MOSELEY ASSOCIATES, INC.

CH1 = ON/OFF
CH2 = PLANTS ON/OFF
CH3 = R/L

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 one (1) year, or (2) years for all MRC series equipment, 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. Goleta, California, as directed by Moseley Associates, Inc.; or

B. To accept the return thereof f.o.b. Goleta, 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 specifications, 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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INSTRUCTION MANUAL

MRC-1600 MICROPROCESSOR

REMOTE CONTROL SYSTEM

Fourth Edition

1 August 1984

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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
FSK	frequency shift keying
IC	integrated circuit
LED	light-emitting diode
Modem	FSK modulator/demodulator
NC	normally closed (contact)
NO	normally open (contact)
EEROM	electrically-erasable read-only memory
RAM	random-access memory
ROM	read-only memory
SCA	Subsidiary Communications Authority
Status	On/Off (Go/No Go) input to Remote Terminal representing an occurence of interest, such as doors opening, transmitter overloads, fire, etc. External interfacing is normally required, providing a contact closure (or opening) to the MRC-1600.
Telco	Telephone Company, 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 MRC-1600 Microprocessor Remote Control System is designed to provide the ability to monitor and control broadcast transmitters and similar installations from a remote location.

It provides sixteen "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 or absence 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 pushing the RAISE or LOWER button on the front panel.

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.

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

An optional CRT Display Option may be added to the Control Terminal only. An Auto-Logging Option may be added to the CRT Option if desired.

1.2 SYSTEM SPECIFICATIONS

Type of System	Microprocessor-based Control and Remote Terminals.
Control Failsafe	Complies with current FCC requirements for AM and FM service. Responds 45 seconds after failure of interconnecting circuit.
Failsafe Output	SPDT relay contacts (Form C) 2 amperes at 30 Vdc, noninductive.

Alarm Indications	Visual and aural (both Remote and Control Terminals). Aural alarm defeatable and remoteable.
Maintenance Override	Remote Terminal front-panel control provides Remote Terminal relay closure. SPDT relay contacts (Form C) 2 amperes at 30 Vdc, noninductive. LED indication at both terminals.

INTERCONNECTS

Classes	2-wire and 4-wire, FM subcarrier, subaudible, or combinations of these.
2-wire and 4-wire	600 ohm balanced line, nominal. Series 3002 (basic conditioning) data channel per Bell System Technical Reference PUB-41004. Send level: 0 dBm, nominal. Receive level: -30 dBm nominal.
Subcarrier	2200 ohm unbalanced line, in/out nominal. Send level: 1.5 V p-p, nominal. Receive level: 0.25 V p-p, minimum. Frequency modulation of subcarrier on specific frequency between 26 kHz and 185 kHz.
Modulation (Subcarrier/ 2 W - 4 W)	Two-tone FSK. 1070/1270 Hz wire Remote to Control, 2025/2225 Hz wire Control to Remote. 1070/1270 Hz all subcarrier.
Data Rate (Subcarrier/ 2 W - 4 W)	300 bits/second. 2-way simultaneous, full duplex.

Subaudible	2200 ohm unbalanced line, in/out send level: 1.5 V p-p, nominal. Receive level: 0.25 p-p minimum. Two-tone FSK 20-25 Hz, baud rate 9.4 bits per second.
Data Format	8-bit data byte plus parity in a 11-bit character frame, with LRCC and parity bit in each frame.

COMMAND FUNCTIONS

Number of Command Lines	16 raise and 16 lower.
Inputs	Front panel raise/lower buttons.
Outputs	SPDT (Form C) relay contacts, rated at 30 Vdc, 2 amperes, noninductive.
Response Time	425 msec, 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 LEDs at Remote and Control Terminals.
Response Time	450 msec, typical from status change to indication at Control terminal.

TELEMETRY (ANALOG) FUNCTIONS

Number of Channels	16 inputs.
Inputs	Analog ±4.5 Vdc maximum, single ended referenced to ground.
Input Impedance	500 K ohm, nominal.
Input Filtering	L-C low-pass filter for each channel.
Calibration	Via front panel switches 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).
Measurement Accuracy	Better than 0.5%
Sample Rate	Greater than 9 times/second displayed channel.
Display	4 digits (9999 counts, maximum) plus sign and decimal point. Alphanumeric setup menu.
Response Time	525 ms, typical, from an input change exceeding ±10 mV to be displayed at the Control Terminal.

PHYSICAL

Power (Command and Remote)	120/240 Vac, 50/60 Hz, 30 W, typical.
Operating Temperature	0-50°C
Size (W x H x D)	19" x 7" x 9" (48.3 cm x 17.8 cm x 22.9 cm).

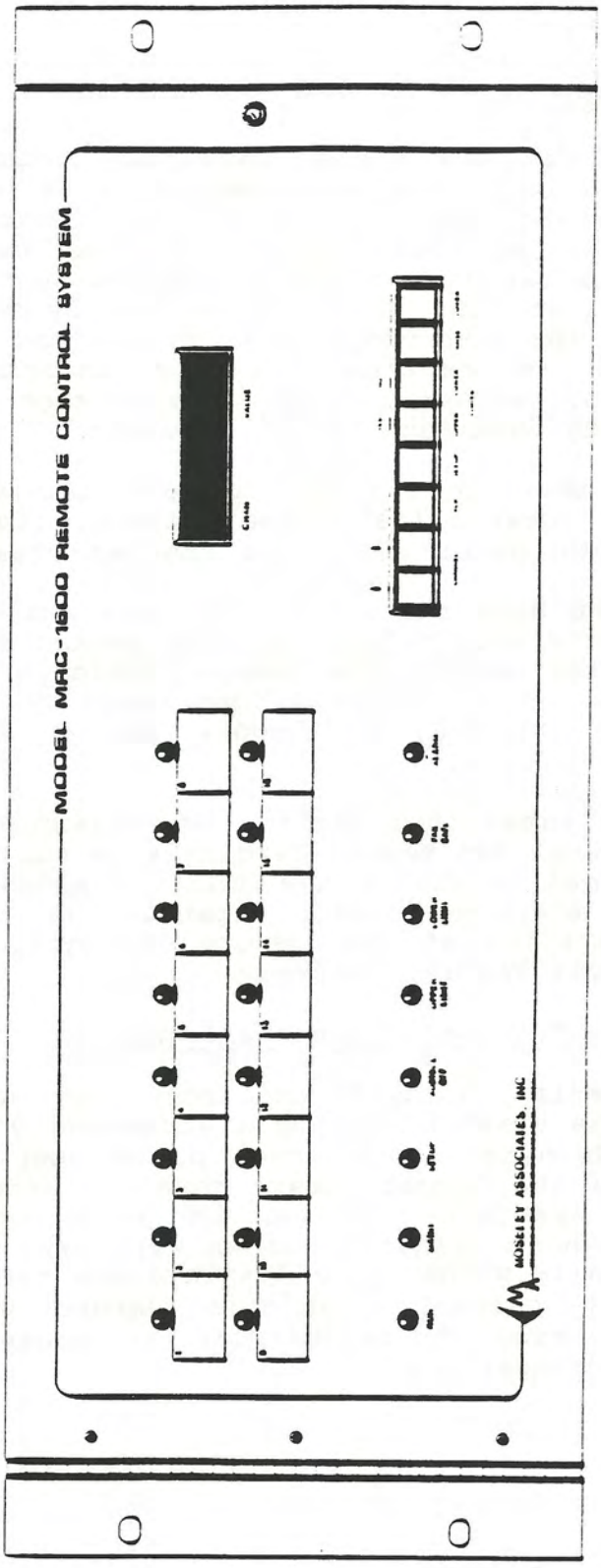


Figure 1-1

1.3 OPERATION

1.3.1 Introduction

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 tabletop, and connect them together (using wire or coax cable terminated by BNC connectors, depending on the interconnection options you have ordered). Check ahead 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 screw to do this.

If you do not have the units available while reading this section, Figure 1-1, showing a front panel, is provided for reference. The Control and Remote terminals have identical front panels. (You can tell them apart by looking at the rear of the units. The Remote 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 setup capabilities. We will first describe operation at the Remote Terminal, then describe how the Control Terminal differs.

1.3.2 Remote Terminal - General Comments

The alphanumeric display on the front panel always pertains to one of the nineteen channels (numbered 0 to 18). 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, 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, push the ↑ or ↓ button. 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 18, channel 0 is selected (and vice-versa).

Channels 1-16 display the current value of the sixteen analog ("telemetry") inputs. Channels 17 and 18 are measurements of the performance of the system. 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 the two terminals. The first two digits represent the quality of communications (proportion of error-free messages) received from the other terminal. The second two digits represent a report from the other terminal on the communications it is receiving from this terminal. If this terminal is not receiving communications at all, the second two digits will be displayed as "XX", indicating that the conditions at the other terminal aren't known. Each of these data quality displays is a number from 00 to 99, with 99 being best.

1.3.3 Remote Terminal - Channel 0 Operation

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

SETUP and UPPER LIMIT simultaneously:
Lamp Test: All LEDs and all segments of the alphanumeric display are lit up.

SETUP 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 the enabling jumper on the rear of the unit before the alarm will sound. Refer to section 2 for information.

SETUP 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.

SETUP and LOWER simultaneously:

Maintenance override enable/disable. FCC regulations require 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.

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 SETUP and LOWER at the Remote Terminal while channel 0 is selected reverses the current state of maintenance override.

SETUP and ACK simultaneously:

This clears all alarms at once. Various conditions cause alarms in the MRC-1600. 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, SETUP and ACK pushed simultaneously while on channel 0 will clear all the alarms.

1.3.4 Remote Terminal - Channel 1-16 Operation

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.

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

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 may establish alarms on transitions of the 16 status channels. We will describe how to do this later.)

Interruption of data from Control Terminal.

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

When one or more of these conditions occurs, the alarm LED flashes. If the audible alarm has not been disabled (via SETUP 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 loss of signal from the Control Terminal, channel 18, which displays data link performance, is selected.)

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 occured, 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.

1.3.5 Failsafe

Another provision of FCC regulations requires that "any fault causing loss of control will automatically place the transmitter in an inoperative position". Therefore, when the Remote Terminal senses that it is no longer receiving data transmissions from the Control Terminal, the "failsafe" sequence commences. After 5 seconds of no data, an alarm is sounded. The failsafe LED on the front panel flashes. After 45 seconds, the LED remains on steadily and the failsafe relay opens. This relay must be connected to make your transmitter inoperative if you are within the jurisdiction of FCC regulations.

As soon as communication from Control to Remote is reestablished, the LED goes off and the failsafe relay closes again. Putting the Remote Terminal in maintenance override mode will also end failsafe.

1.3.6 Remote Terminal Setup

Channels 1-16 may be calibrated, given tolerance alarm limits, etc. To do this, select a channel (using ↑ and ↓) and push SETUP.

When you are in setup mode, the SETUP LED is lit. You may think of setup as a series of questions. At the end of

the sequence the SETUP LED goes off and the various setup parameters you have established go into effect. To abort the sequence simply push SETUP again.

YOU MUST GO THROUGH THE ENTIRE SEQUENCE OR NONE OF YOUR ENTRIES WILL TAKE EFFECT; SAMPLE TELEMETRY VOLTAGES MUST BE INPUT DURING TELEMETRY SETUP. STATUS INPUTS SHOULD BE CONNECTED FOR STATUS ALARM SETUP.

While in SETUP 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, you push NO, ↑ , or ↓ as appropriate until the alphanumeric display shows what you want to see. Then you push YES to enter the proper parameter and go on to the next question.

After you select a channel and push SETUP, 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 push NO, each of these choices will be displayed in turn. Push 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, you will enter a calibration factor later.) Since channel one has no next lower channel, INDIRECT will not be offered as a choice when you are setting it up.

If you have selected MVOLT mode, you will skip the next three entries, and advance directly to upper limit entry, below. Otherwise, you now must choose from these:

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

This entry specifies the position of the decimal point for the display. Push NO until you see the position you want, then push YES.

Next you choose from:

SIGN +
SIGN -

This entry specifies the sign of the calibration factor you are about to have calculated by the MRC-1600 (see below). Use NO and YES.

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. With the MRC-1600, you use ↑ and ↓ to adjust the display value upward or downward, 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, push SETUP, select LINEAR, 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, using ↑ and ↓ . Let's suppose 100.0 is exactly what you want. You push YES. After you complete the remaining questions, you leave setup 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:	Channel 2:	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 MRC-1600, 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 at full scale. The voltage applied should never exceed 4.5 volts, however.

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 tolerance. 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 ↑ and ↓ to change the limit as you please.

Pushing NO will set the display value to 0. Push YES when the display shows the correct value and the limit will be established.

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

STATNORM

and

STAT INV

This setup allows you to invert the status applied to the input before it is displayed. When STATNORM 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.

Finally, we 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 SETUP LED will go off, and the value as calibrated will be displayed.

You may check the setups at any time without changing them. Simply push SETUP and push YES successively. You may change one aspect of the setup without changing the others, simply by using NO, ↑ , or ↓ as appropriate and then pushing YES until you reach the end of the sequence. You must continue to the end of the setup sequence for any new setup factors to be entered.

1.3.7 Final Notes on the Remote Terminal

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.

When the Remote Terminal is powered up, it has no record of any previous setups. The first thing it does is make some assumptions. It automatically sets up every channel as follows:

MVOLT (millivolt) mode
Upper Limit 0 (i.e., disabled)
Lower Limit 0 (i.e., disabled)
STATNORM (i.e., not inverting)
NONE (i.e., no status alarms)

When the Remote and Control Terminals are interconnected, the Remote Terminal routinely sends setup data down to the Control Terminal for backup storage. So the second thing the Remote Terminal does is send a message to the Control Terminal asking for its copy of the setups. During this fetch period, the setup LED flashes. If the Control Terminal is indeed connected to the Remote, this fetch cycle takes about 15 seconds. The time required for transmission of a complete backup copy of the setup data from Remote to Control is about five minutes (with audible telmetry).

1.3.8 Control Terminal Operation

Operation at the Control Terminal is almost identical 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, SETUP and LOWER pressed simultaneously on channel 0 has no effect.

There is no failsafe relay at the Control Terminal. (You will nonetheless get an alarm upon failure of the data link from Control to Remote.)

There is no setup at all at the Control Terminal. Pushing the SETUP key has no effect.

The summary at the end of this chapter (Section 1.3.11) lists the remaining functions for quick reference.

1.3.9 Notes on Recovery After Power Failure

We have already described how the Remote Terminal sends its setup data to the Control Terminal (sending one complete copy every five minutes); and also how the Remote Terminal when powered up requests a copy of this data from the Control Terminal (this takes 15 seconds).

After a power failure (or power "hit") at the Remote, an operator at the Control Terminal will see the SETUP LED flash for 15 seconds. Otherwise the displays will be completely normal and accurate, and he/she will have full control capability. The Control Terminal gives accurate, calibrated displays even though the Remote Terminal has no setup data because the Control Terminal does its own calculations.

Upon power-up for the first time, the Control Terminal displays will appear to be uncalibrated until the Remote Terminal sends the setup data. Depending on where the Remote was in its cycle when the Control was powered up, 15 seconds to 5 minutes will elapse before a particular channel is calibrated.

During this period, the operator does have full control (raise/lower) capability, and all data is available, but the values are expressed in millivolts. (As you will recall, the system automatically initializes each channel to MVOLT mode.) The uncalibrated channels will be marked with an *. When the asterisk disappears the channel is calibrated.

Upon subsequent power failures at the Control Terminal, there will be no "uncalibrated" time after power-up, since non-volatile memory maintains all setup data at the Control Terminal. Therefore, all channels are calibrated immediately upon restoration of power to the Control Terminal.

1.3.10 Notes on the Subaudible Option

In systems that do NOT have the subaudible option, communication between terminals is at 300 baud (baud = bits per second) in both directions. In subaudible systems, communication from Control to Remote remains at 300 baud, but the return telemetry is sent at a rate of 9.4 baud. This is 1/32 as fast.

Although the command response time is the same (the delay from when RAISE or LOWER is pushed at the Control Terminal until the relay closes at the Remote), the data at the Control is updated very slowly. As you look at an analog channel at the Control Terminal, new values will arrive every 13.1 seconds on average. The Remote Terminal will require 2.3 hours to send its setup data to the Control Terminal the first time. Since this setup data is stored in non-volatile memory, the Control Terminal will be immediately calibrated after restoration of power if a power failure occurs.

1.3.11 Summary of MRC-1600 Operation

A. Normal 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, you will step through 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 on if the Remote Terminal is not:

a. in Maintenance Override,
b. being set up (see below), or
c. in Failsafe or impending failsafe.

There are 19 channel displays as follows:

Channel 0 - After ten seconds the Remote Terminal goes into "power saver mode", with only the run, maintenance and alarm LEDs enabled.

Channel 1-16 - The 16 telemetry inputs.

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

Channel 18 - Data link performance figures. The first number is performance as received; the second number is performance as reported by the other terminal, expressed as a number from 0 - 99.

While at channel 0, the following combinations of keys have special interpretations.

Setup and upper limit simultaneously:

LAMP TEST

Setup and lower limit:

AUDIBLE ALARM TEST

Setup and raise:

ENABLE/DISABLE AUDIBLE ALARM

Setup and lower (R.T. only):

ENABLE/DISABLE MAINTENANCE OVERRIDE

Setup and ACK:

Clears all unacknowledged alarms at once

B. Setup Mode

To set up a channel at the Remote Terminal, select the desired channel and push setup. Telemetry samples must be present.

a. Telemetry Calibration Mode

MVOLT	(millivolt display)
LINEAR	
POWER	
INDIRECT	(proportional to product of this channel and next lower channel - not allowed on channel one)

Push NO to step through the choices; push YES when desired choice is displayed.

b. Telemetry Display Decimal Point

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

Use NO and YES.

c. Sign of Telemetry Calibration Factor

SIGN+
SIGN-

Use NO and YES.

d. Telemetry Calibration Value

e. Telemetry Upper Tolerance Limit

f. Lower Tolerance Limit

Use up- and down-arrow keys to increment and decrement displayed number for d, e, and f. Push YES when desired value is displayed.

g. Status Input Inversion

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

Use NO and YES.

h. Status Alarm

NONE (no alarm)
FALLING (alarm on input "opening")
RISING (alarm on input "closure")
BOTH

Use NO and YES. Do not use on non-connected status channel.

C. Failsafe

After about 5 seconds, the Remote Terminal detects an impending failsafe and causes an alarm. After 45 seconds, failsafe is entered.

D. Power Failure Recovery

When the Remote loses memory, it requests a setup memory dump from the Control. This takes about 15 seconds and is marked by the SETUP LED flashing.

After an initial period of 4 minutes to allow all setup parameters to be sent from the Remote to Control Terminal, the Control Terminal is immediately calibrated upon power-up after experiencing a power failure.

1.4 OPERATION - CRT OPTION

1.4.1 Introduction

A CRT Option may be installed at the Control Terminal of the MRC-1600 to provide a simultaneous display of all analog and status channels. For each channel the user may enter descriptive text, which is stored in non-volatile memory. Alarms may be acknowledged from the CRT keyboard. The user may also select channels and issue raise and lower commands from the keyboard. In reading this section, refer to Figure 1-2 for an illustration of the keyboard of the Viewpoint A2 CRT. In this section we assume you are already very familiar with the basic MRC-1600.

1.4.2 Format of Display

The sixteen analog channels are displayed in a column at the left side of the screen. For each channel, 14 characters of descriptive text may be entered, along with a 7-character units text.

The sixteen status channels are displayed in a column at the right side of the screen. 14 characters of descriptive text may be entered for each status channel. The user may also set up 7-character names for the "on" and "off" conditions. For example, you may wish to name channel one "FRONT DOOR," with the on condition named "OPEN" and the off condition named "SHUT." As you receive the MRC-1600 from the factory, all of the on conditions are set up to read " " (blanks) and all of the off conditions are set up to read " " (blanks).

At the upper right of the display is the time-of-day clock. The time is reset to 00:00 (midnight) whenever the Control Terminal is powered up. At this time, an alarm sounds at the CRT and a message directs you to reset the time. Directions for doing this are in the next section.

Below the displays of analog values and status conditions are the system status messages. These are as follows:

A. "ALARM" duplicates the function of the Alarm LED on the MRC-1600 front panel. Since the Viewpoint A2 has its own internal audible alarm, this also sounds whenever the "ALARM" message appears. However, this audible alarm may be defeated from the CRT keyboard. We will describe how to do this in the next section.

B. "Data Link ERROR" appears whenever the channel 18 display at the front panel is out of tolerance.

C. "A/D ERROR" appears whenever the channel 17 display at the front panel is out of tolerance.

D. "SET TIME-OF-DAY" appears whenever the Control Terminal is powered up. This message disappears when the time is set.

E. "Maintenance Override: ENABLED" or "Maintenance Override: DISABLED" is displayed as appropriate.

1.4.3 Operation from the CRT Keyboard

A small " > " symbol at the left of the screen indicates which channel is selected for raising and lowering. As the selected channel is changed at the MRC-1600 front panel, the CRT display changes also. When channel 0, 17, or 18 is selected at the front panel, no " > " symbol is displayed, and any attempt to raise or lower from the CRT is ignored.

The selected channel may be changed from the CRT keyboard with the use of the "RETURN" key to advance a channel and the "BACK SPACE" key to go back a channel. To raise or lower on the selected channel, press "R" to raise or "L" to lower. Hold the key down for as long as you wish to raise or lower.

Alarms may be acknowledged by pushing the "A" key. The channel with the alarm condition will then be selected automatically. If there is more than one alarm, the different alarming channels will be selected sequentially (one each time "A" is pressed), just as at the MRC-1600 keyboard. Analog channels that are out of tolerance are indicated by " > " (too high) or " < " (too low) after the displayed value. Status channels in an alarm condition are indicated by a "*" preceding the status value.

The CRT's audible alarm may be enabled and disabled with the "B" key. Each time "B" is pressed, the status of the audible alarm is reversed. When the Control Terminal is powered up, the audible alarm is initialized to "enabled."

The time display may be set with the "T" key. For example, to set the time to 5:30 am, enter "0 5 3 0 T." You may use the 10-key pad or the row of numbers at the top of the keyboard, as you choose. To set the time to 5:30 pm, enter "1 7 3 0 T." Note that the 24-hour clock is used.

For the sake of efficiency, the channel titles and similar elements on the display page are output to the CRT only once, when the Control Terminal is powered up. Thereafter, individual elements in the display are changed as required. As a result, if the CRT is powered up after the MRC-1600, part or all of the page frame will be missing. Pushing the "O" key causes the entire page to be rewritten.

1.4.4 CRT Text Setup

As mentioned before, the user may establish descriptive text for each channel. To do this, the "CTRL" key near the lower left of the keyboard is used. First, select the channel you wish to modify by using the "RETURN" and "BACK SPACE" keys. Hold the CTRL key down and then push a second chosen from the table below. You will see a reverse-video field appear on the screen in the appropriate area.

CTRL and Q	Analog channel title
CTRL and W	Analog channel units
CTRL and E	Status channel title
CTRL and R	Status channel text for the ON condition
CTRL and T	Status channel text for the OFF condition

Having selected the field to be modified, you may use all of the alphabetic, numeric, and punctuation keys on the keyboard to enter your text. Mistakes may be eradicated with the "BACK SPACE" key. When the text in the reverse-video field appears in its desired form, press the "RETURN" key to trigger an update of the non-volatile memory.

1.4.5 Interactions with the Logging Option

Whether or not you have purchased an Automatic Logging Option, you can put the CRT in Logger Setup Mode by holding the "CTRL" key down and then pushing "C." This causes the display to clear and places the system in a condition where it is ready to receive logger setup commands. Should the system ever be placed in Logger Setup Mode, it can be returned to CRT Operation Mode by pressing "L" and then "RETURN."

Since the CRT and Logger Options share the same communication lines from the MRC-1600, certain minor interactions may be noted:

A. When the Logger is printing a line, the CRT keyboard is locked out. Since the Logger can print 120 characters per second, this will normally be for very brief periods.

B. The alarm tone may also become intermittent during logging activity.

C. If you happen to be raising or lowering, logging will be postponed until you lift your finger from the "R" or "L" key.

