Technical Manual

MRC 2
MICROPROCESSOR
REMOTE CONTROL SYSTEM
VOLUME ONE

Revised
August 1994

7A0260 Rev. F

Moseley
ISO 9001

111 Castilian Drive
Santa Barbara, CA 93117-3093
U.S.A

Phone: 805-968-9621
Fax: 805-685-9638
http://www.moseleysb.com

MRC 2 Volume One Revision Configuration:

Manual Doc. #7A0260 Rev. F

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WARNING

This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits of FCC rules which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

Note: All peripherals connected to this equipment, for example VDTs, printers, etc., must be connected with shielded cables to maintain this compliance.

Volume One

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GLOSSARY

A/DFC	Analog to digital
ASCII	American Standard Code for Information Interchange
BCD	Binary-coded decimal
CMOS	Complementary metal-oxide semiconductor
CPU	Central processing unit
CRT	Cathode ray tube
D/A	Digital to analog
DACU	Data Acquisition and Command Unit
EAROM	Electrically alterable read-only memory
EPROM	Erasable programmable read-only memory
FSK	Frequency shift keying
GPIB	General purpose interface bus
IC	Integrated circuit
LED	Light-emitting diode
MAI	Moseley Associates Inc.
Modem	FSK MOdulator/DEModulator
NC	Normally closed
NO	Normally open
PROM	Programmable read only memory
PSTN	Public Switched Telephone Network
RAM	Random-only memory
ROM	Read-only memory
RX	Receive or Receiver
SCA	Subsidiary communications authority
Telco	Telephone Company
Telemetry	Refers either to metering samples and functions or to signals from the Remote Terminal to the Control Terminal.
THD	Total harmonic distortion
TTL	Transistor-transistor logic
TX	Transmit or Transmitter

MANUAL ORGANIZATION

The MRC-2 manufactured by Moseley Associates Inc., is a modular microprocessor-based system, which can monitor and control many types of equipment, including radio and TV transmitters.

The MRC-2 manual is divided into two volumes. Volume 1 is a comprehensive guide with information on installation, operation, theory of operation, alignment procedures for customer troubleshooting and repairs, module descriptions, schematic and assembly drawings, and part lists.

Volume 2 is installation and operating instructions for each MRC-2 option available.

If you are not familiar with the basic use of the instrument and want more detailed information, please read Sections 1 through 3 before installing the MRC-2.

Section 1, System Characteristics, is a brief overview of the MRC-2. It includes specifications on the MRC-2 system; Analog Input module, Status Input TTL II module, Status Input Opto II module, Command Output Open Collector module and Command Output Optically Isolated module. It also describes the bus structure and provides a software over-view.

Section 2, Installation, covers unpacking, preinstallation system checkout procedures and installation.

Section 3, Operation, discusses the controls and adjustments for the MRC-2 that the user will encounter in normal operation and initial set-up. Also included is front panel set-up instructions for Dial-Up, MSD and MDC options.

Section 4, Module Characteristics, is a detailed analysis on the theory of operation for each module component. Schematic, assembly and part lists for each module description are located in the appendix.

Section 5, Alignment Procedures, covers system performance checks and customer adjustments that are used to service and maintain the MRC-2. This section also covers recommended test equipment for each alignment procedure and troubleshooting guide.

Section 6, Customer Service Information, describes general procedures for customer assistance by telephone consultation, field repair or return of equipment.

Section 7, Recommended Spares, includes optional spare parts kits, and information on complete module replacements.

Section 8, Part List, contains part information on all MRC-2 modules.

Appendix, contains schematic and assembly drawings refered to in Sections 4 and 5 of Volume One.

1

Section One

System Characteristics

1.1 Introduction

The MRC-2 Remote Control System is a modular microprocessor-based system, which can monitor and control many types of equipment, including radio and TV transmitters. Telemetry (analog) and status (on/off) information can be displayed and recorded at both the control location and the remote location. The MRC-2 configuration can easily be modified to the user's needs.

The MRC-2 consolidates, into one convenient package, all of the features of existing moderately-priced remote Control systems that require numerous auxiliary devices to function as a system, in addition to many features normally found in large-scale remote control systems. The many features incorporated into the MRC-2 are made possible through the use of a microprocessor as the main control and logic element of each Remote Terminal and Control Terminal.

The flexibility of the microprocessor has also led to some changes in the terminology that is used to describe the functions performed by the MRC-2 and the way it is connected as a system. We highly recommend that personnel installing an MRC-2 for the first time completely read and understand the manual before attempting to connect the MRC-2 to the user's equipment. This can best be accomplished by connecting the MRC-2 equipment "back-to-back" on a test bench (see Section 2, Preinstallation Checkout) and exercising the functions described in the manual until familiarity with the system is achieved.

1.2 System Overview

An MRC-2 system can consist of one or more Control Terminals, each communicating with one or more Remote Terminals over one or more communication circuits.

A communication circuit can be a two-wire or four-wire, leased-line telephone circuit, a PSTN (dial-up) circuit, an RS-232 circuit, a microwave or STL subcarrier, an on-air subcarrier, or combinations thereof. There can only be one Control Terminal on a communication circuit; there may be a number of Remote Terminals on the Circuit. A Control Terminal may access up to eight communication circuits, and a Remote Terminal may access to eight circuits.

To satisfy the FCC single-point control rules for broadcasters, one and only one Control Terminal may issue commands to a Remote Terminal at any one time. A feature is incorporated to allow the control point to be passed from Control Terminal to Control Terminal upon operation requests under normal conditions. In the event of communication circuit failure to the Control Terminal in "control", the Remote Terminal attempts to alert the alternate Control Terminals. If a positive operator response is not received within a specified time period, the Remote Terminal takes action to initiate a control failsafe or telemetry failsafe, depending upon the nature of the communication circuit failure, and if configured to do so, can attempt to dial a Control Terminal.

Figure 1-1 illustrates a simple configuration with one Control Terminal and two Remote Terminals. Two independent communication circuits are shown. One circuit would be sufficient; however, two circuits that are independent and not subject to the same failure conditions will provide the user with more reliable and faster operation. For example, if Circuit A fails, communications will automatically continue on Circuit B.

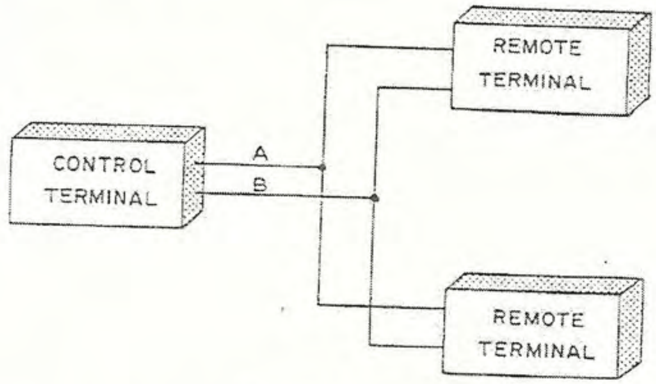


Figure 1-1
A Typical Single Control Terminal System Interconnect

Figure 1-2 illustrates a typical multiple Control Terminal configuration with a circuit interconnection that allows an alternate Control Terminal to assume command capability in the event a failure occurs on the primary communications circuit.

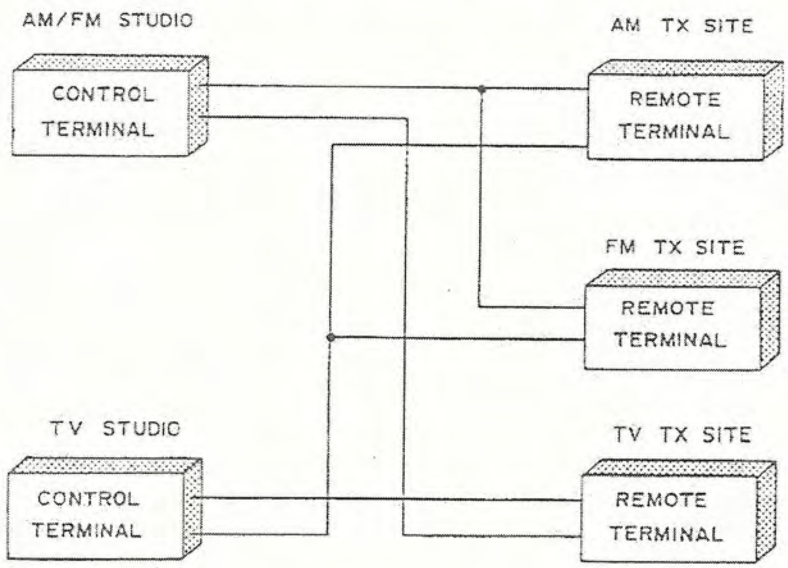


Figure 1-2
A Typical Multiple Control Terminal System Interconnect

In an MRC-2 system there are generally three basic units that function together. They are a Control Terminal, a Remote Terminal, and a Data Acquisition and Command Unit (DACU). Each piece of equipment has a specialized set of functions to perform, which when combined provide the powerful capabilities of the MRC-2 (see Figure 1-3).

The purpose of the Data Acquisition and Command Unit is to interface to the customer's equipment, acquiring data, limit checking of data, converting raw data into user engineering units, and providing the interface to issue commands to the customer's equipment.

A Remote Terminal manages the data at the site providing limit checking of data, converting raw data into user engineering units. It also provides the facilities for observation of the site data and communication of the data to the Control Terminal, CRTs, and Logger. If there is enough space in the Remote Terminal, DACU functions may also be installed here.

The Control Terminal manages the collected data for one or more sites. It has facilities for multiple communications circuits from the remote sites, and can prepare the data for display on the front panel, CRTs, and Loggers.

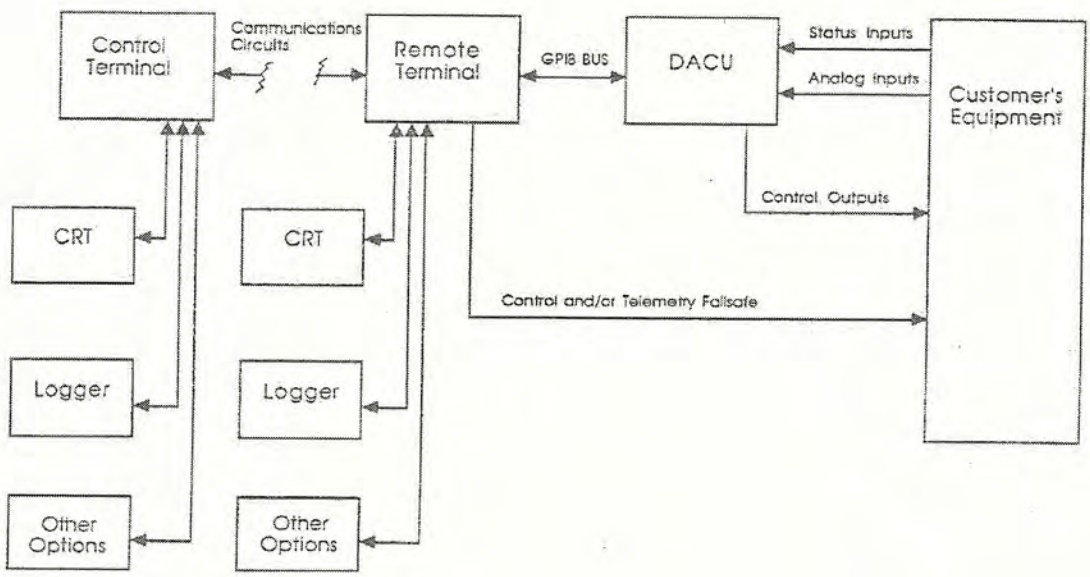


Figure 1-3
Functions of the Three Primary Units of a MRC-2 System

1.3 System Specifications

The MRC-2 Remote Control System can accommodate a wide variety of options with regard to interfacing the system to the user's equipment. The specifications for each interface, in addition to system specifications, are detailed in this section.

1.3.1 MRC-2 Specifications

The following are general system specifications for the MRC-2:

Type of System	Microprocessor-based real-time data acquisition and control.
Control Terminals	One master Control Terminal for a given Remote Terminal. Four Control Terminals maximum per Remote Terminal.
Remote Terminals	One to 64 Remote Terminals per Control Terminal, hardwired; one to 64 Remote Terminals per Control Terminal, Dialup (8 maximum connected simultaneously).
DACUs	Zero to seven, depending on system requirements.
Failsafe	
Control	Responds after failure of interconnecting circuit. User-programmable, default = 3 minutes.
Telemetry (Optional)	Six independent sets of internal timers and monitors for FCC compliance. User-programmable, default = 3 hours.
Output(s)	NC relay contacts, 1 ampere at 24 volts, non-inductive.
Alarm Indications	Visual and aural. Aural alarm defeatable and remoteable.
Maintenance Override	Remote Terminal front-panel control provides Remote Terminal relay closure. No relay at 24 V, 1 ampere, isolated. Last state maintained on power restoration.
Interconnections	
Interconnect Classes	2-wire/4-wire dedicated audio circuits; FM subcarrier, or combinations; RS-232; Public Switched Telephone Network (Dialup)
Number of Interconnects	Two maximum from CT to any RT, 8 maximum per CT, 8 maximum per RT.

4-Wire/ 2-Wire	Series 3002 (unconditioned) data channel per Bell System Technical Reference PUB-41004. Nominal send level, 0 dBm into 600 Ohms; receive level, -30 dBm minimum.
FM Subcarrier (Optional)	Nominal levels 1.5 V p-p into 2 kOhms. Frequency range 26 kHz to 185 kHz.
Dialup	Hayes Smartmodem 1200
Modulation	Two-tone FSK, 1200 Hz space, 2200 Hz mark frequencies; PSK (Bell 212) for dialup
Data Rate	1200 bits per second, default; 9600 bits per second, maximum (with external modems). Restrictions on the number of communications lines apply.
Data Format	8 bits, no parity; 1 stop bit
Data Checking	2-byte CRC-16

(Note: Response time specifications below are for a single site, using a single modem, in a full duplex configuration.)

Command Functions

Number of Command Lines	Up to 256 lines per Remote Terminal in groups of 16.
Command Line Modes	Each line programmable by user for momentary, pulsed or latching operation.
Command Line Association	Each command line is user-assignable to one or more telemetry or status channels.
Tally-Back	Front-panel LED indicators at Remote and Control Terminals.
Command Response Time	<1 sec. nominal, from button push at Control Terminal to implementation at Remote Terminal.
Timing Resolution	100 ms units

Status Functions

Number of Channels	Up to 256 channels per Remote Terminal in groups of 16.
Attributes	Latching or following, invert (NC)/ non-invert (NO).
Alarms	Rising edge, falling edge, both, or neither condition.
Muting	User-assignable status channel to cause alarm muting.

Response Time	<1 sec. nominal, from status change at Remote Terminal to Control Terminal indication.
Sampling Frequency	5 Hz

Telemetry Functions

Number of Channels	Up to 256 analog channels per Remote Terminal in groups of 16. Up to 32 calculated (product/ratio) channels.
Calibration	Via keyboard at Remote Terminal in user-selected units of measure.
Calibration Modes	Millivolt, linear (y=mx+b), power-to-linear, product, ratio, and parallel (binary or BCD)
Display	Four and 1/3 digits with decimal point and polarity sign for value and limits display.
Alarms	Fully tolerance-alarmed with two sets of high and/or low limits, with hysteresis.
Muting	User-assignable status channel to cause alarm muting.
Input Filtering	Hardware low-pass filter
Response Time	<1 sec. nominal, from change at Remote Terminal to Control Terminal indication.
Sampling Frequency	5 Hz

Physical Specifications

Power	120/240 Vac, 50/60 Hz, 100 W nominal per unit.
Size	17.8 cm H x 48.3 cm W x 39.4 cm D (7" H x 19" W x 15.5" D) per unit.
Operating Temperature	0 to 50 degrees C

1.3.2 Analog Input III Module

The following specifications apply to the Analog Input III module supplied as part of the system:

Channels	16 input channels per module.
Resolution	One part in 4096.
Inputs	Differential ±3.5 V nominal, ±300 mV minimum, 100 kOhm dc bridging.
Maximum Input	±4.5 V Application of voltage above this level causes erratic operation of one or more channels. Damage level is ±40 V.
Sample Interval	200 ms
Overall Measurement	Better than 0.5% accuracy.

1.3.3 Status Input, TTL II Module

The following specifications apply to the Status Input, TTL II Module supplied in the MRC-2 System:

Number of Channels	16 input channels per module
Input Configuration	Low-power TTL with 10 kOhm pull-up to +5 Vdc (contact closure to ground will operate circuit).
Voltage Reference	Chassis signal ground
Maximum Input Voltage	+5.5 Vdc
Minimum Input Voltage	0.0 Vdc
Logic High Level Input Voltage	<2.0 Vdc
Logic Low Level Input Voltage	>0.8 Vdc

1.3.4 Status Input, OPTO II Module

The following specifications apply to the Status Input, Opto II module, which can be interchanged with the Status Input, TTL II module. Both module types may be included within a single Remote Terminal:

Number of Channels	16 input channels
Input Configuration	LED optical isolator
Voltage Reference	Two-terminal isolated from ground.
Maximum Input Current	30 mA maximum through optical isolator, user-supplied current. User-changeable current limiting resistors.

Maximum Voltage	$\pm$ 50 V above chassis ground

1.3.5 Command Output, Open Collector Module

The Open Collector Command Output module is supplied in an MRC-2 system for activating external devices.

Number of Outputs	16 command outputs per module
Output Configuration	High current peripheral driver integrated circuit (Open Collector)
Voltage Reference	Chassis signal ground
Maximum Voltage	48 Vdc, user-supplied
Maximum Current	250 mA, user-supplied
Voltage Drop (at 250 mA)	1.5 V

1.3.6 Command Output, Optically Isolated Module

The Optically Isolated Command Output module can be interchanged with the Open Collector Command Output module for activating external devices:

Number of Outputs	16 command outputs per module
Output Configuration	Optical isolator driving high-current Darlington
Voltage Reference	Two-terminal isolated from ground.
Maximum Voltage	48 Vdc, between terminals, user-supplied
Maximum Current	250 mA, user supplied
Voltage Drop (at 250 mA)	1.5 V

1.3.7 CPU Interface Module

Aural Drive Output	Open Collector: 12 Vdc, 25 mA, maximum
+5 V Output	25 mA, maximum (internal current limit)
Maintenance Override Relay	N.O. Contacts: 24 Vdc, 1 A, maximum
Control Failsafe Relay	N.C. Contacts: 24 Vdc, 1 A,maximum

1.3.8 Options

The following is a brief summary of options available for the MRC-2.

Video Display Terminal (VDT)

The VDT allows the user to view 32 command, status, and/or telemetry channels on a single screen. Pages can be set up to view any combination of channels, including channels from different sites. Each channel descriptor, and units or condition can be programmed individually. Up to four VDT options can be installed at Control Terminals and one at Remote Terminals.

Automatic Logging (Logger)

The Logger provides a printed record of selected status and telemetry channels, in a designated number of columns (up to 16) at defined intervals. The Logger will also print multiple headers (maximum line length = 216, default = 132), status and telemetry alarms (as defined in Remote Terminal Setup), system alarms, and status-initiated messages. Up to four logger options can be installed at Control Terminals and one at Remote Terminals.

Multiple Direct Command (MDC)

The MDC provides single-button commands (selecting site, channel, and raise or lower). Each MDC provides 16 switches, each with a tally-back LED. Up to eight MDC options can be installed at Control and Remote Terminals.

Multiple Status Display (MSD)

The MSD provides 32 continuous status indicators. Each bank of 16 LEDs on each MSD can be individually programmed for site and board number. Up to eight MSD options can be installed at Control and Remote Terminals.

Digital Telemetry Input (Parallel Input)

The Parallel Input can be used to input direct binary or BCD telemetry values to the MRC-2. This data is then treated like any other telemetry input. Each Parallel Input option allows one input. Up to 16 Parallel Input options may be installed at Remote Terminals or DACUs.

Barrier Strip Panel (BSP)

A Barrier Strip Panel is available to simplify the connection of telemetry and status inputs as well as open collector or optically-isolated command outputs. Each rack-mounted panel includes an interconnecting cable with plug for 16 input or output connections with grounds, and may be expanded up to a total of 64 lines or channels per panel.

Command Interface Panel (CIP)

+A Command Interface Panel option is available for providing relay-isolated command lines for inter-connecting transmitter or plant control circuits not suitable for standard transistor switching. Each CIP-2 Panel provides 16 relay sockets and power supply with ribbon cable for direct connection to the MRC-2 standard command outputs. The relays are available separately to allow configuring as required.

VDT Modems

In those cases where it is desirable to extend the VDT option great distances from its associated control or remote terminal, modems may be used to connect the VDT and terminal via dial phone lines. Manual or auto-answer modems are available. This can be used as an alternate control point, since all the functions of the VDT are maintained.

MasterController Software

The MasterController software emulates a CT but runs on an IBM AT or equivalent. It has user-defined displays, can log to a printer and/or disk, and can drive MDCs and/or MSDs. Communications to the RT can be via telco, subcarrier or dial-up circuits. The MasterController also has SMARTS, intelligent decision-making capabilities.

1.4 Hardware Overview

This section provides the user with a general overview of the hardware and software of the MRC-2 system. It is not a detailed explanation of microprocessors, but rather discusses the basic design concepts incorporated into the MRC-2. The user is referred to many excellent texts on microprocessors including M6800 Microcomputer System Design Data, published by Motorola, Inc.

The basic MRC-2 system consists of a Control Terminal, Remote Terminal, and (optionally) a Data Acquisition and Command Unit (DACU). The Control Terminal and Remote Terminal are very similar but are not identical. Figures 1-4 through 1-6 are block diagrams of these major components.

The chassis houses the modules and power supply. A mother board is located approximately three quarters of the way back from the front of each Terminal. The functional modules (i.e., CPU, Memory, Modem Options, etc.) plug into the mother board from the front (see Figure 1-7).

The user's connection to a functional module occurs through an interface module that plugs into the rear of the mother board. The interface module provides the physical connectors, terminals, or barrier strips to which the user makes the connection. In some cases, there can be several interface modules that can be associated with a given functional module. For example, a Modem module can have one of four interface modules, depending upon the type of communications circuit. In other cases, the same interface module can serve several functional modules. As an example, the Filtered Interface module is normally used with the Telemetry (analog) and Command modules.

The mother board provides the following:

* Power distribution to all modules
* Interconnection between functional and interface modules
* Distribution of control, data, and address buses to the functional modules.

All modules and subassemblies, except for the mother board, are removable without disassembling the chassis.

Figure 1-4
Control Terminal Block Diagram

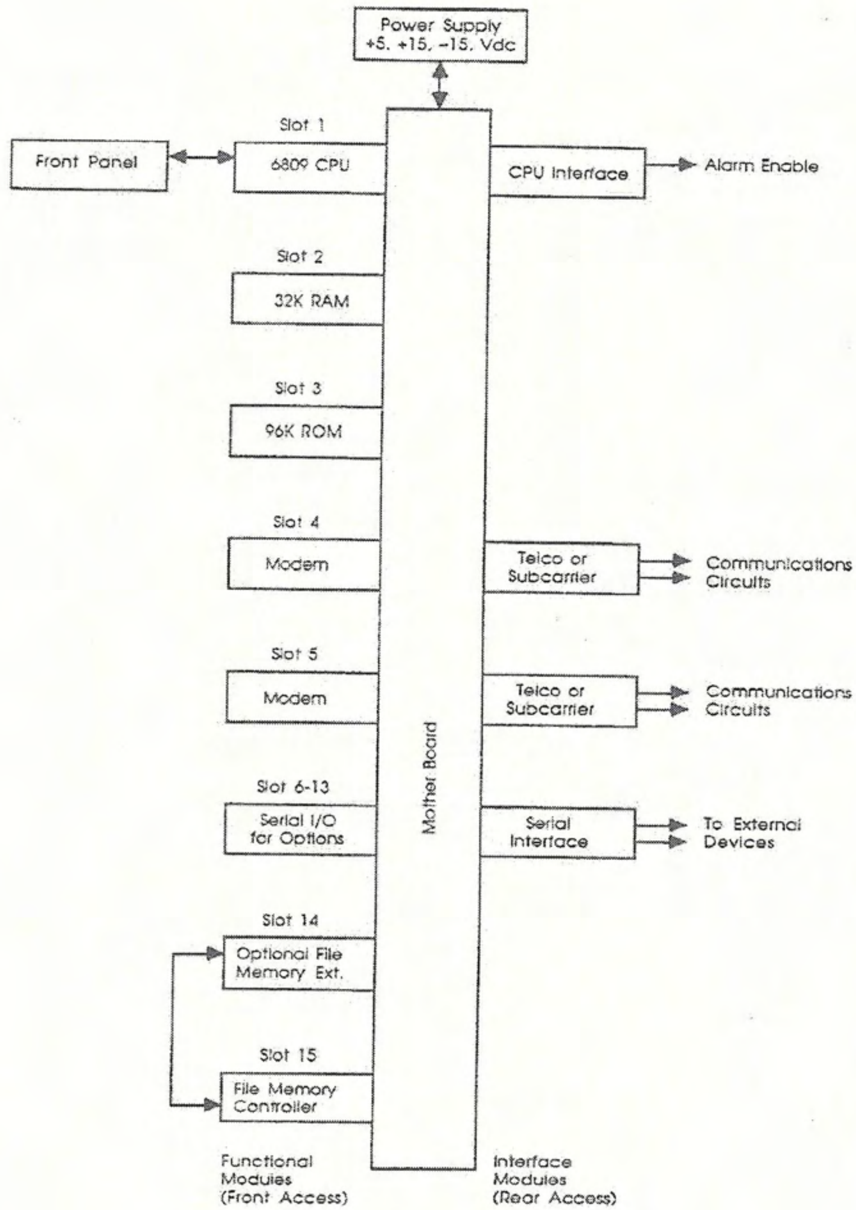


Figure 1-5
Remote Terminal Block Diagram

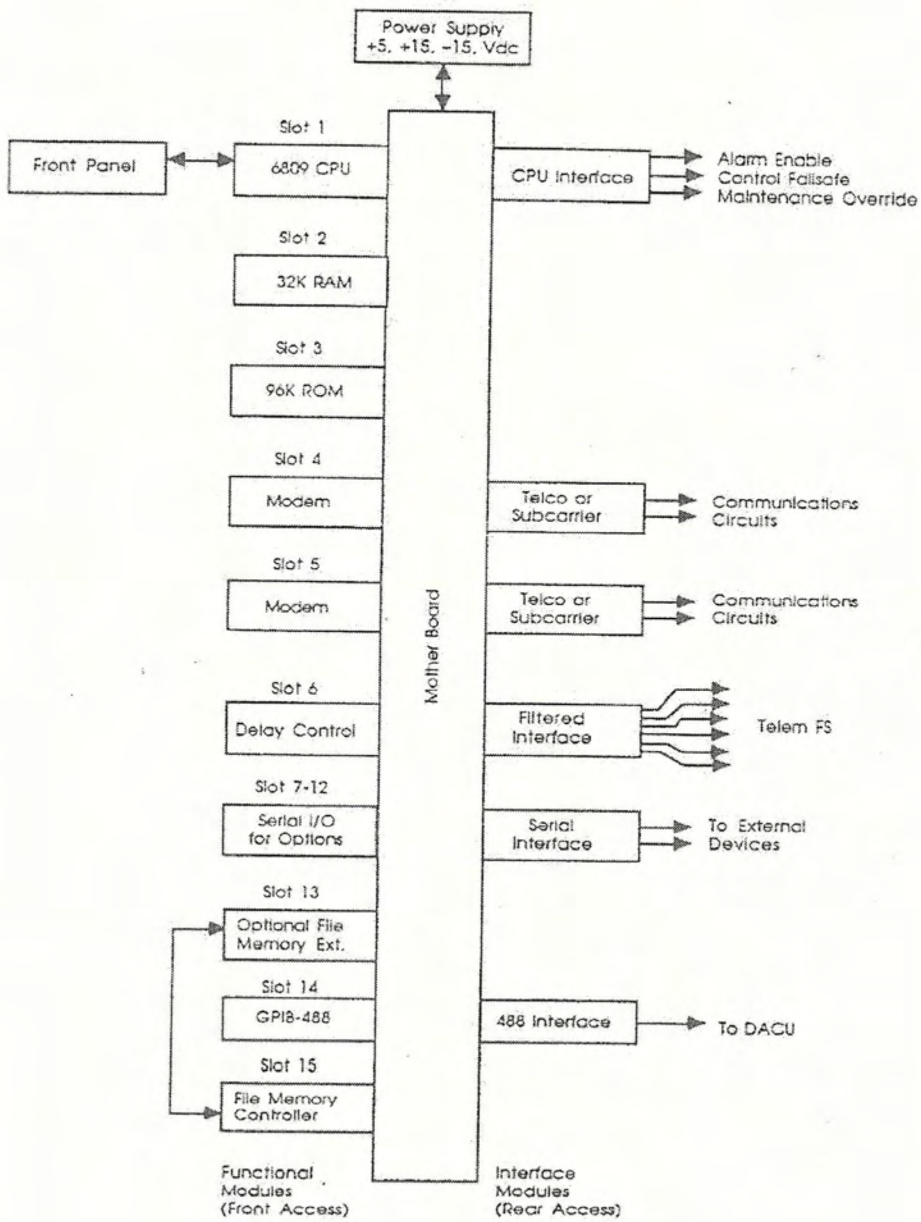


Figure 1-6
DACU Block Diagram

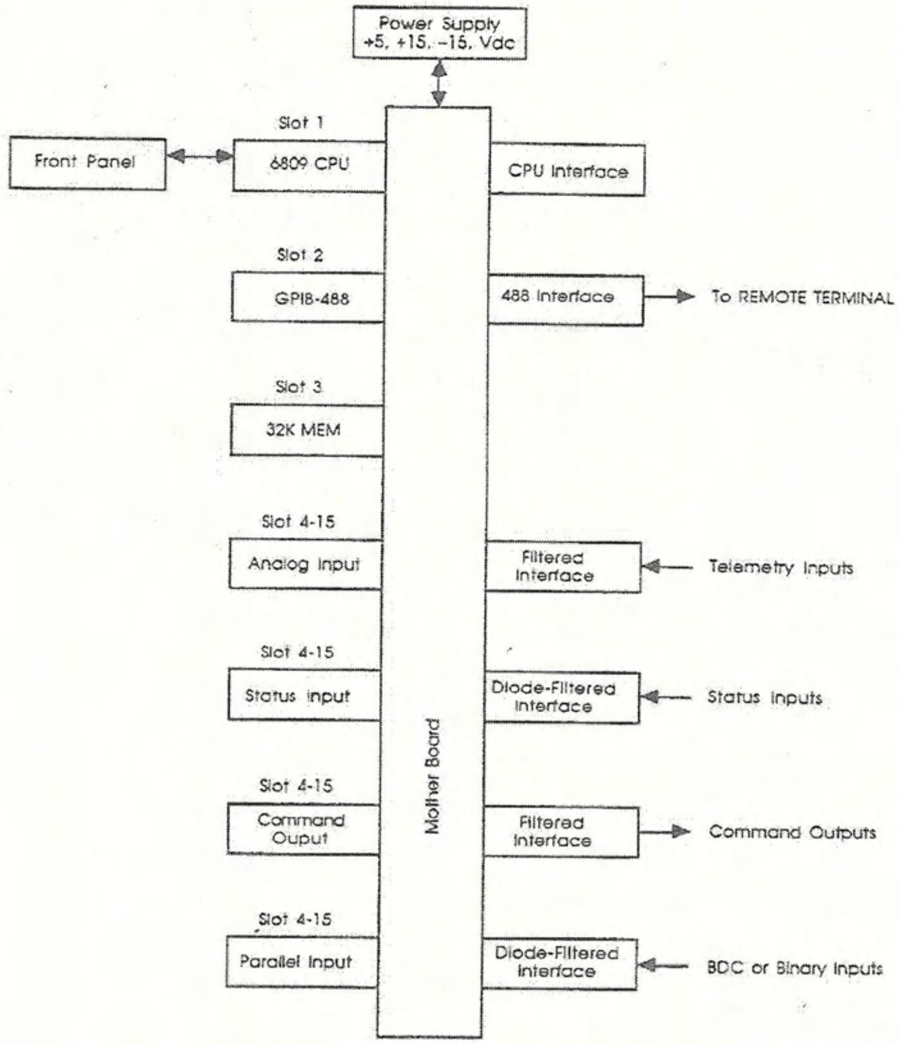
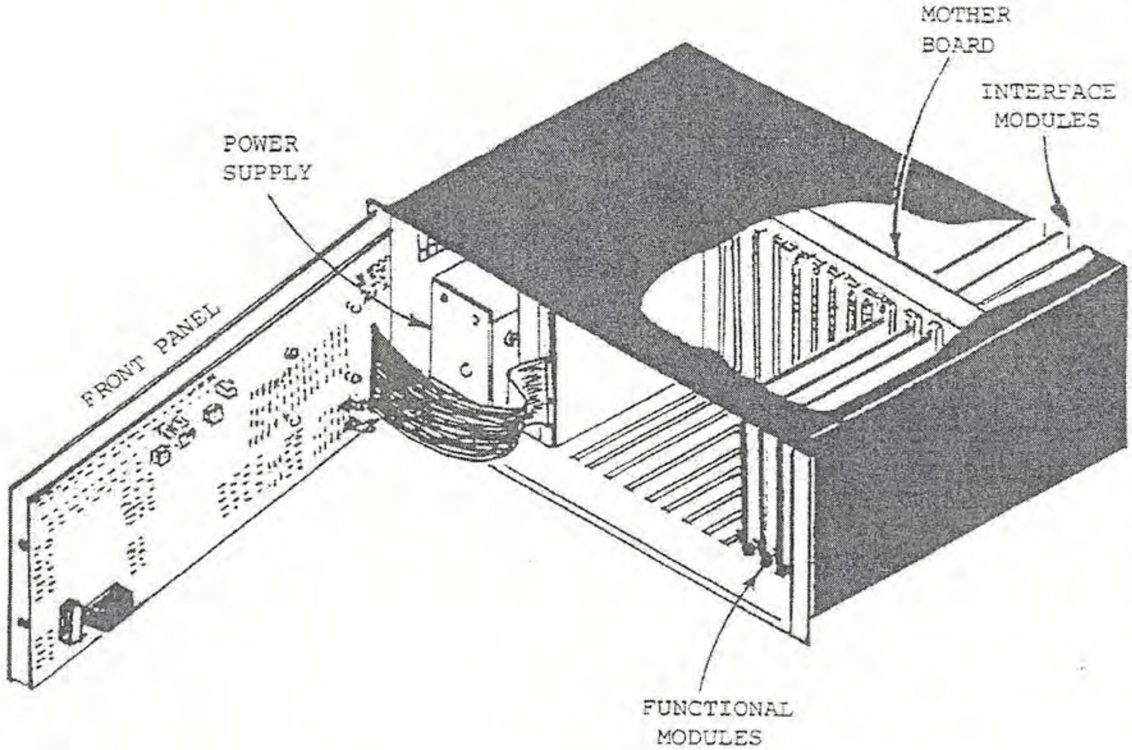


Figure 1-7
MRC-2 Terminal Construction



1.4.1 Bus Architecture

The MRC-2 is designed using a bus structure which allows flexible configuration changes. Fifty control signals and power lines are bused to each module slot. Modules are accessed by digital words on the address bus and do not require an absolute physical slot to be assigned for each module. An exception to this rule is the CPU module, which always must be plugged into the first slot to obtain an ac power sample for the real-time clock and power-fail circuits.

Each module edge connector has 100 pins. The even pins contain the common bus signals. The odd pins are used to communicate via interface modules to external components through the rear panel. To prevent confusion, the even wire-wrap pins are sheared off during manufacturing, leaving only the odd pins for module input/output connections. Signal assignments for the connector pins are shown in Table 1-1.

(Note: The signal ground, +5V, +15V and -15V are available to both functional and interface modules.)

TABLE 1-1
MRC-2 Bus Architecture

Pin	Name	Description
1, 2, 3, 4	Ground	System common signal ground
5,6	+15 V	Positive 15 V supply
7,8	-15 V	Negative 15 V supply
9,10	Not used	
12	D0	
14	D1	
16	D2	
18	D3	Bidirectional 3-state data bus is used to transfer data between the microprocessor, its peripherals and memory.
20	D4	
22	D5	
24	D6	
26	D7	
28	A0	
30	A1	
32	A2	
34	A3	
36	A4	
38	A5	
40	A6	
42	A7	16-pin address bus Both memory and input/output devices and addressed using these lines.
44	A8	
46	A9	
48	A10	
50	A11	
52	A12	
54	A13	
56	A14	
58	A15	
60	*RESET	This active low input is used to reset and start the microprocessor from a power down condition, resulting from a power failure or an initial start-up of the microprocessor. The signal is generated by the CPU Interface module and button S1 on the CPU module and is used to reset functions in the CPU and various modules that have reset capability.
62	E	1 MHz clock signal used to synchronize all system functions.
64	R/*W	This output signals the peripherals and memory devices whether the CPU is in the Read (high) or Write (low) state. The normal standby state of this signal is Read.
66	DMAVMA	Valid Memory Address. This output from the CPU module indicates to peripheral devices that there is a valid address on the bus.

TABLE 1-1
MRC-2 Bus Architecture

Pin	Name	Description
68	PRE	Input/Output Preselect. This line is high when certain addresses in the input/output device address space are accessed.
70	RTC	Real Time Clock. A 50 or 60 Hz signal derived from the ac power line and used as a timing signal.
72	*DMA/BREQ	Direct Memory Access. When this signal goes low, the CPU module releases control over the address bus.
74	BUSGRANT	Bus Available. This signal will normally be in the low state; it will go to a high state to indicate that the microprocessor has stopped and the address bus is available. This will occur if the processor is in the HALT state, or if a WAIT instruction is encountered by the microprocessor.
76	*HALT	When this signal is in the low state, all microprocessor activity will be halted. In the HALT mode, the microprocessor will stop at the end of an instruction, Bus Available will be at a high state, and Valid Memory Address will be at low state.
78	Not used	Reserved for future expansion
80 82 84 86 88 90 92	*INTO *INT1 *INT2 *INT3 *INT4 *INT5 *INT6	Lowest priority. Active low prioritized interrupts. When one of these lines goes to a low state, the microprocessor suspends its normal operation and begins servicing an interrupt routine. A higher priority routine takes precedence over a lower priority.
94	*INT7	Highest priority.
96	*NMI	Non-Maskable Interrupt. When this line is pulled to a low state, the processor completes its current instruction and then branches to an interrupt routine. Interrupt cannot be disabled by setting a mask bit.
97-100	+5 V	Positive 5 V power supply

1.5 Software Overview

The MRC-2 is composed of three types of chassis, known as Remote Terminals (RT), Data Acquisition and Control Units (DACU), and Control Terminals (CT). Each has a distinct role in this system and each is supplied with software unique to that role.

A minimum system consists of a single RT, capable of local data acquisition and control. If large numbers of interface cards are required, DACUs may be added to an RT to serve as expansion chassis. If remote control is desired, this is achieved using a CT at the control point. More complex systems may be configured supporting up to 63 RTs accessible from a given CT, and up to four control points for each RT, with up to 784 input devices and 256 control points per RT. Both the RT and CT support a variety of human interfaces.

1.5.1 Remote Terminals

The RT is responsible for collecting and processing data at the transmitter site. For control purposes it works at 10 Hz; digital outputs are changed on 100 mS boundaries. For data collection purposes, the RT works at 5 Hz. These rates are maintained for devices located in DACU's as well as those located within the RT chassis.

Every 200 mS, all raw data known to the RT are absorbed and remembered. Status inputs are fully processed and any alarms or events noted at this rate. Telemetry inputs are converted to engineeering units and limit checked at whatever rate the data are being interrogated. This rate depends on what, if any, devices the data are being routed to at the time. A background process performs these operations on telemetry data at a relatively low rate to ensure that all inputs are checked at least every few seconds.

The RT may route its data to the Front Panel, nominally updating at 5 Hz; to MSD panels as fast as permitted by number of panels and baud rate; to as many as four CTs, and to either a CRT or Logger option. It is capable of transmitting converted data to all of these devices concurrently at whatever rates their interfaces permit.

The RT may receive control stimuli from the front panel, MDC panels, a CRT, or one of the CTs. Control is implemented with end to end feedback suitable for the device involved.

Most of the RT configuration, stored in nonvolatile memory, is entered at the Front Panel. The CRT and Logger options support their own configuration interfaces.

1.5.2 Data Acquisition and Control Units

The DACU is little more than an expansion box. It only takes action on its outputs when asked to do so by the RT, and it only interrogates its inputs and reports on them under like conditions.

1.5.3 Control Terminals

The CT spends its time maintaining communications with a wide range of RT configurations. The principal responsibility of the software is to efficiently acquire potentially large volumes of data from the RTs and present them on the Front Panel, MSD panels, up to four CRTs, and up to four Loggers. The CT supports a rather large data base for labeling the interfaces of the RTs and configuring various presentations of data. Less frequently required, but vital, is the CTs role in facilitating remote control actions. Operators at the Front Panel, MDC panels, or CRTs may take control actions on various RT's. The communications subsystem is especially optimized to enable tightly coupled analog adjustments with sufficiently frequent and timely feedback for good control; this capability may be used at the Front Panel or a CRT.

2

Section Two

Installation

2.1 Introduction

This section covers the preinstallation checkout and installation of the MRC-2 system. The main purpose of the preinstallation checkout is for the user to gain familiarity with the system before actual physical installation of the Control and Remote Terminals.

We highly recommend that the user read Sections 1-3 (Vol. 1) before attempting equipment hookup. While the instal-lation is relatively simple and straightforward, certain details of installation and operation, if overlooked, may cause what appear to be equipment failures.

All units have been checked out as a total system at the factory. If you have ordered MRC-2 options, separate pre-installation checkout procedures are covered in Volume 2.

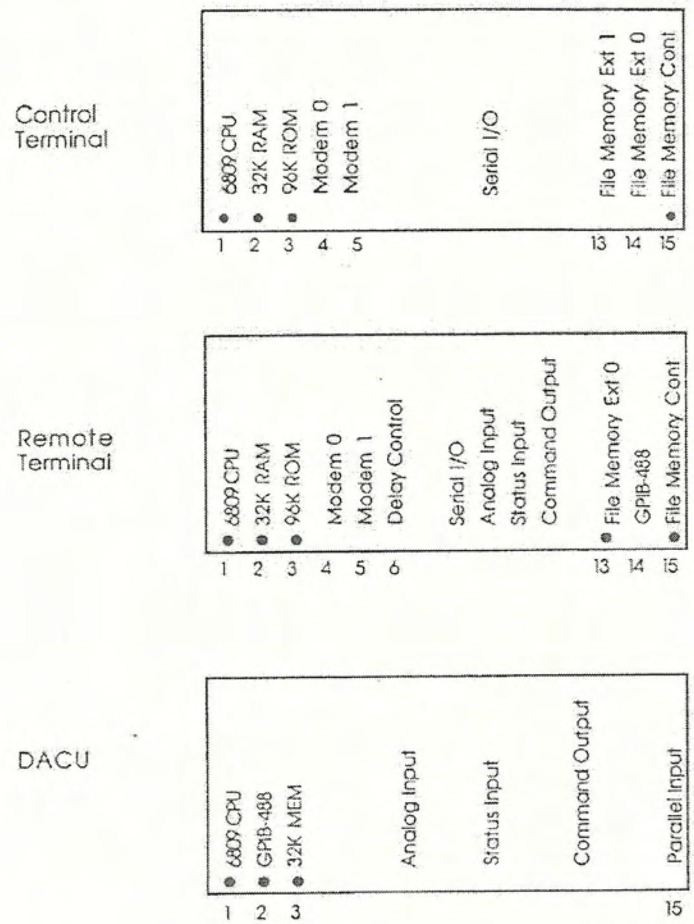
Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.

2.2 Unpacking

The MRC-2 Remote Control System should be carefully unpacked and inspected for shipping damage. Should inspection reveal any shipping damage, visible or hidden, immediately file a claim with the carrier. Keep all packing materials until the performance of the system is confirmed.

We recommend that the front panels be opened for a superficial inspection of the internal components. Open each front panel by turning the knurled screw on the right side of the panel counter-clockwise. Verify that all modules are seated firmly in the mother boards. All modules are the same length and all should appear to be seated to the same depth. (See Figure 2-1 for locations).

Two shipping screws are provided to hold down the power supply during transit. The screws are located on the left-hand side of the bottom of the chassis near the rear. Removal of the shipping screws prior to installation of the terminal into the rack will allow removal of the power supply assembly for servicing without removing the entire chassis from the rack. These screws should be saved in case a possible return shipment is required.



Notes:

1. ● Always Present.

2. Additional File Memory Extension modules are installed next to the File Memory Extension modules on the Remote and Control Terminals.

3. Install Analog Input, Status Input, and Command Output modules in the DACU, in the order shown. Within each group, install the modules according to module number (0=leftmost).

Figure 2-1
Module Positions

2.3 Preinstallation Checkout

The following procedures apply to checking the Control and Remote Terminals and the Data Acquisition and Command Unit (DACU) on a individual basis; Do not interconnect units.

1. Verify that the power line voltage selector and fuse are set for the line voltage to be applied to the units. The voltage selector is located at the left rear of the chassis. The units are shipped for 120 Vac operation, unless otherwise specified. The voltage selected can be observed on the PC card through the window in the ac power connector. To change the voltage, remove the power cord, slide the access window to the left, and with small needle-nose pliers, grasp and remove the PC card. Orient the card for proper operation - either 120 Vac or 220 Vac <u>only</u> and firmly replace the PC card. Install the proper fuse for the applied voltage as indicated by the placard on the ac power connector. Slide the window to the right and install the ac power cord.

2. Open the front panel by turning the knurled screw on the right side of the panel counterclockwise until the fastener disconnects and the panel can be swung open.

3. Connect the ac power cord to the ac mains. The switch located on the front of the power supply turns the ac power to the Terminal on or off.

4. Verify the three green LEDs on the CPU module are on. (the left-most slot of the module cage). These three LEDs monitor the +15, +5, and -15 volt power supplies and are illuminated when voltage is present.

5. Depress the **RESET** switch on the front of the CPU module. Observe that the red LED near the switch illuminates while the switch is depressed and, for a short period, after the switch is released. If the red LED remains on, turn R4 (on the front of the CPU module) clockwise until the LED goes off. Continue turning R4 for two more turns.

6. Observe the bottom LED on the Modem module of the Control Terminal. It should turn on and off at a periodic rate, indicating that the Control Terminal is attempting to communicate with a Remote Terminal.

7. Depress the **TEST** key on the Remote and Control Terminals. All LEDs and characters on the Terminal should illuminate. Release the **TEST** key to restore all LEDs and displays.

8. This concludes initial checkout.

(Note: After a few seconds an alarm condition will be indicated at the Control Terminal by the flashing ALARM RED because of failure to communicate with the Remote Terminal.)

2.4 Preinstallation System Checkout

The following paragraphs tell how to connect the terminals to form an MRC-2 system.

The following interconnection and checkout procedures are for the Control Terminal and each Remote Terminal supplied as part of the MRC-2 system.

The DACU(s) should be connected to the Remote Terminal(s) with the 1 m. GPIB cable(s) supplied with the system. The Remote and Control Terminals should be connected back-to-back to verify communications according to the type of communication modules supplied. Interconnections for each type are described below, and the data link setup procedures are described in Section 3.

2.4.1 Modem - Telco Interface

When telephone leased-lines are used for communication in both directions, Modem-Telco Interface modules will be supplied for the Remote and Control Terminals. Two modes of operation are possible: two-wire or four-wire. In the two-wire mode one telephone pair carries both Remote and Control message transmissions. In the four-wire mode, the Remote and Control Terminal messages are transmitted on separate telephone pairs, giving slightly better noise immunity. In addition, the MRC-2 software will perform slightly faster in the 4-wire mode. Figure 2-2 shows two-wire interconnection techniques. Figure 2-3 shows four-wire interconnection.

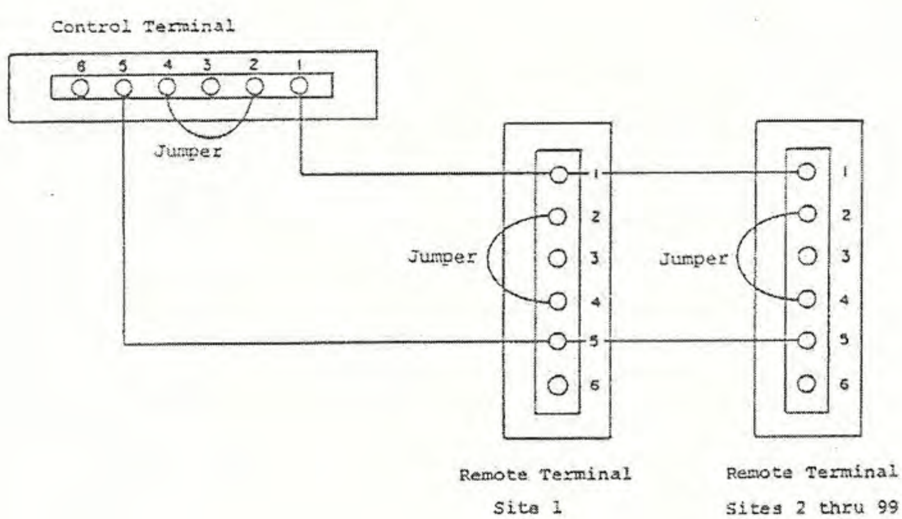


Figure 2-2
Two-Wire Telephone Line Interconnections Between Modem-Telco Interface Modules

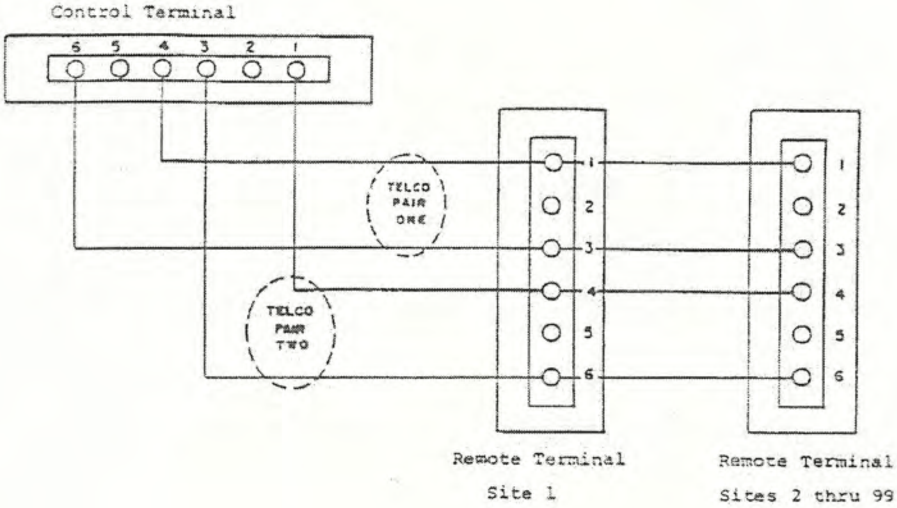


Figure 2-3
Four-Wire Telephone Line Interconnections Between Modem-Telco Interface Modules

2.4.2 Subcarrier Interface

When FM subcarriers are used for data in both directions, Subcarrier Interface modules are supplied. Interconnection is quite simple. Using two BNC-to-BNC connector cables, interconnect units as shown in Figure 2-4. The inter-connections and setups in Section 3 (Vol. 1) should be made for each data link. It is not possible to parallel incoming subcarrier signals at a terminal; external subcarrier demodulators, such as the Moseley SCM-1 Subcarrier Mainframe, must be used before the inputs are combined. See Figure 2-5.

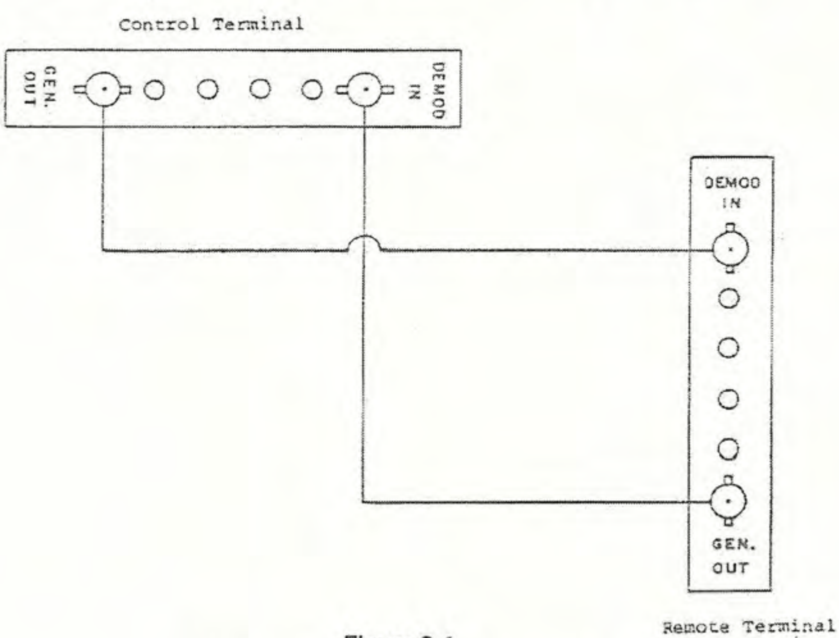


Figure 2-4
Interconnections Between Subcarrier Interface Modules

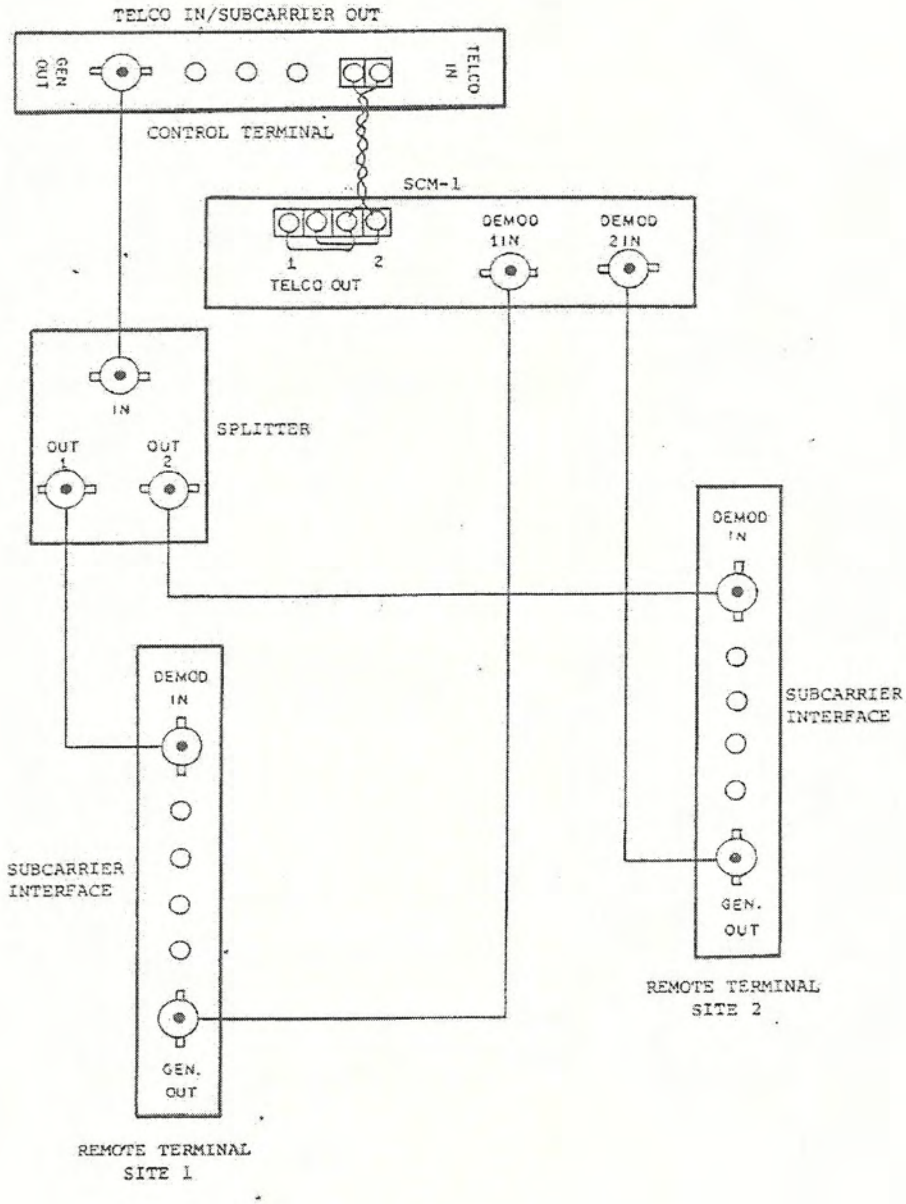


Figure 2-5
Interconnections Between Multiple
Subcarrier Interface Modules

2.4.3 Telco/Subcarrier Interfaces

When one communication direction is on telephone leased-lines and the other direction is on an FM subcarrier, two different modules are used: the Telco In/Subcarrier Out module and the Telco Out/Subcarrier In modules. Interconnections are shown in Figure 2-6. The interconnections and setups should be made for each data link.

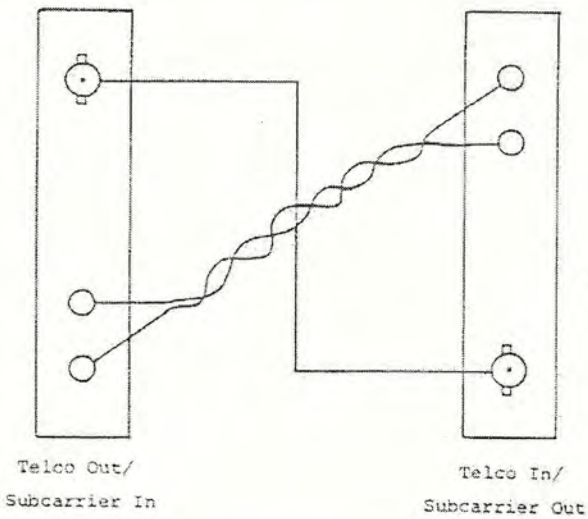


Figure 2-6
Telco/Subcarrier Interconnections

The user may now connect test inputs to status and telemetry interfaces, and connect loads to control outputs as desired. Follow the preliminary set-up procedures shown in Section 2.5 before attempting to operate the interconnected system.

By using the Operating Instructions (see Section 3, Vol. 1), telemetry channels that have inputs may be calibrated. Status channels (with or without input connections) may be programmed. Exercising the command function setup, the effect of commands to RAISE and LOWER may be observed.

If any difficulty is encountered, review Section 5, for wireline modem or subcarrier modem adjustments.

2.5 Site Selection

It is necessary to program the Remote Terminal with the number of the site for the Terminal (see Table 2-1 below). It is assumed that sites are numbered sequentially. The site selection switches are found on the rear of the front panel. They provide decimal site number encoding (see Figure 2-7).

Table 2-1
Remote Terminal Site Selection Switches

Site	S2	S1
1	0	1
2	0	2
3	0	3
4	0	4
9	0	9
16	1	6
20	2	0
30	3	0
40	4	0
64	6	4

The Control Terminal must be set to site 00. The terminal configuration switches are also used for special functions as shown in Table 2-2. The site selection switches are on the rear of the front panel.

Table 2-2
Terminal Configuration Switches

S3	S2	S1	Function
0	9	9	Erase File Memory
1	9	9	Expand File Memory

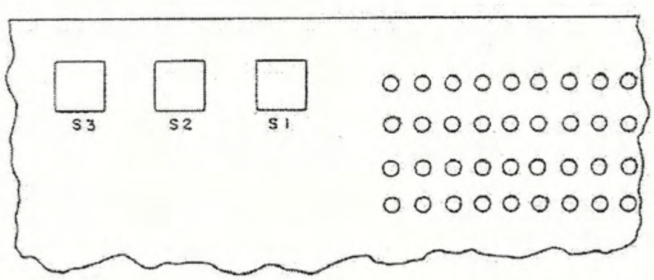


Figure 2-7
Configuration Switches

2.5.1 Dial-Up Initialization Options

The "Dial-Up" operation of the MRC-2 RT can be customized by using jumper locations found on the rear of the front panel.

The number of incoming rings before the MRC-2 RT modem answers the call is set as follows:

Jumper E2-A	Jumper E2-B	Number of Rings
Out	Out	1 (Default)
In	Out	3
Out	In	5
In	In	7

"Out" means jumper not installed; "In" means jumper installed.

A number of rings other than 1 allows you to use a single phone line for voice as well as modem calls. On some slow telephone exchanges, a large number of rings may cause the CT dial attempts to fail because the call will not be completed in the alloted time.

The time delay between RT attempts to dial CTs (or PCs) is set as follows:

Jumper E2-C	Jumper E2-D	Seconds (nominal)
Out	Out	0 (Default)
In	Out	30
Out	In	60
In	In	90

"Out" means jumper not installed; "In" means jumper installed.

A time delay other than 0 allows CTs or PCs to "dial in" to RTs between RT atytempts to dial CTs or PCs under alarm conditions. The dial-out delay starts after the RT has tried to dial all configured ports.

See section 3.7, Remote Terminal Site Set Up for more information on dial-up.

2.5.2 Rude Request Options

The "Rude Request" operation of the MRC-2 RT can be customized by using jumper locatinos found on the rear of the front panel.

The Control Terminals which are allowed to perform a rude request is set as follows:

Jumper Installed	CT (or PC) allowed rude request
E3-A	A (*always* allowed a rude request whether or not jumper is installed)
E3-B	B
E3-C	C
E3-D	D

2.6 Physical Installation

The MRC-2 is designed for industry-standard RTMA rack mounting. We suggest that the Terminals be mounted in the rack at a convenient height for best operational accessibility. With the power supply shipping screws removed, insert the Terminals in the rack or cabinet and install with the appropriate screws. Once installed in the rack, all modules that normally require service can be removed without removing the chassis from the rack.

The Extender board is stowed to the left of the power supply. The flat ribbon cable between the front panel and CPU module may have to be disconnected to remove the Extender board. At this time, remove the Extender board and store it in another location at the Terminal site in order to provide maximum ventilation to the Terminals.

2.7 Interconnections

2.7.1 Phone Line Connection, 4-Wire

If you are using a 4-wire interconnect service, both the Control and Remote Terminals transmit through a pair of wires connected to barrier strip terminals 4 and 6 of the Modem-Telco Interface module. Data is received through terminals 1 and 3.

(Note: The Modem-Telco Interface module contains fuses mounted internal to the module. Should you suspect that the phone lines have been hit by lightning, remove the two screws securing the Modem-Telco Interface module and check and/or replace fuses, as required.)

2.7.2 Phone Line Connection, 2-Wire

If you are using a 2-wire interconnect arrangement, place a short jumper between terminal 2 and 4 of the Modem-Telco Interface module. Then connect the telephone line to terminals 1 and 5. See the preceding paragraph for lightning protection fuses.

2.7.3 FM Subcarrier Interconnect

Each Terminal transmits through connector J3 and receives through connector J2 of the Subcarrier Interface module. Note that the components of the Subcarrier Interface module are frequency dependent. Should your requirements for subcarrier frequencies change in the future, some changes in component values may be required. The component values for various bands of subcarrier frequencies are detailed in Section 4, Subcarrier Interface module.

2.7.4 Mixed Communications

If the system is ordered with mixed communications functions (i.e.,Telco In/Subcarrier Out, or Telco Out/Subcarrier In), the connection procedure is similar to that outlined for the previous methods of communications link interconnection. The subcarrier function (either in or out, as appropriate) is a BNC connector, while the telephone circuit is a terminal block connection.

2.7.5 System Adjustment

After the units are connected, setup the data link(s), measure the output and input levels, and adjust, if necessary, as described in Section 3, Volume 1. Making these adjustments, taking into consideration actual operating conditions, will greatly improve communications reliability.

2.7.6 Audible Alarm

Control of the audible alarm of both the Control and Remote Terminals is provided by pins 5 and 6 of J1 on the CPU Interface module (right-most module viewed from rear of chassis).

Several alternatives are available to the user. The simplest is to jumper pins 5 and 6 on the connector. In this case, the audible alarm will always be activated when an alarm condition is detected. In the event that the terminal is located in a studio booth, it is possible to have external control of the audible alarm so that it will be muted when a microphone is active. Figure 2-8 indicates a typical arrangement of muting the alarm when microphones are active.

The relay contact (supplied by user) is assumed to be open when any microphone is active and closed when two microphones are active. The signal labeled "To External Indicator" may be used to operate a user-supplied indicator for an alarm indication.

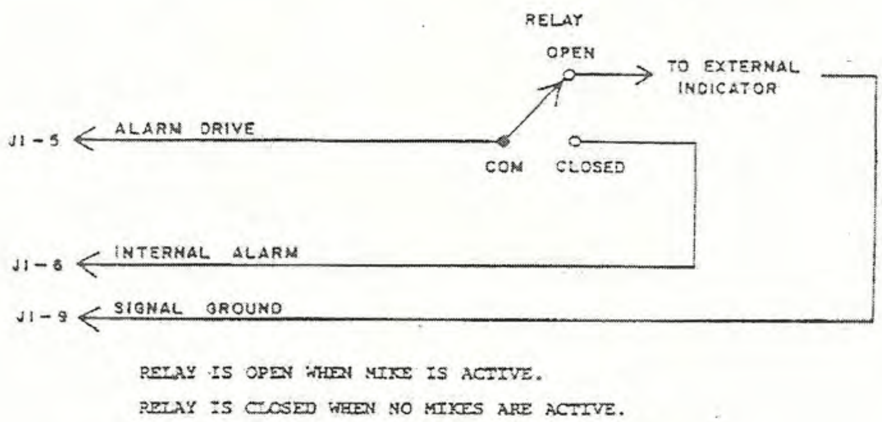


Figure 2-8
Audible Alarm Connections

2.8 Control Failsafe

The control failsafe output is controlled by a relay capable of switching a load of up to 24 Vdc at currents of up to 1 ampere. During normal operation the relay will close a connection between pins 3 and 4 of the rear connector on the CPU Interface module. When MRC-2 power is removed or a control failsafe condition occurs, the relay will open. Figure 2-9 illustrates a typical application of the failsafe output.

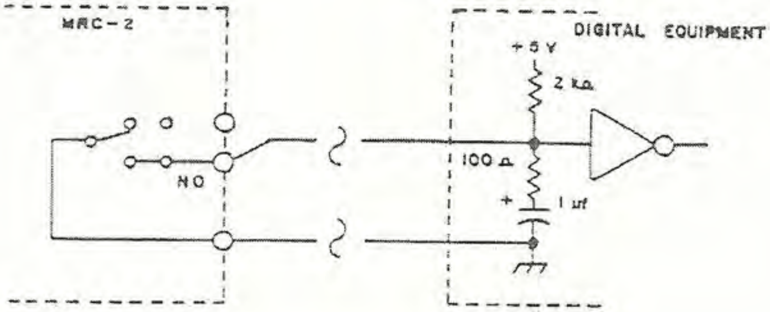


Figure 2-9
Typical Failsafe Output

Inductive loads (relay coils, etc) should have a "clamping" diode wired across them to inhibit negative voltage spikes. External relays should be used when it is desired to switch to greater loads or ac loads, which should have a series RC network (100 ohms, 1 uF) across them.

These relays may also be interfaced with transistor-transistor logic (TTL) digital circuits. The relay contacts should be wired so that one side is referenced to the digital common (ground), and the other relay contact to the digital input. A pull-up resistor may be necessary, and it is advisable to wire a 1 uF capacitor and 100 ohm resistor (in series) across the relay output to suppress contact bounce. For further details, refer to Section 4, CPU Interface module.

2.9 Telemetry Failsafe

This paragraph applies only to those systems which have the telemetry failsafe option installed. The six independent telemetry failsafe circuits are controlled by relays capable of switching loads of up to 24 Vdc and 1 A. During normal operation, the relays are energized. When MRC-2 power is removed or a telemetry failsafe condition occurs, the relays will relax. For output connections, see Table 2-6 and Section 4, Delay Control module. For applications details see Section 2.9, Control Failsafe.

2.10 Maintenance Override

An external indicator is provided in the form of a relay to provide remote indication that the Remote Terminal has been placed in the maintenance override mode of operation. This indication is normally used to illuminate a light near the exit of the transmitter room to warn the operator the Remote Terminal has been left in the maintenance override mode. When in the maintenance override mode, no commands are accepted by the Remote Terminal from the Control Terminal; hence you may save yourself a trip to the transmitter site by getting into the habit of removing the Remote Terminal from the maintenance override mode before you leave. There is no way to exercise this function from the Control Terminal. You may use a relay or TTL logic for indirect control of the lamp, in which case the wiring illustrated for the failsafe output can be followed (Figure 2-9), except that terminals 1 and 2 of JI are used. A small lamp (no more than 24 Vdc and 1 A) may be driven directly, as illustrated in Figure 2-10.

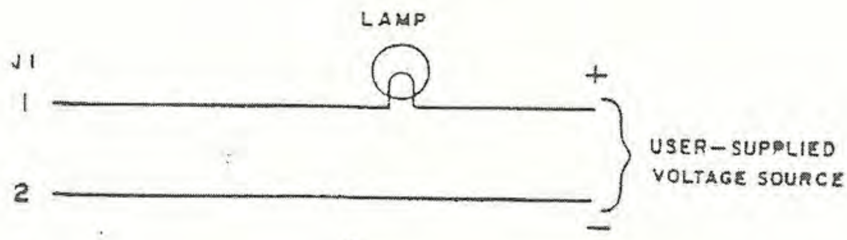


Figure 2-10
Typical Maintenance Override Connection

2.11 Input/Output Connector

The connectors for telemetry (analog), status, and commands may now be wired. A definite wiring pattern has been established for the Analog Input, TTL Status Input, Opto Status Input, Open Collector Command Output, and the Optical Isolated Command Output modules through both the Filtered Interface and Diode-Filtered Interface modules. The most positive voltages of the 16 inputs or outputs are wired consecutively from pins 1 through 16. The negative (or ground return) input or output is wired consecutively from pins 20 through 35 (see Table 2-4 for a summary of input and output connections). This allows twisted pairs to be used as connections to the modules to reduce external field noise pickup and, at the same time, allows a simple pattern to the connection with the two leads at a slight diagonal on the connector. Proper grounding and shielding techniques should be followed throughout. We highly recommend that all interface wiring be done with shielded, twisted pairs. The shield should be connected at one end of the cable only, preferably at the signal source.

External loads if run from dc must have a damping diode across them (e.g., dc relay coil). Connect the diode so that it normally will not conduct. External loads, if ac, must have a series RC network across them. (Values of 1 uf and 100 ohms are suggested.)

For those applications requiring control of high-voltage or ac power, a relay-isolated command output option is available. The connection from the relay panel to a command output module through an interface module has been prewired and only requires that it be plugged in. An optional barrier-strip interface panel is available so that no leads need to be soldered to connectors; all connections may be made to terminal strips.

Changing technology sometimes requires redesign of some of the modules in the MRC-2 system. One case in particular is the Analog Input module. Some older systems have the Analog Input II, while the newer systems are shipped with the Analog Input III. The current software shipped with the MRC-2 only supports the Analog Input III board.

2.12 Installation Completion

This completes installation of the Terminals. Power may now be applied to each Terminal. You will observe the three green power indicator LEDs illuminate on the internally-mounted CPU module. After a short period, the red Reset LED on the CPU module will go out. After a short delay (less than 10 seconds), the Output and Input LEDs on the Modem module should begin to flicker, indicating that data is being sent and received. The modems are factory adjusted for +0.0 dBm output level and a -16.0 dBm receive level. Should the actual levels of your system be radically different, some adjustment of the send and receive levels may be required. Refer to Section 5 for Modem adjustments.

At this point, you may enter command sequences at the keyboard to calibrate telemetry (analog) channels, observe and setup status channels, and setup command outputs.

For your convenience, Tables 2-3, 2-4, and 2-5 are provided to help you record the manner in which you have set up the Remote Terminal. You may reproduce these forms as required for your purposes.

When completed, the tables will provide the user a guide for future reference as to how the Remote Terminal was setup. Most column headings are directly related to the setup functions outlined in Section 3, Volume 1. In Table 2-3, the column labeled "Mode" is for the mode of calibration; e.g., linear (L), power (p), or indirect (I), etc.

Table 2-3. Command Worksheet

COMMAND				ACTIVATED BY	
OUTPUT LINE	DESCRIPTION/FUNCTION	MODE (M, P, L)	PULSE WIDTH	TELEMETRY CHANNELS	STATUS CHANNELS

Table 2-4. Status Worksheet

STATUS		ATTRIBUTES			ALARMS		EVENTS		MUTING	COMMAND	
CHAN	DESCRIPTION	INVERT Y/N	FLASH Y/N	LATCH Y/N	RISING Y/N	FALLING Y/N	RISING Y/N	FALLING Y/N	CHAN	RAISE CHAN	LOWER CHAN

Table 2-5. Telemetry Worksheet

TELEMETRY		CALIBRATION			RED LIMITS		YELLOW LIMITS		ALRM		STAT	EVENTS			COMMAND	
CHAN	DESCRIPTION	MODE	NOMINAL VALUE	MODE	UPPER	LOWER	UPPER	LOWER	RED Y/N	YEL Y/N	MUTE CHAN	RED Y/N	YEL Y/N	END Y/N	RAISE CHAN	LOWER CHAN

Table 2-6. Input and Output Connections

P1	BSP-1 Terminal Connection	Status Input	Analog or Command Output	Delay Control	Parallel Input
	TB1 - 1	..............................Chassis..............................			
1	2	1+	1+	Spare	D15
20	3	1-	1-	1 NC	G15
2	4	2+	2+	1 A	D14
21	5	2-	2-	1 NO	G14
3	6	3+	3+	Spare	D13
22	7	3-	3-	2 NC	G13
4	8	4+	4+	2 A	D12
23	9	4-	4-	2 NO	G12
	10	..............................Chassis..............................			
	TB2 -1	..............................Chassis..............................			
5	2	5+	5+	Spare	D11
24	3	5-	5-	3 NC	G11
6	4	6+	6+	3 A	D10
25	5	6-	6-	3 NO	G10
7	6	7+	7+	Spare	D9
26	7	7-	7-	4 NC	G9
8	8	8+	8+	4 A	D8
27	9	8-	8-	4 NO	G8
	10	..............................Chassis..............................			
	TB3 -1	..............................Chassis..............................			
9	2	9+	9+	Spare	D7
28	3	9-	9-	5 NC	G7
10	4	10+	10+	5 A	D6
29	5	10-	10-	5 NO	G6
11	6	11+	11+	Spare	D5
30	7	11-	11-	6 NC	G5
12	8	12+	12+	6 A	D4
31	9	12-	12-	6 NO	G4
	10	..............................Chassis..............................			
	TB4 -1	..............................Chassis..............................			
13	2	13+	13+	Spare	D3
32	3	13-	13-	Spare	G3
14	4	14+	14+	Spare	D2
33	5	14-	14-	Spare	G2
15	6	15+	15+	Spare	D1
34	7	15-	15-	Spare	G1
16	8	16+	16+	Spare	D0
35	9	16-	16-	Spare	G0
	10	..............................Chassis..............................			
	TB5 -1	..............................Chassis..............................			
17	2	Spare	Spare	Spare	C1
36	3	Spare	Spare	Spare	GND
18	4	Spare	Spare	Spare	C2
37	5	Spare	Spare	Spare	GND
19	6	Spare	Spare	Spare	GND
	7	..............................Chassis..............................			
	9	..............................Chassis..............................			
	10	..............................Chassis..............................			

3

SECTION 3

OPERATING INSTRUCTIONS

3.1 Introduction

This section explains the operation of the MRC-2 Remote Control System. We suggest that the user have the Control and Remote Terminals available at your fingertips while reading this section. If this is not possible, the Terminals are shown in Figures 3-1 and 3-2. A summary of the front panel keys and their use may be found at the end of the section for quick reference.

In presenting this information, we have made a few assumptions. First, the Data Acquisition and Command Unit (DACU), if used, is connected to the Remote Terminal via the GPIB cable. Secondly, the Remote Terminal is connected to the Control Terminal via one or more serial links (modems, subcarriers, RS-232, etc.). If either of these conditions is not met, refer to the Installation Instructions (Section 2) for information on system integration and interconnections.

The basic operation of the Control Terminal is essentially the same as that of the Remote Terminal. The differences are discussed in Section 3.10. Until specified otherwise, the following explanations apply to the Remote Terminal only.

The use of the front panel falls into two modes. The first is the OPERATIONS mode, which involves day-to-day observation of parameters and issuing commands. The second is the SETUP mode, which usually involves procedures that are done only occasionally.

3.1.1 Front Panel

The front panel is divided into four sections. The display consists of two rows of 24 characters. The six LEDs show system status. The LEDs are: red **ALARM**, yellow **SET-UP** and **MAINT**, green **LIMITS**, **RAISE/ON**, and **LOWER/OFF**.

The numeric keypad (blue keys) is set up like a calculator keypad. It is used for numeric entries, 0-9, decimal point (.) and minus sign (-).

The function keypad (the square one) is used for all modes of operation. For a quick reference of the front panel keys and their use refer to Section 3.12.

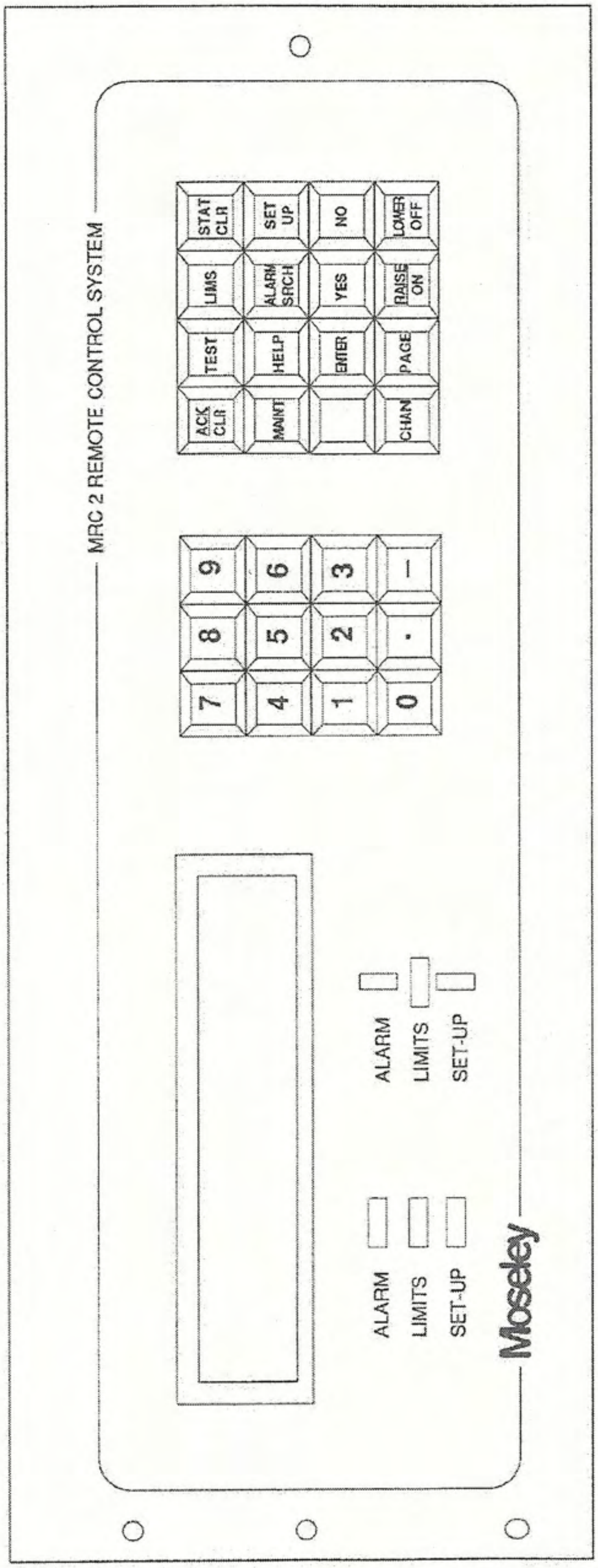


Figure 3-1
MRC-2 Control Terminal

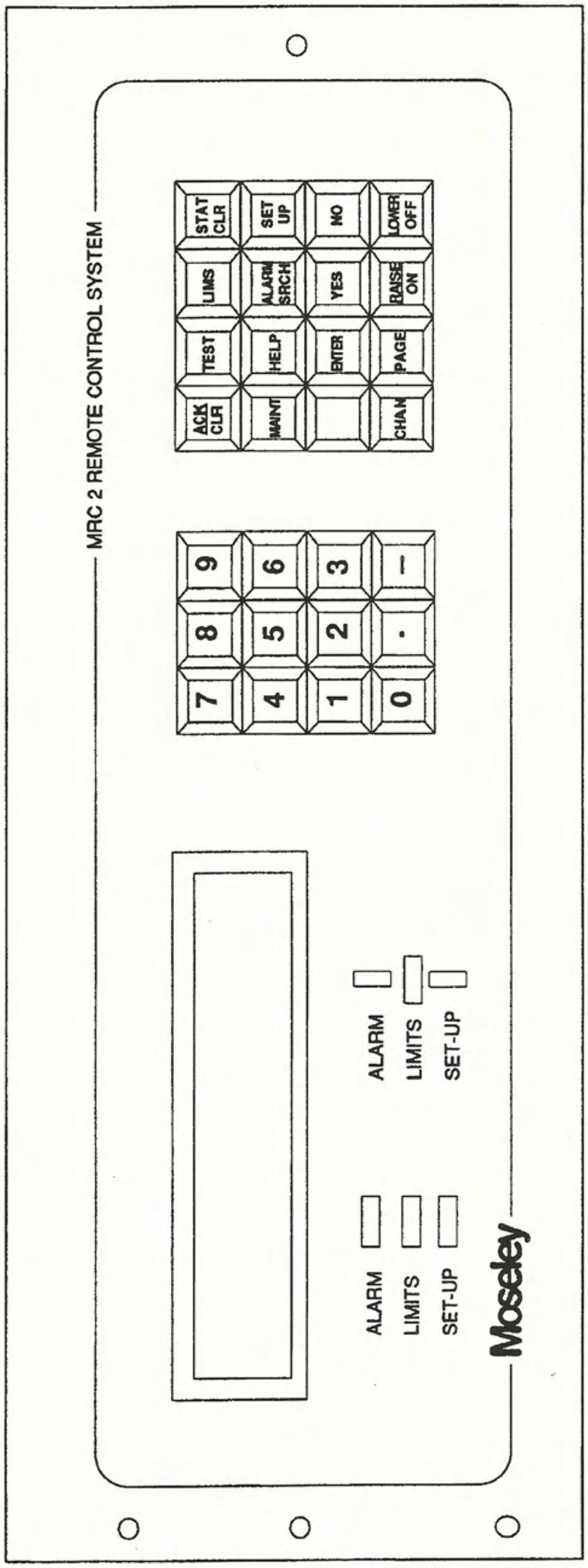


Figure 3-2
MRC-2 Remote Terminal

3.2 OPERATIONS Mode

3.2.1 Power-Up Display

(Note: The front panel key entries are designated in capital letters. TEST. Numeric entries are designated with Xs: XX.XX.)

Apply power to the Remote Terminal and DACU(s). (If power is already on, press the **RESET** switch on the front of the CPU module. After initialization, the display shows **SITE 1** (see figure below). The site shown is selected via the configuration switches on the rear of the front panel (see Section 2, Installation Instructions). The bottom line shows the version number and date of the firmware.

```
SITE 0

RT.OXB 05/02/88
```

3.2.2 OPERATION Mode Function Keys

CHAN (Channel)

Each Remote Terminal supports up to 304 telemetry channels, numbered 1 through 304, and 256 each of command and status channels, numbered 1 through 256. The telemetry channels are divided by type: channels 1 through 256 are analog inputs; channels 257 through 272 are parallel inputs; channels 273 through 304 are calculated channels. A channel may be advanced by one by pressing **CHAN** key. To go back one channel, press **-CHAN**. Any specific channel can be selected by selecting a number **XXX**, and then pressing **CHAN** key (e.g. **321, CHAN**). Entries will "wrap around" if an invalid channel is selected.

ACK/CLR (Clear)

Notice that as you enter a number, the number entered appears to the right of the channel number (see figure below). To clear a numeric entry, press the **ACK/CLR** key. This key is also used to acknowledge alarms, explained later in this section.

```
SITE 1 CHANNEL 1   321

      TELEM.=  6.38 V
                              PAGE
```

A page is the information presented in the display at any one time.

In the example above, the second line of the display, you will see the phrase **TELEM.=**, followed by a value. If the value is "?", then the channel may not have been calibrated (refer to Section 3.5.1, Calibration) or is nonexistent or untrustworthy (no A/D module is currently accessible for that channel).

TELEM is an abbreviation for analog telemetry. Since the voltages or currents measured with the MRC-2 are samples of transmitter parameters, they are analogs of the actual parameters. Telemetry, of course, refers to the transmission of information from one location to another. However, in this manual telemetry refers to analog telemetry.

Digital status and command channels are displayed on separate pages. To look at status information, press **PAGE**. The top line of the display remains the same as a telemetry page (see figure below). The bottom line contains the phrase **STATUS=**, followed by the status indication, either on or off. Note that the channel key also works on status pages as well as telemetry pages. The highest channel number in this case is 256. To return to a telemetry page, press **PAGE** twice or **-PAGE**.

```
SITE 1  CHANNEL 1

STATUS= OFF
```

Again, a "?" indicates that data has never been received for a channel or no status input module is currently accessible for that channel.

The **CHAN** key is actually used to select a new channel within the current page type. Thus, when viewing a status page, **CHAN** will change to another status channel.

<u>TEST</u>

To test the segments of the front panel and the system status LEDs, press the **TEST** key. All segments and LEDs will remain illuminated as long as the key is depressed. The **TEST** key also verifies that the system program is running normally and updates static displays such as telemetry failsafe countdown.

3.2.3 Other Keys

The five other operation function keys include the **LIMS** key which enables or disables limit checking and mutes all alarms on the front panel. The **STAT CLR** key clears any latched status channels at the selected site. Maintenance Override is enabled or disabled using the **MAINT** key. On the Control Terminal **TAKE CTRL** allows control from the front panel. Commands are issued using **RAISE/ON** and **LOWER/OFF** keys. These five keys will be discussed later in detail.

3.2.4 LEDs

The system status LEDs are discussed here to complete the basic Operation subsection. The red **ALARM** LED indicates an unacknowledged alarm in the system. The green **LIMITS** LED indicates limits are enabled. The yellow **SET-UP** LED indicates setup mode. The yellow **MAINT.** LED indicates maintenance override mode. The green **RAISE/ON** and **LOWER/OFF** LEDs are tally-back indicators for commands. Further discussion of all LEDs will be presented later.

3.3 SETUP Mode

The SETUP mode involves procedures that are only done occasionally: telemetry channel calibration, limit setting, setting of status attributes, etc.

The SETUP mode, like the OPERATIONS mode, is divided into pages. Think of a page as a window which allows you to look at a small portion of the available data. Each page has one or more fields. A field is the place to enter a value or an answer to a question. A flashing cursor indicates which field is selected.

3.3.1 SETUP Mode Function Keys

The SETUP mode is selected by pressing **SET UP**. The yellow **SET-UP** LED is on when you are in the SETUP mode. To advance a page, press **PAGE**. To go back to the previous page, press **- PAGE**. To view set-up information for a different channel, use **CHAN**. Every entry into a field, whether numeric or yes/no, must be followed by pressing the **ENTER** key. Pressing **ENTER** without a preceding value advances to the next field or page.

3.4 Command Set-Up

We recommend that you set up all your command channels prior to performing telemetry or status set-up for ease of understanding and use. Table 2-3 has been proved to record your command set-up parameters.

Select the command page by pressing **PAGE** repeatedly in OPERATIONS mode. When you enter SETUP mode the following is displayed:

```
CH 1 PULSE WIDTH =      0

MODE = 0 LATCHED
```

There are four options available:

0 LATCHED

1 MOMENTARY

2 PULSED

3 UNDEFINED

Pressing **HELP** will also sequentially display these choices.

<u>Latched Mode</u>

Pressing **0, ENTER** from the command mode set-up page will select the latched command mode, and advance the cursor to the next field. This mode is the default mode for command lines.

CH 1 PULSE WIDTH = 0

MODE = 0 LATCHED

In this mode, there is only a single command output line assigned to a displayed channel. This mode is appropriate for devices controlled by a single line that remains ON or OFF to hold that device in one of two states. Upon return to the OPERATIONS mode, pressing the **RAISE** key will activate the selected command output line, and pressing the **LOWER** key will deactivate the command line. For example, suppose we set up command line 5 as a latched command. Then, when we press the **RAISE** key, command line 5 will go ON. When we press the **LOWER** key, command line will go OFF.

