Technical Manual

MRC1620

REMOTE CONTROL SYSTEM

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3 October, 1989

Moseley

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Moseley

MRC 1620
Microprocessor Remote Control

MRC 1620 SCADA System

The MRC 1620 Remote Control is an intelligent, integrated Supervisory Control and Data Aquisition (SCADA) system that offers flexibility and sophistication in an economical and dependable package for general remote control applications in the energy, utility, transportation and telecommunication industries.

Configuration

The MRC 1620 system consists of a Remote Terminal that allows an optional Control Terminal or IBM PC with TaskMaster20 software to monitor and control a remote facility from both dedicated and/or dial-up control points. The MRC 1620 Remote Terminal comes equipped with 32 relay isolated command outputs (16 raise/16 lower), 16 TTL status inputs and 16 analog metering inputs with the required terminal connectors.

Accessible

In broadcast applications, the system may be configured as a standard Remote Control with a Control Terminal at the studio and the Remote Terminal at the transmitter. The Remote Terminal may also be interrogated over dial-up lines using the TaskMaster20 software and modems. The TaskMaster20 can also be used to directly connect a PC at the Control or Remote Terminal for automatic logging and automatic controls.

Intelligence

Telemetry limit checking and status alarm capability ensure that an unmanned facility operates at peak efficiency. During alarm conditions, intelligent, automatic corrective action can be taken by the Remote Terminal under the direction of the TaskMaster20.

Communication

The Remote Terminal comes equipped with a built-in internal 1200 baud modem to communicate over dedicated circuits (STL/TSL/FMSCA or 2/4 wire leased lines). An external 1200/2400 baud auto-answer modem for dial-up access over the public switched telephone network is also included with the Remote Terminal. This modem can be moved to the Control Terminal should dial-up access be available only at that location.

Set Up

System set up and calibration are done at the Remote Terminal with eight color coded buttons. For each channel, upper and lower telemetry limits may be set or disabled independently and may be calibrated in either power, indirect power, linear or microvolt mode. Status inputs may be set to display direct or inverted and may be programmed to trigger an alarm on rising, falling, or rising and falling waveforms.

Non-volatile memory is standard in the MRC 1620. In the event of a power-down, all set-up data, calibration and limits are stored in an EEPROM for up to ten years.

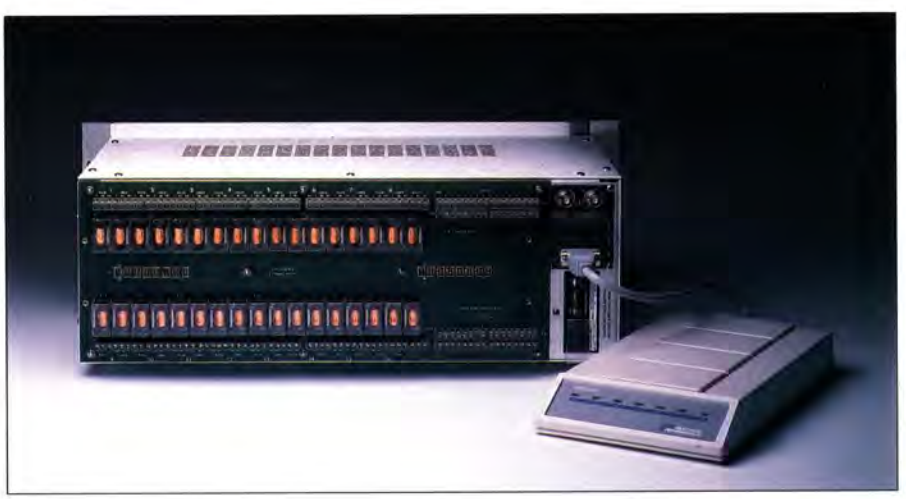
Operation

The MRC 1620 Remote and Control Terminals are simple to operate and easy to understand. All status channels are simultaneously displayed on a set of 16 LEDs. The front panel displays read-outs of selected channel number and telemetry data. LEDs indicate operation mode, alarms and other system parameters.

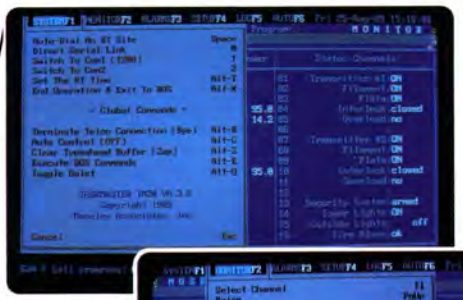
The MRC 1620 constantly checks telemetry and status data for each channel against assigned limits. Out of parameter conditions immediately trigger an audible and visible alarm. The front panel allows the operator to issue commands to either raise or lower the telemetry values to bring that channel back within limits. The telemetry and status channels also have an optional muting feature.

System Diagnostics

The MRC 1620 maintains two special system test channels. One checks A/D conversions and provides an alarm when tolerance exceeds factory-set limits. The second gives the user read-outs of data link quality.



TaskMaster20 Software



The TaskMaster20 software is an easy to use software package that allows you to access and control your Remote Terminal via a PC and modem. Pull down menus are available on each screen to assist you with operation of the TaskMaster20.

The system automatically boots to the Monitor Screen for the site I.D. that you choose. The Monitor Screen allows you to view the parameters for all 16 status and telemetry channels. Use this screen to issue raise and lower commands.

Current alarm conditions are displayed and acknowledged on the Alarm Page. Up to 20 of the latest alarms and hourly log data from the last 30 hours can be logged at your convenience.

A three-tiered password ("Monitor", "Control" and "Master") environment protects your system. Only the "Master" password may change set-up information. Program the Site Name and password on the first Set-up Screen. Nine (9) auto-dial numbers are also programmable to directly call out to a TaskMaster20 when alarm conditions occur.

You customize your own channel and status labels on the second Set-up Screen. Remote setup attributes may be uploaded or downloaded from the MRC 1620. Once you have entered your site labels, status labels and password information, you can access any site by simply entering the site I.D. with the proper password.

Program auto-control information in the Auto Screen. Commands can be set up to be issued when a telemetry value exceeds its limits. Commands can also be initiated from a change of status condition.

Specifications

General

Type of system: Microprocessor-based Control and Remote Terminals.
Failsafe:
- Complies with current FCC requirements.
- Responds after failure of interconnecting circuit. User programmable from 1 to 9999 minutes (0 to 166 hours). Can be disabled.

Failsafe Output: RT SPDT relay contacts (Form C), 2A, 30 Vdc, non-inductive.
Alarm Indications: Visual and aural (both RT and CT). Aural alarm defeatable and remoteable.
Maintenance Override: RT only front panel control provides RT relay closure. SPDT relay contacts (Form C), 2A, 30 Vdc, non-inductive.

Interconnects

Classes: 2/4 leased line, FM subcarrier or combination.
2/4 wire:
- 600 ohm balanced line, nominal. Send level: 0 dBm, nominal.
- Receive level: -30 dBm minimum.
- Requires voice grade Series 422 (2-wire) or Series 420 (4-wire) [basic conditioning] data channel. [Formerly Series 3002—Bell System Technical Reference PUB-41004.]

Subcarrier (Optional):
- 2200 ohm nominal unbalanced line, in & out. Send level: 1.5V p-p, nominal.
- Receive level: 0.25 V p-p, minimum. Frequency modulation of subcarrier on a specific frequency between 26 kHz and 185 kHz.

Modulation: Two tone FSK. 1200/2200 Hz.
Data Rate: 1200 bits/s. Half duplex.
Serial Interface: RS-232 for direct or "AT" modem connection to PC 2400 or 1200 or 300 bits/s.
Data Format (all): 8-bits, no parity, 1 stop bit.

Command Functions

Number of Outputs: 16 raise and 16 lower.
Inputs: Front panel raise/lower buttons.
Outputs: SPDT (Form C) relay contacts, 2A, 30Vdc, non-inductive.
Response Time: 500 ms, typical.

Status Functions

Number of Inputs: 16 inputs
Inputs: TTL-compatible closures at the Remote Terminal. (3300 ohm internal pull-up resistors).
Input Filtering: L-C low-pass filter for each input.
Input States: User programmable for N.O. or N.C. contacts.
Indication: Front panel green LEDs at RT and CT. Changeable to red.
Response Time: 1s, typical, from status change to indication at the CT. 250 ms, typical, when commands are being issued from the CT.

Telemetry (Analog) Functions

Number of Channels: 16 inputs
Inputs: Analog ±4.5 Vdc maximum, single ended referenced to ground. Other inputs optional.
Input Impedance: 500 kOhm, nominal.
Input Filtering: L-C low pass filter for each channel.
Calibration: Via front panel buttons in millivolt, linear, power or indirect power mode. A minimum of 0.25 volts required for full-scale calibration (9999) to maintain stated accuracy.
A/D: One part in 4096 (12 bits + sign)
Measurement Accuracy: Better than 0.5%
Sample Rate: Greater than 9 times/second on displayed channel.
Response Time: 1s, typical, from an input change at the RT to indication at the CT. 250ms, typical, when commands are being issued from the CT.

Physical

Power (CT or RT): 100/120/220/330/240 Vac, 50/60 Hz, 30 W, typical.
Operating Temperature: 0-50C
Size (WxHxD): 49 cm x 18cm x 23cm (29" x 7" x 9")

Options

TaskMaster20: Single-site MRC 1620 PC Software requires IBM PC/XT equivalent or better.
MasterController: Multi-site MRC 1620/MRC 2 PC Software requires IBM PC/AT equivalent or better
Subcarrier Communications: Available on standard frequencies from 26 to 185 kHz

TaskMaster 20 Hardware Requirements

Minimum	Upgrade
Computer	
• IBM PC/XT or PS/2	• 286/386-based compatible
• 320KB RAM	• 640KB RAM or more
• Serial Port	
• Parallel Printer Port	
• 360KB Floppy Disk Drive	• 1.2MB or 720KB or 1.44MB
• 20MB Hard Disk	• 40MB Hard Disk or more
• Color Graphics Adapter	• EGA or VGA capability
Monitor	
• CGA Monitor	• Multi-sync Monitor
Modem	
• 1200 baud	• 2400 baud
• Hayes "AT" compatible Internal or external	

Printer
- IBM compatible parallel printer

Cables
- Parallel printer cable
- Modem cable if using external modem
- Null-modem cable if using direct connect

DOS
- Version 3.0 or later

Software Features

- Dial or direct connect to an MRC 1620 Remote or Control Terminal.
- Display current analog and status values.
- Display and acknowledge alarms.
- Manually control an MRC 1620 Remote Terminal (RT).
- Automatically control (via analog limits and status conditions) an RT.
- Display, edit, and store PC screen labels.
- Download and store the set-up parameters from the MRC 1620.
- Recall and upload the set-up parameters to the MRC 1620.
- Maintain and generate log file(s) from up to 16 RT sites at user-specified intervals during the day.
- Generate a printed log.

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WARNING

This equipment complies with the requirements in Part 15 of FCC Rules for a Class A computing device. Operation of this equipment in a residential area may cause unacceptable interference to radio and TV reception requiring the operator to take whatever steps are necessary to correct the interference.

WARRANTY

All equipment designed and manufactured by Moseley Associates, Inc. is warranted against defects in workmanship and material that develop under normal use within a period of (2) years from the date of original shipment, and is also warranted to meet any specifications represented in writing by Moseley Associates, Inc., so long as the purchaser is not in default under his contract of purchase and subject to the following additional conditions and limitations:

1. The sole responsibility of Moseley Associates, Inc. for any equipment not conforming to this Warranty shall be, at its option:

   A. to repair or replace such equipment or otherwise cause it to meet the represented specifications either at the purchaser's installation or upon the return thereof f.o.b. Santa Barbara, California, as directed by Moseley Associates, Inc.; or

   B. to accept the return thereof f.o.b. Santa Barbara, California, credit the purchaser's account for the unpaid portion, if any, of the purchase price, and refund to the purchaser, without interest, any portion of the purchase price theretofore paid; or

   C. to demonstrate that the equipment has no defect in workmanship or material and that it meets the represented specification, in which event all expenses reasonably incurred by Moseley Associates, Inc., in so demonstrating, including but not limited to costs of travel to and from the purchaser's installation, and subsistence, shall be paid by purchaser to Moseley Associates, Inc.

2. In case of any equipment thought to be defective, the purchaser shall promptly notify Moseley Associates, Inc., in writing, giving full particulars as to the defects. Upon receipt of such notice, Moseley Associates, Inc. will give instructions respecting the shipment of the equipment, or such other manner as it elects to service this Warranty as above provided.

3. This Warranty extends only to the original purchaser and is not assignable or transferable, does not extend to any shipment which has been subjected to abuse, misuse, physical damage, alteration, operation under improper conditions or improper installation, use or maintenance, and does not extend to equipment or parts not manufactured by Moseley Associates, Inc. and such equipment and parts are subject to only adjustments as are available from the manufacturer thereof.

4. NO OTHER WARRANTIES, EXPRESS OR IMPLIED, SHALL BE APPLICABLE TO ANY EQUIPMENT SOLD BY MOSELEY ASSOCIATES, INC. AND NO REPRESENTATIVE OR OTHER PERSON IS AUTHORIZED BY MOSELEY ASSOCIATES, INC. TO ASSUME FOR IT ANY LIABILITY OR OBLIGATION WITH RESPECT TO THE CONDITION OR PERFORMANCE OF ANY EQUIPMENT SOLD BY IT, EXCEPT AS PROVIDED IN THIS WARRANTY. THIS WARRANTY PROVIDES FOR THE SOLE RIGHT AND REMEDY OF THE PURCHASER AND MOSELEY ASSOCIATES, INC. SHALL IN NO EVENT HAVE ANY LIABILITY FOR CONSEQUENTIAL DAMAGES OR FOR LOSS, DAMAGE OR EXPENSE DIRECTLY OR INDIRECTLY ARISING FROM THE USE OF EQUIPMENT PURCHASED FROM MOSELEY ASSOCIATES INC.

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GLOSSARY

A/D	Analog to digital
CMOS	Complementary metal-oxide semiconductor
CPU	Central processing unit
EPROM	Erasable, programmable, read-only memory
EEPROM	Electrically-erasable, programmable, read-only memory
FSK	Frequency shift keying
IC	Integrated circuit
LED	Light-emitting diode
Modem	MOdulator/DEModulator
NC	Normally closed (contact)
NO	Normally open (contact)
PSTN	Public Switched Telephone Network
RAM	Random-access memory
ROM	Read-only memory
SCA	Subsidiary Communications Authority
Status	On/Off (Go/No-Go) input to the Remote Terminal representing an occurrence of interest, such as doors opening, transmitter overloads, fire, etc. External interfacing is normally required, providing a contact closure (or an opening) to the MRC1620.
Telco	Telephone Company, here refers normally to a Series 3002 basic-conditioned data circuit or equivalent.
Telemetry	Varying analog voltage input representing a metering function not normally input directly, i.e. 3.0 Vdc may represent a plate voltage of 7500 volts in a transmitter. External interfacing may be required.
THD	Total harmonic distortion
TTL	Transistor-transistor logic

SECTION 1

SYSTEM CHARACTERISTICS

1.1 Introduction

The Model MRC1620 Remote Control System is designed to provide the ability to monitor and control broadcast transmitters and similar installations from remote locations.

It provides sixteen analog "telemetry" channels, which are digital displays of analog input voltages. Four digits plus decimal point and sign are provided. There are sixteen status (on-off) displays; each is an LED which is lit or not according to the presence of an external contact closure. There are thirty-two relay outputs (sixteen raise-lower pairs) which may be activated by the user by selecting a channel and pressing the **RAISE** or **LOWER** button on the front panel.

The MRC1620 allows a variety of configurations to be used:

1. Remote Terminal (RT) and Control Terminal (CT).
2. RT and Personal Computer (PC) as the Control Terminal.
3. RT and CT with a PC connected to the RT.
4. RT and CT with a PC connected to the CT.
5. RT and CT with a PC connected to both the CT and RT.

Intercommunication between Control and Remote Terminals may be by leased telephone line (2-wire or 4-wire), or optionally by subcarrier or mixed subcarrier and wire systems. Various subcarrier frequencies are available.

The PC may be connected directly (with leased lines, subcarriers, or RS-232) or via the Public Switched Telephone Network (PSTN/Dialup) at either the RT or CT. For use with a PC, it is necessary to use TaskMaster20 (tm) or MasterController (tm) software available from Moseley. This manual discusses the RT-CT configuration and setup. Operation of the TaskMaster20 or MasterController software is described in a separate manual.

Microprocessor technology at both Control and Remote Terminals allows advanced standard features such as single-person keyboard calibration, tolerance alarms, and non-volatile memory.

1.2 System Specifications

Type of System	Microprocessor-based Control and Remote Terminals.
Failsafe	Complies with current FCC requirements. Responds after failure of interconnecting circuit. User-programmable from 1 to 9999 minutes (0 to 166 hours). Can be disabled.
Failsafe Output	RT SPDT relay contacts (Form C) 2A, 30 Vdc, noninductive.
Alarm Indications	Visual and aural (both RT and CT). Aural alarm defeatable and remoteable.
Maintenance Override	RT only front-panel control provides RT relay closure. SPDT relay contacts (Form C) 2A, 30 Vdc, noninductive. LED indication at both RT and CT.

Interconnects

Classes	2-wire or 4-wire leased-line, FM subcarrier, or combination.
2-wire and 4-wire	600 ohm balanced line, nominal. Send level: 0 dBm, nominal. Receive level: -30 dBm minimum. Requires Voicegrade Series 422 (2-wire) or Series 420 (4-wire) [basic conditioning] data channel. {Formerly Series 3002--Bell System Technical Reference PUB-41004.}
Subcarrier (Optional)	2200 ohm nominal unbalanced line, in & out. Send level: 1.5V p-p, nominal. Receive level: 0.25 V p-p, minimum. Frequency modulation of subcarrier on a specific frequency between 26 kHz and 185 kHz.
Modulation	Two-tone FSK. 1200/2200 Hz.
Data Rate	1200 bits/s. Half duplex
Serial Interface	RS-232 for direct or "AT" modem connection to PC 2400 or 1200 or 300 bits/s.
Data Format (all)	8-bits, No parity, 1 stop bit.

Command Functions

Number of Outputs	16 raise and 16 lower.
Inputs	Front-panel raise/lower buttons.
Outputs	SPDT (Form C) relay contacts, 2A, 30 Vdc, non-inductive.
Response Time	500ms, typical

Status Functions

Number of Inputs	16 inputs
Inputs	TTL-compatible closures at the Remote Terminal. (3300 ohm internal pull-up resistors).
Input Filtering	L-C low-pass filter for each input.
Input States	User programmable for N.O. or N.C. contacts.
Indication	Front-panel Green LEDs at RT and CT. Changeable to Red.
Response Time	1s, typical from status change to indication at the CT. 250ms, typical when commands are being issued from the CT.

Telemetry (Analog) Functions

Number of Channels	16 inputs.
Inputs	Analog +/- 4.5 Vdc maximum, single ended referenced to ground.
Input Impedance	500 kOhm, nominal.
Input Filtering	L-C low-pass filter for each channel.
Calibration	Via front-panel buttons in millivolt, linear, power or indirect power mode. A minimum of 0.25 volts required for full-scale calibration (9999) to maintain stated accuracy.
A/D	One part in 4096 (12 bits + sign).
Measurement Accuracy	Better than 0.5%
Sample Rate	Greater than 9 times/second on displayed channel.
Display	4 digits (9999, maximum) plus sign and decimal point. Alphanumeric setup menu.
Response Time	1s, typical, from an input change to display at the CT. 250ms, typical when commands are being issued from the CT.

Physical

Power (CT or RT)	100/120/220/230/240 Vac, 50/60 Hz, 30 W, typical.
Operating Temperature	0-50 ^{o}C
Size (W x H x D)	49 cm x 18 cm x 23 cm (19" x 7" x 9")

Options

TaskMaster20	Single-site MRC1620 PC Software requires IBM PC/XT or equivalent or better
MasterController	Multi-site MRC1620/MRC-2 PC Software requires IBM PC/AT or equivalent or better

Subcarrier Communications	Available on standard frequencies from 26 to 185 kHz

Specifications subject to change without notice.

1.3 System Description

The Control and Remote Terminals consist of several printed circuit modules which share the processing load. Although the Remote and the Control Terminals perform different functions, they are very similar electrically and mechanically: most of the boards appearing in one are identical to the boards appearing in the other. The only exceptions are the Analog/Command/Status board and the External Relay board which are installed only in the Remote Terminal. The following text describes a typical MRC1620 terminal in a "building-block" format. For specific circuit details, see Section 4, Module Descriptions.

The MRC1620 Remote Terminal consists of seven modules: Power Supply, CPU, Front Panel, Communications I/O, Data Modems, Analog/Command/Status, and External Relay board. The Control Terminal omits the Analog/Command/ Status and External Relay boards. The text below describes in general terms the purpose of these individual modules and their interaction with other modules. For a complete circuit description of the modules, see Section 4.

1.3.1 CPU

This board is the heart of the MRC1620 terminal and is located directly behind the front-panel printed circuit board. It holds the Motorola 6809 Microprocessor, the program instructions in EPROM, the RAM, the setup parameters in EEPROM, some interfacing logic for communication with the other modules in the system, and the RS-232 port. Most communication between modules is done through an external I/O address bus and I/O data bus. When the CPU board wants to communicate with another board, it puts an address on the I/O address lines IOAB1-IOAB4. If the operation is a Read, the addressed module puts data on I/O data lines IODB0-IODB7, which is read by the CPU board. For a Write operation, after placing the address on the I/O address lines, it puts data on the I/O data lines and strobes the *WRSTR writestrobe line. The addressed module then receives the data from the I/O data bus.

In addition to the CPU board signals, there are signals which are generated externally that the Processor Board routes to other modules; for example, power lines such as RELAY +15, ANALOG +15, ANALOG -15, and +5.

1.3.2 Front Panel

The Front Panel board is responsible for interfacing operator-oriented functions with the CPU board and is mounted directly on the chassis' front panel. It communicates with the CPU board over the I/O bus and uses no other signals. The LEDs can be changed from green to red by reversing their polarity.

1.3.3 Power Supply

The Power Supply accepts ac line voltage, and supplies +15 Vdc, -15 Vdc, and +5 Vdc to the other modules. It is located within the MRC1620 chassis itself. Depending upon the configuration of the Corcom filter, the ac line voltage input may be 100 Vac, 120 Vac, 220 Vac, or 230/240 Vac (user selectable).

1.3.4 Data Modems

The Data Modems are a family of devices which are used to communicate data between the Control and Remote Terminals. These devices are attached to the CPU board via two connectors. Essentially, there are three types of data modem: Telco, Subcarrier, and Subaudible. Each terminal may be configured with any combination of these. In addition, if the system is to be run over Telco line exclusively, it may be configured for 2-wire or 4-wire operation.

The Data Modems are comprised of two sections: a transmitter, and a receiver, each on its own printed circuit board. The purpose of these modems is to interface serial data used by the CPU board to and from FSK carrier modulation. For Telco interface, the frequencies lie within the audio region. Subcarrier board frequencies are available in a variety of standard frequencies ranging from 26 kHz through 185 kHz.

In addition to modulating and demodulating signals, the modem boards also select the data rate at which information is to be conveyed. Baud rate selection is accomplished by connecting any one of the 6 data clocks to the receive data clock RXCLK, or the transmit data clock TXCLK, as appropriate. This connection is done automatically on each transmit or receive board. The Telco and Subcarrier boards operate at 1200 baud using the 19200 Hz clock line supplied from the CPU board. Other signals such as *DCD, *CTS, and *RTS are used to pass modem status signals to and from the CPU board.

1.3.5 External Relay (RT Only)

The External Relay board accepts the 16 analog voltage samples and the 16 status inputs, and presents them to the Analog/Command/Status board for further processing. It is mounted on the outside of the Remote Terminal's rear panel. Since the analog inputs are single-ended, AD1-AD16 carry the analog samples, and AGND carries the common signal; ST1-ST16 carry the status information. In addition to accepting data, the External Relay board provides a set of 34 relay contact closures. Each channel has a RAISE contact and a LOWER contact. They are activated when the appropriate CHnnR or CHnnL line is driven to ground. The Failsafe and Maintenance Override relays are activated by low levels on the FAILSAFE and MAINT lines.

1.3.6 Analog/Status/Command (RT Only)

The Analog/Command/Status board is a multipurpose module which interfaces the CPU board and the External Relay board. It is located inside the chassis, and is mounted on the rear panel. Like most of the other boards which communicate with the CPU board, the Analog/Command/Status board passes data back and forth over the I/O bus. Perhaps the most important function of the Analog/Command/Status board is the Analog to Digital conversion of the analog sample channels. Following several commands from the CPU board, the A/D converter indicates its state of readiness using the line *ADRDY. When a conversion is complete, the CPU board resets the A/D, and selects the next analog sample channel.

1.3.7 Communications I/O

The Communications I/O board is quite simple since it contains no active components, but still is important. It serves as the gateway for all communications directed towards the other terminal and PC, and contains various circuitry designed to protect the MRC1620 from any high voltage surges over the Telco lines, etc. It passes communications data to and from the Data Modems (via the CPU board) using the TELCO IN, TELCO OUT, SUB IN, and SUB OUT lines. Communications with the PC is via the 9-pin RS-232 EIA connector. In addition, other signals such as *BZDRV and *INTBZ are supplied to the rear panel allowing the user to enable the internal alarm buzzer. The Communications I/O board is mounted on the outside of the rear panel of the chassis.

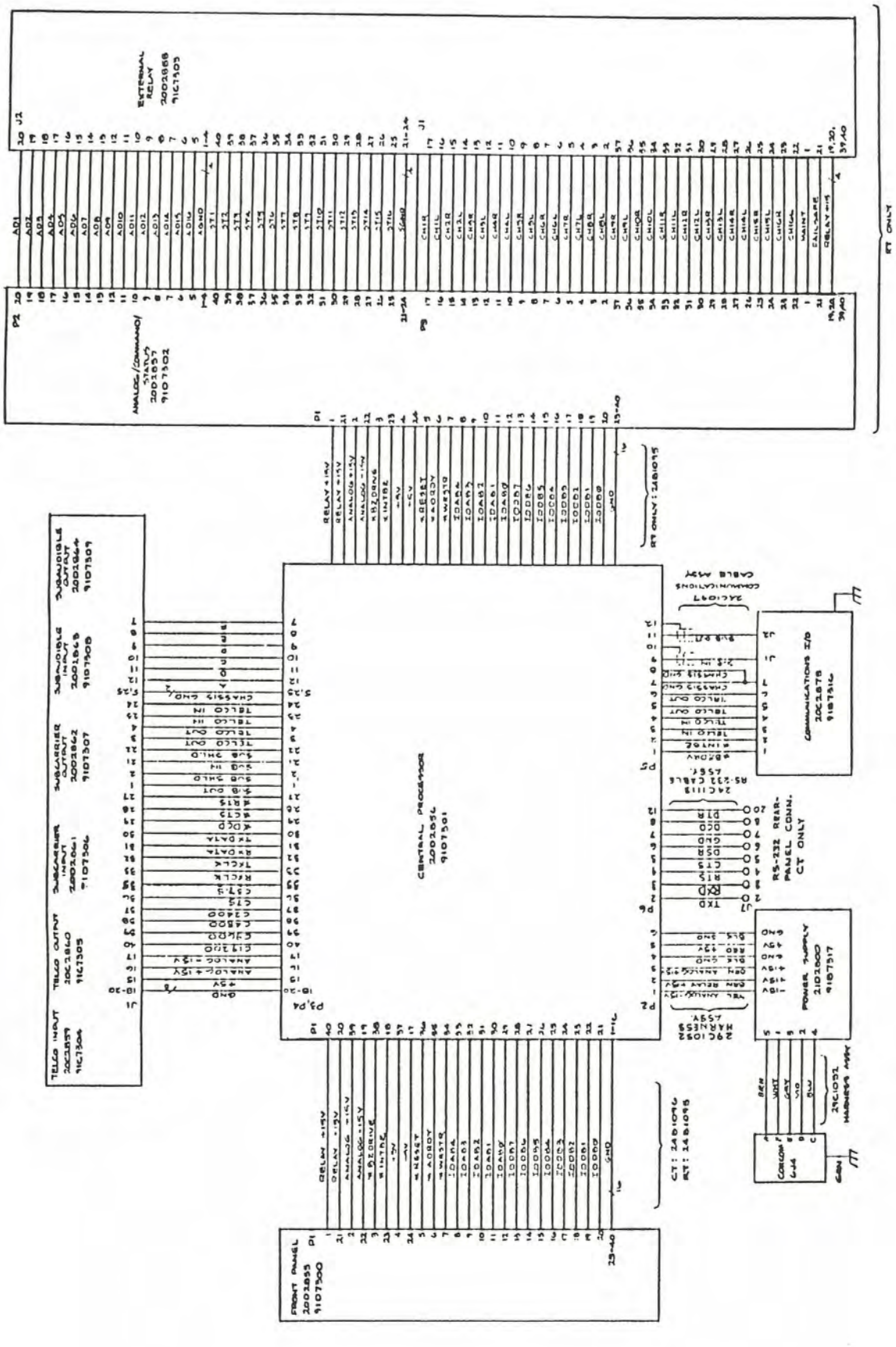

Figure 1-1

MRC1620 Block and Level Diagram

SECTION 2

INSTALLATION

2.1 Introduction

We recommend that you read the entire manual to understand the MRC1620 prior to attempting to hookup this equipment. However, we realize this may be impractical in some situations, so please read at least Sections 2 and 3. In the following discussion, the Remote Terminal is assumed to be used at the transmitter site and the Control Terminal at the studio.

2.2 Unpacking

The MRC1620 Remote and Control Terminals 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 doors to both the Remote and Control Terminals be opened for a superficial inspection of the internal components. This should ascertain that all boards, assemblies, and cables are mechanically secure.

Four screws are used to hold the power supply in place during shipment (located on the underside of the chassis). They should be removed from each terminal before installation. Retain these shipping screws and reinstall them if the terminals are to be moved. This will insure safe transportation.

CAUTION

Do not apply power to either terminal until the procedure in Section 2.3 is completed.

Do not attempt any adjustments of any kind until the nature of each adjustment is understood.

2.3 Line Voltage Selection

The Remote and Control Terminals each have the capability of operating at either 100, 120, 220, or 230/240 Vac, 50-60 Hz. The units are shipped for 120 Vac operation, unless otherwise specified.

The ac power connector on each unit contains a voltage selector card (PC card) and a fuse. The PC card can be inserted four different ways. Verify that the PC card is set for the line voltage to be applied to the unit. The voltage selected can be observed on the PC card through the window in the ac power connector.