1.4.6 Summary of CRT key commands

A	Acknowledge
B	Audible Alarm enable/disable (CRT only)
O	Re-output Page
XXXX T	Set Time (XXXX = a 4-digit time)
RETURN	Increment selected channel
BACK SPACE	Decrement selected channel
R	Raise
L	Lower
CTRL-Q	Set up analog channel title
CTRL-W	Set up analog units
CTRL-E	Set up status channel title
CTRL-R	Set up status channel on-condition text
CTRL-T	Set up status channel off-condition text
CTRL-C	Go to Logger Setup Mode
L	Return to CRT Operation Mode

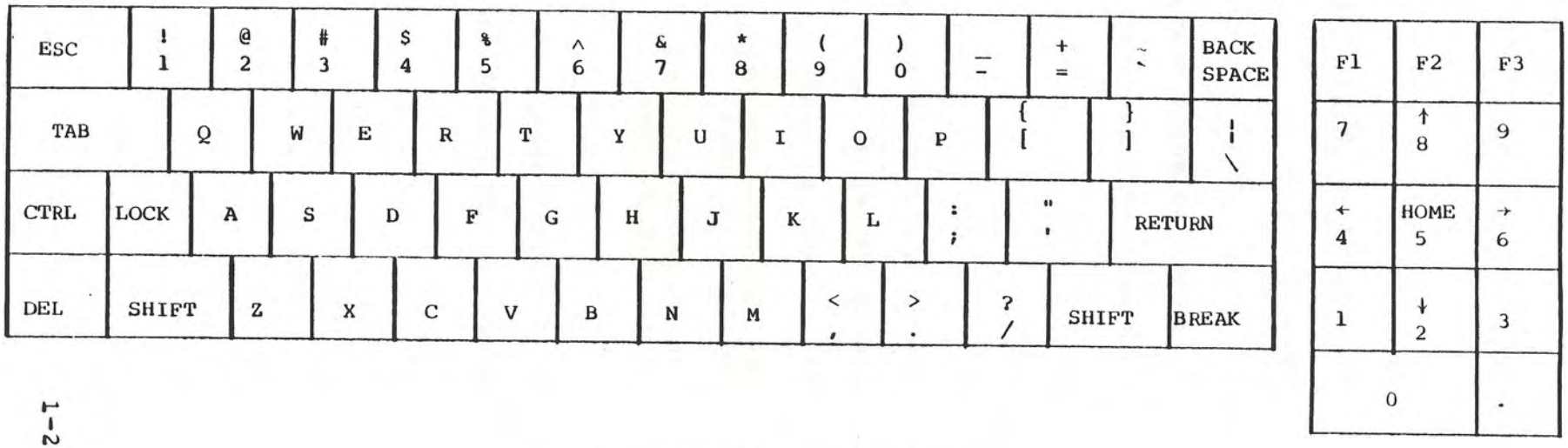


Figure 1.2 VIEWPOINT Keyboard

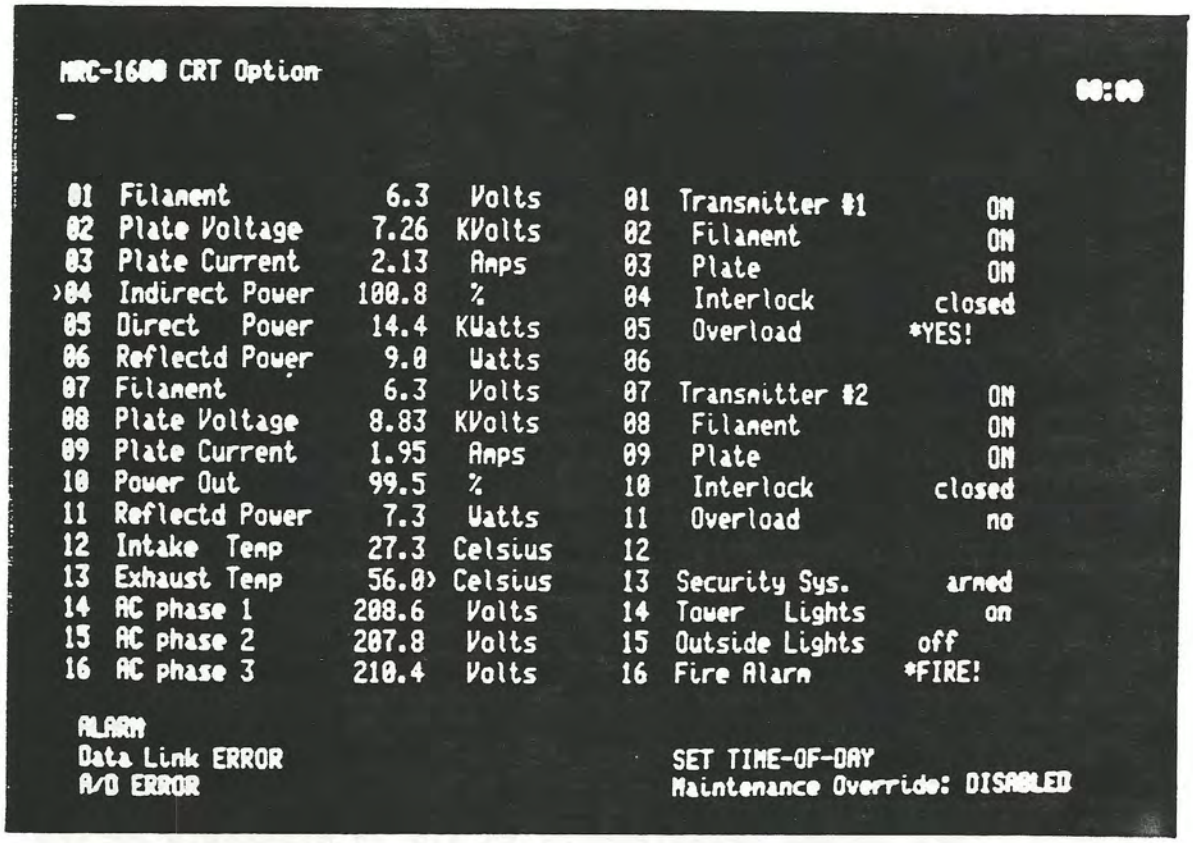


Figure 1-3

1.5 OPERATION - LOGGING OPTION

1.5.1 Introduction

The MRC-1600 Automatic Logging Option presents data collected from the MRC-1600 System on a Texas Instruments Model 850 Printer. The Logging Option consists of the printer and a cable which plugs into the AUX port of the Viewpoint A2 CRT. Logger setup is done from the CRT keyboard.

1.5.2 Log Page Format

Refer to figure 1-4 for a typical log page. The page has three main parts:

1. A page "header," consiting of ten lines of user-entered text, is printed at the top of every page. The interval at which a new page is started is also programmable by the user.

2. Beneath the header, the values of selected analog and status channels are printed at preset intervals. Each log line gives the time followed by one to nine status or analog values. If more than nine values must be logged, multiple log lines are automatically printed.

3. As alarms occur, alarm messages are printed. These give the time, channel number and value. Alarm messages are printed only for channels which have been specified to be logged automatically. At the end of any minute in which an alarm message has been printed, a summary log is made, showing all logged measurements to aid in diagnosis of the problem.

1.5.3 Logger Setup

As mentioned before, setup is done from the CRT keyboard. To enter Logger Setup Mode, hold down the "CTRL" key (near the lower left of the keyboard) and push "C." The CRT display will clear and the system will be ready to receive logger setup commands.

To enter or change header text, type in "H" followed by the two-digit line number, then push the "RETURN" key. Then enter the desired line of text. If you make a mistake while you are entering the line, it may be eradicated with

the "BACK SPACE" key. When you are happy with the text line as it appears on the screen, push the "RETURN" key. The line will then be programmed into non-volatile memory. For example, if you wish for the third line of the header to read "THIS IS A TEST," enter:

```
H03          ("RETURN")

THIS IS A TEST      ("RETURN")
```

Henceforth, we will use the symbol ← to mean "push the RETURN key."

Since a key function of the header text is to provide column titles for the logged data, the "F" command is provided to show where the nine columns are. Simply enter:

```
F ←
```

and nine groups of asterisks are printed, showing how the column titles are to be placed.

To display all ten lines of header text as they are currently on file, enter:

```
H ←
```

The interval at which a new page is ejected and a new header is printed is controlled by the "E" command ("E" stands for "eject"). This will be illustrated by example. If we enter:

```
E0000,2359,0300 ←
```

the system will print a new page from midnight ("0000") to 11:59 pm ("2359") at 3-hour intervals ("0300"). "2359" is the latest legal time; "2400" is not allowed. The interval is to be expressed in hours and minutes. For example, "0230" would mean every 2½ hours. Each of the three numbers must have four digits; leading zeroes may not be deleted.

To display back the E command as it is currently on file, enter:

```
E ←
```

The list of channels is entered with the "C" command. This consists of the letter C followed by the list of channels to be logged. The logged channels will be printed in the order entered, so if you wish the channels to be printed out of sequence, enter them out of sequence. For example, if you wish to log odd-numbered status channels in reverse order, enter:

```
CS15,S13,S11,S09,S07,S05,S03,S01←
```

The "S" stands for status. Each channel number must be two digits; leading zeroes must not be deleted. To log all analog channels in order, enter:

```
CA01,A02,A03,A04,A05,A06,A07,A08,A09,A10,A11←
```

As mentioned before, each log line has nine channels. The example immediately above will cause two log lines to be printed every time a log is made. The list of channels may include all sixteen analog channels and all sixteen status channels if you wish.

To display back the C command as it is currently on file, enter:

```
C←
```

The interval between automatic logs is controlled by the "W" command ("W" stands for "when"). It is identical in format to the "E" command. For example, if we enter:

```
W0600,1800,0130←
```

the system will print log lines (as specified by the C command) from six in the morning (0600) to six in the evening (1800) at 90-minute intervals (0130).

To display back the W command as it is currently on file, enter:

```
W ←
```

If you would like to get a "hard copy" of your logger setups, enter:

```
K ←
```

From this point forward, anything printed on the CRT will also be sent to the logger. To turn off the hard copy, again enter:

```
K ←
```

To end the editing session and return to logger operation, enter:

L ←

1.5.4 Logger Error Messages

If you have made an error in formatting a logger setup command, the system will respond in one of three different ways immediately after you press "RETURN."

A. If the length of the command line is incorrect for the type of command, the system will convert the command into a display command. For example, entering:

   E000 ←

   will have the same effect as entering:

   E ←

B. If there is a letter or punctuation mark in a place requiring a number, the system will respond:

   "Invalid Numeric Entry"

C. In the remaining cases, the system will respond:

   "I Don't Understand"

   followed by the first erroneous character in the command line.

1.5.5 Logger Operation

Once the logger is placed in Operation Mode (after L ← has been entered as described above), the printer runs automatically. You can force the system to log immediately by holding down the "CTRL" key, then pressing "I" while "CTRL" is still held down.

Also, while in Operation Mode, you may hold down "CTRL" and push "K" to cause the printer to advance to the next page and print a new header.

In addition to the interactions with the CRT Option noted previously in Section 1.4.5, it should also be noted that if the operator is "raising" or "lowering" from the CRT, logging will be held off for as long as the command action continues. However, as soon as the operator lifts his finger from the R or L key, any delayed logs will be printed immediately.

1.5.6 Summary of Logger Setup Commands

K←	Enable/Disable Logger Hard Copy
F←	Print Stars
H←	Print Entire Header
HXX←	(xx: 01-10) Prepare for New Header Line
TEXT←	Enter Header Text (up to 79 characters)
E0000,2359,0100←	New Header Command
E←	Display Existing New Header Command
W0000,2359,0100←	New Log-line Command
W←	Display Existing Log-line Command
CA01,S02,...,A33←	Log List
C←	Display Existing Log List
L←	Return to Operation Mode

← = push the RETURN key

For a manually-initiated log while in Operation Mode, hold down the "CTRL" key, then push "I."

To advance to the next page and print a new header while in Operation Mode, hold down the "CTRL" key, then push "K."

MRC-1600 Automatic Logging Option

MOSELEY ASSOCIATES, INC.
111 Castilian Drive
Goleta, CA 93117

The header, logged channels, and logging intervals are all USER programmable!

TIME	Filament Voltage	Plate Voltage	Plate Current	Output Power	Refl. Power	Intake Temp.	Exhaust Temp.	Alarm System	Tower Lights
08:00	6.3	7.44	2.12	101.2	97.	27.4	56.5	On	On
08:10	6.3	7.45	2.12	101.3	97.	27.4	56.6	On	On
08:20	6.3	7.45	2.12	101.3	97.	27.4	56.6	On	On
08:30	6.3	7.45	2.12	101.3	97.	27.4	56.6	On	On
08:35	ALARM - Analog Channel 04: 88.8<								
08:36	6.3	7.45	2.12	87.4<	98.	27.5	56.6	On	On
08:40	6.3	7.45	2.12	87.5<	98.	27.5	56.6	On	On
08:50	6.3	7.45	2.12	87.5<	98.	27.5	56.6	On	On
09:00	6.3	7.45	2.12	87.5<	98.	27.5	56.6	On	On
09:10	6.3	7.45	2.12	87.5<	98.	27.5	56.6	On	On
09:16	ALARM - Status Channel 14: *Off								
09:17	6.3	7.45	2.12	87.4<	98.	27.5	56.6	On	*Off
09:20	6.3	7.45	2.12	87.4<	98.	27.5	56.6	On	*Off
09:30	6.3	7.45	2.12	87.5<	98.	27.5	56.7	On	*Off
09:39	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On
09:40	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On
09:50	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On
10:00	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On
10:10	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On
10:20	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On
10:30	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On
10:40	6.3	7.45	2.12	101.5	98.	27.5	56.6	On	On
10:50	6.3	7.45	2.12	101.5	98.	27.5	56.6	On	On
11:00	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On
11:10	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On
11:20	6.3	7.45	2.12	101.4	98.	27.5	56.6	On	On

Figure 1-4

SECTION 2

INSTALLATION

2.0 INTRODUCTION

We recommend that the user read the entire manual to understand the MRC-1600 prior to attempting a hookup to his/her equipment. In the following discussion, the Remote Terminal is assumed to be used at the transmitter site and the Control Terminal at the studio.

2.1 UNPACKING

The MRC-1600 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 2.2. is completed.
>
> Do not attempt any adjustments of any kind until the nature of each adjustment is understood.

2.2 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.

2.3 PREINSTALLATION 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 straightforward, 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 "0 ". This indicates Channel 0. The FAILSAFE LED should be on

and the SETUP and ALARM LEDs should be flashing. After about 10 seconds the display will go blank and the ALARM LED will be the only one flashing. Press ACK key. The display now should show "18 00 XX". The SETUP LED will again be flashing. Press the " ↑ " CHANNEL 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 also displaying "0 ". Press the " ↓ " CHANNEL key. The display should now show "18 00 XX". Press the " ↑ " CHANNEL 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.

2.4 REMOTE AND CONTROL COMMUNICATIONS INTERCONNECTIONS

The following paragraphs tell how to connect the two terminals to form an MRC-1600 system.

2.4.1 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).

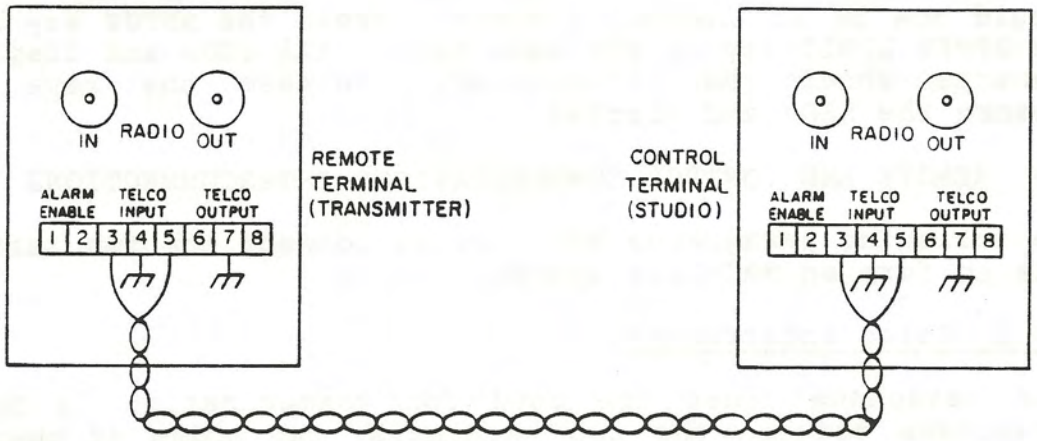


FIGURE 2 - 1
2-WIRE TELCO COMMUNICATIONS

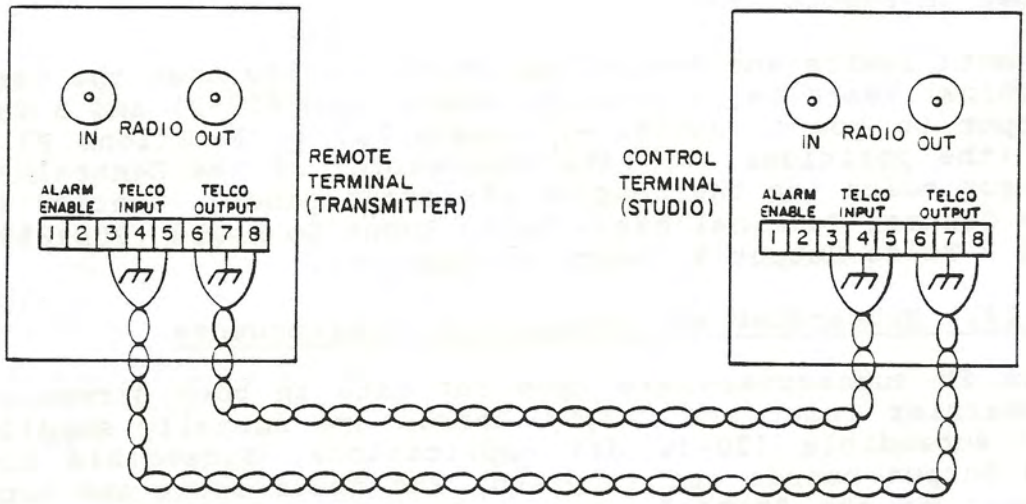


FIGURE 2-2
4-WIRE TELCO COMMUNICATIONS

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.

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.

In both 2-wire and 4-wire operation, verify that the Remote Terminal has a Telco Input Hi board (20D2859-2) and a Telco Output Lo board (20D2860-1) installed at locations P3 and P4 (the positions are interchangeable) of the Central Processor board (on the rear of the front panel). Verify that the Control Terminal has a Telco Input Lo board (20D2859-1) and a Telco Output Hi board (20D2860-2).

2.4.2. Subcarrier and Subaudible Interconnects

When FM subcarriers are used for data in both directions, Subcarrier Input and Output boards are normally supplied. For subaudible (20-30 Hz) applications, Subaudible Input and Output boards are supplied, and their input and output appear on the "RADIO" jacks. 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.

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 Central Processor 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.

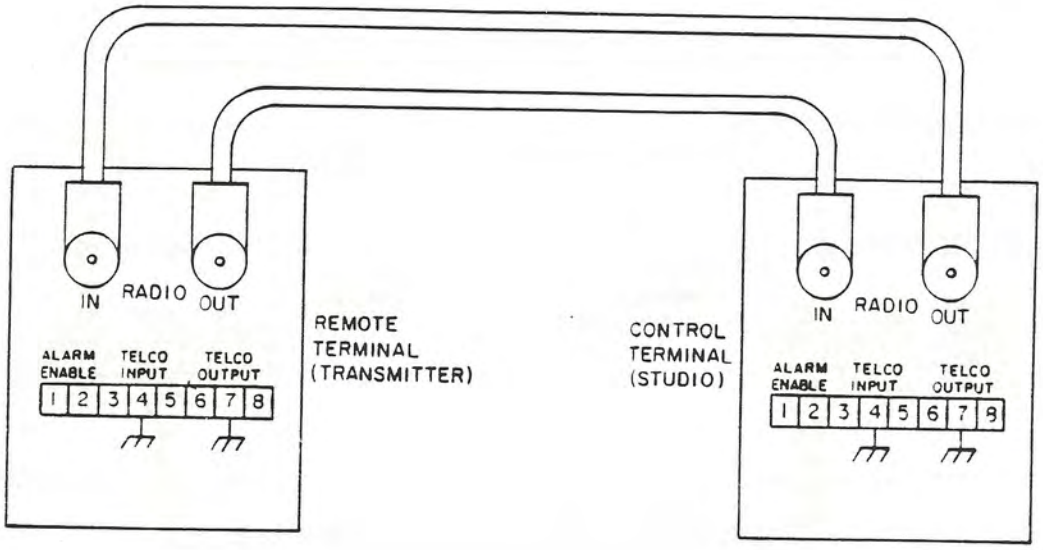


FIGURE 2-3
SUBCARRIER/SUBAUDIBLE COMMUNICATIONS

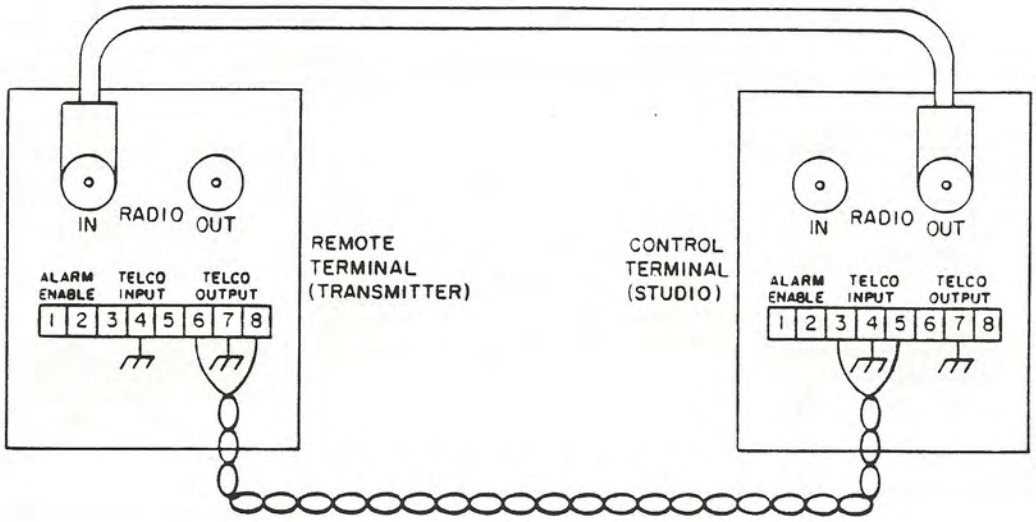


FIGURE 2-4
MIXED COMMUNICATIONS (CASE I)

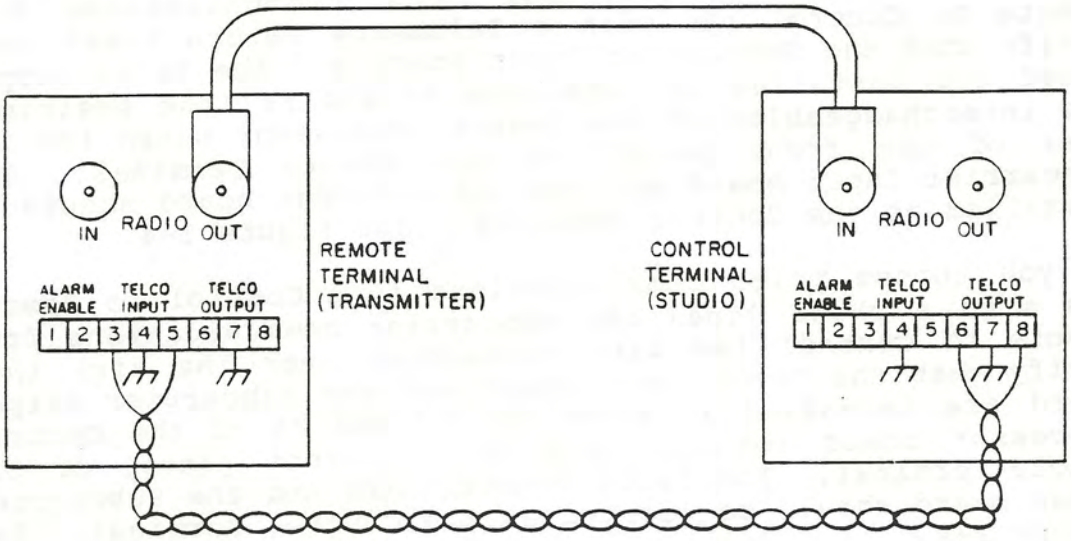


FIGURE 2-5
MIXED COMMUNICATIONS (CASE 2)

2.4.3 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 Central Processor 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.

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 Central Processor 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.

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.

2.4.4 RS-232 Interconnect

When the RS-232 communications option is selected, installation of the system is necessarily very user equipment dependent. There are a few guidelines which, when adhered to, will ensure a successful installation:

* Both MRC-1600 chassis support full RS-232 handshaking and are wired as a DTE (Data Terminal Equipment). If the RS-232 port you are interfacing does not support full RS-232 handshaking, some cable jumpering will be necessary.

* The MRC-1600 communicates over a full-duplex, 300 baud line; the external interface must be able to support this.

* The cable supplied with the unit is a null modem cable, i.e., a cable which allows two DTEs to be connected back to back. It is normally used for testing purposes only and should not be used for actual interconnection to your external port.

* To aid in cable construction and system installation, the following definition of RS-232 signals may be used.

TX (Pin 2)	Transmits outgoing data. Works only if the DCD, DSR, and CTS lines are active.
RX (Pin 3)	Receives incoming data. Works only if the DCD and DSR lines are active.
RTS (Pin 4)	A "Request to Send" signal asserted by the MRC-1600 any time it has some data it needs to send over the TX line.
CTS (Pin 5)	A "Clear to Send" input which is driven by the external port. This input indicates that the external device is ready to receive outgoing data on the TX line. Works in conjunction with the RTS line.
DSR (Pin 6)	A "Data Set Ready" input which is driven by the external port. This input indicates that the external device is in a working condition, i.e., power is on and no errors are noted.
GND (Pin 7)	A signal ground reference line.
DCD (Pin 8)	A "Data Carrier Detect" input which is driven by the external port. This input indicates that the external device is in communication with the "other end."
DTR (Pin 20)	A "Data Terminal Ready" output driven by the MRC-1600. This indicates to the external equipment that the MRC-1600 is in a working condition, i.e., power is on and no errors are noted.

2.5 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 MRC-1600 as discussed in Section 1. Figure 2-11 is provided to help you plan your installation. (The figure is located at the end of this section.)

2.6 PHYSICAL INSTALLATION

The MRC-1600 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.

2.7 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 2-6. The relay contact (supplied by you) is assumed to be open when any mike is active and closed when no mikes are active.

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 2-7.

2.8 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, 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.

