenen Mängel nach Nummer 6 der AU-Richtlinie eintragen.

Weitergehen zum Protokollausdruck

Drücken Sie die Pfeiltaste ⇨ um zur nächsten Ausdruckseite weiter zu gehen.

```
        VORBEREITUNG AUSDRUCK
Gesamtergebnis Prüfung :          i.O.
Abweichungen/Erläuterungen :

123456789012345678901234567890123456
123456789012345678901234567890123456
123456789012345678901234567890123456

Prüfer     : 12345678901234567890
Plakette   : zugeteilt
Nächste AU:  12 / 2006
      PRÜFER / PLAKETTE
ZURÜCK                    AUSDRUCK
```

AU beenden

Erläuterungen und Prüfername eingeben

Wenn erforderlich, können Sie zusätzliche Erläuterungen zum AU-Test eingeben.
Geben Sie den Prüfernamen ein. Der Prüfername bleibt bis zum Ausschalten des Geräts für alle weiteren AU's gespeichert, sofern er nicht verändert wird.

Plakette zuteilen

Es ist möglich, dass die AU-Prüfungen in Ordnung sind, die Plakette aber nicht zugeteilt werden kann. Dies ist z.B. der Fall, wenn das Fahrzeug mit rotem Kennzeichen ausgerüstet ist und die Plakette erst später zugeteilt werden kann. Über die Zuteilung der Plakette entscheidet einzig und allein der Prüfer.
Wählen Sie zwischen „Plakette zugeteilt" und „Plakette nicht zugeteilt" durch Drücken der Taste ☒.

Gültigkeitsdauer der AU-Plakette

In der Zeile "Nächste AU" können Sie mit den numerischen Tasten die Gültigkeitsdauer der AU eingeben. Vorgegebener Standardwert ist das aktuelle Datum plus 2 Jahre.

```
        VORBEREITUNG AUSDRUCK
Gesamtergebnis Prüfung :          i.O.
Abweichungen/Erläuterungen :

123456789012345678901234567890123456
123456789012345678901234567890123456
123456789012345678901234567890123456

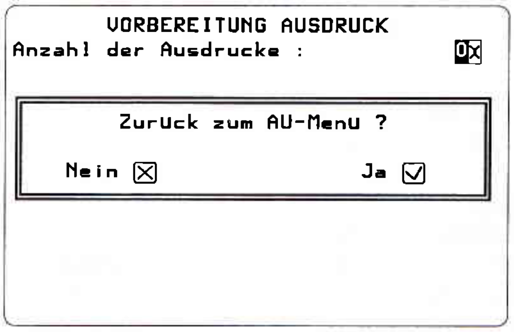
Prüfer     : 12345678901234567890
Plakette   : zugeteilt
Nächste AU:  12 / 2006

             BITTE WARTEN
```

Ausdruck in Arbeit

Nachweis ausdrucken

Starten des Druckvorgangs:
Drücken Sie die Taste "Drucken". Der Ausdruck erfolgt doppelt, so dass ein Exemplar für den Kunden und ein Exemplar für die Werkstatt zur Verfügung steht. Ein Beispiel finden Sie auf den folgenden Seiten.
Manuelle Eingaben sind im Ausdruck mit "#" gekennzeichnet.



Ausdruck in Arbeit

Beenden der AU Diesel mit OBD

Nach dem Protokollausdruck oder dem Ausdrucken des Nachweises haben Sie die Möglichkeit durch Drücken der Tasten Shift und Pfeiltaste ⇦ die AU Prozedur zu verlassen. Es wird die Rückfrage "Zurück zum AU-Menü: Ja/Nein?" angezeigt.
Wenn Sie „JA“ anwählen, kehrt das Programm zum Menü „Diesel mit OBD“ zurück. Es können dann einzelne Teile der AU wiederholt werden, eine neue AU durchgeführt werden oder zum Hauptmessbildschirm zurückgegangen werden.
Wenn Sie „NEIN“ wählen, kehrt das Programm zur Bildschirmseite „Protokollausdruck“ zurück und Sie können weitere Protokollausdrucke anfertigen.

Scanner vom Fahrzeug abklemmen

Schalten Sie nach Beendigung der AU-Prüfungen die Zündung aus.
Ziehen Sie das OBD-Adapterkabel aus der OBD-Diagnosesteckdose des Fahrzeugs.

Beispiel Protokollausdruck

DGA-1800
X4.52 Leitf V3
AU nach § 47a StVZO
Diesel mit OBD
PDL-1000 OBD PRIMARY V5.3

Datum: 08. April 2005 Zeit: 08:42

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8

- Kennzeichen	:	NE-AB 123
- Kilometerstand	:	1234567
1 Emissionsschlüsselnummer:		1234
2 Fahrzeug Hersteller	:	VW
2 Hersteller Schlüsselnr.	:	1234
3 Fahrzeugtyp/Ausführung	:	Golf
3 Fahrzeug Schlüsselnummer:		123XXX
4 Fahrzeugidentnummer	:	ABCDEEF6123456789

Messmodus/Sonden Nr. : B/1
Messzeitanteil tx s : 1.00

Soll/Ist-Vergleich	min	ist	max	
Motortemperatur °C	40	63		iO
LL-Drehzahl 1/min	800	904	1000	iO
AR-Drehzahl 1/min	4800	4905	5100	iO

Ergebnis der Messungen

	-1-	-2-	-3-	
LL-Drehzahl 1/min	904	902	906	iO
AR-Drehzahl 1/min	4966	4962	4962	iO
Beschl.zeit s	1.17	1.05	1.05	
Trüb.wert k 1/m	0.00	0.00	0.00	

		ist	max	
Bandbreite	1/m	0.00	0.50	iO
Arithm. Mittelwert der Trüb.	1/m	0.00	2.50	iO

Prüfbereitschafttests	ECU1 ECU2 ECU3 ECU4 ECU5 ECU6
Komponenten umfassend	ges
Kraftstoff-System	ges
Verbrennungsaussetzer	nunt
Abgasrückführung	ges
O2-Sonden-Heizung	nunt
O2-Sonden	nunt
Klimaanlage	nunt
Sekundärluft	nunt
Tankentlüftung	nunt
Katalysator-Heizung	nunt
Katalysator	nunt

Unterstützt: 11010000000
Gesetzt: 00000000000

Alle Systemtests durchgeführt.

Diesel mit OBD Protokollausdruck

Fehlerspeicher
Anzahl der Fehler: 0

Bewertung

Sichtprüfung Bauteile:		in Ordnung #
Sichtprüfung MIL	:	in Ordnung #
Soll/Ist-Vergleich	:	in Ordnung
Fehlerspeicher	:	in Ordnung
Ansteuerung MIL	:	in Ordnung #
Status MIL	:	in Ordnung

OBD-INFO:
- OBD Version : - EOBD
- Protokoll : - ISO 9141-2

Gesamtergebnis : in Ordnung

Plakette nach Anlage IXa zugeteilt.

ABWEICHUNGEN/ERLÄUTERUNGEN

abcd
ABCD
1234567890

Kontrollnummer nach § 47b : 9
Prüfer : Wegener
Nächste AU : 4 / 2007
Unterschrift der verantwortlichen Person: ....

Hinweise zum Ausdruck

*
Messwert nicht aufgenommen oder fehlerhaft.

#
Manuell eingegebener Wert.

Beispiel Nachweisausdruck

DGA—1800
X4.52 Leitf V3
Nachweis der AU
Diesel mit OBD
PDL—1000 OBD PRIMARY V5.3
Datum: 08. April 2005 Zeit: 08:34

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7
8

- Kennzeichen	:	ME-AB 123
- Kilometerstand	:	1234567
1 Emissionsschlüsselnummer	:	1234
2 Fahrzeug Hersteller	:	VW
2 Hersteller Schlüsselnr.	:	1234
3 Fahrzeugtyp/Ausführung	:	Golf
3 Fahrzeug Schlüsselnummer	:	123XXX
4 Fahrzeugidentnummer	:	ABCDEEF6123456789

Messmodus/Sonden Nr. : B/1
Messzeitanteil tx s : 1.00

Soll/Ist-Vergleich	min	ist	max	
Motortemperatur °C	40	58		iO
LL-Drehzahl 1/min	800	904	1000	iO
AR-Drehzahl 1/min	4800	4957	5100	iO

Ergebnis der Messungen

	-1-	-2-	-3-	
LL-Drehzahl 1/min	905	903	904	iO
AR-Drehzahl 1/min	4961	4954	4964	iO
Beschl.zeit s	0.94	0.82	1.17	
Trüb.wert k 1/m	0.01	0.01	0.00	

		ist	max	
Bandbreite	1/m	0.01	0.50	iO
Arithm. Mittelwert der Trüb.	1/m	0.01	2.50	iO

Prüfbereitschafttests	ECU1	ECU2	ECU3	ECU4	ECU5	ECU6
Komponenten umfassend	ges					
Kraftstoff-System	ges					
Verbrennungsaussetzer	nunt					
Abgasrückführung	ges					
O2-Sonden-Heizung	nunt					
O2-Sonden	nunt					
Klimaanlage	nunt					
Sekundärluft	nunt					
Tankentlüftung	nunt					
Katalysator-Heizung	nunt					
Katalysator	nunt					

Unterstützt: 11010000000
Gesetzt: 00000000000

Alle Systemtests durchgeführt.

Fehlerspeicher
Anzahl der Fehler: 0

Bewertung

Sichtprüfung MIL	:	in Ordnung #
Soll/Ist-Vergleich	:	in Ordnung
Fehlerspeicher	:	in Ordnung
Ansteuerung MIL	:	in Ordnung #
Status MIL	:	in Ordnung

OBD-INFO:
- OBD Version : - EOBD
- Protokoll : - ISO 9141-2

Gesamtergebnis : in Ordnung

Plakette nach Anlage IXa zugeteilt.

Mängel nach Nr.5 der AU Richtlinie (Mängel-Nr.813) :

Festgestellte Mängel wurden behoben: [ ] ja

[X] nein

Erkannte aber nicht behobene Mängel nach Nr.6 der AU-Richtlinie:

ABWEICHUNGEN/ERLÄUTERUNGEN

abcd
ABCD
1234567890

Kontrollnummer nach § 47b : 9
Prüfer :
Nächste AU : 4 / 2007
Unterschrift der verantwortlichen Person: ....

Diesel mit OBD Nachweisausdruck

Hinweise zum Ausdruck

*
Messwert nicht aufgenommen oder fehlerhaft.

#
Manuell eingegebener Wert.

Verfasser:
Snapon-Holdings
Geschäftsbereich SUN Diagnostics
Fritz Wegener
Datum: 21.5.2005

Der Inhalt dieses Handbuches bezieht sich auf den nachfolgend aufgeführten Stand der Software, sowie auf den Stand der Hardware bei Erstellung des Handbuches.

Software Vers. : V 4.58

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).

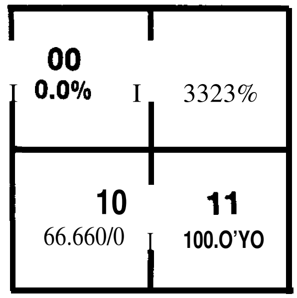


Figure 5-1, Primary Color, Two-Bit Color Selection

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.

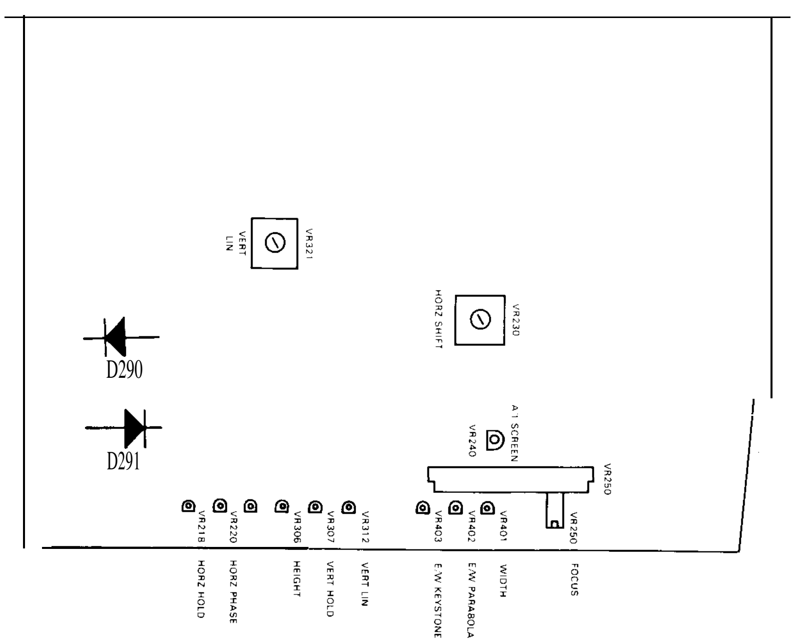


Figure 5-2, Location of Diodes D290 and D291.

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.

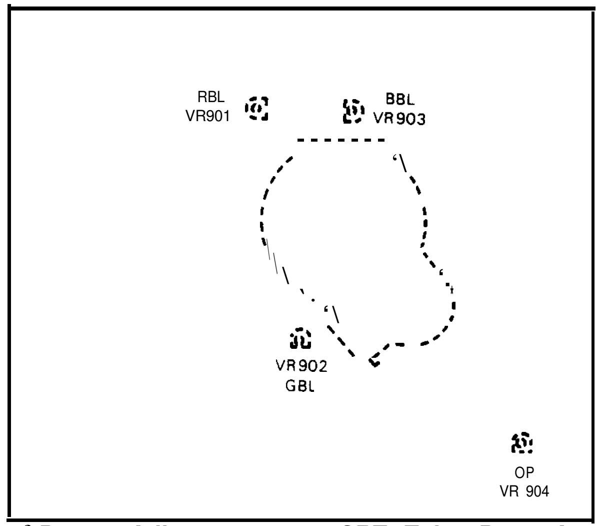
If the raster is shaded towards a primary or secondary color, then adjustments should be make to the appropriate black level preset to obtain a neutral (gray) raster.

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.

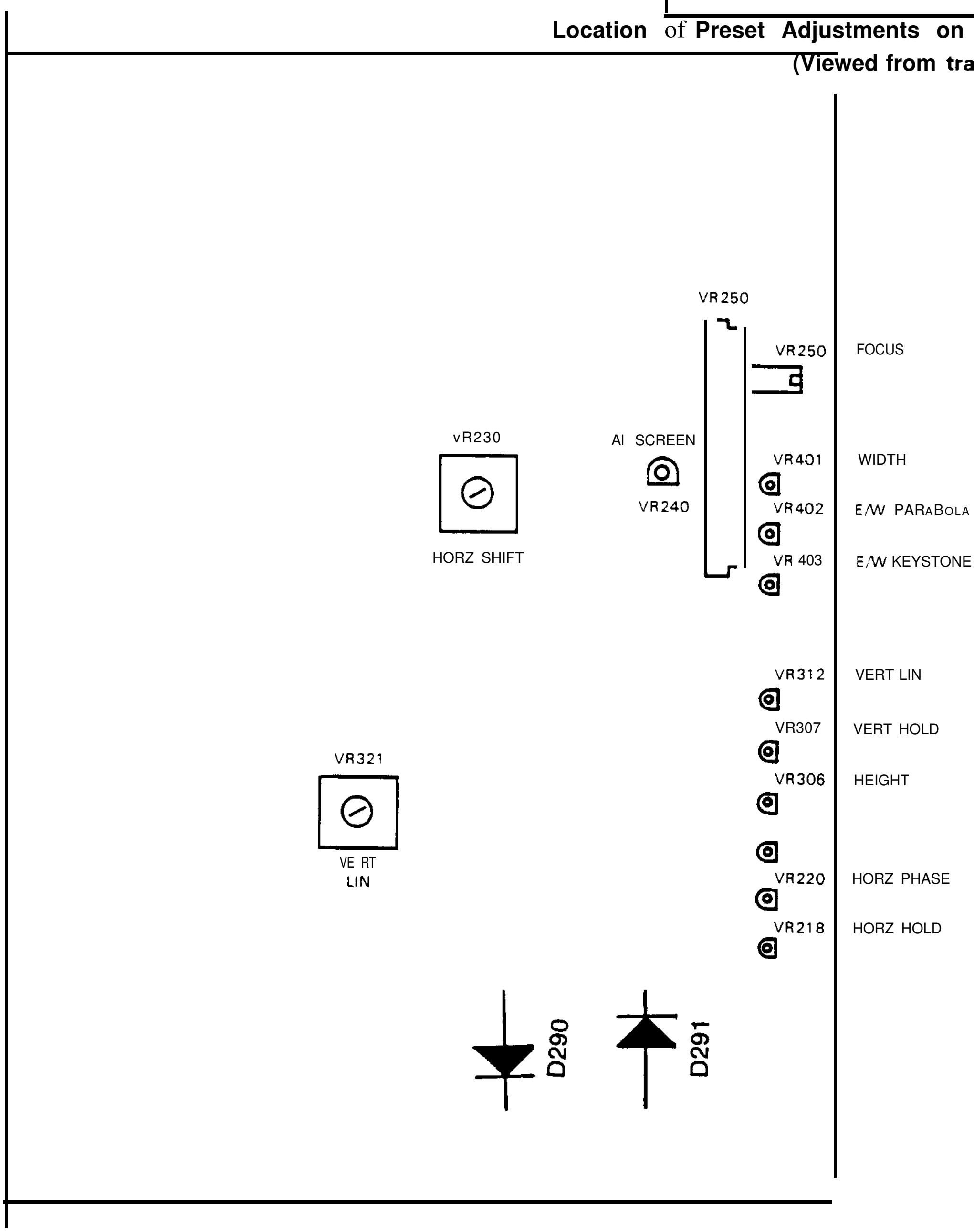
   E) Set the SCREEN VOLTAGE ADJUSTMENT, step 15.

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.

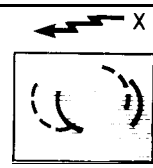
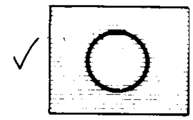
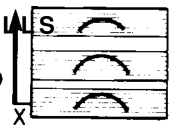
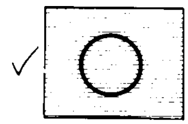
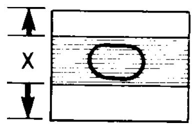
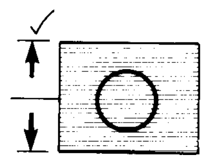
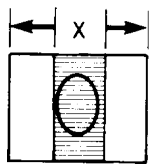
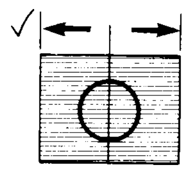
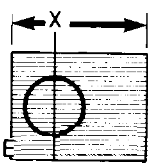
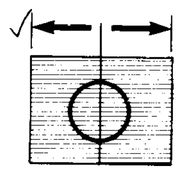
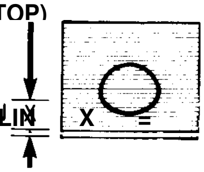
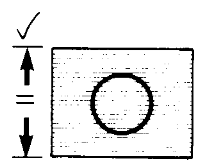
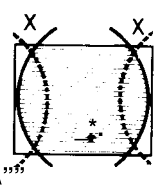
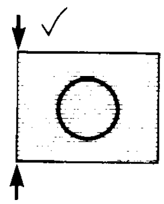
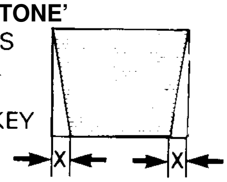
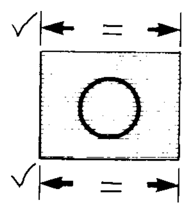
PRESET	WRONG X	RIGHT √
H. HOLD (LINE HOLD)	PICTURE BREAKS UP ADJUST H. HOLD 	 PICTURE LOCKED
V. HOLD (VERTICAL HOLD)	PICTURE ROLLS ADJUST V. HOLD 	 PICTURE LOCKED
HEIGHT	ADJUST HEIGHT 	 HEIGHT SET
WIDTH	ADJUST WIDTH 	 WIDTH SET
4. PHASE * (HORIZONTAL PHASE)	PICTURE NOT CENTRAL ADJUST H. PHASE 	 PICTURE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

TABLE OF PRESET ADJUSTMENTS

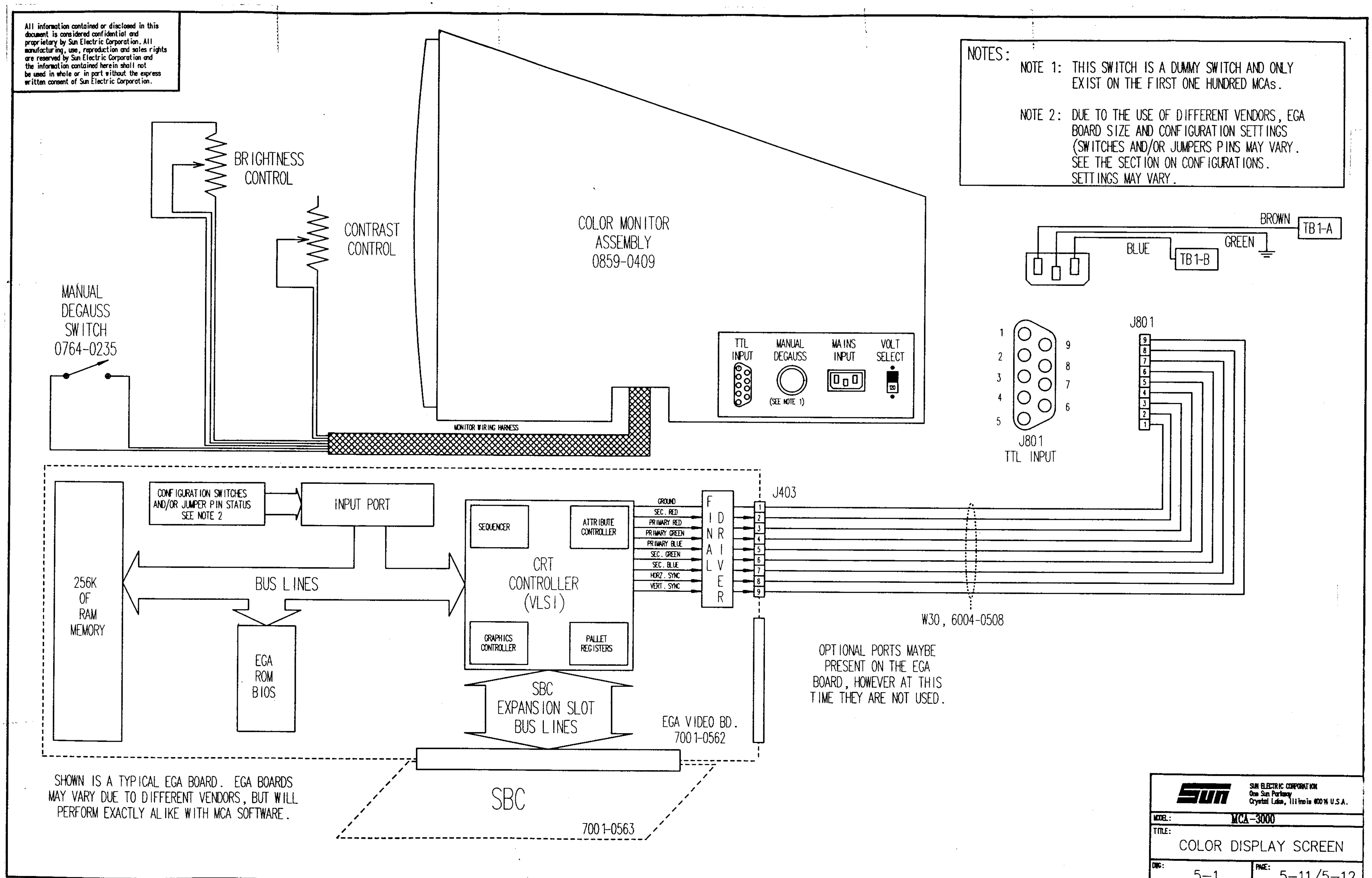
Figure 5-4. Video Display Right/Wrong Control Settings

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
BLUE
GREEN
TB1-B
J801
J801 TTL INPUT
1
2
3
4
5
6
7
8
9
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
GROUND
SEC. RED
PRIMARY RED
PRIMARY GREEN
PRIMARY BLUE
SEC. GREEN
SEC. BLUE
HORZ. SYNC
VERT. SYNC
FINAL DRIVER
J403
W30, 6004-0508
OPTIONAL PORTS MAYBE PRESENT ON THE EGA BOARD, HOWEVER AT THIS TIME THEY ARE NOT USED.
SBC EXPANSION SLOT BUS LINES
EGA VIDEO BD. 7001-0562
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.**

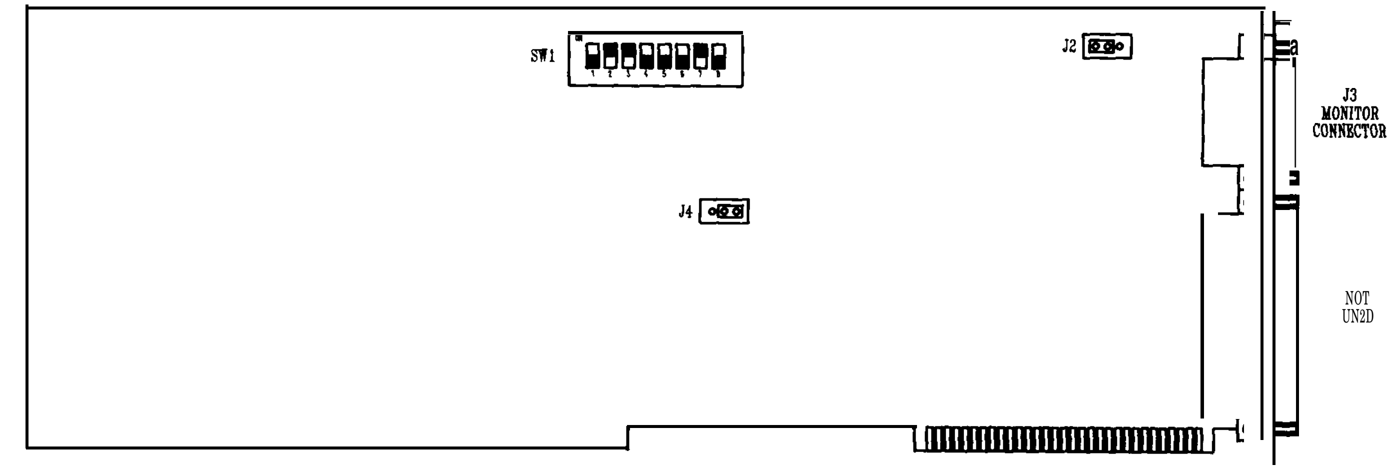


Figure 5-5, STB Multi-Res EGA Board.

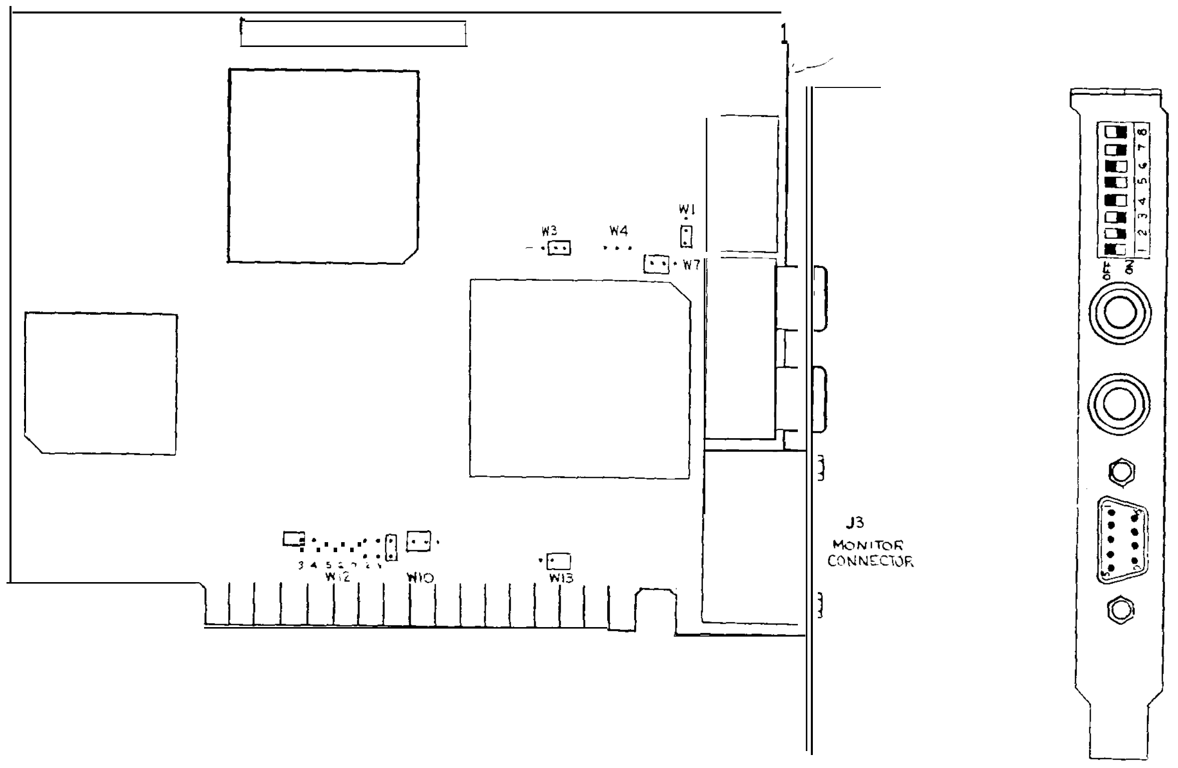


Figure 5-6, Everex EGA Board.

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.

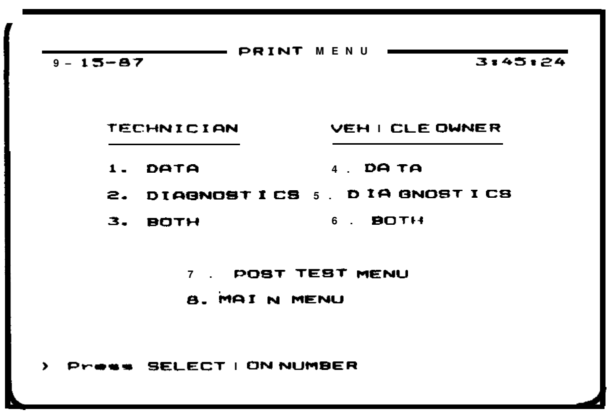


Figure 6-1. PRINT MENU Page

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

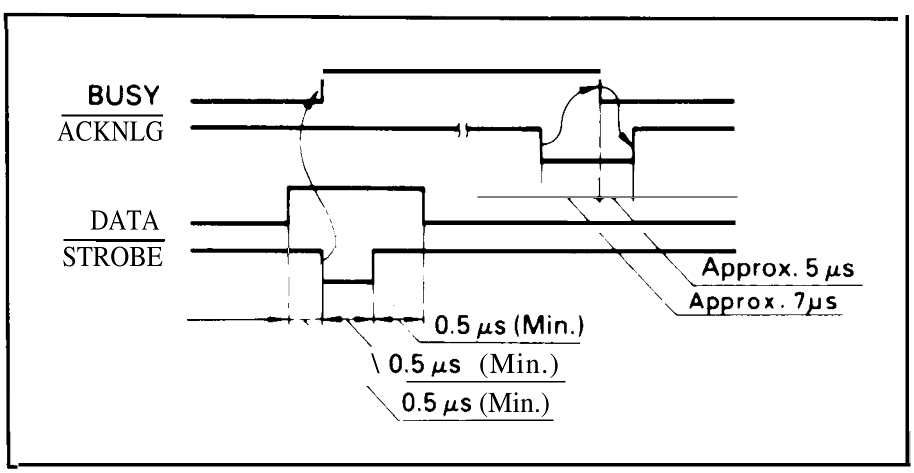


Figure 6-2. Parallel Interface Timing

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.

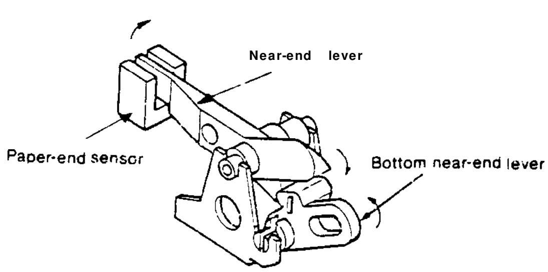
4. Dampen the cloth with alcohol and wipe the bailing roller clean.

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.



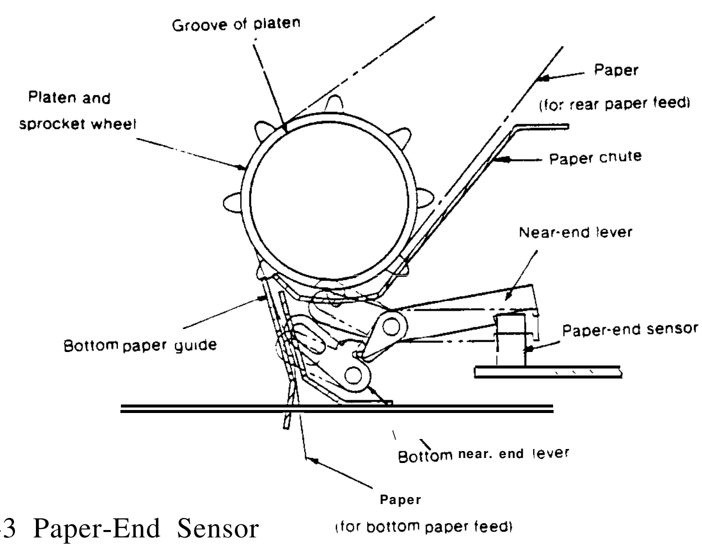


Figure 6-3 Paper-End Sensor

• Cleaning and Lubrication Complete •

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

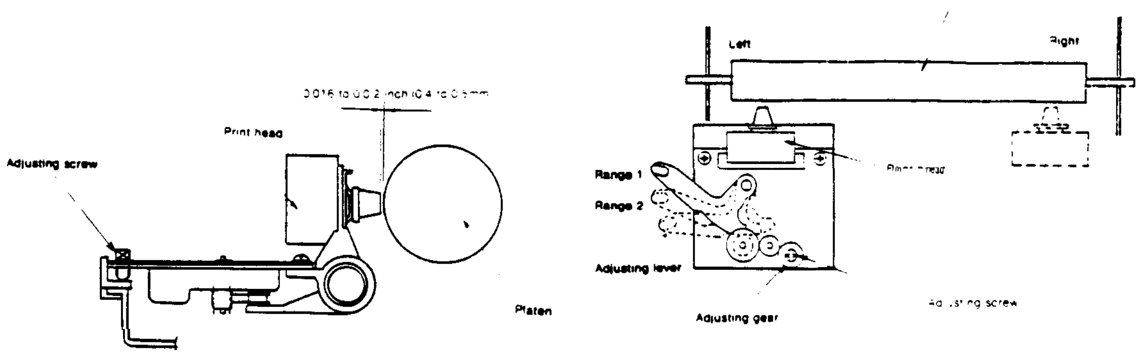


Figure 6-4. Head Gap Adjustment.

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.

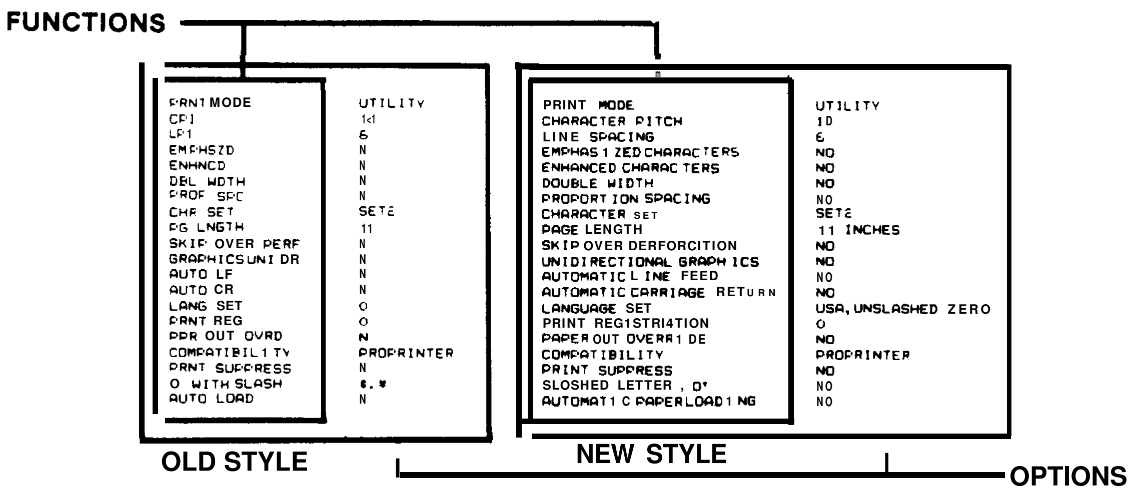


Figure 6-5. Printer Options

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

PRINTER SETUP PROCEDURE (CONT)

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.

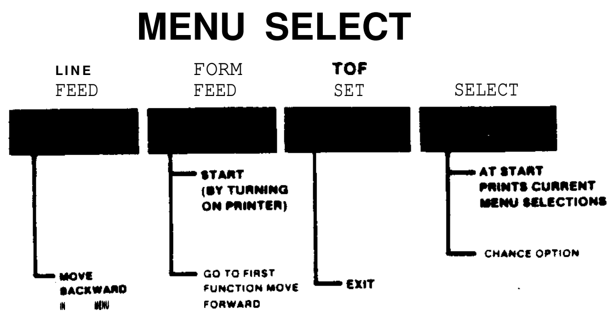


Figure 6-6. Reference Diagram

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

● 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.

```
ML192     IBM     A     F/U 01.01
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmno
"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnop
#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopq
$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqr
%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrs
&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrst
'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstu
()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuv
)*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvw
*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwx
+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxy
,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz
-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{
```

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.

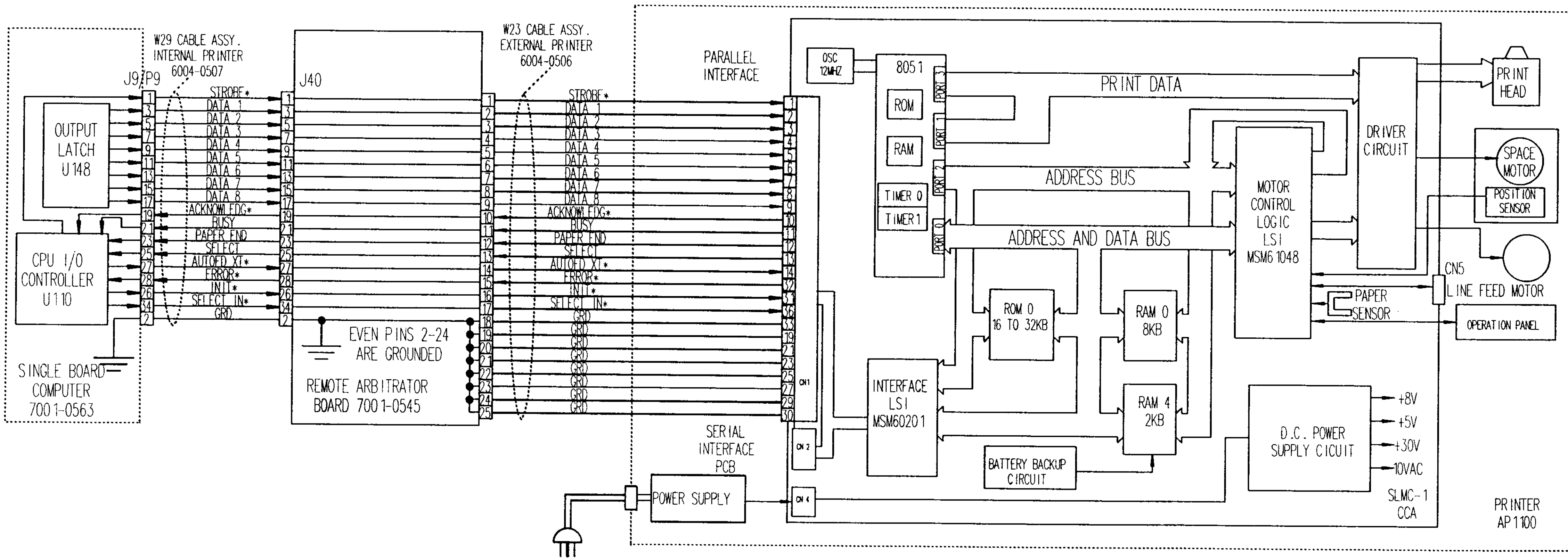
1. Printer in deselect (off line) mode; press SELECT button and make certain SELECT indicator lights.

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 Replace Printer AP-1100. ----------------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 Replace Printer AP-1100. ----------------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 Write to the Sun Bus, the data bus is activated approximately the same time SBACK* goes low and remains active for approximately three microseconds. On a Read from the Sun Bus, 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.

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 __not__ 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, 03H-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. When writing from the SBC to the sun bus; SUN BUS READ/WRITE* is at a low level and when reading from the sun bus to the SBC 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	3	1	.-*	0	0	0
VLOAD						*unused
DATA						

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.

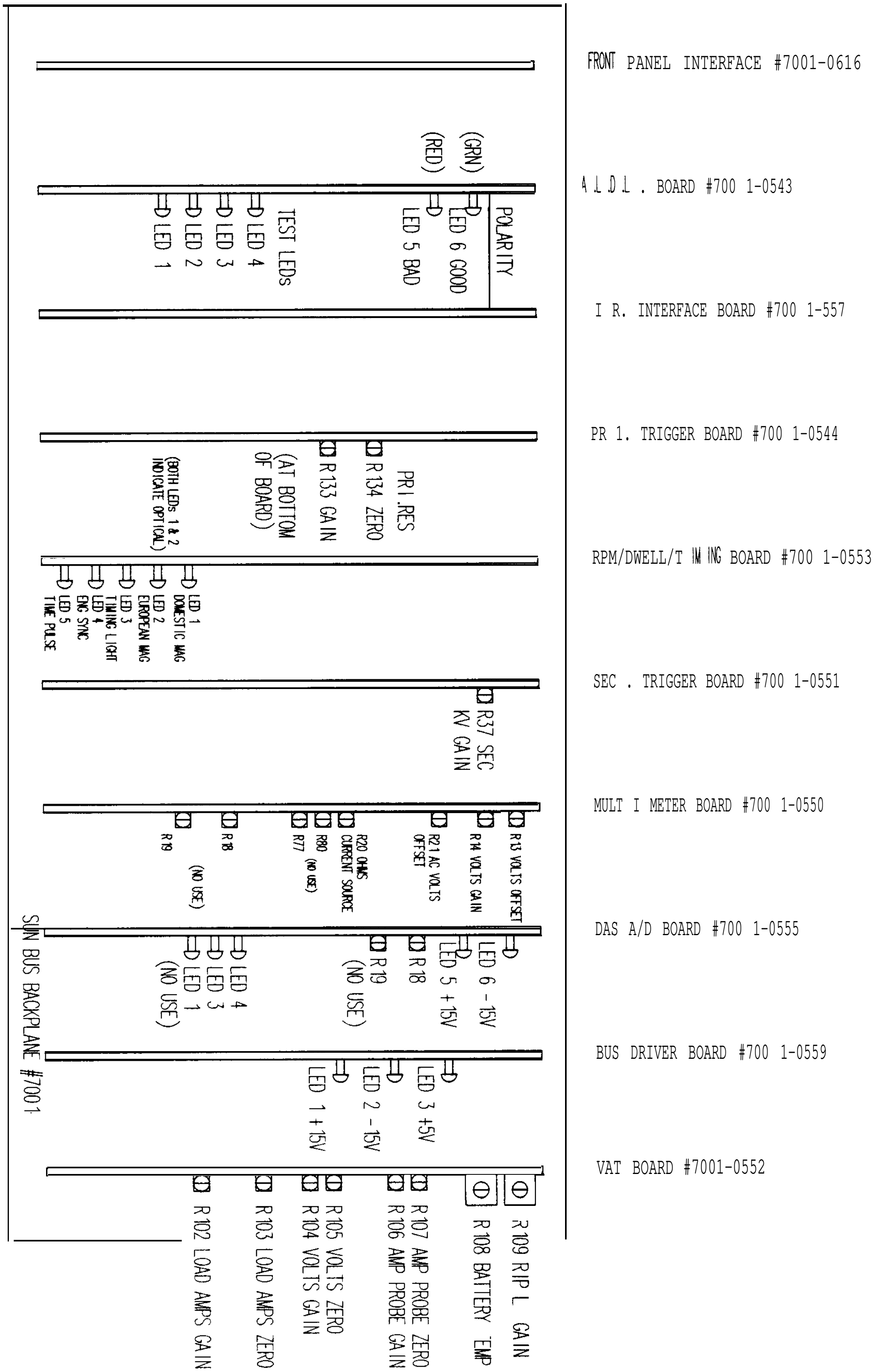
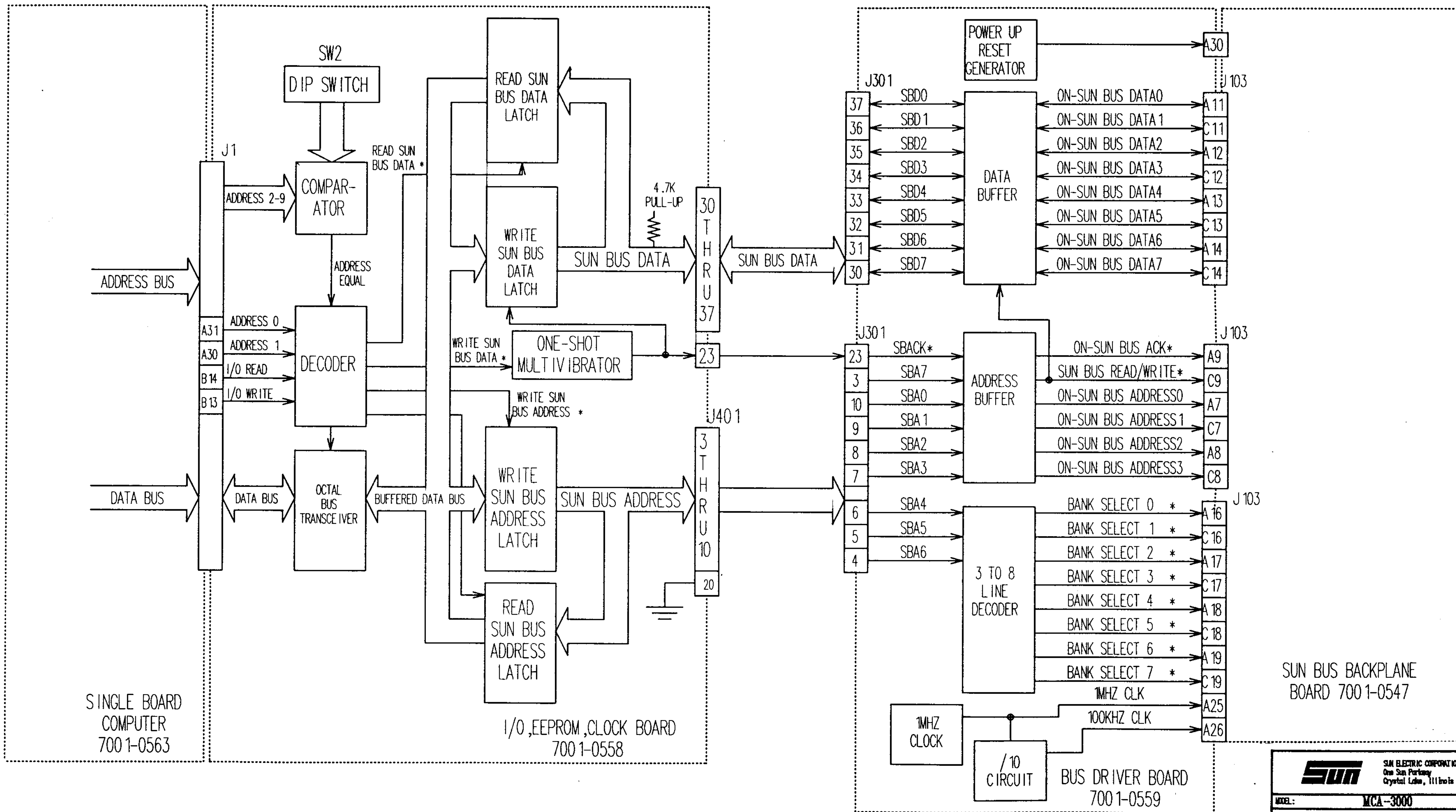


Figure 7-1. Sun Bus, Parts/Control Location.

NOTES



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

MODEL: MCA-3000

TITLE: SUN BUS/COMPUTER COMMUNICATIONS

DWG: 7-1

PAGE: 7-17/7-18

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 1 6 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

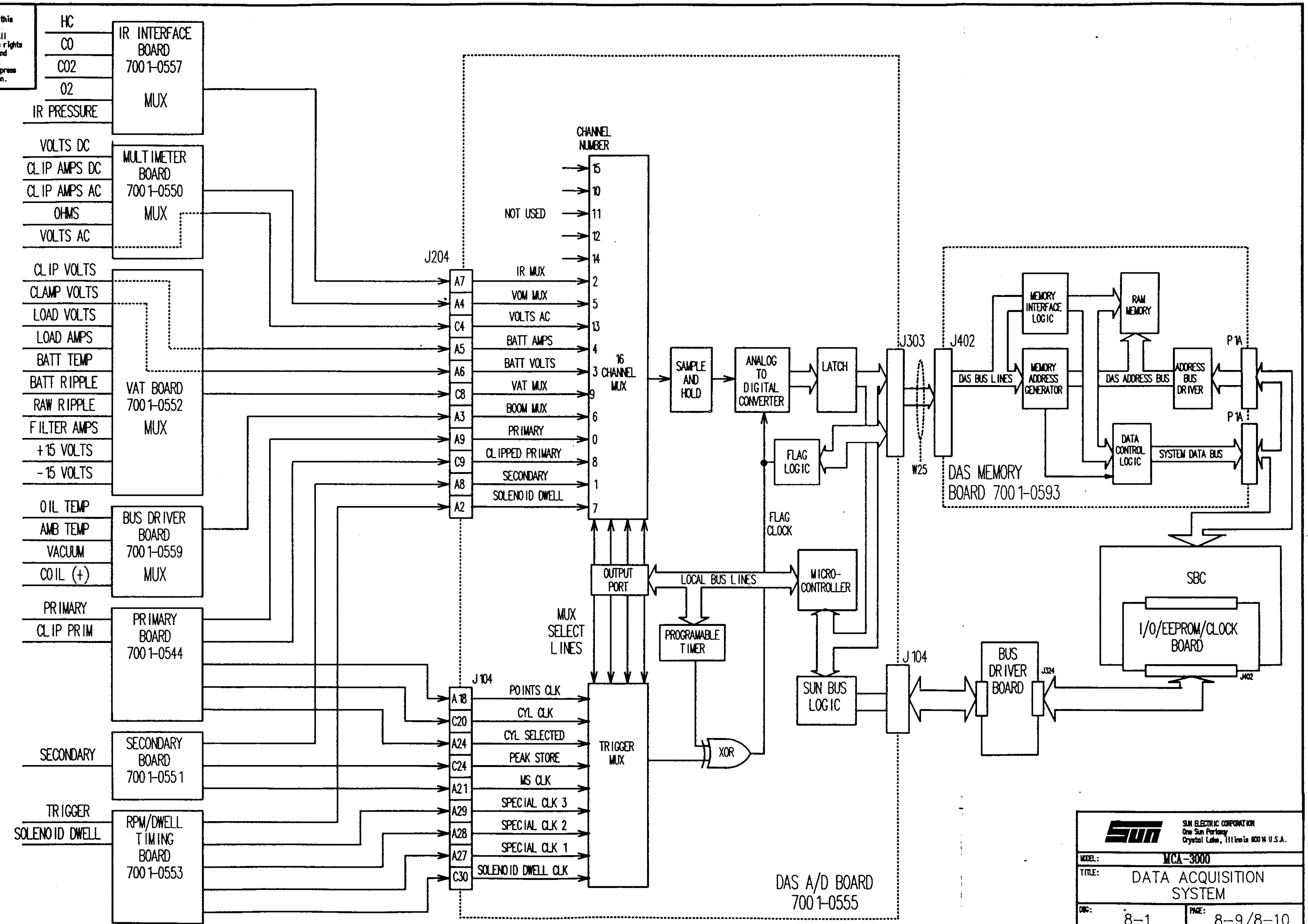
No calibration/adjustment is required. If the DAS System is not functioning properly, the result will be inaccurate or omitted readings on one or more channels. Therefore, if the individual functions of the MCA-3000 are checked and working properly it can be assumed the DAS System is also working properly.

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



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

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.

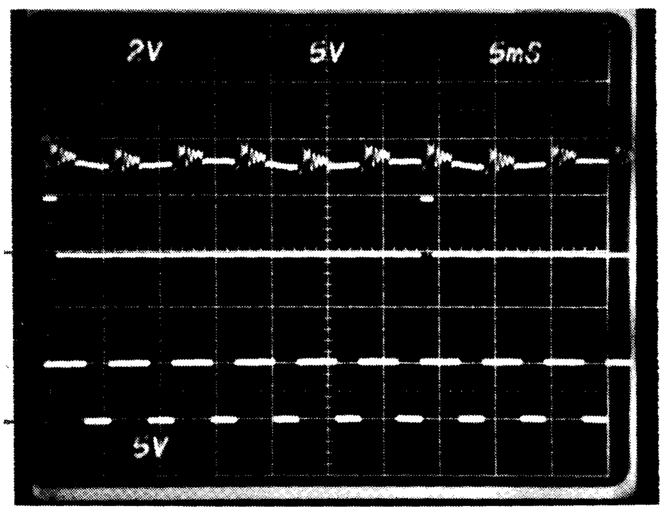


Figure 9-1. ENGINE SYNC and CYLINDER CLOCK (6 Cylinder Engine).