If the voltage selector card needs to be changed to match the available power, do the following: unplug the power cord, and slide the access window down. Pull out the FUSE PULL lever and remove the fuse. With a small needle-nose pliers, firmly grasp the PC card and remove it with a straight pull.

Select the operating voltage by orienting the PC card to position the desired voltage number of the top left side. Replace the PC card with the needle-nose pliers.

Verify the fuse in accordance with the label on the power connector. Return the FUSE PULL lever to its normal position and insert the fuse into the holders. Slide the window up and install the ac power cord.

2.4 Site Selection

The Remote and Control Terminals must be set to the same site for proper operation. The site select switch is provided for multi-site operation with PC Software. The site select switch S2 can be found directly beneath P5 on the CPU board. You will have to remove the communications board nearest the center of the CPU board to gain access to S2. Set S2 as follows (S2-8 is not used):

Site	S2-1	S2-2	S2-3	S2-4	S2-5	S2-6	S2-7	
0	off	off	off	off	off	off	off	(factory default)
1	ON	off	off	off	off	off	off	
2	off	ON	off	off	off	off	off	
3	ON	ON	off	off	off	off	off	
4	off	off	ON	off	off	off	off	
5	ON	off	ON	off	off	off	off	
6	off	ON	ON	off	off	off	off	
7	ON	ON	ON	off	off	off	off	
8	off	off	off	ON	off	off	off	
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125	ON	off	ON	ON	ON	ON	ON	
126	off	ON	ON	ON	ON	ON	ON	
127	ON	ON	ON	ON	ON	ON	ON	

2.5 Pre-installation Checkout

The main purpose of the preinstallation checkout is for the user to gain familiarity with the system while both the Remote and Control Terminals are easily accessible and together on a bench at the same location. While the installation is relatively simple and straight forward, certain details of installation and operation, if overlooked, may cause what appear to be equipment failures.

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 boards.

Connect a power cord to both the Remote (the one with the relays on the rear) and the Control Terminals. Plug these into an ac power source. Open the front panels of each terminal and turn on power with the switch that is located at the lower-right corner of the chassis.

Verify that the Remote Terminal is displaying "RT" followed by the site number (typically 0). This indicates Channel 0. After a few seconds the FAILSAFE and ALARM LEDs should be flashing. After about 10 seconds the display will go blank and these two LEDs will be the only LEDs displayed. Press **ACK** key. The display now should show "**19 1.**".

Press the **CHANNEL UP** arrow key. You should now be at Channel 0 again. Press the **SETUP** key and the **UPPER LIMIT** key at the same time. All LEDs and display segments should be illuminated. Release the keys to restore the LEDs and display.

Verify that the Control Terminal is displaying "CT" followed by the site number (typically 0). Press ACK. The display should now show "**19 1.**". Press the **CHANNEL UP** arrow key. You should now be at Channel 0 again. Press the **SETUP** key and the **UPPER LIMIT** key at the same time. All LEDs and display segments should be illuminated. Release the keys to restore the LEDs and display.

2.6 Remote and Control Communications Interconnections

The following paragraphs tell how to connect the two terminals to form an MRC1620 system.

2.6.1 Telco Interconnect

When telephone lines are used for communication in both directions between the two terminals, two modes of operation are possible, 2-wire or 4-wire. In the 2-wire mode, one telephone pair carries both Remote and Control message transmissions. In the 4-wire mode, the Remote and Control Terminal messages are transmitted on separate telephone pairs or their equivalents, giving slightly better noise immunity. In either case, the conditions of a Bell System Series 3002 "basic-conditioned" data channel should be maintained between the Remote and Control Terminals.

Note: The Communications I/O board (on the rear of each chassis) contains varistors which give some protection against lightning strikes. However, we strongly recommend that you provide an external lightning arrestor on all phone lines, especially those at a transmitter site (where the Remote Terminal is located).

If you choose to use a 2-wire Telco circuit, then verify that each of the four Telco boards (two at each terminal) is jumpered for 2-wire operation. (See the lower-right section of each board.) Connect the TELCO INPUT terminals on the rear of the Remote unit to the TELCO INPUT terminals on the rear of the Control unit as shown in Figure 2-1.

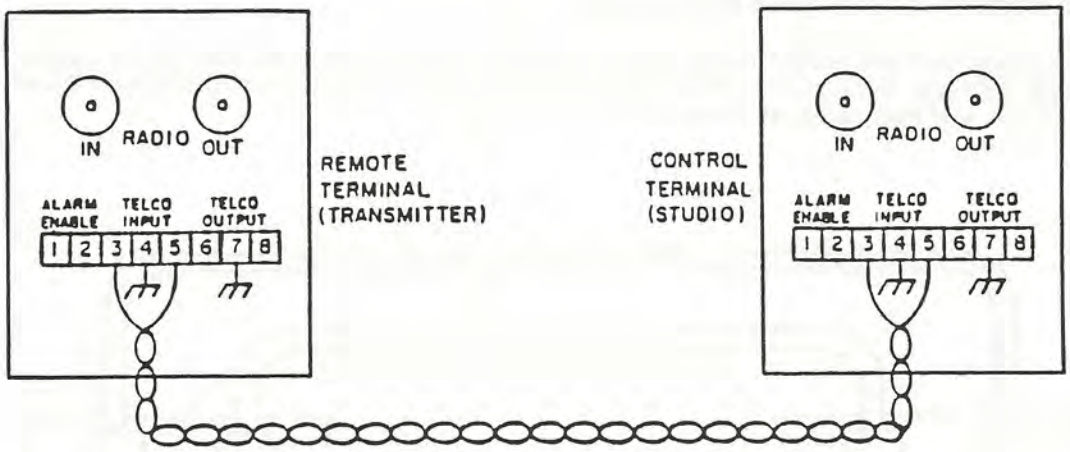


Figure 2-1

2-Wire Telco Communications

If you choose to use a 4-wire Telco circuit, then verify that each of the four Telco boards (two at each terminal) is jumpered for 4-wire operation. (See the lower-right section of each board.) Connect the TELCO INPUT terminals on the rear of the Remote unit to the TELCO OUTPUT terminals on the rear of the Control unit and vice-versa as shown in Figure 2-2.

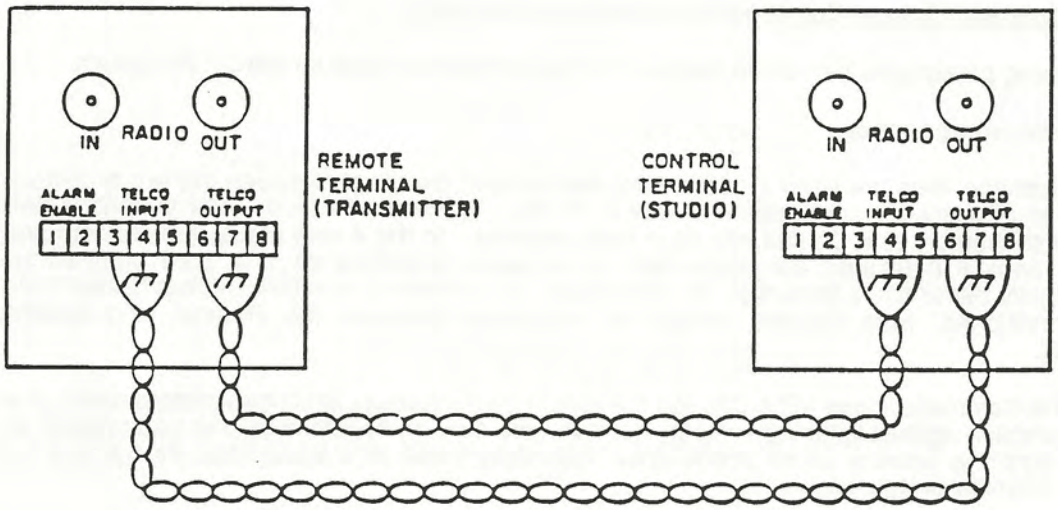


Figure 2-2

4-Wire Telco Communications

2.6.2. Subcarrier and Subaudible Interconnects

When FM subcarriers are used for data in both directions, Subcarrier Input and Output boards are normally supplied. Connect the RADIO INPUT of the Remote unit to the RADIO OUTPUT of the Control unit, and vice-versa, as shown in Figure 2-3.

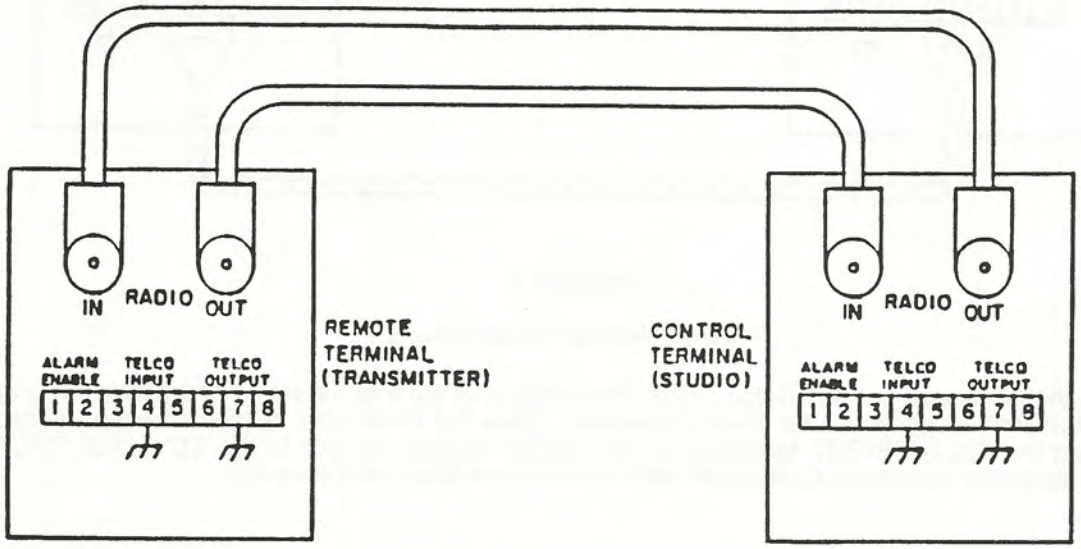


Figure 2-3

Subcarrier Communications

Verify that the correct frequencies for your application are installed. For example, if you want a 110 kHz subcarrier circuit for use over your STL (from Control to Remote) and a 67 kHz subcarrier circuit for use over the air (from Remote to Control), then be sure that the 110 kHz Subcarrier Input board and the 67 kHz Subcarrier Output board are installed at locations P3 and P4 (the positions are interchangeable) of the CPU board (on the rear of the front panel) of the Remote Terminal. It follows that the 110 kHz Subcarrier Output board and the 67 kHz Subcarrier Input board should be located at the Control Terminal.

2.6.3 Mixed Interconnects

When one communication direction is on telephone lines (or equivalent) and the other direction is on subcarrier (or subaudible), then the appropriate boards are supplied. Verify that the Telco boards (there should be two, one at each terminal) are jumpered for 4-wire operation (see the lower-right section of the boards).

If you choose Subcarrier communications from Control to Remote (as with an STL) and Telco communications from Remote to Control (as with a Telemetry Return Link) then verify that the Subcarrier Input board and the Telco Output board are installed at locations P3 and P4 (the positions are interchangeable) of the CPU board (on the rear of the front panel) of the Remote Terminal. The Subcarrier Input board and the Telco Output board should be installed at the Control Terminal. See Figure 2-4.

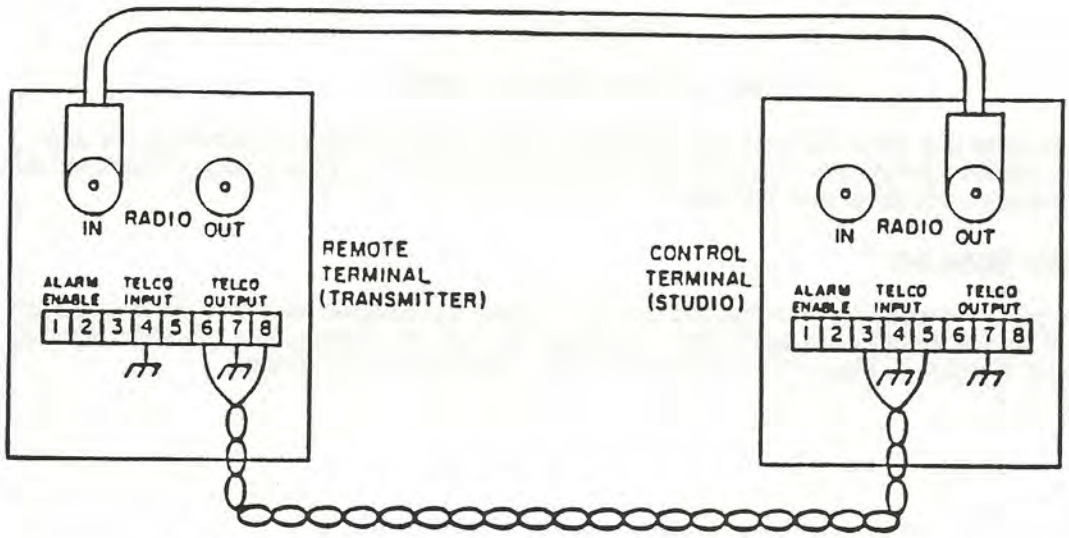


Figure 2-4

Mixed Communications (Case 1)

If you choose Telco communications from Control to Remote (as with a phone line) and Subcarrier communications from Remote to Control (as with subcarrier over the air) then verify that the Telco Input board and the Subcarrier Output board are installed at locations P3 and P4 of the CPU board (on the rear of the front panel) of the Remote Terminal. The Telco Output board and the Subcarrier Input board should be located at the Control Terminal. See Figure 2-5.

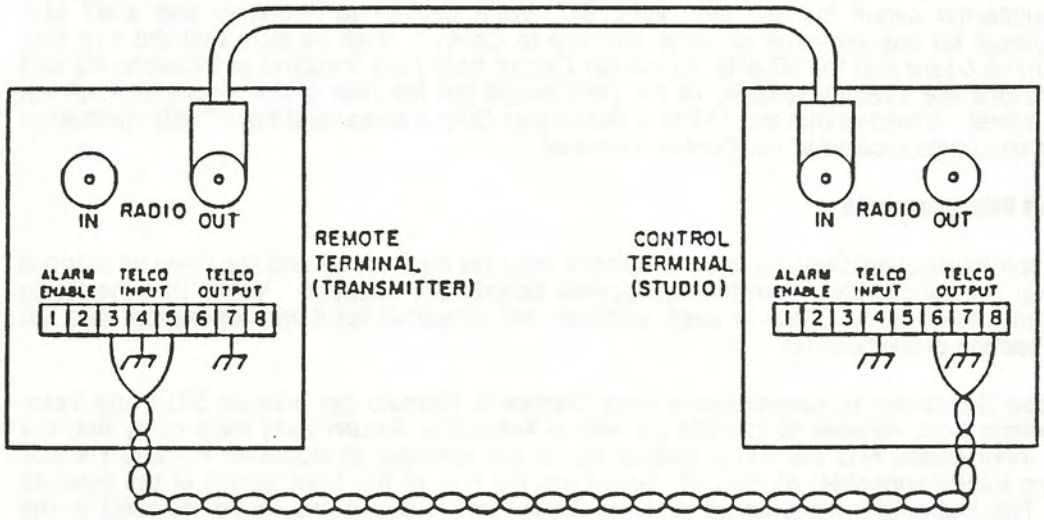


Figure 2-5

Mixed Communications (Case 2)

If you choose to use External Subcarrier equipment with a Telco board to communicate over a Subcarrier Input or Subcarrier Output board, a Telco Lo (in or out, as appropriate) board must be used for the telco portion of that data path.

2.7 System Checkout

Now that you have both the Remote and Control Terminals connected back-to-back on a bench in front of you, it would be a good time to review the SETUP operation of the MRC1620 as discussed in Section 3. Figure 2-6 is provided to help you plan your installation.

CHANNEL	TELEMETRY DESCRIPTION	MODE (M,L,P,I)	NORMAL CALIBRATION	UPPER LIMIT	LOWER LIMIT	MUTE CHAN	STATUS DESCRIPTION	INVERT (YES/NO)	ALARM (N,F,R,B)	MUTE CHAN
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										

Figure 2-6

Setup Worksheet

2.8 Physical Installation

The MRC1620 is designed for industry-standard RTMA rack mounting. If the power supply shipping screws are removed prior to installation, then once the unit is installed in the rack, all boards that normally require service can be removed without removing the chassis from the rack.

2.9 Audible Alarm

Control of the audible alarm (located behind the front panel) at both the Remote and Control Terminals is provided by the terminals labeled "ALARM ENABLE" on the rear of each chassis. *BZDRV is buzzer drive and *INTBZ is internal buzzer.

Several alternatives are available to you. The simplest is to install a jumper between terminals 1 and 2. In this case, the audible alarm will always be activated when an alarm condition is detected.

In the case that a terminal is located in a studio booth, it is possible to have external control of the buzzer so that will be muted when a mike is active. See Figure 2-7. The relay contact (supplied by you) is assumed to be open when any mike is active and closed when no mikes are active.

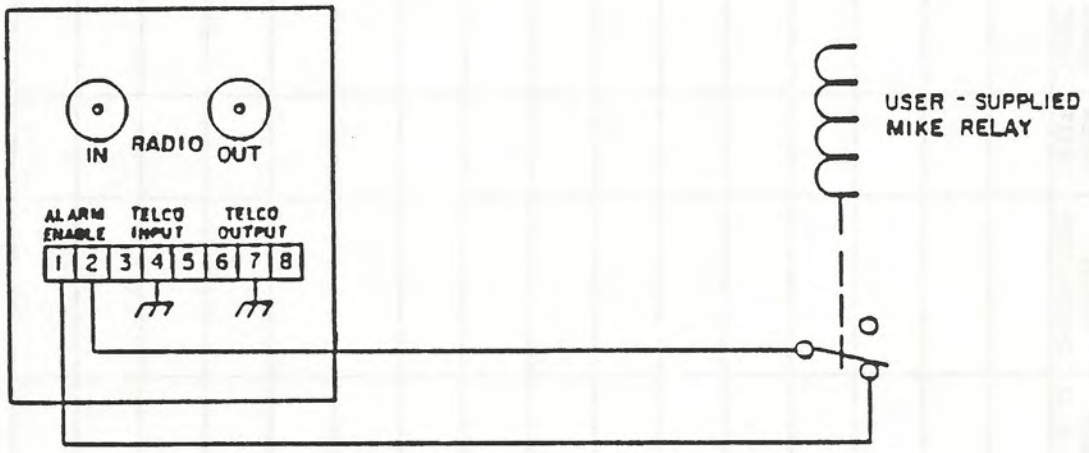


Figure 2-7

Alarm Buzzer Muting

If you wish to use an external indicator (e.g., a lamp or buzzer), note that *BZDRV is a transistor closure capable of sinking only 50 mA at 12 V (to signal ground). For larger loads, use an external relay (supplied by you). See Figure 2-8.

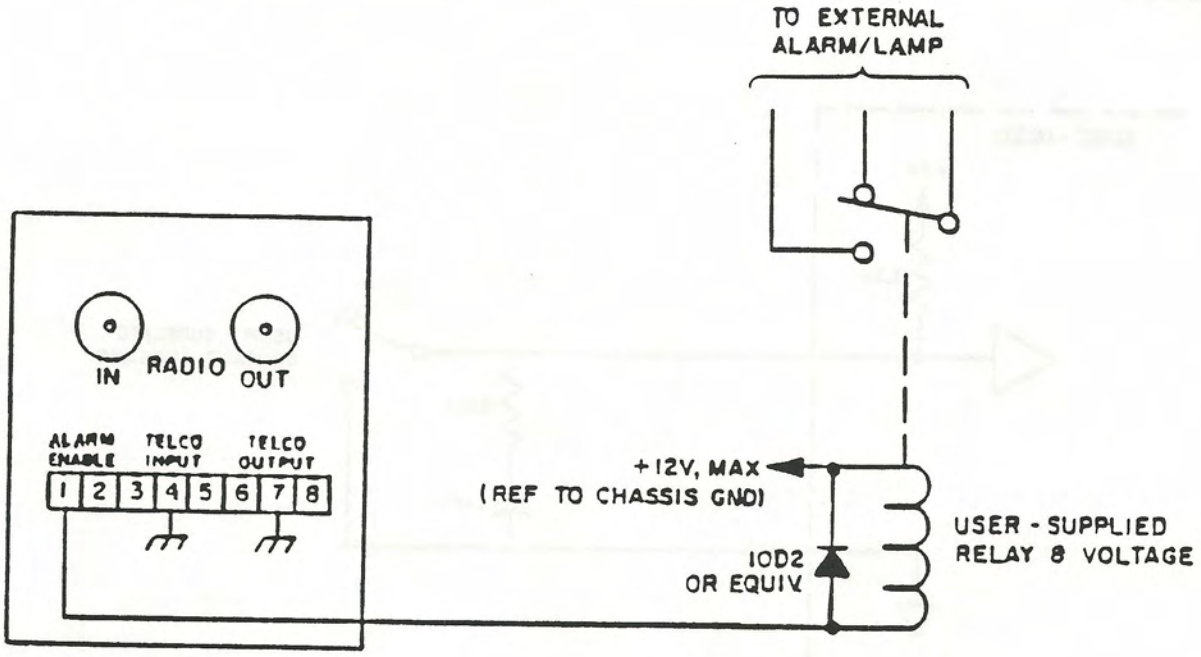


Figure 2-8

External Alarm

2.10 Analog Inputs

The analog input terminals are located at the upper-right corner of the External Relay board on the rear of the chassis at the Remote Terminal. Full-scale input is + or -4.5 Vdc. If you exceed approximately 5 V on an input, "OUCH" will appear in the display, erratic operation may occur on one or more channels. Each input has an integral low-pass filter, so any signal other than dc will be averaged. Each input is singled-ended, i.e., one side of the signal is tied to analog ground. If you wish to use a signal that is floating above analog ground, you must use an external differential and/or isolation amplifier. *We also recommend that you ground any unused analog inputs to prevent erroneous readings.*

2.11 Status Inputs

The status input terminals are located at the lower-right corner of the External Relay board on the rear of the chassis at the Remote Terminal. Each input is TTL compatible, i.e., a "low" is 0 - 0.8 Vdc and a "high" is 2.4-5.0 Vdc. Each input has a 3.3 K ohm pullup so that a simple contact closure will operate a status input. If you use a contact closure (such as a relay), be sure to install an RC network (100 ohm, 0.1 uF) across the contacts to suppress contact bounce. See Figure 2-9.

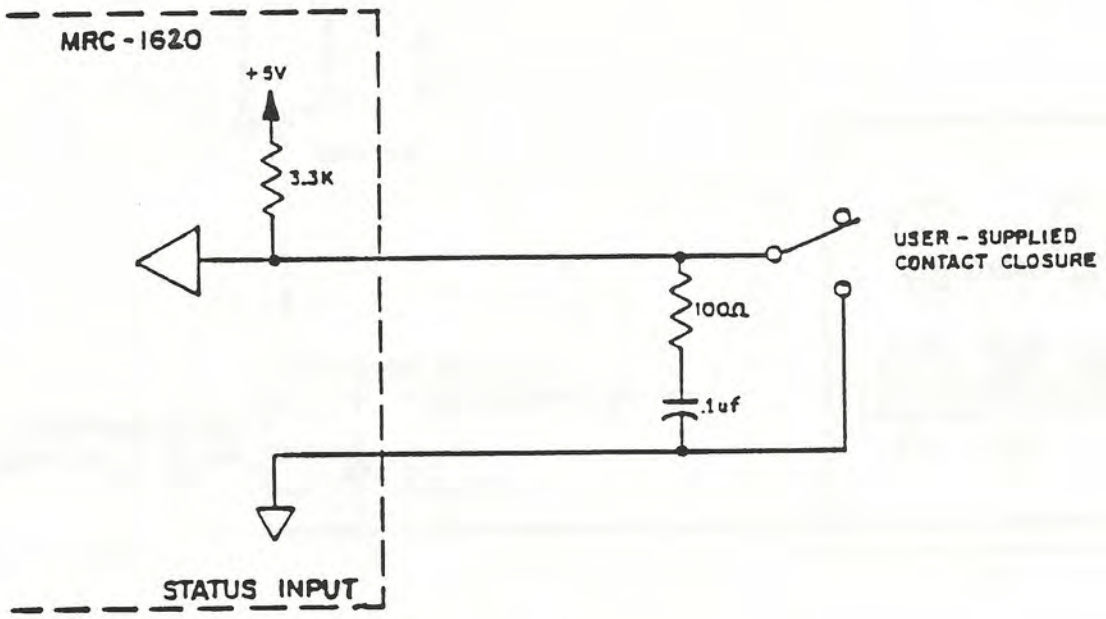


Figure 2-9

Status Input Interfacing

2.12 Relay Outputs

Each of the 34 relays (16 RAISE, 16 LOWER, Maintenance Override, and Failsafe) is rated at 30 V and 2 A, non-inductive. For larger loads and/or higher voltages you should use an external relay (supplied by you), driven by the MRC1620 relay.

For interfacing the relays to TTL equipment, an RC network (100 ohm, 0.1 uF) should be used to suppress contact bounce, and a pullup resistor may be needed, depending on the particular application. See Figure 2-10.

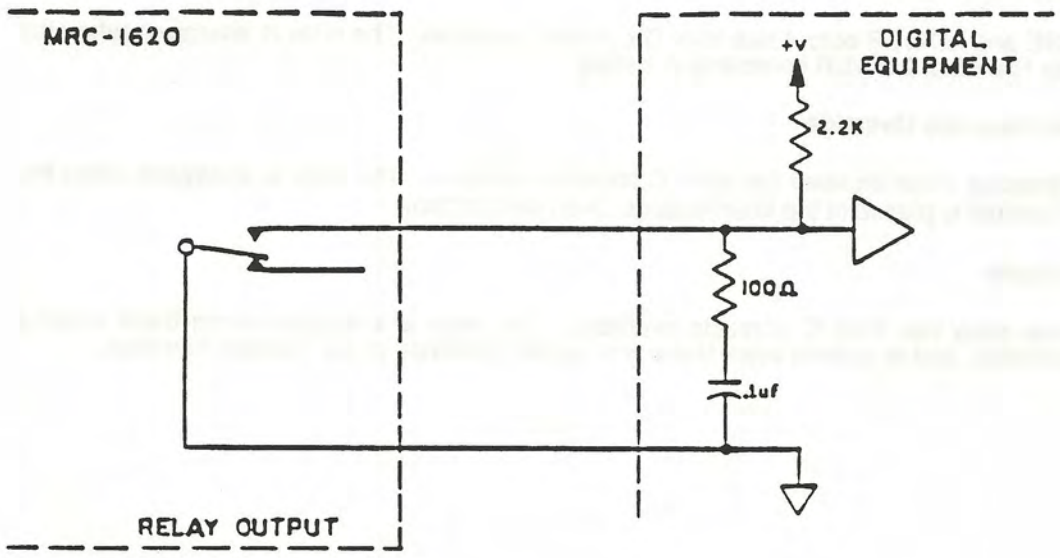


Figure 2-10

Relay Output Interfacing

For interfacing the MRC1620 relays to external relays, external "snubbing" networks (100 ohm, 0.1 uF) must be installed across ac external relay coils or other ac loads; "clamping" diodes (1N4002 or equivalent) must be installed across dc external relay coils. This is mandatory to avoid erratic operation and/or damage to the MRC1620. See Figure 2-11.

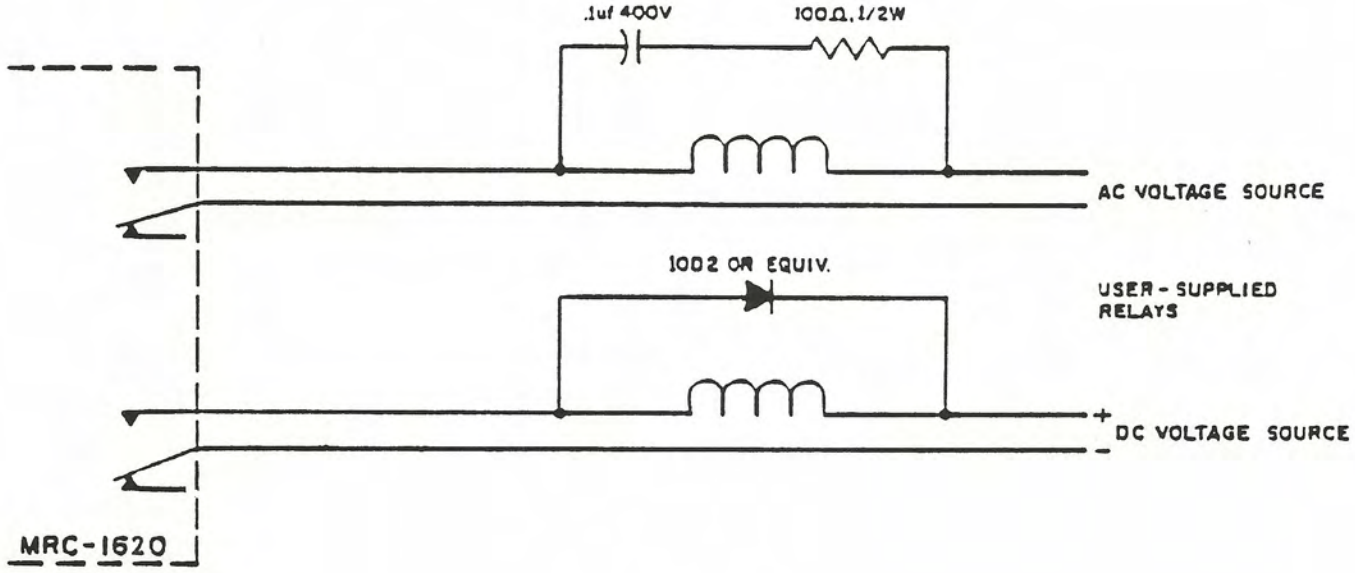


Figure 2-11

Relay-Relay Interfacing

2.12.1 Raise and Lower

Each RAISE and LOWER output has form C contacts available. The relay is energized when the appropriate RAISE or LOWER command is issued.

2.12.2 Maintenance Override

The Maintenance Override relay has form C contacts available. The relay is energized when the Remote Terminal is placed in the Maintenance Override condition.

2.12.3 Failsafe

The Failsafe relay has form C contacts available. The relay is energized when there *is not* a failsafe condition, and is relaxed when there *is* a failsafe condition at the Remote Terminal.