In the Latched command mode, you may ignore the pulse width field since it has no meaning.

Momentary Mode

Pressing **1, ENTER** from the command mode set-up page will select the momentary command mode (see figure below), and advance the cursor to the next field.

CH 1 PULSE WIDTH = 0

MODE = 1 MOMENTARY

Momentary commands are often used in pairs; for example, in making power adjustments. Upon return to the OPERATIONS mode, pressing the **RAISE** or **LOWER** key will activate the command output line that was selected. The command output line will remain active as long as the **RAISE** or **LOWER** key is depressed.

In the Momentary command mode, you may ignore the pulse width field since it has no meaning.

Pulsed Mode

Pressing **2, ENTER** from the command mode set-up page will select the pulsed command mode (see figure below), and advance the cursor to the next field.

CH 1 PULSE WIDTH = 0

MODE = 0 PULSED

The pulsed command mode differs from the momentary command mode in only one respect. In the pulsed mode, the selected command output line is active only for the length of time that is entered on this page. The first field selects the pulse width. The pulse width is tenths-of-seconds (ticks) and is entered by pressing **XXX, ENTER**. Any pulse width between .1 and 6.0 seconds may be chosen. Entering a number greater than 60 will result in a pulse width of 6.0 seconds. Entering 0 for pulse width disables the pulsed command.

Caution: A pulse of 6 seconds is a very, very long pulse. (Try it, but make sure the command output line is not connected to anything. Most transmitter functions that pulsed commands are likely to be used with will require very short pulses.) So, be very careful in choosing pulse widths.

Each time the RAISE or LOWER key is pressed, only one pulse will occur.l If we want another pulse, we must press the **RAISE** or **LOWER** key again. All new raise and lower commands will be ignored during the period a pulsed command line is active.

<u>NONE Mode</u>

The NONE mode is used to disable a particular command output line. When a command line is in this mode, the command state always indicates "OFF". If a telemetry or status channel is mapped to a disable command line, the **RAISE** (or **LOWER**) key will have no effect and there will be no tallyback on the **RAISE** (or **LOWER**) LED.

To advance to the next field, press **ENTER** without pressing a numeric or yes/no entry. To go back to the previous field, press **- ENTER**. An entry on the last field of a page will also advance the page.

The **HELP** key may be used on certain fields which have a list of options. Each time the **HELP** key is pressed, the next item in the list is presented. When you arrive at the wanted item on the list, simply press the **ENTER** key; the item is entered, and without you having to type the number of your selection, the cursor advances to the next field.

When you wish to return to the OPERATIONS mode from the SETUP mode, press **SET UP**. The remainder of the set-up information is presented in three parts: command, telemetry, and status set-up.

<u>3.5 Telemetry (Analog) Set-Up</u>

The following paragraphs describe the telemetry set-up for the Remote Terminal.

3.5.1 Calibration

Select telemetry page, channel 1. Press the **SET UP** key. The first telemetry set-up page, which only has one field, selects the calibration mode to be performed on the telemetry input voltage (see figure below).

```
CH 1 TELEM CALIBRATION

MODE= 0 UNCAL
```

You can select the following modes for telemetry channels 1-256 and parallel input channesl 257-272.

0	UNCAL
1	MVOLT (Millivolt)
2	LINEAR
3	POWER
4	-UNDEF (Undefined)
5	-UNDEF
6	-UNDEF
7	RAW

For derived channels 273-304, you can select the following modes:

0	UNCAL
1	PRDUCT (Product)
2	RATIO
3	-UNDEF (Undefined)
4	-UNDEF
5	-UNDEF
6	-UNDEF
7	RAW

Pressing **HELP** will also display these options.

The default calibration mode is UNCAL.

Table 3-1. Telemetry Unit Selection

0	NONE	no units
1	mV	millivolts
2	V	Volts
3	kV	kilovolts
4	mA	milliamperes
5	A	ampere
6	mW	milliwatt
7	W	watt
8	kW	kilowatt
9	%	percent
10	Hz	hertz
11	kHz	kilohertz
12	MHz	megahertz
13	/1	ratio
14	DEG	degrees
15	C	Celsius
16	'F	degrees Fahrenheit
17	dB	Decibel
18	IRE	IRE units
19	G/M	gallons/minute
20	G/H	gallons/hour
21	"HG	inches of mercury
22	NS	nanoseconds

The default units are "NONE".

UNCAL Mode

Pressing **0, ENTER** will select the UNCAL (Uncalibrated) mode and advance the cursor to the next page. The calibration mode that previously existed on the channel displayed is removed (see figure below).

```
CH 1  UNCAL
NONE              UNIT 0
```

To select units (refer to Table 3-1) press the **ENTER** key to move to the units field. Press **XX, ENTER** to select the desired units. Or you can use the **HELP** key to select your units. When you find the appropriate selection, press the **ENTER** key.

This procedure can be used for telemetry channels 1-256, parallel input channels 257-272, and derived channels 273-304 (see figure below).

```
CH 273 PRDUCT=    0.
A = 1 B = 1 UNIT 0 NONE
```

MVOLT Mode

(Note: The MVOLT, mode of operation is valid only for telemetry channels 1-256 and parallel input channels 257-272, and is meaningful only for telemetry channels 1-256.)

Pressing **1, ENTER** from the first telemetry set-up page will select the Millivolt calibration mode, and advance the cursor to the next page (see figure below). In this mode, the analog sample is read directly as millivolts. The decimal point may be set by entering "dummy" digits with the desired decimal position. The numeric value is ignored. For example, by entering 0.000 you can display values in volts. Units may be selected now as described above in the UNCAL mode. Upon return to the OPERATIONS mode, the value displayed will be calibrated in millivolts, regardless of which units have been selected and will be displayed.

```
CH 1  MVOLT = 0.
          UNIT 0 NONE
```

LINEAR Mode

(Note: The LINEAR mode of operation is valid only for telemetry channels 1-256 and parallel input channels 257-272.)

Pressing **2, ENTER** from the first telemetry set-up page will select the LINEAR calibration mode (y=mx+b) calibration mode and advance the cursor to the next page (see figure below).

```
CH 1  LINEAR= 0.

ZERO=NO          RST=NO
```

In this mode an optional offset is added to the analog sample and then a scale factor is appplied to the analog sample before displaying. The scale factor and offset is calculated in the Remote Terminal by these equations:

Scale Factor = Value Entered/Analog Sample (at the time the value was entered.)

If offset is used:

Scale Factor = Value Entered/[Analog Sample 2 (at the time the value was entered.)- Offset)]

Offset=Analog Sample 1 (at the time the offset is calculated)

To calibrate an offset, ensure that your sample is at the point you want 0 to be displayed, then press **YES, ENTER** in the **ZERO** field. For example, calibrate the offset when the azimuth of an antenna is pointing to 0 degrees. To remove an offset press **YES, ENTER** in the **RST** field. If you do not want to use an offset, simply press **PAGE** to advance to scale factor calibration.

The next page allows calibration of the scale factor and units.

```
CH 1  LINEAR= 0.

          UNIT 0 NONE
```

To calibrate the scale factor, ensure your sample is turned on and enter the value you wish to appear in the display, - **XXX.X ENTER.** (Note that the value entered may be positive or negative and the decimal may be placed in any position.) Continuing our example above, calibrate the scale factor when the azimuth of the antenna is, say, 120 degrees. Another use for the LINEAR mode (usually without offset) would be for reading plate voltage on a transmitter. If the meter on the transmitter reads 9.8, then 9.8 on the front panel.

Units now can be selected as described above under UNCAL.

Upon return to the OPERATIONS mode, the value displayed is determined by this equation:

Value Displayed= Scale Factor x Analog Sample + Offset

In our examples, the value displayed will track the azimuth of the antenna or the plate voltage on the transmitter. The selected units will be displayed next to the value.

POWER Mode

(Note: The POWER mode of operation is valid only for telemetry channels 1-256 and parallel input channels 257-272.)

Pressing **3, ENTER** from the first telemetry set-up page will select the **POWER** calibration mode, and advance the cursor to
the next page (see figure below).

CH 1 POWER= 0
UNIT 0 NONE

In this mode, the analog input is squared and a scale factor applied before displaying. The scale factor is calculated in the Remote Terminal by this equation:

Scale Factor = Value Entered/[Analog Sample]^2 (at time the value was entered.)

To use this mode, enter the value you wish to appear in the display, **- XX.XX ENTER**. (Note that the value entered may be positive or negative, and the decimal may be placed in any position.)

A typical use for the **POWER** mode would be reading TV transmitter visual power from a reflectometer. If the meter on the transmitter reads 98%, then enter 98.0 on the front panel. Units may be selected now as described above under UNCAL mode. Upon return to the OPERATIONS mode, the value displayed is determined by this equation:

Value Displayed = Scale Factor x [Analog Sample]^2

In our example, the value displayed will track the visual power from the TV transmitter. The selected units will be displayed next to the value.

PRDUCT Mode

(Note: The PRODUCT mode of operation is valid only for derived channels 273-304.)

Pressing **1, ENTER** from the first telemetry set-up page will select the **PRODUCT** calibration mode, and advance the cursor to the next page (see figure below).

```
CH 1 PRDUCT =     0.
A= 0  B= 0  UNIT 0 NONE
```

In this mode, two analog samples are multiplied together and a scale factor is applied to arrive at a displayed value. The scale factor is calculated in the Remote Terminal by this equation:

> Scale Factor = Value Entered/[Analog Sample A x Analog Sample B] (both the time the value was entered.)

To use this mode, enter channel A (the first of two): **XXX, ENTER**. Next enter channel B (the second of two): **XXX, ENTER**. Next enter the value you wish to appear in the display: **-X.XXX, ENTER**. (Note that the value entered may be positive or negative, and the decimal may be placed in any position.)

A typical use for the **PRODUCT** mode is determining FM power amplifier output. Channel A analog input would sample the output voltage. Channel B telemetry input would sample the output current. If the power output has been calculated to be 100%, then enter 100.0 on the front panel. Units now may be selected as described above under UNCAL. Upon return to the OPERATIONS mode the value displayed is determined by the equation:

> Value Displayed = Scale Factor x Analog Sample B x Analog Sample A

In our example, the value displayed will track the FM power amplifier output. The selected units wi1l be displayed next to the value.

RATIO Mode

(Note: The RATIO mode of operation is valid only for derived channels 273-304.)

Pressing **2, ENTER** from the first telemetry set-up page will select the Ratio calibration mode, and advance the cursor to
the next page (see figure below).

```
CH 1 RATIO  =      0.
A= 0 B= 0   UNIT 0 NONE
```

In this mode one analog sample is divided by another analog sample and a scale factor is applied to arrive at a displayed value. The scale factor is calculated in the Remote Terminal by this equation:

> Scale Factor = Value Entered/[Analog Sample A/Analog Sample B] (both at the time the value was entered.)

To use this mode, enter channel number A (the dividend): **XXX, ENTER**. Now enter channel number B (the divisor, or reference): **XXX, ENTER.** Next enter the value you wish to appear in the display: **-XXXX. ENTER**. (Note that the value entered may be positive or negative, and the decimal may be placed in any position.)

Caution: Very small voltages on telemetry input B should be avoided, since they produce very small numbers. Dividing any number by a very small number results in a very large number, and this may cause an overflow error display (this will not harm the system).

A typical use for the **RATIO** mode is determining current ratios for AM directional antenna arrays. Channel A telemetry input would sample the current of the antenna to be calculated. Channel B telemetry input would sample the current of the reference antenna. If the current ratio is 1.1, then enter 1.10 on the front panel. Units may be selected now as described above under UNCAL. Upon return to the OPERATIONS mode, the value displayed is determined by this equation:

Value Displayed = Scale Factor x [Analog Sample A - Analog Sample B]

In our example, the value displayed will track the AM current ratio. The selected units will be displayed next to the value.

RAW Mode

(Note: The RAW mode of operation is valid for all channels. It is meaningful only for parallel input channels 257-272.)

Pressing **7, ENTER** from the first telemetry set-up page will select the RAW calibration mode and advance the cursor to the next page (see Figure below).

CH 257	**RAW=0.**
	UNIT 0 NONE

In this mode, the raw A/D counts or parallel input values are displayed. To use this mode, enter a dummy value which has the decimal in the appropriate place.

A typical use for this mode is for a frequency counter with BCD outputs which are fed into a parallel input board.

General Comments

Some general comments on telemetry calibration are now in order. It is good practice to calibrate telemetry inputs with as large as possible a value applied to the input. It is better to apply 4 volts and calibrate than to apply 1 volt and calibrate. This is because analog-to-digital converters return an integer number, proportional to the level applied. So lower levels cause a number with fewer significant digits to be returned. The calculations for calibration therefore have a larger percentage error at low values. Take care, however, to ensure that no telemetry input sample will rise above 5 V.

For this reason, we advise that calibration not be made with less than about 25O millivolts applied to the telemetry input. This insures an acceptable level of accuracy (better, and normally much better, than 0.5%).

When entering values, consider carefully the number of significant digits entered. In general, the greater the number of significant digits, the great the resolution. For example, entering "5" as a calibration factor has a resolution of 20%, because a 1-digit change yields a "4" or "6". Entering "5.00", on the other hand, results in a resolution of 1%, since a 1-digit change yields "4.99" or "5.01". By the same reasoning, the amount of "jitter" is reduced also. Sometimes too much jitter results when using all five significant digits. This is due usually to a fluctuating input sample.

(Note: When five significant digits are used, their range is limited to -32767 to +32766.)

3.5.2 Limit Reset Band

This value, entered as a percentage of the limit (see figure below), specifies the amount of hysteresis employed in determining when a limit has been reset. Zero yields no hysteresis. A small percentage will help avoid nuisance alarms when a signal is hovering very near a limit.

To set the limit reset band, enter a value between 0 and 50; then press the **XX ENTER** key.

CH 1 LIMIT RESET BAND
0%

For example, suppose we have set an upper red limit of 100., and a reset band of 2%. When the telemetry displayed value reaches 100., an alarm will occur. In order for another alarm for the same limit to occur, the telemetry value must first drop below 98. (100. - 2%. X 100.). If it only goes down to 99. and then back over 100., a second alarm will not be generated.

3.5.3 Red and Yellow Limits

Each telemetry channel may be assigned two sets of limits. The upper and lower limits closest to the normal value are called yellow limits. The upper and lower limits farthest from the normal value are called red limits. If limit checking is enabled, and the calibrated telemetry channel violates one of the limits, that channel is said to be out of tolerance. In the OPERATIONS mode, the tolerance flags are found immediately following the value. The tolerance flags are:

>>	exceeding upper red limit
>	exceeding upper yellow limit
<	exceeding lower yellow limit
<<	exceeding lower red limit.

We can now proceed to set up these limits. The Red Limits set-up page (see figure below) can be reached after entering the Telemetry set-up mode by pushing the **PAGE** key three times, or entering the limit reset band.

```
CH 1 RED LIMITS

HI= 0000.    LO= 0000.
```

To set the upper red limit, press **- XX.XX, ENTER** (the number may be positive or negative). If an asterisk "*" appears after the limit, that means the combination of limits and reset band and current value does not make sense. This is usually due to too large of a reset band or limits which are too far from the nominal value. (Be sure to pay attention to decimal point positions.)

If you are satisfied with the value displayed, press **ENTER**. This advances us to the lower red limit, which can be set in the same manner.

After setting a lower red limit, the upper red limit field is selected so you can check both limits to your satisfaction before continuing. When you have both limits set where you want them, press **ENTER** twice, or **PAGE**. Not resetting the lower red limit advances the cursor to the next page (see figure below) and the upper yellow limit field. Set the yellow limits just like you did for the red limits. To remove a limit, press **0, ENTER**. To set a limit of exactly zero, press **0.0, ENTER**.

```
CH 1  YELLOW LIMITS

HI= 0000.    LO= 0000.
```

3.5.4 Alarms, Events and Muting

There are two types of alarm indications: operator alarms (alarms, for short), and events. Operator alarms are for-warded to: (1) the Control and Remote Terminal front panels, (2) all CRTs, and (3) all Loggers. Events are forwarded to Loggers only.

The forwarding of alarm indications is controlled by set up from the front panel. Operator alarms can be triggered by any of the following:

1. Exceeding a telemetry upper red limit
2. Exceeding a telemetry upper yellow limit
3. Exceeding a telemetry lower yellow limit
4. Exceeding a telemetry lower red limit
5. Experiencing a status rising edge
6. Experiencing a status falling edge.

Events can be triggered by any of the above, or

7. Returning within a telemetry limit.

An alarm indication occurs only when all of the following our conditions are met:

1. One of the triggers listed above occurs.
2. That specific channel is enabled in the SETUP mode.
3. Limit checking is enabled in the OPERATIONS mode.
4. That specific channel is not muted.

The effects of alarms on the front panel are discussed later. The effects of alarms on a CRT or Logger are discussed in Section 9, CRT Option. We can now proceed to set up alarm indication enabling.

The telemetry operator alarm set-up page (see figure below) can be reached after entering the telemetry set-up mode by pressing the **PAGE** key five times. This page is auto-matically selected after not resetting a lower yellow limit.

CH 1 TELEM. ALARMS
RED=YES YEL=YES MUTE= 0

To enable or disable operator alarms on a red limit, press **YES** or **NO** and then **ENTER**. Enabling or disabling operator alarms on a yellow limit is entered in the same manner, and advances the cursor to the next field, mute channel number.

The mute function is used to enable and disable limit checking on the individual telemetry channels, under the control of a status input.

Subsequently, limit checking will be controlled by the selected status channel. For example, suppose we set up telemetry channel 17 to be muted on status channel 12. Whenever status channel 12 is off (after inverting and/or latching, if specified (see Section 3.6, Status Set-up) limit checking on telemetry channel 17 will be disabled. When status channel 12 goes on again (after inverting and/or latching), limit checking will be enabled after a short delay (the delay provides time for muted parameters to settle).

The status channel can be selected by pressing **XXX, ENTER.** A mute condition can be removed by pressing **0, ENTER.** In OPERATIONS mode, a muted value appears in brackets, e.g. [1.234].

(Note: It is possible to assign more than one telemetry channel to a single status input for muting purposes.)

All of the telemetry channels for the main transmitter can be assigned to one status input that indicates the main transmitter is operational, and all telemetry channels for a backup transmitter can be assigned to a second status channel that indicates the backup transmitter is operational. Telemetry channel alarms will then only occur when the corresponding transmitter is operational.

Status channels which are used for muting purposes should be given alarm attributes so that if a transmitter failure occurs, at least one alarm condition is presented to the operator. Muting conditions also can affect other status channels and telemetry failsafe countdowns, as noted later.

The telemetry event set-up page (see example below) is used to enable or disable events on exceeding a red limit, exceeding a yellow limit, and/or returning within a limit. Entering these conditions is also accomplished by pressing **YES** or **NO** and then **ENTER.**

```
CH 1 TELEM. EVENTS

RED=NO  YEL=NO END=NO
```

3.5.5 Telemetry Commands

The MRC-2 may activate up to 255 command output lines. To be activated, each command output must first be associated with a channel. This process is called "mapping". As an added item of flexibility, the MRC-2 allows telemetry and status channels to be mapped to different command outputs.

The telemetry command channel set-up page (see example below) may be selected after entering the telemetry SETUP mode by pressing the **PAGE** key seven times. This page is automatically selected after entering an event-on-return-within-limit attribute.

CH 1 TELEM. COMMANDS
RAISE= 0 LOWER= 0

Select the RAISE command line by pressing **XXX, ENTER**. Pressing **0, ENTER** will unmap the command line from the displayed channel. Selecting a command line which does not exist has the same effect as unmapping the command line. Select the LOWER command line by pressing **XXX, ENTER**.

For latched command lines, select the same command line for both RAISE and LOWER. Upon return to the OPERATIONS mode, pressing the **RAISE** key will activate the selected command output line, and pressing the **LOWER** key will deactivate the command line. For example, suppose we set up command line 5 as a latched command on telemetry channel 2. Then, when we press the **RAISE** key, command line 5 will go ON. When we press the **LOWER** key, command line will go OFF.

Command outputs may be assigned to more than one channel. This is particularly advantageous when a single Control function - say a final amplifier controller - affects several measured parameters: plate voltage, plate current, and measured power output. If these parameters are assigned to telemetry channels 6, 7, and 8 respectively, and momentary or pulsed command output line 4 connected to cause the power controller to increase, with command output line 5 causing a decrease, then you can assign command output lines 4 and 5 to each of the telemetry channels 6, 7, and 8. Then, regardless of which of the three channels is selected for display of the telemetry value, activating the RAISE or LOWER keys will cause the power controller to function appropriately.

A command likewise may be multiply assigned to status channels. Continuing the example above, command output lines 4 and 5 could also be assigned to status channels 1, 29, 84, and 137. (Note that the channels need not be consecutive, or need not be the same telemetry and status channels.)

For momentary command lines, a different command line is usually used for the RAISE and LOWER fields. Upon return to the OPERATIONS mode, pressing the **RAISE** key will activate the raise-command output line that was selected. Similarly, pressing the **LOWER** key will activate the lower-command output line that was selected. The command output line will remain active as long as the appropriate **RAISE** or **LOWER** key is depressed. For example, suppose we set up command lines 2 and 10 as Raise and Lower on telemetry channel 25. Then, when we select telemetry channel 25 and press the **RAISE** key, command output line 2 will be active as long as the **RAISE** key, command output line 2 will be active as long as the **RAISE** key is depressed, and command output line 10 will be active as long as the **LOWER** key is depressed.

For pulsed command lines, again a different command line is usually used for the RAISE and LOWER fields. Upon return to the OPERATIONS mode, pressing the **RAISE** key will activate the raise-command output line for the number of ticks selected. Likewise, pressing the **LOWER** key will activate the lower command output line for the number of ticks selected.

Each time the **RAISE** or **LOWER** key is pressed, only one pulse will occur. For example, suppose we set-up a pulse width of 32 ticks, and command lines 7 and 3 as raise and lower on the telemetry channel 4. Then, when we select telemetry channel 4 and press the **RAISE** key, command output line 7 will be active for 3.2 seconds. If we press the **LOWER** key, command output line 3 will be active for 3.2 seconds. If we want another 3.2 second pulse, we must press the **RAISE** or **LOWER** key again. All new raise and lower commands will be ignored during the period a pulsed command line is active.

3.6 Status Set-Up

The methods used for status set-up are the same as for telemetry set-up. The following paragraphs will describe additional commands for status set-up.

3.6.1 Status Attributes

Select status page, channel 1. Press the **SET UP** key. The first status set-up page allows us to set the status attributes of invert, latch and flash (see figure below).

```
CH 1 STATUS INVERT=NO

LATCH=NO  FLASH=NO
```

The invert attribute reverses the interpretation of a raw status input. This attribute may be changed by pressing **YES** or **NO** and then **ENTER**. The cursor will be advanced to the next field. Upon return to the OPERATIONS mode, the displayed status will be inverted. That is, a status channel that used to read OFF will now read ON, and vice-versa.

The latch attribute (short for latch-until-status-clear) causes the displayed status channel to remain in the "ON" condition after rising edge is detected. Subsequent edges are disregarded. When a latched channel is "ON", it indicates only the occurrence of a rising edge. It does not reflect the input condition (high or low) of that status channel. The "status clear" function returns all latched status channels to the "OFF" state until the next rising edge. This attribute may be changed by pressing **YES** or **NO** and then **ENTER**.

(Note: The latch function is applied after the invert function. This attribute can be used to "catch" short pulses, or pulses that occur while nobody is looking at any part of the MRC-2. Pulses shorter than 200 ms will not necessarily be caught.)

The flash attribute (short for latch-until-transmit) causes the displayed status channel to remain in the "ON" condition, after a rising edge is detected; until the "ON" condition is transmitted from the DACU to some device (e.g., front panel <u>or</u> CRT) for display. All interim edges are ignored. After the data transmission and the next falling edge is detected, the status channel returns to the "OFF" condition. The attribute may be changed by pressing **YES** or **NO** and then **ENTER**.

(Note: The flash function is applied <u>after</u> the invert function. This attribute can be used to "catch" pulses that have a duty cycle shorter than CT display time. It will <u>not</u> reliably catch pulses shorter than about 200 ms. If multiple display devices are tracking the same channel, the "stretched" pulse will not necessarily appear on all of them.)

Alarms and muting are invoked on the basis of the status value as modified by the invert and latch functions, so care must be taken when using these attributes, or the results may not be as you expect.

3.6.2 Status Alarms and Events

The status operator alarm set-up page (see figure below) can be reached after entering the status set-up mode by pressing the **PAGE** key.

CH 1 STATUS ALARMS
RISING=NO FALLING=NO

This page is automatically selected after setting the status-flash attribute. To enable or disable operator alarms on a rising or falling edge, press **YES** or **NO** and then **ENTER** in the appropriate field. Upon occurrence of a rising or falling edge while in the OPERATIONS mode, a status alarm enables the MRC-2 audible alarm until the alarm is acknowledged. In addition, an asterisk "*" appears next to the status indication on all displays and stays there until the sample on that channel status input returns to normal.

(Note: When using TTL status modules, a rising edge refers to a contact closure across the status inputs, or a contact opening if that status channel is programmed for inversion.)

The status events set-up page (see figure below) can be reached after entering the status set-up mode and pressing the **PAGE** key twice.

CH 1 STATUS EVENTS
RISING=NO FALLING=NO

This page is automatically selected after setting the operator-alarm-on-falling-edge attribute. To enable or disable events on a rising or falling edge, press **YES** or **NO** and then **ENTER** in the appropriate field. Upon return to the OPERATION mode, a rising or falling edge will alert the Logger option.

Please see Section 3.5.4, Alarms, Events, and Muting for a discussion of alarms.

3.6.3 Status Muting

A status channel may be muted in the same manner as telemetry channels. See Section 3.5.4, Muting for further discussion.

The status muting set-up page (see figure below) can be reached after entering the status set-up mode and pressing the **PAGE** key thrice.

```
CH 1 STATUS MUTING

CHAN=  0
```

This page is automatically selected after setting the event-on-falling-edge attribute. To select the muting channel, press **XXX, ENTER.** A mute condition can be removed by pressing **0, ENTER.** In OPERATIONS mode, a muted value appears in brackets, e.g. [ON].

3.6.4 Status Commands

The status command mode set-up page (see figure below) can be reached after entering the status set-up mode by pressing the **PAGE** key four times.

```
CH  1 STATUS COMMAND

RAISE =  0  LOWER = 0
```

This page is automatically selected after entering status mute channel. The remainder of the discussion on status commands is the same as Section 3.5.5, Telemetry Commands.

This concludes the status set-up parameters.

3.7 Remote Terminal Site Set-Up

System set-up parameters pertain to the site as a whole rather than individual channels. These parameters are found on Channel "0", which is selected by pressing **0, CHAN.**

3.7.1 Control Failsafe and Security Code

The control failsafe set-up page (see example below) is used to set up the control failsafe warning time, the control failsafe timeout, the time from alarm to dial, and the security code. This page may be accessed by selecting **0, CHAN** and pressing **SET UP.**

```
CFSW= 120  CFS= 180

DIAL=  60  SECUR=    0
```

Each of the time-related parameters is measured in seconds, and has a range from 0 to 9998, in 2-second increments (odd numbers will be rounded to the next-lower even number). To enter each value, press **XXXX, ENTER.**

In the example above, the Control Failsafe Warning Alarm (CFSW) will occur 2 minutes (120 seconds) after failure of the communications circuits from the "MASTER" Control Terminal, and the Control Failsafe Alarm (CFS) will occur 3 minutes (180 seconds) after failure of the communications circuits from the "MASTER" Control Terminal. The CFSW must be less than the CFS or unpredictable results can occur.

The time from alarm to dial (DIAL) in the example above is 1 minute (60 seconds) from an alarm being generated at the Remote Terminal until the RT begins to dial a Control Terminal. The DIAL parameter is only applicable if you are using dial-up "AT" modems.

The last field on this page is the Security Code (SECUR) for the Remote Terminal. Its range is 0 to 9999. To enter the value, press **XXXX, ENTER**. When the security code is 0, the Remote Terminal is in permissive mode and any Control Terminal may gain access to the RT. If it is anything other than 0, then only Control Terminals with the correct security code for that site will be allowed access. The SECUR parameter is only applicable if you are using dial-up "AT" modems.

3.7.2 Dial-Up Modem Telephone Numbers

The dial-up modem telephone numbers page is used to set the telephone numbers of the Control Terminal that the Remote Terminals will dial upon alarms. This page may be reached by selecting **0, CHAN**, pressing **SET UP**, and then **PAGE**. The following display is shown:

```
COM n

DIAL=P
```

where n has a range of 0 to 7, one for each modem board. To enter a phone number, press the digits of the phone number, followed by **ENTER**. If you wish to put a pause between two digits, press the "." (period); this will result in a 3-second pause. (This is sometimes necessary for long-distance dialing.) Pauses are displayed on the front panel as commas. To toggle between Tone (DTMF) and Pulse dialing, press "-" (minus). To remove a digit, press **ACK/CLR**. For example, T1,8059689621 will use tone dialing, dial 1, wait 3 seconds, and then dial the remainder of the number.

To select the next communications link, press **PAGE**. Remember that, while setting telephone numbers, CT A must be connected to modems 0 and 1, CT B to modems 2 and 3, CT C to modems 4 and 5, and CT D to modems 6 and 7 in order for multiple Control Terminals to work properly.

These pages are only applicable for dial-up "AT" modems.

3.7.3 Communication Link

The communication link set-up page (see example below) is use to set some of the software parameters use for modem control. This page can be reached by selecting **0 CHAN**, pressing **PAGE**, then **SET UP**.

```
COM n DU= 0 PAD=  3, 2

TXI=  3 TXR=  2 RMAX= 83
```

In the above example, n is the modem number from 0 thru 7. The parameters are as follows:

Parameter and Function		Suggested Values
DU	Dial-Up/Hard-Wire	0=Hard-wire 1=Dial-Up
PAD	Starting and Ending Message Pad	3,2 for 2-wire HW links 1,0 for 4-wire HW or DU links
TXI	Initial TX Timeout	3 for Moseley Internal Modems
TXR	Remainder TX Timeout	2 for Moseley Internal Modems
RMAX	Total Rx Message Length	83 for 1200 baud

To enter each field press **XXX, ENTER**. TXI, TXR, and RMAX are measured in tenths of seconds. The TXI parameter is essentially a control to allow differing RTS to CTS modem delays. For example, this may be adjusted for a longer period to use half-duplex (2-wire) radio links. In general, a slight improvement in performance will result by using 4-wire configurations.

Each communications link (modem) may be selected by pressing **PAGE**.

Caution: If you change the communications link setup from normal to dialup, or vice-versa, you must reset the terminal so that all hardware will be properly initialized.

Table 3-2. Remote Terminal Serial Board Assignment

RT Serial Board #	Control Terminal #
0	CT A, MAIN
1	CT A, ALT
2	CT B, MAIN
3	CT B, ALT
4	CT C, MAIN
5	CT C, ALT
6	CT D, MAIN
7	CT D, ALT

3.7.4 Telemetry Failsafe

If you have the telemetry failsafe option installed, you can select the first set-up page (see example below) by selecting **0, CHAN,** then pressing **PAGE** twice, and the **SET UP**.

```
TELEM F.S. 1  MUTE= 0

A= 0 B= 0 C= 0 D= 0
```

To enter the failsafe monitoring channel (A-D) press **XXX ENTER.** You can monitor up to four telemetry channels for each of six failsafe outputs. (Traditionally these have been aural plate voltage, aural plate current, aural power output and visual power output.) When any one of these parameters vanishes (falls below about .25V) for 180 minutes (3 hours), the failsafe output (on the Delay Control board) is relaxed.

If the status mute channel is specified, and that status channel is Off, the failsafe is ended. To select the status mute channel, press **XXX, ENTER.**

If the maintenance override mode is entered, failsafe is also ended.

To select each of the six failsafe set-up pages, press **PAGE** successively.

3.7.5 System Configuration

The system configuration pages are used when you add or delete boards from the RT or DACUs and when you wish to review the configuration of the RT and DACUs. These pages can be reached by selecting **0, CHAN**, pressing **PAGE** thrice, and pressing **SET UP**.

The first page shows which DACUs the Remote Terminal thinks it is connected to:

```
DACUS UP 1 2 3 4 5 6 7 8
         Y N ------
```

In the example above, the RT is currently communicating with DACU 1. It also has at one time, but is not now communicating with DACU 2. It has never communicated with DACUs 3 thru 8. If an "N" appears, you should check the connections to that DACU. (Checking the operation of the boards may also be necessary.)

The second page (press **PAGE**) shows in which DACUs exist analog, status, or command boards which are addressed the same.

```
DACUS W/ 1 2 3 4 5 6 7 8
ADR OLAP Y -------
```

In the example above, the DACU 1 has a board which has the same board address as one in the RT. (All boards of the same type at a given site must have a unique board address.)

The third page (press **PAGE**) shows in which terminal each command board resides:

```
CMD BDS 0011 ------------
SAVED: 00001111 --------
```

In the example above, command boards 0 and 1 (given by their position in the list on the top line, 0-15) reside in the RT and command boards 2 and 3 reside in DACU 1. The bottom line shows what configuration is saved in file memory. In this case, command boards 0-3 in the RT and command boards 4-7 in DACU 1. (More on SAVED later.)

The fourth page (press **PAGE**) shows in which terminal each status board resides:

```
STS BDS 0011 ------------
SAVED:  0011 ------------
```

The fifth page (press **PAGE**) shows in which terminal each analog board resides:

```
ANA BDS 0011 ------------
SAVED:  0011 ------------
```

The sixth page (press **PAGE**) shows in which terminal each parallel input board resides:

```
PAR BDS 1 ---------------
SAVED:  1 ---------------
```

The seventh and last page (press **PAGE**) shows whether a Delay Control board exists. It also allows you to reconfigure the system and save the configuration in file memory:

```
DLY BRD 1 RECONFIG=NO
SAVED:  1   SAVE=NO
```

To reconfigure the system after adding or deleting boards, press **YES, ENTER** in the RECONFIG field. This completely re-checks the configuration of the RT and of all DACUs in communication at the time. To save the results in (non-volatile) file memory, press **YES, ENTER** in the SAVE field.

3.7.6 MSD-1 Option Set-Up

The MSD-1 set-up page (see figure below) can be accessed by pressing **SET UP** while viewing the "MSD SETUP" legend in CT or RT system-wide page sequences. If the MSD-1 Option is installed at a Control Terminal and set-ups are password protected, key in the proper password and press the **ENTER** key. To exit the MSD-1 set-up page press the **SET UP** key again.

```
MSD= 0  BANK=0  SITE=1
STATUS BOARD=0
```

The MSD-1 set-up assigns MRC-2 site-and- status-board numbers. There are 16 status channel inputs per status board, so the specification of one status board completely determines the state of one bank of MSD-1 LEDs .

3.7.6.1 MSD-1 Set-Up Fields

MSD

This field selects the MSD-1 board number set in the MSD-1 chassis. Since there is a maximum of 18 MSD-1s, the value can be set from 0-7. Enter the desired board number using the numeric keypad; correct any input errors with the **ACK/CLR** key. Press the **ENTER** key when the desired board number is displayed.

BANK

This field selects which row of 16 LEDs is to be referenced on the selected MSD-1 chassis. Pressing the **0** key, selects the upper bank, 1 selects the lower bank. Press the **ENTER** key when the desired bank number is displayed.

SITE

This field chooses the MRC-2 site from which data is requested. Enter the site number to be monitored. To de-assign the current MSD-1 board/bank combination, enter **0**. De-assigned board/bank combinations display zero for their site number. Press the **ENTER** key when the desired site number is displayed.

STATUS BOARD

This field selects which status board in the MRC-2 at the specified site is to be displayed on the MSD-1. Status boards are numbered from 0-15. Enter the desired status board number and press the **ENTER** key to return to the MSD= field.

3.7.7 MDC-2 Option Set-Up

The MDC-2 set-up page (see figure below) can be accessed by by pressing **SET UP** while viewing the "MDC SETUP" legend in either CT or RT system-wide page sequences. If the option is installed at a Control Terminal and set-ups are password protected, key in the proper password and press the **ENTER** key. To exit the set-up page, press the **SET UP** key again.

```
MDC= 0  SW= 0  SITE = 1

COMMAND LINE=  1  R/L=1
```

The MDC-2 set-up assigns 16 momentary push-buttons to specific MRC-2 site numbers, control line numbers, and control actions. In effect, once the association has been made, pressing a button activates (or deactivates) a specific command line. For example, say MDC-2 chassis 2, switch 5 is assigned MRC-2 site 1 command line 21 action 1 (RAISE). This means that when the fifth button on the MDC-2 chassis with its board number set to 2 is pressed, command line 21 at site 1 will activate, and the tallyback LED on switch 5 reflects this activation.

3.7.7.1 MDC-2 Set-Up Fields

<u>MDC</u>

This field selects the MDC-2 board number set in the MDC-2 chassis itself. Since there is a maximum of 8 MDC-2s, the value can be from 0-7. Enter the desired board number using the numeric keypad; correct any input errors using the **ACK/CLR** key. When the desired board number is displayed, press the **ENTER** key.

<u>SW</u>

This field selects the switch number on the specified MDC-2 chassis. Switch numbers range from 0-15, with 0 being the far left switch, and 15 being the far right switch. When the desired switch number is displayed, press **ENTER**.

<u>SITE</u>

The **SITE** field selects the MRC-2 site to which the command request will go. Any number from 1-64 may be selected. Entering site **0** de-assigns the current switch number. De-assigned switches display zero for their site. When the desired site number is displayed, hit the **ENTER** key.

<u>COMMAND LINE</u>

This field indicates the command output line to which the command request is destined. Valid command lines range from 1-256. Press **ENTER** when the desired command line is displayed, or if the current button number is being de-assigned.

<u>RAISE/LOWER</u>

The R/L or Raise/Lower field indicates the action the command line will undergo upon a command request. For a pulsed or momentary command line, either Raise (1), or Lower (0) may be selected since both of them will activate the specified command line. When dealing with a latching command line, the raise and lower attributes take on different meanings: Setting the Raise (1) attribute activates the line; setting the Lower (0) attribute de-activates the line. Enter the desired command action and press the **ENTER** key to return to the MDC field.

3.7.8 RT Dial-Up Worksheet "A" - Instructions

1. Make a copy of RT Dial-Up Worksheet "A" for each RT (see Figure 3-6).

2. Enter the site number in the upper right-hand corner.

3. Enter any dial-up details particular to this RT, such as modem and Telco line information.

4. Enter the BOARD ASSIGNMENT for each board into the boxes provided. Use HW for hard-wire, DU for dial-up, or leave blank if that board will not be used.

5. For each DU (dial-up) board, make a note of the telephone number that will dial the modem connected to the board. Refer back to these numbers when filling out CT Dial-Up Worksheet "B".

6. For each board with the dial-up (DU) assignment, enter a "T" for tone dialing, or a "P" for pulse dialing into the first box of the LINK ASSIGNMENT. In the remaining 18 boxes, enter the "phone # to CT modem" from the CT Dial-Up Worksheet "A" for the CT of this RT. Enter a period whenever a three second delay is needed before the next digit is dialed. If longer delays are required, more than one period can be used consecutively.

7. Enter the security code for the RT into the appropriate boxes. If a number from 1 to 9999 is used, the RT will expect each CT that communicates with it to be set up with this security code. If the RT is set up with security code 0000, it will respond to any CT, no matter which security code is set up at the CT.

Figures 3-3 and 3-4, at the end of Section 3, summarize the SETUP modes for the Remote and Terminal and the Control Terminal.

3.8 Additional Operations

3.8.1 Status Clear

The **STAT CLR** key is used to clear any status channels that are latched on (see Section 3.6.1, Status Attributes).

This key operates in a momentary mode; each push clears any latched status channels.

3.8.2 Limits Enable

The **LIMS** key is used to enable and disable alarm limit checking on telemetry and status channels (see Section 3.5.4, Alarms, Events and Muting). This key operates in a push-on/push-off mode. The first push enables limits, and the second push disables limits and clears outstanding alarms. The green limits LED turns on when limits are enabled.

3.8.3 Acknowledge Alarms

When an operator alarm (see Sections 3.5.4 and 3.6.2, Alarms and Events) or a system alarm (see below) occurs, the red ALARM LED flashes and the audible alarm sounds if enabled. Pressing **ACK/CLR** automatically selects the channel and page of the alarm. If it was a telemetry alarm, the selected telemetry page will show an asterisk (*) preceding the value and one of these four limit flags:

>> (upper red limit)

> (upper yellow limit)

< (lower yellow limit)

<< (lower red limit)

If it was a status alarm, the selected status page will show an asterisk "*" preceding the status condition if the condition has persisted. If it was a system alarm, channel 0 will be selected and the appropriate message displayed.

A system alarm can be one of the following:

1. SYSTEM CONFIGURATION -- The Remote Terminal senses that one or more of the boards installed does not agree with what is saved in file memory. See Section 3.7.5.

2. CONTROL FAILSAFE WARNING -- Communications has failed with the "Master" Control Terminal. See Section 3.7.1.

3. CONTROL FAILSAFE -- Communications has failed with the "Master" Control Terminal and the output relay has relaxed. See Section 3.7.1.

4. TELEMETRY FAILSAFE COUNTDOWN HAS BEGUN (1 MIN.) -- One or more of the telemetry failsafe monitoring channels has dropped below approximately .25V. See Section 3.7.4.

5. TELEMETRY FAILSAFE (180 MIN.) -- One or more of the output relays has relaxed. See Section 3.7.4.

6. CONTROL REQUEST -- A Control Terminal has requested to be "Master". See Section 3.10.9.

Acknowledging a system alarm will take you to the appropriate channel "0" page.

3.8.4 Alarm Search

The **ALARM SRCH** (Alarm Search) function is used to scan the system for acknowledged alarms where the alarm-causing condition has persisted. Successive pushes of **ALARM SRCH** cause successive acknowledged alarms to be displayed by selecting the site and channel numbers where the alarm occurred. For status alarms, the alarm-causing condition is considered to persist until the channel experiences its next edge after the alarm-causing edge. For example, suppose a status channel is given a falling edge attribute, and then experiences a falling edge (going from on to off) causing an alarm, which is then acknowledged. The status channel will continue to be selected during alarm searches until it experiences its next transition, going back to on again.

Telemetry channels will continue to be selected during alarm set-up searches as long as they violate their limits (provided, of course, that limit checking is enabled, and the channel is not in a mute condition).

3.8.5 Maintenance Override

The **MAINT** (maintenance override) key is used to establish local control at the Remote Terminal. If the system is not in maintenance override, commands from the Remote Terminal and its CRTs and MDCs are disabled. Conversely, if the system is maintenance override, commands form the Control Terminal and its CRTs and MDCs are inhibited. The MAINT key operates in a toggle mode. The first push puts the system in maintenance override and ends any failsafe condition that may exist. The next push takes the system out of maintenance override and resets all failsafe timers. The yellow MAINT LED is on when the Remote Terminal is in maintenance override.

Maintenance Override status is maintained in nonvolatile memory.

3.8.6 RAISE/ON and LOWER/OFF

The **RAISE/ON** and **LOWER/OFF** keys are used to activate commands as set up in the telemetry or status SETUP mode. The green **RAISE/ON** and **LOWER/OFF** LEDs indicate a tally-back for the commands; i.e., they indicate the actual state of the command outputs, and not just whether or not the key is depressed. To activate a command, select the channel and page of the desired command, and press **RAISE** or **LOWER**. (Remember, the status channel and the telemetry channel may not necessarily have the same command mapping.

If a momentary command has been activated, the **RAISE/ON** LED will be on when the raise command output line is on (by pressing **RAISE**), and the **LOWER/OFF** LED will be on when the lower command output line is on. If a latched command has been activated, the **RAISE/ON** LED will be on when the command output line changes state from Off to On, and the **LOWER/OFF** LED will be on when the output line changes state from On to Off.

The tally-back for pulsed commands does not show the actual duration of the pulse. The display merely acknowledges the receipt of the raise or lower command by the DACU. If the LEDs do not activate after a reasonable time, the requested command could not be performed.

This can occur if the DACU is not operational, the command line in question is not physically installed, or the individual command line has been disabled in he setup mode.

(Note: Maintenance Override must be enabled to activate commands from the Remote Terminal.)

3.8.7 Telemetry Display

If no CRT option is installed at the Remote Terminal, the display appears as follows:

```
SITE 1 CHANNEL 1

TELEM=   1.234
```

If a CRT option is installed at the Remote Terminal, <u>and</u> the particular telemetry channel has text entered on the CRT, then the following format is assumed:

```
1 1 TEXT FROM CRT.

TELEM=   1.234
```

The first number is the site and the second number is the channel.

The display following the phrase "TELEM=" can have the following meanings:

1. If the channel is not on a module that is install-ed, a "?" appears.
2. If the channel is uncalibrated, a "?" appears.

3. If the data displayed is not current, a "?" appears before the value: ?1.234

4. If the value exceeds a limit, an asterisk "*" precedes the value and the limit flag is appended to the value; for example: 1.234<<.

5. If the channel is muted, the value appears in brackets: [1.234].

6. If the channel is in an overflow condition, ">>>>" will appear in the display. An overflow condition occurs when the telemetry value for the selected channel is too large to be displayed as calibrated. For example, if telemetry channel 72 is calibrated linearly to display a value of 19000 for 2.0 V applied, and 4.0 V is then applied, the resulting value (38000) will overflow the five digits available, and ">>>>" will be displayed.

7. If more than about 5 V is applied, the selected telemetry channel may be in a saturated condition; i.e. the A/D converter is operating beyond the range where it is accurate. In this case, "-----" will be displayed.

3.8.8 Status Display

If no CRT option is installed at the Remote Terminal, the display appears as follows:

```
SITE 1 CHANNEL 1

STATUS= ON
```

If a CRT option is installed at the Remote Terminal, and the particular status channel has text entered on the CRT, then the following format is used:

```
1 1 TEXT FROM CRT.

STATUS=   TEXTOFF
```

The first number is the site and the second number is the channel.

The text following "STATUS=" on the second line can take several forms:

1. If the channel is not on a module that is installed, a "?" appears.

2. If the data displayed is not current, a "?" appears before the value: ?OFF

3. If the value experiences a rising or falling alarm, an asterisk, "*", precedes the value: *OFF

4. If the channel is muted, the value appears in brackets: [OFF]

5. If a CRT option is installed at the Remote Terminal, and the particular status channel has been given On-and-Off-Text, that text will appear as the value. (See example above.)

3.8.9 Command Display

If no CRT option is installed at the Remote Terminal, the display appears as follows:

```
SITE 2 CHANNEL 1

COMMAND=   OFF
```

If a CRT option is installed at the Remote Terminal, and the particular command channel has text entered on the CRT, then the following form is used:

```
1 1 MORE CRT TEXT

COMMAND=   RAISE
```

The first number is the site and the second number is the channel.

The text following "**COMMAND=**" takes on these forms:

1. If no CRT is installed, "ON" or "OFF" appears.
2. If a CRT option is installed at the Remote Terminal, and the particular command channel has been given On-and-Off-Text, that text will appear as the value. (See example above.)

3.8.10 Channel Zero For Remote Terminal

Channel zero operations are site-wide functions and can be accessed by selecting **0, CHAN**, and pressing **PAGE** repeatedly.

The first page shows the revision number and date of the firmware:

```
SITE 1

RT.0 06/09/88
```

This page is the gateway to control failsafe, security code, and telephone number setup. (See Sections 3.7.1 and 3.7.2.)

The second page (see figure below) shows which Control Terminal is master (see section -.-.-, Multi-Control Terminal Operations) and whether a control failsafe condition exists (see Section 3.9, Failsafe Conditions).

SITE 1 C.T. A IS MASTER
CONTROL FAILSAFE

This page is a static display. To update the screen, press **TEST**. This page is the gateway to communications link setup. (See section 3.7.3)

The third page (see figure below) shows the telemetry failsafe countdown times (see Section 3.9).

SITE 1 TELEM F.S. WAS
180 180 180 180 180 180

This page is a static display. To update the screen, press **TEST**. This page is the gateway to telemetry failsafe setup. (See section 3.7.4)

The fourth page (see figure below) shows system configuration.

SITE 1 SYS CONFIG
NORMAL

This page is the gateway to system configuration setup. (See section 3.7.5)

The fifth page (see figure below) is a gateway for MSD-1 set-up. (See section 3.7.6.)

SITE 1 MSD SETUP

The sixth page (see figure below) is a gateway for MDC-2 set-up. (See section 3.7.7.)

SITE 1 MDC SETUP

3.8.11 Erasing File Memory

There may be situations when you wish to erase file memory. To do so, perform these steps:

> ***Caution: Erasing file memory is permanent! All set-up parameters will be lost, including CRT, Logger, MSD, and MDC at that terminal.***

1. Turn off power to the Terminal.
2. Set the front panel rotary switches SW3, SW2, and SW1 to 099.
3. Turn on power to the Terminal. The display will show:

WIPE...DONE

   when the file memory has been erased.
4. Turn off power to the Terminal.
5. Set SW3 to 1 and SW2 and SW1 to the site number.
6. Turn on power to the Terminal. The display will show:

FILE BAD; HIT YES
TO CLR.

   Press **YES** to initialize file memory for MRC-2 use. (The MRC-2 will not work with insufficient or unintialized file memory)

3.8.12 Full File Memory

When the limit of file memory is reached, i.e. full, the display will report "**FILE FULL**" after any operation which requires more file memory.

3.8.13 Expanding File Memory

When you add a file memory board to a chassis, you must tell the MRC-2 software that it exists. Perform these steps:

1. Turn off power to the Terminal.
2. Set the front panel rotary switches SW3, SW2, and SW1 to 199
3. Turn on power to the Terminal. The display will show:

GROW DONE

4. Turn off power to the Terminal.

5. Set SW3 to 1 and SW2 and SW1 to the site number.

6. Turn on power to the Terminal.

3.9 Failsafe Conditions

MRC-2 Remote Terminals provide a control failsafe output. The failsafe output is activated a user-selected period after communications from the Control Terminal cease (hence, control failsafe). The failsafe output is relaxed immediately on receipt of a valid message from the Control Terminal or when maintenance override is engaged. The control failsafe output is located on the CPU Interface module. (See also section 3.7.1.)

In addition to the control failsafe output, the MRC-2 Remote Terminals optionally provide six telemetry failsafe outputs. Each output has a 3-hour countdown upon loss of one of four user-defined telemetry channels. The six outputs allow each Remote Terminal to monitor up to six separate transmitters. The six outputs are provided by the Delay Control module. (See also section 3.7.4.)

When the Maintenance Override mode is entered, all times are reset, so there is once again a user-defined wait until control failsafe and a 3-hour wait until telemetry failsafe, regardless of past conditions at the Remote Terminal. In addition, if the mute status channel becomes off, then telemetry failsafe is ended.

3.10 Control Terminal Versus Remote Terminal

3.10.1 Introduction

By comparing the front panels of the Remote and Control Terminals (see Figures 3-1 and 3-2), you can see there is very little difference in the hardware. So it is also for the operation of the Control Terminal. The following paragraphs explain the differences.

3.10.2 OPERATIONS Mode

<u>Site Selection</u>

When power is applied to the Control Terminal (or the RESET switch is pushed on the front of the CPU module), the display shows Site 00 (see example below). The site may be advanced by pressing the **SITE** key.

```
SITE 00

CT.0 08/01/90
```

To go back one site, press **-SITE**. Any site between 0 and 64 may be selected by pressing **XX, SITE**. Site 00 is reserved for system-wide functions (see Site Zero). Site 00 does not request data from any Remote Terminal (although alarm polling does continue for all enabled sites).

The second line of the display shows the revision number and date of the firmware.

Take Control

The MRC-2 software is structured so that there is only a single control point for any given Remote Terminal at any given time; i.e., only one person at a time can issue commands to a Remote Terminal. To this end, you must "take control" of a Remote Terminal before issuing a Raise or Lower. To do this, press **TAKE CTRL** (just above theSITE key).

If there is no CRT installed at the CT, the top line of a telemetry, status, or command page shows:

```
SITE 1 CONTROL 1
```

As you can see, "CHANNEL" has been replaced with "CONTROL".

If there is a CRT installed at the CT, and text from the CRT is being displayed on the front panel, an asterisk, "*", appears between the site and channel numbers on the top line of the display:

```
1*1 TEXT FROM CRT
```

Control times out (reverts to normal operation) after four seconds if a status or command channel is displayed and 20 seconds if a telemetry channel is displayed. The timer is re-started with every key press (Raise or Lower). You also can relinquish control by pressing **TAKE CTRL** again.

After front-panel control is relinquished or times out, other devices, e.g., CRT and MDC, can take control. Conversely, front-panel control may not be entered until all other devices have relinquished control (or timed out).

If you want to lock out CRT control, you can do so by selecting **0 SITE** and pressing **PAGE** four times. This display is shown:

```
CRT LOCK=NO
```

By pressing **YES ENTER**, CRT control is locked out. Pressing **NO ENTER** re-enables CRT control. This is a toggle function and does not time out, so be sure to re-enable CRT control when you are finished.

If the Remote Terminal is in maintenance override, no control can be taken at any Control Terminal device. In a multi-CT system, a Control Terminal must also be master of any RT in order to control it.

<u>Other Keys</u>

The other keys at the Control Terminal operate the same as those for the Remote Terminal. There are no MAINT or HELP functions.

3.10.3 SETUP Mode

The general procedures for the SETUP modes (as described in Sections 3.3 through 3.7) apply to the Control Terminal as well as the Remote Terminal, with the exception that the **HELP** key is not available.

In addition, a password may be required after the **SET UP** key is invoked (see figure below).

```
PASSWORD=XXXX
```

The process of changing the password is described in Section 3.10.6. To continue with set up, enter the established password: **XXXX, ENTER**. If no password is enabled, this page will be skipped.

3.10.4 Telemetry Setup

The telemetry setups available at the Control Terminal are Reset Band and Red and Yellow Limits. See Sections 3.5.3and 3.5.3.

Status and control setups are not available at the Control Terminal.

3.10.5 Site Setup

Site setup parameters are Control Terminal parameters which pertain to a particular Remote Terminal. These parameters are found on Channel "0" of a given site, which is selected by pressing **0 CHAN**.

3.10.5.1 Data Links Assignment

The Data Links Assignment Page (see below) is used to assign a Remote Terminal to one or two modems. This page may be reached by selecting **0 CHAN** and pressing **PAGE**, then **SETUP**.

```
SITE 1 DATA LINKS

A= 1 TO= 3 B= 0 TO= 3
```

"A" represents the "main" data link and "B" represents the "alternate" data link. To select a modem for a site, press **X ENTER**, where **X** is the board number for a Moseley modem, or **8** for a dialup "AT" modem (regardless of the SERIAL I/O board number). To de-assign a modem, press **9 ENTER**.

The "TO" following "A" or "B" is used to select the initial response time-out for the particular RT on this link. Its units are ticks (tenths-of-seconds). This parameter can be made longer to allow for slower responses from Remote Terminals, e.g., when using simplex radio links. The default time-out is 3.

3.10.5.2 Main Dial-up Security Code and Telephone Number

The next page is used to enter the security code and telephone number for the Remote Terminal using the main Control Terminal data link. It can be reached by selecting **0 CHAN**, then pressing **PAGE**, **SETUP**, and **PAGE 1**, or automatically after entering data on the Data Links Assignment Page:

```
SITE 1 MAIN SECUR=  0

DIAL=P
```

Enter the security code of the selected site by pressing **XXXX ENTER**. (See also section 3.7.1.) To enter the telephone number of the Remote Terminal, press the DIGITS of the phone number, followed by **ENTER**. If you wish to put a pause between two digits, press the "." (period); this will result in a 3-second pause and is displayed as a comma. (This is sometimes necessary for long-distance dialing.) To toggle between tone (DTMF) and pulse dialing, press "-" (minus). To remove a digit, press **ACK/CLR**. For example, T1,8059689621 will use tone dialing. Dial 1, wait three seconds, and then dial the remainder of the number.

This page is only used for dial-up "AT" modems.

3.10.5.3 Main Dial-up Schedule

The Dial-up Schedule Page is used to set how often and how long to dial a Remote Terminal. It can be reached by selecting **0 CHAN**, then pressing **PAGE**, **SETUP**, and **PAGE** twice, or automatically after the Main Dial-up Phone Number Page:

```
SITE 1 MAIN

SKED=bbbb,eeee,iiii,cccc
```

Pressing **ENTER** or **-ENTER** chooses which of the four fields will be changed when digits are entered.

All four of the data fields are in hhmm 24-hour format.

bbbb is the begin time of the automatic dialing sequence.
eeee is the end time of the sequence.
iiii is the interval the CT will automatically dial the RT.
cccc is the connect length of each call.

For example, if

bbbb = 1800,
eeee = 0800,
iiii = 0030, and
cccc = 0005,

the CT will automatically dial the RT between 6PM (1800) and 8AM. It will dial every 30 minutes and hang up after five minutes.

If the interval (iiii) is zero, that RT will not be dialed.

(NOTE: The interval (iiii) must be greater than or equal to the connect time (cccc).)

All initial setting times are 0000 (no automatic dialing).

This page is used only for dial-up "AT" modems.

If you are using only dial-up circuits, and you are using a logger at the Control Terminal, make sure this schedule includes the logger schedule times since the logger software does not automatically dial the Remote Terminal.

(Note: The CT dials early in hopes of having the link established by the above start time of the logger.)

3.10.5.4 Alt Dial-up Security Code and Telephone Number

This page can be reached by selecting **0 CHAN**, then pressing **PAGE**, **SETUP**, and **PAGE** thrice, or after entering the Main Dial-up Schedule:

```
SITE 1  ALT SECUR=  0

DIAL=P
```

The parameters are the same as for the main data link (see section 3.10.5.2).

3.10.5.5 Alt Dial-up Schedule

This page can be reached by selecting **0 CHAN**, then pressing **PAGE**, **SETUP**, and **PAGE** four times, or after entering the Alt Dial-up Phone Number:

```
SITE 1  ALT

SKED=bbbb,eeee,iiii,cccc
```

The parameters are the same as for the Main Data Link (see section 3.10.5.3).

3.10.5.6 CT Dial-Up Worksheet "A" - Instructions

Complete this worksheet first (see Figure 3-5).

1. Make a copy of CT Dial-Up Worksheet "A" for each CT.

2. Enter the CT name in the upper right-hand corner.

3. Enter any dial-up details particular to this CT, such as modem and Telco line information.

4. Enter the BOARD ASSIGNMENT for each board into the boxes provided. Use HW for hard-wire, DU for dial-up, or leave blank if the board will not be used.

5. For each DU (dial-up) board, make a note of the telephone number that will dial the Hayes modem connected to the board. Refer back to these numbers when filling out RT Dial-Up Worksheet.

6. Decide which SITEs will be calling the dial-up serial boards. Remember that when the CT automatically dials out to an RT, it will always select the available serial board with the lowest number. So, make sure that your RTs dial in to the CTs to the highest numbered boards (to reduce dial-up calls that result in busy signals).

   For example, if there was a CT with eight serial boards (0-7), used for dial-up, then whenever the CT dialed out, it would first check board 0. If this board was not in use, it would be used for dialing out. If it was in use, the CT would try board 1. If this board was also in use, the CT would try board 2, and so on. Board 7 would always be the least active serial board. Board 6 would be the next to least active serial board, and so on down to board 0. The higher the number of the serial board that an RT dials in to, the greater the chance that it will not be busy.

   However, connecting RTs to the same serial board of a CT would greatly increase the chance that an RT dialing up the CT with an alarm, would encounter a busy line. To get around this, have the RTs use no more than half of the CTs dial-up serial boards; the ones with the highest board numbers.

7. Enter the DIAL-UP ALARM TIME-OUT into the boxes provided. This is how long the CT will wait before hanging up on an RT that has dialed in with an alarm.

8. After completing one CT DIAL-UP WORKSHEET "A" for each CT, go on to the RT DIAL-UP WORKSHEET.

3.10.5.7 CT Dial-Up Worksheet "B" - Instructions

1. For each CT, make a copy of the CT Dial-Up Worksheet "B" (see Figure 3-7) for every RT that will communicate with the CT.

2. Enter the CT name in the upper right-hand corner.

3. Using as many of the worksheets as necessary, enter the SITE number of each RT that will communicate with the CT.

4. For Main and Alt dial-up links only:

   a. Enter "T" for tone dialing, or a "P" for pulse dialing.

   b. Enter the "Phone # to RT modem" from the RT Dial-Up Worksheet for the CT of this RT. Enter a period whenever a three second delay is needed before th next digit is dialed. If longer delays are required, more than one period can be used consecutively.

   c. Enter the start time, end time, interval, and on time of the dial-up schedule for that link.

5. Enter the security code of each site.

3.10.6 System SetUp

System set-up parameters are CT parameters which pertain to system-wide functions, and not a particular RT. These parameters are found on Site "0" of the CT, which is selected by pressing **0 SITE**.

3.10.6.1 Password

To change the password, select **0 SITE** and press **SETUP**:

```
PASSWORD

OLD=XXXX  NEW=0
```

Then enter the old password: **XXXX, ENTER.** (The factory-set master password may be used the first time the password is set up.) The new user-selected password may now be entered: **XXXX ENTER.** To disable the user-selected password, enter the 0 in the second field. Return to site zero by pressing **SET UP**. When the password is enabled, any restricted function at the CT will require the password.

3.10.6.2 Dial-Up Alarm Time-out and Time-of-Day

This page can be reached by selecting 0 SITE and pressing **PAGE**, then **SET UP**:

```
SITE 0  DU ALM TO= 0

08:00:00 HHMM=  0
```

The first field is the Dial-up Alarm Time-Out, which indicates how long a CT will remain connected to the RT after the RT calls the CT with an alarm. The range for this parameter is 0 to 99, measured in minutes. To avoid tying up a CT phone line for long periods (especially in multi-site configurations), you should set this to a small number. To enter a time-out, press **XX ENTER**.

The second field is used to set the time-of-day for dial-up schedules. The time is in 24-hour format. To enter a new time, press **HHMM, ENTER,** where HH is hours and MM in minutes. The seconds are automatically set to 0.

This page is used only for dial-up "AT" modems.

3.10.6.3 Communication Links

These pages can be reached by selecting **0 SITE**, and pressing **PAGE, SET UP,** then **PAGE.** This page follows the Time-of-Day Set-up Field:

```
COM n DU= 0 PAD= 3, 2

TXI= 3 TXR= 2 RMAX= 83
```

The Communications links setup is the same as that for the RT. See section 3.7.3.

Four-wire multi-drop RTs can be set up like 2-wire (3,2) but the CT can be (1,0) since it owns the outbound channel. That will keep the outbound carrier on at all times and minimize delays.

3.10.6.4 MSD

This page can be reached by selecting **0 SITE**, and pressing **PAGE** twice, then **SET UP**:

```
MSD= 0 BANK= 0 SITE= 0

STATUS BOARD= 0
```

The MSD setup is the same as that for the RT. See section 3.7.4.

3.10.6.5 MDC

This page can be reached by selecting **0 SITE,** and pressing **PAGE** three times, then **SET UP**:

```
MDC= 0 SW= 0 SITE= 0

COMMAND LINE= 1 R/L=0
```

The MDC setup is the same as that for the RT. See section 3.7.5.

This concludes the setup for the Control Terminal.

3.10.7 Additional Operations

Additional operations are the same as those for the **RT** except as noted below:

3.10.7.1 Acknowledge Alarms

In general, acknowledging an alarm at the CT also acknowledges that alarm at the RT, and vice-versa. This is not the case for CT-generated alarms which are described below.

In addition to the alarms mentioned in Section 3.8.3, Acknowledge Alarms, a data link error may occur at the Control Terminal. If the Control Terminal attempts to send a message to a Remote Terminal and receives no response or a garbled response, the Control Terminal makes note of this. Should the data link performance drop below 25%, a data link error alarm results. When the alarm is acknowledged, the data link performance page is selected (see "Channel ZERO"). After the alarm is acknowledged, Alarm Search will indicate the continuing presence of the problem. If, over an extended period (a few seconds), the error count returns above the factory-set tolerance, the alarm condition is cancelled.

The Control Terminal also can generate certain dial-up alarms. The first is when a CT attempts to dial a RT and fails to connect; (e.g., RT telephone is busy, or the wrong security code is used). Then "DIAL A FAIL" OR "DIAL B FAIL" will appear on a "Channel 0" page when the alarm is ackowledged. The second is if the dial-up connection is terminated by something other than the CT. In this case, "DIAL A SEVER" or "DIAL B SEVER" will appear on a "Channel 0" page when the alarm is acknowledged.

3.10.7.2 Channel Zero

Channel Zero operations are site-wide functions and can be accessed at a given site by pressing **0 CHAN**, and pressing **PAGE** repeatedly.

The first page is the "housekeeping" page. It shows whether the CT is "Master" of the particular RT. (See section 3.10.9, Multi-Control Terminal Operations). It also shows whether there is an alarm at the RT and the communications mode:

```
SITE 1  MASTER

ALARM SLOW ALT MENU
```

"SLOW" indicates the CT is in slow-poll mode; i.e., trying to make contact with the (connected) RT. "ALT" indicates the CT is using the alternate data link for that site. "Menu" indicates the CT is telling the RT what subset of data it needs for display for the various devices (front panel, CRT, MSD, and MDC). During that time, data is not being acquired.

This page is the gateway for multi-CT control requests.

The second page shows Data Links Performance:

```
SITE 2  DATA LINKS
MAIN=100%  ALT=  0%
```

This page is the gateway to Data Links Assignment and Main and ALT Dial-up Setup.

The third page allows manual dialing of the RT:

```
SITE 1 DIAL=NO
HANGUP  A=NO   B=NO
```

To manually dial a RT, press **YES ENTER** in the "DIAL" field. The CT will use the first available modem. To hang up the connection to the RT, press **YES ENTER** on the appropriate field (A=Main, B=ALT).

The fourth page shows telemetry failsafe countdown times:

```
SITE 2 TELEM F.S. WAS
180 180 180 180 180 180
```

See sections 3.7.4 and 3.9 for further discussion.

3.10.7.3 Site Zero

Site zero is reserved for system-wide functions. To go to site zero, press **0, SITE**. We recommend that the Control Terminal be left at site zero when not in use.

The first Site 0 page shows the revision number and date of the firmware:

```
SITE 0
CT.0   06/09/88
```

This page is the gateway for Password Set Up.

The second page is the gateway for Communications Line Set Up:

```
SITE 0

COMM LINE SETUP
```

The third page is the gateway for MSD Set Up:

```
SITE 0

 MSD SETUP
```

The fourth page is the gateway for MDC Set Up:

```
SITE 0

 MDC SETUP
```

The fifth and final page allows command lockout of the CRT:

```
CRT LOCK=NO
```

See section 3.10, Control Terminal Operations.

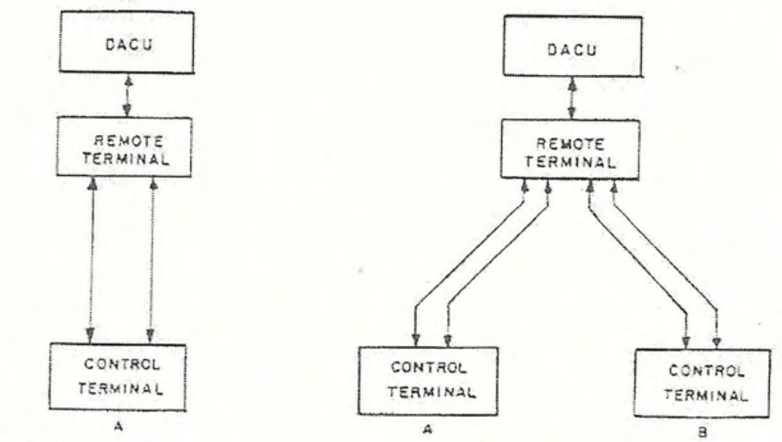
3.10.8 Failsafe Conditions

There are no control failsafe or telemetry failsafe outputs available for use at the Control Terminal.

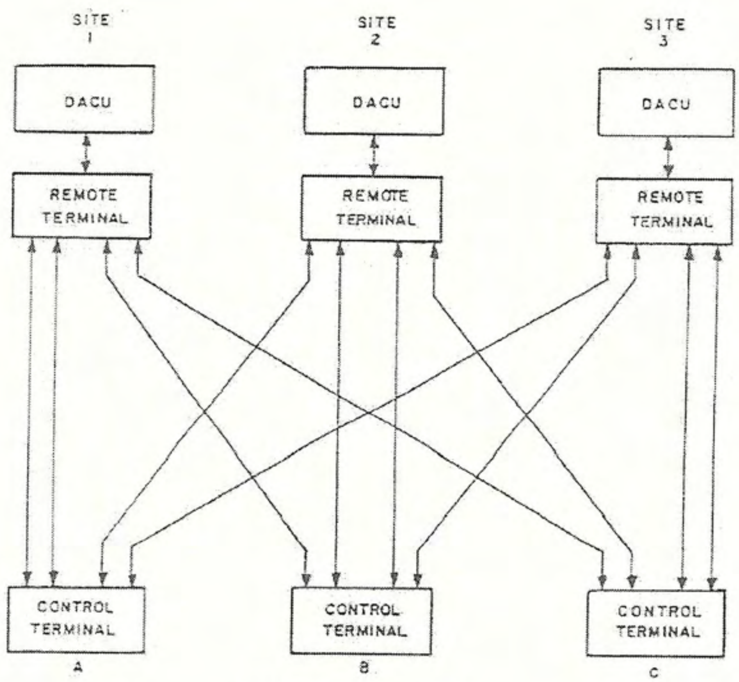
3.10.9 Multi-Control Terminal Operations

Figure 3-5 shows the interconnections for a standard single Control Terminal, a simple MCT system, and a more complex MCT system.

Figure 3-3
Examples of Interconnections Between Control Terminals and Remote Terminals



(a) STANDARD SYSTEM (b) SIMPLE MCT SYSTEM



(c) COMPLEX MCT SYSTEM

In the simple MCT system, each Control Terminal communicates independently with each Remote terminal through two data links. In the more complex MCT system, each Control Terminal talks to one Remote Terminal through two links and the other Remote terminals through a single link.

(Note: Control Terminals communicate only with Remote terminals, not with each other.)

Each Remote Terminal may have up to four Control Terminals. These are designated "A", "B", "C" and "D" in front-panel displays. A maximum of eight modem modules maybe installed in a Remote Terminal. The communications from the various Control Terminals are distinguished by the switch settings of S1 (the yellow rotary switch) on the Remote Terminal modems. Data link assignments are given in Table 3-2.

Table 3-3. Control Terminal Data Link Assignments

Switch S1 Setting on Modem In Remote Terminal	Control Terminal Data Link Assignments
0	A - Main
1	A - Alternate
2	B - Main
3	B - Alternate
4	C - Main
5	C - Alternate
6	D - Main
7	D - Alternate

Referring back to Figure 3-3, in example (a) in the modems in the Remote Terminal will be set to 0 and 1. In example (b), the modems will be set to 0, 1, 2, and 3. In example (c), the modems of each Remote terminal will be set to (from left to right): 0, 1, 2, 4; 0, 2, 3, 4; and 0, 2, 4, 5.

In the MRC-2 (stemming from traditional FCC requirements), there can be only one control point at a time for each Remote Terminal. This means that the Raise and Lower functions may be active only from one Control Terminal (the "master") at a time (Raise and Lower commands from other Control Terminals are ignored). The Status Clear function also is restricted to the control point. Operator alarms are passed only to the master Control Terminal.

There are three basic methods for transfer of control from one Control Terminal to another, as follows:

1. Automatic transfer, in which impending control failsafe triggers alarms at the other Control Terminals. If the alarm is acknowledged in time, the responding Control Terminal becomes the new master.

2. "Rude" transfer, in which Control Terminal "A" summarily seizes master status from the Control Terminal previously in charge.

3. "Polite" transfer, in which a Control Terminal not in charge can request master status from the present master. The operator at the present master can choose to grant or deny the request.

In greater depth, operation of these transfer modes is as follows:

An automatic transfer is initiated when the Remote Terminal receives no valid communications from its master for the period CFSW, determined by the user. Each remaining Control Terminal is given an alarm. If an operator acknowledges the alarm, master status is transferred (the control failsafe warning alarm message appears when ACK is pushed). A control failsafe condition results if no CT acknowledges the alarm and the period CFS (set by the user) expires. However, the alarms continue until communication is restored from the failed master or someone answers the alarm at one of the other Control Terminals. In either case, control failsafe ends. See also Section 3.7.1, Control Failsafe Set-up.

A rude transfer can be initiated by the operator at Control Terminal A. It results in an alarm at the former master. When acknowledged, a message informing the operator that master status has been lost is displayed. If the terminal making a rude request is not Control Terminal A or is already master, the request is ignored.

A polite transfer can be initiated by the operator at any Control Terminal not currently the master. An alarm sounds at the present master which, when acknowledged, informs the operator of the request. He may grant or deny the request by using the YES or NO keys on the front panel or by pressing CTRL and Y or CTRL and N simultaneously at the keyboard of the CRT.

On power-up, Control Terminal A is selected as master. Note that different Remote Terminals may have different masters and that an individual Control Terminal may be Control Terminal A for one site and B for another, if this is desired.

To make a control request for a given site, select **0 CHAN** and press **SET UP**:

```
SITE 1 CTL RQST

POLITE=NO
```

To make a polite request, press **YES ENTER**. To make a rude request (CT "A" only), press **NO ENTER**. The display will return to Channel 0 operations. If you were not already"master", then MASTER will appear shortly on the display. If you were already "master", or if you are not Control Terminal A, then the request will b ignored.

If you are Control Terminal B, C, or D and are master, and if Control Terminal A makes a rude request, then the word "MASTER" no longer appears on Channel 0.

If you are at a Control Terminal that is currently "master" and another Control Terminal makes a polite request, an alarm will occur, and the following display will appear after acknowledgement:

SITE 1 CTL RQST n
GRANT=NO

where n is A, B, C or D (the requesting CT).

Press **YES** or **NO** and then **ENTER** to grant or deny control to the requesting Control Terminal. If the alarm is ignored, a NO is assumed. However, the alarm remains in the system and may be recalled by **ALARM SRCH** until the next time the RT must decide which CT is master (e.g., another request, reset, etc.).

If the master CT grants the request, "**MASTER**" will appear at the requesting CT; otherwise, nothing changes.

Figure 3-4
Summary of SETUP Modes for the Remote Terminal

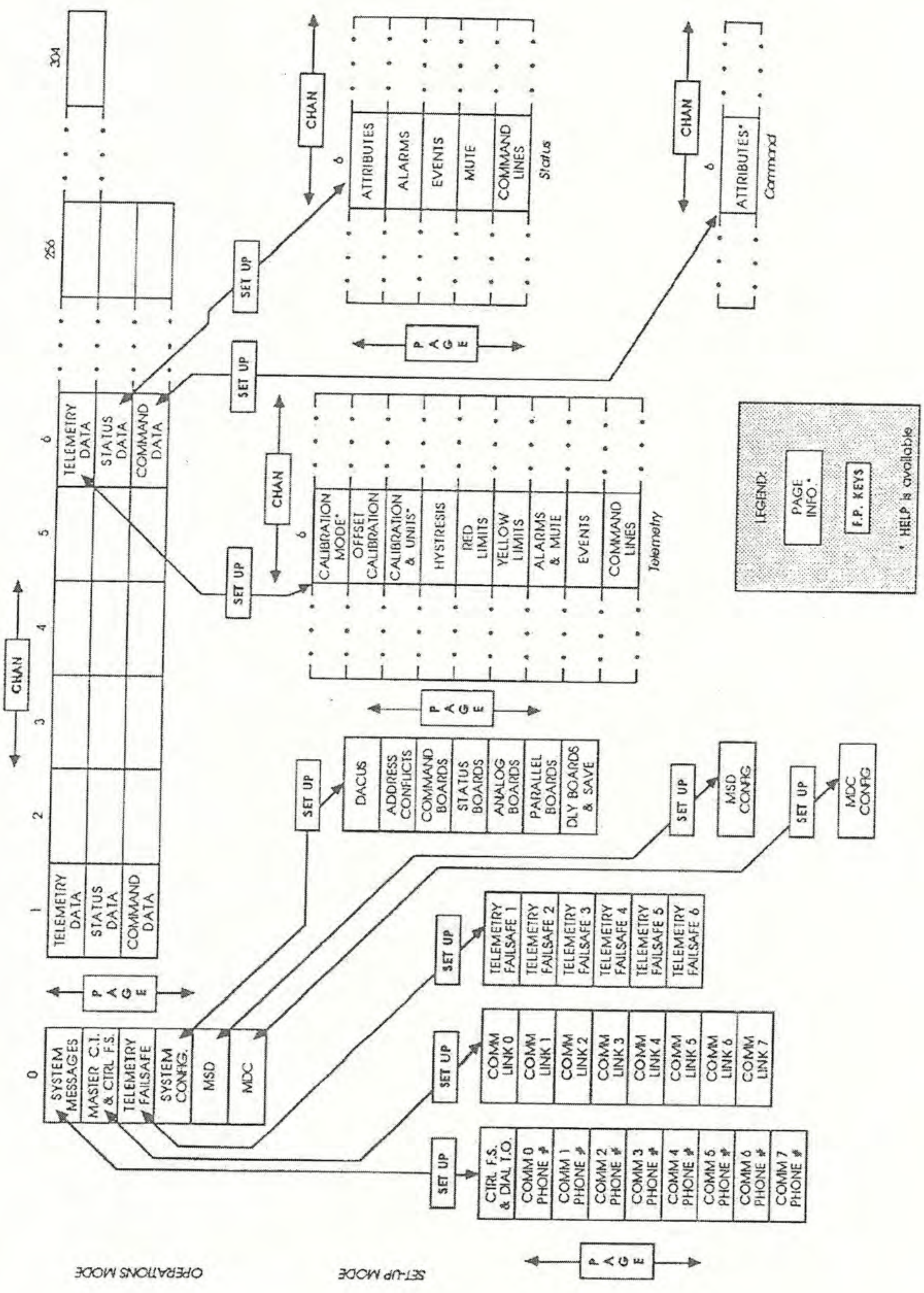


Figure 3-5
Summary of SETUP Modes for the Control Terminal

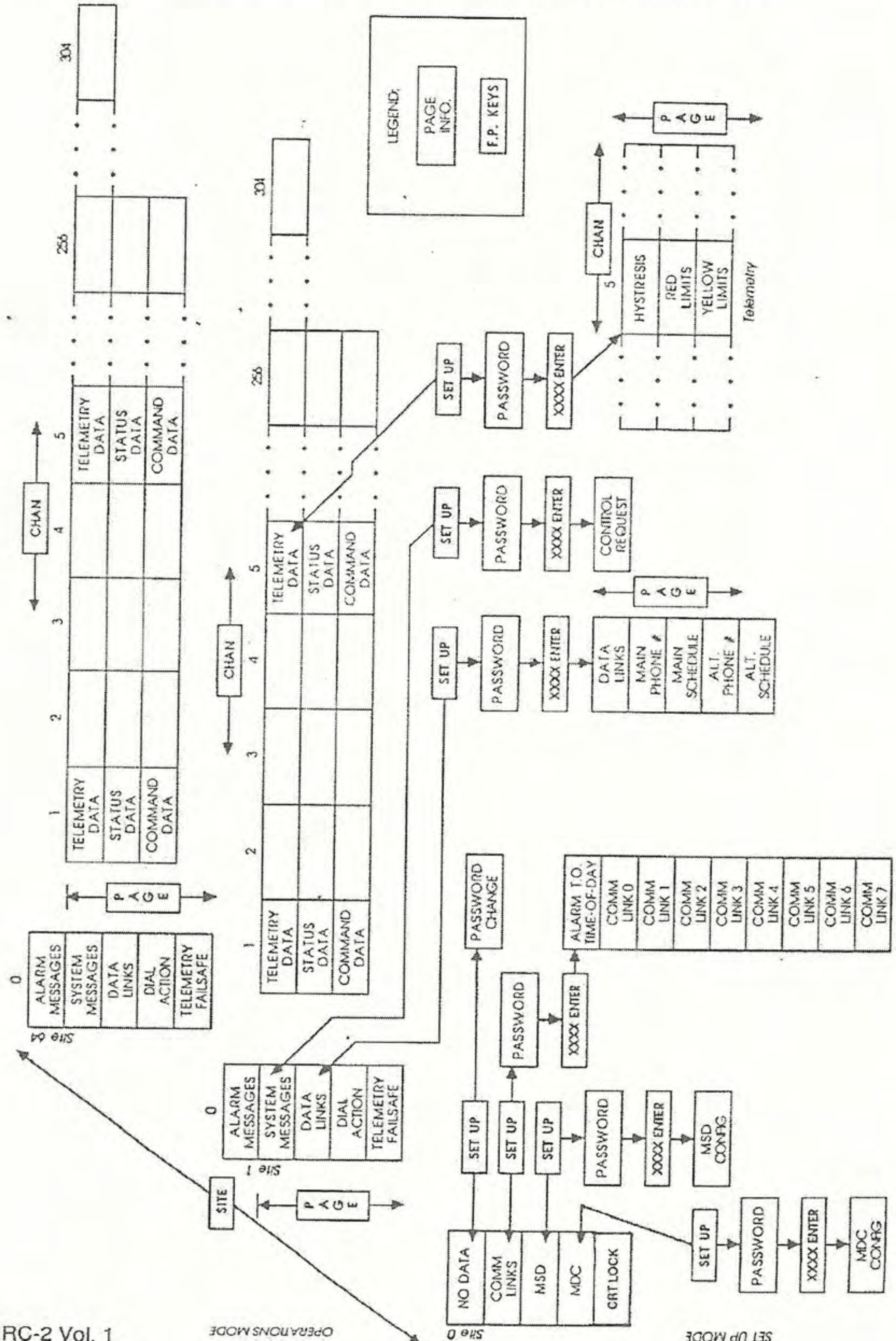


Figure 3-6
Remote Terminal Dial-up Worksheet "A"

SITE #: ______

Details: ______________________________

BOARD ASSIGN-MENT (HW or DU)	Phone # to RT modem (Only if DU)	LINK ASSIGNMENT (Phone # to CT) (Only if DU)	CT
0=			
1=			
2=			
3=			
4=			
5=			
6=			
7=			

SECURITY CODE: ____

To Enter Worksheet Information Into Remote Terminal:

1) At the remote terminal's front panel, select the control terminal status page, and press SETUP to get the BOARD ASSIGNMENT page.

2) Enter the BOARD ASSIGNMENTs from this worksheet (0=de-assign, 1=HW, 2=DU).

3) At the next setup page, select tone or pulse dialing by pressing the "-" key.

4) Enter the LINK ASSIGNMENT from this worksheet.

5) At the next setup page, enter the remote terminal's SECURITY CODE.

Figure 3-7
Control Terminal Dial-up Worksheet "A"

CT: ____________

Details: ______________________________

____

____

____

____

BOARD #	BOARD ASSIGNMENT (DU or HW)	Phone # to CT modem (Only if DU)	Site numbers of RT's calling into board.
0 =	☐☐		
1 =	☐☐		
2 =	☐☐		
3 =	☐☐		
4 =	☐☐		
5 =	☐☐		
6 =	☐☐		
7 =	☐☐		

DIALUP ALARM TIME-OUT (1-15): ☐☐

To Enter Worksheet Information Into Control Terminal:

1) At the control terminal's front panel, go to the PASSWORD setup page.

2) Press PAGE to go to the board-assignment setup page.

3) Enter the BOARD ASSIGNMENTs from this worksheet (0=de-assign, 1=HW, 2=DU).

4) Enter the DIALUP ALARM TIMEOUT into the next setup page (1-15 minutes).

5) Go to the next setup page (TIME OF DAY).

6) If the time displayed is wrong, enter the correct time (HH - hours, MM - minutes).

Figure 3-8
Control Terminal Dial-up Worksheet "B"

CT: ____________

Worksheet #: ________

SITE #		LINK ASSIGNMENT (dialup links only)	START TIME	END TIME	INTER-VAL	ON TIME	SEC. CODE
	M						
	A						
	M						
	A						
	M						
	A						
	M						
	A						
	M						
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	M						
	A						

For each SITE # on this worksheet, do the following:

1) At the control terminal's front panel, go to the DATA LINKS page for the SITE, and press SETUP.

2) Enter the MAIN LINK ASSIGNMENT
Press "-" to select DT for tone dialing, DP for pulse dialing, or blank for hardwired.

3) For each dialup LINK ASSIGNMENT, the next set up page will be the DIALUP SCHEDULE for that link. Enter the START TIME, END TIME, INTERVAL, and ON TIME.

4) Enter the ALT LINK ASSIGNMENT, and its DIALUP SCHEDULE (if DU).

5) Enter the security code that the SITE # RT is set for into the next setup page.

4

Section Four

Module Characteristics

4.1 Introduction

This section provides theory of operation for each MRC-2 module. See Appendix for schematic and assembly drawings.

4.2 Main Front Panel

Schematic: 91D7253 (Figure A-1)
Assembly: 20D2804 (Figure A-2)

The Main Front Panel has six functions:

1. Decoding
2. Display
3. Keyboard Encoder
4. System Status
5. Time-of-Day Clock
6. System Configuration Switches.

Decoding

The Main Front Panel has its own bus structure consisting of eight data lines (FPD7-FPDO), eight address lines (FPA7 FPAO), and four control lines (*RESET, FPI1, FPI2, and *FPEN). All of these lines (except *RESET) interface to PIA 1 On the CPU module. *RESET clears all data from the front panel (except time-of-day). FPI1 and FPI2 are interrupts from the front panel, and *FPEN enables front panel functions.

U20 and U21 decode lines A5-A7 along with *FPEN to create seven enable lines (*ENO-*EN3, *EN5-*EN7). The truth table for the front panel is found on the schematic.

Display

The front panel display consists of 12 4-digit, 17-segment ICs. Each IC (U2-U13) contains 1-of-4 address decoding, RAM, and ASCII-to-17-segment decoding. The display is arranged as two rows of six ICs.

Incoming data is buffered by U1 and U16. U17 further decodes the address lines (A2-A4) to select one or two of eight display ICs. When used with A5, a 1-of-12 selection is accomplished via *CE1 and *CE2 on U2-U13.

The remaining pin descriptions on U2-U13 are as follows:

*BL blanks the total display. This pin is not used (tied high).
DO-D6 is ASCII data.
AO-A1 is used for 1-of-4 character decoding.
*CU interprets the data as cursor information.
CUE enables the cursors.
*CLR clears the display upon a reset condition.
*WR allows data to be written into U2-U13.

Keyboard Encoder

The keys on the front panel are arranged in four rows of seven switches. The switches are wired to the keyboard encoded (U15) such that, when depressed, the top-left switch yields a binary 0 and the bottom-right switch yields a binary 27.

U15 continually scans the matrix (Y0-Y10 and X3-X6) until a key is depressed. The switch number (0-27) is then encoded for the outputs (B1-B5). The strobe output is brought high, causing an interrupt. The interrupt routine then reads the switch number buffered by U24. The scanning frequency is determined by R3 and C6 and is approximately 50 kHz. The strobe delay is determined by C15 and R20 and is approximately 1 ms.

Voltage regulator VR1 provides -12 V for U15.

System Status

System status is latched from the data inputs (D1-D3) by U18. Outputs Q1-Q6 drive LEDs CR41-CR46. Output Q7 is the cursor enable for the display. Output Q8 drives transistor Q1, which drives the audio indicator BZ1 via a jumper on the rear of the CPU Interface module.

Time-of-Day Clock

The Time-of-Day Clock (U23) keeps track of month, day, date, hours, minutes, seconds, and fractions of seconds. A particular pair of bytes is read or written by specifying an address (A0-A4) and reading or writing the data on the data lines (D0-D7) .

Y1, C13, C19, R15, and U23 comprise a crystal-controlled oscillator. U23 divides down 32.768 kHz for the time functions.

A battery backup system is comprised of BT1, RI6-R19, Q2, Q3, and C20, so that the time-of-day is not lost during a power interruption. U20 insures that power-down, power-up and *RESET occur in an orderly fashion.

System Configuration Switches

The Main Front Panel allows for the use of 10 BCD switches, 40 individual jumpers, or any combination of both in multiples of four jumpers or one switch. Two switches or eight jumpers are selected to be read by pulling low one and only one address line (AO-A4). The data is then read via the data lines (DO-D7).

