instruction book

model 800 specialty mode terminal

ROBOT

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INSTRUCTION BOOK MODEL 800 SPECIALTY MODE TERMINAL

SECTION ONE
INTRODUCTION

The ROBOT Model 800 is a complete communications terminal for sending and receiving Baudot, ASCII and Morse Code. In addition, the Model 800 generates alphanumeric character displays for use in Slow Scan Television, and transmits this information in the amateur SSTV format. The Model 800 is a microprocessor based system utilizing the 8085 Microprocessor, 6144 bytes of ROM, and 2560 bytes of RAM. An intel 8251 USART is used for serial I/O and intel 8155's are used for parallel I/O and keyboard interface.

The Model 800 can be interfaced directly to the audio input and output jacks of communications equipment. It has a built-in terminal unit for demodulation of incoming Morse and RTTY signals as well as an audio frequency shift keyer for transmission. A standard closed circuit television monitor is used for the display and is connected directly to the Model 800 Terminal.

SPECIFICATIONS

INPUT/OUTPUT— ELECTRICAL CHARACTERISTICS

AUDIO INPUT-20 millivolts to 3 volts; 600 ohm impedance.

AUDIO OUTPUT-0 to 2 volts adjustable; 600 ohm impedance.

VIDEO OUTPUT-Standard TV video signal 1.4 volts p-p white positive into 75 ohms, compatible with standard 525 line CCTV monitor (625 lines in 50 Hz countries).

TTY LOOP KEYER OUTPUT-Transistor switched current loop keyer.

CW KEYER OUTPUT-Transistor switched to ground for cathode or grid-block keying.

PTT OUTPUT-PTT line switched to ground during transmit.

SCOPE OUTPUTS-Separate discriminator outputs for oscilloscope monitoring.

INPUT/OUTPUT— SIGNAL CHARACTERISTICS

BAUDOT-7.5 unit code (1 start, 5 data, 1.5 stop) A-Z, 0 to 9, ! " # $ & ' ( ) - : BELL ; , 1 ? / ; CR, LF, LTRS, FIGS, SPEEDS: 60, 66, 75, 100, 132 WPM.

ASCII-110 Baud, 11 unit code (1 start, 8 data, 2 stop) A-Z Upper and Lower case, 0 to 9, ! " # $ % & ' ( ) * = - ' @ BELL + ; [ ] <>, . ? /.

TONE FREQUENCIES-IARU Low Tone Pairs, Model 800 170Hz Shift-1275Hz Mark, 1445Hz Space 850Hz Shift-1275Hz Mark, 2125Hz Space.
High Tone Pairs, Model 800H
170Hz Shift-2125Hz Mark, 2295Hz Space, 850Hz Shift-2125Hz Mark, 2975Hz Space.
(See Page 7-2)

MORSE-International Morse Code, A-Z, 0 to 9, ., ? : ; - /, AR, AS, BT, KN, SK.

SSTV OUTPUT-Crystal controlled SSTV Audio-FM 1200 Hz Sync, 1500 Hz Black, 2300 Hz White, 3.0 volts p-p (adjustable) into 600 ohm load. Horizontal sync 6 ms., vertical sync 66 ms.
Notice: The Model 800 does not receive SSTV pictures. An SSTV Scan Converter such as the Robot Model 400 is required for this purpose.

TRANSMIT MODES

BAUDOT, MORSE, ASCII

Continuous-Transmits each character as it is entered on the keyboard.
Word-Transmits whole word when space bar is depressed.
Line-Transmits entire line when complete.
Editing-Delete key causes backspace and erases previous character.
Tune-Locks CW Keyer Output for transmitter tuning.
Transmit Text Buffer-511 characters.
Automatic CR, LF-Prevents splitting of words at the end of each line.

SSTV

Display-Real time display of transmitted text. 36 or 18 characters (6 lines of 6 characters or 3 lines of 6 characters).
Cursors-"Winking" cursor indicates the next character position. Line cursor indicates which portion of the display is being transmitted.
Editing-Cursor controls include up, down, left, right and home to top of screen. CLEAR function causes the entire display to be erased and "homes" cursor.
Fractional Frame-LINES function changes the number of character lines transmitted. Operator may select from 1 to all 6 lines.
Reverse-Causes display to change from normal black on white to white on black.
Test Patterns-6 bar gray scale and checkerboard.

PROGRAMMABLE FEATURES

WRU-8 character programmable WRU code. The Model 800 responds to valid code by transmitting one of its HERE IS messages.

SELCAL-8 character programmable SELCAL Code. The Model 800 responds to receipt of valid code by copying the message immediately following the code into display memory.

HERE IS-2 programmable 64 character HERE IS message memories.

ID-Programmable 8 character ID memory.

AUTOMATIC CQ-A CQ message can be accessed which automatically inserts your call letters from the programmable ID memory.

OTHER FEATURES

DISPLAY-72 characters per line; 11 lines received text, 11 lines transmit text (split screen mode); 24 lines total (full screen mode): 5 x 7 dot matrix (except in SSTV mode).

UNSHIFT ON SPACE-Automatically returns terminal to letters mode when space is sent or received.

KEYBOARD TRANSMITTER CONTROL-Complete transmit control via PTT line.

SIDE TONE OSCILLATOR-Audible side tone oscillator can be enabled for code monitoring. Volume is adjustable via rear panel control.

MORSE TRAINER-Automatically sends random 5 letter groups at selected speeds (1-99) WPM.

ON SCREEN STATUS INDICATOR-Status line shows all operational modes, shifts, and data rates which are in effect.

ON SCREEN TUNING INDICATOR-"Plus-Plus" type, displayed as a moving bar in the status line. Displays relative outputs of the discriminator filters.

MORSE AUTO TRACK-Tracking of received Morse code is totally automatic over the entire range of 4 to 99 WPM.

TEST MESSAGES-RY and "Quick Brown Fox" test messages.

DEMODULATOR

DUAL TWO-TONE ACTIVE FILTER DISCRIMINATOR

SHIFT FREQUENCIES-170 Hz, 850 Hz.

AUTO START RESPONSE TIME: 2 seconds.

AUDIO FREQUENCY SHIFT KEYER

TYPE-Phase coherent crystal controlled.

DISTORTION-All harmonics below the 15th are 50 db down.

STABILITY-Crystal controlled to plus or minus .025%.

CONNECTORS AND CONTROLS

KEYBOARD-55 key alphanumeric array, two-shot molded keytops, matte grey finish, tilted keys.

CAPS LOCK-Key is alternate action.

TO MONITOR-Is a BNC video output connector for connection of fast scan monitor display.

TTY LOOP-Is a phono connector for connection of peripheral TTY equipment to the loop keyer output.

SCOPE MARK-and SCOPE SPACE are phono connectors for connection of an oscilliscope display to the discriminator outputs.

FROM RCVR-Is a phono connector for inputing audio to the Model 800 from the station receiver audio output or from the Model 400 SSTV Converter.

AUX OUT-Is a phono connector auxiliary output jack for connection to an audio tape recorder or the Model 400 SSTV Scan Converter.

TO XMTR-Is a three conductor ¼-inch jack. One conductor is used for the push to talk line which is grounded during transmit. The other two conductors are for audio and ground.

OUTPUT LEVEL-Is a control which sets the audio output level between 0 and 2 volts.

TO CW KEY-Is a ¼-inch three conductor jack for connection to the transmitter CW key input.

SIDE TONE-Is a control which sets the volume level of the audible side tone oscillator.