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)

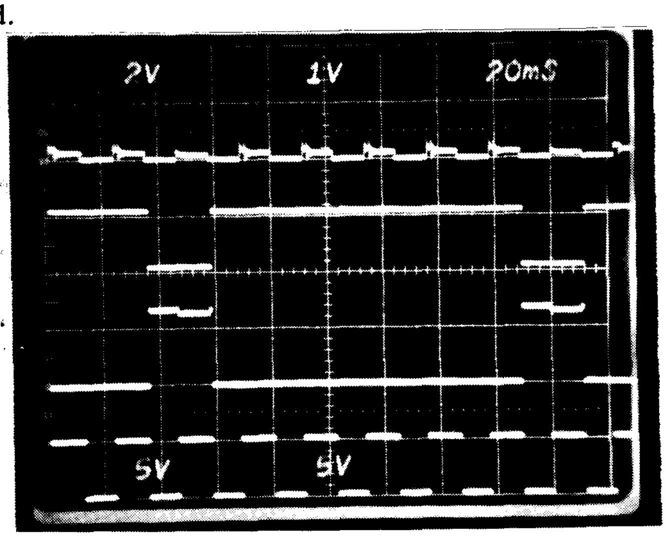
During power balancing; one cylinder is shorted and the RPM drop is measured, then the next cylinder in the firing order is shorted and its RPM drop is measured. The Secondary Trigger Board initiates cylinder shorting by virtue of CYL CLK development. The Primary Processor Board keeps track of which 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

CYL CLK

CYL SELECTED

MS CLOCK



J205, pin A09.

J105, pin C20.

J105, pin A24.

J105, pin A21.

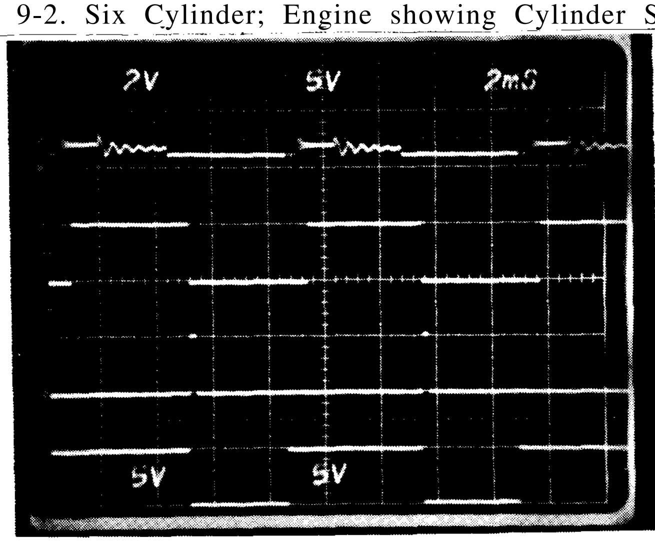
Figure 9-2. Six Cylinder; Engine showing Cylinder Selected.

Primary

CYL Short*

Triac Gate

CYL CLK



J205, pin A09.

J105, pin C21.

J305, pin 4.

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.

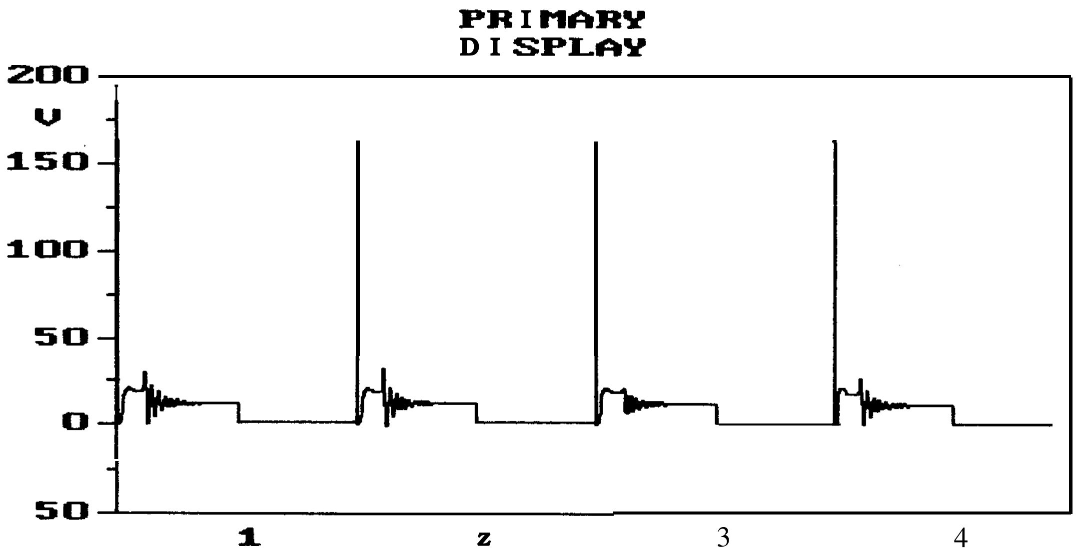


FIGURE 9-4

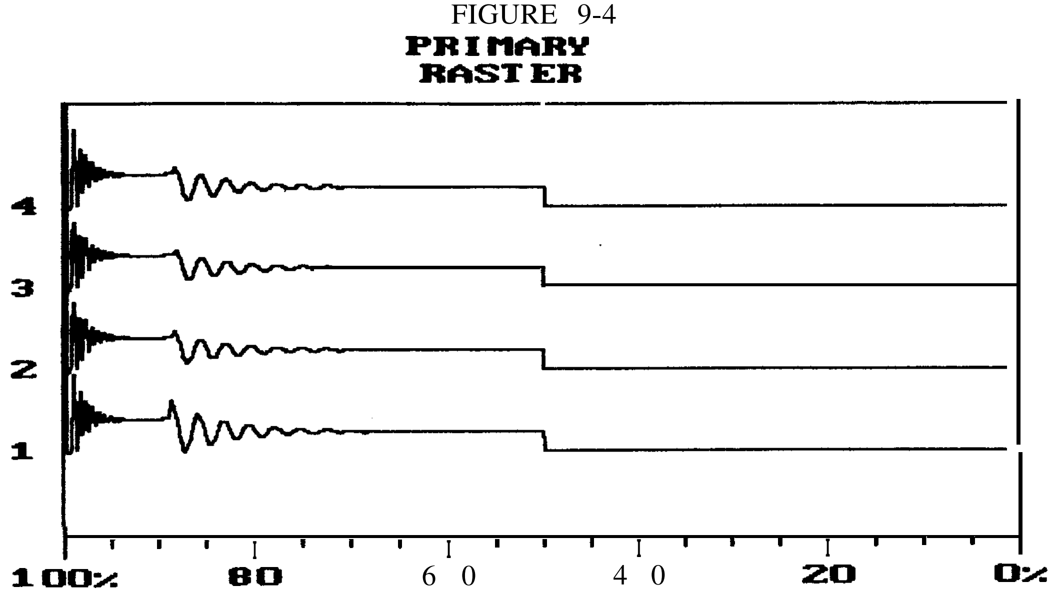


FIGURE 9-5

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.

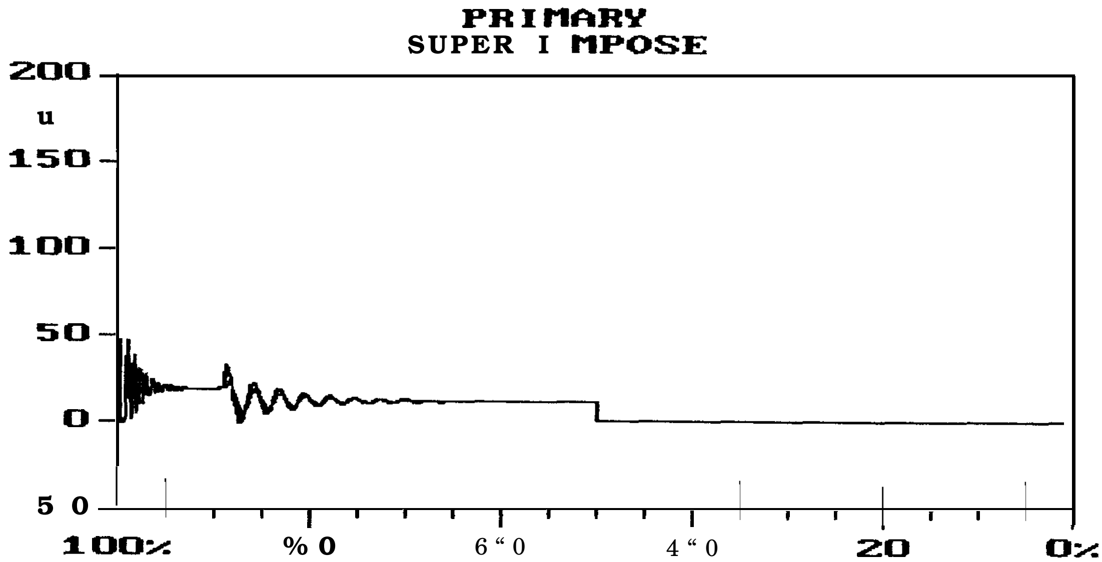


FIGURE 9-6

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 •
• ***************************

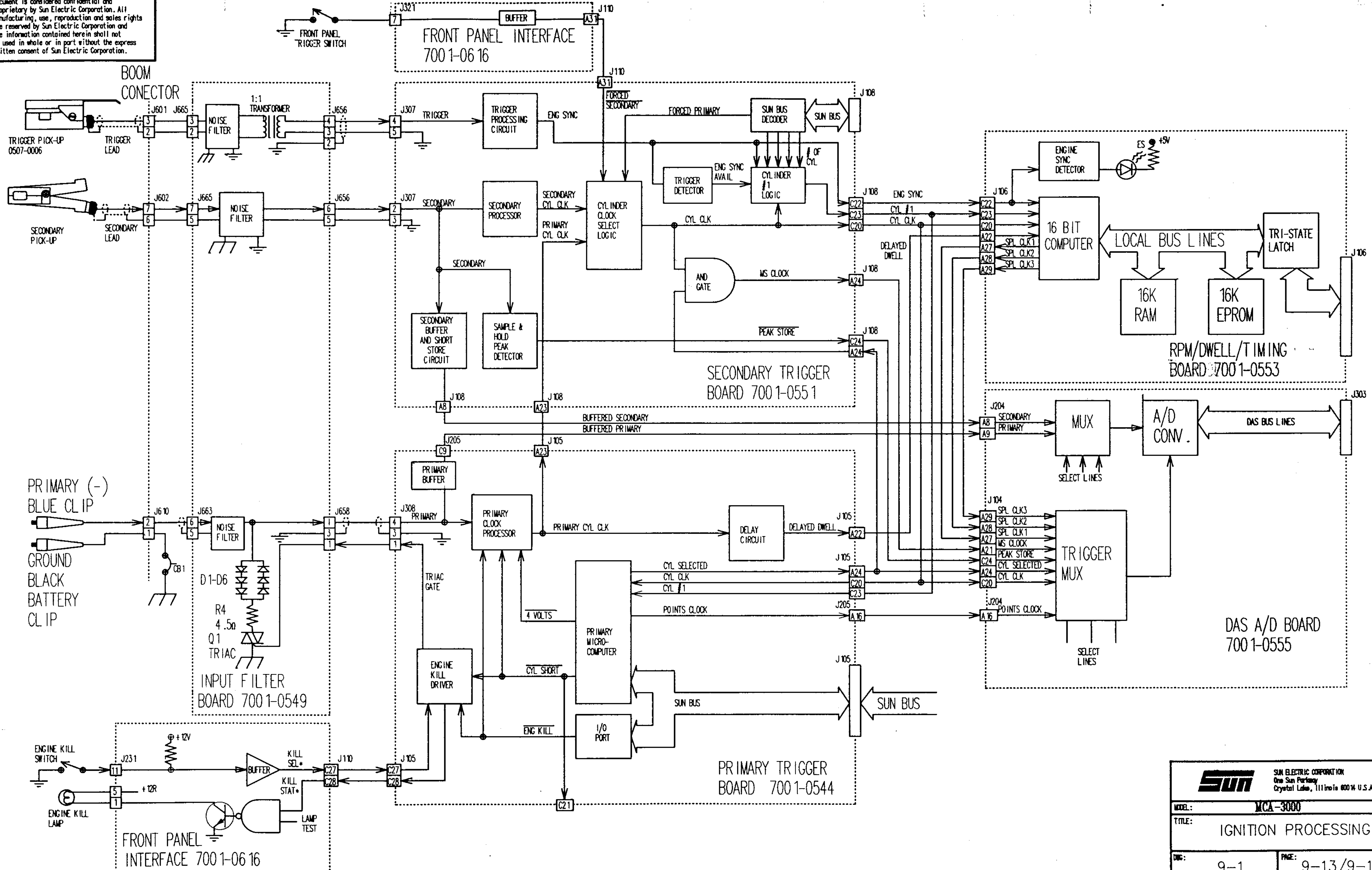
SECTION III. Ignition Processing and Cylinder Shorting Troubleshooting

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.



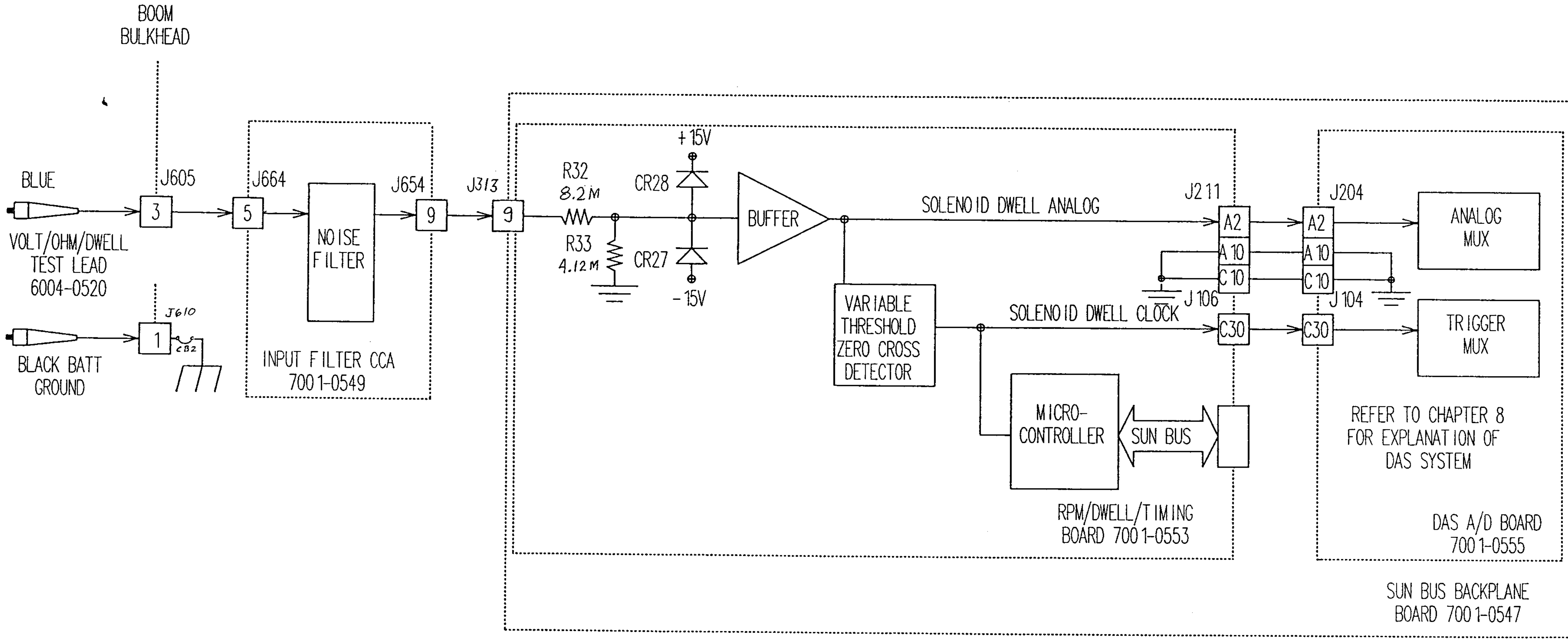
SUN ELECTRIC CORPORATION
One Sun Parkway
Crystal Lake, Illinois 60014 U.S.A.

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 — J308, pin 4.

ENG SYNC — J108, pin C22.

FLASH — J305, pin 4.

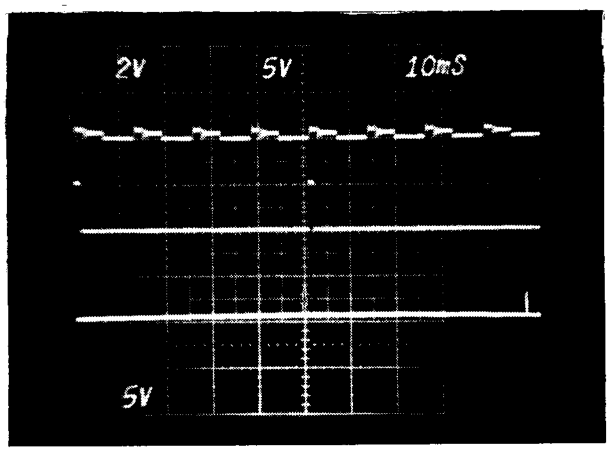


Figure 10-1. Timing Degrees Retarded.

PRIMARY — J308, pin 4.

ENG SYNC — J108, pin C22.

FLASH — **J301,** pin 4.

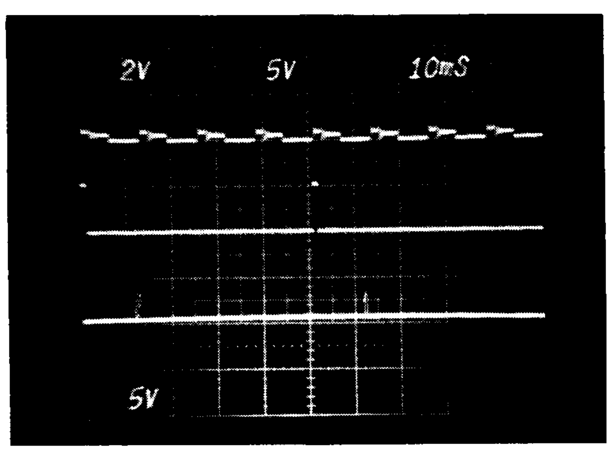


Figure 10-2. 90 Degrees Advance.

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	All	1.6 -68.0	3.8* V -309.0	
Displacements	Displacements	1.9 -68.0	3.3 I -135.0	All
		2.3 OHC -52.5	3.8" V -334.0	Displacements
-9.5	-10.0	2.3 HSC -314.0	4.9 I -135.0	-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 U p 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 t o 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 •

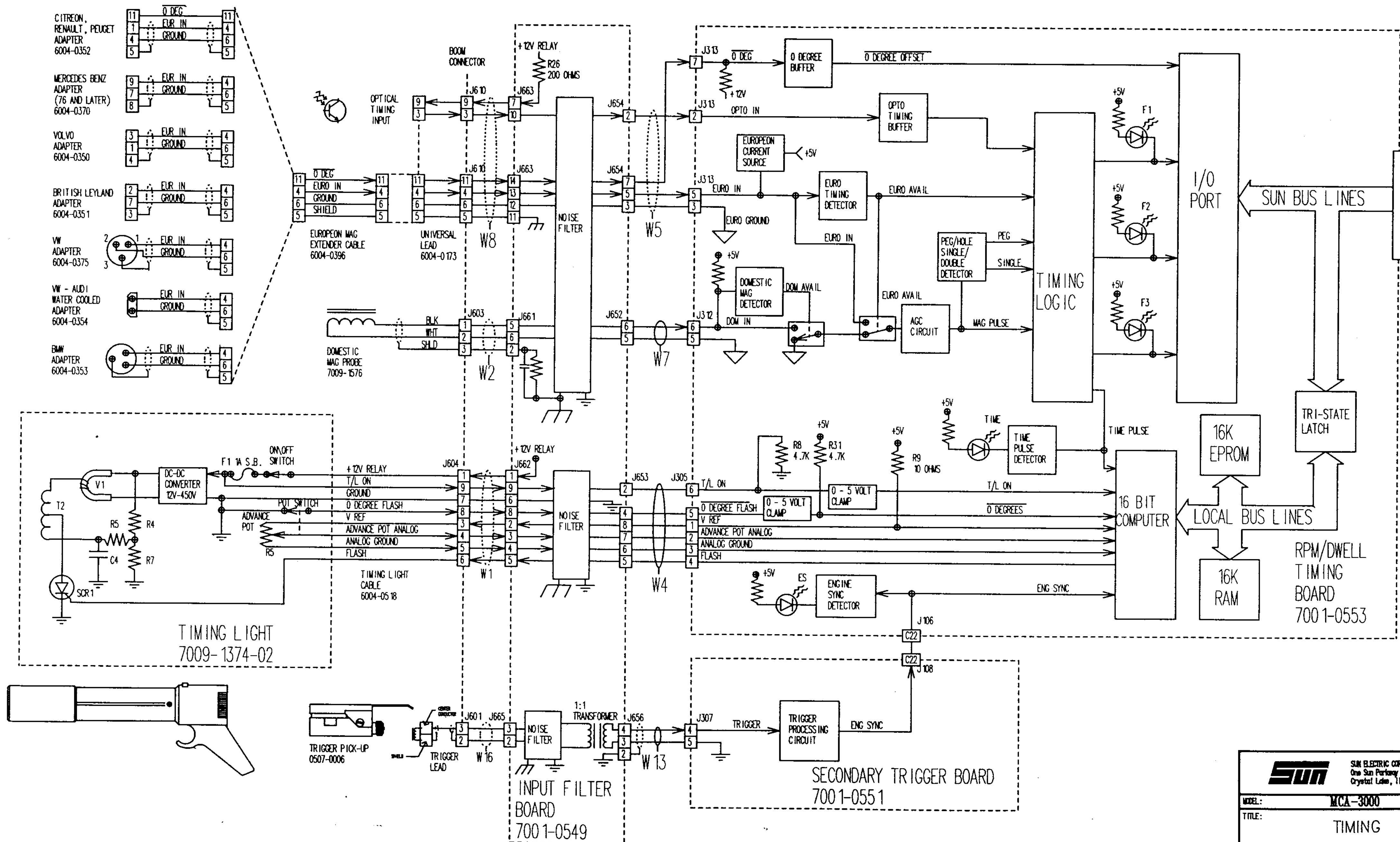
•************************

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.

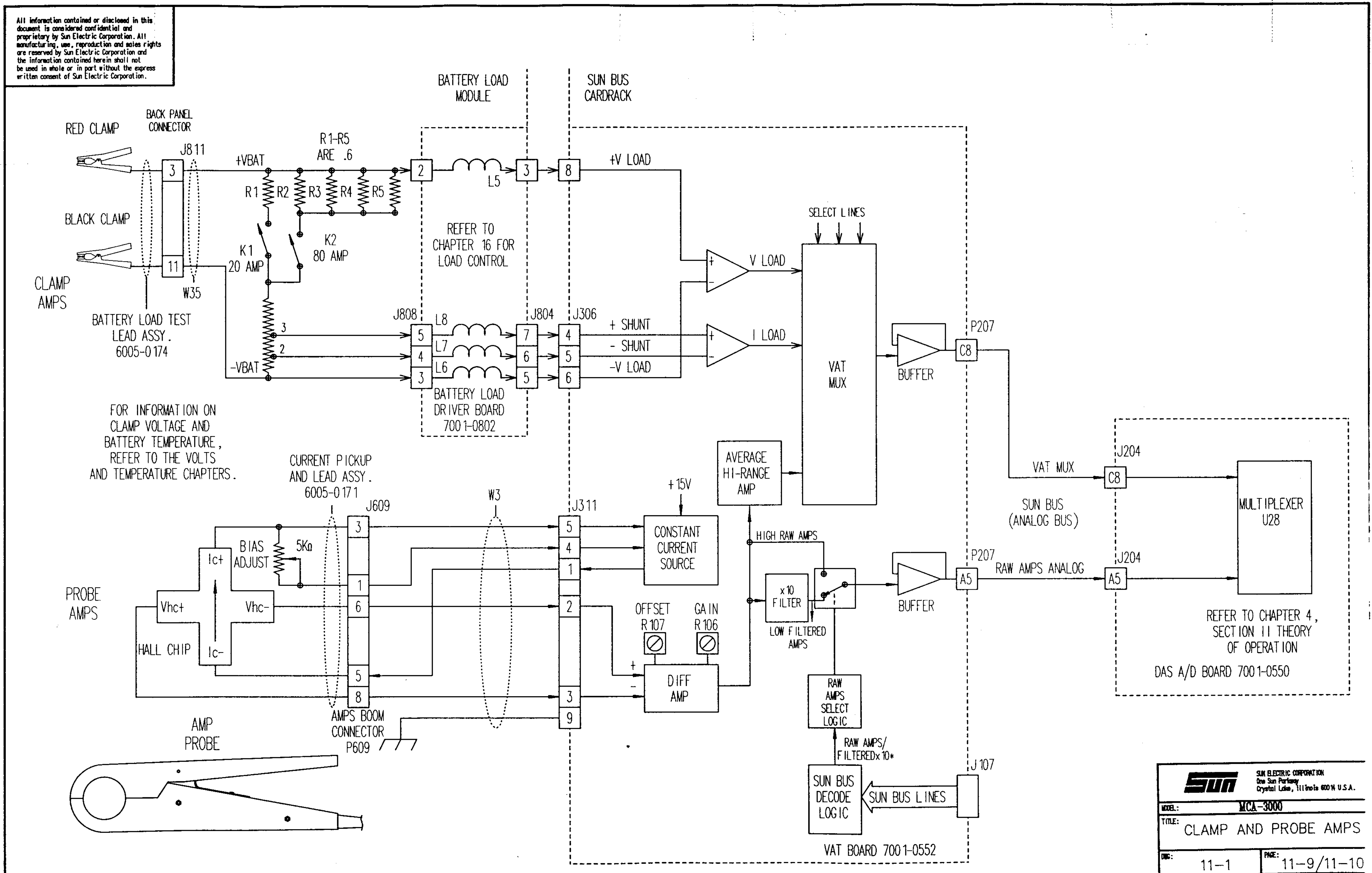
SECTION V. CLAMP AMPS CALIBRATION

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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BATTERY LOAD MODULE
SUN BUS CARDRACK
RED CLAMP
BACK PANEL CONNECTOR
J811
+VBAT
R1-R5 ARE .6
R1
R2
R3
R4
R5
L5
+V LOAD
BLACK CLAMP
K1 20 AMP
K2 80 AMP
REFER TO CHAPTER 16 FOR LOAD CONTROL
SELECT LINES
V LOAD
CLAMP AMPS
W35
BATTERY LOAD TEST LEAD ASSY. 6005-0174
J808
L8
J804
J306
+ SHUNT
- SHUNT
-V LOAD
I LOAD
L7
L6
-VBAT
BATTERY LOAD DRIVER BOARD 7001-0802
VAT MUX
BUFFER
P207
C8
FOR INFORMATION ON CLAMP VOLTAGE AND BATTERY TEMPERATURE, REFER TO THE VOLTS AND TEMPERATURE CHAPTERS.
CURRENT PICKUP AND LEAD ASSY. 6005-0171
J609
W3
J311
+15V
AVERAGE HI-RANGE AMP
VAT MUX
J204
MULTIPLEXER U28
SUN BUS (ANALOG BUS)
CONSTANT CURRENT SOURCE
HIGH RAW AMPS
BIAS ADJUST
5KΩ
Ic+
Vhc+
Vhc-
Ic-
HALL CHIP
PROBE AMPS
x10 FILTER
LOW FILTERED AMPS
RAW AMPS ANALOG
A5
OFFSET R107
GAIN R106
DIFF AMP
RAW AMPS SELECT LOGIC
REFER TO CHAPTER 4, SECTION II THEORY OF OPERATION
DAS A/D BOARD 7001-0550
AMP PROBE
AMPS BOOM CONNECTOR P609
RAW AMPS/ FILTEREDx10*
J107
SUN BUS DECODE LOGIC
SUN BUS LINES
VAT BOARD 7001-0552
SUN ELECTRIC CORPORATION One Sun Parkway Crystal Lake, Illinois 60014 U.S.A.
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 lowlevelPIN POINT 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.

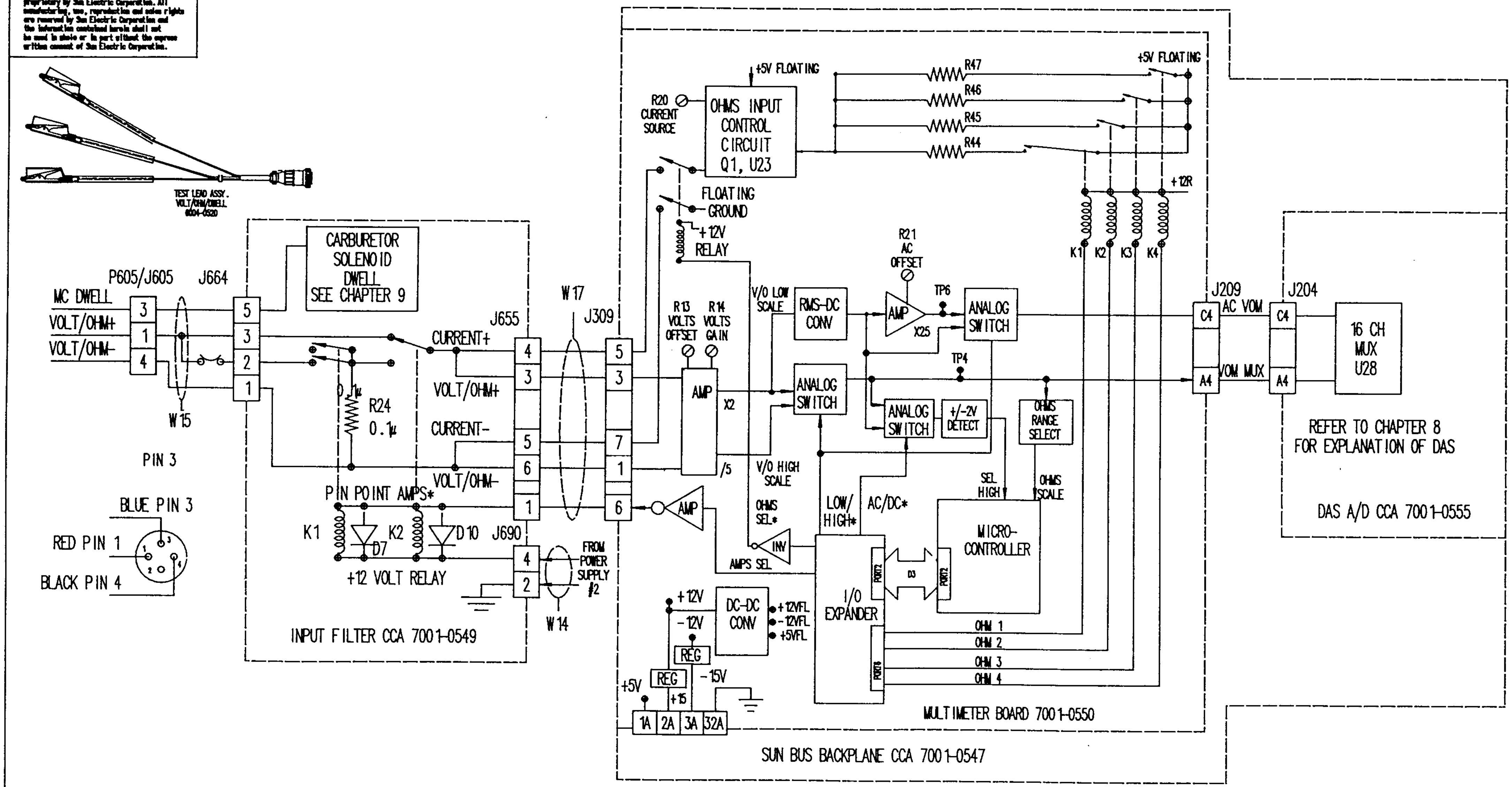
****
" Check-Out/Calibration Complete •
•**********************************

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



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.

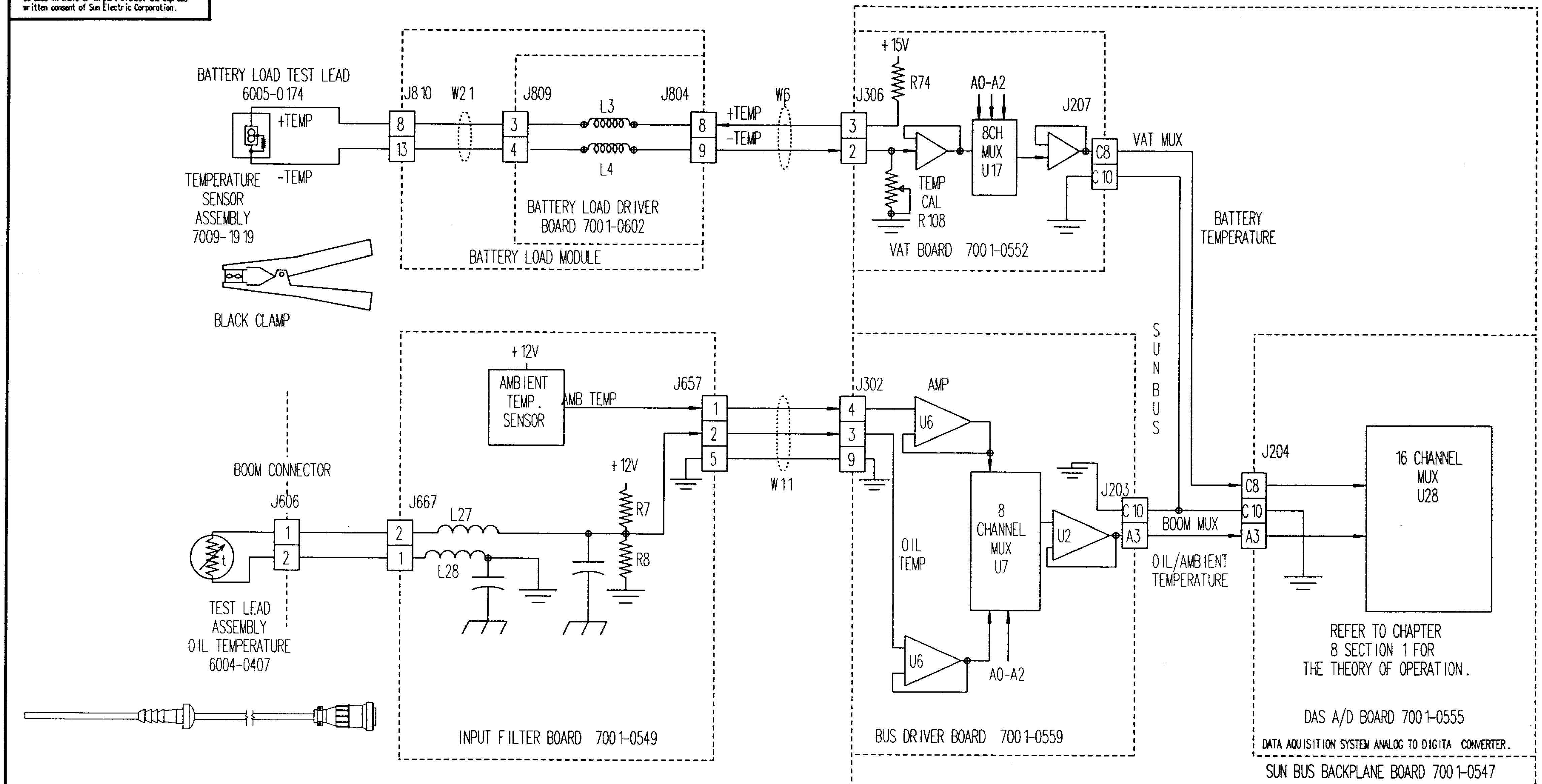
TEMP (C)	TEMP (F)	VOLTS	TEMP (C)	TEMP (F)	VOLTS
10	50.0	7.64	27	80.6	8.12
11	51.8	7.67	28	82.4	8.15
12	53.6	7.70	29	84.2	8.17
13	55.4	7.73	30	86	8.20
14	57.2	7.75	31	87.8	8.23
15	59.0	7.78	32	89.6	8.26
16	60.8	7.81	33	91.4	8.29
17	62,6	7.84	34	93.2	8.31
18	64.4	7.87	35	95	8.34
19	66.2	7.89	36	96.8	8.37
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)

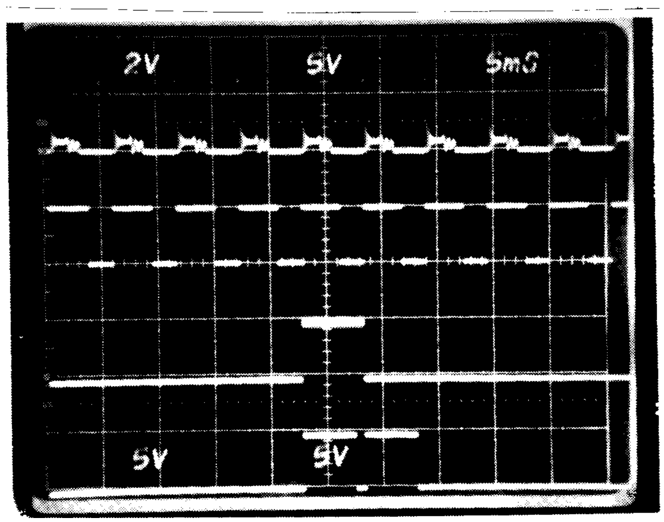
Dynamic Primary Distributor Resistance is the voltage developed across the points when the points are closed. With electronic ignition systems it is the voltage developed across the transistor when the transistor is turned on. Dynamic distributor resistance is obtained during the cranking test. As the 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** •
• ***********************************

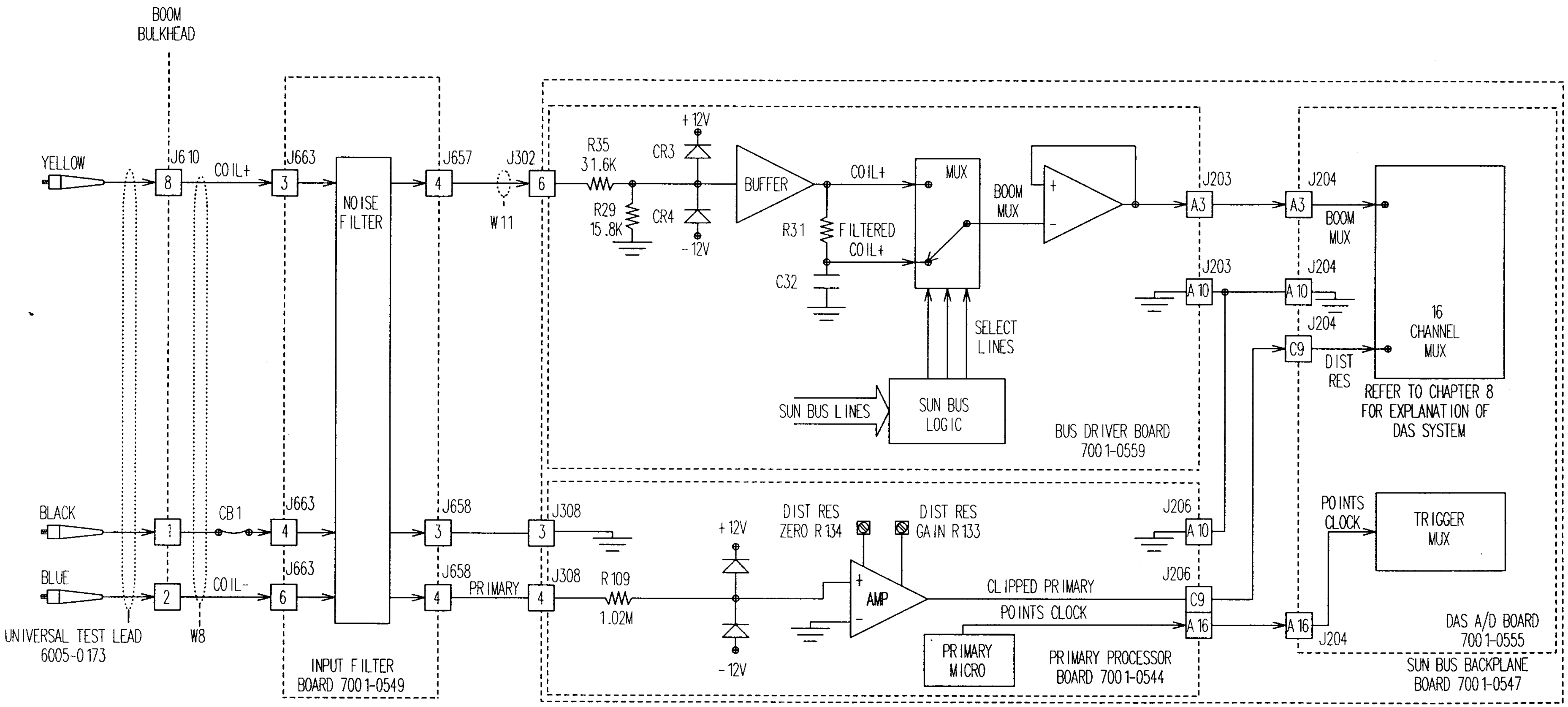
SECTION III. TROUBLESHOOTING

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



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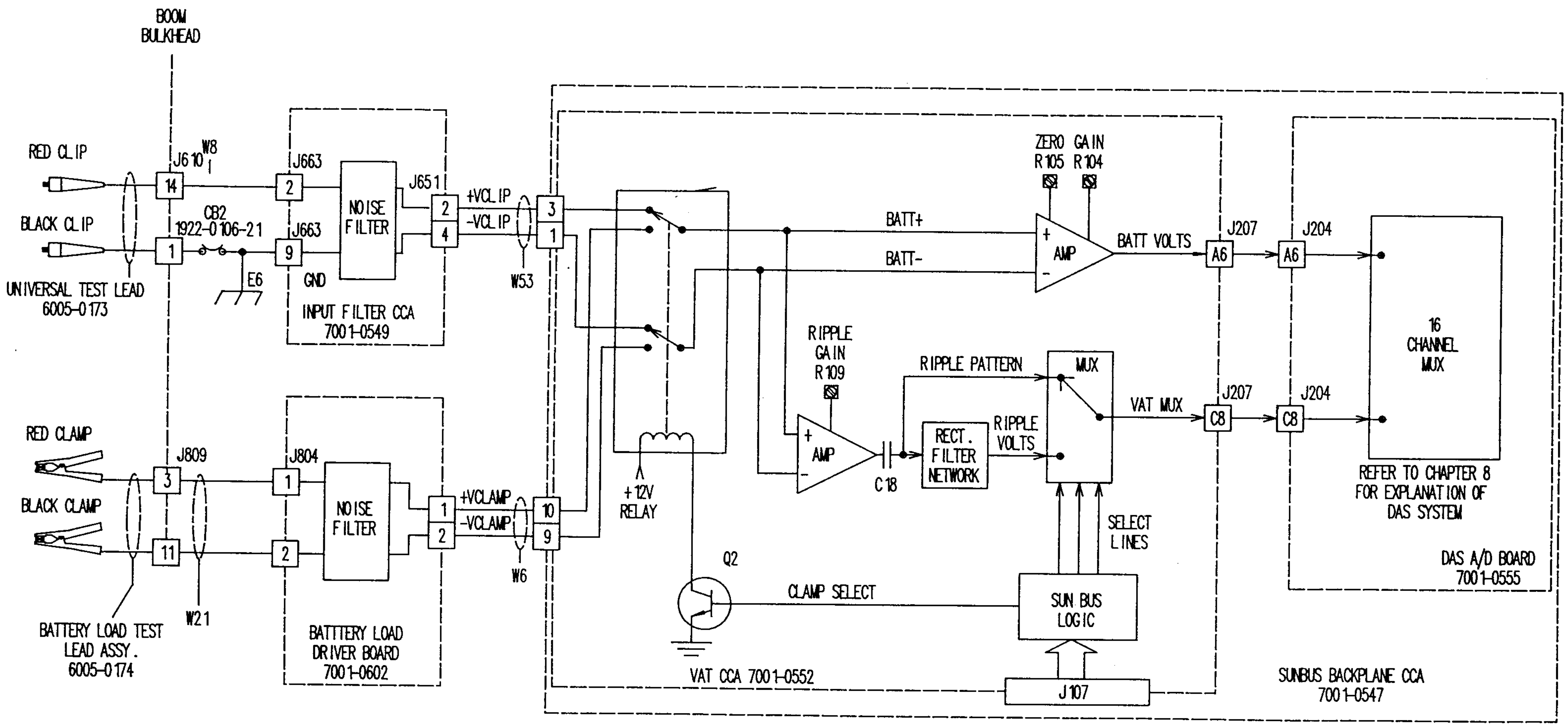
MODEL:	MCA-3000
TITLE:	COIL +/DISTRIBUTOR RESISTANCE
DWG: 14-1	PAGE: 14-9/14-10



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

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.

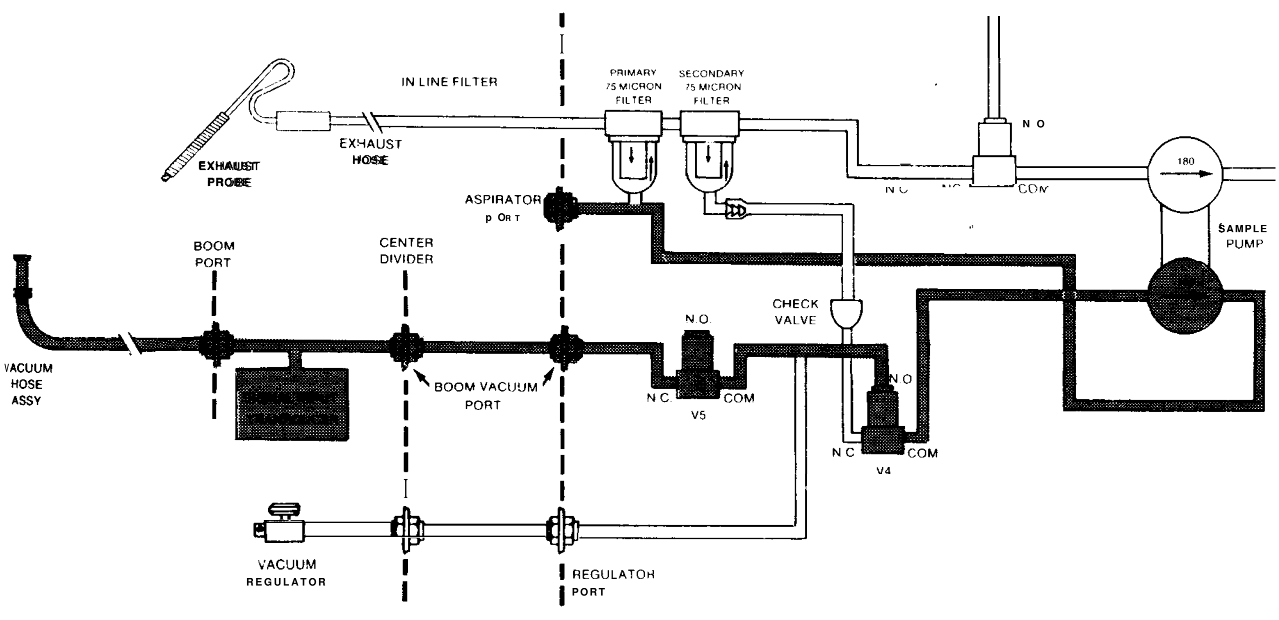


FIGURE 15-1. Vacuum System (pneumatics)

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).

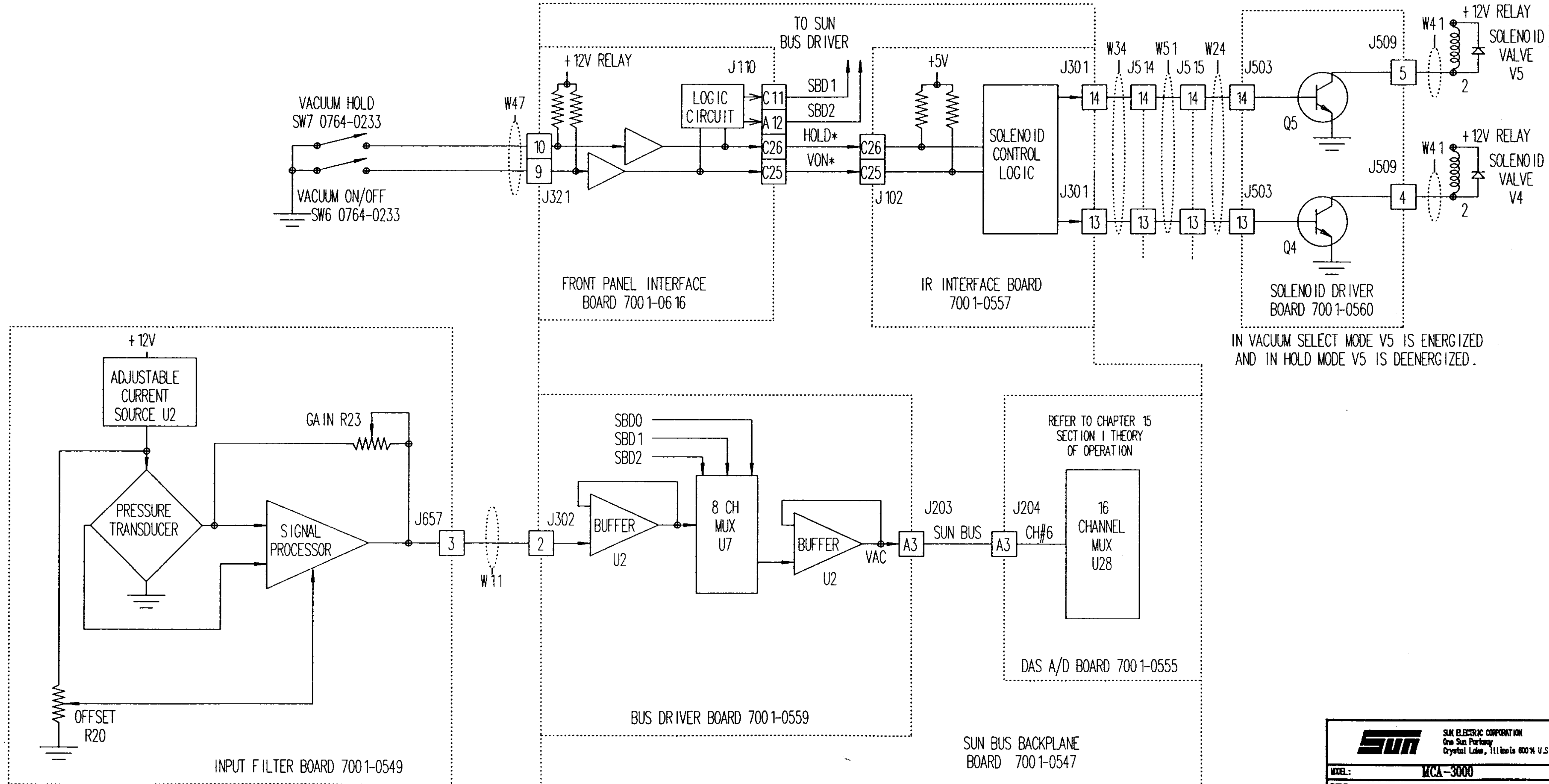
7. DVM should read +3.80 volts +/- 0.01 volts, if not adjust gain variable resistor R23 until the DVM indicates +3.8 (+/- 0.01) volts. Remove vacuum source to allow calibration.

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 *
****

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.



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

MODEL: MCA-3000

TITLE: VACUUM FUNCTIONAL BLOCK

DWG: 15-1

PAGE: 15-5/15-6

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.