SECTION 3

OPERATION

3.1 Remote Terminal Operation

We suggest that the reader have the Control and Remote Terminals available for experimentation while reading this section. Pushing the buttons on the front panel cannot damage the units. Place the Control and Remote terminals together on a bench or table top, and connect them together (using wire or coax cable terminated by BNC connectors, depending on the interconnection options you have ordered). Refer to Section 2.4 for information on interconnection, Section 2.2 for line voltage selection, and Section 2.3 for preinstallation checkout.

This having been done, power up both terminals using the power switch located inside the chassis. You will have to open the front panel using the knurled knob to do this.

If you do not have the units available while reading this section, Figure 3-1, showing a front panel, is provided below for reference. The Control and Remote terminals have identical front panels. (You can tell them apart by looking at Channel "0" or the rear of the units. The Remote Terminal has an external relay board.)

As one might guess from their close resemblance, operation from the Control and Remote Terminals is very similar. The Remote Terminal (which is the unit installed at the transmitter) has additional set-up capabilities. We will first describe operation at the Remote Terminal, then describe how the Control Terminal differs.

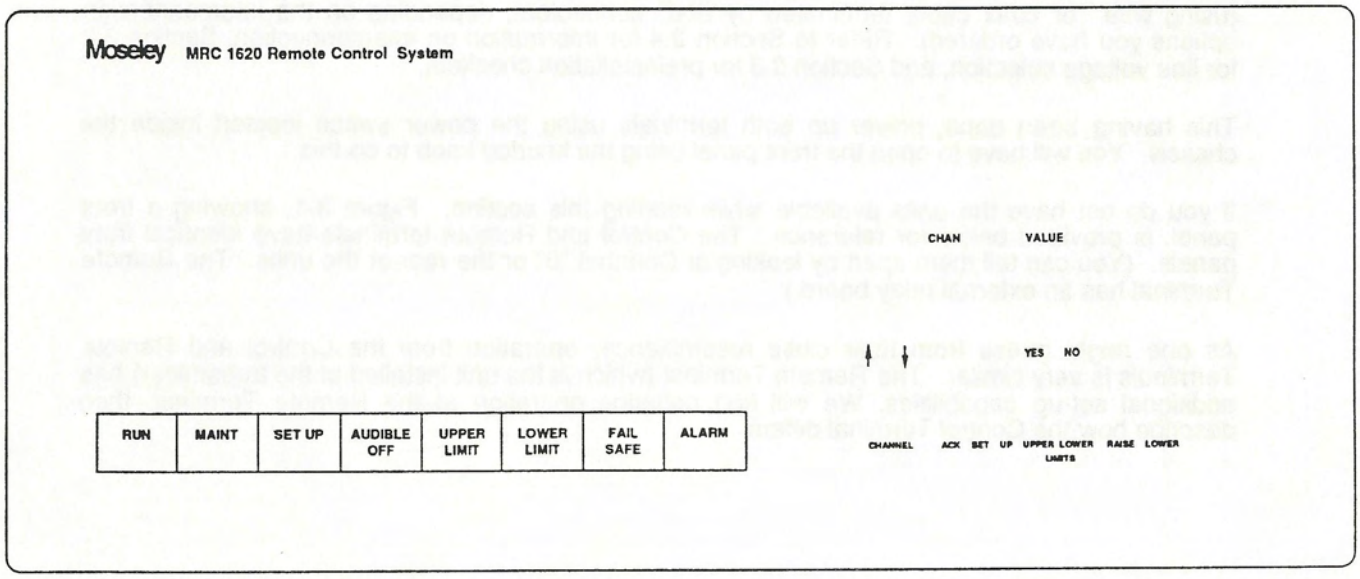


Figure 3-1

MRC1620 Front Panel

3.1.1 General Comments

The alphanumeric display on the front panel always pertains to one of the twenty channels (numbered 0 to 19). When the Remote Terminal is powered up, it goes to channel 0. Channel 0 is the "power saver" channel; after ten seconds the displays are turned off (except for the RUN, MAINT, FAILSAFE, and ALARM LEDs, whose significance we will explain later). Any time a button is pushed, the displays are turned on for ten seconds. Only channel 0 has this feature, which is useful if you are using an uninterruptible power supply (UPS) containing a battery.

To select a different channel, press the **UP** or **DOWN** arrow keys. Each time you push the button, the channel number is incremented or decremented. Holding the button down will cause the system to advance (or retreat) through the channels continuously. After channel 19, channel 0 is selected (and vice-versa).

Channel 0 displays the terminal type (RT or CT) and the site number.

Channels 1-16 display the current value of the sixteen analog (telemetry) inputs.

Channel 17 is a test of the A/D (analog-to-digital) converter. The A/D reference voltage is fed through the input amplifier and back into the A/D converter. It should always read within 20 counts of 2048.

Channel 18 is an indication of the performance of the interconnection between terminals. The first two digits represent the quality of communications (proportion of error-free messages) received from the other terminal (hardwire port, HW, connected through the plug in cards). The second two digits represent the quality of communications it is receiving from the PC port. Each of these data quality displays is a number from 00 to 99, with 99 being best.

Channel 19 displays the time remaining until Failsafe as a number of minutes between 0 and 9999. If Failsafe is not enabled, 0 will be displayed.

3.1.2 Channel 0

When channel 0 is selected, the keys have different meanings than those marked on the front panel. At the Remote Terminal, we have:

SET UP and **UPPER LIMIT** simultaneously:

Lamp Test: All LEDs and all segments of the alpha-numeric display are lit up.

SET UP and **LOWER LIMIT** simultaneously:

Audible Alarm Test: The front panel audible alarm is sounded as long as the keys are pressed.

NOTE

You must install an enabling jumper on the rear of the unit before the alarm will sound. Refer to Section 2.8, Audible Alarm for information.

SET UP and **RAISE** simultaneously:

Audible alarm enable/disable. Each simultaneous push of these keys reverses the status of audible alarming. The LED labeled AUDIBLE OFF shows the current status. The audible alarm disable function does not disable the audible alarm test.

SET UP and **LOWER** simultaneously:

Maintenance override enable/disable. FCC regulations traditionally required that only one point at a time in a Remote Control system may be the "control point". The control point has the ability to execute command actions. In the Moseley MRC product line, when the Remote Terminal is the control point, there is said to be a "Maintenance Override" condition. This corresponds to the local/remote function on many older remote controls and is essential for personnel security at the transmitter site.

When a maintenance override condition exists, the MAINT LED is lit at both Control and Remote Terminals. The **RAISE** and **LOWER** keys at the Control Terminal are disabled and the **RAISE** and **LOWER** keys at the Remote Terminal are armed. A relay at the Remote Terminal is closed when the system is in a maintenance override condition. This permits the connection of an external light or alarm to warn personnel to remove the system from Maintenance Override Mode before leaving the transmitter plant. ***MAINTENANCE OVERRIDE MAY NOT BE ENDED FROM THE CONTROL TERMINAL.*** Each simultaneous push of **SET UP** and **LOWER** at the Remote Terminal while channel 0 is selected reverses the current state of maintenance override.

SET UP and **ACK** simultaneously:

This clears all alarms at once. Various conditions cause alarms in the MRC1620. These will be described later. If there are several different alarms (for instance, several channels go out of tolerance) the alarms will be stacked. Normally each alarm will be displayed in turn. (Each time **ACK** is pushed the next alarm is displayed.) If for some reason you do not want to step through all the alarms, **SET UP** and **ACK** pushed simultaneously while on channel 0 will clear all the alarms.

3.1.3 Channels 1-16

The preceding key combinations pertain to channel 0. For channels 1-16 the keys have the following effects:

RAISE: Activates the RAISE relay associated with the selected channel. See note under "LOWER."

LOWER: Activates the LOWER relay associated with the selected channel.

NOTE

RAISE and LOWER at the Remote Terminal will have no effect unless the unit is in maintenance override mode. Maintenance override defeats RAISE and LOWER at the Control Terminal.

UPPER AND LOWER LIMITS: These keys are used to display any tolerance limits which you have established for the selected channel. (These limits are entered via set-up mode, which we will describe later.) The limit will be displayed as long as the key is held down. A display of 0. indicates that no limit has been established for the selected channel, not that the limit is 0 units.

ACK (Acknowledge): This key is used to acknowledge alarms. The following conditions cause alarms at the Remote Terminal:

Channels 1-16 out of user-established tolerance limits.

Status alarms. (You can establish alarms on transitions of the 16 status channels. We will describe how to do this later.)

Channel 17 (A/D test) out of factory-preset tolerances.

Interruption of data from Control Terminal. (Channel 18)

Failsafe started/activated. (Channel 19)

When one or more of these conditions occurs, the alarm LED flashes. If the audible alarm has not been disabled (via **SET UP** and **RAISE** on channel 0, described previously) and the enabling jumper has been installed on the rear panel, the audible alarm will sound also. The alarm is cleared by pushing **ACK**. The appropriate alarming channel is selected automatically.

In the case of telemetry tolerance alarms, the red LEDs labeled UPPER LIMIT and LOWER LIMIT are lit as appropriate, for as long as the out-of-tolerance condition persists. (These LEDs pertain to the selected channel only. If you go to another channel that is not out of tolerance, they will go out.) If an alarm conditions ends, the alarm must still be acknowledged. The affected channel will be selected, but the tolerance LEDs will not be lit.

If several alarms have occurred, the alarms will be stacked. Pushing **ACK** clears the first alarm. After a four-second delay the alarm LED will flash again, the audible alarm will sound if it has been enabled, and when the operator pushes **ACK** the next alarm channel will be selected. This process continues until all of the alarms have been cleared.

If there are no unacknowledged alarms, pushing **ACK** will select channels where the previously acknowledged alarm condition remains in effect. If there is more than one such channel, each channel will be selected in turn as **ACK** is pushed successively. (You must wait four seconds between pushes.) In the case of status alarms, the alarm channel will be among those selected until the next status transition on that channel.

If an analog channel is muted, a "[" will appear in front of the value and limit checking will be suspended for that analog channel. If a status channel is muted, alarm checking will be suspended for that status channel.

3.1.4 Failsafe

When the Remote or Control Terminal senses that it is no longer receiving data transmissions from the other terminal, the failsafe sequence commences. When the data performance reaches 50, an alarm is sounded for channel 18. When the data performance reaches 00, the FAILSAFE LED on the front panel begins to flash and the failsafe countdown begins (from the user-set nominal time). When three minutes remain in the countdown, an alarm is sounded for channel 19. When zero minutes is reached, the LED remains on steadily , another alarm is sounded, and the failsafe relay relaxes at the RT. This relay can be connected to make your transmitter inoperative under failsafe conditions. As soon as communication from Control to Remote is reestablished, the LED goes off and the failsafe relay energizes again.

Entering maintenance override at the Remote Terminal ends failsafe. Failsafe can be disabled (see Section 3.2.2).

3.2 Remote Terminal Set Up

Channels 1-16 can be calibrated, given tolerance alarm limits, et cetera. Channel 18 can be used to set up communications header and trailer bytes. Channel 19 can be used to set up Failsafe. To enter set-up mode, select a channel using the **UP** and **DOWN** arrow keys and press **SET UP**.

When in set-up mode, the SET UP LED is lit. You may think of setup as a series of questions. At the end of the sequence the SET UP LED goes off and the various setup parameters you have established go into effect. To abort the sequence simply press **SET UP** again.

WARNING

You must go through the entire sequence or none of your entries will take effect; sample telemetry voltages must be present during telemetry set-up. Status inputs should be connected for status alarm set-up.

While in set-up mode, the keys marked UPPER and LOWER LIMIT take on the meanings YES and NO. ("YES" and "NO" are marked above the keys.)

In general, press **NO**, **UP**, or **DOWN** as appropriate until the alphanumeric display shows what you want to see. Then press **YES** to enter the proper parameter and go on to the next question.

3.2.1 Channels 1-16

Calibration Mode

After you select a channel and press **SET UP**, you will see MVOLT in the alphanumeric display. We are choosing the telemetry calibration mode. Our choices are:

MVOLT (millivolt)
LINEAR
POWER
INDIRECT (except on channel 1)

As you press **NO**, each of these choices will be displayed in turn. Press **YES** when your choice appears in the window.

MVOLT specifies that the display value for the selected channel will be expressed in millivolts. For example, if channel 1 is calibrated in MVOLT mode and 3.2 volts is applied to the corresponding analog input, "3200*" will be displayed. The "*" indicates that value is in millivolts.

LINEAR specifies that the display value will be directly proportional to the input sample voltage for the channel being set up. Later on you will have to enter a calibration value. We will explain this when we get to it.

POWER mode specifies that the display value will vary as the square of the input sample voltage. You may use this mode to compute power from a telemetry input that varies proportional to current. This mode also requires a calibration value, and will be explained more fully later.

INDIRECT mode specifies that the display value will vary in proportion to the product of the input voltage on the channel being set up, and that of the next lower-numbered channel. For instance, if channel two is calibrated in INDIRECT mode, the input voltages on channel one and two are multiplied, and the display value is proportional to this product. (As with LINEAR and POWER modes , you will enter a calibration factor later.) Since channel one has no next lower channel, INDIRECT mode will not be offered as a choice when you are setting it up.

Decimal Point Position

If you have selected MVOLT mode, you will skip the next three choices, and advance directly to upper limit entry, below. Otherwise (in LINEAR, POWER and INDIRECT modes), you must now choose from these:

XXXX.
XXX.X
XX.XX
X.XXX
.XXXX

This entry specifies the position of the decimal point for the display. Press **NO** until you see the position you want, then press **YES**.

Displayed Sign

Next you choose from:

SIGN +
SIGN -

This entry specifies the sign of the calibration factor you are about to have calculated by the MRC1620 (see below). Use **NO** and **YES**.

Calibration Value

Now we enter the calibration value. This process is exactly analogous to the process of calibration on a conventional remote control, where you adjust a trim-pot until the meter reads correctly. To adjust the display value use the use the **UP** and **DOWN** keys until you see the value you want to be displayed for the input sample voltage you have applied.

For example, suppose you apply a 3.0 volt telemetry sample to the input for channel two, select channel two, press **SET UP**, select Linear mode, select XXX.X, and select sign +. When you get to the calibration factor, the display starts out at 100.0. You may adjust this to any value you want by using **UP** and **DOWN** keys. Let's suppose 100.0 is exactly what you want. You press **YES**. After you complete the remaining questions, you leave set-up mode. From now on, whenever 3.0 volts of sample is applied to the input for channel two, 100.0 will be displayed when channel 2 is selected. If 1.5 volts is applied, this is half as much, so 50.0 will be displayed. Suppose you had chosen POWER instead of LINEAR mode (with all the other entries exactly the same). For a 3.0 volt sample applied to the input, the display says 100.0, just as for LINEAR. But when you apply 1.5 volts, the input voltage is half as much, so the display value falls according to the square of one-half (i.e., one-fourth) and therefore 25.0 is displayed.

Let us take the same example again, but this time choosing INDIRECT mode. Suppose a 1.0 volt sample has been applied to channel 1 and 3.0 volts to channel 2 at calibration time. We once again choose 100.0 as the calibration factor. Since the display value is proportional to the product of the two voltages, we can develop the following table:

	Channel 1: Input:	Channel 2: Input:	Channel 2: Display:
Original Conditions:	1.0 V	3.0 V	100.0
Changed Conditions:	0.5 V (x 1/2)	3.0 V (x 1)	50.0
	0.5 V (x 1/2)	1.5 V (x 1/2)	25.0
	3.0 V (x 3)	3.0 V (x 1)	300.0

Studying these examples should give you a good grasp of the operation of INDIRECT mode.

Due to the characteristics of the A/D converter used in the MRC1620, accuracy is proportional to the input sample voltage at calibration time. If you apply less than 0.25 V, accuracy is not enough to meet the accuracy specification of 0.5%. Therefore, any attempt to calibrate with less than 0.25 V applied to the appropriate input (either inputs in INDIRECT mode) will be ignored. The channel will remain calibrated in whatever mode it was in before you entered setup mode. In general, you should try to calibrate with the input voltage near full scale. The voltage applied should never exceed 4.5 volts, however.

Upper and Lower Limits

After you have entered the calibration factor, you are asked for upper and lower telemetry tolerance limits. If the value as calibrated goes outside the tolerance you have entered, an alarm results. Setting a tolerance of 0 is equivalent to defeating the limit. The system displays an initial value of 5% over or under the display value as appropriate. For example, if you have calibrated the channel to display 100.0, the initial value for upper limit will be 104.9, and that for lower limit will be 95.0. You may use **UP** and **DOWN** keys to change the limit as you please. Pressing **NO** will set the display value to 0. Press **YES** when the display shows the correct value and the limit will be established.

Analog Mute Channel

Limit checking (upper and lower) may be suspended (muted) for a given analog channel when a chosen status channel is OFF. After completing limits setup, you are asked for the status channel that will mute the analog channel you are setting up. Setting the mute channel to 0 turns off the muting (limits always checked) for the analog channel. Use **UP** and **DOWN** keys to change the mute channel.

NOTE

Muting always is determined from displayed status channel (LED off).

Status Invert

This completes the setup of the analog telemetry input for the selected channel. The remainder of the set-up sequence is for STATUS indications. The first choices are:

STAT NORM and
STAT INV

This set-up allows you to invert the status applied to the input before it is displayed. When STAT NORM is selected, a closure across the status input terminals for the selected channel causes the LED to be ON. When there is no continuity between the terminals, the LED is OFF. Selecting STAT INV reverses this. **NO** and **YES** are used to select between the choices, as before.

Status Alarms

Now, you can specify the conditions for status alarms:

NONE
RISING
FALLING
BOTH

If you select RISING, an alarm will be triggered whenever the LED indication for the selected status channel goes from OFF to ON. FALLING is the reverse transition. Both specifies there will be an alarm on any transition. Do not use any response except NONE if you are not using the status inputs, as superfluous alarms may result upon leaving the setup mode. As before, use **NO** and **YES** to make your choice. When you have made your selection, you have completed the setups for this channel. The SET UP LED will go off, and the value as calibrated will be displayed.

Status Mute Channel

Status alarm checking may be suspended (muted) for a given status channel when a chosen status channel is OFF. This is analogous to limit check muting. Again you are asked for the status channel that will mute the status channel you are setting up. Setting the mute channel to 0 turns off muting (alarms are always checked) for the status channel. Use the **UP** and **DOWN** keys to change the mute channel.

NOTE

Muting is always determined from the status channel as displayed (LED off).

3.2.2 Channel 18 -- Communications Header and Trailer Bytes

Select Channel 18 and press SET UP. "HBYTE=nn" will be diplayed where nn is from 0 to 16, indicating the number of header fill bytes preceding normal MRC 1620 communications messages. Select the desired time using UP and DOWN keys. Press YES to accept the valve and continue. "TBYTE=nn" will be displayed, indicating the number of trailer fill bytes appended to normal MRC 1620 communications messages. Select the desired time using UP and DOWN keys. Press YES to accept the valve and exit setup.

These two values should be set to the minimum value required for your modems being used. The factory default is zero for both.

Modem Type	HBYTE	TBYTE
Moseley Internal	0	0
"AT" dialup	0	0
Multitech 202T (AT PC)	2	0

3.2.3 Channel 19 -- Failsafe

Select Channel 19 and press **SET UP**. "FS= nnnn." will be displayed where nnnn is from 0 through 9999. 0 represents disabled and 1 through 9999 are minutes until failsafe. Select the desired time using **UP** and **DOWN** keys. Press **YES** to accept the time and exit set up. The factory default is 1 minute.

Be sure to consult the current FCC rules and regulations regarding failsafe. The failsafe time should be set to a value which is determined by your transmitter installation. If you are using a PC control terminal with dial-up operation only, you might set this period to just longer than the period that you intend to dial the RT. For example, 180 for 3 hours or 1440 for 24 hours. The RT will then dial the PC if it has not been queried within the allotted time. 9999 minutes corresponds to 166 hours, which is just short of a week.

3.3 Final Notes on the Remote Terminal

Verifying Parameters

You may check the set-up parameters at any time without changing them. Simply press **SET UP** and press **YES** successively. You may change one aspect of the set up without changing the others, simply by using **NO**, **UP**, or **DOWN** keys as appropriate and then pressing **YES** until you reach the end of the sequence. You must continue to the end of the setup sequence for any new set-up factors to be entered.

RUN LED

The RUN LED has not been mentioned yet. This is simply an indication at a glance that conditions at the terminal are normal. The RUN LED will be OFF if the terminal is:

a. in maintenance override
b. being set up, or
c. in failsafe or impending failsafe.

3.4 Control Terminal Operation

Operation at the Control Terminal is similar to that at the Remote. These are the differences:

Channel 0 does not have the "power saver" feature.

The status of Maintenance Override may not be changed from the Control Terminal. Therefore SET UP and LOWER pressed simultaneously on channel 0 have no effect. There is no maintenance override relay at the CT

There is no failsafe relay at the Control Terminal (you will nonetheless get an alarm upon failsafe or impending failsafe).

There is no set up at the CT except Channel 18. Pressing the SET UP key on other channels has no effect.

The RUN LED, in addition to the conditions listed above (see Section 3.3), is OFF when the RT received data quality is less than 50.

The summary of MRC1620 Operation (see Section 3.5) lists the functions for quick reference.

3.5 Summary of Operations

Operation

Press **UP** or **DOWN** arrow keys to advance or retreat through the channels.

Press **RAISE** or **LOWER** for relay activation after selecting desired channel.

Press **UPPER LIMIT** or **LOWER LIMIT** to display telemetry tolerance limit. A limit of 0 means no limit has been established.

Press **ACK** to acknowledge tolerance or status alarm (in response to flashing alarm LED and audible alarm). The channel in question will be selected. If there is more than one alarm, they will be presented in order of channel number.

If there is no flashing alarm LED, press **ACK** to disclose any previously acknowledged alarms where the alarm condition persists. These include:

a. Telemetry channel remains out tolerance.
b. Status channel remains OFF after falling edge alarm.
c. Status channel remains ON after rising edge alarm.

The RUN LED is OFF if the Remote Terminal is:

a. In Maintenance Override,
b. Being set up,
c. In failsafe or impending failsafe, or,
d. Not communicating with the CT (CT only)

There are 20 channel displays as follows:

Channel 0 - After ten seconds the RT goes into "power saver mode", with only the RUN, MAINT, SET UP, and ALARM LEDs enabled.

Channels 1-16 - The 16 telemetry inputs.

Channel 17 - A/D gain reference - should be 2048 +/- 20 counts.

Channel 18 - Data link performance figures. HW port;PC port. Each performance value is expressed as a number from 0 - 99.

Channel 19 - Time until Failsafe, expressed as minutes from 0 to 9999.

Channel 0--The following combinations of keys pressed simultaneously have special meanings:

SET UP & UPPER LIMIT:	Lamp Test
SET UP & LOWER LIMIT:	Audible Alarm Test
SET UP & RAISE:	Toggle Audible Alarm
SET UP & LOWER:	Toggle Maintenance Override (RT only)
SET UP & ACK:	Clears all unacknowledged alarms

Failsafe

Alarms when CT to RT link performance is < 50. Starts countdown from nominal when link performance = 00. Alarms when countdown < 4. Alarms and enters failsafe when countdown = 0.

SET UP

To set up a channel at the Remote Terminal, select the desired channel and press **SET UP**. Telemetry samples must be present.

1. Telemetry Calibration Mode

   MVOLT (millivolt display)

   LINEAR (proportional to input)

   POWER (proportional to square of input)

   INDIRECT (proportional to product of this channel and next lower channel - not allowed on channel 1)

   Press **NO** to step through the choices; press **YES** when desired choice is displayed.

2. Telemetry Display Decimal Point

   XXXX.
   XXX.X
   XX.XX
   X.XXX
   .XXXX

   Use **NO** and **YES**.

3. Sign of Telemetry Calibration Factor

   SIGN+
   SIGN-

   Use **NO** and **YES**.

4. Telemetry Calibration Value

5. Telemetry Upper Tolerance Limit

6. Telemetry Lower Tolerance Limit

7. Analog Mute Channel

   Use **UP** and **DOWN** arrow keys to increment and decrement displayed number for 4, 5, 6, and 7. Press **YES** when desired value is displayed.

8. Status Input Inversion

   STAT NORM (i.e., not inverting)
   STAT INV (i.e., inverting)

   Use **NO** and **YES**.

9. Status Alarm

   NONE (no alarm)
   FALLING (alarm on LED change to OFF)
   RISING (alarm on LED change to ON)
   BOTH

   Use **NO** and **YES**. Do not use on unused status channel (i.e. leave as NONE).

10. Status Mute Channel

    Use **UP** and **DOWN** arrow keys to increment and decrement the displayed channel. Press **YES** when desired channel is displayed.

CHANNEL	TELEMETRY DESCRIPTION	MODE (M,L,P,I)	NORMAL CALIBRATION	UPPER LIMIT	LOWER LIMIT	MUTE CHAN	STATUS DESCRIPTION	INVERT (YES/NO)	ALARM (N,F,R,B)	MUTE CHAN
1	DAY KV	L	DP XXXX. + 152Ø	Ø	Ø	Ø		N	N	Ø
2	DAY AMPS	L	DPX.XXX+.42Ø	Ø	Ø	Ø		N	N	Ø
3	MODE	L	DPXX.XX+.13	Ø	Ø	Ø	NITE MODE	N	N	Ø
4	NITE KV	L	DPXXX.+1713	Ø	Ø	Ø		N	N	Ø
5	NITE AMPS	L	DPX.XXX+.365	.ØØØ	.ØØØ	Ø		N	N	Ø
6	C.P. AMPS	L	DPXX.XX +3.27	.ØØ	.ØØ	Ø		N	N	Ø
7	DAY-ANT/N-REF	L	DPXXX.X +.2	Ø	Ø	Ø		N	N	Ø
8	RATIO	L	DP X.XXX +.ØØ2	.ØØØ	.ØØØ	Ø		N	N	Ø
9	PHASE	L	DPXXX.X +47.5	.Ø	.Ø	Ø		N	N	Ø
10		L	DPXXXX. 1ØØØ.	Ø	Ø	Ø		N	N	Ø
11		L	DPXXXX. 1ØØØ.	Ø	Ø	Ø		N	N	Ø
12		L	DPXXXX. 1ØØØ.	Ø	Ø	Ø		N	N	Ø
13		L	DPXXXX. 1ØØØ.	Ø	Ø	Ø		N	N	Ø
14		L	DPXXX.X +119.6	Ø	Ø	Ø	RACK PWR	Y	N	Ø
15		L	DPXXXX. 1ØØØ.	Ø	Ø	Ø	TWR LITES	N	N	Ø
16		L	DPXXXX. 1ØØØ.	Ø	Ø	Ø	BLD ALM	N	N	Ø

17 – 2Ø47*
18 – ØØ99 (Current Being Adjusted By Remote Attenuator ØØØØ)
19 – 18Ø min = 3 HOURS (Currently at ZERO "Ø" – Data Inoperational)

Figure 2-6
Setup Worksheet

SECTION 4

MODULE CHARACTERISTICS

4.1 Introduction

This section provides theory of operation for the MRC1620. Please see Section 9 for schematics, assemblies and parts lists.

The modules are discussed in the following order:

4.2 Power Supply

Schematic: 91D7317 (Fig. 8-1)

The power supply module generates the dc voltages required by the other boards. This power supply can operate at one of four nominal ac power source voltages: 100, 120, 220, or 230/240 Vac, 50-60 Hz. Input voltage selection is done through the voltage selector card (pc card) within the CORCOM 6J4.

The supply produces a total of three different voltages: +15 Vdc at .8 A, +5 Vdc at 3 A, and -15 Vdc at .8A. Voltages are generated through a full-wave center-tap diode scheme, capacitively filtered, then regulated using solid state series-pass integrated-circuit regulators. Voltages are supplied to the CPU board via a six pin connector assembly.

4.3 CPU

Schematic: 91D7365 (Fig. 8-2)
Assembly: 20D2917 (Fig. 8-3)

This section provides a comprehensive technical description of the CPU board. It is not a detailed explanation of microprocessors, but rather discusses the basic design concepts incorporated into the board. The user is referred to many excellent texts on microprocessors which can be found at your local library.

The CPU board is composed of six sections.

* MPU
* Address Decoding
* System I/O
* Reset Circuitry
* Modem I/O
* RS-232 I/O

MPU

U20 is the MPU (Microprocessing Unit) 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 board to select the PIA (Peripheral Interface Adapter), the ACIAs (Asynchronous Communications Interface Adapter), the RAM (Random Access Memory), the EEPROM (Electrically-Erasable Programmable Read-Only Memory), or the EPROMs (Erasable, Programmable Read-Only Memory).

The data bus (D0-D7) is used to carry the data between the MPU and other parts of the board. This bus is bidirectional. 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 to a known state. BA indicates the MPU is accessing the bus. *IRQ, *FIRQ, and *NMI are interrupt inputs. *HALT and *DMA/BREQ are inputs used with direct memory access schemes and are not used in the MRC1620. MRDY is a memory ready signal used to interface with slow memories and is also not used in the MRC1620. XTAL and EXTAL connect with Y1 to form a 4.0 MHz oscillator. R30, C24 and C25 prevent oscillation at overtones.

Address Decoding

The majority of the address decoding is done by U19 which functions as a one-of-eight selector. Depending upon the address generated by the MPU, U30 drives the proper select line to the logic zero level. U9 and U10 facilitate address decoding by providing signals to U19. The remainder of the address decoding is completed within the selected chip itself. The jumper block at the bottom of the board (near U19) determines the address block size.

Below is a chart showing the range of addresses for which a specific integrated circuit is selected.

Integrated Circuit	Address (HEX) "2K" Jumpers	"4K" Jumpers
EPROM U8	F800-FFFF	F000-FFFF
EPROM U7	F000-F7FF	E000-EFFF
EPROM U6	E800-EFFF	D000-DFFF
EPROM U5	E000-E7FF	C000-CFFF
EPROM/BATRAM U17	D800-DFFF	B000-BFFF
EEPROM U16	D000-D7FF	A000-AFFF
RAM U15	C800-CFFF	9000-9FFF
S2	C000	8000
ACIA U21	C004-C005	8004-8005
PIA U13	C00B-C00B	800B-800B
ACIA U14	C00C-C00D	800C-800D

System I/O

The bulk of the system I/O is done through the PIA installed at U13. It is organized as two sets of 8-bit bidirectional data lines, PA0-PA7, and PB0-PB4 act as outputs and generate Input/Output (I/O) device addresses. This I/O address bus is buffered by U12 before driving other boards in the system. PB5 selects the data direction of the I/O data bus from pins PA0-PA7. For an input operation, PB5 is driven low, thus selecting the direction of the bidirectional buffer U11. Internally, the PIA is configured for input on PA0-PA7 during this time. Output operations are accomplished in much the same way: PB5 is driven high this time, thus selecting the reverse direction of the bidirectional buffer U11. The PIA internally is configured PA0-PA7 for output. In addition, the PIA strobes the Write Strobe *WRSTR to signal the addressed device of the write operation.