OTHER CHARACTERISTICS

POWER INPUT-Line voltage range is 105 to 125 volts AC or 210 to 250 volts AC (specify) and 50 or 60 Hz (specify). Power consumption is 10 watts.

MECHANICAL-Width: 15.5 inches; Depth: 10.25 inches; Height: 4 inches.

WEIGHT-10 pounds.

CONSTRUCTION-All solid state circuits on glass epoxy circuit boards. Two tone grey, all aluminum cabinet.

SECTION TWO
INSTALLATION

2.1 UNPACKING

Remove the Model 800 from the carton and remove the protective cover and packing material. If visible evidence of damage is observed, save the box and packing material and notify the transportation company. Check the keys and power switch for freedom of action (Note: The CAPS LOCK key is alternate action). Check the equipment included with the Model 800 against the following packing list:

MODEL 800 PACKING LIST

ITEM	QUANTITY
Model 800 Keyboard	1
6 Foot Shielded Cable with RCA Phono Plugs on each end	1
6 Foot Coax Cable with BNC Plugs on each end	1
6 Foot Three Conductor Shielded Cable with Phone Plug on one end	2
Instruction Manual	1

Locate the Instruction Manual Dividers and insert them in the proper places in your manual. Pages are numbered by section. For example, page 2-1 is the first page of Section Two. The divider marked INSTALLATION should be inserted in front of this page.

2.2 CONNECTING TO RECEIVE

To connect the Model 800 to the station receiver, use the RCA phono plug patch cable furnished, and connect the cable to the rear panel jack marked FROM RCVR. Connect the other end of the cable to the receiver speaker voice coil or 500 ohm output. Using the six foot coax cable with BNC plugs, connect one end to the CCTV monitor video input and the other to the TO MONITOR video output connector on the rear panel of the Model 800.

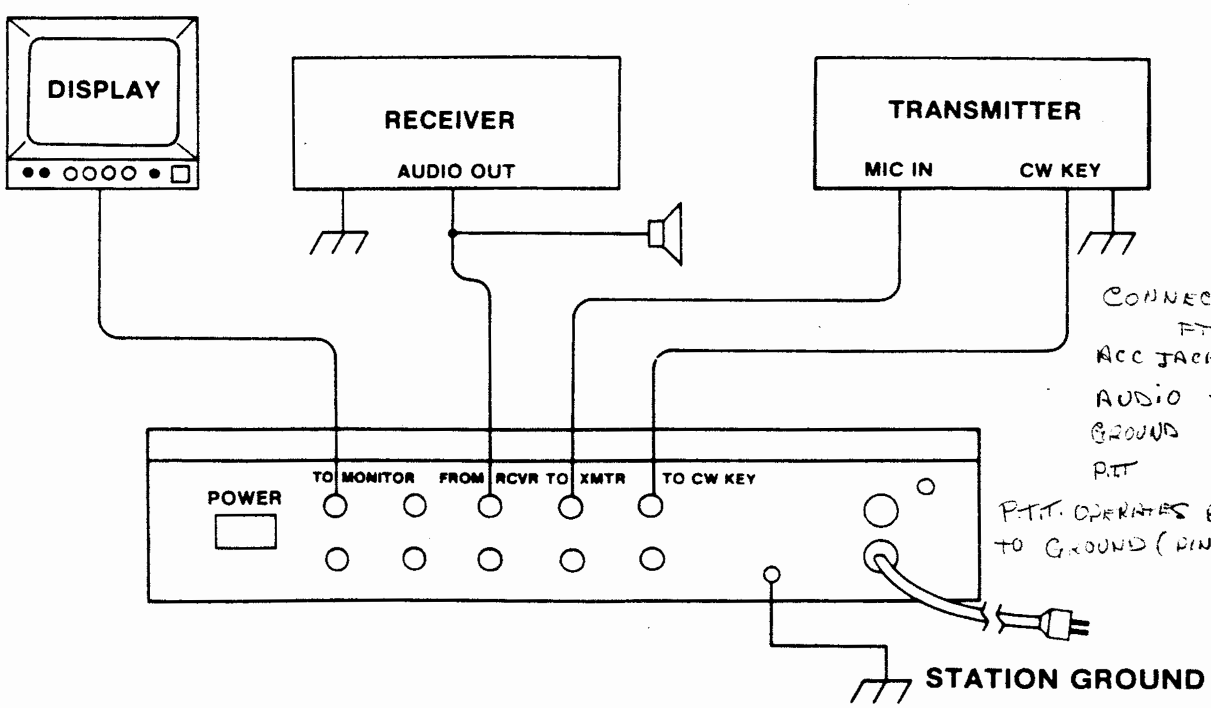
2.3 CONNECTING TO TRANSMIT

Connect the Model 800 for transmitting as follows: The three conductor shielded cables are terminated on one end with a three wire, quarter inch phone plug. Attach a connector which will mate with the microphone input jack on your transmitter to the free end of one of these cables. Connections are made as indicated in the table below. Using this cable, connect the jack marked TO XMTR on the Model 800 rear panel to the microphone input of the station radio transmitter.

MICROPHONE CABLE WIRING

Color	Function
White	Audio — PIN 1
Shield	Audio (Return)
Red	Push-To-Talk PIN 2
Black*	Push-To-Talk (Return) PLUG SHIELD

* The black wire connects with the shield to transmitter ground.



CONNECTION TO
FT-707
ACC JACK.
AUDIO - TO PIN 7
GROUND TO PIN 3
P.T.T. TO PIN 4
P.T.T. OPERATES BY PIN 4
TO GROUND (PIN 3)

FIG. 2-1. STATION INTERCONNECTION FOR RTTY AND MORSE CODE.

The other three conductor shielded cable is used for CW operation. There are two main types of CW keying used in amateur transmitting equipment. These are grid-block keying and cathode keying. Determine which type is used on your equipment. Attach a connector which will mate with the CW key input on your transmitter to the free end of this cable according to the table below (see Fig. 2-2). Using this cable, connect the jack marked TO CW KEY on the Model 800 rear panel to the CW key input on the transmitter.

CW KEY CABLE WIRING
Transmitter Connections

Color	Grid Block Keying	Cathode Keying
White	Ground	Keying Input
Red	Keying Input	Ground
Black & Shield	Ground	Ground

2.4 CONNECTING TO AN EXTERNAL OSCILLOSCOPE

Mark and space discriminator outputs are available on the rear panel to provide an additional tuning indicator, if desired. Connect the SCOPE MARK jack to the horizontal axis input of an oscilloscope and the SCOPE SPACE jack to the vertical axis input. Output impedance is 1000 ohms, approximate signal amplitude is 6 volts.

2.5 CONNECTING TO EXTERNAL TTY LOOP

A TTY Loop Output is available on the rear panel of the Model 800. A transistor is switched to ground for keying the loop. The TTY LOOP output is connected in series with a standard loop supply (60 ma, 150V typical) and loop sensing devices such as a hard copy printer. Connect the (-) side of the loop supply to the grounded side of the TTY LOOP jack. The (+) side of the supply is connected through the printer to the Model 800 (see Fig. 2-4).

2.6 INTERFACING WITH A MODEL 400 SSTV SCAN CONVERTER

If the Model 800 is to be used in conjunction with the Model 400 SSTV Scan Converter, connect a patch cord between the AUX OUT jack on the rear panel of the Model 800 and the FROM OTHER jack on the rear panel of the Model 400 (See Fig. 2-3). Transmission through the Model 400 may be accomplished by selecting the OTHER position on the TRANSMIT SELECT switch on the Model 400. The TO XMTR jack on the Model 800 need not be used. This means that the transmitter would have to be keyed manually or by VOX, as the PTT line is not connected. All other station connections are the same.