4.3 6809 CPU Module

Schematic: 91D7252 (Figure A-3)
Assembly: 20D2793 (Figure A-4)

This module contains the "brain" of the MRC terminals. It has seven sections:

1. MPU
2. Bus Control
3. Bus Drivers
4. Address Decoding
5. Priority Interrupts
6. Front Panel Connections
7. CPU Interface Connections

MPU

U1 is the MPU (Microprocessing Unit) J which generates the address from which data will be stored or retrieved. The address bus consists of 16 bits, allowing 65,536 (2^{16}) addresses. These lines are used on the CPU module to select the PIAs (Peripheral Interface Adapter), the PIC (Priority Interrupt Controller), or devices external to the CPU module.

The data bus (D0-D7) is used to carry the data between the CPU and other parts in the system. This bus is bi-directional. When the MPU writes data, the MPU outputs and the peripherals input. Conversely, when the MPU reads data, the MPU inputs and the peripherals output. The direction of data flow is controlled by the R/W (Read or Write) line. Data is read into the MPU when this line is high.

E (Enable) is a 1-MHz square wave used for bus timing. Data transfers occur on the falling edge of E. Q is a quadrature signal with E. *RESET disables operation and resets the MPU in a known state. BS and BA indicate the internal state of the MPU. *IRQ, *FIRQ, and *NMI are interrupt inputs. *HALT and *DMA/BREQ are inputs used with direct-memory-access schemes. MRDY is a memory ready signal used to interface with slow memories. XTAL and EXTAL connect with Y1 to form a 4.0 MHz crystal oscillator. R11, C22, and C23 prevent oscillation at overtones.

Bus Control

A valid memory signal (MPUVMA) is generated using U5-U9. MPUVMA is high if the MPU has generated a valid memory address.

A bus available signal (BUSGRANT) is generated using U5, U6, and U8. This signal is high if the MPU is not using the bus.

Bus Drivers

The data is gated to and from the system bus via U16 and U17, which are controlled by U15 and U9. *WRITE or *READ is selected when the MPU is using the bus and not accessing the PIAs. Control signals are transferred to and from the System bus via U20. Addresses are gated onto the system bus via U18 and U19. U18 and U19 are selected when the MPU is using the bus.

Address Decoding

An I/O preselect (MPUPRE) is decoded using U9, U10, and U11. MPUPRE is high if an address between 8000H and 81FFH is selected. This line is used on those I/0 modules which lie within that address range.

A PIA preselect (*PIA) is decoded using U11 and U12. *PIC is low if an address between 8010H and 8017H is selected.

A PIC preselect (*FFE0-FFFF) is decoded using U13. *FFE0- FFFF is low if an address between FFEOH and FFFFH is selected. An alternate PIC preselect (*E7EO-E7FF) is decoded using U14, U12, and U9. *E7EO-E7FF is used only for development purposes.

Priority Interrupts

The PIC enables the use of eight prioritized interrupts instead of one general interrupt. During normal operation, A1-A4 pass through the PIC unchanged. When one of the interrupt lines (e.g., *INT4) is pulled low, the PIC pulls *IRQ low, causing the CPU to interrupt its normal operation. The CPU then fetches the address of the interrupt routine from locations FFF8H and FFF9H. The PIC modifies FFF8H and FFF9H to a different address depending on the interrupt priority (e.g., *INT4 implies FFFOH and FFF1H) . The CPU then receives the correct address of the prioritized interrupt routine.

Front Panel Connections

The front panel PIA, U2, passes data to and from the front panel. The front panel address bus (FPAO-FPA7), the front panel data bus (FPDO-FPD7), and three control lines (FPI1, FPI2, and FPC1) are available to the front panel. In addition, *RESET, GND, +5 V, +15 V, -15 V, alarm drive, and INT alarm are passed to the front panel.

CPU Interface Connections

The CPU interface PIA, U3, passes data to and from the CPU Interface module. MEMRST (Memory Reset) is used to strobe the auto-restart circuit. MEMOK (Memory OK) is used to sense if the contents of RAM are still valid after a reset condition. MODR (Maintenance Override Drive) drives the maintenance override relay circuit. FSTRIG (Failsafe Trigger) drives U4, which is configured as a 5-second one- shot. The output of U4, FSDR (Failsafe Drive), drives the control failsafe relay circuit. *PF (Power-Fail) is used to cause a reset condition. RTC (Real-Time Clock) provides a 60 Hz square wave for software timing. Manual reset, S1, is used to cause a system reset via *PF. Power-fail-threshold potentiometer R4 is used to adjust the point at which the system resets.

In addition, CR1 monitors the *RESET line, and CR2-CR4 monitor the power supply voltages. Alarm drive and INT alarm are also passed to the CPU Interface module.

4.4 CPU Interface

Schematic: 91C7215 (Figure A-5)
Assembly: 20C2781 (Figure A-6)

The CPU Interface module has eight functions:

1. Power Failure Sensing
2. Power-On Reset
3. 50-Hz or 60-Hz Real Time Clock
4. Battery Backup Switching and Charging
5. Low Battery Voltage Sensing
6. Output Relays for Failsafe and Maintenance Override Indication
7. Connection for Audible Alarm Muting
8. Auto-Restart in the Event of Malfunction

Power Failure Sensing

AC voltage from the secondary of the power supply transformer is supplied at pins P1-11 and P1-13. The ac is full-wave rectified by CR1 and CR2, and then filtered using C1. A potentiometer is connected to P1-91 and ground on the CPU board. R1, R2 and the potentiometer form an adjustable attenuator that is used to compensate for variances in local line voltage and frequency. U1A and R4 form a comparator with hysteresis. The threshold is maintained constant with CR3, a 3.1 V Zener diode When normal line voltage is applied, the positive input of U1A is above 3.1 V, causing the output to be high. If the ac supply should fail for a period of time (nominally 10 ms), the positive input to the comparator will fall below 3.1 V and cause the output *PF to go low.

Power-On Reset

When power is applied to the unit, *PF will go high, allowing C4 to charge through R8. This voltage is applied to the negative input of a comparator consisting of U1B and the 3.1 V reference. After approximately 400 ms, the negative input will reach the reference level causing the output of U1B to go low, which removes the base drive to Q1 allowing the collector to be pulled high by R14. When power is removed from the unit, *PF will go low, discharging C4 through R7 and CR4. Operation is much quicker in this direction and reactivates *RESET approximately 3 ms after *PF goes low.

Real Time Clock

AC voltage from the power supply transformer secondary is supplied at P1-13 and rectified by CR5. This is applied through voltage divider R15 and R16 to the positive input of a voltage comparator (U1C). On the output of the comparator is a rectangular wave having a duty cycle of about 55%.

Battery Backup Switching and Charging

Fifteen volts from the power supply is regulated down to 7.45 volts by U2. This is passed through CR10 to the battery terminal. R28 is adjusted so that 6.75 V is applied at the battery terminals with no load. R29 is used to Protect U2 in case of a short across the battery terminals. During normal operation, Q3 is biased on through R26 by the +15 V supply; this allows the main 5 V supply to be applied to the 5 V standby bus. When either the +15 V or main 5 V supply fails, the base of Q5 is pulled toward ground by either CR7 or CR8. This forward biases Q4, allowing the battery voltage to be passed to the 5 V standby bus. The 6 V at the battery terminals is reduced to an acceptable voltage by the voltage drops of CR9, Q4 and Q5. This circuit is not used by the MRC-2.

Low Voltage Sensing

A comparator (U1D) is used as a bistable multivibrator. When main power is not applied, the voltage at the output of U1D will reflect the voltage of the 5 V standby bus. This voltage is dropped 0.6 V by CR6 and fed back to the positive input of UID to keep the output high. If the voltage at the positive input falls below the reference voltage, the output of U1D will be forced low. This occurs when the 5 V standby bus falls to 3.1 V. This removes the voltage at the positive input, which effectively latches the output low. Upon reapplication of main power, C6 filters out any glitches that might alter the state of U1D. If the output of U1D did go low, this will tell the computer that the battery failed during the power outage. To reset the latch, a pulse of at least 10 ms is applied by the CPU to P1-71. This causes Q2 to conduct, removing the reference voltage to the comparator. The voltage divider of R22 and R25 is used to provide at least 0.4 V at the positive input to cause the output to go high when the reference voltage is removed.

Maintenance Override and Failsafe Relays

To activate the Failsafe output, P1-79 is set high from the CPU module. U5 ensures that the relay will not close when the *RESET line is in its low state, thus preventing a "glitch" when the unit is plugged in or the reset button is pushed. Each gate of U5 has an open-collector output which can sink the current required to activate the relay when both inputs to the gate are in their "high" state. Voltage regulator U4 provides +12 V to the other side of the coil. When the Failsafe relay is activated, closure occurs between pins 3 and 4 of the rear connector.

The Maintenance Override output is almost identical. P1-77 is set high from the CPU module to activate the relay. A closure will then be observed between pins 1 and 2 of the rear connector.

Closure between the Failsafe terminals will be observed when the unit is <u>not</u> in a failsafe condition. Closure across the Maintenance Override terminals will be observed when the unit <u>is</u> in a Maintenance Override condition.

In modules installed in a Control Terminal, these relays are never activated and serve no function. The relays are installed, however, to preserve interchangeability with modules installed in Remote Terminals.

The Maintenance Override and Failsafe relays are capable of switching a load of up to 24 Vdc at currents of up to 1 ampere. Inductive loads (relay coils, etc) should have a "clamping" diode wired across them to inhibit negative voltage spikes. External relays should be used when it is desired to switch greater loads (or ac loads).

These relays may also be interface with transistor-transistor logic (TTL) digital circuits. The relay contacts should be wired so that one side is referenced to the digital input. A pull-up resistor may be necessary, and it is advisable to wire a 1 uF capacitor and a 100-ohm resistor (in series) across the relay output to suppress contact bounce (Figure 4-1).

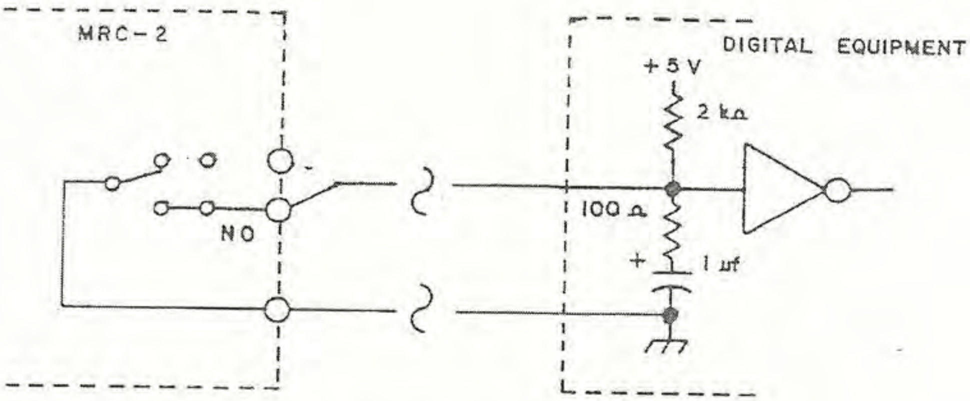

Figure 4-1
Digital Circuit Interface

Auto-Restart in the Event of Program Malfunction

Integrated circuit U3 is a dual retriggerable monostable multivibrator ("one-shot"). During normal program operation, line PI-71 is continually strobed from the CPU module. Each pulse reaching pin 1 of U3 "retriggers" the first stage of U3 for another 500 ms. The output at pin 13 will remain high as long as pulses at pin 1 arrive at least every 500 ms. Should these pulses cease (because the program has ceased running properly), the output at pin 13 falls to ground. The falling edge at pin 9 causes a 1 ms pulse at pin 5. If the jumper marked "Auto-Restart" has been installed, transistor Q6 is switched on, causing the *RESET line to fall to ground and re-initiating operation of the program.

The jumper marked "Continuous Restart" enables continuous retries, should the first attempt to restart be unsuccessful.

Alarm Drive

An alarm drive output is available to the user at pin 5 of connector J1 at the rear of the chassis. When the system is in a condition where an audible alarm is appropriate (see the Section 3, Operation), a transistor on the front panel assembly is switched on, enabling current to sink to ground. The collector of this transistor is brought out to pin 5 via a trace extending across the CPU module and onto that CPU Interface module. No more than +l2 V should be placed on this pin, and a current-limiting resistor should be used so that no more than 25 mA may flow through the transistor. This input is not RF-filtered (since a studio environment is assumed). Figure 4-2 shows a suggested circuit to use if filtering is necessary. We suggest that the components be mounted in the cable near the connector.

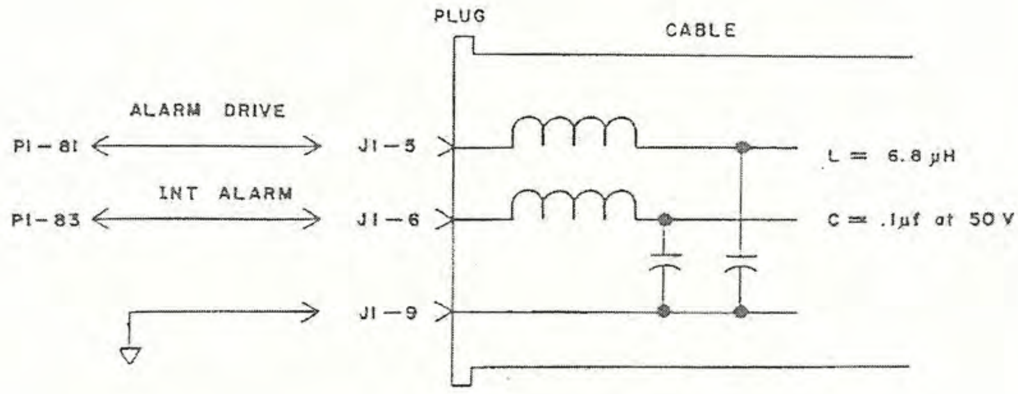

Figure 4-2
RF Filter Circuit

Internal Alarm

The Sonalert on the front panel is enabled when pin 6 of J1 is connected by a simple jumper to pin 5. Current limiting is provided internally. Unless the jumper is installed, the audible alarm is disabled. Pins 5 and 6 may also be used for remotely disabling the Sonalert (for instance, when a microphone in the studio is active) if a switch is placed between the pins.

4.5 96K ROM Board

Schematic: 91D7370 (Figure A-7)
Assembly: 20D2929 (Figure A-8)

The 96K ROM board provides up to 96 Kilobytes of program storage on EPROMs (Erasable Programmable Read Only Memory). Switches define various modes of operation, either 96K mode or 24K mode. In the 24K mode this board has been designed to emulate the older 24K boards (20D2783). (The 24K mode is no longer supported.)

The memory on this board consists of 12 ICs, U6 through U17. These are 8K x 8 EPROMs (for the 96K mode). Line drivers U1 and U2 buffer the address lines from the system address bus, while line driver U3 buffers the data to and from the system data bus. Switches S1 and S2 determine the mode of operation. PALs (Programmable Array Logic) U4 and U5 decode the addresses and switches to determine which single EPROM is selected, as well as providing a board select signal to enable data line driver U3. The appropriate EPROM select line (SEL 1 through SEL 12) goes low (logic 0) when the EPROMs is selected. The SELECT line goes low whenever any of the EPROMs is selected. VMA (Valid Memory Address) must be high (logic 1) for any of the EPROMs to be selected. For switch settings see Table 5-2.

Table 4-1. 96K ROM Board Address Range

IC	S2-2	Address Range
U6	X	Not used
U7	Off	6000-7FFF
U8	Off	8800-9FFF
U9	Off	A000-BFFF
U10	Off	C000-DFFF
U11	X	E000-FFFF
U12	X	Not used
U13	On	6000-7FFF
U14	On	8800-9FFF
U15	On	A000-BFFF
U16	On	C000-DFFF
U17	X	Not used

4.6 32K RAM Board

Schematic: 91D7371 (Figure A-9)
Assembly: 20D2930 (Figure A-10)

The 32K RAM board performs two functions. It provides up to 32 Kilobytes of RAM (Random Access Memory), and it provides latches for RAM address line A16 and system bus address line A16. This board has been designed to replace the older 16K RAM board (20D2788). In a different incarnation (with different PALs) it functions as a 16K RAM/16K ROM board.

The following summarizes the selected IC for each address range:

Table 4-2. IC Address Range

IC	32K RAM Function	16K RAM/16K ROM Function
U6	RAM 0000-1FFF	RAM 4000-5FFF
U7	RAM 2000-3FFF	RAM 6000-7FFF
U8	RAM 4000-5FFF	ROM C000-DFFF
U9	Not used	ROM E000-FFFF

Two PALs (Programmable Array Logic) U10 and U5 perform address decoding for board selection (SELECT) and RAM IC selection (SEL1 through SEL4), as well as A16 latch read and write selection (SEL 5R and SEL 5W). U5 decodes the upper address lines, while U10 decodes the lower address while U10 decodes the lower address lines. U10 also serves as latches for address lines RAM A16 and ROM A16 at I/O address x87FF. These latches can be read from as well as written to. D0 accesses the ROM latch and D1 accesses the RAM latch. U1, U2 and U3 are line drivers for board control and addressing. U4 is a line driver for the board's data lines. It is only active when the board is selected; its direction is determined by R/*W.

4.7 File Memory Controller

Schematic: 91D7250 (Figure A-11)
Assembly: 20D2789 (Figure A-12)

This board provides 2K bytes of non-volatile storage on Electrically-Alterable Read Only Memory (EAROM) along with the support circuitry necessary to read and write data. It is also capable of providing signals to control up to seven File Memory Extension modules (these are described separately).

Data is read and written to the EAROM integrated circuits via U10 and U11, which are Peripheral Interface Adapters (PIAs). One PIA (U10) is used to hold a 16-bit address. The other PIA (U11) is divided between eight data lines and eight control lines. Each PIA will respond to a block of four addresses. Which block of addresses is selected depends on the setting of switch S1 (see Table 5-2). In position 0, all outputs of S1 are isolated from ground and the three associated gates of U19 act as inverters. The remaining address decoding (involving U17, U20, U18 and U12) causes the two PIAs to occupy the block of addresses from 82C0H to 82C7H (see Table 5-2).

Address line A2 is used to select between the PIAs (high for U10, low for U11) . The various combinations of A1 and AO determine which internal register of the PIA is selected.

Data written into the PIAs is latched in and remains until other data is written into the PIA. This permits file memory operations, which are relatively slow (12 ms to erase and 1.2 ms to write), to proceed while the microprocessor continues with its other tasks. When the operation is completed the microprocessor is notified via one of the interrupt lines (see Table 5-2).

Timing for erase and write operations is available from U13, which is a dual one-shot. A rising edge at the B input to either half of the one-shot causes the Q output and the line marked FIN (U9, pin 12) to go high an appropriate period of time later. This line is an input to PIA U11. The internal programming of the PIA causes output IRQA to go low, causing an interrupt which forces the microprocessor to perform a service routine.

Since erase and write operations require -30 volts, the -30 V power supply is switched on and off by line CB2 from PIA U10. This prevents noise or transient "glitches" from writing erroneous data to the EAROM memory chips (U2 to U5) when no actual write or erase operations are in progress.

When line CB2 is in its high state, the phototransistor in opto-isolator U1 can conduct current, switching on Q1 and Q2 and thereby providing -30 V to the EAROMs.

The -30 V supply is provided by operational amplifier U6. The output of U6 at pin 6 oscillates between +15 V and -15 V. This signal is used to drive Q3 and Q4, which provide current to C9. The "-" side of C9 oscillates between -30 V and -45 V. This signal is rectified by CR2 and CR3 and filtered by C7, causing a value of approximately -37 V to appear on the input of VR1. VR1 maintains a difference of -15 V between its output and ground terminals. Since the "ground" terminal is connected to the -15 V power supply, -30 V appears at the output of VR1.

The File Memory Controller module can also control EAROM devices on other modules. The control lines, data lines, address lines, and -30 V power supply are brought out to 40 pin connector P2 on the front of the module. These lines are connected to the companion File Memory Extension modules with a File Memory Interconnect cable.

There are 16 address lines; ten of these are connected to every EAROM device. These determine which of the 1024 internal addresses in each memory device is selected. Six additional lines select which module and which pair of devices are to be accessed (each device stores four bits of an eight-bit word). When the most significant three address lines (B2, B1, and B0) are all 1, the File Memory Controller module itself is selected. Pin 6 of U9 goes to 0, selecting U8. Multiplexer U8 then selects one of the two pairs of EAROM devices, depending on the state of lines P2, P1, and P0. If B2, B1, and B0 are not all 1, one of the extensions is selected.

The lines labeled "INTENAB" and "EXTENAB," coming from outputs CB2 of U10 and U11, respectively, offer additional security against erroneous writes. On the File Memory controller module, the line INTENAB must be in its high state or inputs C1 and C0 on the EAROM chips will remain low, allowing only read operations. EXTENAB is used similarly on the File Memory Extension modules.

U2 to U5 are EAROM devices, which store data by trapping charges in a silicon dioxide-silicon nitride interface. Silicon dioxide and silicon nitride are excellent insulators, and charges are retained even when all power is removed. (The manufacturer guarantees data retention for 10 years.)

Write operations are accomplished by application of -30 V, causing electrons to tunnel through the silicon dioxide layer away from the interface, leaving a positive charge. The device used offers the capability to erase and rewrite individual words.

Operations on the EAROM ICs (U2 to U5) proceed as follows (signal names refer to pins of the integrated circuits):

1. Address is set-up on EAO-EA9, P0-P2, and B0-B2.

2. Function is set-up on C0 and C1 as follows:

	C0	C1
Read	0	0
Write	1	0
Erase	0	1
Block erase	1	1

3. If erase or write operation is to follow, CB2 of U10 (or U11, if the ICs are on an extension module) is set high, causing -30 V to be switched to the EAROM ICs.

4. If reading, *CE is set low; data appears on D0-D3 after 900 ns and the operation is over.

5. If writing, data is applied to D0-D3.

6. If writing or erasing, *WE is set low for at least 500 ns and set high again.

7. *CE is set high again. If writing it is held high for 1-2 ms. If erasing it is held high for 10-20 ms.

8. If writing or erasing, conclude by reading back the data just written.

All of the above operations are performed automatically by the software of the Terminal where the module is installed, as required.

4.8 File Memory Extension

Schematic: 91D7251 (Figure A-13)
Assembly: 20D2790 (Figure A-14)

The File Memory Extension module provides an additional 8192 bytes (8K) of nonvolatile storage on Electrically-Alterable Read Only Memory (EAROM), beyond the 2K bytes provided on the File Memory Controller. This module must be used in conjunction with a File Memory Controller module, which provides control signals, timing, and a -30 V power supply:

Data is read and written to the EAROM integrated circuits via the File Memory Controller module, which is connected to its associated File Memory Extension modules with the File Memory Interconnect cable, a 40-strand flat ribbon connector. Data, address, and control levels are latched into the PIAs on the Controller and carried to the Extension modules via this cable.

Whether the Controller or one of the Extensions is selected depends on the state of the three most significant address lines (labeled B2, B1, and B0). If all three of these lines are set to 1, the Controller is selected. Otherwise an Extension is selected.

Which Extension is selected is determined by the setting of S1 on the various modules. When S1 is set to 0, all outputs of the switch are isolated from ground, causing the three gates of U20 to act as inverters. In this case, the line labeled BSEL will go low when B2, B1, and B0 all have a value of 0. Other switch settings cause various outputs of S1 to be connected to or isolated from ground, and cause the gates of U20 to act variously as inverters or buffers. BSEL will go low, selecting the module, when the setting of S1 matches the number obtained if B2, B1, and B0 are interpreted as a binary number which will range from 0 (000) to 6 (110)) . Therefore 0 to 6 are the settings of S1 that are used. Normally the various File Memory Extensions should be switched to consecutive numbers, starting at 0.

When BSEL is low, demultiplexer U19 is selected. Address lines P2, P1 and P0 are inputs to this multiplexer. When CE (chip enable) is low, depending on the values of P2, P1, and P0, one of Y0-Y7 will be low, selecting a particular pair of EAROM ICs. (Each member of a pair handles 4 bits of each 8-bit byte.)

For erase and write operations, a -30 V supply is required. This supply is generated on the associated File Memory Controller. To prevent glitches from causing erroneous erase or write operations, the line marked EXTENAB is used to switch the -30 V supply on and off.

When EXTENAB is high and BSEL is low, current conducts through the diode of opto-isolator U21, causing the phototransistor to switch on. This provides current to the base of Q2, which in turn provides current to the base of Q1, switching it on and providing -30 V to pin 1 of U1-U16.

EXTENAB is also used to control function-select lines C0 and C1. If EXTENAB is low, Cl and co will be forced to 0, which is the code for a read operation and which cannot modify the contents of the memories.

Lines EXTENAB and WE (write enable) are protected to ensure that if the File Memory Interconnect cable is removed, the lines go to a harmless state. In the case of EXTENAB, pull-down resistor R1 coupled with U17 ensure that EXTENAB will float low. WE is connected to pull-up resistor R3-8 to ensure that WE remains high and writing is not enabled.

The EAROM integrated circuits used on this module are the same as those on the File Memory Controller, and the sequence of signals is the same. The previous subsection should be consulted for details concerning read, write, and erase operations.

4.9 GPIB-488 Module

Schematic: 91D7254 (Figure A-15)
Assembly: 20D2791 (Figure A-16)

The GPIB-488 module provides an interface conforming with IEEE Standard 488-1978 (Standard Digital Interface for Programmable Instrumentation). Communication may be provided with other devices conforming to the standard by means of this module. The GPIB in this module's name stands for General Purpose Interface Bus.

IEEE Standard 488-1978 is far too detailed and elaborate to explain here in its entirety. Copies of the complete standard may be obtained from:

Standards Department
The Institute Of Electrical and Electronics Engineers
345 E. 47th Street
New York, N. Y. 10017

A broad overview is as follows:

The purpose of the standard is to provide a means by which separate devices may communicate with one another. Data transfers take place simultaneously on 8 data lines, each data line transmitting one bit of an 8-bit byte.

Data transfers are coordinated by a three-wire "handshake." The three handshake lines are RFD ("Ready for Data"), DAV ("Data Valid") and DAC ("Data Accepted") . The device which is talking ("talking" is the expression used by the standard) waits for the RFD line to be set to 1 by all listeners. As long as a listener is not ready for new data, it holds the line low. When RFD is set to 1, the data byte is put on the bus by the talker and DPV ("Data Valid") is asserted. The listeners use this to gate in the data, and when all of them have accepted the data, DAC is allowed to rise to its high level, ending the data transfer and enabling another one.

The "controller" controls which device talks and which devices listen. Thus the intervention of a controller is required for every data transfer. Different devices may have different sets of capabilities. The GPIB-488 module allows for talker, listener, and controller capabilities, although the software of the terminal where the module is installed may not make use of all of these.

The five remaining lines, ATN ("Attention"), IFC ("Interface Clear"), REN ("Remote Enable"), EOI ("End of Identify"), and SRQ ("Service Request"), are used to accomplish control. Of these, ATN is the most important. The controller issues commands by sending data bytes (using the same three-wire handshake). When ATN is asserted, it indicates that the data byte is to be interpreted as a controller command. A typical controller command might be "device 3 talk" (01000011, with ATN asserted).

U2 implements the functions required for talking and listening. It automatically adapts to controller commands. If it detects that it has been told to talk, line IRQ is held low, forcing the microprocessor to a service routine which results in a data byte being deposited in one of the internal registers of the IC. This is automatically transmitted by U2, using the three-wire handshake previously described. If U2 detects a controller command ordering it to listen, as each data byte arrives the IRQ line is set low, once again forcing the microprocessor to a service routine to read the data.

The Standard indicates that each device shall have a means of setting its GPIB bus address. This function is filled by switch S2 (marked TALK/LISTEN ADDR on the module). Each device interfaced to the GPIB bus must have a unique identity so that only one device talks at a time.

Controller functions are implemented by U3, which is a Peripheral Interface Adapter (PIA). Essentially it provides a way of directly manipulating the various lines of the bus. When controller commands are sent, the software must monitor each stage of the three-wire handshake. U2 automates this process but it handles only talking and listening, not controlling.

U14 and U16 convert the signals from U2 and U3 to levels compatible with the Standard. Pins 1 of U14 and U16 (TE or "talk enable") control the direction of these bus driver/receivers according to whether U2 has detected instructions to talk or listen. The four gates of U5 force the driver/receivers to become drivers when the system is transmitting a control message.

U2 and U3 occupy a block of 16 consecutive memory addresses. Switch S1 controls which addresses these are. According to the position of S1, pins 1 and 4 of S1 are either connected to or isolated from ground. With switch S1 at position 0, the module occupies the block of addresses from 8400H to 840FH.

For the module to be selected, both U6 pin 8 and U11 pin 8 must be low. If so, U4 pin 8 goes low (this is the line labeled BSEL or Board Select). Line A3 is then used to determine whether U2 or U3 is selected. If U3 is selected, PIASEL goes low, and if U2 is selected, 488SEL goes low. Address lines A2, A1, and A0 determine which of the internal addresses of U2 or U3 are selected.

When an address in the range occupied by the module appears on lines A0-A15, line R/W ("Read/Write") is used to control the direction of buffers U7 and U13.

When a particular internal address of U2 is read from, pin 4 (ASE) is set low, causing the setting of S2 to be gated onto the data bus. This is read by the microprocessor when the system is initialized and written back into U2 to set the bus address.

4.10 GPIB-488 Interface

Schematic: 91C7255 (Figure A-17)
Assembly: 20C2792 (Figure A-18)

The GPIB-488 Interface Module is used to bring signals from the GPIB-488 module to a connector conforming to IEEE Standard 488-1978 on the rear of the chassis.

4.11 Modem II Module

Schematic: 91D7233 (Figure A-19)
Assembly: 20D2787 (Figure A-20)

The modem (MOdulator/DEModulator) is used to communicate digital information between the Remote and Control Terminals via leased telephone lines.

U8 is the Asynchronous Communications Interface Adapter (ACIA), which provides the data formatting and control to interface serial asynchronous communications information to the 8-bit data bus. The functional configuration of the ACIA is programmed automatically during system initialization. A programmable control register provides variable word lengths, clock division ratios, transmit control, receiver control and interrupts. The baud-rate generator (U16) and Y1 form a crystal-controlled oscillator, which provides the clock frequency for the ACIA.

The modem has switch-programmable address specification, allowing multiple Modem modules to be used in special applications. BCD switch S3, U10 and U12 provide address decoding for the module. See Table 5-2 for switch settings.

Two bus drivers (U3 and U4) are used to write and read data onto the bus. Parts of U6 and U7 are used to enable reading and writing according to the status of the read/write line and the module address.

Outgoing serial data is modulated into dual-tone frequency shift keying by modulator U15. Serial data input is applied to pin 9. A high input causes a low frequency (Mark) of 1200 Hz to be generated. A low input causes a high frequency (Space) of 2200 Hz to be generated. Resistor R38 is used to reduce harmonic distortion.

Transistor Q3 serves as a switch to turn on the modulator according to request-to-send (RTS) from the ACIA. Switch S2 and parts of U11 and U13 will turn on the modem continuously for test purposes. The output of the modulator is ac coupled and fed into Output Amplifier U2 before being transmitted via the Modem-Telco Interface module.

The Deadman Circuit (U9) turns off the modulator if a system failure occurs for more than 2.5 seconds.

The incoming FSK signal is fed through a bandpass filter consisting of U14a and U14b. The filtered signal is further amplified by U14c and clamped by CR1 and CR2. The clamped signal is then demodulated by U1. The output of the demodulator is gated with *DCD at U7a and buffered by U13d to provide data output only when a carrier is present. The amplified signal from U14c is peak-detected by CR8, CR7, CR6, and U14d. This signal is buffered by parts of U5 and inverted by transistor Q1 to provide data carrier detect (*DCD).

4.12 Modem-Telco Interface

Schematic: 91A7147 (Figure A-21)
Assembly: 20B2716 (Figure A-22)

The Modem-Telco Interface module interconnects the Modem with either a 2-wire or 4-wire dedicated-circuitry telephone line. Telephone line interconnections are balanced, isolated, fused and filtered.

Telephone line inputs are filtered to reduce RF interference. Each input line is individually fused, using an AGC 1/4-amp fuse. Transformers T1 and T2 are 600-Ohm to 600-Ohm matching transformers. Resistors R1, R2, R4 and R5 are used to convert 600 Ohms to 300-Ohms for use in the 2- wire mode. Resistors R3 and R6 are used in the 4-wire mode to make the impedance of the phone line connections approximately 600 Ohms. Diodes D1 through D4 are used to protect the transformers and Modem module from large transients on the telephone line.

Two interconnection schemes are possible using this module. The 2-wire scheme uses a single pair of wires for communicating in both directions. The 4-wire system uses two pairs of wires separating send telemetry and receive signals. The connections necessary for 2-wire inter-connections are shown in Figure 4-25. Figure 4-26 illustrates 4-wire connections. When interconnecting a Control Terminal with Remote Terminals, no special line polarity must be observed as each input has a balanced 300-Ohm or 600-Ohm impedance.

A Bell 3002, unconditioned data circuit is specified. The use of long (over 1000 ft) dc continuous circuits is not recommended as their ac frequency response is not guaranteed, and induced currents may prove troublesome.

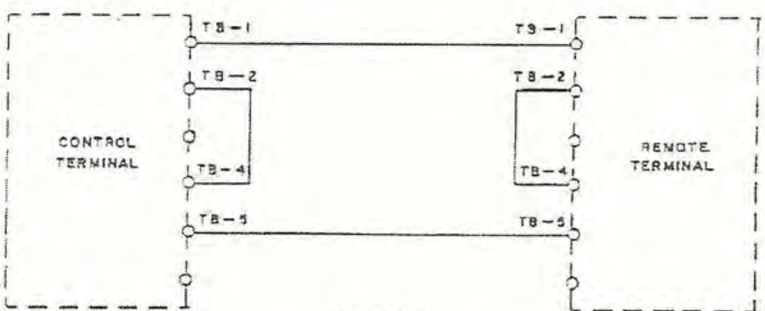

Figure 4-3
Two-Wire Interconnections for Modem-Telco Interface Modules

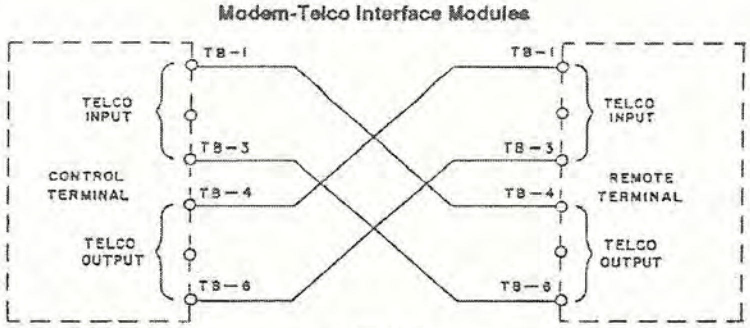

Figure 4-4
Four-Wire Interconnections for Modem-Telco Interface Modules

4.13 Telco In/Subcarrier Out

Schematic: 91B7144 (Figure A-23)
Assembly: 20A2737 (Figure A-24)

The Telco In/subcarrier Out module transmits data via an FM subcarrier and interfaces the modem demodulator with the telephone line for received data. This module is the companion module for Moseley Telco Out/Subcarrier In (20B2736). Operation in several standard subcarrier bands is possible by specifying different frequency-selective components.

Incoming data on the telephone line is filtered by L1 and L2 to reduce radio frequency interference. Fuses F1 and F2 are used for protection from large surges on the phone line. Resistors R13, R14, and R15 form a 600-Ohm impedance matching network between the phone line and the transformer. T1 is a 600-Ohm to 600-Ohm impedance matching transformer.

Integrated circuit U1 is a function generator, which is used to generate an FM signal from the frequency shift keyed output of the Modem module. The frequency of oscillation is controlled by applying a control voltage to the activated timing pin (pin 7). Resistors R8, R9, R10, and R11 form a voltage divider network used to adjust the frequency control voltage. Timing capacitor C4 is also used for frequency control. Its value is dependent on which subcarrier band is used. Capacitor C5 is a bypass capacitor required by U1. Resistors R6 and R7 are used to reduce the total harmonic distortion (THD). This can be reduced to 0.5% by trimming, or in the worst case, approximately 2.5%. The dc output level is adjusted by applying a voltage bias to U1 pin 3, using OUTPUT Adjust R4.

4.14 Telco Out/Subcarrier In

Schematic: 91C7160 (Figure A-25)
Assembly: 20B2736 (Figure A-26)

The Telco/Subcarrier In module interconnects transmitted signals from the modem with a dedicated telephone line, and demodulates FM subcarrier data transmissions to provide received data to the modem. This module is the companion module to the Telco In/Subcarrier Out assembly (20A2737). Operation in several different standard subcarrier bands is possible by selection of component values.

Integrated circuit U1 is a phase-locked loop used to demodulate the incoming FM subcarrier. The input filter connected to pin 2 is a telemetry extraction bandpass filter and is used to reject frequencies other than the telemetry subcarrier. The components used in the input filter are frequency dependent and are specified according to the subcarrier band being used. Recommended signal input at pin 2 is from 10 mV rms to 3 mV rms. The operating frequency is determined by C5, R5 and FREQ Adjust R6. Resistor R3 and capacitor C8 form a lock detect filter to eliminate chatter at the lock detect output (pin 6). Capacitor C9 is used as a bypass capacitor for an internal voltage reference.

The demodulated output is taken from the loop phase detector (pin 11), through a post detection filter made up of R7, C12, and buffer amplifier U2. This buffer amplifier is necessary because of the high impedance output at pin 11. U2 is a non-inverting unity gain operational amplifier.

4.15 Subcarrier Interface

Schematic: 91C7156 (Figure A-27)
Assembly: 20D2719 (Figure A-28)

The Subcarrier Interface module when used with the Modem II module generates and demodulates FM subcarrier data transmissions.

Subcarrier generator U3 is used to generate an FM signal from the frequency shift keyed output of the Modem module. The frequency of oscillation is controlled by applying a control voltage to the activated timing pin (pin 7). Resistors R17, R18, R19 and R20 form a voltage divider network used to adjust the frequency control voltage. Timing capacitor C6 is also used for frequency control. Its value is dependent on which sub-carrier band is used. Capacitor C20 is a bypass capacitor required by the IC. Resistors R15 and R16 are used to reduce the total harmonic distortion. This can be reduced to 0.5% by trimming, or in the worst case, approximately 2.5%. The dc output level is adjusted by applying a voltage bias to pin 3, using R14.

U1 is a phase-locked loop used to demodulate the incoming FM subcarrier. The input filter connected to pin 2 is a telemetry extraction bandpass filter and is used to reject frequencies other than the telemetry subcarrier. The components used in the input filter are frequency dependent and are specified according to the subcarrier band being used. Recommended signal input at pin 2 is from 10 mV rms to 3 V rms. The operating frequency is determined by C5, R5 and R6. Resistor R3 and capacitor C9 form a lock detect filter to eliminate chatter at the lock detect output (pin 6). Capacitor C8 is used as a bypass capacitor for an internal voltage reference. The demodulated output is taken from the loop phase detector (pin 11), through a post detection filter made up of R7 and C12; to buffer amplifier U2. This buffer amplifier is necessary because of the high impedance output at pin 11. U2 is a noninverting unity gain operational amplifier.

U4 provides +12 V for use on the module.

4.16 Serial I/O Module

Schematic: 91D7243 (Figure A-29)
Assembly: 20D2800 (Figure A-30)

The Serial I/O module serves the following functions:

1. Provides an interface to the MRC bus, allowing data to be read from and written to the Asynchronous Communications Interface Adapter (ACIA) under the control of the Microprocessor.

2. Converts parallel data taken from the MRC bus into serial data for the Serial Interface module (RS-232 or 20 mA loop).

3. Converts serial data from the Serial Interface module into 8-bit parallel data suitable for the MRC bus.

4. Optionally provides a crystal-controlled clock which supplies the ACIA with selectable baud rates.

U7, U8, U10, U11 and U12 serve as bus drivers and receivers, passing data to and from the microprocessor bus. Address decoding is performed by U3, U4, U5, U6, and U9, ultimately controlling several device-select lines.

Switch S1 and positions 1 and 2 of S2 determine the memory addresses filled by the ACIA (see Table 5-2).

The Asynchronous Communications Interface Adapter (ACIA) (U2) provides the data formatting and control to interface serial data to the 8-bit data bus. A programmable control register, which is set when the system is initialized, determines word length, transmission rate, etc.

The ACIA Performs most of the actual work of this module under software control. The clock signal for the ACIA normally is provided to pins 3 and 4 from the Serial Interface module via P1-77. The baud rate is determined under program control. The *RTS (Request-to-Send) line may be turned on and off under program control, and the *CTS (Clear-to-Send) and *DCD (Data-Carrier-Detect) lines are used to enable sending and receiving respectively.

Part of U9, S2 (positions 3 and 4), and CR1 and CR2 allow the user to monitor the activity on the receive-data and transmit-data lines to and from the Serial Interface module.

Jumper block E2 determines which (if any) interrupt priority is used for the module (see Table 5-2).

For the -2 option (special applications only), U1 and crystal Y1 form a crystal-controlled clock. U1 divides down the 1.8432 MHz crystal frequency to provide the selectable baud rates for the ACIA.

Voltage regulator VR1 supplies +12 V to the Serial Interface module.

4.17 Serial Interface Module

Schematic: 91C7249 (Figure A-31)
Assembly: 20C2803 (Figure A-32)

The primary purpose of the Serial Interface module is to convert the TTL compatible signals generated by the Serial I/O module to signal levels meeting the RS-232 standard, and to convert incoming RS-232 signals to TTL levels acceptable to the Serial I/O module.

The module also provides a 20 mA loop capability, but the cable supplied with the standard options provides an RS-232 interconnect and does not make use of the 20 mA loop portion of the module.

Conversion from TTL levels to RS-232 levels is provided by both parts of U1. The opposite conversion is provided by all four parts of U3. U2 provides current-sinking capability for the transmit-current loop.

The Serial I/O module has two status inputs and one status output to accomplish "handshaking". The *SEND line (an output from the Serial I/O module) is inverted, converted to RS-232 standard levels and brought out to the rear connector as "request to send". Data terminal ready" is always active if power is applied to the module.

*CARRIER and *READY are inputs to the Serial I/O module from the RS-232 interface.

The *READY line is set low if the "data set ready" and "clear to send" lines are both in a logic-positive condition.

Should the "clear to send" line or the "data set ready" line be in a false condition as defined by the RS-232 standard, incoming serial data will be ignored and the Serial I/O module will not transmit data. (The decision to ignore incoming data and not transmit outgoing data takes place entirely on the Serial I/O module. The Serial Interface module plays no part in this.)

U5 in conjunction with crystal Y1 generates square waves of various frequencies. If pin 23 is pulled up to +5 V, one set of frequencies is chosen. If pin 23 is taken to ground, another set is chosen. Switch 8 of S1 is used to put +5 V or 0 V on pin 23. Switches 1 through 7 are connected to the various output pins of U5. One of these switches is set to the ON position to route the desired frequency through J2-77 to the Serial I/O module (for use in baud rate generation).

4.18 Analog Input III

Schematic: 91D7343 (Figure A-33)
Assembly: 20D2897 (Figure A-34)

The Analog Input III board is used to measure 16 differential analog inputs and convert these input voltages to digital signals suitable for use by the microprocessor.

The address of the Analog Input is selected by switch S1, and is decoded by the 74LS86 (U9) and the 74LS30 (U5). The board occupies four adjacent address locations in the range from 8140 to 817F (Hex), with the exact starting address programmed by S1.

When the microprocessor outputs the address of the Analog Input board, *BOARD SELECT is pulled low, enabling the MC6821 (U1) PIA and the 74LS245 (U8) octal transceiver. The enabled direction of the transceiver is determined by the R/*W line from the microprocessor.

PIA lines PA0-PA7 are used to read the eight least-significant bits of the MN574A (U2) output. The four most-significant bits are read with PB0-PB3. The channel to be converted is output on lines PB4-PB7 and CB2. Line CA2 is used to put the A/D either in read or convert mode, and line CA1 is used to monitor when the A/D conversion is complete.

The three most-significant bits of the channel select lines (CHSEl2-CHSEL4) are used on the inputs of the 74LS138 (U3) 3-to-8 decoder, which selects one of five MC14052 (U11-U15) differential analog multiplexers. Four of the MUXs are used for the sixteen user inputs. The remaining MUX is used for the four self-check channels (OFFSET/GND, +Vref, -Vref, and +5 V).

The selected differential input signal is buffered by the TL072 (U7) op amps. The buffered differential signal is then converted to a single-ended signal by op amp LM308A (U6) which is configured as a unity-gain differential amplifier. This single-ended signal is then fed directly into the MN574A (U2) A/D converter.

The A/D converter is the heart of the Analog Input board. This hybrid IC contains a successive-approximation register, a 12-bit D/A converter, control logic, a clock, switches, buffers, a comparator, and a precision reference. Since the A/D uses successive-approximation techniques, a conversion is completed in about 25 us.

The sequence of commands issued by the software is as follows:

1. Wait for conversion to be completed.
2. Set R/*C high (read mode).
3. Read previously-converted data.
4. Output channel to MUXs.
5. Set R/*C low (convert mode).

4.19 Status Input, TTL II

Schematic: 91C7237 (Figure A-35)
Assembly: 20D2798 (Figure A-36)

The Status Input, TTL II module issued to interface the MRC system with 16 TTL inputs. The inputs can be used as status or as a single 16-bit word.

U6, in conjunction with switch S1, is a programmable inverter for address selection. U5 ANDS the outputs of U6 with PRE (I/O Select), A6, A7 and *A8 to form the module address. When switch S1 is set to "0", the module is addressed in its lowest address range, 80C0 to 80C3. When switch S1 is set to "F", the module is addressed from 8OFC to 8OFF.

When the correct address is decoded, pin 8 of U5 goes to a low state, enabling decoder U4. U1 and U2 are tristate buffers used to gate 8 bits of status information onto the data bus. U3 provides a unique module ID pattern on the data bus when selected.

When address lines A0 and A1 are both low and U4 is enabled, status bits 1 through 8 are gated onto the data bus. When A0 is high and A1 is low, status bits 9 through 16 are gated onto the bus. When A0 is low and A1 is high, the unique module ID is gated onto the bus.

4.20 Status Input, OPTO II

Schematic: 91C7236 (Figure A-37)
Assembly: 20D2795 (Figure A-38)

The Status Input, Opto II module is used to bring 16 on/off inputs into the CPU. It can be used for individual bits (status) or as a 16-bit word. Optical isolators are used for ground isolation.

U1, in conjunction with S1, is used as a programmable inverter for address selection. U2 ANDS the output of U1 along with PRE (I/O Select), A6, A7, and *A8 to form the address at which the module will operate.

With switch S1 set to "0", the address for the module will begin at 80C0 and end at 80C3 as each module uses four addresses. If switch S1 is set to "F", the address for the module will begin at 8OFC and end at 8OFF.

The output of U2 is used to enable 1-of-4 decoder U3, with only the first three outputs being used. The outputs of U3 are active low enables for tristate buffers U4, U5 and U22.

U4A-D and U5A-D are used to bring the first eight channels onto the data bus, while U4E-H and U5E-H are used to bring the second eight channels onto the data bus. U22 provides a unique module ID pattern on the data bus when selected.

4.21 Open Collector Command Output

Schematic: 91C7171 (Figure A-39)
Assembly: 20D2755 (Figure A-40)

The Open Collector Command Output module provides 16 open-collector outputs for driving control relays or digital circuitry.

U1, in conjunction with switch S1, is used as a programmable inverter for address selection. U2 ANDS the outputs of U1 along with VMA (Valid Memory Address), PRE (I/O Select), A7 and A8 to form the module address location.

With all four switches in the OFF position, the address for the module will begin at 8180 and end at 8183 as each module requires four addresses. If all four switches are ON, the address will begin at 8IBC and end at 8IBF.

The output of U2 is inverted by U6 to form an active-high board select, which is fed to the chip select on U3 (pin 24) and to bus buffer selector U6. If the CPU requests data from PIA (Peripheral Interface Adapter) U3, the R/*W (Read/Write) line (J1-64) will be high, enabling pin 19 of U4 and U5 and allowing data to pass onto the data bus. This read function is used to check operation of the PIA. If R/*W is low, pin 19 of U4 and U5 will be low enabling a command to be written into the PIA.

Output CB2 on U3 is used to disable all outputs simultaneously upon Reset. Transistors Q1 and Q2 are current sources to interface the PIA with drivers U7 to U14.

4.22 Optically Isolated Command Output

Schematic: 91C7129 (Figure A-41)
Assembly: 20C2705 (Figure A-42)

The Optically Isolated Command Output module provides 16 optically isolated outputs for control of external equipment.

U1, in conjunction with S1, is used as a programmable inverter for address selection. U2 ANDS the outputs of U along with VMA (valid Memory Address), PRE (I/0 Select), A7 (Address Line 7), and A8 (Address Line 8) to form the address at which the module will operate. With all four switches on S1 OFF, the address for the module will begin at 8180 and end at 8183 as each module requires four addresses. If all four switches on S1 are ON, the address for the module will begin at 81BC and end at 81BF.

The output of U2 is inverted by U3B to form an active-high board select, which is fed to the chip select on U6 (pin 24) and the bus buffer selectors U3C and U3D. If the CPU desires to read data from the PIA (Peripheral Interface Adapter) U6, the R/W (Read/Write) line (J1-64) will be high. This causes the output of U3D to go low, which enables U4A-D and U5A-D to activate. This allows data from U6 to pass through U4 and U5 to the data bus. If the CPU desires to write data to U6, the R/W line will be low. This causes the output of U3C to go low, which enables U4E-H and U5E-H to activate. This allows data from the data bus to pass through U4 and U5 to U6.

Output CB2 on U6 (pin 19) is used to disable all outputs simultaneously. This occurs during reset. To enable outputs, CB2 is brought low, forward biasing Q33 and Q34 which supply +5 V to the optical isolators. Drivers Q1 through Q16 are used to boost the output current of U6 to a sufficient value in order to drive optical isolators U7 through U22. The outputs of U7 through U22 are used to forward bias the Darlington output transistors Q17 through Q32 (floating from chassis).

4.23 Parallel Input Module

Schematic: 91D7272 (Figure A-43)
Assembly: 20D2822 (Figure A-44)

The Parallel Input module provides a means of interfacing digital data to an MRC system. Configuration switches allow the user to select whether the 16 lines provided will be interpreted as four BCD numerals or one 16-bit binary number, and to specify the channel number on which the data will appear.

This module occupies a block of eight addresses. S1 controls which addresses these are. According to the switch setting, the outputs of S1 are either connected to ground or isolated from ground. When an output of S1 is isolated from ground, the corresponding gate of U6 acts as an inverter. With S1 in position 0, U13 pin 3 goes high and the module is selected for addresses 838OH-8387H. For successive positions of S1 the address range of the module moves higher by 8. Table 4-23 shows the corresponding analog channels for S1 settings.

When address line A2 is 0, U1 is selected. A1 and A0 are used to determine which internal address of U1 is selected. The data provided by the user on external data lines D0-D15 may be read by the microprocessor from these internal addresses.

When address line A2 is 1, configuration switches S2, S3, S4, and S5 may be read. Each of the four possible combinations of A1 and A0 results in the contents of one of the four switches being placed on the data bus. This is accomplished by dual data selectors U2 and U3. Each of the four selectors has as inputs one bit from each of the four switches. According to the states of A1 and A0, one of these bits is selected and gated onto the data bus.

Lines C1 and C2 are "handshake" lines provided for the user. C1 is set from low to high by the user to indicate that the data on lines D0-D15 is valid. When the microprocessor has read the data thus provided, line C2 is set from high to low by the software of the MRC system to signal that the data has been absorbed.

S5 determines the interpretation of the data bits (see Table 5-2). When S5 is set to 0 thru 9, the number is interpreted as a 4-digit BCD value. When S5 is set to position 8, the data is interpreted as a l5-bit binary number. The most significant bit is the sign bit, with 1 = minus and 0 = plus. When S5 is set to position 9, the data is interpreted as a 16-bit 2s complement binary number.

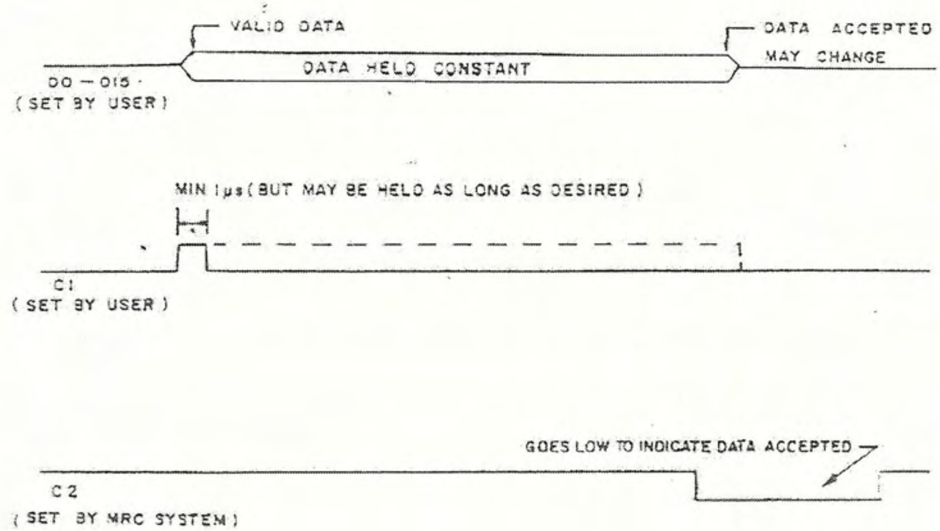

Figure 4-5
Timing for Signal Lines C1 and C2

If there is no need for "handshaking", C2 may be connected directly to C1 and the system will read the data as often as possible. However, it will then be possible for the system to read the data while it is changing or in an indeterminate state. This will cause glitches in the display which are harmless, though annoying.

This module is designed for use with a Diode-Filtered Interface module, which connects the various lines with a 37-pin connector at the rear of the chassis (refer to Table 4-3).

Table 4-23
Parallel Input Channels

S1 Setting	Analog Channel
0	257
1	258
2	259
3	260
4	261
5	262
6	263
7	264
8	265
9	266
A	267
B	268
C	269
D	270
E	271
F	272

Table 4-3
Diode-Filtered Interface Pin Connections

Pin Number On Rear Connector	Signal Line	Interpretation
1	D15	Most-significant bit (or sign bt)
2	D14	
3	D13	Digit 4 (D15 thru D12)
4	D12	
5	D11	
6	D10	Digit 3 (D11 thru D8)
7	D9	
8	D8	
9	D7	
10	D6	Digit 2 (D7 thru D4)
11	D5	
12	D4	
13	D3	
14	D2	Digit 1 (D3 thru D0)
15	D1	
16	D0	Least-significant bit
17	C1	Data Valid
18	C2	Data Accepted
20-37	GND	

4.24 Delay Control

Schematic: 91D7244 (Figure A-45)
Assembly: 20D2801 (Figure A-46)

The Delay Control module provides six form "C" relay utputs. In addition, six one-shots are used to delay relay relaxation. (On the MRC-2, this module provides six outputsfor the Telemetry Failsafe Option.)

Address decoding (involving 9-U11 ad U13-U16) causes this module to occupy I address, ocated at 8300 H + 4 x S1 (BCD). A 0 on an Output of S1 cause the associated XOR gate (U11) to act as a buffer, and a 1 causes the gate to act as an inverter (see Table 5-2).

When the module is Write Selected (R/*W is low), and on the rising edge of *E, data is gated onto the module via U7 and U12 by U8 and U9. The one-shots (U1-U3) are then triggered via U16 (refer to Table 4-4 below).

Table 4-4. Pin U1-U3 Triggered Relays

D7	D6	D5	D4	D3	D2	D1	D0	Result
X	1	0	0	0	0	0	0	Trigger all relays
X	1	1	1	1	0	1	1	Trigger relay 3
X	1	1	1	1	1	1	1	Tigger no relay

The outputs of U1-U3 drive the relays via U4-U6. R1, C1, C3, C4, C6, C7, and C9 provide a time constant of 45 seconds for U1-U3. To keep a relay energized, its associated one-shot must be triggered at least once every 3O seconds.

When the module is Read Selected (R/*W is high), and on the rising edge of *E, the state of the outputs of U1-U3 may be read (refer to Table 4-5).

Table 4-5. Pins U1-U3 Outputs

Data Line	Relay
D0	K1
D1	K2 Logic 1 = Relay On
D2	K3 Logic 0 = Relay Off
D3	K4
D4	K5
D5	K6

4.25 Diode-Filtered Interface II

Schematic: 91A7273 (Figure A-47)
Assembly: 20C2823 (Figure A-48)

The Diode-Filtered Interface module provides filtering and damping for the Status Input, TTL II module. Each input is passed through an LC low-pass filter to inhibit RF. Diodes CR1-CR32 prevent voltages from rising above about 5.8 V or below -0.8 V when the input signal changes suddenly.

4.26 Filtered Interface

Schematic: 91A7119 (Figure A-49)
Assembly: 20B2718 (Figure A-50)

The Filtered Interface module provides a means of connecting to an I/O module where RF filtering is required. Each line is passed through an LC lowpass filter to inhibit RF. A metal shield is used to prevent RF field leakage.

4.27 DC Power Supply

Schematic: 91C7179 (Figure A-51)
Assembly: 20C2655 (Figure A-52)

The power supply provides +5 V, +15 V, and -15 V. The module is easily removed for adjustment, service, or replacement. No adjustments are required under normal conditions.

Attached to the rear of the power supply is a Corcom filter, which includes a fuse, an RF filter, and the voltage selection card. A nine-pin Molex connector interfaces the power supply with the chassis wiring harness.

The ac input voltage may be either 120 V or 240 V. The voltage selection card has positions for four input voltages; however, the 100 V and 220 V positions are not connected.

To service the power supply, remove two screws at the front of the power supply and one screw at the rear of the terminal. Slide the module forward.

4.28 Extender Board

Assembly: 20B2724 (Figure A-53)

The Extender board allows active modules to be mounted outside the Terminal for troubleshooting. Test leads can be attached to the connector leads for ease in examining bus signals and input/output signals. This board contains no active components.

Exposure of MRC modules outside the protected RF chassis environment via the Extender board may cause the unit to be susceptible to RF effects.

4.29 4 RU Mother Board

Schematic: 91C7201 (Figure A-54)
Assembly: 20D2706 (Figure A-55)

The mother board has three functions:

1. To supply power to all modules.

2. To provide interconnections between the CPU module and the other front modules (the functional modules).

3. To provide connections from the front modules to their corresponding rear modules (the interface modules).

The mother board is located three-fourths of the way toward the rear of the chassis, in the same plane as the Front Panel (when closed). The functional modules slide in from the front and plug into sockets on the mother board. The edge connector of each functional module has 50 contacts on each side. Those on the component side (even numbered from 2 to 100) connect to a 50-line bus that is common to all functional modules (see Section 1.4.1 for details on the 50 line bus).

The odd-numbered contacts (3 to 97 on the trace side of the edge connector) connect through the mother board to a vertical row of 48 pins which extend out of the mother board toward the rear of the Terminal. Each interface module slides in from the rear of the Terminal and plugs onto this row of 48 pins, thus making connection with its respective functional module. When removing and replacing the interface modules, take care that the pins on the mother board are properly lined up so that they do not become bent when the module is seated.

4.30 Cable Assemblies

Assemblies:	24C1080	25M-25M Null Modem Cable	(Figure A-60)
	24C1081	25M-25F Null Modem Cable	(Figure A-61)
	24C1099	25M-25M Modem Cable Norm	(Figure A-62)
	24C1165	25M-25M Modem Cable 4x20	(Figure A-63)
	24C1167	9F-25M Modem Cable Norm	(Figure A-64)
	24C1168	9F-25M Modem Cable 4x20	(Figure A-65)
	24C1169	9F-25M Null Modem Cable	(Figure A-66)
	24C1170	9F-25F Null Modem Cable	(Figure A-67)
	24C1171	9F- 9F Null Modem Cable	(Figure A-68)

The following table lists the cable assemblies used to connect peripherals to the MRC-2.

Table 4-6. Cable Assemblies

Connection	Cable Used	MAI Part No.
CRT To Serial Int.	24C1080	2300754
CRT To Quad Serial Int.	24C1169	2301330
LOGGER to Serial Int.	24C1081	2300747
LOGGER to Quad Serial Int.	24C1170	2301398
MSD to Serial Int.	24C1080	2300754
MSD to Quad Serial Int.	24C1169	2301380
MDC to Serial Int.	24C1080	2300754
MDC to Quad Serial Int.	24C1169	2301380
Dial-Up Modem to Serial Int.	24C1165	2301356
Dial-Up Modem to Quad Serial Int.	24C1168	2301372
MSD to MDC	24C1080-5	2300861
PC (25-pin) to Serial Int.	24C1081	2300747
PC (25-pin) to Quad Serial Int.	24C1170	2301398
PC (25-pin) to Modem	MF2210	2301315
PC (25-pin) to MDC or MSD	24C1081	2300747
PC (9-pin) to Serial Int.	24C1169	2301380
PC (9-pin) to Quad Serial Int.	24C1171	2301406
PC (9-pin) to Modem	24C1167	2301364
PC (9-pin) to MDC or MSD	24C1169	2301380

4.31 Quad Serial I/O Module

Schematic: 91D7394 (Figure A-56)
Assembly: 20D2954 (Figure A-57)

The Quad Serial I/O module serves the following functions:

1. Provides an interface to the MRC bus, allowing data to be read from and written to the four Asynchronous Communications Interface Adapters (ACIAs) under the control of the Microprocessor.

2. Converts parallel data taken from the MRC bus into serial data for the Quad RS-232 Interface module.

3. Converts serial data from the Quad RS-232 Interface module into 8-bit parallel data suitable for the MRC bus.

4. Provides a crystal-controlled clock which supplies the ACIAs with selectable baud rates.

The Quad Serial I/O board has many components which are duplicated for each Serial I/O port. These components are indicated with a reference designator ending in a letter, e.g., S1A, S1B, S1C, and S1D. Components which are shared by the four ports do not end in a letter, e.g. U2. The descriptions below are written in the singular, but pertain to each port.

Drivers U11, U12, U13, and U14 serve as bus drivers and receivers, passing data to and from the microprocessor bus. Address decoding is performed by U8, U7 (or U9), U4 (or U5), U3, U6, and U10, ultimately controlling device-select lines *BSA-D, and *BS.

Switch S1 (board address) and positions 1 and 2 of S2 (block starting address) determine the memory addresses filled by ACIA U1:

S2-1	S2-2	Block Starting Address
Off	Off	8040h
Off	On	8140h
On	Off	8240h
On	On	8340h

Baud Rate Generator U2 and 1.8432MHz crystal Y1 form an oscillator and divider to generate square waves of various frequencies. S2 switch positions 3 through 8 are connected to the various output pins of U2. One of these switches is set to the ON position to route the desired frequency to the ACIA which then further divides the clock signal to produce the baud rate.

The ACIA provides the data formatting and control to interface serial data to the 8-bit data bus. A programmable control register, which is set when the system is initialized, determines word length, parity, transmission rate (clock divide ratio), etc. The *RTS (Request-to-Send) line may be turned on and off under program control, and the *CTS (Clear-to-Send) and *DCD (Data-Carrier-Detect) lines are used to enable sending and receiving respectively.

Driver U13, and LEDs CR1 (Tx) and CR2 (Rx) allow the user to monitor the activity on the transmit-data and receive-data lines to and from the Quad RS-232 Interface module.

Jumper block E1 determines which (if any) interrupt priority is used for the module.

4.32 Quad RS-232 Interface Module

Schematic: 91C7395 (Figure A-58)
Assembly: 20C2955 (Figure A-59)

The primary purpose of the Quad RS-232 Interface module is to convert the TTL compatible signals generated by the Quad Serial I/O module to signal levels meeting the RS-232 standard, and to convert incoming RS-232 signals to TTL levels acceptable to the Quad Serial I/O module.

The Quad RS-232 Interface board has many components which are duplicated for each serial port. These components are indicated with a reference designator ending in a letter, e.g., S1A, S1B, S1C, and S1D. Components which are shared by the four ports do not end in a letter, e.g. U2. The descriptions below are written in the singular, but pertain to each port.

Conversion from TTL levels to RS-232 levels and vice-versa is provided by U1. It contains four transmitters and four receivers. In addition, U1 has on-board charge-pump voltage converters which convert +5V to ± 10V RS-232 voltages. C1, C2, C3, and C4 are the charge-transferring capacitors.

The Quad Serial I/O module has two status inputs and one status output to accomplish "handshaking". The *RTS (request to send) line (an output from the Quad Serial I/O module) is inverted, converted to RS-232 levels and brought out to the rear connector as RTS. DTR (data terminal ready) is always active if power is applied to the module.

*CTS (clear to send) and *DCD (data carrier detect) are inputs to the Quad Serial I/O module from the Quad RS-232 Interface. The *CTS line is set low if the RS-232 DSR (data set ready) and CTS lines are both in a logic-positive condition.

Should the CTS line <u>or</u> the DSR line be in a false condition as defined by the RS-232 standard, incoming serial data will be ignored and the Quad Serial I/O module will not transmit data. (The decision to ignore incoming data and not transmit outgoing data takes place entirely on the Quad Serial I/O module. The Quad RS-232 Interface module plays no part in this.)

The MRC-2 Serial Ports are configured as DTEs (Data Terminal Equipment). The following summarizes the Quad RS-232 Interface (DB-9) connections (the DB-25 connections are given for comparison):

Function	DB-9S	DB-25
Chassis Gnd	shell	1
DCD	1	8
Rx Data	2	3
Tx Data	3	2
DTR	4	20
Signal Gnd	5	7
DSR	6	6
RTS	7	4
CTS	8	5
RI (not used)	9	22

4.33 File Memory

Schematic: 91D7485 (Figure A-60)
Assembly: 20D3073 (Figure A-61)

This board provides 64K bytes (56K for the MRC-2) of non-volatile storage in Electrically-Erasable Programmable Read-Only Memory (EEPROM).

Data is read and written to the EEPROM ICs via U5 and U6, Peripheral Interface Adapters (PIAs). One PIA (U5) is used to hold a 16-bit address. The other PIA (U6) is divided between eight data lines and eight control lines. Each PIA will respond to a block of four addresses. These addresses are determined by switch S1. The address decoding is performed by U11, U13, U14, and U7. Address buffering is provided by U12, U10, and U15, while data buffering is provided by U4. U9 determines bus direction for the data buffers.

Data written into the PIAs is latched and remains until other data is written to the PIAs. This permits file memory operations, which are relatively slow (10 ms write), to proceed while the microprocessor continues with its other tasks. When the EEPROM operation is complete, the microprocessor is notified via one of the interrupt lines.

Timing for erase and write operations is available from U8, a dual one-shot. The one-shot outputs are connected to the PIA via U9 such that the PIA generates an interrupt when the timing operation is complete.

The operations of the EEPROM are decoded by U7 and U9 and are as follows:

Function	C0	C1
Read	0	0
Write	1	0
Erase	0	1 (write FFh)
Block Erase	1	1 (not used)

For the MRC-2 set the switch and jumper as follows:

Location	Setting	Function
S1	0	Board select
E1	Int 5 (F)	Interrupt select

5

Section Five

Alignment and Troubleshooting Procedures

5.1 Introduction

This section provides a guide to isolate faults to the module level. Also included are descriptions of all module adjustment procedures. Troubleshooting information is included at the end of each adjustment procedure.

> ***Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution can cause damage to one or more modules.***

5.2 Handling CMOS Devices

The MRC-2 contains several MOS devices which unfortunately can be damaged by severe electrical transient voltages. A person walking over a waxed floor, depending upon floor conditions and humidity, can generate voltage potential in excess of 15 kV. The following is recommended to reduce damage to the MOS devices:

1. All CMOS devices should be stored in materials that are anti-static. CMOS devices must not be inserted into styrofoam.
2. All CMOS devices should be placed on a grounded bench surface and the user should be grounded before touching the device.
3. Nylon or other static generating materials should not come into contact with the device.
4. Do not remove modules or CMOS devices with power applied.
5. Treat modules that contain CMOS devices just like the device itself.
6. When wrapping a module for shipment, never use any plastic material that is not marked as being anti-static. Most anti-static plastic material is a pale pink color and is identified as such.
7. Always use grounded test equipment to diagnose problems, and ground the test equipment to the unit before placing probes on the circuits.

5.3 Module Address and Option Switches

Most modules contain small switches referred to as DIP switches, which select the address of the module and, in some cases, provide various common options on the module (see Table 5-1).

Table 5-1. HEX and DIP Switch Settings

Device Number	Channel Association	HEX Switch Position	DIP Switch Position 1	2	3	4
0	1 - 16	0	Off	Off	Off	Off
1	17 - 32	1	On	Off	Off	Off
2	33 - 48	2	Off	On	Off	Off
3	49 - 64	3	On	On	Off	Off
4	65 - 80	4	Off	Off	On	Off
5	81 - 96	5	On	Off	On	Off
6	97 - 102	6	Off	On	On	Off
7	103 - 128	7	On	On	On	Off
8	129 - 144	8	Off	Off	Off	On
9	145 - 160	9	On	Off	Off	On
10	161 - 176	A	Off	On	Off	On
11	77 - 192	B	On	On	Off	On
12	193 - 208	C	Off	Off	On	On
13	209 - 224	D	On	Off	On	On
14	225 - 240	E	Off	On	On	On
15	241 - 256	F	On	On	On	On

Since each module (except the CPU module) can be placed in any module slot, 2 through 15 on the mother board, there needs to be some way of identifying the module when it is inserted. This identification is called the module address and is composed of two parts:

1. A fixed hardwired address that identifies the module type.
2. A variable part of the address that identifies the particular module of a given type.

For example, if the system contains two Status Input modules, they are identical in all respects except for the switch positions. This allows the software to distinguish between the module that is assigned to channels 1-16 and the module that is assigned to channels 17-32.

For troubleshooting purposes, you may interchange modules of the same type, but be sure to set the switches to the proper setting before inserting the module.

The memory module requirements are listed for each Terminal in Table 5-2. If you interchange memory modules make sure the correct software is installed for each Terminal.

5.4 Fault Isolation - Level 1

The MRC-2 contains several indications to aid in fault isolation down to the module level. Always go through these steps before attempting to service the equipment.

1. The three green LED power indicators on the CPU modules indicate the presence of voltages. The LEDs should all glow with approximately the same brightness. If in doubt, check the voltages with a voltmeter.

2. Depress the **RESET** switch (S1) on the CPU module. This forces the CPU to begin the program from the beginning. When reset, all LEDs on the front panel will illuminate briefly. Should the LEDs remain on, the fault could be either in the CPU or memory modules (96K ROM or 32K RAM).

3. If simple command functions like SITE, TEST, or CHAN keys function properly, the most likely candidate is the modem. In most likelihood, the levels need adjustment refer to the Modem module alignment in Section 5.7. If the bottom LED of the modem is flashing, it indicates that the modem is being keyed. An ac voltmeter across the output circuit should indicate a voltage that varies in step with the LED. If there is no voltage, check the fuses in the Modem-Telco Interface module.

4. If data is getting out onto the communications circuit from the Control Terminal, determine if the Remote Terminal is receiving data. The top LED on the Remote modem should flash in step with the transmit LED of the control Terminal. When the Remote Terminal transmits, its transmit LED will illuminate, which in turn should cause the receive LED at the Control Terminal to be illuminated. You can force the modem to transmit by activating the TEST switch on the front of the Modem module.

   When using a 2-wire line, the modem hears itself transmit. You will see the transmit LED flash, and the receive LED will be on most of the time with a periodic short-duration off period.

5.5 Fault Isolation - Level 2

The following is a guide to the isolation of problems that are associated with the various sensor inputs to the MRC-2. Each input or output, if subjected to an overvoltage or overcurrent condition, will, in general, affect only a single sensor. If any single telemetry, status, or command function fails to function properly, first check the external wiring carefully. With the suspect module placed on the Extender board, determine if the signal is present at the input (or output) of the final transistor or gate on the module. If optically-isolated inputs or outputs are involved, be sure that a voltage source is provided and measure the voltages differentially with respect to the chassis. Also, with the telemetry signals, a minimum voltage of 0.25 V must be present across the two inputs in order to calibrate a telemetry channel.

Because of the very heavy filtering that is done on all lines that pass through the interface modules, do not expect the system to respond to very-short-duration pulses. The problem of keeping stray RF energy out of the Remote Terminal places a number of constraints on the response time of all inputs and outputs of the MRC-2. Due to the filtration used on analog inputs, step charges will take on the order of one second to stabilize. The filters are overdamped so that ringing will not occur and cause spurious alarms.

A Terminal may not function properly due to the RF fields present if the front panel is open or modules are placed on extender boards. The MRC-2 has been subjected to operation in AM, FM, TV and combination transmitter environments with confirmed success. However, since we have no control over your particular environment, no guarantee is made that the unit will function open in all circumstances.

Table 5-2. Module Configuration

Module	Switches or Jumpers	Setting	Function
Control Terminal Front Panel, 20D2804	S2, S1	00	Site
	S3	1	*Special--see below.
Remote Terminal Front Panel, 20D2804	S2, S1	1 - 64	Site
	S3	1	*Special--see below.
	E2-A	If installed	Adds 2 rings to RT answer.
	E2-B	If installed	Adds 4 rings to RT answer. Default minimum is 1 ring.
	E2-C	If installed	Adds 30 seconds to RT dial-out delay.
	E2-D	If installed	Adds 60 seconds to RT dial-out delay. Default is 0-second delay.
*CT & RT Front Panel	S3, S2, S1	099	Erase File Memory
	S3, S2, S1	199	Expand File Memory
DACU Front Panel, 20D2809	S1A, S1B	00	Not used
6809 CPU, 20D2793	A-B	Installed	Interrupt vector select
	C-D	None	Not used
96K ROM, 20D2929	S1	96K	Mode select
	S2-1	On	Mode (On = 96K)
	S2-2	Off	Bank select (Off = Top)
	S2-3	Off	Not used
	S2-4	Off	A16 (Off = Norm)
32K RAM, 20D2930 for CT or RT	U6	RAM	
	U7	RAM	
	U8	RAM	
	U9	NONE	
32K RAM, 20D2930 for DACU	U6	RAM	
	U7	RAM	
	U8	ROM	
	U9	ROM	
File Memory Controller, 20D2789	S1	0	Board Address
	E1	Int 5(F)	Interrupt select

Table 5-2. Module Configuration

Module	Switches or Jumpers	Setting	Function
File Memory Extension, 20D2790	S1	0 - 7	Board Address
Modem, 20D2787	S1	Oper	Receive test
	S2	Oper	Transmit test
	S3	0-7	Board Address
	S4-1	Off	Deadman circuit
	S4-2	Off	Baud select (1200)
	S4-3	Off	Baud select (1200)
	S4-4	Off	Not used
Serial I/O, 20D2800 for MODEM or for PC	S1	0 - 7	Board Address
	S2-1	Off	Block Address
	S2-2	Off	"
	S2-3	On	TX LED
	S2-4	On	RX LED
	E1	none	Internal baud select
	E2	D(Int 3)	Interrupt select
Serial I/O, 20D2800 for MSD/MDC	S1	0	Board Address
	S2-1	On	Block Address
	S2-2	On	"
	S2-3	On	TX LED
	S2-4	On	RX LED
	E2	E(Int 4)	Interrupt select
Serial I/O, 20D2800 for VDT	S1	0 - 3	Board Address CT
		0	Board Address RT
	S2-1	On	Block Address
	S2-2	Off	"
	S2-3	On	TX LED
	S2-4	On	RX LED
	E2	C(Int 2)	Interrupt select
Serial I/O, 20D2800 for Logger	S1	8 - B	Board Address CT
		8	Board Address RT
	S2-1	On	Block Address
	S2-2	Off	"
	S2-3	On	TX LED
	S2-4	On	RX LED
	E2	B(Int 1)	Interrupt select
Serial I/O, 20D2800 for Debugger	S1	F	Board Address
	S2-1	On	Block Address
	S2-2	On	"
	S2-3	On	TX LED
	S-4	On	RX LED
	E2	G(Int 6)	Interrupt select

Table 5-2. Module Configuration

Module	Switches or Jumpers	Setting	Function
Quad Serial I/O, 20D2954 for MODEM or for PC	S1	0 - 7	Board Address
	S2-1	Off	Block Address
	S2-2	Off	"
	S2-3	Off	300 Baud
	S2-4	On	1200 Baud <-
	S2-5	Off	2400 Baud
	S2-6	Off	4800 Baud
	S2-7	Off	9600 Baud
	S2-8	Off	19.2k Baud
	E1	Int 3	Interrupt select
Quad Serial I/O, 20D2954 for MSD/MDC	S1	0	Board Address
	S2-1	On	Block Address
	S2-2	On	"
	S2-3	Off	300 Baud
	S2-4	On	1200 Baud <-
	S2-5	Off	2400 Baud
	S2-6	Off	4800 Baud
	S2-7	Off	9600 Baud
	S2-8	Off	19.2k Baud
	E1	Int 4	Interrupt select
Quad Serial I/O, 20D2954 for VDT	S1	0 - 3	Board Address CT
		0	Board Address RT
	S2-1	On	Block Address
	S2-2	Off	"
	S2-3	Off	300 Baud
	S2-4	Off	1200 Baud
	S2-5	Off	2400 Baud
	S2-6	Off	4800 Baud
	S2-7	Off	9600 Baud
	S2-8	On	19.2k Baud <-
	E1	Int 2	Interrupt select
Quad Serial I/O, 20D2954 for Logger	S1	8 - B	Board Address CT
		8	Board Address RT
	S2-1	On	Block Address
	S2-2	Off	"
	S2-3	Off	300 Baud
	S2-4	Off	1200 Baud
	S2-5	Off	2400 Baud
	S2-6	On	4800 Baud <-
	S2-7	Off	9600 Baud
	S2-8	Off	19.2k Baud
	E1	Int 1	Interrupt select

Table 5-2. Module Configuration

Module	Switches or Jumpers	Setting	Function
Quad Serial I/O, 20D2954 unused ports	S1	1-4	Board Address
	S2-1	On	Block Address
	S2-2	On	"
	S2-3	Off	300 Baud
	S2-4	Off	1200 Baud
	S2-5	Off	2400 Baud
	S2-6	Off	4800 Baud
	S2-7	Off	9600 Baud
	S2-8	Off	19.2k Baud
	E1	none	Interrupt select
Delay Control, 20D2801	S1	0	Board Address
GPIB-488, 20D2791 for Remote Terminal	S1	0	Board Address
	S2	0	Talk-listen address
	Jumper	None	Interrupt select
GPIB-488, 20D2791 for DACU	S1	0	Module address
	S2	1 - 8	Talk-listen address
	Jumper	Int 0	Interrupt select
Analog Input III, 20D2897	S1	0 - F	Board Address
Status Input, TTL, 20D2798	S1	0 - F	Board Address
Status Input, Opto, 20D2795	S1	0 - F	Board Address
Command Output, Open Collector 20D2755	S1	0 - F	Board Address (binary progression--Table 5-1)
Command Output Optically Isolated, 20D2705	S1	0 - F	Board Address (binary progression--Table 5-1)
Parallel Input, 20D2822	S1	0 - F	Module address
	S2,S3,S4	000	Not used
	S5	0 - 9	Interpret: 0-7 = BCD 8 = 15-bit binary plus sign 9 = 2's complement
	Jumper	None	Interrupt select

Table 5-2. Module Configuration

Module	Switches or Jumpers	Setting	Function
Hayes Smartmodem 1200	S1-1	U	DTR controlled
	S1-2	D	Digit results(terse mode)
	S1-3	D	Result codes sent
	S1-4	D	No echo-full duplex
	S1-5	U	Answer on first ring
	S1-6	D	DCD always on
	S1-7	U	RJ11 Jack
	S1-8	D	Enable commands
	S1-9	U	103/212A compatible
	S1-10	U	Hang-up command state
CPU Interface, 20C2781	Auto Restart Jumper	Installed	
	Cont. Restart Jumper	Installed	
Serial Interface, 20C2803 for MODEM or for PC	S1-5	On	Baud select (1200)
	S1-Others	Off	
Serial Interface, 20C2803 for MSD/MDC	S1-5	On	Baud select (1200)
	S1-Others	Off	
Serial Interface, 20C2803 for ADDS Viewpoint or 2020 or 2060 VDT	S1-2	On	Baud select (19200)
	S1-Others	Off	
Serial Interface, 20C2803 for ADDS Regent 40 VDT	S1-1,8	On	Baud select (9600)
	S1-Others	Off	
Serial Interface, 20C2803 for Genicom 2030 Logger	S1-2,8	On	Baud select (4800)
	S1-Others	Off	
Serial Interface, 20C2803 for Model 43 Logger	S1-5,8	On	Baud select (300)
	S1-Others	Off	
Serial Interface, 20C2803 for Debugger	S1-2	On	Baud select (19200)
	S1-Others	Off	

5.6 Suggested Test Equipment

The following items of test equipment (or equivalent) are suggested for use in the adjustment procedures.

Name	Manufacturer/Model
Multimeter	Simpson 260 or equivalent
Audio Frequency Counter	Data Precision 5740 or equivalent
Oscilloscope/ Dual-trace	DC to 50 MHz bandwidth

5.7 Module Adjustments and Troubleshooting Information

This section is intended to provide additional technical information to assist you during alignment, troubleshooting, and module repair and replacement.

The modules are discussed in the same order as in Section 4.

5.7.1 Main Front Panel

Schematic: 91D7253 (Figure A-1)
Assembly: 20D2804 (Figure A-2)

Adjustments

The time-of-day oscillator has been adjusted at the factory for 32.768 kHz using a special test program. This adjustment cannot be accurately made by the user, so we recommend not adjusting C19.

Troubleshooting

Determine which parts of the front panel are inoperative. If the whole front panel seems inactive, check the following:

1. Depress the **TEST** key momentarily. If none of the displays illuminate, the CPU program may have stopped running. Open the front door on the Control Terminal and observe the LEDs on the Modem module. If the bottom modem LED is not blinking, depress the **RESET** button on the front of the CPU module. This should start the program running again. If it does not, it may be necessary to momentarily turn off the power to the Terminal and then turn it back on again.

Caution: Remember that by depressing the CPU RESET button (or turning the power off) on a DACU or RT will cause all command channels in that terminal programmed for the Latching mode to go to the "OFF" condition.

2. Verify that +5 V and GND from the chassis are con-nected to the front panel on P2 and P3, respec-tively. Verify that +5 V is present on the front panel.

3. Verify that the interconnect cable between the CPU module and the front panel is connected correctly. There should not be a twist in the cable (i.e., pin 1 should be on the bottom at both ends). Check for bent pins on the connectors.

4. Check for activity on U21 pin 1. If not present, remove U21 and check again at pin 1. If still not present, the problem probably is not on the front panel. If activity is now present, suspect U21. Replace U21.

5. Remove U18. Check for activity on U21 pin 11. If not present, suspect U20 or U21. Reinstall U18.

6. Check for activity on the address lines (FPA7-FPAO) and data lines (FPD7-FPDO). If one or more lines are not active, suspect ICs connected to the inactive lines.

If any single front panel function is inactive, locate the specific troubleshooting section and perform those steps.

A. Decoding

The steps for troubleshooting this circuit are steps 4 and 5 above.

B. Display

Depress the **TEST** key momentarily. If one segment, one character, or four characters on the same display IC (U2-U13) are bad, then suspect that IC. The IC may be exchanged with an adjacent one. If the problem moves with the IC, replace it with a new one.

If all or a group of several display ICs are not working, then perform the following: Any measurements on U2-U13 must be done on the rear of the module.

1. Verify +5 V at each IC in the display section (U1-U13, U17, and U19).

2. Verify a high level at pin 18 of ICs U2-U13.

3. Verify activity on U17 pin 5. If not present, suspect U19. Verify activity on U17 pins 7 and 9-15. If not present, suspect U17 or U2-U13.

4. Compare the inputs and outputs of U1 and U16. If not the same, suspect U1 or U16, or U2-U13.

5. Verify activity on U16 pins 4 and 8. If not active, suspect U19.

6. Verify activity on U1 pin 17. If not present, suspect U21.

C. Keyboard Encoder

If a single switch function is not working, suspect that specific switch.

If all switches are not working, perform the following:

1. Verify +5 V on U15 pin 1 and -12 V at U15 pin 18. If -12 V is not present, suspect VR1. Verify ground at U15 pins 4, 5, 6, and 20.

2. Check for activity on U15 pins 2, 3, 8-15, and 32-40. If not present, suspect C6, R3, or U15.

3. Depress the "7" key repeatedly and check for activity on U15 pin 16. If not present, suspect U15.

4. Depress the "7" key repeatedly and check for activity on U19 pin 12. If not present, suspect U19 or U21.

5. Depress the "7" key repeatedly and check for activity on U24 pins 1 and 15. If not present, suspect U19, U20, or U24.

D. System Status

Depress the **TEST** key momentarily. If a single LED (CR41-CR46) is not lighted, suspect that LED.

If the audio indicator is not working, check that the CPU and CPU Interface modules are firmly seated. Check to see that there is a jumper between pins 5 and 6 on the connector on the rear of the CPU Interface module.

If all LEDS are not working, then perform the following;

1. Verify +5 V at U18 pin 20.

2. Check for activity on U18 pin 11. If not present, suspect U20 or U21. Otherwise, Suspect U18.

E. Time-of-Day Clock

If time can be set (from the CRT Display or Automatic Logging options) but the clock does not keep time after power interruptions, then with power on, check for +5 V at U23 pin 24. Now turn the power off. Check for +3.4 V to +4.2 V at U23 pin 24. If not present, suspect BTI, Q2 or Q3. If it is present, suspect U20 or u23. Turn the power back on.

If time cannot be set or is unreliable, perform the following:

1. Verify +5 V at U23 pin 24. If not present, suspect Q1 Or Q3.

2. Verify a 32.768 kHz signal at U23 pin 11, If not present, suspect Y1 or U23.

3. Check for activity on U23 pins 1 and 2. If not present, suspect U20 or U21. Otherwise suspect U23.

F. System Configuration Switches

(Note: These switches are normally only read upon power up or from a "Reset" condition. Therefore, normally there is no activity in circuit. To trouble shoot, the RESET switch on the front of the CPU module must be periodically pushed.)

1. Make sure the correct jumpers are installed. See note 5 on the schematic.

2. Verify +5 V at U22 pin 15 and U14 pin 20.

3. Check for activity on U22 pins 1 or 15 or U14 pins 1 or 19. If not present, suspect U20 or U22.

4. Check for activity on U22 pin 9. If not present, suspect U22.

5. Check for activity on U14 pin 2. If not present, suspect one of the switches or diodes.

5.7.2 6809 CPU Module

Schematic: 91D7252 (Figure A-3)
Assembly: 20D2793 (Figure A-4)

> ***Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.***

Adjustments

Power Fail Threshold adjustment R4 has been adjusted at the factory. If necessary, it may be adjusted as follows: Turn R4 counter-clockwise until CR1 (reset) illuminates. Then, turn clockwise until the LED goes off. Continue turning R4 for two more full turns.

A jumper (trace) should be installed between points A and B on the module. There should be no continuity between points C and D.

Troubleshooting

The following tests assume that ROM, RAM and CPU Interface modules are installed:

A. MPU

1. Check the three green LEDs (CR2-CR4) for approx-imately equal brightness. If in doubt, check the actual voltages at R1-R3. Check for +5 V at each IC.

2. The red RESET LED should be off except when switch S1 is depressed or during initial power up. If it is on, perform the adjustment described in the Adjustments subsection. If it is still on, suspect one of the ICs connected to *RESET.

3. Verify a 1 MHz square wave at U1 pin 34 and at U1 pin 35. If not present, remove U2, U3, U7, U20, and U21. If it is still not present, suspect Y1 or U1. If it is now present, suspect one of the removed ICs. Reinstall the removed ICs.

4. Verify a high logic level at U1 pins 2, 4, 33, 36, and 40. If not high, suspect U20 or a pull-up resistor.

5. Verify activity on U8 pin 32 (R/*W). If not present, suspect U1 or another IC connected to R/*W (U2, U3, U9, U15, U20, or U21).

B. Bus Control

1. Verify activity on U8 pin 8. If not present, suspect U5, U6, U7, U8, U9, or U13.

C. **Bus Drivers**

1. Verify activity on U20 pins 3, 5, 7, and 12. If not present, check the corresponding inputs (pins 17, 15, 13 and 8, respectively). If present on the inputs, suspect U20.

2. Compare the inputs and outputs of U16, U17, U18, and U19. The inputs and outputs should have equivalent duty cycles, but not necessarily the same amplitude.

D. **Address Decoding**

1. Verify activity on U13 pin 9. If not present, suspect U13, U7, or U9.

2. Verify activity on U9 pin 8. If not present, suspect U9, U10, or U11.

3. Verify activity on U11 pin 8. If not present, suspect U11, U12, U2, or U3.

E. **Priority Interrupts**

1. Verify approximately 20 ms low-going pulses on U21 pin 23. If these pulses are not also present on U21 pin 11, suspect U21.