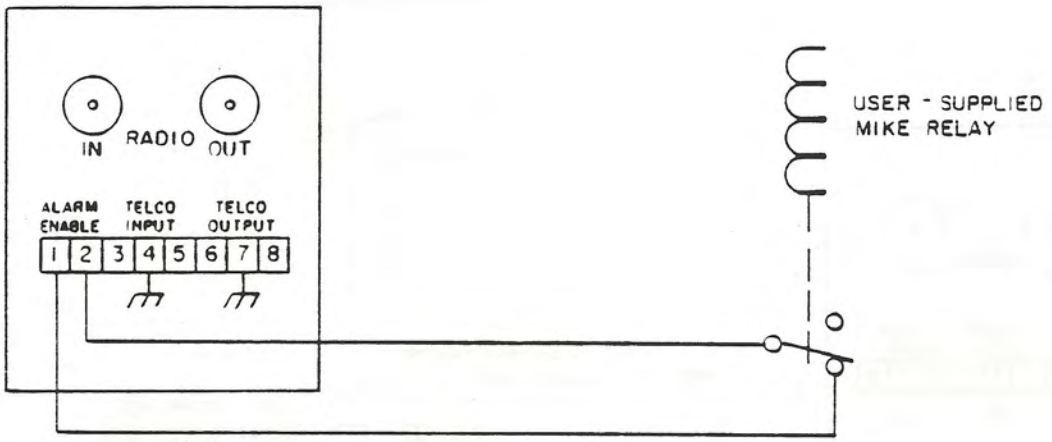


FIGURE 2-6
ALARM BUZZER MUTING

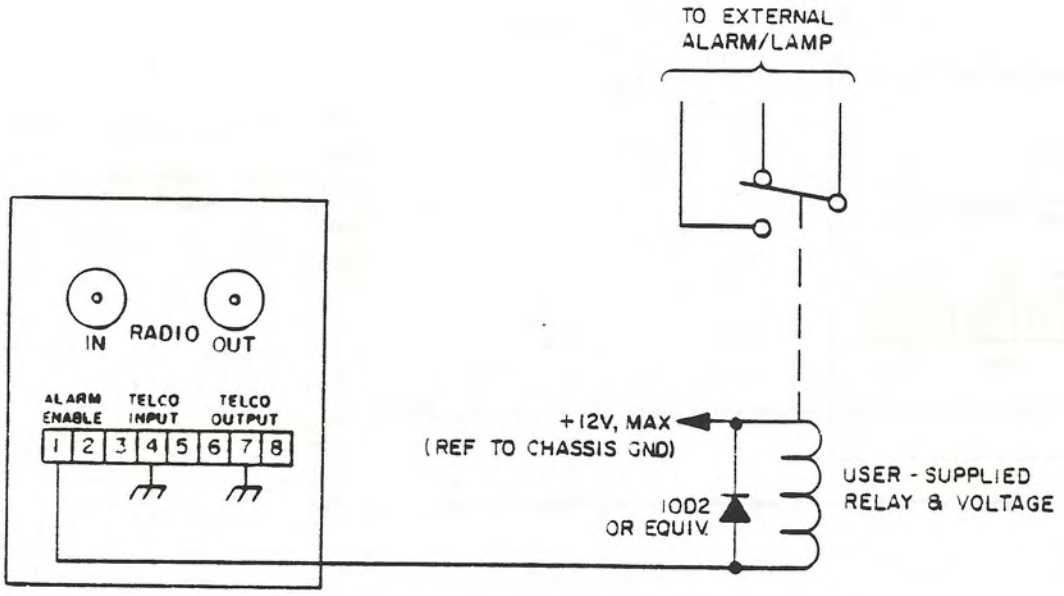


FIGURE 2 -7
EXTERNAL ALARM

2.9 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, .1 F) across the contacts to suppress contact bounce. See Figure 2-8.

2.10 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 MRC-1600 relay.

For interfacing the relays to TTL equipment, an RC network (100 ohm, .1 F) should be used to suppress contact bounce, and a pullup resistor may be needed, depending on the particular application. See Figure 2-9.

For interfacing the MRC-1600 relays to external relays, external "snubbing" networks (100 ohm, .1 F) must be installed across ac external relay coils or other ac loads; "clamping" diodes (10D2 or equivalent) must be installed across dc external relay coils. This is mandatory to avoid erratic operation and/or damage to the MRC-1600. See Figure 2-10.

2.10.1 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.

2.10.2 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.

2.10.3 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.

2.11 CRT DISPLAY AND AUTOMATIC LOGGER OPTIONS

The CRT and Logger may be installed only at the Control Terminal. A CRT may be installed without a Logger; however, a Logger may not be installed without a CRT.

If your CRT option was shipped with your MRC-1600, you may skip section 2.11.1, Chassis Preparation, and go directly to section 2.11.2, CRT.

2.11.1 Chassis Preparation

Locate the RS-232 ribbon cable (24B1113) and the #4-40 screws, washers and nuts shipped with the CRT option. Install the "D" connector inside the chassis rear with pin 1 on the top (the cable should be on the inside of the chassis). Solder the open end of the green wire to the ground lug on the chassis bottom. Remove the communications board installed at P3 on the Central Processor (the left of two). Install the other end of the cable on P6 with pin 1 on the top (identified by brown wire). Be sure to route the cable behind the communications board on the right. Re-install the communications board.

Locate the three programmed EPROMs (25A1071, 25A1072, and 25A1073). Install them on the Central Processor at locations U6, U5, and U17 as marked on the ICs. This completes Chassis Preparation.

2.11.2 CRT

Verify that the switch settings on the rear of the ADDS Viewpoint A2 are set correctly:

Switch #	Position
1	up
2	down
3	up
4	down
5	up
6	down
7	up
8	down

Attach the keyboard to the CRT using the "phone" cord. Install the Null Modem cable (24C1080) between the connector on the rear of the Control Terminal and the "EIA" port on the rear of the CRT. It doesn't matter which end

goes where. Plug in the CRT to 117 VAC. Apply power to the CRT and the Control Terminal to begin operation. See section 1.4, CRT Operation.

2.11.3 Logger

Verify that the switch settings inside the front cover of the T.I. 850 are set correctly:

Switch #	Position
1	open
2	open
3	open
4	open
5	open
6	open
7	closed
8	closed

Install the CRT-to-Printer cable (24B1114) between the "AUX" port on the rear of the CRT and the connector on the rear of the printer. Load paper into the printer. Plug in the printer to 117 VAC. Apply power to the printer to begin operation. See section 1.5, Logger Operation.

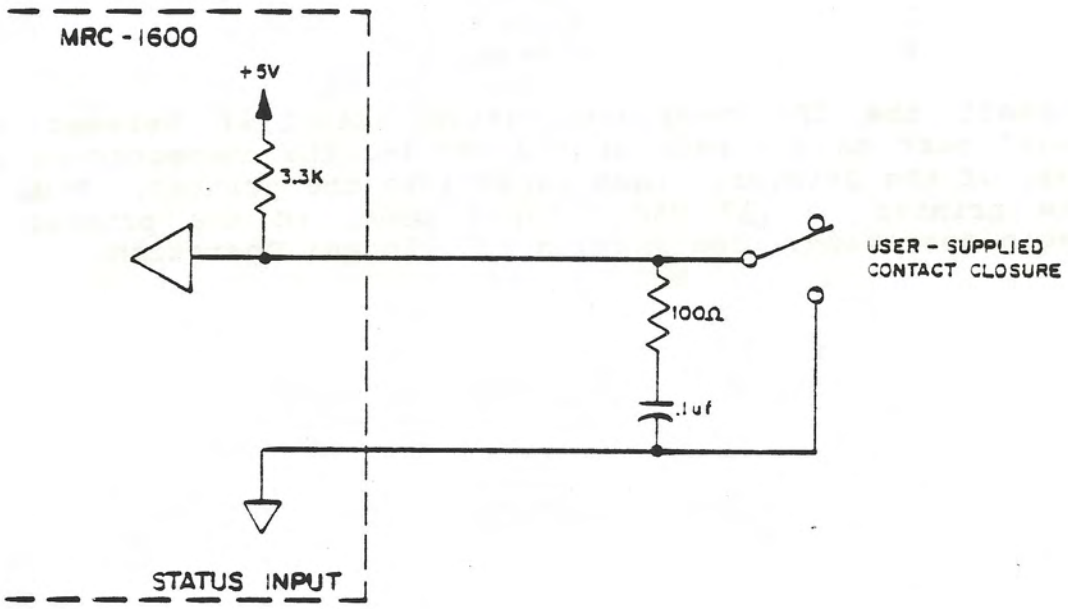


Figure 2-8

Status Input Interfacing

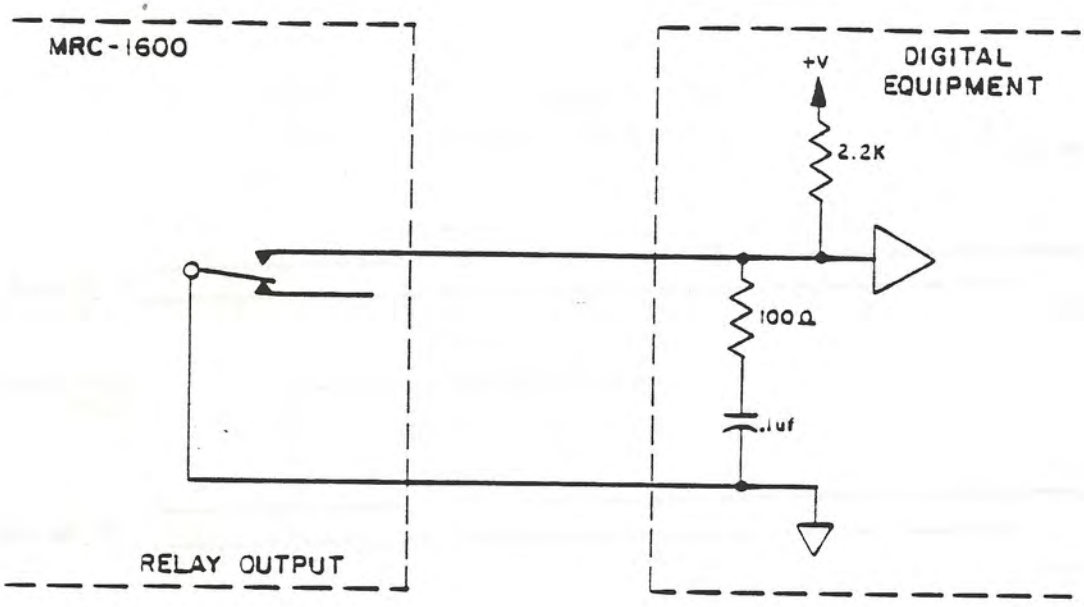


Figure 2-9

Relay Output Interfacing

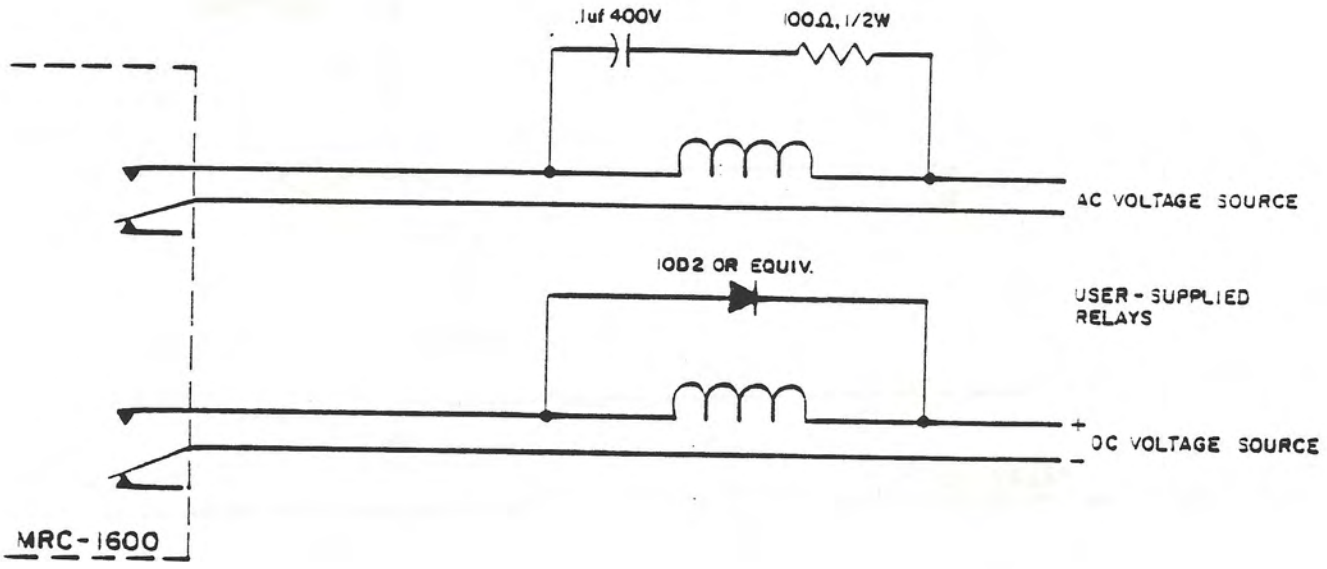


Figure 2-10

Relay-Relay Interfacing

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

Figure 2-11

Setup Worksheet

SECTION 3

MOSELEY ASSOCIATES GENERAL INFORMATION

3.1 EQUIPMENT ISSUE IDENTIFICATION SYSTEM

Moseley Associates provides constant attention to the improvement of its product line, which requies occasional circuit changes on some modules and units. Whenever a circuit change is made, the schematic diagram and assembly drawing for the affected equipment are revised and reissued under a new revision letter. Identification markings on each module or unit identify the drawing revision used in its assembly and test.

The module identification markings of interest are normally on the component side of the PC board. These include the following:

Assembly drawing number

Revision letter to the assembly drawing

Stock number

The assembly drawing number is printed on the PC board. A sample is

ASSY 20D2827

The revision letter is in a smallwhite circle on the PC board. Samples are

The stock number is on a small piece of clear tape. A sample is

2211/9301268

In some cases the stock number may not be included, or only the last seven digits may be on the piece of tape.

The other numbers on the PC board usually are not need for identification, nor is the inspection stamp, whicn includes a number in a small white circle with the letters MAI.

3.2 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. Any initial problems may be due to unfamiliarity with the equipment and can usually be corrected by the customer on site with the aid of the factory. Telephone consultation should always be the first step in factory service transaction.

Arrangements for factory service can be made after consultation with the factory and assignment of a return order number. This order number assists our Receiving Department when you unit is returned for factory service and expedites processing while it is being repaired.

Telephone Consultation

If telephone assistance is necessary, please have the following information available prior to calling the factory. Supply the model number and serial number of your unit. If possible, include the module identification markings discussed above. Be prepared to accurately describe the difficulties encountered with your unit. What is the specific problem? Is the problem constant or intermittent? If intermittent, can it be correlated to external influences, i.e., temperature, time of day, humidity, etc.? In short, describe the problem as accurately and concisely as possible. A complete set of test point readings would also be very helpful.

Once prepared with the above-requested information, contact our Technical Services Department for assistance. A Technical Services Engineer is available during normal work hours (8:00 a.m. to 5:00 p.m., Pacific time, Monday thru Friday). Should you require assistance outside of normal work hours, or on weekends and holidays, Moseley Associates does maintain an emergency only telephone service.

If telephone assistance is required, our telephone number is

(805) 968-9621

This is both our normal business-hour telephone number as well as our emergency-only telephone number after hours.

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. Section 7 lists the recommended spares.

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, pre-bend 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.

Factory Service

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
Goleta, CA 93117

Display your return order number clearly on the shipping label, and insure the equipment for the appropriate amount.

SECTION 4

SYSTEM DESCRIPTIVE INFORMATION
(Text: 35A1004 B)

4.1 INTRODUCTION

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 MRC-1600 terminal in a "building-block" format. For specific circuit details, refer the the Module Description section of this manual (Section 5).

4.2 GENERAL DESCRIPTION

The MRC-1600 Remote Terminal consists of seven modules: Power Supply, Central Processor, 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, consult Section 5 of this manual.

Central Processor

This board is the heart of the MRC-1600 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 EEROM (Control Terminal only), 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 Central Processor 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 Central Processor 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 write-strobe line. The addressed module then receives the data from the I/O data bus.

In addition to the Central Processor 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.

Front Panel

The Front Panel Board is responsible for interfacing operator-oriented functions with the Central Processor board and is mounted directly on the chassis' front panel. It communicates with the Central Processor board over the I/O bus and uses no other signals.

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 MRC-1600 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).

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 Central Processor 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 configuredfor 2- 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 Central Processor board to and from Frequency Shift Keyed 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. The Subaudible board operates at a center frequency of 22.5 Hz.

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 300 baud using the 4800 Hz clock line supplied from the Central Processor board. The Subaudible boards use the 150 Hz clock for a baud rate of 9.4 baud. Other signals such as *DCD, *CTS, and *RTS are used to pass modem status signals to and from the Central Processor board.

External Relay (Remote 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 CH##R or CH##L line is driven to ground. The Failsafe and Maintenance Override relays are activated by low levels on the FAILSAFE and MAINT lines.

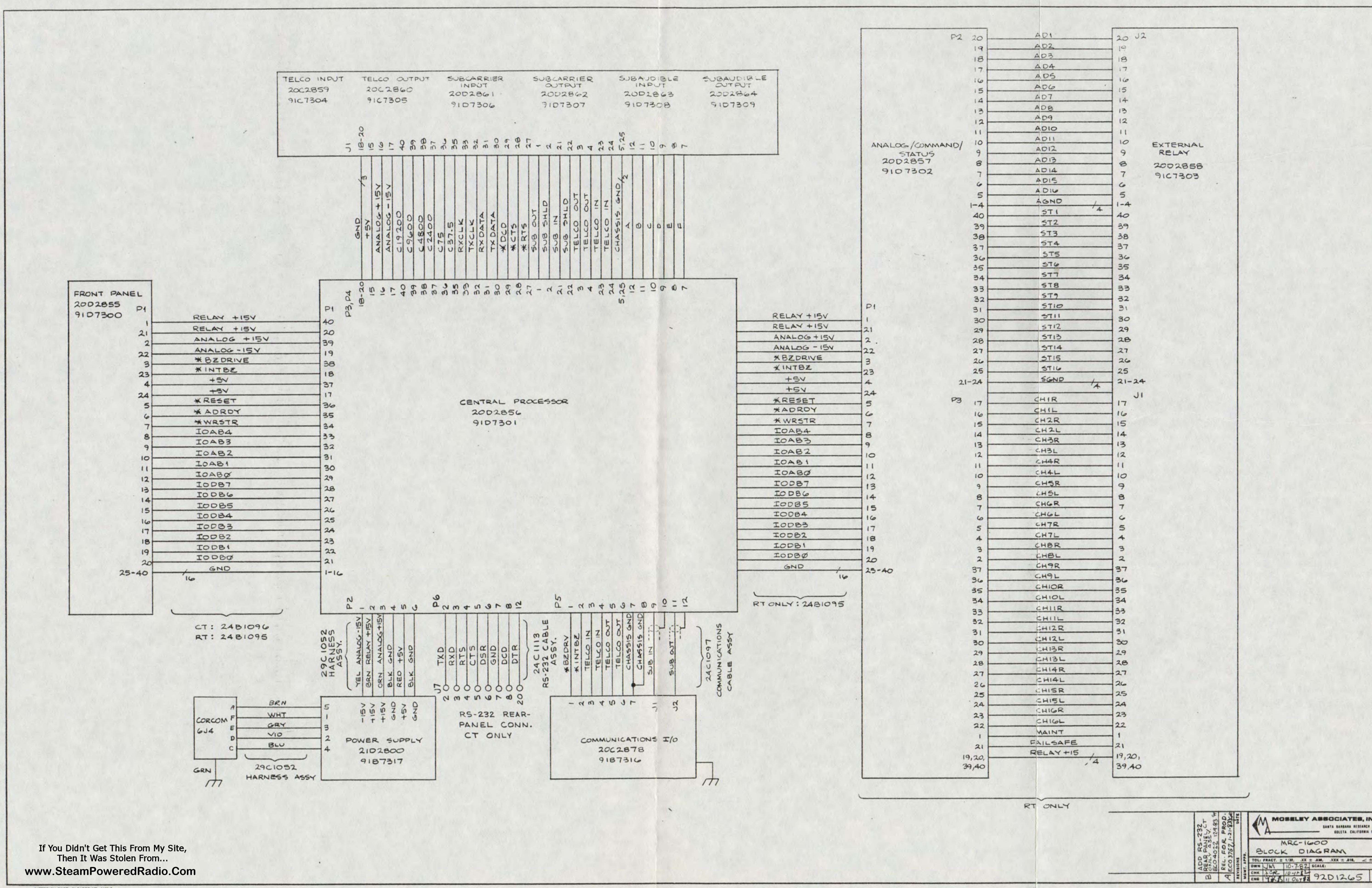
Analog/Status/Command (Remote Only)

The Analog/Command/Status board is a multipurpose module which interfaces the Central Processor 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 Central Processor 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 Central Processor board, the A/D converter indicates its state of readiness using the line *ADRDY. When a conversion is complete, the Central Processor board resets the A/D, and selects the next analog sample channel.

Communications I/O

The Communications I/O board is quite simple since it

contains no active components, but it is important. It serves as the gateway for all communications directed towards the other terminal, and contains various circuitry designed to protect the MRC-1600 from any high voltage surges over the Telco lines, etc. It passes communications data to and from the Data Modems (via the Central Processor board) using the TELCO IN, TELCO OUT, SUB IN, and SUB OUT lines. 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.



SECTION 5

MODULE CHARACTERISTICS

5.1 INTRODUCTION

The purpose of this document is to provide comprehensive technical information on the modules which constitute the MRC-1600 Microprocessor Remote Control System. The seven-digit Moseley stock number follows the module name. The reference following that is the schematic drawing number.

5.2 POWER SUPPLY (9103722) (Ref: 91B7317) (Text: 33A1022 A)

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 Central Processor board via a six pin molex connector assembly.

5.3 CENTRAL PROCESSOR (9204939/9204918) (Ref: 91D7365) (Text: 33A1023 B)

This section provides a comprehensive technical description of the Central Processor 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 microprocessor including <u>What Every Engineer Should Know About Microcomputers</u>, published by Motorola, Inc.

The Central Processor board is composed of six sections.

A. MPU
B. Address Decoding
C. System I/O
D. Reset Circuitry
E. Modem I/O
F. RS-232 I/O

5.3.1 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 Central Processor board to select the PIA (Peripheral Interface Adapter), the ACIAs (Asynchronous Communications Interface Adapter), the RAM (Random Access Memory), the EEROM (Electrically-Erasable 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 MRC-1600. MRDY is a memory ready signal used to interface with slow memories and is also not used in the MRC-1600. XTAL and EXTAL connect with Y1 to form a 4.0 MHz oscillator. R30, C24 and C25 prevent oscillation at overtones.

5.3.2 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.

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

Integrated Circuit	Address (HEX)
EPROM U8	F800-FFFF
EPROM U7	F000-F7FF
EPROM U6	E800-EFFF
EPROM U5	E000-E7FF
EPROM U17	D800-DFFF
EEROM U16	D000-D7FF
RAM U15	C800-CFFF
ACIA U21	C004-C005
PIA U13	C00B-C00B
ACIA U14	C00C-C00D

5.3.3 System I/O

The bulk of the system I/O is done through the PIA installed in 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 configures 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 configures PA0-PA7 for output. In addition, the PIA strobes the Write Strobe *WRSTR to signal the addressed device of the write operaton.

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 Central Processor 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 C 75 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 ms.

5.3.4 Reset Circuitry

The Reset Circuit is the only analog section of the Central Processor 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 restart 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 kind of 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.

5.3.5 Modem I/O

The Modem I/O section of the Central Processor 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.

5.3.6 RS-232 I/O

The RS-232 I/O section of the Central Processor board provides the interface between the MRC-1600 software and the external CRT and printer. 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 is normally set for 1200.

5.4 ANALOG/COMMAND/STATUS (9204496) (Ref: 91D7302) (Text: 33A1024)

As suggested by its name, the Analog/Command/Status board performs three functions for the MRC-1600 Remote Terminal. Most of the communication between this board and the Central Processor 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 H inductor and a .1 F capacitor. When the proper I/O address is asserted by the Central Processor 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 H inductor, .1 F capacitor, and an RC network consisting of 33K ohm resistor and a .1 F 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 Central Processor board via the *ADRDY line. The Central Processor 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.

5.5 FRONT PANEL (9204470) (Ref: 91D7300) (Text: 33A1025)

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 Central Processor 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.

5.6 EXTERNAL RELAY (9204504) (Ref: 91C7303) (Text: 33A1026)

The External Relay board is one of the simpler boards in the MRC-1600 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.

5.7 COMMUNICATIONS I/O (9204710) (Ref: 91B7316) (Text: 33A1027)

The Communications I/O board serves as an interface between the Central Processor 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 protect sensitive high-frequency filtering. The alarm enable contacts are provided so that the user can enable or disable the internal alarm buzzer.

5.8 DATA MODEMS

This section describes the various types of data modems available for the MRC-1600. Although there are a number of different configurations of the modem cards, the basic operation of each of these boards is unaffected. The only exception to this is the 2-wire Telco/Telco configuration.

5.8.1 Telco Input (High: 9204686; Low: 9204512) (Ref: 91C7304) (Text: 33A1028)

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 6-pole bandpass filter, then presented to the input of the FSK demodulator. There are two frequency pairs that are used over the Telco line to transmit information. The High pair is 2025 Hz and 2225 Hz, while the Low pair is 1070 Hz and 1270 Hz. This difference will affect the bandpass filter component values. Frequency-dependent components and their values are specified on the schematic. The High pair is normally used for control data while the Low pair is normally used for telemetry data. A telco input board that receives data through an external subcarrier demodulator from a subcarrier output board on the same data link must be a Low pair board, as all subcarrier communication boards use the Low pair of audio frequencies.

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 Central Processor board that carrier is present. Demodulated data is transmitted to the Central Processor board over the RECEIVE DATA line.

The data transmission rate for Telco communications is 300 baud. Accordingly, the Telco receiver selects 300 baud demodulation rate by connecting the C4800 clock generated by the Central Processor board to the RXCLK receiver clock input.

5.8.2 Telco Output (High: 9204694; Low 9204520) (Ref: 91C7305) (Text: 33A1029)

The Telco output board generates FSK data from serial digital output signals supplied by the Central Processor 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 two pairs of carrier frequencies: 2025 and 2225 Hz, and 1070 and 1270 Hz. Using this scheme, full-duplex operation is possible over a two-wire line. Component values for frequency-dependent parts are specified on the schematic. The High pair is normally used for control data while the Low pair is normally used for telemetry data. A telco output board that communicates through an external subcarrier generator to a subcarrier input board on the same data link will be a Low pair board, as all subcarrier communication boards use the Low pair of audio frequencies.

The function generator is activated by the Central Processor board which drives the request-to-send *RTS line low. The carrier frequency is modulated by the serial data generated by the Central Processor 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 300 baud. This is set by the jumper connecting the transmit clock TXCLK to the C4800 clock.

5.8.3 Subcarrier Input (Ref: 91D7306) (Text: 33A1030)

(26 kHz: 9204546)	(110 kHz: 9204579)
(39 kHz: 9204553)	(152 kHz: 9204538)
(67 kHz: 9204561)	(185 kHz: 9204587)
(92 kHz: 9204876)	

The Subcarrier Input board accepts modulated data from a companion Subcarrier Output board within the MRC-1600 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 six available which include 26 kHz, 39 kHz, 67 kHz, 110 kHz, 152 kHz, and 189 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 six-pole audio bandpass filter before presented to the input of the FSK demodulator U1. The FSK demodulator operates identically to the subcarrier demodulator. 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 signalling the Central Processor board.

5.8.4 Subcarrier Output (Ref: 91D7307) (Text: 33A1031)

(26-66 kHz: 9204603) (67-185 kHz: 9204629)

The Subcarrier Output board generates a frequency-modulated subcarrier from digital serial data it receives from the Central Processor 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 Central Processor 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 six subcarrier frequencies available: 26 kHz, 39 kHz, 67 kHz, 110 kHz, 152 kHz, 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.