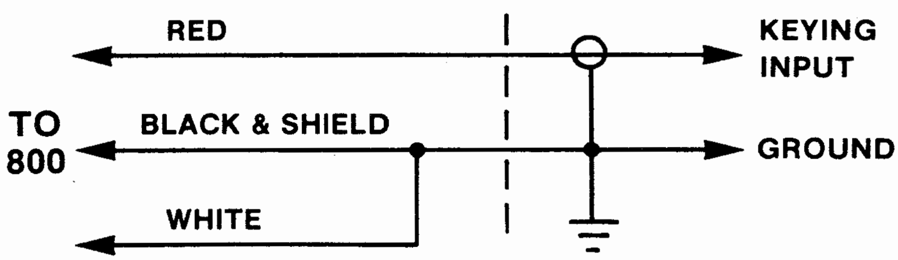


FIG. 2-2A. WIRING FOR GROUNDED GRID KEYING OR NEGATIVE VOLTAGE KEYING.

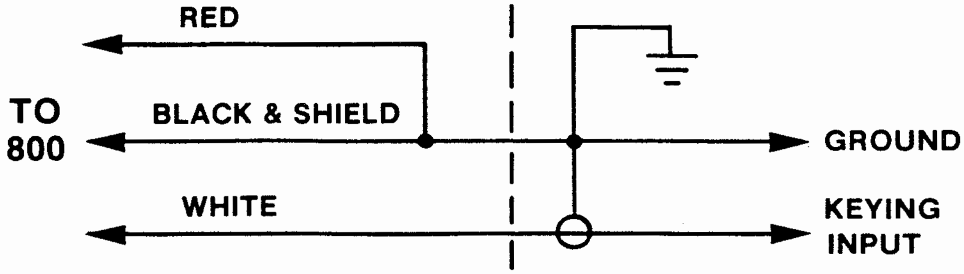


FIG. 2-2B. WIRING FOR CATHODE KEYING OR POSITIVE VOLTAGE KEYING.

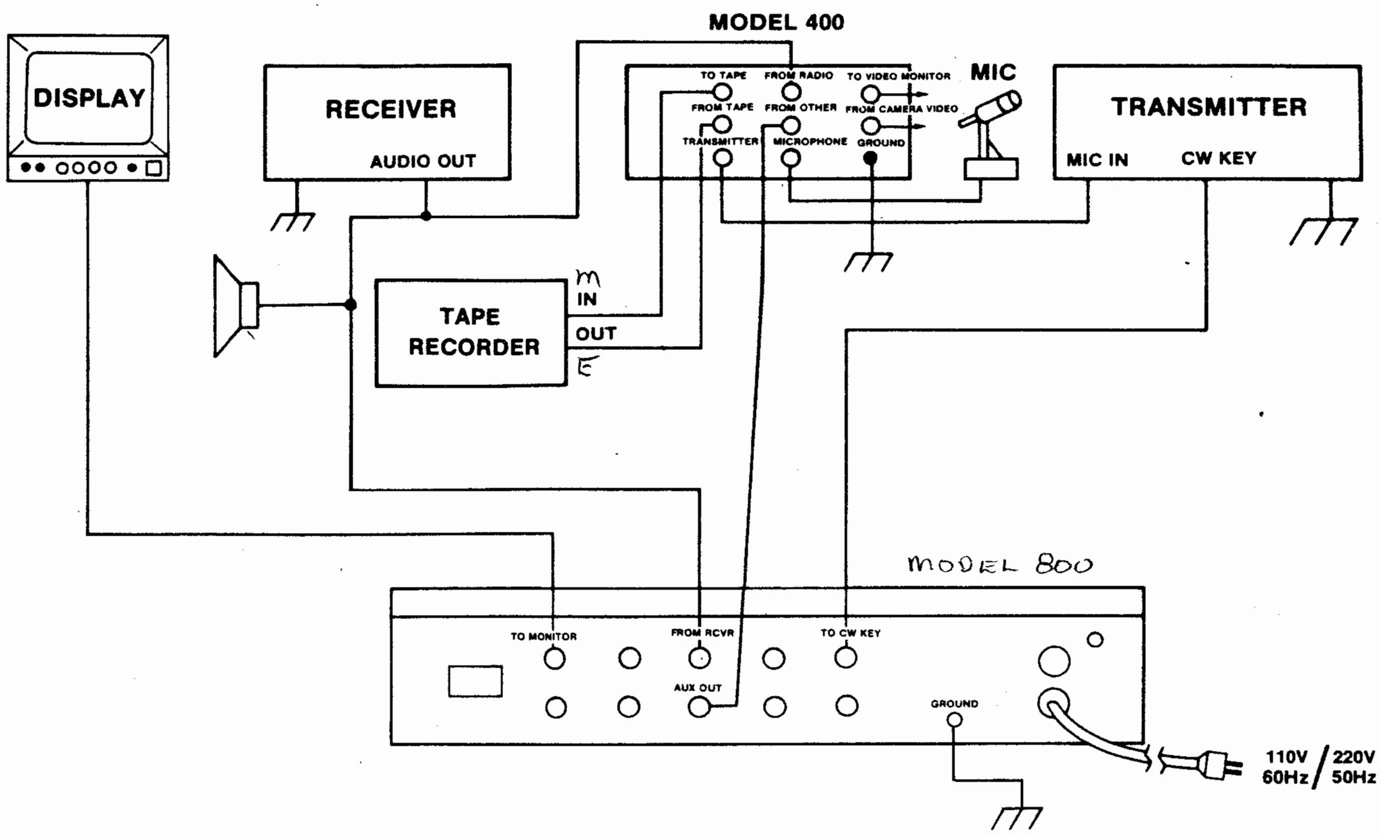


FIG. 2-3. STATION INTERCONNECTION FOR ALL MODES (WITH ROBOT MODEL 400).