F. **Front Panel Connections**

1. Verify activity on U2 pin 19. If not present, disconnect the front panel cable. If still not present, suspect U2.

2. Check also for activity on U2 pins 2-17. If not present, suspect U2.

G. **CPU Interface Connections**

1. Verify low-going pulses on U3 pins 6 and 9. If not present, suspect U3 or the CPU Interface module.

2. Verify low-going pulses on U3 pin 38. If not present, check U3 pin 40 for a 60 Hz square wave. If the square wave is present, suspect U3. If not present, suspect the CPU Interface module.

5.7.3 CPU Interface

Schematic: 91C7215 (Figure A-5)
Assembly: 20C2781 (Figure A-6)

Adjustments

1. Battery Charge Voltage (R28): This control is set at the factory for 6.95 V $\pm$ .1 V into 270 Ohm load. The battery charge circuit is not used for the MRC-2. This should not need adjustment.

Troubleshooting

1. Specific areas on this module that must be functional for operation of the CPU are as follows:

   a. Verify presence of +5 V on the 5 V standby bus (emitter of Q4). If it is not there, check for short to ground or Q3 open.

   b. Check for waveform at P1-11 and P1-13 (ac power in). If not there, check CR1, CR2, C1 and the two 100 Ohm resistors mounted on the dc power supply (R113 and R114).

   c. Check voltage at pin 4 of U1. It should be between 3.0 and 3.2 volts. If not, check U1 and CR3.

   d. Check voltage at U1 pin 2 (*PF). If it is low, try readjusting the trim potentiometer on the CPU module (R30). If this does not correct it, check for shorts or replace U1.

   e. If *PF is normal but *RESET is still low, check for at least 4.5 V at pin 6 of U1 and 2.5 to 3.5 V at pin 7. If these are normal, pin 1 of U1 should be less than 0.5 V If not, suspect U1. THe collector of Q1 (P1-59) should be near +5 V. If not, check U3 pin 5, which should be near ground. If not, suspect U3. If U3 pin 5 is indeed near ground, suspect Q1, Q6, or a short to ground at P1-59.

   f. Check waveform at U1 pin 13. If a 60-Hz square wave is not present, suspect CR5 or U1.

2. Circuits that will not stop operation of the CPU are:

   a. Maintenance override and failsafe drivers can be checked with a VOM; most probable cause of failure is U4 or U5.

   b. When main power is applied to the unit, U1 pin 14 should be near +5 V. If it is not, try momentarily grounding pin 8. If pin 14 is still low, suspect CR6, C6 or U1.

   c. If the voltage at the red (+) battery terminal is not around 7.3 V, suspect U2 or R28 if the voltage is too high. If too low, suspect Q4 or Q5.

5.7.4 96K ROM Board

Schematic: 91D7370 (Figure A-7)
Assembly: 20D2929 (Figure A-8)

> ***Caution:** Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.*

Troubleshooting

1. Verify that the switch settings and EPROM configurations are correct (see Table 5-2).

2. Verify that +5 V is present on the Vcc, Vpp, and PGM pins of U6 through U17. Verify 0V on the GND and S pins.

3. Verify activity on the SEL lines of any EPROMS which are installed. If there is not activity present, U4 or U5 may be suspect, but see Step 6 below.

4. Verify activity on address lines A0 through A15 (U2 and U1 pins 2 through 9) and VMA. If there is no activity present, U1 or U2 may be suspect, but see Step 6 below.

5. Verify activity on data lines D0 through D7 (U3 pin 2 through 9). If there is no activity, suspect U3 or one of the EPROMs (U6 through U17), but see Step 6 below.

6. The best way to confirm a suspected problem on this board is to exchange it with an identical board from another chassis. Begin by exchanging EPROMs between the two boards. If the problem moves with the board, the 96K board is confirmed as the source of the problem. Otherwise, the problem could be on another board or in an EPROM.

   Please use caution when removing and installing EPROMs. They are MOS devices (see Section 5.4, Fault Isolation for precautions). It is easy to bend a pin without noticing it when installing the part. It is also easy to install them backwards or in the wrong part of the socket. Check your EPROM installation very carefully before returning the board to the chassis.

7. Remove the EPROMs from the suspect board and install them, with care, in exactly the same configurations on a duplicate board. Be sure the switches are in the same positions as the suspect board. Remove U3 from the suspect board, which will allow both boards to run at once. Install both in the terminal. If the terminal fails to run, suspect a short on the board or a failure in one of the remaining parts which are directly in contact with the bus (U1, U2, U4 or U5).

8. Otherwise, proceed by comparison between the suspect module, which is being "exercised" by the bus (although it cannot modify the data bus because U3 has been removed), and the duplicate board, which, of course, is successfully working. Compare the address lines on both boards. If they are not exactly the same, suspect U1 or U2. Otherwise, compare the SEL lines of U6 through U17 of each board. The corresponding SEL lines should go low at the same time on each board. If not, suspect U4 or U5. If each EPROM socket appears to be receiving exactly the same signals, check for shorts or opens on data lines D0 through D7.

5.7.5 32K RAM Board

Schematic: 91D7371 (Figure A-9)
Assembly: 20D2930 (Figure A-10)

Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.

Troubleshooting

1. Verify that the RAM configurations are correct (see Table 5-2). If the necessary RAM has not been installed, the entire system will not work properly. However, extra ICs beyond those required will not prevent the system from working properly.

2. Verify activity on the SEL lines of any RAMs which are installed. If there is no activity present, U5 or U10 may be present, but see Step 5 below.

3. Verify activity on address lines A0 through A15 (U2 and U3 pins 2 through 9) and VMA. If there is no activity present, U2 or U3 maybe suspect, but see Step 5 below.

4. Verify activity on data lines D0 through D7 (U4 pins 2 through 9). If there is no activity suspect U4 or one of the RAMs (U6 through U9), but see Step 5 below.

5. The best way to confirm a suspected problem on this board is to exchange it with an identical board form another chassis. Begin by exchanging RAM ICs between the two boards. If the problem moves with the board, the 32K board is confirmed as the source of the problem. Otherwise, the problem could be on another board or in a RAM IC.

   Please use caution when removing and installing RAMs. They are CMOS devices (see Section 5.4, Fault Isolation for precautions). It is easy to bend a pin without noticing it when installing the part. It is also easy to install them backwards or in the wrong part of the socket. Check your RAM installation very carefully before returning the board to the chassis.

6. If the board is still suspected of being the problem, begin exchanging ICs, one at a time, with the known working board.

5.7.6 File Memory Controller

Schematic: 91D7250 (Figure A-11)
Assembly: 20D2789 (Figure A-12)

Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.

Troubleshooting

1. If the entire Terminal fails to run, remove the File Memory Controller and its associated Extension modules. If the Terminal still doesn't run, it can be assumed the File Memory Controller is not the cause.

2. Check that switch S1 and the interrupt jumper are set correctly (see Table 5-2).

3. Check that the module is firmly seated into the mother board, and that the guide pin is in place in the mother board socket.

4. Check that the switch settings on all File Memory Extension modules are correct. The settings start at 0 and run consecutively upward.

5. Check that the File Memory Interconnect cable is properly installed. It is possible to seat the cable quite convincingly and yet for a pin to be bent under the connector. It is also possible to insert the cable so it is connected to only one row of pins.

6. Failures on this module can be grouped into two broad classes: Partial failures where some functions remain operational, and total failures, where the system totally fails with the module installed. If the failure is partial, proceed to step 10 below.

7. Check that all three power supply lights on the front of the CPU module are lit, indicating proper power supply. If not and if the power supplies are normal when the module is removed, suspect Q3, Q4, or VR2 if the problem involves the +15 V or -15 V power supplies. Otherwise suspect a short on the module.

8. If the power supply is normal, total nonoperation of the entire chassis will probably involve U7 and U14. Verify that pin 1 of U7 or U14 is not continuously low. If it is, work backward from U15 through the address decoding network until the malfunctioning logic gate is found (i.e., where the output is inappropriate for the inputs).

9. If pin 1 of U7 or U14 is not continuously low, remove U7, U14, U16, U18, and U21. If the chassis still fails to work, suspect a short on the module.

10. In the event of partial failure, the -12 V power supply should be checked, at the output of VR2 and at pin 2 of U2, U3, U4, and U5.

11. The -30 V supply should be checked at the output of VR1. If it is not at -30 V, verify that approximately -42 V ($\pm$ 5 V) is present at the input terminal and -15 V at the ground terminal. If so, suspect VR1.

12. If there is not approximately -42 V ($\pm$ 5 V) at the input terminal of VR2, suspect U6, Q3, and Q4. A square wave of approximately 250 Hz from +15 V to -15 V should be observed at pin 6 of U11.

13. Check that +5 V and not -30 V appears at pin 1 of U2, U3, U4, and U5. If -30 V is observed, check that the emitter of Q1 is at -30 V. If it is not, remove U1. If the emitter of Q1 then goes to -30 V, suspect U1. If the emitter of Ql does not go to -30 V, suspect Q1.

14. If -30 V appears at the emitter of Ql and also at pin 1 of U2, U3, U4, and U5, replace Q2.

15. Remove U7 and U14 from the module, reinsert the module into the chassis, and push the **RESET** button on the CPU module. This will initialize all pins of both PIAs to inputs. Apply an 0 to 5 V 20 Hz square wave to pin 17 of U11. Approximately 1.2 ms after each rising edge at pin 17 of U11, a falling edge should be seen at pin 4 of U13. If not, suspect U13.

16. Apply an 0 to 5 V 20 Hz square wave to pin 15 of U11. Approximately 12 ms after each rising edge, a falling edge should be seen at pin 12 of U13. If not, suspect U13.

17. Apply +5 V to U10, pin 19. -30 V should be observed at pin 1 of U2, U3, U4, and U5. If not, check that -15 V appears at pin 4 of U1. If not, suspect U1. If -15 V is at pins 4 of U1, check that less than 1 V is present at the emitter of Q1. If not replace Q1; otherwise suspect Q2.

5.7.7 File Memory Extension

Schematic: 91D7251 (Figure A-13)
Assembly: 20D2790 (Figure A-14)

Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.

Troubleshooting

1. Verify that the File Memory Interconnect cable is properly installed. It is possible to seat the cable quite convincingly and yet for a pin to be bent under the connector. It is also possible to insert the cable so it is connected to only one row of pins.

2. Check that the switch S1 settings on all File Memory Extension modules are correct. The settings should start at 0 and run consecutively upward.

3. Check that the File Memory Controller and all associated Extensions are firmly seated into the Mother board, and that the guide pins are in place in the Mother board sockets.

4. Check that all three power supply LEDs on the front of the CPU module are lit, indicating proper power supply. If not, and if the power supplies are normal when the File Memory Extension module is removed, suspect VR1 when the problem involves the +15 V supply. Otherwise, look for a short on the module.

5. Since this module works in close conjunction with the File Memory Controller module, first verify proper operation of the File Memory Controller module when operated without any extensions. This can be done by removing the File Memory Interconnect cable and all Extension modules. The system should begin to work (except of course for diminished memory capacity). If it does not, go through the troubleshooting procedure for the File Memory Controller.

6. If the system functions correctly with the Controller operating alone but malfunctions with the Extensions installed, the problem may be on the Controller module, in the interconnect cable, or in one or more Extension modules. Trouble-shooting must be done on all three as a unit.

7. If you have more than one Extension module, test each Extension module in turn, setting S1 on each Extension module to position 0. If the problem is on a single Extension module, it should be possible to determine by this method which is causing the problem.

8. Remove power from the system and check for con-tinuity through the cable and connectors. This can be done with a VOM or similar tool. The internal wiring of the cable is straight-forward, e.g., pin 1 of each connector is connected with pin 1 of every other connector.

9. Remove U7 and U14 from the Controller (not the Extension), reinsert the module into the chassis, reconnect the interconnect cable, and push the Reset button on the CPU module. Verify that -30 V is not present on pin 1 of U1-U16. If -30 V is not observed, go to step 12. If -30 V is observed, check pin 1 of U17 (EXTENAB). If this line is high, suspect U11 on the Controller module.

10. If pin 1 of U17 is low, look at pin 4 of U21, which should be at approximately -30 V. If so, suspect Q1 and Q2. If it is not at approximately -30 V, suspect U21.

11. With U7 and U14 still removed from the Controller module, remove U17 from the Extension module, reinstall the module, apply power, and push RESET on the CPU module.

    Apply +5 V to pin 3 of the socket where U17 was installed. pin 1 of U1-U16 should go from +5 V to -30 V as +5 V is applied. If not, suspect CR1 CR1, U21, Q1, and Q2.

5.7.8 GPIB-488 Module

Schematic: 91D7254 (Figure A-15)
Assembly: 20D2791 (Figure A-16)

Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.

Troubleshooting

1. Check that switches S1 and S2 and Header E1 have been set properly for the chassis where the module is installed (see Table 5-2).

2. Check that the interconnecting cable(s) are securely fastened at every Terminal interconnected by the bus. Make sure none of the pins in the rear connector or in the connectors on the cable are bent under or touching each other.

3. Make sure that all modules are firmly seated with the guide key properly inserted, and that all three green LEDS on the CPU module are lit, indicating proper power supply.

4. Verify that the Terminal operates properly with the GPIB-488 module removed. If it does not, it may be assumed that the problem does not involve this module.

5. Failures on this module may be divided into two broad types: those that prevent the entire Terminal from operating, and those that affect intercommunication without affecting other func-tions of the Terminal in a serious way. If the entire Terminal fails to function with the GPIB-488 module installed, remove U7, U8, and U13 and reinstall the module. If the Terminal does not resume operation, suspect a short or open on the module, or a failure in one of the remaining circuits which make contact with the motherboard of the Terminal (U1, U10, and U15).

6. If the Terminal resumes operation after U7, U8, and U13 are removed, examine U4 pin 6. If it is continuously low, work backward until the malfunc-tioning gate is found. (U3 pin 4 should not be steadily low. If it is, replace U3.)

7. If the failure is partial and the Terminal con-tinues to operate even with all components of the module installed, install the module in a chassis where it will act as a controller, in place of the module presently in the chassis. Make sure S1, S2, and the jumper in header E1 are set correctly (see Table 5-2). Disconnect the interconnect cable. Examine U14 pins 4, 5, and 6 and check that the three-wire handshake described in Section 4.10. is present, at least intermittently.

8. If the characteristic three-wire handshake was not observed in step 8, go to step 13. Otherwise check that U14, pins 11 and 13 vary between high and low values as the system operates. If not, suspect U3, U5, and U9.

9. Check that the three-wire handshake occurs during periods when U14, pins 11 and 13 are not low. If not, suspect U2 and U14.

10. Check that the outputs of U16 faithfully reflect the inputs. If not, replace U16. Check that the outputs of U5 are proper NOR functions of the inputs.

11. If none of the above tests disclosed a failure, suspect the Interface module, the cable, or one of the other chassis connected to the bus.

12. If no three-wire handshake is ever observed, suspect U3, U2, U14, and U9.

5.7.9 GPIB-488 Interface

Schematic: 91C7255 (Figure A-17)
Assembly: 20C2792 (Figure A-18)

Troubleshooting

Check for foreign particles across the connector pads, broken traces, and improper solder joints.

5.7.10 Modem II Module

Schematic: 91D7233 (Figure A-19)
Assembly: 20D2787 (Figure A-20)

> ***Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.***

Adjustments

Normally no adjustments need be made to the high frequency, low frequency, and VCO controls (R36, R35, and R11) . These are painted at the factory with red lacquer to discourage casual adjustment. The procedure for making these adjustments is described in the Frequency and VCO Adjustments, but it should be stressed that such adjustments are unnecessary under normal circumstances.

Each of the procedures outlined below assumes a one-site system. For multi-site systems, each Remote Terminal must be connected in turn and adjusted individually before they are all connected in parallel. When more than two sites are connected in parallel at one modem, be sure the 600 Ohm output impedance is properly matched. We suggest that initial adjustment be made with the Terminals back-to-back on the bench to gain familiarity with the controls prior to installation.

Test Equipment

Name	Manufacturer/Model
Multimeter	Simpson 260 or equivalent
Audio Frequency Counter	Data Precision 5740 or equivalent
Oscilloscope/Dual-trace	DC to 50 MHz bandwidth

Procedure

In the following adjustment procedure, refer to Figure 5-6 for the location of controls and test points on the Modem II module.

1. Connect the Control and Remote Terminals back-to-back on the bench. For a two-wire system, see Figure 5-2. For a four-wire system, see Figure 5-3 For a mixed Telco and subcarrier system, see Figure 5-4. For systems using a subcarrier interconnect in both directions, see Figure 5-5.

(Note: A simulated telephone line with 30 dB loss may be constructed using a T pad with 560 Ohms in each arm and 37 Ohms in common (see Figure 5-1).)

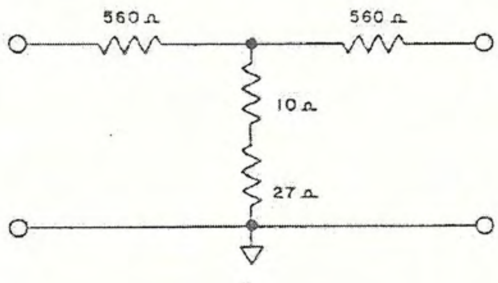

Figure 5-1
Simulated 30 dB Phone Line

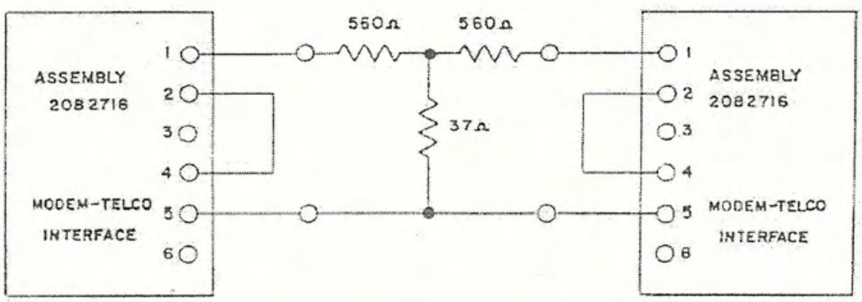

Figure 5-2
Two-Wire Test Interconnect

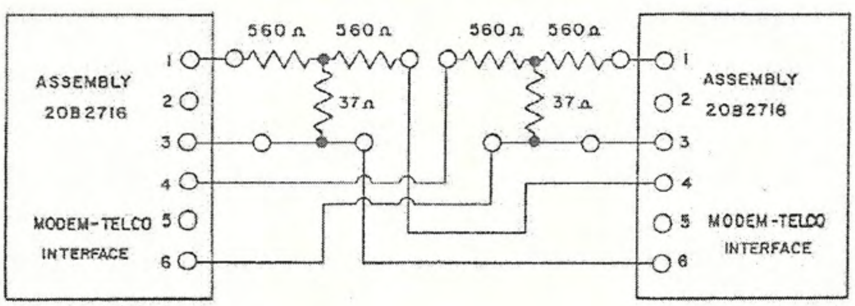

Figure 5-3
Four-Wire Test Interconnect

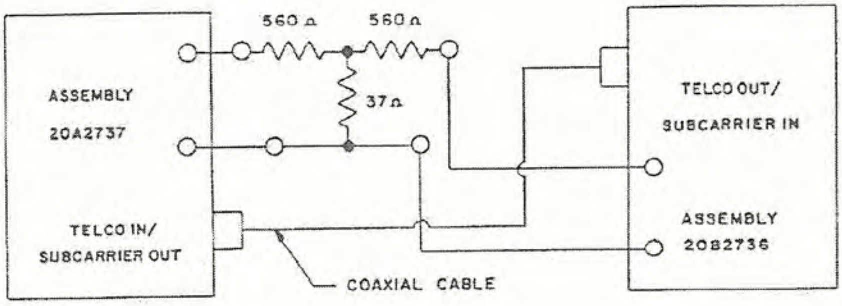

Figure 5-4
Mixed Subcarrier and Telco

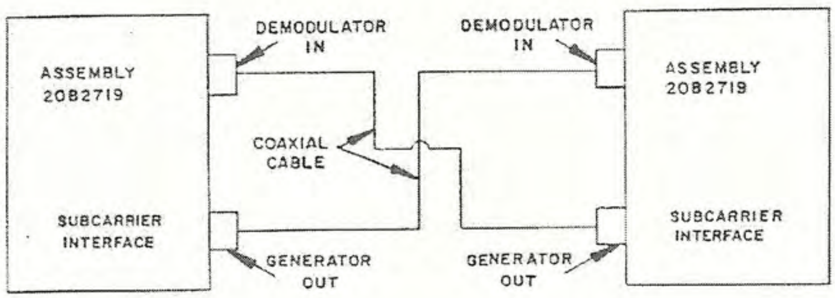

Figure 5-5
Subcarrier Interconnect

2. Apply power to both Terminals. Disable all active sites at the Control Terminal (see Section 3, Volume 1 for a full explanation). The TRANSMIT LED on the front on the Modem II module should be off, indicating no sites are enabled.

3. Place toggle switch S2 (on the front of the Modem II module) in either TEST position. This causes the modulator to generate a continuous tone.

4. Adjust the output voltage levels, using Send Level Adjust R10 on the front of the Modem II modules.

   Two-wire systems: Measure the output level across barrier strip terminals 1 and 5 on the Modem-Telco Interface module. Zero dBm should be observed at both the Control and Remote Terminals.

   Four-wire systems: Measure the output level across barrier strip terminals 4 and 6 on the Modem-Telco Interface module. Zero dBm should be observed at both the Control and Remote Terminals.

Mixed systems: Measure the output level at the Telco output barrier strip terminals on the Telco Out/Subcarrier In module at the appropriate Terminal. Zero dBm should be observed. Using a calibrated oscilloscope, measure the voltage at the subcarrier output BNC connector on the Telco In/Subcarrier Out Interface module at the other Terminal. 1.5 volts peak-to-peak should be observed. The OUTPUT potentiometer above the BNC connector should be adjusted if necessary to meet this requirement. The waveform observed should conform to Figure 5-7. Adjust R10 (Send Level Adjust) on the front of the Modem II module if necessary to meet this requirement.

Subcarrier-In/Subcarrier-Out systems: At both Terminals, measure the output at the subcarrier output BNC connector on the Subcarrier Interface module and adjust as described immediately above (under "mixed systems").

5. Put the Control Terminal modem in OPERATE mode (using S2) and the Remote Terminal in either TEST mode. Adjust the Control Terminal modem input level using R12 (receive level adjust) on the front edge of the Control Terminal's Modem module. Measure the input levels across test points 6 and 3. Turn R12 clockwise to increase voltage level.

   Two-wire systems: Between .5 and .6 Vac should be observed across the test points (-30 dBm input).

   All other systems: Between .5 and .6 Vac should be observed across the test points (-30 dBm input).

6. Put the Remote Terminal modem in OPERATE mode and the Control Terminal modem in the down (TEST) position (using S2). Adjust the Remote Terminal input level (exactly as was done in Step 5 at the Control Terminal).

7. Place all modems in the OPERATE mode. Push the RESET button on the front of the CPU modules at both Terminals. Re-enable the Remote Terminal(s) by assigning data links (refer to Section 3, Operation).

8. The Control Terminal and Remote Terminal should now be "talking" successfully. Having selected a site, telemetry or status information should appear on the display. Pushing the CHAN (channel) key at the Control Terminal should cause the channel display at the Control Terminal to advance by one channel.

   The Control Terminal initiates each communication by sending an interrogation to the Remote Terminal. The Remote Terminal replies with its response. As a result, a regular "heartbeat" can be observed on the Transmit LED at the Control Terminal. If the Remote Terminal does not properly receive a message, it does not respond and the unit appears to "skip a beat." In a properly adjusted system, a regular pattern of pulses can be observed on the Transmit LEDs.

   Two-wire systems: In a two-wire system, each unit can "hear itself speak" so the Receive LED remains on most of the time. Sometimes a pulsation or flicker can be observed.

   Other systems: The Transmit and Receive LEDs will flash alternately at both Terminals. If a Receive LED remains on steadily, the input level on the module is probably too high.

Multiple site systems: The Remote Terminal modem at the selected site will periodically seem to skip a beat as other sites are interrogated by the Control Terminal. Other Remote Terminal modems will blink only occasionally as they are interrogated by the Control Terminal.

9. Systems involving subcarrier: Upon completion of the back-to-back tests and after connection to the actual interconnecting radio link, it may be necessary to adjust the OUTPUT pot on the appropriate interface modules at the rear of the Terminals, in order to assure proper modulation of the interconnecting radio circuits.

Frequency and VCO Adjustments

High frequency, low frequency, and VCO should not normally need adjustment. To emphasize this fact, R36, R35, and R11 are painted with red lacquer at the factory after their initial alignment. This section is included in case a need arises to realign the board, perhaps following a repair accomplished by the user. Refer to Figure 5-6 for the location of controls and test points on the Modem II module.

If the frequency counter does not give stable readings, the following steps are suggested:

1. Place a 10 k Ohm resistor between the frequency counter input and TP1 (white) to increase frequency counter input impedance.

2. Reduce false triggering by placing a small value (.001 to .1uF) capacitor between TP1 (white) and ground.

We suggest that the Terminals be connected back-to-back at the same location (See preceding subsection) so that both ends are easily accessible.

1. With the Terminals not connected to each other, prepare to set the frequencies as follows: Connect a frequency counter between TP1 (white) and ground (TP3, black).

2. Set the high frequency. Place S2 in High Test position and adjust R36 to obtain a frequency of 2200 Hz.

3. Set the low frequency. Place S2 in Low Test position and adjust R35 to obtain a frequency of 1200 Hz.

4. Set S1 to TEST position. Connect frequency counter to TP4 (Yellow). Adjust R11 (VCO Adjust) to obtain a frequency of 1700 Hz at TP4.

5. Return S1 and S2 to OPER position and adjust the input and output levels as described in the Procedures subsection, with the Terminals connected.

Troubleshooting

Verify that data link set-up has been completed as described in Section 3.

Refer to the Adjustments subsection for instructions for adjustment of the input and output levels.

If trouble is encountered:

1. Check all switch positions (see Table 5-2).

2. Verify that proper power supply voltages are present. This should be done at the IC pins.

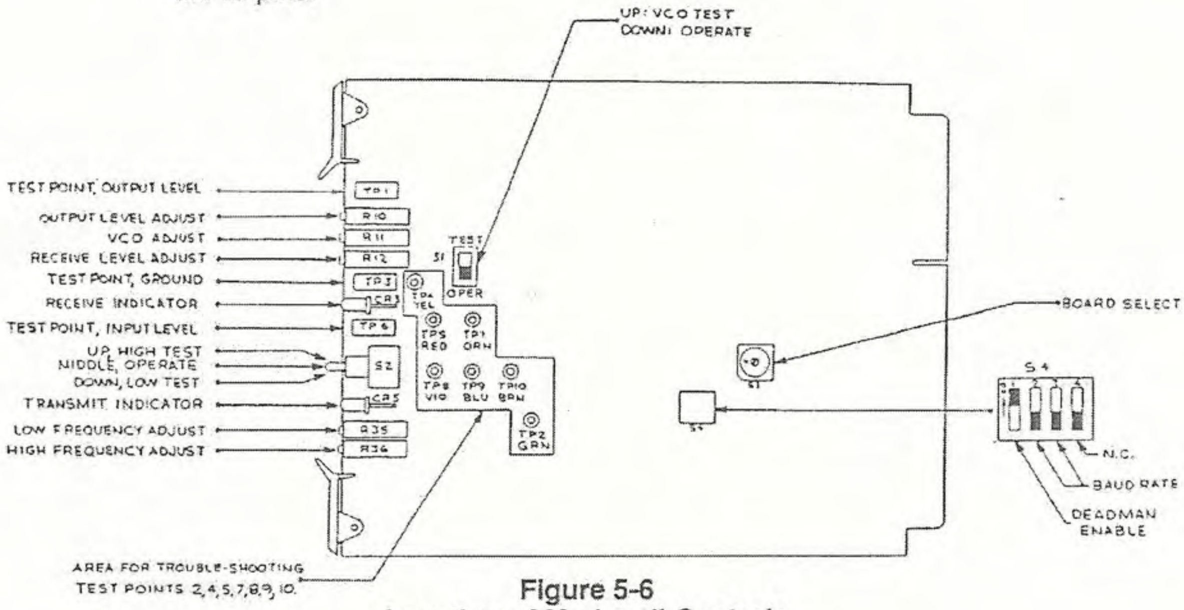

Figure 5-6
Location of Modem II Controls and Test Points

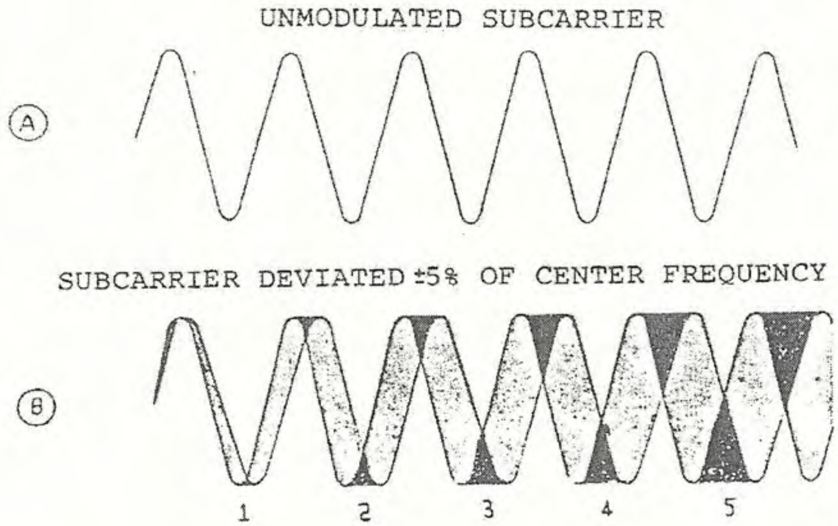

Figure 5-7
Standard Subcarrier Pattern

Notes: 1) Use internally derived positive-slope triggered sweep. 2) Set sweep time to achieve trace A. 3) Set generator deviation to achieve trace B.

5.7.11 Modem-Telco Interface

Schematic: 91A7147 (Figure A-21)
Assembly: 20B2716 (Figure A-22)

Troubleshooting

1. Check fuses and fuse clips for continuity.

2. After lightning damage:

   a. Check inductors for open circuits.

   b. Diodes D1 through D4 may be shorted.

   c. Capacitors C1 through C8 may be shorted.

   d. Check transformer continuity.

5.7.12 Telco In/Subcarrier Out

Schematic: 91B7144 (Figure A-23)
Assembly: 20A2737 (Figure A-24)

Adjustments

Subcarrier Generator (U1)

1. Remove modulation applied to the subcarrier generator using Send Level Adjust R10 on the modem.

2. Connect a frequency counter to the SUBCARR OUT connector (J3). Adjust subcarrier frequency using pots R9 and R10. R9 is a course frequency adjustment, and R10 is a fine frequency adjustment. Both pots are accessible from the rear panel and are labelled "COARSE" and "FINE".

3. Disconnect the frequency counter and connect a distortion analyzer to the SUBCARR OUT connector (J3). Adjust Distortion pot R6 for minimum distortion. Using this control approximately 0.5% distortion is obtainable. If no distortion anal-yzer is available, no adjustment on this pot is required. The worst case distortion is approx-imately 2.5%, which is quite acceptable in most applications.

4. Disconnect the analyzer and attach an oscilloscope to SUBCARR OUT J3. To understand this adjustment, refer to Figure 5.7 in the Modem section for representative waveforms. Adjust the oscilloscope to display about six periods of the unmodulated subcarrier as shown in (A). Using the modem Send Level Adjust (R10), increase Subcarrier modulation until the fifth crossover occurs midway as shown in (B).

5. Adjust the output level to 2.5 volts peak-to-peak Using OUTPUT Adjust R4. This pot is accessible through the rear panel.

Troubleshooting

1. Verify that +12 Vdc is present on pin 4 of U1.

2. Modulator

   a. Verify that the modem is generating an FSK signal, which may be observed at pin 7 of the function generator U1.

   b. If no output is observed, check chip voltages and grounds. If U1 is replaced, verify proper adjustment by performing the subcarrier generator adjustment procedure.

   c. Note the Modem module must be properly adjusted and working correctly for the Telco In/subcarrier Out module to function. Refer to the Modem Troubleshooting subsection of this manual.

5.7.13 Telco Out/Subcarrier In

Schematic: 91C7160 (Figure A-25)
Assembly: 20B2736 (Figure A-26)

Adjustments

A. Telemetry Extraction Filter

1. Apply a modulated subcarrier signal from a subcarrier generator to the input (J1).

2. Adjust inductors L1 and L2 for maximum amplitude and minimum AM. The filter output should be similar in appearance to the subcarrier generator output.

B. FM Demodulator Frequency

1. Apply a modulated subcarrier signal to the input (J1).

2. Adjust R6 (FREQ) for the cleanest FSK output. Note that some residual high-frequency subcarrier may be superimposed on the FSK Signal; this is quite normal.

<u>Troubleshooting</u>

1. Verify that correct power supply voltages are present on the module (+15, +12, and -15 volts).

2. Using an oscilloscope, observe the extraction filter output at U1, pin 2. This signal should appear much like the subcarrier generator output. If it is distorted check the input filter for proper tuning or defective Components.

3. Check demodulator frequency as described in the Adjustment subsection above.

4. Check operation of Buffer Amplifier U2.

5. Check operation of the Modem module. Refer to the Modem subsection of this manual.

5.7.14 Subcarrier Interface

Schematic: 91C7156 (Figure A-27)
Assembly: 20D2719 (Figure A-28)

Adjustments

A. Subcarrier Generator (U3)

1. Remove modulation applied to the subcarrier generator using Send Level Adjust R10 on the Modem II module.

2. Connect a frequency counter to the GEN OUT connector (J3). Adjust the subcarrier frequency adjustments, COARSE Adjust R19 and FINE Adjust R20. Both pots are accessible from the rear panel.

3. Disconnect the frequency counter and connect a distortion analyzer to the GEN OUT connector (J3). Adjust Distortion pot R15 for minimum distortion. Using this control approximately 0.5% distortion is obtainable. If no distortion analyzer is available, no adjustment on this pot is required. The worst-case distortion is approximately 2.5%, which is quite acceptable in most applications.

4. Disconnect the analyzer and attach an oscilloscope to GEN OUT (J3). To understand this adjustment, see Figure 5-7 in the Modem II subsection for representative waveforms. Adjust the oscilloscope to display about six periods of the unmodulated subcarrier as shown in (A). Using the modem Send Level Adjust R10, increase subcarrier modulation until the fifth crossover occurs midway as shown in (B).

5. Adjust the output level to 2.5 volts peak-to-peak using OUT Adjust R14. This pot is accessible through the rear panel.

B. Subcarrier Demodulator (U1)

1. Telemetry Extraction Filter Adjustment

   Apply a modulated subcarrier signal to the DEMOD IN connector (J2). Adjust inductors L1 and L2 for maximum amplitude and minimum AM. The filter output should be similar in appearance to the subcarrier generator output.

2. FM Demodulator Frequency Adjustment

   Apply a modulated subcarrier signal to the DEMOD IN connector (J2). Adjust FREQ Adjust R5 for the cleanest FSK output. Note that some residual high-frequency subcarrier may be superimposed on the FSK signal; this is quite normal.

Troubleshooting

A. General

1. Verify that correct power supply voltages are present on the module (+5, +12, and -15 volts).

B. Modulator

1. Verify that the modem is generating an FSK signal, which may be observed at U3, pin 7.

2. If no output is observed, check chip voltages and grounds. If U3 is replaced, verify proper adjustment by performing the subcarrier adjustment procedure described previously.

3. Note the Modem module must be properly adjusted and working correctly for the Subcarrier Interface module to function. Refer to the Modem II subsection of this manual for troubleshooting details.

C. Subcarrier Demodulator

1. Using an oscilloscope, observe the extraction filter output at U1, pin 2. This signal should appear much like the subcarrier generator output. If it is distorted, check the input filter for proper tuning or defective components.

2. Check demodulator frequency as described in the adjustment subsection.

3. Check operation of Buffer Amplifier U2.

4. Check operation of the Modem module. Refer to the Modem II subsection of this manual.

5.7.15 Serial I/O Module

Schematic: 91D7243 (Figure A-29)
Assembly: 20D2800 (Figure A-30)

Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.

Troubleshooting

Make the following preliminary checks:

1. Verify proper +5 V power supply voltages throughout the module. Measure these voltages directly on the integrated circuit pins.

2. Make sure the switches and jumpers are set correctly (see Table 5-2). Make sure all devices are completely seated.

3. If the Terminal where the module is installed operates when the module is removed but fails to operate when it is present, remove U7 and U10. This prevents the module from affecting the data lines on the MRC-2 bus. In almost all cases this will allow the Terminal to run with the failing module plugged into the System.

   Check U3, pins 3 and 9 to verify that they are not continuously low. If so, suspect U3. Check the ICs in the address decoding portion of the module to insure that *BS is pulsing periodically.

4. If the Terminal where the module is installed continues to operate properly after the failure (except, of course, for the optional feature), refer to Section 5.4.1, Fault Isolation and make the checks described there. If no problems are found, then try the following:

5. Generate a continuous stream of characters from the external device. On the printer, hold the space bar and **REPEAT** key down. On the Multiple Direct Command, or CRT hold one of the keys down continuously. You should be able to observe the received data on U2 pin 2. If the received data is not present, suspect the printer, the cable, or the Serial Interface module.

6. Check that the "Ready" and "Carrier" lines are in their low state (near ground). If not, suspect the receiving device, the Serial Interface module, or the cable.

5.7.16 Serial Interface Module

Schematic: 91C7249 (Figure A-31)
Assembly: 20C2803 (Figure A-32)

Troubleshooting

1. Verify that the module is properly seated in the proper slot at the Terminal.

2. Verify the following power supply connections by measuring directly on the specified pins of these integrated circuits (refer to Table 5-3).

Table 5-3. Power Supply Pin Connections

IC	Pin	Value
U1	14	+12 V
U1	1	-12 V
U2	8	+ 5 V
U3	14	+ 5 V
U4	24	+ 5 V

3. Check that a square wave of proper frequency as observed on pins 1 through 7 of S1. This frequency is 16 X the frequency listed in Table 5-2. If the frequency is not correct, suspect the switch settings, U5, or Y1.

4. Verify that the *SEND line (U1 pin 12) is near ground. If not, suspect the Serial I/O module.

   Verify that the *CARRIER line is near ground. If not, suspect U3, U1, and the cable in that order. If the *SEND line is not near ground, the *CARRIER and *READY lines will also not be near ground.

   Verify that about +10 V is present at U3 pin 1. If some other value is observed, suspect the cable.

5. Hold the space bar down on the CRT keyboard and observe the received data on U3 pin 4. If absent, suspect the external device or the cable. If present at U3 pin 4, check U3 pin

6. If absent there, replace U3. If present, examine the seating of the Serial I/O and the Serial Interface modules.

7. Push the RESET button on the CPU module. Data should be observed for 30 seconds or so at U1 pin 2. If absent, check the seating of the Serial I/O and the Serial Interface modules. If present at U1 pin 2, check U1 pin 3. If absent there, replace U1. If present at U1 pin 3, suspect the external device or the cable.

5.7.17 Analog Input III

Schematic: 91D7343 (Figure A-33)
Assembly: 20D2897 (Figure A-34)

Application Hints

DC input resistance is 500 k Ohm. However, it is recommended that the output impedance of the circuit driving the board not exceed 10 k Ohm at .25 Hz, increasing to 25 k Ohm at 4 Hz. Normal mode rejection at 60 Hz is 35 dB with a common mode rejection (within input voltage range) of at least 60 dB. For best overall accuracy, the normal mode input should be close to $\pm$4 V, with maximum inputs not exceeding $\pm$5 V.

Measurement accuracy is 0.4% $\pm$ 1 bit. The maximum input voltage from either input to ground is $\pm$ 5 V. Exceeding this voltage will cause improper operation of the board for the duration of the over-voltage condition. If either input voltage exceed $\pm$ 40 V, permanent damage to U11-U15, or U7 may result.

Adjustments

Board addressing is accomplished using HEX switch S1. Up to 16 different A/D channels per board can be accessed, with the lowest 16 data channels on board 0, the next 16 data channels on board 1, and so on. Switch programming positions are shown in Section 5.1, Module Address and Option Switches. S1 is programmed at the factory and normally will not require changing. If a defective board is replaced, be sure that the address switch is set to the proper position.

Troubleshooting

1. Verify that the Analog Input board and the Filtered Interface board are firmly seated in the corresponding slots.

2. Check for power supply voltages on the board (see Figure A-33).

3. Verify proper switch position by checking for activity on *BOARD SELECT.

4. Check the R/* and status lines of the A/D converter (U2-5 and 28) for activity.

5. Check analog switch addressing. Under normal operations, the system will be scanning all 16 input channels.

5.7.18 Status Input, TTL II

Schematic: 91C7237 (Figure A-35)
Assembly: 20D2798 (Figure A-36)

Application Hints

Inputs are TTL active low. Input voltage should be restricted from 0 to +5 volts or module damage may result. A switch closure across the input pins is all that is required to operate a status channel.

Module Address Specification

Switch S1 is used to assign a module address from 0 to 15. Module 0 will output channels 1 through 16; module 1 will output channels 11 through 32, etc. Programming of S1 is shown in Table 5-1. If replacement modules are installed for any reason, verify that S1 is set correctly.

Troubleshooting

Check for periodic low pulses on U5 pin 8, indicating the CPU is attempting to read data from this module. Low-going pulses should also be observed on pins 1 and 19 of U1 and U2.

5.7.19 Status Input, OPTO II

Schematic: 91C7236 (Figure A-37)
Assembly: 20D2795 (Figure A-38)

Application Hints

Each input requires between 5 mA and 30 mA of current (user supplied) to drive the optical isolator for that input. The unit is shipped with 1800 Ohm current-limiting resistors. These are suitable for input voltages from 20 V to 48 V. For lower voltages, the resistors will have to be changed to 500 Ohms. This will allow operation with input voltages from 6 V to 15 V. The maximum voltage from any input to ground should not exceed +/- 50 Vdc. Exceeding this voltage may cause damage to the module.

Adjustments

Switch S1 is used to assign a module address from 0 to 15. Module 0 will output channels 1 through 16; module 1 will output channels 17 through 32, etc. Programming of S1 is given in Table 5-1. S1 is programmed at the factory and will normally only be reset if a defective module is replaced. In this case, the switch on the new module should be set to the same position as the module it is replacing.

Troubleshooting

As a general guideline, if only certain bits on a module fail to function properly, the cause is usually associated with the input optical isolators. Complete module failure is associated with U1 through U3. If there are multiple modules in the user system, the modules may be interchanged (after setting switch S1) to pinpoint the cause. Before swapping modules, check all inputs to ensure that excessive currents are not being applied.

Verify that pin 5 of the optical isolator drops below 0.8 volts when current is passed through the appropriate input. If not, suspect the optical isolator or a defective input on U4 or U5. Check for a periodic low pulse on U2 pin 8. This indicates that the CPU is trying to read data from this module. Low going pulses should also appear on pins 1 and 19 of U4 and U5. If not, suspect U1 through U3 or S1.

5.7.20 Open Collector Command Output

Schematic: 91C7171 (Figure A-39)
Assembly: 20D2755 (Figure A-40)

Application Hints

Maximum voltage that can be applied to outputs without causing output latch-up is 55 V. Up to 300 mA may be sinked by drivers U7 to U14.

Adjustments

Switch S1 is used to assign a module address from 0 to 15. Module 0 will output channels 1 through 16; nodule 1 will output channels 16 through 32, etc. Programming of S1 is shown in Table 5-1. S1 is programmed at the factory and will not normally require changing. Any replacement module should be switched to the same configuration as the original module.

Troubleshooting

1. Partial Failure (Some Channels Work)

   This indicates that at least some PIA channels are functioning. Trace back from the output driver to the output of the PIA. Example: Assume channel 1 does not function. If tally-back does not function, suspect U4, U5 or U3. If the tally-back functions, the failure is in the output driver.

2. Complete Failure (All Channels)

Check U3 pin 19 for a low level. If the ENABLE signal is low, check operation of Q1 and Q2. If pin 19 is high, check U3 pin 24 for an active high pulse when a raise on this module is attempted. If no pulse is seen, verify operation of S1, U1, U2 and U6.

If a pulse is seen at U3 pin 19, verify that the pulses are repeated at 1 of U4 and U5. If these pulses are present, suspect U4, U5 or U3.

5.7.21 Optically Isolated Command Output

Schematic: 91C7129 (Figure A-41)
Assembly: 20C2705 (Figure A-42)

Application Hints

The maximum voltage that should be applied to the outputs is 48 Vdc. The maximum voltage drop on an ON channel is 1.4 V, with a maximum 240 mA load. When a channel is OFF, the leakage current will not exceed 5O uA. The outputs incorporate built-in reverse polarity and inductive load protection. The maximum voltage from an output line to ground is + 5O Vdc. Exceeding that voltage may cause damage to the module. The output is floating with respect to the chassis.

Adjustments

Switch S1 is used to assign a module address from 0 to 15. Module O will output channels 1 through 16; module 1 will output channels 17 through 32, etc. Programming of S1 is given in Table 5-1. S1 is programmed at the factory and will normally on1y be reset if a defective module is replaced. In this case, the switch on the new module should be set to the same position as the module it is replacing.

Troubleshooting

1. Partial Failure (Some Channels Work)

This indicates that PIA U6 is at least partially functioning. Trace back from the output stage to the output of the PIA. Example: Assume output 1 does not function. If the tally-back does not function, suspect U4, U5 or U6. If the tally-back functions, the failure is in the output drive of U6 or the transistor buffers (QI7-Q32).

2. Complete Failure (All Channels)

Check U6 pin I9 for a low level. If it is low, verify that the emitter of Q32 is near 5 V. If it is not, suspect Q33 or Q34. Check U6 pin 24 for an active high pulse when a raise is attempted for a channel on the module. If no pulse is seen check S1, U1, U2 and U3 pins for correct operation. If a pulse is seen, verify that pulses appear at U4 and U5 pins I and 19; if not, suspect U3. If these pulses are present, suspect U4, U5 or U6.

5.7.22 Parallel Input Module

Schematic: 91D7272 (Figure A-43)
Assembly: 20D2822 (Figure A-44)

> ***Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.***

Troubleshooting

1. Verify that configuration switches on the Parallel Input module are properly set (see Table 5-2).

2. Verify that the module is firmly seated and the guide pin is properly inserted.

3. Check that user-generated signals are reaching U1 properly. If not, suspect the Diode-Filtered Interface module or the connector on the rear of the chassis.

4. If the entire Terminal fails to operate with the module installed, remove the module. If the Terminal still does not operate, you may assume the Parallel Input module is not at fault. Other-wise, remove U4 and U10 and reinstall the module. If the Terminal resumes operation, check if U11 pin 6 is continually low. If so, work backward through the address-decoding network until the malfunctioning gate is found. If U11 pin 6 is not continually low, suspect U10 or U4.

5. If removing U4 and U10 has no effect on operation, suspect U12, U13, U14 or a problem involving a trace or a solder joint.

6. Observe U9 pin 8 and verify that it pulses low from time to time. If not, work backward through the address-decoding network to find the malfunctioning gate.

5.7.23 Delay Control

Schematic: 91D7244 (Figure A-45)
Assembly: 20D2801 (Figure A-46)

> ***Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.***

Troubleshooting

1. Verify proper setting of S1 (see Table 5-2). If the switch setting is wrong, change it and then press **RESET** on the front of the CPU module.

2. Verify +5 V at each IC. The table on the schematic (see Figure A-45) lists the +5 V pins. Verify +15 V at the input of VR1. Verify +12 V at the output of VR1 (or the cathodes of CR1-CR6). (If a green LED ON the CPU module is OFF when the Delay Control module is installed, and ON when removed, then suspect a short on the Delay Control module.)

3. With the Remote Terminal in Maintenance Override, verify the following:

   a. Verify pulses at regular intervals at U10 pin 8. If not present, suspect U10, U15, U16, U11, U9, U13, U14, or S1.

   b. Verify a 1-MHz square wave at U9 pin 5. If not present, suspect U16 or U17.

   c. Verify regular pulses at U7 pin 19 and U12 pin I9. If not present, suspect U8 or U9.

   d. Verify regular pulses at the "B" inputs of U1-U3 for the telemetry channels that are set up (see list below). If not present, suspect U7 or U12. If pulses are present at the "B" inputs of U1 to U3, check the corresponding "Q" outputs for a high level. If not present, suspect U1 to U3 (refer to Table 5-13).

   e. Check U4 to U6 pins 5 or 3 for a low level. If high, suspect U4 to U6. If low, suspect CR1 to CR6 or K1 to K6.

Table 5-4. Telemetry Channel "B" Inputs and "Q" Outputs

Telemetry Channel	"B" Input	"Q" Output
1	U1 Pin 2	U1 Pin 13
2	U1Pin 10	U1 Pin 5
3	U2 Pin 2	U2 Pin 13
4	U2 Pin 10	U2 Pin 5
5	U3 Pin 2	U3 Pin 13
6	U3 Pin 10	U3 Pin 5

5.7.24 Diode-Filtered Interface II

Schematic: 91A7273 (Figure A-47)
Assembly: 20C2823 (Figure A-48)

Specifications

The attenuation at various frequencies is essentially the same as that of the Filtered Interface module.

Troubleshooting

Check for foreign particles across the connector pads, broken traces, and improper solder joints. Check the inductors for continuity and the capacitors for leakage.

Proper shielding and grounding techniques should be observed for all input/output lines.

5.7.25 Filtered Interface

Schematic: 91A7119 (Figure A-49)
Assembly: 20B2718 (Figure A-50)

Specifications

Attenuation:

-10 dB	200 kHz
-20 dB	700 kHz
-40 dB	2 MHz

Troubleshooting

Check for foreign particles across the connector pads, broken traces, and improper solder joints. Check the inductors for continuity and the capacitors for leakage.

Proper shielding and grounding techniques should be observed for all input/output lines.

5.7.26 DC Power Supply

Schematic: 91C7179 (Figure A-51)
Assembly: 20C2655 (Figure A-52)

Adjustment

Three voltage adjustment potentiometers are present for +5 V, +15 V, and -15 V. These adjustments are:

+5 V	V.ADJ.	R108
+15 V	+V.ADJ.	R11
-15 V	-V.ADJ.	R10

A sealed potentiometer is included for current limiting for +5 V (R1O4).

A. 120 Volt Operation

Unless otherwise tagged, the power supply is set for 120 V operation when it is shipped from the factory. Normally no changes are required.

The 120 V label should be visible on the voltage selection card. If a different voltage is visible, remove the card and reinsert so the 120 V label is on the top. The card may be removed by using needle-nose pliers. An MDL 2 A fuse is used for 120 V.

B. 240 Volt Operation

Change the voltage selection card so the 240 V label is visible when the card is installed. Use an MDL 1 A fuse.

5.7.27 Extender Board

Schematic: 20B2724 (Figure A-53)

No adjustments are required.

5.7.28 4 RU Mother Board

Schematic: 91C7201 (Figure A-54)
Assembly: 20D2706 (Figure A-55)

No adjustments are required.

5.7.29 Quad Serial I/O Module

Schematic: 91D7394 (Figure A-56)
Assembly: 20D2954 (Figure A-57)

> ***Caution: Always remove power from the terminal whenever printed circuit modules are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.***

Troubleshooting

The Quad Serial I/O board has many components which are duplicated for each Serial I/O port. These components are indicated with a reference designator ending in a letter, e.g., S1A, S1B, S1C, and S1D. Components which are shared by the four ports do not end in a letter, e.g. U2. The descriptions below are written in the singular, but pertain to each port.

The Quad Serial I/O board has been designed so that the majority of the components are duplicated on the board, since there are four (mostly) independent ports. Therefore, ICs may be swapped between ports to "shot-gun" the problem. In addition you can reset switches S1 and S2 (see table 5-2) to swap the options between ports.

1. Make sure the switches and jumpers are set correctly (see Table 5-2). Make sure all devices are completely seated.

2. Verify proper +5 V power supply voltages through-out the module. Measure these voltages directly on the integrated circuit pins (see Schematic for pin numbers).

3. If the Terminal where the module is installed operates when the module is removed but fails to operate when it is present, remove U11. This prevents the module from affecting the data lines on the MRC-2 bus. In almost all cases this will allow the Terminal to run with the failing module plugged into the System.

4. If the Terminal where the module is installed continues to operate properly after the failure (except, of course, for the options attached to this board), refer to Section 5.4.1, Fault Isolation and make the checks described there. If no problems are found, then try the following:

5. Verify activity on the address and control lines (U12, U13, and U14). LED driver U13 may be used as a replacement if one of these ICs (or U11) is bad.

6. Check the ICs in the address decoding portion of the module (U10, U6, U3, U7 or U9, U4 or U5) to insure that *BS is pulsing periodically.

7. Check for a square wave of proper frequency as observed on pins 3 and 4 of U2. This frequency is 16x the frequency listed in Table 5-2. If the frequency is not correct, suspect S2 switch settings, U2, or Y1.

8. Generate a continuous stream of characters from the external device. On the printer, hold the **space bar** and **REPEAT** keys down. On the Multiple Direct Command or CRT continuously hold down one of the keys. You should be able to observe the received data on U1 pin 2 (and the Rx LED, CR1). If the received data is not present, suspect the printer, the cable, or the Quad Serial Interface module.

   Check that the *CTS (U1 pin 24) and *DCD (U1 pin 23) lines are in their low state (near ground). If not, suspect the external device, the Quad Serial Interface module, or the cable.

5.7.30 Quad RS-232 Interface Module

Schematic: 91C7395 (Figure A-58)
Assembly: 20C2955 (Figure A-59)

Troubleshooting

The Quad RS-232 Interface board has many components which are duplicated for each serial port. These components are indicated with a reference designator ending in a letter, e.g., S1A, S1B, S1C, and S1D. Components which are shared by the four ports do not end in a letter, e.g. U2. The descriptions below are written in the singular, but pertain to each port.

The Quad RS-232 Interface board has been designed so that the majority of the components are duplicated on the board, since there are four (mostly) independent ports. Therefore, ICs may be swapped between ports to "shot-gun" the problem. In addition you can reset switches S1 and S2 of the Quad Serial I/O board (see table 5-2) to swap the options between ports.

1. Verify that the module is properly seated in the proper slot at the Terminal.

2. Verify the +5V connections by measuring directly on the specified pins of U1 and U2 (see Schematic).

3. Verify that approximately +10V appears on U1 pin 11 and -10V appears on U1 pin 15. If not, suspect U1 or capacitors C1, C2, C3, or C4.

4. Verify that the *RTS line (U1 pin 18) is not continuously high. If it is, suspect the Quad Serial I/O module.

5.7.31 File Memory

Schematic: 91D7485 (Figure A-60)
Assembly: 20D3073 (Figure A-61)

> **Caution:**
>
> ***Always remove power from the terminal whenever printed circuit boards are removed or replaced in the terminal. Failure to observe this caution may cause damage to one or more modules.***

Troubleshooting

Note: It may be necessary to press the CHAN or PAGE button on the front panel of the MRC-2 to initiate File Memory bus activity.

1. Make sure the switch and jumper are set correctly. For the MRC-2, set the switch and jumper as follows:

Location	Setting	Function
S1	0	Board select
E1	Int 5 (F)	Interrupt select

2. Check that the board is firmly seated into the motherboard. (Try a different slot, if available.)
3. Check for activity on the outputs of U12, U10, U15, and U4 (outputs toward PIAs). If one of these lines is not active (except *RESET), suspect the associated IC.
4. Check U7-6, U12-3, U9-6, U9-8, and U9-11 for activity. Again, suspect the associated IC if no activity occurs.
5. Check the outputs of the PIAAs (U5 and U6). If no activity, suspect U5 or U6. (Note, ED0 through ED7 are bi-directional).
6. Check U13-11, U7-3, U7-8, and U7-11 for activity. If not found, suspect that IC.
7. Change a setup parameter from the front panel and monitor U9-3. If a 15 ms pulse does not appear, suspect U8 or U9 or the timing components for U8.
8. Swap U1 and U2. **(NOTE: THIS WILL "ERASE" FILE MEMORY)**

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Section Six

Customer Service Information

Moseley Associates, Inc. has a Technical Services Department to assist Moseley product users who experience difficulties. Our service is available at two levels: telephone consultation, and factory service. Different circumstances apply whether the product(s) are under Warranty/Service Agreement or are outside Warranty/Service Agreement status.

Please read the manual; a large portion of telephone calls to Moseley request information which is needed due to nonfamiliarity with the equipment. The majority of those questions are already answered by the Installation/Operation sections of each manual. If these do not help your problem, the first step in any factory service transaction should always be telephone consultation.

Telephone Consultation

If telephone assistance is necessary, please have the following information available prior to calling the factory:

A. Model Number and Serial Number of unit.

B. Shipment date or date of purchase of an Extended Service Agreement.

C. Suspected module identification markings.

D. Be prepared to accurately describe the problems with the unit: Constant or intermittent? Precise symptoms? Meter readings? Operational frequency of unit?

E. Factory test data, if applicable.

Once you are prepared with the above-requested information, contact our Technical Services Department for assistance. A Technical Services Representative who knows your product(s) is available during normal work hours (8:00 a.m. to 5:00 p.m., Pacific time, Monday thru Friday). Please have patience if the particular representative you should talk to is busy. Leave your name, call letters, equipment type and telephone number(s) where you can be reached in the next few hours. Someone will get back to you as soon as possible.

Please be prepared to keep telephone consultations as short as possible in order to free up the Technical Service Representative to help someone else in trouble. Usually the Technical Service Representative will make suggestions and recommendations for your next step. After trying these, you may call back if you continue to experience problems.

For telephone assistance call **(805) 968-9621**

After Hours Emergency (Only) Telephone Consultation

Emergency service is provided from 5:00 p.m. to 10:00 p.m, Pacific Time, Monday to Friday, and from 8:00 a.m. to 10:00 p.m., Pacific Time, on weekends and holidays. For telephone assistance call (805)968-9621.

This after hours service is for emergencies only. Please do not expect our representative to know the status of your order, to take parts orders or to be equipped to help with installation problems.

Factory Service

Arrangements for factory service can be made after consultation with the factory Technical Service Representative and his assignment to you of a Return Authorization (R.A.) Number. This number expedites your equipment's routing from the Receiving Department to Technical Services.

When returning your equipment to Moseley Associates, the following suggestions are offered to assist you. If you are returning a module, ensure that the module is packed sufficiently to withstand the rigors of the journey. Make sure the shipping carton is packed evenly and fully, with packing material filling all voids so that the module cannot shift inside the shipping carton. The package should also be marked in red with the words" Electronic Equipment" or "Fragile". Remember, the condition of the module is totally dependent on the care taken in the packing. Reference the return order number that you had previously obtained from the factory on the outside of the carton or on the shipping label. Make sure that the name of your company is listed on the shipping label, and insure your module appropriately.

If you are shipping a complete chassis, all modules should be tied down as they were originally received. On some Moseley Associates equipment, shipping screws are required on the underside or topside of the chassis. In this case, printing on the chassis will indicate where such screws should be installed and secured.

Include any and all descriptions of the difficulties encountered with your equipment in the field. This will greatly assist us in processing your equipment and returning it as expeditiously as possible.

Use the original shipping carton in which your equipment was supplied if possible. Ensure that the carton is packed evenly and fully, with packing material filling any voids so that the chassis cannot shift inside the carton. Make sure the carton is sealed properly with either nylon-reinforced tape or shipping sealing tape. Mark the outside of the carton "Electronic Equipment - Fragile" in big, red letters. This will assist the survival of the equipment in the shipping process. Again, bear in mind that the survival of the unit depends almost solely on the preparation taken in shipping it.

When returning your equipment to our factory, please address it to the following:

MOSELEY ASSOCIATES, INC.
Attn: Technical Services Department
111 Castilian Drive
Santa Barbara, CA 93117-3093

Display your return order number clearly on the shipping label, and insure the equipment for the appropriate amount.

All equipment must be shipped prepaid; Moseley Associates, Inc. will return the equipment prepaid under Warranty and Service Agreement conditions, and either freight collect or billed for equipment not covered by Warranty or a Service Agreement.

GENERAL

Replacement Modules

Moseley Associates encourages the purchase of recommended spare parts kits to allow the customer to be totally self sufficient with regard to parts. We recognize that there are extenuating circumstances when troubleshooting to the component level is neither practical nor possible. If this is the case, replacement module exchange may be the most expedient way of correcting the problem. Each product manual lists recommended spares.

Non-frequency sensitive replacement modules are normally available for immediate shipment. If you require a replacement module from Moseley Associates, please give your shipping address to our Technical Services Engineer. If the module or equipment to be supplied to your company is to be held at the airport with a telephone number to call, provide at least two telephone numbers. This will often expedite the delivery or pickup of the replacement module or equipment.

Field Repair

Always try to isolate the problem to a specific area or module, if possible. By comparing actual wave shapes and levels with those referenced on the block and level diagrams or schematics, the problem often can be localized to the component level.

If an integrated circuit is suspect, carefully remove the original and install the new one in the same direction. These devices are installed one way only. Installing a new device backward may damage the newly-installed component or the surrounding circuitry. ICs occasionally exhibit temperature-sensitive characteristics. If a suspicious device operates intermittently, or appears to drift, Freeze Mist may aid in diagnosing the problem.

If a soldered component has to be removed from a printed circuit board, do the following:

> Use a 40 W soldering iron with a 1/8-inch tip. Do not use a soldering gun. Excessive heat may cause damage.
>
> Remove all solder contacting the lead or leads from the component and from the associated printed circuit pad. To assist in the removal of the solder, solder-sipping braid such as solder wick is very useful. Once the solder has been removed, remove the component from the board.

When installing the new component, prebend the leads of the replacement component so they will easily fit into the appropriate PC board holes. Solder each lead of the component to the bottom side of the board with a 40 W soldering iron with a 1/8-inch tip. Always use a good brand of rosin-core solder. The solder joint should be smooth and shiny. Also, be sure that excessive heat is not used in this soldering operation. Excessive heat will damage the printed circuit pad that comes in contact with the new component. Finally, cut each lead of the replacement component close to the solder on the pad side of the printed circuit board with a pair of diagonal cutters. Then remove all residual flux with either flux cleaner or a cotton swab moistened with flux cleaner.

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Section Seven

Recommended Spares

This section contains replacement parts information for the MRC-2 system. Price information on replacement parts is available upon request.

MRC-2 SPARE PARTS LIST

REF DES	DESCRIPTION	MFG	MFG P/N (MAI DWG #)	MAI P/N
	LED RED 2.0 @ 20 WIDE DIFF	FAIR	FLV160	3390127
	LED GRN 7-12 @ 20 DIFF 75DEG	H/P	HLMP-3507	3390614
	DIO GER 100V 80MW D07	KBC	IN270	3600012
	DIO 75V 75MA S1 A398	TI	IN914	3600053
	DIO 25V 4NS SI D035	GE	IN4154	3600145
	DIO 10V 1W 5% AIAY	SCHAUR	IN4740A Z10.0A	3600202
	DIO 16V 1W 5% AIAY	IR	IN4745A	3600236
	DIO 200V 1A SI D039	IR	10D2	3610003
	DIO 3.1 V	SCHAUR	SZ3.1	3610169
	XT NS2N2924LFS.2W16M025V.1A7P	GE	2N2924-LF5	3630027
	XT NP2N3053 05W100M080V.7A	RCA	2N3053	3630035
	XT PS2N3640 .2W500M012V80M3.5P	FAIR	2N3643	3630092
	XT PP2N4037 01W060M060V01A	RCA	2N4037	3630191
	XT NP2N5293 36W800K080V04A	RCA	2N5293	3630316
	RGLTR 6.9V 30MA T092	NATL	LM-329BZ	3650066
	RGLTR 7812 VARV1.5A	NATL	LM340T-12	3650074
	RGLTR 05V 0.1A T092	MOTOR	MC79L05 ACP	3650132
	RGLTR 05V 1.0A T0220	FAIR	UA7805UC	3650173
	RGLTR 12/V 0.1A T092	TI	MC79L12ACLP	3650140
	IC OPAMP GEN COMP	TI	UA741CP	3660008

MRC-2 SPARE PARTS LIST

REF DES	DESCRIPTION	MFG	MFG P/N (MAI DWG #)	MAI P/N
	IC 4-16LINE DEMUX	TI	SN74154N	3660487
	IC QU 2IN NAND	TI	SN74LS00N	3660669
	IC QU 2IN NOR	TI	SN74LS02N	3660677
	IC HX INV	TI	SN74LS04N	3660685
	IC QU 2IN AND	TI	SN74LS08N	3660693
	IC TR 3IN NAND	TI	SN74LS20N	3660701
	IC DU 4IN NAND	TI	SN74LS20N	3660719
	IC TR 3IN NOR	TI	SN74LS27N	3660727
	IC SI 8IN NAND	TI	SN74LS30N	3660735
	IC QU 2IN EXCL OR	TI	SN74LS86N	3660743
	IC DU JK MAS/SL	TI	SN74LS107AN	3660750
	IC DURETRMONOMULTI	TI	SN74LS123N	3660768
	IC QU NAND ST	TI	SN74LS132N	3660776
	IC 3-BLINEDECDEMUX	TI	SN74LS138N	3660792
	IC DU2-4LNDECDEMUX	TI	SN74LS139N	3660800
	IC OCT BUS/DRIV ST	TI	SN74LS244N	3660859
	IC HEX BUF 3/ST	TI	SN74LS367AN	3660867
	IC DU NAND HIGHV OC	TI	SN75452BP	3660925
	IC DU NAND HIGHV OC	TI	SN75472P	3660941
	IC QUAD 2-INPUT NOR	TI	SN74LS32N	3660958

MRC-2 SPARE PARTS LIST

REF DES	DESCRIPTION	MFG	MFG P/N (MAI DWG #)	MAI P/N
	IC DU 5IN NOR	MOTOR	SN74LS260N	3660966
	IC OCT BUS/DRIV ST	TI	SN74LS240N	3660974
	IC OCTAL FLIP-FLOP	TI	SN74273	3661006
	IC GPIB	TI	SN75160N	3661022
	IC TRANSCIEVER	TI	SN7516N	3661030
	IC MPU	MOTOR	MC6809P	3661048
	IC TRIPLE 3INPUT AND	TI	SN74LS11N	3661055
	IC DUAL D FLIP FLOP	TI	SN74LS74AN	3661063
	IC 13-INPUT NAND	TI	SN74LS133N	3661071
	IC DU 4IN MUX	TI	SN74LS153N	3661089
	IC BIT RATE GENERATOR	MOTOR	MC14411P	3680212
	IC DIFFERENTIAL AMUX 4CH	MOTOR	MC14052BCP	3680220
	DISPLAY 17-SEG 4-DIGIT RED		DL-2416T	3690054
	IC EAROM 1K X 4	GENIN	ER3400	3710001
	IC PIA INTERFACE	MOTOR	MC6821P	3710027
	IC PRIOR INTERRUPT	MOTOR	MC6828P	3710035
	IC ACIA INTERFACE	MOTOR	MC6850P	3710043
	IC RAM STATIC 1K X 4	MTSBSH	M5L2114LP-3	3710225
	IC MICRO COMP REAL TIME	NATL	MM58167	3710274
	IC GPIB ADAPTER	MOTOR	MC68488P	3710282

MRC-2 SPARE PARTS LIST

REF DES	DESCRIPTION	MFG	MFG P/N (MAI DWG #)	MAI P/N
	IC A-D CONV 4.5DIG	NATL	LF13300D	3730132
	IC OPAMP PRECISION	NATL	LM-308AN	3730157
	IC COMPARITOR QUAD	NATL	LM-339N	3730207
	IC QU LINE DRIVER PLST	MOTOR	MC1488P	3730355
	IC QU LINE RECEIVER	MOTOR	MC1489P	3730363
	IC OPAMP QUAD 741	TI	RC4136N	3730462
	IC A-D CONV 12+SGN	NATL	ADB1200PCN	3730595
	IC OPAMP HI SLEW	SIGN	NE-531N	3730694
	IC TIMER	SIGN	NE-555N	3730702
	IC VCO WAVE GEN	EXAR	XR-2206CP	3730819
	IC FSK MODEM	EXAR	XR-2211CP	3730827
	IC OPTICAL ISOLATOR	MOTOR	MOC-8030	3730868
	IC DUAL OP-AMP	TI	TL072A	3730876
	IC KEYBOARD ENCODER	GENIN	AY-5-2376	3730926

8

Section Eight

Parts Lists

8.1 Introduction

This section provides a complete parts description of each MRC-2 module. The reference designation number is located on the schematic and assembly drawings (see Appendix).

PARENT ITEM: 9203506 DESCRIPTION: ASSY FRONT PANEL MRC-2
ENG.DRAWING NO.: 2002804 H

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3472537	PCB FRONT PANEL MRC-2	5105919	D	1.000	EA
3	3660693	IC SN74LS08N QU 2IN AND U20	SN74LS08N		1.000	EA
4	3660800	IC SN74LS139N DU2-4LNDECDEMUX U21	SN74LS139N		1.000	EA
5	3660859	IC SN74LS244N OCT BUS/DRIV ST U1,U14,U16	SN74LS244N		3.000	EA
6	3660867	IC SN74LS367 HEX BUF 3/ST U22,U24	SN74LS367AN		2.000	EA
7	3710274	IC MM58167 MICRO COMP REAL TME U23	MM58167		1.000	EA
8	3730926	IC AY-5-2376 KEYBOARD ENCODER U15	AY-5-2376		1.000	EA
9	3661006	IC SN74273 OCTAL FLIP-FLOP U18	SN74273		1.000	EA
10	3660685	IC SN74LS04N HX INV U19	SN74LS04N		1.000	EA
11	3690054	DISPLAY 17-SEG 4-DIGIT RED U2,U3,U4,U5,U6,U7,U8,U9,U10,U11,U12,U13	DL-2416T		12.000	E
12	3660792	IC SN74LS138N 3-8LINEDECDEMUX U17	SN74LS138N		1.000	EA
14	3250024	SKT DUAL IN LINE 14 PIN U19,U20	2-640357-1		2.000	EA
15	3250032	SKT DUAL IN LINE 16 PIN U17,U21,U22,U24	2-640358-1		4.000	EA
16	3250073	SKT DUAL IN LINE 24 PIN U23	2-640361-1		1.000	EA
17	3250057	SKT DUAL IN LINE 20 PIN U1,U14,U16,U18	2-640464-1		4.000	EA
18	3250099	SKT DUAL IN LINE 40 PIN U2,U3,U4,U5,U6,U7,U8,U9,U10,U11,U12,U13,U15	2-640379-1		7.000	EA
21	3390333	HORN ALM BZ1	AI-105		1.000	EA
22	3390341	HORN MT BZ1	PM-101		1.000	EA
24	3170164	SW PB SPST S11,S12,S13,S14,S15,S16,S17,S18,S19,S20,S21,S22, S23,S24,S25,S26,S27,S28,S29,S30,S31,S32,S33,S34, S35,S36,S37,S38	TFD		28.000	EA
25	3150133	SW 10P BCD ROT OUTPUT "ORANGE" S1,S2,S3	230012G		3.000	EA
26	4410494	RES 100K OHM 1/4W 10% R3	RC07GF104K		1.000	EA
27	4410379	RES 10K OHM 1/4W 10% R19	RC07GF103K		1.000	EA

PARENT ITEM: 9203506

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
28	4410247	RES 1K OHM 1/4W 10% R10	RC07GF102K	1.000	EA
29	4410163	RES 220 OHM 1/4W 10% R6,R7,R8,R11,R12,R13,R16	RC07GF221K	7.000	EA
30	4410593	RES 680K OHM 1/4W 10% R20	RC07GF684K	1.000	EA
31	4410437	RES 33K OHM 1/4W 10% R17	RC07GF333K	1.000	EA
32	4460572	RES 200K OHM 1/4W 5% R15	RC07GF204J	1.000	EA
33	4410254	RES 1.2K OHM 1/4W 10% R18	RC07GF122K	1.000	EA
34	4540118	RES SIP 10K OHM 1/8W 2% 8 PIN R14	750-81-R10K	1.000	EA
35	4540134	RES SIP 10K OHM 1/8W 2% 10 R1,R2,R4,R5,R9	750-101-R10K	5.000	EA
37	3110509	CONN SCTCHFLX R ANGLE W/O EJCT	3432-1002	1.000	EA
39	4260186	CAP TANT EPOX-DIP 220/10V 10% C8	K220E10	1.000	EA
40	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C7,C9,C10,C11,C12,C13,C14,C17, C20,C21	CY20C104M	15.000	EA
41	4280020	CAP TANT EPOX-DIP .33/35V 20% C16	199D334X0035AB2	1.000	EA
42	4220182	CAP MICA DIP 3300PF 5% C15	DM-19-332J	1.000	EA
43	4210134	CAP MICA DIP 30PF 5% C6	DM-15-300J	1.000	EA
44	4210092	CAP MICA DIP 20PF 5% C18	DM-15-200J	1.000	EA
45	4370268	CAP VAR PC MT 5-60PF C19	2810000560QN02F	1.000	EA
47	3290830	LUG GND P2,P3	836	2.000	EA
48	1641943	W BUSS 26GA	299/1	1.000	FT
49	1640366	W W/W GREEN	M0015-195A	1.000	FT
52	3600012	DIO GER 1N270 100V 80MW DO7 CR1,CR2,CR3,CR4,CR5,CR6,CR7,CR8,CR9,CR10,CR11, CR12,CR37,CR38,CR39,CR40	1N270	16.000	EA
53	1030055	NUT HEX 3-48 SM PATT SST P1		2.000	EA
54	3340742	XTAL 32768 HZ MRC-2 Y1	30A0075 B	1.000	EA
56	3630027	XT NS2N2924LFS.2W160M025V.1A7P Q1,Q3	2N2924-LFS	2.000	EA
57	3630092	XT PS2N3640 .2W500M012V80M3.5P Q2	2N3640	1.000	EA
58	3250511	SKT PC BD MT .025 LEAD	7785-7	4.000	EA
59	3650140	RGLTR MC79L12 12V/0.1A TO92 VR1	MC79L12ACLP	1.000	EA
62	1030030	SCR PNH PHPS 3-48 X 3/8 SST 1		2.000	EA

PARENT ITEM: 9203498 DESCRIPTION: ASSY 6809 CPU MRC-2
ENG.DRAWING NO.: 20D2793 H

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3472529	PCB 6809 CPU	51C5918	F	1.000	EA
2	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
3	3430386	LBL LOGIC CD "CPU 6809"	10B1068-11	E	1.000	EA
4	3601048	IC MC6809P MPU U1	MC6809P		1.000	EA
5	3710027	IC MC6821P PIA INTERFACE U2,U3	MC6821P		2.000	EA
6	3710035	IC MC6828P PRIOR INTERRUPT U21	MC6828P		1.000	EA
7	3660685	IC SN74LS04N HX INV U9	SN74LS04N		1.000	EA
8	3660701	IC SN74LS10 TR 3IN NAND U15	SN74LS10N		1.000	EA
9	3661055	IC SN74LS11N TRIPLE 3INPUT AND U8	SN74LS11N		1.000	EA
10	3660719	IC SN74LS20N DU 4IN NAND U11	SN74LS20N		1.000	EA
11	3660727	IC SN74LS27N TR 3IN NOR U10,U12	SN74LS27N		2.000	E
12	3660958	IC SN74LS32 QUAD 2-INPUT NOR U7	SN74LS32N		1.000	EA
13	3661063	IC SN74LS74N DUAL D FLIP FLOP U5	SN74LS74AN		1.000	EA
14	3660743	IC SN74LS86N QU 2IN EXCL OR U6	SN74LS86N		1.000	EA
15	3661071	IC SN74LS133N 13-INPUT NAND U13	SN74LS133N		1.000	EA
16	3660859	IC SN74LS244N OCT BUS/DRIV ST U16,U17,U18,U19,U20	SN74LS244N		5.000	EA
17	3730702	IC NE555N TIMER U4	NE-555N		1.000	EA
18	3340163	XTAL 4.00 MHZ MRC/TCS Y1	30A0066	C	1.000	EA
19	3630092	XT PS2N3640 .2W500M012V80M3.5P Q1	2N3640		1.000	EA
20	3390127	LED RED 3.5@10 DIFF65 T1.75 CR1	HLMP-3300		1.000	EA
21	3390614	LED GRN 5.2@10 DIFF75 T1.75 CR2,CR3,CR4	HLMP-3507		3.000	EA
22	3250016	SKT DUAL IN LINE 8 PIN U4	2-640463-1		1.000	EA
23	3250024	SKT DUAL IN LINE 14 PIN U5,U6,U7,U8,U9,U10,U11,U12,U15	2-640357-1		9.000	EA
24	3250032	SKT DUAL IN LINE 16 PIN U13	2-640358-1		1.000	EA

PARENT ITEM: 9203498

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
25	3250057	SKT DUAL IN LINE 20 PIN U16,U17,U18,U19,U20	2-640464-1	5.000	EA
26	3250073	SKT DUAL IN LINE 24 PIN U21	2-640361-1	1.000	EA
27	3250099	SKT DUAL IN LINE 40 PIN U1,U2,U3	2-640379-1	3.000	EA
28	4630075	POT CER PC PIN 1K OHM .75W 15T R4	3006P-1-102	1.000	EA
29	4540134	RES SIP 10K OHM 1/8W 2% 10 R17	750-101-R10K	1.000	EA
30	4410163	RES 220 OHM 1/4W 10% R3	RC07GF221K	1.000	EA
31	4410189	RES 330 OHM 1/4W 10% R10	RC07GF331K	1.000	EA
32	4410247	RES 1K OHM 1/4W 10% R1,R2,R5,R9,R12	RC07GF102K	5.000	EA
33	4540167	RES SIP 3.3K 1/8W 2% R15	750-101-3.3K	1.000	EA
34	4410379	RES 10K OHM 1/4W 10% R6,R13,R14,R16,R18,R19,R20	RC07GF103K	7.000	EA
35	4410650	RES 15MEG OHM 1/4W 10% R11	RC07GF156K	1.000	EA
36	4410619	RES 2.2MEG OHM 1/4W 10% R8	RC07GF225K	1.000	EA
37	4310165	CAP .01UF/100V W/O.LIN LD SPCG C24	CY15A103M	1.000	EA
38	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,C12,C13,C14, C15,C16,C17,C18,C19,C20,C21,C27,C28	CY20C104M	23.000	EA
39	4280046	CAP TANT EPOX-DIP 2.2/35V 20% C25	199D225X0035CA2	1.000	EA
40	4280186	CAP TANT EPOX-DIP 220/10V 10% C29	K220E10	1.000	EA
41	4210118	CAP MICA DIP 24PF 5% C22,C23	DM-15-240J	2.000	EA
42	1030030	SCR PNH PHPS 3-48 X 3/8 SST P2		2.000	EA
43	1030055	NUT HEX 3-48 SM PATT SST P2		2.000	EA
44	1030089	WSHR LK #3 SR SST P2		2.000	EA
45	3170065	SW RT ANG SPDT S1	8121SD9AGE	1.000	EA
46	3110509	CONN SCTCHFLX R ANGLE W/O EJCT P2	3432-1002	1.000	EA

PARENT ITEM: 9203076 DESCRIPTION: ASSY CPU INTERFACE MRC-1/1A/2
ENG.DRAWING NO.: 20C2781 H

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3472271	PCB CPU INTERFACE	51C5907	C	1.000	EA
2	3110442	CONN 48 PIN P1	65001-081		1.000	EA
3	3050234	CONN 09PLG PLASTIC PC RTANG J1	207081-1		1.000	EA
4	3250032	SKT DUAL IN LINE 16 PIN U3	640358-1		1.000	EA
5	3250024	SKT DUAL IN LINE 14 PIN U1	640357-1		1.000	EA
6	3250016	SKT DUAL IN LINE 8 PIN U5	640463-1		1.000	EA
8	3730207	IC LM339N COMPARITOR QUAD U1	LM339N		1.000	EA
9	3650175	RGLTR UA7805UC 05V 1.0A TO220 U2	UA7805UC		1.000	EA
10	3650074	RGLTR LM340T12/7812 VARV1.5A U4	LM340T-12		1.000	EA
11	3660925	IC SN75452BP DU NAND HIGHV OC U5	SN75452BP		1.000	E
12	3660768	IC SN74LS123N DURETRMONOMULTI U3	SN74LS123N		1.000	EA
13	3430485	LBL LOGIC CO "CPU INT"	10A1069-1	B0	1.000	EA
14	3630316	XT NP2N5293 36W800K080V04A Q3,Q4	2N5293		2.000	EA
15	3630027	XT NS2N2924LFS.2W160M025V.1A7P Q1,Q2,Q6	2N2924-LFS		3.000	EA
16	3630191	XT PP2N4037 01W060M060V01A Q5	2N4037		1.000	EA
17	4440079	RES 100 OHM 2W 10% R26	RC42GF101K		1.000	EA
18	4440053	RES 47 OHM 2W 10% R30	RC42GF470K		1.000	EA
20	4420170	RES 180 OHM 1/2W 10% R27	RC20GF181K		1.000	EA
21	4460226	RES 3.3K OHM 1/4W 5% R1,R13,R21,R29,R33	RC07GF332J		5.000	EA
22	4460549	RES 470K OHM 1/4W 5% R22	RC07GF474J		1.000	EA
24	4460481	RES 100K OHM 1/4W 5% R11,R18	RC07GF104J		2.000	EA
25	4460374	RES 22K OHM 1/4W 5% R32	RC07GF223J		1.000	EA
26	4460317	RES 10K OHM 1/4W 5% R8,R9,R10,R15,R17,R20	RC07GF103J		6.000	EA
27	4460242	RES 4.7K OHM 1/4W 5% R16	RC07GF472J		1.000	E

PARENT ITEM: 9203076

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
28	4460499	RES 120K OHM 1/4W 5% R31	RC07GF124J	1.000	EA
29	4460192	RES 2.2K OHM 1/4W 5% R23,R36	RC07GF222J	2.000	EA
30	4460184	RES 1.8K OHM 1/4W 5% R4,R12	RC07GF182J	2.000	EA
31	4460168	RES 1.5K OHM 1/4W 5% R5,R19,R35	RC07GF152J	3.000	EA
32	4460143	RES 1K OHM 1/4W 5% R6,R14,R24	RC07GF102J	3.000	EA
33	4460432	RES 47K OHM 1/4W 5% R25	RC07GF473J	1.000	EA
34	4460051	RES 100 OHM 1/4W 5% R7	RC07GF101J	1.000	EA
35	4460010	RES 10 OHM 1/4W 5% R3,R34	RC07GF100J	2.000	EA
36	4460119	RES 470 OHM 1/4W 5% R2	RCR07G471J	1.000	EA
38	4630067	POT CER PC PIN 1K OHM .5W R28	3386R-1-102	1.000	EA
39	4020343	IDCTR RF 6.80 UH L1,L2	9310-32	2.000	EA
40	4280038	CAP TANT EPOX-DIP 1/35V 20% C1,C6	199D105X0035HA1	2.000	EA
41	4310132	CAP DISC .01/50V C2,C5	UK-50-103	2.000	EA
42	4310207	CAP .1UF/50V 20% C3,C7,C9,C11,C12,C14,C15,C16	CY20C104M	8.000	EA
44	4280186	CAP TANT EPOX-DIP 220/10V 10% C8,C10	K220E10	2.000	EA
45	4280079	CAP TANT EPOX-DIP 10/25V 20% C13	199D106X0025KA1	1.000	EA
46	4280095	CAP TANT EPOX-DIP 22/35V 10% C4	199D226X9035PE4	1.000	EA
47	3610003	DIO 1002 200V 1A SI D039 CR1,CR2,CR4,CR5,CR7,CR8,CR9, CR10,CR11,CR12	1002	10.000	EA
48	3610169	DIO ZSZ3.1 3.1V CR3	SZ3.1	1.000	EA
49	3600053	DIO 1N914 75V 75MA SI A398 CR6	1N914	1.000	EA
51	3270113	RELAY MIN PC 200OHM 12V NOM K1,K2	AZ-2530-09-2	2.000	EA
52	1641927	W BUSS 22GA	298	.500	FT
53	3290012	POST BDG BLK	111-0203-001	1.000	EA
54	3290004	POST BDG RED	111-202-001	1.000	EA
55	2060374	PANEL CPU INTF MRC	05A2640 D	1.000	EA
56	1050145	SCR PNH PHPS 4-40 X 5/16 SS		4.000	EA
57	1050582	NUT HEX 4-40 SM PATT SST		4.000	EA
58	1090182	SCR PNH PHPS 6-32 X 1/4 SST		4.000	EA
59	1090554	NUT HEX 6-32 SM PATT		5.000	EA

PARENT ITEM: 9203076

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
60	1050632	WSHR LK #4 SR CD PL		2.000	EA
61	1090588	WSHR LK #6 SR SST		4.000	EA
62	2060051	BRKT ANGLE	7575-C	1.000	EA
63	1090190	SCR PNH PHPS 6-32 X 5/16 SST		1.000	EA
64	1090174	SCR PNH PHPS 6-32 X 3/16 SST		1.000	EA
65	1090604	WSHR FL #6 CD PL	AN960-6 CAD 1	1.000	EA

PARENT ITEM: 9205105 DESCRIPTION: ASSY 96K ROM MRC-2
ENG.DRAWING NO.: 2002929 B

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3473766	PCB 96K ROM MRC-2	51C6039	B	1.000	EA
2	3190071	SW DIP 4 POSITION S2	206-4		1.000	EA
3	3250024	SKT DUAL IN LINE 14 PIN U18	2-640357-1		1.000	EA
4	3250057	SKT DUAL IN LINE 20 PIN U1,U2,U3,U4,U5	2-640464-1		5.000	EA
5	3250081	SKT DUAL IN LINE 28 PIN U6,U7,U8,U9,U10,U11,U12,U13,U14,U15,U16,U17	2-640362-1		12.000	EA
6	3430972	LBL LOGIC CD 96K ROM	1081068-22	E	1.000	EA
7	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
8	3660677	IC SN74LS02N QU 2IN NOR U18	SN74LS02N		1.000	EA
9	3661152	IC SN74LS245N OCT BUS TRNCVR U1,U2,U3	SN74LS245N		3.000	EA
10	4280186	CAP TANT EPOX-DIP 220/10V 10% C19	K220E10		1.000	EA
11	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,C12,C13,C14, C15,C16,C17,C18	CY20C104M		18.000	EA
12	4540113	RES SIP 10K OHM 1/8W 2% 8 PIN R1	750-81-R10K		1.000	EA
13	3190816	SW DIP SPDT 1 S1	206-121		1.000	EA
14	9104696	IC PROG MRC-2 96K ROM U4 U4	26M1099	E	1.000	EA
15	9104670	IC PROG MRC-2 96K ROM U5 U5	26M1100	D	1.000	EA

PARENT ITEM: 9205113 DESCRIPTION: ASSY COMP 32K RAM MRC-2 (24K)
ENG.DRAWING NO.: 20D2930-1 D

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3473774	PCB 32K RAM MRC-2	51C6040	B	1.000	EA
2	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
3	3430980	LBL LOGIC CD 32K RAM	1081068-23	E	1.000	EA
4	3250057	SKT DUAL IN LINE 20 PIN U1,U2,U3,U4,U5,U10	2-640464-1		6.000	EA
5	3250081	SKT DUAL IN LINE 28 PIN U6,U7,U8,U9	2-640362-1		4.000	EA
6	3661162	IC SN74LS245N OCT BUS TRNCVR U1,U2,U3,U4	SN74LS245N		4.000	EA
7	9104688	IC PROG MRC-2 32K RAM U5 U5	26M1101	C	1.000	EA
8	9104662	IC PROG MRC-2 32K RAM U10 U10	26M1102	B	1.000	EA
9	4280186	CAP TANT EPOX-DIP 220/10V 10% C11	K220E10		1.000	EA
10	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C7,C8,C9,C10	CY20C104M		10.000	EA
11	3710662	IC RAM STATIC 8K X 8 U6,U7,U8	HM6264		3.000	E

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PARENT ITEM: 9205170 DESCRIPTION: ASSY COMP 32K RAM/ROM MRC-2
ENG.DRAWING NO.: 2002930-2 D