5.8.5 Subaudible Input (9204652) (Ref: 91D7308) (Text: 33A1032)

The Subaudible Input board accepts frequency-modulated data centered at 22.5 Hz and demodulates it to digital serial data. Since the carrier frequency is quite low, the data rate has been reduced to 9.4 baud, which is determined by the jumper connecting the receiver clock RXCLK to the C150 clock.

The Subaudible board is comprised of two sections: The Input filter and the Demodulator. The input filter is a 7-pole elliptical low-pass filter designed around D-element

technology to eliminate inductors. The filtered subaudible carrier is then amplified by the op-amp U5 which drives the input of the demodulator.

U1 is a phase-lock loop based demodulator. Its internal voltage-controlled oscillator frequency is determined by the timing capacitor C9, resistor R14, and potentiometer R13 which operates as a fine-tune adjustment. The RECEIVE DATA line is driven with the demodulated digital serial data. The *DATA CARRIER DETECT line is driven low when U1 detects a valid subaudible carrier at its input.

5.8.6 Subaudible Output (9204660) (Ref: 91D7309) (Text: 33A1033)

The Subaudible Output board generates a frequency-modulated carrier centered at 22.5 Hz. Because the carrier frequency is quite low, the data rate is slowed to 9.4 baud as determined by the jumper which connects the transmit-clock TXCLK to the C150 clock.

The board is comprised of two sections: The FSK modulator, and the output filter. The FSK modulator is based around a function generator IC U2. It is activated whenever the Central Processor board drives the request-to-send *RTS line low, forcing Q1 to cut-off. Serial Data on the TRANSMIT DATA line frequency-shifts the carrier. The timing capacitor C9, resistors R7 and R8, and the potentiometers R3 and R9 determine the carrier frequency. R9 is set to a value which yields 25 Hz for a "high" TRANSMIT DATA line, and R3 is set to a value which yields 20 Hz for a "low" TRANSMIT DATA line.

The frequency-modulated carrier is coupled through C15 and amplified by the op-amp U5 whose gain is determined by potentiometer R24. It is then filtered by a seven-pole elliptical low-pass filter, and amplified by op-amp U1. The output filter is designed with D-element technology to eliminate inductors.

5.9 RS-232 Communications Board (9205097) (Ref: 91C7368) (Text: 33A1045)

The RS-232 Communications Board performs the necessary level interfacing between TTL logic levels and RS-232 signal levels. In addition, it selects the communication rate for the transmitter and receiver via a hardwired jumper, and provides a logical-and between the CTS and DSR signal lines.

Transmit Driver U3 accepts TTL input and generates RS-232. Diodes CR1 and CR2 keep line transients out of the +15 and -15 volt supply lines.

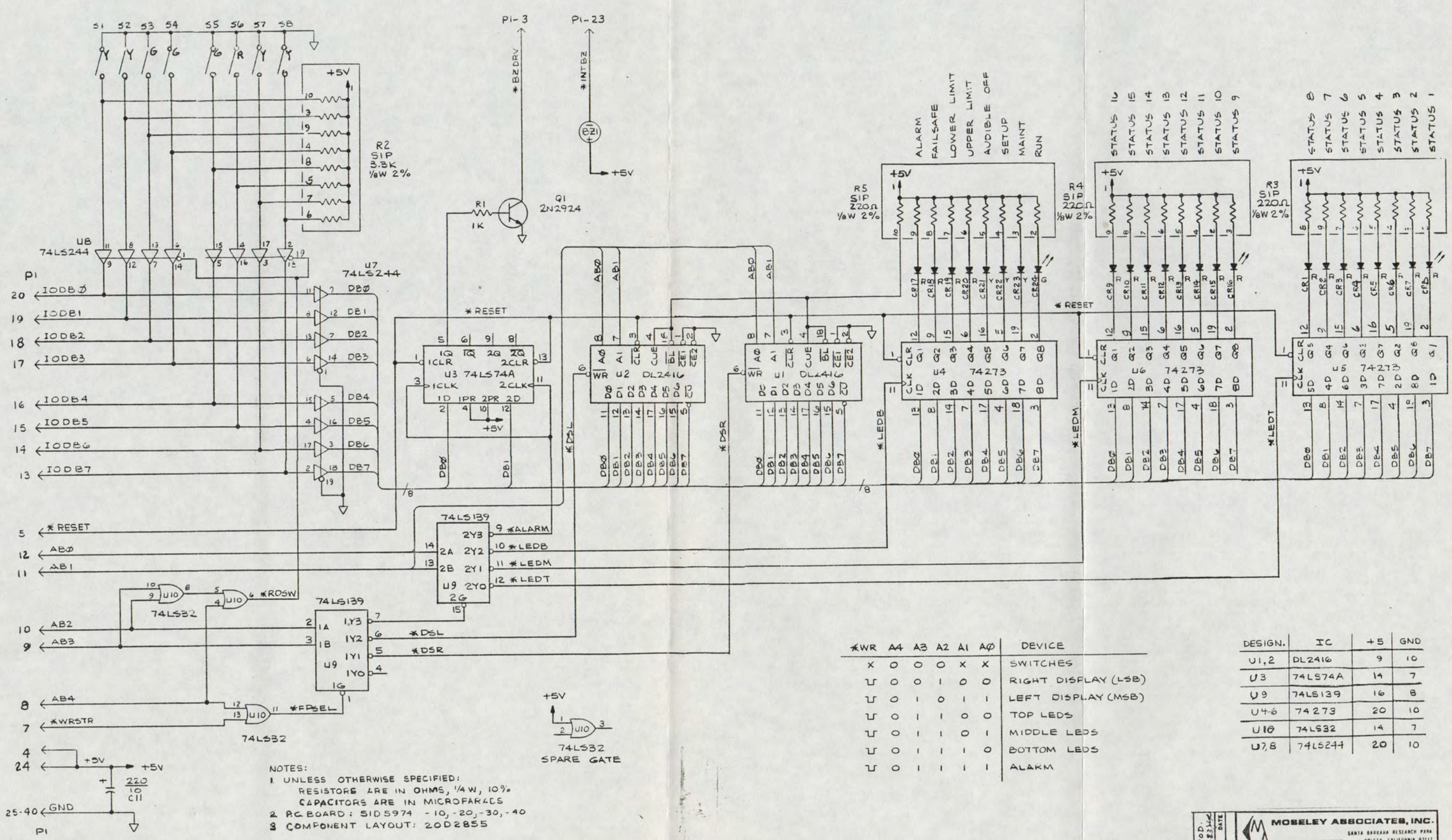
Receive Buffer U1 accepts RS-232 signals and generates TTL output. The external R-C combination sets the mark-space threshold of the internal Schmitt trigger.

Since the CTS and DSR lines are active-low signals, the OR-gate Buffer U2 functions as a logic and operator between the two signals.

5.10 RS-232 Communications I/O (9104639) (Ref: 91A7369) (Text: 33A1046)

The RS-232 Communications I/O Board serves as an interface between the central processor board and the outside world. It provides a standard DB-255 RS-232 connector for ease of interfacing to other pieces of user-supplied equipment. The alarm enable contacts are provided so that the user can enable or disable the internal alarm buzzer.

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



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   RESISTORS ARE IN OHMS, 1/4W, 10%
   CAPACITORS ARE IN MICROFARADS
2. P.C. BOARD: SID5974 -10, -20, -30, -40
3. COMPONENT LAYOUT: 20D2855

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

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA CALIFORNIA 93117

SCHEMATIC
MRC-1600 FRONT PANEL

TOL: FRACT. ± 1/32, XX ± .030, XXX ± .010, ∠ ± 1/2°
DWN JW 6-7-82 SCALE:
CHK [illegible] 6-15-82
ENG [illegible] 15-JUN-82
91D7300 A

REVISIONS: A REL. FOR PROD. ECO 3757, 6-16-82 JW

MRC-1600 FRT PANEL
20D2855

Item No.	Quantity	Stock No.	Reference Des	Description
1	1	3473329	Rev. -11,-21	PCB MRC-1600 Frt Panel 51D5974
2	2	3690054	U1, U2	I.C. DL2416 Display, 17 Seg 4 digit red
3	1	3661063	U3	I.C. 74LS74A Dual D Flip-Flop
4	1	3660800	U9	I.C. 74LS139 Du2-4LN Decde MUX
5	3	3661006	U4, U5, U6	I.C. 74273 Octal Flip-Flop
6	1	3660958	U10	I.C. 74LS32 QU 2 in OR
7	2	3660859	U7, U8	I.C. 74LS244N OCT BUS/DRIV ST
8	1	3390333	BZ1	Horn Alarm AI-105
9	1	3390341	BZ1	Horn Mount PM 101
10				
11	1	3630027	Q1	XTNS2924LFS 2W160M025V 1A7P
12	1	3110509	P1	Conn SCTCHFLX R ANGLE w/o EJCT
13	3	3170842	S3, S4, S5	Switch, MRC-1600 SPST-GRN 320 01-E1-1GRN
14	4	3170834	S1, S2, S7, S8	Switch, MRC-1600 SPST-YEL 320 01-E1-1-YE
15	1	3170826	S6	Switch, MRC-1600 SPST-RED 320 01-E1-1-RE
16	20	3390127	CR1-CR20	L.E.D. 2.0 @ 20 Wide Diff FLV160 RED
17	3	3390143	CR21-CR23	L.E.D. 10 @ 20 Narrow D1 MV-5354-YEL

REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3751	1-21-83	

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GOLETA, CALIFORNIA 93117

MRC-1600 FRONT PANEL

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

DWN			SCALE: Page 1 of 2
CHK			
ENG		2/24/83	27A1011 A

27A1011	A

Item No.	Quantity	Stock No.	Reference Des	Description
18	1	3390614	CR21	L.E.D. 9.0 @ 20 Narrow Diff. HLMP-3507 Grn.
19				
20	3	4540217	R3, R4, R5	Resistor 220Ω, 1/8 W, 2% SIP
21	1	4540167	R2	Resistor 3.3K, 1/8 W, 2% SIP
22	1	4460143	R1	Resistor 1K, 1/4 W, 5%
23	1	4280079	C11	Capacitor 10/25 V Sprag 196D106x0025 KAI Epox Dip
24	10	4310207	C1-C10	Capacitor .1UF/50 V, 20%, CY20C104M

REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3157	1-21-83	

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MRC-1600 FRONT PANEL

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

DWN		SCALE: Page 2 of 2	
CHK			
ENG		27A1011	A

I.C.	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	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

P2-5 +5V
P2-3 +15V
P2-1 -15V
C28 10/25V, C27 10/25V, C26 10/25V
P2-6
P2-4
P2-2 RELAY +15V

MEMORY MONITOR — AUTO RESTART — POWER MONITOR

DECODING

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   RESISTOR VALUES ARE IN OHMS, 1/4W, 10%
   CAPACITOR VALUES ARE IN MICROFARADS
2. P.C. BOARD: 51D6029
3. COMPONENT LAYOUT: 20D2917
4. PIA = C$\phi\phi$8$_H$, ACIA1 = C$\phi\phi$4$_H$,
   ACIA2 = C$\phi\phi$C$_H$
5. P3 AND P4 HAVE THE SAME CONNECTIONS ON ALL PINS.
6. CR5-CR9, CR11-12 AND R31-R38 ARE INSTALLED FOR TEST PURPOSES ONLY.
7. BAUD RATE SELECTED BY TEST DEPT

DIETERICH-POST CLEARPRINT 1020-8

REVISIONS				
LTR	DESCRIPTION	DATE	APPR.	
A	ECO 4022	4 JAN 84	CH	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

SCHEMATIC
MRC-1600 CENTRAL PROCESSOR

TOL FRACT. ± 1/32 .XX ± .030 .XXX ± .010 ∠ ± 1/2°
DWN KAH 4 JAN 84 SCALE: —
CHK [illegible] 1-27-84
ENG [illegible] 12-5-83

91D7365 A

27A1012 | B

CENTRAL PROCESSOR
20D2917

Item No.	Quantity -2	-1	Stock No.	Reference Des	Description
1	1	1	3473337 SB 3473717	-13,-23 S/B -10,-20	PCB MRC-1600 Central Processor 51D5975 S/B 51D6029
2	1	1	3730207	U3	ICLM339 Comparator Quad
3	2	1	3710043	U14,U21	ICMC6850PACIA Interface
4	1	1	3710027	U13	ICMC6821PPIA Interface
5	1	1	3680063	U1	ICCD4040BE 12 Stage Bin
6	1	1	3661162	U11	ICSN74LS245N OCT Bus TR
7	1	1	3661048	U20	ICMC6809P MPU
8	1	1	3660958	U10	ICSN74LS32 Quad 2-Input
9	1	1	3660859	U12	ICSN74LS244N Oct Bus/Dr
10	1	1	3660826	U2	ICSN74LS163AN Bincount
11	1	1	3660792	U19	ICSN74LS138N 3-8L INEDEC
12	1	1	3660768	U4	ICSN74LS123N Duretrmono
13	1	1	3660685	U18	ICSN74LS04N HX INV
14	1	1	3660669	U9	ICSN74LS00N QU 2IN Nand
15	1	1	4460952	R30	Res 15 Meg Ohm 1/4 W 5% RCO7GF156J
16	1	1	4460549	R14	Res 470K Ohm 1/4 W 5% RCO7GF474J
17	1	1	4460564	R8	Res 220K Ohm 1/4 W 5% RCO7GF224J
18	1	1	4460499	R23	Res 120K Ohm 1/4 W 5% RCO7GF124J
19	1	1	4460481	R16	Res 100K Ohm 1/4 W 5% RCO7GF104J
20	1	1	4460432	R15	Res 47K Ohm 1/4 W 5% RCO7GF473J
21	1	1	4461034	R22	Res 22K Ohm 1/4 W 5% RCO7GF223J

REVISIONS	DATE	MGMT. APPR.
B CHGS PER ECO 4022 CH	10 JAN 84	
A REL FOR PROD. ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

CENTRAL PROCESSOR II

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

DWN			SCALE: Page 1 of 3
CHK			
ENG		21 JAN 83	27A1012 B

Item No.	Quantity -2	Quantity -1	Stock No.	Reference Des	Description
39	2	2	3110574	P3, P4	Conn M 40 Pin Straight P66506-025
40	1	1	3110509	P1	Conn Sctchflx R Angle w/3432-1002
41	1	1	3110111	P2	Conn Male 6-Pin Power 1-380999
42	2	1	3090222	P5,P6	Conn Edge 12 Pin 1-87233-2
43	2	2	1230275		STDF 1/4 Hex 6-32 x 7/16 8214-A-0632
44	2	2	1090182		SCR BDRH SLTD 6/32 x 1/4
45	2	2	1090562		Washer #6, INT Tooth LK
46	2	2	4310173	C30,C31	Cap .01/600Y, Erie 811000Z5U0103M
47	2	2	4020376	L1,L2	Coil 10 µH, Miller 74F105AP
48	1	1	3600160	CR10	DIO, IN4731A 4.3 V Zener
49	2	2	4470282	R9,R26	Res 560 Ohm 1/2 W 5% RC20GF561J
50	1	1	3710639	U15	IC TMS4016 2Kx8 RAM
51	1	0	3710647	U16	IC X2816 2Kx8 EEROM
52	1	0	3730363	U22	IC MC1489 Line Receiver
53	1	0	3730355	U23	IC MC1488 Line Driver
54	4	0	4410437	R39-42	RES 33K Ohm 1 1/4W 10%
55	4	0	4210415	C32-35	CAP Mica Dip 330 pF DM-15-331J

REVISIONS	MGMT. APPR.	DATE
B CHGS PER ECO 4022 10JAN84	CH	
A REL FOR PROD ECO 3757		1-21-83

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

CENTRAL PROCESSOR II

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

DWN			SCALE: Page 3 of 3
CHK			
ENG	DAB	21 Jan 83	27A1012 B

Item No.	Quantity -2	Quantity -1	Stock No.	Reference Des	Description
22	2	2	4460317	R1, R27	Res 10K Ohm 1/4 W 5% RCO7GF103J
23	3	3	4460226	R4, R18, R20	Res 3.3K Ohm 1/4 W 5% RCO7GF332J
24	7	7	4461026	R5, R10, R11, R19, R21 R28, R29	Res 2.2K Ohm 1/4 W 5% RCO7GF222J
25	1	1	4460168	R24	Res 1.5K Ohm 1/4 W 5% RCO7GF152J
26	4	4	4460143	R3, R7, R12, R13	Res 1K Ohm 1/4 W 5% RCO7GF102J
27	1	1	4460051	R17	Res 100 Ohm 1/4 W 5% RCO7GF101J
28	27	20	4310207	C1-C3, C5, C6, C8-C23, C29, C36-C40	Cap. 1 UF/50 V 20% CY20C104M
29	4	4	4280079	C7, C26, C27, C28	Cap. Epox-Dip 10/25 V 196D106x0025KAI
30	1	1	4280038	C4	Cap. Epox Dip 1/35 V 196D105x0035 HAI
31	2	2	4210118	C24, C25	Cap. Mica Dip 24 PF DM-15-240J
32	3	3	3630027	Q1, Q2, Q3	XT NS2N2924LFS 2W160M025
33	1	1	3600152	CR3	DIO Z523.9A 3.9 V Zener
34	4	2	3600053	CR1, 2, 13, 14	DIO IN914 75 V 75 MA SI A3
35	1	1	3340163	Y1	XTAL 4.0 MHz MRC-VTCS-2 30A0066
36	2	2	3250099	U13, U20	SKT Dual In Line 40 Pin 640379-1
37	9	5	3250073	U5-U8, U14-U17, U21	SKT Dual In Line 24 Pin 640361-1
38	1	1	3170008	S1	SW PB 34 550 004

REVISIONS		DATE	MGMT. APPR.
B	CHGS. PER ECO 4022 10 JAN 84	CH	
A	REL. FOR PROD ECO 3752	1-21-83	

MCSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

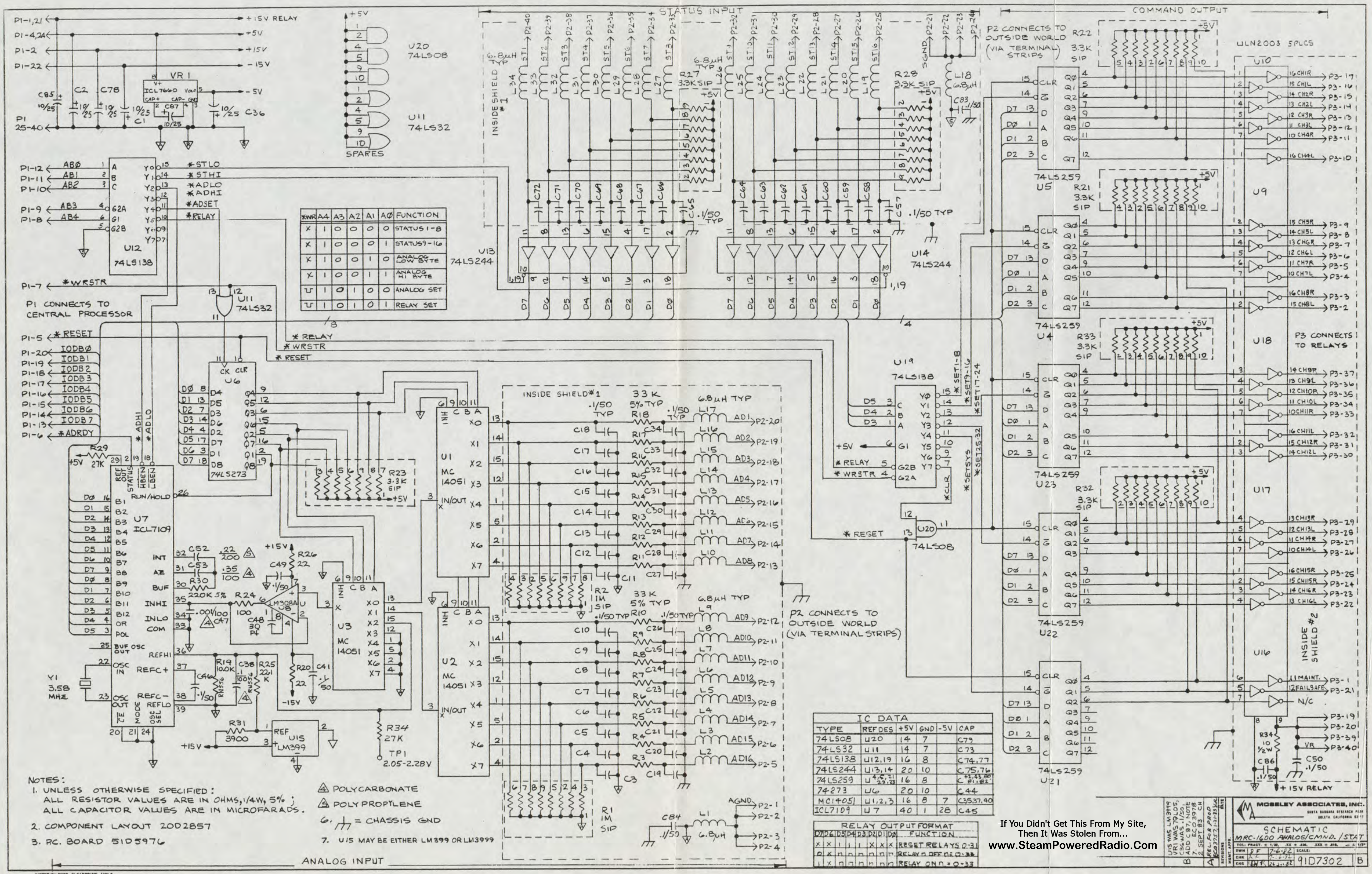
CENTRAL PROCESSOR II

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

DWN | CHK | ENG DLB 21 JAN 83

SCALE: Page 2 of 3

27A1012 B



*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 5105976

△ POLYCARBONATE
△ 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	DØ	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

REVISIONS: B — U15 WAS LM3999, VR1 WAS 79L05, C36 WAS .1/50, ADD C87, NOTE 7. ECO 3978 2 SEPT 83 CH; A — REL. FOR PROD ECO 3757, 1-21-83

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA CALIFORNIA

SCHEMATIC
MRC-1600 ANALOG/CMND./STAT

DWN R F 7-6-82 | CHK 7-6-82 | ENG 24-82 | SCALE: | 91D7302 | B

DIETERICH-POST CLEARPRINT 1000H

MRC-1600 ANALOG/CMND/STAT

20D2857

Item No.	Quantity	Stock No.	Reference Des	Description
1	1	3473345	-12,-22	PC BD., MRC-1600 Input/ Output, MAI 515976 -11, -21
2	1	2062826		Shield, MRC-1600 RF #1, MAI 5B2907
3	1	2062867		Shield, MRC-1600 RF #2, MAI 5B2917
4	1	3110509	P1	Conn., 3M 3432-1002, Sctchflx R Angle
5	2	3110574	P2,P3	Conn., Berg 66506-025 M 40 Pin Straight, PC Mtg.
6	1	3250099	U7	Socket, I. C., Amp 640379-1 Dual-In-Line 40 Pin
7	1	3340189	Y1	Crystal, MAI 30A0072 3.579545 MHz
8	1	3650132	VR 1	Regulator, Motor., NMC 79L05 05 V 0.1A to 92
9	1	3650249	U15	Regulator, Natl., LM3999Z 6.9 V to 92
10	1	3660693	U20	I.C., T.I., SN74LS08N
11	2	3660792	U12,U19	I.C., T.I., SN74LS138N
12	2	3660859	U13,U14	I.C., T.I., SN74LS244N
13	1	3660958	U11	I.C., T.I., SN74LS32
14	1	3661188	U6	I.C., T.I., SN74LS273
15	5	3661170	U4,5,21-23	I.C., T.I., SN74LS259N
16	3	3680139	U1,2,3	I.C., Motor., MC14051P
17	1	3730157	U8	I.C., Natl., LM-308AN
18	1	3730629	U7	I.C., Intersil, ICL7109 CPL
19	5	3731007	U9,10,16-18	I.C., T.I., ULN2003AN
20				

REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 37571	1-21-93	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 ANALOG/CMND/STAT

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

DWN			SCALE: Page 1 of 3
CHK			
ENG	DLA	21 Jan 93	27A1013 A

Item No.	Quantity	Stock No.	Reference Des	Description
21	34	4020343	L1-34	Inductor, Miller 9310-32 RF 6.80 µH
22	1	4210134	C48	Cap., Arco DM-15-300J, Mica Dip 30 PF
23	1	4250007	C47	Cap., SEI 22UB102H, Poly-carb., .001/100 V 3%
24	1	4250486	C38	Cap., SEI 22UB104H, Poly-carb., .1/100 V 3%
25	1	4250619	C53	Cap., SEI 22UB354H, Poly-carb., .35/100 V 3%
26	1	4250684	C52	Cap., TRW, XX363UW, Axial .22/200 V 10%
27	4	4280079	C1,2,78,85	Cap., Sprague, 196D106 x 002 KAI Epoxy Dip 10/25 V
28	73	4310207	C3-37,40-46, 50,57-77,79-84,49	Cap., CRL., CY20C104M .1/50
29	7	4540167	R21,22,23, 27,28,32,33	Res., CTS, 750-101-3.3K, SIP 3.3K 1/8 W 2%
30	2	4540225	R1,2	Res., CTS, 750-101-R106, SIP 1 Meg 1/8 W 2%
31	1	4510186	R25	Res., Mepco., RN55C2212F 22.1 K 1/8 W 1%
32	1	4510145	R19	Res., Mepco., RN55C1002F 10K 1/8 W 1%
33	1	4460523	R30	Res., A.B., RC07GF224J
34	2	4460382	R29,34	Res., A.B. RC07GF273J 27K 1/4 W 5%
35	1	4460697	R31	Res., A.B. RC07GF392J 3.9K 1/4 W 5%
36	1	4460051	R24	Res., A.B. RC07GF101J 100Ω 1/4 W 5%
37	2	4460754	R20,R26	Res., A.B. RC07GF220J 22Ω 1/4 W 5%

REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 ANALOG/CMND/STAT

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

DWN			SCALE: Page 2 of 3
CHK			
ENG	[illegible]	21 JAN 83	27A1013 A

Item No.	Quantity	Stock No.	Reference Des	Description
38	16	4460390	R3-18	Res., A.B. RC07GF333J 33K 1/4 W 5%
39	1	4470290	R35	Res., A.B. RC20GF100J 10Ω 1/4 W 5%