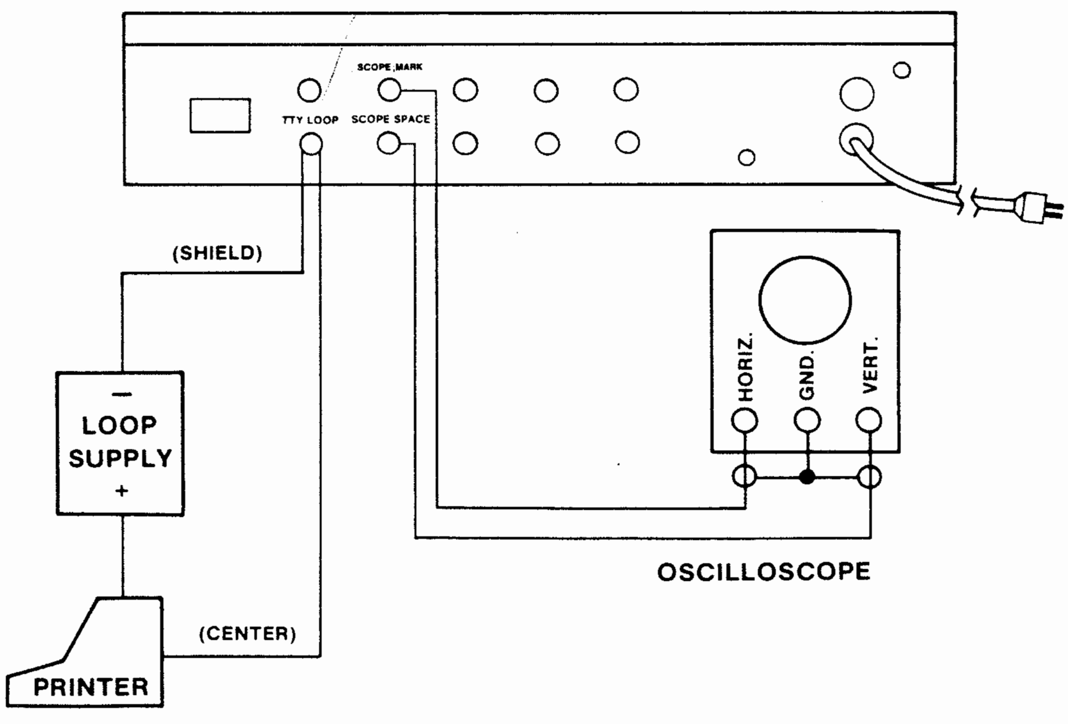


FIG. 2-4. INTERCONNECTION WITH OSCILLOSCOPE DISPLAY AND EXTERNAL TTY LOOP.

SECTION THREE
GET ON THE AIR!

3.1 INTRODUCTION

This section of the instruction manual is designed to give you immediate "hands-on" experience with your new Model 800 Terminal. This section covers only those operating procedures necessary to have your first QSO on RTTY and machine CW. It does not cover any of the more advanced operating features and procedures. These will be covered in Sections Four and Five and should be referred to after you are familiar with your Model 800 and its basic operating procedures. SSTV operation is described in Section Six. Before getting started, some terms will need to be defined.

Throughout this manual operating procedures will be described by naming certain keys which are to be pressed. A given key can have as many as three different functions. Its basic function is that which occurs when the key itself is pressed. A SHIFT function is that which occurs when the SHIFT key is first pushed and held when the object key is pressed. For example, the basic function of the upper left hand key on the Model 800 Keyboard is to print a 1. The SHIFT function of this same key is to print !. In addition, this key also has a third function called its *control* function. A control function is enabled by holding the CTRL key down when the object key is pressed. In our example, this would cause the keyboard to go into the RTTY mode. Almost all of the control functions in the Model 800 are associated with the top row of keys. These keys have silk screened labels above them to identify the control function. The functions which are described in the top line of silk screening are those functions used in the SSTV mode. The functions which are described in the bottom line of silk screening are those used when in the RTTY or Morse Code modes. In this manual, these control function keys will be referred to by the silk screen name, rather than the name on the key itself. In other words, to put the unit into the RTTY mode, we would instruct you to type: CTRL-RTTY, rather than CTRL-1. A few of the control functions are "hidden," that is, they are associated with unlabeled keys. These functions will be described in the next section.

3.2 RTTY OPERATION

When the power is first applied to the Model 800, it "wakes up" in the RTTY, split screen mode. A status line at the top of the screen indicates which combination of modes are active. It should read: RECEIVE BAUDOT 60 WPM 170Hz SHIFT BUFF = 000. This means that the terminal is now ready to receive RTTY at 60 WPM with normal polarity narrow shift. This is the most commonly used mode in amateur RTTY. Switch your radio onto lower sideband and tune in on an RTTY signal. Tune the receiver for maximum length and minimum flicker of the tuning indicator bar on the status line. Your terminal should now be printing copy on the display monitor. If it does not, it is possible that the station you have selected is using a different shift, speed, or is

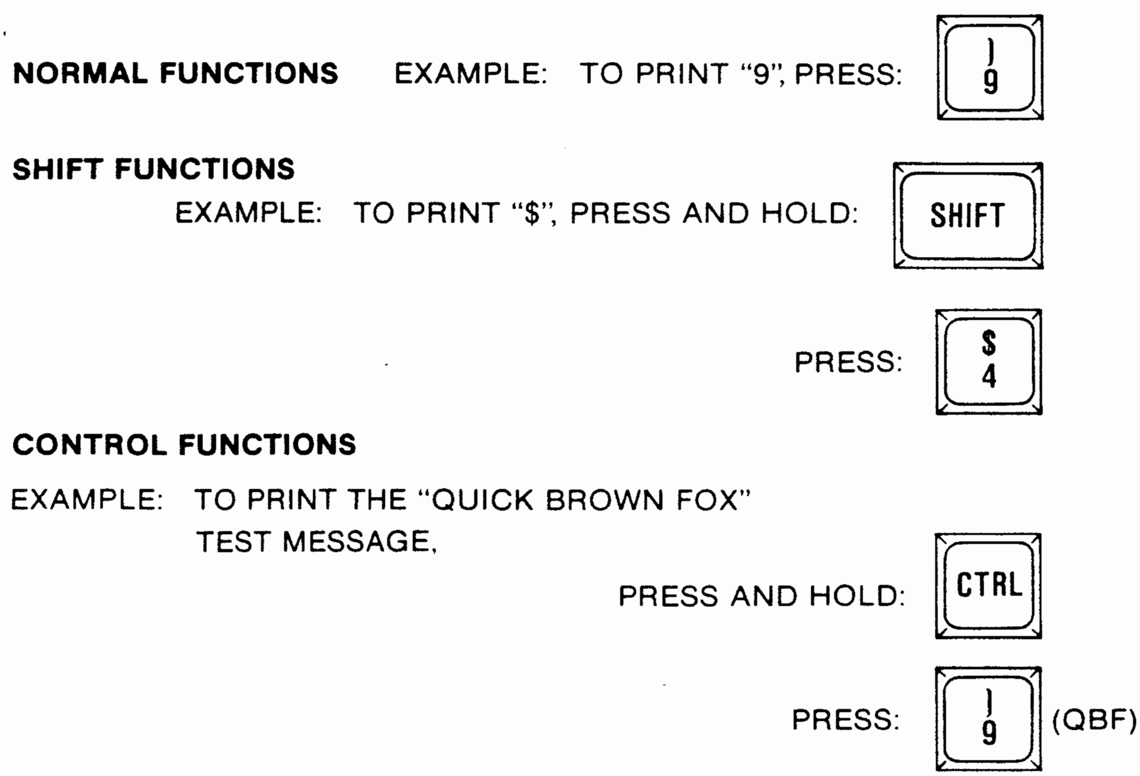


FIG. 3-1. KEY FUNCTIONS.

transmitting with reverse polarity. If you do not find a station which you can copy, refer to Section Four for the procedures to change these settings.

Before making your first transmission, you should program your call letters into the ID memory. To do this, type: CTRL-I; followed by your call letters; followed by RETURN. The FCC requires that you identify your station by CW at the beginning and end of each transmission, and at least once every 10 minutes. To do this, type: CTRL-ID. The Model 800 will transmit your call in 100Hz shift CW and will also communicate your call via the sidetone oscillator.

The Model 800 is equipped with the "split screen feature". This feature allows you to compose your message, and "load" the memory (displayed on the bottom half of the display screen) while simultaneously receiving text from another station (displayed on the top half). This can be disabled by typing CTRL-/ (fraction bar), to allow received text to be shown on the entire screen. To return to split screen operation, type CTRL-/ again. Typing on the keyboard displays the transmit text on the lower half of the screen. The position cursor (small line) shows the position of the next character to be displayed. The "white box" to the lower left of the screen is the moving transmit cursor. This cursor shows the next character to be transmitted at any given time. To send the transmit text, type ESC (which toggles the keyboard into the transmit mode). Then hit the space bar (or any key), and text is sent at selected speed. The "white box" transmit cursor moves along the lines of stored text as each character is sent. You may continue to type in and load the buffer memory at this point, as the buffer operates on a first in, first out basis. This allows you to type several lines ahead.