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

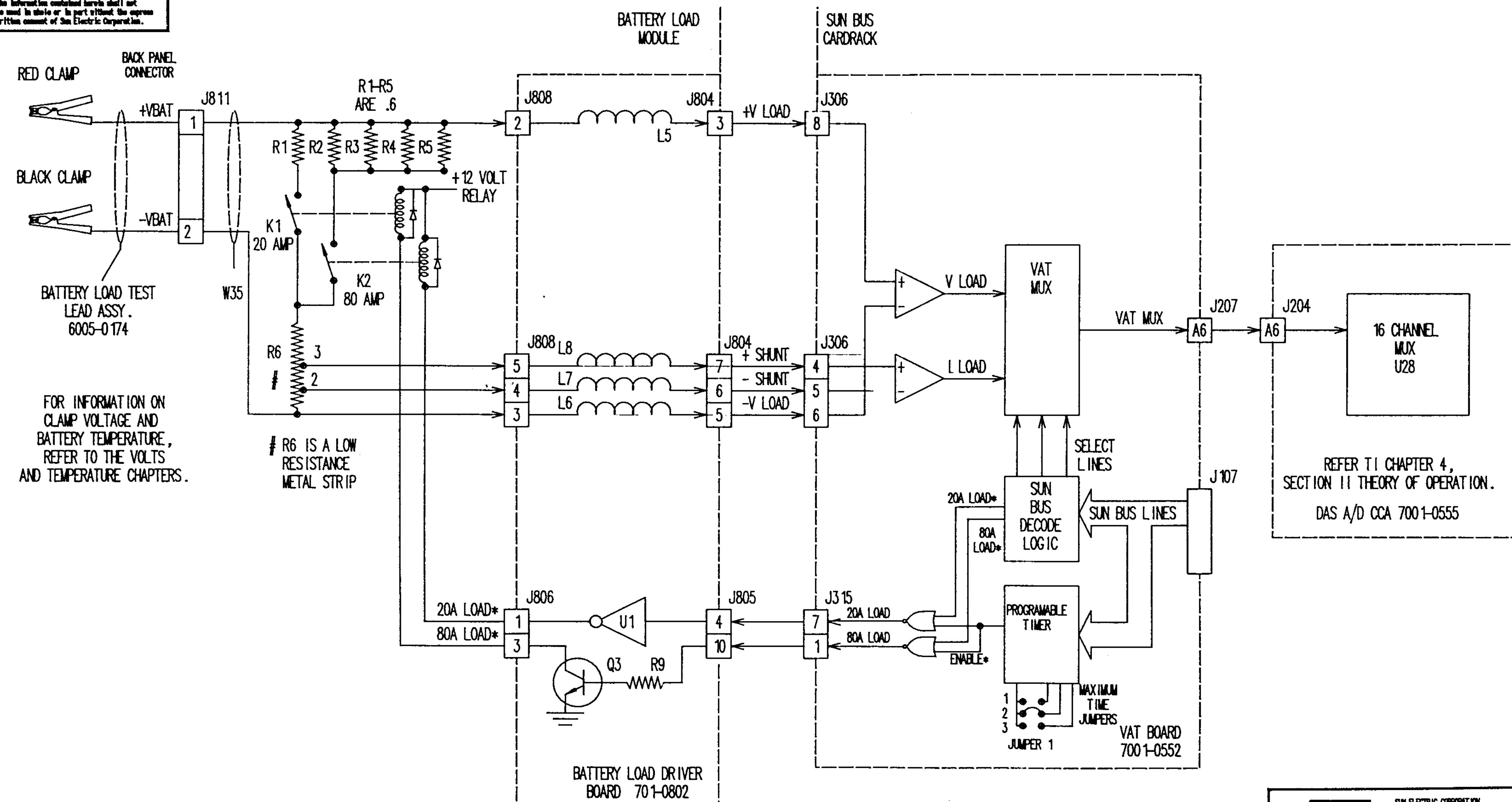
* Checkout Complete *

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

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 NO NO: Refer to Chapter 2, DC Power. YES: Does 20A LOAD* on J806-1 go low during loading? YES NO NO: Does 20A LOAD on J805-4 goes high during load? YES NO NO: Substitute Vat Board #7001-0552 YES: Sustitute Battery Load Driver Board 7001-0802. YES: Susbstitute 20 Amp Relay 0783-0326. 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 NO NO: Refer to Chapter 2, DC Power. YES: Does 80A LOAD* on J806-3 go low during loading? YES NO NO: Does 80A LOAD on J805-10 goes high during load? YES NO NO: Substitute Vat Board #7001-0552 YES: Sustitute Battery Load Driver Board 7001-0802. YES: Susbstitute 80 Amp Relay 0783-0324. 2. Refer to theory of operation and Funtional Block Diagram.

NOTES



SUN ELECTRIC CORPORATION
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_2/0_2

SECTION I. HC/CO/$C0_2$ 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-->C02-->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 <u>stability</u> 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.

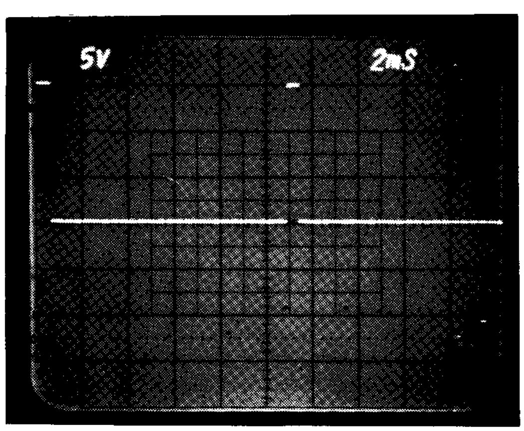


Figure 17-1. Dark Level Test Point (DLTP) Signal Waveform.

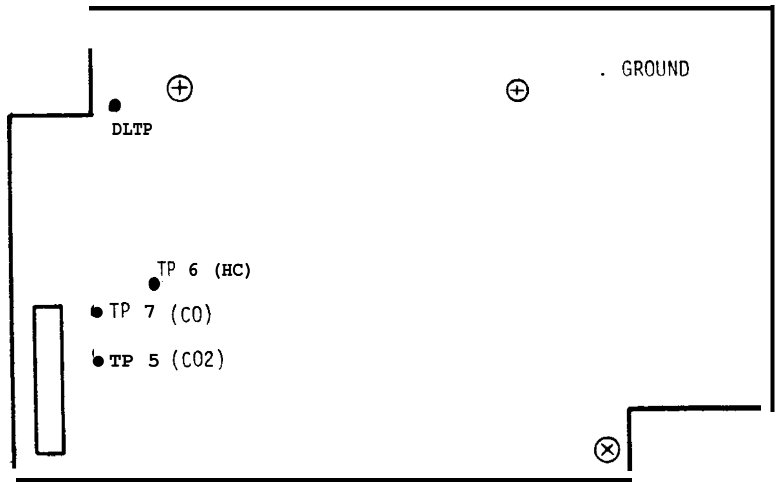


Figure 17-2. Gas Channel Test Point Location.

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

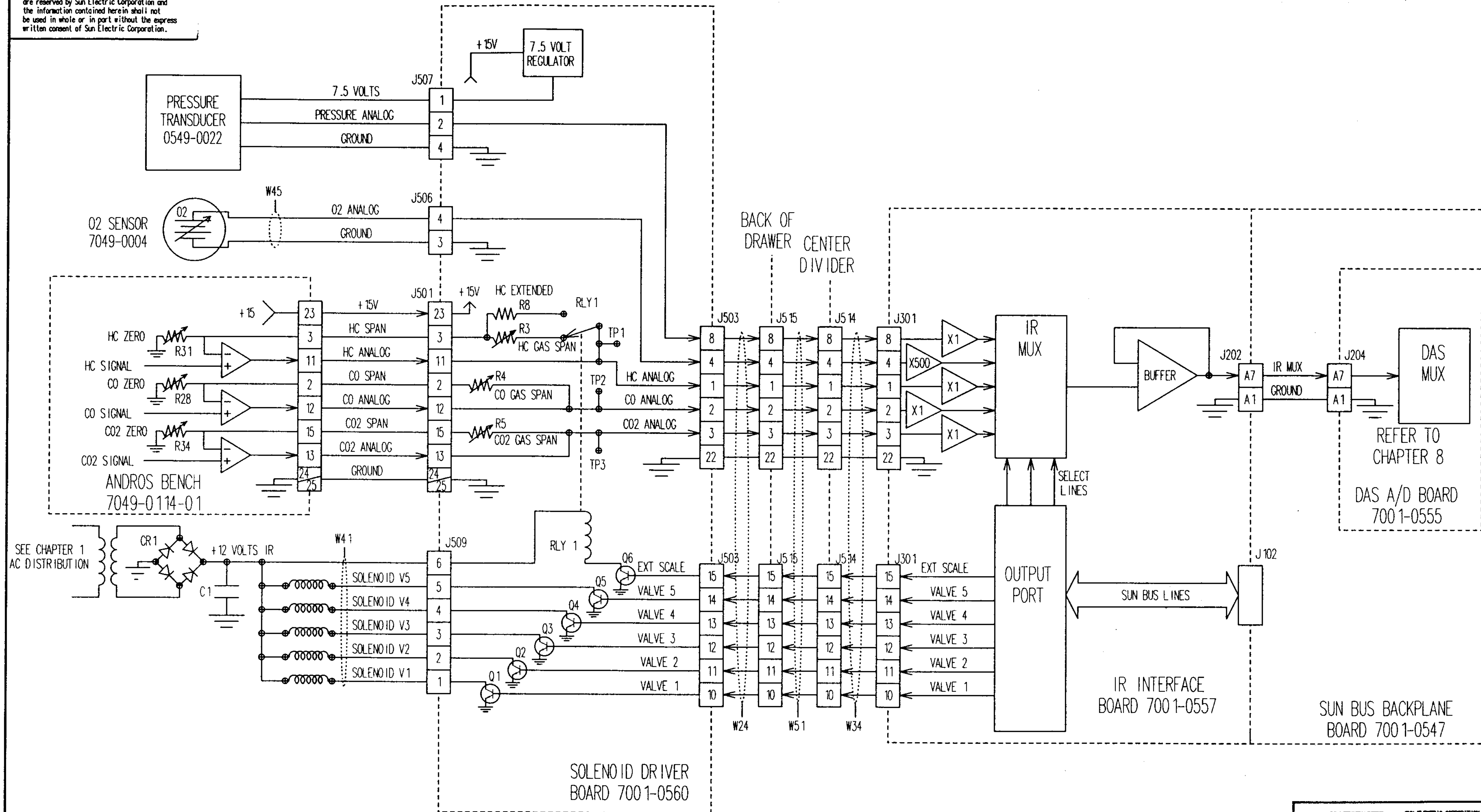
The low flow switch, installed within the Exhaust Analyzer Assembly, informs the computer and controls operation of the front panel LOW FLOW lamp whenever the pneumatic system is restricted. The most typical restriction results from infrequent changing of the primary and secondary filter elements.

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

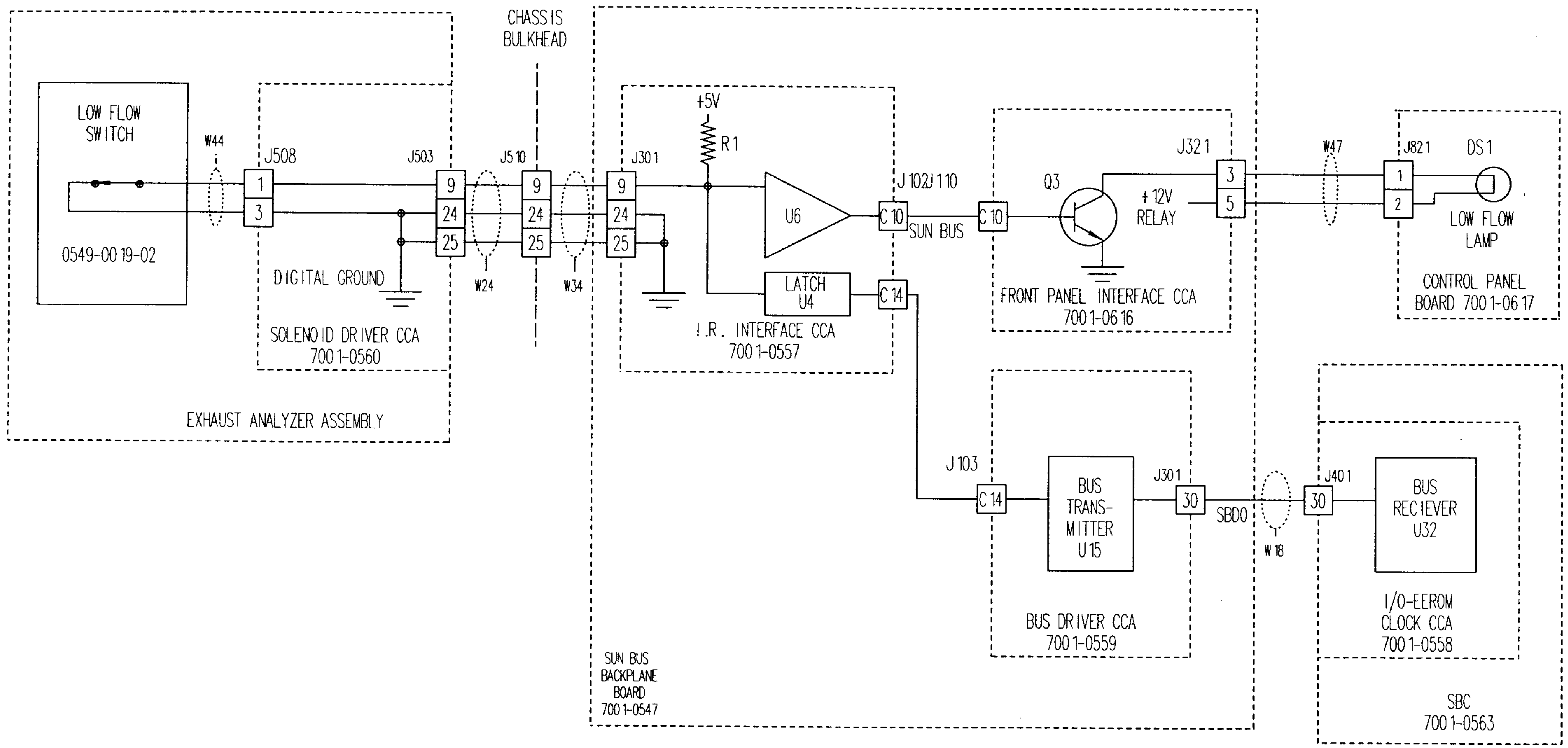
COMPLAINT	CORRECTIVE ACTION
I. LOW FLOW lamp does not light when pneumatic blockage occurs. LOW FLOW message flashes on Video Display Unit.	1. Check for virtual ground at J321 pin 3. If present, replace LOW FLOW lamp. If not present, proceed to step 2. 2. Check for high level signal between J102-C1O 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.

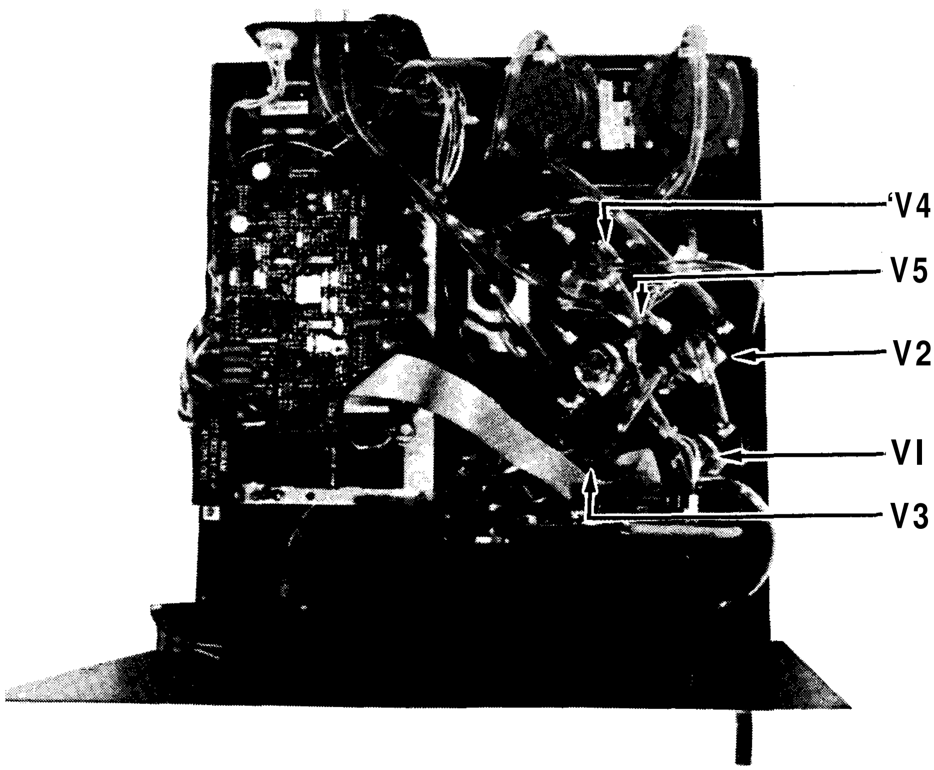


Figure 18-1. Solenoid Valve V1-V5, Location Diagram.,

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** *

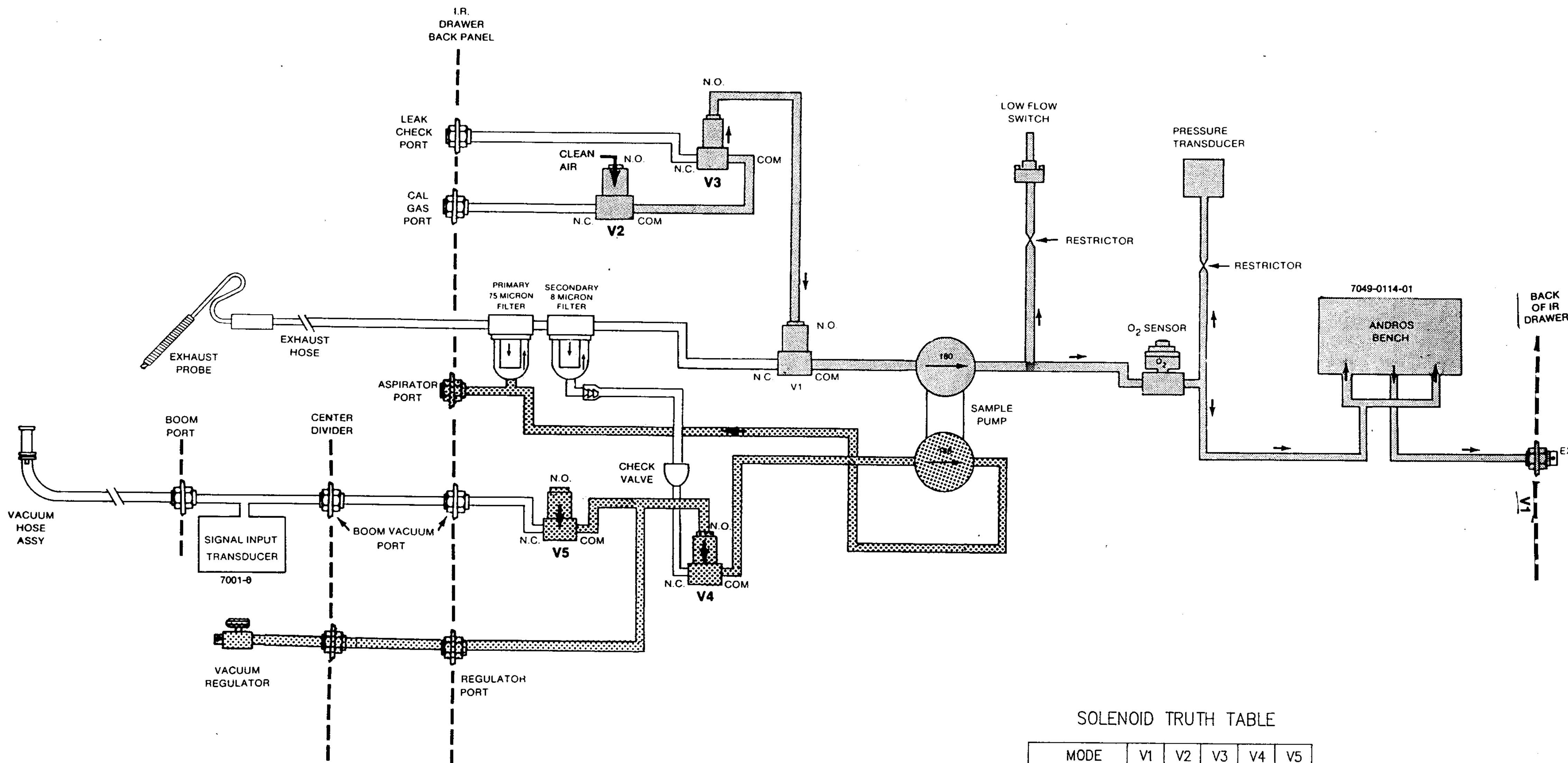
****

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

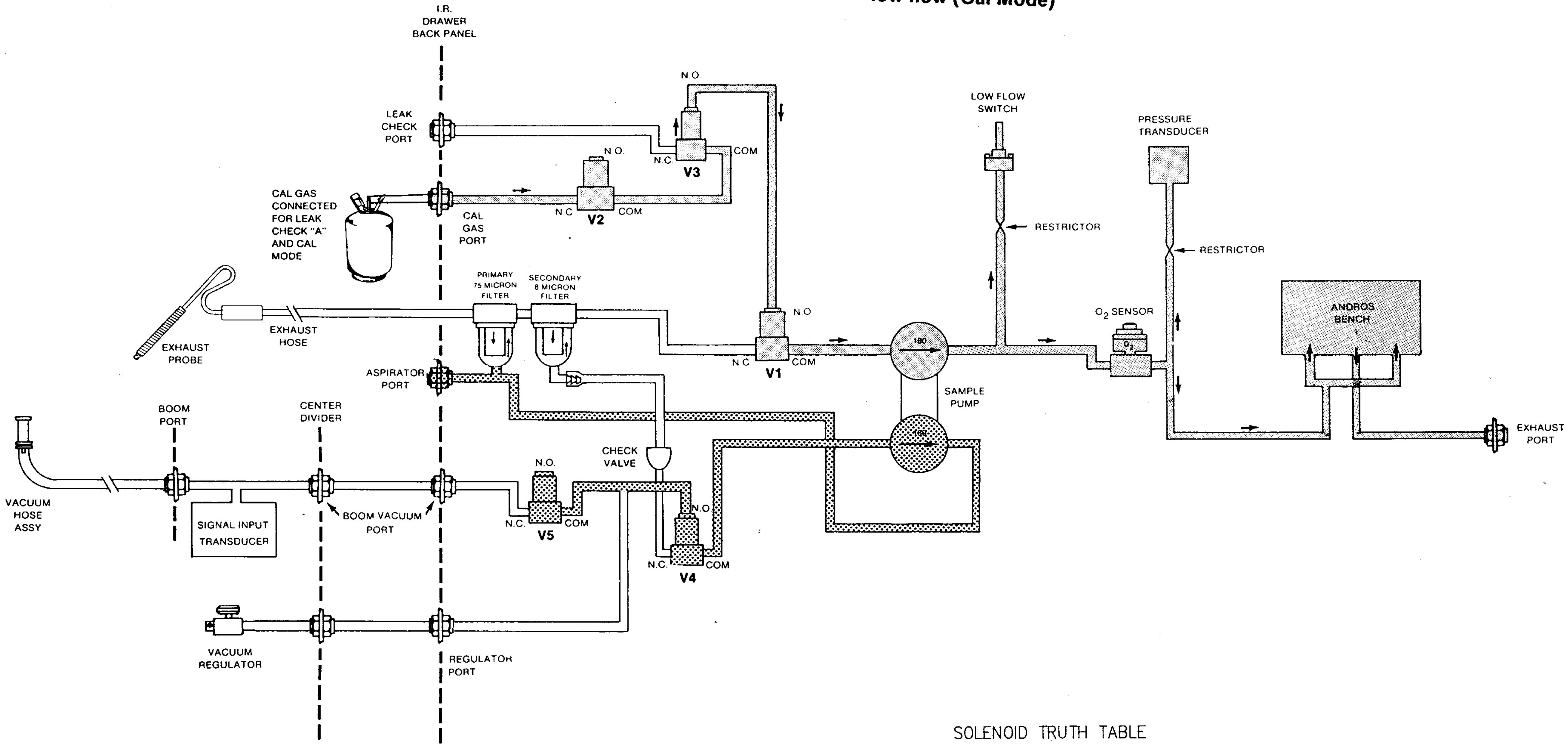
TITLE: PNEUMATIC DIAGRAM, ZERO/VAC HOLD MODE CONFIGURATION

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.

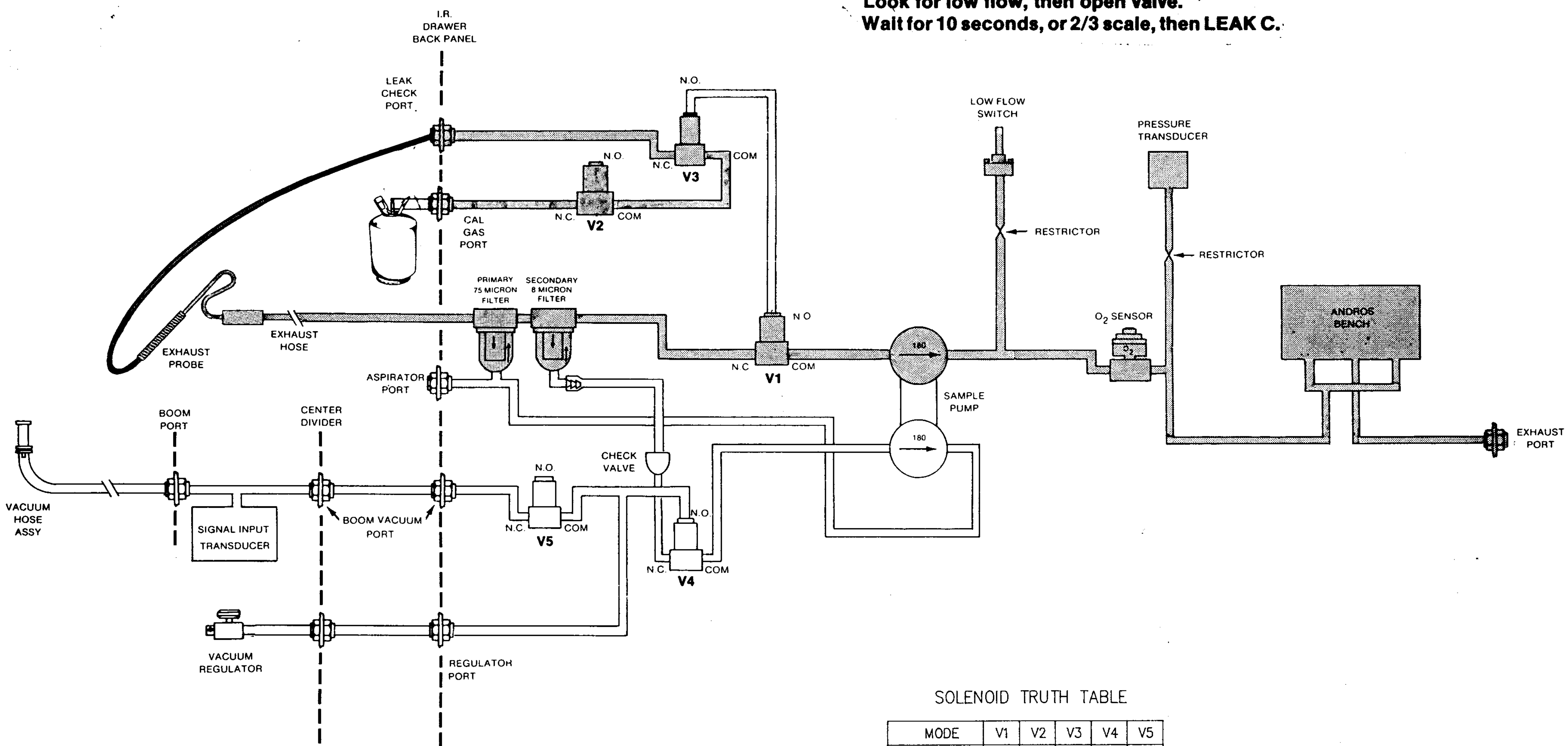
MODEL: MCA-3000

TITLE: PNEUMATIC DIAGRAM, CALIBRATION/LEAK CHECK "A" MODE CONFIGURATION

DWG: 18-2

PAGE: 18-13/18-14

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.

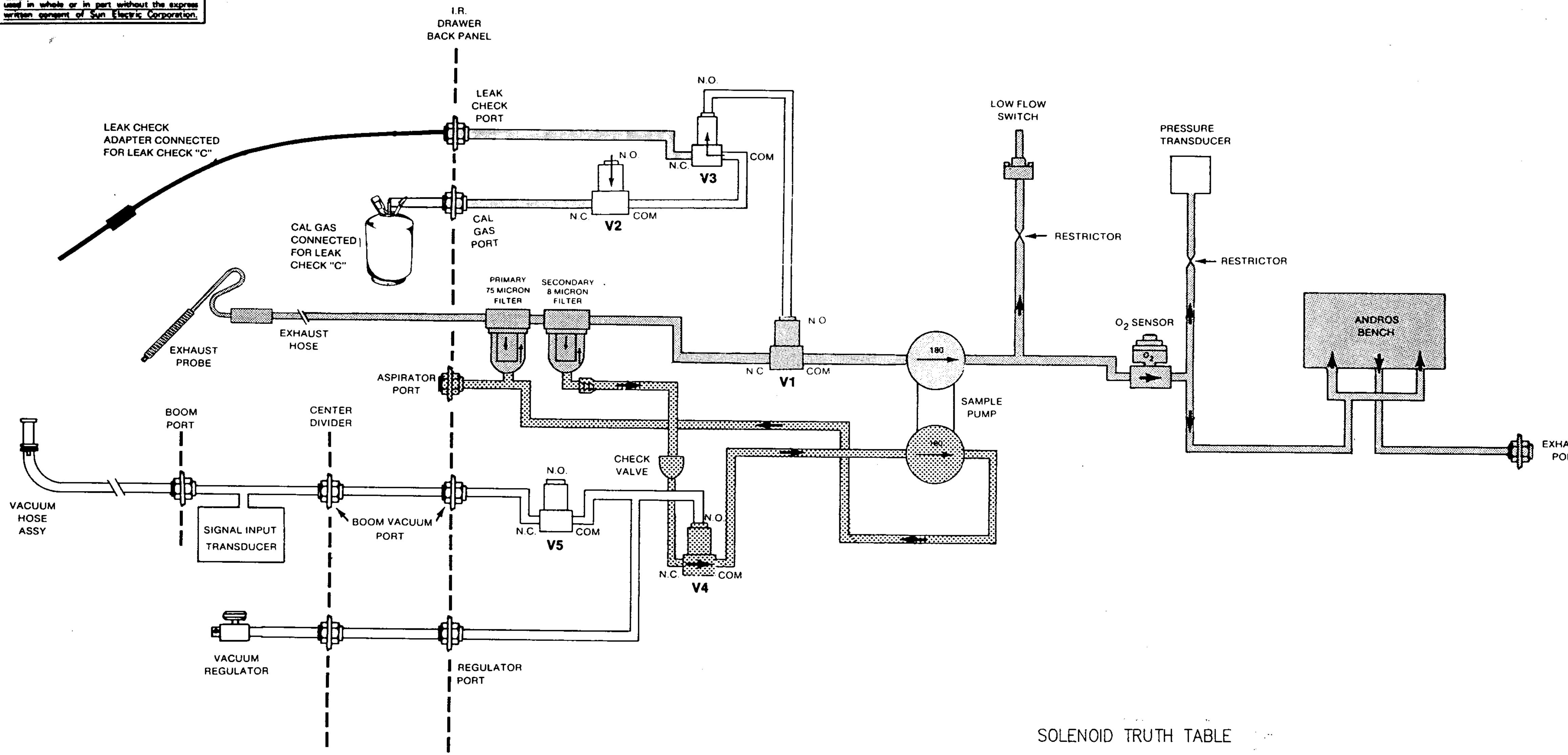


SOLENOID TRUTH TABLE

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



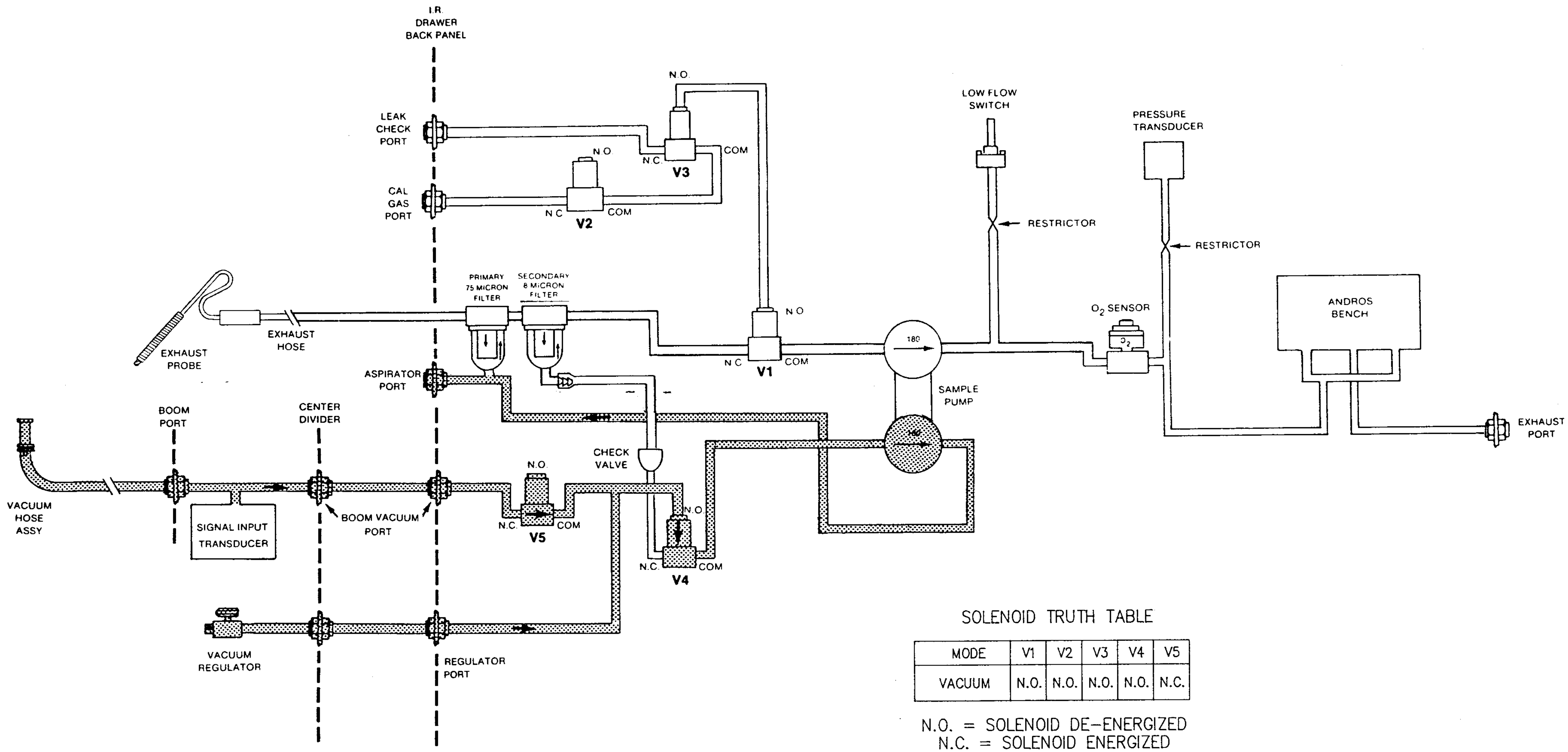
SOLENOID TRUTH TABLE

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: 18-17/18-18



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

   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

   NO: Try a new MCA MASTER PROGRAM DISK.

   YES: Re-insert the MCA's LIMITS Disk into Drive "B" and try to load a vehicle code. Can a code be entered ?
   YES NO

   NO: Refer to Chapter 3, Section III, Troubleshooting on page 3-14.

   YES: Drive B is functioning properly try a different ALDL disk. If this disk works, replace the other disk.

   YES: 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

   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.

   YES: 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 ↓

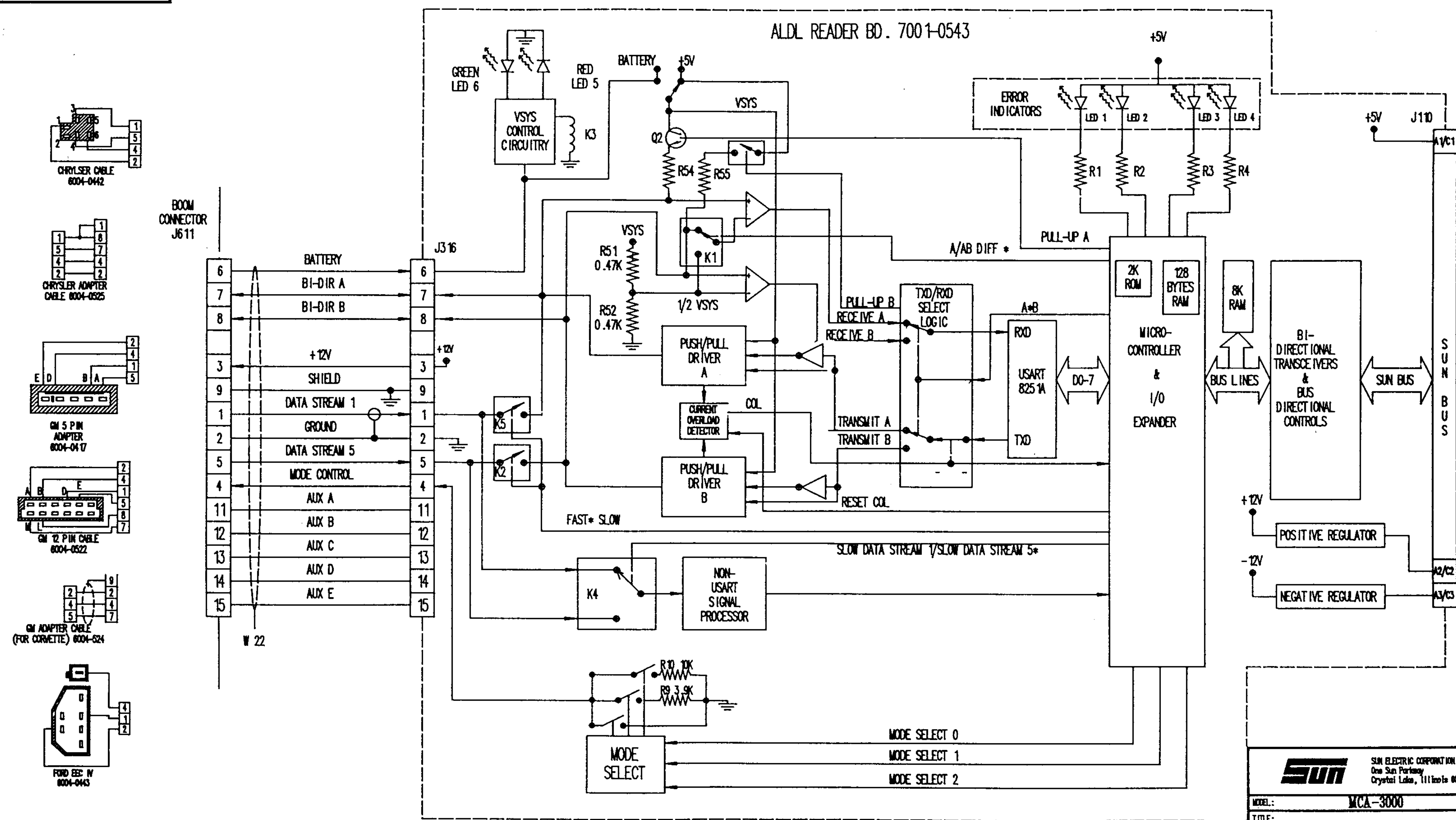
   ------------SUBSTITUTE-------------
   1. The ALDL Board 7001-0543.
   2. The BUS DRIVER Board 7001-0559.
   3. The I/O EEPROM CLOCK Board, 7001-0558.

   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
Crystal Lake, Illinois 60014 U.S.A.

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 1/4-inch Disk Drive (if present) and can run IBM compatible software for the 5 1/4-inch Disk Drive. For more information see Chapter 3.

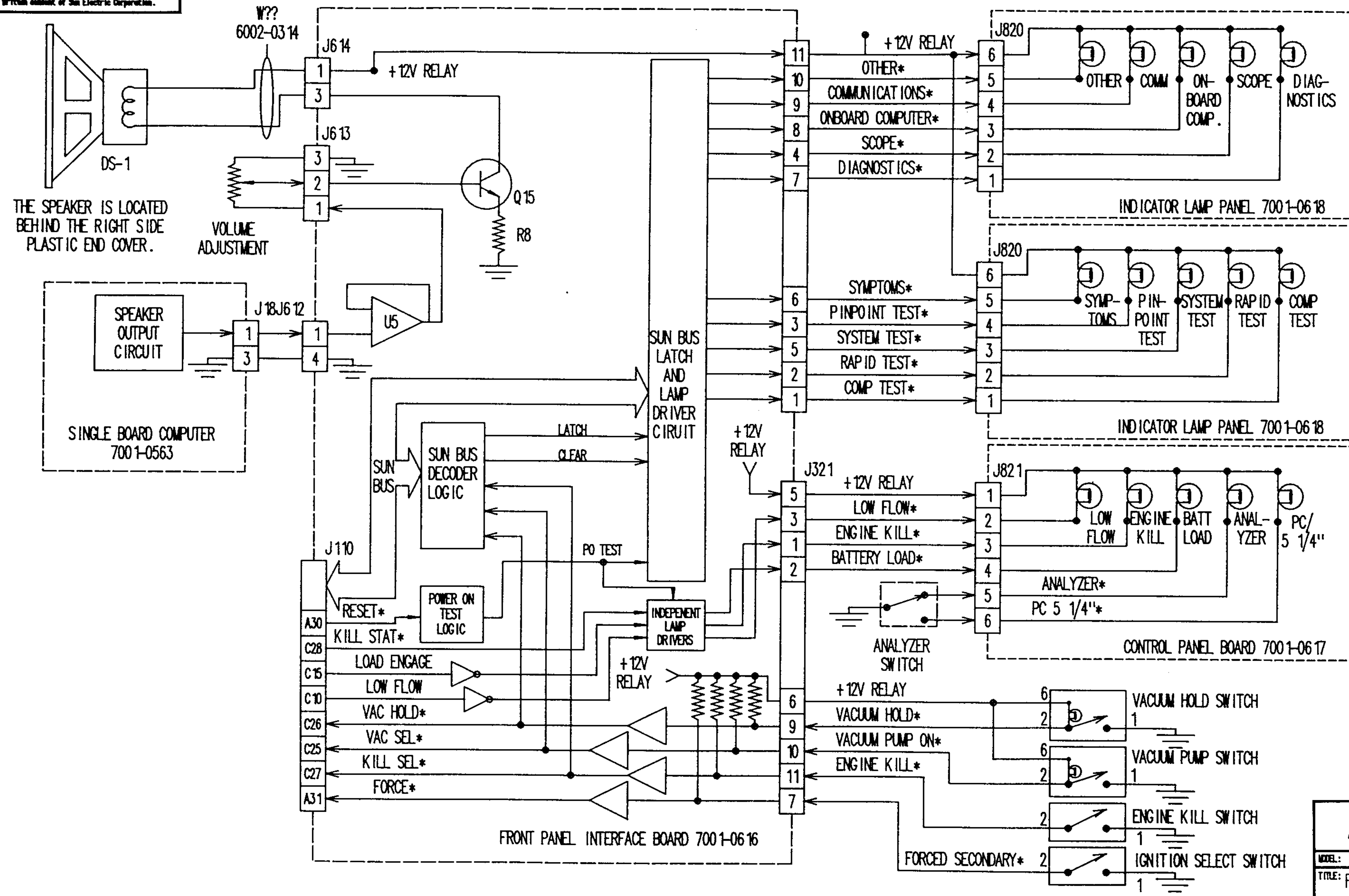
RESET Pushbutton. Momentary depression of this pushbutton switch forces the MCA's SBC to reset. This will cause a resetting of the MCA to its program starting location, thus causing the tester to reboot. For more information see Chapter 3.

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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MODEL: MCA-3000

TITLE: FRONT PANEL LAMP AND SWITCH INTERFACE

DWG: 20-1

PAGE: 20-7/20-8

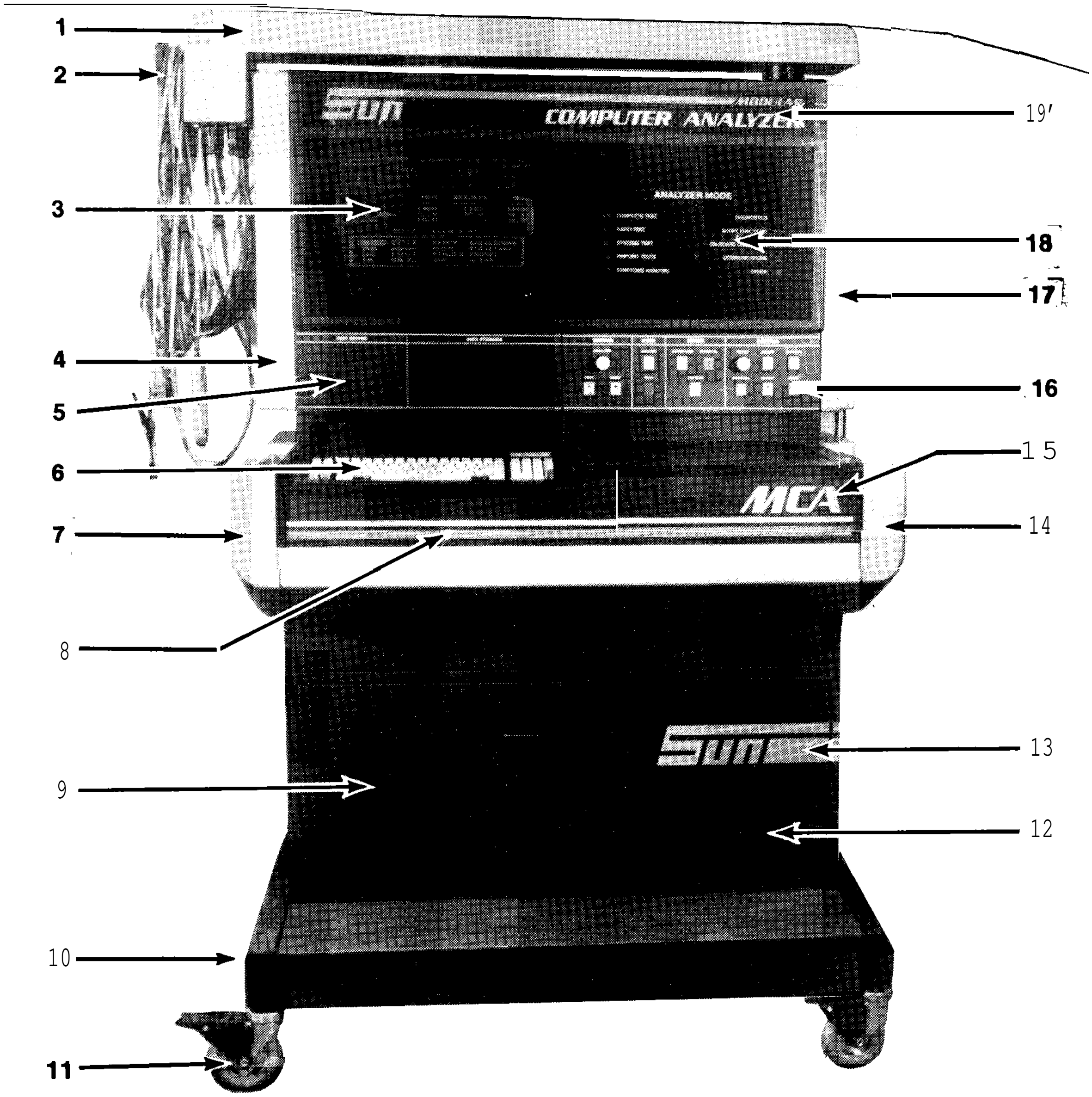
CHAPTER 21

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.