Other system I/O is accomplished by this PIA. The *ADRDY line is generated by the Analog/Command/Status board, and serves to notify the CPU board when the Analog-to-Digital converter (A/D) finishes a conversion. MEMOK indicates the state of the memory-ok circuitry (described in the Reset Circuitry section following). MEMRST serves as a program-ok watchdog output to the reset circuitry (also described later). The C75 clock at the input of CB1 works in conjunction with the PIA to form a real-time clock -- a device which interrupts the processor for timing purposes every 13.312 ms.

Reset Circuitry

The Reset Circuit is the only analog section of the CPU board. The reset circuit's purpose is threefold:

Provide a *RESET signal upon power-up and power-fail.
Provide a *RESET signal when the program is not running properly.
Provide a valid Memory OK signal based upon power failure status.

The heart of the reset circuitry is capacitor C3 located in the Power Monitor section. Assuming transistor Q2 is cut-off, capacitor C3 charges through R16 forming a large time constant RC network. When the voltage across C3 reaches a value greater than 4.3 volts, the comparator U3 changes its state. R8 provides positive feedback around the comparator, forcing clean, sharp edges. Another comparator then drives its output low forcing Q1 to cut-off, allowing the active-low *RESET line to be driven high, thus removing the reset condition from the microprocessor and associated peripherals.

Power-fail conditions operate in much the same way: as the +5 volt line drops, diode CR2 discharges C3. Since the +15 volt line decreases more slowly then the +5 volt line, the voltage across C3 will drop below the 4.3 volt threshold, forcing the comparator U3 to change its state. This change forces the next comparator to a high condition, forcing Q1 to saturation which pulls the *RESET line low, resetting the microprocessor and peripherals.

Up to this point, we have assumed that transistor Q2 has been held in cut-off. Now, we consider the operation of the auto-restart circuitry, and its impact on the power-monitor circuitry. For normal operation Q2 is cut-off, therefore the output of the retriggerable one-shot U4 must be low. This will remain low as long as the A input of the one-shot is not driven low by the output of the previous one-shot. This output will remain high if the MEMRST line is driven low at a rate faster than the time-constant determined by C7 and R23. In summary then, as long as the program strobes the MEMRST line, the auto-reset circuitry will remain dormant. If the program should fail however, the MEMRST line will not get strobed, therefore the second one-shot gets triggered which discharges C3 through Q2, ultimately forcing a system reset. If the continuous re-start jumper is installed, the second one-shot retriggers the first. If the program fails to strobe the MEMRST line, the first one-shot times out as before, generating another reset sequence.

The memory monitor, although considered part of the reset circuit, does not have any effect on the *RESET line itself. It instead serves as a latch which is reset upon power-fail, and can be set by the program. In this way, the program can differentiate between a power-up cold start, and just a system reset (caused by pushing the front panel RESET button). The difference is important because it tells the microprocessor if information stored in RAM has been violated (RAMs 'forget' when power is removed from them). The latch itself is based on a positive-feedback comparator. When power is applied to the system, C4 is charged by R14. The voltage across C4 rises until it reaches the voltage set by the voltage dropping resistor pair R14 and R15 (for +5 volts, voltage is about .5 volt). Since .5 volts is less than 3.9 volts, the comparator pulls the MEMOK line low. Diode CR1 prevents C4 from discharging through the comparator. The circuit will stay in this state until the program drives the MEMRST line high. The program will read the state of the MEMOK line, then drive the MEMRST line high to reset the latch. When MEMRST is driven high, Q3 conducts, which forces the 3.9 volt reference to zero. In this condition, the voltage across C4 is large enough to force the comparator to drive MEMOK high. Now, CR1 is forward biased, therefore C4 gets charged through R11 and R12. The voltage across C4 increases to 4.5 volts. The program can then remove the high condition on the MEMRST line, and use it as a program strobe for the auto restart circuitry as described earlier. The MEMOK line will remain in a high condition until the next power failure.

Modem I/O

The Modem I/O section of the CPU board works in conjunction with the Data Modems installed in the Communications Input and Communications Output plugs P3 and P4. The basic parts are the ACIA installed in U14, the communications clock generators U1, and U2, and the communications I/O plugs P3 and P4. All communications clock signals are divided down from E, the 1 MHz system clock. U2 serves as a divide by 13 which feeds the 12-bit binary counter U1 to produce the various clocks, among them, the 75 Hz real-time clock. Baud rate selection is accomplished by jumpers within the Data Modems which connect any one of the communications clocks to the receiver clock RXCLK, or to the transmitter clock TXCLK.

RS-232 I/O

The RS-232 I/O section of the CPU board provides the interface between the MRC1620 software and the external PC. The basic parts are the ACIA (U21), the Line Driver (U23), and the Line Receiver (U22). The clock signals for the ACIA are taken from Divider U1. The baud rate is selected via a jumper (near U1) and can be set for 2400 or 1200 or 300. The factory default is 1200.

4.4 Front Panel

Schematic: 91D7300 (Fig. 8-4)
Assembly: 20D2855 (Fig. 8-5)

The Front Panel board is the module that the user is most familiar with since all operation and setups are done through it. Like most of the boards, the Front Panel board communicates with the CPU board over the Address and Data I/O buses. The Front Panel is divided into four sections: alphanumeric display output, LED output, buzzer output, and switch input. Depending upon the I/O address asserted on AB0-AB4, the two 2-to-4 line decoders in U9 handle the bulk of the address decoding. Switch inputs are buffered through U7 which enabled by the *RDSW signal derived from the random logic configuration of U10.

LED data is stored in the 8-bit bus latches U4, U5, and U6 which are strobed by signals *LEDB, *LEDM, and *LEDT whenever U9 detects the proper I/O address, and the write strobe *WRSTR is driven low. The alphanumeric displays are selected to accept data whenever the *DSL or *DSR lines are driven low. The audible buzzer signal is supplied by the D-type flip-flop U3. This is set to latch on the incoming data whenever the *ALARM line is drive low. If the audible alarm jumper is installed on the back of the Communications I/O board, the collector of Q1 driving *BZDRV the buzzer drive signal is looped back to the *INTBZ internal buzzer activate line causing it to drive the audible alarm.

4.5 Analog/Command/Status (A/C/S) Board

Schematic: 91D7302 (Fig. 8-4)
Assembly: 20D2857 (Fig. 8-5)

As suggested by its name, the A/C/S board performs three functions for the MRC1620 Remote Terminal. All the communication between this board and the CPU board is done over the I/O address and data buses. The 3-to-8 line decoder U12 serves as the I/O address decoder to enable various sections of the board.

The status, which are supplied by the External Relay board, are filtered by a 6.8 mH inductor and a .1 uF capacitor. When the proper I/O address is asserted by the CPU board, U12 drives either the *STLO or *STHI low which enables the appropriate bus driver U13 or U14 to put data on the I/O data lines.

Command outputs are generated by addressable latches U4, U5, U21, U22, and U23. When U12 senses the proper I/O address, it drives the *RELAY signal low. U19, another 3-to-8 line decoder selects the proper addressable latch. Output from the addressable latches are fed into U9, U10, U6, U17, and U18 relay drivers which ultimately activate the proper relay on the External Relay board.

The Analog path and its associated Analog-to-Digital converter (A/D) comprise the rest of the circuitry. Single-ended analog inputs from the External Relay board are passed to lines AD1-AD16 where they are filtered by a 6.8 mH inductor, .1 uF capacitor, and an RC network consisting of 33K ohm resistor and a .1 uF capacitor, then presented to the inputs of the analog multiplexers U1 and U2. When the proper I/O address is selected, U12 drives the *ADSET line low. At the same time, the program puts the analog channel number on the data I/O bus, then strobes the *WRSTR write strobe line which through U11 activates the 8-bit latch U6. The output of U6 then selects the proper analog input channel via the analog multiplexers U1, U2, and U3, which present the analog voltage to the input of the op-amp U8. The signal is then buffered and fed into the A/D converter.

When the A/D converter finishes its conversion, it signals the CPU board via the *ADRDY line. The CPU responds by selecting the I/O addresses which activate in turn the *ADLO, and *ADHI lines which place the digital data on the Data I/O lines.

4.6 External Relay

Schematic: 91C7303 (Fig. 8-8)
Assembly: 20D2858 (Fig. 8-9)

The External Relay board is one of the simpler boards in the MRC1620 system. Its purpose is to provide a set of barrier strips for outside-world connection of analog samples, status inputs, and command outputs. In addition, connections for Maintenance-override and Failsafe are provided on this board. All of the outputs are contact closures from the relays mounted on this board, which are activated by signals from the Analog/Command/Status board.

4.7 Communications I/O

Schematic: 91B7316 (Fig. 8-10)
Assembly: 20C3048 (Fig. 8-11)

The Communications I/O board serves as an interface between the CPU board and the outside world. It provides connectors for Telco lines and Radio lines with appropriate protection. RV1-RV4 are varistors which function as back-to-back zener diodes and provide sensitive high-energy filtering. The alarm enable contacts are provided so the user can enable or disable the internal alarm buzzer. This board also has a 9-pin "D" connector for RS-232 interfacing.

4.8 Data Modems

This section describes the various types of data modems available for the MRC1620. Although there
these boards is unaffected. The only exception to this is the 2-wire Telco/Telco configuration.

Telco Input

Schematic: 91C7304 (Fig. 8-12)
Assembly: 20C2859 (Fig. 8-13)

The Telco input board has four sections: RF filter, Active coupler, Audio bandpass filter, and demodulator. Modulated data is accepted by the Communications I/O board and passed to J1-23 and J1-24. L1, L2, C5, C6, C9, and C10 serve as an RF filter, rejecting any stray high-frequency energy. Zener diodes CR1 and CR2 insure that the maximum voltage does not exceed 17 volts. The signal is then coupled through transformer T1 to the input of amplifier U2. For 2-wire operation, the 2-wire/4-wire jumper is set to the 2-wire position allowing FSK data generated from the Telco output board to be injected through R14 to the secondary of T1, and ultimately to be coupled to the 2-wire Telco line. For 4-wire operation, this line is simply grounded. In either case, the input signal is filtered by the 4-pole bandpass filter, then presented to the input of the FSK demodulator. The frequencies that are used are 1200 Hz and 2200 Hz. Frequency-dependent components and their values are specified on the schematic.

FSK data to digital data demodulation is accomplished by the phase-lock loop based IC U1. The range of the internal voltage-controlled oscillator is set by frequency dependent components C3, C7 and R7. When the proper carrier frequencies are presented on the input pin, the chip drives the *DATA CARRIER DETECT line low which signals the CPU board that carrier is present. Demodulated data is transmitted to the CPU board over the RECEIVE DATA line.

The data transmission rate for Telco communications is 1200 baud. Accordingly, the Telco receiver selects 1200 baud demodulation rate by connecting the C19200 clock generated by the CPU board to the RXCLK receiver clock input.

Telco Output

Schematic: 91C7305 (Fig. 8-14)
Assembly: 20C2860 (Fig. 8-15)

The Telco output board generates FSK data from serial digital output signals supplied by the CPU board. It consists of three sections: Modulator, Output amplifier, and RF filter. The modulator section is built around U1, a function generator configured to produce frequency-shifted sine waves. Frequency-determinant resistors R5 and R7 set the high-frequency carrier frequency while R2 and R6 set the low-frequency carrier. FSK transmission over Telco lines uses carrier frequencies of 1200 and 2200 Hz. Component values for frequency-dependent parts are specified on the schematic.

The function generator is activated by the CPU board which drives the request-to-send *RTS line low. The carrier frequency is modulated by the serial data generated by the CPU board on the TRANSMIT DATA line. FSK data is then amplified by op-amp U2 whose gain is set by potentiometer R12. If the installation is operating over a 2-wire line, the 2-wire/ 4-wire jumper set is installed in the 2-wire position which couples the FSK output to the 2-wire line through the Telco input board. For 4-wire operation, the 2-wire/ 4-wire jumper set is set to the 4-wire position which couples the output signal through T1 to the Output Telco line. Zener diodes CR1 and CR2 protect the FSK modulation circuitry by clamping voltage transients to a maximum of 17 volts. Inductors L1 and L2, along with capacitors C4, C5, and C7 filter high-frequency energy. The data transmission rate for Telco communications is 1200 baud. This is set by the jumper connecting the transmit clock TXCLK to the C19200 clock.

Subcarrier Input

Schematic: 91D7306 (Fig. 8-16)
Assembly: 20D2861 (Fig. 8-17)

The Subcarrier Input board accepts modulated data from a companion Subcarrier Output board within the MRC1620 system. The board consists of four major sections: Input filter, Subcarrier demodulator, Audio bandpass filter, and Data demodulator.

The modulation scheme of the subcarrier differs from the normal FSK modulation of the audio spectrum in that it is really composed of two modulation processes. The first translates serial data into FSK in the audio region. The second takes that audio FSK and frequency-modulates a subcarrier. The subcarrier frequency is selected from a list of the available which include 26, 39, 67, 110, 152, and 185 kHz. The input filter comprised of inductors L1 and L2, resistors R5 and R17, and capacitors C5, C12, and C15 form a bandpass filter centered around the selected subcarrier. Frequency-dependent component values are specified on the schematic. The filtered subcarrier is then presented to the phase-lock loop based subcarrier demodulator U3 which produces audio FSK data. The internal voltage-controlled oscillator frequency is determined by C27, also specified for various frequencies on the schematic. The FSK adjust potentiometer R27 serves as a fine-tuning adjustment of the VCO. Audio FSK data is then filtered by the 4-pole audio bandpass filter before presented to the input of the FSK demodulator U1. The FSK demodulator operates identically to the telco demodulator, described above. C7 functions as the VCO timing capacitor while the VCO adjust potentiometer serves as a VCO fine-tune. U1 drives the RECEIVE DATA line with the demodulated serial data. In addition, when the FSK demodulator receives a valid audio carrier, U1 drives the *DATA CARRIER DETECT line low signaling the CPU board.

Subcarrier Output

Schematic: 91D7307 (Fig. 8-18)
Assembly: 20D2862 (Fig. 8-19)

The Subcarrier Output board generates a frequency-modulated subcarrier from digital serial data it receives from the CPU board. The modulation scheme is a two-step process: Digital data is modulated into audio FSK data. The audio FSK data then frequency-modulates the subcarrier.

The Subcarrier Output board is comprised of three sections: The audio FSK modulator, the output amplifier, and the Subcarrier generator. The audio FSK modulator is based around a function generator U1. Activation of the IC occurs when the CPU board drives the request-to-send *RTS line low, forcing Q1 into cutoff. Serial data on the TRANSMIT DATA line frequency-modulates the carrier. Along with the timing capacitor C6, the output frequencies are determined by resistors R5 and R6, and potentiometers R2 and R9. Audio FSK data is coupled through C9 to the Output amplifier U3, whose gain is determined by potentiometer R17, then fed into the Subcarrier generator U2.

There are several subcarrier frequencies available, among them: 26, 39, 67, 110, 152, and 185 kHz. Accordingly, the timing capacitor C8 which determines the subcarrier frequency, varies. A list of values is provided on the schematic. Potentiometers R8 and R7 serve as coarse and fine frequency adjustments. Resistor R21 determines the modulated subcarrier output level. R12 may be adjusted to minimize the Total Harmonic Distortion (THD) of the subcarrier sinusoid.

4.9 Cable Assemblies

The following is a list of cable assemblies and their use on the MRC1620:

24C1167	9F-25M Modem Cable Assembly	MRC1620 to Modem
24C1170	9F-25F Null Modem Cable Assembly	MRC1620 to PC/XT (25-pin)
24C1171	9F-9F Null Modem Cable Assembly	MRC1620 to PC/AT (9-pin)

SECTION 5

ALIGNMENT PROCEDURES

5.1 Introduction

These procedures outline the steps necessary to align the Telco Input and Output boards, the Subcarrier Input and Output boards, and the Subaudible Input and Output boards. In addition, general troubleshooting procedures are provided should your system ever need fixing.

Many of the smaller integrated circuits are permanently soldered to the printed circuit boards to enhance reliability. For this reason, it is highly recommended that users stock spare modules and do any necessary repairs via module exchange.

5.2 Test Equipment

The following or their equivalent are required for these alignment procedures:

Frequency Counter	Data Precision 7540
Distortion Analyzer	Hewlett Packard 334A
Audio Signal Generator	Wavetek Model 136
Oscilloscope	30 MHz bandwidth

5.3 Alignment Procedures

5.3.1 Telco Input and Telco Output Alignment

1. Connect the "Telco Output" terminals to the "Telco Input" terminals of the board(s) that are to be aligned. (The terminals are on the rear of the chassis.)

Telco Output Alignment

1. Connect a frequency counter to TP1. Set S1 to test (position 3 ON, the remainder OFF).
2. With S1-4 OFF, adjust the LOW FREQ pot (R2) to obtain 1200 +/- 5 Hz.
3. With S1-4 ON, adjust the HIGH FREQ pot (R7) to obtain 2200 +/- 5 Hz. Disconnect the frequency counter.
4. Connect an oscilloscope to the TELCO INPUT terminals (if boards are set for 2-wire) or the TELCO OUTPUT terminals (if the boards are set for 4-wire) on the rear of the chassis. Adjust the OUTPUT LEVEL (R12) for 0 dBm (2.2 V p-p).
5. Return the Telco Output board to the operate mode (S1 positions 1 and 2 ON, the remainder OFF).

Telco Input Alignment

1. Connect a frequency counter to TP1. Set S1 to calibrate (positions 1 and 2 OFF, 3 ON). Adjust the VCO frequency (R5) to approximately 1700 Hz. Disconnect the frequency counter.
2. Connect an oscilloscope to RECEIVE DATA (U1-7).
3. Set S1 to operate (positions 1 and 2 ON, 3 OFF). On the Telco Output board (which is located in the other unit), set S1 to test (positions 1, 2, and 4 OFF, 3 and 5 ON).
4. Carefully adjust the VCO (R5) on the Telco Input board to obtain a square wave.
5. Return both boards to the OPERATE mode (S1 positions 1 and 2 ON, the remainder OFF).

Troubleshooting Telco Boards

1. Align the Telco Output board before aligning the Telco Input board.

2. Verify +15 V and -15 V are connected to the appropriate pins on the ICs. (See the tables on the schematics.)

Telco Output Troubleshooting

1. Check the frequency dependent values for the modulator (see table on the schematic).
2. Check for a signal at the output of the XR2206 modulator (U1-2). If no signal is present, the problem likely lies within the modulator. Otherwise, the problem probably lies with the 741 output op-amp (U2).

Telco Input Troubleshooting

1. Verify an FSK signal on the output of the filter (U2-10). If not present, then check the frequency-dependent values of the filter (see table on the schematic). If they are all correct, then suspect the RC4136 quad op-amp (U2).
2. If there is an FSK signal present on the output of the filter, then check the switch positions.
3. Also check the frequency-dependent values surrounding the FSK demodulator (U1) (see table on the schematic). If these are all correct, then suspect the demodulator (U1).

5.3.2 Subcarrier Input and Subcarrier Output Alignment

1. Make sure the Subcarrier Output board is of the same frequency as the Subcarrier Input board, e.g., both should be 67 kHz or 110 kHz, etc.
2. Connect the "Radio Out" BNC to the "Radio In" BNC of the board(s) that are to be aligned. (The BNC connectors are on the rear of the chassis.)

Subcarrier Output Alignment

1. Connect a frequency counter to TP1. Set S1 to test (position 2 ON, the remainder OFF).
2. With S1-4 OFF, adjust the LOW FREQ pot (R2) to obtain 1200 +/- 5 Hz. With S1-4 ON, adjust the HIGH FREQ pot (R9) to obtain 2200 +/- 5 Hz. Disconnect the frequency counter.
3. Remove modulation applied to the subcarrier generator using the MODULATION ADJUST pot (R17).
4. Connect the frequency counter to the "RADIO OUT" BNC connector on the rear of the chassis.
5. Adjust the subcarrier frequency using the COARSE FREQ (R8) and FINE FREQ (R7) pots. Disconnect the frequency counter.
6. Connect a distortion analyzer to the "RADIO OUT" BNC.
7. Adjust the DISTORTION pot (R13) for minimum distortion. Using this control, approximately 0.5% distortion is obtainable. If no distortion analyzer is available, then no adjustment of this pot is required. The worst-case distortion is approximately 2.5% which is quite acceptable in most applications. Disconnect the analyzer.
8. Attach an oscilloscope to the "RADIO OUT" BNC. Refer to print 15A1114 while doing this step. (See Figure 5-1)
9. Adjust the oscilloscope to display about six periods of the unmodulated subcarrier as shown in (A) on the drawing. Using the MODULATION ADJUST pot (R17), increase subcarrier modulation until the fifth crossover occurs midway as shown in (B) on the drawing.
10. Adjust the OUTPUT LEVEL pot (R21) to obtain 1.5 V p-p. Remove the oscilloscope.
11. Return the board to the operate mode (S1 positions 1 and 2 ON, the remainder OFF).

Subcarrier Input Alignment

1. Set the Subcarrier Output board to the test mode (S1 positions 3 and 5 ON, the remainder OFF).
2. Connect the "RADIO OUT" BNC to the "RADIO IN" BNC. This applies a modulated subcarrier to the input of the Subcarrier Input board.
2. Connect an oscilloscope to TP2. Adjust inductors L1 and L2 to obtain minimum AM and maximum amplitude. The filter output should be similar in appearance to the modulated subcarrier input.
3. Move the oscilloscope probe to TP3. Adjust the FSK pot (R27) to obtain the cleanest FSK output. Note that some residual high-frequency subcarrier may be superimposed on the FSK signal; this is quite normal. Remove the oscilloscope.
4. Connect a frequency counter to TP1. Set S1 to calibrate (positions 1 and 2 OFF, 3 ON). Adjust the VCO frequency (R7) to 1170 +/- 5 Hz. Disconnect the frequency counter.
5. Connect the oscilloscope to RECEIVE DATA (U1-7). Set S1 to operate (positions 1 and 2 ON, 3 OFF). On the Subcarrier Output board, set S1 to test (positions 1, 2, and 4 OFF, 3 and 5 ON). Carefully adjust the VCO (R7) on the Subcarrier Input board to obtain a square wave.
6. Return both boards to the operate mode (S1 positions 1 and 2 ON, the remainder OFF).

Troubleshooting the Subcarrier Boards

1. Align the Subcarrier Output board before aligning the Subcarrier Input board.
2. Verify +15 V and -15 V are connected to the appropriate IC pins. (See the tables on the schematics.)

Subcarrier Output Troubleshooting

1. Check the frequency-dependent values of the subcarrier generator. (See the table on the schematic.)
2. Check for an FSK signal on the output of the XR2206 modulator (U1-2). If no signal is present, suspect the switch settings or the modulator itself.
3. Check for a signal at the output of the 741 op-amp (U3-6). If the FSK signal is not present, then suspect the op-amp.
4. Check for a subcarrier signal on the output of the sub-carrier generator (U2-2). If it is not present, then the problem likely lies with U2.

Subcarrier Input Troubleshooting

1. Verify the frequency-dependent values for the input filter.
2. If the filter output cannot be obtained, then one or more of the filter components is probably at fault.
3. If the FSK signal cannot be obtained properly, then the XR2211 subcarrier demodulator (U3) probably is at fault.
4. If the FSK signal is present at the input of the audio filter and not at the output, then check the component values of the filter. If these are all correct, the RC4136 quad op-amp is probably bad.
5. If the FSK signal is present at the output of the audio filter and the components surrounding the FSK demodulator are correct, then the problem probably lies with the XR2211 (U1).

5.4 General System Troubleshooting

Should your system fail to work, the following steps may be taken to find the problem:

1. Verify that all cables are securely attached to the printed circuit boards.

2. Verify that all ICs are either seated firmly in their sockets or properly soldered into the printed circuit boards. (Check especially for bent pins.)

3. Verify that the three power supply voltages (+5 V, +15 V, and -15 V) are present.

4. Press the RESET switch (S1) on the Central Processor board. This forces the program to start the program from the beginning. When reset, all LEDs on the front panel will illuminate briefly. If the LEDs remain ON, the fault may either be on the front panel or Central Processor boards.

5. If the keys seem to be operating properly (e.g., the CHANNEL keys), then the most likely candidates are the modem boards (Telco Input and Output, Subcarrier Input and Output, etc.). Verify that these boards have been aligned properly.

6. If the problem you are experiencing involves only one or two channels, then the likely candidates for inspection are the Analog/Command/Status board, the External Relay board, and the interface wiring to your equipment. If you think you know which board has the problem, then try substituting a known working board (e.g., the Central Processor or front panel boards from the other terminal).

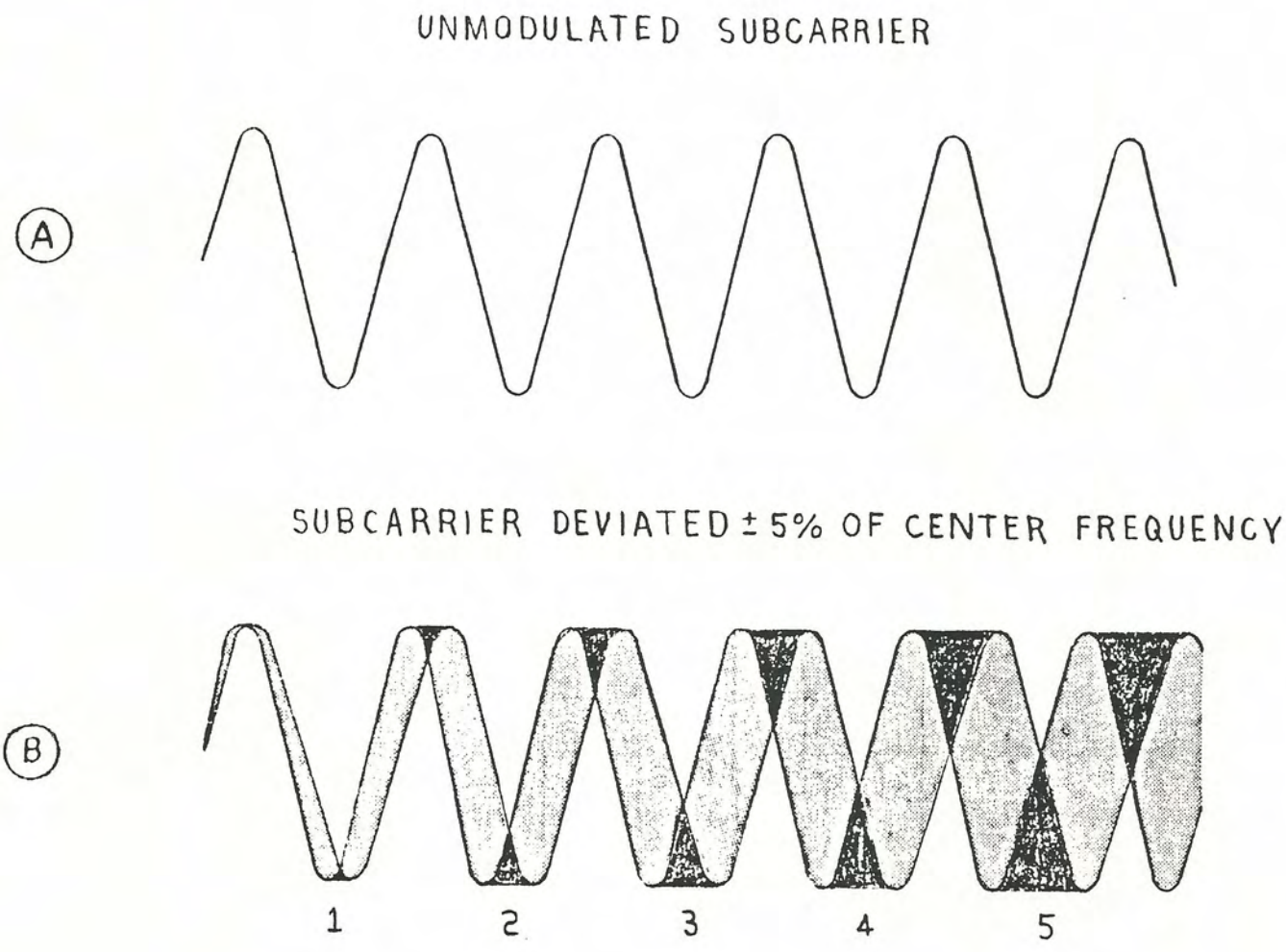


Figure 5-1

FM/FSK Modulation (15A1114)

SECTION 6

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 this 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.