The buffer counter is displayed at the right side of the status line. This feature shows the number of characters contained in the buffer memory. This will show when you are approaching the "full buffer" condition. When the buffer is full (511 characters), the side tone oscillator will "beep" and the unit will not accept any further characters.

On your first transmission, you may wish to utilize the automatic CQ function. By typing CTRL-C, a string of CQs is sent with your call letters, taken from the ID memory, automatically inserted. This may be preloaded into the buffer memory before transmission has begun. In the RTTY mode, the CQ format is a line of CQs with your call inserted in the center. In the CW mode, this is done in the standard 3 x 3 format.

3.3 MORSE CODE OPERATION

Now that you have your "feet wet" on RTTY, you are probably anxious to try your new terminal on machine Morse Code. Operation is much the same in this mode as it is in RTTY. To put the terminal into the Morse Code mode type: CTRL-MORSE. Set the receiver AGC on SLOW. Tune your receiver in on a CW station, adjusting for maximum indication on the tuning bar. Keep in mind that being a machine, the Model 800 requires that there be a certain minimum accuracy in the code it receives for accurate reproduction. The Model 800 automatically tracks the incoming code speed and reads this on the status line.

Unless otherwise instructed, the transmit speed in the Morse Code mode is 13 wpm. To change this, type: CTRL-SPEED, followed by a two digit numerical entry between 3 and 99. The Model 800 Terminal will then transmit at this speed. The ID key retains the call letters you programmed into it earlier and can be used in the Morse Code mode to start and finish your transmissions. Once again, use the ESC key to toggle between transmit and receive.

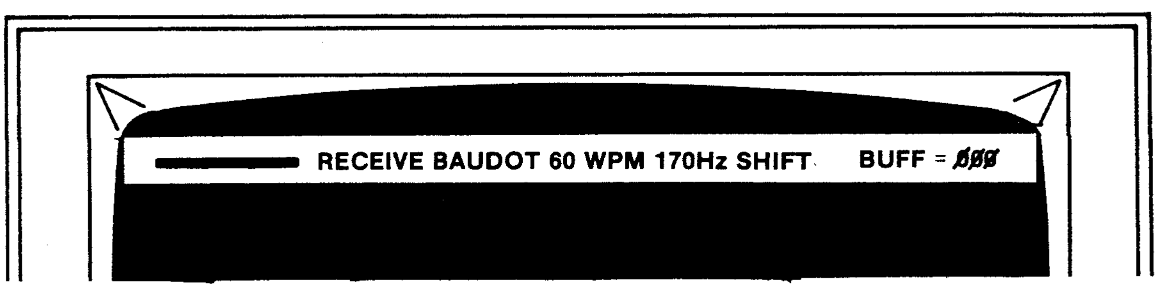


FIG. 3-2. POWER-UP STATUS.

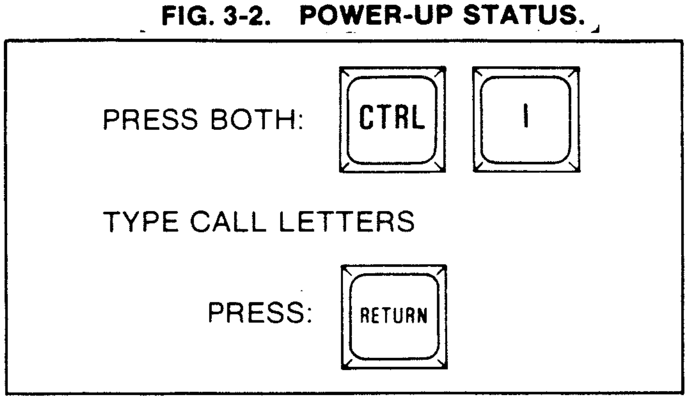


FIG. 3-3. PROGRAMMING ID MEMORY.

SECTION FOUR
RTTY OPERATION

4.1 INTRODUCTION

This section of the instruction manual is intended to give the owner a more detailed description of the operation of the Model 800 on RTTY. Section 4.2 discusses the RTTY concepts referred to in this manual. The following paragraphs describe the advanced operating features and procedures of the terminal. In order to obtain optimum performance from the Model 800, the user should carefully read this section, and try the operations described.

4.2 BACKGROUND INFORMATION

To fully understand and appreciate RTTY, it is highly recommended that you do some background reading on this subject (i.e., *Specialized Communications Techniques* (ARRL); *RTTY Handbook*, etc.). This is important not only for your own enjoyment of the mode, but those you meet on the air will also appreciate your competency on this subject. An example of incompetence caused by ignorance is the newcomer to RTTY who begins his transmissions by typing CARRIAGE RETURN 24 times in order to clear his TV screen. This does not make too many points with the chap on the other end who is watching paper crank out of his machine and go to waste! A brief overview of RTTY concepts is given here so that you may understand the operating features and procedures described later.

As most amateurs are familiar with Morse Code transmission, this description will begin by comparing RTTY with conventional CW. RTTY and CW are similar in that they use standard codes for communication of text information. The two basic distinctions between them are the codes which they use for communication and the method by which they are transmitted. The predominate code used on CW is International Morse, which is designed for interpretation directly by a human being. It is a variable length code, in that different characters have a differing number of transmission elements. The predominant code used on RTTY is Baudot. The FCC has recently approved the use of ASCII in the United States, which will add a new dimension to RTTY. Both of these codes were designed for interpretation by machines, and are fixed length codes; Baudot uses five transmission elements per character, and ASCII uses eight elements per character (not including start and stop bits).

CW is transmitted as a series of "On-Off" conditions which are used to create and interrupt the transmitted

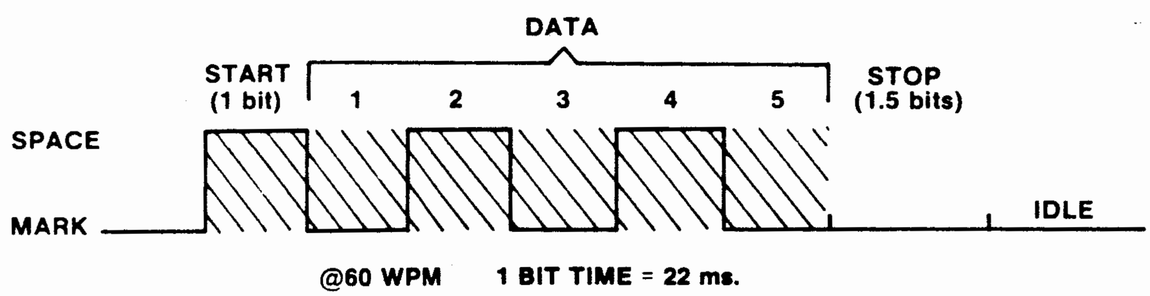


FIG. 4-1. BAUDOT CODE TIMING DIAGRAM (60 WPM).