REVISIONS	DATE	MGMT. APPR.
A Rel for Prod ECO 3747	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

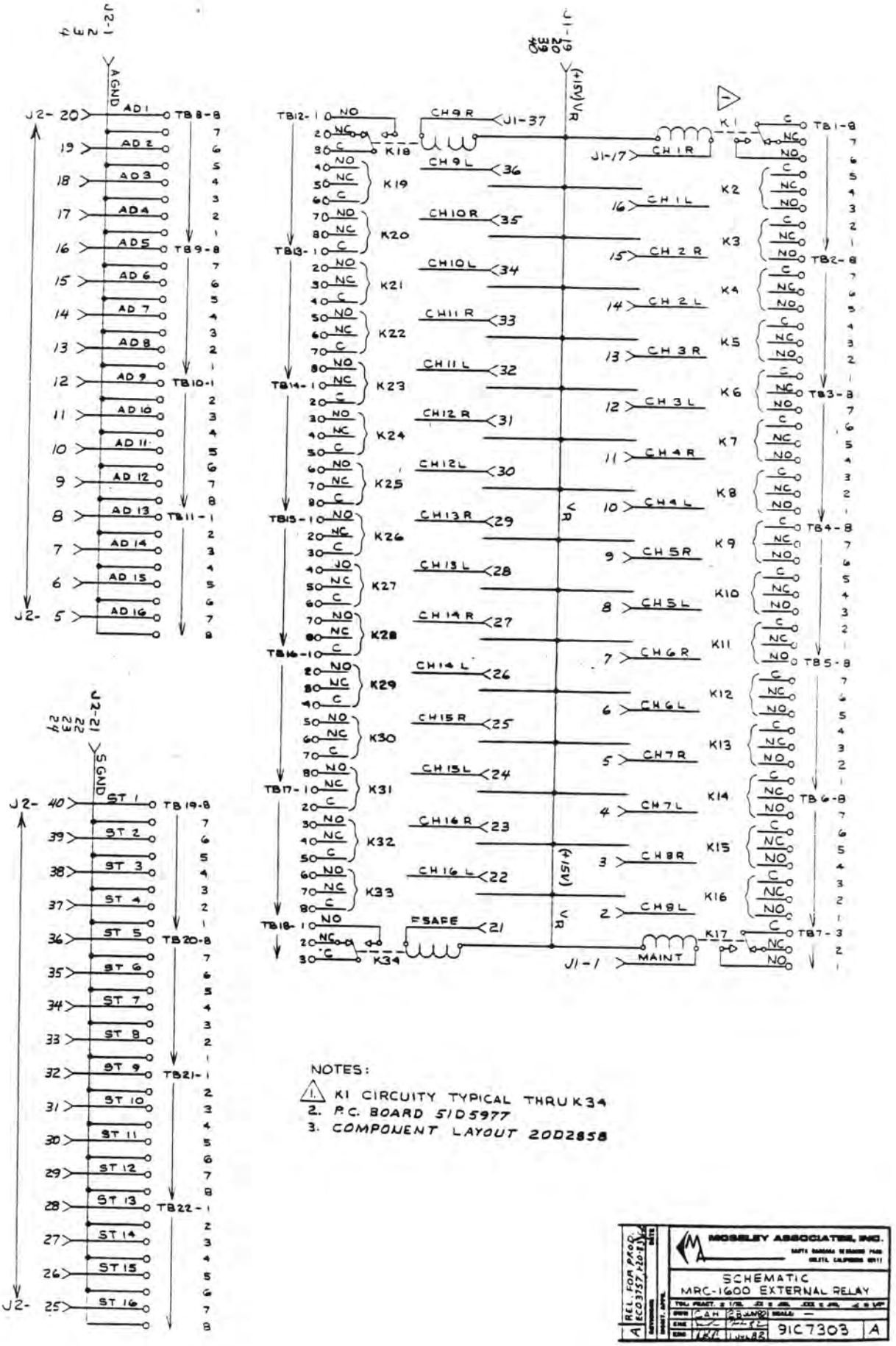
MRC-1600 ANALOG/CMND/STAT

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

DWN | CHK | ENG

SCALE: Page 3 of 3

27A1013 A



NOTES:

1. K1 CIRCUITY TYPICAL THRU K34
2. P.C. BOARD 51D5977
3. COMPONENT LAYOUT 20D2858

A	REL. FOR PROD. ECO 3757, H20-E1	MOSELEY ASSOCIATES, INC.	
		SCHEMATIC MRC-1600 EXTERNAL RELAY	
		91C7303	A

MRC-1600 EXTERNAL RELAY BOARD

20D2858

Item No.	Quantity	Stock No.	Reference Des	Description
1	1	3473352	-12,-22	PC Bd., MRC-1600 External Relay, 51D5977-11, -21
2	2	3110582	J1, J2	Conn., Berg 66953-022 Female 44-Pin Straight PC Mount
3	20	3291143	TB 1-6, 8-17, 19-22	Term. Strip, Elvert 25.102. 0853 8181/8 Pin 5 MM
4	2	3291135	TB 7, TB 18	Term. Strip, Elvert 25.102.0353 8181/3 Pin 5 MM
5	34	3270162	K1-K34	Relay, Arrow-M HA1 DC 12 V
6	1	2062966		Shield, Insulating, MAI 5C2936
7	4	1050129		Screw, B.H. S.S. #4-40 x 1/4"

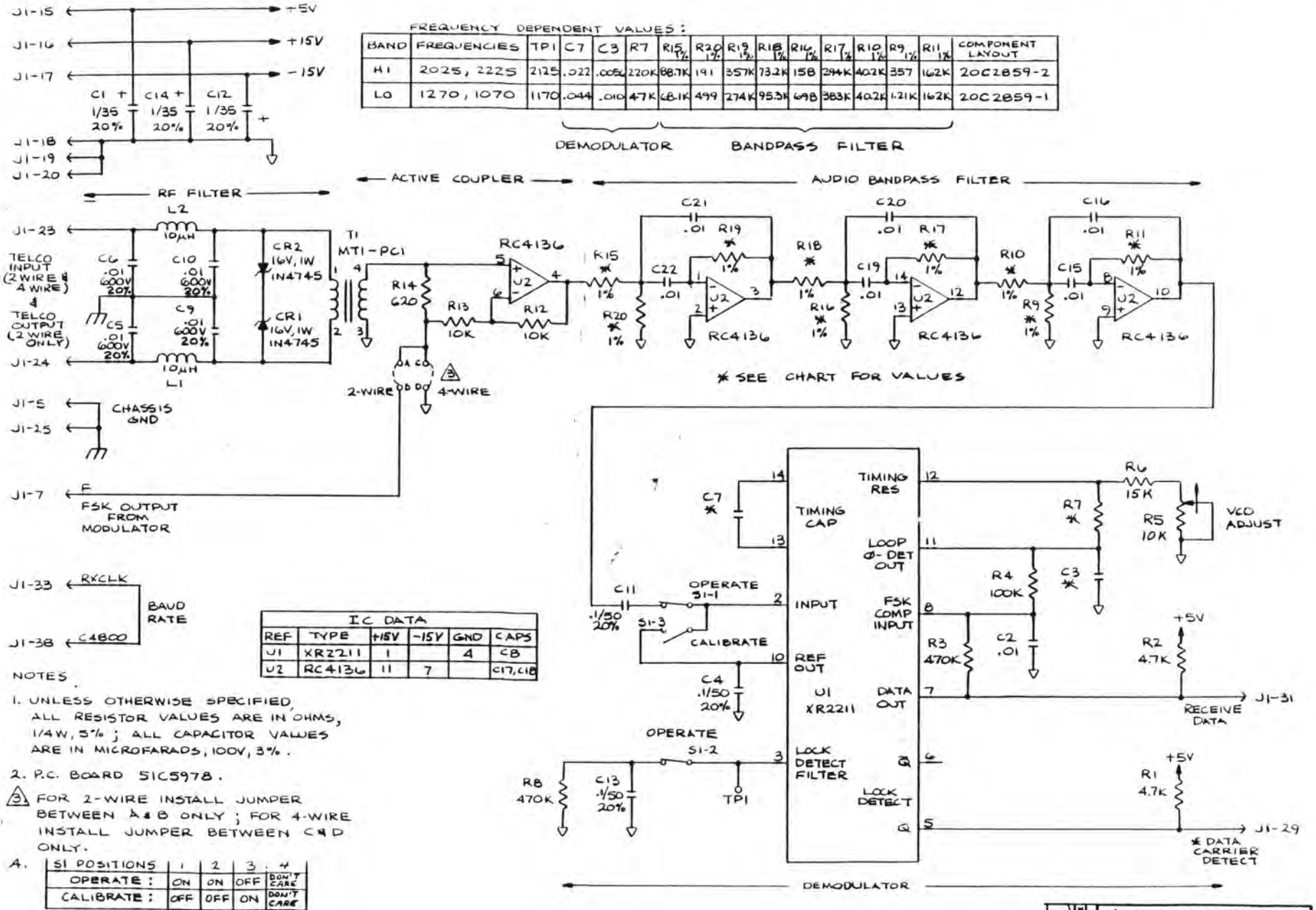
REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 EXTERNAL RELAY BOARD

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

DWN			SCALE: Page 1 of 1
CHK			
ENG	[illegible]	21 Jan 83	27A1014 A



FREQUENCY DEPENDENT VALUES:

BAND	FREQUENCIES	TP1	C7	C3	R7	R15 1%	R20 1%	R19 1%	R18 1%	R16 1%	R17 1%	R10 1%	R9 1%	R11 1%	COMPONENT LAYOUT
HI	2025, 2225	2125	.022	.0056	220K	88.7K	191	357K	73.2K	158	294K	40.2K	357	162K	20C2859-2
LO	1270, 1070	1170	.044	.010	47K	68.1K	499	274K	95.3K	698	383K	40.2K	1.21K	162K	20C2859-1

DEMODULATOR BANDPASS FILTER

IC DATA

REF	TYPE	+15V	-15V	GND	CAPS
U1	XR2211	1		4	C8
U2	RC4136	11	7		C17, C18

NOTES

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%; ALL CAPACITOR VALUES ARE IN MICROFARADS, 100V, 3%.
2. P.C. BOARD 51C5978.
3. FOR 2-WIRE INSTALL JUMPER BETWEEN A & B ONLY; FOR 4-WIRE INSTALL JUMPER BETWEEN C & D ONLY.
4.

S1 POSITIONS	1	2	3	4
OPERATE:	ON	ON	OFF	DON'T CARE
CALIBRATE:	OFF	OFF	ON	DON'T CARE

MOSELEY ASSOCIATES, INC.
SCHEMATIC
TELCO INPUT
91C7304 A
REL. FOR PROD. PER ECO 5727, 11-3-82

TELCO INPUT

20C2859

Item No.	Quantity -1	-2	-3	Stock No.	Reference Des	Description
1	1	1		3473360	-10,-20	PCB Telco Input 51C5978
2	1	1		3110582	J1	Conn., Berg 66953-022F, 44 Pin Straight PC Mtg.
3	1	1		3730827	U1	IC Exar XR-2211 CP
4	1	1		3730462	U2	IC, TI RC4136N
5	1	1		4090106	T1	Xfmr, Mcrtrn MT1-PC
6	1	1		3190071	S1	SW Dip 4 CTS 206 4
7	2	2		3600236	CR1, CR2	Diode IN4745A, 16 V, 1 W
8	.05	.05		1641927		Wire #22 Buss, Alpha 298
9	2	2		4020376	L1,L2	Inductor 10µH Miller 74F105AP
10	4	4		4310173	C5,C6,C9, C10	Cap., Cer Disc, Erie 8110025U0103M .01/600 V
11	6	6		4310207	C4,C8,C11, C13,C17,C18	Cap., CRL CY20C104M .1µF/50 V 20%
12	8	7		4250171	C2,C3,C15, C16,C19,C20, C21,C22	Cap., Polycarb SEI 22UB103H .01/100 V 3%
13	0	1		4250114	C3	Cap., Polycarb SEI 22UB562H .0056/100 V 3%
14	0	1		4250288	C7	Cap., Polycarb SEI 22UB223H .022/100 V 3%
15	1	0		4250387	C7	Cap., Polycarb SEI 22UB443H .044/100 V 3%
16	3	3		4280038	C1,C12,C14	Cap., Epoxy Dip, Sprague 196D105x0035HAI 1/35 V
17	1	1		4630273	R5	Pot, Bourns 3299W-1-103 10K
18	2	2		4460242	R1,R2	Res., A/B RC07GF472J 4.7K 1/4 W 5%
19	1	1		4460127	R14	Res., A/B RC07GF621J 620Ω 1/4 W 5%

REVISIONS	DATE	MGMT. APPR.
A Rel For Prod ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

TELCO INPUT

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

DWN			SCALE: Page 1 of 3
CHK			27A1015 A
ENG	CLB	2-10-83	

Item No.	Quantity -1	-2	-3	Stock No.	Reference Des	Description
20	2	2		4460317	R12,R13	Res., A/B RC07GF103J 10K 1/4 W 5%
21	1	1		4460341	R6	Res., A/B RC07GF153J 15K 1/4 W 5%
22	1	1		4460481	R4	Res., A/B RC07GF104J 100K 1/4 W 5%
23	2	2		4460549	R3,R8	Res., A/B RC07GF474J 470K 1/4 W 5%
24	0	1		4510350	R16	Res., A/B RN55E 1580F 158Ω 1/8 W 1%
25	0	1		4510368	R20	Res., A/B RN55E1910F 191Ω 1/8 W 1%
26	0	1		4510376	R9	Res., A/B RN55E3570F 357Ω 1/8 W 1%
27	1	0		4510384	R20	Res., A/B RN55E 4990F 499Ω 1/8 W 1%
28	1	0		4510327	R16	Res., A/B RN55E 6980F 698Ω 1/8 W 1%
29	1	0		4510392	R9	Res., A/B RN55E 1211F 1.21K 1/8 W 1%
30	1	1		4510400	R10	Res., A/B RN55E 4022F 40.2K 1/8 W 1%
31	1	0		4510418	R15	Res., A/B RN55E 6812F 68.1K 1/8 W 1%
32	0	1		4510426	R18	Res., A/B RN55E 7322F 73.2K 1/8 W 1%
33	0	1		4510434	R15	Res., A/B RN55E 8872F 88.7K 1/8 W 1%
34	1	0		4510442	R18	Res., A/B RN55E 9532F 95.3K 1/8 W 1%
35	0	1		4460523	R7	Res., A/B RC07GF224J 220K 1/4 W 5%
36	1	0		4460432	R7	Res., A/B RC07GF473J 47K 1/4 W 5%

REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

TELCO INPUT

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

DWN | CHK | ENG (21 Jan 83)

SCALE: Page 2 of 3

27A1015 / A

Item No.	Quantity -1	-2	-3	Stock No.	Reference Des	Description
37	1	1		4510459	R11	Res., A/B RN55E 1623F 162K 1/8 W 1%
38	1	0		4510467	R19	Res., A/B RN55E 2743F 274K 1/8 W 1%
39	0	1		4510475	R17	Res., A/B RN55E 2943F 294K 1/8 W 1%
40	0	1		4510483	R19	Res., A/B RN55E 3573F 357K 1/8 W 1%
41	1	0		4510491	R17	Res., A/B RN55E 3833F 383K 1/8 W 1%

REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

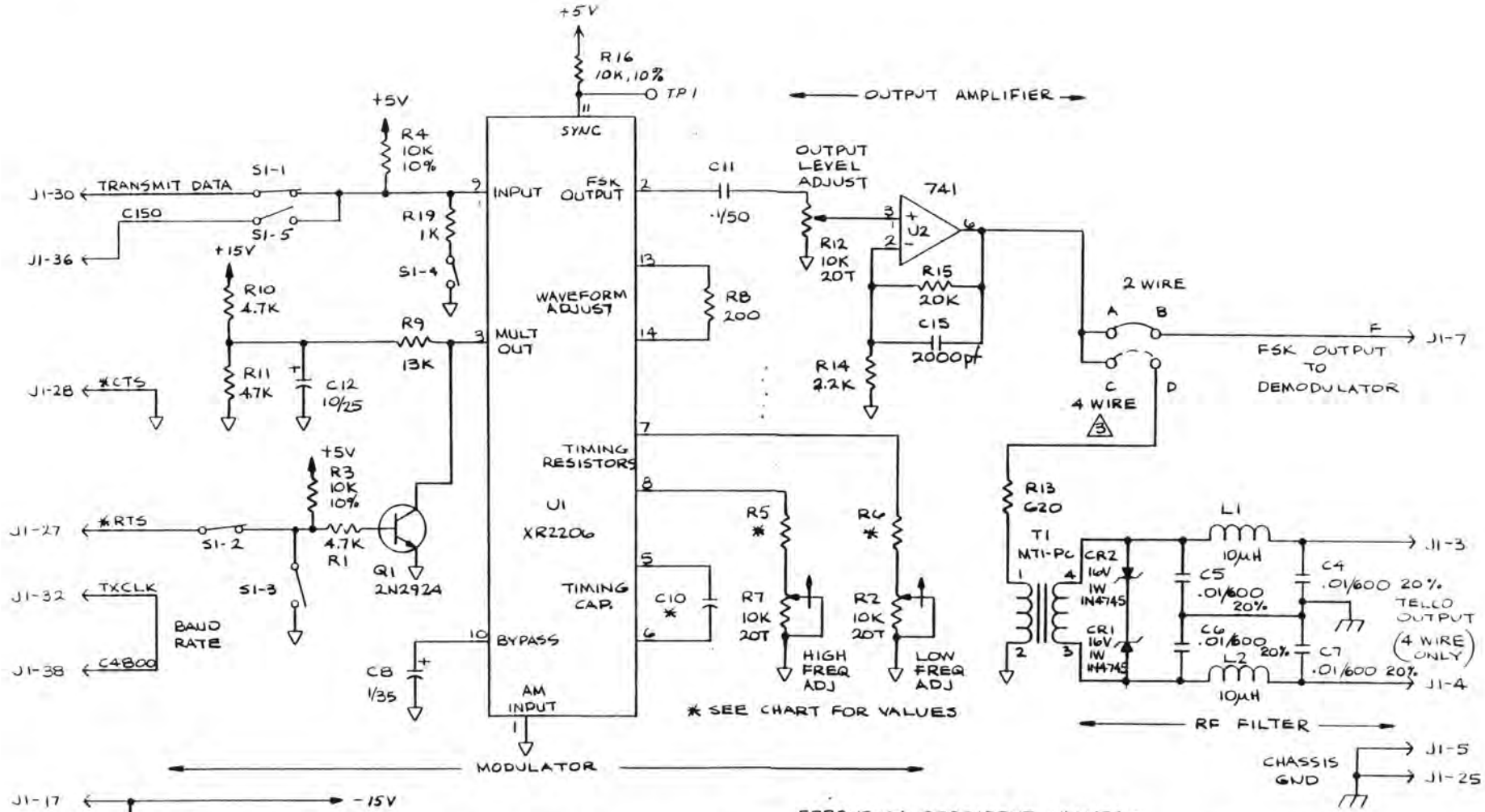
TELCO INPUT

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

DWN | CHK | ENG 21-1-83

SCALE: Page 3 of 3

27A1015 A



REF	TYPE	+15V	-15V	GND	CAPS
U1	XR2206	4		12	C9
U2	UA741P	7	4		C13 C14

FREQUENCY DEPENDENT VALUES :

BAND	FREQUENCIES	C10 ±%	R5	R6	COMPONENT LAYOUT
HI	2025 ; 2225	.022	15K	18K	20C2860-2
LO	1270 ; 1070	.044	12K	15K	20C2860-1

NOTES :

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS, 1/4W 5%; CAPACITOR VALUES ARE IN MICROFARADS.
2. P.C. BOARD 31C5979.
3. FOR 2-WIRE INSTALL JUMPER BETWEEN A & B ONLY, FOR 4-WIRE INSTALL JUMPER BETWEEN C & D ONLY.
4. S1 POSITIONS

	1	2	3	4	5
OPERATE	ON	ON	OFF	OFF	OFF
TEST	OFF	OFF	ON	FREQ	DEMOD

FREQ: 1 = HI : Ø = LO

MOSELEY ASSOCIATES, INC.
SCHEMATIC
TELCO OUTPUT
91C7305 A

MRC-1600 TELCO OUTPUT

20C2860

Item No.	Quantity -1	-2	-3	Stock No.	Reference Des	Description
1	1	1		3473378	-12,-22	PC Bd., MRC-1600 Telco Output MAI 51C5979
2	1	1		3110582	J1	Conn., Berg 66953-022 F44 Pin Straight PC Mtg
3	1	1		4090106	T1	XMFR., MCRTRN MT1-PC 600 Ω
4	1	1		3730819	U1	I.C., EXAR XR-2206CP
5	1	1		3660008	U2	I.C., T.I. SN72741P
6	2	2		3600236	CR 1, CR 2	Diode, IR IN4745A, 16 V, 1 W
7	1	1		3190790	S1	Switch, CTS 206 5 DIP5-Pos.
8	2	2		4020376	L1, L2	Inductor, Miller 74F105AP RF 10 µH
9	4	4		4280038	C1-3, 8	Cap., Sprague 196D105 x 0035 HAI Epoxy Dip 1/35 V
10	1	1		4280079	C12	Cap., Sprague 196D106 x 0025 KAI Epoxy Dip 10/25 V
11	1	1		4220125	C15	Cap., Arco DM-19-202J, Mica Dip 2000 PF 5%
12	0	1		4250387	C10	Cap., SEI 22UB443H, Polycarb. .044/100 V 3%
13	1	0		4250288	C10	Cap., SEI 22UB223H, Polycarb .022/100 V 3%
14	4	4		4310173	C4-7	Cap., Erie 811000Z5U0103M Cer. Disc. .01/600 V
15	4	4		4310207	C9, 11, 13, 14	Cap., CRL CY20C104M .1/50V 20%
16	3	3		4630281	R2, 7, 12	Pot., Bournes 3386R-1-103 PC Pin 10K .5W
17	1	1		4460069	R8	Res., A.B. RC07GF 201J 200 Ω 1/4 W 5%

REVISIONS		DATE	MGMT. APPR.
A	REL FOR PROD ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 TELCO OUTPUT

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

DWN			SCALE: Page 1 of 2
CHK			
ENG	DJT	21 JAN-83	27A1016 A

Item No.	Quantity -1 -2 -3	Stock No.	Reference Des	Description
18	1 1	4460127	R13	Res., A.B. RC07GF 621 J 620Ω 1/4 W 5%
19	1 1	4460192	R14	Res., A.B. RC07GF 222J 2.2K 1/4 W 5%
20	3 3	4460242	R1, 10, 11	Res., A.B. RC07GF 472J 4.7K 1/4 W 5%
21	0 1	4460325	R5(-1)	Res., A.B. RC07GF 123J 12K 1/4 W 5%
22	1 1	4460333	R9	Res., A.B. RC07GF 133J 13K 1/4 W 5%
23	1 1	4460341	R6(-1) R5(-2)	Res., A.B. RC07GF 153J 15K 1/4 W 5%
24	1 0	4460358	R6(-2)	Res., A.B. RC07GF 183J 18K 1/4 W 5%
25	1 1	4460366	R15	Res., A.B. RC07GF 203J 20K 1/4 W 5%
26	3 3	4460317	R3, 4, 16	Res., A.B. RC07GF 103J 10K 1/4 W 5%
27	1 1	3630027	Q1	Transistor, G.E. 2N2924-LF5
28	.05' .05'	1641927	A-B	Buss Wire, Alpha 298 #22
29	1 1	4460143	R19	Res., A.B. RC07GF102 1K 1/4 W 5%

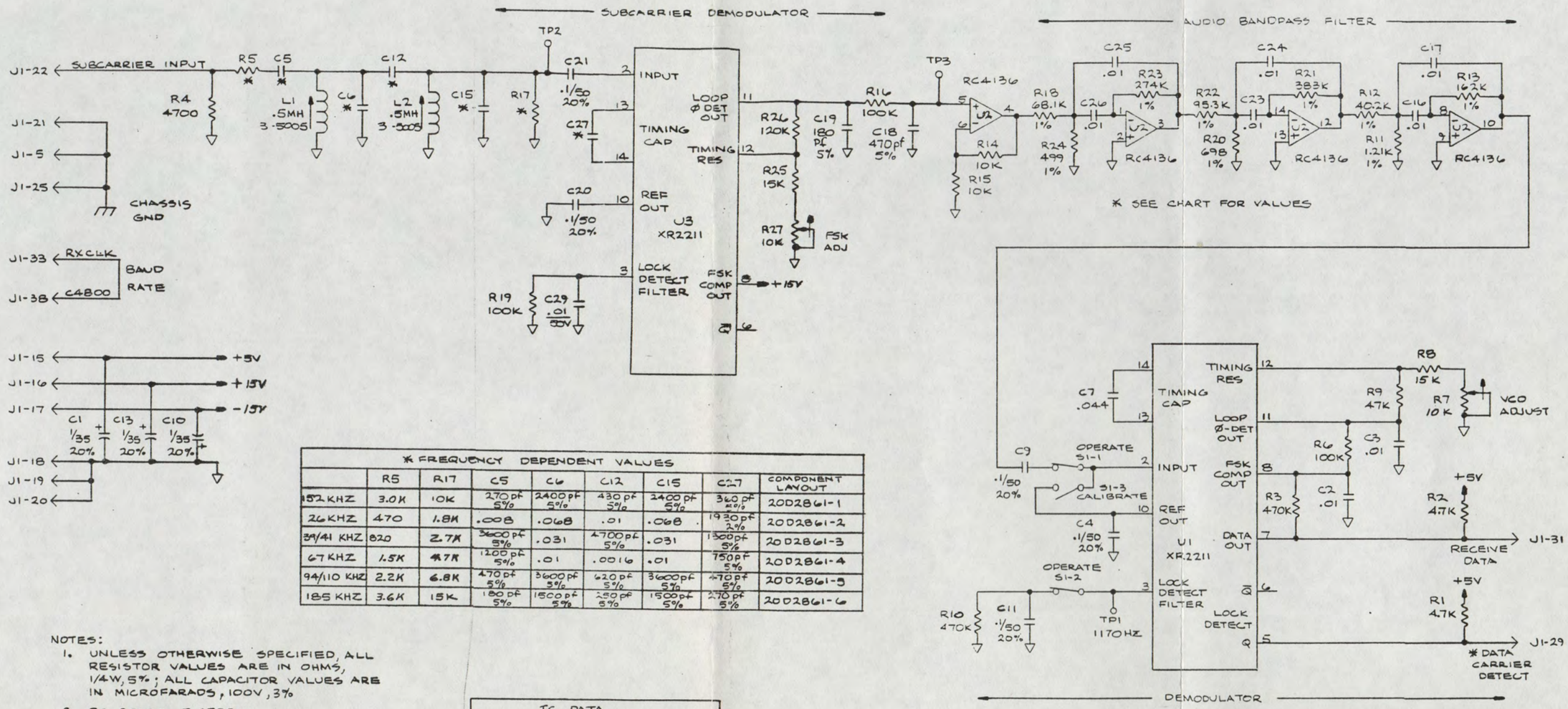
REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 TELCO OUTPUT

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

DWN			SCALE: Page 2 of 2
CHK			27A1016 A
ENG		21 Jan 83	



* FREQUENCY DEPENDENT VALUES								
	R5	R17	C5	C6	C12	C15	C17	COMPONENT LAYOUT
152 KHZ	3.0K	10K	270 pf 5%	2400 pf 5%	430 pf 5%	2400 pf 5%	360 pf 5%	20D2861-1
26 KHZ	470	1.8K	.008	.068	.01	.068	1930 pf 2%	20D2861-2
39/41 KHZ	820	2.7K	3600 pf 5%	.031	4700 pf 5%	.031	1300 pf 5%	20D2861-3
67 KHZ	1.5K	4.7K	1200 pf 5%	.01	.0016	.01	750 pf 5%	20D2861-4
94/110 KHZ	2.2K	6.8K	470 pf 5%	3600 pf 5%	620 pf 5%	3600 pf 5%	470 pf 5%	20D2861-5
185 KHZ	3.6K	15K	180 pf 5%	1500 pf 5%	250 pf 5%	1500 pf 5%	270 pf 5%	20D2861-6

NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%; ALL CAPACITOR VALUES ARE IN MICROFARADS, 100V, 3%
2. P.C. BOARD 51C5980.
3. COMPONENT LAYOUT 20D2861.
4.