SECTION 7

RECOMMENDED SPARES

PARENT ITEM: 9051533 DESCRIPTION: S/P MRC-1600/1620
ENG.DRAWING NO.: ST-558

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
	3270162	RELAY SPDT 3A 12VDC PC MT	HA1 DC12V	8.000	EA
	3390127	LED RED 3.5@10 DIFF65 T1.75	HLMP-3300	1.000	EA
	3390143	LED YEL 8.0@10 DIFF75 T1.75	HLMP-3401	2.000	EA
	3390598	LED R/G 2@10 DIFF 2-LEAD	521-9177	2.000	EA
	3390614	LED GRN 5.2@10 DIFF75 T1.75	HLMP-3507	1.000	EA
	3600053	DIO 1N914 75V 75MA SI A398	1N914	1.000	EA
	3600236	DIO Z1N4745A 16V 1W 5% AIAY	1N4745A	2.000	EA
	3630027	XT NS2N2924LFS.2W160M025V.1A7P	2N2924-LFS	2.000	EA
	3650249	RGLTR LM3999Z 6.9V TO92	LM3999Z	1.000	EA
	3660008	IC UA741P OPAMP GEN COMP	UA741CP	1.000	EA
	3660069	IC SN74LS00N QU 2IN NAND	SN74LS00N	1.000	EA
	3660693	IC SN74LS08N QU 2IN AND	SN74LS08N	1.000	EA
	3660768	IC SN74LS123N DURETRIGMONOMULTI	SN74LS123N	1.000	EA
	3660792	IC SN74LS138N 3-8LINEDECDEMUX	SN74LS138N	3.000	EA
	3660800	IC SN74LS139N DU2-4LNDECDEMUX	SN74LS139N	1.000	EA
	3660826	IC SN74LS163AN BINCOUNT PRESET	SN74LS163AN	1.000	EA
	3660859	IC SN74LS244N OCT BUS/DRIV ST	SN74LS244N	4.000	EA
	3660958	IC SN74LS32 QUAD 2-INPUT NOR	SN74LS32N	2.000	EA
	3661006	IC SN74273 OCTAL FLIP-FLOP	SN74273	2.000	EA
	3661048	IC MC6809P MPU	MC6809P	1.000	EA
	3661063	IC SN74LS74N DUAL D FLIP FLOP	SN74LS74AN	1.000	EA
	3661162	IC SN74LS245N OCT BUS TRNCVR	SN74LS245N	1.000	EA
	3661170	IC SN74LS259N OCTAL ADDR LATCH	SN74LS259N	2.000	EA
	3661188	IC SN74LS273 OCT LATCH	SN74LS273N	1.000	EA
	3680063	IC CD4040BE 12 STAGE BIN CT	CD4040BE	1.000	EA
	3680139	IC MC14051P 8CH MUX R280 7V	MC14051P	2.000	EA
	3680287	IC VOLTAGE CONVERTER(+5 TO -5)	ICL7660CPA	1.000	EA
	3690054	DISPLAY 17-SEG 4-DIGIT RED	DL-2416T	1.000	EA
	3710027	IC MC6821P PIA INTERFACE	MC6821P	1.000	EA
	3710043	IC MC6850P ACIA INTERFACE	MC6850P	1.000	EA
	3710639	IC RAM STATIC 2K X 8	TMS4016-25NL	1.000	EA
	3730157	IC LM308AN OPAMP PRECISION	LM308AN	1.000	EA
	3730207	IC LM339N COMPARITOR QUAD	LM339N	1.000	EA
	3730355	IC MC1488P QU LINE DRIVER PLST	MC1488P	1.000	EA
	3730363	IC MC1489 QU LINE RECEIVER	MC1489P	1.000	EA
	3730462	IC RC4136N OPAMP QUAD 741	RC4136N	1.000	EA
	3730629	IC ICL7109CPL A-D CONV 12BITS	ICL7109CPL	1.000	EA
	3730819	IC XR-2206CP VCO WAVE GEN	XR-2206CP	3.000	EA
	3730827	IC XR-2211CP FSK MODEM	XR-2211CP	1.000	EA
	3730876	IC DUAL OP-AMP	TL072A	2.000	EA
	3731007	IC 7-DARLINGTON ARRAY HI-V,A	ULN2003AN	3.000	EA
	4590170	VARISTOR	V-120-MA1A	2.000	EA

SECTION 8

SCHEMATICS AND ASSEMBLIES (including PARTS LISTS)

Please see Section 1 (System Information) and Section 4 (Module Descriptions) for further information.

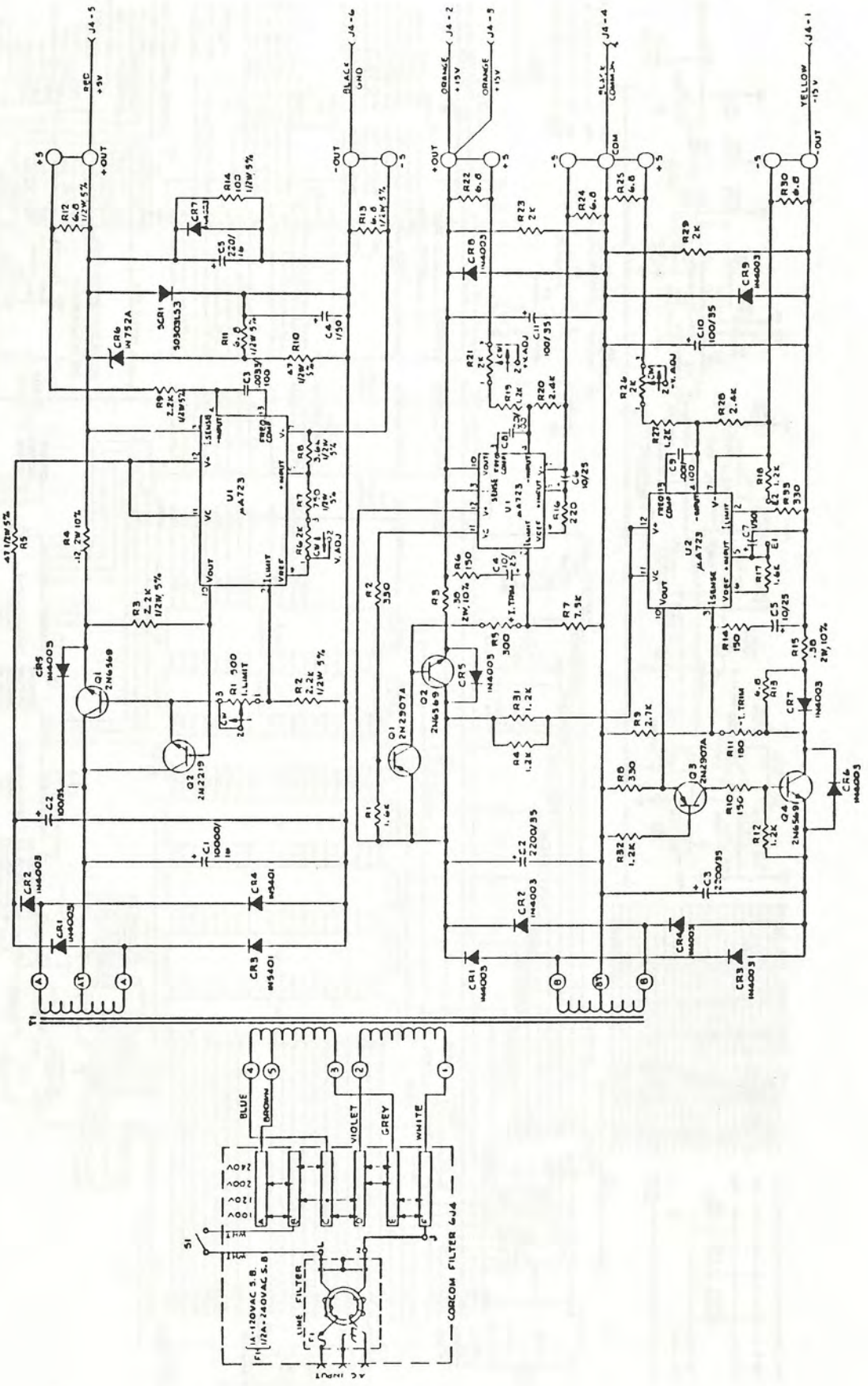


Figure 8-1
Power Supply Schematic
91D7317

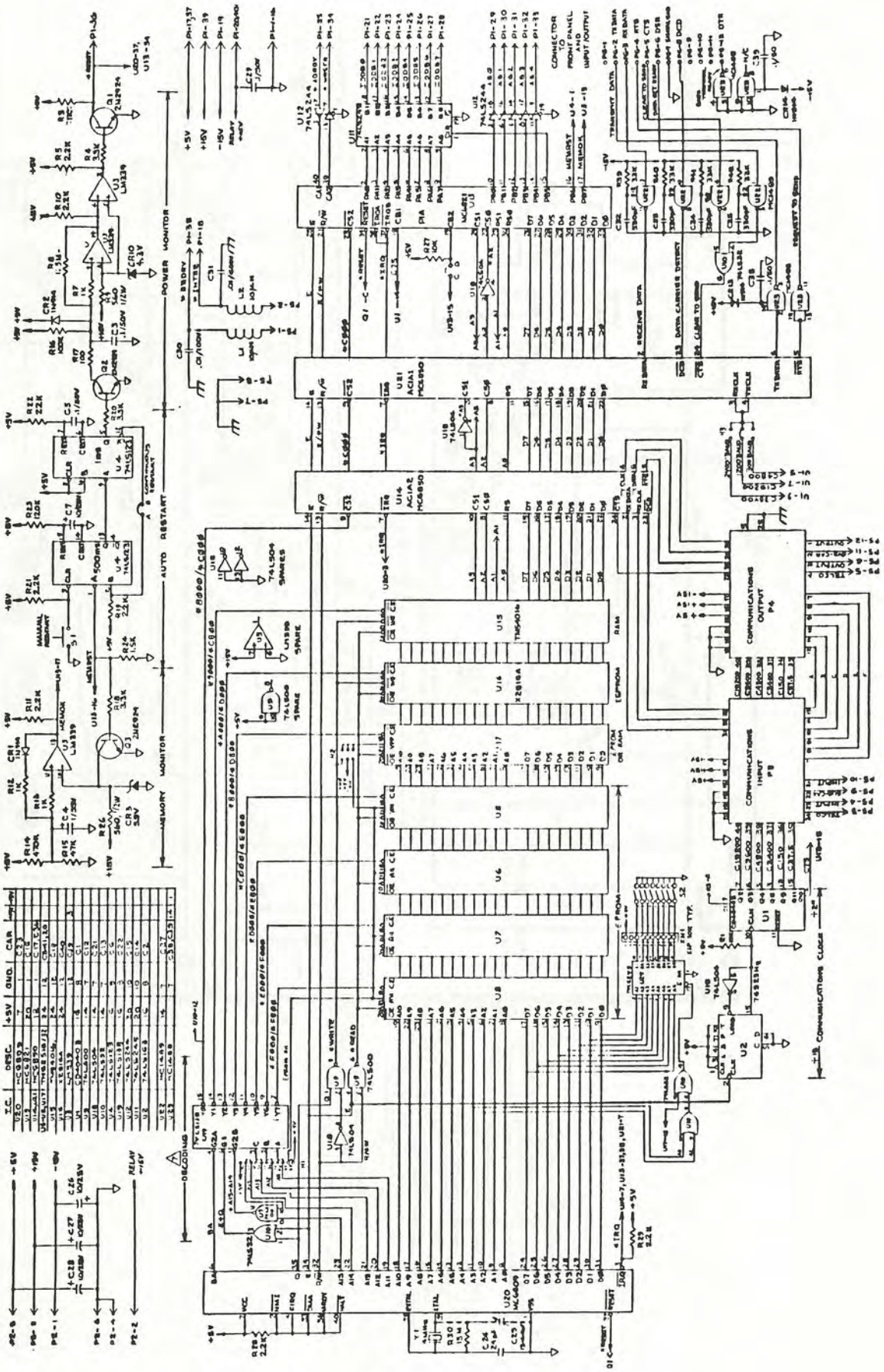


Figure 8-2
CPU Schematic
91D7365

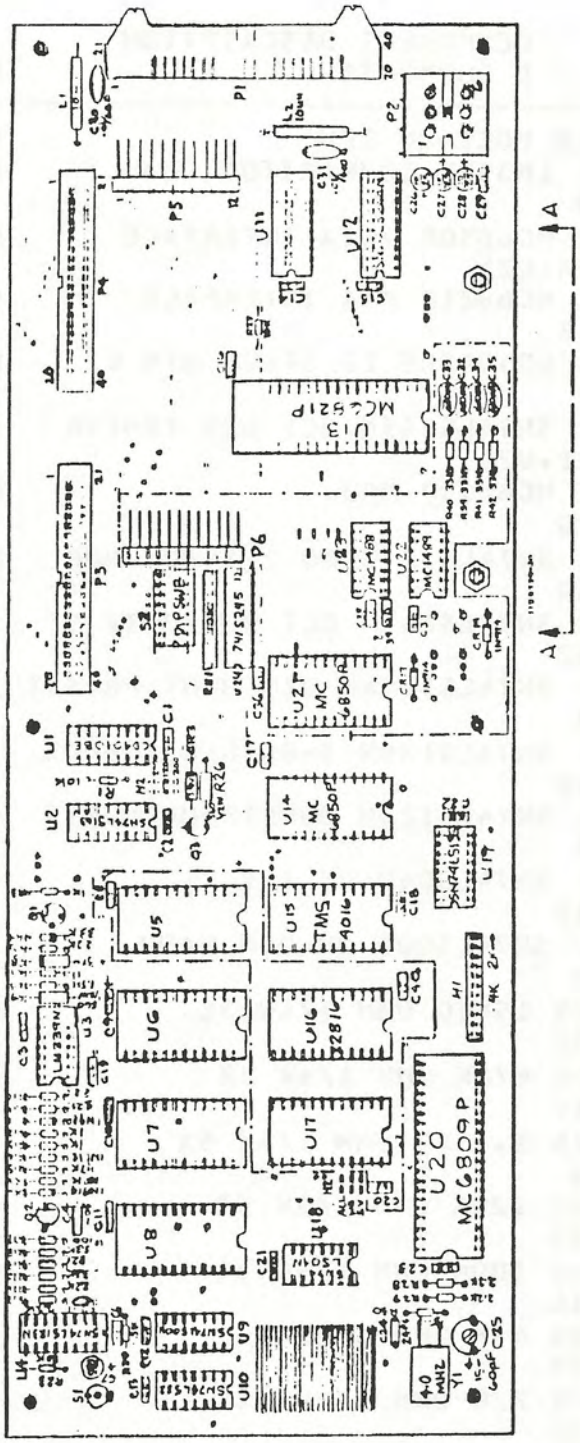


Figure 8-3
CPU Assembly
20D2917

PARENT ITEM: 9205915 DESCRIPTION: ASSY COMP MRC1620 CPU
ENG.DRAWING NO.: 20D2917-20 F

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3474582	PCB MRC1620 CPU	51D6120	A	1.000	EA
2	3730207	IC LM339N COMPARITOR QUAD U3	LM339N		1.000	EA
3	3710043	IC MC6850P ACIA INTERFACE U14,U21	MC6850P		2.000	EA
4	3710027	IC MC6821P PIA INTERFACE U13	MC6821P		1.000	EA
5	3680063	IC CD4040BE 12 STAGE BIN CT U1	CD4040BE		1.000	EA
6	3661162	IC SN74LS245N OCT BUS TRNCVR U11,U24	SN74LS245N		2.000	EA
7	3661048	IC MC6809P MPU U20	MC6809P		1.000	EA
8	3660958	IC SN74LS32 QUAD 2-INPUT NOR U10	SN74LS32N		1.000	EA
9	3660859	IC SN74LS244N OCT BUS/DRIV ST U12	SN74LS244N		1.000	EA
10	3660826	IC SN74LS163AN BINCOUNT PRESET U2	SN74LS163AN		1.000	EA
11	3660792	IC SN74LS138N 3-8LINEDECDEMUX U19	SN74LS138N		1.000	A
12	3660768	IC SN74LS123N DURETRMONOMULTI U4	SN74LS123N		1.000	EA
13	3660685	IC SN74LS04N HX INV U18	SN74LS04N		1.000	EA
14	3660669	IC SN74LS00N QU 2IN NAND U9	SN74LS00N		1.000	EA
15	4460952	RES 15MEG OHM 1/4W 5% R30	RC07GF156J		1.000	EA
16	4460549	RES 470K OHM 1/4W 5% R14	RC07GF474J		1.000	EA
17	4460564	RES 1.5MEG OHM 1/4W 5% R8	RC07GF155J		1.000	EA
18	4460499	RES 120K OHM 1/4W 5% R23	RC07GF124J		1.000	EA
19	4460481	RES 100K OHM 1/4W 5% R16	RC07GF104J		1.000	EA
20	4460432	RES 47K OHM 1/4W 5% R15	RC07GF473J		1.000	EA
21	4460374	RES 22K OHM 1/4W 5% R22	RC07GF223J		1.000	EA
22	4460317	RES 10K OHM 1/4W 5% R1,R27	RC07GF103J		2.000	EA
23	4460226	RES 3.3K OHM 1/4W 5% R4,R18,R20	RC07GF332J		3.000	EA

PARENT ITEM: 9205915

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
24	4460192	RES 2.2K OHM 1/4W 5% R5,R10,R11,R19,R21,R28,R29	RC07GF222J		7.000	EA
25	4460168	RES 1.5K OHM 1/4W 5% R24	RC07GF152J		1.000	EA
26	4460143	RES 1K OHM 1/4W 5% R3,R7,R12,R13	RC07GF102J		4.000	EA
27	4460051	RES 100 OHM 1/4W 5% R17	RC07GF101J		1.000	EA
28	4310207	CAP .1UF/50V 20% C1,C2,C3,C5,C6,C8,C9,C10,C11, C12,C13,C14,C15,C16,C17,C18, C19,C20,C21,C22,C23,C29,C36, C37,C38,C39,C40	CY20C104M		27.000	EA
29	4280079	CAP TANT EPOX-DIP 10/25V 20% C7,C26,C27,C28	199D106X0025KA1		4.000	EA
30	4280038	CAP TANT EPOX-DIP 1/35V 20% C4	199D105X0035HA1		1.000	EA
31	4210118	CAP MICA DIP 24PF 5% C24	DM-15-240J		1.000	EA
32	3630027	XT NS2N2924LFS.2W160M025V.1A7P Q1,Q2,Q3	2N2924-LFS		3.000	EA
33	3600152	DIO ZSZ3.9A 3.9V 1W A3G CR3	Z53.9A		1.000	EA
34	3600053	DIO 1N914 75V 75MA SI A398 CR1,CR2,CR13,CR14	1N914		4.000	EA
35	3340163	XTAL 4.00 MHZ MRC/TCS Y1	30A0066	C	1.000	EA
36	3250099	SKT DUAL IN LINE 40 PIN U13,U20	640379-1		2.000	EA
37	3250073	SKT DUAL IN LINE 24 PIN U5,U6,U7,U8,U14,U15,U16, U17,U21	640361-1		9.000	EA
38	3170008	SW PB S1	34 550 004		1.000	EA
39	3110574	CONN M 40-PIN STRAIGHT PC MTG P3,P4	66506-025		2.000	EA
40	3110509	CONN SCTCHFLX R ANGLE W/O EJCT P1	3432-1002		1.000	EA
41	3110111	CONN MALE 6 PIN POWER P2	1-380999		1.000	EA
42	3090222	CONN 12PIN SNGL ROW RTANG HDR P5,P6	1-87233-2		2.000	EA
43	1230275	STDF 1/4 HEX 6-32 X 7/16 AL	8214-A-0632		2.000	EA
44	1090182	SCR PNH PHPS 6-32 X 1/4 SST			2.000	EA
45	1090562	WSHR LK #6 INTL T CD PL			2.000	EA
46	4310173	CAP DISC .01/600V C30,C31	811000Z5U0103M		2.000	EA
47	4020376	IDCTR RF 10 UH L1,L2	74F105AP		2.000	EA
48	3600160	DIO ZIN4731A 4.3V 1W 5% AIAY CR10	1N4731A		1.000	EA

PARENT ITEM: 9205915

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	M
49	4470282	RES 560 OHM 1/2W 5% R9,R26	RC20GF561J	2.000	EA
50	3710639	IC RAM STATIC 2K X 8 U15	TMS4016-25NL	1.000	EA
51	3710647	IC EEPROM 2K X 8 U16	X2816AP-45	1.000	EA
52	3730363	IC MC1489 QU LINE RECEIVER U22	MC1489P	1.000	EA
53	3730355	IC MC1488P QU LINE DRIVER PLST U23	MC1488P	1.000	EA
54	4410437	RES 33K OHM 1/4W 10% R39,R40,R41,R42	RC07GF333K	4.000	EA
55	4210415	CAP MICA DIP 330PF 5% C32,C33,C34,C35	DM-15-331J	4.000	EA
57	4370169	CAP PC MINVAR 15-60PF N1500 C25	DV11PS60Q	1.000	EA
58	3710845	IC RAM STAT/BAT 2K X 8 W/RTC U17	MK48T02B-25	1.000	EA
59	3110905	JUMPER BUSS WIRE 0.1 IN H1=4K(5 PLCS),H2=WE,H3=1200	J0.100X0.125P24	7.000	EA
61	3190089	SW DIP 8 POSITION S2	206-8	1.000	EA
62	4540134	RES SIP 10K OHM 1/8W 2% 10 RN1	750-101-R10K	1.000	EA
63	3250057	SKT DUAL IN LINE 20 PIN U11,U12,U24	640464-1	3.000	EA

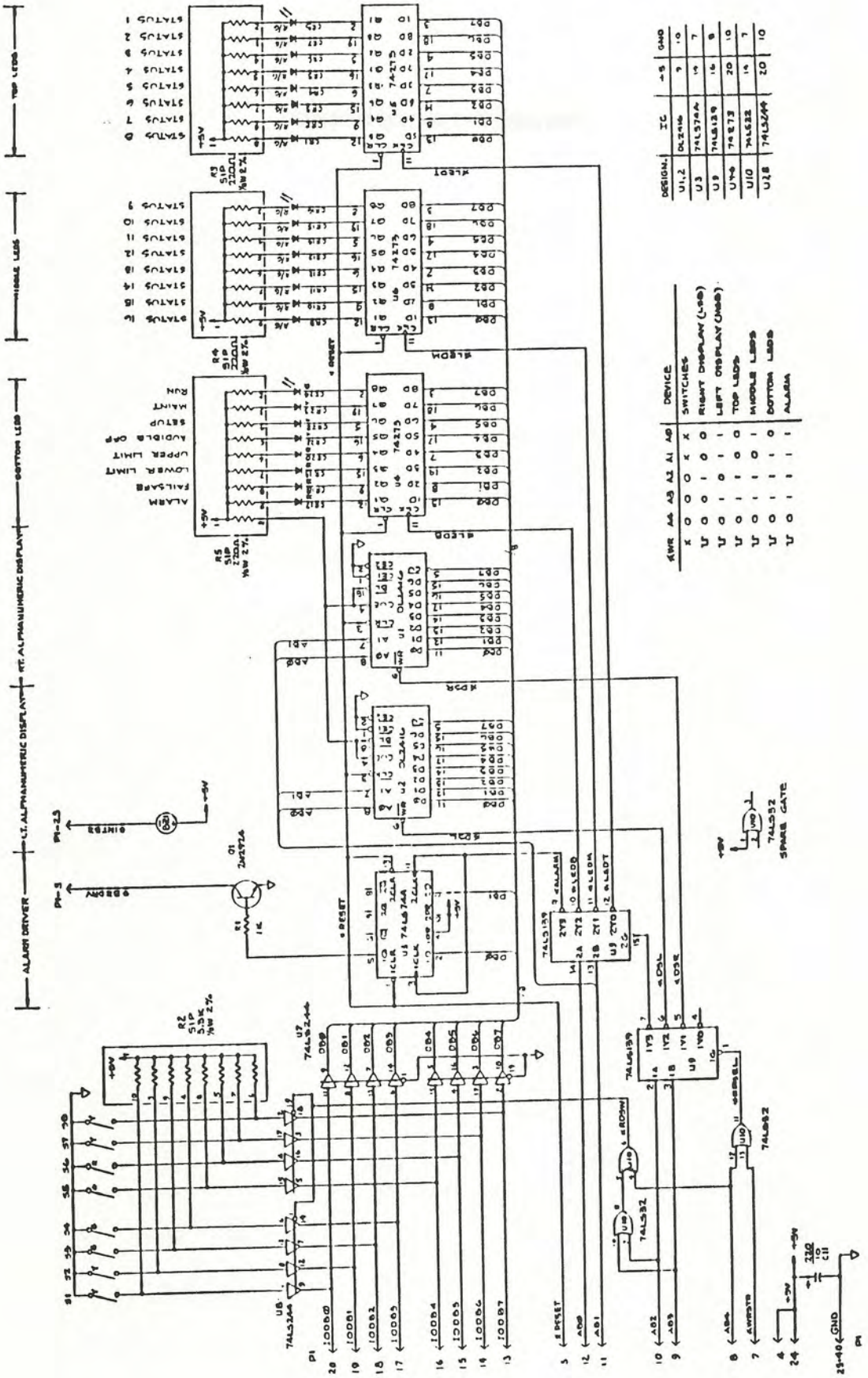


Figure 8-4
Front Panel Schematic
91D7300

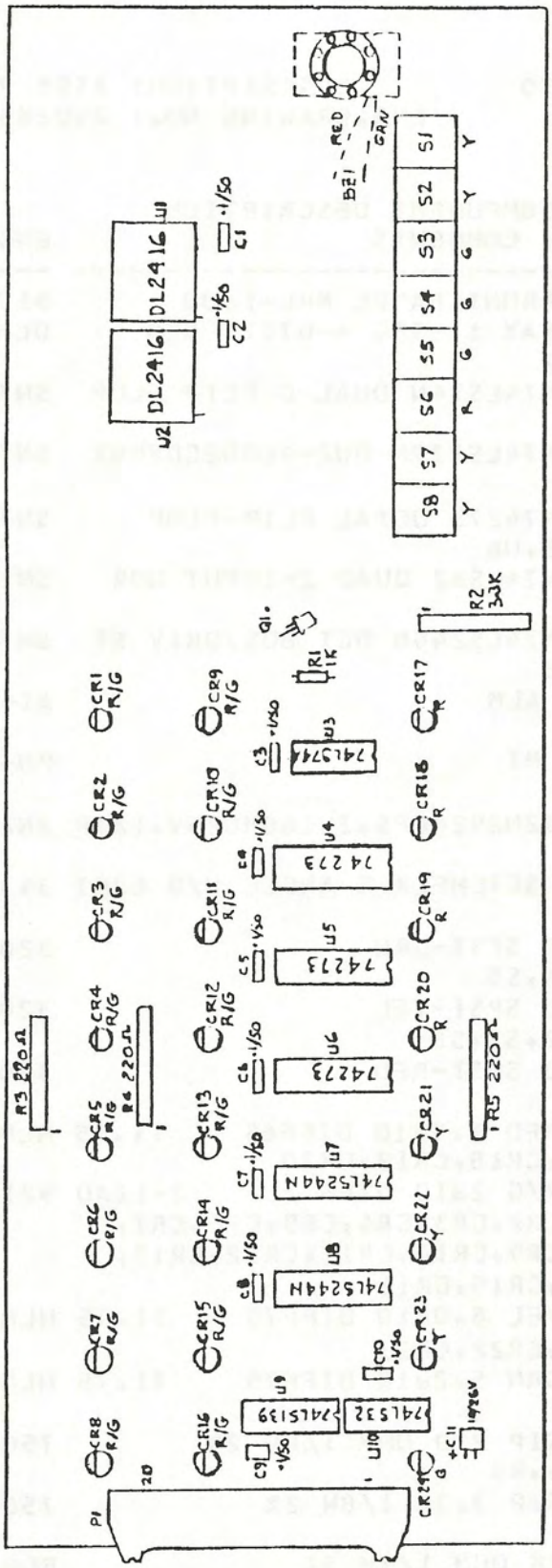


Figure 8-5
Front Panel Assembly
20D2855

PARENT ITEM: 9204470 DESCRIPTION: ASSY PCB FRT PANEL
ENG.DRAWING NO.: 20D2855 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	3473329	PCB FRONT PANEL MRC-1600	51D5974 A	1.000	EA
2	3690054	DISPLAY 17-SEG 4-DIGIT RED U1,U2	DL-2416T	2.000	EA
3	3661063	IC SN74LS74N DUAL D FLIP FLOP U3	SN74LS74AN	1.000	EA
4	3660800	IC SN74LS139N DU2-4LNDECDEMUX U9	SN74LS139N	1.000	EA
5	3661006	IC SN74273 OCTAL FLIP-FLOP U4,U5,U6	SN74273	3.000	EA
6	3660958	IC SN74LS32 QUAD 2-INPUT NOR U10	SN74LS32N	1.000	EA
7	3660859	IC SN74LS244N OCT BUS/DRIV ST U7,U8	SN74LS244N	2.000	EA
8	3390333	HORN ALM BZ1	AI-105	1.000	EA
9	3390341	HORN MT BZ1	PM-101	1.000	EA
11	3630027	XT NS2N2924LFS.2W160M025V.1A7P Q1	2N2924-LFS	1.000	EA
12	3110509	CONN SCTCHFLX R ANGLE W/O EJCT P1	3432-1002	1.000	EA
13	3170842	SW PB SPST-GRN S3,S4,S5	320.01-E1-1-GRN	3.000	EA
14	3170834	SW PB SPST-YEL S1,S2,S7,S8	320.01-E1-1-YEL	4.000	EA
15	3170826	SW PB SPST-RED S6	320.01-E1-1-RED	1.000	EA
16	3390127	LED RED 3.5@10 DIFF65 T1.75 CR17,CR18,CR19,CR20	HLMP-3300	4.000	EA
16	3390598	LED R/G 2@10 DIFF 2-LEAD CR1,CR2,CR3,CR4,CR5,CR6,CR7, CR8,CR9,CR10,CR11,CR12,CR13, CR14,CR15,CR16	521-9177	16.000	EA
17	3390143	LED YEL 8.0@10 DIFF75 T1.75 CR21,CR22,CR23	HLMP-3401	3.000	EA
18	3390614	LED GRN 5.2@10 DIFF75 T1.75 CR24	HLMP-3507	1.000	EA
20	4540217	RES SIP 220 OHM 1/8W 2% R3,R4,R5	750-101-R220	3.000	EA
21	4540167	RES SIP 3.3K 1/8W 2% R2	750-101-3.3K	1.000	EA
22	4460143	RES 1K OHM 1/4W 5% R1	RC07GF102J	1.000	EA
23	4280079	CAP TANT EPOX-DIP 10/25V 20% C11	199D106X0025KA1	1.000	EA

PARENT ITEM: 9204470

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG. DRAWING NO.	QUANTITY PER	UM
24	4310207	CAP .1UF/50V 20% C1,C2,C3,C4,C5,C6,C7,C8,C9,C10	CY20C104M	10.000	EA
25	3250057	SKT DUAL IN LINE 20 PIN U7,U8	640464-1	2.000	EA