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3473774	PCB 32K RAM MRC-2	51C6040	B	1.000	EA
2	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
3	3430980	LBL LOGIC CD 32K RAM	1081068-23	E	1.000	EA
4	3250057	SKT DUAL IN LINE 20 PIN U1,U2,U3,U4,U5,U10	2-640464-1		6.000	EA
5	3250081	SKT DUAL IN LINE 28 PIN U6,U7,U8,U9	2-640362-1		4.000	EA
6	3661162	IC SN74LS245N OCT BUS TRNCVR U1,U2,U3,U4	SN74LS245N		4.000	EA
7	9106485	IC PROG MRC-2 32K RAM/ROM U5 U5	26M1170	A	1.000	EA
8	9106493	IC PROG MRC-2 32K RAM/ROM U10 U10	26M1171	A	1.000	EA
9	4280186	CAP TANT EPOX-DIP 220/10V 10% C11	K220E10		1.000	EA
10	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C7,C8,C9, C10	CY20C104M		10.000	EA
11	3710662	IC RAM STATIC 8K X 8 U6,U7	HM6264		2.000	EA

PARENT ITEM: 9203472 DESCRIPTION: ASSY FILE MEMORY CTL MRC-2
ENG.DRAWING NO.: 2002789 H1

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	3472503	PCB FILE MEMORY CONTROL	51C5916 B	1.000	EA
2	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409	1.000	PR
3	3430451	LBL LOGIC CD "FIL CTL"	1081068-18 E	1.000	EA
4	3730777	IC TIL-112 OPTOCOUPLER U1	TIL-112	1.000	EA
5	3710001	IC EAROM 1K X 4 U2,U3,U4,U5	ER3400	4.000	EA
6	3730694	IC NE-531 OPAMP HI SLEW U6	NE-531N	1.000	EA
7	3660859	IC SN74LS244N OCT BUS/DRIV ST U7,U14,U16,U21	SN74LS244N	4.000	EA
8	3660792	IC SN74LS138N 3-8LINEDECDEMUX U8	SN74LS138N	1.000	EA
9	3660701	IC SN74LS10 TR 3IN NAND U9	SN74LS10N	1.000	EA
10	3710027	IC MC6821P PIA INTERFACE U10,U11	MC6821P	2.000	EA
11	3660693	IC SN74LS08N QU 2IN AND U12	SN74LS08N	1.000	E
12	3660768	IC SN74LS123N DURETRMONOMULTI U13	SN74LS123N	1.000	EA
13	3660669	IC SN74LS00N QU 2IN NAND U15	SN74LS00N	1.000	EA
14	3660735	IC SN74LS30N SI 8IN NAND U17,U20	SN74LS30N	2.000	EA
15	3660974	IC SN74LS240 OCT BUS/DRIV ST U18	SN74LS240N	1.000	EA
16	3660743	IC SN74LS86N QU 2IN EXCL OR U19	SN74LS86N	1.000	EA
18	3250008	SKT DUAL IN LINE 6 PIN U1	ICN-063-S3-G	1.000	EA
19	3250016	SKT DUAL IN LINE 8 PIN U6	2-640463-1	1.000	EA
20	3250024	SKT DUAL IN LINE 14 PIN U9,U12,U15,U17,U19,U20	2-640357-1	6.000	EA
21	3250032	SKT DUAL IN LINE 16 PIN U8,U13	2-640358-1	2.000	EA
22	3250057	SKT DUAL IN LINE 20 PIN U7,U14,U16,U18,U21	2-640464-1	5.000	EA
23	3250065	SKT DUAL IN LINE 22 PIN U2,U3,U4,U5	2-640360-1	4.000	EA
24	3250099	SKT DUAL IN LINE 40 PIN U10,U11	2-640379-1	2.000	EA
25	3630035	XT NP2N3053 05W100M080V.7A Q1,Q3	2N3053	2.000	EA

PARENT ITEM: 9203472

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
26	3630316	XT NP2N5293 36W800K080V04A Q2	2N5293	1.000	EA
27	3630191	XT PP2N4037 01W060M060V01A Q4	2N4037	1.000	EA
29	3650314	RGLTR MC7915CT VR1	MC7915CT	1.000	EA
30	3650140	RGLTR MC79L12 12V/0.1A T092 VR2	MC79L12ACLP	1.000	EA
31	4420261	RES 1K OHM 1/2W 10% R6	RC20GF102K	1.000	EA
32	4420303	RES 2.2K OHM 1/2W 10% R1	RC20GF222K	1.000	EA
33	4420113	RES 47 OHM 1/2W 10% R2	RC20GF470K	1.000	EA
34	4410403	RES 18K OHM 1/4W 10% R12	RC07GF182K	1.000	EA
35	4410270	RES 1.8K OHM 1/4W 10% R16	RC07GF182K	1.000	EA
36	4460390	RES 33K OHM 1/4W 5% R20,R21	RC07GF333J	2.000	EA
37	4410247	RES 1K OHM 1/4W 10% R14,R25	RC07GF102K	2.000	EA
38	4410262	RES 1.5K OHM 1/4W 10% R3,R4,R7,R17,R18,R26	RC07GF152K	6.000	EA
39	4410379	RES 10K OHM 1/4W 10% R8,R9,R10,R11,R13,R15,R19,R22,R23,R24,R27,R28,R29	RC07GF103K	13.000	EA
40	4420386	RES 10K OHM 1/2W 10% R5	RC20GF103K	1.000	EA
41	3600145	DIO 1N4154 25V 4NS SI D035 CR1	1N4154	1.000	EA
42	3610003	DIO 1002 200V 1A SI D039 CR2,CR3	1002	2.000	EA
43	4410510	RES 150K OHM 1/4W 10% R30	RC07GF154K	1.000	EA
44	3150117	SW 16P BCD ROT OUTPUT "YELLOW" S1	230057G	1.000	EA
46	4280079	CAP TANT EPOX-DIP 10/20V 20% C11	199D106X0020CA2	1.000	EA
47	4260186	CAP TANT EPOX-DIP 220/10V 10% C30	K220E10	1.000	EA
48	4280020	CAP TANT EPOX-DIP .33/35V 20% C10	199D334X0035AB2	1.000	EA
49	4310140	CAP DISC .01/100V C12	TG-S10	1.000	EA
50	4260121	CAP LYTIC LITL 50/50V C1	TE-1307	1.000	EA
51	4280038	CAP TANT EPOX-DIP 1/35V 20% C7,C9,C21	199D105X0035AA2	3.000	EA
52	4310207	CAP .1UF/50V 20% C2,C3,C4,C5,C6,C8,C13,C14,C15,C16,C18,C19,C20,C22,C23,C24,C25,C26,C27,C28,C29	CY20C104M	21.000	EA

PARENT ITEM: 9203472

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
53	2110237	HEATSINK TO-5 PUSH-ON Q3,Q4	#11158	2.000	EA
54	3110509	CONN SCTCHFLX R ANGLE W/O EJCT P2	3432-1002	1.000	EA
55	3250909	HDR 18-PIN (9 X 2) E1	65610-X18	1.000	EA
56	1090182	SCR PNH PHPS 6-32 X 1/4 SST Q2,VR1		2.000	EA
57	1090554	NUT HEX 6-32 SM PATT Q2,VR1		2.000	EA
58	1030030	SCR PNH PHPS 3-48 X 3/8 SST P2		2.000	EA
59	1030089	WSHR LK #3 SR SST P2		2.000	EA
60	1030055	NUT HEX 3-48 SM PATT SST P2		2.000	EA
61	3250917	JUMPER MINI FOR 2 PINS=.025/.1 E1:INT4	65474-001	1.000	EA
62	1090562	WSHR LK #6 INTL T CD PL Q2,VR1		2.000	EA
63	3250354	PAD XSTR Q1,Q3,Q4	513-075	3.000	EA
64	4280004	CAP TANT EPOX-DIP .1/35V C17	1990104X0035AA2	1.000	EA

PARENT ITEM: 9203480 DESCRIPTION: ASSY FILE MEMORY EXT MRC-2
ENG.DRAWING NO.: 2002790 F

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	3472511	PCB FILE MEMORY EXTENSION	51C5917 B	1.000	EA
2	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409	1.000	PR
3	3710001	IC EAROM 1K X 4 U1-16	ER3400	16.000	EA
4	3660693	IC SN74LS08N QU 2IN AND U17	SN74LS08N	1.000	EA
5	3660701	IC SN74LS10 TR 3IN NAND U18	SN74LS10N	1.000	EA
6	3660792	IC SN74LS138N 3-8LINEDECDEMUX U19	SN74LS138N	1.000	EA
7	3660743	IC SN74LS86N QU 2IN EXCL OR U20	SN74LS86N	1.000	EA
8	3730777	IC TIL-112 OPTOCOUPLER U21	TIL-112	1.000	EA
10	3250065	SKT DUAL IN LINE 22 PIN U1-16	2-640360-1	16.000	EA
11	3250024	SKT DUAL IN LINE 14 PIN U17,U18,U20	2-640357-1	3.000	EA
12	3250032	SKT DUAL IN LINE 16 PIN U19	2-640358-1	1.000	EA
13	3250008	SKT DUAL IN LINE 6 PIN U21	ICN-063-S3-G	1.000	EA
15	3430469	LBL LOGIC CD "FIL EXP"	1081068-19 E	1.000	EA
16	4460507	RES 150K OHM 1/4W 5% R1,R7	RC07GF154J	2.000	EA
18	4420386	RES 10K OHM 1/2W 10% R4	RC20GF103K	1.000	EA
19	4420261	RES 1K OHM 1/2W 10% R5	RC20GF102K	1.000	EA
20	4420303	RES 2.2K OHM 1/2W 10% R6	RC20GF222K	1.000	EA
21	4420113	RES 47 OHM 1/2W 10% R8	RC20GF470K	1.000	EA
23	4310207	CAP .1UF/50V 20% C1-22	CY20C104M	22.000	EA
24	4280020	CAP TANT EPOX-DIP .33/35V 20% C23	199D334X0035AB2	1.000	EA
25	4260186	CAP TANT EPOX-DIP 220/10V 10% C24	K220E10	1.000	EA
27	3600145	DIO 1N4154 25V 4NS SI D035 CR1	1N4154	1.000	EA
29	3150117	SW 16P BCD ROT OUTPUT "YELLOW" S1	230057G	1.000	EA
31	3630316	XT NP2N5293 36W800K080V04A Q1	2N5293	1.000	EA

PARENT ITEM: 9203480

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
32	3630035	XT NP2N3053 05W100M080V.7A Q2	2N3053	1.000	EA
34	3650330	RGLTR MC7912CT VR1	MC7912CT	1.000	EA
36	3110509	CONN SCTCHFLX R ANGLE W/O EJCT P2	3432-1002	1.000	EA
39	1090182	SCR PNH PHPS 6-32 X 1/4 SST Q1,VR1		2.000	EA
42	1090554	NUT HEX 6-32 SM PATT Q1,VR1		2.000	EA
43	1030030	SCR PNH PHPS 3-48 X 3/8 SST P2		2.000	EA
44	1030055	NUT HEX 3-48 SM PATT SST P2		2.000	EA
45	1030089	WSHR LK #3 SR SST P2		2.000	EA
46	1090588	WSHR LK #6 SR SST Q1,VR1		2.000	EA
47	3250354	PAD XSTR Q2	513-075	1.000	EA
48	4540134	RES SIP 10K OHM 1/8W 2% 10 R2	750-101-R10K	1.000	EA
49	4540118	RES SIP 10K OHM 1/8W 2% 8 PIN R3	750-81-R10K	1.000	EA

PARENT ITEM: 9203514   DESCRIPTION: ASSY GPIB-488 MRC-2
ENG.DRAWING NO.: 2002791   B

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
	3150117	SW 16P BCD ROT OUTPUT "YELLOW"	230057G		2.000	EA
	3250024	SKT DUAL IN LINE 14 PIN	2-640357-1		6.000	EA
	3250057	SKT DUAL IN LINE 20 PIN	2-640464-1		8.000	EA
	3250099	SKT DUAL IN LINE 40 PIN	2-640379-1		2.000	EA
	3250909	HDR 18-PIN (9 X 2)	65610-X18		1.000	EA
	3250917	JUMPER MINI FOR 2 PINS=.025/.1	65474-001		1.000	EA
	3430394	LBL LOGIC CD 488	1081068-12	E	1.000	EA
	3472545	PCB GPIB-448	51C5920	B	1.000	EA
	3660669	IC SN74LS00N QU 2IN NAND	SN74LS00N		1.000	EA
	3660677	IC SN74LS02N QU 2IN NOR	SN74LS02N		1.000	EA
	3660735	IC SN74LS30N SI 8IN NAND	SN74LS30N		2.000	EA
	3660743	IC SN74LS86N QU 2IN EXCL OR	SN74LS86N		1.000	EA
	3660859	IC SN74LS244N OCT BUS/DRIV ST	SN74LS244N		5.000	EA
	3660958	IC SN74LS32 QUAD 2-INPUT NOR	SN74LS32N		1.000	EA
	3660974	IC SN74LS240 OCT BUS/DRIV ST	SN74LS240N		1.000	EA
	3661022	IC SN75160N GPIB	SN75160N		1.000	EA
	3661030	IC SN75161N TRANSCIEVER	SN75161N		1.000	EA
	3710027	IC MC6821P PIA INTERFACE	MC6821P		1.000	EA
	3710282	IC MC68488P GPIB ADAPTER	MC68488P		1.000	EA
	4260186	CAP TANT EPOX-DIP 220/10V 10%	K220E10		1.000	EA
	4310207	CAP .1UF/50V 20%	CY20C104M		16.000	EA
	4410247	RES 1K OHM 1/4W 10%	RC07GF102K		2.000	EA
	4410379	RES 10K OHM 1/4W 10%	RC07GF103K		6.000	EA

PARENT ITEM: 9203522 DESCRIPTION: ASSY GPIB-488 INTERFACE MRC-2
ENG.DRAWING NO.: 20C2792 A1

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1050129	SCR PNH PHPS 4-40 X 1/4 SST			2.000	EA
	1090174	SCR PNH PHPS 6-32 X 3/16 SST			2.000	EA
	1090182	SCR PNH PHPS 6-32 X 1/4 SST			2.000	EA
	1090554	NUT HEX 6-32 SM PATT			2.000	EA
	1090588	WSHR LK #6 SR SST			2.000	EA
	1190155	SCR LOCK KIT	552633-4		1.000	EA
	2060051	BRKT ANGLE	7575-C		2.000	EA
	2062388	PANEL INRFC GPIB-488	05A2744	C	1.000	EA
	3050309	CONN EDGE-R ANGLE 24 PIN	552791-2		1.000	EA
	3110442	CONN 48 PIN	65001-081		1.000	EA
	3430576	LBL LOGIC CD "GPIB 488"	10A1069-10	BO	1.000	EA
	3472552	PCB GPIB-488 INTERFACE	51C5921	AO	1.000	EA

PARENT ITEM: 9203399 DESCRIPTION: ASSY MODEM II MRC-1/-2
ENG.DRAWING NO.: 2002787 B

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
	3150117	SW 16P BCD ROT OUTPUT "YELLOW"	230057G		1.000	EA
	3160181	SW TGL SPDT	7105-M-D9-ABE		1.000	EA
	3190071	SW DIP 4 POSITION	206-4		1.000	EA
	3190253	SW SLD	23 021 114		1.000	EA
	3250016	SKT DUAL IN LINE 8 PIN	2-640463-1		1.000	EA
	3250024	SKT DUAL IN LINE 14 PIN	2-640357-1		9.000	EA
	3250032	SKT DUAL IN LINE 16 PIN	2-640358-1		2.000	EA
	3250057	SKT DUAL IN LINE 20 PIN	2-640464-1		2.000	EA
	3250073	SKT DUAL IN LINE 24 PIN	2-640361-1		2.000	EA
	3290038	TEST PT BROWN VERT	105-0853-001		1.000	EA
	3290046	TEST PT RED VERT	105-0852-001		1.000	EA
	3290053	TEST PT ORANGE VERT	105-0856-001		1.000	EA
	3290061	TEST PT YELLOW VERT	105-0857-001		1.000	EA
	3290079	TEST PT GREEN VERT	105-0854-001		1.000	EA
	3290087	TEST PT BLUE VERT	105-0860-001		1.000	EA
	3290095	TEST PT VIOLET VERT	105-0862-001		1.000	EA
	3290145	JACK TEST BLACK R ANGLE	430-103		1.000	EA
	3290152	JACK TEST WHITE R ANGLE	430-101		2.000	EA
	3340726	XTAL 1.8432 MHZ MODULE 2 MRC-1	30A0073	C	1.000	EA
	3390127	LED RED 3.5310 DIFF65 T1.75	HLMP-3300		2.000	EA
	3430436	LBL LOGIC CD "MDM II"	1081068-16	E	1.000	EA
	3472420	PCB MODEM II	51C5909	D	1.000	EA
	3600145	DIO 1N4154 25V 4NS SI DO35	1N4154		6.000	EA
	3630027	XT NS2N2924LFS.2W160M025V.1A7P	2N2924-LFS		4.000	EA
	3650124	RGLTR MC78L12 12V 0.1A TO92	MC78L12ACP		1.000	EA
	3650140	RGLTR MC79L12 12V/0.1A TO92	MC79L12ACLP		1.000	EA
	3660008	IC UA741P OPAMP GEN COMP	UA741CP		1.000	EA
	3660677	IC SN74LS02N QU 2IN NOR	SN74LS02N		1.000	EA
	3660693	IC SN74LS08N QU 2IN AND	SN74LS08N		2.000	EA
	3660735	IC SN74LS30N SI 8IN NAND	SN74LS30N		1.000	EA
	3660743	IC SN74LS86N QU 2IN EXCL OR	SN74LS86N		2.000	EA
	3660768	IC SN74LS123N DURETRMONOMULTI	SN74LS123N		1.000	EA
	3660776	IC SN74LS132N QU NAND ST	SN74LS132N		1.000	EA
	3660859	IC SN74LS244N OCT BUS/DRIV ST	SN74LS244N		2.000	EA
	3680212	IC BIT RATE GENERATOR	MC14411P		1.000	EA
	3710043	IC MC6850P ACIA INTERFACE	MC6850P		1.000	EA
	3730462	IC RC4136N OPAMP QUAD 741	RC4136N		1.000	EA
	3730819	IC XR-2206CP VCO WAVE GEN	XR-2206CP		1.000	EA
	3730827	IC XR-2211CP FSK MODEM	XR-2211CP		1.000	EA
	4210183	CAP MICA DIP 47PF 5%	DM-15-470J		1.000	EA
	4210415	CAP MICA DIP 330PF 5%	DM-15-331J		1.000	EA
	4250049	CAP POLYCARB .0022/100 3%	22UB222H		1.000	EA
	4250171	CAP POLYCARB .01/100V 3%	22UB103H		5.000	EA
	4250288	CAP POLYCARB .022/100V 3%	22UB223H		1.000	EA

PARENT ITEM: 9203399

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG. DRAWING NO.	QUANTITY PER	UM
	4250312	CAP POLYCARB .027/100V 3%	22U8273H	2.000	EA
	4250486	CAP POLYCARB .1/100V 3%	22U8104H	1.000	EA
	4280038	CAP TANT EPOX-DIP 1/35V 20%	199D105X0035AA2	1.000	EA
	4280079	CAP TANT EPOX-DIP 10/20V 20%	199D106X0020CA2	7.000	EA
	4280137	CAP TANT EPOX-DIP 47/20V	199D476X0020EE3	1.000	EA
	4280186	CAP TANT EPOX-DIP 220/10V 10%	K220E10	1.000	EA
	4310207	CAP .1UF/50V 20%	CY20C104M	29.000	EA
	4410080	RES 47 OHM 1/4W 10%	RC07GF470K	1.000	EA
	4410122	RES 100 OHM 1/4W 10%	RC07GF101K	4.000	EA
	4410163	RES 220 OHM 1/4W 10%	RC07GF221K	1.000	EA
	4410205	RES 470 OHM 1/4W 10%	RC07GF471K	3.000	EA
	4410239	RES 820 OHM 1/4W 10%	RC07GF821K	1.000	EA
	4410247	RES 1K OHM 1/4W 10%	RC07GF102K	4.000	EA
	4410262	RES 1.5K OHM 1/4W 10%	RC07GF152K	1.000	EA
	4410288	RES 2.2K OHM 1/4W 10%	RC07GF222K	3.000	EA
	4410320	RES 3.9K OHM 1/4W 10%	RC07GF392K	2.000	EA
	4410338	RES 4.7K OHM 1/4W 10%	RC07GF472K	6.000	EA
	4410379	RES 10K OHM 1/4W 10%	RC07GF103K	13.000	EA
	4410411	RES 22K OHM 1/4W 10%	RC07GF223K	1.000	EA
	4410437	RES 33K OHM 1/4W 10%	RC07GF333K	1.000	EA
	4410494	RES 100K OHM 1/4W 10%	RC07GF104K	2.000	EA
	4410502	RES 120K OHM 1/4W 10%	RC07GF124K	1.000	EA
	4410510	RES 150K OHM 1/4W 10%	RC07GF154K	1.000	EA
	4410536	RES 220K OHM 1/4W 10%	RC07GF224K	1.000	E
	4410577	RES 470K OHM 1/4W 10%	RC07GF474K	2.000	EA
	4410650	RES 15MEG OHM 1/4W 10%	RC07GF156K	1.000	EA
	4460242	RES 4.7K OHM 1/4W 5%	RC07GF472J	2.000	EA
	4460325	RES 12K OHM 1/4W 5%	RC07GF123J	2.000	EA
	4460341	RES 15K OHM 1/4W 5%	RC07GF153J	1.000	EA
	4460390	RES 33K OHM 1/4W 5%	RC07GF333J	1.000	EA
	4460416	RES 39K OHM 1/4W 5%	RC07GF393J	1.000	EA
	4460481	RES 100K OHM 1/4W 5%	RC07GF104J	1.000	EA
	4460549	RES 470K OHM 1/4W 5%	RC07GF474J	1.000	EA
	4510152	RES 15.0K OHM 1/8W 1%	RN55C1502F	1.000	EA
	4510178	RES 18.2K OHM 1/8W 1%	RN55D1822F	1.000	EA
	4510194	RES 28.0K OHM 1/8W 1%	RN55D2802F	1.000	EA
	4630299	POT CER PC PIN 10K OHM .75W	3006P-1-103	2.000	EA
	4630547	POT CER PC PIN 100K OHM .75W	3006P-1-104	1.000	EA
	4630620	POT CER PC PIN 20K OHM .75W .1	3006P-1-203	1.000	EA
	4630638	POT CER PC PIN 5K OHM .75W	3006P-1-502	1.000	EA

PARENT ITEM: 9200379 DESCRIPTION: INTERFACE MODEM-TELCO MRC-1/2
ENG.DRAWING NO.: 2082716 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3471141	PCB MODEM/TELCO INTERFACE	5185856	E	1.000	EA
2	3110442	CONN 48 PIN P1	65001-081		1.000	EA
3	3290244	BARR STP 6 TERM 3/8" SPCG BLK J1	71606-49-E		1.000	EA
4	4090096	XFMR T1,T2	MMTL-FB		2.000	EA
5	1030089	WSHR LK #3 SR SST			4.000	EA
6	3370061	FUSE 1/4 AMP FAST-BLO F1,F2,F3,F4	AGC 1/4		4.000	EA
7	4410171	RES 270 OHM 1/4W 10% R1,R3,R4,R6	RC07GF271K		4.000	EA
8	4410205	RES 470 OHM 1/4W 10% R2,R5	RC07GF471K		2.000	EA
9	4410213	RES 560 OHM 1/4W 10% R7	RC07GF561K		1.000	EA
10	3600236	DID Z1N4745A 16V 1W 5% AIAY D1,D2,D3,D4	1N4745A		4.000	EA
11	2060051	BRKT ANGLE	7575-C		2.000	EA
12	1090190	SCR PNH PHPS 6-32 X 5/16 SST			2.000	EA
13	1090216	SCR PNH PHPS 6-32 X 7/16 SST			2.000	EA
14	1090174	SCR PNH PHPS 6-32 X 3/16 SST			4.000	EA
15	1030014	SCR PNH PHPS 3-48 X 3/16 SST	BINDER HEAD		4.000	EA
16	1090554	NUT HEX 6-32 SM PATT			2.000	EA
17	1030071	NUT HEX 3-48 LGE PATT SST	3/48 X3/16X1/16		4.000	EA
18	1090588	WSHR LK #6 SR SST			2.000	EA
19	2060416	PANEL MOD TELCO INTF MRC	05A2628	C	1.000	EA
20	4020376	IDCTR RF 10 UH L1,L2,L3,L4	74F105AP		4.000	EA
21	4310173	CAP DISC .01/600V C1,C2,C3,C4,C5,C6,C7,C8	811000Z5U0103M		8.000	EA
22	2061059	COVER INTERFACE MRC-1/-2	0582638	K	1.000	EA
23	3430493	LBL LOGIC CD "TELCO"	10A1069-2	BO	1.000	EA
24	3370384	CLIP FUSE STEEL W/TIN PLATE	6008-33AT		8.000	EA
25	1210053	EYELET BRASS	GS3-4		8.000	EA
26	1641927	W BUSS 22GA	298		1.000	FT
27	1050129	SCR PNH PHPS 4-40 X 1/4 SST			2.000	EA
28	1090604	WSHR FL #6 CD PL	AN960-6 CAD 1		2.000	EA

PARENT ITEM: 9204819 DESCRIPTION: ASSY TELCO IN-SUB OUT NEU MRC
ENG.DRAWING NO.: 20A2737-7 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1210053	EYELET BRASS	GS3-4		4.000	EA
1	3471984	PCB TELCO IN/SUBCAR OUT	5185865	B3	1.000	EA
2	2060390	PANEL TEL IN/SUBC OUT MRC	05A2637	D	1.000	EA
3	4310132	CAP DISC .01/50V C9,C10,C11,C12	UK-50-103		4.000	EA
4	4310207	CAP .1UF/50V 20% C1,C3,C6,C8,C13	CY20C104M		5.000	EA
5	4280079	CAP TANT EPOX-DIP 10/20V 20% C2,C7	199D106X0020CA2		2.000	EA
6	4280038	CAP TANT EPOX-DIP 1/35V 20% C5	199D105X0035AA2		1.000	EA
13	3250032	SKT DUAL IN LINE 16 PIN U1	2-640358-1		1.000	EA
14	4410213	RES 560 OHM 1/4W 10% R12	RC07GF561K		1.000	EA
15	4410171	RES 270 OHM 1/4W 10% R13,R15	RC07GF271K		2.000	EA
16	4410205	RES 470 OHM 1/4W 10% R14	RC07GF471K		1.000	E
17	4410379	RES 10K OHM 1/4W 10% R1	RC07GF103K		1.000	EA
18	4410338	RES 4.7K OHM 1/4W 10% R2,R3	RC07GF472K		2.000	EA
19	4410536	RES 220K OHM 1/4W 10% R11	RC07GF224K		1.000	EA
20	4410130	RES 120 OHM 1/4W 10% R7	RC07GF121K		1.000	EA
21	4520052	RES 4.99K OHM 1/4W 1% R8	RN60D4991F		1.000	EA
22	4410494	RES 100K OHM 1/4W 10% R5	RC07GF104K		1.000	EA
23	4630547	POT CER PC PIN 100K OHM .75W R4	3006P-1-104		1.000	EA
24	4630018	POT CER PC PIN 200 OHM .5W R6	3386R-1-201		1.000	EA
25	4630075	POT CER PC PIN 1K OHM .75W 15T R10	3006P-1-102		1.000	EA
26	4630323	POT WW PC PIN 20K OHM .5W R9	3006W-1-203		1.000	EA
27	3030244	CONN BNC BULKHD UG-1094/U J3	31-221		1.000	EA
28	3110442	CONN 48 PIN P1	65001-081		1.000	EA
29	3600236	DIO Z1N4745A 16V 1W 5% AIAY D1,D2	1N4745A		2.000	EA

PARENT ITEM: 9204819

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
30	3650124	RGLTR MC78L12 12V 0.1A TO92 U2	MC78L12ACP	1.000	EA
31	3370061	FUSE 1/4 AMP FAST-BLO F1,F2	AGC 1/4	2.000	EA
32	3370384	CLIP FUSE STEEL W/TIN PLATE F1,F2	6008-33AT	4.000	EA
33	4020244	IDCTR RF 10 UH L1,L2	9230-44	2.000	EA
34	3730819	IC XR-2206CP VCO WAVE GEN U1	XR-2206CP	1.000	EA
35	3290202	BARR STP 2 TERM 3/8" SPCG BLK	71602-49-E	1.000	EA
36	4090098	XFMR T1	MMT1-FB	1.000	EA
37	2060051	BRKT ANGLE	7575-C	2.000	EA
39	1090132	SCR PNH PHPS 6-32 X 1/4 SST		2.000	EA
40	1090224	SCR PNH PHPS 6-32 X 1/2 SST		2.000	EA
41	1090174	SCR PNH PHPS 6-32 X 3/16 SST		2.000	EA
42	1090554	NUT HEX 6-32 SM PATT		4.000	EA
43	1090588	WSHR LK #6 SR SST		2.000	EA
44	1030014	SCR PNH PHPS 3-48 X 3/16 SST	BINDER HEAD	2.000	EA
45	1030071	NUT HEX 3-48 LGE PATT SST	3/43 X3/16X1/16	2.000	EA
46	3430519	LBL LOGIC CO "TELCO/SUBC"	10A1069-4 BO	1.000	EA
47	1641927	W BUSS 22GA	298	.333	FT
48	1190073	LUG J3	334 W/.375	1.000	EA

PARENT ITEM: 9200411 DESCRIPTION: TELCO OUT SUBCARR IN 20KHZ MRC
ENG.DRAWING NO.: 2032736-1 K

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
23	4410205	RES 470 OHM 1/4W 10% R1	RC07GF471K	1.000	EA
25	4410262	RES 1.5K OHM 1/4W 10% R2	RC07GF152K	1.000	EA
41	4250205	CAP POLYCARB .0131/100V 3% C1	22UB1312H	1.000	EA
42	4250502	CAP POLYCARB .111/100V 3% C2,C4	22UB1113H	2.000	EA
43	4250247	CAP POLYCARB .0175/100V 3% C3	22UB1752H	1.000	EA
45	4220166	CAP MICA DIP 2530PF 2% C5	DM-19-F2531G	1.000	EA
79	9204801	ASSY TELCO OUT SUBCAR IN NEUT	2032736-7 K	1.000	EA

PARENT ITEM: 9203159 DESCRIPTION: ASSY TELOUT/SUBCIN 26 MRC-1/2
ENG.DRAWING NO.: 20B2736-2 K

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
23	4410205	RES 470 OHM 1/4W 10% R1	RC07GF471K	1.000	EA
29	4410270	RES 1.8K OHM 1/4W 10% R2	RC07GF182K	1.000	EA
38	4310132	CAP DISC .01/50V C3	UK-50-103	1.000	EA
46	4250163	CAP POLYCARB .008/100V 3% C1	22UB802H	1.000	EA
47	4250445	CAP POLYCARB .068/100V 3% C2,C4	22UB683H	2.000	EA
48	4220117	CAP MICA DIP 1930PF 2% C5	DM-19-1931G	1.000	EA
79	9204801	ASSY TELCO OUT SUBCAR IN NEUT	20B2736-7 K	1.000	EA

PARENT ITEM: 9203167 DESCRIPTION: ASSY TELOUT/SUBCIN 39 MRC-1/2
ENG.DRAWING NO.: 2082736-3 K

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
24	4410239	RES 820 OHM 1/4W 10% R1	RC07GF821K	1.000	EA
30	4410296	RES 2.7K OHM 1/4W 10% R2	RC07GF272K	1.000	EA
49	4220190	CAP MICA DIP 3600PF 5% C1	DM-19-362J	1.000	EA
50	4220216	CAP MICA DIP 4700PF 5% C3	DM-19-472J	1.000	EA
51	4220059	CAP MICA DIP 1300PF 5% C5	DM-19-132J	1.000	EA
53	4250320	CAP POLYCARB .031/100V 3% C2,C4	22UB313H	2.000	EA
79	9204801	ASSY TELCO OUT SUBCAR IN NEUT	2082736-7 K	1.000	EA

PARENT ITEM: 9203175 DESCRIPTION: ASSY TELOUT/SUBCIN 67 MRC-1/2
ENG.DRAWING NO.: 20B2736-4 K

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
25	4410262	RES 1.5K OHM 1/4W 10% R1	RC07GF152K		1.000	EA
31	4410338	RES 4.7K OHM 1/4W 10% R2	RC07GF472K		1.000	EA
44	4250023	CAP POLYCARB .0016/100V 3% C3	22UB162H		1.000	EA
52	4220042	CAP MICA DIP 1200PF 5% C1	DM-19-122J		1.000	EA
54	4210514	CAP MICA DIP 750PF 5% C5	DM-15-751J		1.000	EA
59	4250171	CAP POLYCARB .01/100V 3% C2,C4	22UB103H		2.000	EA
79	9204801	ASSY TELCO OUT SUBCAR IN NEUT	20B2736-7	K	1.000	EA

PARENT ITEM: 9203183 DESCRIPTION: ASSY TELOUT/SUBCIN 110 MRC-1/2
ENG.DRAWING NO.: 20B2736-5 K

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
26	4410288	RES 2.2K OHM 1/4W 10% R1	RC07GF222K	1.000	EA
28	4410353	RES 6.8K OHM 1/4W 10% R2	RC07GF682K	1.000	EA
55	4210498	CAP MICA DIP 620PF 5% C3	DM-15-621J	1.000	EA
79	9204801	ASSY TELCO OUT SUBCAR IN NEUT	20B2736-7 K	1.000	EA
81	4210456	CAP MICA DIP 470PF 5% C1,C5	DM-15-471J	2.000	EA
82	4220190	CAP MICA DIP 3600PF 5% C2,C4	DM-19-362J	2.000	EA

PARENT ITEM: 9203191 DESCRIPTION: ASSY TELOUT/SUBCIN 185 MRC-1/2
ENG.DRAWING NO.: 2082736-6 K

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
18	4410395	RES 15K OHM 1/4W 10% R2	RC07GF153K		1.000	EA
27	4410312	RES 3.6K OHM 1/4W 10% R1	RC07GF362K		1.000	EA
39	4210324	CAP MICA DIP 180PF 5% C1	DM-15-181J		1.000	EA
56	4210381	CAP MICA DIP 250PF 5% C3	DM-15-251J		1.000	EA
57	4220067	CAP MICA DIP 1500PF 5% C2,C4	DM-19-152J		2.000	EA
58	4210407	CAP MICA DIP 300PF 5% C5	DM-15-301J		1.000	EA
79	9204801	ASSY TELCO OUT SUBCAR IN NEUT	2082736-7	K	1.000	EA

PARENT ITEM: 9204801 DESCRIPTION: ASSY TELCO OUT SUBCAR IN NEUT
ENG.DRAWING NO.: 2082736-7 K

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3471117	PCB TELCO OUT/SUBCARRIER IN	51A5870	E	1.000	EA
2	3430527	LBL LOGIC CD "SUBC/TELCO"	10A1069-5		1.000	EA
3	3730827	IC XR-2211CP FSK MODEM U1	XR-2211CP		1.000	EA
4	3650124	RGLTR MC78L12 12V 0.1A TO92 U3	MC78L12ACP		1.000	EA
5	3660008	IC UA741P OPAMP GEN COMP U2	UA741CP		1.000	EA
7	3250016	SKT DUAL IN LINE 8 PIN U2	2-640463-1		1.000	EA
8	3250024	SKT DUAL IN LINE 14 PIN U1	2-640357-1		1.000	EA
10	3110442	CONN 48 PIN P1	65001-081		1.000	EA
11	3030244	CONN BNC BULKHD UG-1094/U J1	31-221		1.000	EA
13	4630315	POT WW PC PIN 10K OHM .5W R6	ET34Y103		1.000	E
15	4410338	RES 4.7K OHM 1/4W 10% R13	RC07GF472K		1.000	EA
16	4410494	RES 100K OHM 1/4W 10% R3,R7,R8	RC07GF104K		3.000	EA
17	4410502	RES 120K OHM 1/4W 10% R4	RC07GF124K		1.000	EA
18	4410395	RES 15K OHM 1/4W 10% R5	RC07GF153K		1.000	EA
19	4410247	RES 1K OHM 1/4W 10% R9	RC07GF102K		1.000	EA
20	4410171	RES 270 OHM 1/4W 10% R11,R12	RC07GF271K		2.000	EA
21	3290202	BARR STP 2 TERM 3/8" SPCG BLK	71602-49-E		1.000	EA
22	2060051	BRKT ANGLE	7575-C		2.000	EA
23	4410205	RES 470 OHM 1/4W 10% R10	RC07GF471K		1.000	EA
25	1210053	EYELET BRASS	GS3-4		4.000	EA
26	3370384	CLIP FUSE STEEL W/TIN PLATE	6008-33AT		4.000	EA
31	1090588	WSHR LK #6 SR SST			2.000	EA
32	1090554	NUT HEX 6-32 SM PATT			4.000	EA
33	1090224	SCR PNH PHPS 6-32 X 1/2 SST			2.000	EA
34	1090174	SCR PNH PHPS 6-32 X 3/16 SST			2.000	EA
35	1090182	SCR PNH PHPS 6-32 X 1/4 SST			2.000	EA
36	4310207	CAP .1UF/50V 20% C6,C7,C9,C13,C14,C15,C20,C21	CY20C104M		8.000	EA
37	4280079	CAP TANT EPOX-DIP 10/20V 20% C10	199D106X0020CA2		1.000	EA

PARENT ITEM: 9204801

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
38	4310132	CAP DISC .01/50V C8,C16,C17,C18,C19	UK-50-103		5.000	EA
39	4210324	CAP MICA DIP 180PF 5% C11	DM-15-181J		1.000	EA
40	4210456	CAP MICA DIP 470PF 5% C12	DM-15-471J		1.000	EA
60	4020244	IDCTR RF 10 UH L3,L4	9230-44		2.000	EA
61	4041703	COIL ASSEMBLY L1,L2	03-5005	C	2.000	EA
62	3600236	DIO Z1N4745A 16V 1W 5% AIAY D1,D2	1N4745A		2.000	EA
63	4090093	XFMR T1	MMT1-FB		1.000	EA
64	3370061	FUSE 1/4 AMP FAST-BLO F1,F2	AGC 1/4		2.000	EA
66	2060358	PANEL TEL OUT/SUB IN MRC	05A2654	D	1.000	EA
67	1030022	SCR PNH PHPS 3-48 X 1/4 SST	BINDER HEAD		2.000	EA
68	1030071	NUT HEX 3-48 LGE PATT SST	3/48 X3/16X1/16		2.000	EA
69	1190073	LUG	334 W/.375		1.000	EA
70	1641927	W BUSS 22GA	298		.033	FT

PARENT ITEM: 9204884 DESCRIPTION: ASSY TELOUT/SUBCIN 92 MRC-1/2
ENG.DRAWING NO.: 2082736-8 K

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
29	4410270	RES 1.8K OHM 1/4W 10% R1	RC07GF182K		1.000	EA
71	4210480	CAP MICA DIP 560PF 5% C5	DM-15-561J		1.000	EA
72	4210506	CAP MICA DIP 680PF 5% C1	DM-15-681J		1.000	EA
73	4220018	CAP MICA DIP 1000PF 5% C3	DM-19-102J		1.000	EA
74	4250130	CAP POLYCARB .0068/100V 3% C2,C4	22U3682H		2.000	EA
75	4460267	RES 6.2K OHM 1/4W 5% R2	RC07GF622J		1.000	EA
79	9204801	ASSY TELCO OUT SUBCAR IN NEUT	2082736-7	K	1.000	EA

PARENT ITEM: 9205014 DESCRIPTION: ASSY TELOUT/SUBCIN 152 MRC-1/2
ENG.DRAWING NO.: 20B2736-9 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
12	4410379	RES 10K OHM 1/4W 10% R2	RC07GF103K		1.000	EA
14	4460218	RES 3K OHM 1/4W 5% R1	RC07GF302J		1.000	EA
76	4210399	CAP MICA DIP 270PF 5% C1	DM-15-271J		1.000	EA
77	4220158	CAP MICA DIP 2400PF 5% C2,C4	DM-19-242J		2.000	EA
78	4210449	CAP MICA DIP 430PF 5% C3	DM-15-431J		1.000	EA
79	4210423	CAP MICA DIP 360PF 5% C5	DM-15-361J		1.000	EA
79	9204801	ASSY TELCO OUT SUBCAR IN NEUT	2082736-7	K	1.000	EA

PARENT ITEM: 9200353 DESCRIPTION: MRC-1 SUBCARRIER INTFC 20KHZ
ENG.DRAWING NO.: 20D2719-1 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
27	4410205	RES 470 OHM 1/4W 10% R1	RC07GF471K	1.000	EA
29	4410262	RES 1.5K OHM 1/4W 10% R2	RC07GF152K	1.000	EA
46	4250205	CAP POLYCARB .0131/100V 3% C1	22UB1312H	1.000	EA
47	4250502	CAP POLYCARB .111/100V 3% C2,C4	22UB1113H	2.000	EA
48	4250247	CAP POLYCARB .0175/100V 3% C3	22UB1752H	1.000	EA
49	4220166	CAP MICA DIP 2530PF 2% C5,C6	DM-19-F2531G	2.000	EA
99	9204777	ASSY SUBCAR INTFC NEUTER MRC-1	20D2719-7 L	1.000	EA

PARENT ITEM: 9203290 DESCRIPTION: ASSY SUBC 26IN/TBA OUTMRC-1/2
ENG.DRAWING NO.: 2002719-2 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
28	4410205	RES 470 OHM 1/4W 10% R1	RC07GF471K		1.000	EA
30	4410270	RES 1.8K OHM 1/4W 10% R2	RC07GF182K		1.000	EA
50	4250163	CAP POLYCARB .008/100V 3% C1	22U8802H		1.000	EA
51	4250445	CAP POLYCARB .068/100V 3% C2,C4	22U8683H		2.000	EA
52	4220117	CAP MICA DIP 1930PF 2% C5,C6	DM-19-1931G		2.000	EA
65	4250171	CAP POLYCARB .01/100V 3% C3	22U8103H		1.000	EA
99	9204777	ASSY SUBCAR INTFC NEUTER MRC-1	2002719-7	L	1.000	EA

PARENT ITEM: 9203282 DESCRIPTION: ASSY SUBC 39IN/TBA OUTMRC-1/2
ENG.DRAWING NO.: 2002719-3 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
31	4410239	RES 820 OHM 1/4W 10% R1	RC07GF821K	1.000	EA
34	4410296	RES 2.7K OHM 1/4W 10% R2	RC07GF272K	1.000	EA
53	4220190	CAP MICA DIP 3600PF 5% C1	DM-19-362J	1.000	EA
54	4220216	CAP MICA DIP 4700PF 5% C3	DM-19-472J	1.000	EA
55	4220059	CAP MICA DIP 1300PF 5% C5,C6	DM-19-132J	2.000	EA
63	4250320	CAP POLYCARB .031/100V 3% C2,C4	22UB313H	2.000	EA
99	9204777	ASSY SUBCAR INTFC NEUTER MRC-1	2002719-7 L	1.000	EA

PARENT ITEM: 9203274 DESCRIPTION: ASSY SUBC 67IN/TBA OUTMRC-1/2
ENG.DRAWING NO.: 2002719-4 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
26	4410338	RES 4.7K OHM 1/4W 10% R2	RC07GF472K		1.000	EA
29	4410262	RES 1.5K OHM 1/4W 10% R1	RC07GF152K		1.000	EA
56	4220042	CAP MICA DIP 1200PF 5% C1	DM-19-122J		1.000	EA
57	4250023	CAP POLYCARB .0016/100V 3% C3	22UB162H		1.000	EA
58	4210514	CAP MICA DIP 750PF 5% C5,C6	DM-15-751J		2.000	EA
65	4250171	CAP POLYCARB .01/100V 3% C2,C4	22UB103H		2.000	EA
99	9204777	ASSY SUBCAR INTFC NEUTER MRC-1	2002719-7	L	1.000	EA

PARENT ITEM: 9203266 DESCRIPTION: ASSY SUBC 110IN/TBA OUTMRC-1/2
ENG.DRAWING NO.: 2002719-5 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
32	4410288	RES 2.2K OHM 1/4W 10% R1	RC07GF222K		1.000	EA
36	4410353	RES 6.8K OHM 1/4W 10% R2	RC07GF682K		1.000	EA
43	4210456	CAP MICA DIP 470PF 5% C1,C5	DM-15-471J		2.000	EA
53	4220190	CAP MICA DIP 3600PF 5% C2,C4	DM-19-362J		2.000	EA
59	4210498	CAP MICA DIP 620PF 5% C3	DM-15-621J		1.000	EA
60	4210480	CAP MICA DIP 560PF 5% C6	DM-15-561J		1.000	EA
99	9204777	ASSY SUBCAR INTFC NEUTER MRC-1	2002719-7	L	1.000	EA

PARENT ITEM: 9203258 DESCRIPTION: ASSY SUBC 185IN/TBA OUTMRC-1/2
ENG.DRAWING NO.: 20D2719-6 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
27	4410395	RES 15K OHM 1/4W 10% R2	RC07GF153K	1.000	EA
33	4410312	RES 3.6K OHM 1/4W 10% R1	RC07GF362K	1.000	EA
42	4210324	CAP MICA DIP 180PF 5% C1	DM-15-181J	1.000	EA
43	4210456	CAP MICA DIP 470PF 5% C6	DM-15-471J	1.000	EA
61	4210381	CAP MICA DIP 250PF 5% C3	DM-15-251J	1.000	EA
62	4220067	CAP MICA DIP 1500PF 5% C2,C4	DM-19-152J	2.000	EA
64	4210407	CAP MICA DIP 300PF 5% C5	DM-15-301J	1.000	EA
99	9204777	ASSY SUBCAR INTFC NEUTER MRC-1	20D2719-7 L	1.000	EA

MOSELEY ASSOCIATES, INC.
111 CASTILIAN DRIVE
SANTA BARBARA, CA 93117-3093
(805) 968-9621

DATE: 10/09/8

PARENT ITEM: 9204777 DESCRIPTION: ASSY SUBCAR INTFC NEUTER MRC-1
ENG.DRAWING NO.: 2002719-7 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3471976	PCB SUBCARRIER INTRF	5185858	B1	1.000	EA
2	2060408	PANEL SUBC INTF MRC	05A2636	E	1.000	EA
3	3730827	IC XR-2211CP FSK MODEM U1	XR-2211CP		1.000	EA
4	3730819	IC XR-2206CP VCO WAVE GEN U3	XR-2206CP		1.000	EA
5	3650124	RGLTR MC78L12 12V 0.1A TO92 U4	MC78L12ACP		1.000	EA
6	3660008	IC UA741P OPAMP GEN COMP U2	UA741CP		1.000	EA
7	3250016	SKT DUAL IN LINE 8 PIN U2	2-640463-1		1.000	EA
8	3250024	SKT DUAL IN LINE 14 PIN U1	2-640357-1		1.000	EA
9	3250032	SKT DUAL IN LINE 16 PIN U3	2-640358-1		1.000	EA
11	3110442	CONN 48 PIN P1	65001-081		1.000	E
12	3030244	CONN BNC BULKHD UG-1094/U J2,J3	31-221		2.000	EA
14	4630323	POT WW PC PIN 20K OHM .5W R19	3006W-1-203		1.000	EA
15	4630059	POT WW PC PIN 1K OHM .5W R20	3006W-1-102		1.000	EA
16	4630539	POT WW PC PIN 100K OHM .5W R14	ET34Y104		1.000	EA
17	4630315	POT WW PC PIN 10K OHM .5W R5	ET34Y103		1.000	EA
18	4630018	POT CER PC PIN 200 OHM .5W R15	3386R-1-201		1.000	EA
19	4410213	RES 560 OHM 1/4W 10% R21	RC07GF561K		1.000	EA
20	4410247	RES 1K OHM 1/4W 10% R9	RC07GF102K		1.000	EA
21	4410494	RES 100K OHM 1/4W 10% R3,R7,R8,R10	RC07GF104K		4.000	EA
22	4520052	RES 4.99K OHM 1/4W 1% R18	RN60D4991F		1.000	EA
24	4410130	RES 120 OHM 1/4W 10% R16	RC07GF121K		1.000	EA
25	4410379	RES 10K OHM 1/4W 10% R11	RC07GF103K		1.000	EA
26	4410338	RES 4.7K OHM 1/4W 10% R12,R13,R22	RC07GF472K		3.000	EA
35	4410502	RES 120K OHM 1/4W 10% R4	RC07GF124K		1.000	E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
37	1641927	W BUSS 22GA	298		.333	FT
39	4310207	CAP .1UF/50V 20%	CY20C104M		12.000	EA
		C7,C8,C10,C13,C14,C15,C16,C17,C18,C21,C23,C24				
40	4280038	CAP TANT EPOX-DIP 1/35V 20%	199D105X0035AA2		1.000	EA
		C20				
41	4280079	CAP TANT EPOX-DIP 10/20V 20%	199D106X0020CA2		2.000	EA
		C19,C22				
42	4210324	CAP MICA DIP 180PF 5%	DM-15-181J		1.000	EA
		C11				
43	4210456	CAP MICA DIP 470PF 5%	DM-15-471J		1.000	EA
		C12				
44	3430501	LBL LOGIC CD "SUBC"	10A1069-3	BO	1.000	EA
45	4310132	CAP DISC .01/50V	UK-50-103		1.000	EA
		C9				
66	4041703	COIL ASSEMBLY	03-5005	C	2.000	EA
		L1,L2				
67	2060051	BRKT ANGLE	7575-C		2.000	EA
68	1090182	SCR PNH PHPS 6-32 X 1/4 SST			4.000	EA
69	1090554	NUT HEX 6-32 SM PATT			2.000	EA
71	1190073	LUG	334 W/.375		2.000	EA
72	4410395	RES 15K OHM 1/4W 10%	RC07GF153K		1.000	EA
		R6				
77	4410536	RES 220K OHM 1/4W 10%	RC07GF224K		1.000	EA
		R17				
78	1560259	TBG TEFLON 26AWG NAT	TFT200-26		.042	FT
79	1641943	W BUSS 26GA	299/1		.080	FT

PARENT ITEM: 9204892 DESCRIPTION: ASSY SUBC 92IN/TBA OUTMRC-1/2
ENG.DRAWING NO.: 2002719-8 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
30	4410270	RES 1.8K OHM 1/4W 10% R1	RC07GF182K		1.000	EA
60	4210480	CAP MICA DIP 560PF 5% C5,C6	DM-15-561J		2.000	EA
73	4210506	CAP MICA DIP 680PF 5% C1	DM-15-681J		1.000	EA
74	4220018	CAP MICA DIP 1000PF 5% C3	DM-19-102J		1.000	EA
75	4250130	CAP POLYCARB .0068/100V 3% C2,C4	22UB682H		2.000	EA
76	4460267	RES 6.2K OHM 1/4W 5% R2	RC07GF622J		1.000	EA
99	9204777	ASSY SUBCAR INTFC NEUTER MRC-1	2002719-7	L	1.000	EA

PARENT ITEM: 9204835 DESCRIPTION: ASSY SUBC 152IN/TBA OUTMRC-1/2
ENG.DRAWING NO.: 20D2719-9 L

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
25	4410379	RES 10K OHM 1/4W 10% R2	RC07GF103K	1.000	EA
77	4460218	RES 3K OHM 1/4W 5% R1	RC07GF302J	1.000	EA
78	4210399	CAP MICA DIP 270PF 5% C1	DM-15-271J	1.000	EA
79	4210449	CAP MICA DIP 430PF 5% C3	DM-15-431J	1.000	EA
79	4220158	CAP MICA DIP 2400PF 5% C2,C4	DM-19-242J	2.000	EA
81	4210423	CAP MICA DIP 360PF 5% C5	DM-15-361J	1.000	EA
82	4210472	CAP MICA DIP 510PF 5% C6	DM-15-511J	1.000	EA
99	9204777	ASSY SUBCAR INTFC NEUTER MRC-1	20D2719-7 L	1.000	EA

PARENT ITEM: 9203431   DESCRIPTION: ASSY SERIAL I/O MRC
ENG.DRAWING NO.: 2002800-1   C

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
	3150117	SW 16P BCD ROT OUTPUT "YELLOW"	230057G		1.000	EA
	3190071	SW DIP 4 POSITION	206-4		1.000	EA
	3250024	SKT DUAL IN LINE 14 PIN	2-640357-1		5.000	EA
	3250057	SKT DUAL IN LINE 20 PIN	2-640464-1		5.000	EA
	3250073	SKT DUAL IN LINE 24 PIN	2-640361-1		1.000	EA
	3250909	HDR 18-PIN (9 X 2)	65610-X18		1.000	EA
	3250917	JUMPER MINI FOR 2 PINS=.025/.1	65474-001		1.000	EA
	3390127	LED RED 3.5D10 DIFF65 T1.75	HLMP-3300		2.000	EA
	3430444	LBL LOGIC CD "SER IAL"	1081068-17	E	1.000	EA
	3472461	PCB SERIAL I/O	51C5913	B	1.000	EA
	3650124	RGLTR MC78L12 12V 0.1A T092	MC78L12ACP		1.000	EA
	3660669	IC SN74LS00N QU 2IN NAND	SN74LS00N		1.000	EA
	3660735	IC SN74LS30N SI 8IN NAND	SN74LS30N		1.000	EA
	3660743	IC SN74LS86N QU 2IN EXCL OR	SN74LS86N		2.000	EA
	3660859	IC SN74LS244N OCT BUS/DRIV ST	SN74LS244N		5.000	EA
	3660966	IC SN74LS260N DU 5IN NOR	SN74LS260N		1.000	EA
	3710043	IC MC6850P ACIA INTERFACE	MC6850P		1.000	E
	4260004	CAP TANT EPOX-DIP .1/35V	199D104X0035AA2		1.000	EA
	4280020	CAP TANT EPOX-DIP .33/35V 20%	199D334X0035AB2		1.000	EA
	4280186	CAP TANT EPOX-DIP 220/10V 10%	K220E10		1.000	EA
	4310207	CAP .1UF/50V 20%	CY20C104M		11.000	EA
	4410189	RES 330 OHM 1/4W 10%	RC07GF331K		2.000	EA
	4410379	RES 10K OHM 1/4W 10%	RC07GF103K		10.000	EA

PARENT ITEM: 9203456 DESCRIPTION: ASSY SERIAL INTFC RS-232 MRC
ENG.DRAWING NO.: 20C2803 D

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3472487	PCB SERIAL INTERFACE	51C5915	C	1.000	EA
2	3730363	IC MC1489 QU LINE RECEIVER U3	MC1489P		1.000	EA
3	3660958	IC SN74LS32 QUAD 2-INPUT NOR U4	SN74LS32N		1.000	EA
4	3730355	IC MC1488P QU LINE DRIVER PLST U1	MC1488P		1.000	EA
5	3660941	IC SN75472N DU NAND HIGHV OC U2	SN75472P		1.000	EA
6	3680212	IC BIT RATE GENERATOR U5	MC14411P		1.000	EA
7	3190089	SW DIP 8 POSITION S1	206-8		1.000	EA
8	3430584	LBL LOGIC CO "RS 232"	10A1069-11	BO	1.000	EA
9	3250016	SKT DUAL IN LINE 8 PIN U2	2-640463-1		1.000	EA
10	3250024	SKT DUAL IN LINE 14 PIN U1,U3,U4	2-640357-1		3.000	EA
11	3250073	SKT DUAL IN LINE 24 PIN U5	2-640361-1		1.000	EA
12	3650140	RGLTR MC79L12 12V/0.1A TO92 VR1	MC79L12ACLP		1.000	EA
14	4280004	CAP TANT EPOX-DIP .1/35V C6	199D104X0035AA2		1.000	EA
15	4280020	CAP TANT EPOX-DIP .33/35V 20% C7	199D334X0035AB2		1.000	EA
16	4210415	CAP MICA DIP 330PF 5% C1,C2,C3,C4,C5	DM-15-331J		5.000	EA
17	4310207	CAP .1UF/50V 20% C8,C9,C10,C12	CY20C104M		4.000	EA
18	4280186	CAP TANT EPOX-DIP 220/10V 10% C11	K220E10		1.000	EA
20	4410080	RES 47 OHM 1/4W 10% R8	RC07GF470K		1.000	EA
21	4410163	RES 220 OHM 1/4W 10% R1,R2	RC07GF221K		2.000	EA
22	4410429	RES 27K OHM 1/4W 10% R3,R4,R6,R7	RC07GF273K		4.000	EA
24	4410379	RES 10K OHM 1/4W 10% R9,R10,R12	RC07GF103K		3.000	EA
25	4410650	RES 15MEG OHM 1/4W 10% R11	RC07GF156K		1.000	EA
27	3610003	DIO 1002 200V 1A SI D039 CR1,CR2	1002		2.000	EA
28	3340726	XTAL 1.8432 MHZ MODULE 2 MRC-1 Y1	30A0073	C	1.000	EA

PARENT ITEM: 9203456

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
30	2060051	BRKT ANGLE	7575-C		2.000	EA
31	3050192	CONN 25 PIN D.P.C. J1	206584-1		1.000	EA
32	3110442	CONN 48 PIN J2	65001-081		1.000	EA
33	2060309	PANEL LGR INTERFACE MRC-1/-2	05A2713	F	1.000	EA
35	1090190	SCR PNH PHPS 6-32 X 5/16 SST			2.000	EA
36	1090174	SCR PNH PHPS 6-32 X 3/16 SST			2.000	EA
37	1090554	NUT HEX 6-32 SM PATT			2.000	EA
39	1050145	SCR PNH PHPS 4-40 X 5/16 SS			2.000	EA
40	1050632	WSHR LK #4 SR CD PL			2.000	EA
41	1050582	NUT HEX 4-40 SM PATT SST			2.000	EA
42	1090588	WSHR LK #6 SR SST			2.000	EA
43	1640366	W W/W GREEN	M0015-195A		.160	FT

PARENT ITEM: 9204827 DESCRIPTION: ASSY ANALOG INPUT III MRC-1/-2
ENG.DRAWING NO.: 2002897 B

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	3473600	PCB ANALOG INPUT III	51C6013 A	1.000	EA
2	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409	1.000	PR
3	3430378	LBL LOGIC CD "A/D"	10B1068-10 E	1.000	EA
4	3250016	SKT DUAL IN LINE 8 PIN U6,U7	2-640463-1	2.000	EA
5	3250024	SKT DUAL IN LINE 14 PIN U4,U5,U9	2-640357-1	3.000	EA
6	3250032	SKT DUAL IN LINE 16 PIN U3,U11,U12,U13,U14,U15	2-640358-1	6.000	EA
7	3250057	SKT DUAL IN LINE 20 PIN U8,U10	2-640464-1	2.000	EA
8	3250081	SKT DUAL IN LINE 28 PIN U2	2-640362-1	1.000	EA
9	3250099	SKT DUAL IN LINE 40 PIN U1	2-640379-1	1.000	EA
11	3150117	SW 16P BCD ROT OUTPUT "YELLOW" S1	2300576	1.000	EA
12	4540233	RES DIP 10K OHM 1/8W 2% (8X) R5,R8,R14,R15,R16,R17	3168103	6.000	EA
13	4410247	RES 1K OHM 1/4W 10% R1,R4	RC07GF102K	2.000	EA
14	4460952	RES 15MEG OHM 1/4W 5% R6,R7	RC07GF156J	2.000	EA
15	4510863	RES 49.9 OHM 1/8W 1% R2,R3	RN55E49R9F	2.000	EA
16	4510103	RES 4.99K OHM 1/8W 1% R19	RN55E4991F	1.000	EA
17	4510699	RES 10.2K OHM 1/8W 1% R21	RN55E1022F	1.000	EA
18	4510715	RES 11.3K OHM 1/8W 1% R20	RN55E1132F	1.000	EA
19	3650132	RGLTR MC79L05 05V 0.1A TO92 VR1	MC79L05ACP	1.000	EA
20	4510657	RES 22.1K OHM 1/8W 1% R18	RN55E2212F	1.000	EA
21	4210191	CAP MICA DIP 51PF 5% C10	DM-15-510J	1.000	EA
22	4280079	CAP TANT EPOX-DIP 10/20V 20% C2,C5,C7,C22,C23,C27,C29,C30,C31,C32,C33,C34, C35,C36,C37,C38,C39,C40,C41,C42,C43,C44,C45,C46, C47,C48,C49,C50,C51,C52,C53,C54,C55,C56,C57,C58, C59,C60,C61	199D106X0020CA2	39.000	EA
23	4280186	CAP TANT EPOX-DIP 220/10V 10% C64	K220E10	1.000	EA
24	4310207	CAP .1UF/50V 20% C1,C3,C4,C6,C8,C9,C11,C12,C13,C14,C15,C16,C17, C18,C19,C20,C21,C24,C25,C26,C28,C62,C63	CY20C104M	23.000	EA

PARENT ITEM: 9204827

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG. DRAWING NO.	QUANTITY PER	UM
26	4020244	IDCTR RF 10 UH L1,L2	9230-44	2.000	EA
28	3660735	IC SN74LS30N SI 8IN NAND U4,U5	SN74LS30N	2.000	EA
29	3660743	IC SN74LS86N QU 2IN EXCL OR U9	SN74LS86N	1.000	EA
30	3660792	IC SN74LS138N 3-8LINEDECDEMUX U3	SN74LS138N	1.000	EA
31	3660859	IC SN74LS244N OCT BUS/DRIV ST U10	SN74LS244N	1.000	EA
32	3661162	IC SN74LS245N OCT BUS TRNCVR U8	SN74LS245N	1.000	EA
33	3680220	IC DIFFERENTIAL AMUX 4CH U11,U12,U13,U14,U15	MC14052BCP	5.000	EA
34	3680279	IC A/D CONVERTER 12 BITS U2	AD574AKD	1.000	EA
35	3710027	IC MC6821P PIA INTERFACE U1	MC6821P	1.000	EA
36	3730157	IC LM308AN OPAMP PRECISION U6	LM308AN	1.000	EA
37	3730376	IC DUAL OP-AMP U7	TL072A	1.000	EA

PARENT ITEM: 9203415   DESCRIPTION: ASSY TTL STATUS INPTII MRC-1/2
ENG.DRAWING NO.: 2002798   B

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	3472446	PCB TTL STATUS II	51C5912 C	1.000	EA
2	1250075	EJCTR CO (LEFT,RIGHT & 2 PINS)	41-1274L,C12409	1.000	PR
3	3430345	LBL LOGIC CO "TTL ST"	10B1068-07 E	1.000	EA
4	3660735	IC SN74LS30N SI 8IN NAND U5	SN74LS30N	1.000	EA
5	3660743	IC SN74LS86N QU 2IN EXCL OR U6	SN74LS86N	1.000	EA
6	3660800	IC SN74LS139N DU2-4LNDECDEMUX U4	SN74LS139N	1.000	EA
7	3660974	IC SN74LS240 OCT BUS/DRIV ST U1,U2,U3	SN74LS240N	3.000	EA
8	3660859	IC SN74LS244N OCT BUS/DRIV ST U7	SN74LS244N	1.000	EA
9	3250057	SKT DUAL IN LINE 20 PIN U1,U2,U3,U7	2-640464-1	4.000	EA
10	3250032	SKT DUAL IN LINE 16 PIN U4	2-640358-1	1.000	EA
11	3250024	SKT DUAL IN LINE 14 PIN U5,U6	2-640357-1	2.000	EA
12	3150117	SW 16P BCD ROT OUTPUT "YELLOW" S1	230057G	1.000	EA
13	4410247	RES 1K OHM 1/4W 10% R1	RC07GF102K	1.000	EA
14	4410379	RES 10K OHM 1/4W 10% R2,R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13,R14,R15,R16,R17,R18,R19,R20,R21	RC07GF103K	20.000	EA
15	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C7	CY20C104M	7.000	EA
16	4280186	CAP TANT EPOX-DIP 220/10V 10% C8	K220E10	1.000	EA

PARENT ITEM: 9203423 DESCRIPTION: ASSY OPTO STATUS II
ENG.DRAWING NO.: 2002795 B

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	3472453	PCB OPTO STATUS II	51C5911 B	1.000	EA
2	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409	1.000	PR
3	3430337	LBL LOGIC CD "OPT ST"	1081068-06 E	1.000	EA
4	3660735	IC SN74LS30N SI 8IN NAND U2	SN74LS30N	1.000	EA
5	3660743	IC SN74LS86N QU 2IN EXCL OR U1	SN74LS86N	1.000	EA
6	3660800	IC SN74LS139N DU2-4LNDECDEMUX U3	SN74LS139N	1.000	EA
7	3660974	IC SN74LS240 OCT BUS/DRIV ST U4,U5,U22	SN74LS240N	3.000	EA
8	3660859	IC SN74LS244N OCT BUS/DRIV ST U23	SN74LS244N	1.000	EA
9	3730777	IC TIL-112 OPTOCOUPLER U6,U7,U8,U9,U10,U11,U12,U13,U14,U15,U16,U17,U18, U19,U20,U21	TIL-112	16.000	EA
10	3250057	SKT DUAL IN LINE 20 PIN U4,U5,U22,U23	2-640464-1	4.000	EA
11	3250032	SKT DUAL IN LINE 16 PIN U3	2-640358-1	1.000	EA
12	3250024	SKT DUAL IN LINE 14 PIN U1,U2	2-640357-1	2.000	EA
13	3250008	SKT DUAL IN LINE 6 PIN U6,U7,U8,U9,U10,U11,U12,U13,U14,U15,U16,U17,U18, U19,U20,U21	ICN-063-S3-G	16.000	EA
14	3150117	SW 16P BCD ROT OUTPUT "YELLOW" S1	230057G	1.000	EA
15	4410247	RES 1K OHM 1/4W 10% R37	RC07GF102K	1.000	EA
16	4410270	RES 1.8K OHM 1/4W 10% R21,R22,R23,R24,R25,R26,R27,R28,R29,R30,R31,R32, R33,R34,R35,R36	RC07GF182K	16.000	EA
17	4410379	RES 10K OHM 1/4W 10% R1,R2,R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13,R14, R15,R16,R17,R18,R19,R20	RC07GF103K	20.000	EA
18	4310207	CAP .1UF/50V 20% C3,C4,C5,C6,C7,C8,C9	CY20C104M	7.000	EA
19	4280186	CAP TANT EPOX-DIP 220/10V 10% C2	K220E10	1.000	EA

PARENT ITEM: 9203613 DESCRIPTION: ASSY OC CMD OUTPT MRC-1/-2
ENG.DRAWING NO.: 2002755-1 D

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	3472644	PCB OPEN COLLECTOR BD MRC-1	51C5885 D	1.000	EA
2	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409	1.000	PR
3	3660669	IC SN74LS00N QU 2IN NAND U6	SN74LS00N	1.000	EA
4	3660735	IC SN74LS30N SI 8IN NAND U2	SN74LS30N	1.000	EA
5	3660743	IC SN74LS86N QU 2IN EXCL OR U1	SN74LS86N	1.000	EA
6	3660859	IC SN74LS244N OCT BUS/DRIV ST U4,U5	SN74LS244N	2.000	EA
7	3710027	IC MC6821P PIA INTERFACE U3	MC6821P	1.000	EA
8	3660941	IC SN75472N DU NAND HIGHV OC U7,U8,U9,U10,U11,U12,U13,U14	SN75472P	8.000	EA
9	3430360	LBL LOGIC CD "O.C. CMD"	1081068-09 E	1.000	EA
10	3630027	XT NS2N2924LFS.2W160M025V.1A7P Q1	2N2924-LFS	1.000	EA
11	3630035	XT NP2N3053 05W100M080V.7A Q2	2N3053	1.000	EA
13	3250016	SKT DUAL IN LINE 8 PIN U7,U8,U9,U10,U11,U12,U13,U14	2-640463-1	8.000	EA
14	3250024	SKT DUAL IN LINE 14 PIN U1,U2,U6	2-640357-1	3.000	EA
15	3250057	SKT DUAL IN LINE 20 PIN U4,U5	2-640464-1	2.000	EA
16	3250099	SKT DUAL IN LINE 40 PIN U3	2-640379-1	1.000	EA
18	3190071	SW DIP 4 POSITION S1	206-4	1.000	EA
20	4280186	CAP TANT EPOX-DIP 220/10V 10% C7	K220E10	1.000	EA
21	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C8,C9,C10,C11,C12,C13,C14,C15	CY20C104M	14.000	EA
22	4310090	CAP CER .001/200V X7R 10% C16,C17,C18,C19,C20,C21,C22,C23,C24,C25,C26,C27, C28,C29,C30,C31	CKR05BX102KL	16.000	EA
23	4410205	RES 470 OHM 1/4W 10% R9	RC07GF471K	1.000	EA
24	4410247	RES 1K OHM 1/4W 10% R5,R7,R8	RC07GF102K	3.000	EA
25	4410288	RES 2.2K OHM 1/4W 10% R6	RC07GF222K	1.000	EA
26	4410379	RES 10K OHM 1/4W 10% R1,R2,R3,R4	RC07GF103K	4.000	EA
27	4420261	RES 1K OHM 1/2W 10% R10	RC20GF102K	1.000	EA

PARENT ITEM: 9200312 DESCRIPTION: DIGIT OUTPUT OPTIC ISOLA MRC-1
ENG.DRAWING NO.: 2002705 F1

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1050129	SCR PNH PHPS 4-40 X 1/4 SST			16.000	EA
	1050582	NUT HEX 4-40 SM PATT SST			16.000	EA
	1050632	WSHR LK #4 SR CD.PL			16.000	EA
	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
	3190071	SW DIP 4 POSITION	206-4		1.000	EA
	3250008	SKT DUAL IN LINE 6 PIN	ICN-063-S3-G		16.000	EA
	3250024	SKT DUAL IN LINE 14 PIN	2-640357-1		3.000	EA
	3250057	SKT DUAL IN LINE 20 PIN	2-640464-1		2.000	EA
	3250099	SKT DUAL IN LINE 40 PIN	2-640379-1		1.000	EA
	3250347	PAD XSTR	RC-T05075-4A		1.000	EA
	3430352	LBL LOGIC CD "OPT CMD"	1081068-08	E	1.000	EA
	3471901	PCB OUTPUT MODULE OPT	51C5846	E	1.000	EA
	3630027	XT NS2N2924LFS.2W160M025V.1A7P	2N2924-LFS		16.000	EA
	3630035	XT NP2N3053 05W100M080V.7A	2N3053		1.000	EA
	3630092	XT PS2N3640 .2W500M012V80M3.5P	2N3640		1.000	EA
	3630316	XT NP2N5293 36W800K080V04A	2N5293		16.000	EA
	3660669	IC SN74LS00N QU 2IN NAND	SN74LS00N		1.000	EA
	3660735	IC SN74LS30N SI 8IN NAND	SN74LS30N		1.000	EA
	3660743	IC SN74LS86N QU 2IN EXCL OR	SN74LS86N		1.000	EA
	3660859	IC SN74LS244N OCT BUS/DRIV ST	SN74LS244N		2.000	EA
	3710027	IC MC6821P PIA INTERFACE	MC6821P		1.000	EA
	3730868	IC MOC-8030 OPTICAL ISOLATOR	MOC-8030		16.000	EA
	4280186	CAP TANT EPOX-DIP 220/10V 10%	K220E10		1.000	EA
	4310207	CAP .1UF/50V 20%	CY20C104M		5.000	EA
	4410163	RES 220 OHM 1/4W 10%	RC07GF221K		16.000	EA
	4410247	RES 1K OHM 1/4W 10%	RC07GF102K		1.000	EA
	4410338	RES 4.7K OHM 1/4W 10%	RC07GF472K		1.000	EA
	4410379	RES 10K OHM 1/4W 10%	RC07GF103K		5.000	EA
	4410411	RES 22K OHM 1/4W 10%	RC07GF223K		16.000	EA

PARENT ITEM: 920411б   DESCRIPTION: ASSY PARALLEL INPUT MRC-2
ENG.DRAWING NO.: 2002822   BO

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
	3150117	SW 16P BCD ROT OUTPUT "YELLOW"	230057G		1.000	EA
	3150133	SW 10P BCD ROT OUTPUT "ORANGE"	230012G		4.000	EA
	3250024	SKT DUAL IN LINE 14 PIN	2-640357-1		5.000	EA
	3250032	SKT DUAL IN LINE 16 PIN	2-640358-1		2.000	EA
	3250057	SKT DUAL IN LINE 20 PIN	2-640464-1		6.000	EA
	3250099	SKT DUAL IN LINE 40 PIN	2-640379-1		1.000	EA
	3250909	HDR 18-PIN (9 X 2)	65610-X18		1.000	EA
	3250917	JUMPER MINI FOR 2 PINS=.025/.1	65474-001		1.000	EA
	3430907	LBL LOGIC CD PAR INP	1081068-21	E	1.000	EA
	3472966	PCB PARALLEL INPUT MRC	51C5940		1.000	EA
	3660669	IC SN74LS00N QU 2IN NAND	SN74LS00N		1.000	EA
	3660735	IC SN74LS30N SI 8IN NAND	SN74LS30N		2.000	EA
	3660743	IC SN74LS86N QU 2IN EXCL OR	SN74LS86N		1.000	EA
	3660859	IC SN74LS244N OCT BUS/DRIV ST	SN74LS244N		5.000	EA
	3660953	IC SN74LS32 QUAD 2-INPUT NOR	SN74LS32N		1.000	EA
	3660974	IC SN74LS240 OCT BUS/DRIV ST	SN74LS240N		1.000	EA
	3661039	IC SN74LS153N DU 4IN MUX	SN74LS153N		2.000	EA
	3710027	IC MC6821P PIA INTERFACE	MC6821P		1.000	EA
	4280186	CAP TANT EPOX-DIP 220/10V 10%	K220E10		1.000	EA
	4310207	CAP .1UF/50V 20%	CY20C104M		14.000	EA
	4410247	RES 1K OHM 1/4W 10%	RC07GF102K		1.000	EA
	4540134	RES SIP 10K OHM 1/8W 2% 10	750-101-R10K		3.000	EA

PARENT ITEM: 9203449 DESCRIPTION: ASSY DELAY CONTROL MRC-2
ENG.DRAWING NO.: 20D2801 CO

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1090190	SCR PNH PHPS 6-32 X 5/16 SST			1.000	EA
	1090554	NUT HEX 6-32 SM PATT			1.000	EA
	1090596	WSHR LK #6 SR CD PL			1.000	EA
	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
	3150117	SW 16P BCD ROT OUTPUT "YELLOW"	230057G		1.000	EA
	3250016	SKT DUAL IN LINE 8 PIN	2-640463-1		3.000	EA
	3250024	SKT DUAL IN LINE 14 PIN	2-640357-1		6.000	EA
	3250032	SKT DUAL IN LINE 16 PIN	2-640358-1		3.000	EA
	3250057	SKT DUAL IN LINE 20 PIN	2-640464-1		5.000	EA
	3270113	RELAY MIN PC 200OHM 12V NOM	AZ-2530-09-2		6.000	EA
	3430428	LBL LOGIC CD "DLY CTL"	1081068-15	E	1.000	EA
	3472479	PCB DELAY CONTROL	51C5914	D	1.000	EA
	3610003	DIO 1002 200V 1A SI D039	1002		6.000	EA
	3650074	RGLTR LM340T12/7812 VARV1.5A	LM340T-12		1.000	EA
	3660669	IC SN74LS00N QU 2IN NAND	SN74LS00N		2.000	EA
	3660735	IC SN74LS30N SI 8IN NAND	SN74LS30N		1.000	EA
	3660743	IC SN74LS86N QU 2IN EXCL OR	SN74LS86N		1.000	EA
	3660768	IC SN74LS123N DURETRMONOMULTI	SN74LS123N		3.000	E
	3660859	IC SN74LS244N OCT BUS/DRIV ST	SN74LS244N		5.000	EA
	3660925	IC SN75452BP DU NAND HIGHV OC	SN75452BP		3.000	EA
	3660958	IC SN74LS32 QUAD 2-INPUT NOR	SN74LS32N		1.000	EA
	3660966	IC SN74LS260N DU 5IN NOR	SN74LS260N		1.000	EA
	4260261	CAP TC1205A 500 MF 12V	TC1205A		6.000	EA
	4280020	CAP TANT EPOX-DIP .33/35V 20%	199D334X0035AB2		1.000	EA
	4280186	CAP TANT EPOX-DIP 220/10V 10%	K220E10		1.000	EA
	4310207	CAP .1UF/50V 20%	CY20C104M		18.000	EA
	4410304	RES 3.3K OHM 1/4W 10%	RC07GF332K		1.000	EA
	4540118	RES SIP 10K OHM 1/8W 2% 8 PIN	750-81-R10K		1.000	EA
	4540134	RES SIP 10K OHM 1/8W 2% 10	750-101-R10K		1.000	EA
	4540167	RES SIP 3.3K 1/8W 2%	750-101-3.3K		1.000	EA
	4540175	RES SIP 150K 1/8W 2%	750-101-R150K		1.000	EA

MOSELEY ASSOCIATES, INC.
111 CASTILIAN DRIVE
SANTA BARBARA, CA 93117-3093
(805) 968-9621

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DATE:10/09/89

PARENT ITEM: 9203449 DESCRIPTION: ASSY DELAY CONTROL MRC-2
ENG.DRAWING NO.: 2002801 CO

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1090190	SCR PNH PHPS 6-32 X 5/16 SST			1.000	EA
	1090554	NUT HEX 6-32 SM PATT			1.000	EA
	1090596	WSHR LK #6 SR CD PL			1.000	EA
	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409		1.000	PR
	3150117	SW 16P BCD ROT OUTPUT "YELLOW"	230057G		1.000	EA
	3250016	SKT DUAL IN LINE 8 PIN	2-640463-1		3.000	EA
	3250024	SKT DUAL IN LINE 14 PIN	2-640357-1		6.000	EA
	3250032	SKT DUAL IN LINE 16 PIN	2-640358-1		3.000	EA
	3250057	SKT DUAL IN LINE 20 PIN	2-640464-1		5.000	EA
	3270113	RELAY MIN PC 200OHM 12V NOM	AZ-2530-09-2		6.000	EA
	3430428	LBL LOGIC CD "DLY CTL"	1081068-15	E	1.000	EA
	3472479	PCB DELAY CONTROL	5105914	D	1.000	EA
	3610003	DIO 1002 200V 1A SI D039	1002		6.000	EA
	3650074	RGLTR LM340T12/7812 VARV1.5A	LM340T-12		1.000	EA
	3660669	IC SN74LS00N QU 2IN NAND	SN74LS00N		2.000	EA
	3660735	IC SN74LS30N SI 8IN NAND	SN74LS30N		1.000	EA
	3660743	IC SN74LS86N QU 2IN EXCL OR	SN74LS86N		1.000	EA
	3660768	IC SN74LS123N DURETRMONOMULTI	SN74LS123N		3.000	EA
	3660859	IC SN74LS244N OCT BUS/DRIV ST	SN74LS244N		5.000	EA
	3660925	IC SN75452BP DU NAND HIGHV OC	SN75452SP		3.000	EA
	3660958	IC SN74LS32 QUAD 2-INPUT NOR	SN74LS32N		1.000	EA
	3660966	IC SN74LS260N DU 5IN NOR	SN74LS260N		1.000	EA
	4260261	CAP TC1205A 500 MF 12V	TC1205A		6.000	EA
	4280020	CAP TANT EPOX-DIP .33/35V 20%	199D334X0035AB2		1.000	EA
	4280186	CAP TANT EPOX-DIP 220/10V 10%	K220E10		1.000	EA
	4310207	CAP .1UF/50V 20%	CY20C104M		18.000	EA
	4410304	RES 3.3K OHM 1/4W 10%	RC07GF332K		1.000	EA
	4540118	RES SIP 10K OHM 1/8W 2% 8 PIN	750-81-R10K		1.000	EA
	4540134	RES SIP 10K OHM 1/8W 2% 10	750-101-R10K		1.000	EA
	4540167	RES SIP 3.3K 1/8W 2%	750-101-3.3K		1.000	EA
	4540175	RES SIP 150K 1/8W 2%	750-101-R150K		1.000	EA

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DATE:10/09/8?