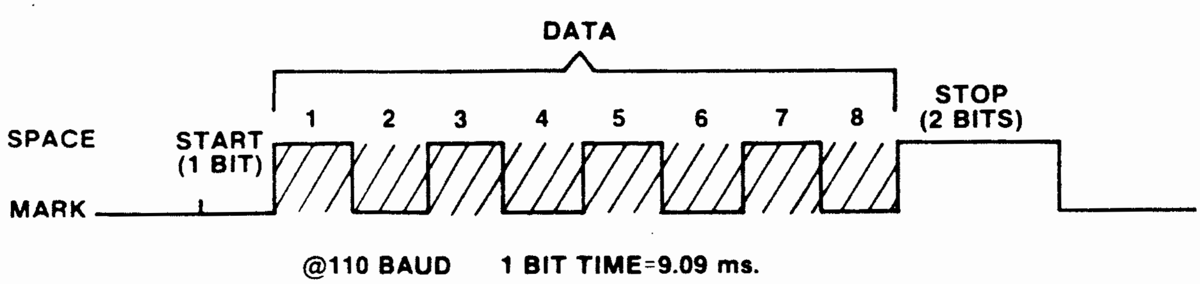


FIG. 4-2. ASCII CODE TIMING DIAGRAM (110 BAUD).

carrier (and eventually the audio tone which the operator listens to). The relative duration and spacing of the code elements are used to convey intelligence. In RTTY, the transmitter is operating continuously. The traditional method for modulating the transmitter was to shift the carrier between two slightly different frequencies ("frequency shift keying" or FSK). With the improvements which have been made to SSB transmitters in recent years, audio frequency shift keying (AFSK) has become popular on RTTY. With audio frequency shift keying, frequency shifted audio tones are supplied to the microphone jack of the transmitter. Despite which keying method is used, the RTTY signal output of a receiver is composed of two audio tones which differ slightly in frequency. The higher frequency tone of this pair is commonly referred to as a "space" and the lower tone of the pair is commonly referred to as a "mark." It is the combination of mark and space pulses which make up the codes used for RTTY. The difference in frequency between the mark and space tones is known as the "shift." In the early days of amateur RTTY, the only shift which was allowed was 850 Hz. Today, any shift below 900 Hz may be used, and amateurs have settled upon 170 Hz as a standard. 170 Hz is often referred to as "narrow shift" and 850 Hz is referred to as "wide shift." Commercial stations typically use a shift of 425 Hz.

There are several situations which can cause the mark and space frequencies to be inverted, where instead of the mark being the low tone, the mark is high. One such situation is when the transmitting and receiving stations are operating on different sidebands. The Model 800 Terminal has provisions for reversing the polarity of the incoming signal in these situations. It is standard practice to use lower sideband for all RTTY operations.

Proper receiver tuning is imperative for reliable RTTY reception. The RTTY demodulator in the model 800 uses two active discriminator filters for separating the mark and space tones. Optimum RTTY tuning is had when the outputs of these filters are evenly matched. The tuning indicator system on the Model 800 is the "plus-plus" type (see Fig. 4-3). It alternately displays the outputs of the mark and space discriminators. The tuning indicator is a bar on the status line which varies in length with respect to the output amplitude of the discriminators. If the receiver is mistuned, these outputs will differ and the bar will change in length as it shifts between mark and space. Due to the speed of the frequency shifting, this causes the bar to "flicker." The receiver should be tuned to minimize the flicker in the bar. It is possible to copy the 425Hz shift commercial broadcasts, using the 850Hz shift discriminator, by a process known as "straddle tuning". The signal to be received is tuned such that it falls in between the 850Hz mark and space frequencies and is straddling the midpoint of the 850Hz shift. In this case, again tune for minimum bar flicker, however, the bar length will be about ½ the length displayed when tuning the normal 170Hz or 850Hz amateur signals. For those who prefer an oscilloscope display tuning indicator, the scope outputs on the back panel of the Model 800 can be used for this purpose.

Many commercial RTTY stations cannot be copied for various reasons. Some could be transmitting in a foreign language which has characters that are not common to the English language. Others could be using privacy codes such as bit inversion of any one of the bits of the RTTY code.

The Input Level control, located on the cover, provides linear operation of the Model 800 input amplifier, allowing the Model 800 to function as a limiterless or "AM" demodulator. This eliminates errors due to FM capture problems associated with limiting of "FM" type demodulators. The Model 800 tuning indicator bar provides a convenient indication of the input level to assure true limiterless operation. FM or limiting type reception, if desired, can still be attained by turning the input level control fully clockwise. It is suggested for limiterless reception of RTTY that the input level be set such that the tuning bar is at about 75% amplitude while copying a properly tuned signal. Limiterless operation will provide superior performance during selective fading or weak signal reception. FM or limiting type operation must be used in AUTOSTART or SELCOM modes. Proper tuning of the Model 800 is accomplished by tuning the signal for maximum amplitude of the tuning bar.

4.3 RTTY OPERATING INSTRUCTIONS

DISPLAY - Figure 4-3 illustrates the status line on the display used in the RTTY mode. The status line is used to give the operator direct feedback when changing

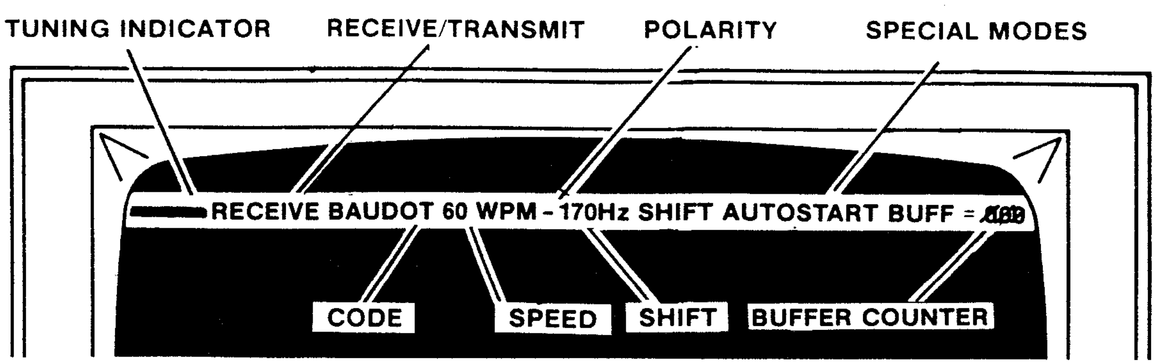


FIG. 4-3. STATUS INDICATOR LINE, RTTY MODE.

modes or programming message memories. As the operations are described, try them on the terminal taking note of changes in the status line.

SPECIAL RECEIVE MODES - There are two special functions which can be selected and used when in the receive mode. CTRL-RCV is used to select these modes. Typing CTRL-RCV will cause the terminal to go into the receive mode if it was previously in the transmit mode. Typing CTRL-RCV when the terminal is already in the receive mode will cause it to change into one of the special receive modes as indicated by the status line. The first special receive mode which is encountered is AUTOSTART. The second special receive mode which is encountered (enabled by typing CTRL-RCV again), is SELCOM. These special modes are described in the following paragraphs. Typing CTRL-RCV yet another time causes the terminal to revert to the "normal" mode where neither the AUTO START nor the SELCOM modes are enabled. The Model 800 will print random characters in the "normal" mode in the absence of an RTTY signal. In this case, the machine decodes noise as characters, much the same as a television set that will display "noise" in the absence of a signal, even with the antenna disconnected.

AUTO START - This mode prevents writing of unwanted characters on the display in the absence of a legitimate RTTY signal. In this mode, the machine will require three to four seconds of RTTY signal before it will print characters.