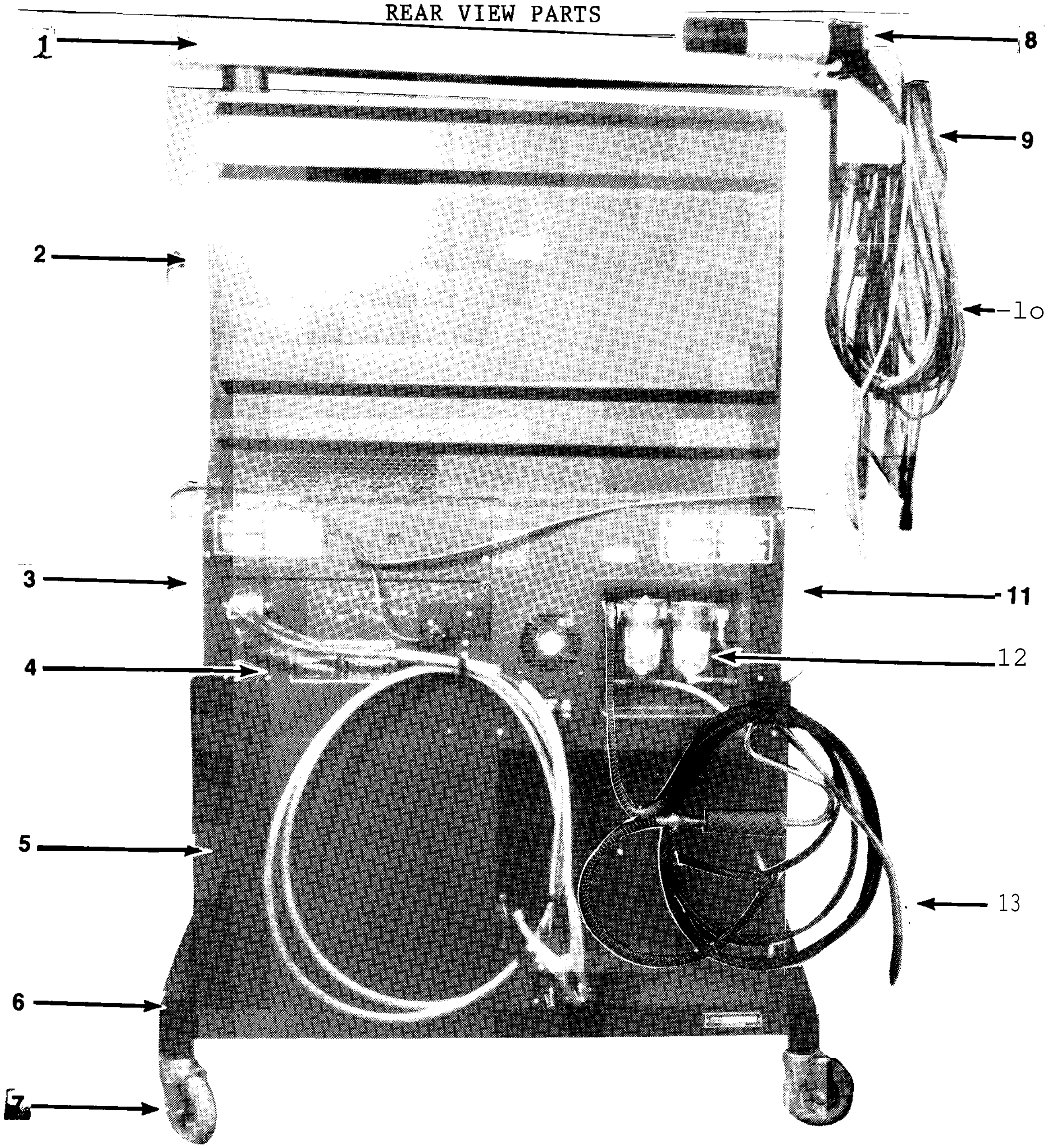
Table of Contents

FRONT VIEW PARTS DIAGRAM



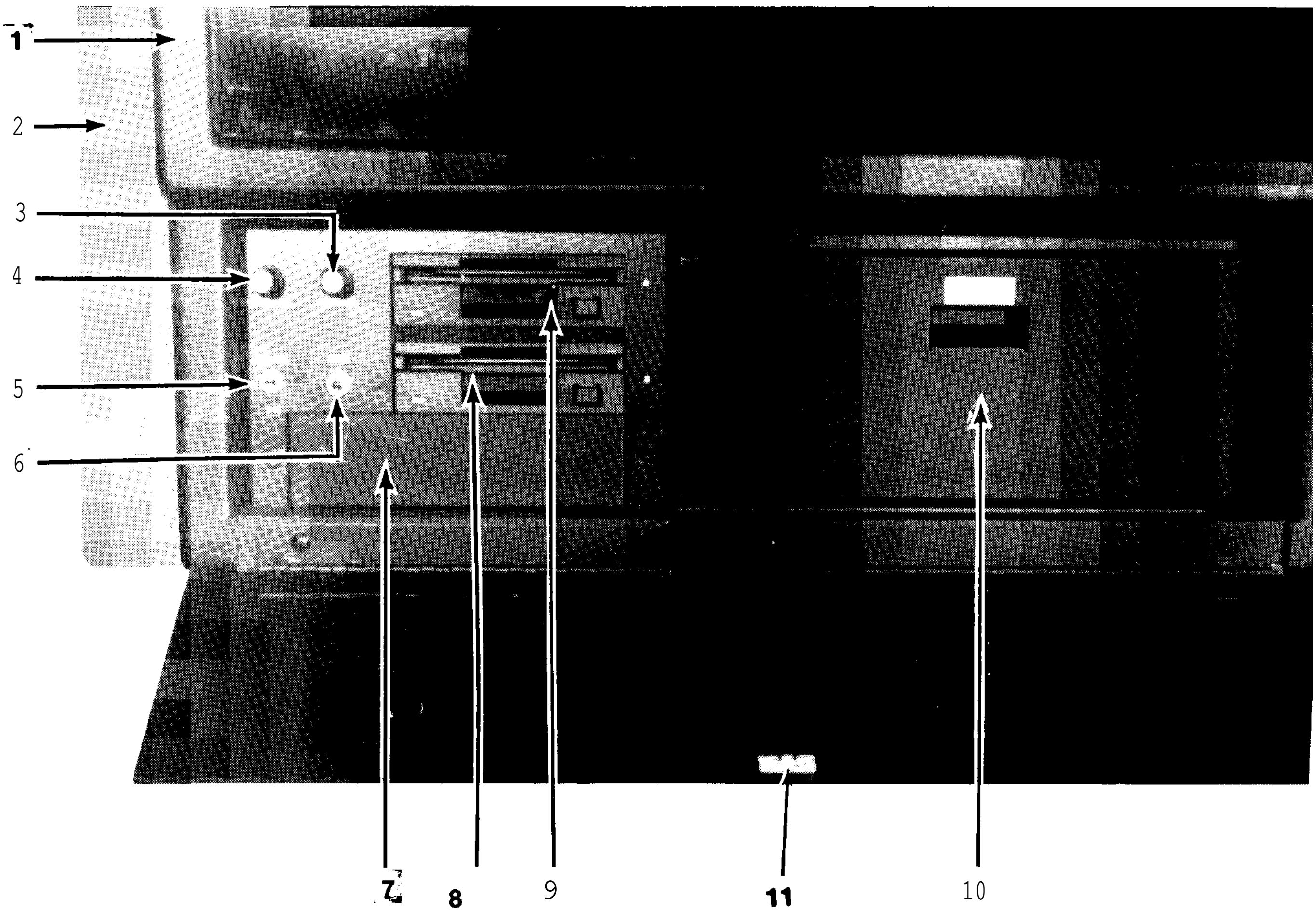
1. Boom Weld Assy . . . . . . See Pg 21-3
2. Cable Manag. Cover.. 7054-0106
   Connector Plate 7003-0572
3. Monitor Color 0859-0409
   Filter Plexiglass... 7030-0163
4. L.H. Upper Cover 7054-0090
5. Door, Disk Drive 7009-1917
   Latch Set 5666-0032
6. Keyboard Ashy 0552-0030
7. L.H. Lower Cover 7054-0092
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 110V.. 0764-0229
    I.R. Pump SW3 110V. 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



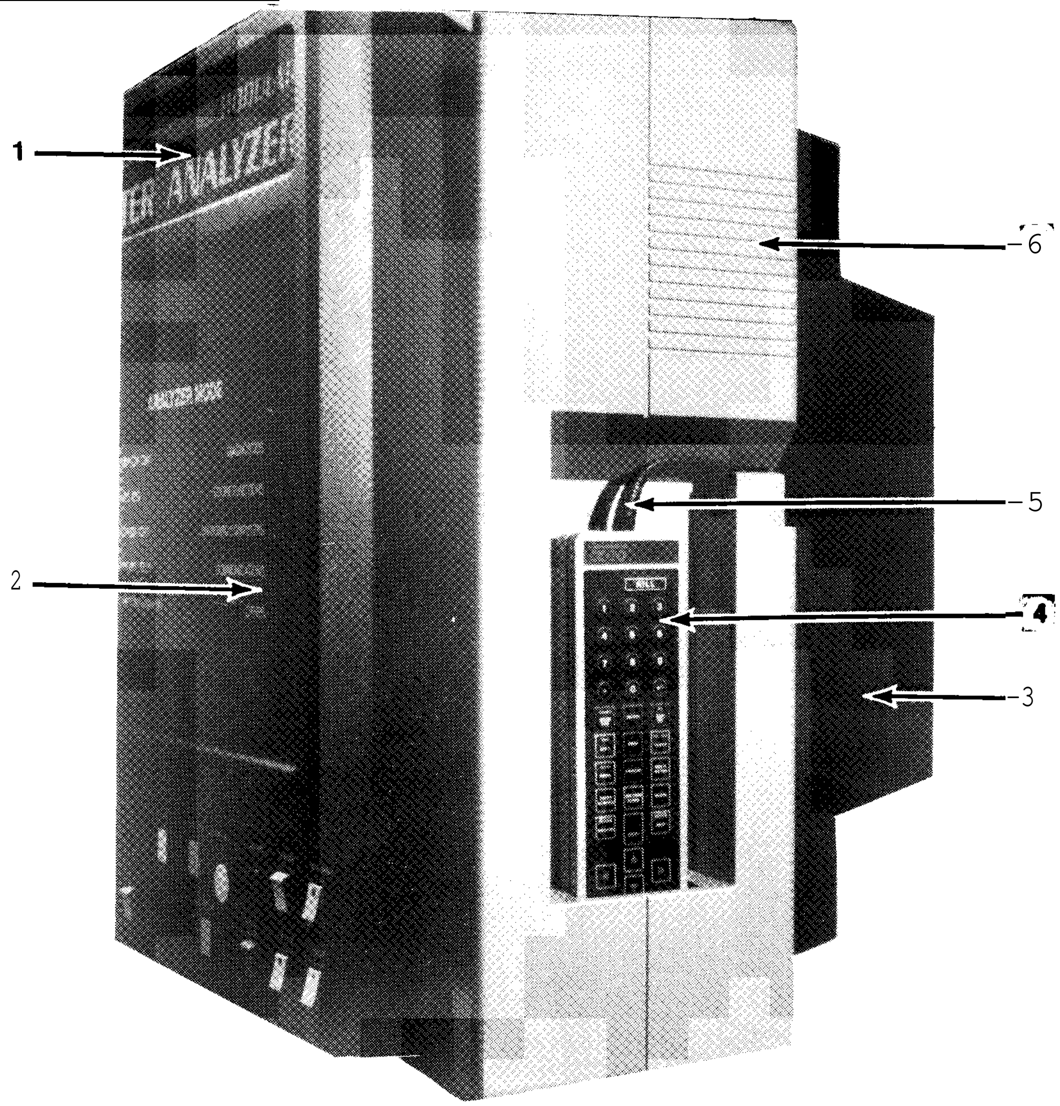
1. Boom Weld **Assy** 7020-1873
   Input Filter PCB... 7001-0549
   Circuit Breaker CB2 1922-0106-21
   Circuit Breaker CB5 1922-0112-11
   Boom Cover 7054-0104
   Cover, Cable Manag. 7054-0106
2. **R.H.** Top Cover **Assy** 7054-0091
3. **R.H.** Lower cover... 7054-0093
4. Label, Safety 0682-0724
5. 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



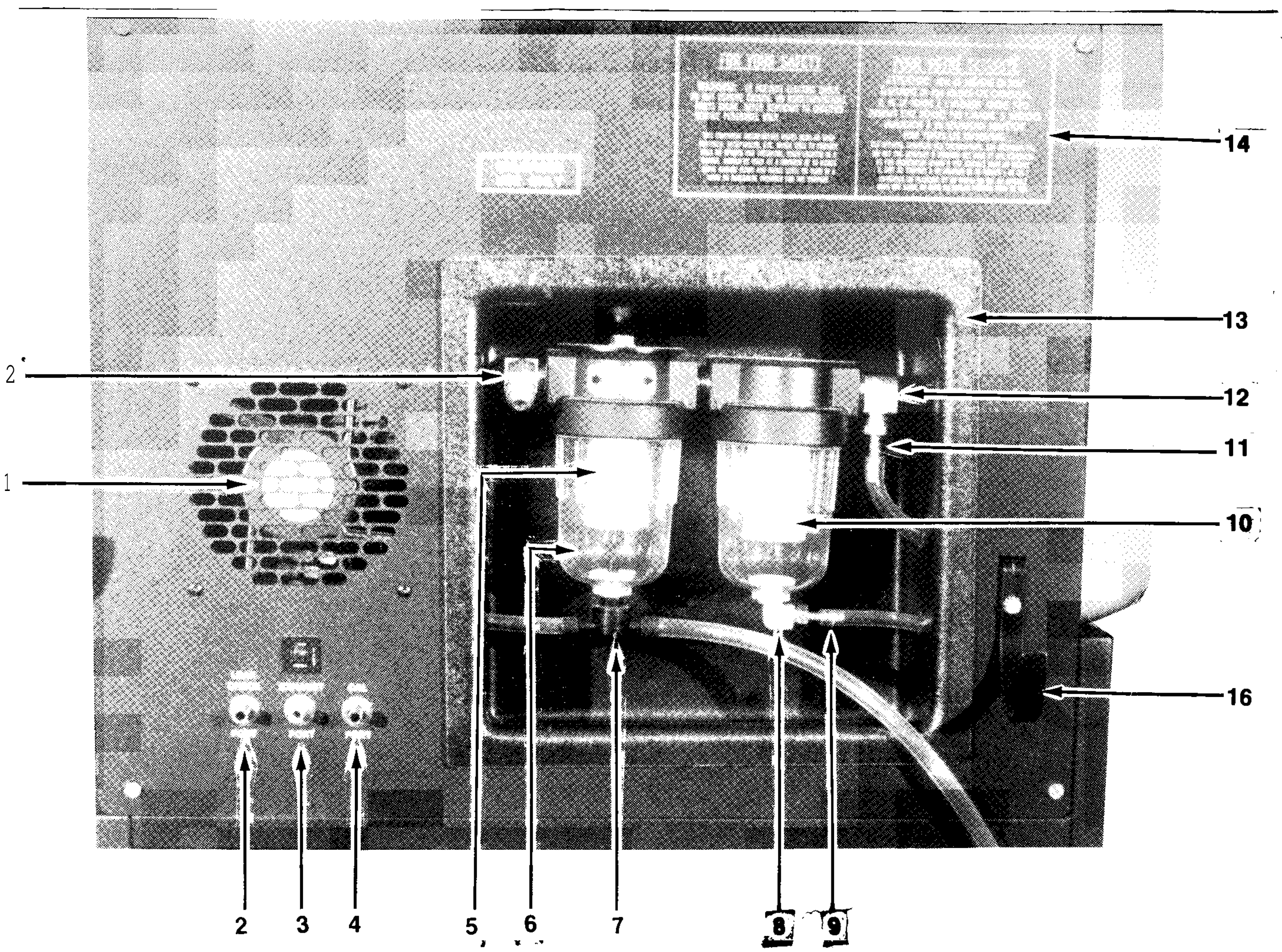
1. Front Panel 7054-0101
2. L.H. Upper Cover... 7054-0090
3. Contrast Knob . . . . -
4. Brightness Knob . . . . . -
5. PC/5 1/4 SW 0689-0114
6. Reset SW 0799-0233
7. Plate, Blank Cover. 7003-0573
8. Disk DriveB: 0552-0024-01
9. Disk Drive A: 0552-0024-01
10. Drawer Ashy 7009-1901
    Drawer Weld Ass 7020-1842
    Rubber Malt 7019-0065
    Partition 7005-2253
    Slide 0109-0010
    Disk Divider 0621-0218
11. Latch Set 5666-0032

RIGHT SIDE PARTS



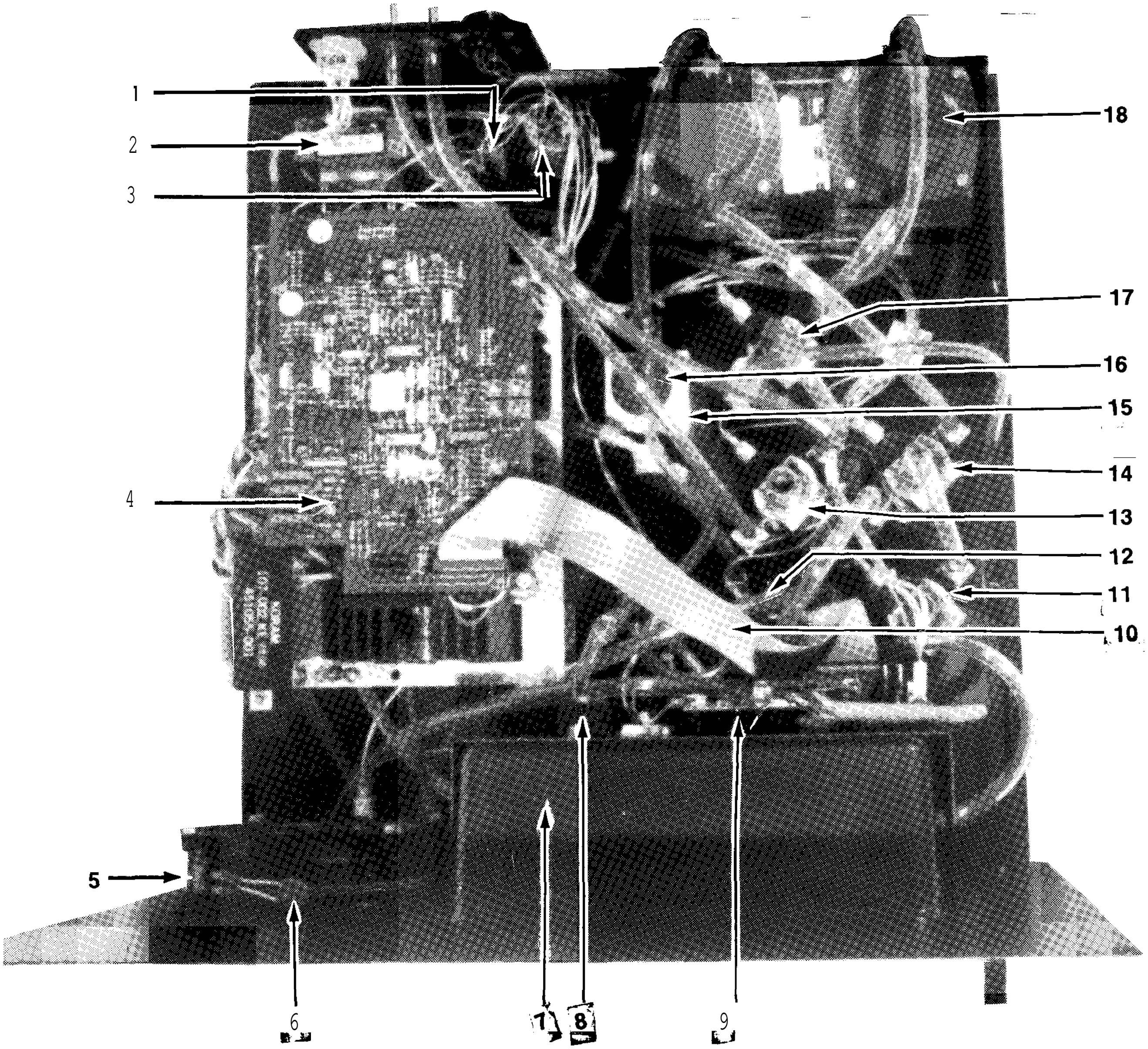
1. Headsign 7030-0164
   Headsign Retainer.. 7054-0100
2. Filter Plexiglass.. 7030-0163
3. Rear Cover 7054-0105
4. Remote Control Asm. 7009-1921-02
   Sun Logo label 0682-0701
   Case Front 7054-0102
   Case Back 7054-0103
   Keypad 0552-0031
   Remote PCB 7001-0546
   Magnet 2" X 2"..... 0865-0112
5. Cable, Remote 6004-0517
6. R.H. Upper Cover... 7045-0091

FILTER DRAWER COVER PARTS



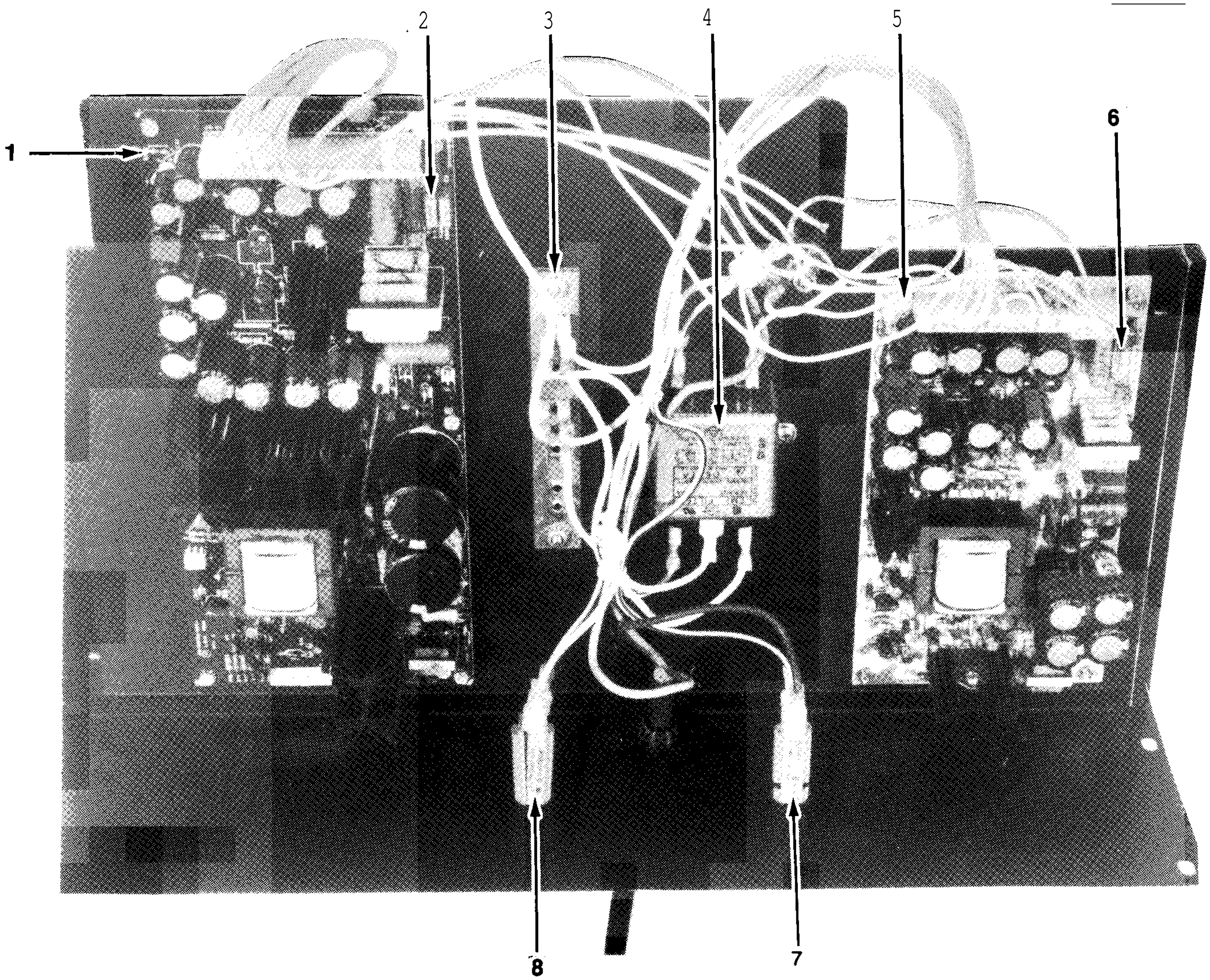
1. Fan Axial 110V 0587-0504
   " " 220V 0587-0507-01
2. Nipple, Hose 2209-0001
   Washer Flat 3/8''... 0400-0004
   Lockwasher 3/8'' 0602-0035
   Nut , Hex 3/8'' 0409-0020
3. Nipple, Exhaust 7016-0005
   Nut, Hex 7/16'' 0407-0216
4. Same as Item 2
5. Filter 75 Micron... 0301-0926
6. Bowl 0301-0931
7. 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	13.	Solenoid V5	0304-0040
2.	Transformer T1	0778-0476	14.	Solenoid V2	0304-0039
3.	Capacitor 8000 Mfd.	0679-0541	15.	Block 02 Mount	7002-0207
	Bracket, Cap Mount.	0679-0904	16.	02 Sensor	7049-0004
4.	I.R. Bench Andros..	7049-0114-01	17.	Solenoid V4	0304-0040
	Flexible Mount	0561-0139	18.	Vacuum Pump 110V...	0303-0093
5.	Axial Fan 110V	0587-0504		" " 220V...	0303-0099
	" " 220V.....	0587-0507-01		Connector Body 2Pin	4162-0307
6.	Varistor 110V	0749-0207		Contact Socket	4162-0557
	" 220V	0749-0214	PARTS NOT SHOWN		
7.	Panel Recessed	7005-2023-03		Hose 3/16″ I.D	0669-0229
8.	Pressure Transducer	7009-1910		Hose 1/4″ I.D	0669-0220
9.	Solenoid Driver PCB	7001-0560		Hose Tee	0647-0107
10.	I.R. Cable	6004-0505		Restrictor Pressure Transducer	3841-0101-02
11.	Solenoid Vi	0304-0040		Restrictor Low Flow	3841-0101-06
	Diode Ashy	7009-1486-03			
12.	Low FLow SW	0549-0019-02			

POWER SUPPLY DRAWER PARTS

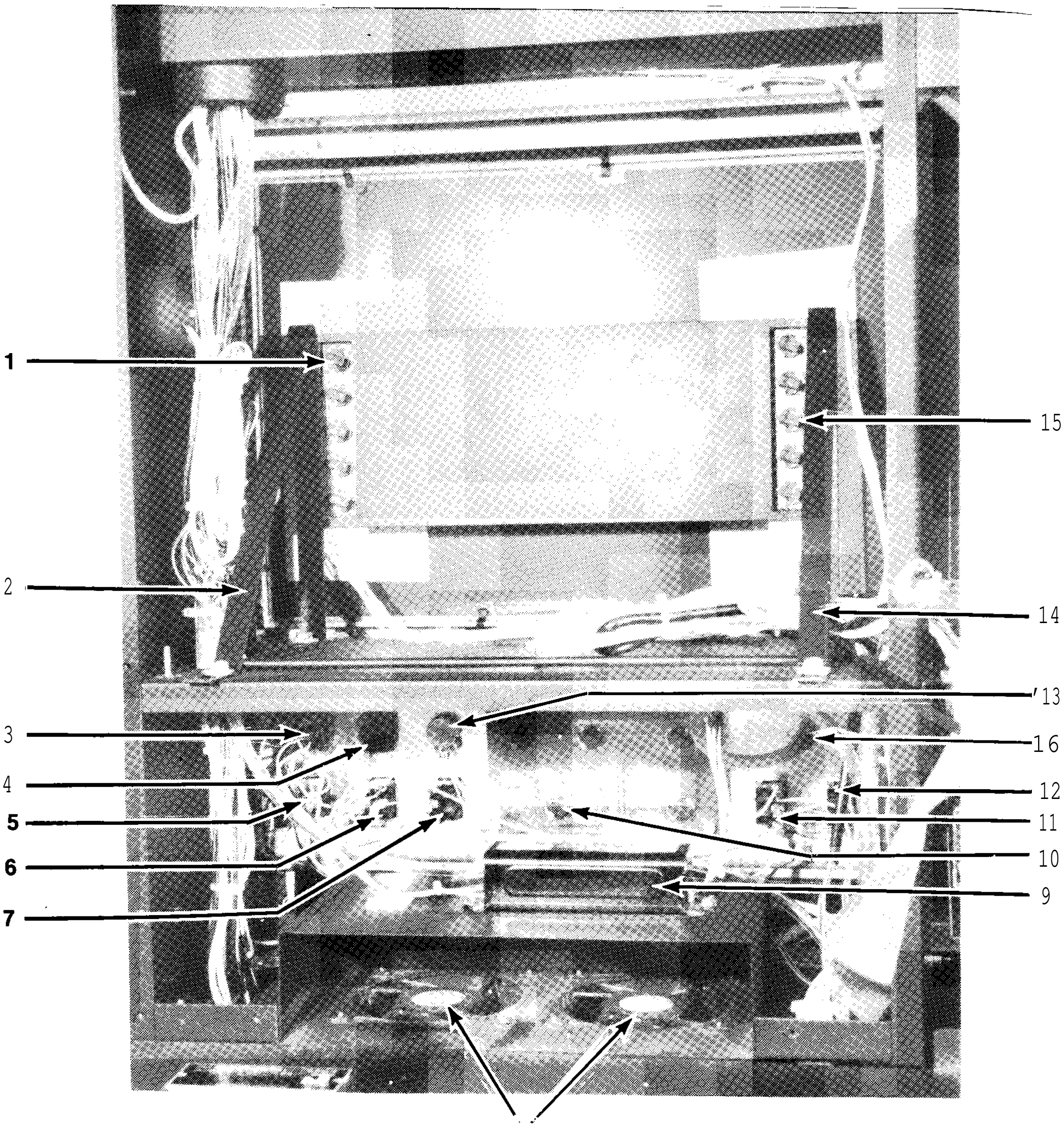


1. Power Supply #1 0532-0018
2. Fuse 5A 110V Line. 0739-0055
3. Terminal Strip TB1. 7008-0318
   Insulator Strip 7031-0180
4. EMI Filter FL1 0531-0003
5. Power Supply #2 0532-0017
6. Fuse 3A 110V Line. 0739-0026
   " 1.5A 220V Line. 0739-0095
7. CB1 10A 110V Line.. 1922-0112-13
   " 5A 220V Line.. 1922-0112-08
8. CB2 3A 110V Line... 1922-0112-06
   " 2A 220V Line... 1922-0112-05

PARTS NOT SHOWN

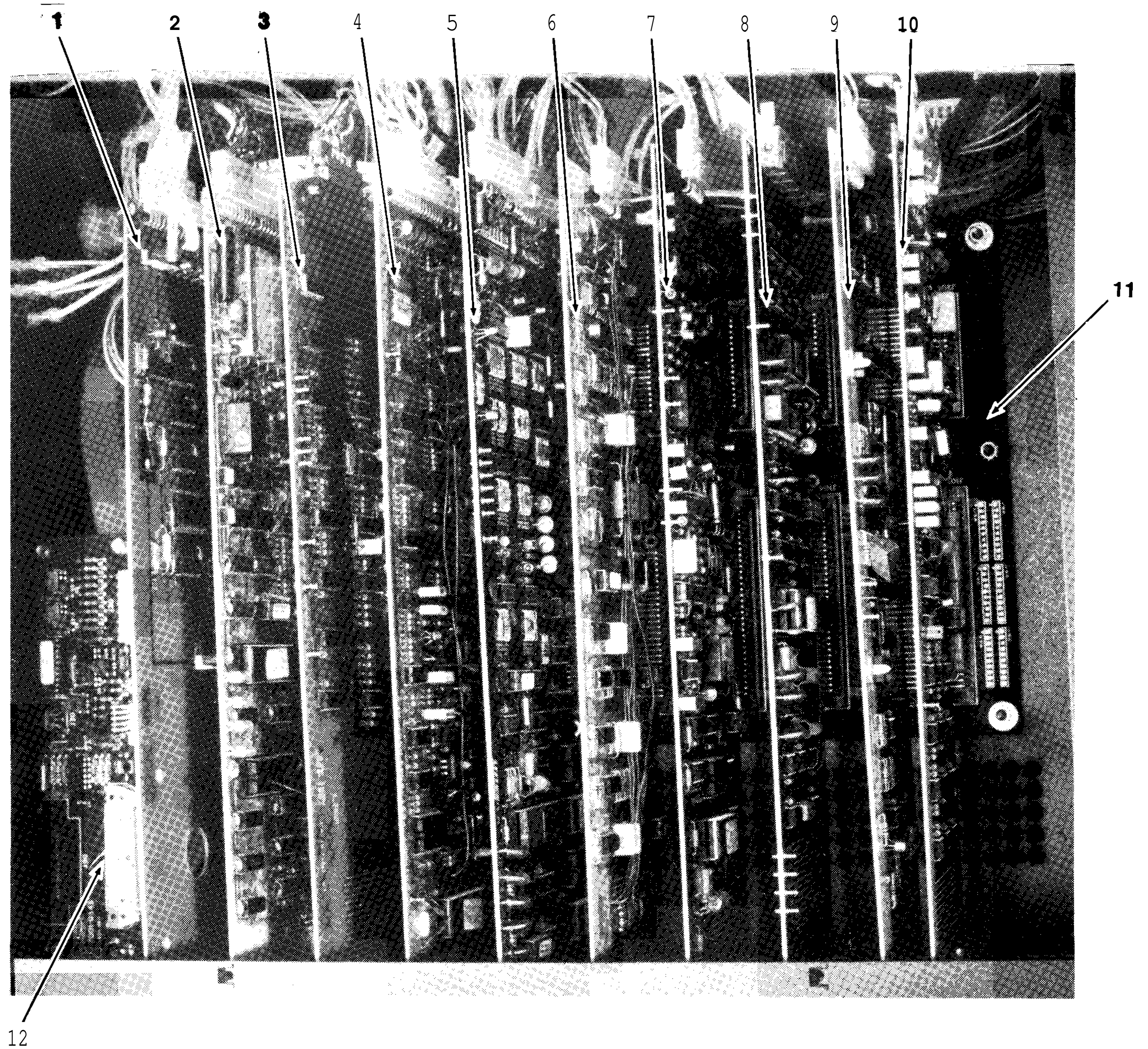
P.S. Drawer Weld Assy.. 7020-1834
Slide, Drawer 7024-0462
A.C. Power Cable 110V.. 6001-0177
" " " 220V. . 6001-0178
Bushing, Power Cable... 2035-0008
Replacement A.C. Plug... 0528-0020

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	7.	Multimeter PUB 7001-0550
2.	ALDL PUB 7001-0543-01	8.	DAS A/D PUB 7001-0555
3	I.R. Interface PCB 7001-0557	9.	BUS Driver PUB 7001-0559
4.	Primary Trigger PCB... 7001-0544	10.	VAT PUB 7001-0552
5.	RPM/Dwell/Timing PCB.. 7001-0553	11.	SUN BUS Backplane PCB. 7001-0547
6.	Secondary Trigger PCB. 7001-0551	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 AS SY . 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.

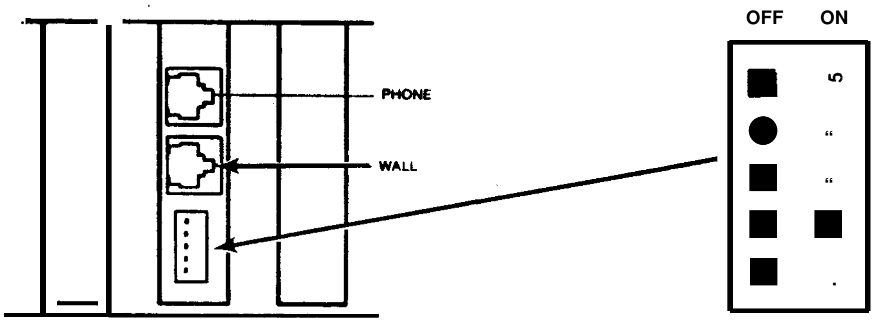


FIGURE 22-1. MODEM CONFIGURATION

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.

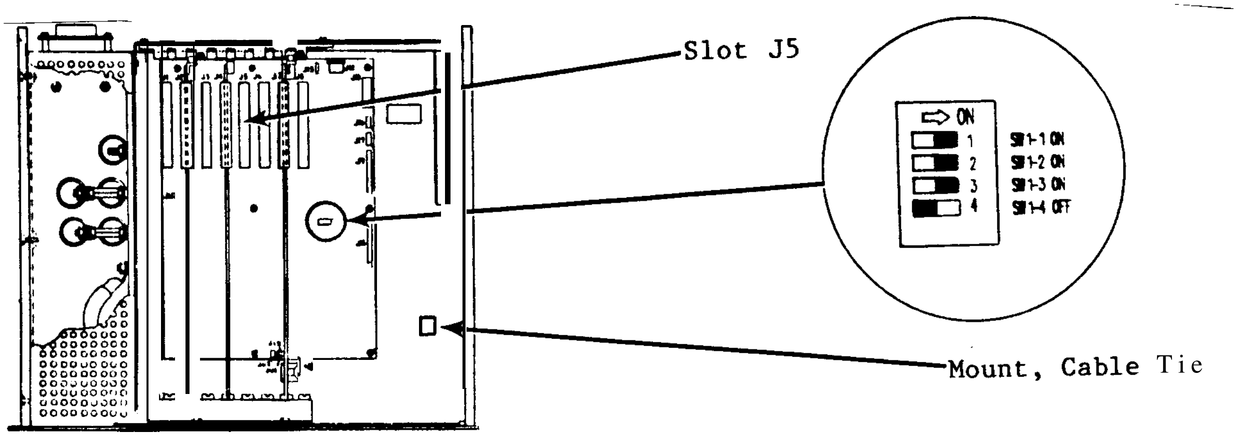
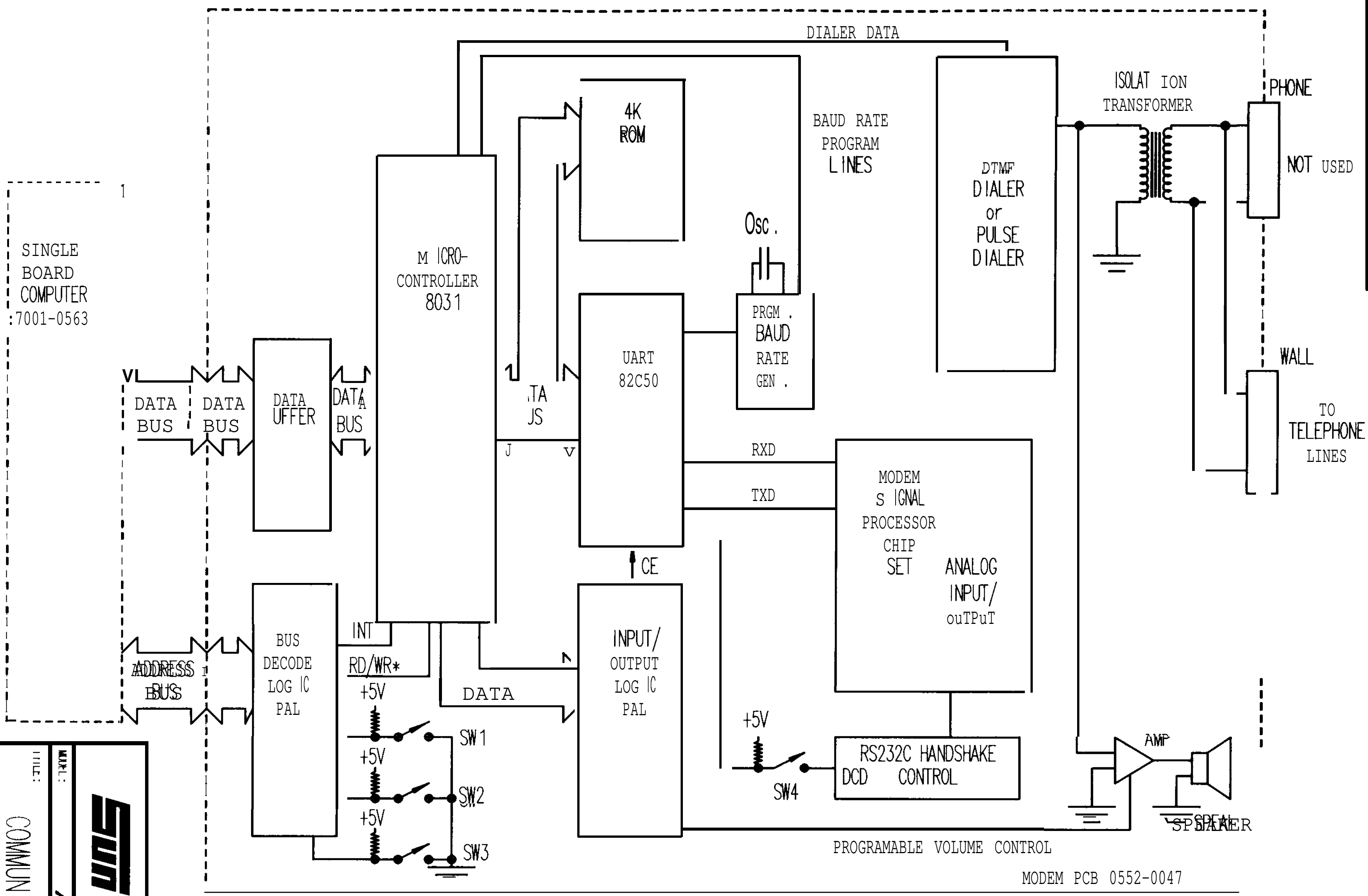


FIGURE 22-2. SBC CONFIGURATION SWITCH SW1



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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/cvlinder x 820 cylinders/drive =42,823,680 bytes/formatted drive

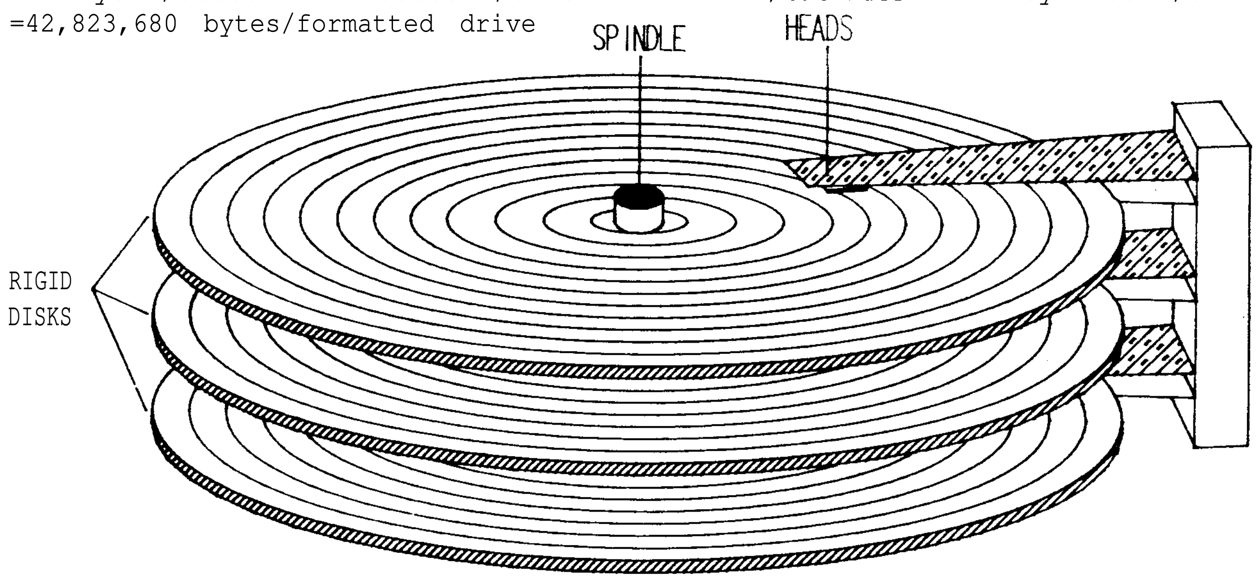


Figure 23-1. TECH-10 Hard Drive

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*.

DS0* 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.

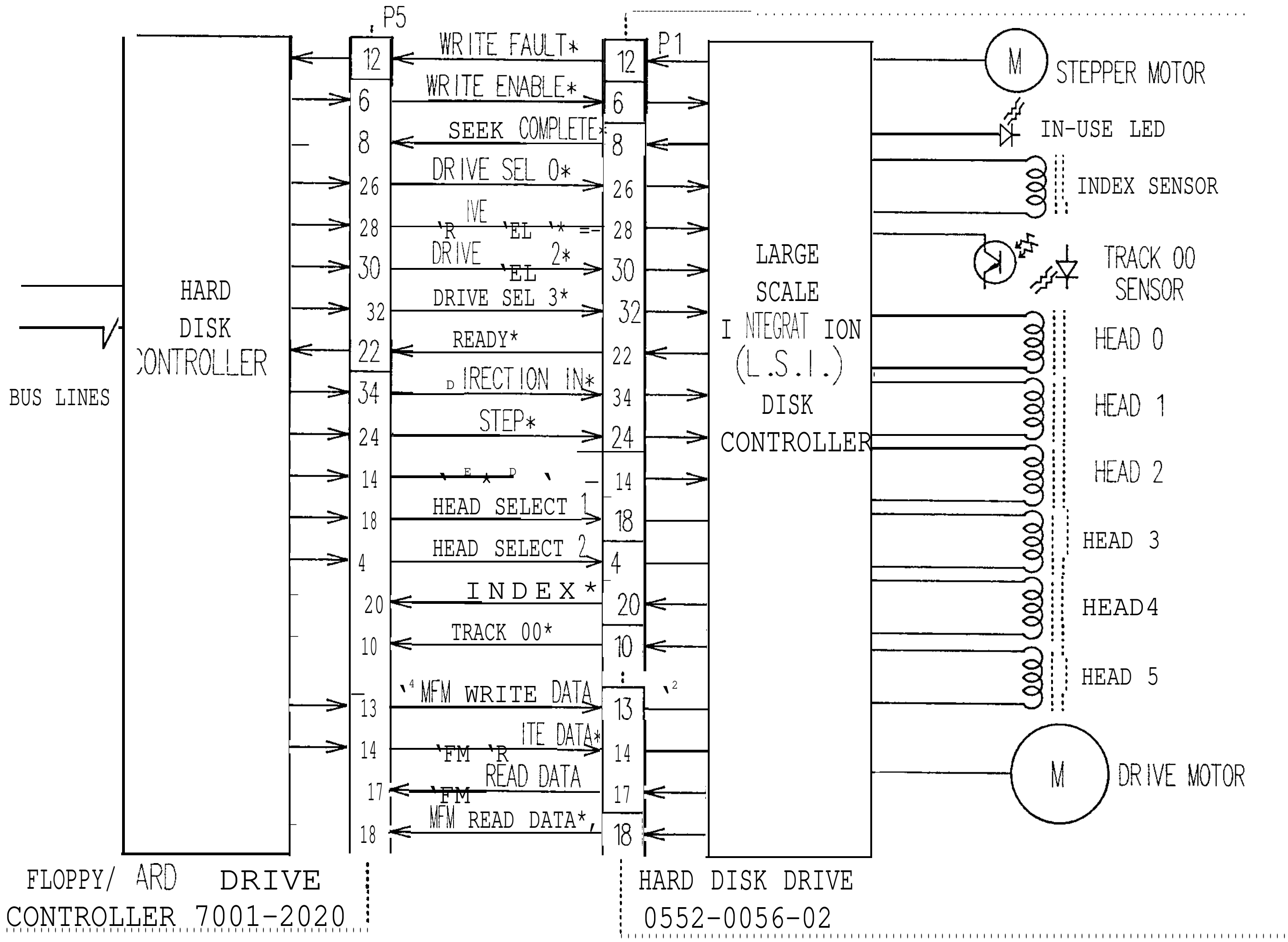
2. You will be instructed to insert the (the latest) Expertec CD in the CD ROM drive and hit any key. The MCA/TECH-10 will begin to load the Expertec files from CD ROM Drive to Drive E (this will take approximately 2 minutes).

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 → (continue below) 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 → (continue below) 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 → (continue below) 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 → (continue below) NO → Replace Parallel/Serial Board 7001-2034-01 Reinstall the files on the hard drive using the procedure on page 23-7.

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 (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. (High Level reformat — 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. (Low & High level reformat — 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.



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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.

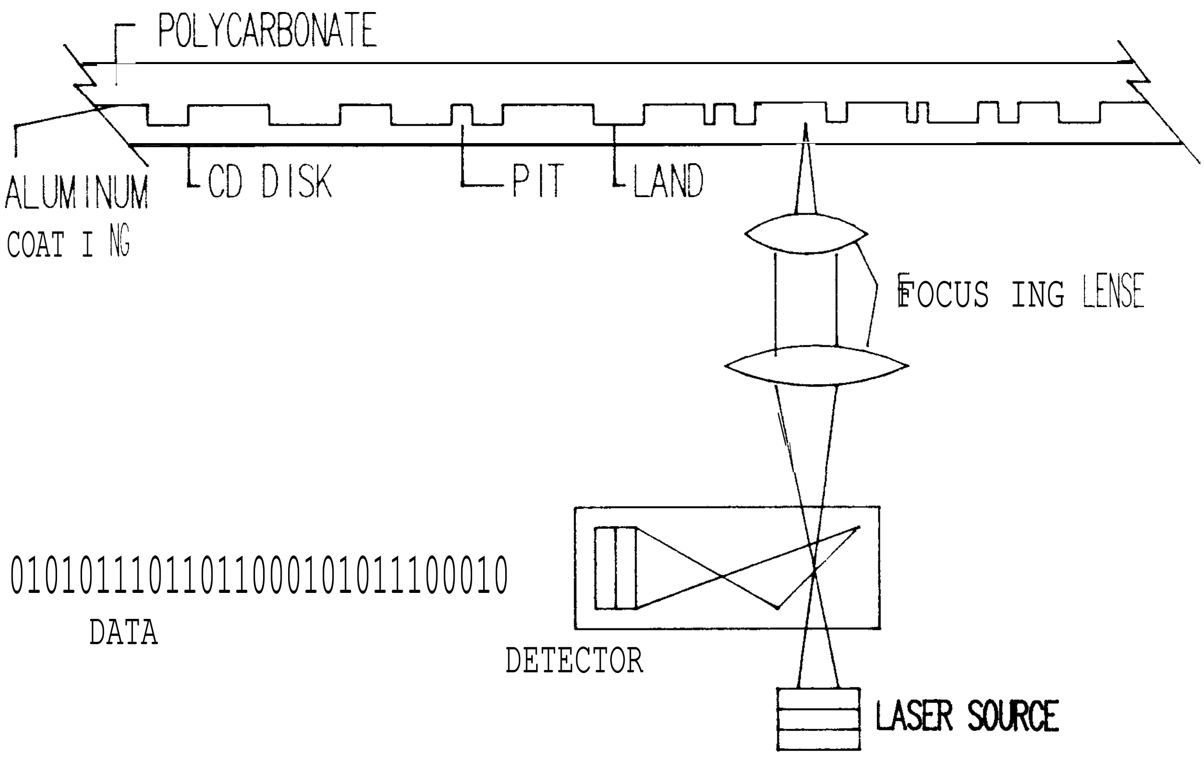


FIGURE 23-2. CD ROM DRIVE PICKUP DEVICE

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.

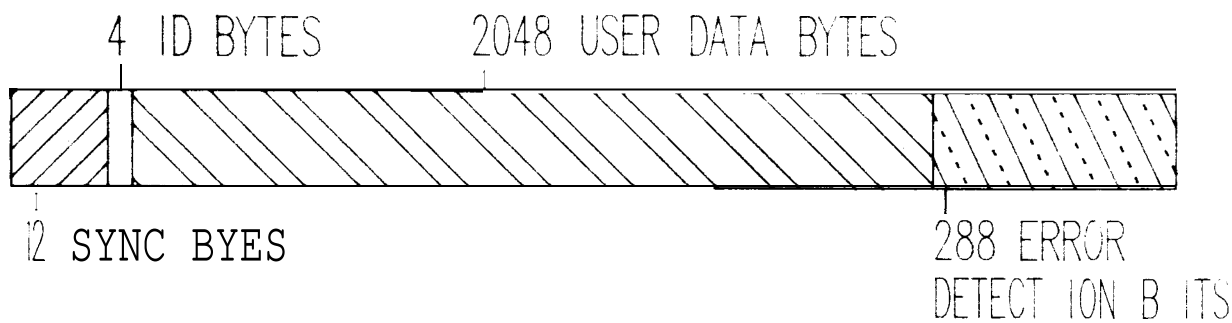


Figure 23-3. Format of a Sector.

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.

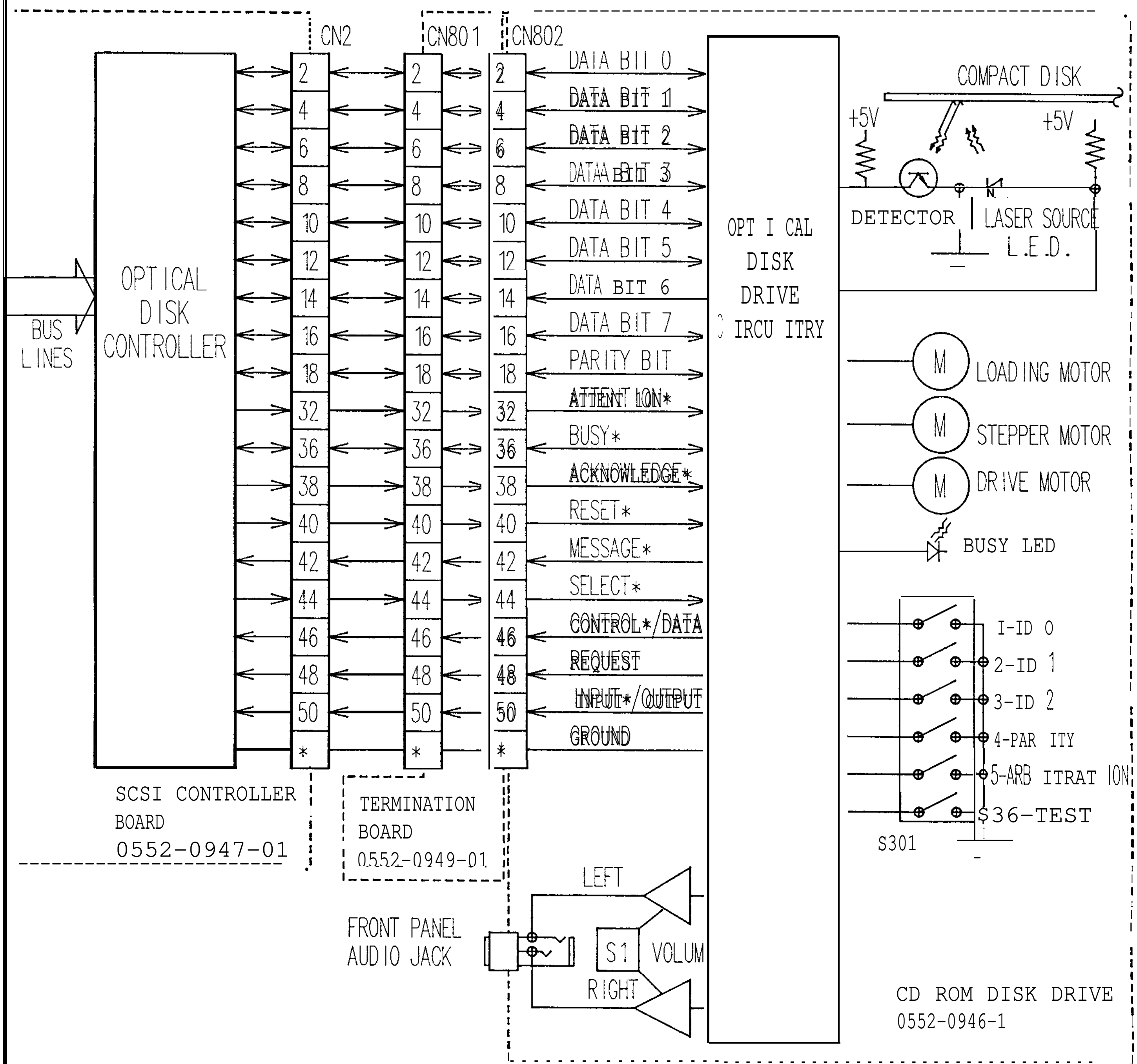
11. Press "RESET."

****
* 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 NO NO: Trouble shoot accordingly. YES: SUBSTITUTE the CD ROM Drive 0552-0946-01
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 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/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 <u>printer has not yet been initialized, and is not on line to print.</u> 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 are not contained in COMMAND.COM. 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 directory.

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, <u>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.</u> 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. <u>Disk Manager is a copyrighted software and is not to be copied in any form</u>.

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
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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
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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.

ERROR DETECTION AND OPERATOR ACTIONS (continued)

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.