PARENT ITEM: 9204140 DESCRIPTION: ASSY DIODE-FILTD INTFC II MRC
ENG.DRAWING NO.: 20C2823 C

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3472990	PCB DIODE I/O II	51C5941	C1	1.000	EA
2	3050226	CONN 37 PIN D.P.C. J1	206817-1		1.000	EA
3	3110442	CONN 48 PIN P1	65001-031		1.000	EA
4	4020343	IDCTR RF 6.80 UH L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14, L15,L16,L17,L18,L19	9310-32		19.000	EA
5	4460051	RES 100 OHM 1/4W 5% R1,R2,R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13,R14, R15,R16,R17,R18	RC07GF101J		18.000	EA
6	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,C12,C13,C14, C15,C16,C17,C18,C19,C20	CY20C104M		20.000	EA
7	3600145	DIO 1N4154 25V 4NS SI DO35 CR1,CR2,CR3,CR4,CR5,CR6,CR7,CR8,CR9,CR10,CR11, CR12,CR13,CR14,CR15,CR16,CR17,CR18,CR19,CR20, CR21,CR22,CR23,CR24,CR25,CR26,CR27,CR28,CR29, CR30,CR31,CR32,CR33,CR34,CR35,CR36	1N4154		36.000	EA
8	1090162	SCR PNH PHPS 6-32 X 1/4 SST			4.000	EA
9	1050145	SCR PNH PHPS 4-40 X 5/16 SS			2.000	EA
10	1050624	WSHR LK #4 INTL T CD PL			2.000	EA
11	1050582	NUT HEX 4-40 SM PATT SST			2.000	EA
12	1050129	SCR PNH PHPS 4-40 X 1/4 SST			2.000	EA
13	2061059	COVER INTERFACE MRC-1/-2	05B2638	K	1.000	EA
14	2060382	PANEL FLTRD INTF MRC	05A2639	F	1.000	EA
15	3430568	LBL LOGIC CD "DIODE INT"	10A1069-9	B0	1.000	EA

PARENT ITEM: 9200361 DESCRIPTION: ASSY FILT INTFC MRC-1/-2
ENG.DRAWING NO.: 20B2718 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3470069	PCB FILTERED I/O INTFC MRC-1	51A5851	D1	1.000	EA
2	3110442	CONN 48 PIN P1	65001-081		1.000	EA
3	3050226	CONN 37 PIN D.P.C. J1	206817-1		1.000	EA
4	2060382	PANEL FLTRD INTF MRC	05A2639	F	1.000	EA
5	4020343	IDCTR RF 6.80 UH L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14, L15,L16,L17,L18,L19,L20,L21,L22,L23,L24,L25,L26, L27,L28,L29,L30,L31,L32,L33,L34,L35,L36	9310-32		36.000	EA
6	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,C12,C13,C14, C15,C16,C17,C18,C19,C20,C21,C22,C23,C24,C25,C26, C27,C28,C29,C30,C31,C32,C33,C34,C35,C36	CY20C104M		36.000	EA
7	2061059	COVER INTERFACE MRC-1/-2	05B2638	K	1.000	EA
8	1050145	SCR PNH PHPS 4-40 X 5/16 SS			2.000	EA
9	1050582	NUT HEX 4-40 SM PATT SST			2.000	EA
10	1050632	WSHR LK #4 SR CD PL			2.000	EA
12	1090174	SCR PNH PHPS 6-32 X 3/16 SST			4.000	EA
13	1050103	SCR PNH PHPS 4-40 X 3/16 SS			2.000	EA
14	3430543	LBL LOGIC CD "FILT INT"	10A1059-7	B0	1.000	EA

PARENT ITEM: 9100611 DESCRIPTION: ASSY PWR SPLY 2WR 4RU MRC-1/2
ENG.DRAWING NO.: 2102655-2 N

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	1090745	PEMNUT CLS 632-2	CLS 632-2		1.000	EA
1	9104738	SUBASSY PWR SPLY W/TAPD HOLES	05C3177	A	1.000	EA
2	3290624	TERM	1409A		4.000	EA
3	4410122	RES 100 OHM 1/4W 10%	RC07GF101K		2.000	EA
4	2060440	BRKT MRC-1	05A2615	D	1.000	EA
5	2061018	BRKT MTG 4RU MRC-1/2	05B2616	F	1.000	EA
6	3370046	CONN PWR W/FUSE FILTER 6J4	6J4		1.000	EA
7	4310173	CAP DISC .01/500V C101,C102	811000Z5U0103M		2.000	EA
8	3370277	FUSE 2 AMP SLOW-BLO	MDL 2		1.000	EA
9	3370251	FUSE 1 AMP SLOW-BLO	MDL 1		.000	EA
10	3430055	LBL FUSE "1AMP-2AMP"	85-1503		1.000	EA
11	3430071	LBL HIGH VOLTAGE SYMBOL	10A1058-2	A0	1.000	EA
12	3250628	CONN SKT HSG 9 CKT J1	1-480274-0		1.000	EA
13	3250735	SKT 22 J1	61173-5		2.000	EA
14	3250701	SKT 18/16 J1	60619-5		7.000	E
15	1130095	SCR PNH PHPS 8-32 X 3/8 SST			6.000	EA
16	1130277	NUT HEX 8-32 1/4 FLATS SST			7.000	EA
17	1130293	WSHR LK #8 INTL T			7.000	EA
18	1090695	LUG LKG #6	T-197		1.000	EA
19	1210160	RIVET	AN470AD-4-3		1.000	EA
20	1130103	SCR PNH PHPS 8-32 X 1/2 SST			1.000	EA
21	1130335	WSHR FL #8 SST	AN960-C8		1.000	EA
22	1270057	CLP CA BUTYRATE H-5/16	834		1.000	EA
23	2063303	BRKT SWITCH MRC-1/2	05B3013	E	1.000	EA
24	3160108	SW TGL SPDT ON-NONE-ON S1	FH 123		1.000	EA
25	1090208	SCR PNH PHPS 6-32 X 3/8 SST			1.000	EA
26	1560036	TBG SHRINK 3/16" CLEAR	FIT 221 3/16CL		.080	FT
27	1560069	TBG SHRINK 1/2" CLEAR S1	FIT 221 1/2CL		.100	FT
28	1641620	W STRD 18GA VIOLET 16/30	MIL-W76B TYPEMW		2.200	FT
29	1641596	W STRD 18GA YELLOW 16/30	MIL-W76B TYPEMW		2.100	FT
30	1641562	W STRD 18GA BROWN 16/30	MIL-W76B TYPEMW		2.000	FT
31	1641547	W STRD 16GA WHITE 26/30	MIL-W76B TYPEMW		2.100	FT
32	1641638	W STRD 18GA GRAY 16/30	MIL-W76B TYPEMW		1.900	FT
33	1641612	W STRD 18GA BLUE 16/30	MIL-W76B TYPEMW		1.900	FT
34	1641703	W STRD 20GA GREEN 10/30	MIL-W76B TYPEMW		.100	FT
35	1641554	W STRD 18GA BLACK 16/30	MIL-W76B TYPEMW		1.600	FT
36	1641455	W STRD 16GA BLACK 26/30	MIL-W76B TYPEMW		1.600	FT
37	1641570	W STRD 18GA RED 16/30	MIL-W76B TYPEMW		1.500	FT
38	1641471	W STRD 16GA RED 26/30	MIL-W76B TYPEMW		1.500	F

PARENT ITEM: 9100611

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
39	1640697	W STRD 22GA WHITE-BLUE	BU-730-22*96	1.400	FT
40	1640622	W STRD 22GA GRAY-WHITE	BU-730-22*89	1.000	FT
41	1640689	W STRD 22GA WHITE-GREEN	BU-730-22*95	1.200	FT
42	1640457	W STRD 22GA GRAY	BU-730-22*8	.900	FT
43	1641588	W STRD 16GA ORANGE 16/30	MIL-W76B TYPEMW	1.200	FT
44	1641919	W BUSS 20GA	297	.500	FT
45	1641901	W BUSS 18GA	296	.100	FT
46	1090588	WSHR LK #6 SR SST		4.000	EA
47	1560218	TBG TEFLON 18AWG NAT	TFT200-18	.080	FT

PARENT ITEM: 9200304 DESCRIPTION: MOTHER BOARD 4RU MRC-1/2
ENG.DRAWING NO.: 2002706 N

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3472974	PCB 4RU MOTHER BD	5105839	G	1.000	EA
3	3090149	KEY LOCATER	15C-K5		15.000	EA
4	3090248	CONN EDGE 50P .100 C/L	532072-1		15.000	EA
5	1250521	RAIL PC MTG LOWER MRC-1/2	05C2592-1	P	1.000	EA
6	1250513	RAIL PC MTG UPPER MRC-1/2	05C2592-2	P	1.000	EA
7	1050152	SCR PND PHPS 4-40 X 3/8 SST			30.000	EA
8	4410197	RES 390 OHM 1/4W 10%	RC07GF391K		1.000	EA
9	4540092	RES SIP 330 OHMS 1/4W 10%	4310R-101-331		4.000	EA
10	4540100	RES SIP 390 OHM 1/4W 10%	4310R-101-391		2.000	EA
11	2300390	ASSY CABLE 4RU TERMINAL	2401042	G	1.000	EA

PARENT ITEM: 9205253 DESCRIPTION: ASSY COMP MRC-2 QUAD SERIAL 4
ENG.DRAWING NO.: 2002954 A

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
	3150117	SW 16P BCD ROT OUTPUT "YELLOW" S1A,S1B,S1C,S1D	230057G	4.000	EA
	3190089	SW DIP 8 S2A,S2B,S2C,S2D	206 8	4.000	EA
	3250024	SKT DUAL IN LINE 14 PIN U3A,U3B,U3C,U3D,U4,U5,U6, U7,U8A,U8B,U8C,U8D,U9,U10	640357-1	14.000	EA
	3250057	SKT DUAL IN LINE 20 PIN U11,U12,U13,U14,U15	640464-1	5.000	EA
	3250073	SKT DUAL IN LINE 24 PIN U1A,U1B,U1C,U1D,U2	640361-1	5.000	EA
	3250909	HDR 18-PIN (9 X 2) E1A,E1B,E1C,E1D	65610-X18	4.000	EA
	3340726	XTAL 1.8432 MHZ MODULE 2 MRC-1 Y1	30A0073 C	1.000	EA
	3390580	LED DUAL (90) CR1A,CR1B,CR1C,CR1D,CR2A, CR2B,CR2C,CR2D	550-3006	8.000	EA
	3660735	IC SN74LS30N SI 8IN NAND U3A,U3B,U3C,U3D,U6	SN74LS30N	5.000	EA
	3660743	IC SN74LS86N QU 2IN EXCL OR U4,U5,U8A,U8B,U8C,U8D	SN74LS86N	6.000	EA
	3660966	IC SN74LS260N DU 5IN NOR U7,U9,U10	SN74LS260N	3.000	EA
	3661162	IC SN74LS245N OCT BUS TRNCVR U11,U12,U13,U14,U15	SN74LS245N	5.000	EA
	3680212	IC BIT RATE GENERATOR U2	MC14411P	1.000	EA
	3710043	IC MC6850P ACIA INTERFACE U1A,U1B,U1C,U1D	MC6850P	4.000	EA
	4280186	CAP TANT EPOX-DIP 220/10V 10% C25	K220E10	1.000	EA
	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C7,C8,C9, C10,C11,C12,C13,C14,C15, C16,C17,C18,C19,C20,C21, C22,C23,C24	CY20C104M	24.000	EA
	4460952	RES 15MEG OHM 1/4W 5% R1	RC07GF156J	1.000	EA
	4540092	RES SIP 330 OHMS 1/4W 10% RN1	4310R-101-331	1.000	EA
	4540134	RES SIP 10K OHM 1/8W 2% 10 RN2,RN3	750-101-R10K	2.000	EA
1	3473964	PCB MRC-2 QUAD SERIAL I/O	51C6060 A	1.000	EA
2	1250075	EJCTR CD (LEFT,RIGHT & 2 PINS)	41-1274L,C12409	1.000	PR

PARENT ITEM: 9205253

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG. DRAWING NO.		QUANTITY PER	UM
3	3430444	LBL LOGIC CD "SER-IAL"	1081068-17	E	1.000	EA
4	3250917	JUMPER MINI FOR 2 PINS=.025/.1 E1A,E1B,E1C,E1D	65474-001		4.000	EA

PARENT ITEM: 2300754 DESCRIPTION: ASSY CA 25M-25M NULL MODEM 15'
ENG.DRAWING NO.: 24C1080-1 G

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	15.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
3	1641943	W BUSS 26GA	299/1	.200	FT
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA
6	1560028	TBG SHRINK 1/8" CLEAR	FIT 221 1/8CL	.200	FT

PARENT ITEM: 2300762 DESCRIPTION: ASSY CA 25M-25M NULL MODEM 30'
ENG.DRAWING NO.: 24C1080-2 G

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	30.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
3	1641943	W BUSS 26GA	299/1	.200	FT
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA
6	1560028	TBG SHRINK 1/8" CLEAR	FIT 221 1/8CL	.200	FT

PARENT ITEM: 2300770 DESCRIPTION: ASSY CA 25M-25M NULL MODEM 50'
ENG.DRAWING NO.: 24C1080-3 G

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	50.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
3	1641943	W BUSS 26GA	299/1	.200	FT
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA
6	1560028	TBG SHRINK 1/8" CLEAR	FIT 221 1/8CL	.200	FT

PARENT ITEM: 2300788 DESCRIPTION: ASSY CA 25M-25M NULL MODEM 100
ENG.DRAWING NO.: 24C1080-4 G

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	100.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
3	1641943	W BUSS 26GA	299/1	.200	FT
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA
6	1560028	TBG SHRINK 1/8" CLEAR	FIT 221 1/8CL	.200	FT

PARENT ITEM: 2300361   DESCRIPTION: ASSY CA 25M-25M NULL MODEM 3'
ENG.DRAWING NO.: 24C1080-5   G

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	3.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
3	1641943	W BUSS 26GA	299/1	.200	FT
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA
6	1560028	TBG SHRINK 1/8" CLEAR	FIT 221 1/8CL	.200	FT

PARENT ITEM: 2300713 DESCRIPTION: ASSY CA 25M-25F NULL MODEM 15'
ENG.DRAWING NO.: 24C1081-1 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	15.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
3	1641943	W BUSS 26GA	299/1	.200	FT
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	1.000	EA
6	3050069	CONN 25PIN"D"SKT W/SLDRPOTCONN	DB-25S	1.000	EA
7	1560028	TBG SHRINK 1/8" CLEAR	FIT 221 1/8CL	.200	FT

PARENT ITEM: 2300721 DESCRIPTION: ASSY CA 25M-25F NULL MODEM 30'
ENG.DRAWING NO.: 24C1081-2 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	30.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
3	1641943	W BUSS 26GA	299/1	.200	FT
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	1.000	EA
6	3050069	CONN 25PIN"D"SKT W/SLDRPOTCONN	DB-25S	1.000	EA
7	1560028	TBG SHRINK 1/8" CLEAR	FIT 221 1/8CL	.200	FT

PARENT ITEM: 2300739 DESCRIPTION: ASSY CA 25M-25F NULL MODEM 50*
ENG.DRAWING NO.: 24C1081-3 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	50.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
3	1641943	W BUSS 26GA	299/1	.200	FT
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	1.000	EA
6	3050069	CONN 25PIN"D"SKT W/SLDRPOTCONN	DB-25S	1.000	EA
7	1560028	TBG SHRINK 1/8" CLEAR	FIT 221 1/8CL	.200	FT

PARENT ITEM: 2300747 DESCRIPTION: ASSY CA 25M-25F NULL MODEM 100
ENG.DRAWING NO.: 24C1081-4 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	100.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
3	1641943	W BUSS 26GA	299/1	.200	FT
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	1.000	EA
6	3050069	CONN 25PIN"D"SKT W/SLDRPOTCONN	DB-25S	1.000	EA
7	1560028	TBG SHRINK 1/8" CLEAR	FIT 221 1/8CL	.200	FT

PARENT ITEM: 2300887 DESCRIPTION: ASSY CA 25M-25M MODEM NORM 15'
ENG.DRAWING NO.: 24C1099-1 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	15.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA

PARENT ITEM: 2300895 DESCRIPTION: ASSY CA 25M-25M MODEM NORM 30'
ENG.DRAWING NO.: 24C1099-2 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	30.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA

PARENT ITEM: 2300903 DESCRIPTION: ASSY CA 25M-25M MODEM NORM 50'
ENG.DRAWING NO.: 24C1099-3 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	50.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA

PARENT ITEM: 2300911 DESCRIPTION: ASSY CA 25M-25M MODEM NORM 100
ENG.DRAWING NO.: 24C1099-4 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	100.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA

PARENT ITEM: 2300929 DESCRIPTION: ASSY CA 25M-25M MODEM NORM 3'
ENG.DRAWING NO.: 24C1099-5 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	3.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA

PARENT ITEM: 9205261 DESCRIPTION: ASSY COMP MRC-2 QUAD RS-232 4
ENG.DRAWING NO.: 20C2955 A

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
	3250024	SKT DUAL IN LINE 14 PIN U2	640357-1		1.000	EA
	3251071	SKT DUAL IN LINE 24 PIN SKINNY U1A,U1B,U1C,U1D	2-641932-1		4.000	EA
	3661253	IC 74HC32 QUAD OR GATE U2	MM74HC32N		1.000	EA
	3680311	IC RS-232 4-DRIVER 4-RECEIVER U1A,U1B,U1C,U1D	MAX238ENG		4.000	EA
	4280053	CAP TANT EPOX-DIP 4.7/35V 10% C2A,C2B,C2C,C2D,C4A,C4B,C4C,C4D	199D475X0035JA1		8.000	EA
	4280079	CAP TANT EPOX-DIP 10/25V 20% C1A,C1B,C1C,C1D,C3A,C3B,C3C,C3D	199D106X0025KA1		8.000	EA
	4280186	CAP TANT EPOX-DIP 220/10V 10% C6	K220E10		1.000	EA
	4310207	CAP .1UF/50V 20% C5	CY20C104M		1.000	EA
1	3473972	PCB MRC-2 QUAD RS-232 INT	51C6061	A	1.000	EA
2	2063758	PANEL MRC-2 QUAD RS232 INT	05A3174	A	1.000	EA
3	3050416	CONN 09PLG METALSHELL PC RTANG P1A,P1B,P1C,P1D	745990-3		4.000	EA
4	3110442	CONN 43 PIN J1	65001-081		1.000	EA
5	1050939	SCR JACK 3/16HEX4-40 X 5/16L P1	4750-3		8.000	EA
6	1050145	SCR PNH PHPS 4-40 X 5/16 SS P1			8.000	EA
7	1050632	WSHR LK #4 SR CD PL P1			8.000	EA
8	1050582	NUT HEX 4-40 SM PATT SST P1			8.000	EA

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(805) 963-9621

PAGE: 1

DATE: 10/09/8

PARENT ITEM: 2301356 DESCRIPTION: ASSY CA 25M-25M MODEM 4X20 10'
ENG.DRAWING NO.: 24C1165 A

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	10.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	2.000	EA
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.400	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	2.000	EA

PARENT ITEM: 2301364 DESCRIPTION: ASSY CA 9F-25M MODEM NORM 10"
ENG.DRAWING NO.: 24C1167 A

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	10.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	1.000	EA
3	3050424	SHELL CONN RFI/EMI 09P .250 CA	745854-3	1.000	EA
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.200	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	1.000	EA
6	3050051	CONN 9 PIN"D"SKT W/SLDRPOTCONN	DEM-9S	1.000	EA

PARENT ITEM: 2301372 DESCRIPTION: ASSY CA 9F-25M MODEM 4X20 10'
ENG.DRAWING NO.: 24C1168 A

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	10.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	1.000	EA
3	3050424	SHELL CONN RFI/EMI 09P .250 CA	745854-3	1.000	EA
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.200	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	1.000	EA
6	3050051	CONN 9 PIN"D"SKT W/SLDRPOTCONN	DEM-9S	1.000	EA

PARENT ITEM: 2301380   DESCRIPTION: ASSY CA 9F-25M NULL MODEM 25'
ENG.DRAWING NO.: 24C1169   A

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	25.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	1.000	EA
3	3050424	SHELL CONN RFI/EMI 09P .250 CA	745854-3	1.000	EA
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.200	FT
5	3050077	CONN 25PIN"D"PLG W/SLDRPOTCONN	DB-25P	1.000	EA
6	3050051	CONN 9 PIN"D"SKT W/SLDRPOTCONN	DEM-9S	1.000	EA

PARENT ITEM: 2301398

DESCRIPTION: ASSY CA 9F-25F NULL MODEM 25'
ENG.DRAWING NO.: 24C1170 A

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	25.000	FT
2	3050382	SHELL CONN RFI/EMI 25P .280 CA	745833-9	1.000	EA
3	3050424	SHELL CONN RFI/EMI 09P .250 CA	745854-3	1.000	EA
4	1560259	TBG TEFLON 26AWG NAT	TFT200-26	.200	FT
5	3050069	CONN 25PIN"D"SKT W/SLDRPOTCONN	DB-25S	1.000	EA
6	3050051	CONN 9 PIN"D"SKT W/SLDRPOTCONN	DEM-9S	1.000	EA

PARENT ITEM: 2301406 DESCRIPTION: ASSY CA 9F-9F NULL MODEM 25'
ENG.DRAWING NO.: 24C1171 A

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	1700103	CA 24 GA 4PR CHROME-VINYL	9504	25.000	FT
3	3050424	SHELL CONN RFI/EMI 09P .250 CA	745854-3	2.000	EA
6	3050051	CONN 9 PIN"D"SKT W/SLDRPOTCONN	DEM-9S	2.000	EA

APP

APPENDIX

This section contains the schematics and assembly drawings mentioned in Sections 4 and 5 of Volume 1. Corresponding parts lists can be found in Section 8. Spare parts kits are described in Section 7.

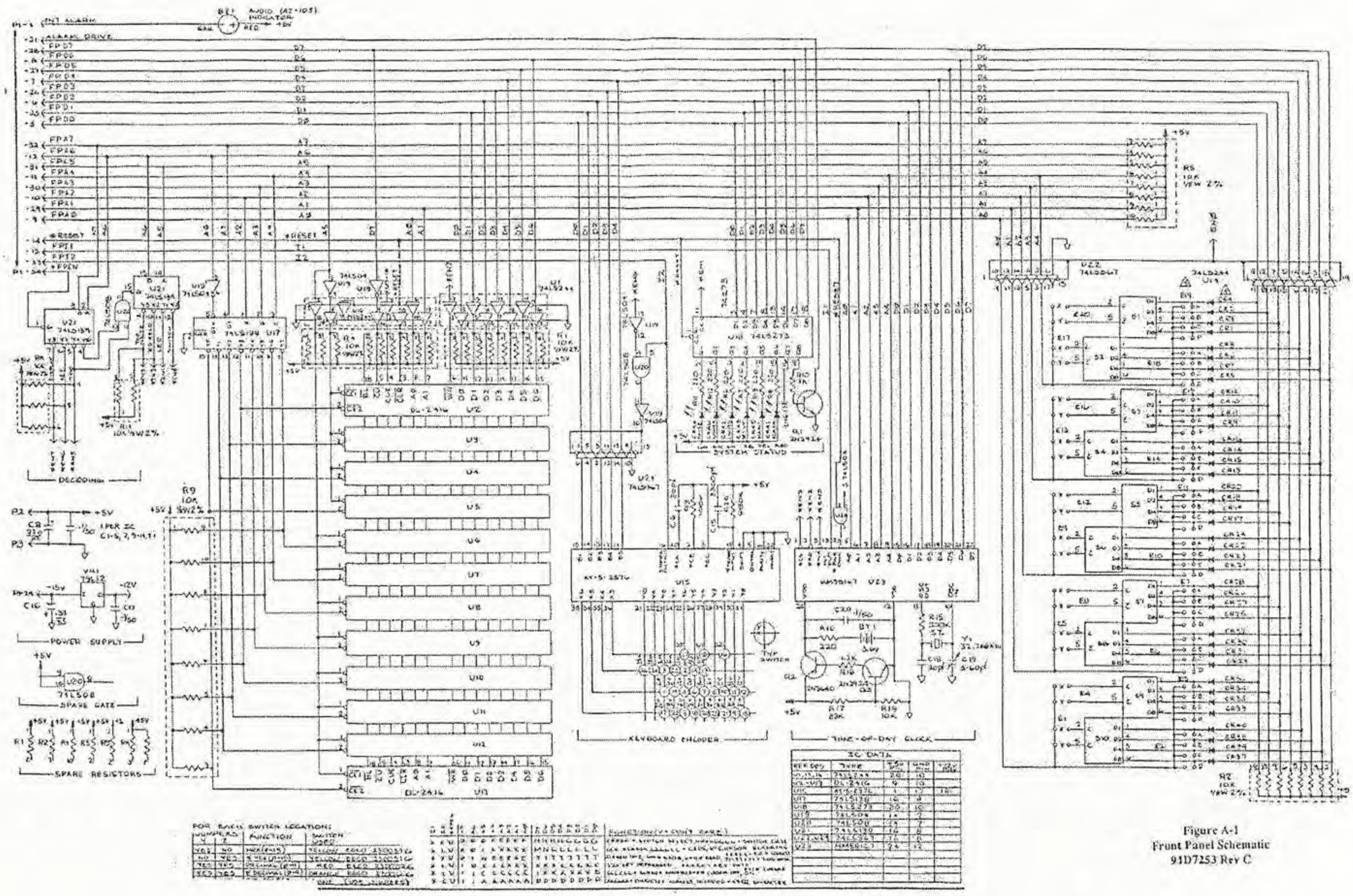
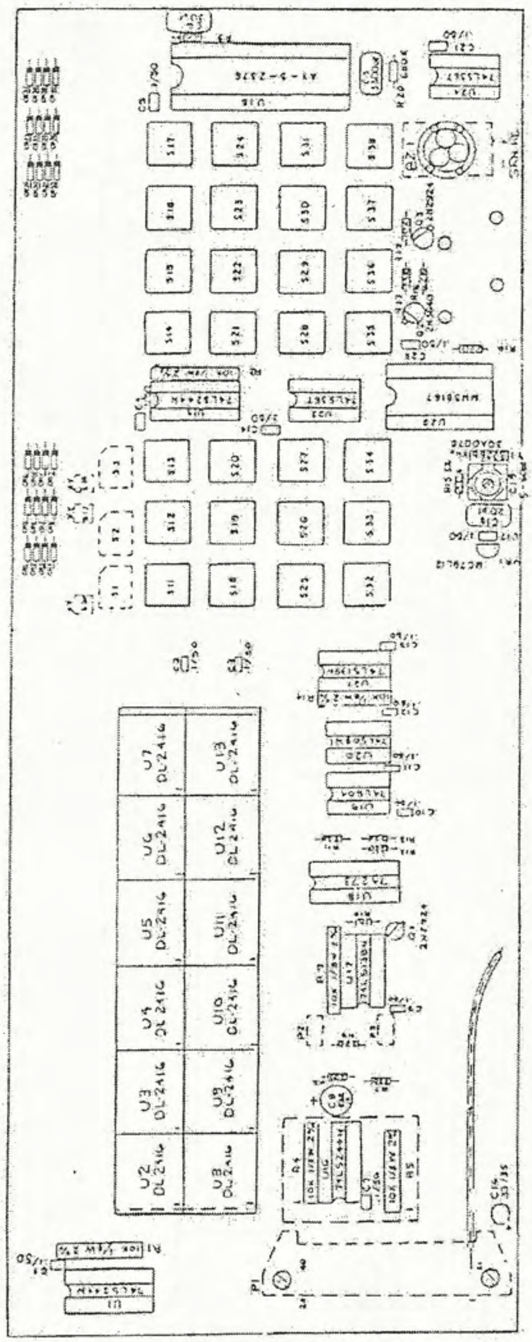
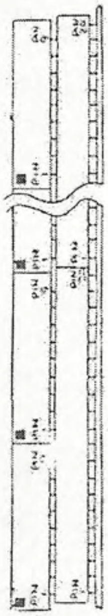


Figure A-1
Front Panel Schematic
91D7253 Rev C

Figure A-2
Front Panel Assembly
20D2804 Rev K





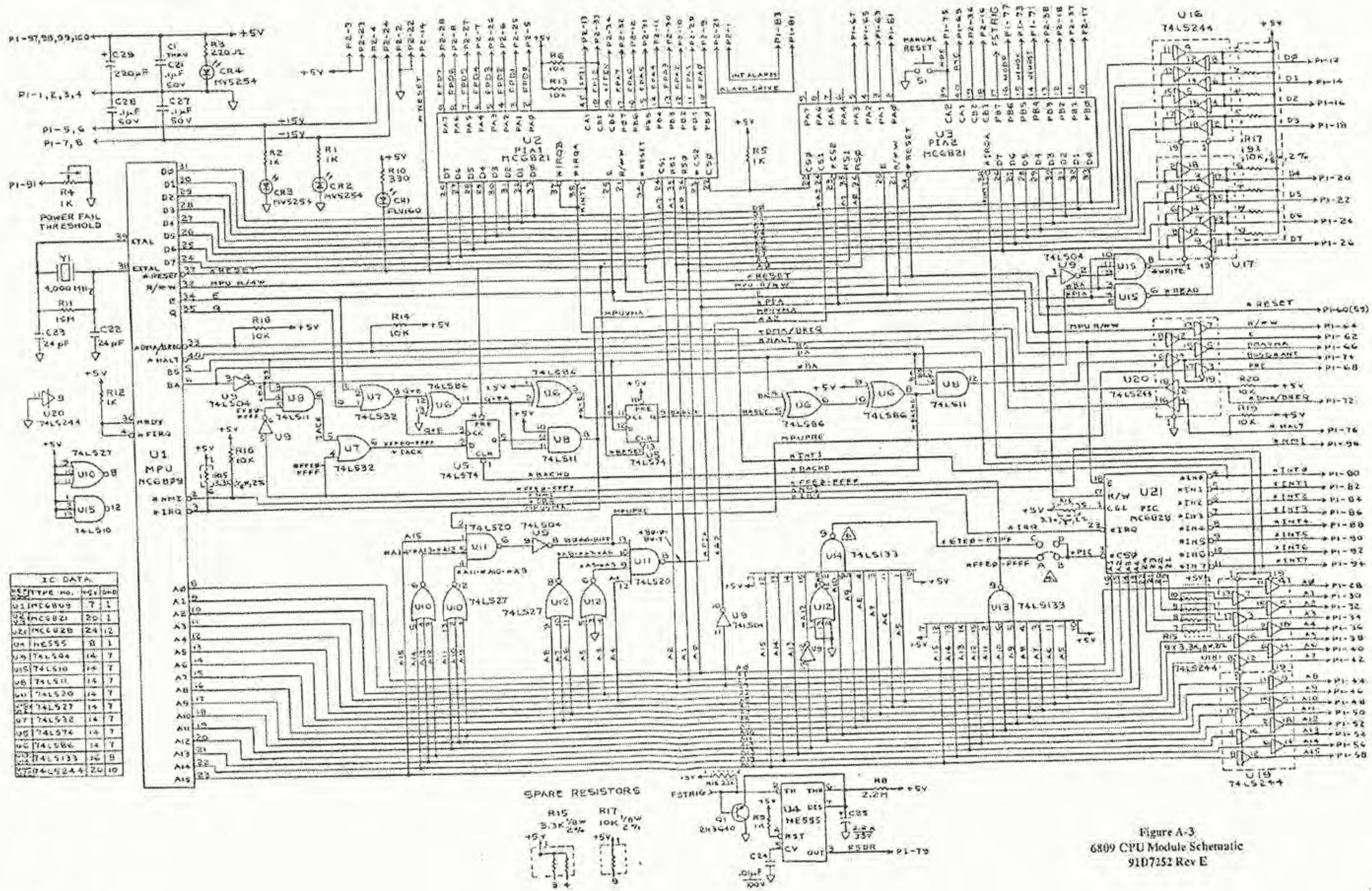


Figure A-3
6809 CPU Module Schematic
91D7252 Rev E

Figure A-4
6809 CPU Module Assembly
20D2793 Rev H

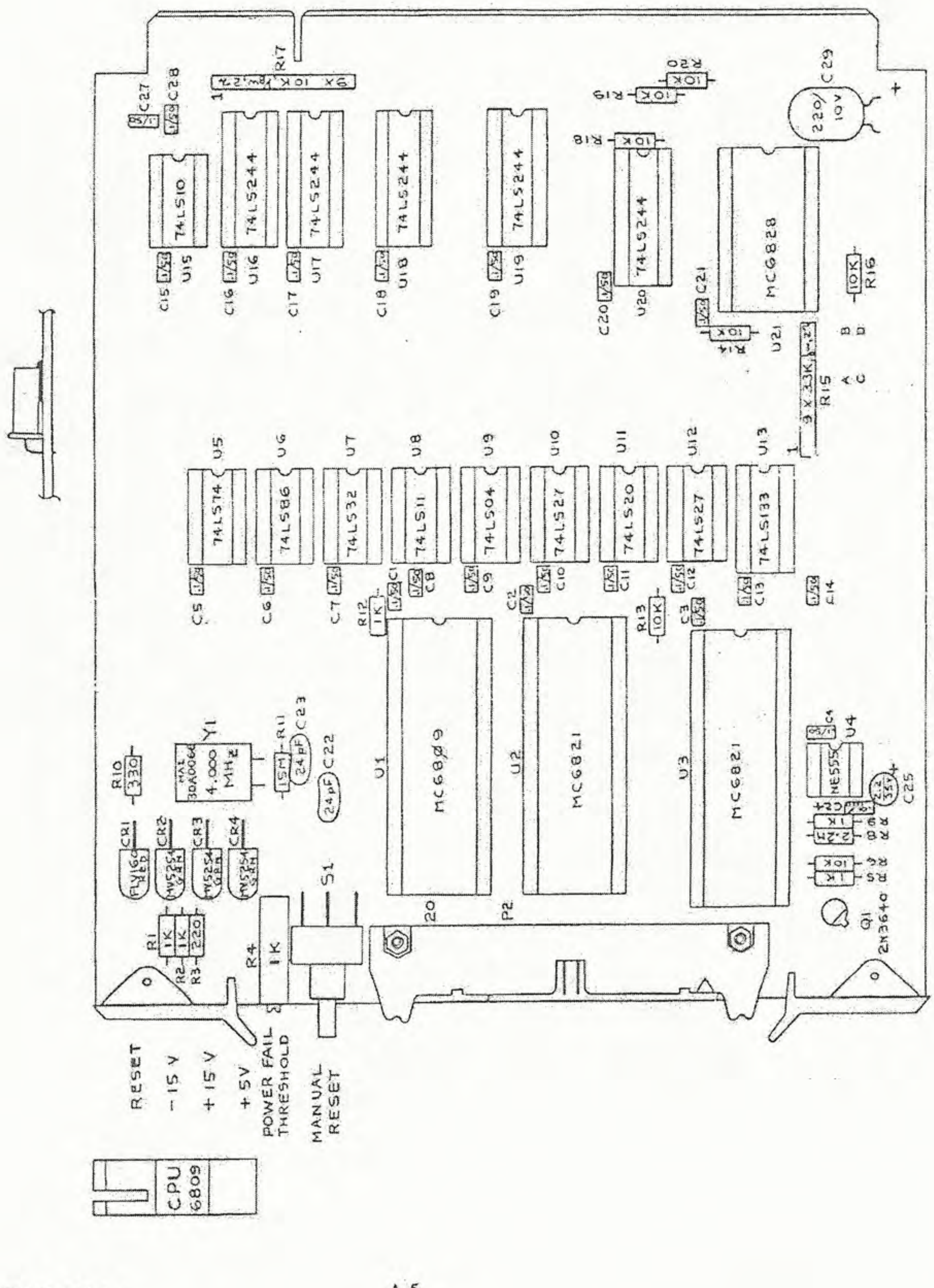


Figure A-5
CPU Interface Schematic
91C7215 Rev F

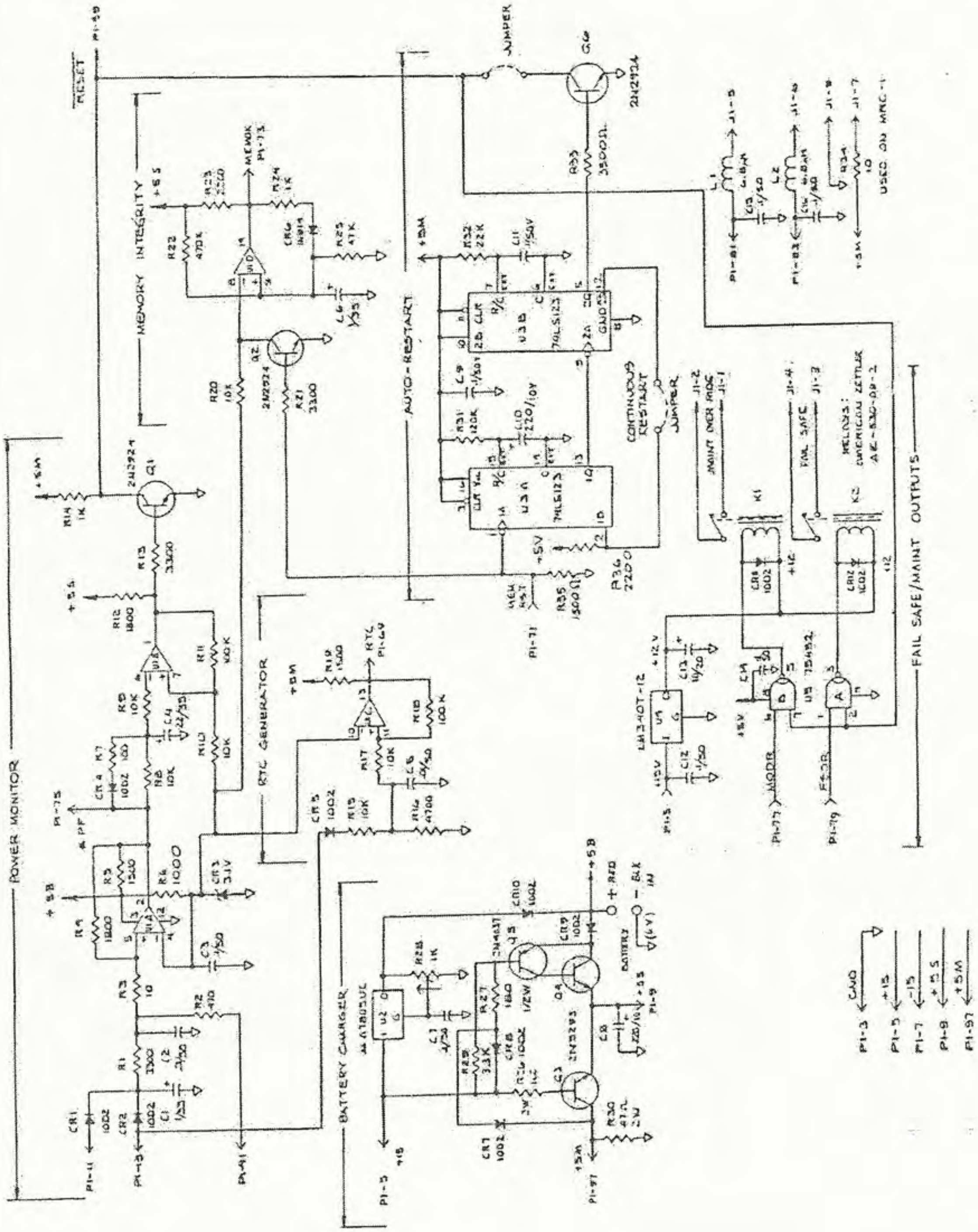


Figure A-6
CPU Interface Assembly
20C2781 Rev H

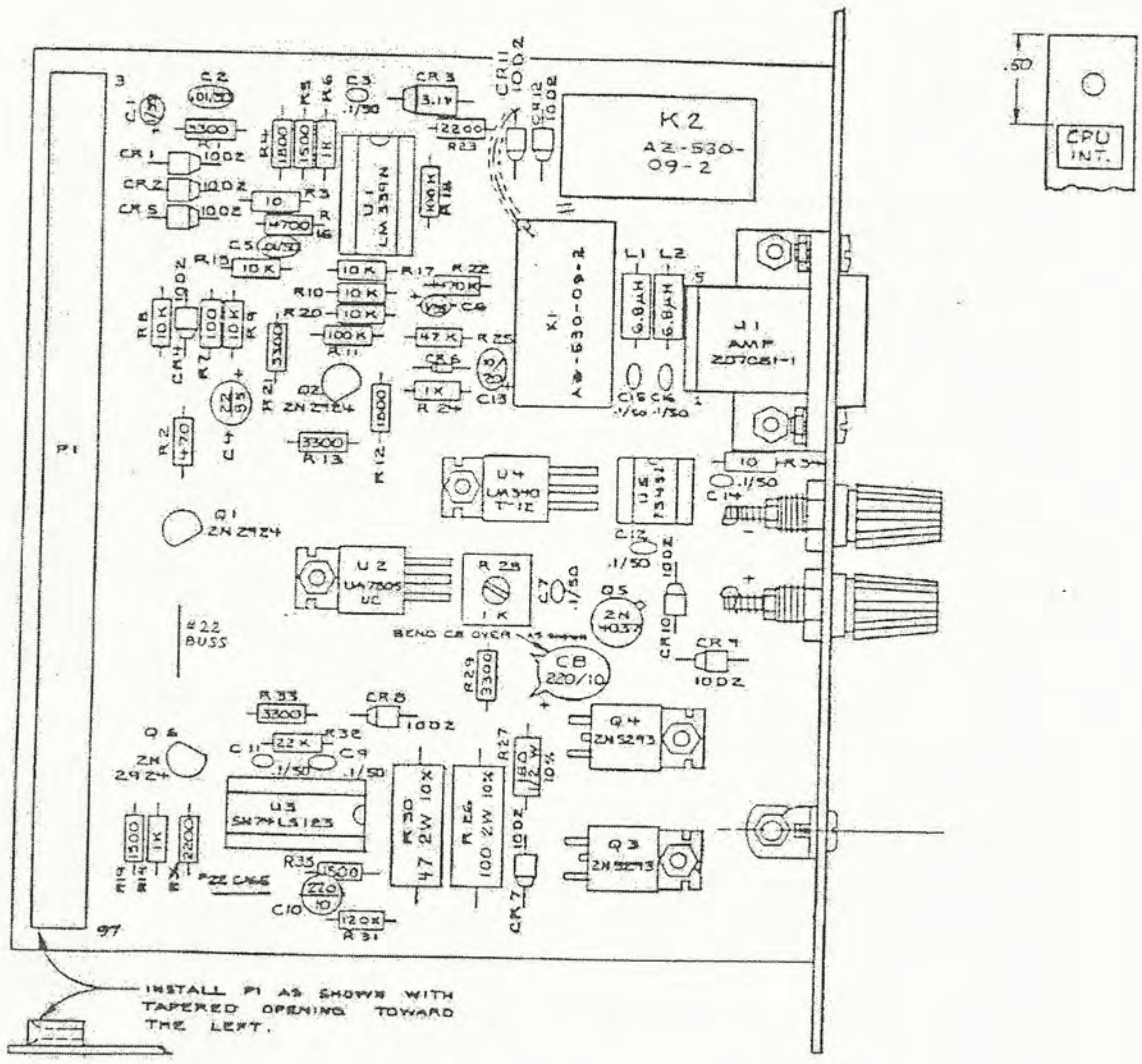


Figure A-7
96K ROM Board Schematic
91D7370 Rev B

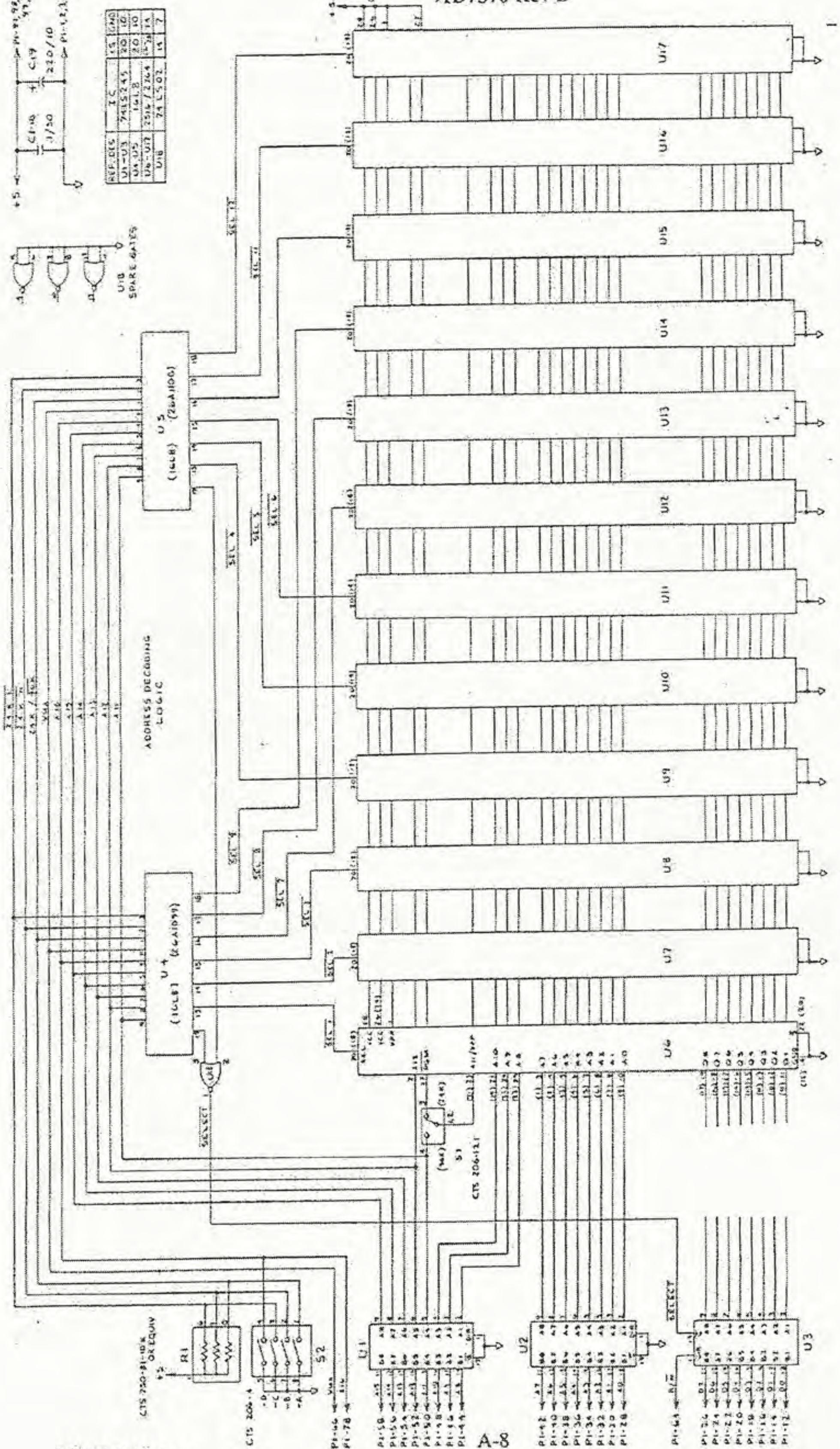
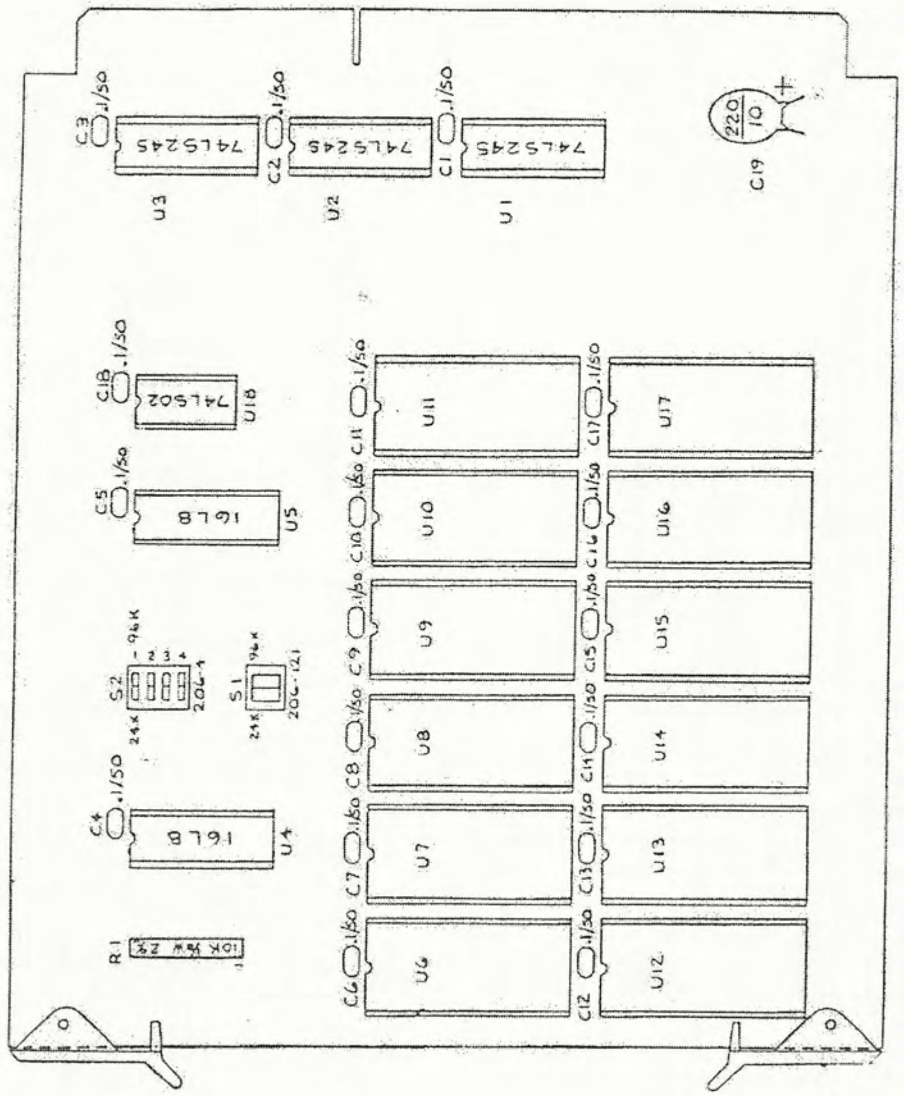


Figure A-8
96K ROM Board Assembly
20D2929 Rev B



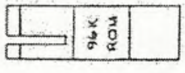


Figure A-9
32K RAM Board Schematic
91D7371 Rev B

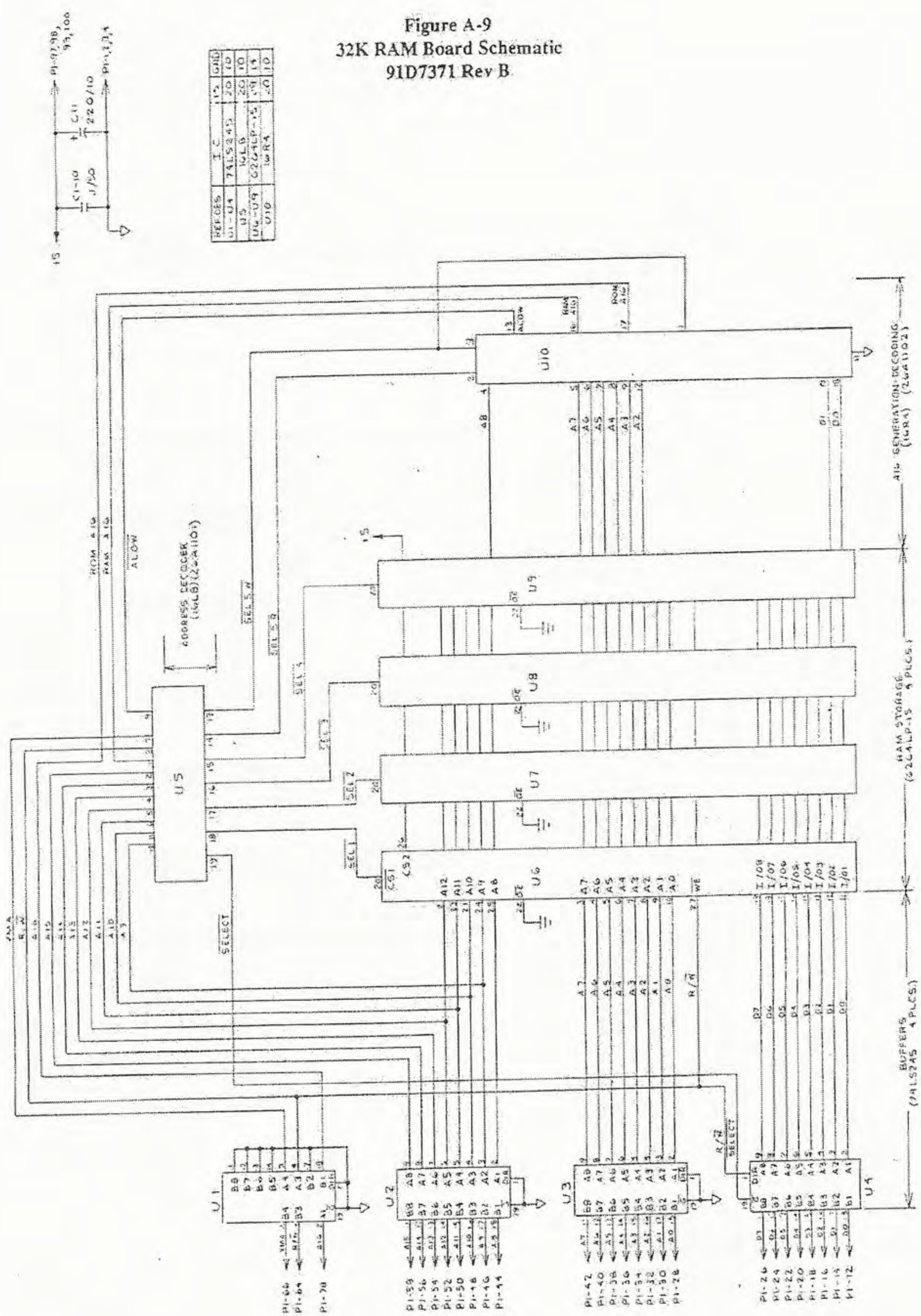


Figure A-10
32K RAM Board Assembly
20D2930 Rev D

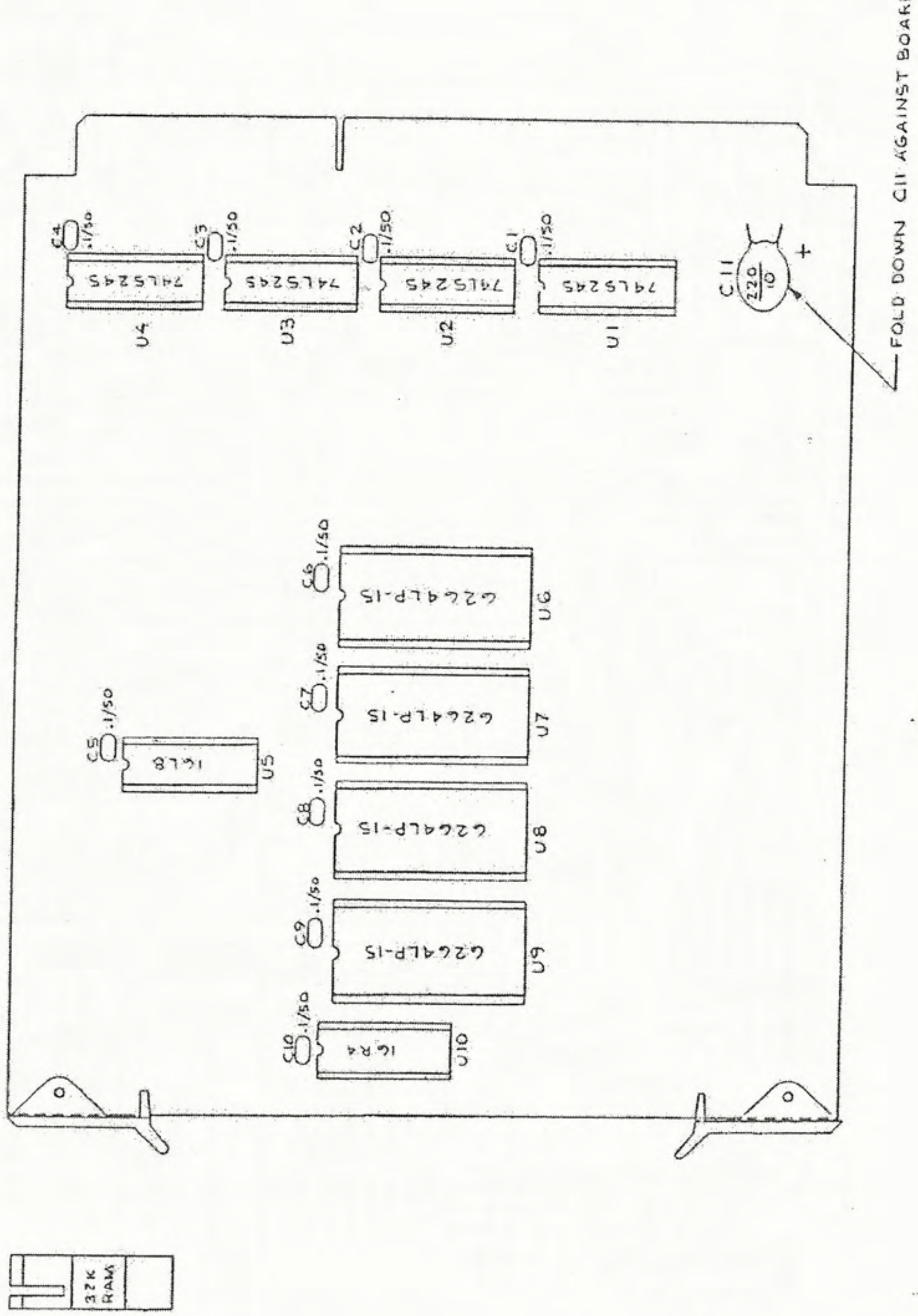


Figure A-11
File Memory Controller Schematic
91D7250 Rev G

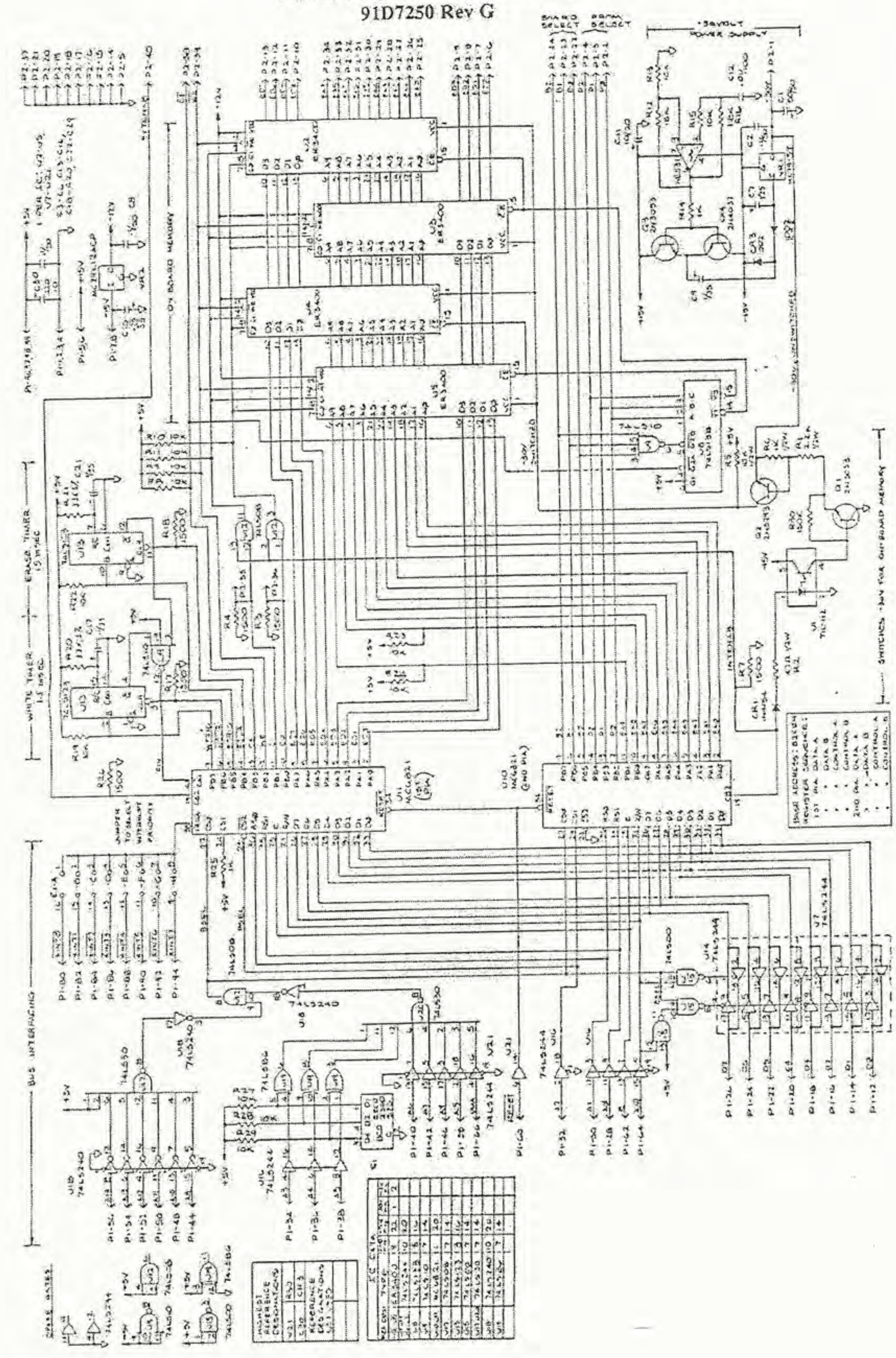


Figure A-12
File Memory Controller Assembly
20D2789 Rev H1

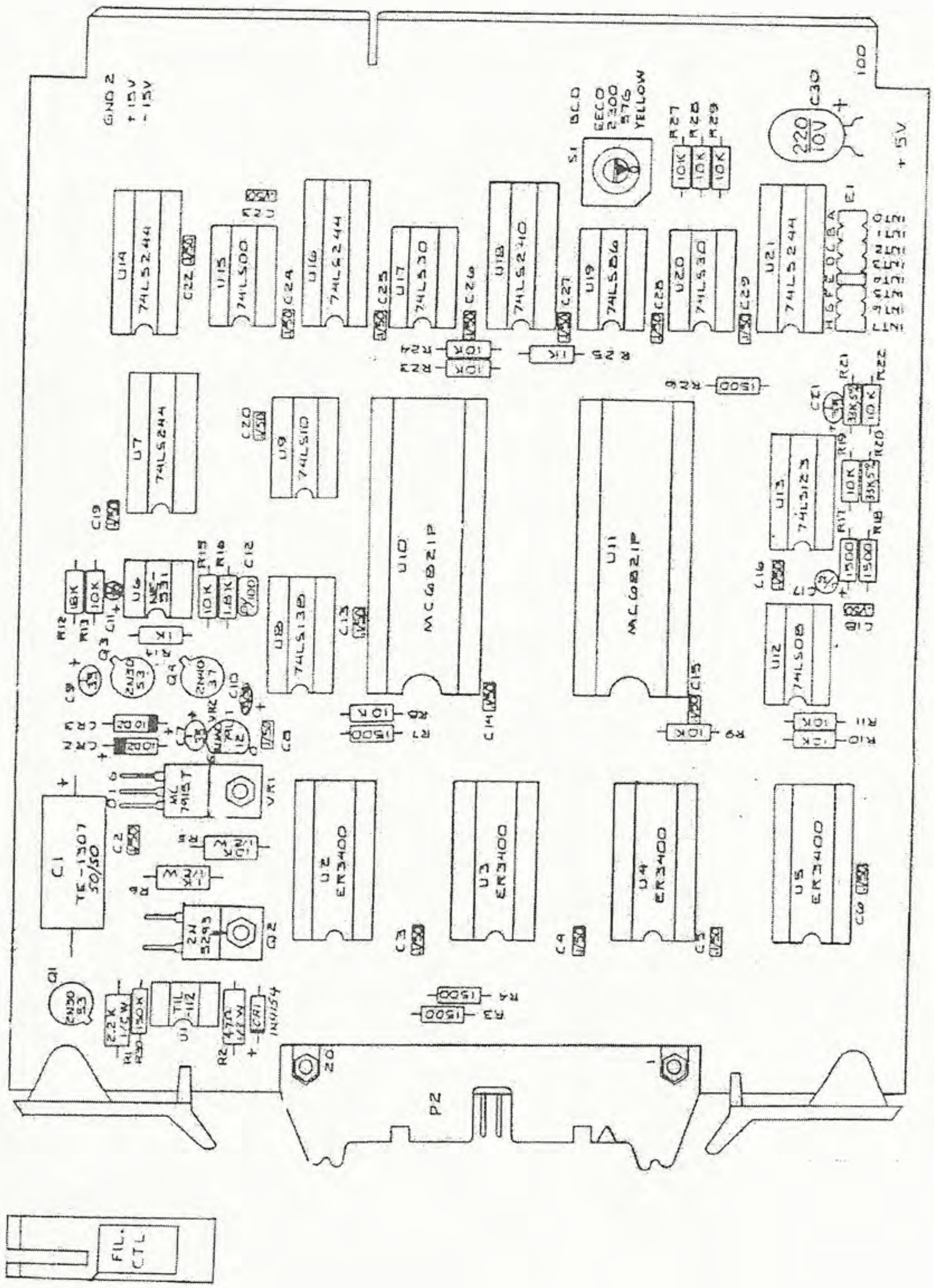
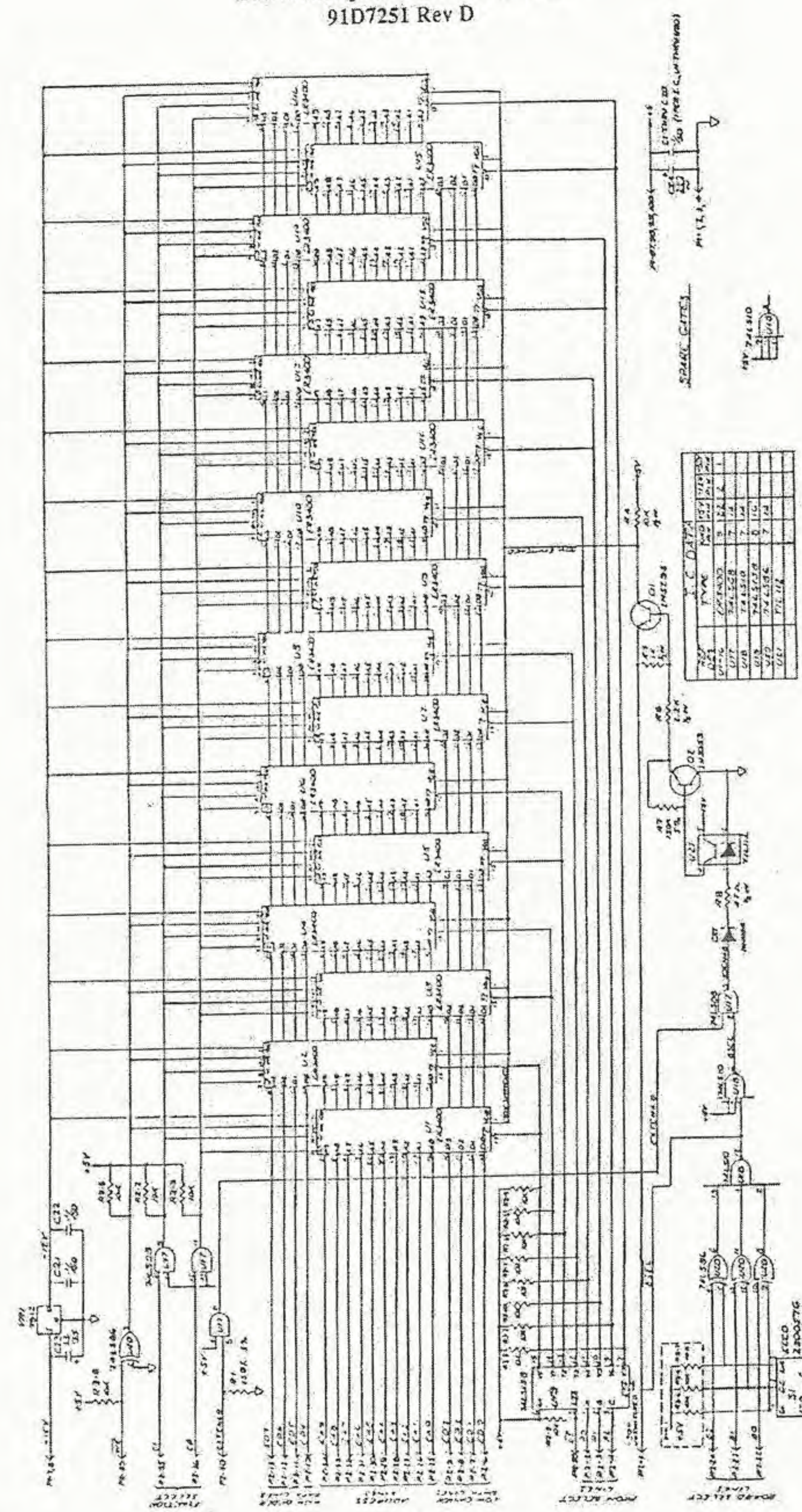