SELCOM - The SELCOM feature (Selective Communications) is composed of two basic parts: automatic answer back "Who are you," and automatic message recording (Selective Calling or "SELCAL"). These features provide totally automatic station operation. Both features use an eight character code to activate them. The user programs the "Who are you" (WRU) code by typing: CTRL-W followed by the eight character code, followed by RETURN. During the programming process, the status line will display each key entry. The "SELCAL" code is programmed by typing: CTRL-S, followed by the eight character code, followed by RETURN. The terminal is inactive until it receives one of the programmed SELCOM codes. If it receives the "Whe are you" code, its response is to automatically go into the transmit mode and transmit the contents of the first HERE IS message (the HERE IS feature is described later). If it receives the "SELCAL" code, its response is to go into the receive mode and copy down any message which follows. The transmitting station must end the message with "NNNN" in order to shut down the receiving station. The Model 800 will not write any new information unless it receives an additional SELCAL code.

TRANSMIT MODES - There are three transmit modes which may be selected by the user. CTRL-XMIT is used to select these modes. Typing: CTRL-XMIT when in the receive mode will cause the terminal to go into the transmit mode. On "power-up," the terminal would use the CONTINUOUS transmit mode, where each letter is transmitted as it is typed. Typing: CTRL-XMIT when the terminal is already in the transmit mode will cause it to change to a new mode. These modes are displayed on the status line. The first mode change encountered is the WORD mode where the terminal transmits each entire word when it is completed (when the space bar is hit). This allows the operator to use the DELETE key in order to edit mistakes in the word prior to transmission. Typing: CTRL-XMIT again causes the terminal to go into the LINE mode, where the terminal transmits each entire line as it is completed, allowing editing of the entire line. Line completion is detected by a RETURN entry or by the automatic carriage return feature. This feature automatically transmits a carriage RETURN and LINE FEED when a word is completed (space entry) between the 64th and 72nd character in a given line.

CHANGING SPEEDS - There are six commonly used speeds in RTTY communication. These are: 60, 66, 75, 100 and 132 wpm (Baudot); and 110 Baud ASCII. To change speeds type: CTRL-SPEED. Each time you type CTRL-SPEED, the terminal will automatically shift to the next higher speed. On the fifth time, the terminal will change its operating code from Baudot to ASCII. On the sixth time, the terminal will revert back to 60 wpm Baudot.

CHANGING SHIFTS - To change shifts, type: CTRL-SHIFT. The terminal will toggle between 850 Hz and 170 Hz shift each time the CTRL-SHIFT key is depressed. (Note: For copying 425 Hz shift commercial broadcasts, use the 850 Hz mode).

REVERSE KEYING - Certain situations may cause a station to transmit RTTY code with reverse polarity (mark and space frequencies inverted). One example of this situation is caused by the transmitting station being on a different sideband from that of the receiving station. To compensate for this, the operator may choose to reverse the mark and space frequencies by typing: CTRL-REVERSE. Typing: CTRL-REVERSE a second time will return the terminal to the normal mode.

TEST MESSAGES - "RY" and "Quick Brown Fox" are two commonly used test messages on RTTY. To access the "RY" message, type: CTRL-RY. To access the "Quick Brown Fox" test message type: CTRL-QBF.

AUTOMATIC ID MEMORY - Typing: CTRL-ID will cause the terminal to automatically transmit a preprogrammed eight character string by 100 Hz shift CW. To program this string, type: CTRL-I, followed by the characters in the string, followed by RETURN.

AUTOMATIC CQ - This feature sends a string of CQs with your call, taken from the ID memory, automatically inserted. To access this, type CTRL-C (ID memory must be programmed first if not already accomplished).

HERE IS MESSAGES - The Model 800 has two programmable 64 character HERE IS message memories. The first HERE IS message is accessed by pressing the HERE IS key. The second HERE IS message is accessed by typing: SHIFT-HERE IS. To program the first HERE IS message, type: CTRL-H, followed by the contents of the message, followed by RETURN. To program the second HERE IS message, type: CTRL-H twice followed by the contents of the message, followed by RETURN.

SPLIT SCREEN - It is possible to disable the split screen feature to allow text to be displayed on the entire screen. To do this, type CTRL-/ (fraction bar). Typing this again returns to split screen. This is most useful when copying commercial broadcasts or W1AW bulletins.

STATUS LINE - It is possible to erase the Status Line so that all 24 lines of the display can be used for text. To do this, type: CTRL-STATUS. Typing this again will make the Status Line reappear.

TUNE - TUNE is a feature used for Transmitter tune up. When enabled, it gives a "Lock Key" condition to the transmitter through the CW KEY line. To enable this feature, type: CTRL-TUNE. To disable, type: CTRL-TUNE again.

WORD WRAP-AROUND - This feature is used in the receive mode to prevent splitting of words at the end of a line. This is a totally automatic feature which need not be enabled. If the transmitting station begins a new word after the 64th character in a line, and this word is not finished at the end of the line, the Model 800 will erase the first portion of the word at the end of the line and move it all to the beginning of the following line.

TUNING INDICATOR - The Tuning Indicator for the RTTY mode is the black bar located on the left end of the status line. Optimum receiver tuning is had when there is a minimum amount of movement or "flicker" in this bar. Details on the operation of this tuning indicator are given in the background information section 4.2.

TRANSMIT BUFFER - Text may be loaded into the transmit buffer before transmission, or if the typist is typing faster than the machine is sending, a 511 character buffer memory is used (on a first in - first out basis) to store the information until it is transmitted. The number of characters contained in the buffer is displayed on the status line.

SPECIAL FUNCTION KEYS

ESC - Toggles the terminal between transmit and receive.

RETURN - Transmits a carriage return and line feed command to the other station. Returns the local cursor to the left hand side of the display and scrolls the display one line.

NOTE: A separate carriage return without line feed function is not used in that it is impossible to "over strike" a video display.

LINE FEED - Used only in the SSTV mode.

CAPS LOCK - This is an alternate action key, which is used only in the ASCII mode. Both upper and lower case ASCII are available on the Model 800. Upper case letters are obtained by use of the SHIFT key. When depressed, the CAPS LOCK key causes the terminal to use only upper case letters.

DELETE - The delete key is used for editing mistakes prior to transmission. When pressed, this key causes the cursor to back up and erase any character which is there. It is not possible to delete any characters which have been transmitted, as this is not a transmittable function. This key also cannot be used to delete characters on a previous line. This key would be used primarily where characters are pre-loaded into the buffer memory and in the WORD and LINE transmission modes, where transmission of characters is not immediate. In the CONTINUOUS mode, the DELETE key will backspace over any characters which have not yet been transmitted. When it reaches a character which has been transmitted, or the beginning of the line, it will become inoperative.