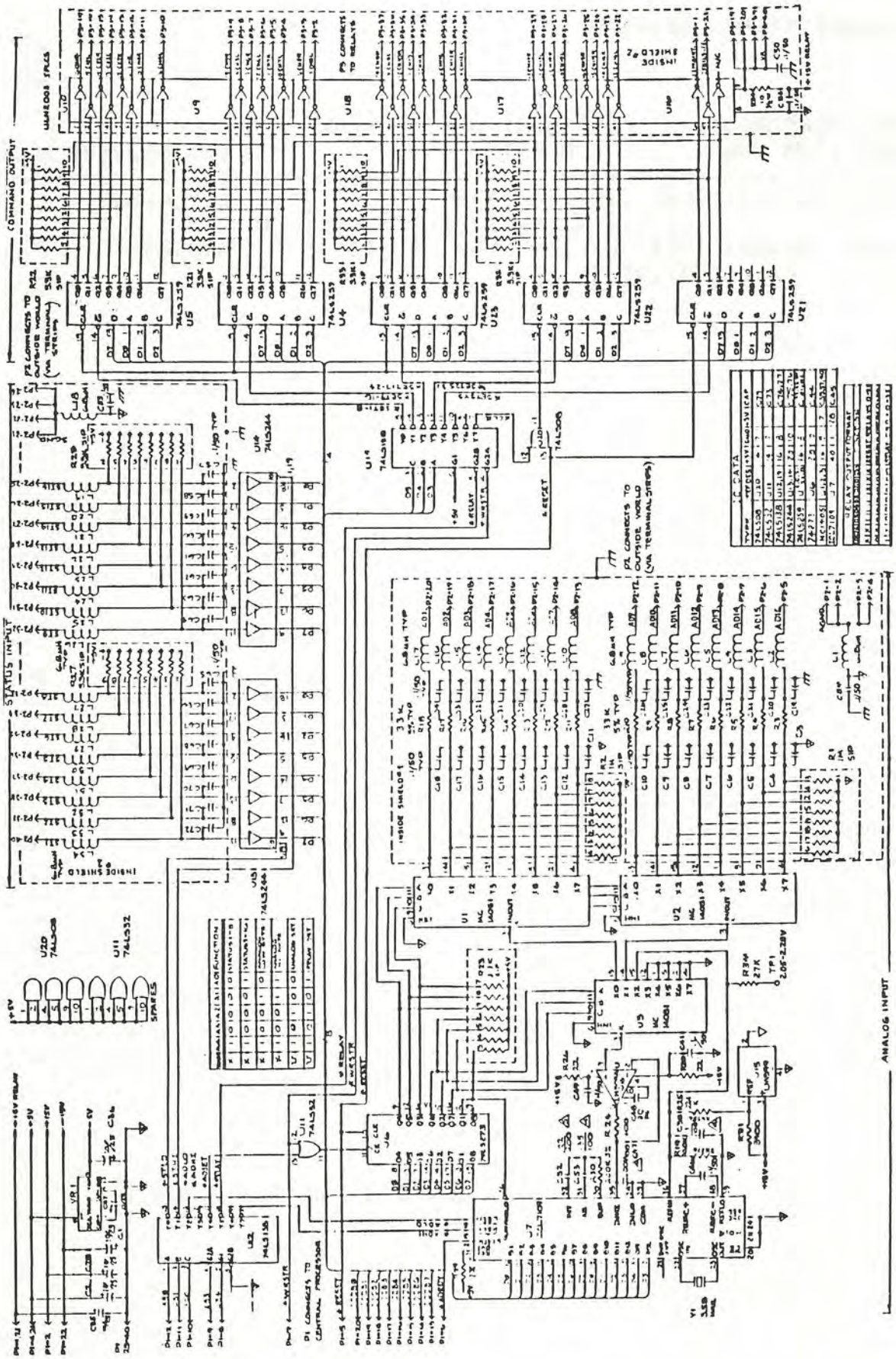


Figure 8-6
A/C/S Schematic
91D7302

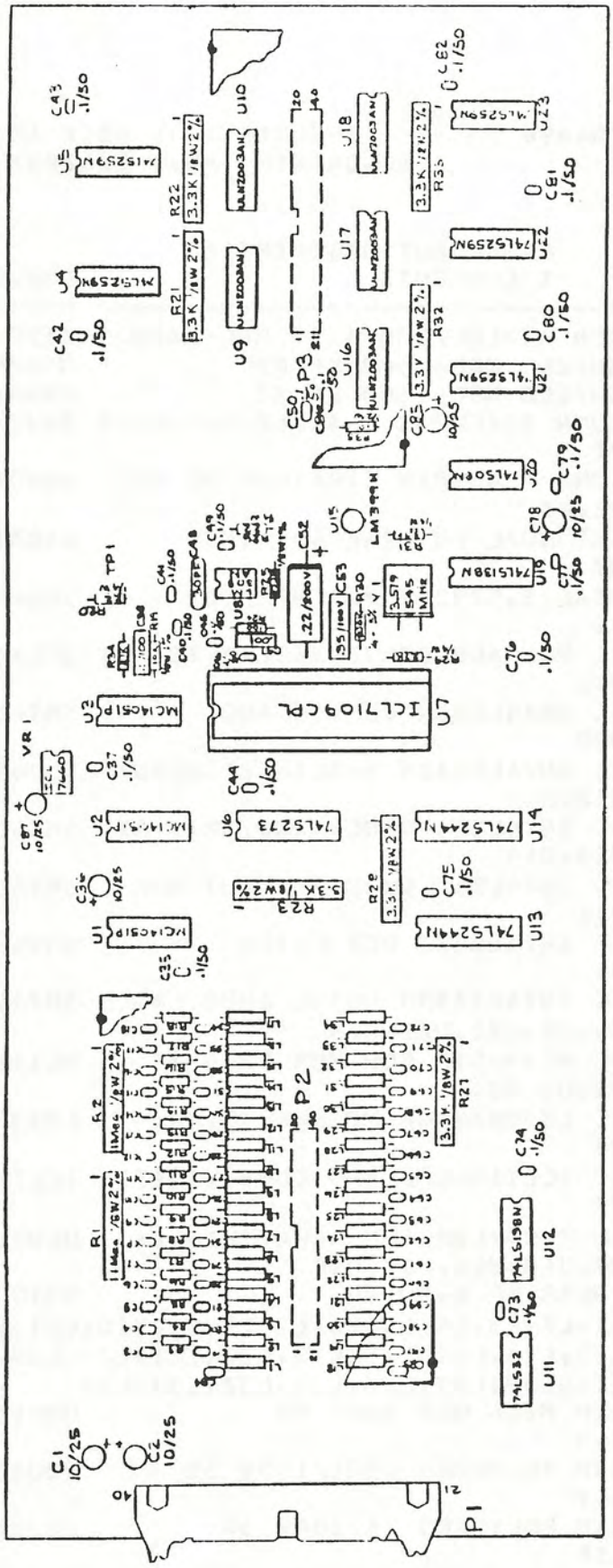


Figure 8-7
A/C/S Assembly
20D2857

PARENT ITEM: 9204496 DESCRIPTION: ASSY ANLG/CMD/STAT
ENG.DRAWING NO.: 2002857 F

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3473345	PCB ANALOG/CMD/STAT MRC-1600	5105976	B	1.000	EA
2	2062826	SHIELD MRC-1600 RF #1	0582907	C	1.000	EA
3	2062867	SHIELD MRC-1600 RF #2	0582917	C	1.000	EA
4	3110509	CONN SCTCHFLX R ANGLE W/O EJCT P1	3432-1002		1.000	EA
5	3110574	CONN M 40-PIN STRAIGHT PC MTG P2,P3	66506-025		2.000	EA
6	3250099	SKT DUAL IN LINE 40 PIN U7	640379-1		1.000	EA
7	3340189	XTAL 3.579545 MHZ MRC/TCS Y1	30A0072	D	1.000	EA
8	3680287	IC VOLTAGE CONVERTER(+5 TO -5) VR1	ICL7660CPA		1.000	EA
10	3660693	IC SN74LS08N QU 2IN AND U20	SN74LS08N		1.000	EA
11	3660792	IC SN74LS138N 3-8LINEDECDEMUX U12,U19	SN74LS138N		2.000	EA
12	3660859	IC SN74LS244N OCT BUS/DRIV ST U13,U14	SN74LS244N		2.000	EA
13	3660958	IC SN74LS32 QUAD 2-INPUT NOR U11	SN74LS32N		1.000	EA
14	3661188	IC SN74LS273 OCT LATCH U6	SN74LS273N		1.000	EA
15	3661170	IC SN74LS259N OCTAL ADDR LATCH U4,U5,U21,U22,U23	SN74LS259N		5.000	EA
16	3680139	IC MC14051P 8CH MUX R280 7V U1,U2,U3	MC14051P		3.000	EA
17	3730157	IC LM308AN OPAMP PRECISION U8	LM308AN		1.000	EA
18	3730629	IC ICL7109CPL A-D CONV 12BITS U7	ICL7109CPL		1.000	EA
19	3731007	IC 7-DARLINGTON ARRAY HI-V,A U9,U10,U16,U17,U18	ULN2003AN		5.000	EA
21	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	9310-32		34.000	EA
22	4210134	CAP MICA DIP 30PF 5% C48	DM-15-300J		1.000	EA
23	4250007	CAP POLYCARB .001/100V 3% C47	22UB102H		1.000	EA
24	4250486	CAP POLYCARB .1/100V 3% C38	22UB104H		1.000	EA
25	4250619	CAP POLYCARB .35/100V 3% C53	22UB354H		1.000	EA

PARENT ITEM: 9204496

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
26	4250684	CAP .22/200V 10% AXIAL C52	X363UW/.22/10%	1.000	EA
27	4280079	CAP TANT EPOX-DIP 10/25V 20% C1,C2,C36,C78,C85,C87	199D106X0025KA1	6.000	EA
28	4310207	CAP .1UF/50V 20% 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,C37,C40,C41,C42, C43,C44,C45,C46,C49,C50,C57,C58,C59,C60,C61,C62, C63,C64,C65,C66,C67,C68,C69,C70,C71,C72,C73,C74, C75,C76,C77,C79,C80,C81,C82,C83,C84,C86	CY20C104M	71.000	EA
29	4540167	RES SIP 3.3K 1/8W 2% R21,R22,R23,R27,R28,R32,R33	750-101-3.3K	7.000	EA
30	4540225	RES SIP 1M 1/8W 2% R1,R2	750-101-R105	2.000	EA
31	4510186	RES 22.1K OHM 1/8W 1% R25	RN55D2212F	1.000	EA
32	4510145	RES 10.0K OHM 1/8W 1% R19	RN55C1002F	1.000	EA
33	4460572	RES 200K OHM 1/4W 5% R30	RC07GF204J	1.000	EA
34	4460382	RES 27K OHM 1/4W 5% R29,R34	RC07GF273J	2.000	EA
35	4460697	RES 3.9K OHM 1/4W 5% R31	RC07GF392J	1.000	EA
36	4460051	RES 100 OHM 1/4W 5% R24	RC07GF101J	1.000	EA
37	4460754	RES 22 OHM 1/4W 5% R20,R26	RC07GF220J	2.000	EA
38	4460390	RES 33K OHM 1/4W 5% R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13,R14,R15, R16,R17,R18	RC07GF333J	16.000	EA
39	4470290	RES 10 OHM 1/2W 5% R35	RC20GF100K	1.000	EA
40	3650371	RGLTR LM399H 6.9V TO-46 U15	LM399H	1.000	EA
41	3250057	SKT DUAL IN LINE 20 PIN U13,U14	640464-1	2.000	EA

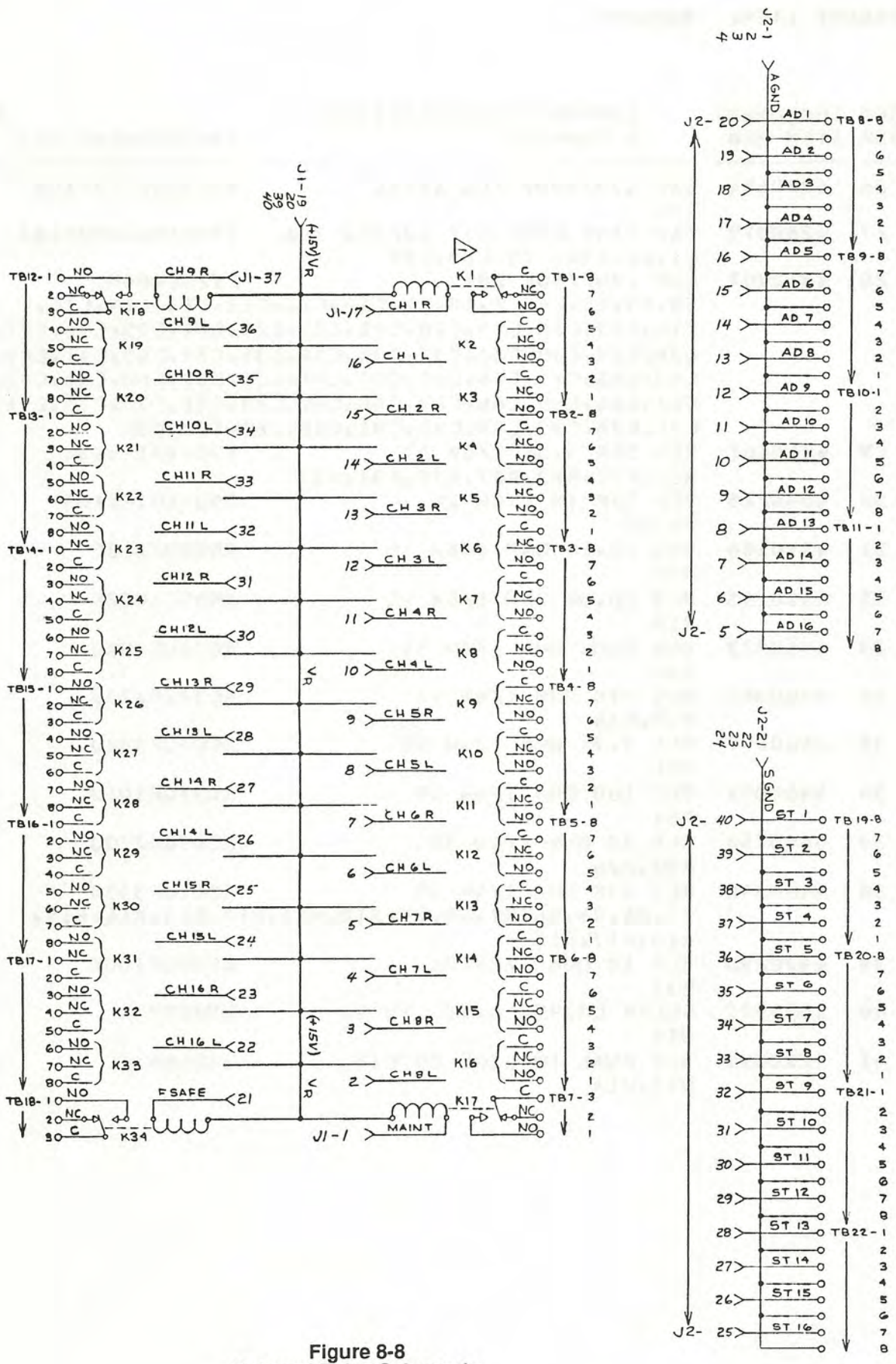


Figure 8-8
External Relay Schematic
91C7303

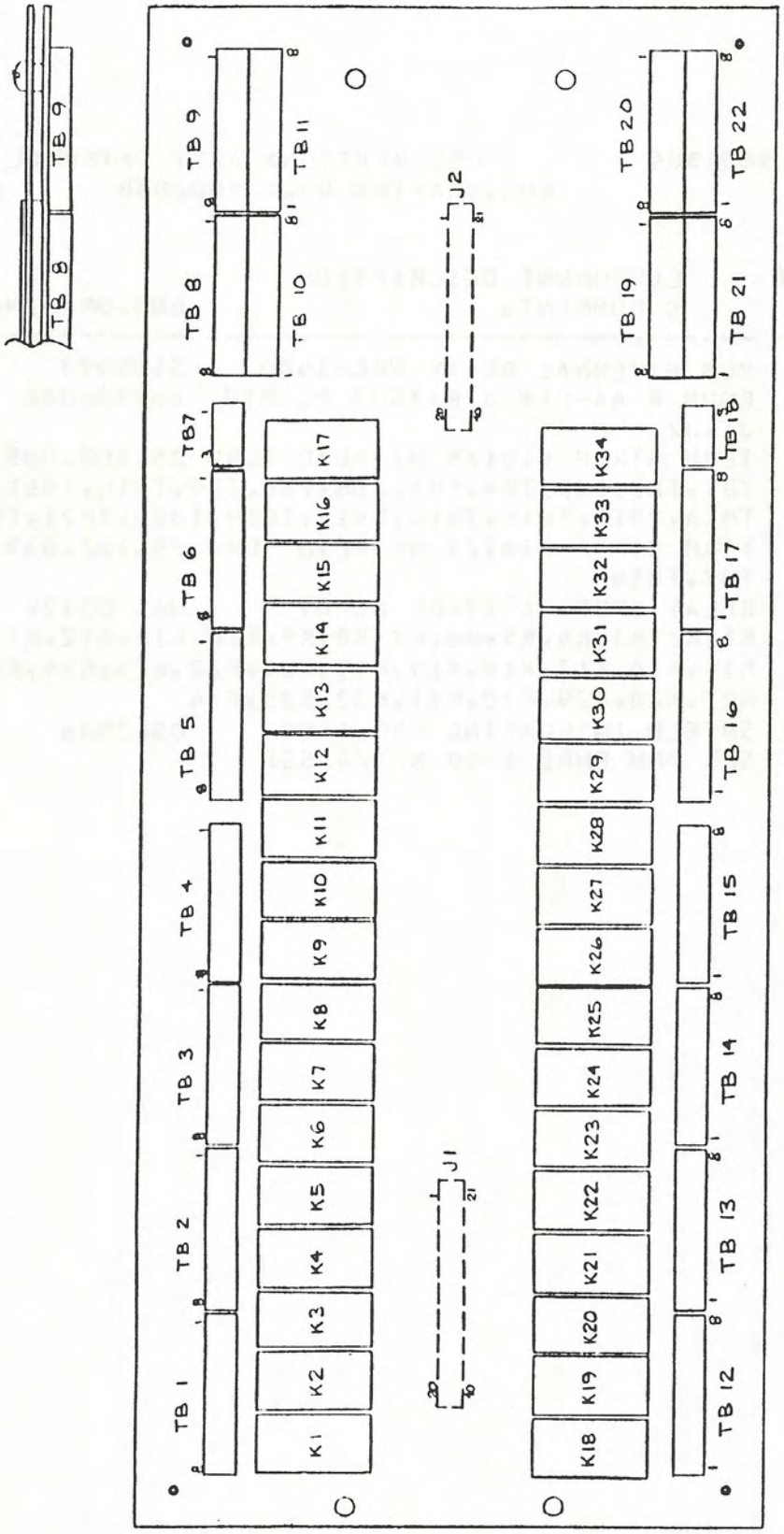


Figure 8-9
External Relay Assembly
20D2858

PARENT ITEM: 9204504 DESCRIPTION: ASSY EXTERNAL RELAY
ENG.DRAWING NO.: 20D2858 A

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3473352	PCB EXTERNAL RELAY MRC-1600	51D5977	D	1.000	EA
2	3110582	CONN F 44-PIN STRAIGHT PC MTG J1,J2	66953-022		2.000	EA
3	3291143	TERM STRIP 8181/8 NI PLTD SCRW TB1,TB2,TB3,TB4,TB5,TB6,TB8,TB9,TB10,TB11,TB12, TB13,TB14,TB15,TB16,TB17,TB19,TB20,TB21,TB22	25.102.0853S		20.000	EA
4	3291135	TERM STRIP 8181/3 NI PLTD SCRW TB7,TB18	25.102.0353S		2.000	EA
5	3270162	RELAY SPDT 3A 12VDC PC MT K1,K2,K3,K4,K5,K6,K7,K8,K9,K10,K11,K12,K13,K14, K15,K16,K17,K18,K19,K20,K21,K22,K23,K24,K25,K26, K27,K28,K29,K30,K31,K32,K33,K34	HA1 DC12V		34.000	EA
6	2062966	SHIELD INSULATING MRC-1600	05C2936	B	1.000	EA
7	1050129	SCR PNH PHPS 4-40 X 1/4 SST			4.000	EA

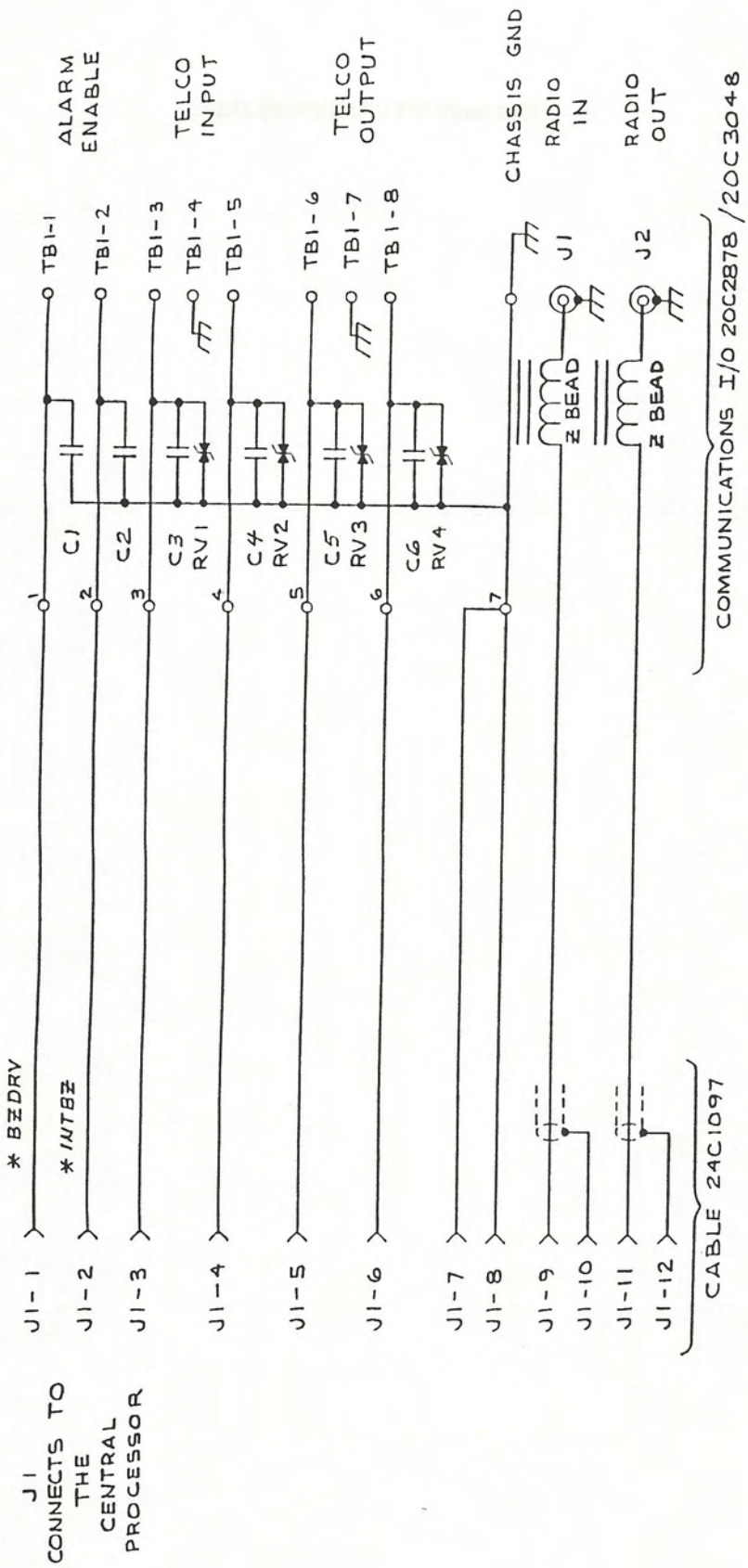


Figure 8-10
Communications I/O Schematic
91B7316

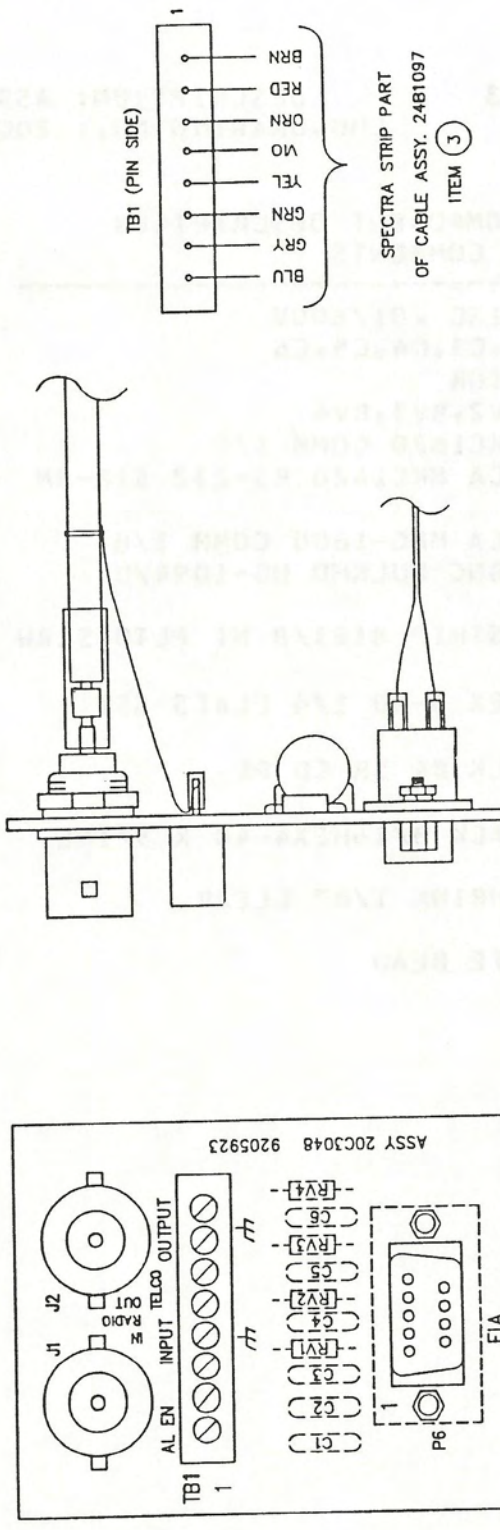


Figure 8-11
Communications I/O Assembly
20C3048

PARENT ITEM: 9205923 DESCRIPTION: ASSY COMP MRC1620 COMM I/O
ENG.DRAWING NO.: 20C3048 PLT 2

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
	4310173	CAP DISC .01/600V C1,C2,C3,C4,C5,C6	811000Z5U0103M	6.000	EA
	4590170	VARISTOR RV1,RV2,RV3,RV4	V-120-MA1A	4.000	EA
1	3474590	PCB MRC1620 COMM I/O	5186121 PLT 1	1.000	EA
2	2301307	ASSY CA MRC1620 RS-232 SIP-9M P6	24B1178 PLT 1	1.000	EA
3	2300879	ASSY CA MRC-1600 COMM I/O	24B1097-1 E	1.000	EA
4	3030244	CONN BNC BULKHD UG-1094/U J1,J2	31-221	2.000	EA
5	3291143	TERM STRIP 8181/8 NI PLTD SCRW TB1	25.102.0853S	1.000	EA
6	1050590	NUT HEX 4-40 1/4 FLATS SST P6		2.000	EA
7	1050632	WSHR LK #4 SR CD PL P6		2.000	EA
8	1050939	SCR JACK 3/16HEX4-40 X 5/16L P6	4750-3	2.000	EA
9	1560028	TBG SHRINK 1/8" CLEAR J1,J2	FIT 221 1/8CL	1.000	[illegible]
10	4130035	FERRITE BEAD J1,J2	K S 001 00/3B	2.000	EA