Figure A-13
File Memory Extension Schematic
91D7251 Rev D



A-14

Figure A-14
File Memory Extension Assembly
20D2790 Rev F

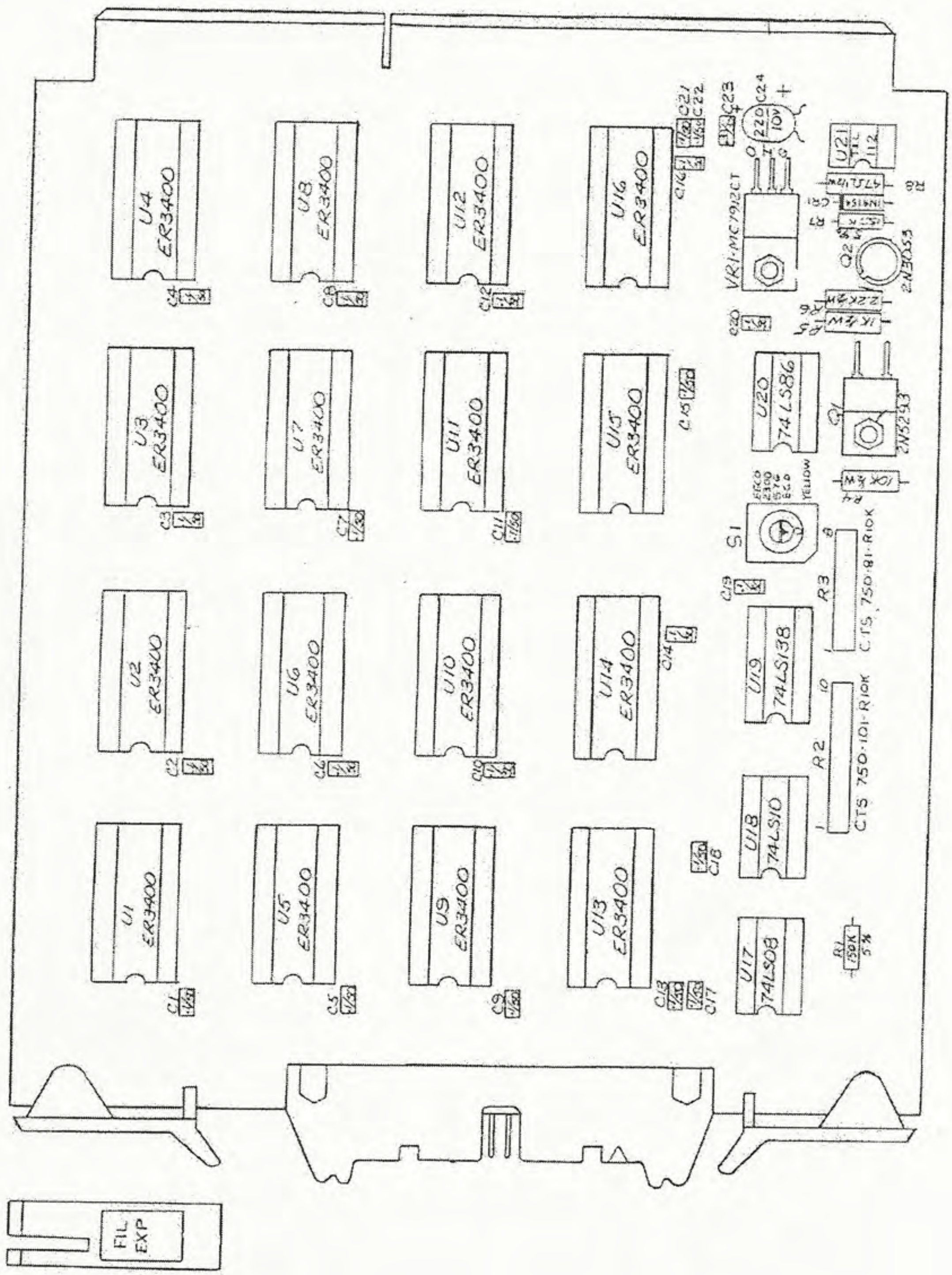


Figure A-15
GPIB-488 Module Schematic
91D7254 Rev A0

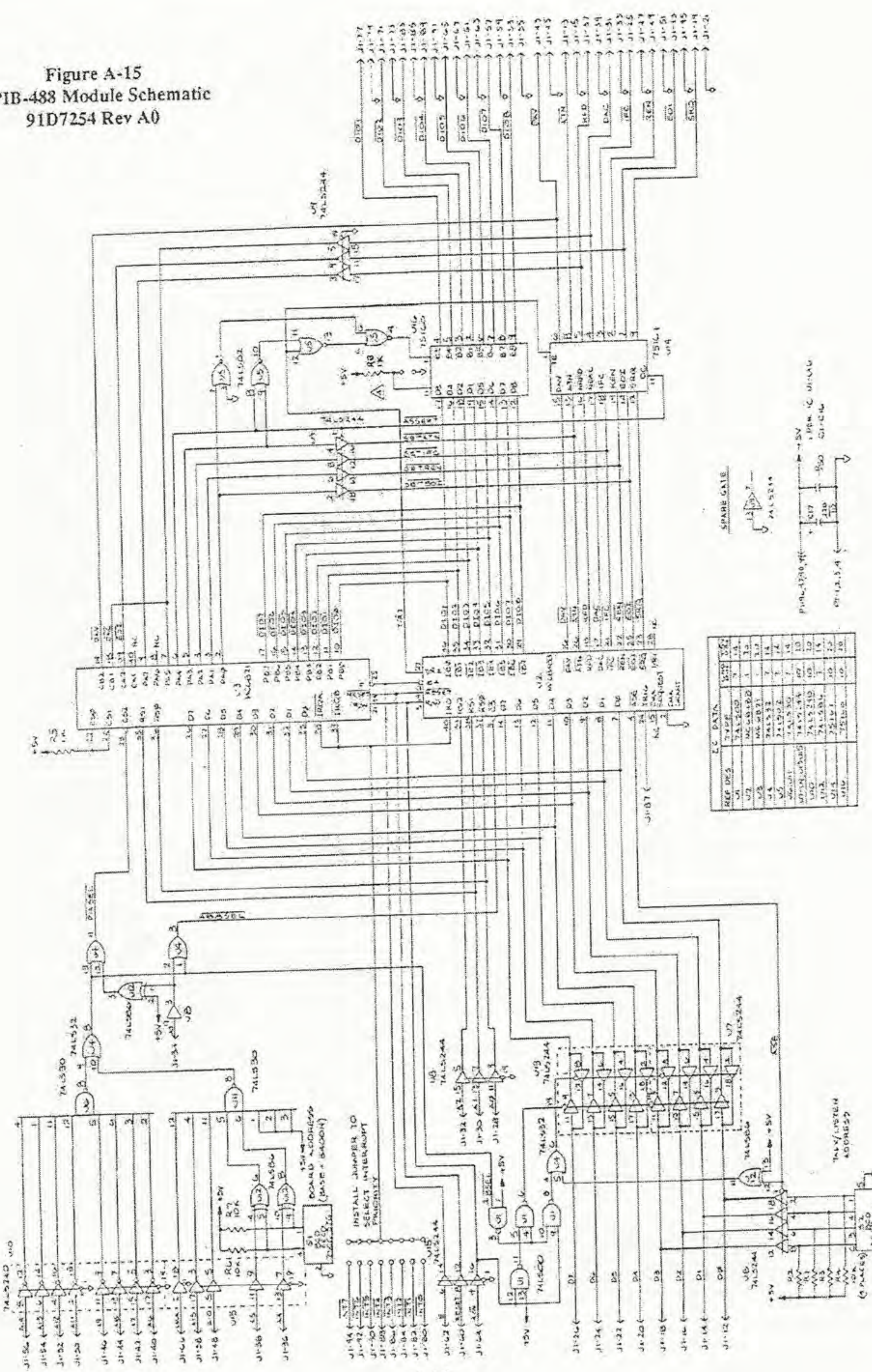


Figure A-16
GPIB-488 Module Assembly
20D2791 Rev B

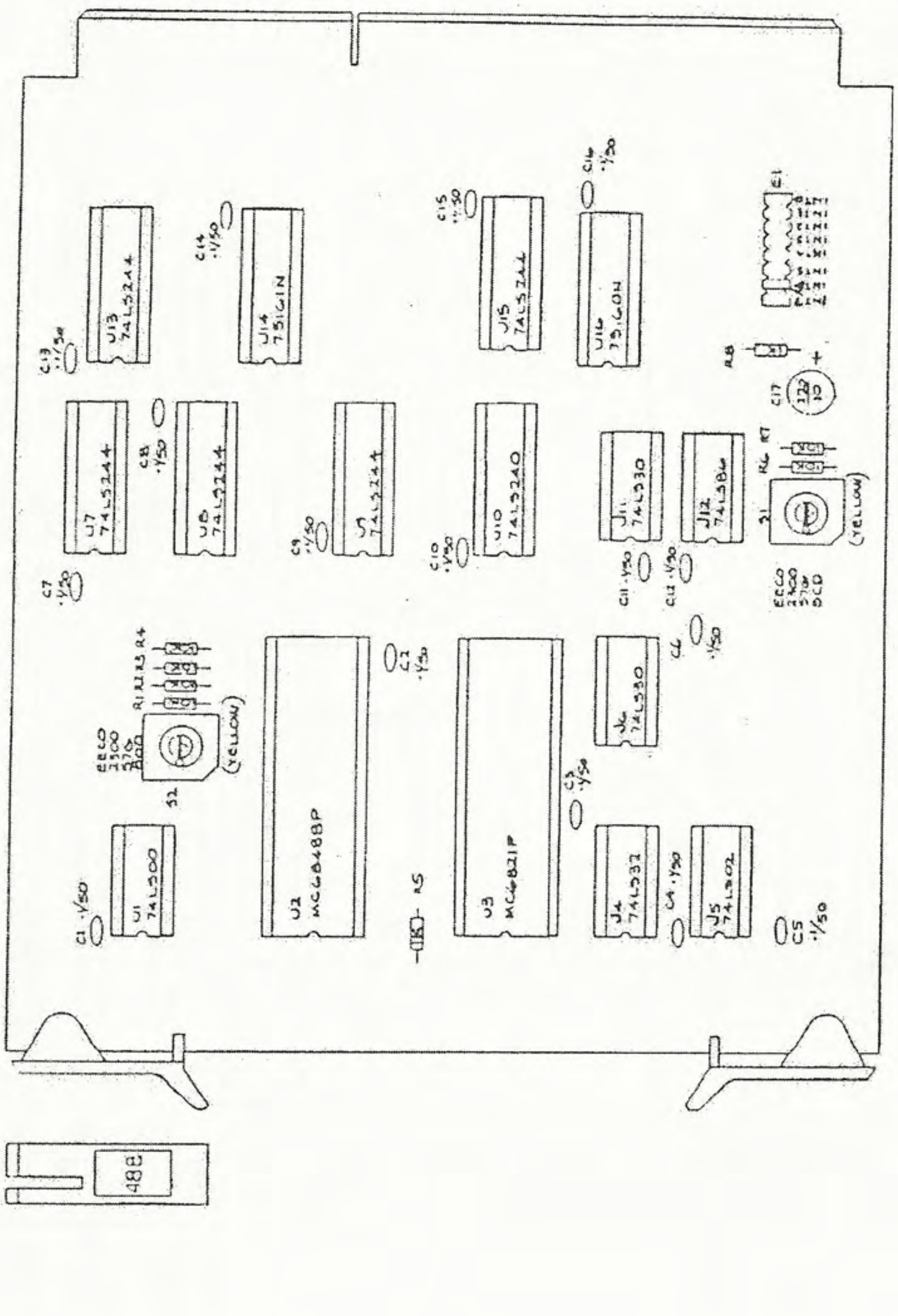


Figure A-17
GPIB-488 Interface Schematic
91C7255 Rev B

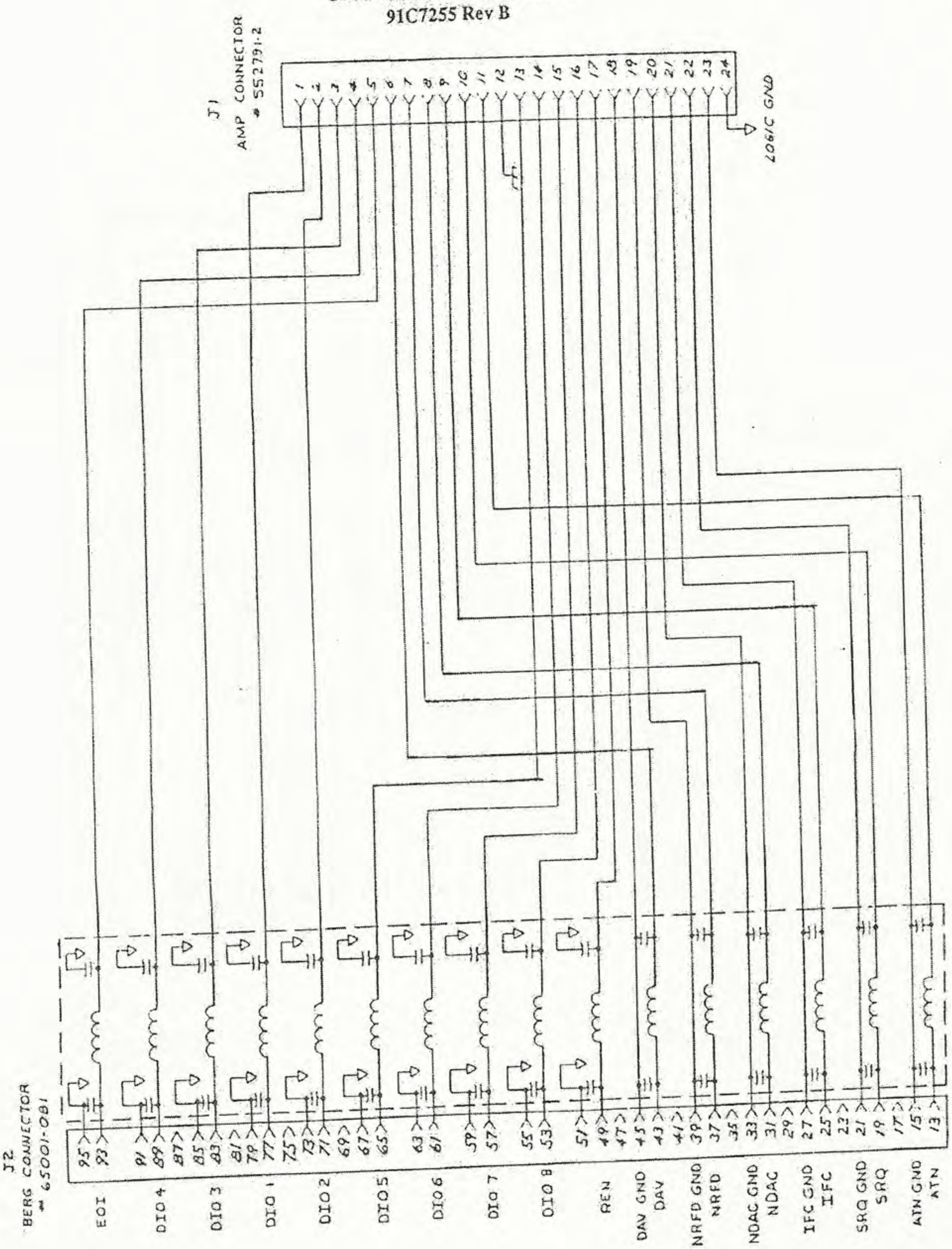


Figure A-18
GPIB-488 Interface Assembly
20C2792 Rev A1

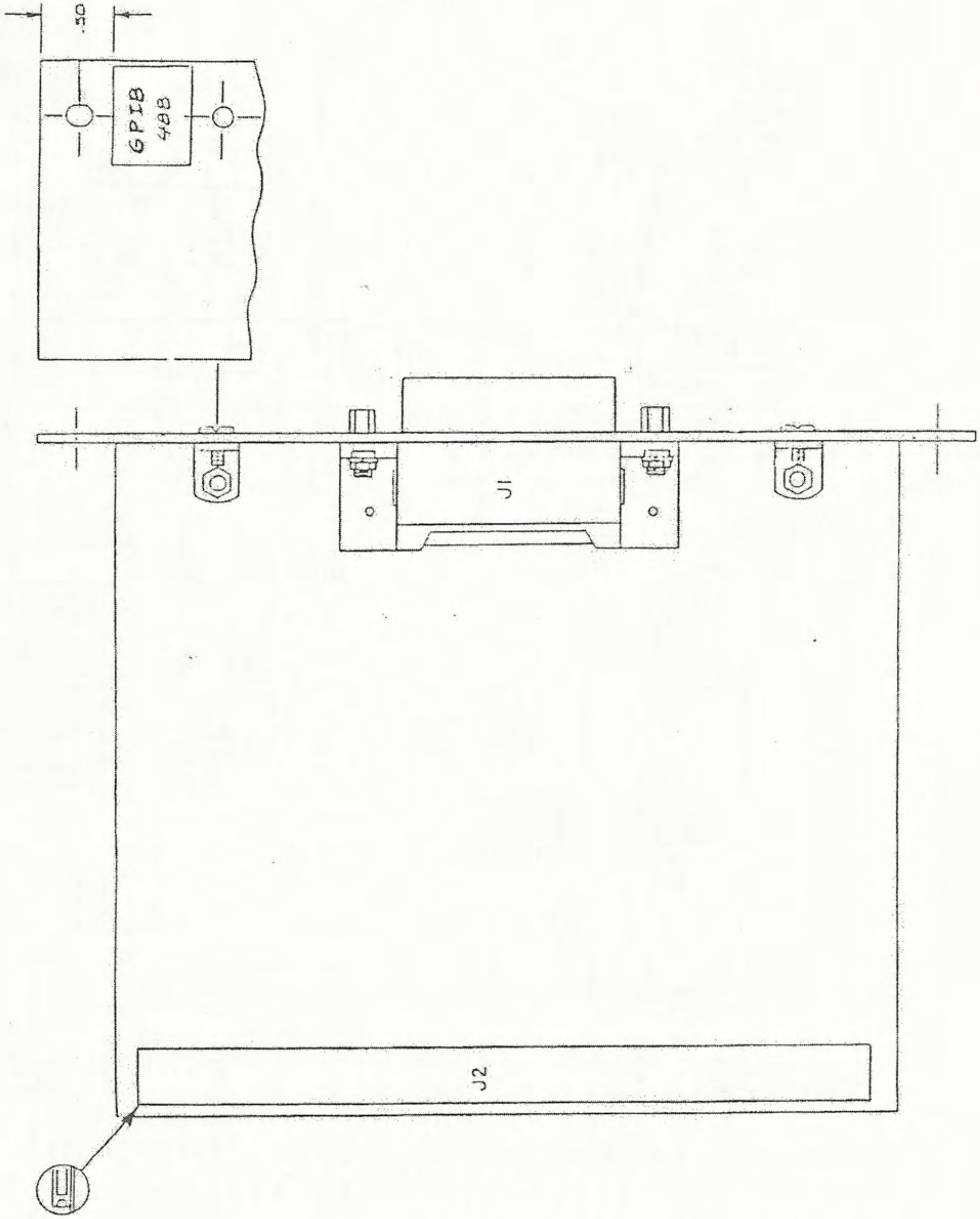


Figure A-19
Modem II Schematic
91D7233 Rev C

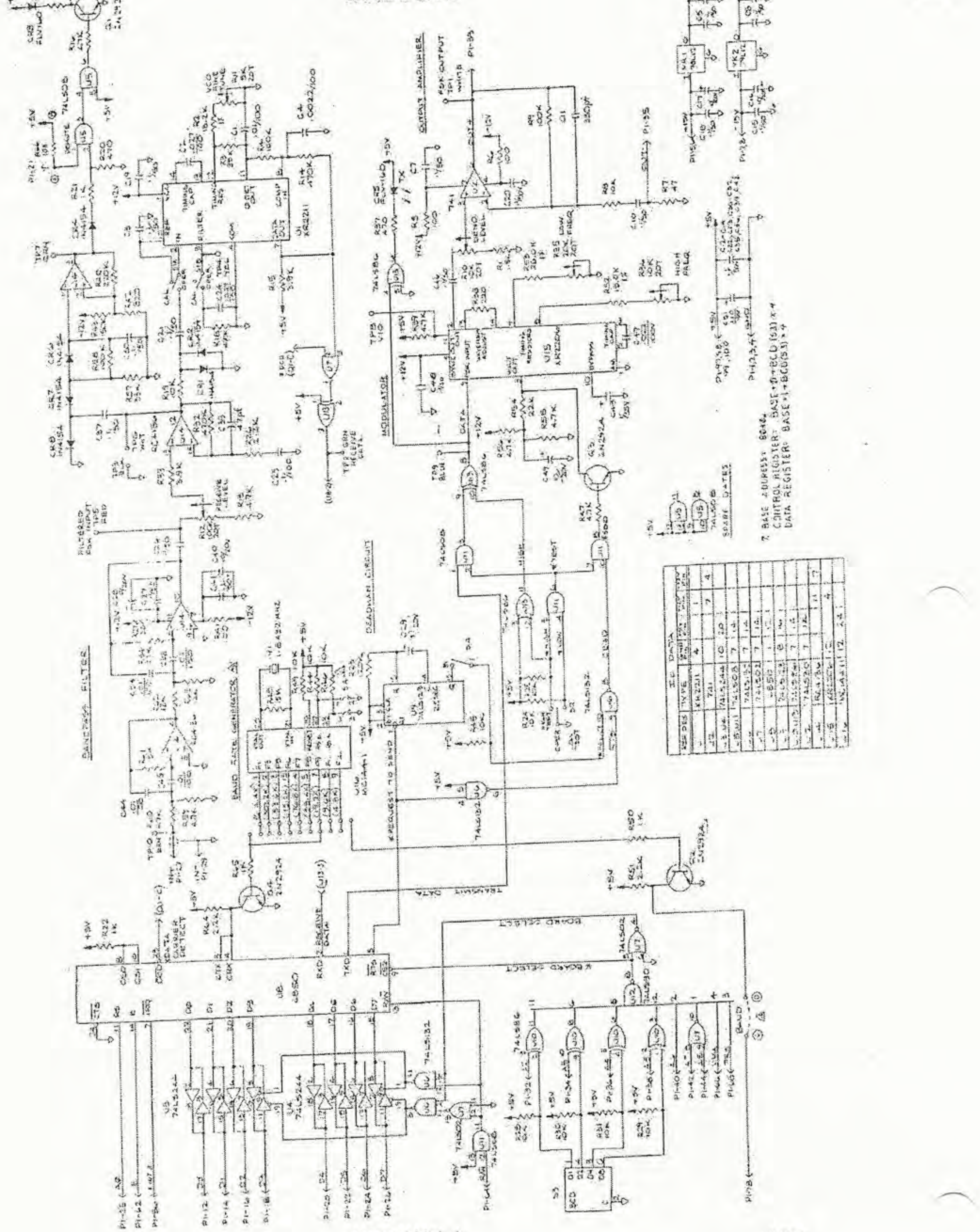


Figure A-20
Modem II Module Assembly
20D2787 Rev D

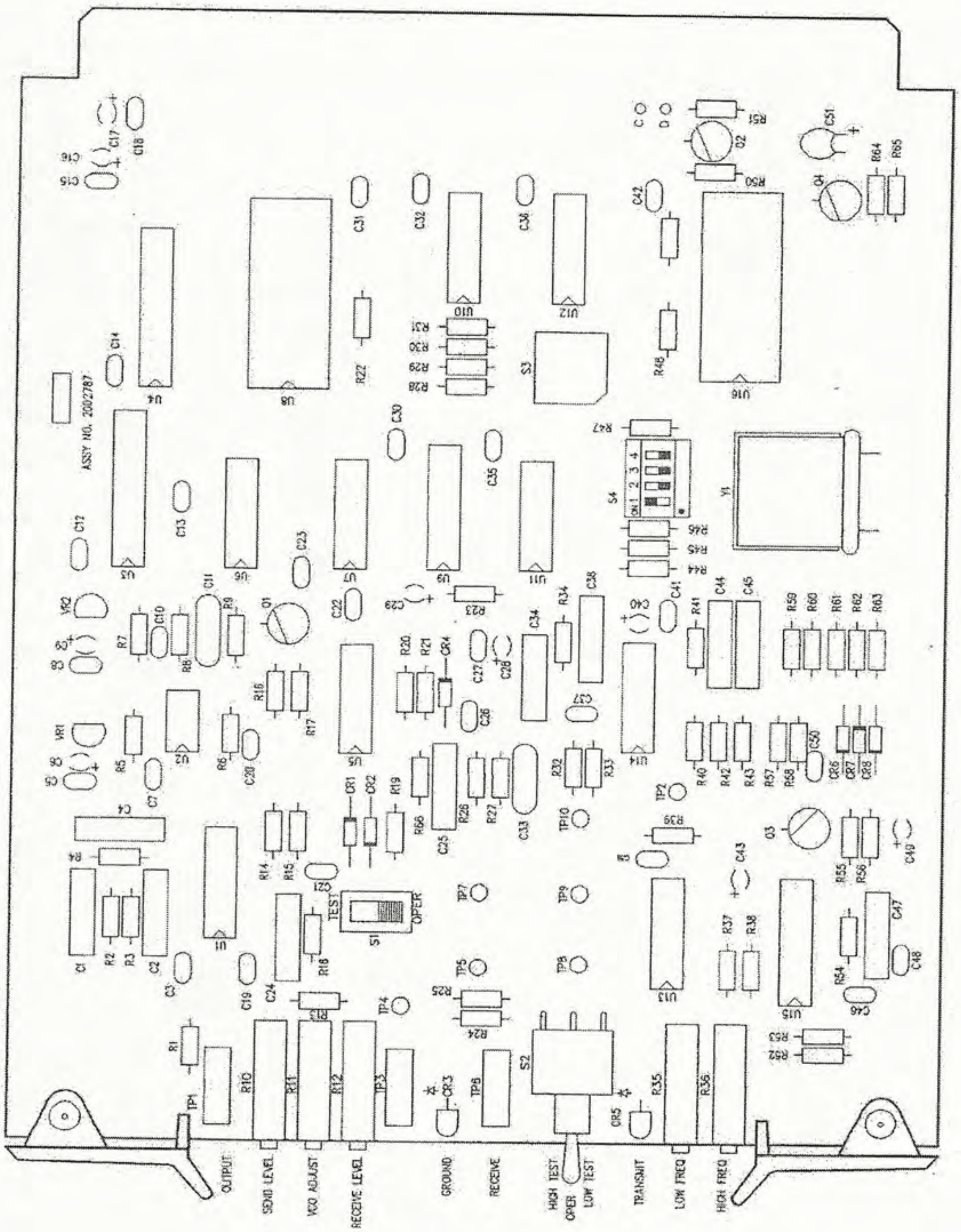


Figure A-21
Modem Telco Interface Schematic
91A7147 Rev C

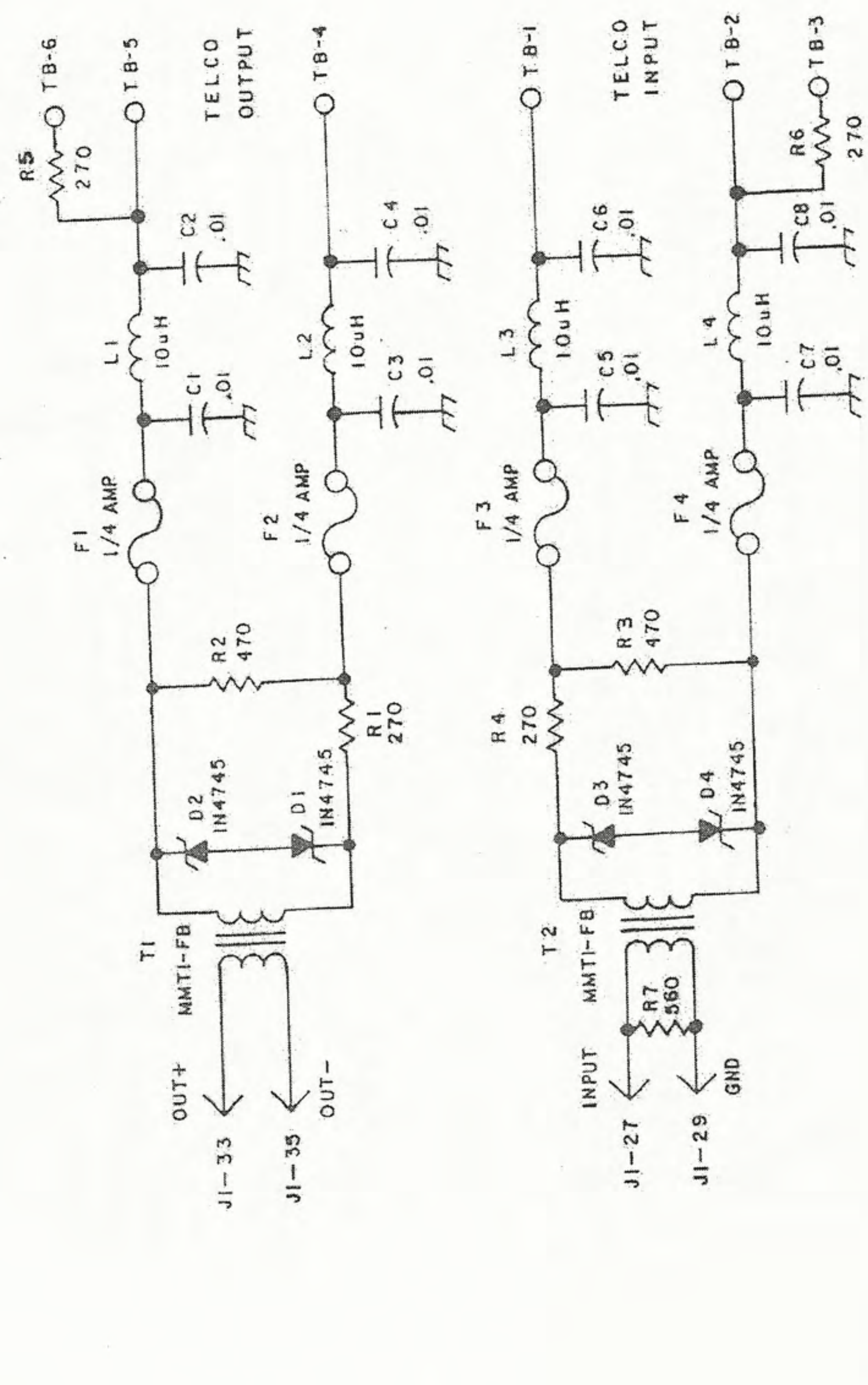


Figure A-22
Modem Telco Interface Assembly
29B2716 Rev H

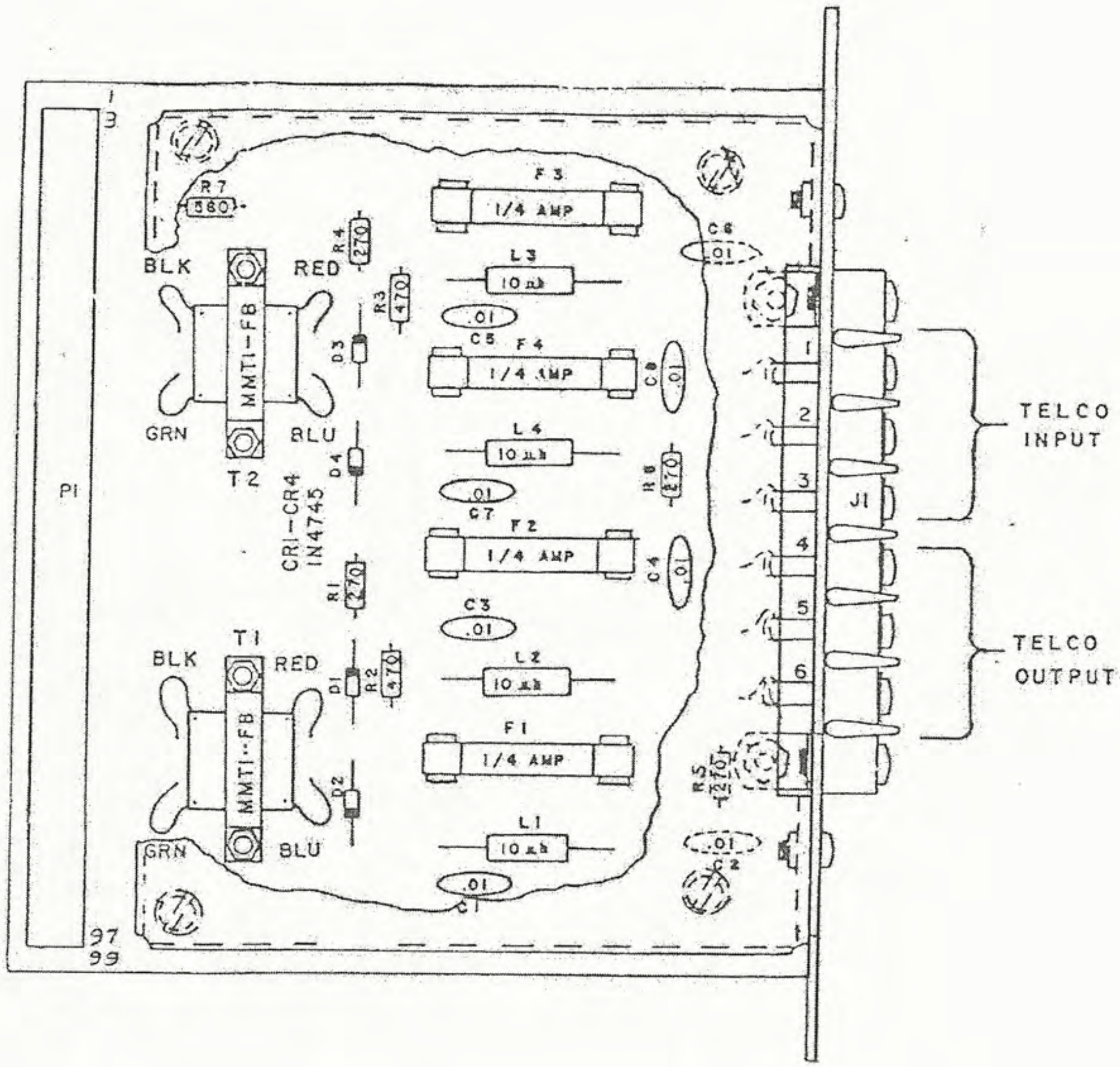


Figure A-23
Telco In/Subcarrier Out
Interface Schematic
91B7144 Rev E

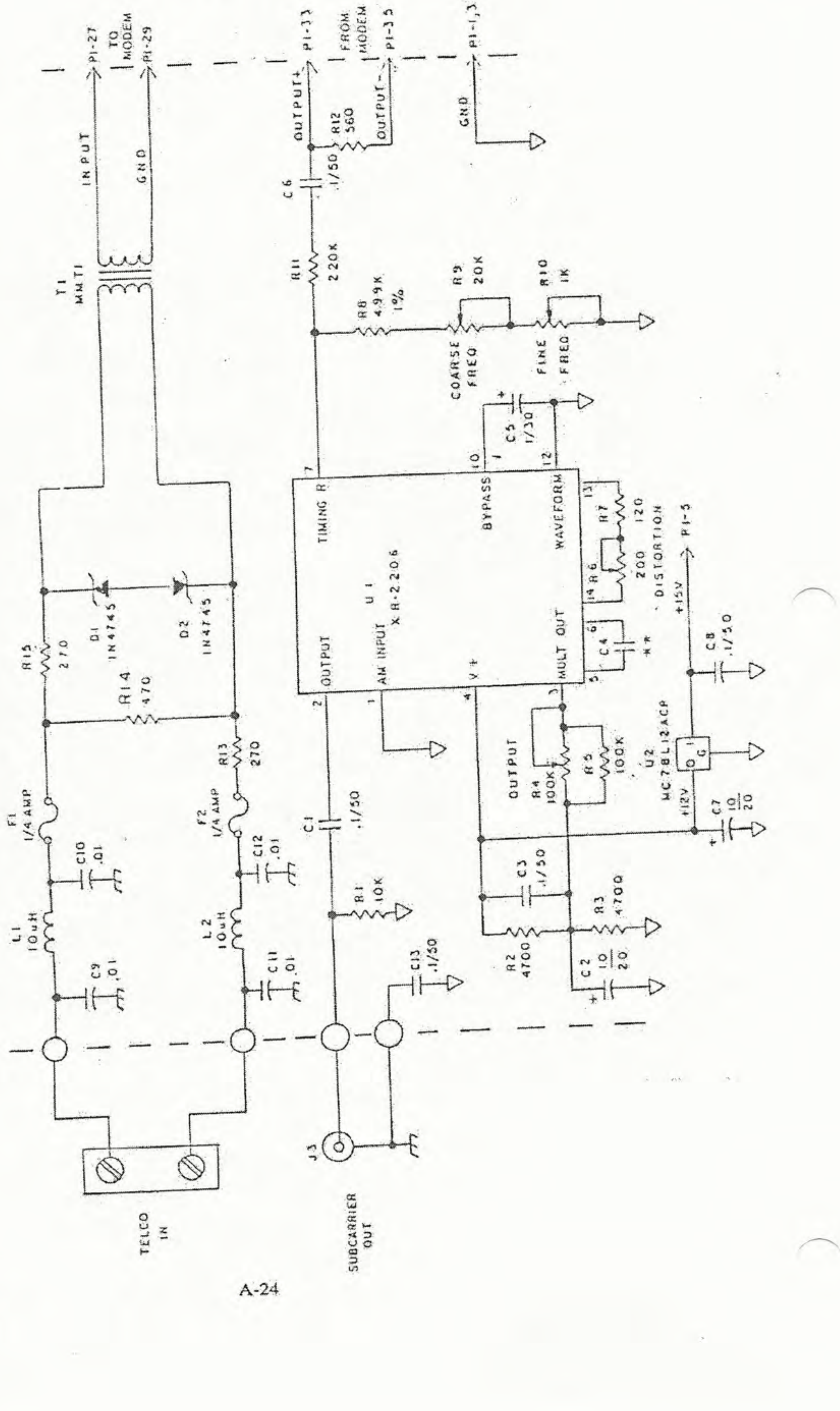


Figure A-24
Telco In/Subcarrier Out
Interface Assembly
20A2737 Rev L

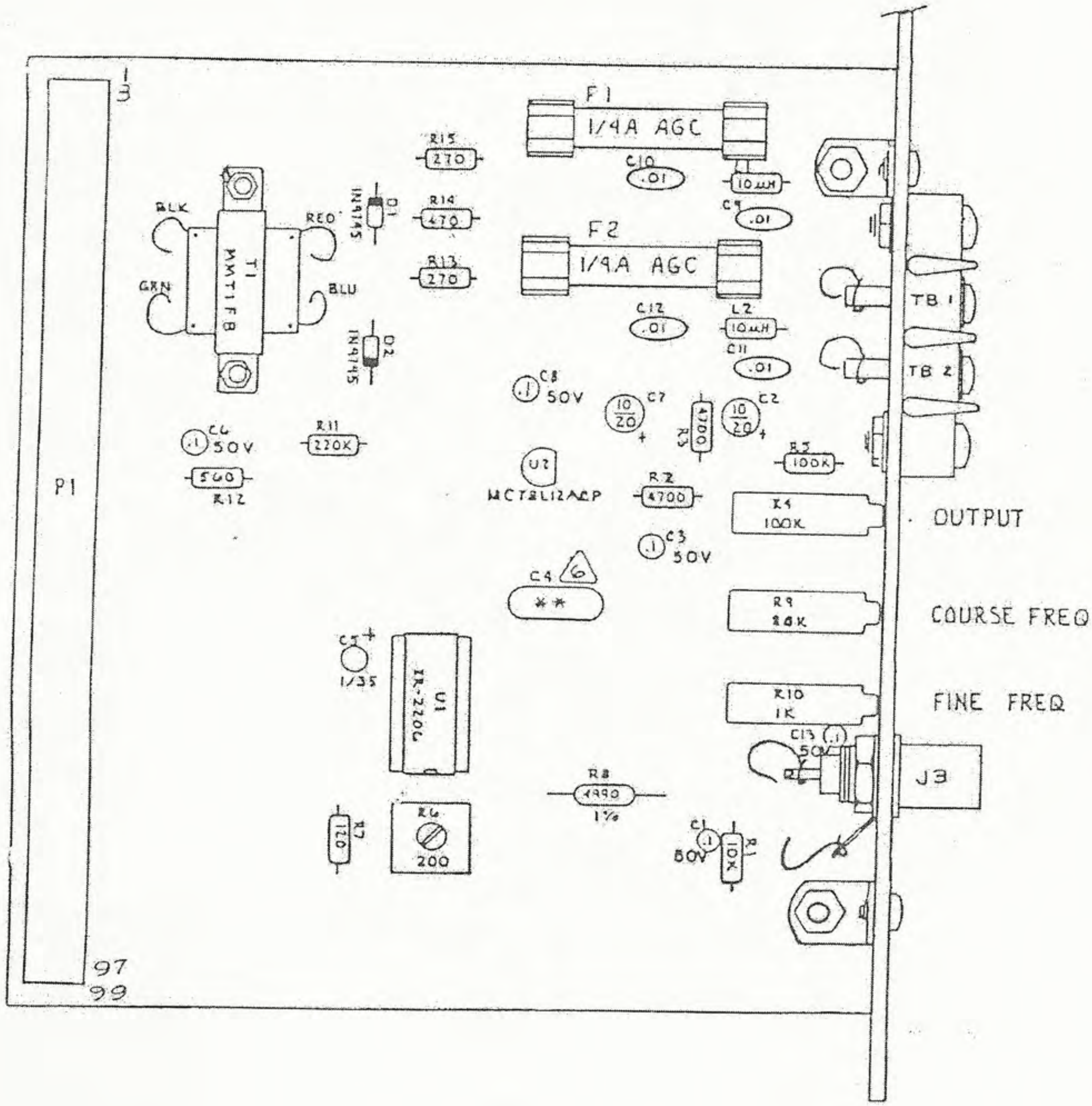
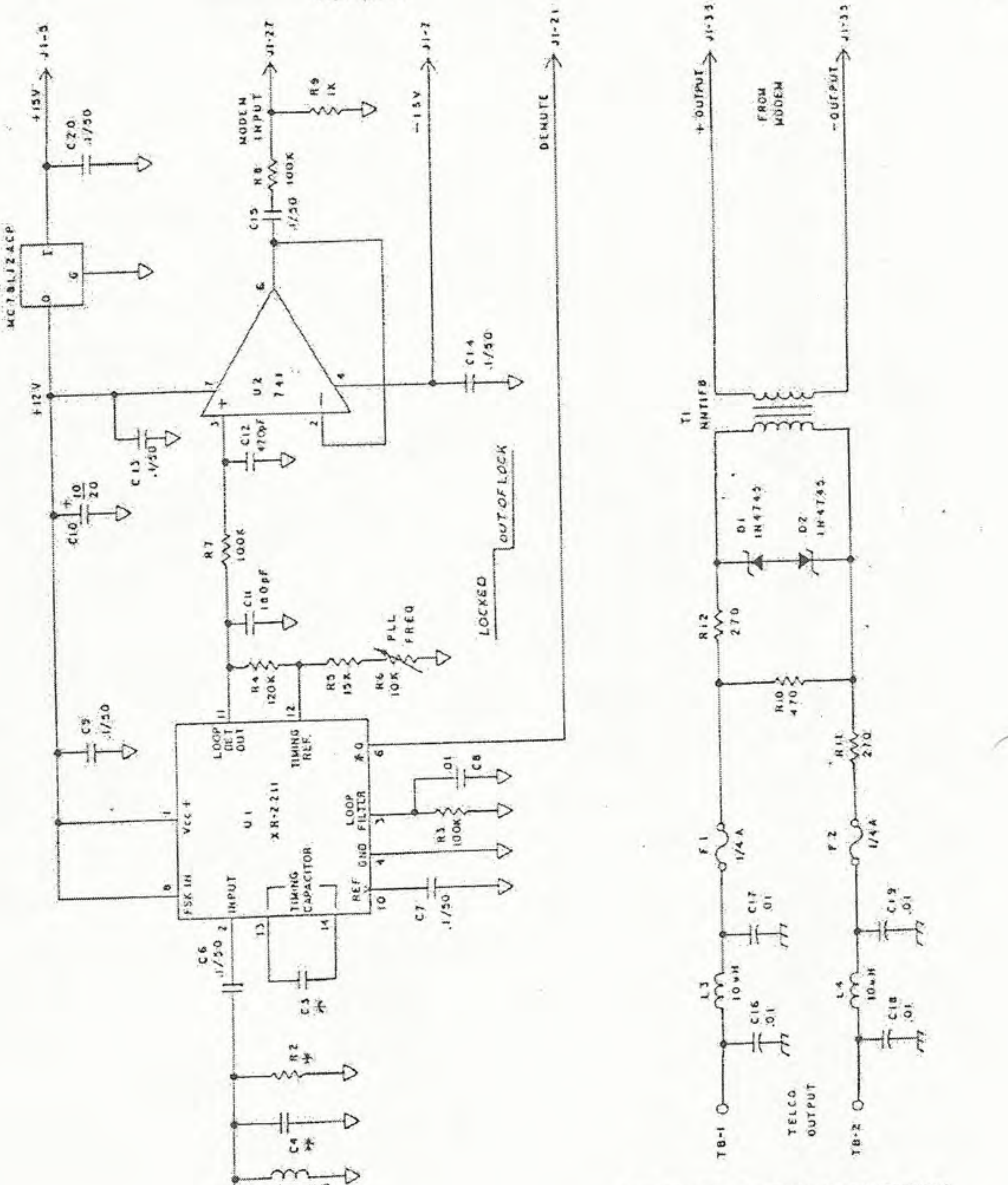


Figure A-25
Telco Out/Subcarrier In Schematic
91C7160 F



* FREQ DEPENDENT PARTS							
	R1	R2	C1	C2	C3	C4	C5
20KHZ	470	1500	.0131	.111	.0175	.111	2530pF
26KHZ	470	1800	.008	.068	.01	.068	1950pF
39KHZ	820	2700	3600pF	.031	4700pF	.031	1300pF
67KHZ	1500	4700	.0012	.01	.0016	.01	750pF
110KHZ	2200	6800	470pF	3600pF	620pF	3600pF	470pF
185KHZ	5600	15K	180pF	1500pF	250pF	1500pF	300pF
NEUTRX	Ø	Ø	Ø	Ø	Ø	Ø	Ø
92KHZ	1800	6200	680pF	.0068	1000pF	.0068	560pF
152KHZ	3000	10K	270pF	2400pF	430pF	2400pF	360pF

Figure A-26
Telco In/Subcarrier Out Assembly
20B2736 Rev K

ITEM	✳ FREQ DEPENDENT PARTS							
ITEM	FREQ	R1	R2	C1	C2	C3	C4	C5
ITEM 1	20KHZ	470	1500	.0131	.111	.0175	.111	2530pF
ITEM 2	26KHZ	470	1800	.008	.068	.01	.068	1930pF
ITEM 3	39KHZ	820	2700	3600pF	.031	4700pF	.031	1300pF
ITEM 4	67KHZ	1500	4700	1200pF	.01	.0016	.01	750pF
ITEM 5	110KHZ	2200	6800	470pF	3600pF	620pF	3600pF	470pF
ITEM 6	185KHZ	3600	15K	180pF	1500pF	250pF	1500pF	300pF
ITEM 7	NEUTER	ø	ø	ø	ø	ø	ø	ø
ITEM 8	92KHZ	1800	6200	680pF	.0068	1000pF	.0068	560pF
ITEM 9	152KHZ	3000	10K	270pF	2400pF	430pF	2400pF	360pF

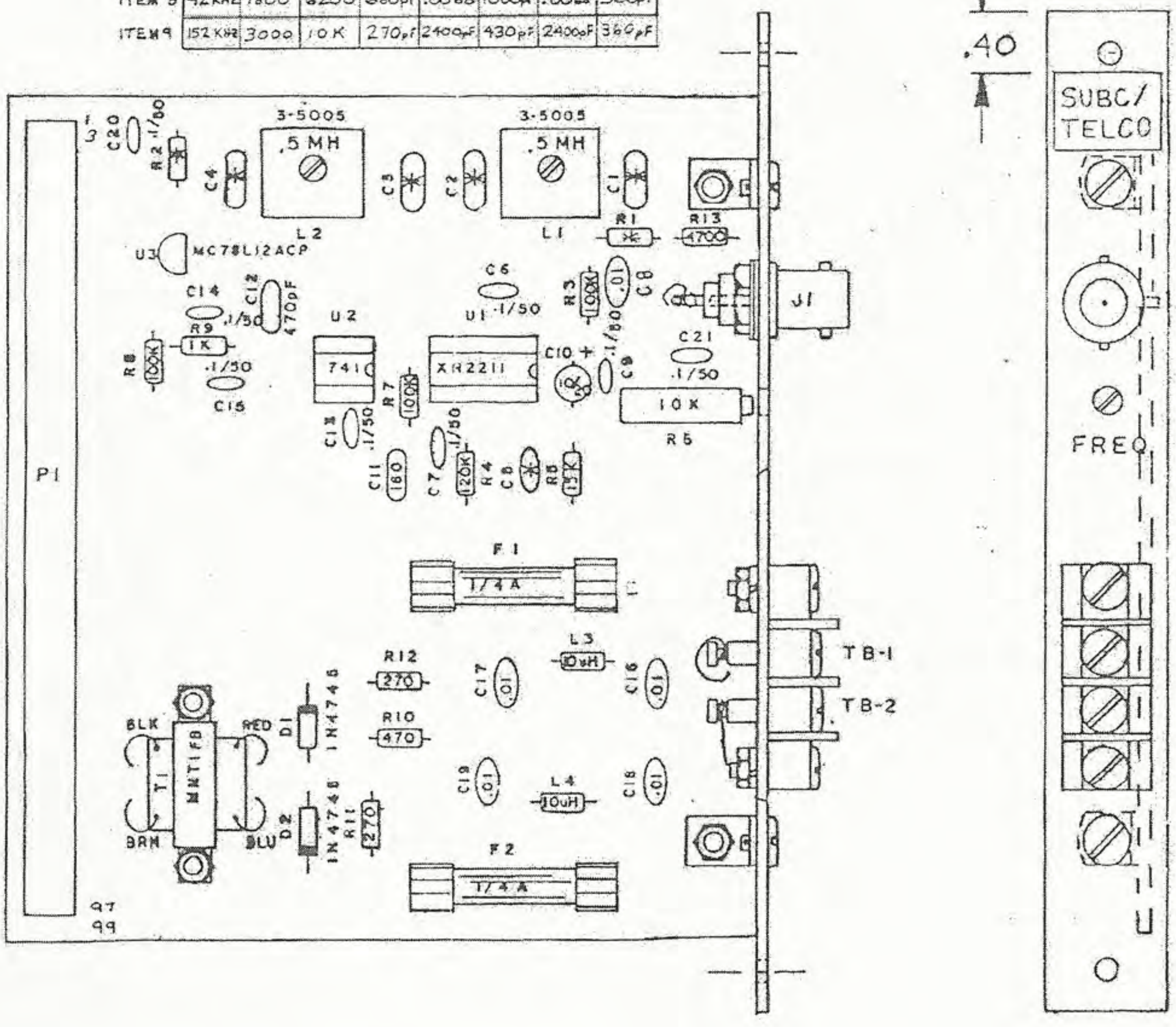
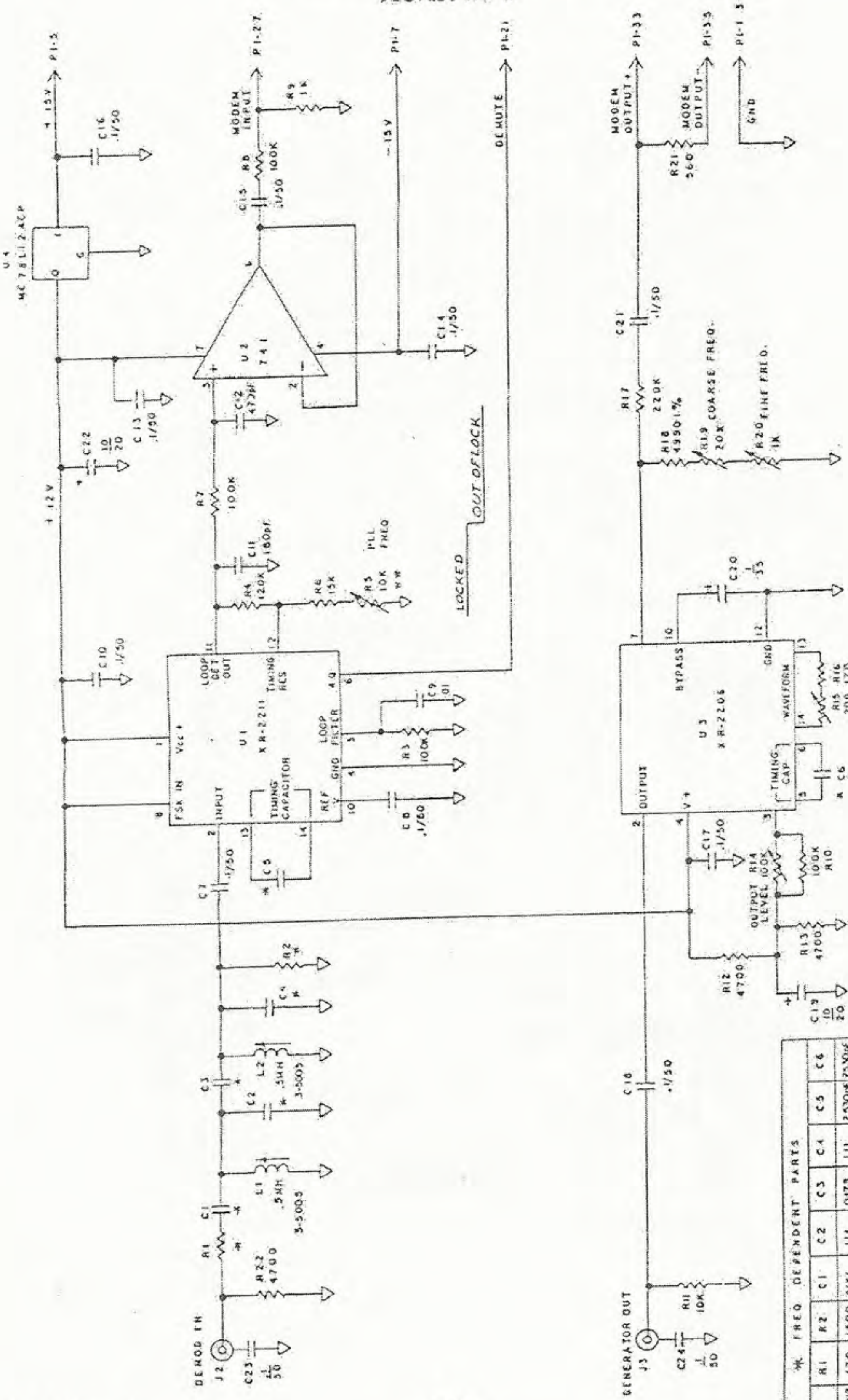
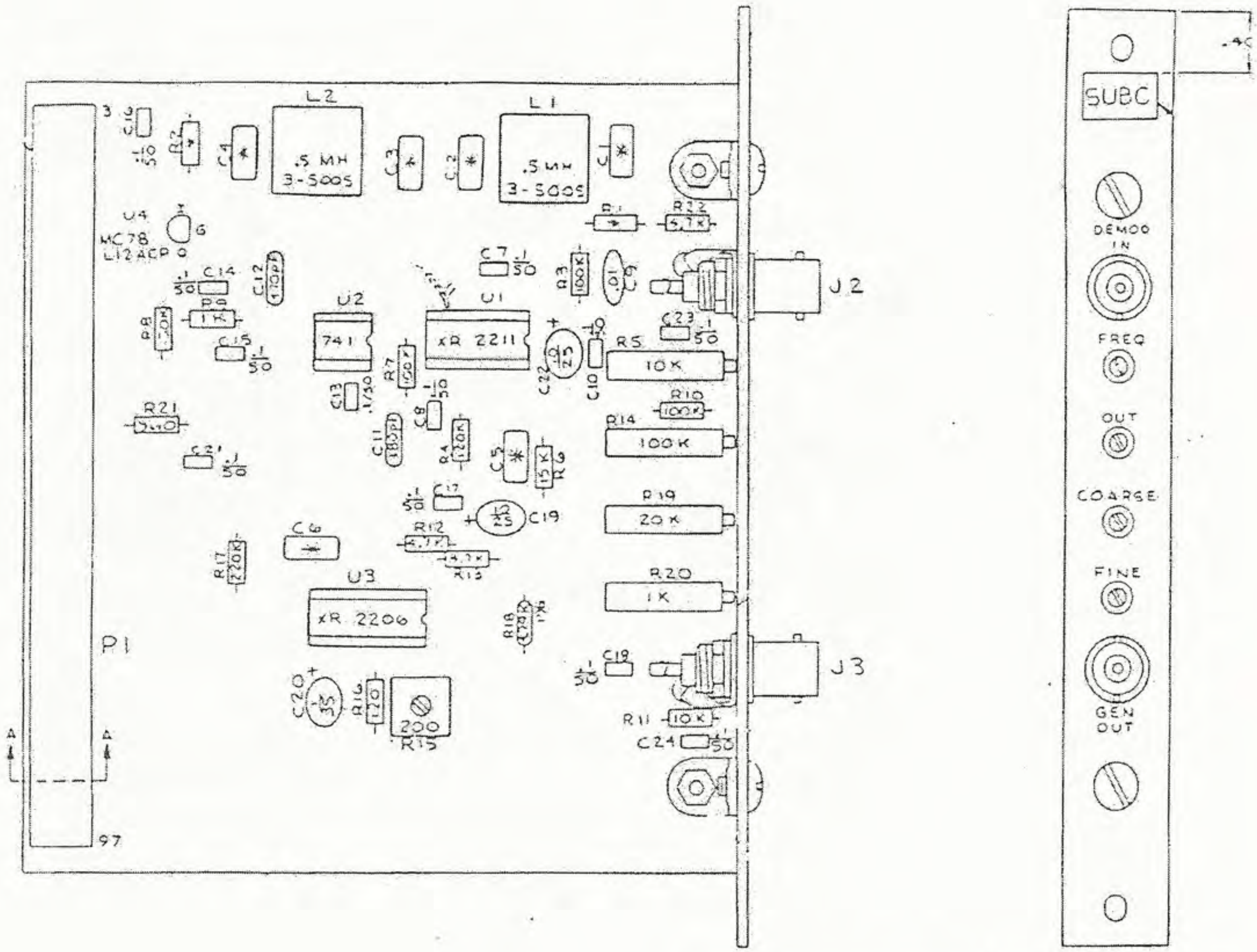


Figure A-27
Subcarrier Interface Schematic
91C7156 Rev F



* FREQ DEPENDENT PARTS	R1	R2	C1	C2	C3	C4	C5	C6
20KHZ	470	1500	.0151	.111	.0175	.111	2530pF	2530pF
26KHZ	470	1800	.008	.068	.01	.068	1930pF	1930pF
39KHZ	820	2700	3600pF	.031	4700pF	.031	1300pF	1300pF
6.7KHZ	1500	4700	1200pF	.01	.0016	.01	750pF	750pF
110KHZ	2200	6800	470pF	3600pF	620pF	3600pF	470pF	560pF
105KHZ	3600	15K	180pF	1500pF	250pF	1500pF	300pF	470pF
92KHZ	1800	6200	680pF	.0068	1000pF	.0068	520pF	520pF
152	[illegible]00	10K	230pF	2400pF	430pF	2400pF	360pF	[illegible]0pF

Figure A-28
Subcarrier Interface Assembly
20B2719 Rev L



FREQUENCY DEPENDENT PARTS: *								
INPUT								OUTPUT
FREQ	R1	R2	C1	C2	C3	C4	C5	C6
20 KHZ	470	1.5 K	.0131	.111	.0175	.111	2530pF	2530pF
26 KHZ	470	1.8 K	.008	.068	.01	.068	1930pF	1930pF
39 KHZ	820	2.7K	3600pF	.031	4700pF	.031pF	1300pF	1300pF
67 KHZ	1.5 K	4.7K	1200pF	.01	.0016	.01	750pF	750pF
110 KHZ	2.2K	6.8K	470pF	3600pF	620pF	3600pF	470pF	560pF
185 KHZ	3.6K	15 K	180 pF	1500pF	250pF	1500pF	300pF	470pF
92 KHZ	1.8 K	6.2K	680pF	.0068	1000pF	.0068	560pF	560pF
152 KHZ	3 K	10 K	270pF	2400pF	430pF	2400pF	360pF	510pF

Figure A-29
Serial I/O Schematic
91D7243 Rev B

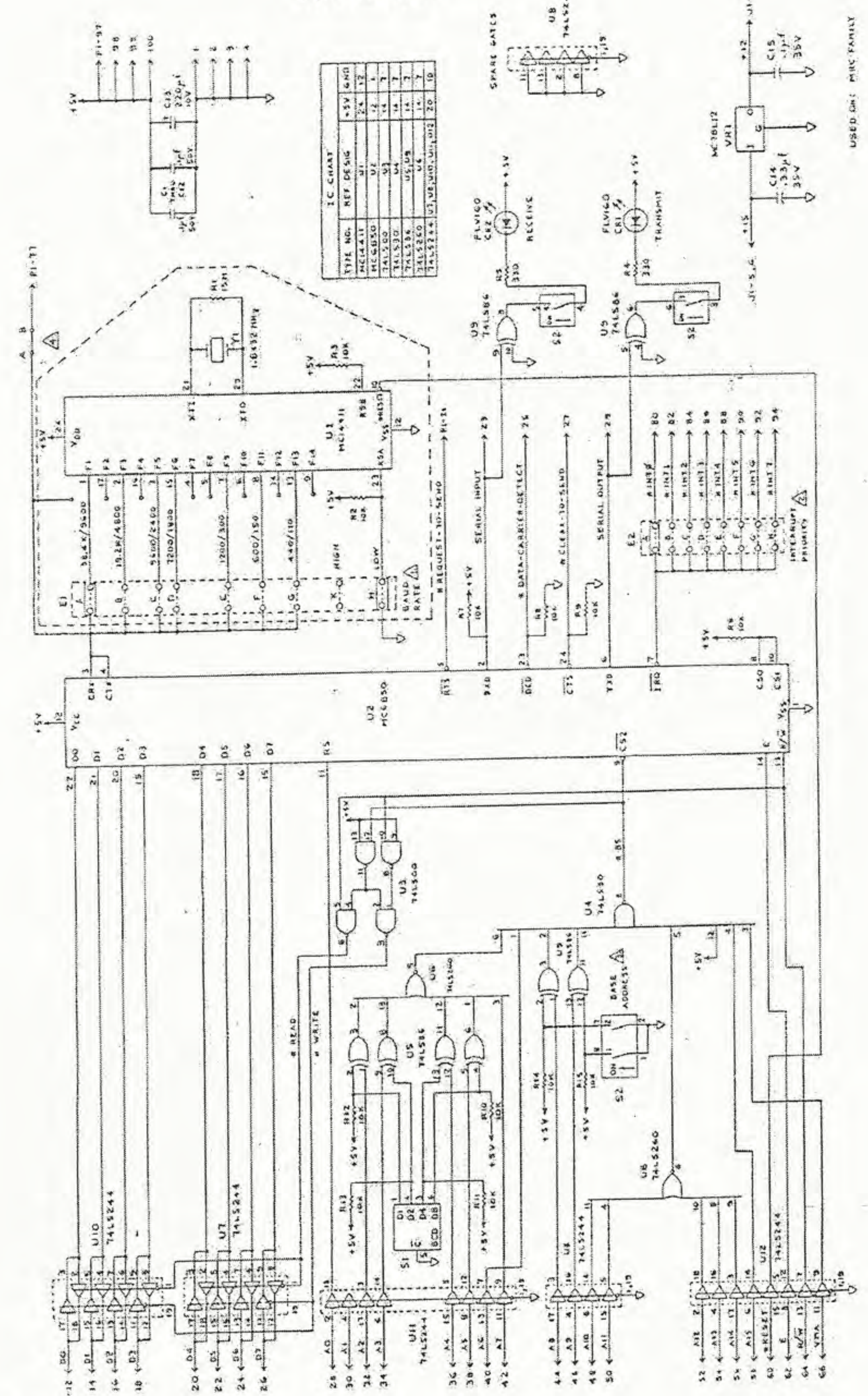


Figure A-30
Serial I/O Assembly
20D2800 Rev C

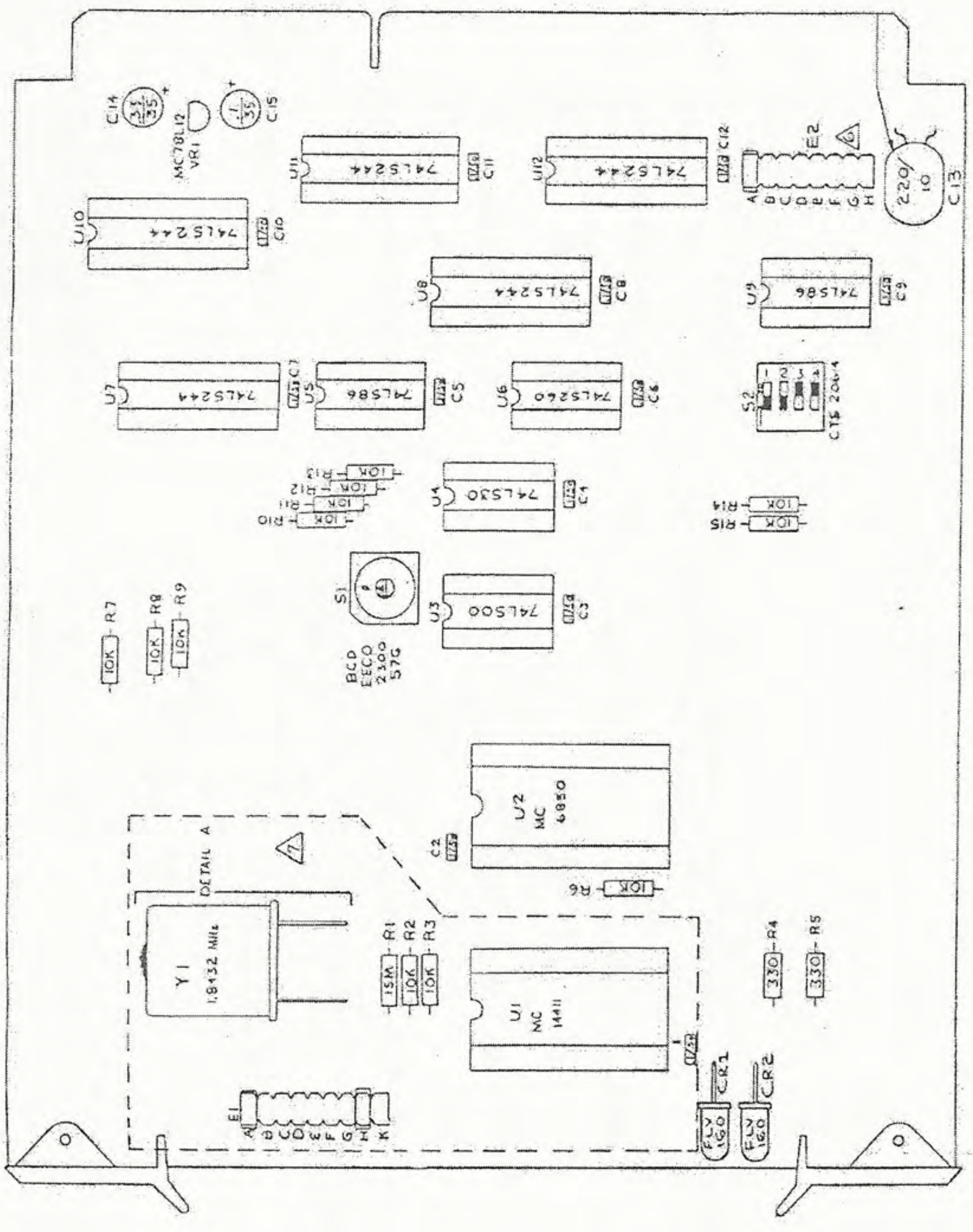


Figure A-31
Serial Interface Schematic
91C7249 Rev C

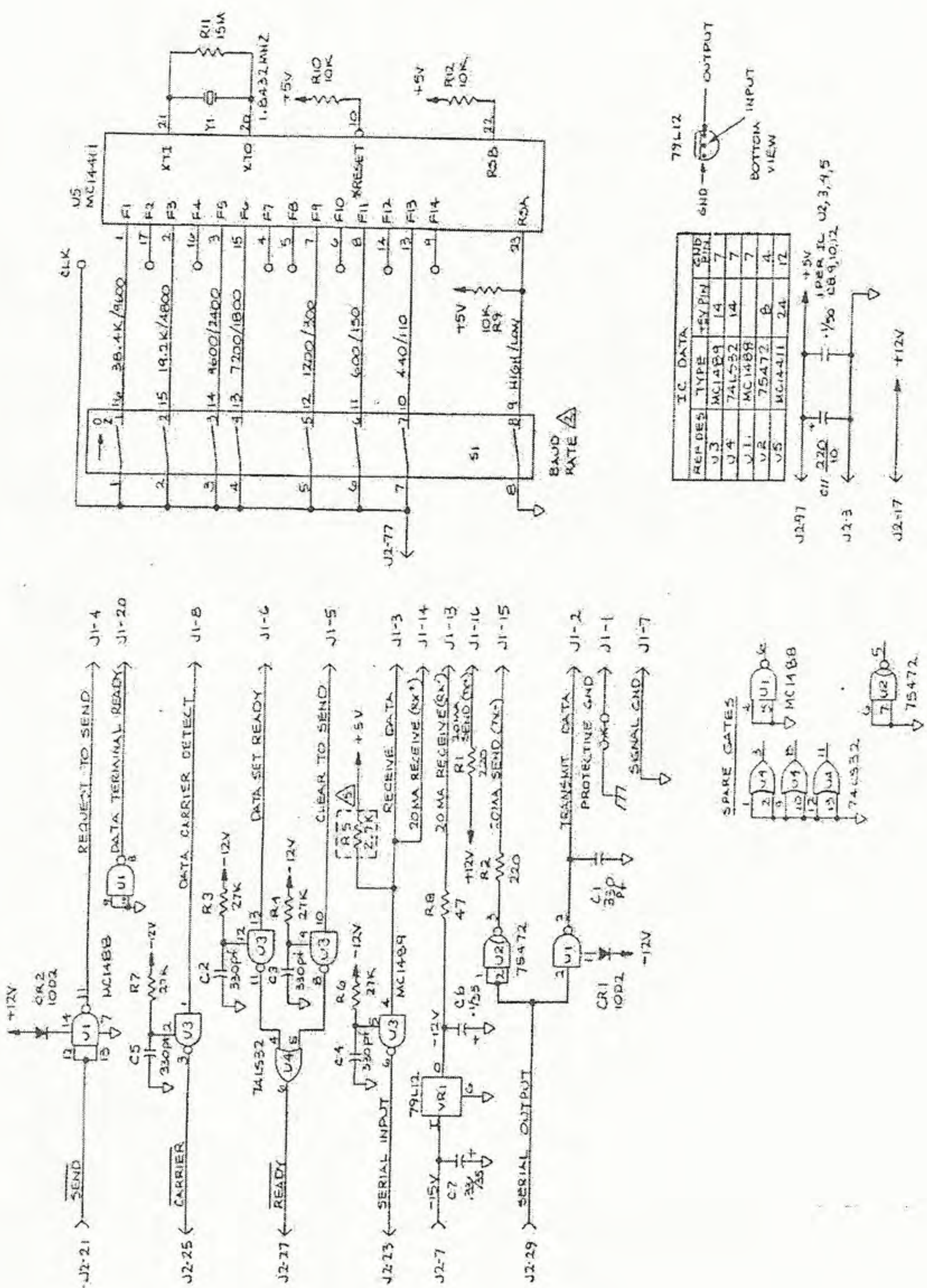


Figure A-32
Serial Interface Assembly
20C2803 Rev D

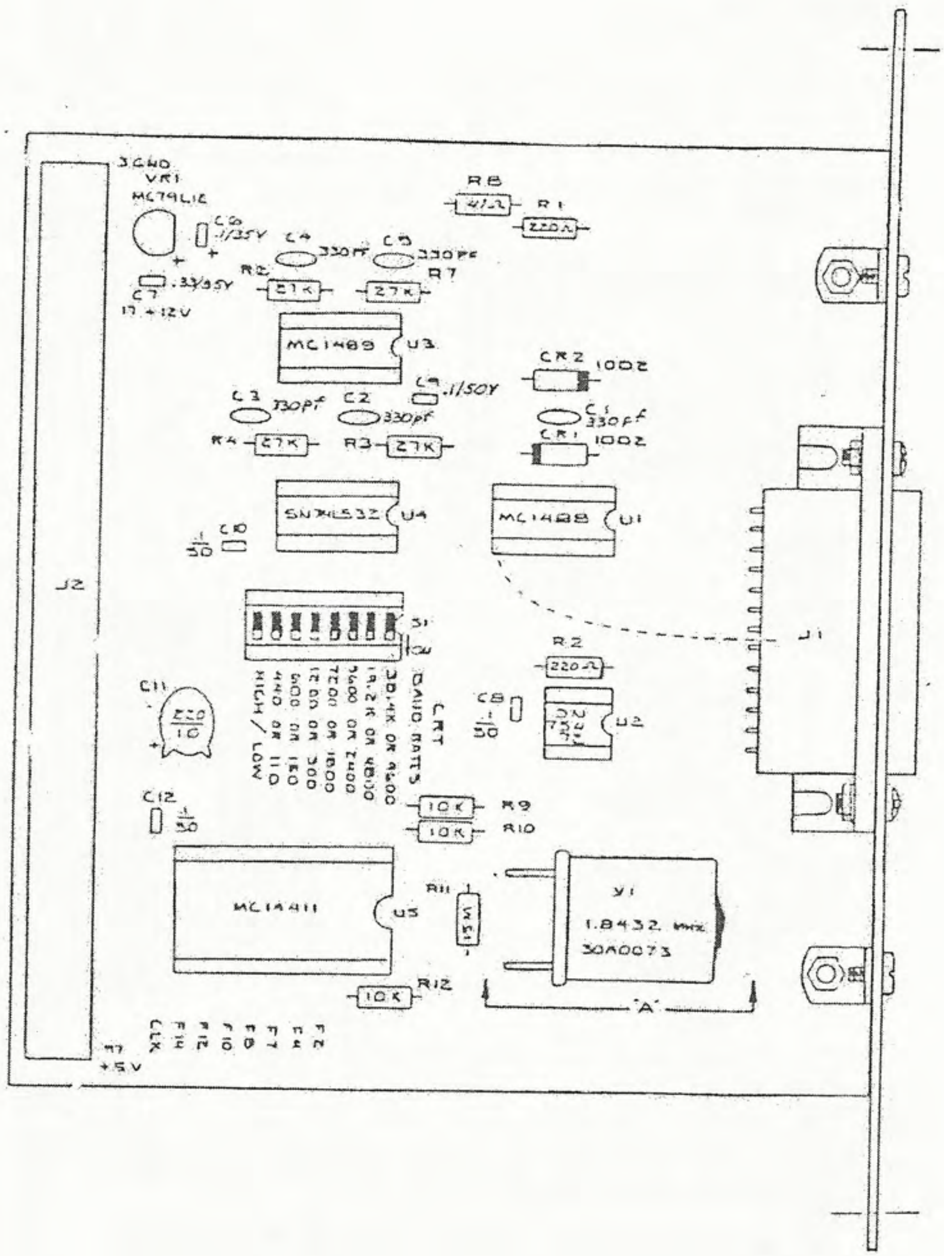


Figure A-33
Analog Input III Schematic
91D7343 Rev B

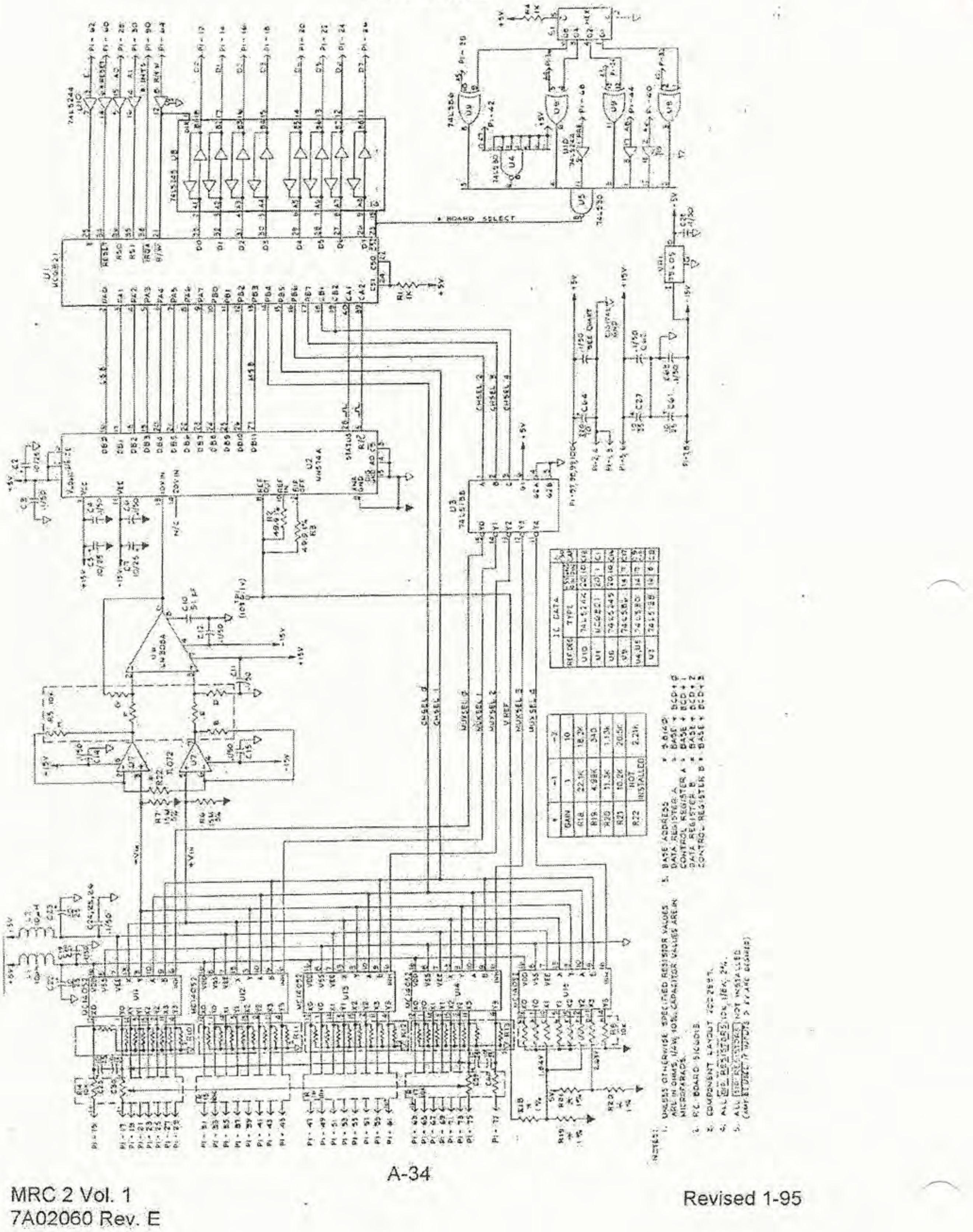


Figure A-34
Analog Input III Assembly
20D2897 Rev C

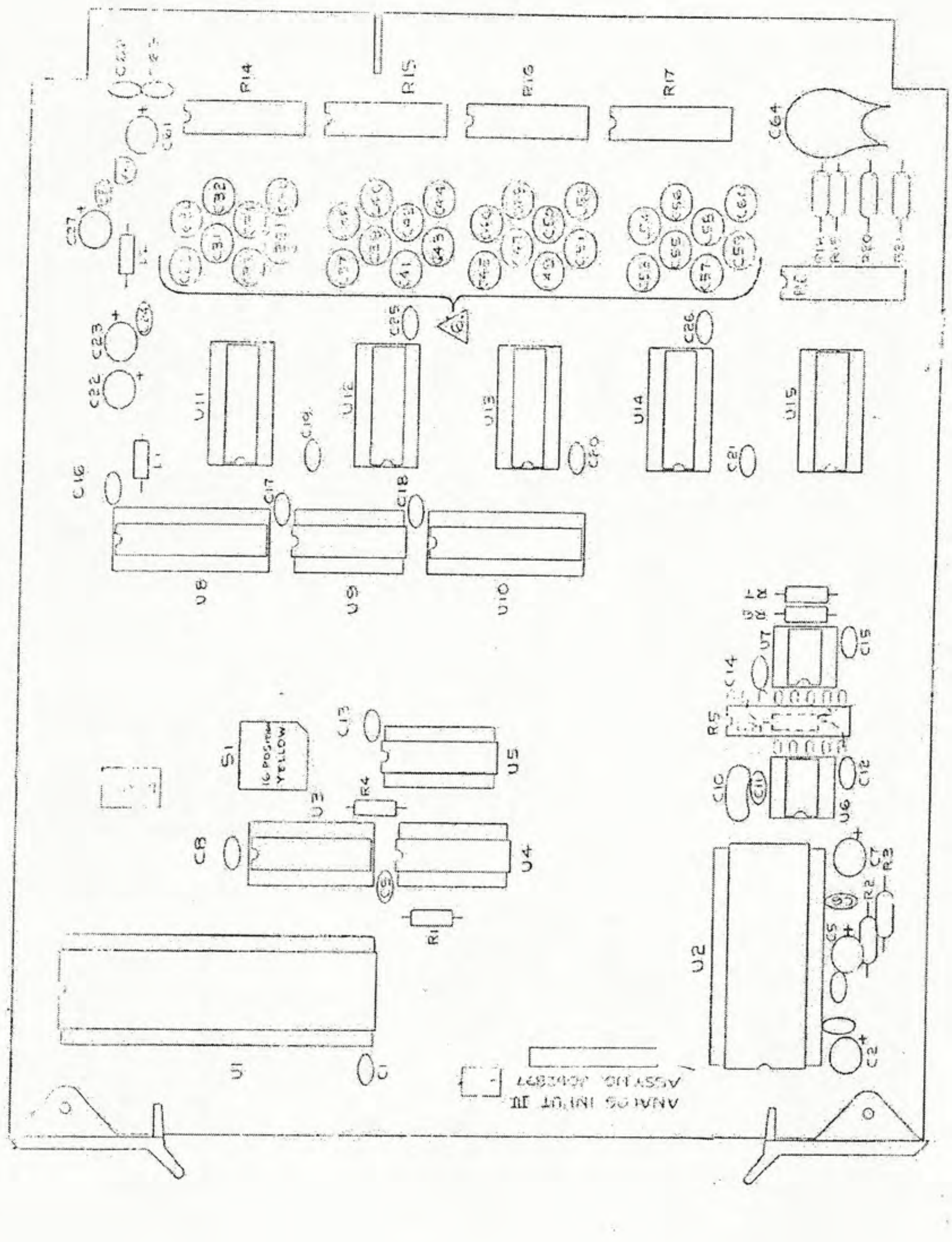
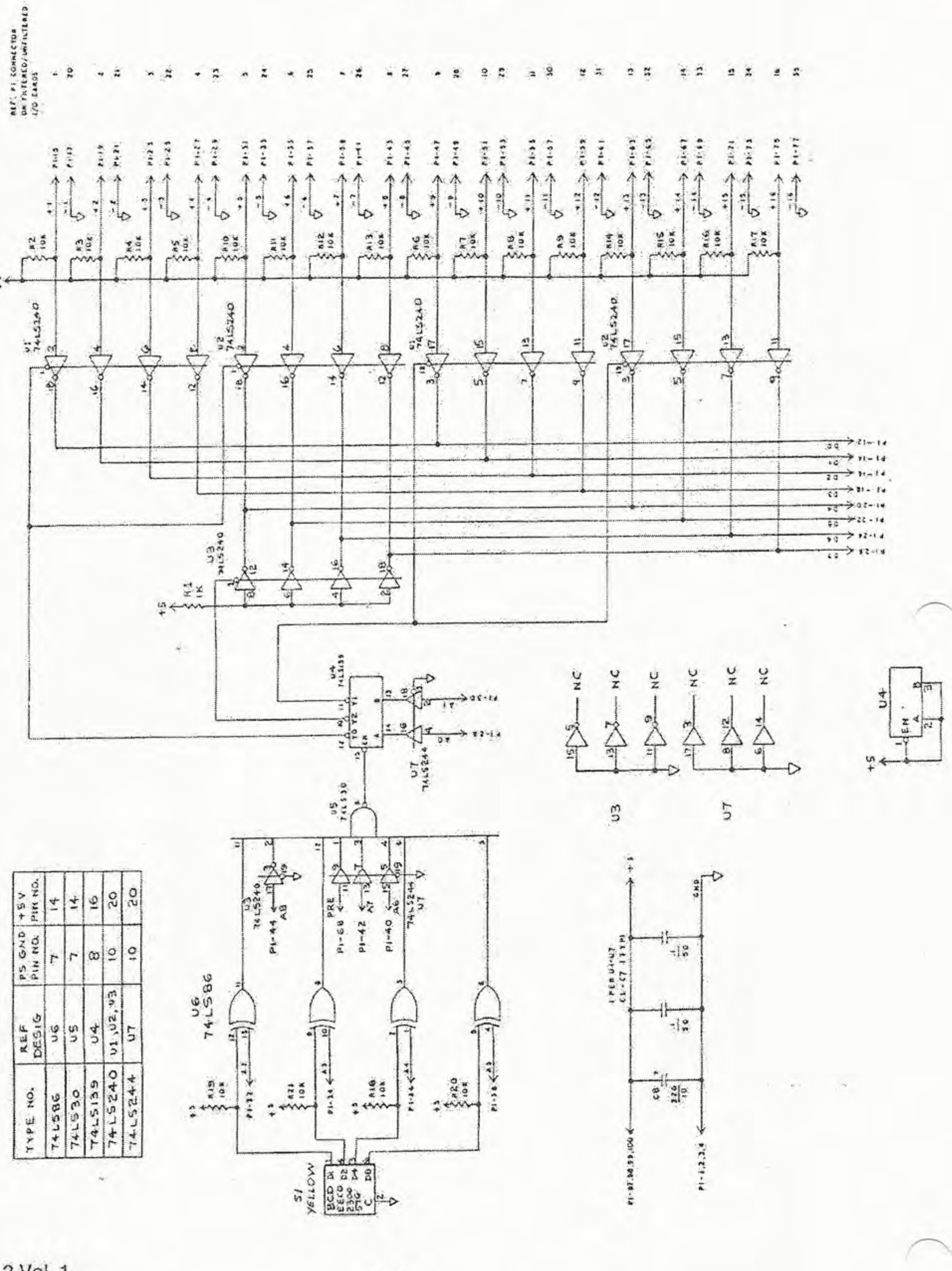


Figure A-35
Status Input, TTL II Schematic
91C7237 Rev C



TYPE NO.	REF DESIG	PS GND PIN NO.	+5V PIN NO.
74LS86	U6	7	14
74LS30	U5	7	14
74LS139	U4	8	16
74LS240	U1, U2, U3	10	20
74LS244	U7	10	20

Figure A-36
Status Input, TTL II Assembly
20D2798 Rev B

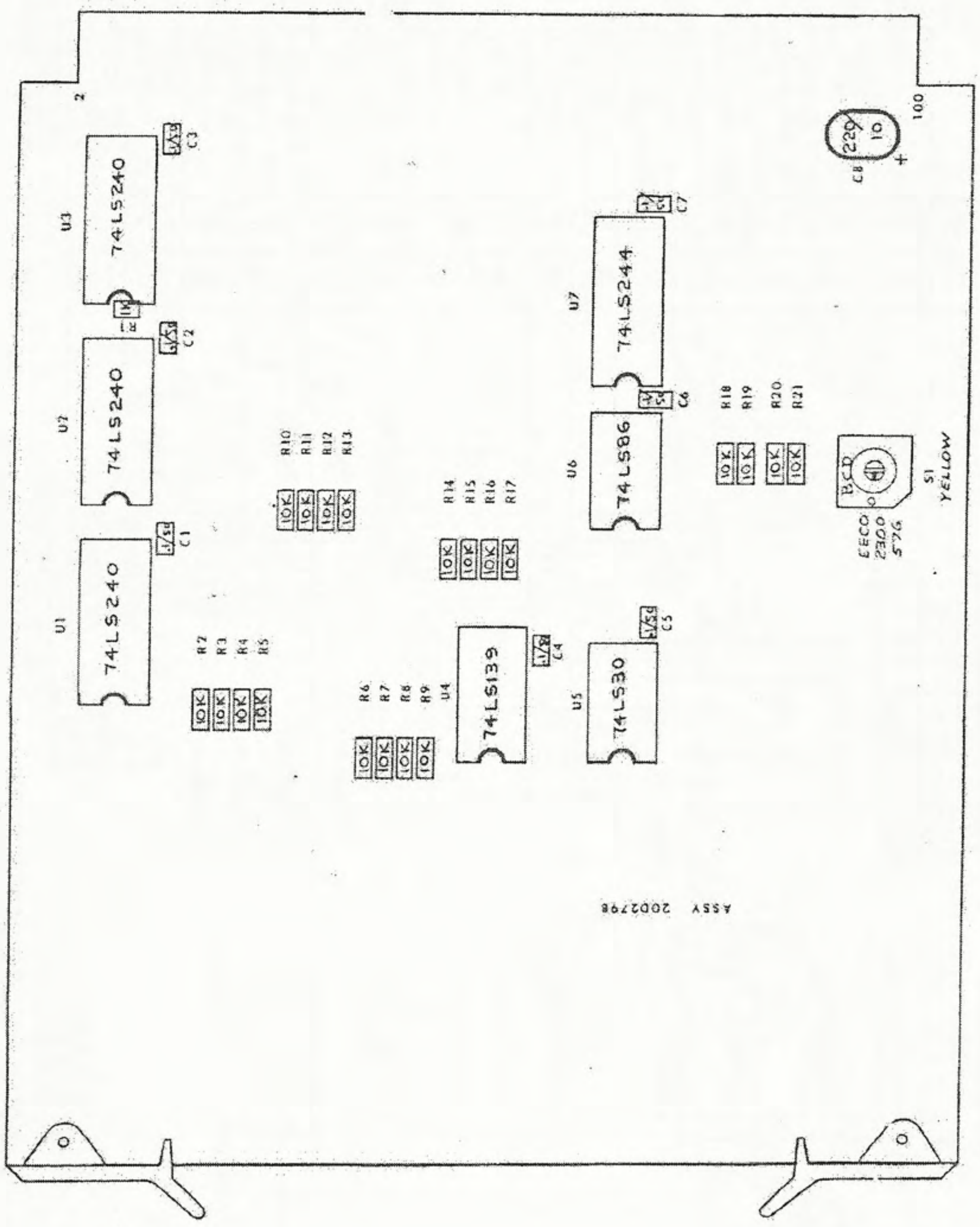
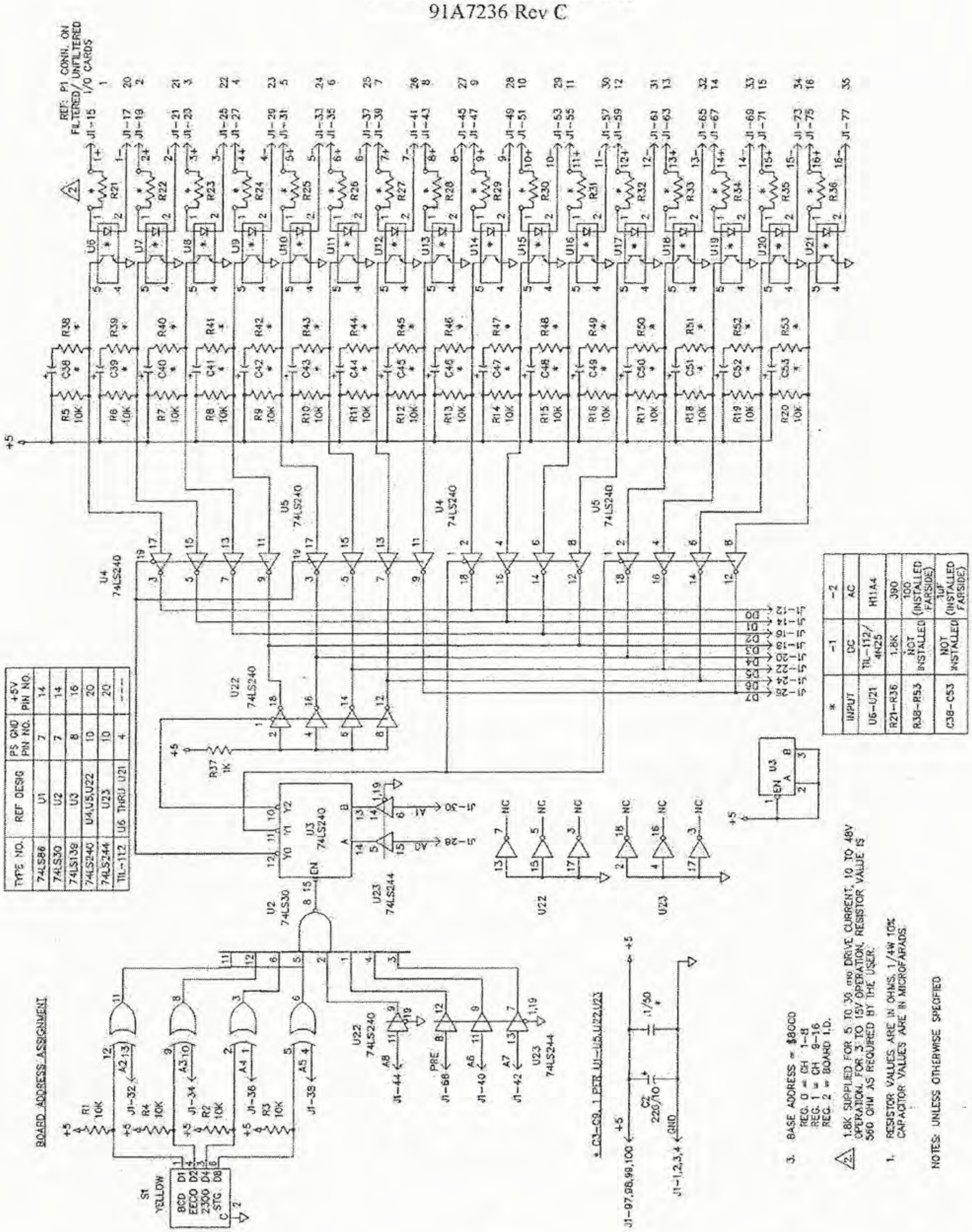