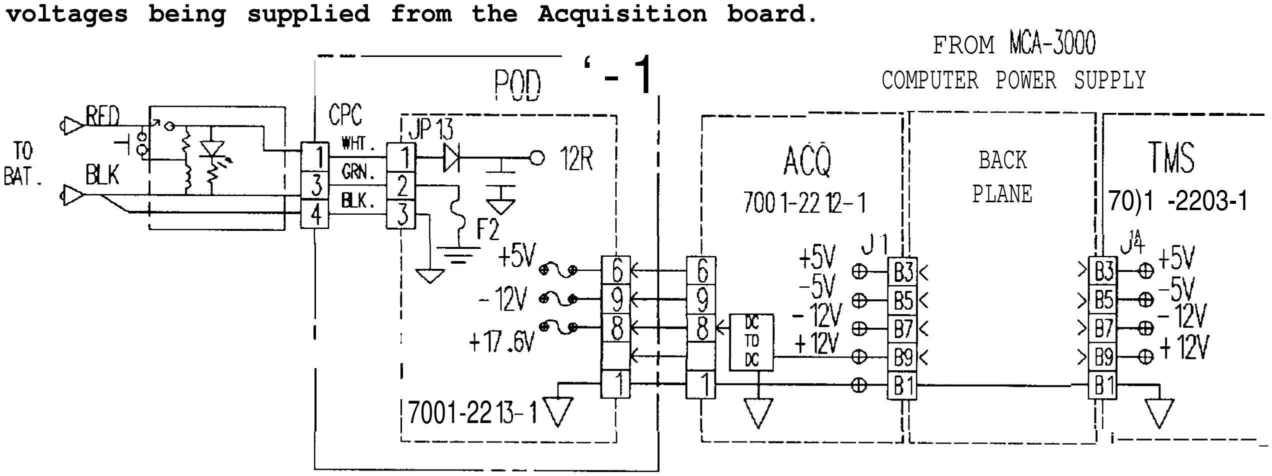


Figure 1-1. Power Supply Diagram

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:

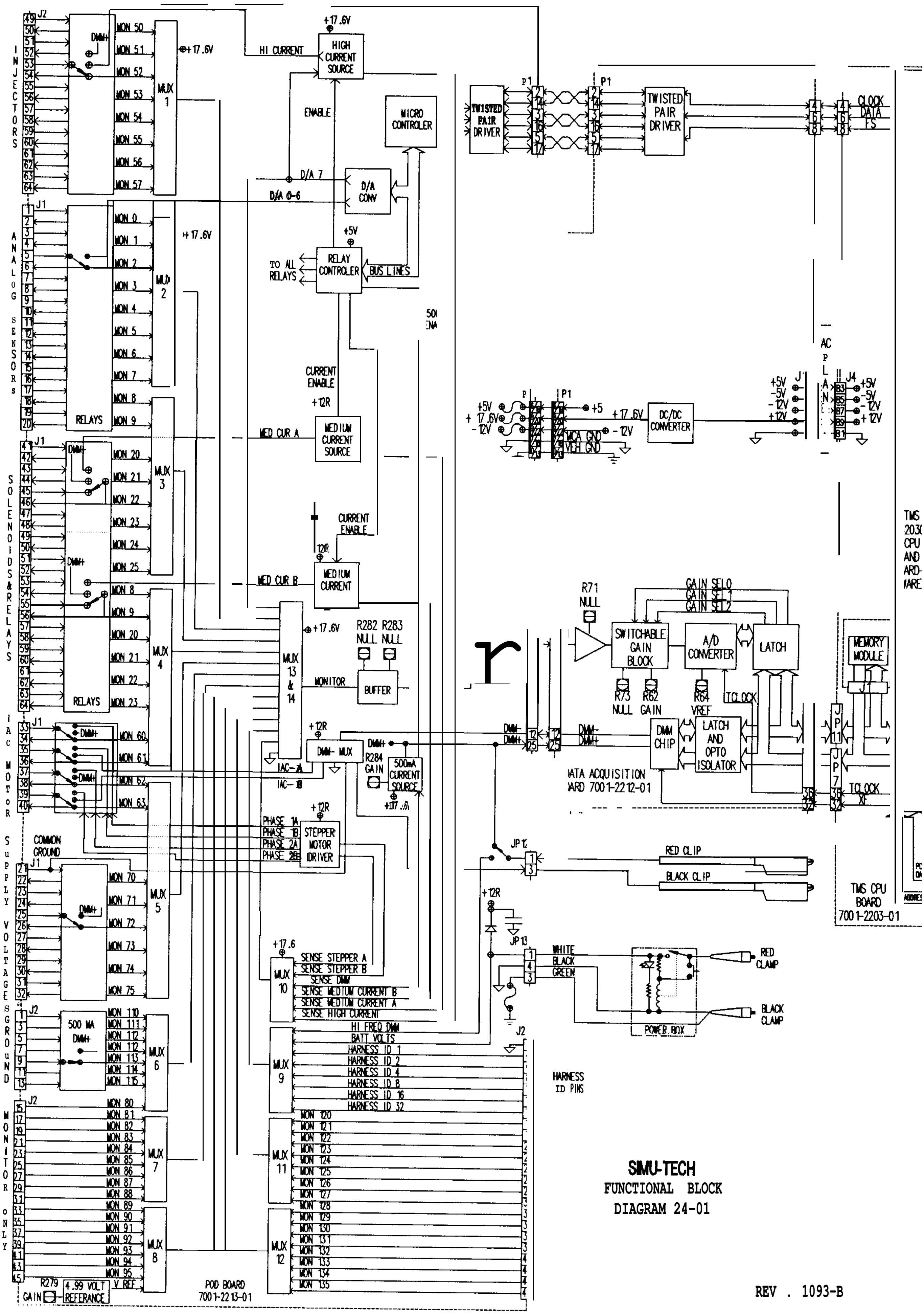
CABLE	ID NUMBER	J2 PINS CONNECTED TO J2-2					
		4	6	8	10	12	14
FM 01	15					x	x
FM 02	23				x		x
FM 03	10	x		x		x	x
GM 01	1		x	x	x	x	x
GM 03	3			x	x	x	x
GM 04	4	x	x		x	x	x
GM 05	5		x		x	x	x
GM 06	6	x			x	x	x
GM 07	7				x	x	x
GM 08	11			x		x	x
GM 10	9		x	x		x	x
CR 01, 1A, 1B	12	x	x			x	x
CR 02	13		x			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.

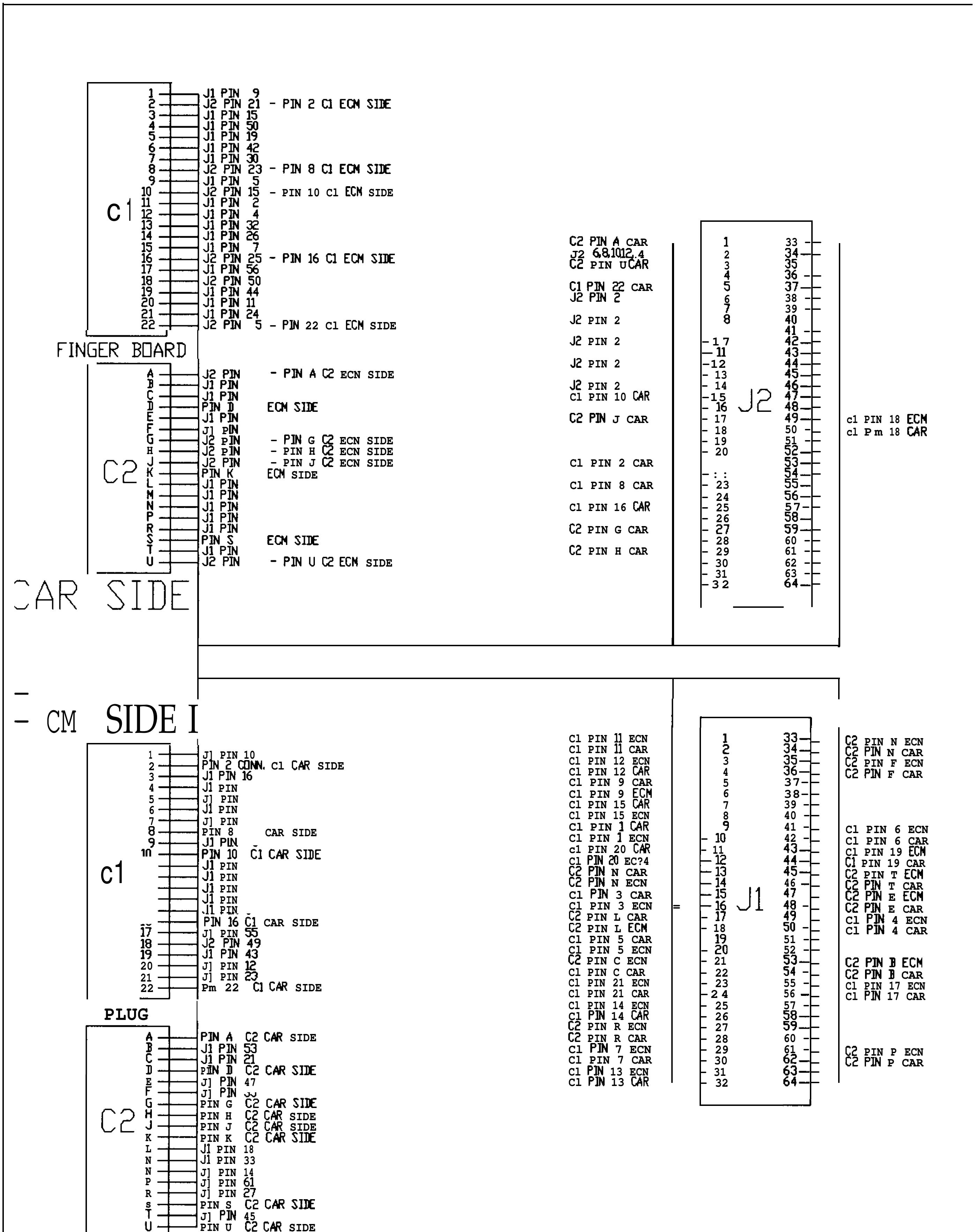

SIMU-TECH
FUNCTIONAL BLOCK
DIAGRAM 24-01
REV . 1093-B
POD BOARD
7001-2213-01
DATA ACQUISITION
BOARD 7001-2212-01
TMS CPU
BOARD
7001-2203-01

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.

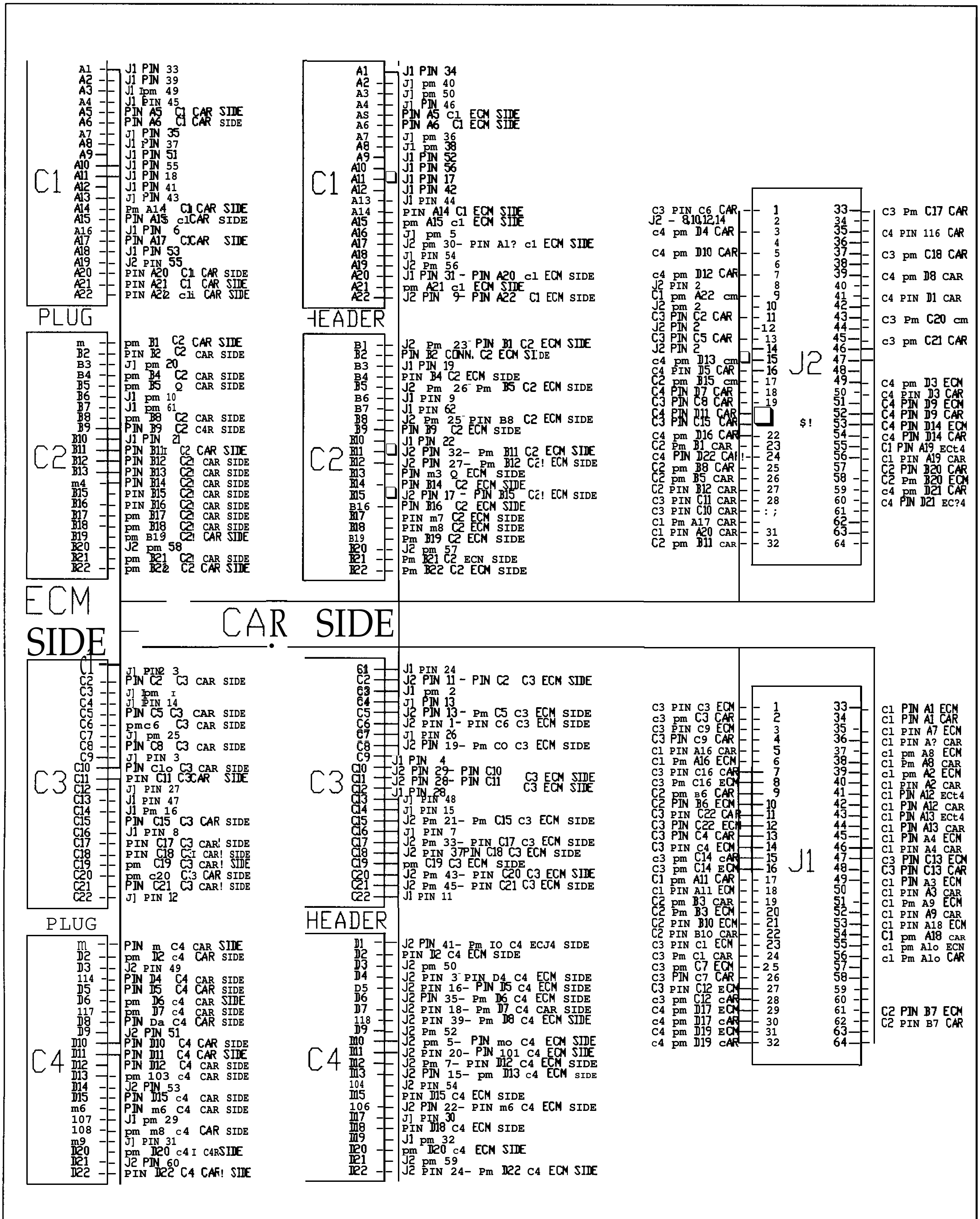
These diagrams include:

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			

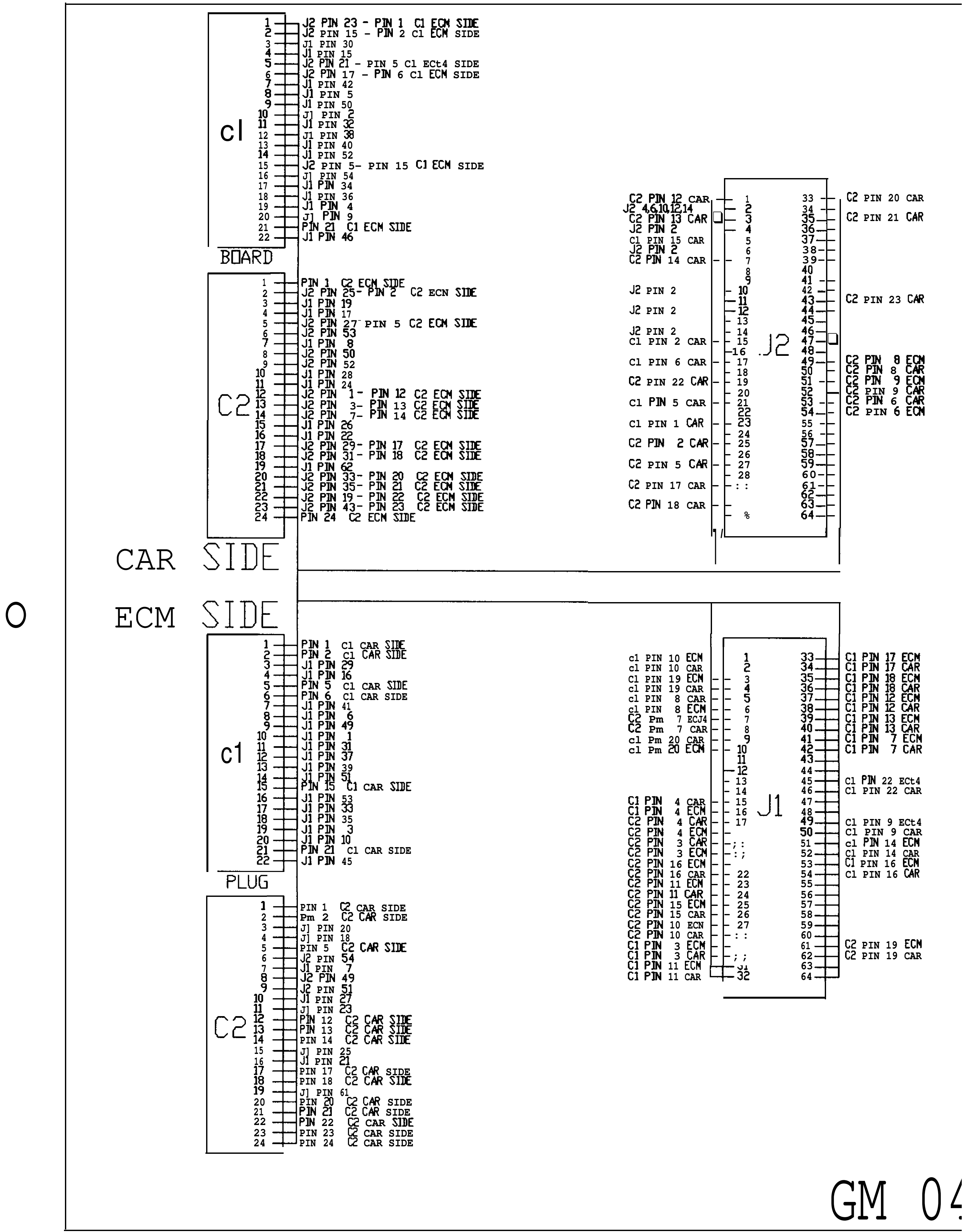


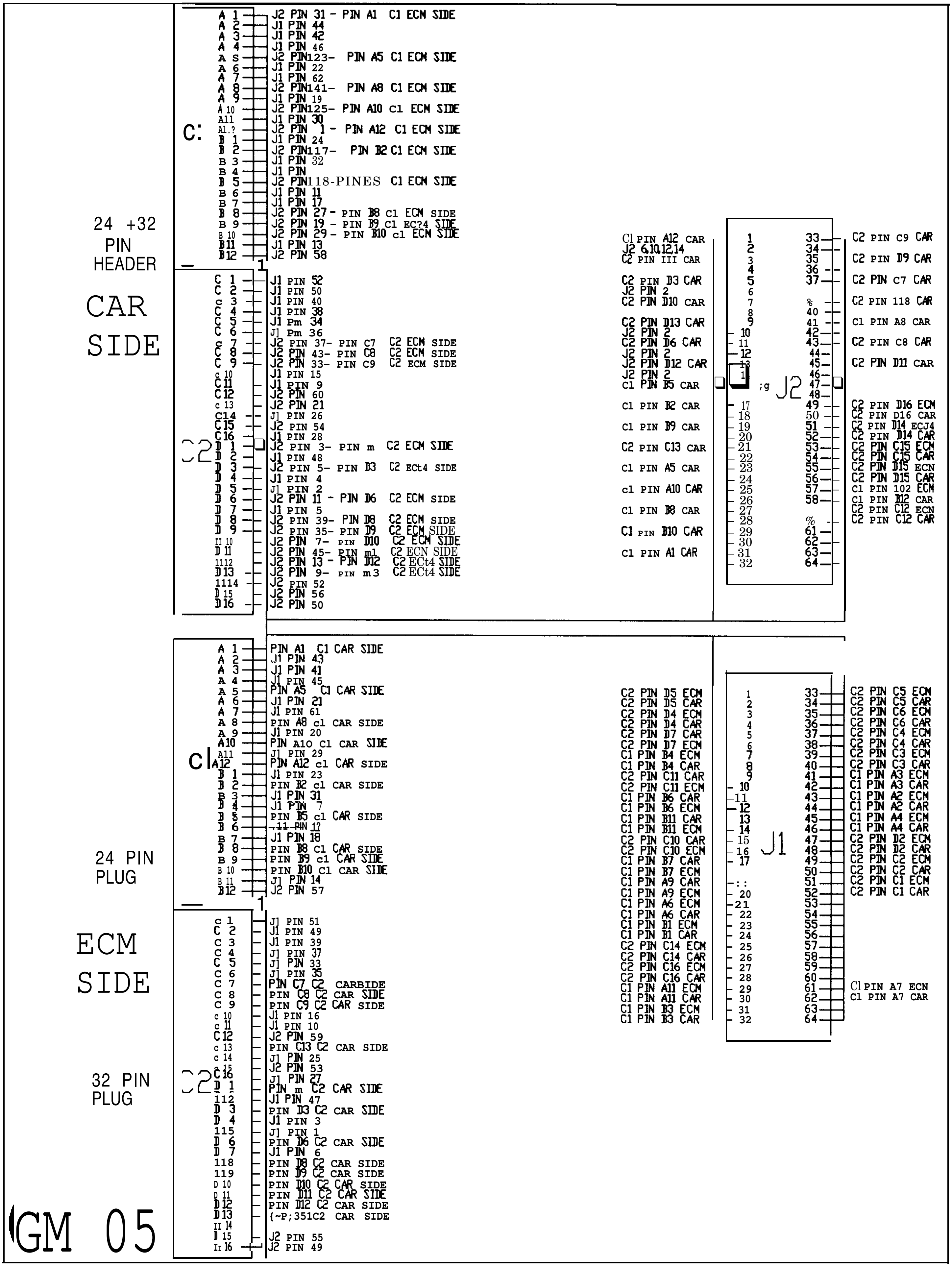
FINGER BOARD
C1
C2
CAR SIDE
ECM SIDE
PLUG
J2
J1
C2 PIN A CAR
C1 PIN 22 CAR
C1 PIN 2 CAR
C1 PIN 8 CAR
C1 PIN 16 CAR
C2 PIN G CAR
C2 PIN H CAR
c1 PIN 18 ECM
c1 Pm 18 CAR
C2 PIN N ECN
C2 PIN N CAR
C2 PIN F ECN
C2 PIN F CAR
C1 PIN 6 ECN
C1 PIN 6 CAR
C1 PIN 19 ECM
C1 PIN 19 CAR
C2 PIN T ECM
C2 PIN T CAR
C2 PIN E ECM
C2 PIN E CAR
C1 PIN 4 ECN
C1 PIN 4 CAR
C2 PIN B ECM
C2 PIN B CAR
C1 PIN 17 ECN
C1 PIN 17 CAR
C2 PIN P ECN
C2 PIN P CAR

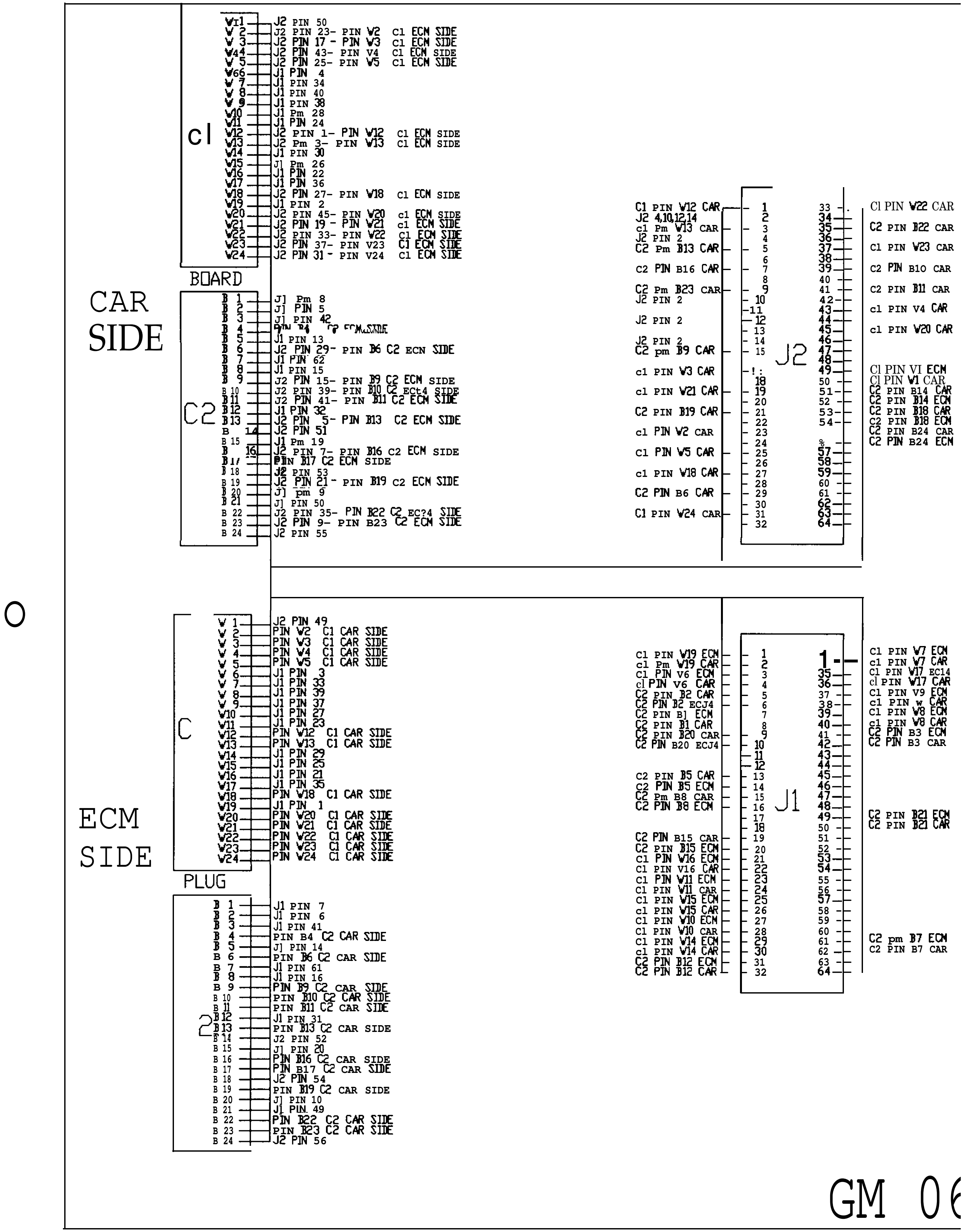
GM 01

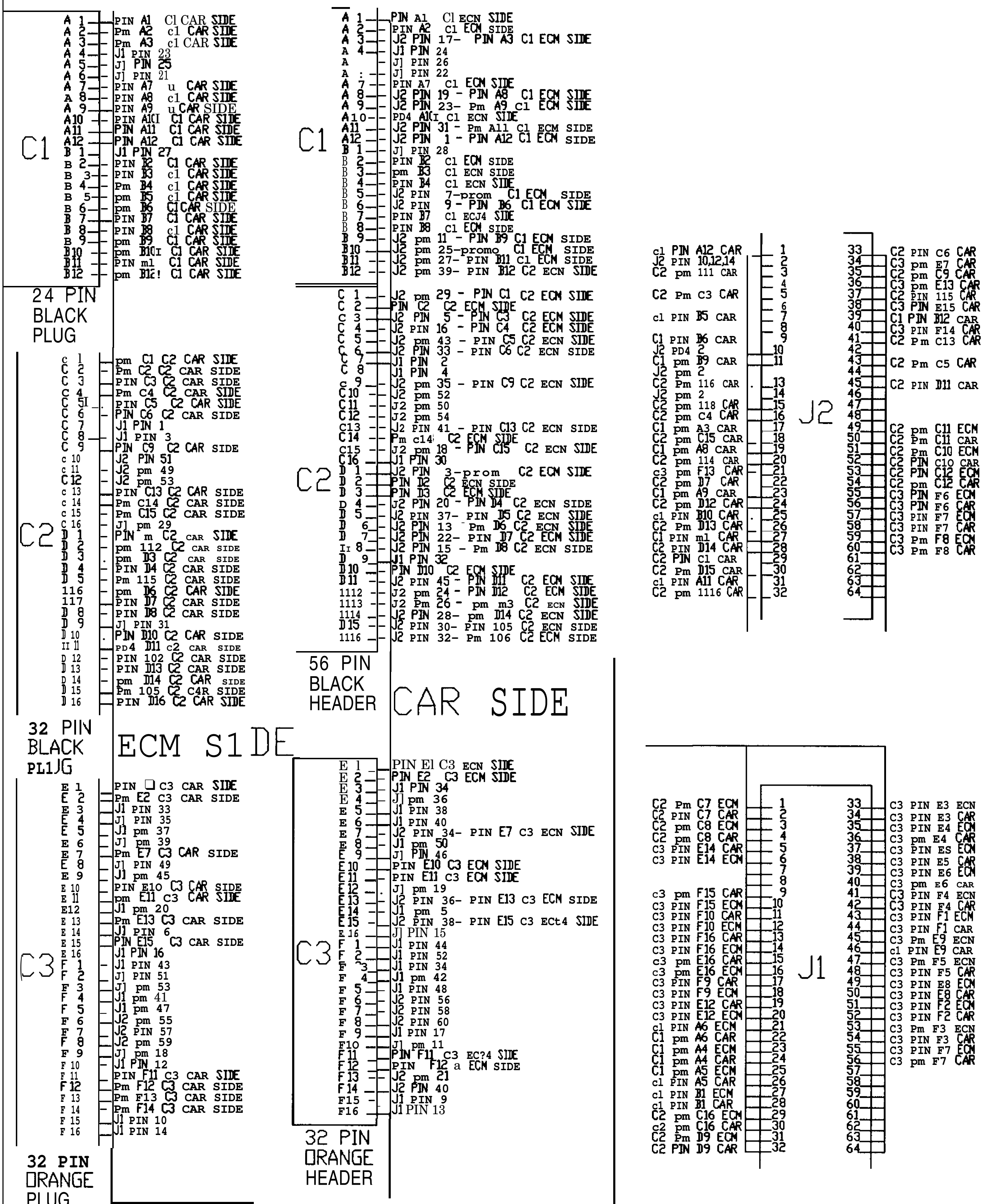


GM 03

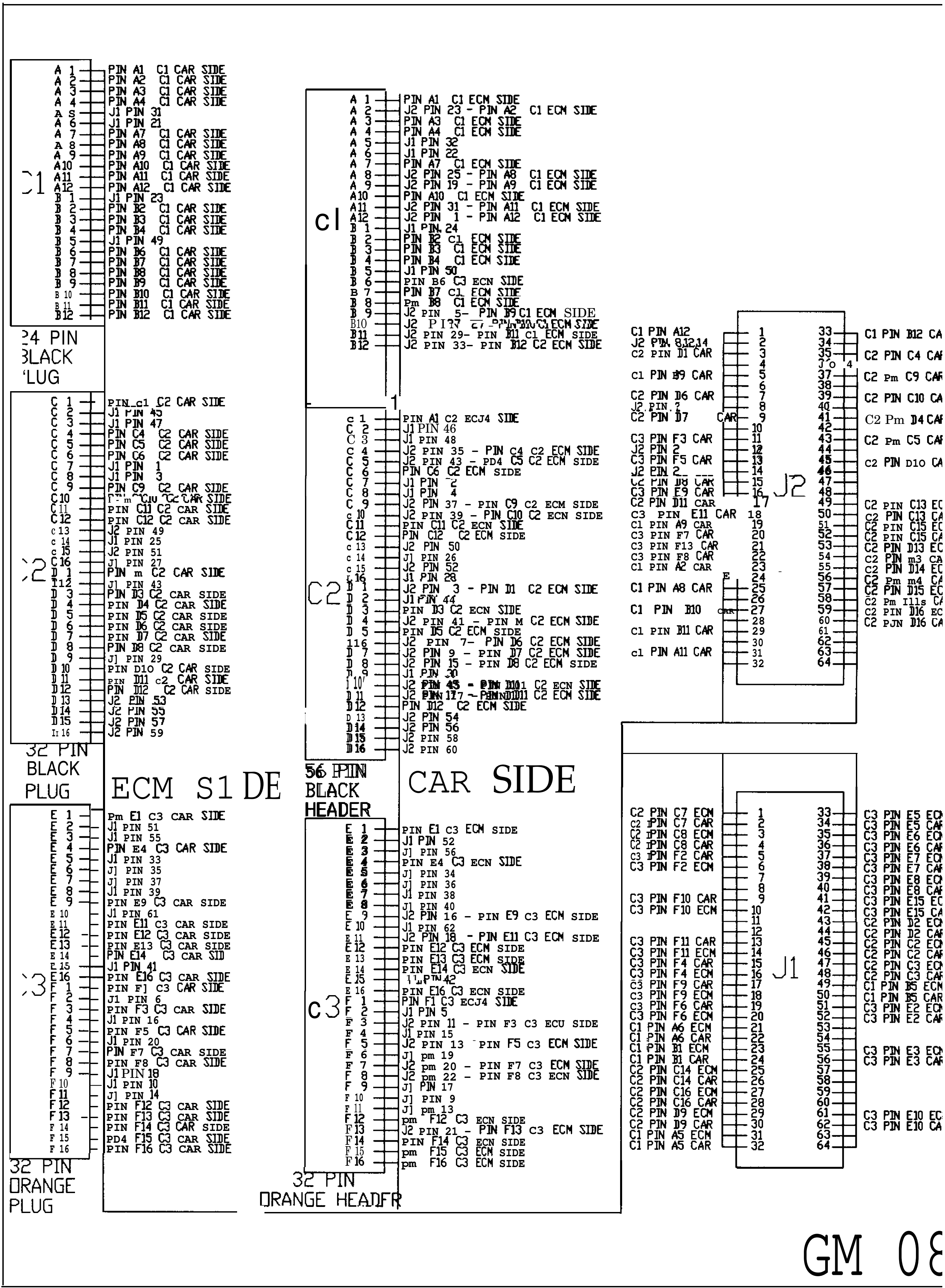

C1
BOARD
1 J2 PIN 23 - PIN 1 C1 ECM SIDE
2 J2 PIN 15 - PIN 2 C1 ECM SIDE
3 J1 PIN 30
4 J1 PIN 15
5 J2 PIN 21 - PIN 5 C1 ECt4 SIDE
6 J2 PIN 17 - PIN 6 C1 ECM SIDE
7 J1 PIN 42
8 J1 PIN 5
9 J1 PIN 50
10 J1 PIN 2
11 J1 PIN 32
12 J1 PIN 38
13 J1 PIN 40
14 J1 PIN 52
15 J2 PIN 5- PIN 15 C1 ECM SIDE
16 J1 PIN 54
17 J1 PIN 34
18 J1 PIN 36
19 J1 PIN 4
20 J1 PIN 9
21 PIN 21 C1 ECM SIDE
22 J1 PIN 46
C2
1 PIN 1 C2 ECM SIDE
2 J2 PIN 25- PIN 2 C2 ECN SIDE
3 J1 PIN 19
4 J1 PIN 17
5 J2 PIN 27- PIN 5 C2 ECM SIDE
6 J2 PIN 53
7 J1 PIN 8
8 J2 PIN 50
9 J2 PIN 52
10 J1 PIN 28
11 J1 PIN 24
12 J2 PIN 1- PIN 12 C2 ECM SIDE
13 J2 PIN 3- PIN 13 C2 ECM SIDE
14 J2 PIN 7- PIN 14 C2 ECM SIDE
15 J1 PIN 26
16 J1 PIN 22
17 J2 PIN 29- PIN 17 C2 ECM SIDE
18 J2 PIN 31- PIN 18 C2 ECM SIDE
19 J1 PIN 62
20 J2 PIN 33- PIN 20 C2 ECM SIDE
21 J2 PIN 35- PIN 21 C2 ECM SIDE
22 J2 PIN 19- PIN 22 C2 ECM SIDE
23 J2 PIN 43- PIN 23 C2 ECM SIDE
24 PIN 24 C2 ECM SIDE
CAR SIDE
J2
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
O
ECM SIDE
C1
PLUG
1 PIN 1 C1 CAR SIDE
2 PIN 2 C1 CAR SIDE
3 J1 PIN 29
4 J1 PIN 16
5 PIN 5 C1 CAR SIDE
6 PIN 6 C1 CAR SIDE
7 J1 PIN 41
8 J1 PIN 6
9 J1 PIN 49
10 J1 PIN 1
11 J1 PIN 31
12 J1 PIN 37
13 J1 PIN 39
14 J1 PIN 51
15 PIN 15 C1 CAR SIDE
16 J1 PIN 53
17 J1 PIN 33
18 J1 PIN 35
19 J1 PIN 3
20 J1 PIN 10
21 PIN 21 C1 CAR SIDE
22 J1 PIN 45
C2
1 PIN 1 C2 CAR SIDE
2 PIN 2 C2 CAR SIDE
3 J1 PIN 20
4 J1 PIN 18
5 PIN 5 C2 CAR SIDE
6 J2 PIN 54
7 J1 PIN 7
8 J2 PIN 49
9 J2 PIN 51
10 J1 PIN 27
11 J1 PIN 23
12 PIN 12 C2 CAR SIDE
13 PIN 13 C2 CAR SIDE
14 PIN 14 C2 CAR SIDE
15 J1 PIN 25
16 J1 PIN 21
17 PIN 17 C2 CAR SIDE
18 PIN 18 C2 CAR SIDE
19 J1 PIN 61
20 PIN 20 C2 CAR SIDE
21 PIN 21 C2 CAR SIDE
22 PIN 22 C2 CAR SIDE
23 PIN 23 C2 CAR SIDE
24 PIN 24 C2 CAR SIDE
J1
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
C1 PIN 9 CAR
C1 PIN 14 ECM
C1 PIN 14 CAR
C1 PIN 16 ECM
C1 PIN 16 CAR
C2 PIN 19 ECM
C2 PIN 19 CAR
GM 04


24 +32
PIN
HEADER
CAR
SIDE
C1
J2 PIN 31 - PIN A1 C1 ECM SIDE
J1 PIN 44
J1 PIN 42
J1 PIN 46
J2 PIN123- PIN A5 C1 ECM SIDE
J1 PIN 22
J1 PIN 62
J2 PIN141- PIN A8 C1 ECM SIDE
J1 PIN 19
J2 PIN125- PIN A10 C1 ECM SIDE
J1 PIN 30
J2 PIN 1 - PIN A12 C1 ECM SIDE
J1 PIN 24
J2 PIN117- PIN B2 C1 ECM SIDE
J1 PIN 32
J1 PIN
J2 PIN118-PINES C1 ECM SIDE
J1 PIN 11
J1 PIN 17
J2 PIN 27 - PIN B8 C1 ECM SIDE
J2 PIN 19 - PIN B9 C1 EC?4 SIDE
J2 PIN 29 - PIN B10 C1 ECM SIDE
J1 PIN 13
J2 PIN 58
C2
J1 PIN 52
J1 PIN 50
J1 PIN 40
J1 PIN 38
J1 Pm 34
J1 Pm 36
J2 PIN 37- PIN C7 C2 ECM SIDE
J2 PIN 43- PIN C8 C2 ECM SIDE
J2 PIN 33- PIN C9 C2 ECM SIDE
J1 PIN 15
J1 PIN 9
J2 PIN 60
J2 PIN 21
J1 PIN 26
J2 PIN 54
J1 PIN 28
J2 PIN 3- PIN m C2 ECM SIDE
J1 PIN 48
J2 PIN 5- PIN D3 C2 ECt4 SIDE
J1 PIN 4
J1 PIN 2
J2 PIN 11 - PIN D6 C2 ECM SIDE
J1 PIN 5
J2 PIN 39- PIN D8 C2 ECM SIDE
J2 PIN 35- PIN D9 C2 ECM SIDE
J2 PIN 7- PIN D10 C2 ECM SIDE
J2 PIN 45- PIN m1 C2 ECN SIDE
J2 PIN 13 - PIN D12 C2 ECt4 SIDE
J2 PIN 9- PIN m3 C2 ECt4 SIDE
J2 PIN 52
J2 PIN 56
J2 PIN 50
J2
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
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
PIN A1 C1 CAR SIDE
J1 PIN 43
J1 PIN 41
J1 PIN 45
PIN A5 C1 CAR SIDE
J1 PIN 21
J1 PIN 61
PIN A8 C1 CAR SIDE
J1 PIN 20
PIN A10 C1 CAR SIDE
J1 PIN 29
PIN A12 C1 CAR SIDE
J1 PIN 23
PIN B2 C1 CAR SIDE
J1 PIN 31
J1 PIN 7
PIN B5 C1 CAR SIDE
J1 PIN 12
J1 PIN 18
PIN B8 C1 CAR SIDE
PIN B9 C1 CAR SIDE
PIN B10 C1 CAR SIDE
J1 PIN 14
J2 PIN 57
C2
J1 PIN 51
J1 PIN 49
J1 PIN 39
J1 PIN 37
J1 PIN 33
J1 PIN 35
PIN C7 C2 CARBIDE
PIN C8 C2 CAR SIDE
PIN C9 C2 CAR SIDE
J1 PIN 16
J1 PIN 10
J2 PIN 59
PIN C13 C2 CAR SIDE
J1 PIN 25
J2 PIN 53
J1 PIN 27
PIN m C2 CAR SIDE
J1 PIN 47
PIN D3 C2 CAR SIDE
J1 PIN 3
J1 PIN 1
PIN D6 C2 CAR SIDE
J1 PIN 6
PIN D8 C2 CAR SIDE
PIN D9 C2 CAR SIDE
PIN D10 C2 CAR SIDE
PIN D11 C2 CAR SIDE
PIN D12 C2 CAR SIDE
{~P;351C2 CAR SIDE
J2 PIN 55
J2 PIN 49
J1
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
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
ECM SIDE
C1
BOARD
C2
C
PLUG
2
J2
J1
V1 J2 PIN 50
V 2 J2 PIN 23- PIN V2 C1 ECM SIDE
V 3 J2 PIN 17 - PIN V3 C1 ECM SIDE
V4 J2 PIN 43- PIN V4 C1 ECM SIDE
V 5 J2 PIN 25- PIN V5 C1 ECM SIDE
V6 J1 PIN 4
V 7 J1 PIN 34
V 8 J1 PIN 40
V 9 J1 PIN 38
V10 J1 PIN 28
V11 J1 PIN 24
V12 J2 PIN 1- PIN V12 C1 ECM SIDE
V13 J2 PIN 3- PIN V13 C1 ECM SIDE
V14 J1 PIN 30
V15 J1 PIN 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
B 1 J1 PIN 8
B 2 J1 PIN 5
B 3 J1 PIN 42
B 4 PIN B4 C2 ECM SIDE
B 5 J1 PIN 13
B 6 J2 PIN 29- PIN B6 C2 ECM SIDE
B 7 J1 PIN 62
B 8 J1 PIN 15
B 9 J2 PIN 15- PIN B9 C2 ECM SIDE
B 10 J2 PIN 39- PIN B10 C2 ECM SIDE
B 11 J2 PIN 41- PIN B11 C2 ECM SIDE
B 12 J1 PIN 32
B 13 J2 PIN 5- PIN B13 C2 ECM SIDE
B 14 J2 PIN 51
B 15 J1 PIN 19
B 16 J2 PIN 7- PIN B16 C2 ECM SIDE
B 17 PIN B17 C2 ECM SIDE
B 18 J2 PIN 53
B 19 J2 PIN 21 - PIN B19 C2 ECM SIDE
B 20 J1 PIN 9
B 21 J1 PIN 50
B 22 J2 PIN 35- PIN B22 C2 ECM SIDE
B 23 J2 PIN 9- PIN B23 C2 ECM SIDE
B 24 J2 PIN 55
C1 PIN V12 CAR - 1
J2 4,10,12,14 - 2
C1 PIN V13 CAR - 3
J2 PIN 2 - 4
C2 PIN B13 CAR - 5
6
C2 PIN B16 CAR - 7
8
C2 PIN B23 CAR - 9
J2 PIN 2 - 10
11
J2 PIN 2 - 12
13
J2 PIN 2 - 14
C2 PIN B9 CAR - 15
C1 PIN V3 CAR - 17
C1 PIN V21 CAR - 18, 19
20
C2 PIN B19 CAR - 21
22
C1 PIN V2 CAR - 23
24
C1 PIN V5 CAR - 25
26
C1 PIN V18 CAR - 27
28
C2 PIN B6 CAR - 29
30
C1 PIN V24 CAR - 31
32
33 - C1 PIN V22 CAR
34
35 - C2 PIN B22 CAR
36
37 - C1 PIN V23 CAR
38
39 - C2 PIN B10 CAR
40
41 - C2 PIN B11 CAR
42
43 - C1 PIN V4 CAR
44
45 - C1 PIN V20 CAR
46
47
48
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
C2 PIN B24 CAR
C2 PIN B24 ECM
57
58
59
60
61
62
63
64
V 1 J2 PIN 49
V 2 PIN V2 C1 CAR SIDE
V 3 PIN V3 C1 CAR SIDE
V 4 PIN V4 C1 CAR SIDE
V 5 PIN V5 C1 CAR SIDE
V 6 J1 PIN 3
V 7 J1 PIN 33
V 8 J1 PIN 39
V 9 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
B 1 J1 PIN 7
B 2 J1 PIN 6
B 3 J1 PIN 41
B 4 PIN B4 C2 CAR SIDE
B 5 J1 PIN 14
B 6 PIN B6 C2 CAR SIDE
B 7 J1 PIN 61
B 8 J1 PIN 16
B 9 PIN B9 C2 CAR SIDE
B 10 PIN B10 C2 CAR SIDE
B 11 PIN B11 C2 CAR SIDE
B 12 J1 PIN 31
B 13 PIN B13 C2 CAR SIDE
B 14 J2 PIN 52
B 15 J1 PIN 20
B 16 PIN B16 C2 CAR SIDE
B 17 PIN B17 C2 CAR SIDE
B 18 J2 PIN 54
B 19 PIN B19 C2 CAR SIDE
B 20 J1 PIN 10
B 21 J1 PIN 49
B 22 PIN B22 C2 CAR SIDE
B 23 PIN B23 C2 CAR SIDE
B 24 J2 PIN 56
C1 PIN V19 ECM - 1
C1 PIN V19 CAR - 2
C1 PIN V6 ECM - 3
C1 PIN V6 CAR - 4
C2 PIN B2 CAR - 5
C2 PIN B2 ECM - 6
C2 PIN B1 ECM - 7
C2 PIN B1 CAR - 8
C2 PIN B20 CAR - 9
C2 PIN B20 ECM - 10
11
12
C2 PIN B5 CAR - 13
C2 PIN B5 ECM - 14
C2 PIN B8 CAR - 15
C2 PIN B8 ECM - 16
17
18
C2 PIN B15 CAR - 19
C2 PIN B15 ECM - 20
C1 PIN V16 ECM - 21
C1 PIN V16 CAR - 22
C1 PIN V11 ECM - 23
C1 PIN V11 CAR - 24
C1 PIN V15 ECM - 25
C1 PIN V15 CAR - 26
C1 PIN V10 ECM - 27
C1 PIN V10 CAR - 28
C1 PIN V14 ECM - 29
C1 PIN V14 CAR - 30
C2 PIN B12 ECM - 31
C2 PIN B12 CAR - 32
1 - C1 PIN V7 ECM
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
43
44
45
46
47
48 - C2 PIN B21 ECM
49 - C2 PIN B21 CAR
50
51
52
53
54
55
56
57
58
59
60
61 - C2 PIN B7 ECM
62 - C2 PIN B7 CAR
63
64
GM 06


C1
24 PIN BLACK PLUG
A 1 PIN A1 C1 CAR SIDE
A 2 PIN A2 C1 CAR SIDE
A 3 PIN A3 C1 CAR SIDE
A 4 J1 PIN 23
A 5 J1 PIN 25
A 6 J1 PIN 21
A 7 PIN A7 C1 CAR SIDE
A 8 PIN A8 C1 CAR SIDE
A 9 PIN A9 C1 CAR SIDE
A10 PIN A10 C1 CAR SIDE
A11 PIN A11 C1 CAR SIDE
A12 PIN A12 C1 CAR SIDE
B 1 J1 PIN 27
B 2 PIN B2 C1 CAR SIDE
B 3 PIN B3 C1 CAR SIDE
B 4 PIN B4 C1 CAR SIDE
B 5 PIN B5 C1 CAR SIDE
B 6 PIN B6 C1 CAR SIDE
B 7 PIN B7 C1 CAR SIDE
B 8 PIN B8 C1 CAR SIDE
B 9 PIN B9 C1 CAR SIDE
B10 PIN B10 C1 CAR SIDE
B11 PIN B11 C1 CAR SIDE
B12 PIN B12 C1 CAR SIDE
C2
32 PIN BLACK PLUG
C 1 PIN C1 C2 CAR SIDE
C 2 PIN C2 C2 CAR SIDE
C 3 PIN C3 C2 CAR SIDE
C 4 PIN C4 C2 CAR SIDE
C 5 PIN C5 C2 CAR SIDE
C 6 PIN C6 C2 CAR SIDE
C 7 J1 PIN 1
C 8 J1 PIN 3
C 9 PIN C9 C2 CAR SIDE
C 10 J2 PIN 51
C 11 J2 PIN 49
C 12 J2 PIN 53
C 13 PIN C13 C2 CAR SIDE
C 14 PIN C14 C2 CAR SIDE
C 15 PIN C15 C2 CAR SIDE
C 16 J1 PIN 29
D 1 PIN D1 C2 CAR SIDE
D 2 PIN D2 C2 CAR SIDE
D 3 PIN D3 C2 CAR SIDE
D 4 PIN D4 C2 CAR SIDE
D 5 PIN D5 C2 CAR SIDE
D 6 PIN D6 C2 CAR SIDE
D 7 PIN D7 C2 CAR SIDE
D 8 PIN D8 C2 CAR SIDE
D 9 J1 PIN 31
D 10 PIN D10 C2 CAR SIDE
D 11 PIN D11 C2 CAR SIDE
D 12 PIN D12 C2 CAR SIDE
D 13 PIN D13 C2 CAR SIDE
D 14 PIN D14 C2 CAR SIDE
D 15 PIN D15 C2 CAR SIDE
D 16 PIN D16 C2 CAR SIDE
ECM SIDE
C3
32 PIN ORANGE PLUG
E 1 PIN E1 C3 CAR SIDE
E 2 PIN E2 C3 CAR SIDE
E 3 J1 PIN 33
E 4 J1 PIN 35
E 5 J1 PIN 37
E 6 J1 PIN 39
E 7 PIN E7 C3 CAR SIDE
E 8 J1 PIN 49
E 9 J1 PIN 45
E 10 PIN E10 C3 CAR SIDE
E 11 PIN E11 C3 CAR SIDE
E12 J1 PIN 20
E 13 PIN E13 C3 CAR SIDE
E 14 J1 PIN 6
E 15 PIN E15 C3 CAR SIDE
E 16 J1 PIN 16
F 1 J1 PIN 43
F 2 J1 PIN 51
F 3 J1 PIN 53
F 4 J1 PIN 41
F 5 J1 PIN 47
F 6 J2 PIN 55
F 7 J2 PIN 57
F 8 J2 PIN 59
F 9 J1 PIN 18
F 10 J1 PIN 12
F 11 PIN F11 C3 CAR SIDE
F 12 PIN F12 C3 CAR SIDE
F 13 PIN F13 C3 CAR SIDE
F 14 PIN F14 C3 CAR SIDE
F 15 J1 PIN 10
F 16 J1 PIN 14
C1
A 1 PIN A1 C1 ECM SIDE
A 2 PIN A2 C1 ECM SIDE
A 3 J2 PIN 17 - PIN A3 C1 ECM SIDE
A 4 J1 PIN 24
A 5 J1 PIN 26
A 6 J1 PIN 22
A 7 PIN A7 C1 ECM SIDE
A 8 J2 PIN 19 - PIN A8 C1 ECM SIDE
A 9 J2 PIN 23 - PIN A9 C1 ECM SIDE
A10 PIN A10 C1 ECM SIDE
A11 J2 PIN 31 - PIN A11 C1 ECM SIDE
A12 J2 PIN 1 - PIN A12 C1 ECM SIDE
B 1 J1 PIN 28
B 2 PIN B2 C1 ECM SIDE
B 3 PIN B3 C1 ECM SIDE
B 4 PIN B4 C1 ECM SIDE
B 5 J2 PIN 7-prom C1 ECM SIDE
B 6 J2 PIN 9 - PIN B6 C1 ECM SIDE
B 7 PIN B7 C1 ECM SIDE
B 8 PIN B8 C1 ECM SIDE
B 9 J2 PIN 11 - PIN B9 C1 ECM SIDE
B10 J2 PIN 25-prom C1 ECM SIDE
B11 J2 PIN 27 - PIN B11 C1 ECM SIDE
B12 J2 PIN 39 - PIN B12 C2 ECM SIDE
C2
C 1 J2 PIN 29 - PIN C1 C2 ECM SIDE
C 2 PIN C2 C2 ECM SIDE
C 3 J2 PIN 5 - PIN C3 C2 ECM SIDE
C 4 J2 PIN 16 - PIN C4 C2 ECM SIDE
C 5 J2 PIN 43 - PIN C5 C2 ECM SIDE
C 6 J2 PIN 33 - PIN C6 C2 ECM SIDE
C 7 J1 PIN 2
C 8 J1 PIN 4
C 9 J2 PIN 35 - PIN C9 C2 ECM SIDE
C10 J2 PIN 52
C11 J2 PIN 50
C12 J2 PIN 54
C13 J2 PIN 41 - PIN C13 C2 ECM SIDE
C14 PIN C14 C2 ECM SIDE
C15 J2 PIN 18 - PIN C15 C2 ECM SIDE
C16 J1 PIN 30
D 1 J2 PIN 3-prom C2 ECM SIDE
D 2 PIN D2 C2 ECM SIDE
D 3 PIN D3 C2 ECM SIDE
D 4 J2 PIN 20 - PIN D4 C2 ECM SIDE
D 5 J2 PIN 37 - PIN D5 C2 ECM SIDE
D 6 J2 PIN 13 - PIN D6 C2 ECM SIDE
D 7 J2 PIN 22 - PIN D7 C2 ECM SIDE
D 8 J2 PIN 15 - PIN D8 C2 ECM SIDE
D 9 J1 PIN 32
D10 PIN D10 C2 ECM SIDE
D11 J2 PIN 45 - PIN D11 C2 ECM SIDE
D12 J2 PIN 24 - PIN D12 C2 ECM SIDE
D13 J2 PIN 26 - PIN D13 C2 ECM SIDE
D14 J2 PIN 28 - PIN D14 C2 ECM SIDE
D15 J2 PIN 30 - PIN D15 C2 ECM SIDE
D16 J2 PIN 32 - PIN D16 C2 ECM SIDE
56 PIN BLACK HEADER
CAR SIDE
C3
E 1 PIN E1 C3 ECM SIDE
E 2 PIN E2 C3 ECM SIDE
E 3 J1 PIN 34
E 4 J1 PIN 36
E 5 J1 PIN 38
E 6 J1 PIN 40
E 7 J2 PIN 34 - PIN E7 C3 ECM SIDE
E 8 J1 PIN 50
E 9 J1 PIN 46
E10 PIN E10 C3 ECM SIDE
E11 PIN E11 C3 ECM SIDE
E12 J1 PIN 19
E13 J2 PIN 36 - PIN E13 C3 ECM SIDE
E14 J1 PIN 5
E15 J2 PIN 38 - PIN E15 C3 ECM SIDE
E16 J1 PIN 15
F 1 J1 PIN 44
F 2 J1 PIN 52
F 3 J1 PIN 34
F 4 J1 PIN 42
F 5 J1 PIN 48
F 6 J2 PIN 56
F 7 J2 PIN 58
F 8 J2 PIN 60
F 9 J1 PIN 17
F10 J1 PIN 11
F11 PIN F11 C3 ECM SIDE
F12 PIN F12 C3 ECM SIDE
F13 J2 PIN 21
F14 J2 PIN 40
F15 J1 PIN 9
F16 J1 PIN 13
32 PIN ORANGE HEADER
J2
1 C1 PIN A12 CAR
2 J2 PIN 10,12,14
3 C2 PIN 111 CAR
5 C2 PIN C3 CAR
7 C1 PIN B5 CAR
9 C1 PIN B6 CAR
10 J2 PD4 2
11 C1 PIN B9 CAR
J2 PIN 2
13 C2 PIN 116 CAR
14 J2 PIN 2
15 C2 PIN 118 CAR
16 C2 PIN C4 CAR
17 C1 PIN A3 CAR
18 C2 PIN C15 CAR
19 C1 PIN A8 CAR
20 C2 PIN 114 CAR
21 C3 PIN F13 CAR
22 C2 PIN D7 CAR
23 C1 PIN A9 CAR
24 C2 PIN D12 CAR
25 C1 PIN B10 CAR
26 C2 PIN D13 CAR
27 C1 PIN m1 CAR
28 C2 PIN D14 CAR
29 C2 PIN C1 CAR
30 C2 PIN D15 CAR
31 C1 PIN A11 CAR
32 C2 PIN 1116 CAR
33 C2 PIN C6 CAR
34 C3 PIN E7 CAR
35 C2 PIN C9 CAR
36 C3 PIN E13 CAR
37 C2 PIN 115 CAR
38 C3 PIN E15 CAR
39 C1 PIN B12 CAR
40 C3 PIN F14 CAR
41 C2 PIN C13 CAR
43 C2 PIN C5 CAR
45 C2 PIN D11 CAR
49 C2 PIN C11 ECM
50 C2 PIN C11 CAR
51 C2 PIN C10 ECM
52 C2 PIN C10 CAR
53 C2 PIN C12 ECM
54 C2 PIN C12 CAR
55 C3 PIN F6 ECM
56 C3 PIN F6 CAR
57 C3 PIN F7 ECM
58 C3 PIN F7 CAR
59 C3 PIN F8 ECM
60 C3 PIN F8 CAR
J1
1 C2 PIN C7 ECM
2 C2 PIN C7 CAR
3 C2 PIN C8 ECM
4 C2 PIN C8 CAR
5 C3 PIN E14 CAR
6 C3 PIN E14 ECM
9 C3 PIN F15 CAR
10 C3 PIN F15 ECM
11 C3 PIN F10 CAR
12 C3 PIN F10 ECM
13 C3 PIN F16 CAR
14 C3 PIN F16 ECM
15 C3 PIN E16 CAR
16 C3 PIN E16 ECM
17 C3 PIN F9 CAR
18 C3 PIN F9 ECM
19 C3 PIN E12 CAR
20 C3 PIN E12 ECM
21 C1 PIN A6 ECM
22 C1 PIN A6 CAR
23 C1 PIN A4 ECM
24 C1 PIN A4 CAR
25 C1 PIN A5 ECM
26 C1 PIN A5 CAR
27 C1 PIN B1 ECM
28 C1 PIN B1 CAR
29 C2 PIN C16 ECM
30 C2 PIN C16 CAR
31 C2 PIN D9 ECM
32 C2 PIN D9 CAR
33 C3 PIN E3 ECM
34 C3 PIN E3 CAR
35 C3 PIN E4 ECM
36 C3 PIN E4 CAR
37 C3 PIN E5 ECM
38 C3 PIN E5 CAR
39 C3 PIN E6 ECM
40 C3 PIN E6 CAR
41 C3 PIN F4 ECM
42 C3 PIN F4 CAR
43 C3 PIN F1 ECM
44 C3 PIN F1 CAR
45 C3 PIN E9 ECM
46 C1 PIN E9 CAR
47 C3 PIN F5 ECM
48 C3 PIN F5 CAR
49 C3 PIN E8 ECM
50 C3 PIN E8 CAR
51 C3 PIN F2 ECM
52 C3 PIN F2 CAR
53 C3 PIN F3 ECM
54 C3 PIN F3 CAR
55 C3 PIN F7 ECM
56 C3 PIN F7 CAR