S1 POSITIONS	1	2	3	4
OPERATE :	ON	ON	OFF	DON'T CARE
CALIBRATE :	OFF	OFF	ON	DON'T CARE

IC DATA					
REF	TYPE	+15V	-15V	GND	CAPS .1/50 20%
U1,U3	XR2211	1		4	C8 C28
U2	RC4136	11	7		C14 C22

REVISIONS	DATE	MGMT. APPR.
A REL. FOR PROD. ECO 3757	1-18-82	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA CALIFORNIA 93117

SCHEMATIC MRC 1600
SUBCARRIER INPUT

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

DWN	JM	8-24-82	SCALE:
CHK	[illegible]	9-7-82	
ENG	[illegible]	[illegible]	91D7306 A

MRC-1600 SUBCARRIER INPUT

20D2861

Item No.	Quantity -1	-2	-3	-4	-5	-6	Stock No.	Reference Des	Description
1	1	1	1	1	1	1	3473386	-11,-21	PC Bd., MRC-1600 Sub-carrier Input 51C5980
2	1	1	1	1	1	1	3110582	J1	Conn., Berg 66953-022F 44 Pin Straight PC Mnt
3	2	2	2	2	2	2	3730827	U1,U3	I.C., Exar XR-2211CP
4	1	1	1	1	1	1	3730462	U2	I.C., T.I. RC4136N
5	1	1	1	1	1	1	3190071	S1	Switch, CTS 2064 Dip 4-Pos
6	2	2	2	2	2	2	4460549	R3,R10	Res., A/B RC07GF474J 470K 1/4 W 5%
7	1	1	1	1	1	1	4510491	R21	Res., A/B RN55E3833F 383K 1/8 W 1%
8	1	1	1	1	1	1	4510467	R23	Res., A/B RN55E2743F 274K 1/8 W 1%
9	1	1	1	1	1	1	4510459	R13	Res., A/B RN55E1623F 162K 1/8 W 1%
10	1	1	1	1	1	1	4460499	R26	Res., A/B RC07GF124J 120K 1/4 W 5%
11	3	3	3	3	3	3	4460481	R6,R16, R19	Res., A/B RC07GF104J 100K 1/4 W 5%
12	1	1	1	1	1	1	4510442	R22	Res., A/B RN55E9532F 95.3K 1/8 W 1%
13	1	1	1	1	1	1	4510418	R18	Res., A/B RN55E6812F 68.1K 1/8 W 1%
14	1	1	1	1	1	1	4460432	R9	Res., A/B RC07GF473J 47K 1/4 W 5%
15	1	1	1	1	1	1	4510400	R12	Res., A/B RN55E4022F 40.2K 1/8 W 1%
16	1	1	1	1	1	1	4460358	R8	Res., A/B RC07GF183J 18K 1/4 W 5%
17	1	1	1	1	1	2	4460341	R17(-6), R25	Res., A/B RC07GF153J 15K 1/4 W 5%

REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3752	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 SUBCARRIER INPUT

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

DWN			SCALE: Page 1 of 4
CHK			27A1017 A
ENG		21 Jan 83	

Item No.	Quantity -1	-2	-3	-4	-5	-6	Stock No.	Reference Des	Description
18	3	2	2	2	2	2	4460317	R14,R15, R17(-1)	Res., A/B RC07GF103J 10K 1/4 W 5%
19	0	0	0	0	1	0	4460275	R17(-5)	Res., A/B RC07GF682J 6.8K 1/4 W 5%
20									
21	3	3	3	4	3	3	4460242	R4,R17(-4) R1,R2	Res., A/B RC07GF472J 4.7K 1/4 W 5%
22	0	0	0	0	0	1	4460234	R5(-6)	Res., A/B RC07GF362J 3.6K 1/4 W 5%
23	0	0	1	0	0	0	4460200	R17(-3)	Res., A/B RC07GF272J 2.7K 1/4 W 5%
24	0	0	0	0	1	0	4460192	R5(-5)	Res., A/B RC07GF222J 2.2K 1/4 W 5%
25	0	1	0	0	0	0	4460184	R17(-2)	Res., A/B RC07GF182J 1.8K 1/4 W 5%
26	0	0	0	1	0	0	4460168	R5(-4),	Res., A/B RC07GF152J 1.5K 1/4 W 5%
27	1	1	1	1	1	1	4510392	R11	Res., A/B RN55E1211F 1.21K 1/8 W 1%
28	0	0	1	0	0	0	4460853	R5(-3)	Res., A/B RC07GF821K 820Ω 1/4 W 5%
29	0	1	0	0	0	0	4460119	R5(-2)	Res., A/B RCR07G471J 470Ω 1/4 W 5%
30	1	1	1	1	1	1	4510327	R20	Res., A/B RN55E6980F 698Ω 1/8 W 1%
31	1	1	1	1	1	1	4510384	R24	Res., A/B RN55E4990F 499Ω 1/8 W 1%
32	1	1	1	1	1	1	4630166	R7	Pot, Bourns 3299W-1-502 5K
33	1	1	1	1	1	1	4630273	R27	Pot, Bourns 3299W-1-103 10K
34	0	0	1	0	0	0	4220216	C12(-3)	Cap., Arco DM-19-472J Mica Dip 4700 pf 5%
35	0	0	1	0	2	0	4220190	C5(-3), C6(-5), C15(-5)	Cap., Arco DM-19-362J 3600 pf 5%

REVISIONS	DATE	MGMT. APPR.
A Rel For Prod ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 SUBCARRIER INPUT

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

DWN			SCALE: Page 2 of 4
CHK			
ENG	OAB	21 Jan 83	27A1017 A

Item No.	Quantity -1	-2	-3	-4	-5	-6	Stock No.	Reference Des	Description
36	1	0	0	0	0	0	4210423	C27(-1)	Cap., Arco DM-15-361J Mica Dip 360 pf 5%
37	0	1	0	0	0	0	4220117	C27(-2)	Cap., Arco DM-19-F19310G Mica Dip 1930 pf 2%
38	0	0	0	0	0	2	4220067	C6(-6) C15(-6)	Cap., Arco DM-19-152J Mica Dip 1500 pf 5%
39	0	0	1	0	0	0	4220059	C27(-3)	Cap., Aroc DM-19-132J Mica Dip 1300 pf 5%
40	0	0	0	1	0	0	4210514	C27(-4)	Cap., Arco DM-15-751J Mica Dip 750 pf 5%
41	0	0	0	0	1	0	4210498	C12(-5)	Cap., Arco DM-15-621J Mica Dip 620 pf 5%
42	1	1	1	1	3	1	4210456	C18,C5 (-5),C27 (-5)	Cap., Arco DM-15-471J Mica Dip 470 pf 5%
43	1	0	0	0	0	1	4210399	C27(-6) (-1)	Cap., Arco DM-15-271J Mica Dip 270 pf 5%
44	0	0	0	0	0	1	4210381	C12(-6)	Cap., Arco DM-15-251J Mica Dip 250 pf 5%
45	1	1	1	1	1	2	4210324	C19,C5 (-6)	Cap., Arco DM-15-181J Mica Dip 180 pf 5%
46	2	0	0	0	0	0	4220158	C6(-1), C15(-1)	Cap., Arco DM-19-242J Mica Dip 2400 pf 5%
47	0	2	0	0	0	0	4250445	C6(-2), C15(-2)	Cap., Polycarb SEI 22UB683H .068/100V
48	1	1	1	1	1	1	4250387	C7	Cap., Polycarb SEI 22UB443H .044/100V
49	0	0	2	0	0	0	4250320	C6(-3), C15(-3)	Cap., Polycarb SEI 22UB313H .031/100V
50									
51									
52	8	9	8	10	8	8	4250171	C2,C3,C16, C17,C23-C26,C15(-4) C6(-4), C12(-2)	Cap., Polycarb SEI 22UB103H .01/100V

REVISIONS | DATE | MGMT. APPR.
A | REL FOR P200 ECO 3757 | 1-21-83

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 SUBCARRIER INPUT

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

DWN			SCALE: Page 3 of 4
CHK			
ENG		21 Jan-83	27A1017 A

Item No.	Quantity -1	-2	-3	-4	-5	-6	Stock No.	Reference Des	Description
53	0	1	0	0	0	0	4250163	C5(-2)	Cap., Polycarb SEI 22UB802H .008/100V
54	0	0	0	1	0	0	4250023	C12(-4)	Cap., Polycarb SEI 22UB162H .0016/100V 3%
55	0	0	0	1	0	0	4220042	C5(-4)	Cap., Arco DM-19-122J Mica Dip 1200 pf 5%
56	9	9	9	9	9	9	4310207	C4,C8,C9, C11,C14, C20,C21, C22,C28	Cap., CRL CY20C104M .1/50V 20%
57	1	1	1	1	1	1	4310132	C29	Cap., CRL UK-50-103 .01/50V
58	3	3	3	3	3	3	4280038	C1,C10, C13	Cap., Sprague 196D105x 0035HAI Epoxy Dip 1/35V
59	2	2	2	2	2	2	4041703	L1,L2	Inductor .5MH 3-5005
60	1	0	0	0	0	0	4460218	R5(-1)	Res RC07GF302J 3K 1/4 W 5%
61	1	0	0	0	0	0	4210449	C12(-1)	Cap., Arco DM-15-431J Mica Dip 430 pf

REVISIONS	DATE	MGMT. APPR.
A RLL FOR PROD ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 SUBCARRIER INPUT

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

DWN | CHK | ENG OJR 21 JAN 83

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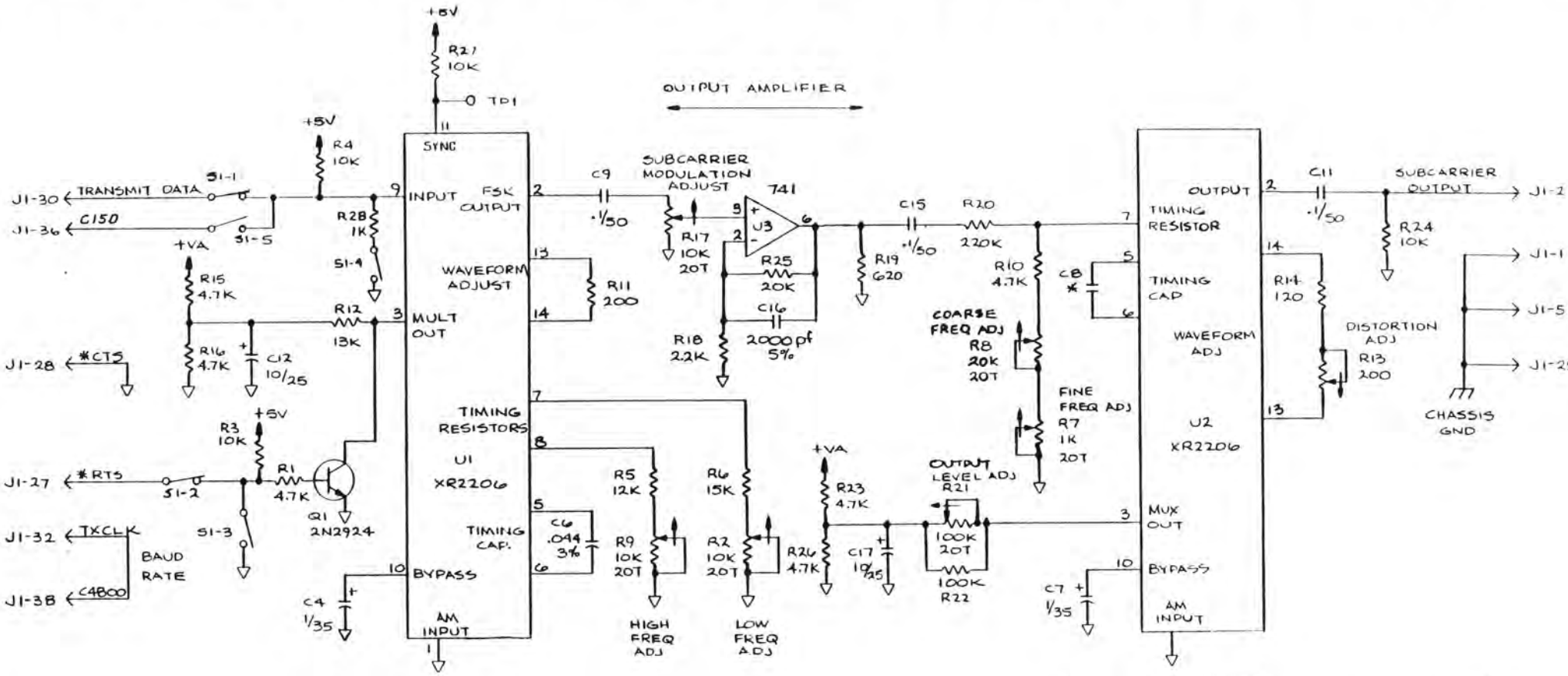
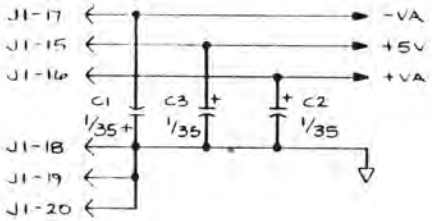
27A1017 A





REF	TYPE	+15V	-15V	GND	CAPS .1/50 ±0%
U1,U2	XR2206	4		12	C5,C10
U3	UA741P	7	4		C13,C14

* FREQUENCY DEPENDENT VALUES

TUNING RANGE	NOMINAL FREQ	C8	COMPONENT LAYOUT
-	152 KHz	510 pf 5%	20D2862-1
26-66 KHz	26 KHz	1930 pf 2%	20D2862-2
-	39/41 KHz	1300 pf 5%	20D2862-3
67-185 KHz	67 KHz	750 pf 5%	20D2862-4
-	94/110 KHz	560 pf 5%	20D2862-5
-	185 KHz	470 pf 5%	20D2862-6

NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTER VALUES ARE IN OHMS, 1/4W 5%; CAPACITOR VALUES ARE IN MICROFARADS.
2. PC. BOARD 51C5981.
3. COMPONENT LAYOUT 20D2862.
4. SI POSITIONS

SI POSITIONS	1	2	3	4	5
OPERATE:	ON	ON	OFF	OFF	OFF
TEST:	OFF	OFF	ON	FREQ	DEMOD

FREQ: OFF = LOW ON = HIGH

MOSELEY ASSOCIATES, INC

SCHEMATIC MRC-1600
SUBCARRIER OUTPUT

91D7307 A

27A1018 | A

MRC-1600 SUBCARRIER OUTPUT

20D2862

Item No.	Quantity -1	-2	-3	-4	-5	-6	Stock No.	Reference Des	Description
1	1	1	1	1	1	1	3473394	-12,-22	PC Bd., MRC-1600 Sub-carrier Output 51C5981
2	1	1	1	1	1	1	3110582	U1	Conn., Berg 66953-022F 44 Pin Straight PC Mnt
3	2	2	2	2	2	2	3730819	U1,U2	IC, Exar XR-2206CP
4	1	1	1	1	1	1	3660008	U3	IC, TI SN72741D
5	1	1	1	1	1	1	4460523	R20	Res., A/B RC07GF224J 220K 1/4 W 5%
6	1	1	1	1	1	1	4460481	R22	Res, A/B RC07GF104J 100K
7	1	1	1	1	1	1	4460366	R25	Res., A/B RC07GF203J 20K
8	1	1	1	1	1	1	4460341	R6	Res., A/B RC07GF153J 15K
9	1	1	1	1	1	1	4460333	R12	Res., A/B RC07GF133J 13K
10	1	1	1	1	1	1	4460325	R5	Res., A/B RC07GF123J 12K
11	4	4	4	4	4	4	4460317	R3,R4, R24,R27	Res., A/B RC07GF103J 10K
12	7	7	7	7	7	7	4460242	R1,10,15, 16,23,26,28	Res., A/B RC07GF472J 4.7K
13	1	1	1	1	1	1	4460192	R18	Res., A/B RC07GF222J 2.2K
14	1	1	1	1	1	1	4460127	R19	Res., A/B RC07GF621J 620Ω
15	1	1	1	1	1	1	4460069	R11	Res., A/B RC07GF201J 200Ω
16	1	1	1	1	1	1	4460655	R14	Res., A/B RC07GF121J 120Ω 1/4 W 5%
17									
18	1	1	1	1	1	1	4630778	R21	Pot, Bournes 3299W-1-104 100K
19	1	1	1	1	1	1	4630331	R8	Pot, Bournes 3299W-1-203 20K
20	3	3	3	3	3	3	4630273	R2,9,17	Pot, Bournes 3299W-1-103 10K

REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 SUBCARRIER OUTPUT

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

DWN | CHK | ENG (21 Jan 83)

SCALE: Page 1 of 2

27A1018 | A

Item No.	Quantity -1	-2	-3	-4	-5	-6	Stock No.	Reference Des	Description
21	1	1	1	1	1	1	4630786	R7	Pot, Bournes 3299W-1-102 1K
22	1	1	1	1	1	1	4630018	R13	Pot, Bournes 3386R-1-201 200Ω
23									
24	1	0	0	0	0	0	4210472	C8(-1)	Cap., Arco DM-15-511J Mica Dip 510 pf 2%
25	0	1	0	0	0	0	4220117	C8(-2)	Cap., Arco DM-19-F19310G Mica Dip 1930 pf 2%
26	0	0	1	0	0	0	4220059	C8(-3)	Cap., Arco DM-19-132J Mica Dip 1300 pf
27	0	0	0	1	0	0	4210514	C8(-4)	Cap., Arco DM-15-751J Mica Dip 750 pf
28	0	0	0	0	1	0	4210480	C8(-5)	Cap., Arco DM-15-561J Mica Dip 560 pf
29	0	0	0	0	0	1	4210456	C8(-6)	Cap., Arco DM-15-471J Mica Dip 470 pf
30	7	7	7	7	7	7	4310207	C5,9,10, 11,13,14, 15	Cap., CRL CY20C104M .1/50V 20%
31	5	5	5	5	5	5	4280038	C1-C4,C7	Cap., Sprague 196D105x 0035 HAI Epoxy Dip 1/35V
32	1	1	1	1	1	1	4250387	C6	Cap., SEI 22UB443H, Polycarb .044/100V 3%
33	2	2	2	2	2	2	4280079	C12,C17	Cap., Sprague 196D106x 0025 KAI Epoxy Dip 10/25V
34	1	1	1	1	1	1	4220125	C16	Cap., Arco DM-19-202J Mica Dip 2000 pf 5%
35	1	1	1	1	1	1	3190790	S1	Switch, CTS 206-5 Dip 5-Pos
36	1	1	1	1	1	1	3630027	Q1	Xstr, GE 2N2924-LFS
37	1	1	1	1	1	1	4460143	R29	Res., A.B. RC07GF102 1K 1/4 W 5%

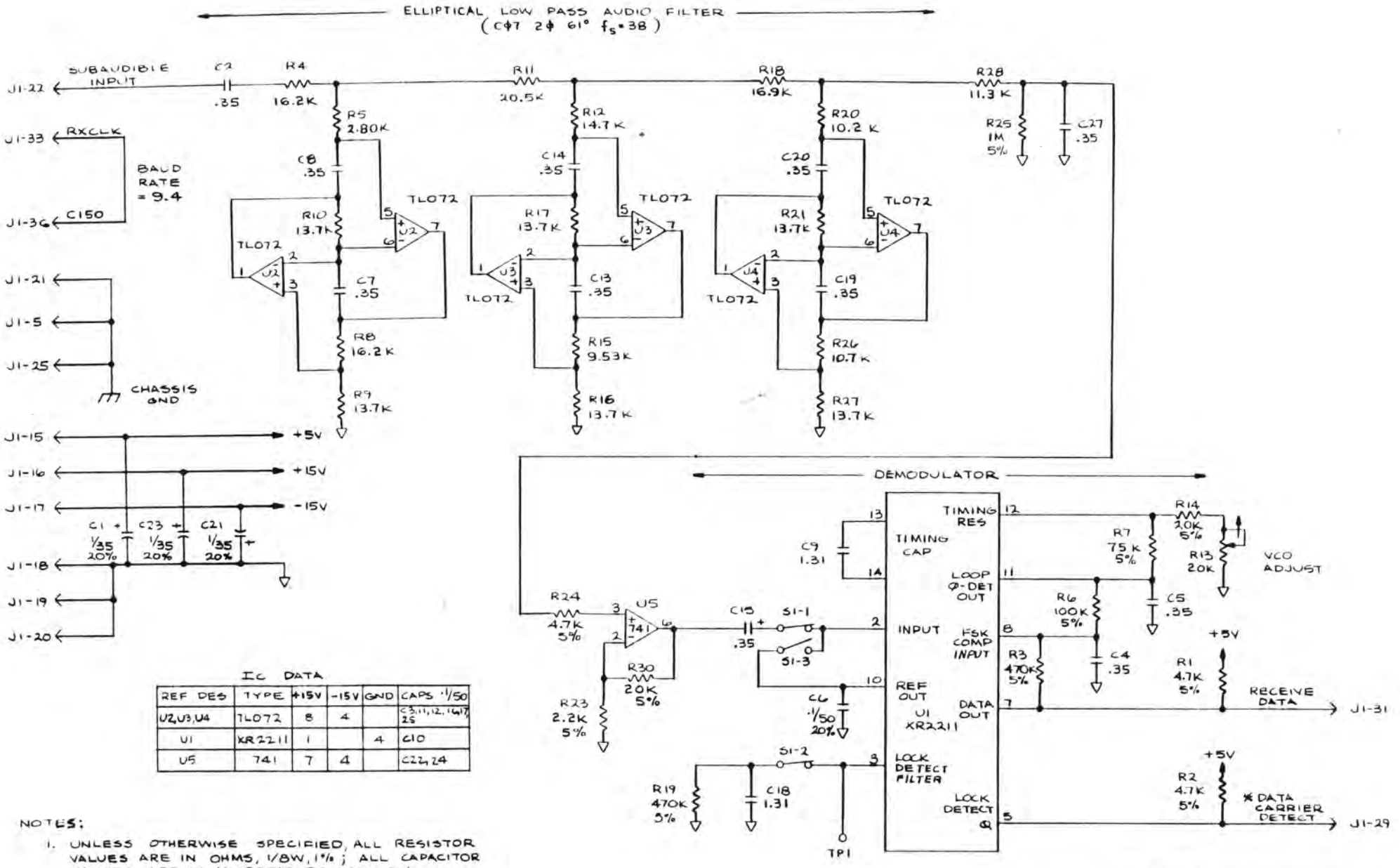
REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD EC03757	1-21-83	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 SUBCARRIER OUTPUT

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

DWN			SCALE: Page 2 of 2
CHK			27A1018 A
ENG	DRB	21 Jan 83	



IC DATA

REF DES	TYPE	+15V	-15V	GND	CAPS .1/50
U2,U3,U4	TL072	8	4		C3,11,12,16,17,25
U1	XR2211	1		4	C10
U5	741	7	4		C22,24

NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, 1/8W, 1%; ALL CAPACITOR VALUES ARE IN MICROFARADS, 100V, 5%.
2. P.C. BOARD 51C5982
3. COMPONENT LAYOUT 2002863
4. S1 SWITCH POSITIONS:

	1	2	3	4
OPERATE	ON	ON	OFF	X
TEST	OFF	OFF	ON	X

MOSELEY ASSOCIATES, INC.
SCHEMATIC
MR0600 SUBAUDIBLE INPUT
91D7308 A

MRC-1600 SUBAUDIBLE INPUT

20D2863

Item No.	Quantity	Stock No.	Reference Des	Description
1	1	3473402		MRC-1600 Subaudible Input PC Bd., MAI 51C5982 -11,-21
2	1	3110582	J1	Conn., Berg 66953-022 F 44 Pin Straight PC Mtg.
3	3	3730876	U2,3,4	I.C., T.I. TL072A
4	1	3660008	U5	I.C., T.I. UA741CP 741
5	1	3730827	U1	I.C., Exar XR2211CP
6	1	3190071	S1	Switch, CTS 206 4 Dip 4
7	3	4280038	C1, 21,23	Cap., Sprague 196 Dio5x 0035HAI Epoxy-Dip 1/35 V 20%
8	11	4250619	C2,5,8,7, 13,19,20, 27, 4,14,15	Cap., SEI 22 UB354H, Poly-carb. .35/100 V 3%
9	2	4250643	C9,C18	Cap., SEI 22UB 1314H, Poly-carb. 1.31/100 V 3%
10				
11	10	4310207	C3,6,10,11, 12,16,17, 22,24,25	Cap., CRL CY20C104M .1/50 V 20%
12	1	4630331	R13	Pot., Bournes 3299W-1-203 20K .5W, 25T
13				
14	1	4510525	R12	Res., Mepco RN55E1472F 14.7K 1/8 W 1%
15	1	4510566	R11	Res., Mepco RN55E2052F 20.5K 1/8 W 1%
16	1	4510673	R5	Res., Mepco RN55E2801F 2.80K 1/8 W 1%
17	6	4510723	R9,10,16, 17,21,27	Res., Mepco RN55E1372F 13.7K 1/8 W 1%