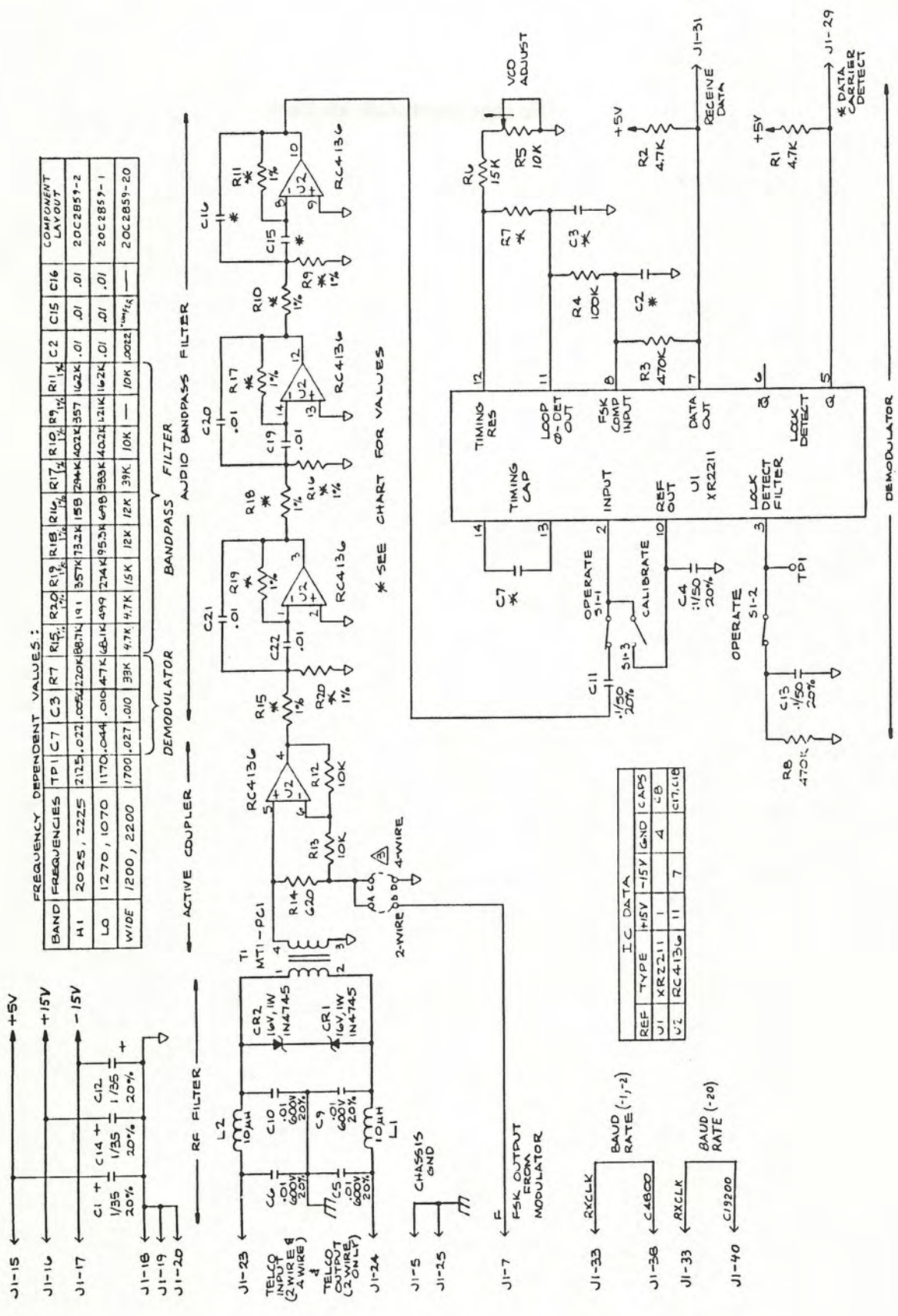


Figure 8-12
Telco Input Schematic
91C7304

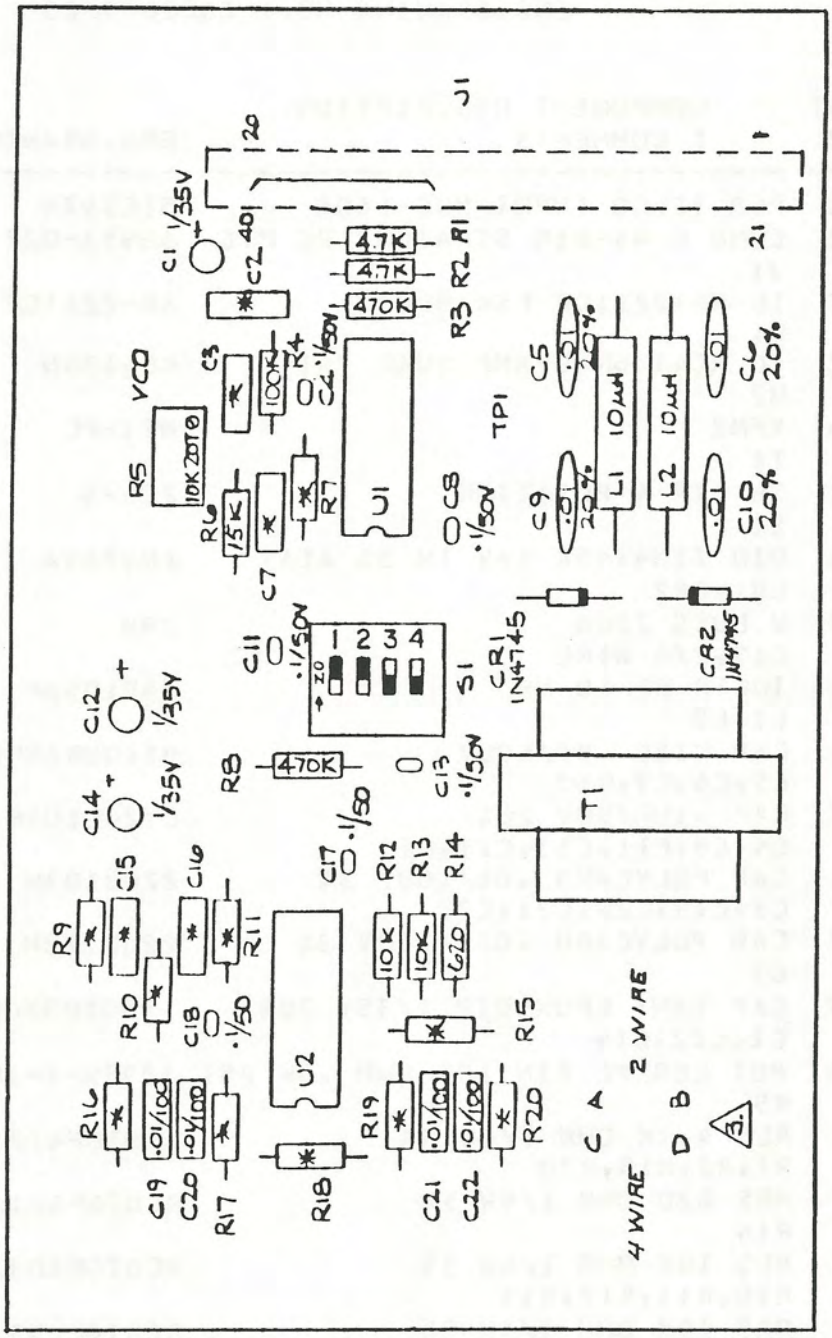


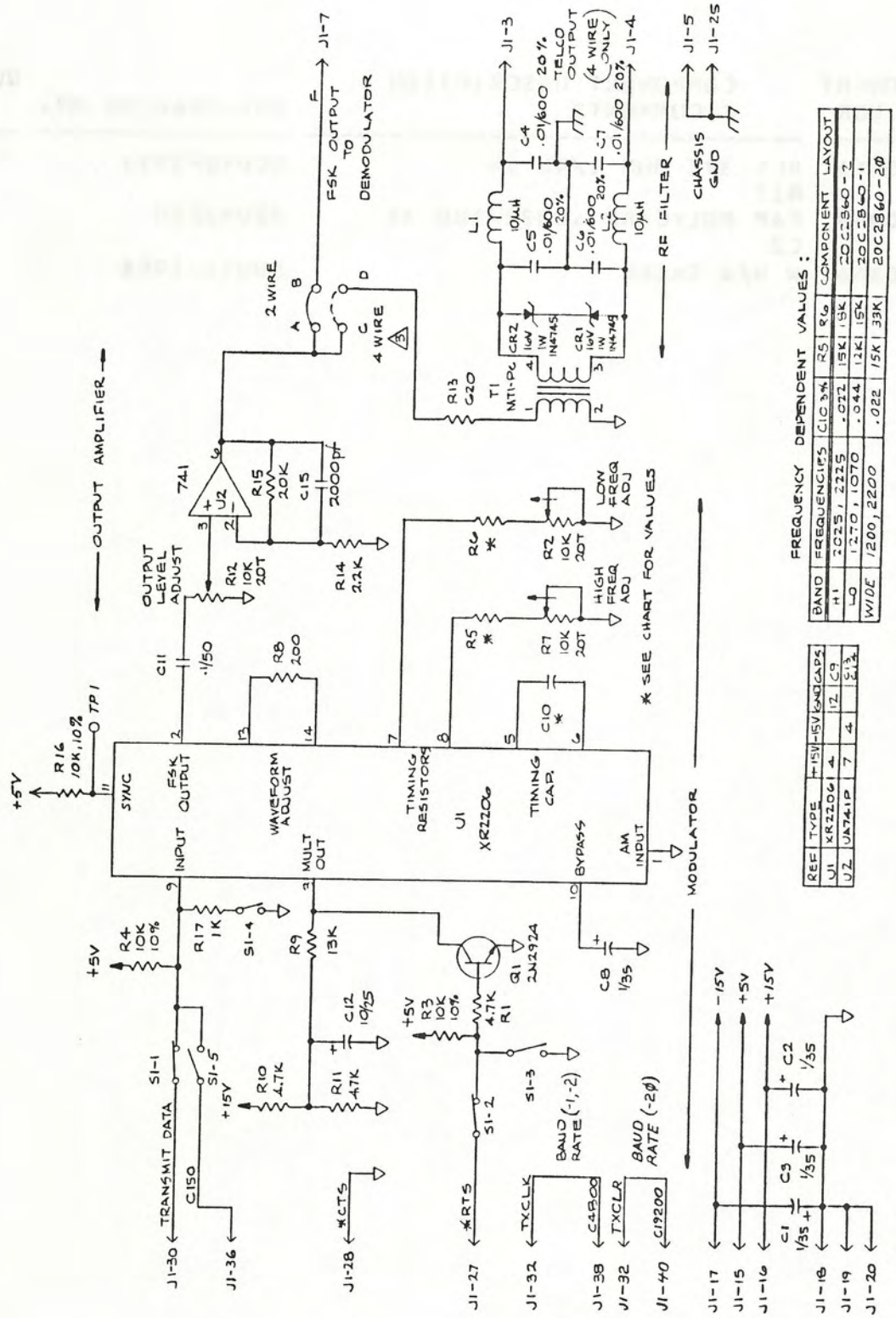
Figure 8-13
Telco Input Assembly
20C2859

PARENT ITEM: 9205931 DESCRIPTION: ASSY COMP MRC1620 TELCO IN
ENG.DRAWING NO.: 20C2859-20 C

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3473360	PCB TELCO INPUT MRC-1600	51C5978	B	1.000	EA
2	3110582	CONN F 44-PIN STRAIGHT PC MTG J1	66953-022		1.000	EA
3	3730827	IC XR-2211CP FSK MODEM U1	XR-2211CP		1.000	EA
4	3730462	IC RC4136N OPAMP QUAD 741 U2	RC4136N		1.000	EA
5	4090106	XFMR T1	MT1-PC		1.000	EA
6	3190071	SW DIP 4 POSITION S1	206-4		1.000	EA
7	3600236	DIO Z1N4745A 16V 1W 5% AIAY CR1,CR2	1N4745A		2.000	EA
8	1641927	W BUSS 22GA C15,2/4 WIRE	298		.050	FT
9	4020376	IDCTR RF 10 UH L1,L2	74F105AP		2.000	EA
10	4310173	CAP DISC .01/600V C5,C6,C9,C10	811000Z5U0103M		4.000	EA
11	4310207	CAP .1UF/50V 20% C4,C8,C11,C13,C17,C18	CY20C104M		6.000	EA
12	4250171	CAP POLYCARB .01/100V 3% C3,C19,C20,C21,C22	22UB103H		5.000	EA
15	4250312	CAP POLYCARB .027/100V 3% C7	22UB273H		1.000	EA
16	4280038	CAP TANT EPOX-DIP 1/35V 20% C1,C12,C14	199D105X0035HA1		3.000	EA
17	4630273	POT CER PC PIN 10K OHM .5W 25T R5	3299W-1-103		1.000	EA
18	4460242	RES 4.7K OHM 1/4W 5% R1,R2,R15,R20	RC07GF472J		4.000	EA
19	4460127	RES 620 OHM 1/4W 5% R14	RC07GF621J		1.000	EA
20	4460317	RES 10K OHM 1/4W 5% R10,R11,R12,R13	RC07GF103J		4.000	EA
21	4460341	RES 15K OHM 1/4W 5% R6,R19	RC07GF153J		2.000	EA
22	4460481	RES 100K OHM 1/4W 5% R4	RC07GF104J		1.000	EA
23	4460549	RES 470K OHM 1/4W 5% R3,R8	RC07GF474J		2.000	EA
36	4460390	RES 33K OHM 1/4W 5% R7	RC07GF333J		1.000	EA
42	4460325	RES 12K OHM 1/4W 5% R16,R18	RC07GF123J		2.000	EA

PARENT ITEM: 9205931

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG. DRAWING NO.	QUANTITY PER	UM
43	4460416	RES 39K OHM 1/4W 5% R17	RC07GF393J	1.000	EA
44	4250049	CAP POLYCARB .0022/100 3% C2	22UB222H	1.000	EA
50	1640366	W W/W GREEN	M0015-195A	.100	FT



REF	TYPE	+15V	-15V	GND	CAPS
U1	XR2206	4		12	C9
U2	UA741P	7	4		C13

FREQUENCY DEPENDENT VALUES:

BAND	FREQUENCIES	C10 5%	R5	R6	COMPONENT LAYOUT
H1	2025, 2225	.022	15K	15K	20C2360-2
LO	1270, 1070	.044	12K	15K	20C2360-1
WIDE	1200, 2200	.022	15K	33K	20C2860-20

Figure 8-14
Telco Output Schematic
91C7305

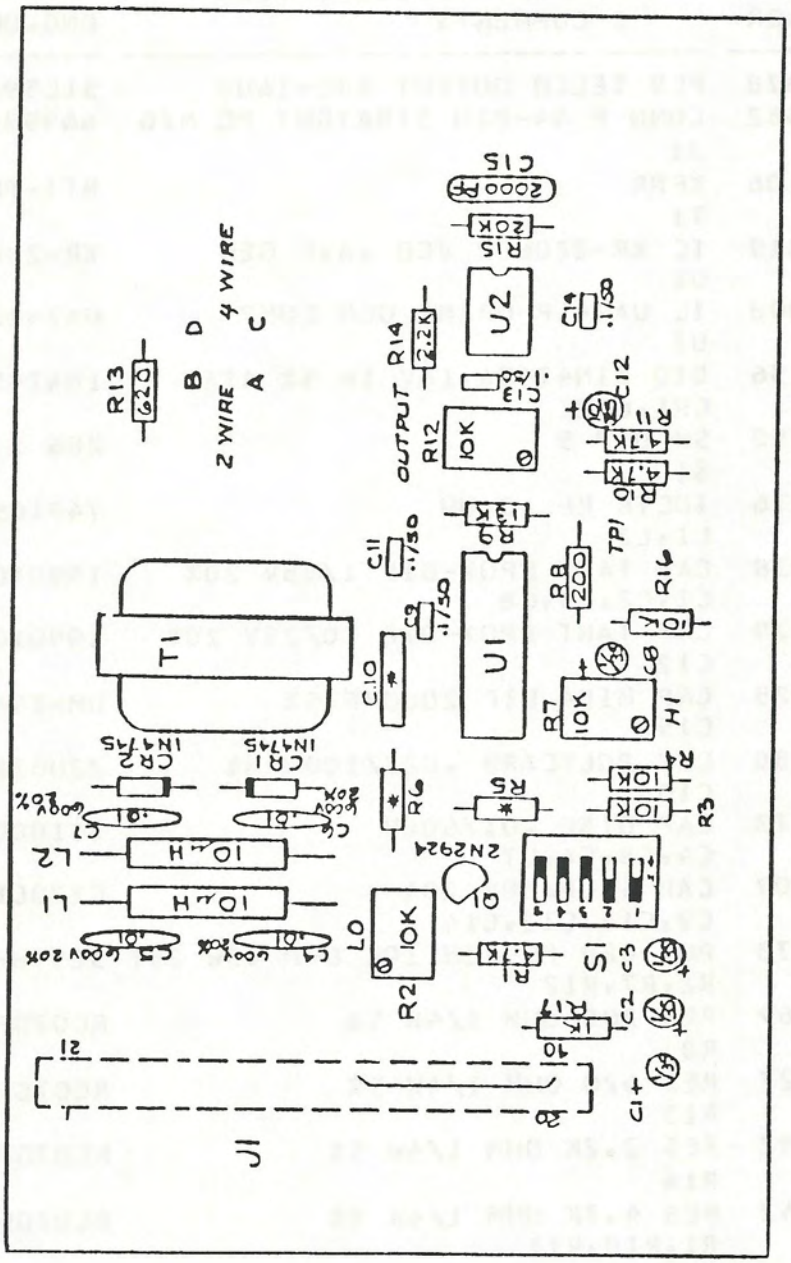


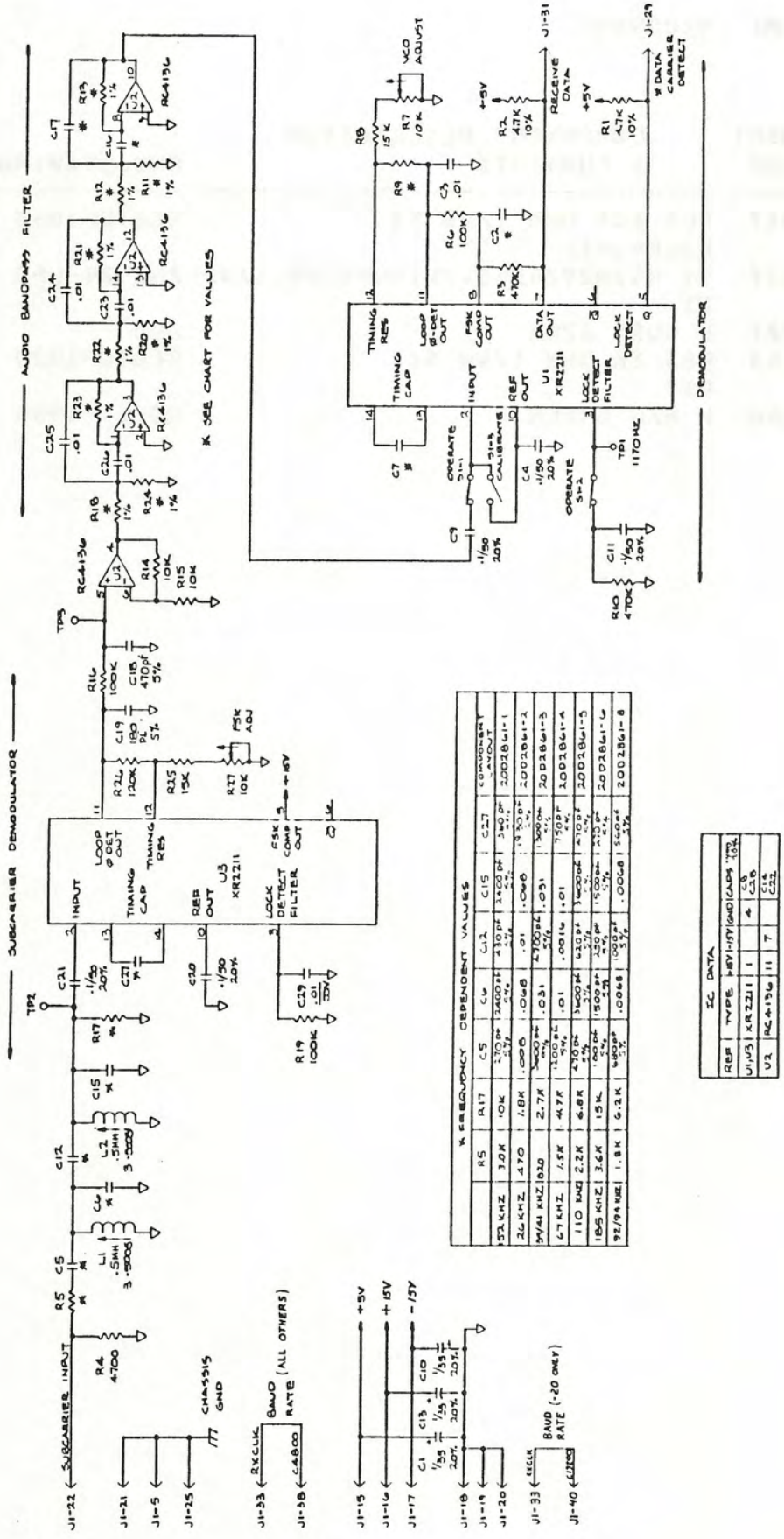
Figure 8-15
Telco Output Assembly
20C2860

PARENT ITEM: 9205949 DESCRIPTION: ASSY COMP MRC1620 TELCO OUT
ENG.DRAWING NO.: 20C2860-20 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
1	3473378	PCB TELCO OUTPUT MRC-1600	51C5979 B	1.000	EA
2	3110582	CONN F 44-PIN STRAIGHT PC MTG J1	66953-022	1.000	EA
3	4090106	XFMR T1	MT1-PC	1.000	EA
4	3730819	IC XR-2206CP VCO WAVE GEN U1	XR-2206CP	1.000	EA
5	3660008	IC UA741P OPAMP GEN COMP U2	UA741CP	1.000	EA
6	3600236	DIO Z1N4745A 16V 1W 5% AIAY CR1,CR2	1N4745A	2.000	EA
7	3190790	SW DIP 5 S1	206 5	1.000	EA
8	4020376	IDCTR RF 10 UH L1,L2	74F105AP	2.000	EA
9	4280038	CAP TANT EPOX-DIP 1/35V 20% C1,C2,C3,C8	199D105X0035HA1	4.000	EA
10	4280079	CAP TANT EPOX-DIP 10/25V 20% C12	199D106X0025KA1	1.000	EA
11	4220125	CAP MICA DIP 2000PF 5% C15	DM-19-202J	1.000	EA
13	4250288	CAP POLYCARB .022/100V 3% C10	22UB223H	1.000	EA
14	4310173	CAP DISC .01/600V C4,C5,C6,C7	811000Z5U0103M	4.000	EA
15	4310207	CAP .1UF/50V 20% C9,C11,C13,C14	CY20C104M	4.000	EA
16	4630273	POT CER PC PIN 10K OHM .5W 25T R2,R7,R12	3299W-1-103	3.000	EA
17	4460069	RES 200 OHM 1/4W 5% R8	RC07GF201J	1.000	EA
18	4460127	RES 620 OHM 1/4W 5% R13	RC07GF621J	1.000	EA
19	4460192	RES 2.2K OHM 1/4W 5% R14	RC07GF222J	1.000	EA
20	4460242	RES 4.7K OHM 1/4W 5% R1,R10,R11	RC07GF472J	3.000	EA
22	4460333	RES 13K OHM 1/4W 5% R9	RC07GF133J	1.000	EA
23	4460341	RES 15K OHM 1/4W 5% R5	RC07GF153J	1.000	EA
24	4460390	RES 33K OHM 1/4W 5% R6	RC07GF333J	1.000	EA
25	4460366	RES 20K OHM 1/4W 5% R15	RC07GF203J	1.000	EA

PARENT ITEM: 9205949

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
26	4460317	RES 10K OHM 1/4W 5% R3,R4,R16	RC07GF103J	3.000	EA
27	3630027	XT NS2N2924LFS.2W160M025V.1A7P Q1	2N2924-LFS	1.000	EA
28	1641927	W BUSS 22GA	298	.050	FT
29	4460143	RES 1K OHM 1/4W 5% R17	RC07GF102J	1.000	EA
50	1640366	W W/W GREEN	M0015-195A	.100	FT



* FREQUENCY DEPENDENT VALUES								
	R5	R17	C5	C6	C12	C15	C27	COMPONENT LAYOUT
132 KHZ	3.0K	10K	2700pf 5%	3400pf 5%	430pf 5%	2400pf 5%	390pf 5%	2002861-1
24 KHZ	470	1.8K	.0068	.01	.0068	.0330pf 5%	2700pf 5%	2002861-2
9/41 KHZ	1620	2.7K	3600pf 5%	.047	2700pf 5%	.051	3600pf 5%	2002861-3
67 KHZ	4.5K	4.7K	.1000pf 5%	.01	.0016	.01	1500pf 5%	2002861-4
110 KHZ	2.2K	6.8K	2700pf 5%	3600pf 5%	430pf 5%	1600pf 5%	470pf 5%	2002861-5
185 KHZ	3.6K	15K	.0047 5%	1500pf 5%	750pf 5%	1500pf 5%	330pf 5%	2002861-6
92/94 KHZ	1.8K	6.2K	6800pf 5%	.0068	1000pf 5%	.0068	3600pf 5%	2002861-8

IC DATA				
REF	TYPE	+8V1-15V	GND	CAPS .1% 10%
U1,U3	XR2211	1	4	C6 C16
U2	RC4136	11	7	C14 C22

Figure 8-16
Subcarrier Input Schematic
91D7306

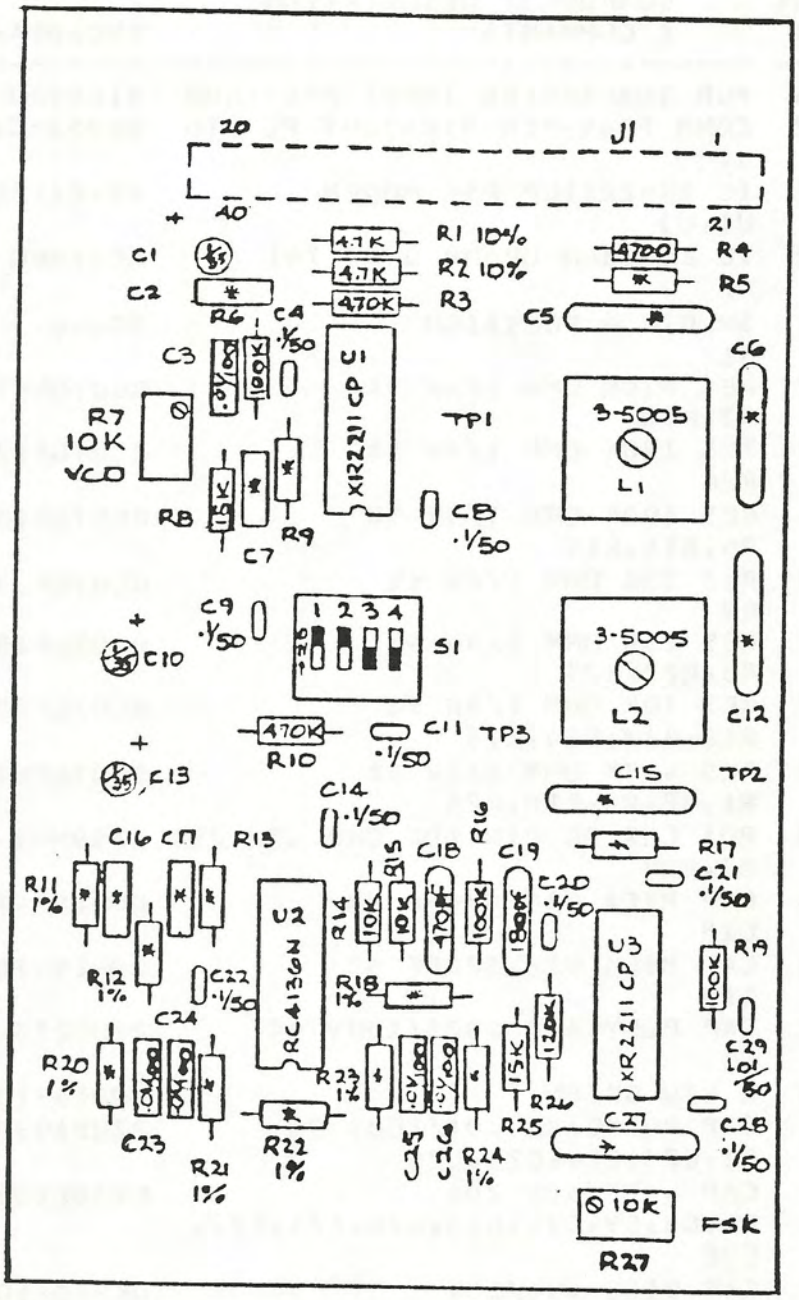


Figure 8-17
Subcarrier Input Assembly
20D2861

PARENT ITEM: 9205956 DESCRIPTION: ASSY COMP MRC1620 SUBC IN NEU
ENG.DRAWING NO.: 2002861-20 E

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3473386	PCB SUBCARRIER INPUT MRC-1600	51C5980	B	1.000	EA
2	3110582	CONN F 44-PIN STRAIGHT PC MTG J1	66953-022		1.000	EA
3	3730827	IC XR-2211CP FSK MODEM U1,U3	XR-2211CP		2.000	EA
4	3730462	IC RC4136N UPAMP QUAD 741 U2	RC4136N		1.000	EA
5	3190071	SW DIP 4 POSITION S1	206-4		1.000	EA
6	4460549	RES 470K OHM 1/4W 5% R3,R10	RC07GF474J		2.000	EA
10	4460499	RES 120K OHM 1/4W 5% R26	RC07GF124J		1.000	EA
11	4460481	RES 100K OHM 1/4W 5% R6,R16,R19	RC07GF104J		3.000	EA
14	4460390	RES 33K OHM 1/4W 5% R9	RC07GF333J		1.000	EA
17	4460341	RES 15K OHM 1/4W 5% R8,R23,R25	RC07GF153J		3.000	EA
18	4460317	RES 10K OHM 1/4W 5% R12,R13,R14,R15	RC07GF103J		4.000	EA
21	4460242	RES 4.7K OHM 1/4W 5% R1,R2,R4,R18,R24	RC07GF472J		5.000	E
33	4630273	POT CER PC PIN 10K OHM .5W 25T R7,R27	3299W-1-103		2.000	EA
42	4210456	CAP MICA DIP 470PF 5% C18	DM-15-471J		1.000	EA
45	4210324	CAP MICA DIP 180PF 5% C19	DM-15-181J		1.000	EA
48	4250312	CAP POLYCARB .027/100V 3% C7	22UB273H		1.000	EA
50	1640366	W W/W GREEN	M0015-105A		.100	FT
52	4250171	CAP POLYCARB .01/100V 3% C3,C23,C24,C25,C26	22UB103H		5.000	EA
56	4310207	CAP .1UF/50V 20% C4,C8,C9,C11,C14,C20,C21,C22, C28	CY20C104M		9.000	EA
57	4310132	CAP DISC .01/50V C29	UK-50-103		1.000	EA
58	4280038	CAP TANT EPOX-DIP 1/35V 20% C1,C10,C13	199D105X0035HA1		3.000	EA
59	4041703	COIL ASSEMBLY L1,L2	03-5005	C	2.000	EA
60	4460325	RES 12K OHM 1/4W 5% R20,R22	RC07GF123J		2.000	EA

PARENT ITEM: 9205956

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
61	4460416	RES 39K OHM 1/4W 5% R21	RC07GF393J	1.000	EA
62	4250049	CAP POLYCARB .0022/100 3% C2	22UB222H	1.000	EA
63	1641927	W BUSS 22GA C16	298	.050	FT