GM 07



C1
24 PIN
BLACK
PLUG
PIN A1 C1 CAR SIDE
PIN A2 C1 CAR SIDE
PIN A3 C1 CAR SIDE
PIN A4 C1 CAR SIDE
J1 PIN 31
J1 PIN 21
PIN A7 C1 CAR SIDE
PIN A8 C1 CAR SIDE
PIN A9 C1 CAR SIDE
PIN A10 C1 CAR SIDE
PIN A11 C1 CAR SIDE
PIN A12 C1 CAR SIDE
J1 PIN 23
PIN B2 C1 CAR SIDE
PIN B3 C1 CAR SIDE
PIN B4 C1 CAR SIDE
J1 PIN 49
PIN B6 C1 CAR SIDE
PIN B7 C1 CAR SIDE
PIN B8 C1 CAR SIDE
PIN B9 C1 CAR SIDE
PIN B10 C1 CAR SIDE
PIN B11 C1 CAR SIDE
PIN B12 C1 CAR SIDE
C2
32 PIN
BLACK
PLUG
PIN C1 C2 CAR SIDE
J1 PIN 45
J1 PIN 47
PIN C4 C2 CAR SIDE
PIN C5 C2 CAR SIDE
PIN C6 C2 CAR SIDE
J1 PIN 1
J1 PIN 3
PIN C9 C2 CAR SIDE
PIN C10 C2 CAR SIDE
PIN C11 C2 CAR SIDE
PIN C12 C2 CAR SIDE
J2 PIN 49
J1 PIN 25
J2 PIN 51
J1 PIN 27
PIN D1 C2 CAR SIDE
J1 PIN 43
PIN D3 C2 CAR SIDE
PIN D4 C2 CAR SIDE
PIN D5 C2 CAR SIDE
PIN D6 C2 CAR SIDE
PIN D7 C2 CAR SIDE
PIN D8 C2 CAR SIDE
J1 PIN 29
PIN D10 C2 CAR SIDE
PIN D11 C2 CAR SIDE
PIN D12 C2 CAR SIDE
J2 PIN 53
J2 PIN 55
J2 PIN 57
J2 PIN 59
ECM SIDE
C3
32 PIN
ORANGE
PLUG
PIN E1 C3 CAR SIDE
J1 PIN 51
J1 PIN 55
PIN E4 C3 CAR SIDE
J1 PIN 33
J1 PIN 35
J1 PIN 37
J1 PIN 39
PIN E9 C3 CAR SIDE
J1 PIN 61
PIN E11 C3 CAR SIDE
PIN E12 C3 CAR SIDE
PIN E13 C3 CAR SIDE
PIN E14 C3 CAR SIDE
J1 PIN 41
PIN E16 C3 CAR SIDE
PIN F1 C3 CAR SIDE
J1 PIN 6
PIN F3 C3 CAR SIDE
J1 PIN 16
PIN F5 C3 CAR SIDE
J1 PIN 20
PIN F7 C3 CAR SIDE
PIN F8 C3 CAR SIDE
J1 PIN 18
J1 PIN 10
J1 PIN 14
PIN F12 C3 CAR SIDE
PIN F13 C3 CAR SIDE
PIN F14 C3 CAR SIDE
PIN F15 C3 CAR SIDE
PIN F16 C3 CAR SIDE
C1
PIN A1 C1 ECM SIDE
J2 PIN 23 - PIN A2 C1 ECM SIDE
PIN A3 C1 ECM SIDE
PIN A4 C1 ECM SIDE
J1 PIN 32
J1 PIN 22
PIN A7 C1 ECM SIDE
J2 PIN 25 - PIN A8 C1 ECM SIDE
J2 PIN 19 - PIN A9 C1 ECM SIDE
PIN A10 C1 ECM SIDE
J2 PIN 31 - PIN A11 C1 ECM SIDE
J2 PIN 1 - PIN A12 C1 ECM SIDE
J1 PIN 24
PIN B2 C1 ECM SIDE
PIN B3 C1 ECM SIDE
PIN B4 C1 ECM SIDE
J1 PIN 50
PIN B6 C3 ECM SIDE
PIN B7 C1 ECM SIDE
PIN B8 C1 ECM SIDE
J2 PIN 5- PIN B9 C1 ECM SIDE
J2 PIN 29- PIN B11 C1 ECM SIDE
J2 PIN 33- PIN B12 C2 ECM SIDE
C2
56 PIN
BLACK
HEADER
PIN A1 C2 ECM SIDE
J1 PIN 46
J1 PIN 48
J2 PIN 35 - PIN C4 C2 ECM SIDE
J2 PIN 43 - PIN C5 C2 ECM SIDE
PIN C6 C2 ECM SIDE
J1 PIN 2
J1 PIN 4
J2 PIN 37 - PIN C9 C2 ECM SIDE
J2 PIN 39 - PIN C10 C2 ECM SIDE
PIN C11 C2 ECM SIDE
PIN C12 C2 ECM SIDE
J2 PIN 50
J1 PIN 26
J2 PIN 52
J1 PIN 28
J2 PIN 3 - PIN D1 C2 ECM SIDE
J1 PIN 44
PIN D3 C2 ECM SIDE
J2 PIN 41 - PIN M C2 ECM SIDE
PIN D5 C2 ECM SIDE
J2 PIN 7- PIN D6 C2 ECM SIDE
J2 PIN 9 - PIN D7 C2 ECM SIDE
J2 PIN 15 - PIN D8 C2 ECM SIDE
J1 PIN 30
J2 PIN 45 - PIN D10 C2 ECM SIDE
J2 PIN 17 - PIN D11 C2 ECM SIDE
PIN D12 C2 ECM SIDE
J2 PIN 54
J2 PIN 56
J2 PIN 58
J2 PIN 60
CAR SIDE
C3
32 PIN
ORANGE HEADER
PIN E1 C3 ECM SIDE
J1 PIN 52
J1 PIN 56
PIN E4 C3 ECM SIDE
J1 PIN 34
J1 PIN 36
J1 PIN 38
J1 PIN 40
J2 PIN 16 - PIN E9 C3 ECM SIDE
J1 PIN 62
J2 PIN 18 - PIN E11 C3 ECM SIDE
PIN E12 C3 ECM SIDE
PIN E13 C3 ECM SIDE
PIN E14 C3 ECM SIDE
J1 PIN 42
PIN E16 C3 ECM SIDE
PIN F1 C3 ECM SIDE
J1 PIN 5
J2 PIN 11 - PIN F3 C3 ECM SIDE
J1 PIN 15
J2 PIN 13 - PIN F5 C3 ECM SIDE
J1 PIN 19
J2 PIN 20 - PIN F7 C3 ECM SIDE
J2 PIN 22 - PIN F8 C3 ECM SIDE
J1 PIN 17
J1 PIN 9
J1 PIN 13
PIN F12 C3 ECM SIDE
J2 PIN 21 - PIN F13 C3 ECM SIDE
PIN F14 C3 ECM SIDE
PIN F15 C3 ECM SIDE
PIN F16 C3 ECM SIDE
J2
C1 PIN A12
J2 PIN 8,12,14
C2 PIN D1 CAR
C1 PIN B9 CAR
C2 PIN D6 CAR
C2 PIN D7
C3 PIN F3 CAR
C3 PIN F5 CAR
C3 PIN F9 CAR
C2 PIN D11 CAR
C3 PIN E11 CAR
C1 PIN A9 CAR
C3 PIN F7 CAR
C3 PIN F13 CAR
C3 PIN F8 CAR
C1 PIN A2 CAR
C1 PIN A8 CAR
C1 PIN B10
C1 PIN B11 CAR
C1 PIN A11 CAR
C1 PIN B12 CA
C2 PIN C4 CA
C2 PIN C9 CA
C2 PIN C10 CA
C2 PIN D4 CA
C2 PIN C5 CA
C2 PIN D10 CA
C2 PIN C13 EC
C2 PIN C13 CA
C2 PIN C15 EC
C2 PIN C15 CA
C2 PIN D13 EC
C2 PIN D14 EC
C2 PIN D15 EC
C2 PIN D16 EC
C2 PIN D16 CA
J1
C2 PIN C7 ECM
C2 PIN C7 CAR
C2 PIN C8 ECM
C2 PIN C8 CAR
C3 PIN F2 CAR
C3 PIN F2 ECM
C3 PIN F10 CAR
C3 PIN F10 ECM
C3 PIN F11 CAR
C3 PIN F11 ECM
C3 PIN F4 CAR
C3 PIN F4 ECM
C3 PIN F9 CAR
C3 PIN F9 ECM
C3 PIN F6 CAR
C3 PIN F6 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
C2 PIN D9 ECM
C2 PIN D9 CAR
C1 PIN A5 ECM
C1 PIN A5 CAR
C3 PIN E5 EC
C3 PIN E5 CA
C3 PIN E6 EC
C3 PIN E6 CA
C3 PIN E7 EC
C3 PIN E7 CA
C3 PIN E8 EC
C3 PIN E8 CA
C3 PIN E15 EC
C3 PIN E15 CA
C2 PIN D2 EC
C2 PIN D2 CA
C2 PIN C2 EC
C2 PIN C2 CA
C2 PIN C3 EC
C2 PIN C3 CA
C1 PIN B5 ECM
C1 PIN B5 CAR
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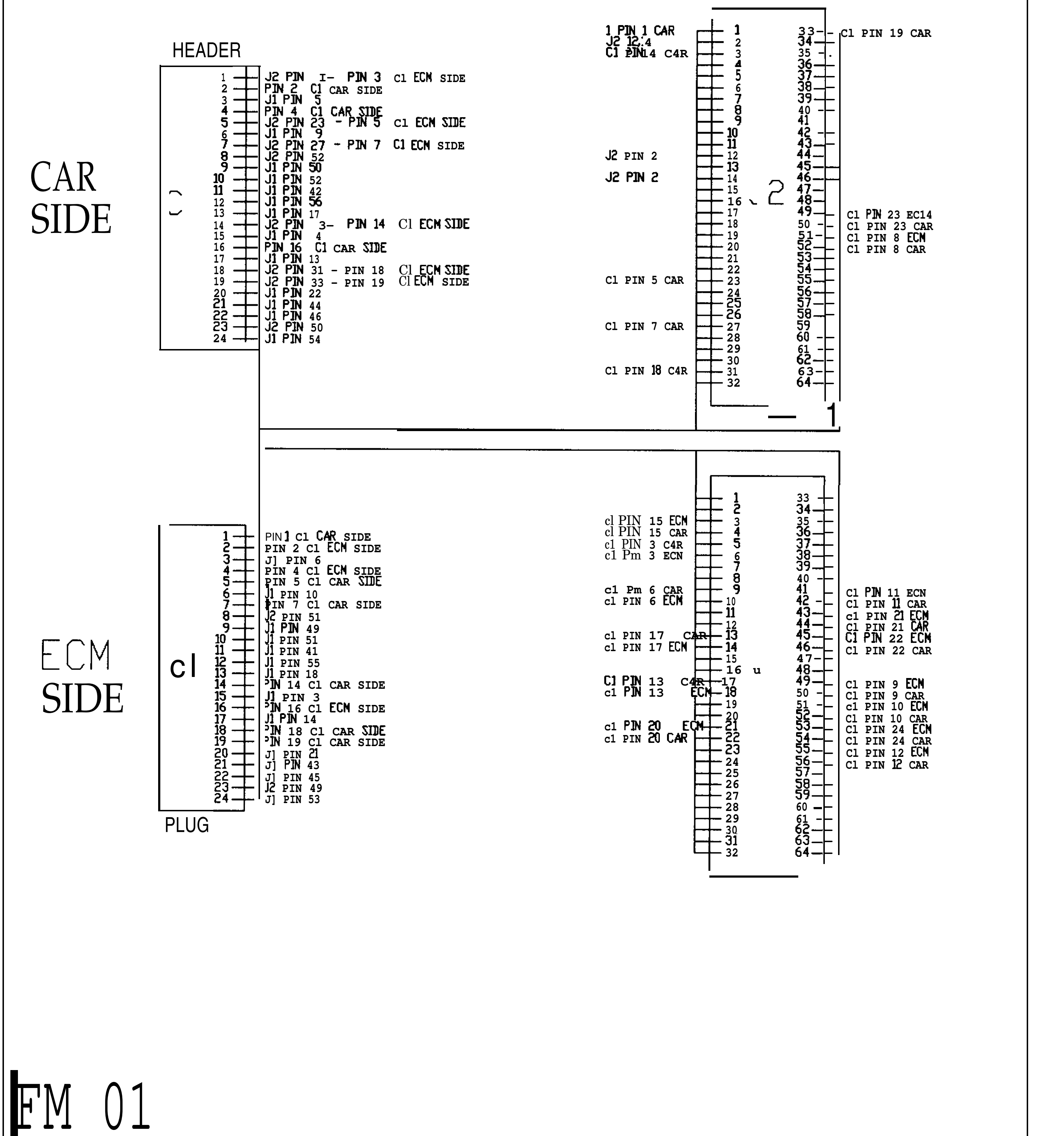
C3 PIN E2 CA
C3 PIN E3 EC
C3 PIN E3 CA
C3 PIN E10 EC
C3 PIN E10 CA
GM 08


HEADER
CAR
SIDE
ECM
SIDE
PLUG
c1
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
C1 PIN 19 CAR
C1 PIN 23 EC14
C1 PIN 23 CAR
C1 PIN 8 ECM
C1 PIN 8 CAR
C1 PIN 5 CAR
C1 PIN 7 CAR
C1 PIN 18 C4R
J2 PIN 2
J2 PIN 2
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 PIN 3 ECN
c1 PIN 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
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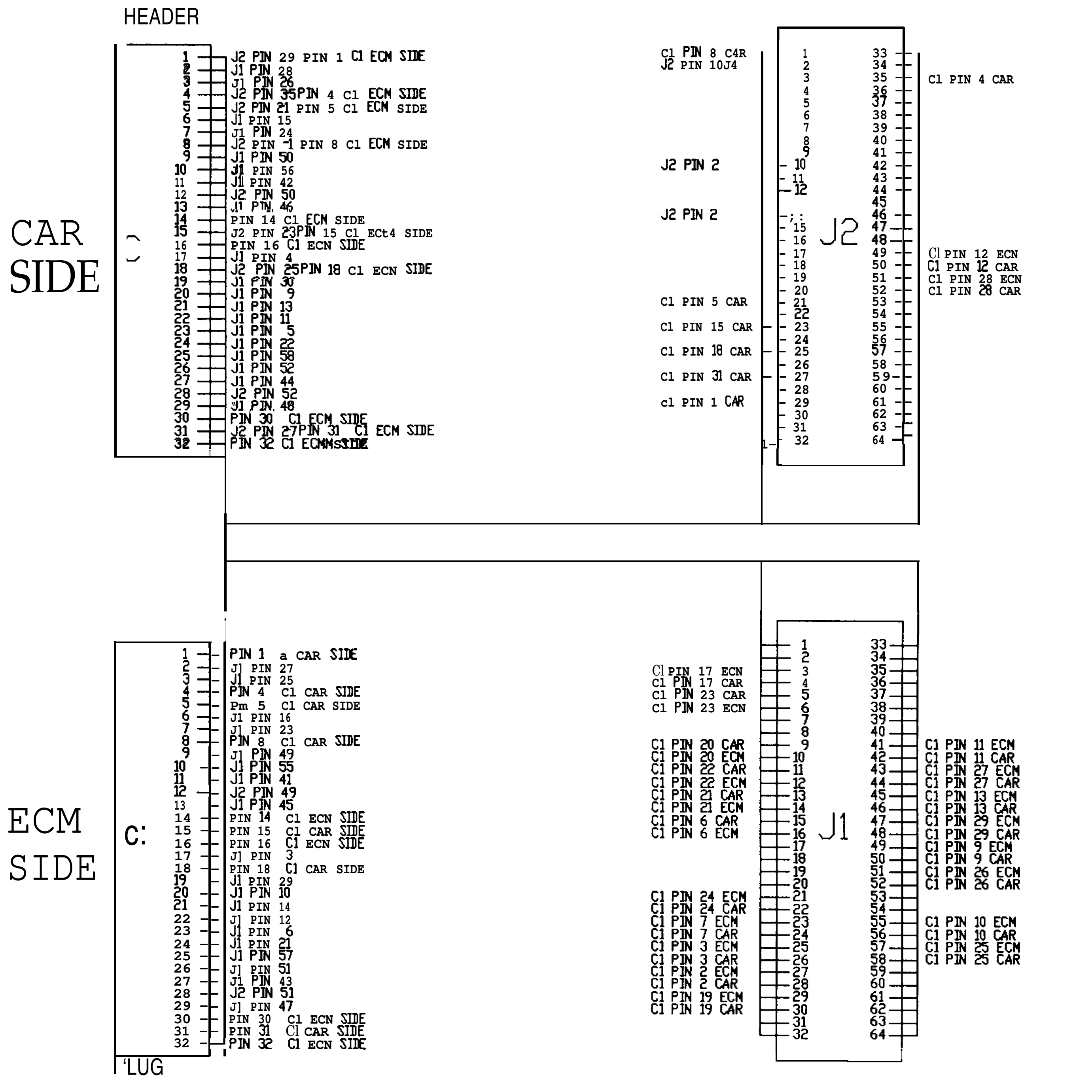
C1 PIN 12 CAR
FM 01



HEADER
CAR SIDE
J2 PIN 29 PIN 1 C1 ECM SIDE
J1 PIN 28
J1 PIN 26
J2 PIN 35 PIN 4 C1 ECM SIDE
J2 PIN 21 PIN 5 C1 ECM SIDE
J1 PIN 15
J1 PIN 24
J2 PIN 1 PIN 8 C1 ECM SIDE
J1 PIN 50
J1 PIN 56
J1 PIN 42
J2 PIN 50
J1 PIN 46
PIN 14 C1 ECM SIDE
J2 PIN 23 PIN 15 C1 ECM SIDE
PIN 16 C1 ECN SIDE
J1 PIN 4
J2 PIN 25 PIN 18 C1 ECN SIDE
J1 PIN 30
J1 PIN 9
J1 PIN 13
J1 PIN 11
J1 PIN 5
J1 PIN 22
J1 PIN 58
J1 PIN 52
J1 PIN 44
J2 PIN 52
J1 PIN 48
PIN 30 C1 ECM SIDE
J2 PIN 27 PIN 31 C1 ECM SIDE
PIN 32 C1 ECM SIDE
C1 PIN 8 CAR
J2 PIN 10
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
ECM SIDE
PIN 1 a CAR SIDE
J1 PIN 27
J1 PIN 25
PIN 4 C1 CAR SIDE
Pm 5 C1 CAR SIDE
J1 PIN 16
J1 PIN 23
PIN 8 C1 CAR SIDE
J1 PIN 49
J1 PIN 55
J1 PIN 41
J2 PIN 49
J1 PIN 45
PIN 14 C1 ECN SIDE
PIN 15 C1 CAR SIDE
PIN 16 C1 ECN SIDE
J1 PIN 3
PIN 18 C1 CAR SIDE
J1 PIN 29
J1 PIN 10
J1 PIN 14
J1 PIN 12
J1 PIN 6
J1 PIN 21
J1 PIN 57
J1 PIN 51
J1 PIN 43
J2 PIN 51
J1 PIN 47
PIN 30 C1 ECN SIDE
PIN 31 C1 CAR SIDE
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
C1 PIN 9 ECM
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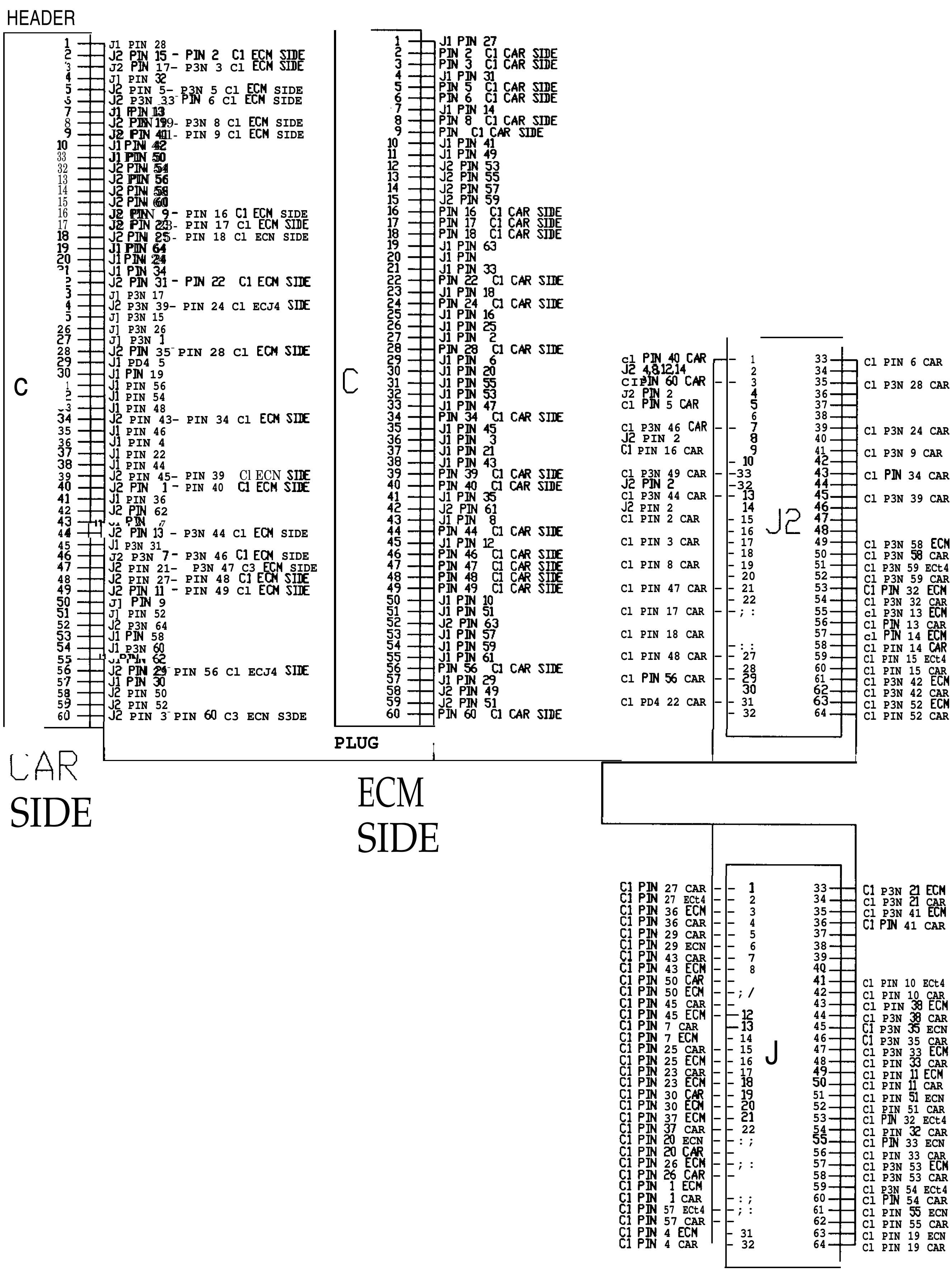
C1 PIN 25 ECM
C1 PIN 25 CAR

FM 02


HEADER
1 J1 PIN 28
2 J2 PIN 15 - PIN 2 C1 ECM SIDE
3 J2 PIN 17- P3N 3 C1 ECM SIDE
4 J1 PIN 32
5 J2 PIN 5- P3N 5 C1 ECM SIDE
6 J2 P3N 33 PIN 6 C1 ECM SIDE
7 J1 PIN 13
8 J2 PIN 19- P3N 8 C1 ECM SIDE
9 J2 PIN 41- PIN 9 C1 ECM SIDE
10 J1 PIN 42
J1 PIN 50
J2 PIN 54
J2 PIN 56
J2 PIN 58
J2 PIN 60
J2 PIN 9- PIN 16 C1 ECM SIDE
J2 PIN 23- PIN 17 C1 ECM SIDE
18 J2 PIN 25- PIN 18 C1 ECN SIDE
19 J1 PIN 64
20 J1 PIN 24
J1 PIN 34
J2 PIN 31 - PIN 22 C1 ECM SIDE
J1 P3N 17
J2 P3N 39- PIN 24 C1 ECJ4 SIDE
J1 P3N 15
26 J1 P3N 26
27 J1 P3N 1
28 J2 PIN 35 PIN 28 C1 ECM SIDE
29 J1 PD4 5
30 J1 PIN 19
J1 PIN 56
J1 PIN 54
J1 PIN 48
34 J2 PIN 43- PIN 34 C1 ECM SIDE
35 J1 PIN 46
36 J1 PIN 4
37 J1 PIN 22
38 J1 PIN 44
39 J2 PIN 45- PIN 39 C1 ECN SIDE
40 J2 PIN 1 - PIN 40 C1 ECM SIDE
41 J1 PIN 36
42 J2 PIN 62
44 J2 PIN 13 - P3N 44 C1 ECM SIDE
45 J1 P3N 31
46 J2 P3N 7- P3N 46 C1 ECM SIDE
47 J2 PIN 21- P3N 47 C3 ECM SIDE
48 J2 PIN 27- PIN 48 C1 ECM SIDE
49 J2 PIN 11 - PIN 49 C1 ECM SIDE
50 J1 PIN 9
51 J1 PIN 52
52 J2 P3N 64
53 J1 PIN 58
54 J1 P3N 60
J1 PIN 62
56 J2 PIN 29 PIN 56 C1 ECJ4 SIDE
57 J1 PIN 30
58 J2 PIN 50
59 J2 PIN 52
60 J2 PIN 3 PIN 60 C3 ECN S3DE
C
CAR
SIDE
1 J1 PIN 27
2 PIN 2 C1 CAR SIDE
3 PIN 3 C1 CAR SIDE
4 J1 PIN 31
5 PIN 5 C1 CAR SIDE
6 PIN 6 C1 CAR SIDE
7 J1 PIN 14
8 PIN 8 C1 CAR SIDE
9 PIN C1 CAR SIDE
10 J1 PIN 41
11 J1 PIN 49
12 J2 PIN 53
13 J2 PIN 55
14 J2 PIN 57
15 J2 PIN 59
16 PIN 16 C1 CAR SIDE
17 PIN 17 C1 CAR SIDE
18 PIN 18 C1 CAR SIDE
19 J1 PIN 63
20 J1 PIN
21 J1 PIN 33
22 PIN 22 C1 CAR SIDE
23 J1 PIN 18
24 PIN 24 C1 CAR SIDE
25 J1 PIN 16
26 J1 PIN 25
27 J1 PIN 2
28 PIN 28 C1 CAR SIDE
29 J1 PIN 6
30 J1 PIN 20
31 J1 PIN 55
32 J1 PIN 53
33 J1 PIN 47
34 PIN 34 C1 CAR SIDE
35 J1 PIN 45
36 J1 PIN 3
37 J1 PIN 21
38 J1 PIN 43
39 PIN 39 C1 CAR SIDE
40 PIN 40 C1 CAR SIDE
41 J1 PIN 35
42 J2 PIN 61
43 J1 PIN 8
44 PIN 44 C1 CAR SIDE
45 J1 PIN 12
46 PIN 46 C1 CAR SIDE
47 PIN 47 C1 CAR SIDE
48 PIN 48 C1 CAR SIDE
49 PIN 49 C1 CAR SIDE
50 J1 PIN 10
51 J1 PIN 51
52 J2 PIN 63
53 J1 PIN 57
54 J1 PIN 59
55 J1 PIN 61
56 PIN 56 C1 CAR SIDE
57 J1 PIN 29
58 J2 PIN 49
59 J2 PIN 51
60 PIN 60 C1 CAR SIDE
C
PLUG
ECM
SIDE
J2
C1 PIN 40 CAR
J2 4,8,12,14
C1 PIN 60 CAR
J2 PIN 2
C1 PIN 5 CAR
C1 P3N 46 CAR
J2 PIN 2
C1 PIN 16 CAR
C1 P3N 49 CAR
J2 PIN 2
C1 P3N 44 CAR
J2 PIN 2
C1 PIN 2 CAR
C1 PIN 3 CAR
C1 PIN 8 CAR
C1 PIN 47 CAR
C1 PIN 17 CAR
C1 PIN 18 CAR
C1 PIN 48 CAR
C1 PIN 56 CAR
C1 PD4 22 CAR
C1 PIN 6 CAR
C1 P3N 28 CAR
C1 P3N 24 CAR
C1 P3N 9 CAR
C1 PIN 34 CAR
C1 P3N 39 CAR
C1 P3N 58 ECM
C1 P3N 58 CAR
C1 P3N 59 ECt4
C1 P3N 59 CAR
C1 PIN 32 ECM
C1 P3N 32 CAR
C1 P3N 13 ECM
C1 PIN 13 CAR
C1 PIN 14 ECM
C1 PIN 14 CAR
C1 PIN 15 ECt4
C1 PIN 15 CAR
C1 P3N 42 ECM
C1 P3N 42 CAR
C1 P3N 52 ECM
C1 PIN 52 CAR
J
C1 PIN 27 CAR
C1 PIN 27 ECt4
C1 PIN 36 ECM
C1 PIN 36 CAR
C1 PIN 29 CAR
C1 PIN 29 ECN
C1 PIN 43 CAR
C1 PIN 43 ECM
C1 PIN 50 CAR
C1 PIN 50 ECM
C1 PIN 45 CAR
C1 PIN 45 ECM
C1 PIN 7 CAR
C1 PIN 7 ECM
C1 PIN 25 CAR
C1 PIN 25 ECM
C1 PIN 23 CAR
C1 PIN 23 ECM
C1 PIN 30 CAR
C1 PIN 30 ECM
C1 PIN 37 ECM
C1 PIN 37 CAR
C1 PIN 20 ECN
C1 PIN 20 CAR
C1 PIN 26 ECM
C1 PIN 26 CAR
C1 PIN 1 ECM
C1 PIN 1 CAR
C1 PIN 57 ECt4
C1 PIN 57 CAR
C1 PIN 4 ECM
C1 PIN 4 CAR
C1 P3N 21 ECM
C1 P3N 21 CAR
C1 P3N 41 ECM
C1 PIN 41 CAR
C1 PIN 10 ECt4
C1 PIN 10 CAR
C1 PIN 38 ECM
C1 P3N 38 CAR
C1 P3N 35 ECN
C1 P3N 35 CAR
C1 P3N 33 ECM
C1 PIN 33 CAR
C1 PIN 11 ECM
C1 PIN 11 CAR
C1 PIN 51 ECN
C1 PIN 51 CAR
C1 PIN 32 ECt4
C1 PIN 32 CAR
C1 PIN 33 ECN
C1 PIN 33 CAR
C1 P3N 53 ECM
C1 P3N 53 CAR
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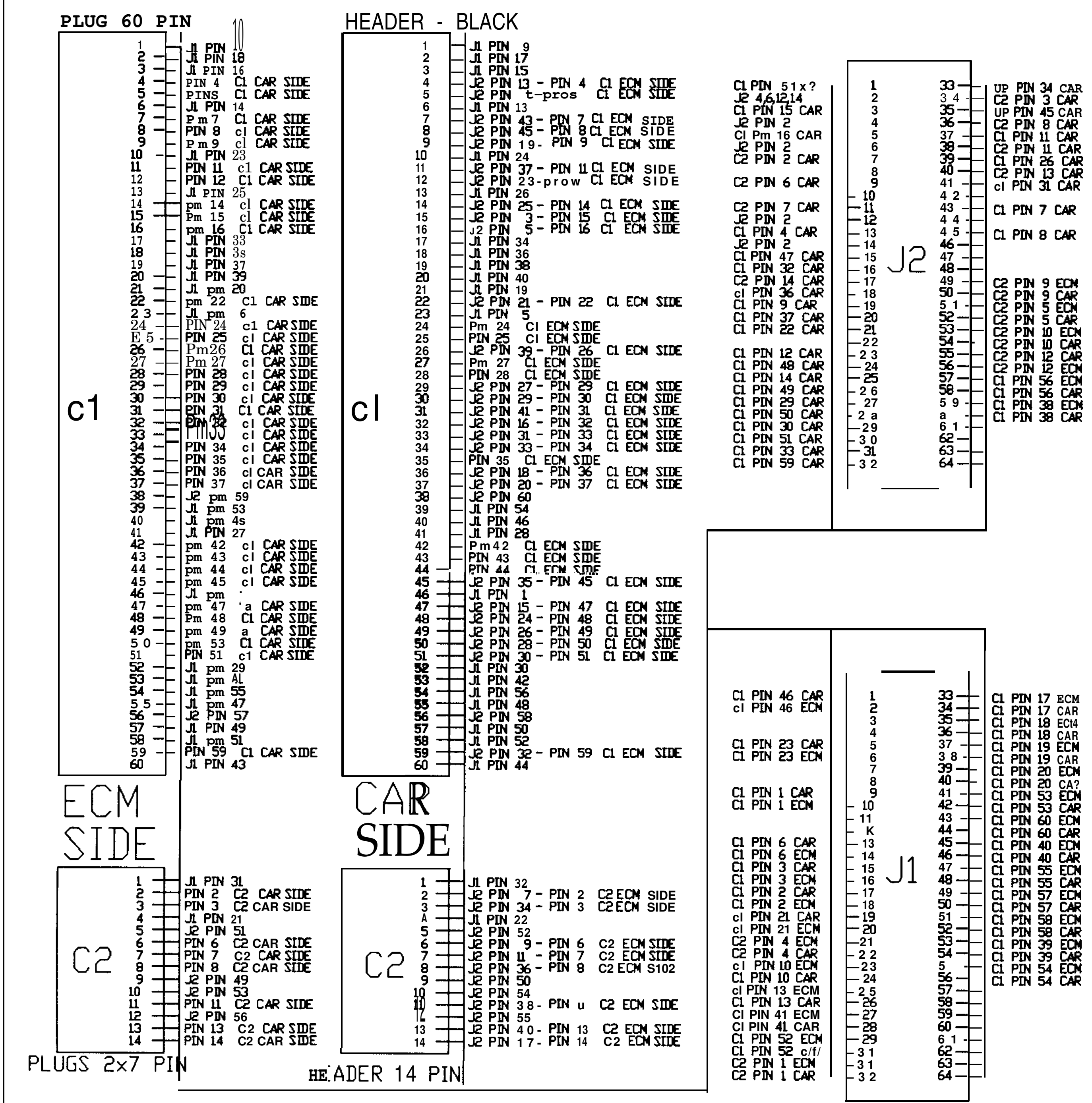
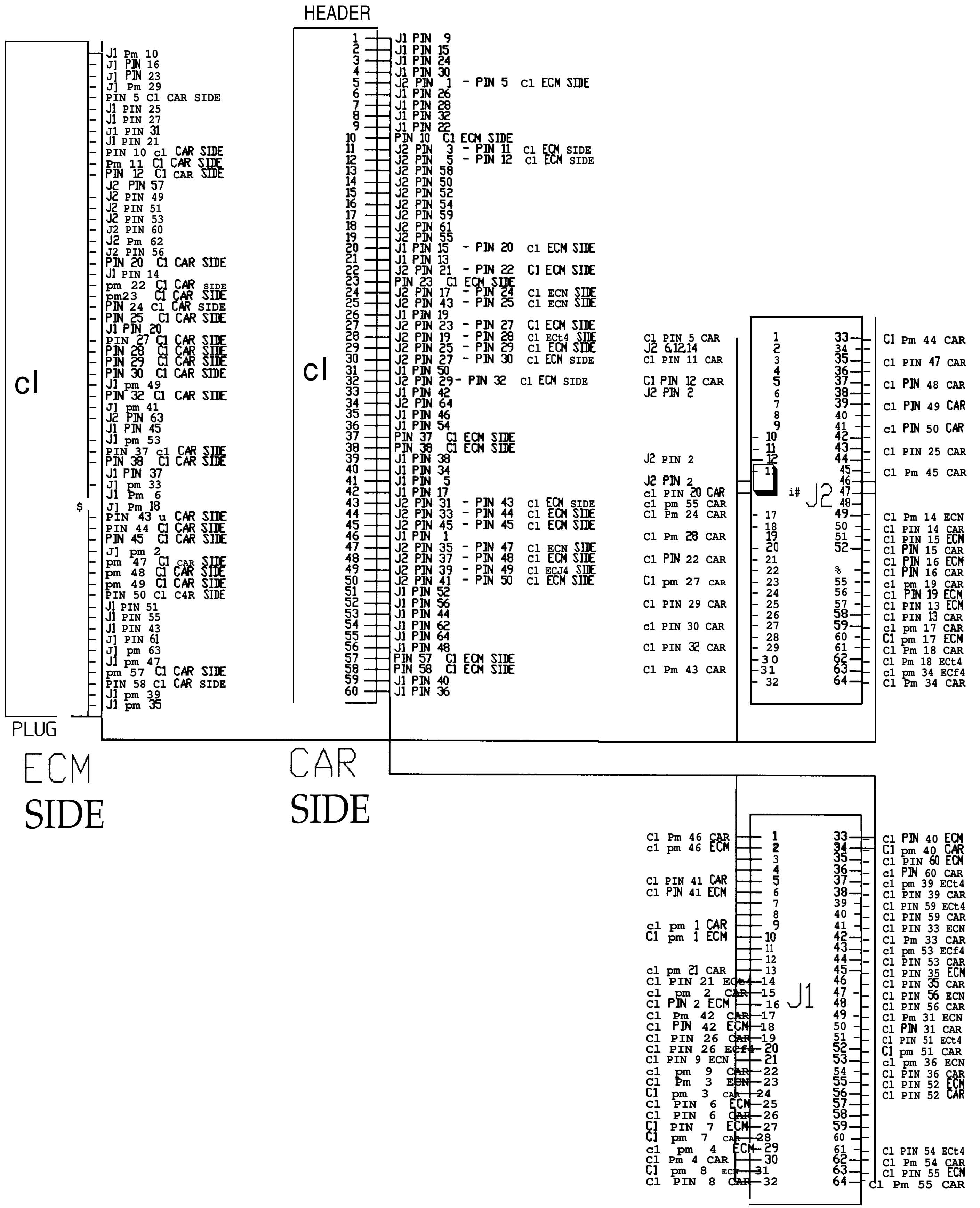
C1 PIN 54 CAR
C1 PIN 55 ECN
C1 PIN 55 CAR
C1 PIN 19 ECN
C1 PIN 19 CAR

FM 03

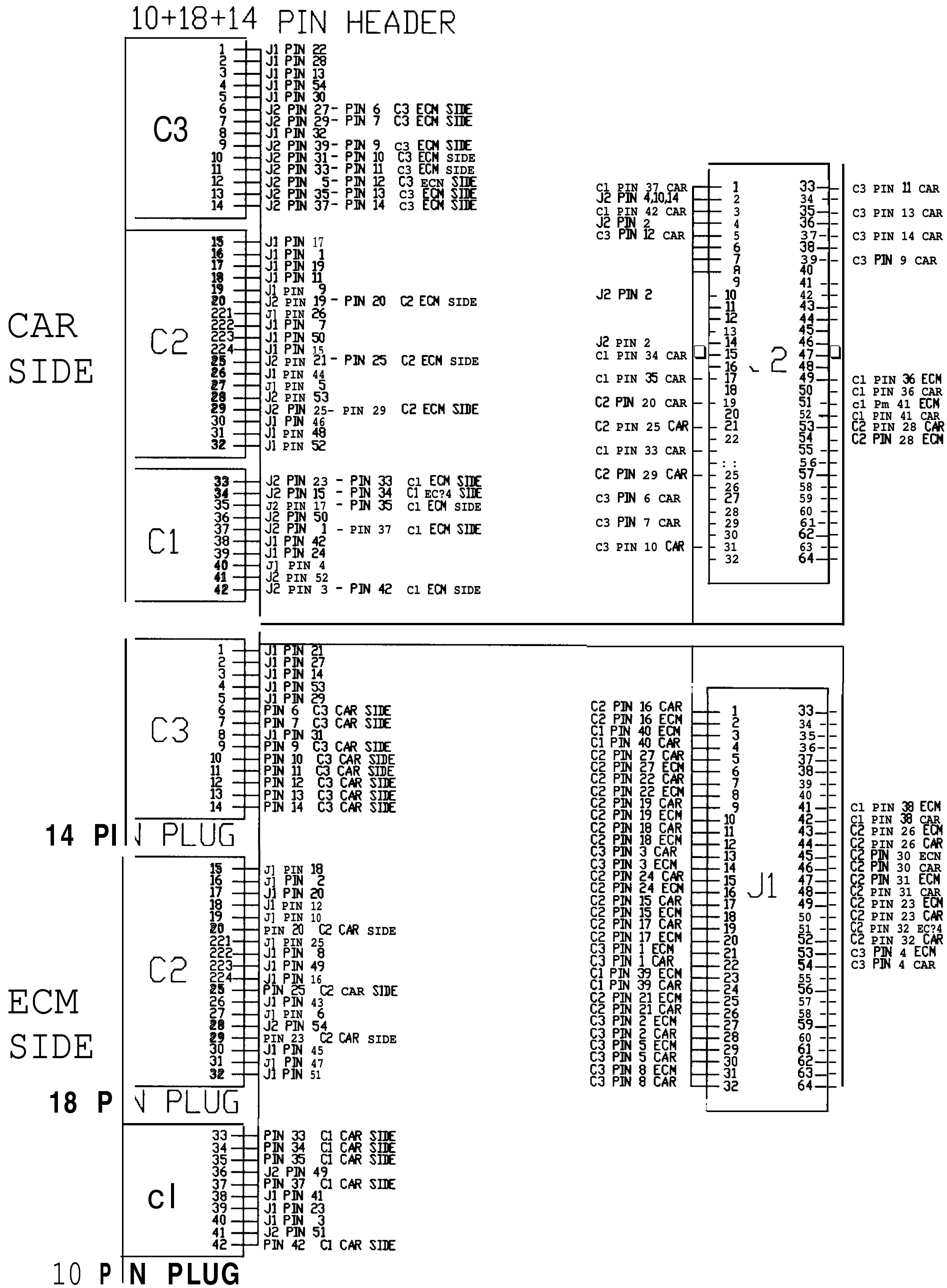

PLUG 60 PIN
HEADER - BLACK
c1
cl
ECM SIDE
CAR SIDE
C2
C2
PLUGS 2x7 PIN
HEADER 14 PIN
J2
J1

CR 1A & CR 1B



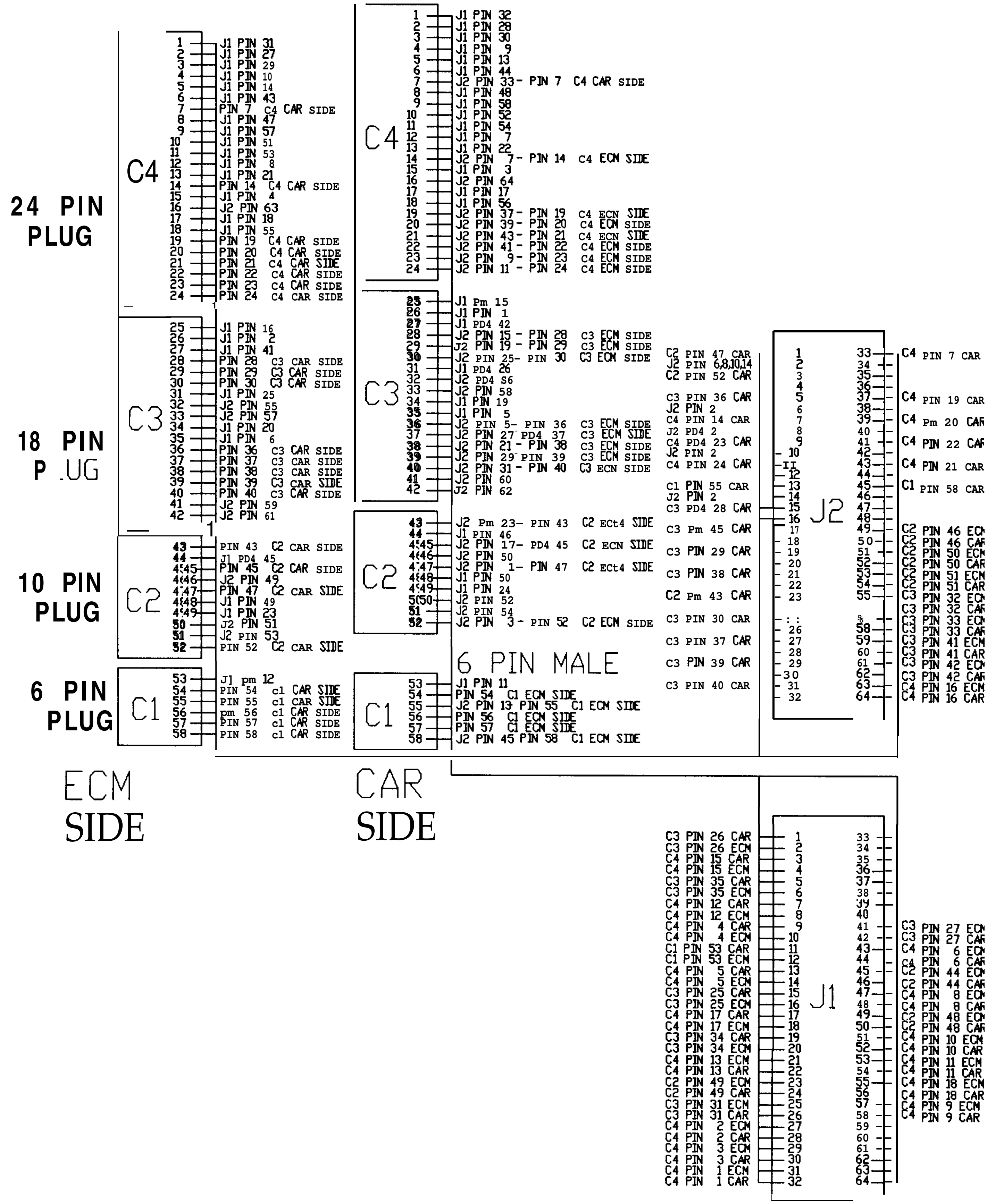
HEADER
C1
PLUG
ECM SIDE
CAR SIDE
J1 Pm 10
J] PIN 16
J] PIN 23
J] Pm 29
PIN 5 C1 CAR SIDE
J1 PIN 25
J1 PIN 27
J1 PIN 31
J1 PIN 21
PIN 10 c1 CAR SIDE
Pm 11 C1 CAR SIDE
PIN 12 C1 CAR SIDE
J2 PIN 57
J2 PIN 49
J2 PIN 51
J2 PIN 53
J2 PIN 60
J2 Pm 62
J2 PIN 56
PIN 20 C1 CAR SIDE
J1 PIN 14
pm 22 C1 CAR SIDE
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

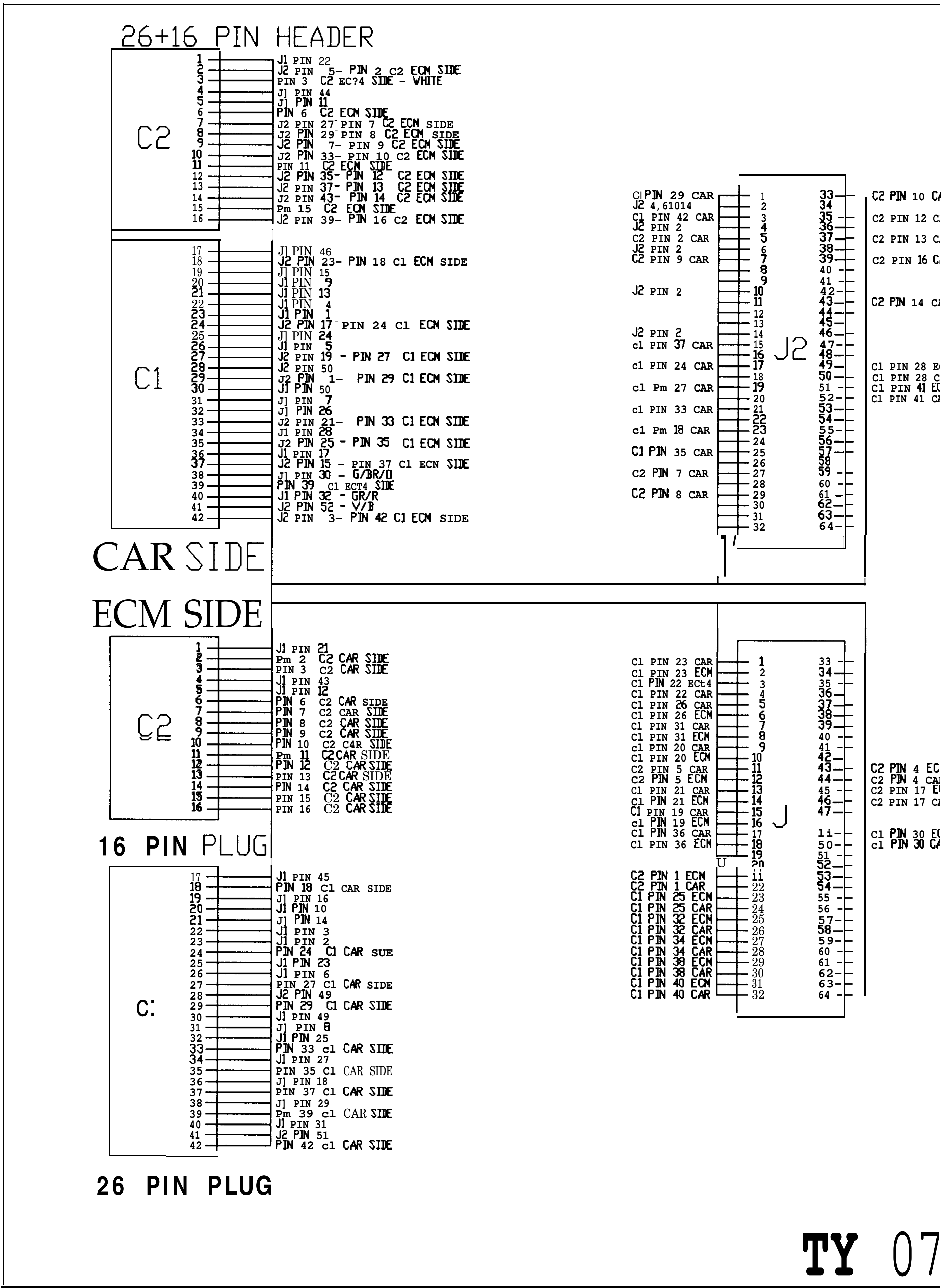

10+18+14 PIN HEADER
C3
J1 PIN 22
J1 PIN 28
J1 PIN 13
J1 PIN 54
J1 PIN 30
J2 PIN 27- PIN 6 C3 ECM SIDE
J2 PIN 29- PIN 7 C3 ECM SIDE
J1 PIN 32
J2 PIN 39- PIN 9 C3 ECM SIDE
J2 PIN 31- PIN 10 C3 ECM SIDE
J2 PIN 33- PIN 11 C3 ECM SIDE
J2 PIN 5- PIN 12 C3 ECN SIDE
J2 PIN 35- PIN 13 C3 ECM SIDE
J2 PIN 37- PIN 14 C3 ECM SIDE
CAR SIDE
C2
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
C1
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
C3
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
ECM SIDE
C2
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
C1
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
C2 PIN 31 CAR
C2 PIN 23 ECM
C2 PIN 23 CAR
C2 PIN 32 EC?4
C2 PIN 32 CAR
C3 PIN 4 ECM
C3 PIN 4 CAR

TY 02

10+18+24 PIN HEADER



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
J1 PIN 44
J1 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
J1 PIN 46
J2 PIN 23- PIN 18 C1 ECM SIDE
J1 PIN 15
J1 PIN 9
J1 PIN 13
J1 PIN 4
J1 PIN 1
J2 PIN 17 PIN 24 C1 ECM SIDE
J1 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
J1 PIN 7
J1 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
J1 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
J1 PIN 16
J1 PIN 10
J1 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
J1 PIN 8
J1 PIN 25
PIN 33 c1 CAR SIDE
J1 PIN 27
PIN 35 C1 CAR SIDE
J1 PIN 18
PIN 37 C1 CAR SIDE
J1 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.