REVISIONS | DATE | MGMT. APPR.
A | REL. FOR PROD. EC0 3813 | 3-21-82 | ke

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SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

MRC-1600 SUBAUDIBLE INPUT

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

DWN | CHK | ENG

SCALE: Page 1 of 2

27A1019 | A

Item No.	Quantity	Stock No.	Reference Des	Description
18	1	4510731	R18	Res., Mepco RN55E1692F 16.9K 1/8 W 1%
19	2	4510533	R4,R8	Res., Mepco RN55E1622F 16.2K 1/8 W 1%
20	1	4510715	R28	Res., Mepco RN55E1132F 11.3K 1/8 W 1%
21				
22	1	4510681	R15	Res., Mepco RN55E9531F 9.53K 1/8 W 1%
23	1	4510707	R26	Res., Mepco RN55E1072F 10.7K 1/8 W 1%
24	1	4510699	R20	Res., Mepco RN55E1022F 10.2K 1/8 W 1%
25	1	4460556	R25	Res., A/B RC07GF105J 1M 1/4 W 5%
26	2	4460549	R3,19	Res., A/B RC07GF474J 470K 1/4 W 5%
27	1	4460721	R7	Res., A/B RC07GF753J 75K 1/4 W 5%
28	1	4460481	R6	Res., A/B RC07GF104J 100K 1/4 W 5%
29	1	4460192	R23	Res., A/B RC07GF222J 2.2K 1/4 W 5%
30	3	4460242	R1,2,24	Res., A/B RC07GF472J 4.7K 1/4 W 5%
31	2	4460366	R14,R30	Res., A/B RC07GF203J 20K 1/4 W 5%

REVISIONS	DATE	MGMT. APPR.
A REL. FOR PROD. ECO 3813, 3-21-83 JC		

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MRC-1600 SUBAUDIBLE INPUT

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

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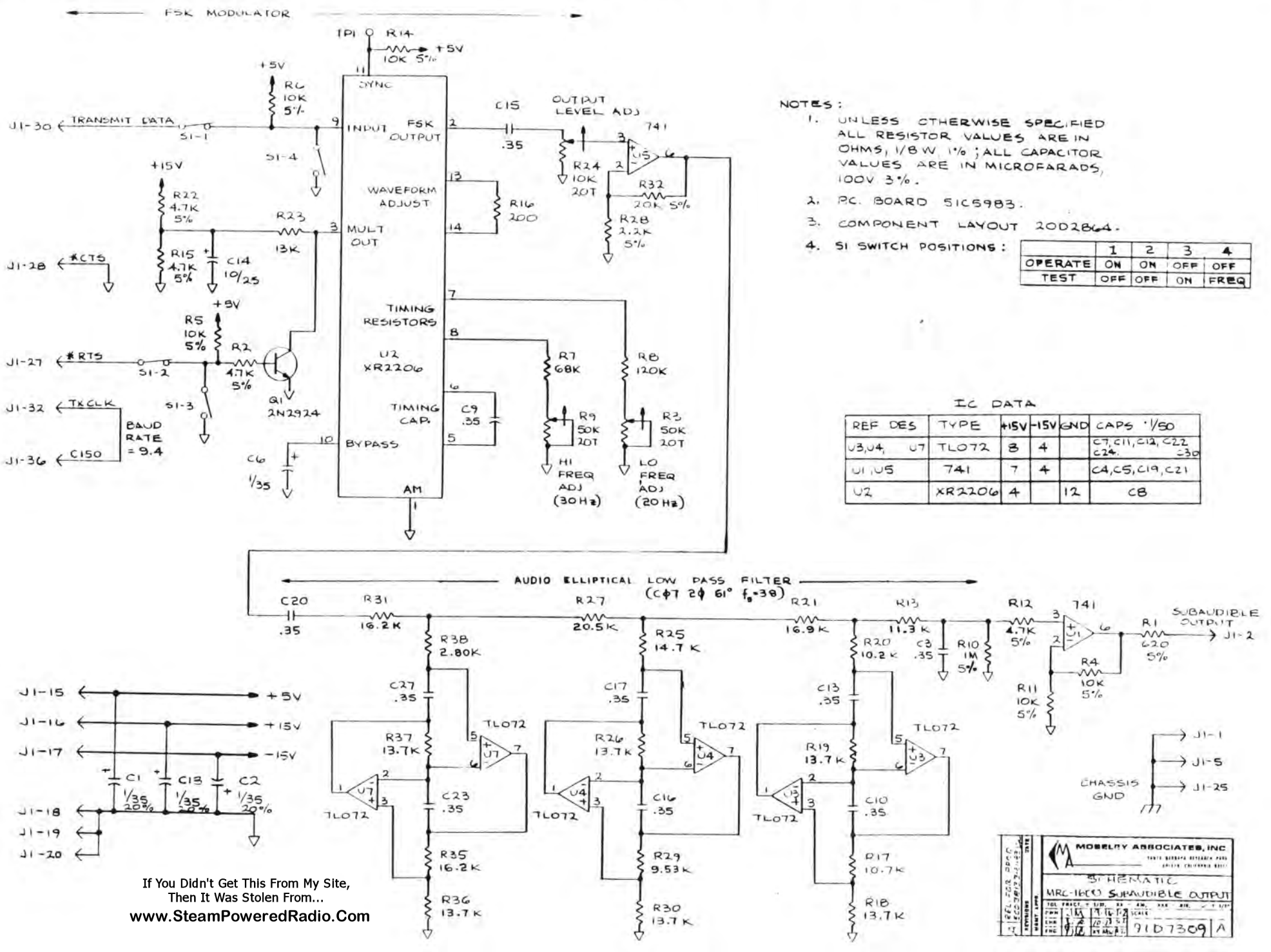
CHK		27A1019	A
ENG			



MRC-1600 SUBAUDIBLE OUTPUT

Item No.	Quantity	Stock No.	Reference Des	Description
1	1	3473410		MRC-1600 Subaudible Output PC Bd MAI 51C5983 -11,-21
2	1	3110582	J1	Conn., Berg 66953-022 F 44 Pin Straight PC Mtg.
3	3	3730876	U3,U4,U7	I.C., T.I. TL072A
4	2	3660008	U1,U5	I.C., T.I. UA741CP
5	1	3730819	U2	I.C., Exar XR2206CP
6	1	3190071	S1	Switch, CTS 206 4 Dip 4
7	1	4280079	C14	Cap., Sprague 196D106 x 0025 KAI Epoxy-Dip 10/25 V
8	4	4280038	C1,2,6,18	Cap., Sprague 196D105 x 0035 HAI Epoxy-Dip 1/35 V 20%
9	10	4250619	C3,9,10,13, 15,16,17, 20,23,27	Cap., SEI 22UB354H, Poly-carb. .35/100 V 3%
10	11	4310207	C4,5,7,8, 11,12,19, 21,24,22	Cap., CRL CY20C104M .1/50V 20%
11	2	4630406	R3,R9	Pot., Spectrol 64W503 50K
12	1	4630273	R24	Pot., Bournes 3299W-1-103 10K .5W 25T
13	2	4510533	R31,R35	Res., Mepco RN55E1622F 16.2K 1/8 W 1%
14				
15	1	4510566	R27	Res., Mepco RN55E2052F 20.5K 1/8 1%
16	1	4510731	R21	Res., Mepco RN55E1692F 16.9K 1/8 W 1%
17	6	4510723	R18,19,26, 30,36,37	Res., Mepco RN55E1372F 13.7K 1/8 W 1%
18	1	4510707	R17	Res., Mepco RN55E1072F 10.7K 1/8 W 1%

REVISIONS	DATE	MGMT. APPR.
A REL. FOR PROD. ECO3813	3-21-83	

MOSELEY ASSOCIATES, INC.
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MRC-1600 SUBAUDIBLE OUTPUT

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

DWN | CHK | ENG

SCALE: Page 1 of 2

27A1020 A

Item No.	Quantity	Stock No.	Reference Des	Description
19	1	4510673	R38	Res., Mepco RN55E2801F 2.80K 1/8 W 1%
20	1	4510715	R13	Res., Mepco RN55E 1132F 11.3K 1/8 W 1%
21	1	4510525	R25	Res., Mepco RN55E1472F 14.7K 1/8 W 1%
22				
23	1	4510699	R20	Res., Mepco RN55E1022F 10.2K 1/8 W 1%
24	1	4510681	R29	Res., Mepco RN55E9531F 9.53K 1/8 W 1%
25	1	4460556	R10	Res., A/B RC07GF105J 1M 1/4 W 5%
26	1	4460499	R8	Res., A/B RC07GF124J 120K 1/4 W 5%
27	1	4460713	R7	Res., A/B RC07GF683J 68K 1/4 W 5%
28	1	4460366	R32	Res., A/B RC07GF203J 20K 1/4 5%
29	1	4460333	R23	Res., A/B RC07GF133J 13K 1/4 W 5%
30	5	4460317	R4,5,6,11, 14	Res., A/B RC07GF103J 10K 1/4 W 5%
31	4	4460242	R2,12,15, 22	Res., A/B RC07GF472J 4.7K 1/4 W 5%
32	1	4460192	R28	Res., A/B RC07GF222J 2.2K 1/4 W 5%
33	1	4460127	R1	Res., A/B RC07GF621J 620 1/4 W 5%
34	1	4460069	R16	Res., A/B RC07GF201J 200 1/4 W 5%
35	1	3630027	Q1	Transistor 2N2924 LFS

REVISIONS	DATE	MGMT. APPR.
A REL. FOR PROD. ECO 3813	3-21-82	

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MRC-1600 SUBAUDIBLE OUTPUT

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

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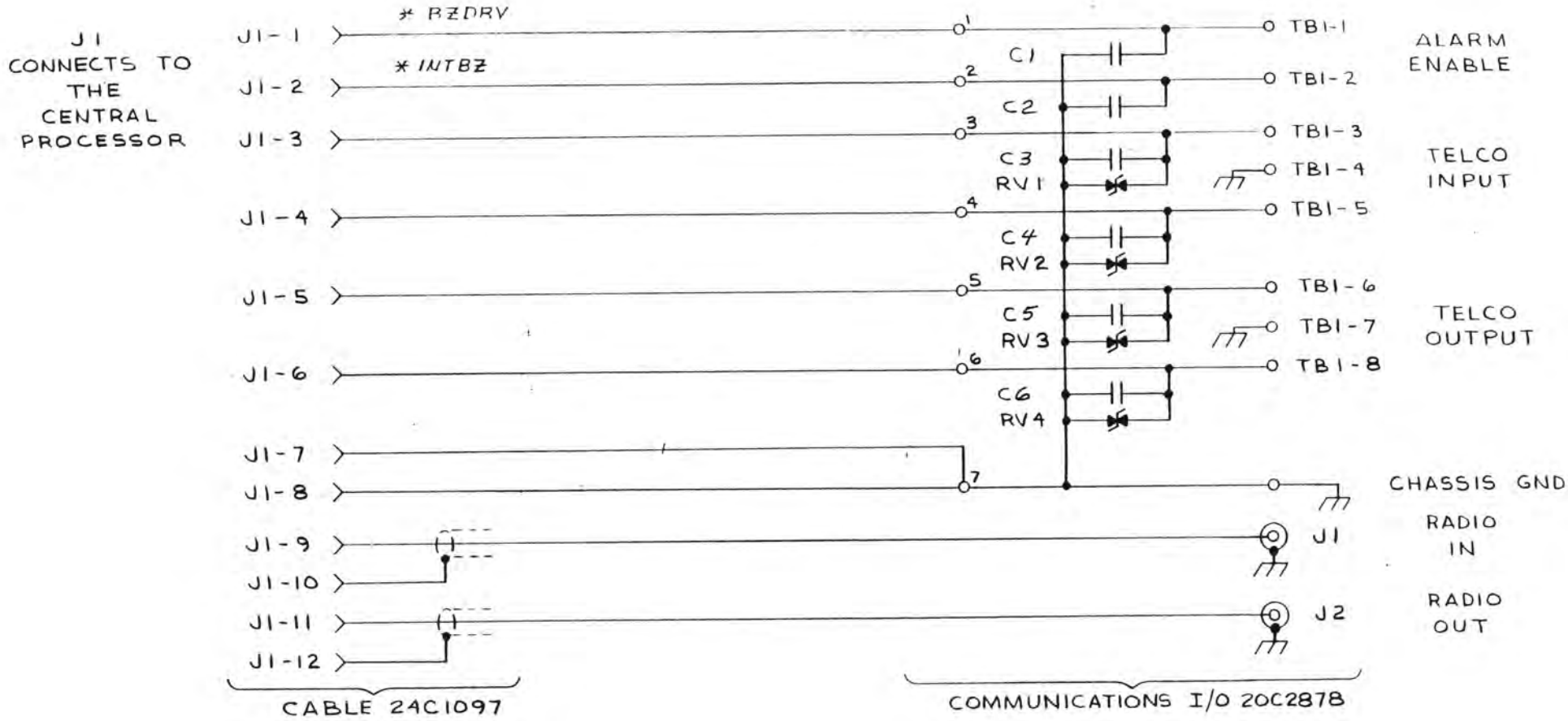
CHK			27A1020 A
ENG			



NOTES:
1. ALL CAPACITORS ARE .01/600V (C1-6)
   ALL VARISTORS ARE 120 V (RV1 - RV4)

REVISIONS			DATE	MGMT. APPR.
A	REL. FOR PROD. ECO 3757		1-18-83	MA

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SCHEMATIC
MRC-1600 COMMUNICATIONS I/O

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

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CHK	ACR	9-30-82	91B7316 A
ENG	DAR	5 Oct 82	

MRC-1600 COMMUNICATIONS I/O

20C2878

Item No.	Quantity	Stock No.	Reference Des	Description
1	1	3473428	-10,-20	PC Bd., MRC-1600 Comm. I/O MAI 51C5999-10, -20
2	1	3030244	J1, J2	Conn., Amphenol UG-1094/U BNC Bulkhead
3	1	2300879		Cable Assy., MRC-1600 Comm., MAI 24B1097
4	1	3291143	TB 1	Term. Strip, Electr. 25.102.0853 3181/8 Pin 5 MM
5	6	4310173	C1-C6	Cap., Erie 811000Z5U0103M, Cer. Disc. .01 µF/600 V
6	4	4590170	RV1-RV4	Varistor, GE V-120-MAIA 120 V
7	.2	1560028	J1, J2	TBG, Shrink 1/8"

REVISIONS	DATE	MGMT. APPR.
A REL FOR PROD ECO 3757	1-21-83	

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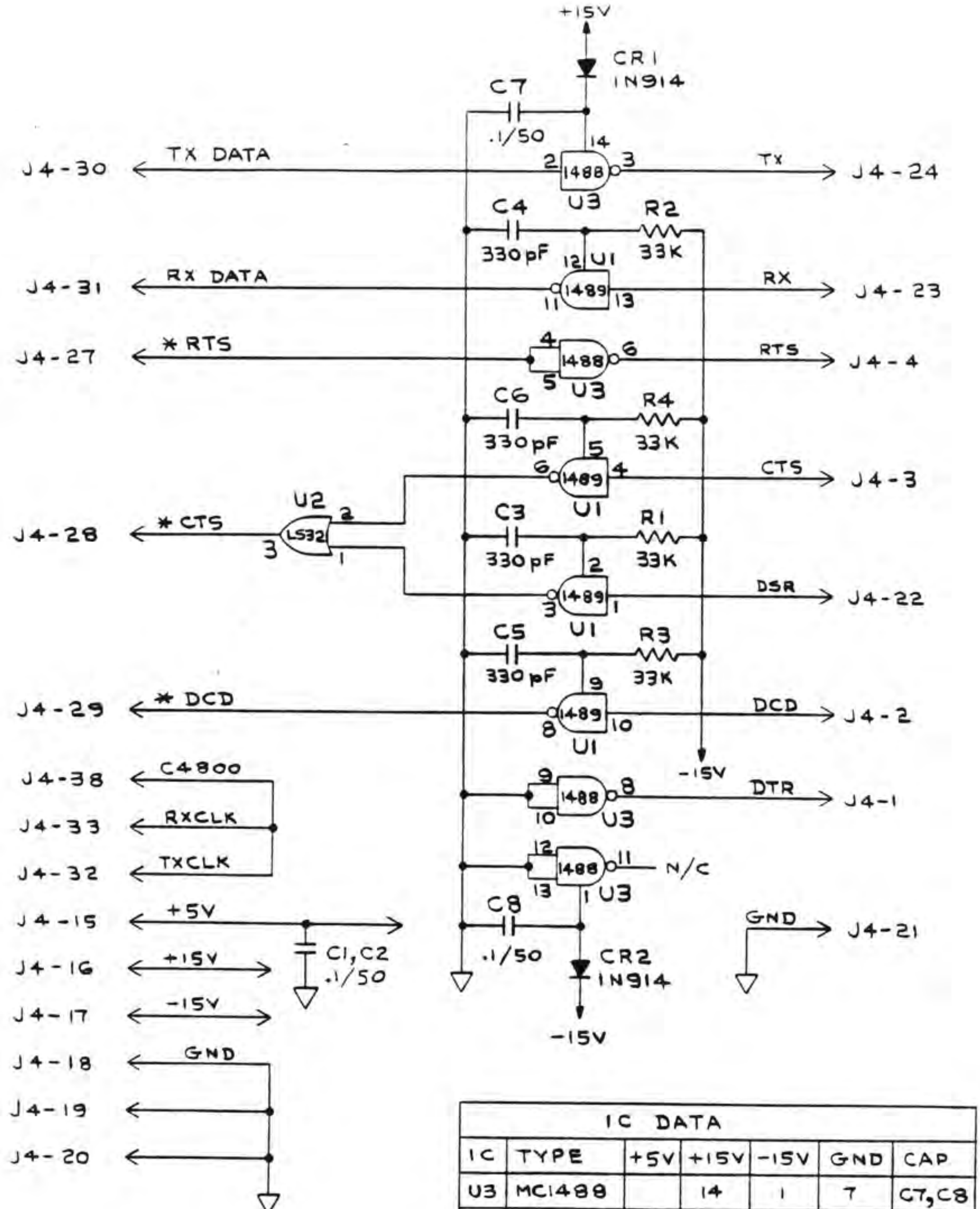
MRC-1600 COMMUNICATIONS I/O

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

DWN			SCALE: Page 1 of 1
CHK			
ENG	[illegible]	21 Jan 83	27A1021 A



IC DATA						
IC	TYPE	+5V	+15V	-15V	GND	CAP
U3	MC1488		14	1	7	C7,C8
U1	MC1489	14			7	C1
U2	74LS32	14			7	C2

3. COMPONENT LAYOUT: 20C2927
2. PC BD: 51B6033
1. UNLESS OTHERWISE SPECIFIED: RESISTOR VALUES ARE IN OHMS ±10%, 1/4 W
CAPACITOR VALUES ARE IN MICROFARADS
NOTES:

REVISIONS		
A	REL FOR PROD	24 SEP 84

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GOLETA, CALIFORNIA 93117

SCHEMATIC-
MRC-1600 RS-232

91C7368 A

MRC-1600 RS-232 COMMUNICATIONS PARTS LIST

20C2927

Item No.	Quantity	Stock No.	Reference Des	Description
1	1	3473758		PCB MRC-1600 RS-232
2	1	3110582	J4	Conn. F 44-Pin Straight PC Mtg.
3	1	3730355	U3	IC MC1488L Qu Line Driver
4	1	3730363	U1	IC MC1489L Qu Line Receiver
5	1	3660958	U2	IC SN74LS32 Quad 2-Input Nor
6	4	4310207	C1,C2,C7,C8	Cap .1UF/50V 20%
7	4	4210415	C3,C4,C5,C6	Cap Mica Dip 330 pF
8	4	4410437	R1,R2,R3,R4	Res 33K Ohm ¼W 10%
9	2	3600053	CR1,CR2	Dio 1N914 75V 75 mA SI A398

REVISIONS	MGMT. APPR.	DATE
A REL FOR PROD. CH ECO 4230		21SEPT84

MOSELEY ASSOCIATES, INC.
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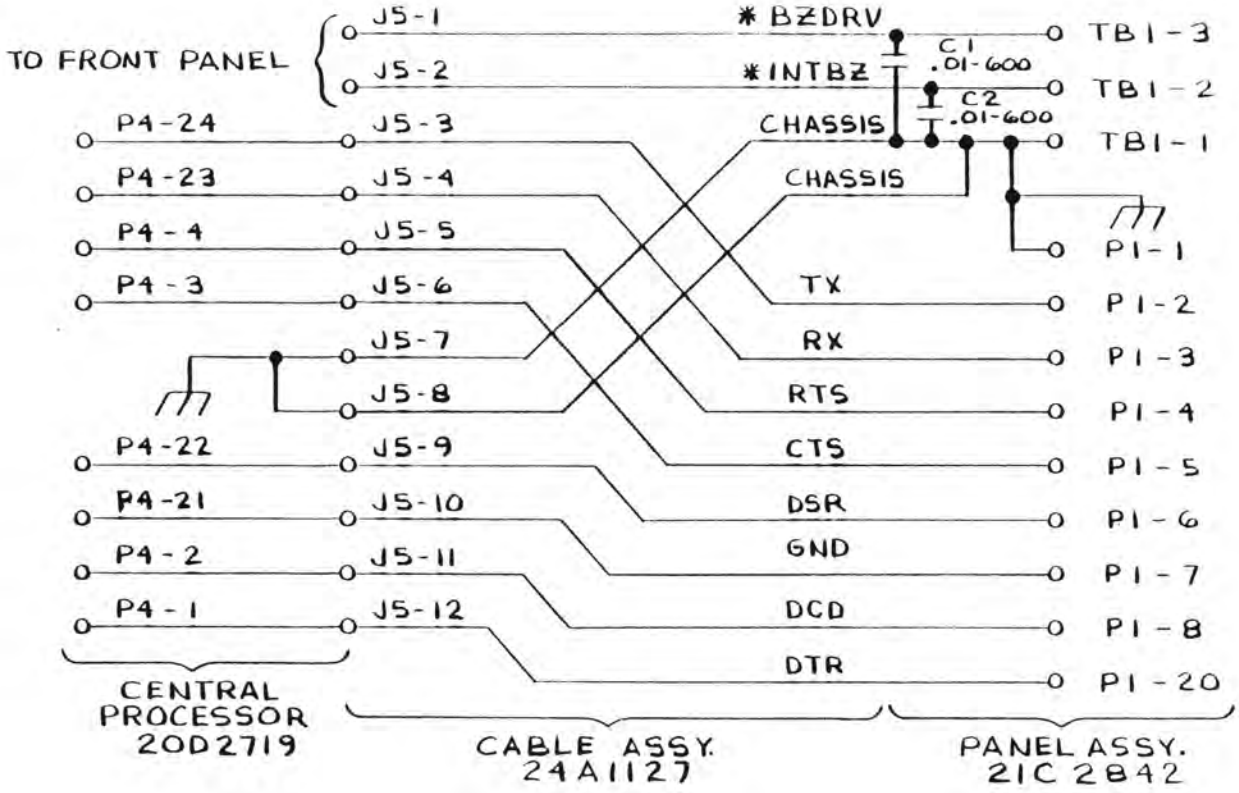
GOLETA, CALIFORNIA 93017

MRC-1600 RS-232 COMMUNICATIONS PARTS LIST

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

DWN			SCALE: Page 1 of 1
CHK			
ENG	[illegible]	9/21/84	27A1022 A



A	REL FOR PROD ECO 4E30	CH	21SEPT84		
REVISIONS			DATE		
DRAFT. APPR.					