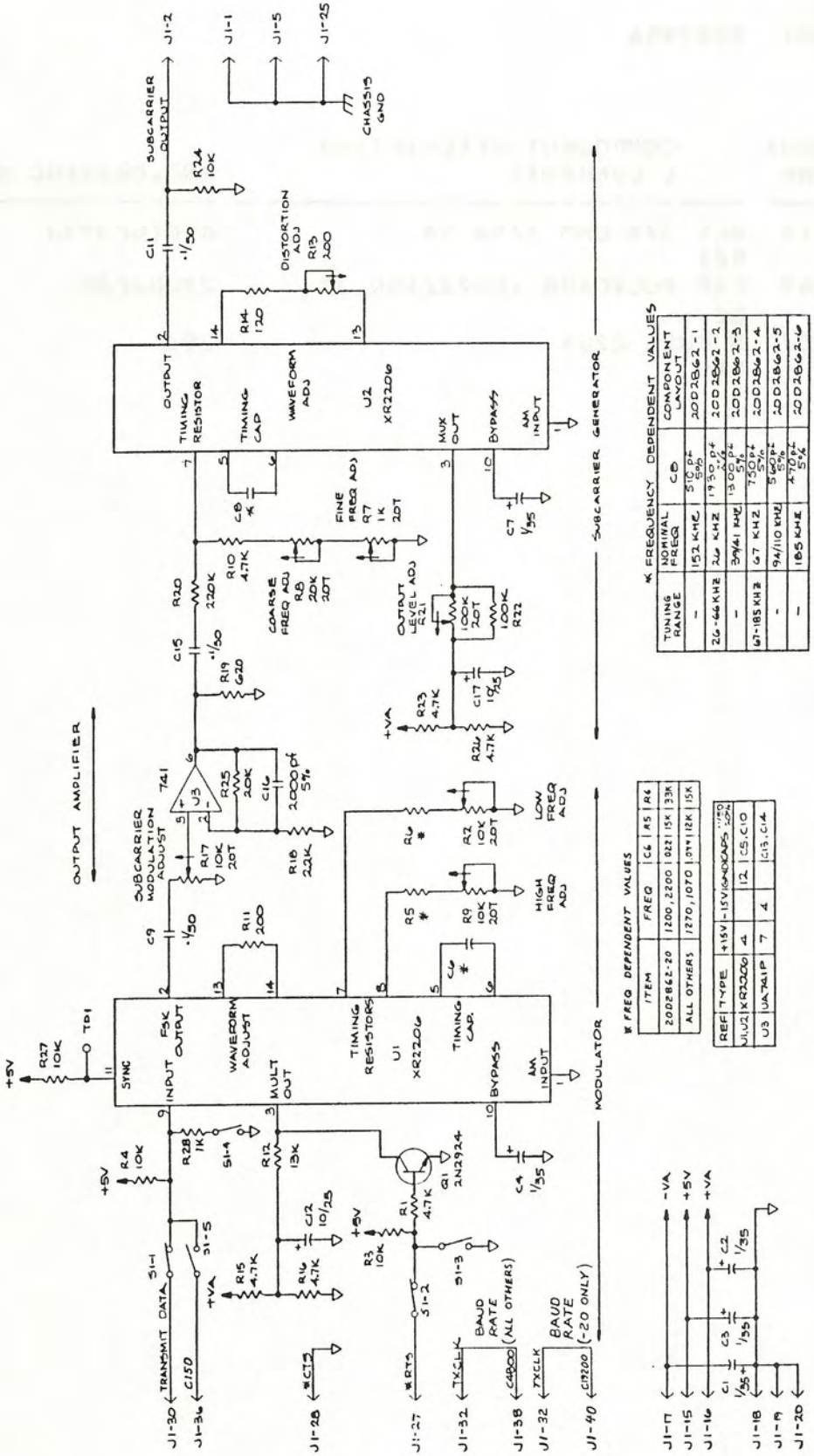


Figure 8-18
Subcarrier Output Schematic
91D7307

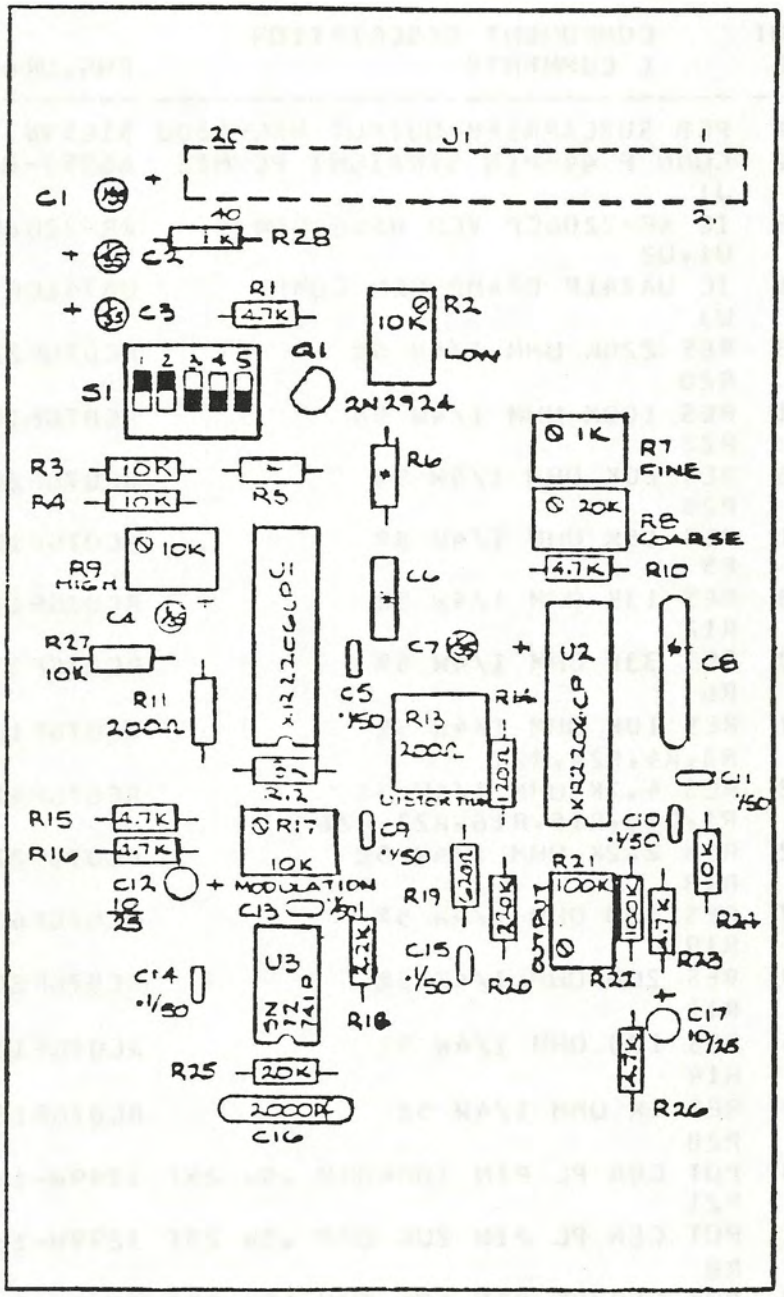


Figure 8-19
Subcarrier Output Assembly
20D2862

PARENT ITEM: 9205964 DESCRIPTION: ASSY COMP MRC1620 SUBC OUT NE
ENG.DRAWING NO.: 20D2862-20 D

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.		QUANTITY PER	UM
1	3473394	PCB SUBCARRIER OUTPUT MRC-1600	51C5981	A	1.000	EA
2	3110582	CONN F 44-PIN STRAIGHT PC MTG J1	66953-022		1.000	EA
3	3730819	IC XR-2206CP VCO WAVE GEN U1,U2	XR-2206CP		2.000	EA
4	3660008	IC UA741P OPAMP GEN COMP U3	UA741CP		1.000	EA
5	4460523	RES 220K OHM 1/4W 5% R20	RC07GF224J		1.000	EA
6	4460481	RES 100K OHM 1/4W 5% R22	RC07GF104J		1.000	EA
7	4460366	RES 20K OHM 1/4W 5% R25	RC07GF203J		1.000	EA
8	4460341	RES 15K OHM 1/4W 5% R5	RC07GF153J		1.000	EA
9	4460333	RES 13K OHM 1/4W 5% R12	RC07GF133J		1.000	EA
10	4460390	RES 33K OHM 1/4W 5% R6	RC07GF333J		1.000	EA
11	4460317	RES 10K OHM 1/4W 5% R3,R4,R24,R27	RC07GF103J		4.000	E
12	4460242	RES 4.7K OHM 1/4W 5% R1,R10,R15,R16,R23,R26	RC07GF472J		6.000	EA
13	4460192	RES 2.2K OHM 1/4W 5% R18	RC07GF222J		1.000	EA
14	4460127	RES 620 OHM 1/4W 5% R19	RC07GF621J		1.000	EA
15	4460069	RES 200 OHM 1/4W 5% R11	RC07GF201J		1.000	EA
16	4460655	RES 120 OHM 1/4W 5% R14	RC07GF121J		1.000	EA
17	4460143	RES 1K OHM 1/4W 5% R28	RC07GF102J		1.000	EA
18	4630778	POT CER PC PIN 100KOHM .5W 25T R21	3299W-1-104		1.000	EA
19	4630331	POT CER PC PIN 20K OHM .5W 25T R8	3299W-1-203		1.000	EA
20	4630273	POT CER PC PIN 10K OHM .5W 25T R2,R9,R17	3299W-1-103		3.000	EA
21	4630786	POT CER PC PIN 1K OHM .5W 25T R7	3299W-1-102		1.000	EA
22	4630018	POT CER PC PIN 200 OHM .5W R13	3386R-1-201		1.000	EA
30	4310207	CAP .1UF/50V 20% C5,C9,C10,C11,C13,C14,C15	CY20C104M		7.000	EA

PARENT ITEM: 9205964

REF NBR	COMPONENT ITEM NBR	COMPONENT DESCRIPTION & COMMENTS	ENG.DRAWING NO.	QUANTITY PER	UM
31	4280038	CAP TANT EPOX-DIP 1/35V 20% C1,C2,C3,C4,C7	199D105X0035HA1	5.000	EA
32	4250288	CAP POLYCARB .022/100V 3% C6	22UB223H	1.000	EA
33	4280079	CAP TANT EPOX-DIP 10/25V 20% C12,C17	199D106X0025KA1	2.000	EA
34	4220125	CAP MICA DIP 2000PF 5% C16	DM-19-202J	1.000	EA
35	3190790	SW DIP 5 S1	206 5	1.000	EA
36	3630027	XT NS2N2924LFS.2W160M025V.1A7P Q1	2N2924-LFS	1.000	EA
50	1640366	W W/W GREEN	M0015-195A	.100	FT

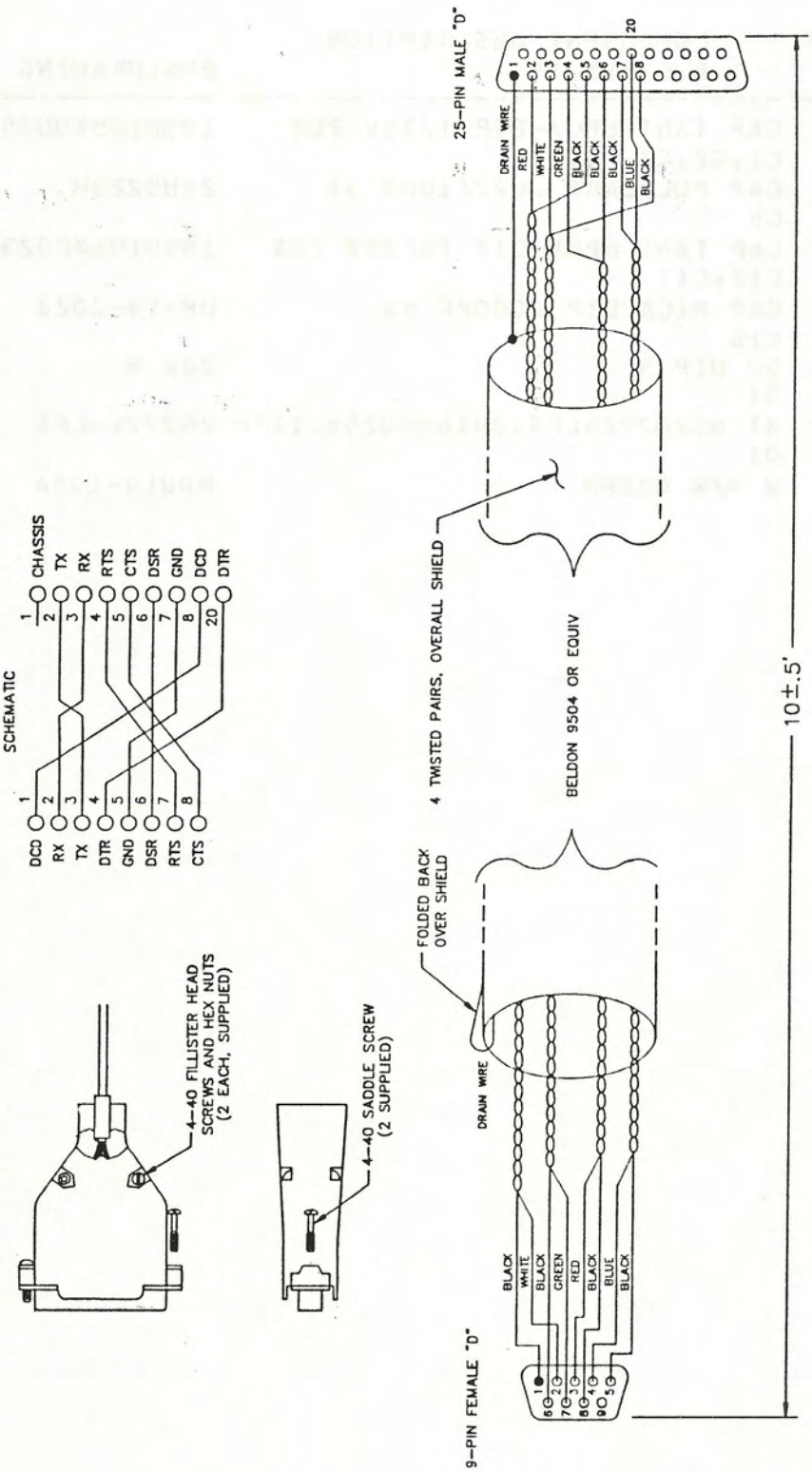
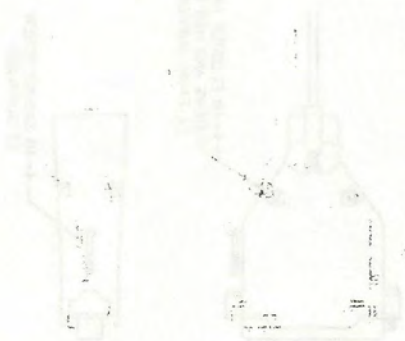


Figure 8-20
9F-25M Modem Cable Assembly
24C1167

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



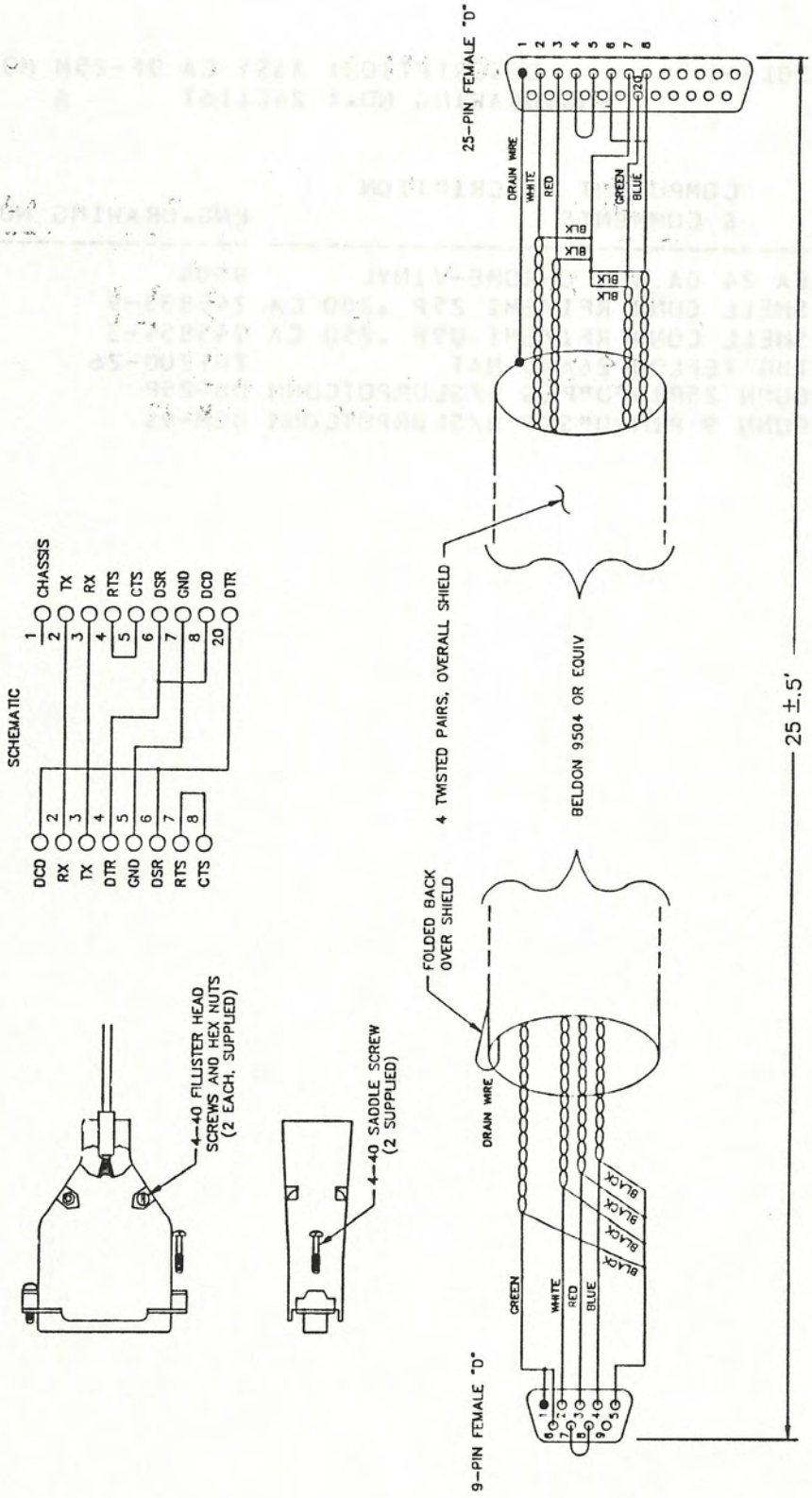


Figure 8-21
9F-25F Null Modem Cable Assembly
24C1170

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

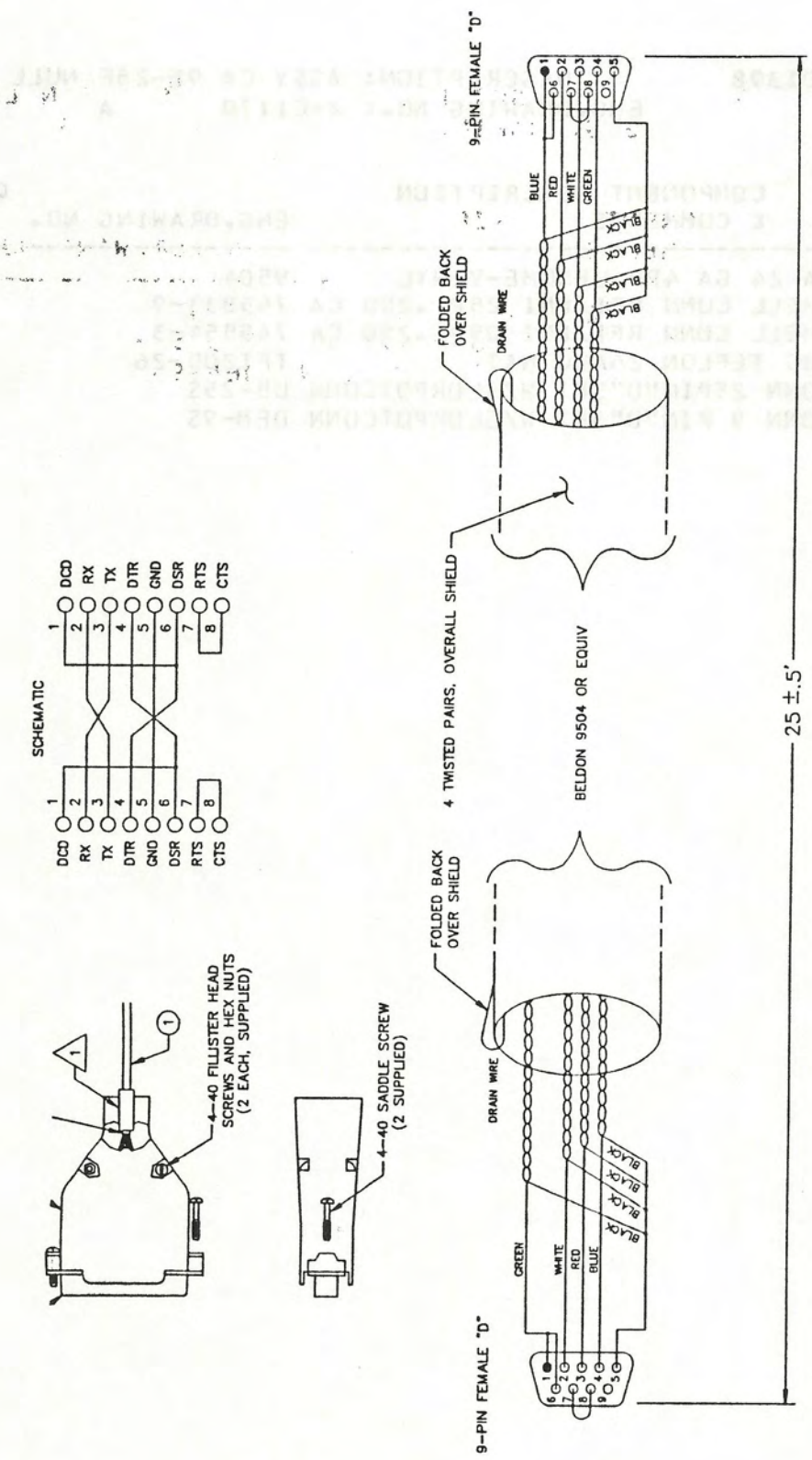


Figure 8-22
9F-9F Null Modem Cable Assembly
24C1171

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

ALARM DRIVER | LT. ALPHANUMERIC DISPLAY | RT. ALPHANUMERIC DISPLAY | BOTTOM LEDS | MIDDLE LEDS | TOP LEDS

S1 S2 S3 S4 S5 S6 S7 S8 (Y Y G G G R Y Y)

R2 SIP 3.3K 1/8W 2%

U8 74LS244 — U7 74LS244

P1: 20 IODB0, 19 IODB1, 18 IODB2, 17 IODB3, 16 IODB4, 15 IODB5, 14 IODB6, 13 IODB7

DB0 DB1 DB2 DB3 DB4 DB5 DB6 DB7

P1-3 *BZDRV — P1-23 *INTBZ — BZ1 — +5V

R1 1K — Q1 2N2924

*RESET

U3 74LS74A (1CLR 1D 1CLK 1PR 2PR 2D 2CLR 2Q 2Q)

U2 DL2416 (A0 A1 WR CLR CUE BL CEI CEO CE2 D0–D7) — *DSL

U1 DL2416 — *DSR

U4 74273 (CLK CLR 1D 2D 3D 4D 5D 6D 7D 8D Q1–Q8) — *LEDB

U6 74273 — *LEDM

U5 74273 — *LEDT

ALARM, FAILSAFE, LOWER LIMIT, UPPER LIMIT, AUDIBLE OFF, SETUP, MAINT, RUN

STATUS 16 15 14 13 12 11 10 9

STATUS 8 7 6 5 4 3 2 1

R5 SIP 220Ω 1/8W 2% — R4 SIP 220Ω 1/8W 2% — R3 SIP 220Ω 1/8W 2%

CR17–CR24 (R/G) — CR9–CR16 (R/G) — CR1–CR8 (R/G)

74LS139 (U9: 1A 1B 1G 2G; 1Y0–1Y3; 2Y0–2Y3)

*ALARM, *LEDB, *LEDM, *LEDT

74LS32 (U10) — *RDSW

*DSL, *DSR

74LS32 (U10) — *FPSEL

*WRSTR

AB0 AB1 AB2 AB3 AB4

+5V — 220Ω 10 C11 — GND (P1 25-40)

74LS32 SPARE GATE (U10)

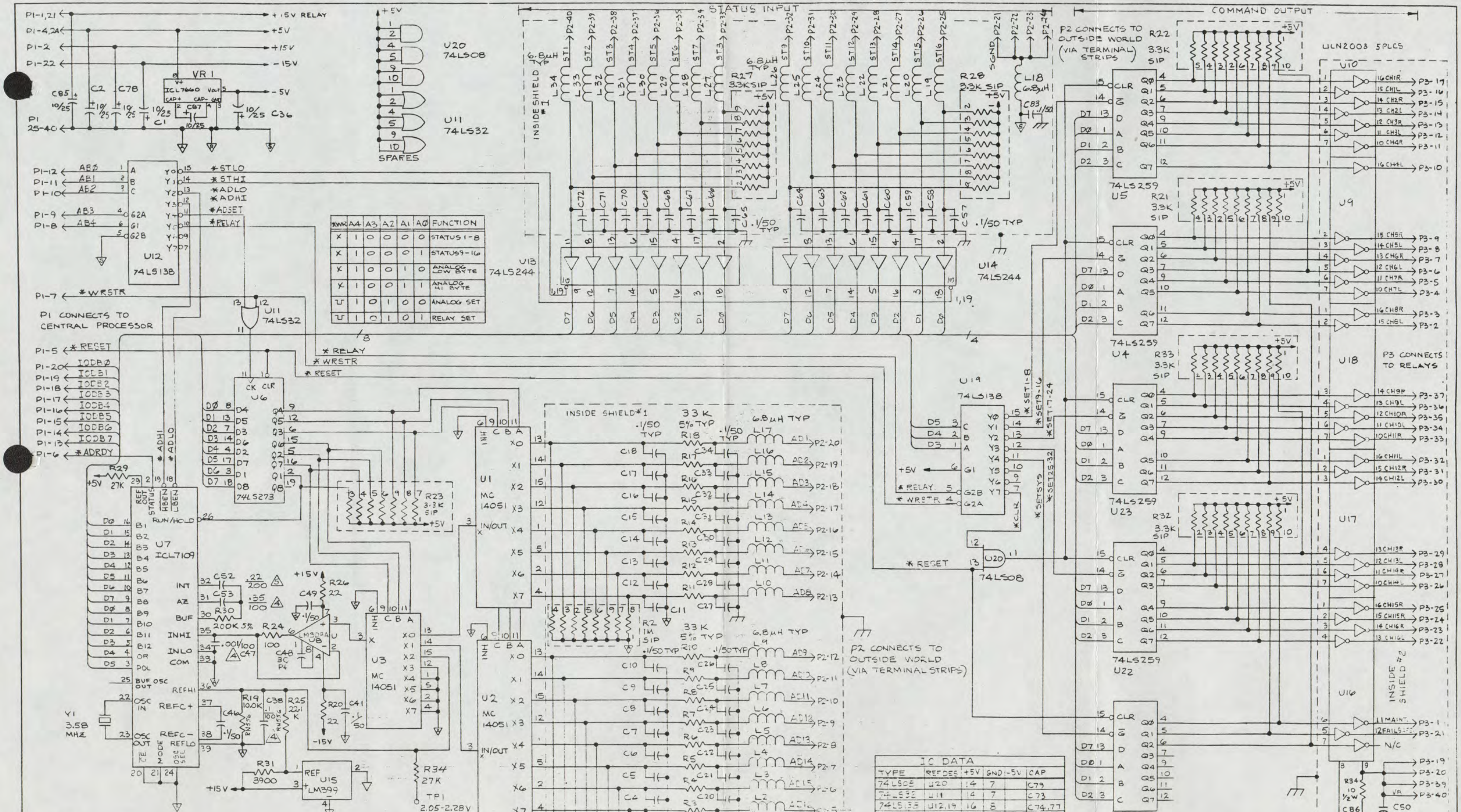
*WR	A4	A3	A2	A1	A0	DEVICE
X	0	0	0	X	X	SWITCHES
⊔	0	0	1	0	0	RIGHT DISPLAY (LSB)
⊔	0	1	0	1	1	LEFT DISPLAY (MSB)
⊔	0	1	1	0	0	TOP LEDS
⊔	0	1	1	0	1	MIDDLE LEDS
⊔	0	1	1	1	0	BOTTOM LEDS
⊔	0	1	1	1	1	ALARM

DESIGN.	IC	+5	GND
U1,2	DL2416	9	10
U3	74LS74A	14	7
U9	74LS139	16	8
U4-6	74273	20	10
U10	74LS32	14	7
U7,8	74LS244	20	10

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   RESISTORS ARE IN OHMS, 1/4W, 5%
   CAPACITORS ARE IN MICROFARADS
2. P.C. BOARD: SID5974
3. COMPONENT LAYOUT: 20D2855

NOV 8 1991

MOSELEY ASSOCIATES, INC.
SCHEMATIC
MRC-1620 FRONT PANEL
7D7300 C



*WR	A4	A3	A2	A1	AØ	FUNCTION
X	1	0	0	0	0	STATUS 1-8
X	1	0	0	0	1	STATUS 9-16
X	1	0	0	1	0	ANALOG LOW BYTE
X	1	0	0	1	1	ANALOG HI BYTE
⊔	1	0	1	0	0	ANALOG SET
⊔	1	0	1	0	1	RELAY SET

NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%; ALL CAPACITOR VALUES ARE IN MICROFARADS.
2. COMPONENT LAYOUT 2002857
3. P.C. BOARD 51D5976

4. POLYCARBONATE
5. POLYPROPYLENE
6. = CHASSIS GND
7. U15 MAY BE EITHER LM399 OR LM3999

IC DATA

TYPE	REF DES	+5V	GND	-5V	CAP
74LS08	U20	14	7		C79
74LS32	U11	14	7		C73
74LS138	U12,19	16	8		C74,77
74LS244	U13,14	20	10		C75,76
74LS259	U4,5,21 22,23	16	8		C42,43,80 81,82
74273	U6	20	10		C44
MC14051	U1,2,3	16	8	7	C35,37,40
ICL7109	U7	40	1	28	C45

RELAY OUTPUT FORMAT

D7	D6	D5	D4	D3	D2	D1	D0	FUNCTION
X	X	1	1	1	X	X	X	RESET RELAYS 0-31
0	X	n	n	n	n	n	n	RELAY n OFF n = 0-33
1	X	n	n	n	n	n	n	RELAY ON n = 0-33

NOV 8 1991

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA CALIFORNIA

SCHEMATIC
MRC-1620 ANALOG/CMD./STAT

TOL: FRACT. ± 1/32, .XX ± .030, .XXX ± .010, ∠ ± 1/2°

91D7302 C

IC.	DESC.	+5V	GND	CAP.	+15V	-15V
U20	MC6809	7	1	C23		
U13	MC6821	20	1	C16		
U14,U21	MC6850	12	1	C17,C36		
U5-U8,U17	TMS2516/32	24	12	C8-11,20		
U15	TMS4016	24	12	C18		
U16	X2816A	24	12	C40		
U3	LM339		12	C19	3	
U1	CD4040B	16	8	C1		
U9	74LS00	14	7	C12		
U18	74LS04	14	7	C21		
U10	74LS32	14	7	C13		
U4	74LS123	16	8	C6		
U19	74LS138	16	8	C22		
U12	74LS244	20	10	C15		
U11	74LS245	20	10	C14		
U2	74LS163	16	8	C2		
U22	MC1489	14	7	C37		
U23	MC1488		7	C38,C39	14	1

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   RESISTOR VALUES ARE IN OHMS, 1/4W, 5%
   CAPACITOR VALUES ARE IN MICROFARADS
2. P.C. BOARD: 51D6120
3. COMPONENT LAYOUT: 20D2917
4. PIA = C0084 H , ACIA1 = C0044 H ,
   S2 = C003C H , ACIA2 = C002C H
5. P3 AND P4 HAVE THE SAME CONNECTIONS ON ALL PINS.
6. ADJUST C25 SO Q (OR E) IS 1.000 000 ± .000 010 MHZ.

7 FOR ADDRESS DECODING,
MRC-1600 = 2K BLOCK, EPROM = TMS2516
MRC-1620 = 4K BLOCK, EPROM = TMS2732

NOV 8 1991

MOSELEY ASSOCIATES, INC.
SCHEMATIC
MRC-1620 CENTRAL PROCESSOR
91D7365 E