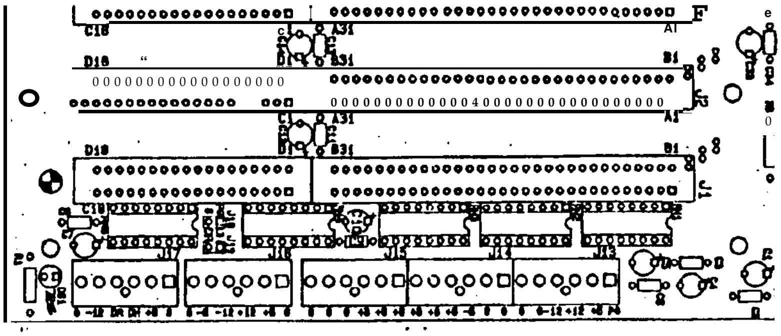


Figure 1. **Computer Power Supply**

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 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	500	(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 OK
26. Unit should initialize SIMU-TECH title screen.

CHECKOUT PROCEDURE:

27. Connect POD battery clips to IS-100A + and - battery lugs and select 13 volts and turn on IS-100A.
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-100A'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.

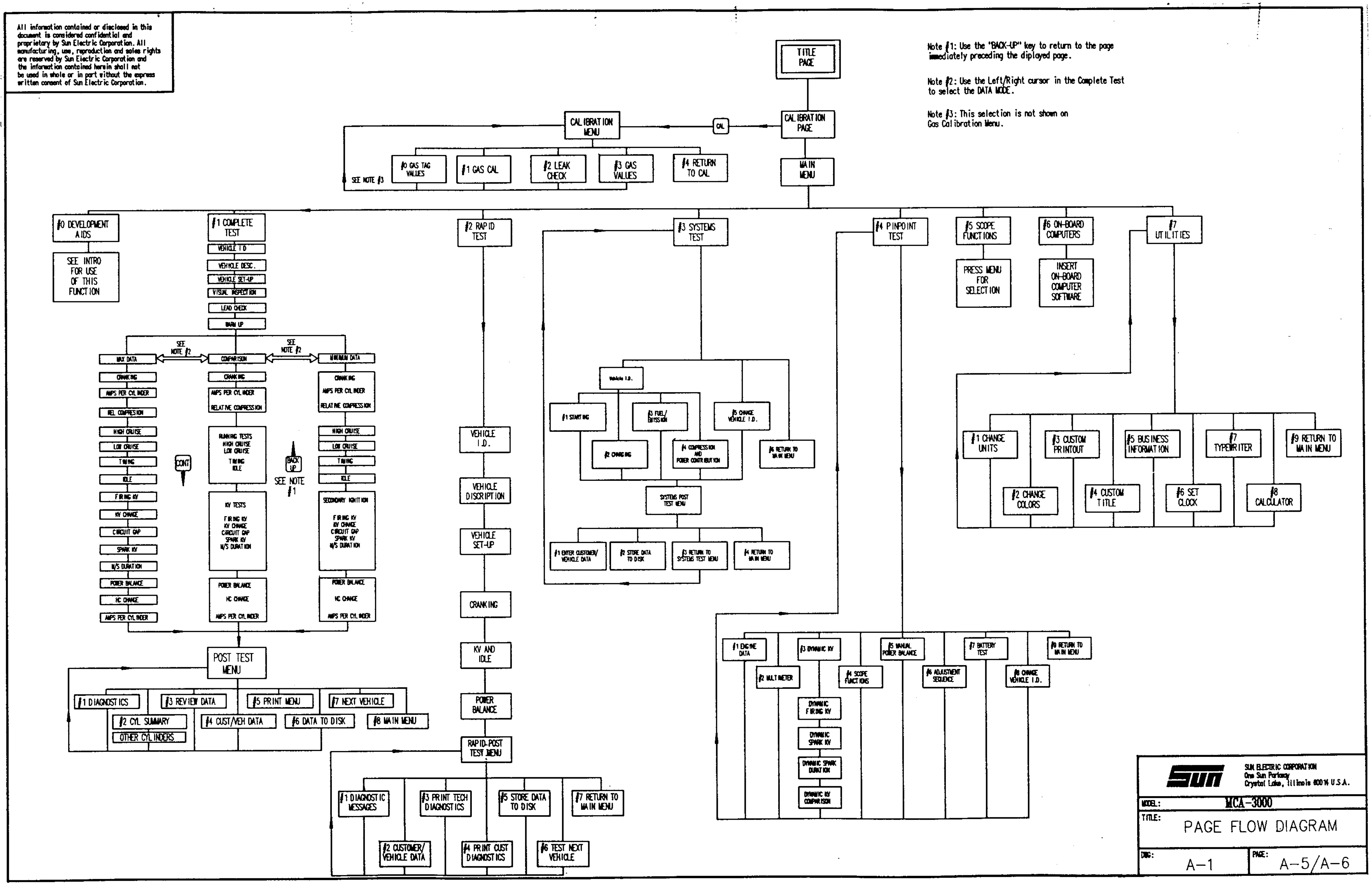
6. Set System Clock - This selection enables the user to set the MCA-3000S internal time/date clock.

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



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TITLE PAGE
CALIBRATION PAGE
CAL
CALIBRATION MENU
#0 GAS TAG VALUES
#1 GAS CAL
#2 LEAK CHECK
#3 GAS VALUES
#4 RETURN TO CAL
SEE NOTE #3
MAIN MENU
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.
#0 DEVELOPMENT AIDS
SEE INTRO FOR USE OF THIS FUNCTION
#1 COMPLETE TEST
VEHICLE I.D.
VEHICLE DESC.
VEHICLE SET-UP
VISUAL INSPECTION
LEAD CHECK
WARM UP
SEE NOTE #2
SEE NOTE #2
MAX DATA
CRANKING
AMPS PER CYLINDER
REL COMPRESION
HIGH CRUISE
LOW CRUISE
TIMING
IDLE
FIRING KV
KV CHANGE
CIRCUIT GAP
SPARK KV
W/S DURATION
POWER BALANCE
HC CHANGE
AMPS PER CYLINDER
COMPARISON
CRANKING
AMPS PER CYLINDER
RELATIVE COMPRESSION
RUNNING TESTS
HIGH CRUISE
LOW CRUISE
TIMING
IDLE
KV TESTS
FIRING KV
KV CHANGE
CIRCUIT GAP
SPARK KV
W/S DURATION
POWER BALANCE
HC CHANGE
AMPS PER CYLINDER
CONT
BACK UP
SEE NOTE #1
MINIMUM DATA
CRANKING
AMPS PER CYLINDER
RELATIVE COMPRESSION
HIGH CRUISE
LOW CRUISE
TIMING
IDLE
SECONDARY IGNITION
FIRING KV
KV CHANGE
CIRCUIT GAP
SPARK KV
W/S DURATION
POWER BALANCE
HC CHANGE
AMPS PER CYLINDER
POST TEST MENU
#1 DIAGNOSTICS
#2 CYL SUMMARY
OTHER CYLINDERS
#3 REVIEW DATA
#4 CUST/VEH DATA
#5 PRINT MENU
#6 DATA TO DISK
#7 NEXT VEHICLE
#8 MAIN MENU
#2 RAPID TEST
VEHICLE I.D.
VEHICLE DISCRIPTION
VEHICLE SET-UP
CRANKING
KV AND IDLE
POWER BALANCE
RAPID-POST TEST MENU
#1 DIAGNOSTIC MESSAGES
#2 CUSTOMER/ VEHICLE DATA
#3 PRINT TECH DIAGNOSTICS
#4 PRINT CUST DIAGNOSTICS
#5 STORE DATA TO DISK
#6 TEST NEXT VEHICLE
#7 RETURN TO MAIN MENU
#3 SYSTEMS TEST
Vehicle I.D.
#1 STARTING
#2 CHARGING
#3 FUEL/ EMISSION
#4 COMPRESSION AND POWER CONTRIBUTION
#5 CHANGE VEHICLE I.D.
#6 RETURN TO MAIN MENU
SYSTEMS POST TEST MENU
#1 ENTER CUSTOMER/ VEHICLE DATA
#2 STORE DATA TO DISK
#3 RETURN TO SYSTEMS TEST MENU
#4 RETURN TO MAIN MENU
#4 PINPOINT TEST
#1 ENGINE DATA
#2 MULTIMETER
#3 DYNAMIC KV
DYNAMIC FIRING KV
DYNAMIC SPARK KV
DYNAMIC SPARK DURATION
DYNAMIC KV COMPARISON
#4 SCOPE FUNCTIONS
#5 MANUAL POWER BALANCE
#6 ADJUSTMENT SEQUENCE
#7 BATTERY TEST
#8 CHANGE VEHICLE I.D.
#9 RETURN TO MAIN MENU
#5 SCOPE FUNCTIONS
PRESS MENU FOR SELECTION
#6 ON-BOARD COMPUTERS
INSERT ON-BOARD COMPUTER SOFTWARE
#7 UTILITIES
#1 CHANGE UNITS
#2 CHANGE COLORS
#3 CUSTOM PRINTOUT
#4 CUSTOM TITLE
#5 BUSINESS INFORMATION
#6 SET CLOCK
#7 TYPEWRITER
#8 CALCULATOR
#9 RETURN TO MAIN 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

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.

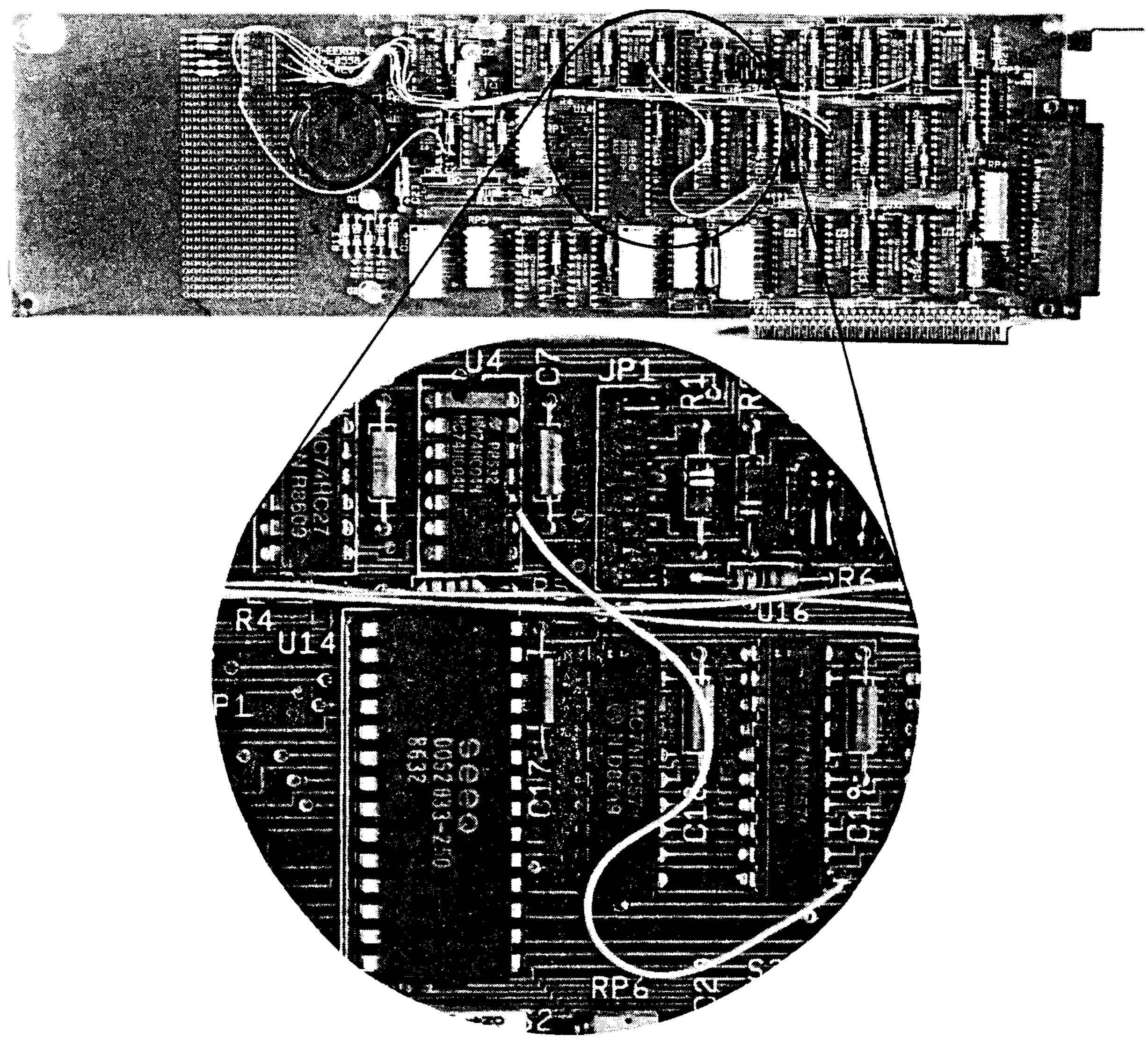

Figure 2. Modifying the I/O/EEPROM/CLOCK Board

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).

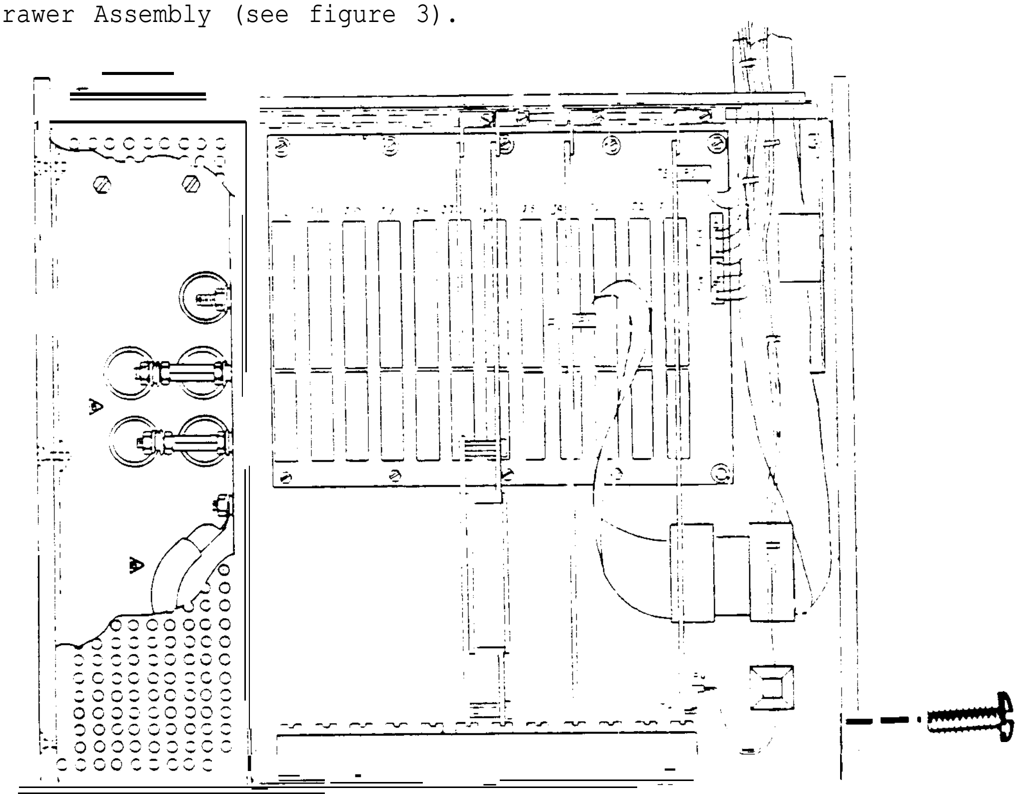

Figure 3. Location of new screw, #0403-1451-08

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.

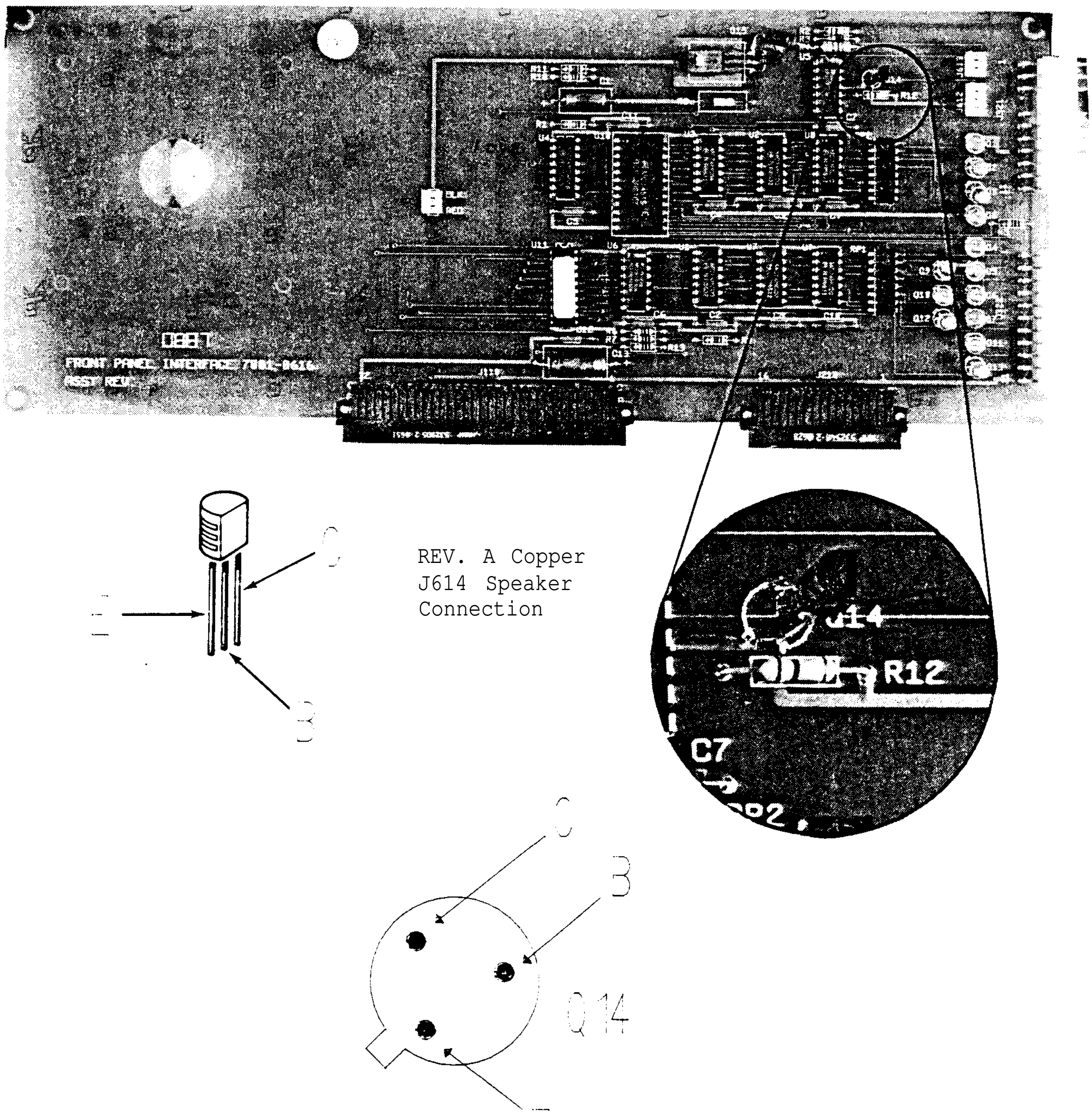

Figure 4. Placement of new Transistor, Q14

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

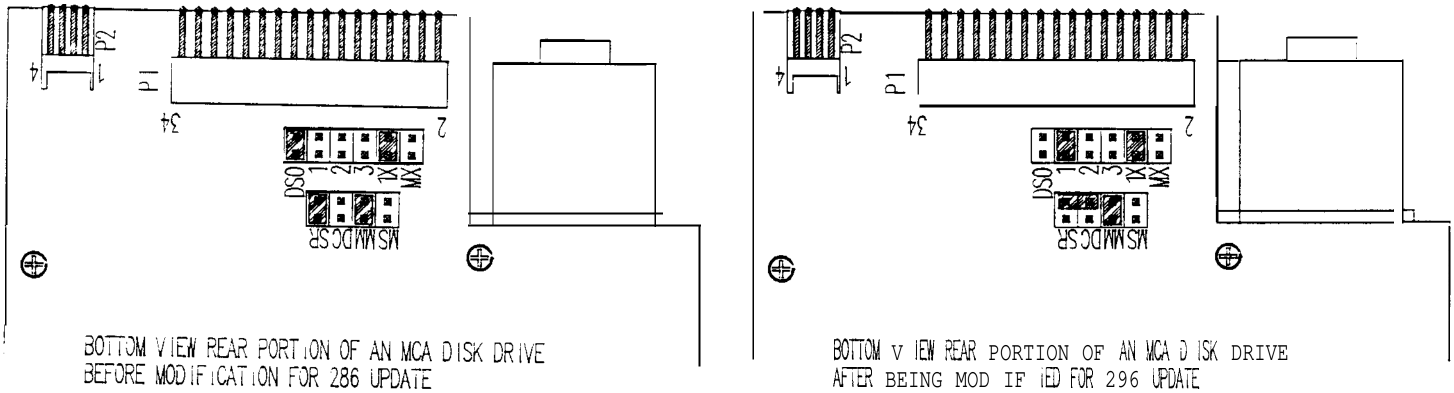

Figure 5. Shorting pin configuration for Model **MF353FA-12U** Disk Drive

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**

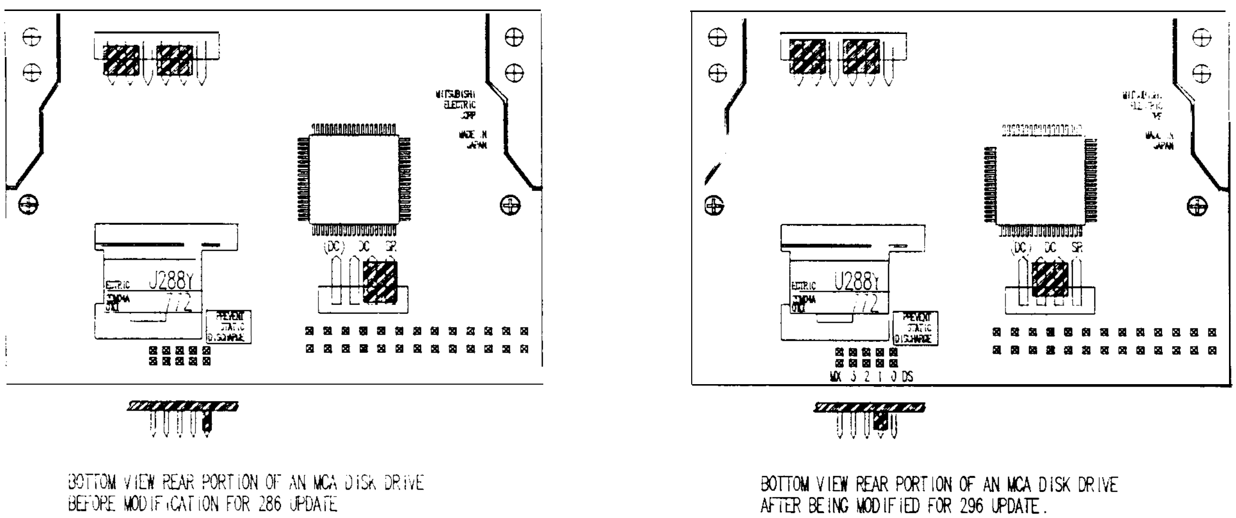

Figure 6. Shorting pin configuration for Model **MF353B-12UJ** Disk Drive.

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,

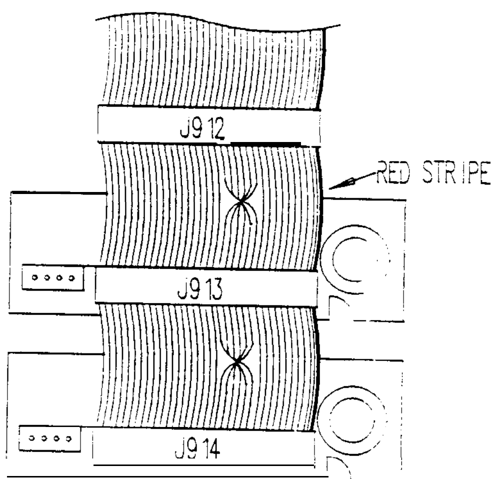

FIGURE 7. W19, Disk Interface Cable connections to Mitsubishi Drives.

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.

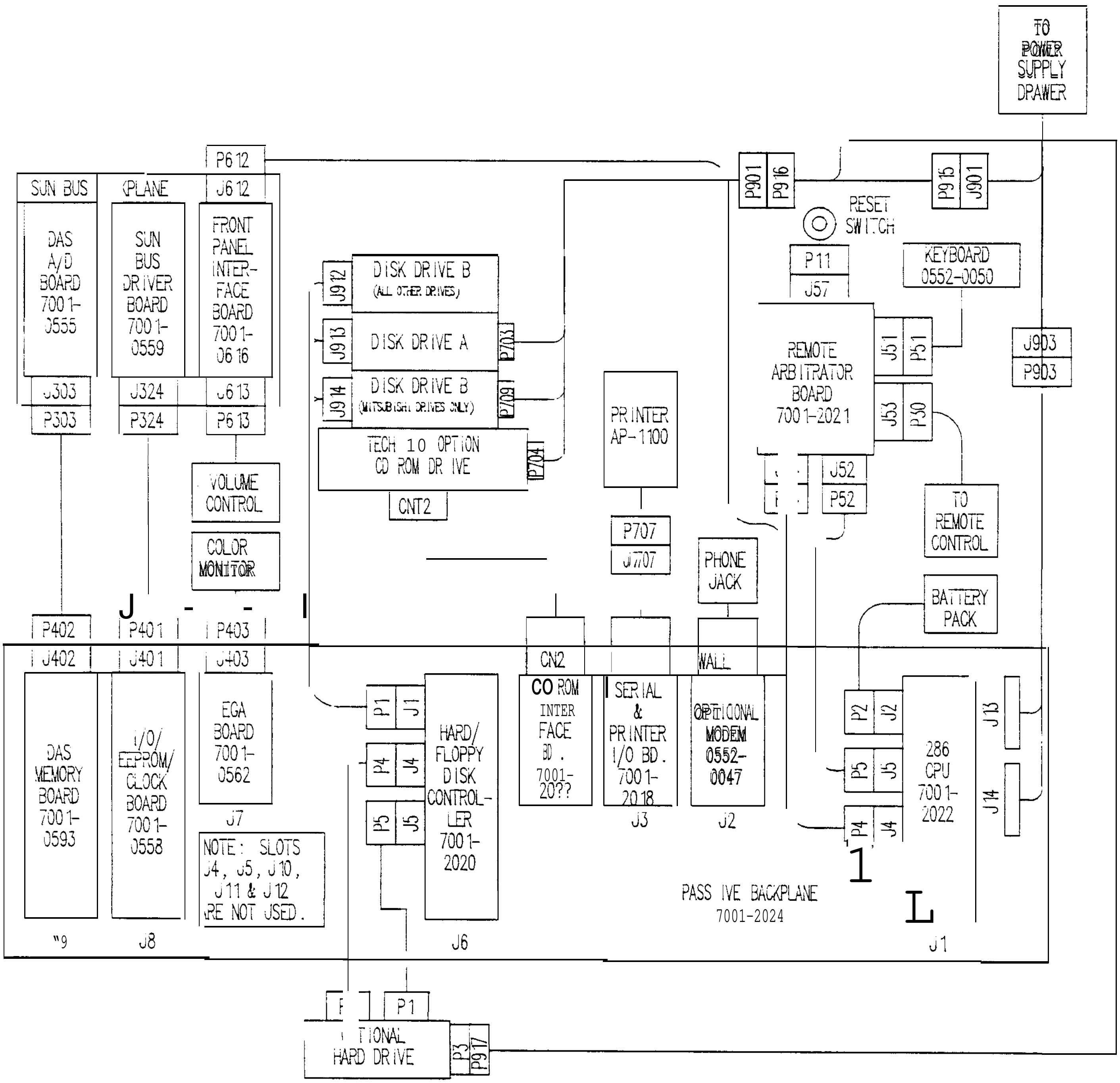

Figure 8. MCA286 Interconnection Diagram

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 "F1" the screen should appear as shown in Figure 9.

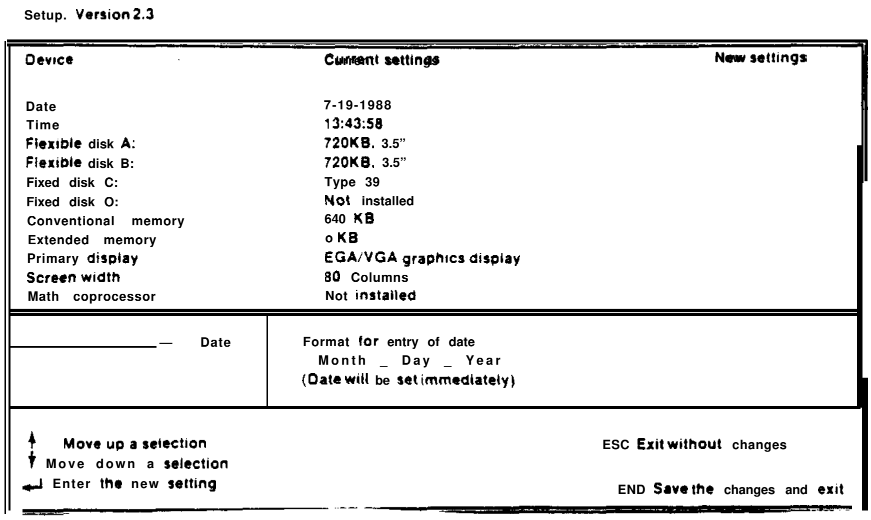

Figure 9. New CPU SET-UP Screen

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 "0" (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 *
*********************
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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

INSTALLAT ION 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).

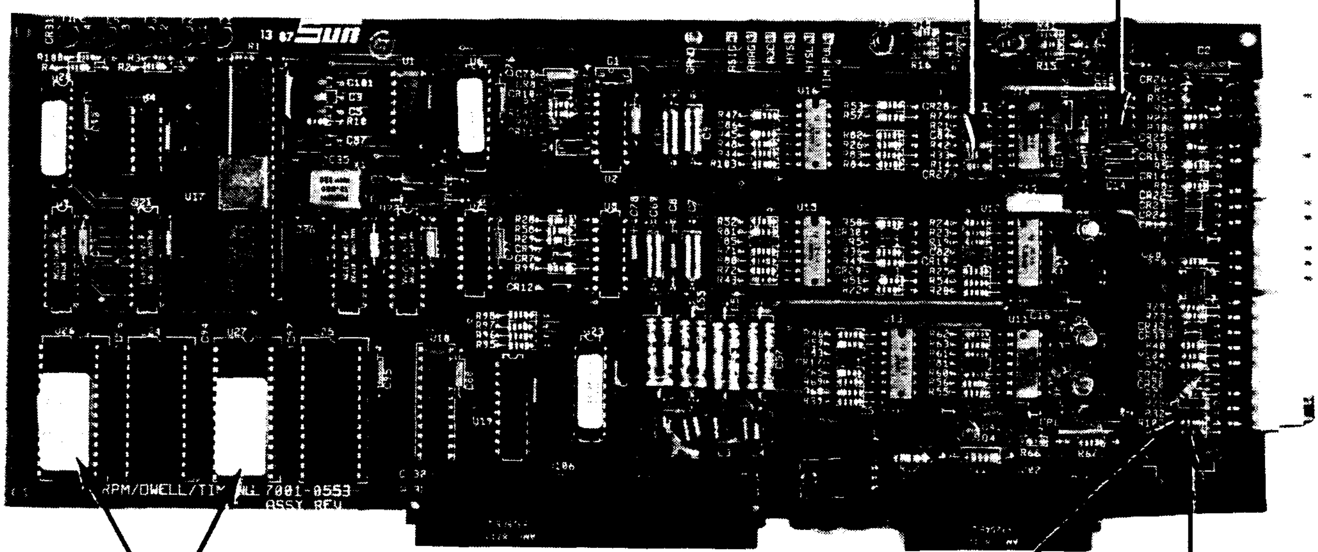
4. Remove resistor R32 and replace using resistor #1670-8256, a 8.25 megaohm 1/4 watt resistor (see Figure 1).

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 *
****

SUN ELECTRIC CORPORATION

Model: 1095-0014-01
ALDL Update Kit

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:

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.

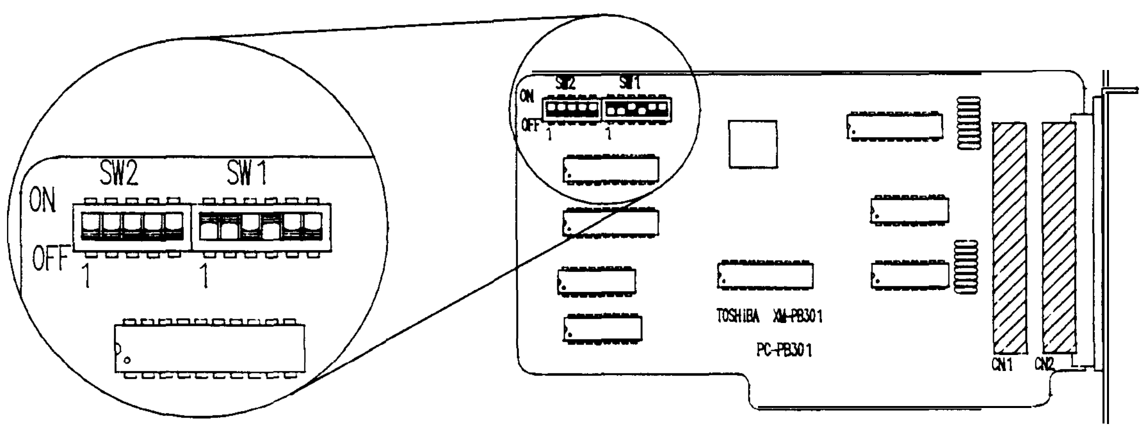


Figure 1. Dip Switch settings for Optical Drive Controller Board.

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

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.

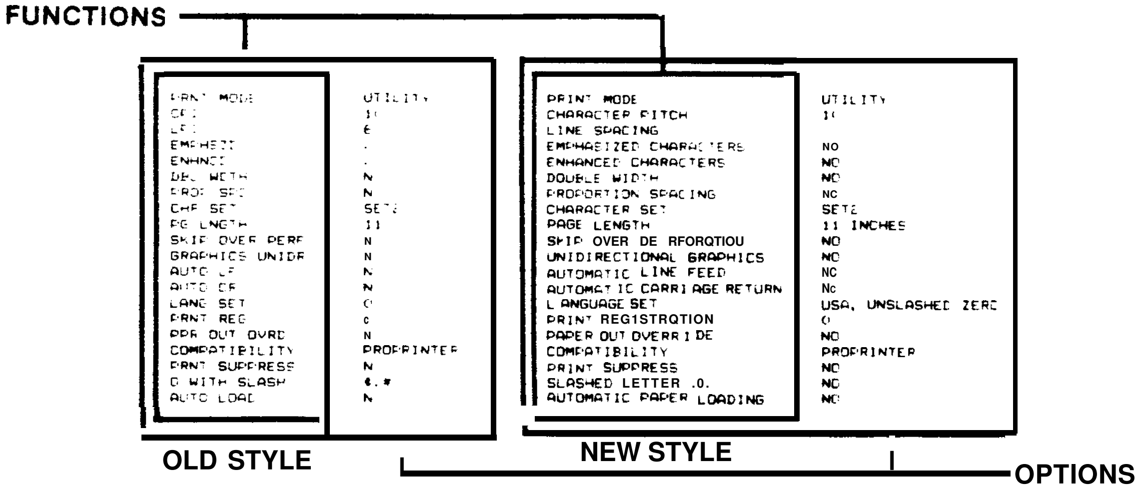


Figure 1. Printer Menus.

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-100A 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-100A from 13V to 5 ohms. The display should read 5 ohms +/- 1 ohm.

39. Rotate the IS-100A Volt/Ohm switch to 50 ohms. The display should read 50 ohms +/- 2 ohms.

40. Rotate the IS-100A Volt/Ohm switch to 5 Kohms. The display should read 5 Kohms +/- 0.2 Kohms.

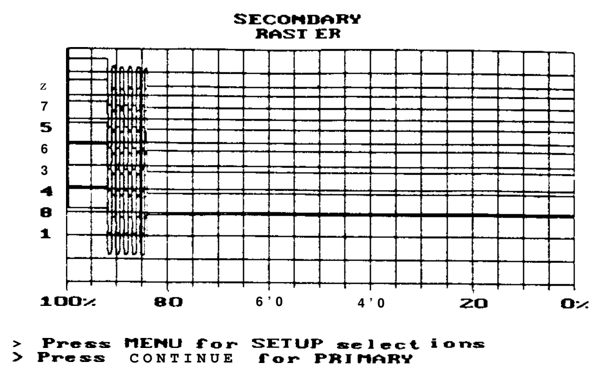
41. Rotate the IS-100A Volt/Ohm switch to 50 Kohms. The display should read 50 Kohms +/- 2 Kohms.

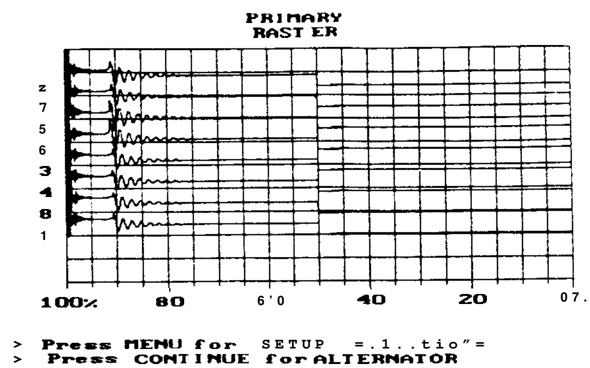
42. Select DC Amps on the Multimeter display and remove the Pinpoint leads from the IS-100A. Connect a DVM to the Pinpoint leads and set DVM to 200 Ohms range. The DVM should read between 0.1 and 0.4 ohms

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.

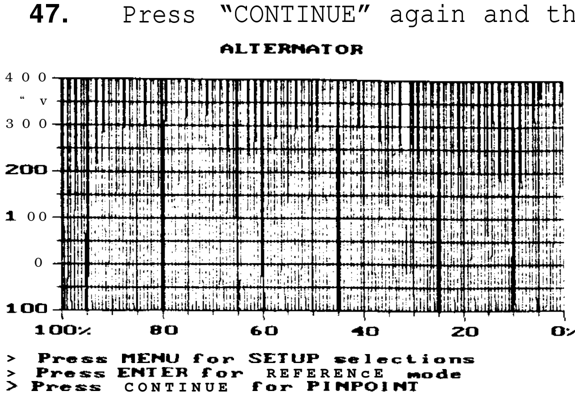
45. Press "SCOPE" and the secondary raster pattern should be displayed.

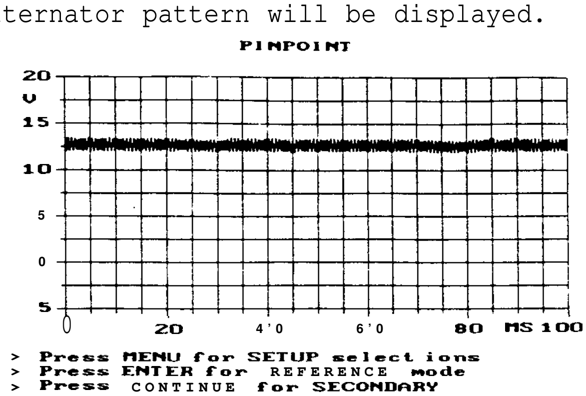




46. Press "CONTINUE" and the primary raster pattern should be displayed.

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-100A. 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 "1''(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

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.

0692-1507(7870)

Printed in U.S.A.

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.

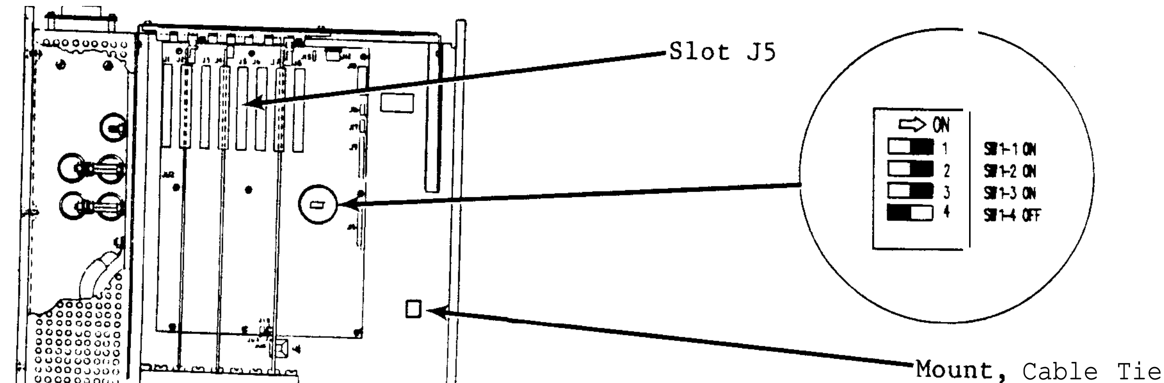

Figure 1.

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.

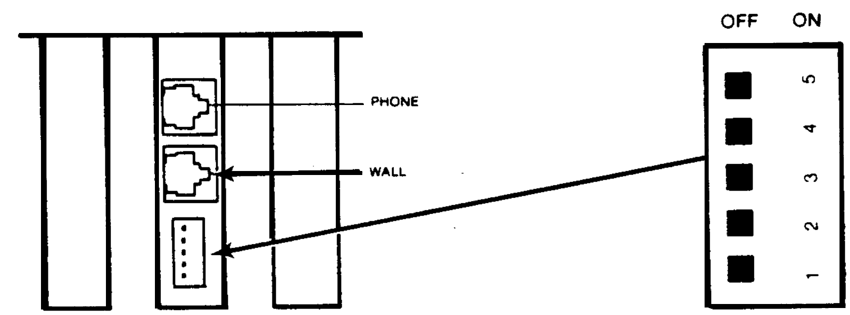

Figure 2.

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.

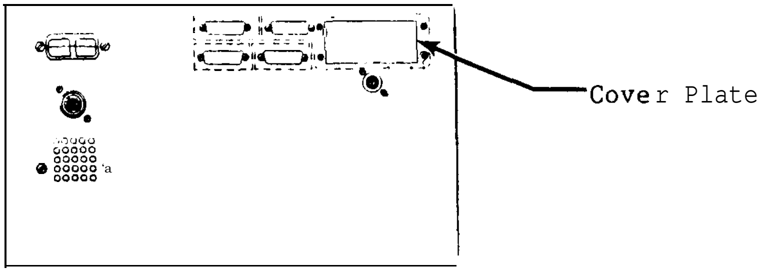

Figure 3.

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.

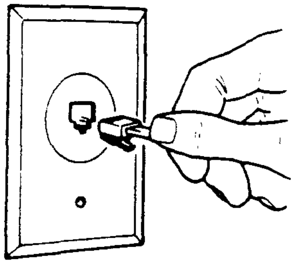

Figure 4

****
* 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 ELECTRIC CORPORATION

Model: HSK-40
HEAD SUSPENSION KIT

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

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0692-1530 (8810)

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.

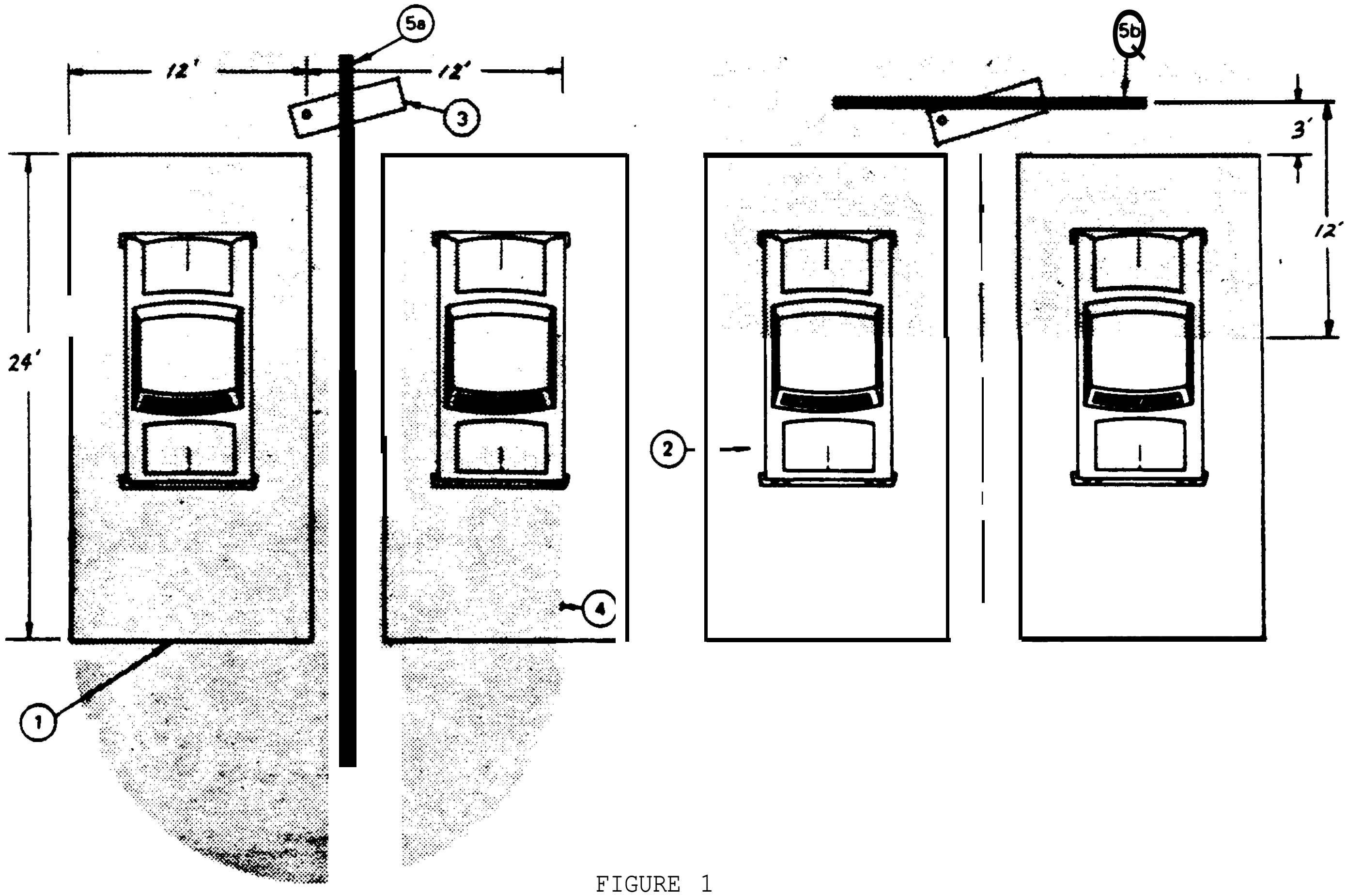

FIGURE 1

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.

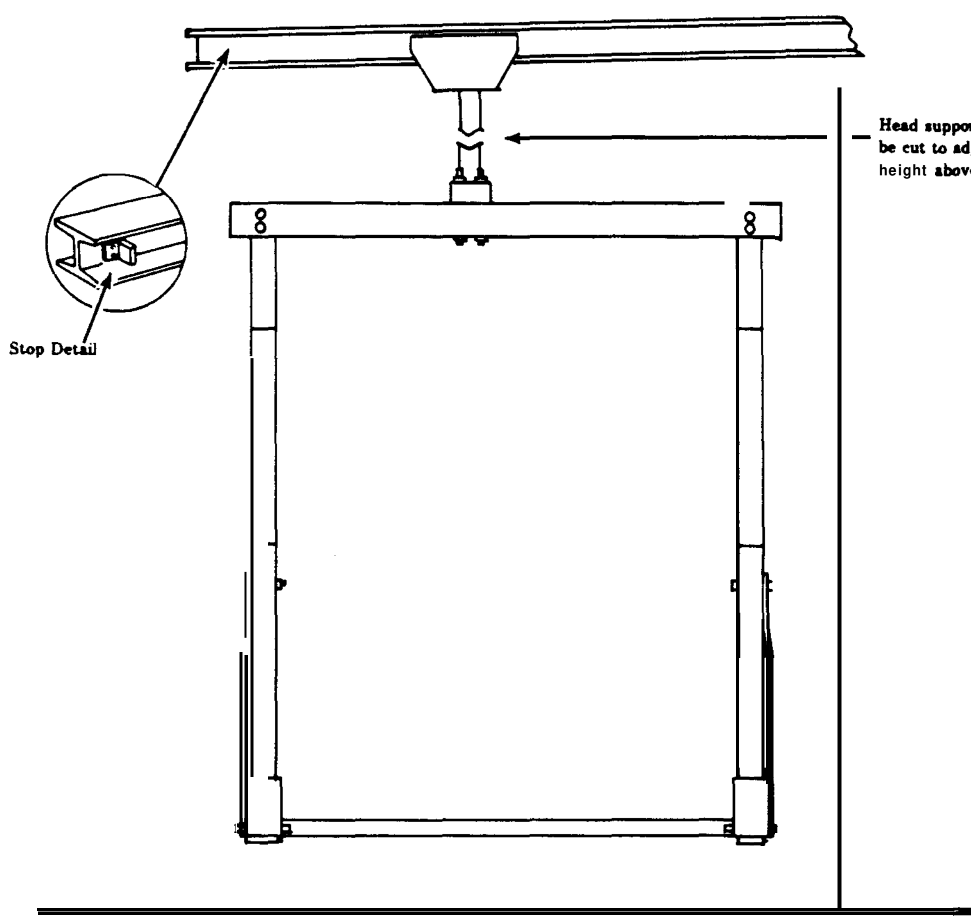

FIGURE 2

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.

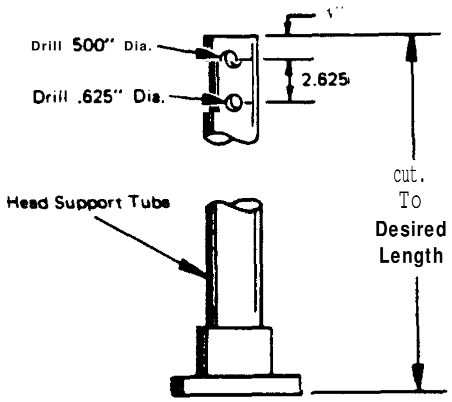

FIGURE 3

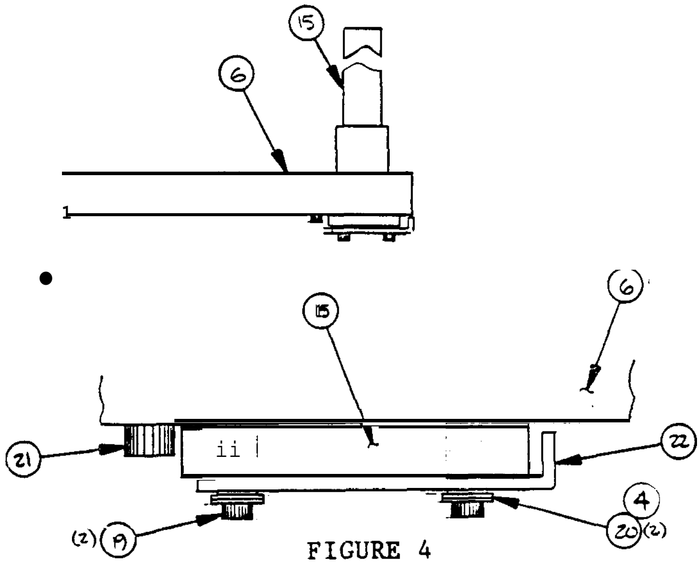

FIGURE 4

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.