MOSELEY ASSOCIATES, INC
SANTA BARBARA RESEARCH PARK
GOLETA CALIFORNIA 93117

SCHEMATIC, MRC-1600
RS-232 I/O

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

DWN	CAH	12 JUL 84	SCALE:
CHK	FCR	7-12-84	91A7369 A
ENG	[illegible]	19 JUL 84	

MRC-1600 RS-232 COMMUNICATIONS
I/O PARTS LIST
21C2842

Item No.	Quantity	Stock No.	Reference Des	Description
1	1	2063469		Panel MRC-1600 RS-232 I/O
2	1	3291127		Barrier Strip, 3 Pos w/Turret
3	2	1190214		Nut, Speed (for 310 Barstp Turret)
4	1	3050069		Conn. 25 Pin "D" Skt w/Sldr Pot Conn
5	2	1050145		Scr Bdrh Sltd 4/40 x 5/16 SS
6	1	1050798		Lug #4 Lkg Preformed
7	2	1050590		Nut Hex 4/40 1/4 Flats SST
8	2	4310173		Cap Disc Cer .01/500V
9	1	1050632		Wshr Lk #4 Sr Cd Pl
10	.250 Ft	1640424		W/Strd 22GA Green
11	.080 Ft	1560234		TBG Teflon 22 AWG Nat
12	1	3090313		Conn 12 Pin
13	12	3110553		Receptacles, High Pressure
14	13	1640333		CA FL 13 Strd

REVISIONS		DATE	MGMT. APPR.
A	REL FOR PROD ECO 1230	CH 21SEPT84	

MOSELEY ASSOCIATES, INC.
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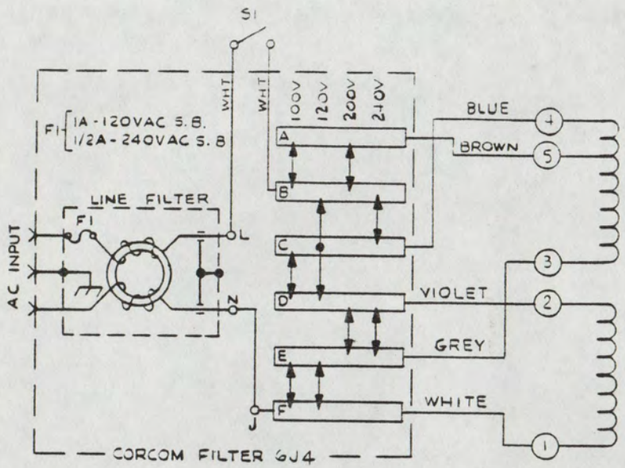
GOLETA, CALIFORNIA 93017

MRC-1600 RS-232 COMMUNICATIONS
I/O PARTS LIST

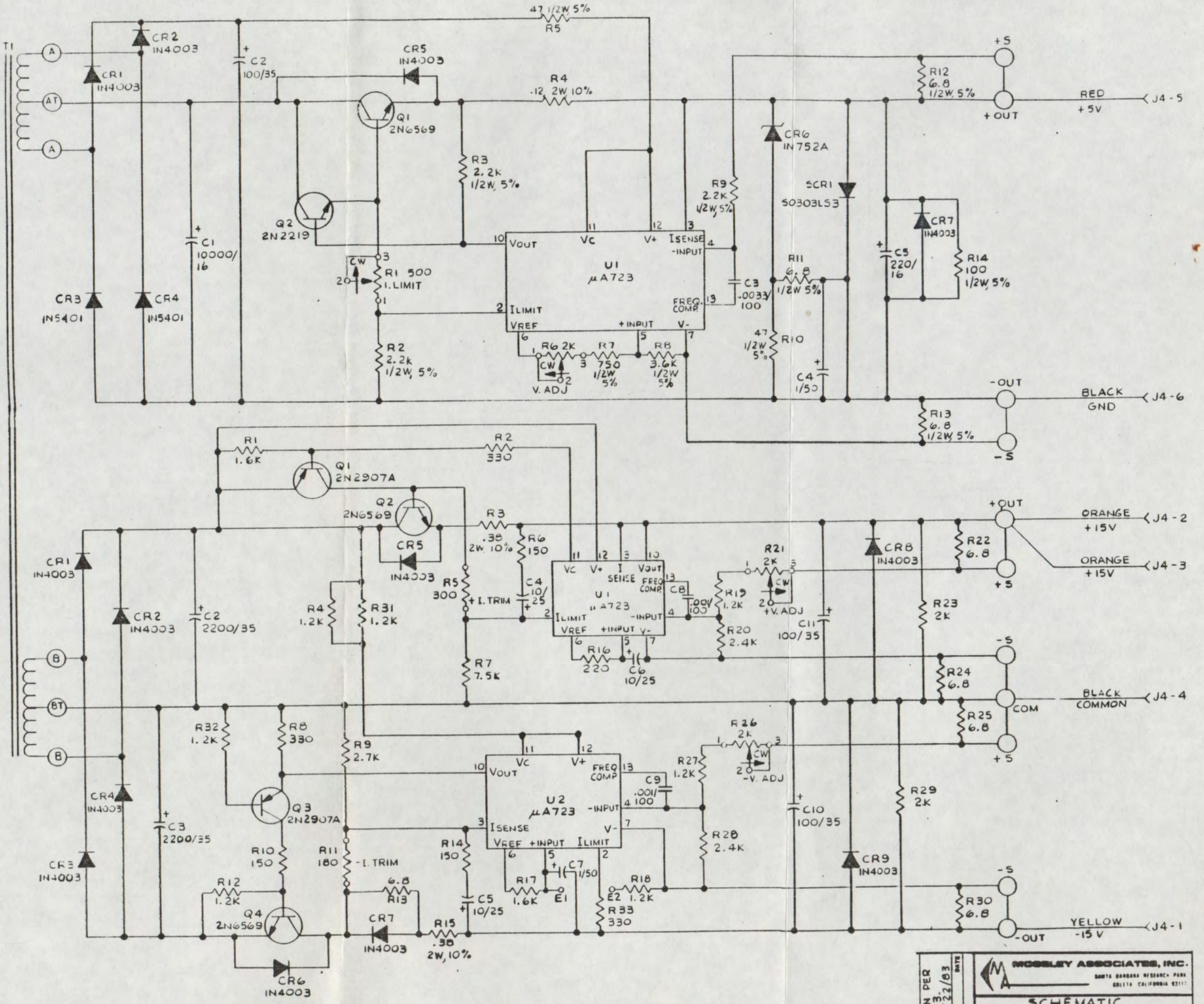
TOL: FRACT. ± 1/32, .XX ± .030, .XXX = .010, ∠ ± 1/2°

DWN			SCALE: Page 1 of 1
CHK			
ENG	SCK	8/1/84	27A1023 A



NOTES:

1. ALL RESISTORS ARE 1/4W, 5% UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS IN UF UNLESS OTHERWISE NOTED.
3. POWER SUPPLY IS MODEL HBAA-40W-A MADE BY POWER-ONE INC., CAMARILLO, CALIFORNIA.
4. CHASSIS ASSY. 2102799 (CORCOM), POWER SUPPLY ASSY. 2102800, HARNESS ASSY 29C1052.



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LTR	DESCRIPTION	DATE	APPR.
B	REDRAWN PER ECO 3913 S.J. 6/22/83		

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA CALIFORNIA 93117

SCHEMATIC
MRC-1600 POWER SUPPLY

TOL: FRACT. ± 1/32 .XX ± .010 .XXX ± .005 ∠ ± 1/2°

DRWN	S.J.	6/15/83
CHK	[illegible]	6-21-83
ENG	[illegible]	7-20-83

SCALE

91D7317 B

SECTION 6

ALIGNMENT PROCEDURES AND

GENERAL SYSTEM TROUBLESHOOTING
(34A1004C)

6.1 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.

6.2 EQUIPMENT REQUIRED

1 - Frequency Counter, Data Precision 7540 (or equivalent)
1 - Oscilloscope, 30 MHz
1 - Distortion Analyzer, Hewlett Packard 334A (or equivlalent)
1 - Signal Generator, Wavetek Model 136 (or equivalent)

6.3 DRAWINGS REQUIRED

Board to be Aligned	Schematic	Other
Telco Input	91C7304	
Telco Output	91C7305	
Subcarrier Input	91D7306	
Subcarrier Output	91D7307	15A1114
Subaudible Input	91D7308	
Subaudible Output	91D7309	
RS-232 Communications	91C7368	

6.4 ALIGNMENT PROCEDURES

6.4.1 Telco Input and Telco Output

Make sure the Telco Output board is of the same variety as the Telco Input board, i.e., both should either be "low" or "high".

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

Connect a frequency counter to TP1. Set S1 to test (position 3 ON, the remainder OFF).

With S1-4 OFF, adjust the LOW FREQ pot (R2) to obtain 2025 ± 5 Hz for the "hi" band (-2) or 1070 ± 5 Hz for the "lo" band (-1).

With S1-4 ON, adjust the HIGH FREQ pot (R7) to obtain 2225 ± 5 Hz for the "hi" band (-2) or 1270 ± 5 Hz for the "lo" band (-1). Disconnect the frequency counter.

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).

Return the Telco Output board to the operate mode (S1 positions 1 and 2 ON, the remainder OFF).

Telco Input

Connect a frequency counter to TP1. Set S1 to calibrate (positions 1 and 2 OFF, 3 ON). Adjust the VCO frequency (R5) to 2125 Hz for the "hi" band (-2) or 1170 Hz for the "lo" band (-1). Disconnect the frequency counter.

Connect an oscilloscope to RECEIVE DATA (U1-7). Set S1 to operate (positions 1 and 2 ON, 3 OFF). On the Telco Output board, set S1 to test (positions 1, 2, and 4 OFF, 3 and 5 ON). Carefully adjust the VCO (R5) on the Telco Input board to obtain a square wave.

Return both boards to the OPERATE mode (S1 positions 1 and 2 ON, the remainder OFF).

Troubleshooting the Telco Boards

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

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

Telco Output

Check the frequency dependent values for the modulator (see table on the schematic).

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

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).

If there is an FSK signal present on the output of the filter, then check the switch positions. 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).

6.4.2 Subcarrier Input and Subcarrier Output

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.

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

Connect a frequency counter to TP1. Set S1 to test (position 2 ON, the remainder OFF).

With S1-4 OFF, adjust the LOW FREQ pot (R2) to obtain 1070 ± 5 Hz. With S1-4 ON, adjust the HIGH FREQ pot (R9) to obtain 1270 ± 5 Hz. Disconnect the frequency counter.

Remove modulation applied to the subcarrier generator using the MODULATION ADJUST pot (R17).

Connect the frequency counter to the "RADIO OUT" BNC connector on the rear of the chassis. Adjust the subcarrier frequency using the COARSE FREQ (R8) and FINE FREQ (R7) pots. Disconnect the frequency counter.

Connect a distortion analyzer to the "RADIO OUT" BNC. 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.

Attach an oscilloscope to the "RADIO OUT" BNC. Refer to print 15A1114 while doing this step. Adjust the oscilloscope to display about six periods of the unmodulated subcarrier as shown in (A) on the drawing. Using the MODULATON ADJUST pot (R17), increase subcarrier modulation until the fifth crossover occurs midway as shown in (B) on the drawing.

Adjust the OUTPUT LEVEL pot (R21) to obtain 2.5 V p-p. Remove the oscilloscope.

Return the board to the operate mode (S1 positions 1 and 2 ON, the remainder OFF).

Subcarrier Input

Set the Subcarrier Output board to the test mode (S1 positions 3 and 5 ON, the remainder OFF). Connect the "RADIO OUT" BNC to the "RADIO IN" BNC. This applies a modulated subcarrier to the input of the Subcarrier Input board.

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.

Move the oscillscope 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.

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.

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.

Return both boards to the operate mode (S1 positions 1 and 2 ON, the remainder OFF).

Troubleshooting the Subcarrier Boards

Align the Subcarrier Output board before aligning the Subcarrier Input board.

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

Subcarrier Output

Check the frequency-dependent values of the subcarrier generator. (See the table on the schematic.)

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.

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.

Check for a subcarrier signal on the output of the subcarrier generator (U2-2). If it is not present, then the problem likely lies with U2.

Subcarrier Input

Verify the frequency-dependent values for the input filter.

If the filter output cannot be obtained, then one or more of the filter components is probably at fault.

If the FSK signal cannot be obtained properly, then the XR2211 subcarrier demodulator (U3) probably is at fault.

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.

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).

6.4.3. Subaudible Input and Subaudible Output

Subaudible Output

Connect a frequency counter to TP1. Set S1 to test (position 3 ON, the remainder OFF).

With S1-4 OFF, adjust the LOW FREQ pot (R3) to obtain 20.0 ± .1 Hz. If your frequency counter has it, it is usually easier to measure period rather than frequency. In this case, adjust the LOW FREQ pot (R3) to obtain 50,000 ± 50 µsec.

With S1-4 ON, adjust the HIGH FREQ pot (R9) to obtain 25.0 ± .1 Hz or 40,000 ± 50 µsec. Disconnect the frequency counter.

Connect an oscilloscope to the "RADIO OUT" terminal on the rear of the chassis. Adjust the OUTPUT LEVEL (R24) for 0 dBm (2.2 V p-p).

Return the Subaudible Output board to the operate mode (S1 positions 1 and 2 ON, 3 and 4 OFF).

Subaudible Input

Connect the "RADIO OUT" BNC to the "RADIO IN" BNC on the rear of the chassis.

Connect a frequency counter to TP1. Set S1 to calibrate (position3 ON, the remainder OFF). Adjust the VCO frequency (R13) to 22.5 ± .1 Hz or 44,444 ± 50 µsec. Disconnect the frequency counter.

Connect an oscilloscope to RECEIVE DATA (U1-7) Set S1 to operate (positions 1 and 2 ON, 3 OFF). On the Subaudible Output board, set S1 to test (position 3 ON, the remainder OFF). Connect a TTL compatible (0 - 5 Vdc) square wave to the input of the modulator (U2-9). Set the signal generator to 4.7 ± .1 Hz or 212750 ± 500 sec. Carefully adjust the VCO (R13) on the Subaudible Input board to obtain a square wave. Disconnect the oscilloscope and signal generator.

Return both boards to the operate mode (S1 positions 1 and 2 ON, the remainder OFF).

Troubleshooting the Subaudible Boards

Align the Subaudible Output board before aligning the Subaudible Input board.

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

Subaudible Output

Check for a signal at the output of the XR2206 modulator (U2-2). If no signal is present, the problem likely lies with the modulator.

If there is no signal present at the output of the filter (U1-6), then check the component values of the filter. If these are correct, then the problem probably lies with one of the op-amps (U1, U3, U4, or U7).

Subaudible Input

If there is a signal at the input of the filter and not at the output (U5-6), then check the component values of the filter. If these are okay, then one of the op-amps is probably bad (U2, U3, U4, or U5).

If there is an FSK signal present on the output of the filter, then check the switch positions. Also check the values of the components surrounding the demodulator (U1). If these are all correct, then suspect the XR2211 demodulator (U1).

6.4.4 RS-232 Communications

There is no alignment procedure for the RS-232 Communications Board; it either works or it doesn't. If, after checking the interconnecting cables, you feel the RS-232 board is at fault, it is strongly suggested that you do a straight module swap, i.e., replace the board with another RS-232 Communications Board. If repair of a known defective board is desired, the following troubleshooting procedure may be followed:

Troubleshooting the RS-232 Communications Board

Connect the two chassis together with the supplied null modem cable.

Verify +15, -15, and +5 are connected to the appropriate IC pins (see table on the schematic).

Verify that the DTR line (U3-8) is about +12 volts. If it isn't, verify that U3-9 and U3-10 are at 0 volts. Disconnect the interconnection cable between the two terminals and check the DTR line again. Depending upon results, either check the cable (or the other terminal) or IC U3.

Reconnect the two terminals. Check the *CTS line; it should be low. If it isn't, check U1-2 and U2-2; these should also be low. If they are, replace U2.

For the remaining gates, verify that all of them act as voltage level translators and inverters, i.e., a high on one input will yield a low on the corresponding output. If they don't, replace the corresponding chip.

If all gates appear to be functioning correctly, check the cable path from the CPU Board to the Communications I/O Board. If that checks out okay, check the interconnect cable or the "other" terminal.

6.5 GENERAL SYSTEM TROUBLESHOOTING

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

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

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

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 Centrol Processor boards.

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.

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).

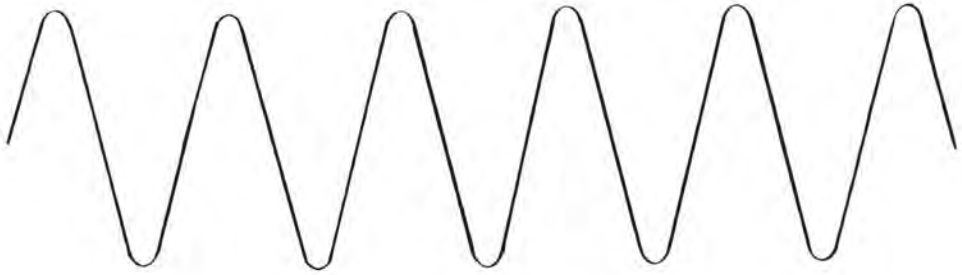
If your CRT/Logger option appears dead, check the interconnect cable between the MRC-1600 and the Control Terminal, the internal cable between the CRT RS-232 connector, the the relevant circuitry on the CPU Board. Also check the CRT/Logger option EPROM chips U5 and U17 and verify that they're installed correctly with no bent pins.

If the CRT/Logger option isn't dead, but the CRT displays trash, turn the CRT off and check the baud rate and parity switches. If problems persist, try replacing the CRT.

If the Logger prints trash occasionally, turn both the CRT and Logger off for about 10 seconds, then reapply power. If problems persist, contact Moseley's Customer Service Department in accordance with the procedure outlined in Section 3.

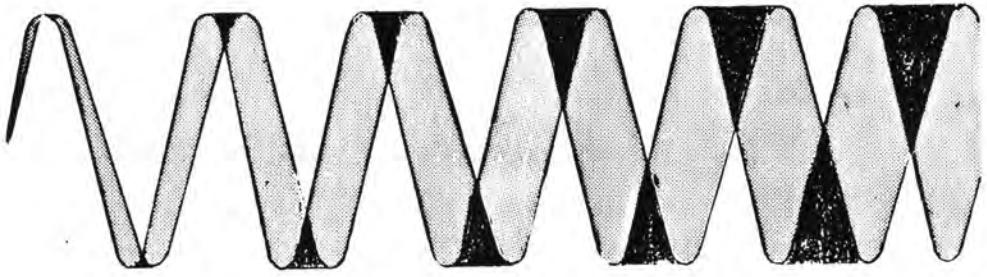
UNMODULATED SUBCARRIER

(A)



SUBCARRIER DEVIATED ± 5% OF CENTER FREQUENCY

(B)



NOTES:

1. USE INTERNALLY - DERIVED POSITIVE - SLOPE TRIGGERED SWEEP.
2. SET SWEEP TIME TO ACHIEVE TRACE "A".
3. SET GENERATOR DEVIATION TO ACHIEVE TRACE "B".

FIRST USED ON: MRC-1

REVISIONS	DATE	MOSELEY ASSOCIATES, INC. SANTA BARBARA RESEARCH PARK GOLETA, CALIFORNIA 93017	
A) RELEASED 9-7-79 JLC		STANDARD SUBCARRIER PATTERN	
		TOL: FRACT. ± 1/32, .XX ± .030, .XXX ± .010, ∠ ± 1/2°	
DWN D.T.W.	6 SEPT 79	SCALE:	
CHK JLC	9-7-79	15A1114	A7
ENG WLH	7 Sept 79		

RECOMMENDED SPARES
FOR MRC-1600

Quantity	Description	Stock No.
*	34A1002-1 MRC-1600 Module Spares	9051525
1	Telco Lo Input Module	9103433
1	Telco Lo Output Module	9103458
1	Telco Hi Input Module	9103441
1	Telco Hi Output Module	9103466
1	Subaudible Input Module	9103599
1	Subaudible Output Module	9103607
1	Subcarrier Input (@ 94/110 kHz) Module	9103516
1	Subcarrier Output (@ 94/110 kHz) Module	9103573
1	Central Processor Module	9204934
1	Front Panel Module	9204470
1	Analog/Command/Status Module	9204496
1	External Relay Module	9204504
1	Communications I/O Module	9204710
1	Power Supply	9103722
*	34A1002-2 MRC-1600 Parts Spares	9051533
1	6809 Microprocessor	3661048
1	6821 PIA	3710027
1	6850 ACIA	3710043
1	74LS00 Quad 2-Input Nand	3660669
1	74LS08 Quad 2-Input And	3660693
2	74LS32 Quad 2-Input OR	3660958
1	74LS74A Dual D-Type Flip-Flop	3661063
1	74LS123 Dual Retrig. One-Shot	3660768
3	74LS138 3-to-8 Line Decoder	3660792
1	74LS139 Dual 2-to-4 Line Decoder	3660800
1	74LS163 Sync. 4-Bit Binary Counter	3660826

REVISIONS	DATE	MGMT. APPR.
D CHGS. ECO 4022 10JAN 84 CH		
C ADD ICL 7660 ON PAGE 2. ECO 3978 2 SEPT 83 CH		
B SEPARATE DWG INTO -1, -2 ECO 3802 29 APR 83 CH		
A REL. FOR PROD. ECO 3757 21JAN 83 CH		

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

RECOMMENDED SPARES/MRC-1600

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

DWN | CHK | ENG

SCALE: Page 1 of 2

34A1002 | D

Quantity	Description	Stock No.
4	74LS244 Octal Bus Driver	3660859
1	74LS245 Octal Bus Transceiver	3661162
2	74LS259 8-Bit Addressable Latches	3661170
2	74273 Octal D-Type Flip-Flop	3661006
1	74LS273 Octal D-Type Flip-Flop	3661188
1	ICL7660 Voltage Converter (+5 V to -5 V)	3680287
1	CD4040 12-Stage Binary Counter	3680063
3	ULN2003 Relay Driver	3731007
1	XR2206 FSK Modulator	3730819
1	XR2211 FSK Demodulator	3730827
1	DL2416 Quad 17 Seg. Display	3690054
1	LM308 Op-Amp	3730157
1	LM339 Quad Comparator	3730207
1	74741 Op-Amp	3660008
2	TL072 Dual FET-Input Op-Amp	3730876
1	LM3999 Precision Reference	3650249
1	ICL7109 Analog/Digital Conv.	3730629
2	MC14051 8-to-1 Analog Mux	3680139
2	2N2924 NPN Transistor	3630027
1	1N914 Switching Diode	3600053
5	FLV-160 Red LED	3390127
2	MV-5354 Yel LED	3390143
1	HLMP-3507 Grn LED	3390614
2	IN4745 16V Zener Diode	3600236
2	Varistor GE V-120-MAIA 120V	4590170
8	Relay Arrow-M HAI DC 12V	3270162
1	TMS4016 2K - 8 RAM	3710639
1	MC1488 Line Driver	3730355
1	MC1489 Line Receiver	3730363
1	X2816A 2K x 8 EEROM	3710647
1	RC4136 Quad Op-Amp	3730462

REVISIONS	DATE	MGMT. APPR.
D CHG: ECO 4022 10JAN84	CH	
C ADD ICL 7660 ON PAGE 2 ECO2718 2SEPT83	CH	
B CHANGE: SEE SHEET 1 ECO 3862 29APR83	CH	
A Rel For Prod ECO 3757 21JAN82	CH	

MOSELEY ASSOCIATES, INC.
SANTA BARBARA RESEARCH PARK
GOLETA, CALIFORNIA 93117

RECOMMENDED SPARES/MRC-1600

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

DWN | CHK | ENG

SCALE: Page 2 of 2

34A1002 D

ITEM NUMBER: 9051533 **** MRC-1600 SPARE PARTS (IC) PAGE 1

MOSELEY ASSOCIATES, INC.
111 CASTILIAN DRIVE
GOLETA, CA. 93117
(805) 968-9621

KIT NUMBER: SP-62 DATE 8/02/84

COMPONENT ITEM NO.	MANUFACTURER PART NUMBER	QTY PER	UNIT PRICE	EXTENDED PRICE
3270162	HAI DC12V RELAY	8	4.93	39.43
3390127	FLV160 LED RED 2.0@20 WIDE DIFFUSED	5	.32	1.58
3390143	MV-5354 LED YEL 10.@20 NARROW DIFFUSED	2	1.02	2.03
3390614	HLMP-3507 LED GRN 9.0@20 NARROW DIFFUSED	1	1.19	1.19
3600053	1N914 DIO 1N914 75V 75MA SI A398	1	.16	.16
3600236	1N4745A DIO Z1N4745A 16V 1W 5% AIAY	2	.27	.55
3630027	2N2924-LF5 XT NS2N2924LFS.2W160M025V.1A7P	2	.56	1.12
3650249	LM-3999Z RGLTR LM3999Z 6.9V TO92	1	3.50	3.50
3660008	UA741CP IC UA741P OPAMP GEN COMP	1	.74	.74
3660669	SN74LS00N IC SN74LS00N QU 2IN NAND	1	.75	.75
3660693	SN74LS08N IC SN74LS08N QU 2IN AND	1	1.80	1.80
3660768	SN74LS123N IC SN74LS123N DURETRMONOMULTI	1	2.59	2.59
3660792	SN74LS138N IC SN74LS138N 3-8LINEDECDEMUX	3	1.51	4.54
3660800	SN74LS139N IC SN74LS139N DU2-4LNDECDEMUX	1	1.11	1.11
3660826	SN74LS163AN IC SN74LS163AN BINCOUNT PRESET	1	2.03	2.03
3660859	SN74LS244N IC SN74LS244N OCT BUS/DRIV ST	4	1.19	4.76
3660958	SN74LS32N IC SN74LS32 QUAD 2-INPUT NOR	2	.50	.99
3661006	SN74273 IC SN74273 OCTAL FLIP-FLOP	2	4.38	8.75
3661048	MC6809P IC MC6809P MPU	1	29.89	29.89
3661063	SN74LS74AN IC SN74LS74N DUAL D FLIP FLOP	1	1.48	1.48
3661162	SN74LS245N IC SN74LS245N OCT BUS TRNCVR	1	3.06	3.06
3661170	SN74LS259N IC SN74LS259N OCTAL ADDR LATCH	2	2.23	4.46
3661188	SN74LS273N IC SN74LS273 OCT LATCH	1	2.72	2.72
3680063	CD4040BE IC CD4040BE 12 STAGE BIN CT	1	1.98	1.98

MOSELEY ASSOCIATES, INC.
111 CASTILIAN DRIVE
GOLETA, CA. 93117
(805) 968-9621

KIT NUMBER: SP-62 DATE 8/02/84

COMPONENT ITEM NO.	MANUFACTURER PART NUMBER	QTY PER	UNIT PRICE	EXTENDED PRICE
3680139	MC14051P IC MC14051P 8CH MUX R280 7V	2	1.52	3.03
3680287	ICL7660CPA IC VOLTAGE CONVERTER(+5 TO -5)	1	6.90	6.90
3690054	DL-2416 DISPLAY, 17-SEC. 4-DIGIT RED	1	71.05	71.05
3710027	MC6821P IC MC6821P PIA INTERFACE	1	7.14	7.14
3710043	MC6850P IC MC6850P ACIA INTERFACE	1	8.01	8.01
3710639	TMS4016-25NL IC 2K BY 8 STATIC RAM	1	38.22	38.22
3730157	LM-308AN IC LM308AN OPAMP PRECISION	1	4.70	4.70
3730207	LM-339N IC LM339N COMPARITOR QUAD	1	1.49	1.49
3730355	MC1488L IC MC1488L QU LINE DRIVER	1	2.38	2.38
3730363	MC1489L IC MC1489L QU LINE RECEIVER	1	2.24	2.24
3730462	RC4136N IC RC4136N OPAMP QUAD 741	1	1.52	1.52
3730629	ICL7109CPL IC ICL7109CPL A-D CONV 12BITS	1	33.96	33.96
3730819	XR-2206CP IC XR-2206CP VCO WAVE GEN	3	9.60	28.80
3730827	XR-2211CP IC XR-2211CP FSK MODEM	1	9.80	9.80
3730876	TL072A IC DUAL OP-AMP	2	1.54	3.08
3731007	ULN2003AN IC 7-DARLINGTON ARRAY HI-V,A	3	1.29	3.87
4590170	V-120-MA1A VARISTOR	2	2.22	4.45

** TOTAL EXTENDED PRICE: 351.85 **