Figure A-37
Status Input, Opto II Schematic
91A7236 Rev C



STEAM POWERED RADIO.COM

Figure A-38
Status Input, Opto II Assembly
20D2795 Rev C

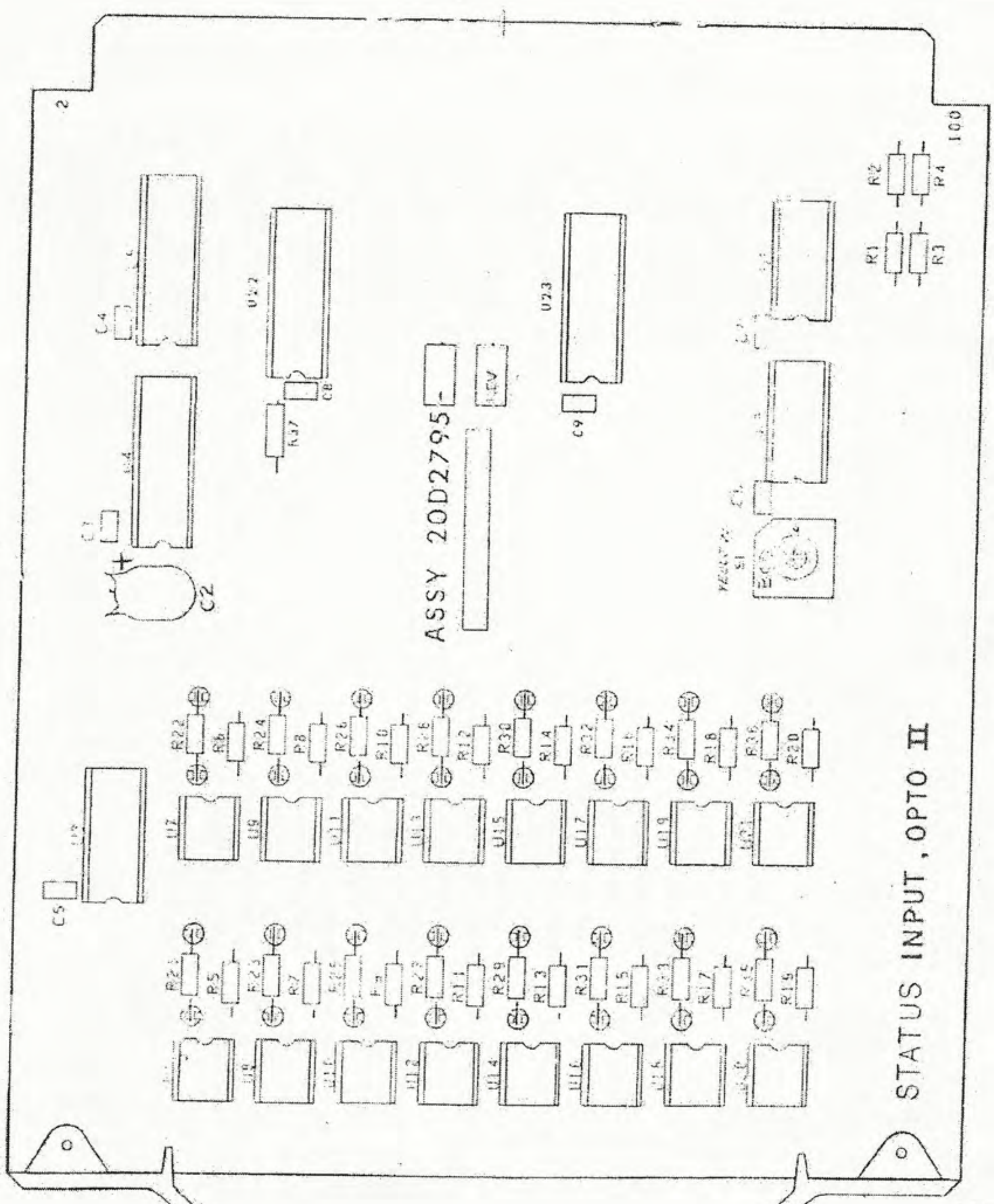


Figure A-39
Open Collector Command
Output Schematic
91C7171 Rev A0

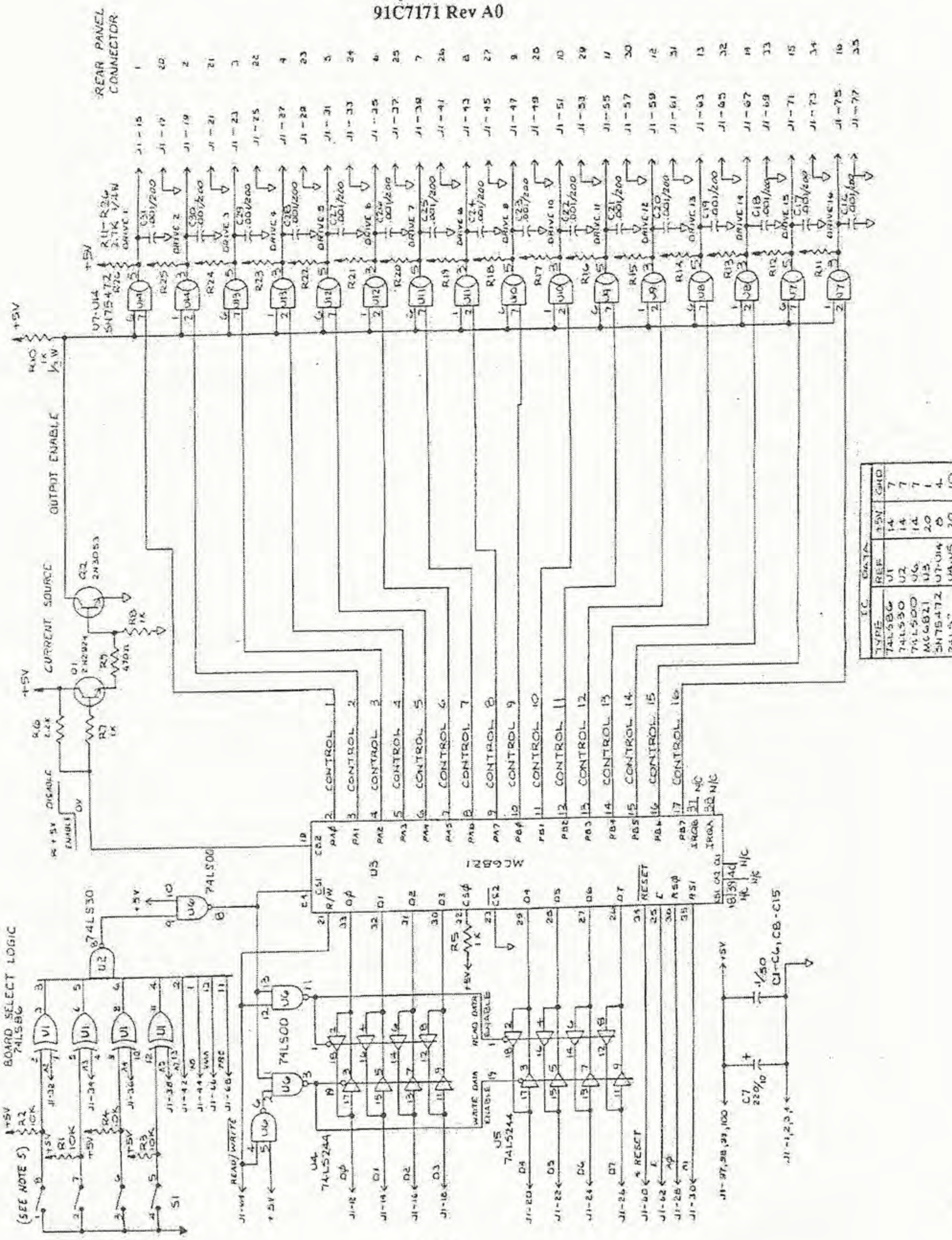


Figure A-40
Open Collector Command
Output Assembly
20C2755 Rev D

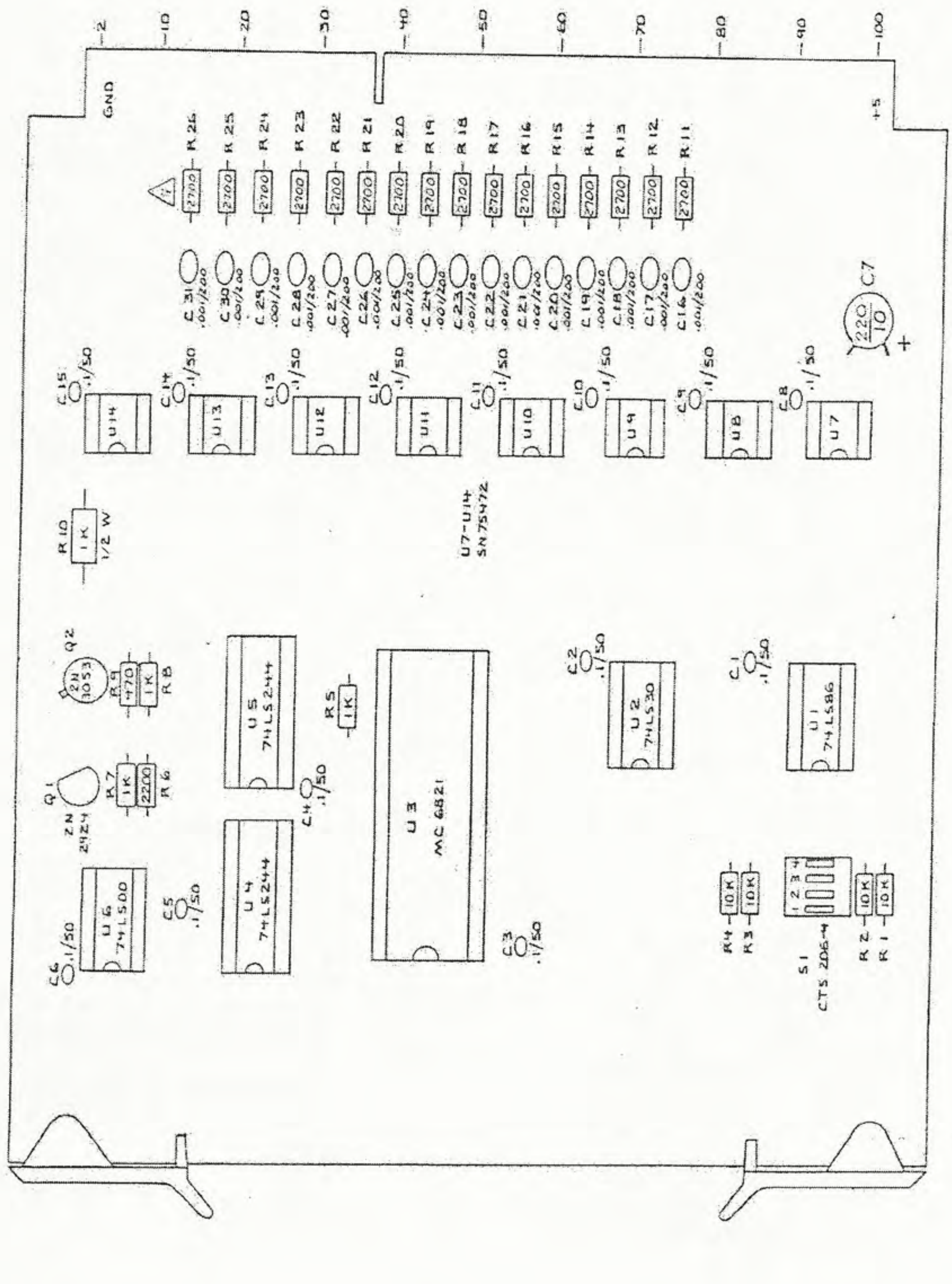


Figure A-41
Optically Isolated Command Output Schematic
91D7129 Rev D0

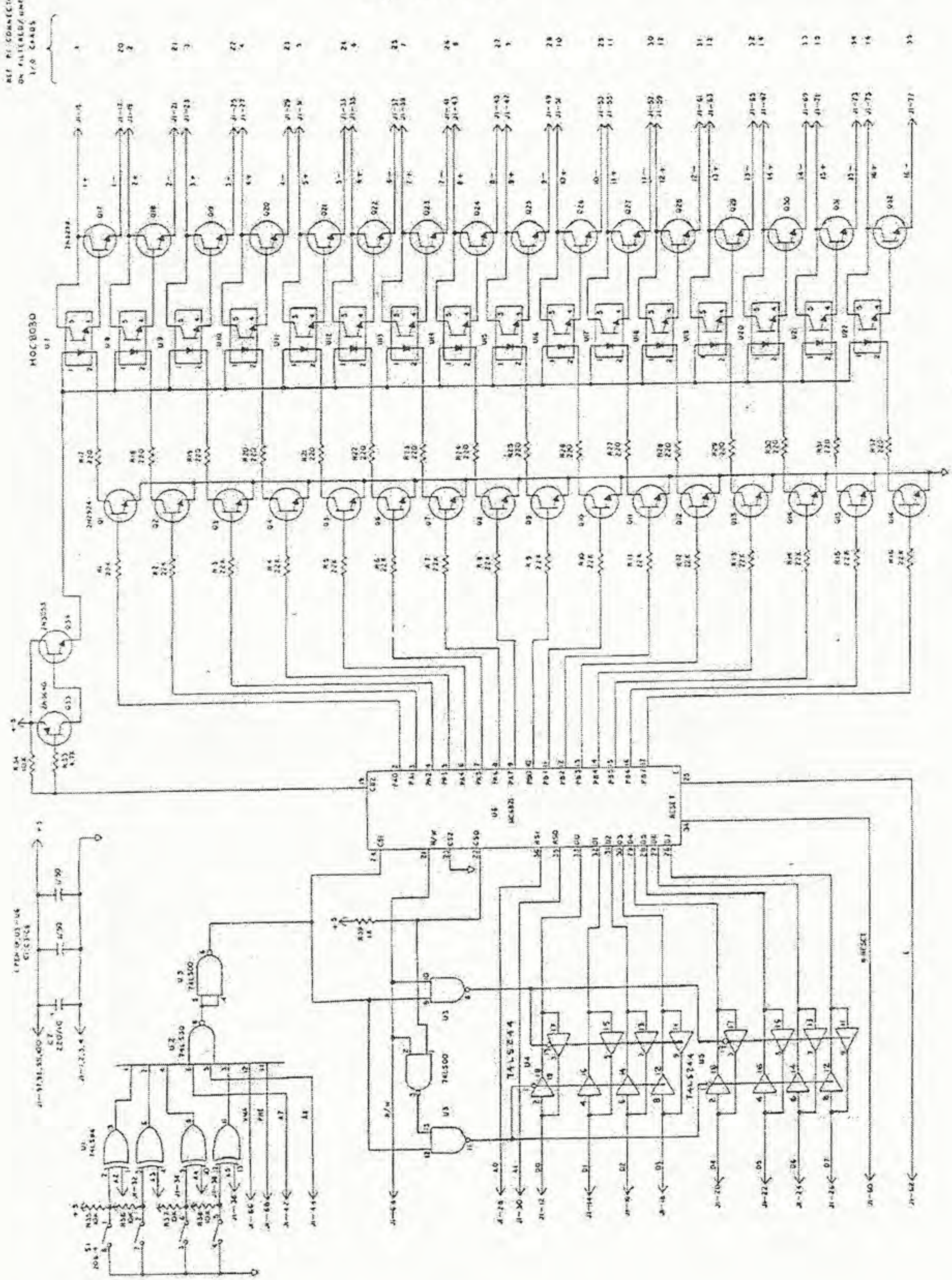


Figure A-42
Optically Isolated Command
Output Assembly
20C2705

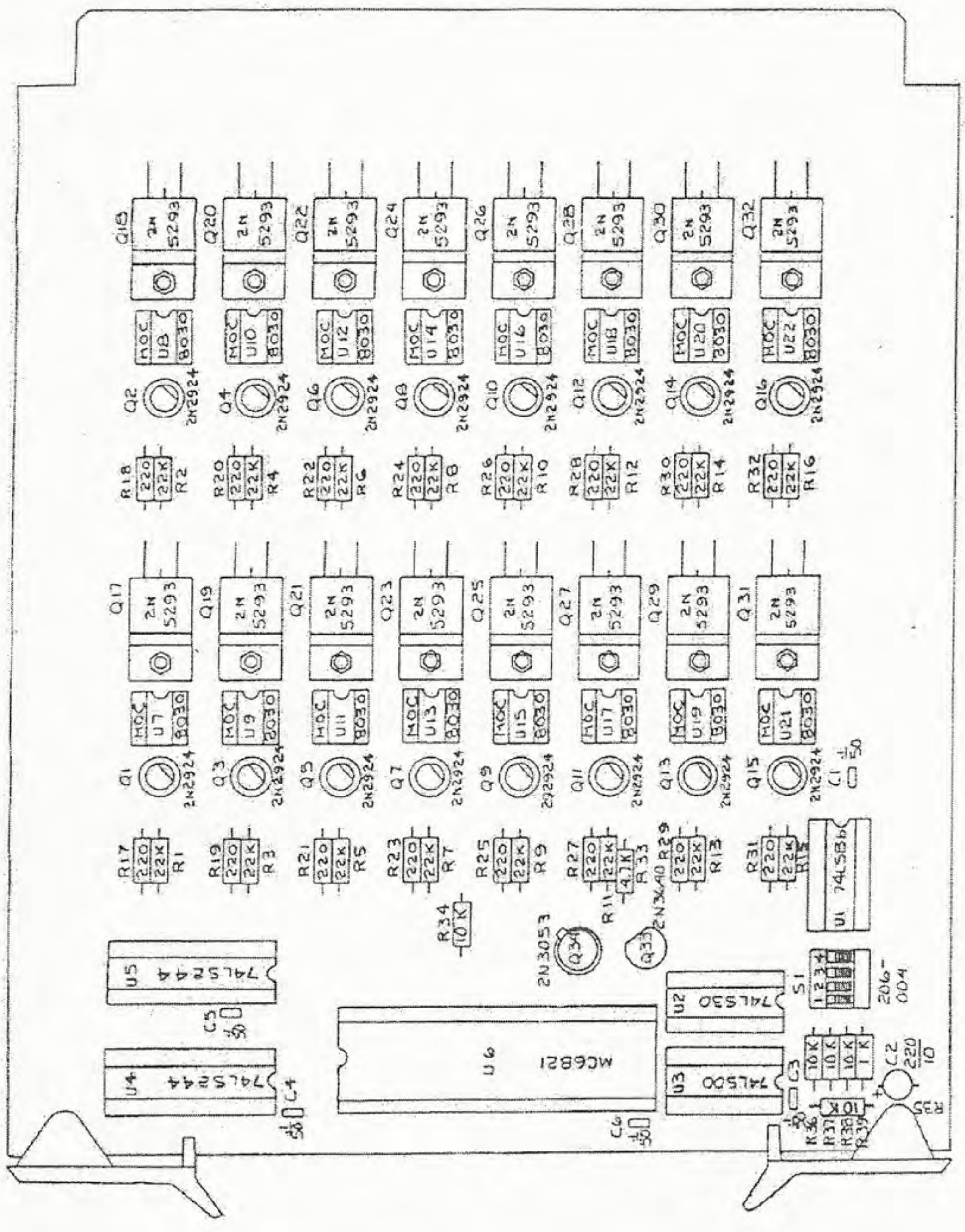


Figure A-43
Parallel Input Schematic
91D7272 Rev C

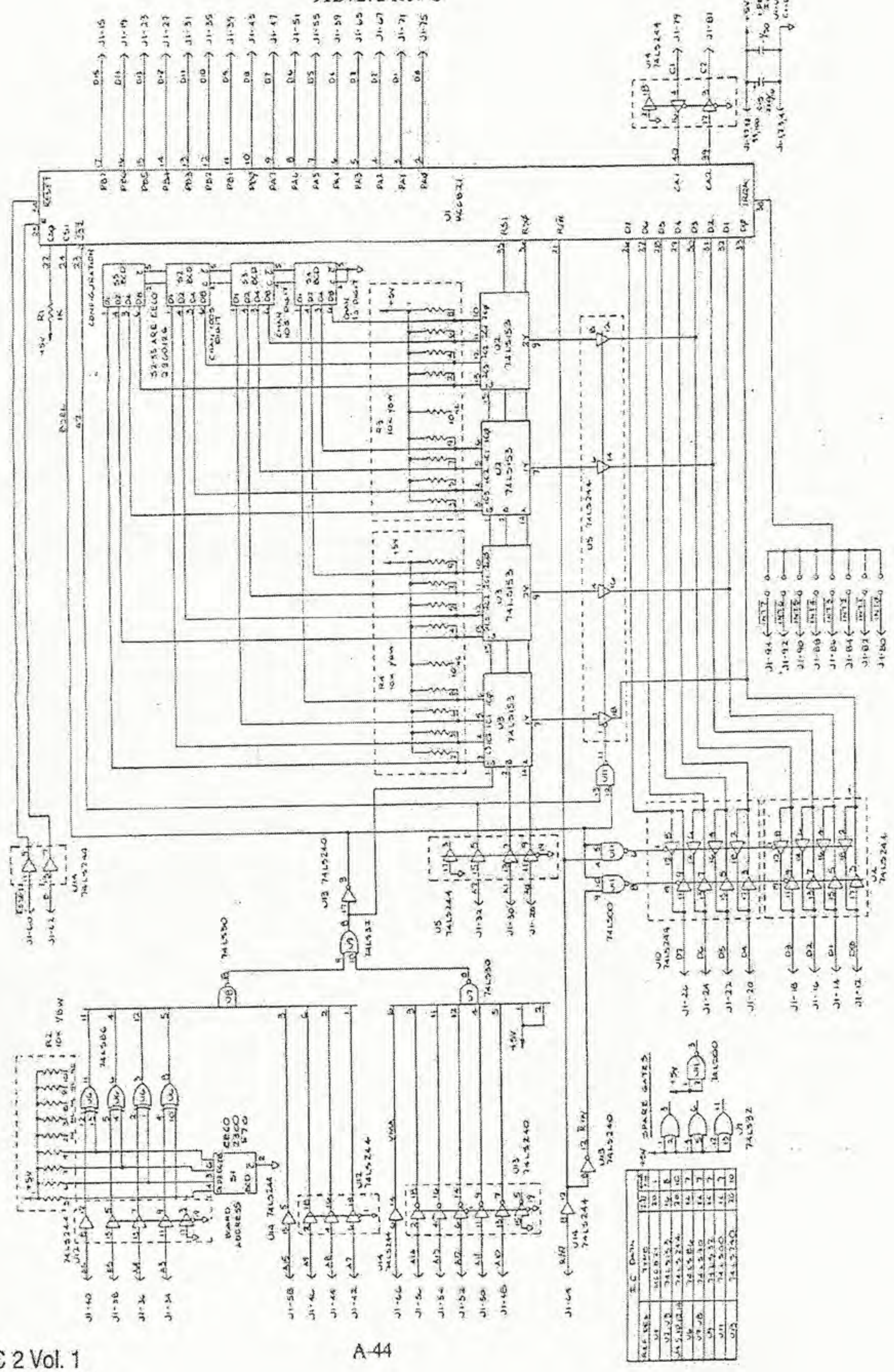


Figure A-44
Parallel Input Assembly
20D2822 Rev BO

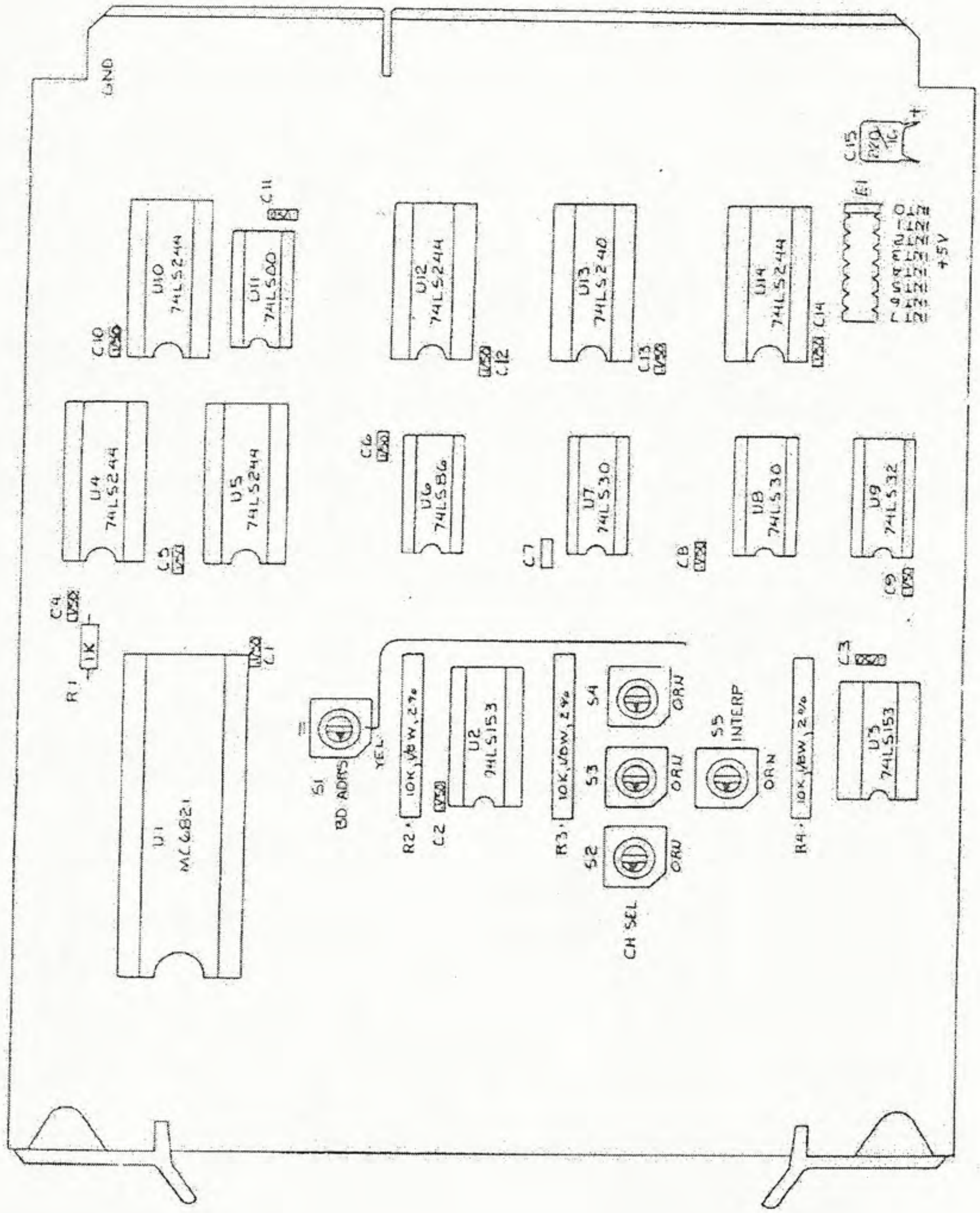


Figure A-45
Delay Control Schematic
91D7244 Rev E

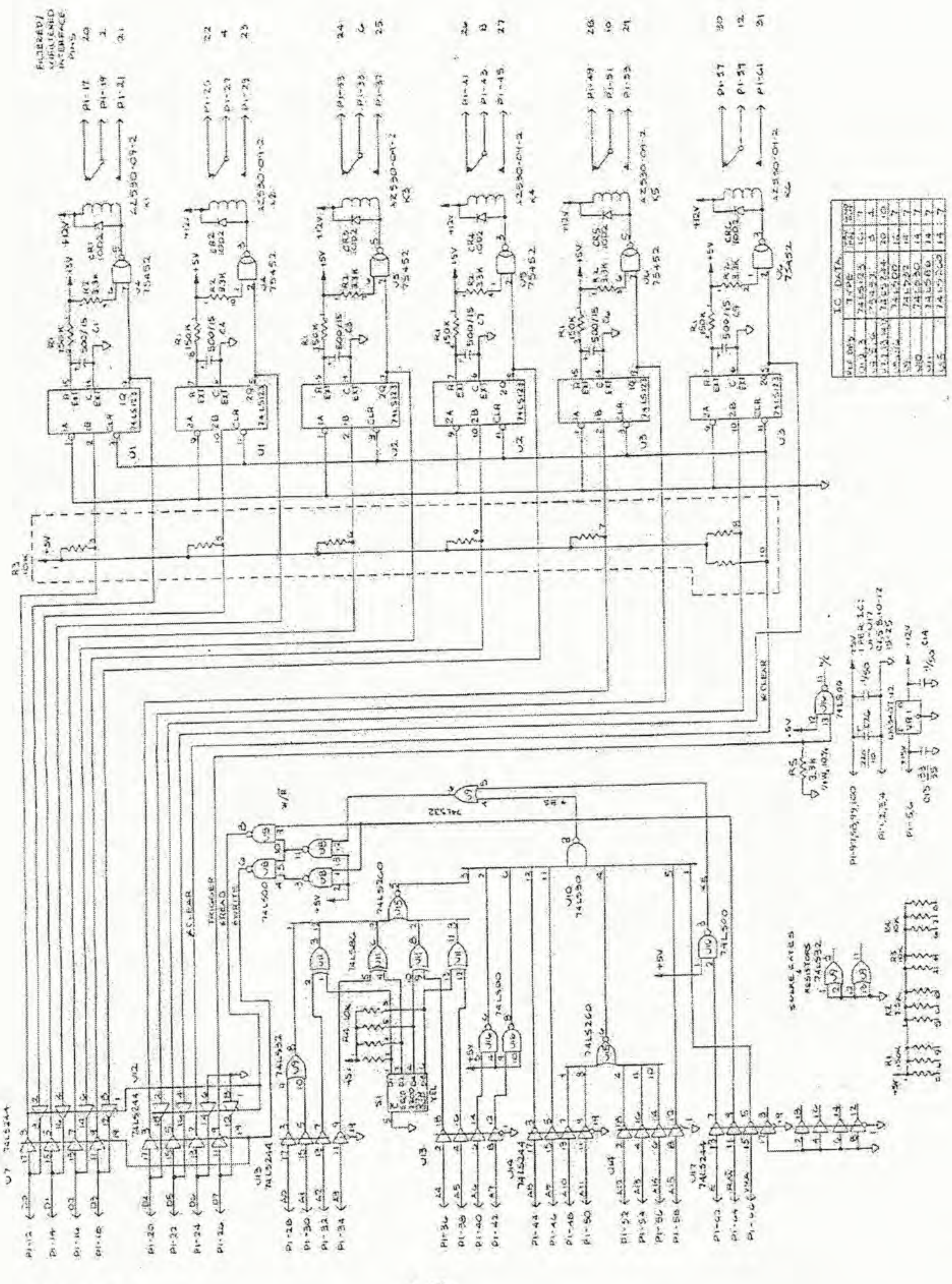


Figure A-46
Delay Control Assembly
20D2801 Rev C0

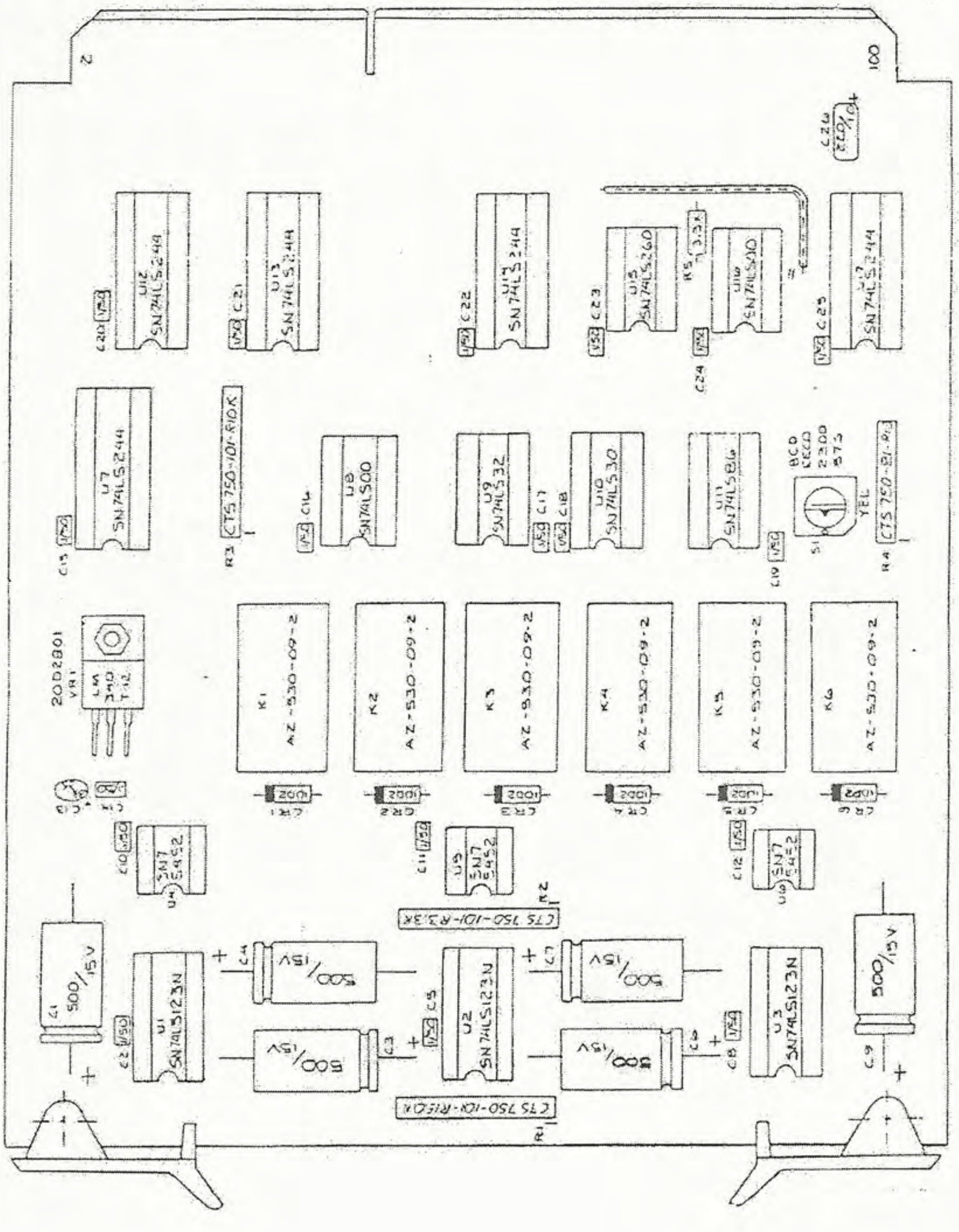


Figure A-47
Diode-Filtered Interface II
Schematic
91A7273 Rev B

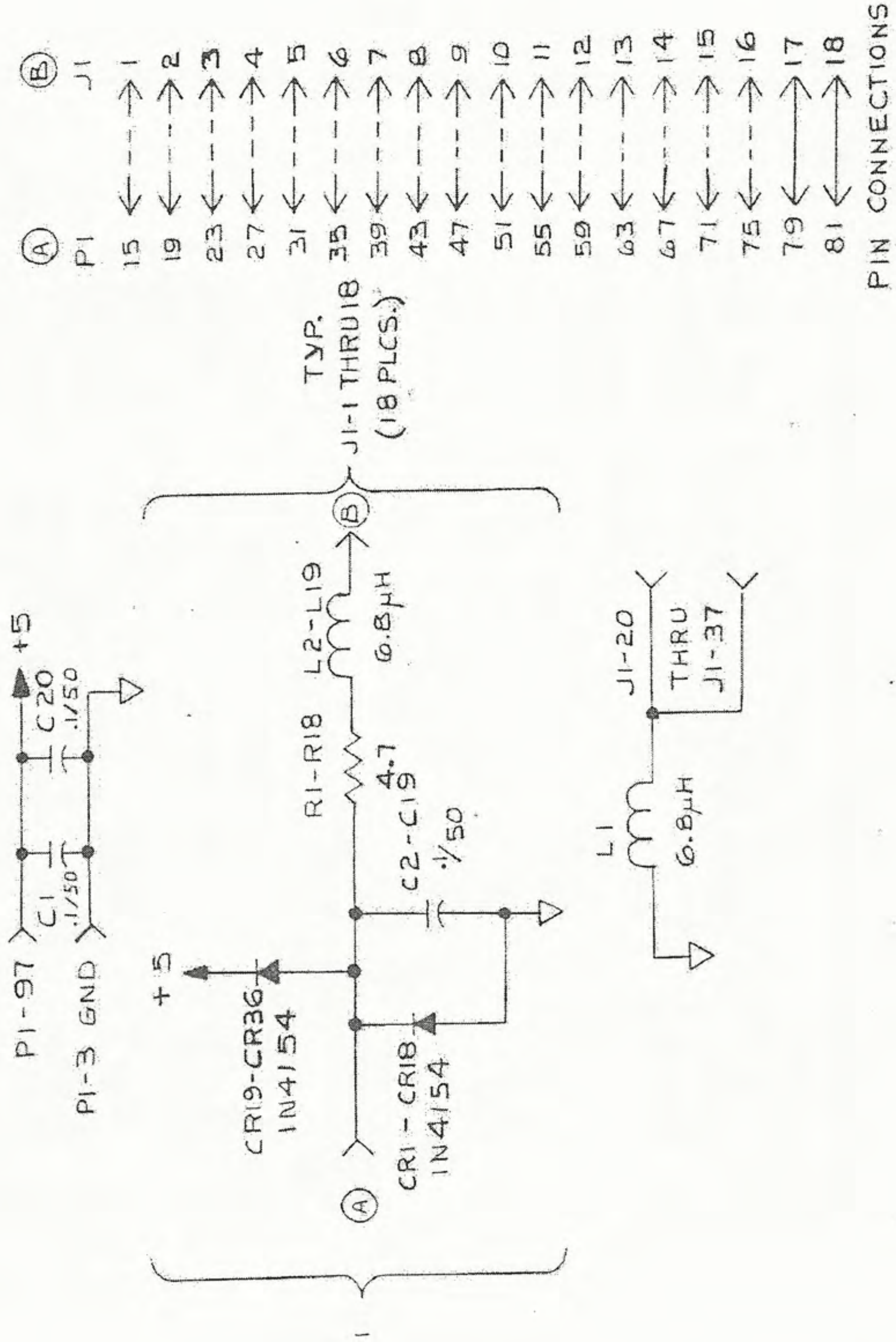
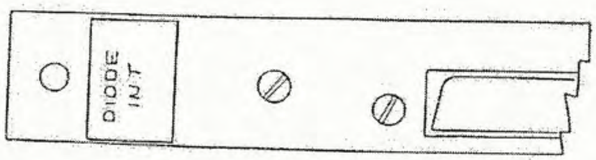


Figure A-48
Diode-Filtered Interface II
Assembly
20C2823 Rev C



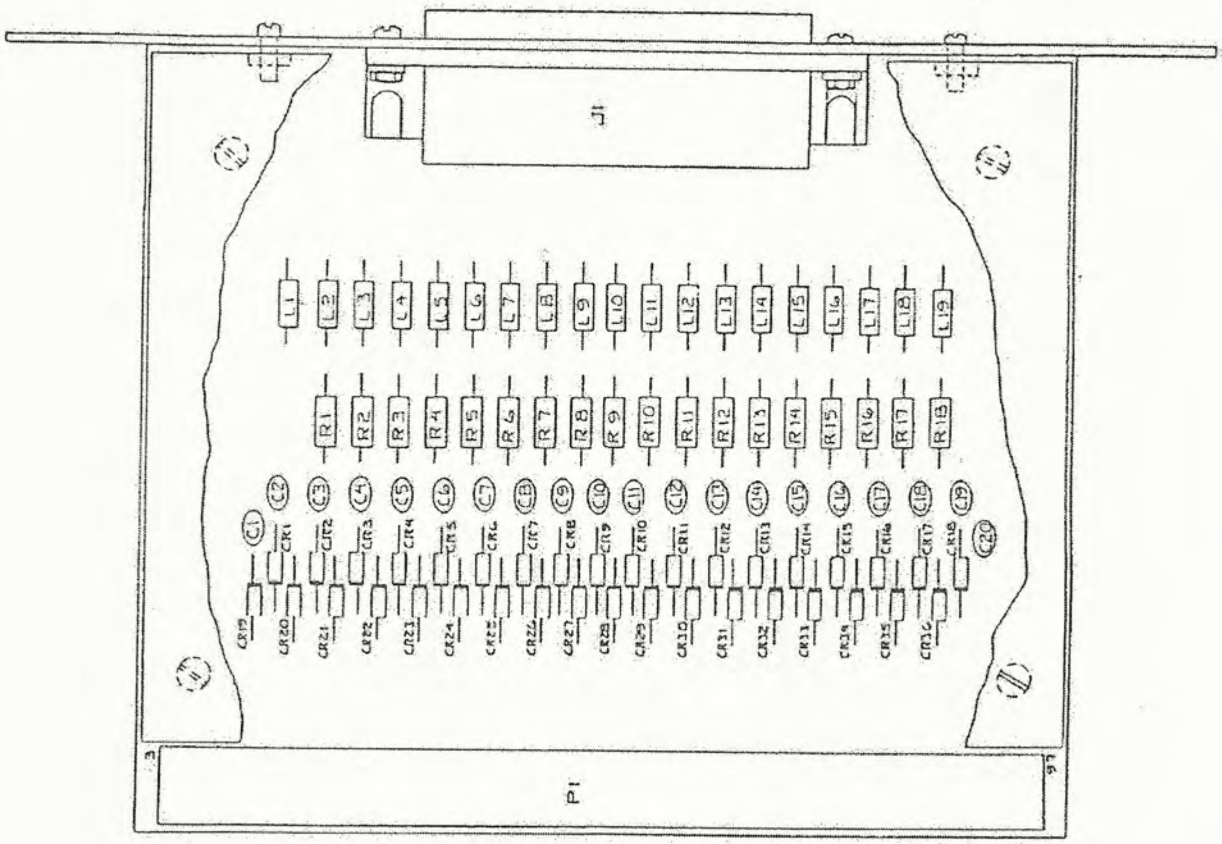


Figure A-49
Filtered Interface Schematic
91A7119 Rev A

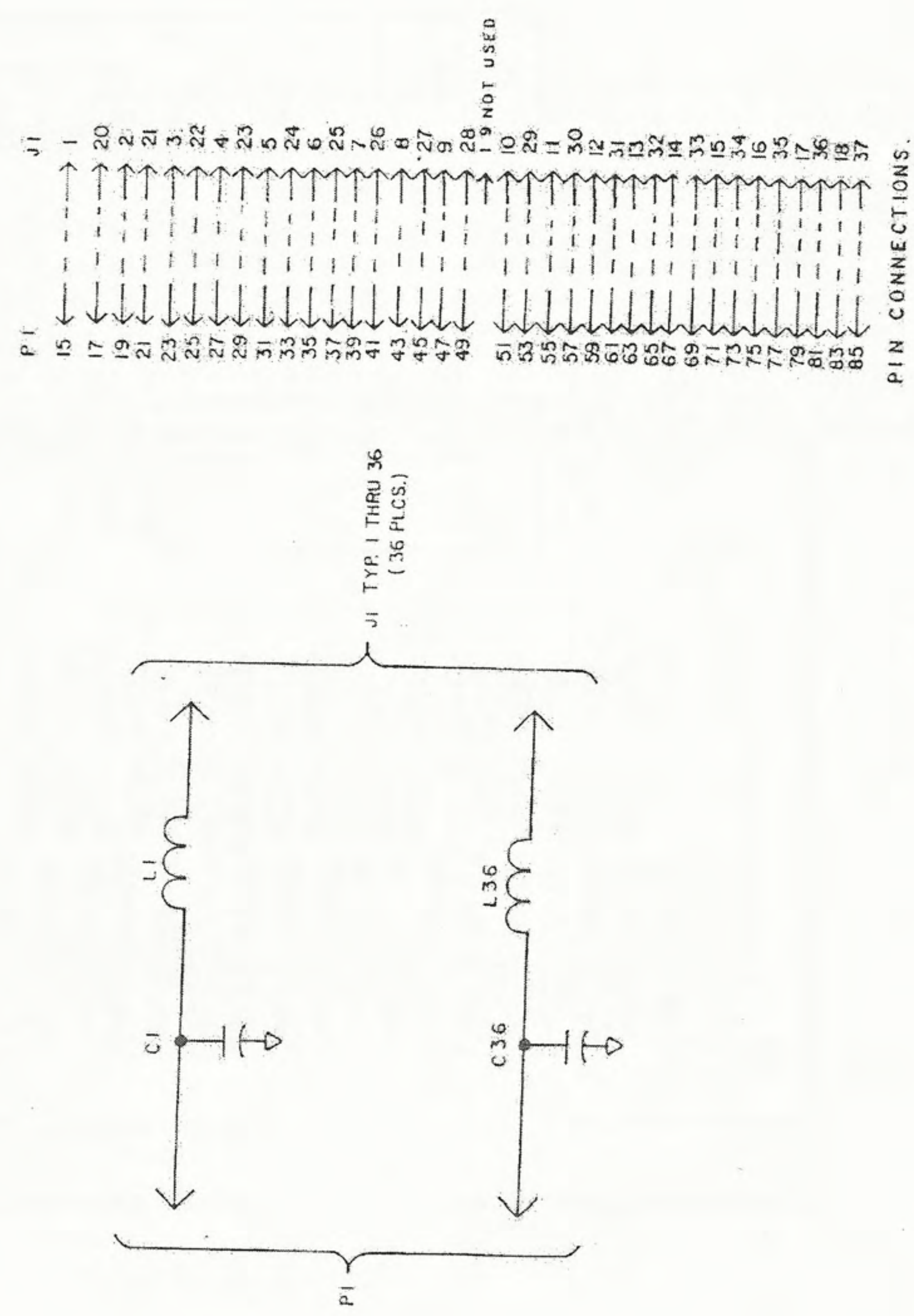
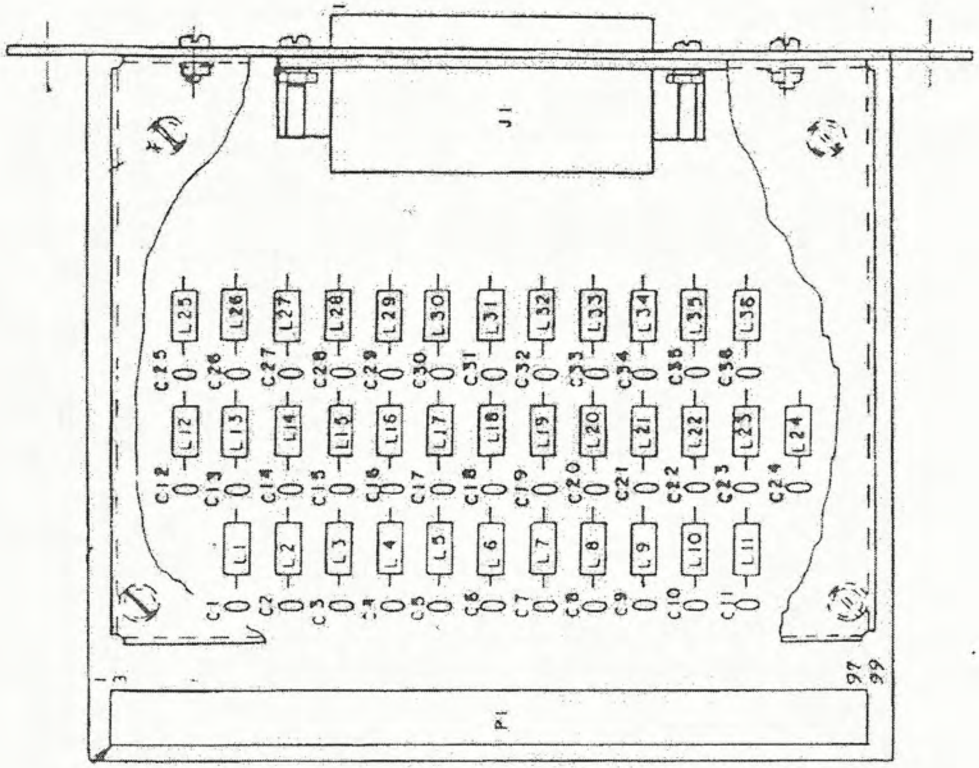


Figure A-50
Filtered Interface Assembly
20B2718 Rev E



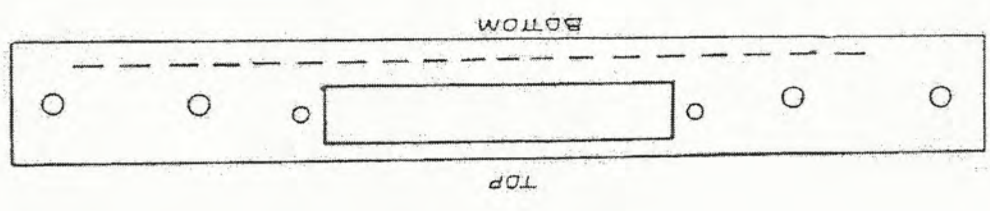


Figure A-51
DC Power Supply Schematic
91D7179 Rev D

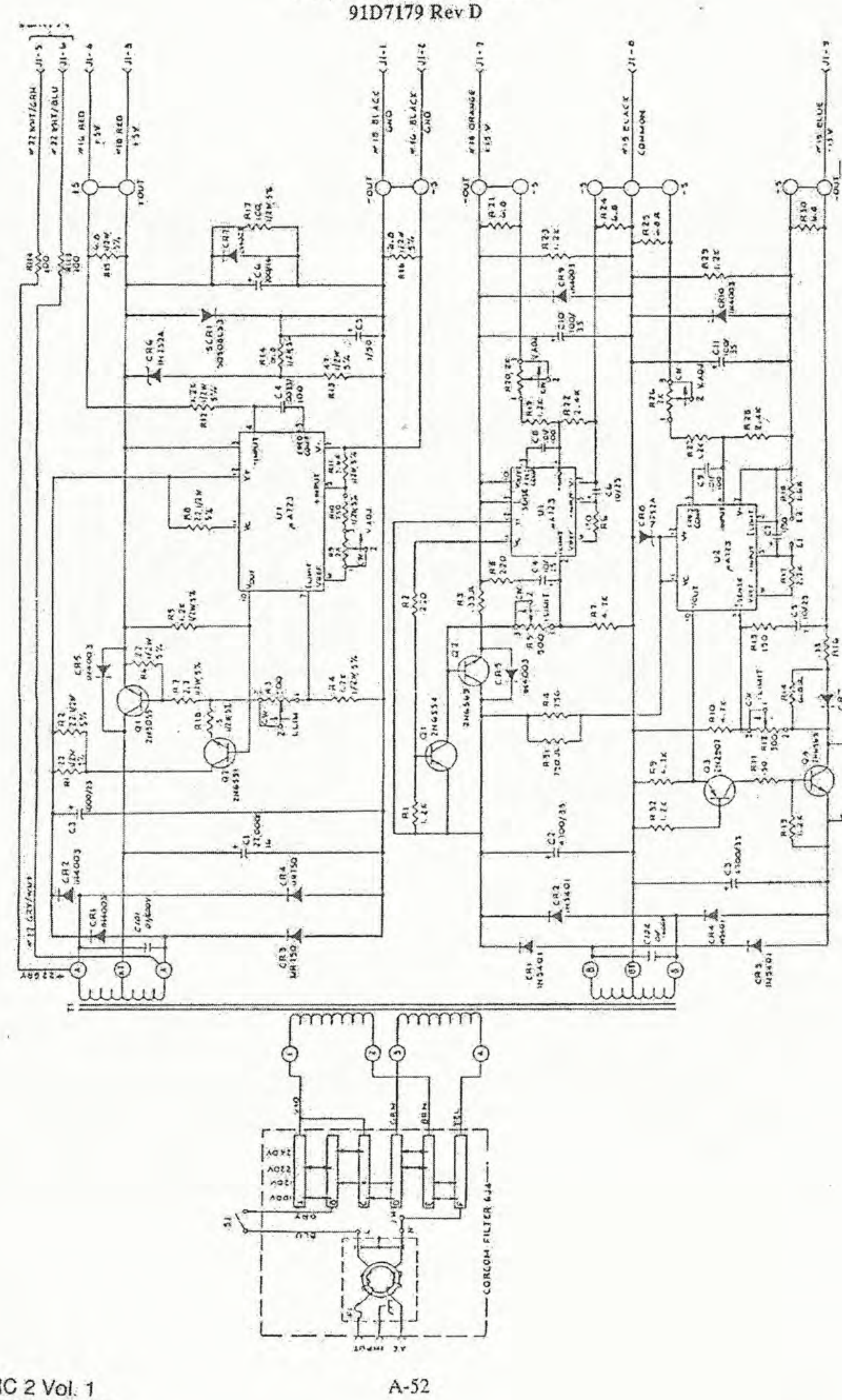


Figure A-52
DC Power Supply Assembly
21D2655 Rev E

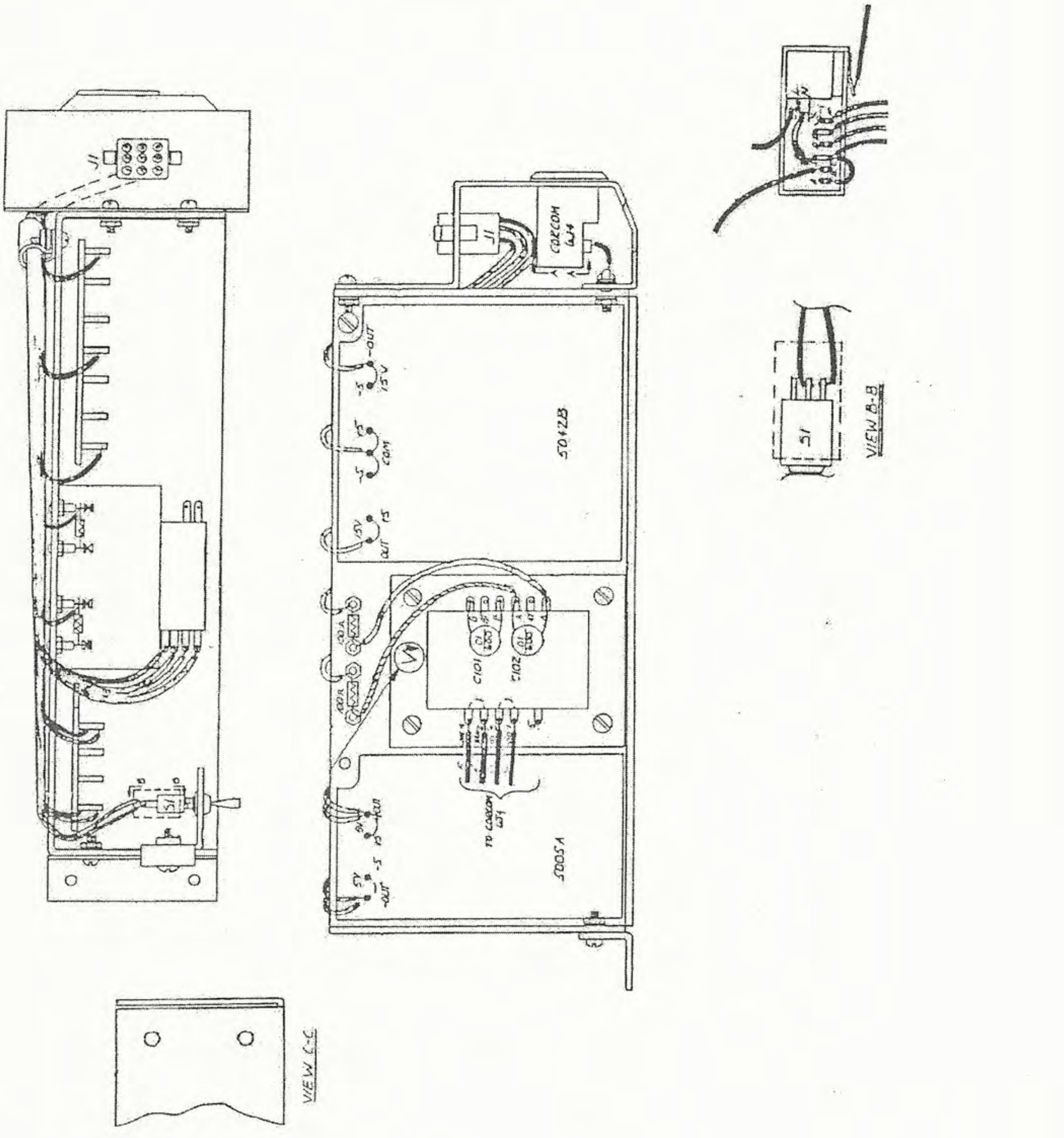


Figure A-53
Extender Board Assembly
20B2724 Rev G

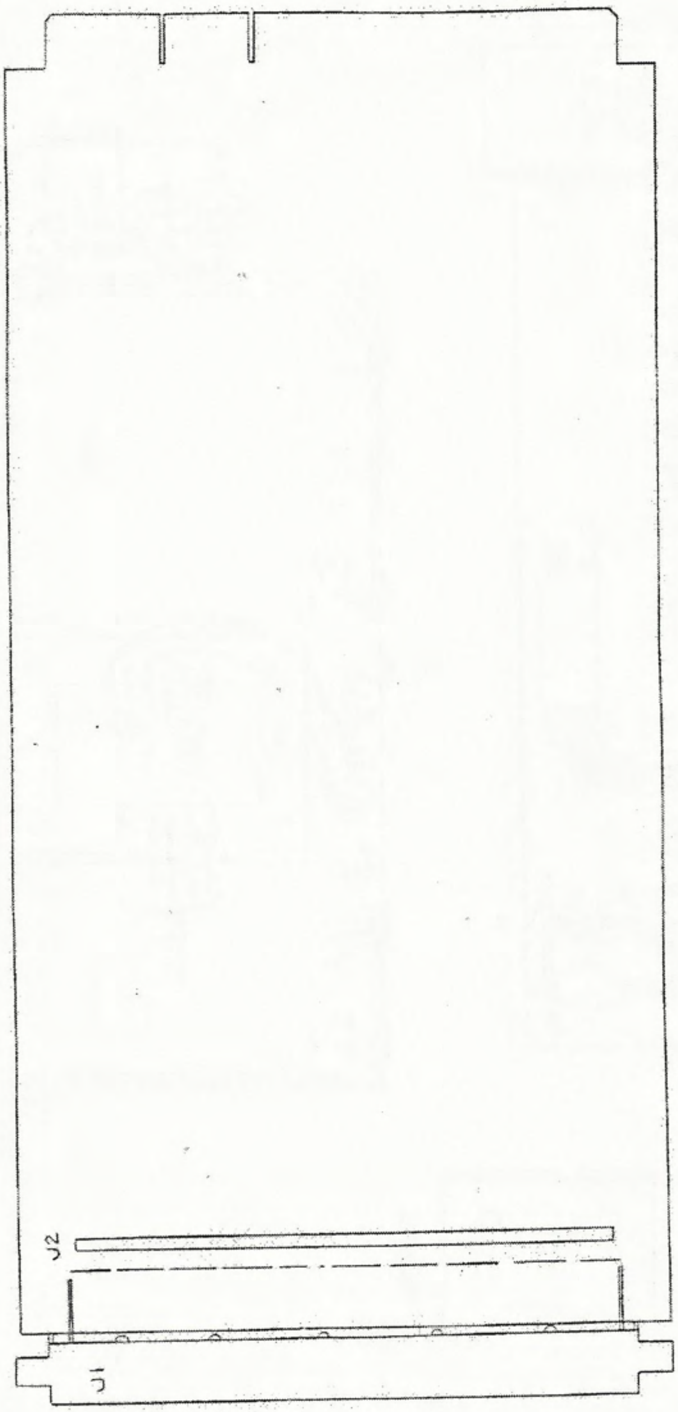
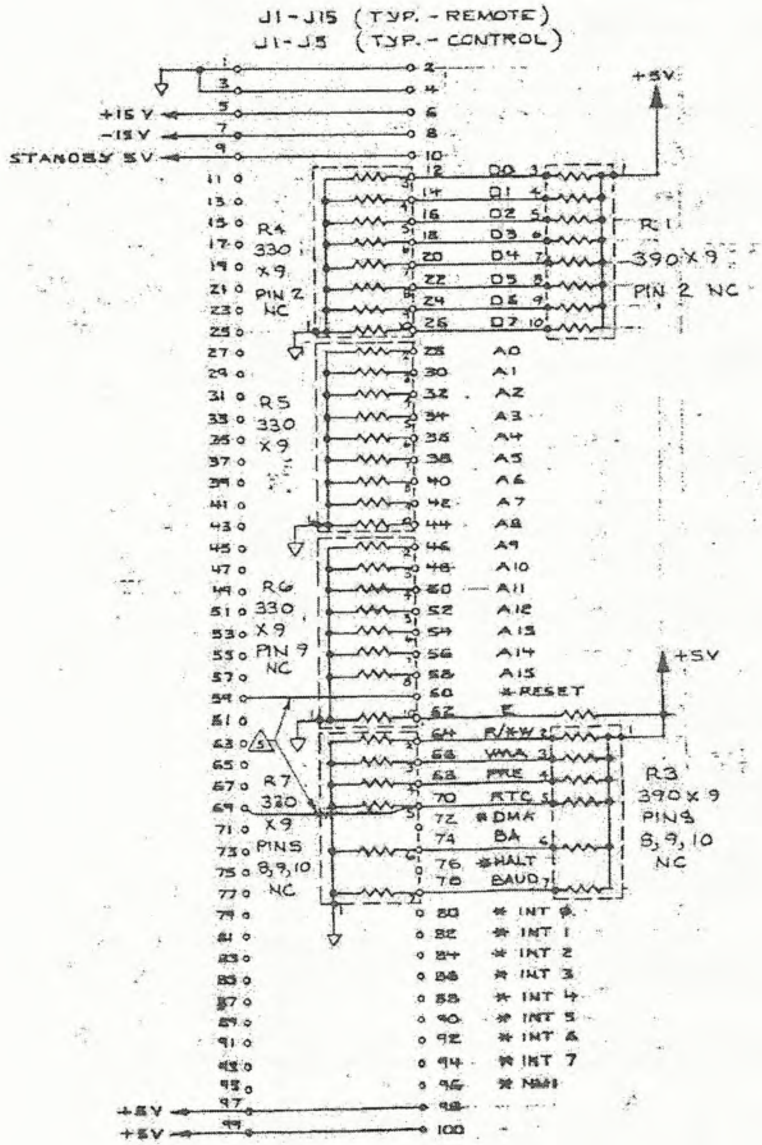


Figure A-54
4 RU Mother Board Schematic
91C7201 Rev B



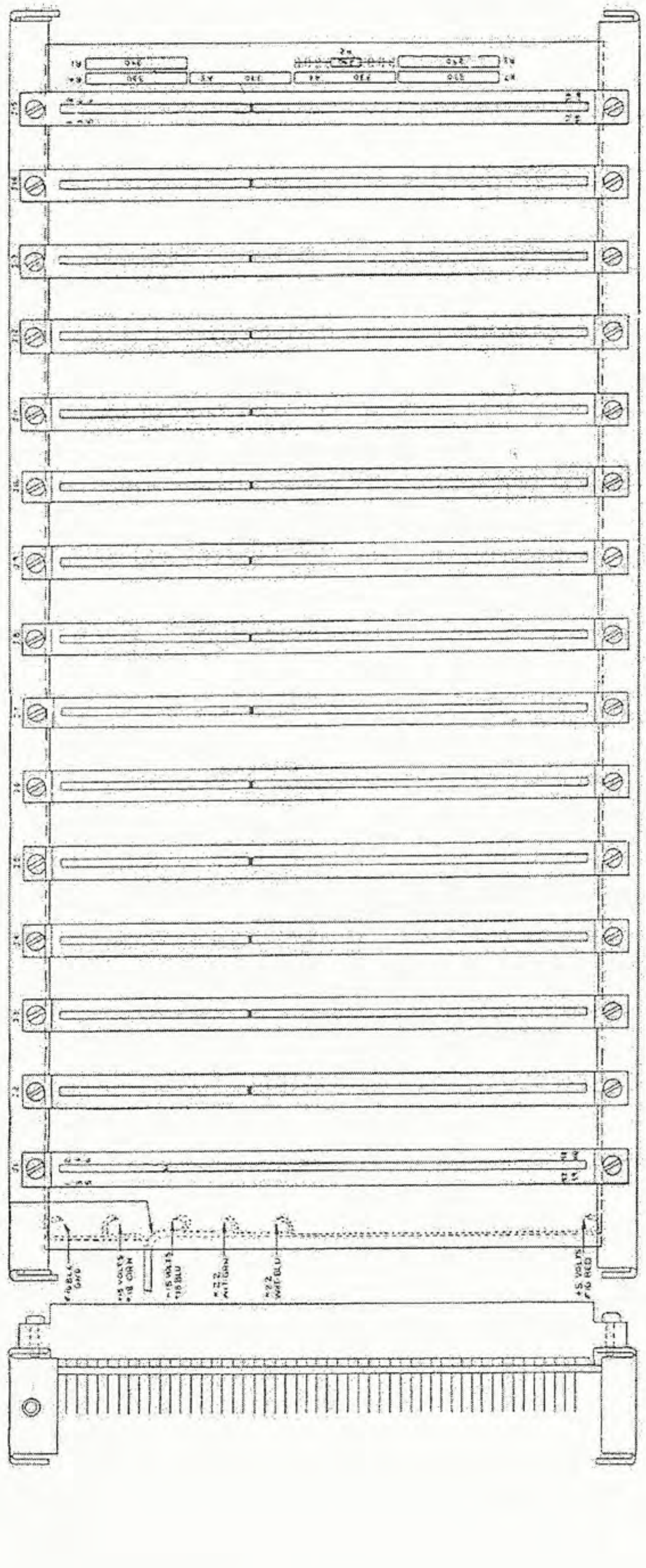


Figure A-55
4 RU Mother Board Assembly
20D2706 Rev N

Figure A-56
Quad Serial I/O Schematic
91D7394 Rev A

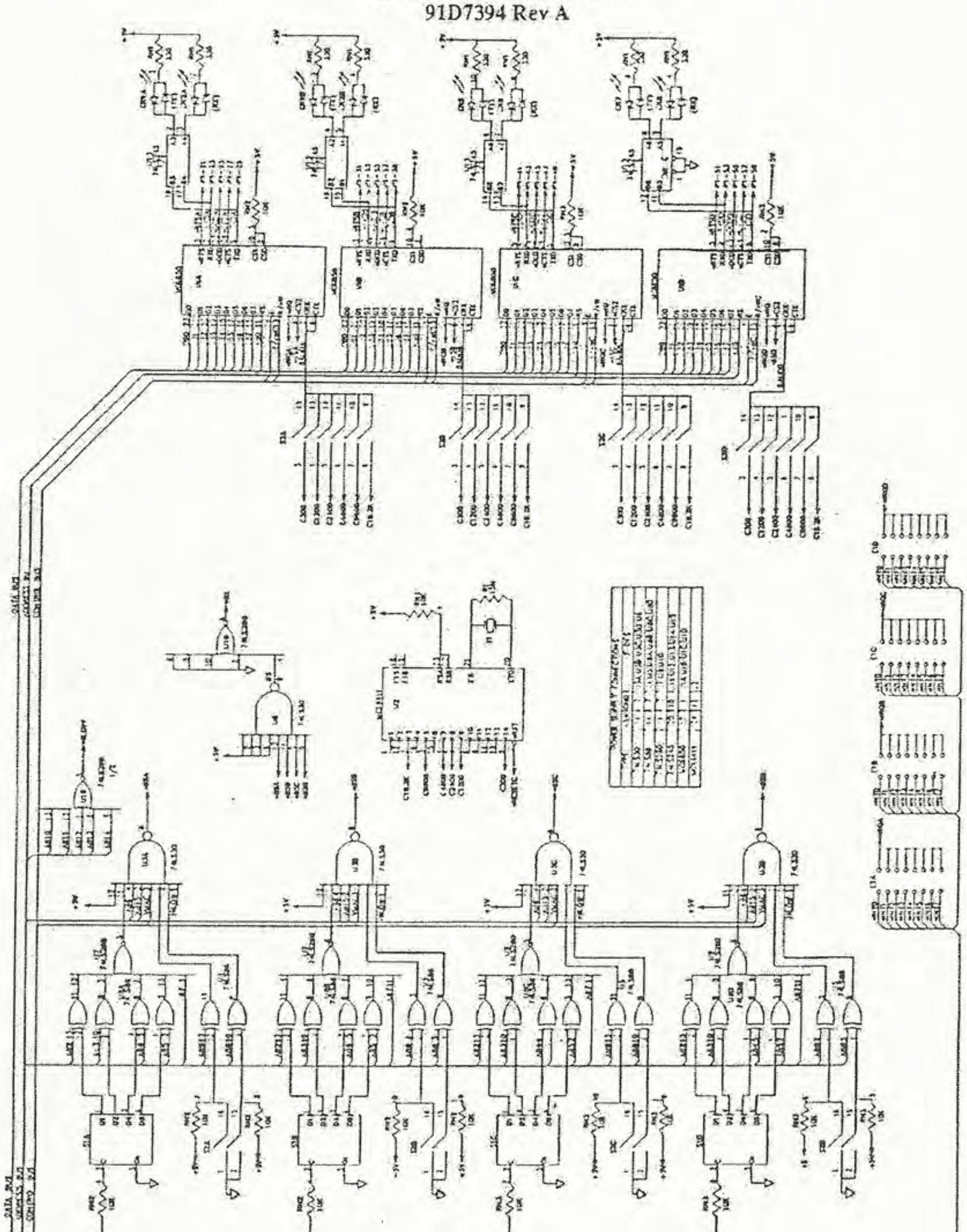
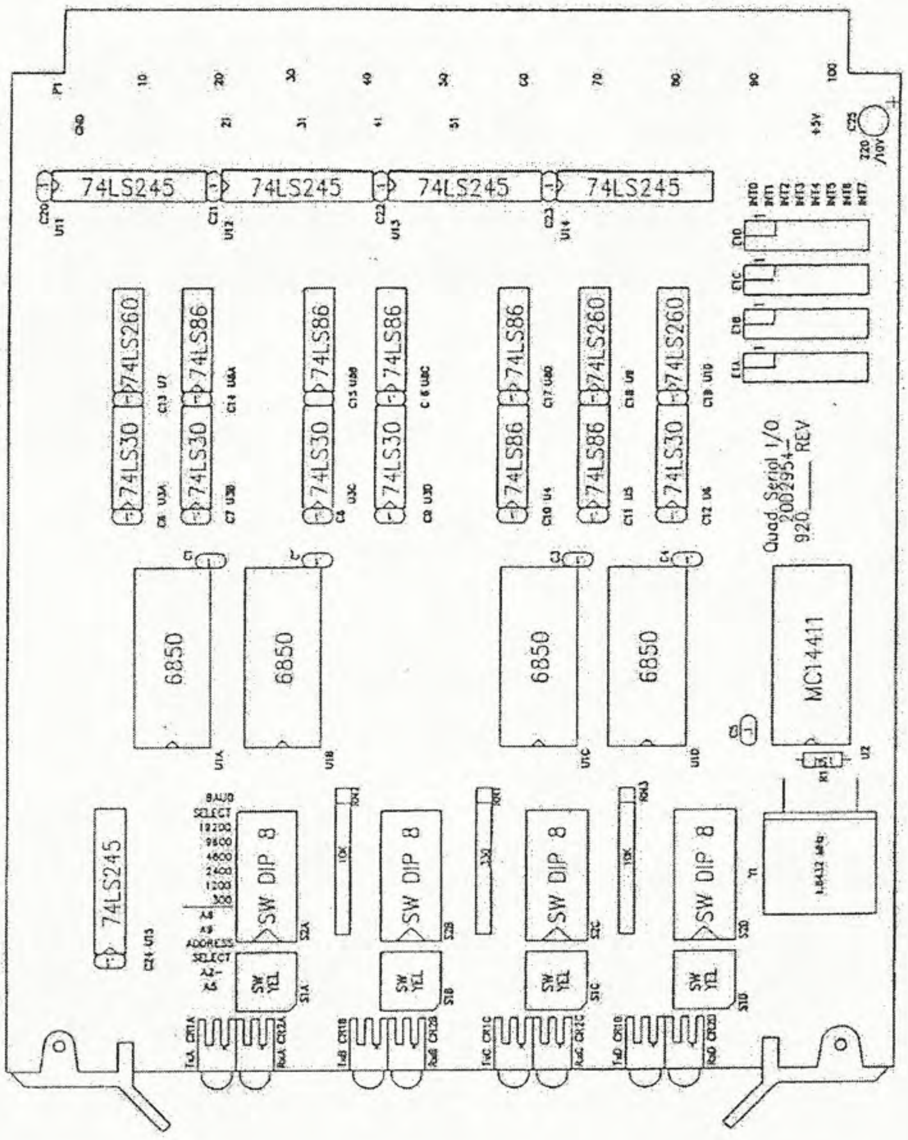


Figure A-57
Quad Serial I/O Assembly
20D2954 Rev A



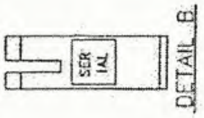


Figure A-58
Quad RS-232 Interface Schematic
91D7395 Rev A

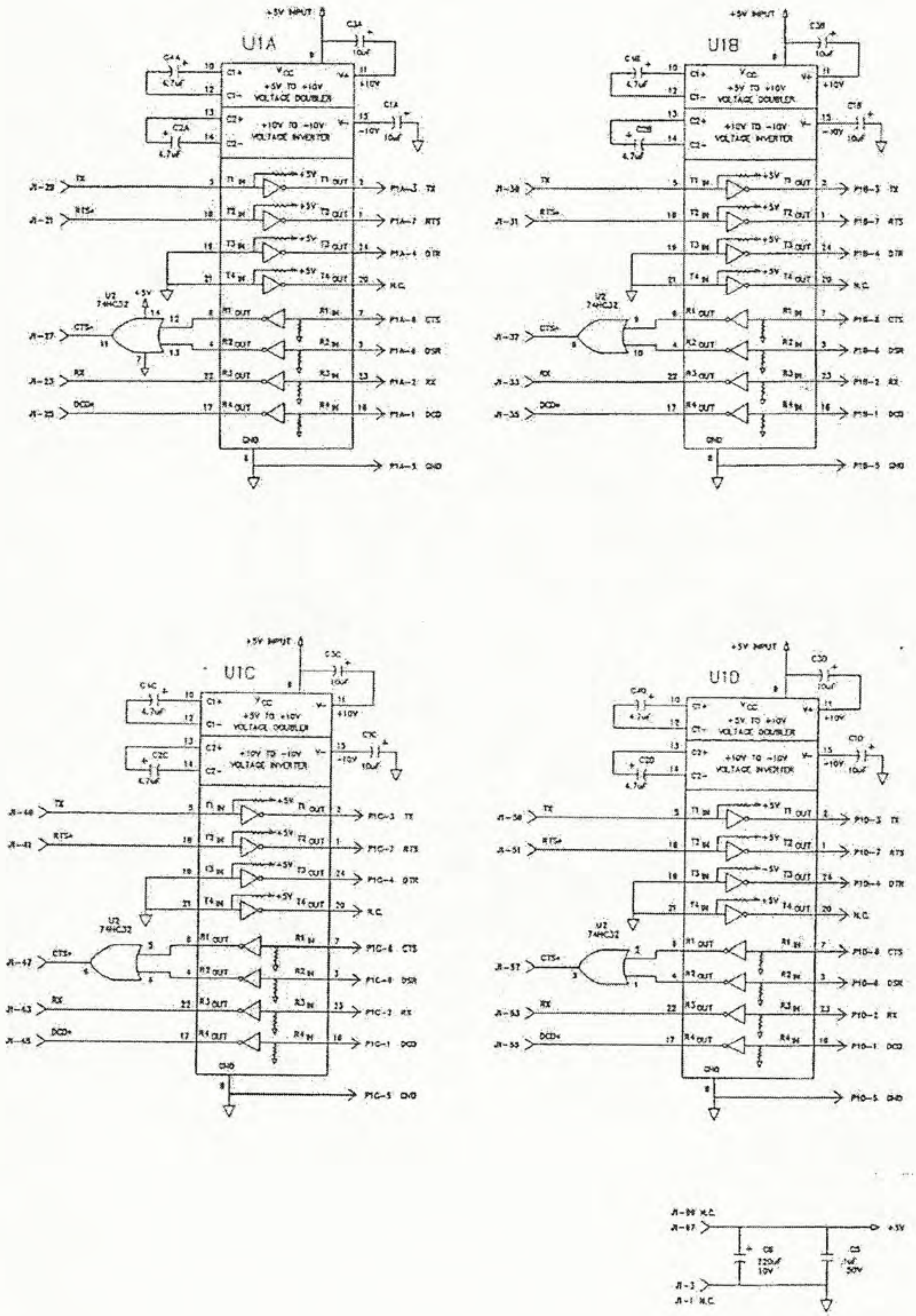
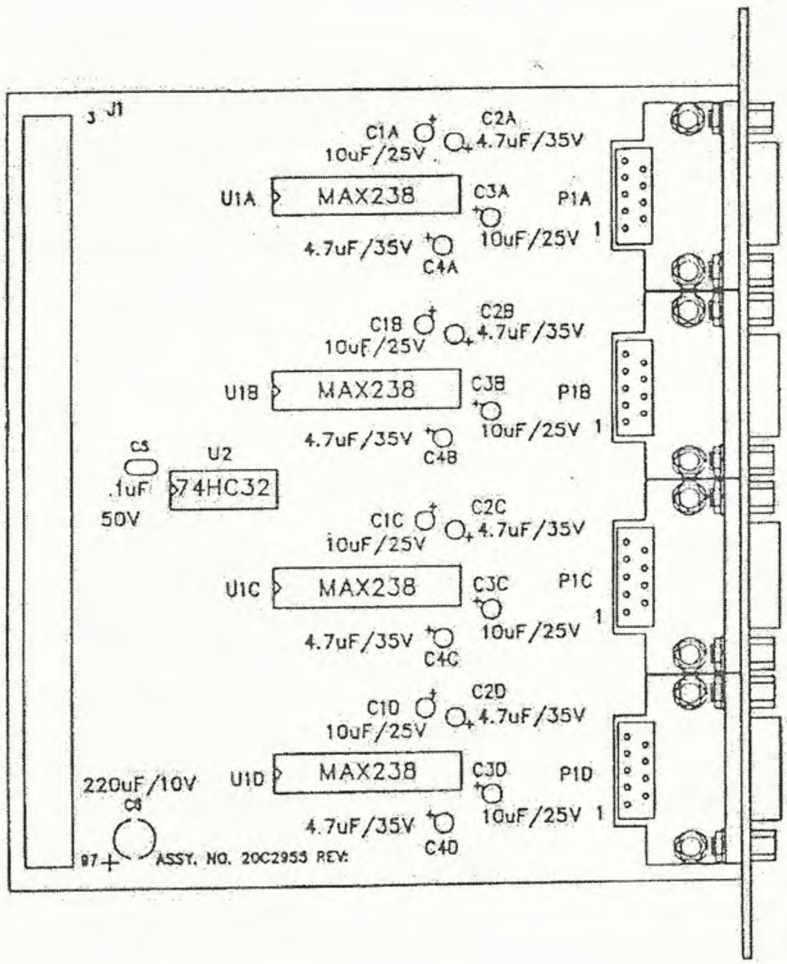


Figure A-59
Quad RS-232 Interface Assembly
20C2955 Rev A



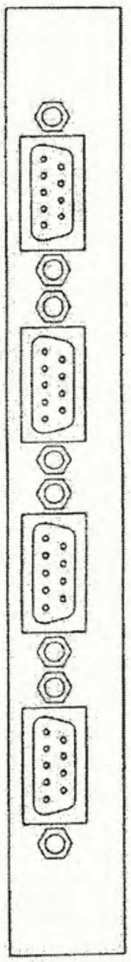


Figure A-60
25M-25M Null Modem Cable Assembly
24C1080 Rev G

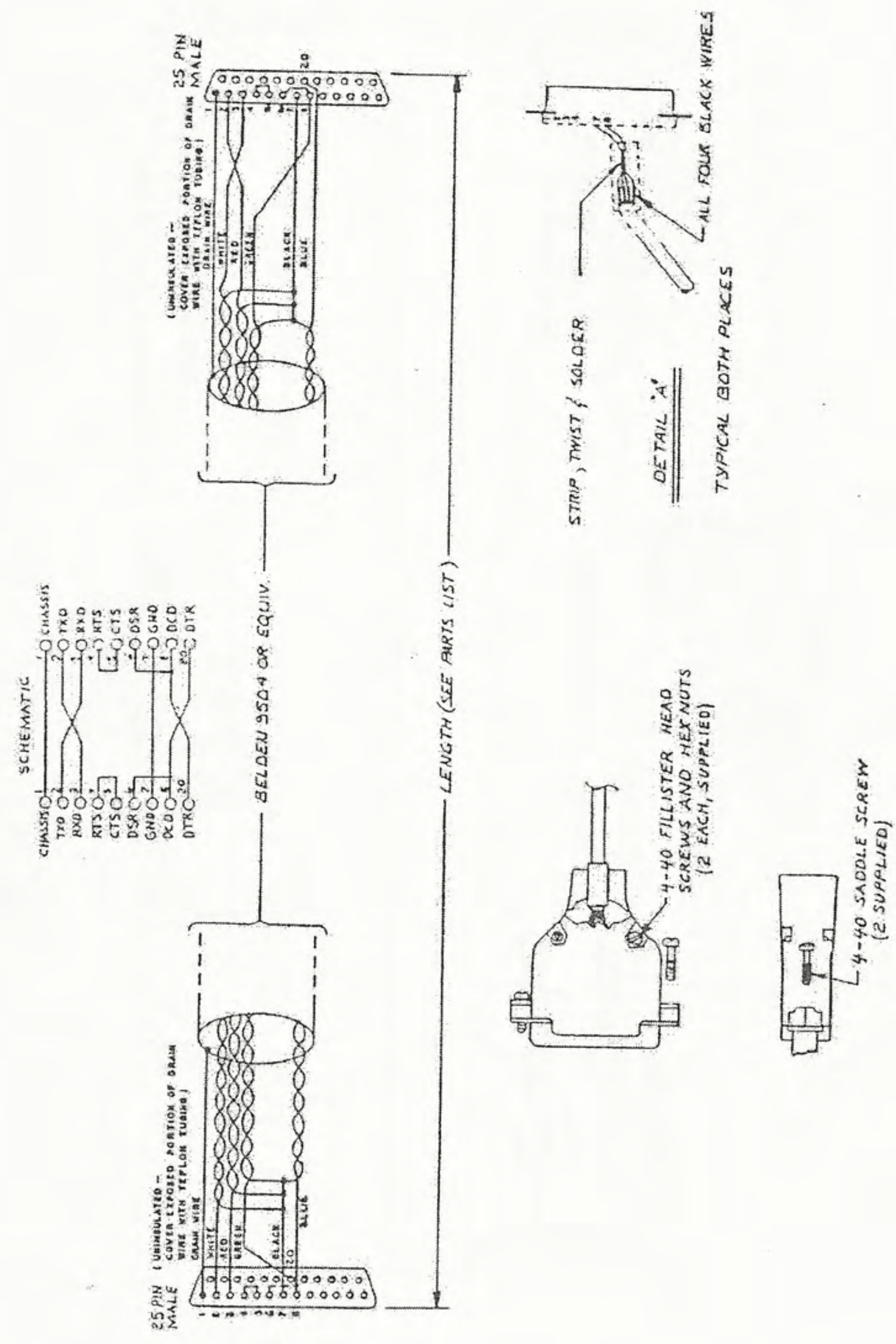


Figure A-61
25M-25F Null Modem Cable Assembly
24C1081 Rev E

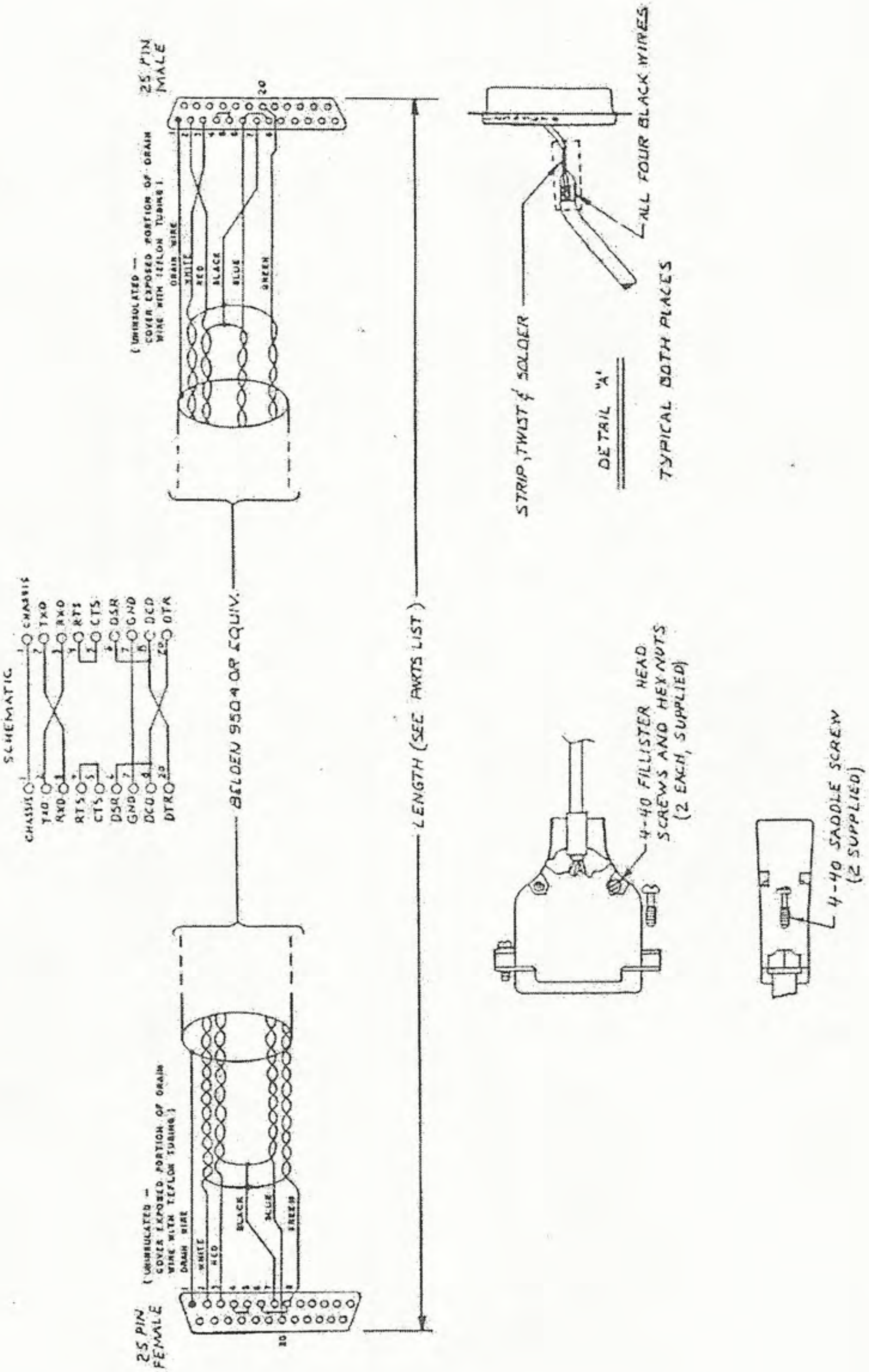


Figure A-62
25M-25M Modem Cable Norm Assembly
24C1099 Rev E

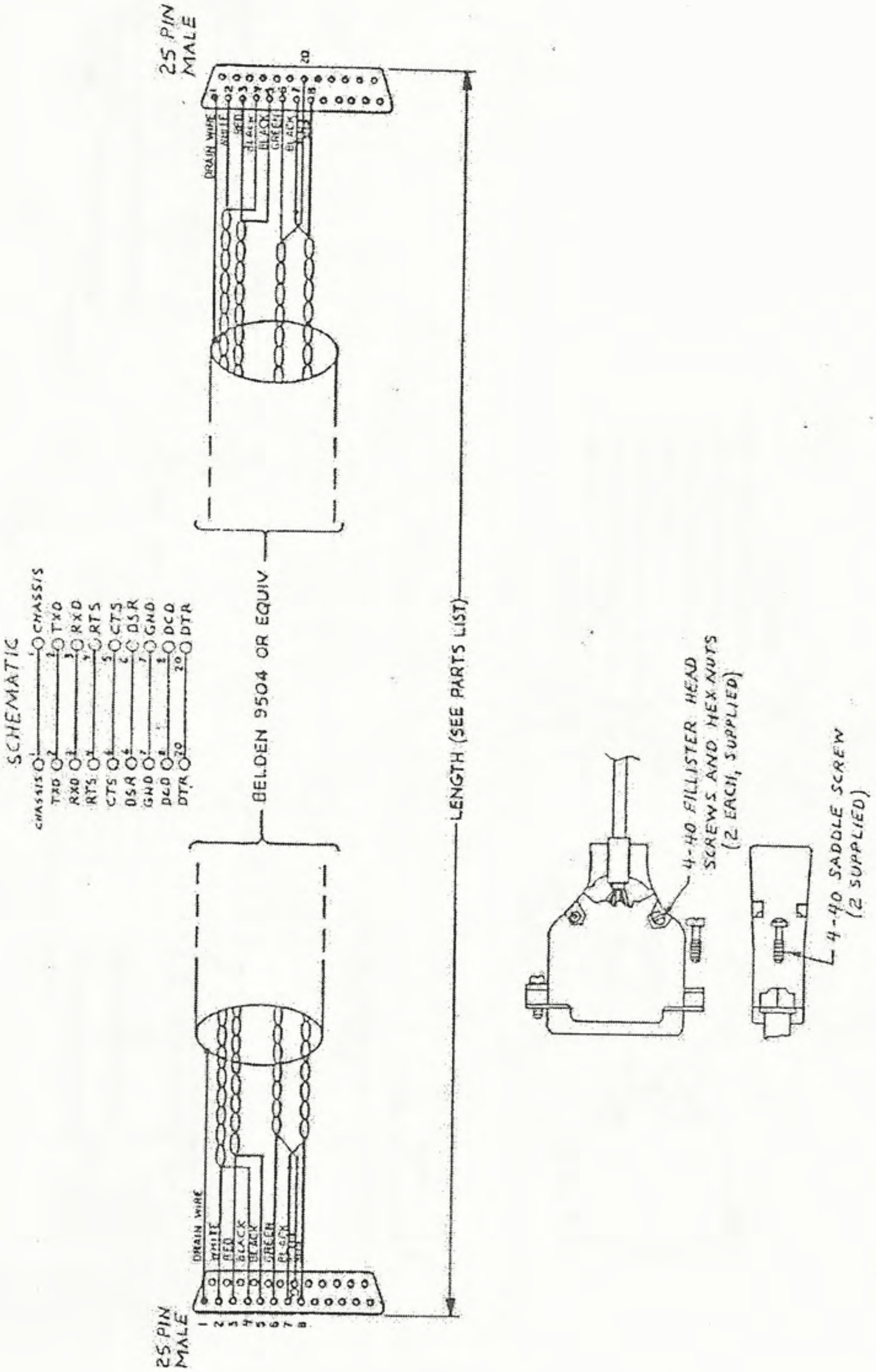


Figure A-63
25M-25M Modem Cable 4x20 Assembly
24C1165 Rev A

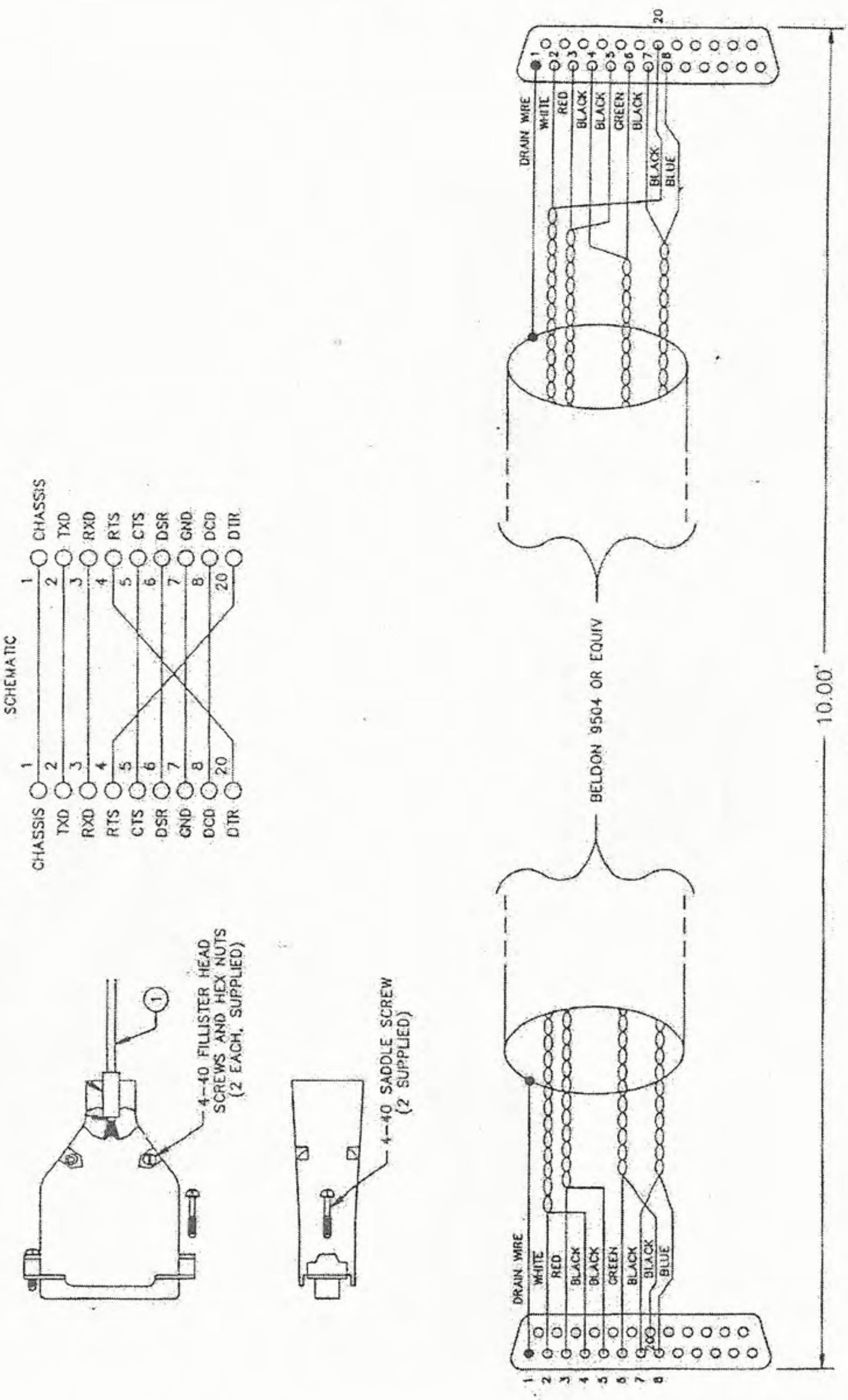


Figure A-64
9F-25M Modem Cable Norm Assembly
24C1167 Rev A

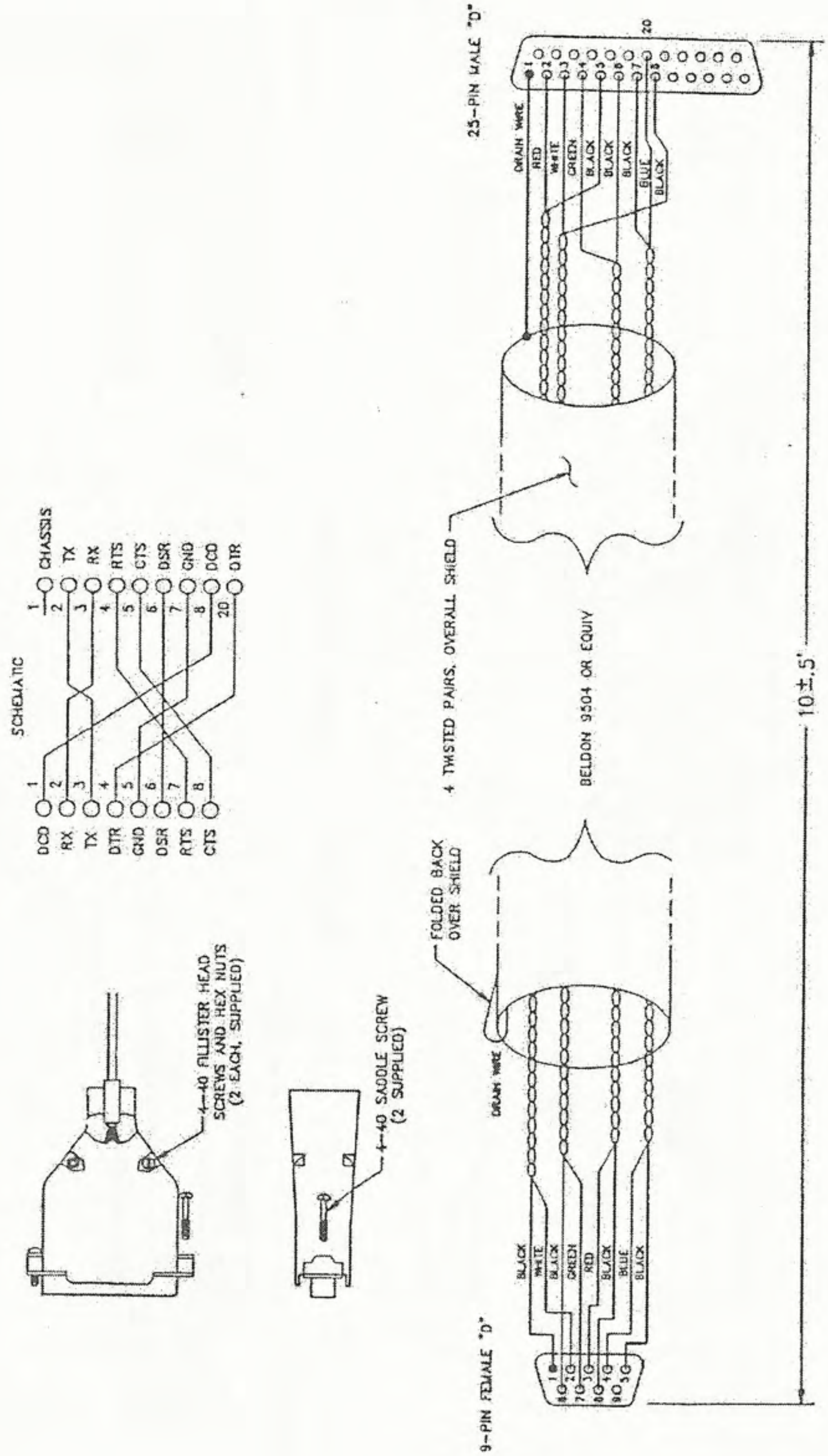


Figure A-65
9F-25M Modem Cable 4x20 Assembly
24C1168 Rev A

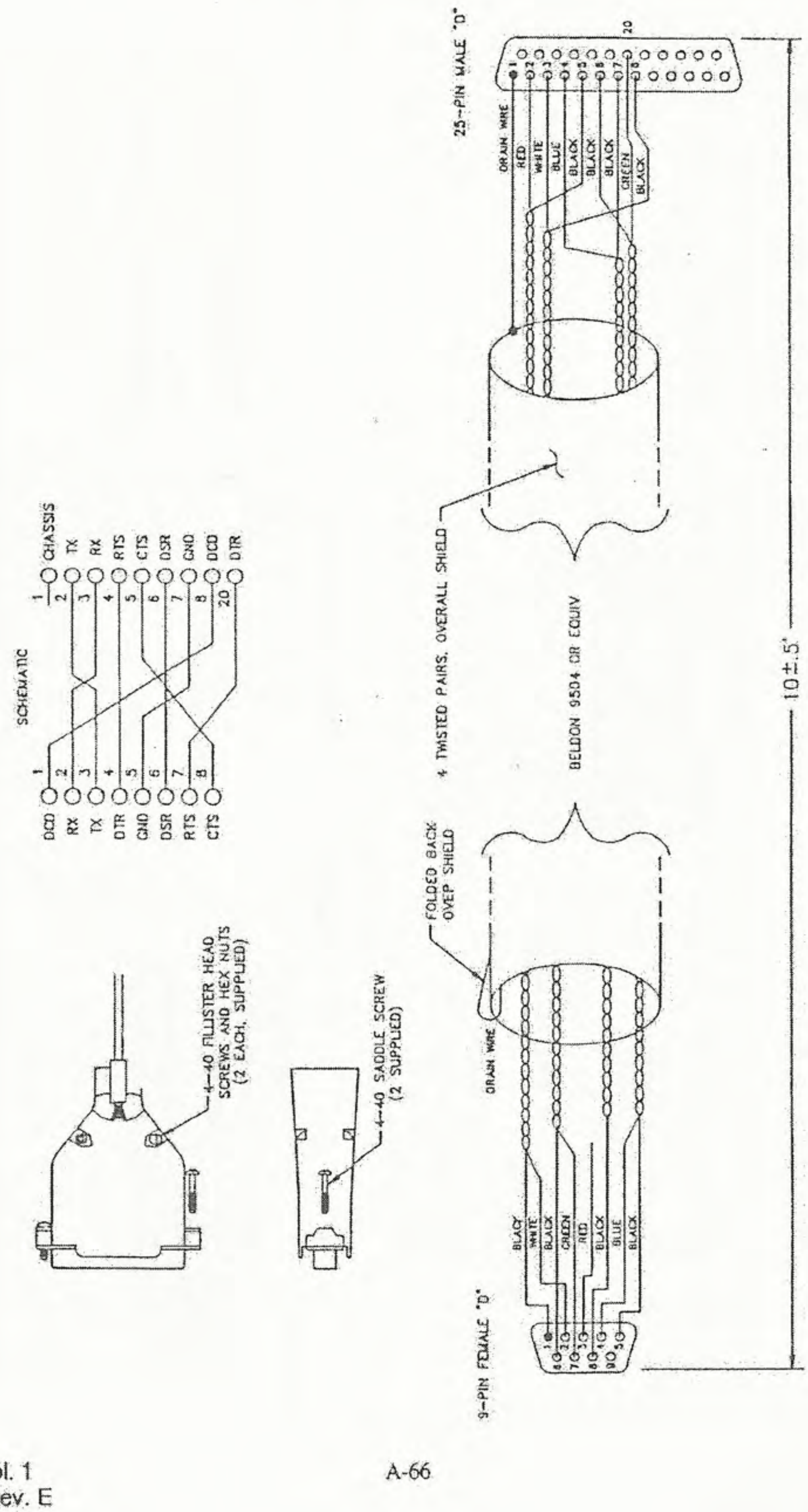


Figure A-66
9F-25M Null Modem Cable Assembly
24C1169 Rev A

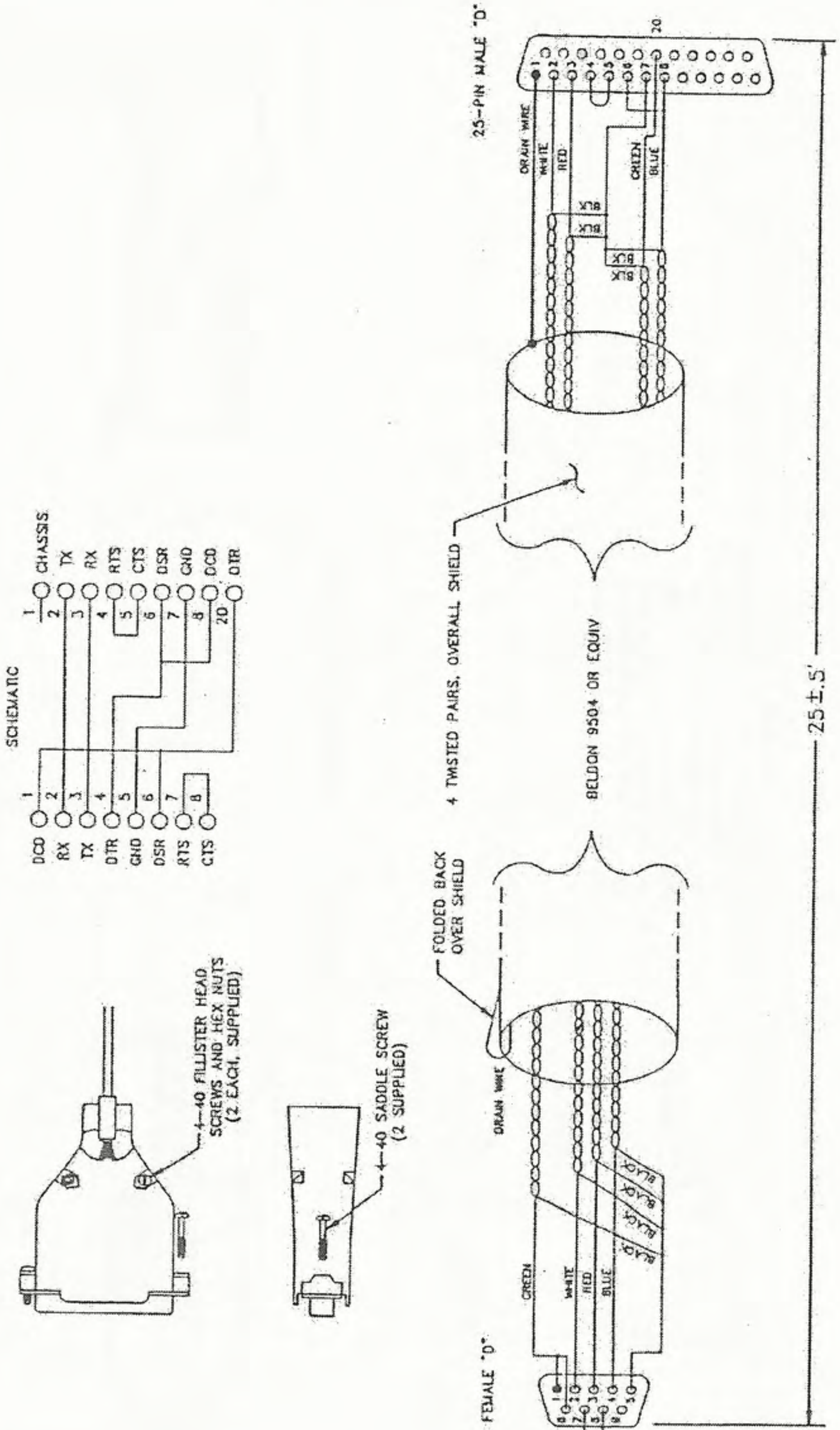


Figure A-67
9F-25F Null Modem Cable Assembly
24C1170 Rev A

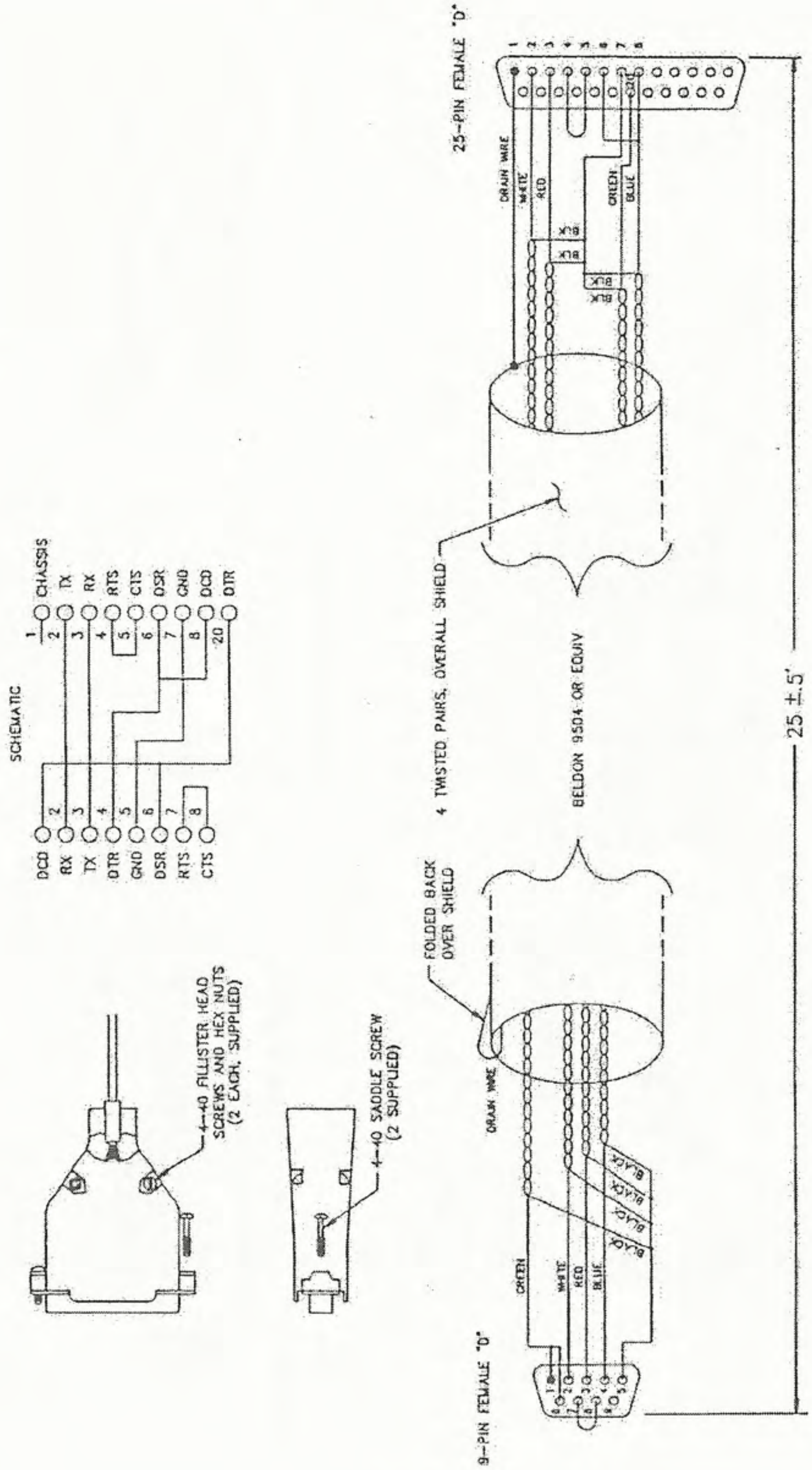


Figure A-68
9F-9F Null Modem Cable Assembly
24C1171 Rev A