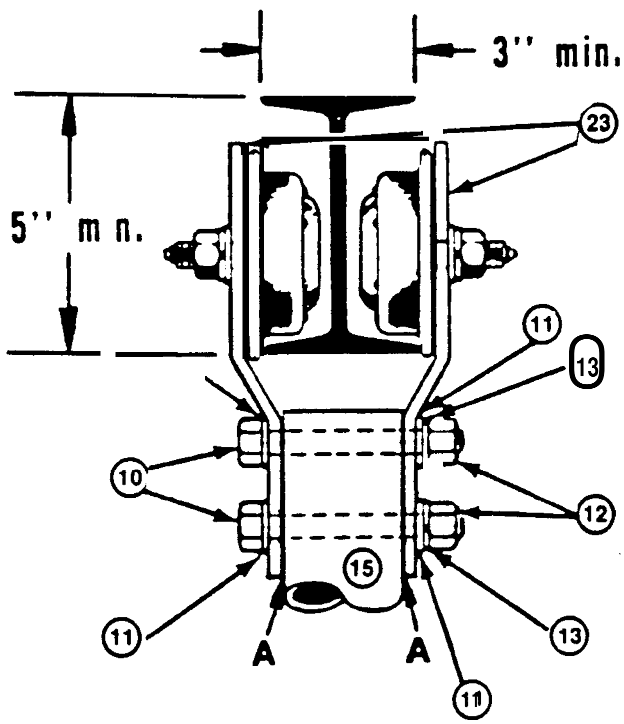

FIGURE 5

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.

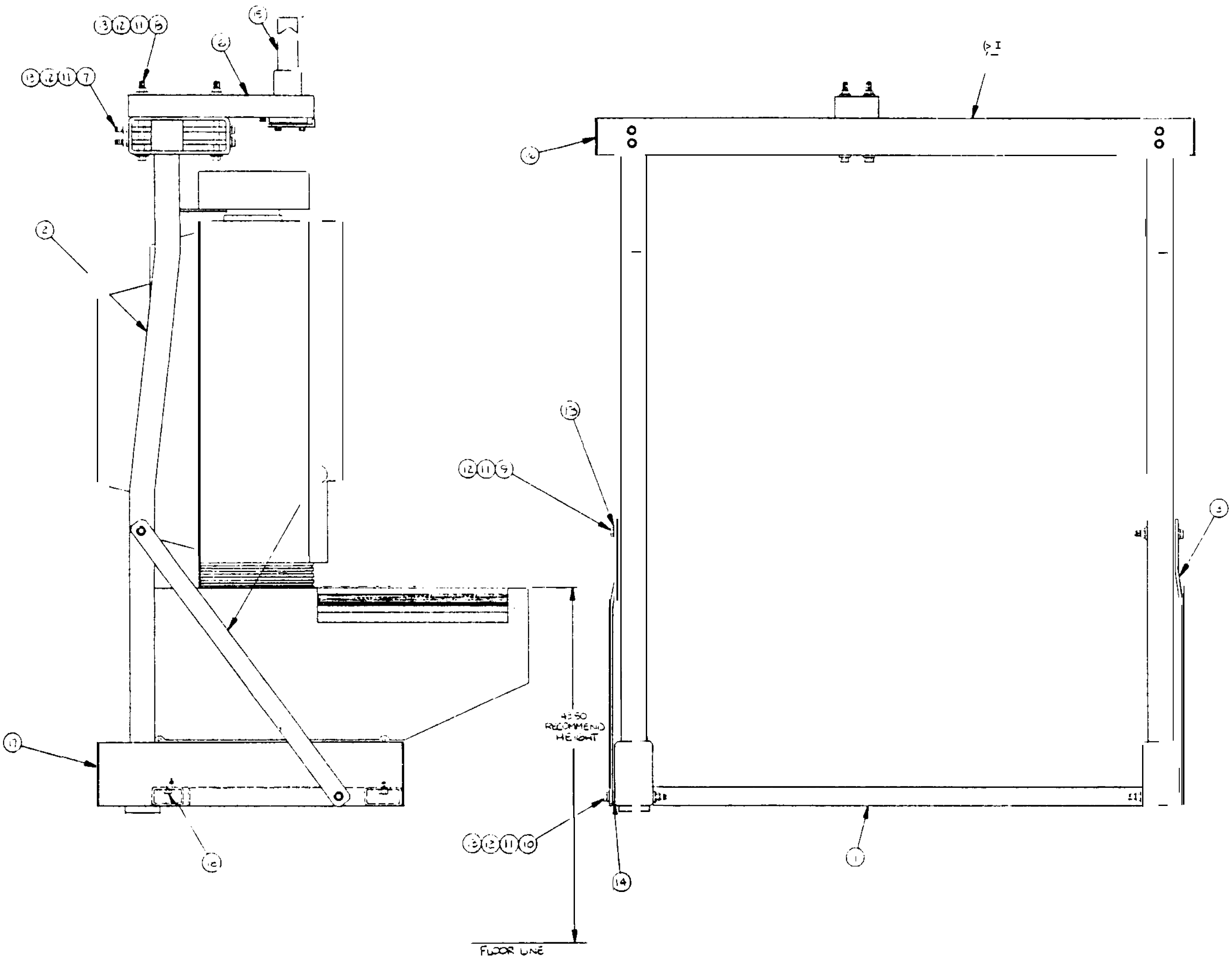

Figure 6

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

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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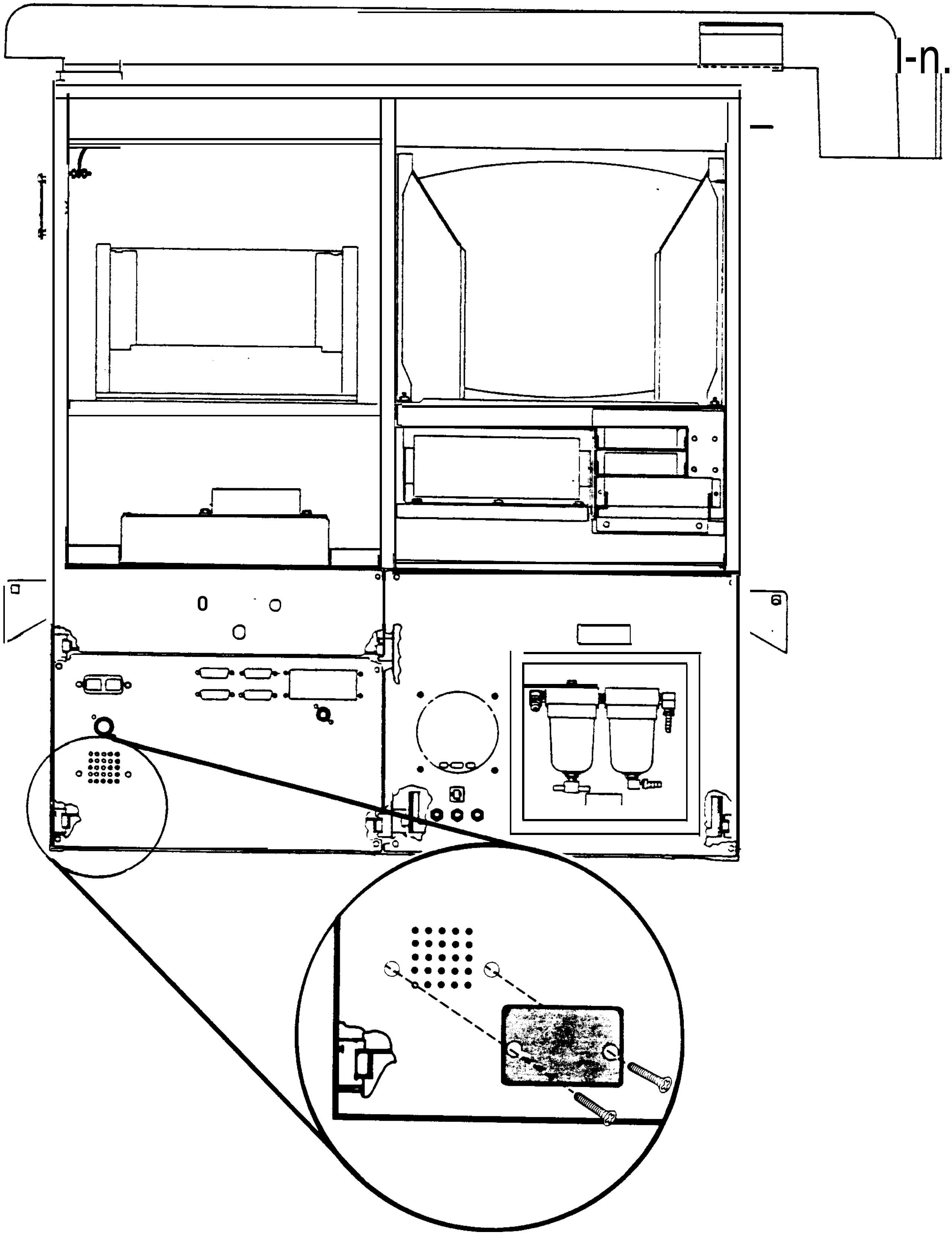


Figure 1. VENT COVER LOCATION

SUN	Model: KIT 0120-0542 **MCA 3000** Timing Light Bracket
SUN ELECTRIC CORPORATION	Page:

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.

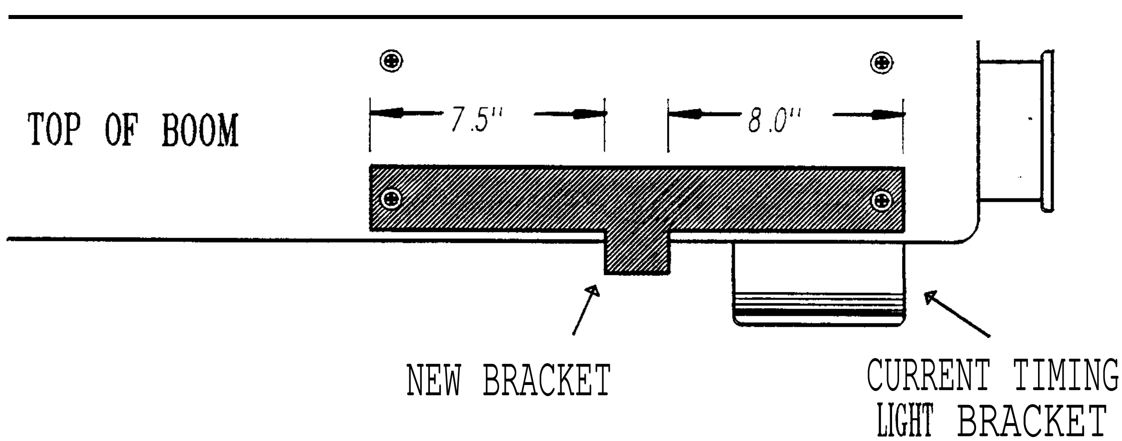


FIGURE 1 TIMING LIGHT **BRACKET** MOUNTING **POSITION**

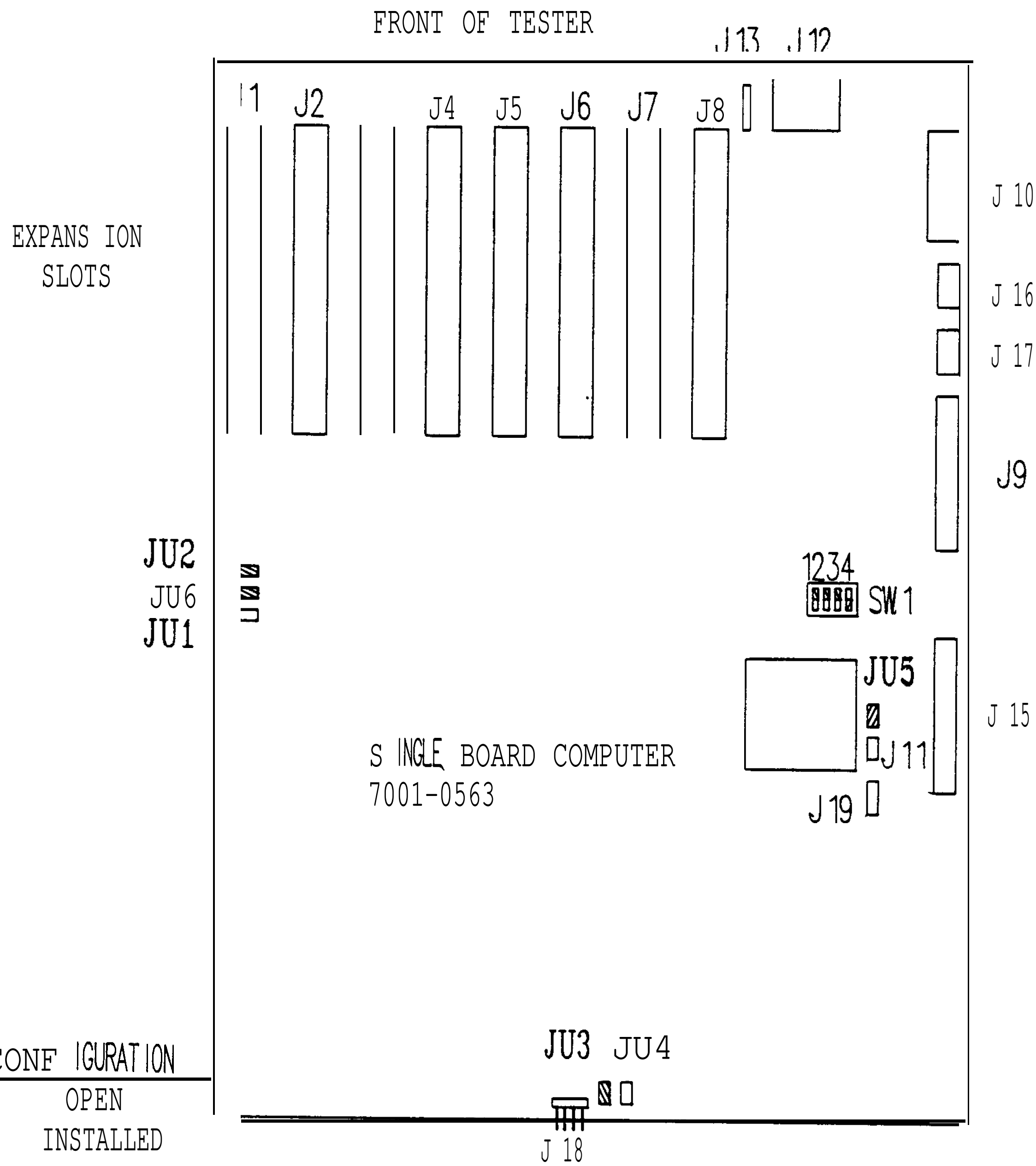
APPENDIX E. CONFIGURATION

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

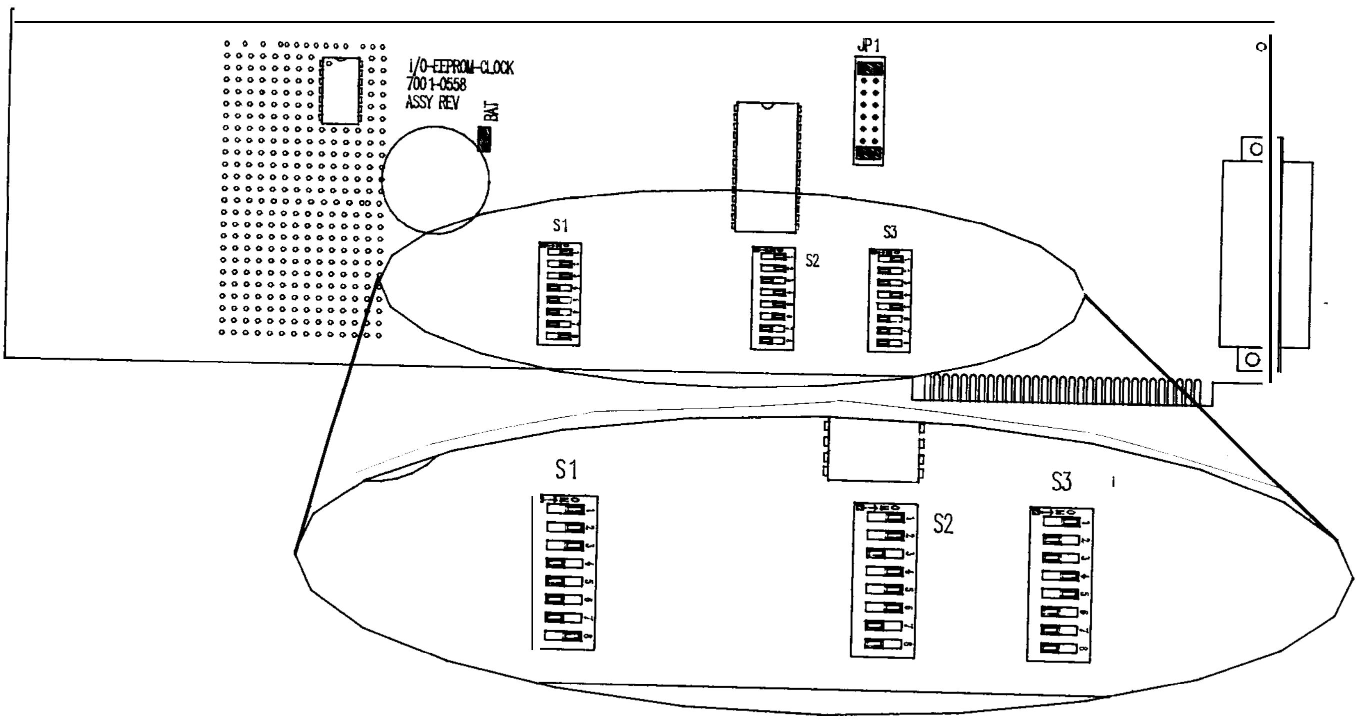


Figure E-2. I/O/EEPROM/CLOCK Board, 7001-0558 or 7001-2016

DAS PROCESSOR ASSEMBLY

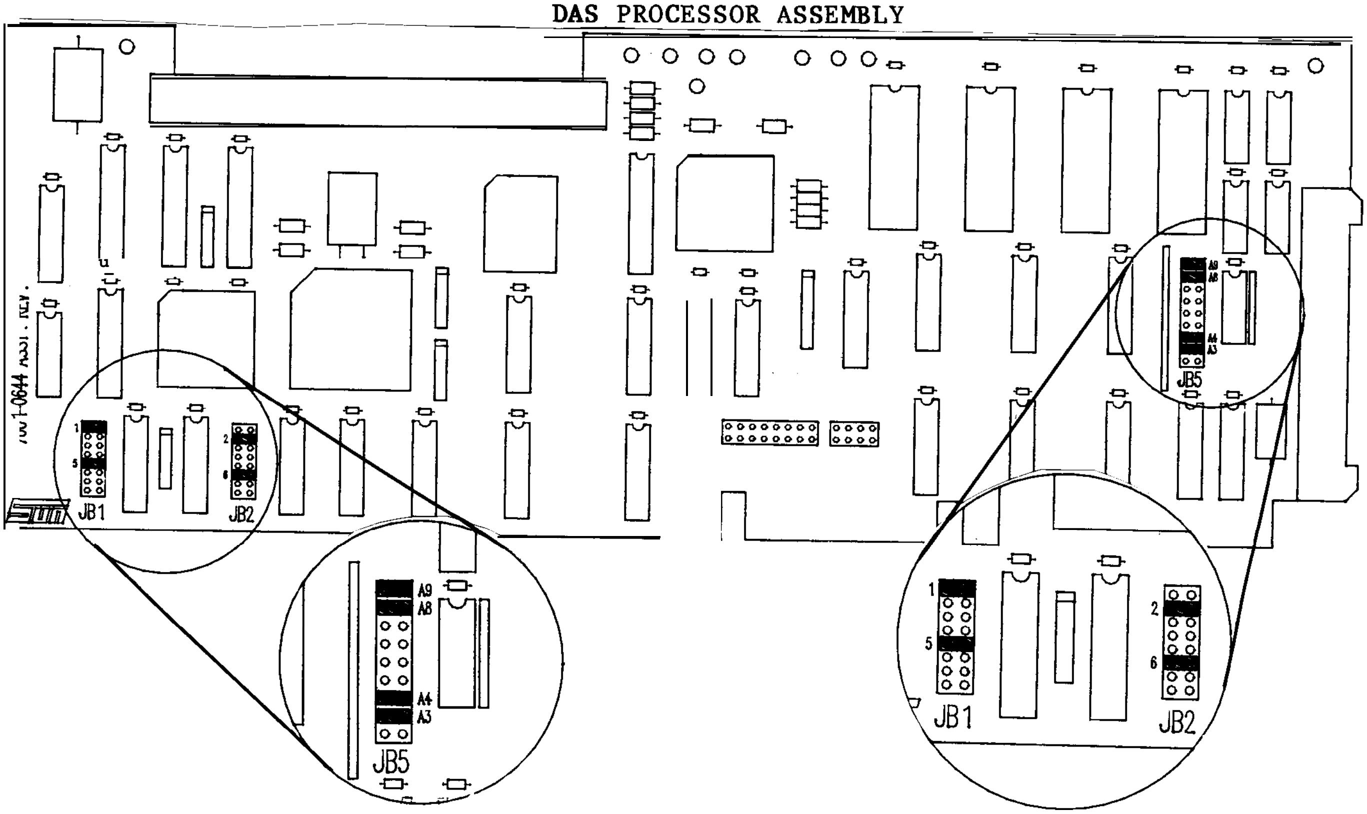


Figure E-3. DAS Processor Assembly, **7009-1989-01**

EGA VIDEO BOARD

There are currently 3 different EGA Video Board approved
Configuration for these three boards are shown below.

for use in the MCA.

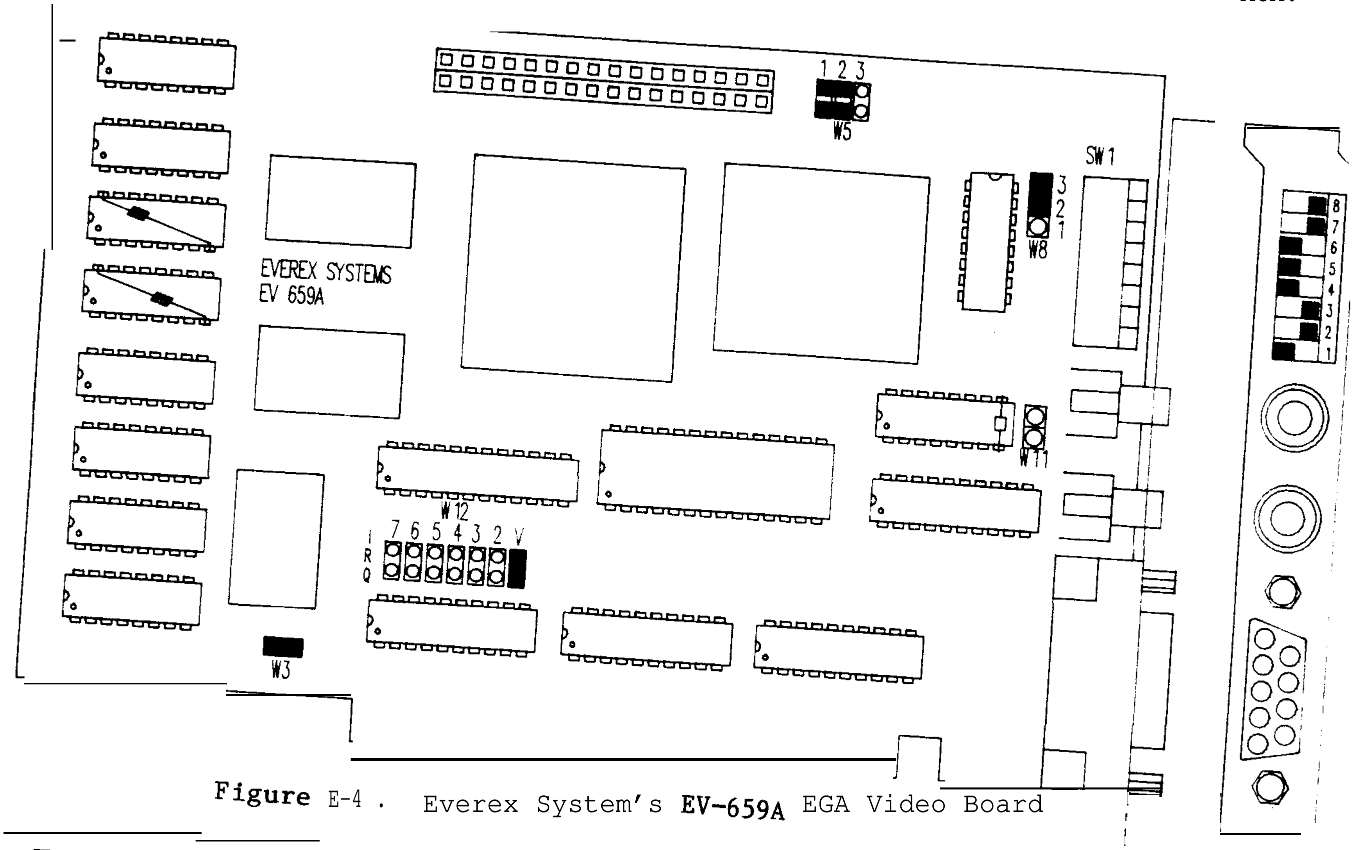


Figure E-4 . Everex System's **EV-659A** EGA Video Board

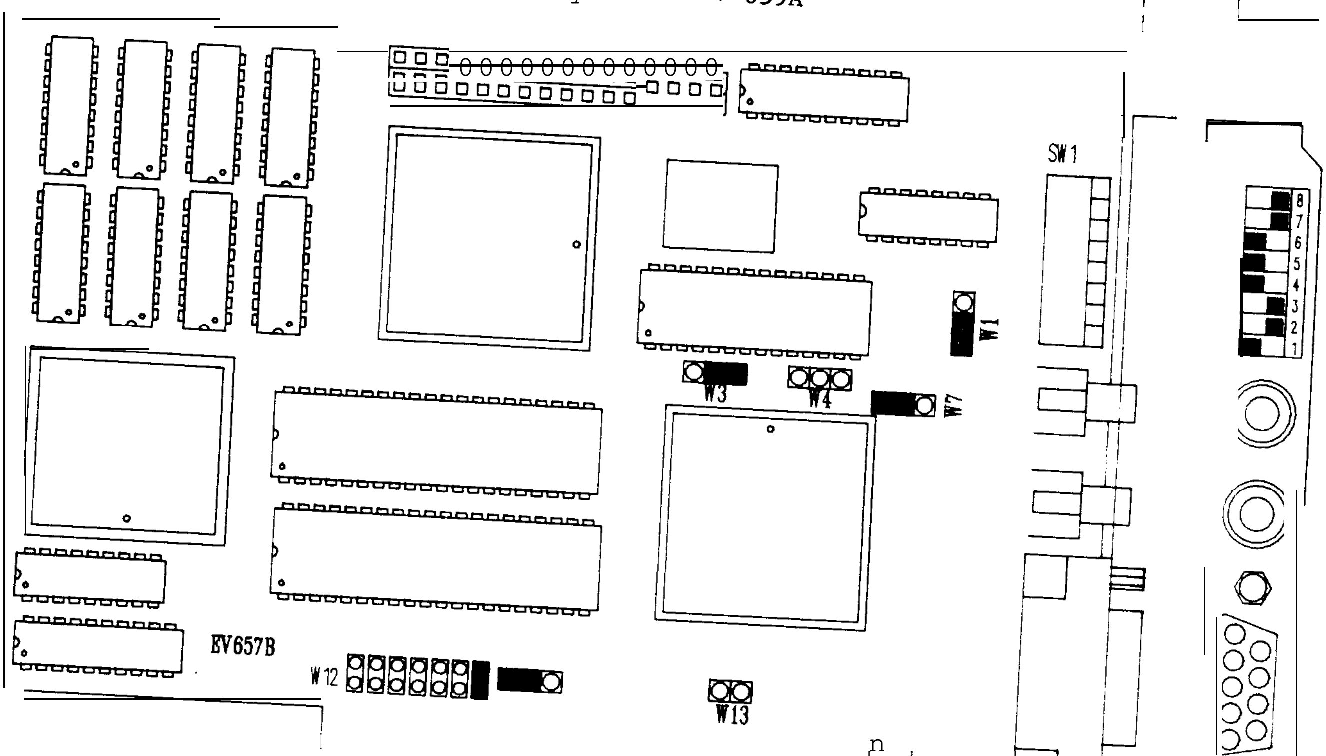


Figure E-5. Everex Systemfs **EV-657B** EGA Video Board

EV-657B EGA Video Board

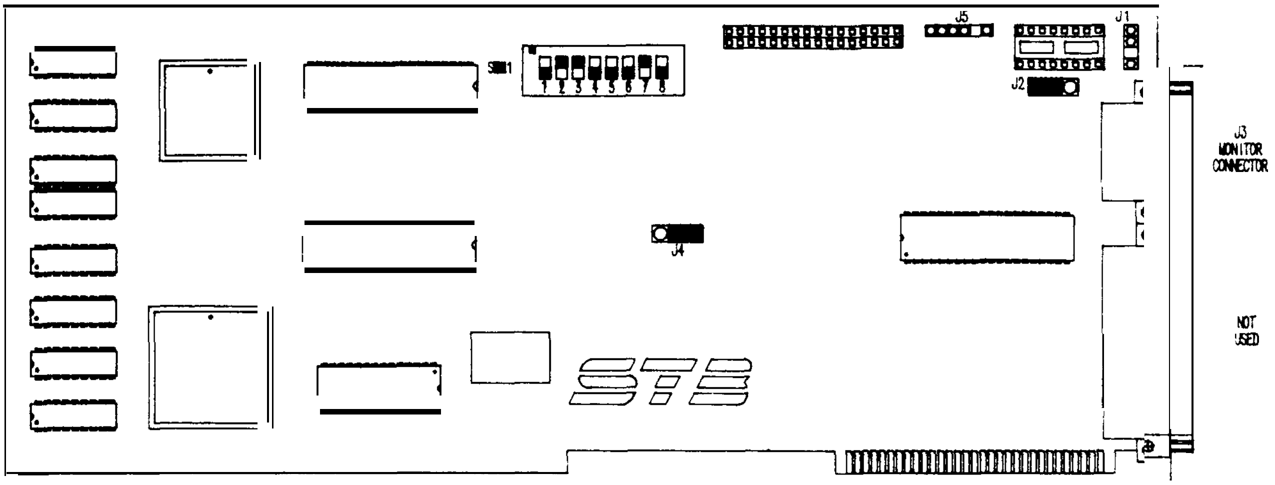


Figure E-6. STB Video Board

286 CPU BOARD

Currently only the NCR 80286 CPU board is approved for use in the MCA-3000 Serial "B".

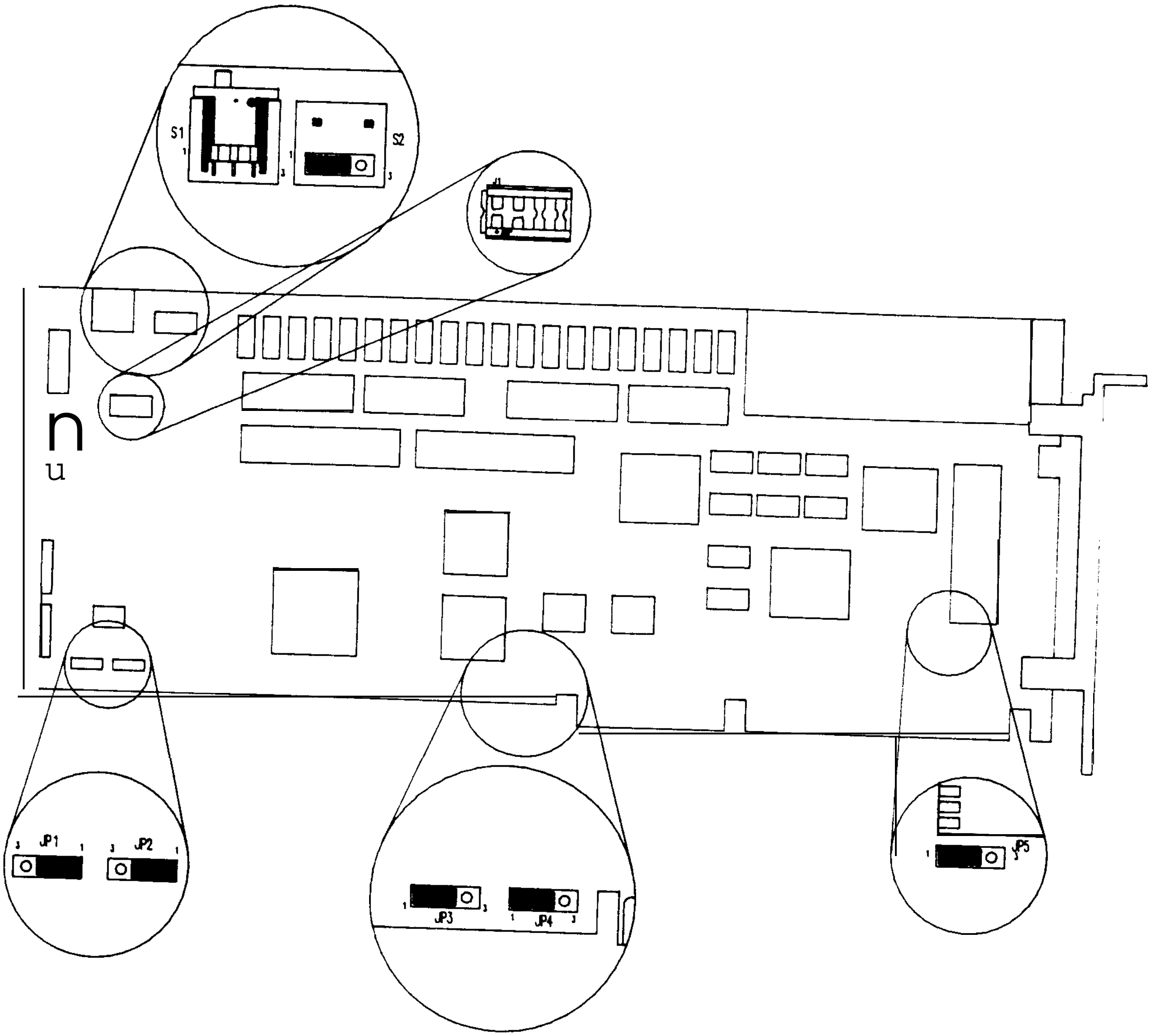


Figure E-7. NCR 286 CPU **BOARD**, 7001-2024

ARBITRATOR BOARD

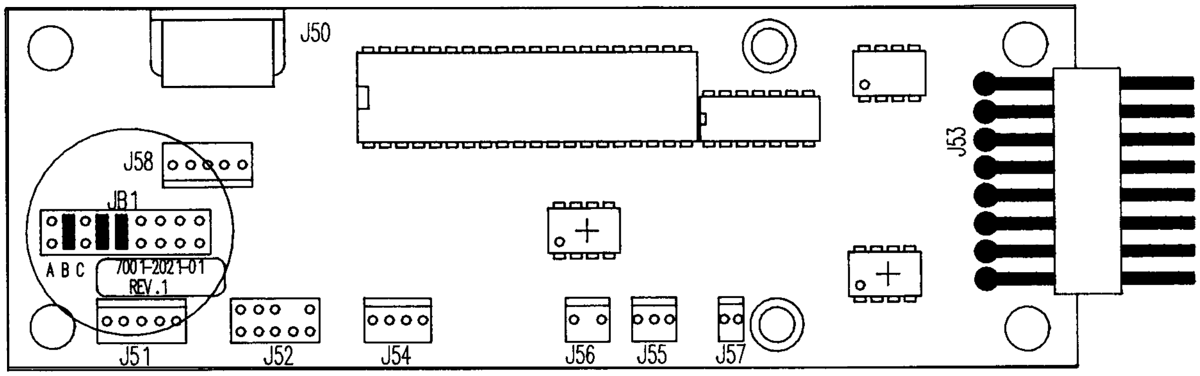


Figure E-8. ARBITRATOR BOARD, 7001-2021-02

PARALLEL/SERIAL 1/0 BOARD

Currently only the Everex EV-170 1/0 board is approved for use in the MCA.

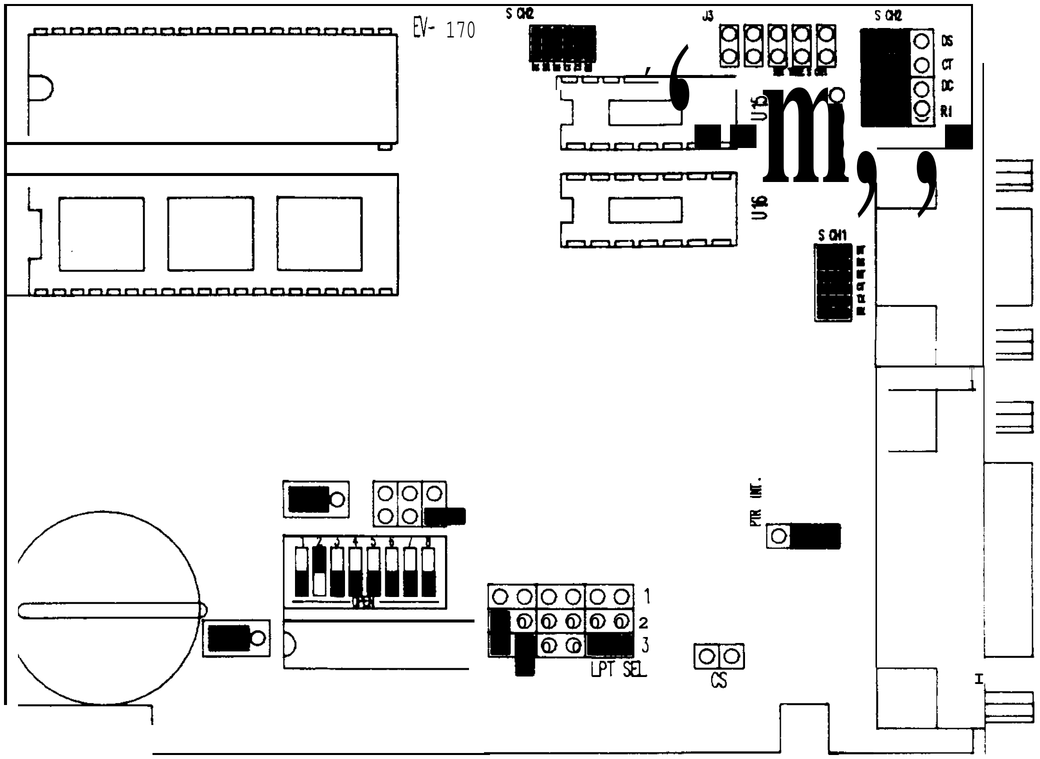


Figure E-9. EVEREX EV-170 Serial/Parallel 1/0 Board 7001-2034-01

FLOPPY/HARD DRIVE CONTROLLER BOARD

Currently only the WD-1003 Controller Board is approved for use in the MCA-3000 Serial "B" units.

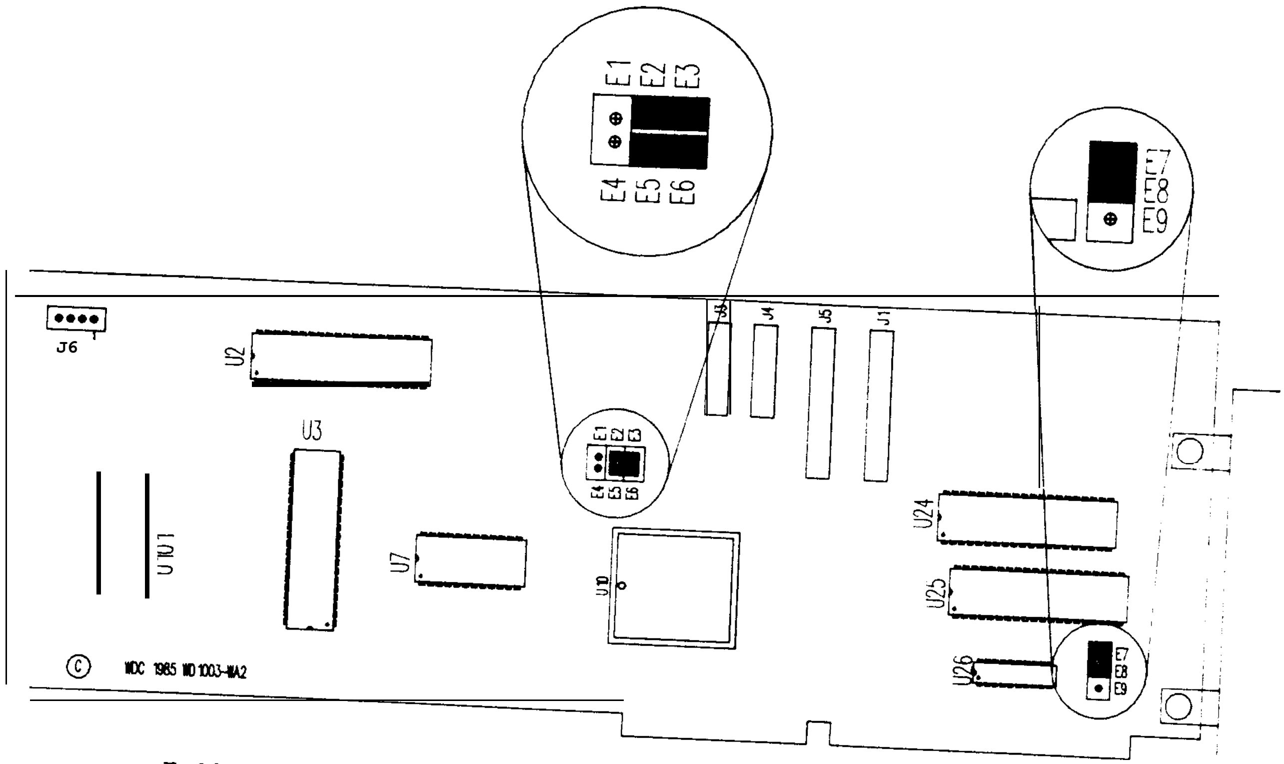


Figure E-10. WD-1003-WA2 Floppy/Hard Drive Controller Board 7001-2020.

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.

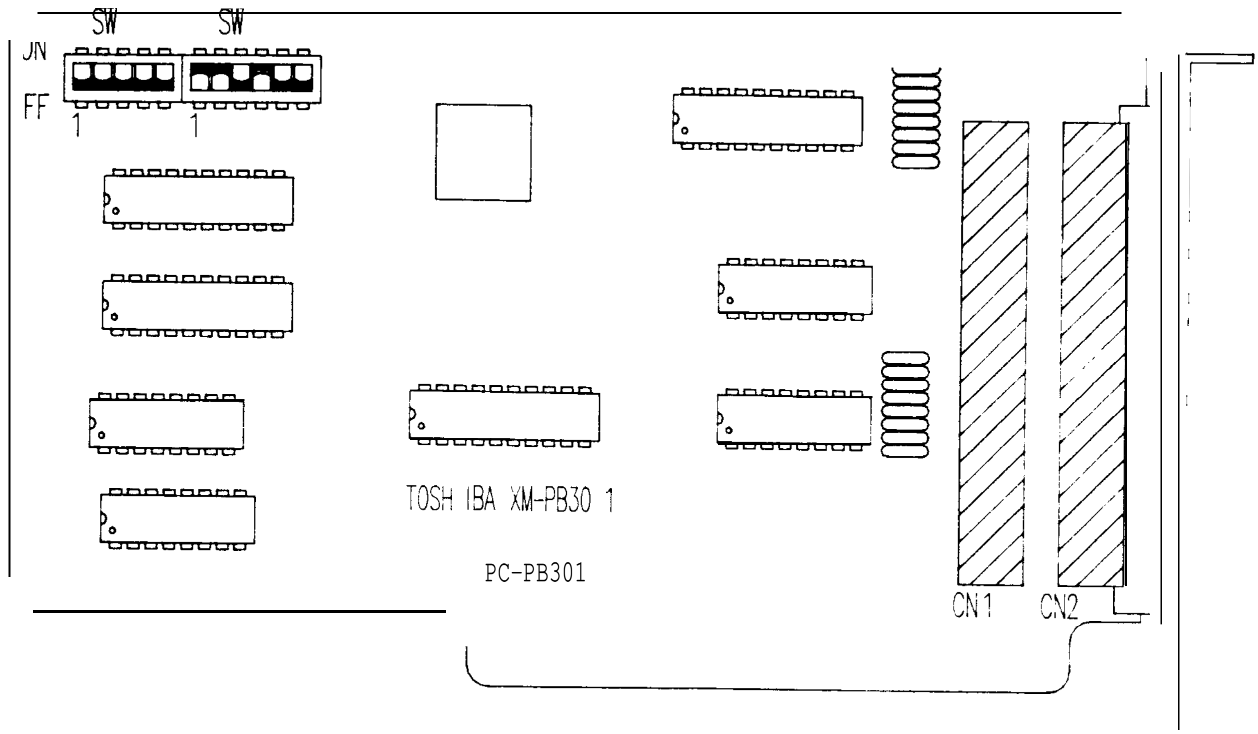


Figure E-n. Toshiba XR-PB301 SCSI Controller Board.

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.

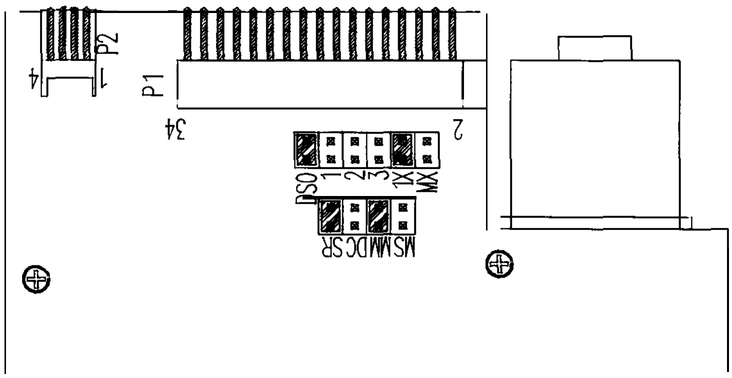


Figure E-12. Mitsubishi Model MF353FA Disk Drive
set for uses with a 8088 CPU.

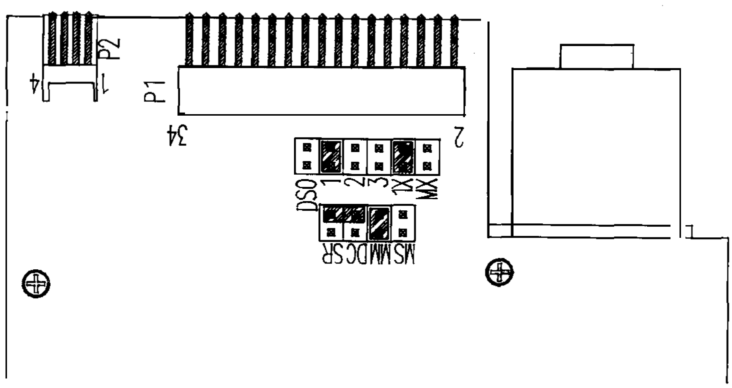


Figure E-13. Mitsubishi Model **MF353FA** Disk Drive
set for uses with a 286 CPU.

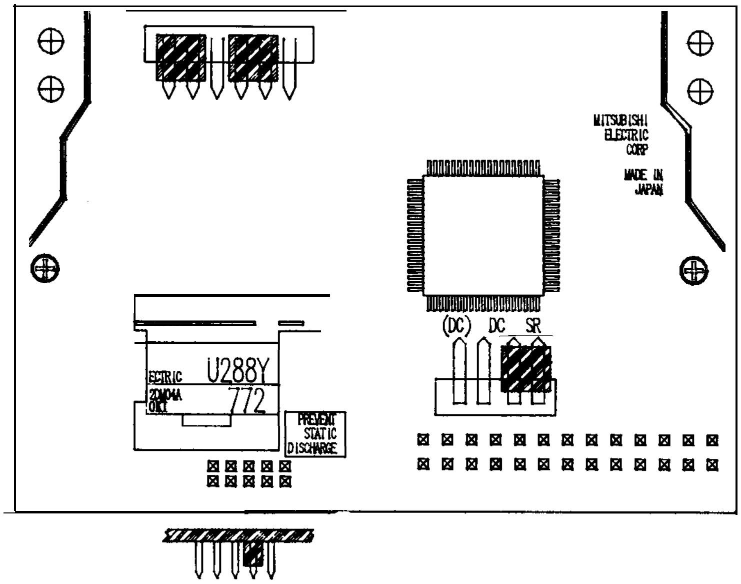


Figure E-14. Mitsubishi Model MF353B-12UJ Disk Drive set for use with an 8088 CPU.

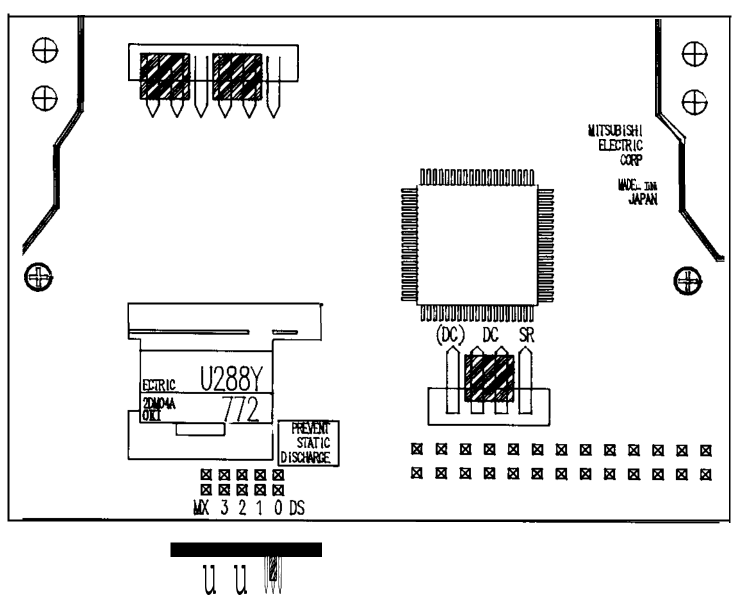


Figure E-15. Mitsubishi Model MF353B-12UJ Disk Drive set for use with an 286 CPU.

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.

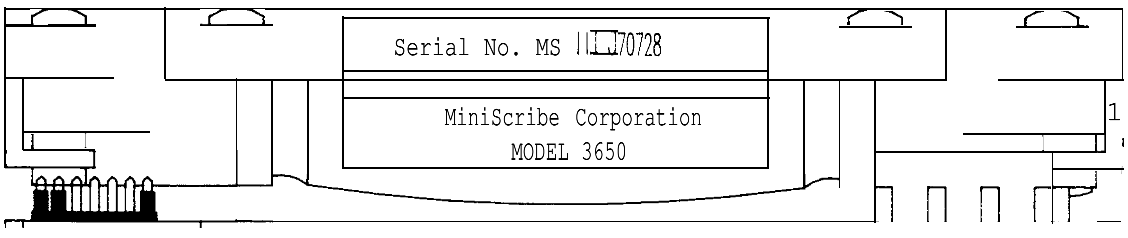


Figure E-16. MiniScribe 3650 and 3675 Hard Drives rear view.

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.

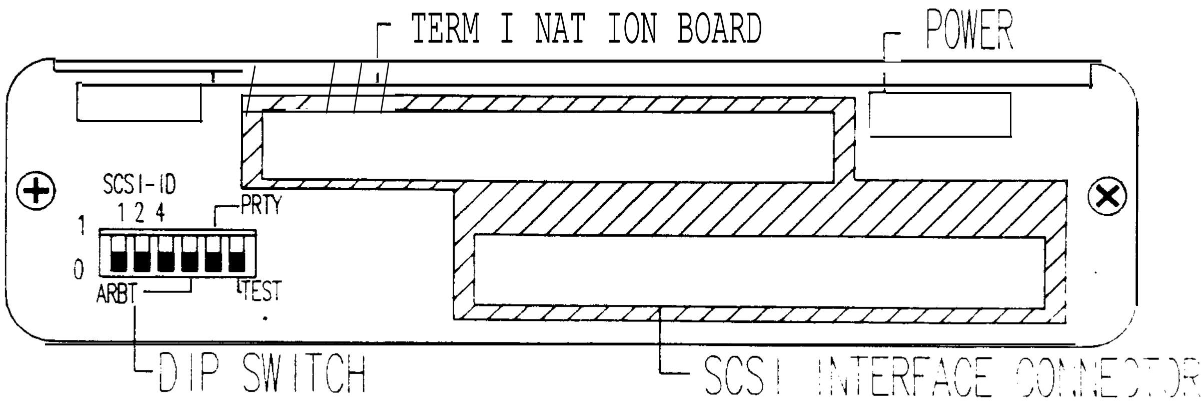


Figure E-17. Toshiba XM-3101 CD ROM Drive rear view.

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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**
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