REPEAT - This key is used for transmitting a series of the same character or function in succession. To use this key, depress and hold down the key which is to be REPEATed. Depress and hold down REPEAT at the

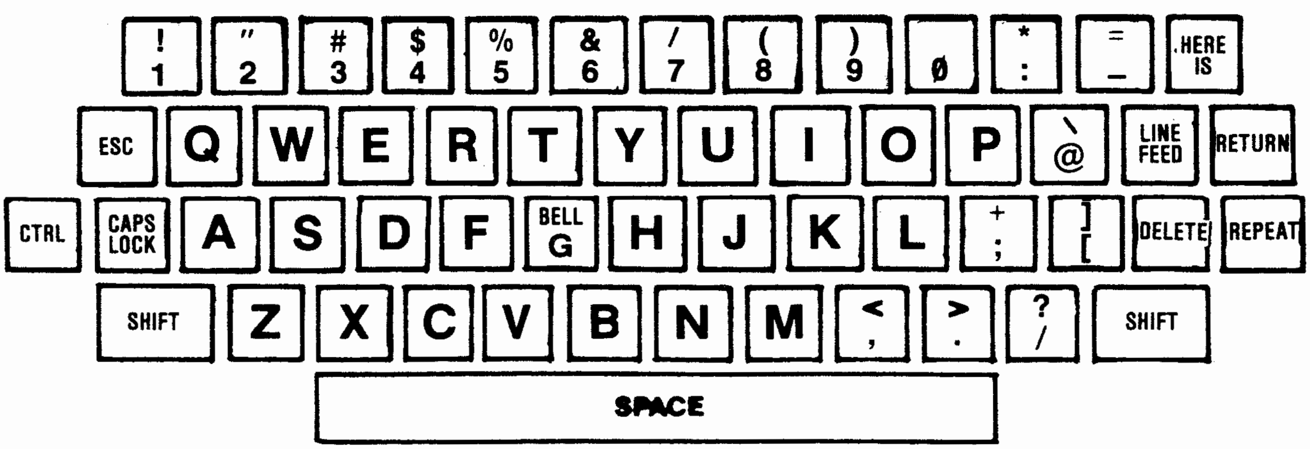


FIG. 4-4. MODEL 800 KEYBOARD.

same time and the terminal will begin printing a succession of characters, or implementing the function which has been selected. To discontinue this, release the keys. For example, to back space and erase an entire line, press and hold the DELETE and REPEAT keys simultaneously.

SHIFT-This key is used to change the function of the keys on the keyboard. In the ASCII mode, this key shifts the terminal between the upper and lower case letter transmission. On numbered keys, it shifts the terminal to the character printed on the top of the key.

In the Baudot mode, there are no lower case letters. However, the SHIFT key is still used to access the figures on the tops of the keys. Because Baudot is a five unit code, there are only 32 possible characters which can be transmitted. Figure 4-4 illustrates the traditional communications-type keyboard which has only 32 keys. On this type of keyboard, letters and figures share the same keys. In order to transmit a figure, the operator would press the FIGS key which causes the machines at both ends to shift into the figures mode. Any keys that are typed while in this mode would print the figures shown on the upper half of the key. To return to normal letters printing, the LTRS key is used. FIGS and LTRS are standard Baudot characters which are transmitted in order to change the machines between these modes. Because the Model 800 is used in modes other than Baudot, we did not want to use this more cumbersome 32 character keyboard.

In the Baudot mode, the Model 800 automatically transmits the FIGS and LTRS functions. For example, to transmit a dollar sign with the Model 800, you would type: SHIFT-4 (see keyboard). The actual transmission sequence in Baudot would be: FIGS-D (see Fig. 4-5). If you then wanted to return to letters to transmit say "X" on the Model 800, you would just type: X. The actual transmitted sequence would be: LTRS-X. As another example of this, say that you wish to type a six letter call sign such as WB6XXX. You would type on the Model 800: W B 6 X X X. The actual transmitted Baudot code would be: W B FIGS Y LTRS X X X (See Fig. 4-5). There may come a time when you wish to transmit these functions manually. RTTY operators often transmit a series of LTRS characters during pauses or at the beginning of transmissions to get the machine at the other end running in sync. LTRS may be manually transmitted by itself by typing CTRL-L on the Model 800. FIGS may be manually transmitted by typing CTRL-F on the Model 800. Remember that under normal circumstances it is not necessary to do any conversions on your keyboard for the Baudot character format. This is all done automatically by the Model 800. This information is included here so that you are aware that these modes exist and that the conversion process has taken place.

All programmed character strings (HERE IS, ID, ETC.) are stored in ASCII format. The Baudot conversion is done at the time of transmission. The LTRS and FIGS characters are not stored. In other words, WB6XXX only requires six spaces of character memory. You do not have to allow for LTRS and FIGS.

CTRL-B-The Baudot "Blank" or null character is transmitted by typing: CTRL-B.

CTRL-BELL-This transmits the Baudot or ASCII bell code which causes a bell to ring on the terminal at the receiving end. When the machine is receiving and printing random characters in the absence of an RTTY signal, it will occasionally decode a "bell" code in the noise and cause the sidetone oscillator to "beep".

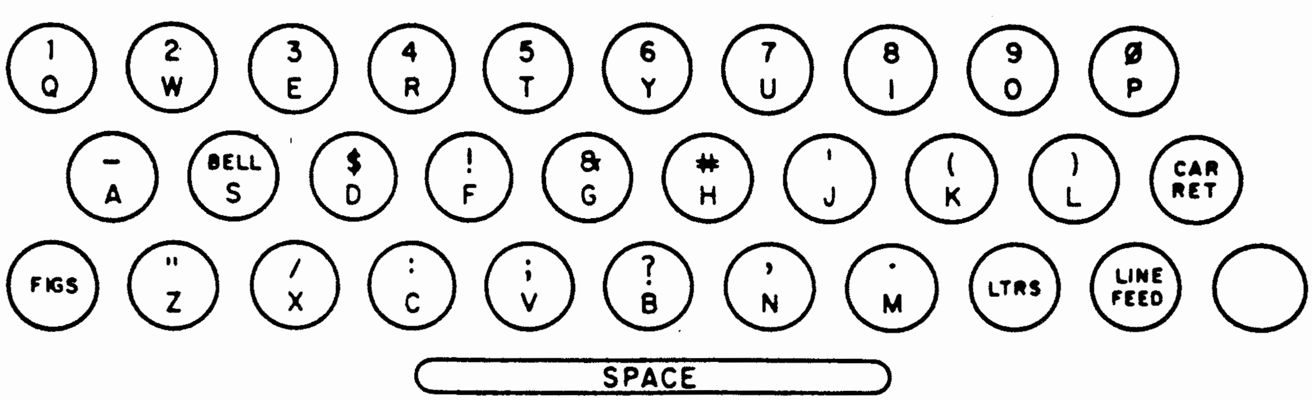


FIG. 4-5. TYPICAL COMMUNICATIONS-TYPE KEYBOARD.

SECTION FIVE
MORSE OPERATION

5.1 INTRODUCTION

This section of the Instruction Manual is intended to give the owner a more detailed description of the operation of the Model 800 on Morse Code. Section 5.2 discusses the concepts relevent to Morse Code which are referred to in this manual. The following paragraphs describe the advanced operating features and procedures of the terminal. In order to obtain optimum performance from the Model 800, the user should carefully read this section and try the operations described.

5.2 BACKGROUND INFORMATION

Continental Morse Code is a variable speed, variable length code originally conceived for human interpretation. There is a special timing relationship between the dots and dashes of the Morse Code which we use for machine interpretation. Figure 5-1 illustrates this relationship. The basic timing element of Morse Code is the "dot." One "dash" is equal to the length of three dots; one dot length is used between elements of the same letter; and three dot lengths are used between letters of the same word and seven dot lengths are used between words. To fully appreciate machine Morse Code communication, the operator should be familiar with these relationships as well as the methods used for the interpretation of the code.

Figure 5-2 is a flow chart diagram of the computer program used in the Model 800 for interpretation of Morse Code. In this explanation, a single transmitted bit of information (dot or dash) is referred to as a "mark" in that the mark discriminator filter is used in the Morse Code receive mode. The length of the inputed mark is first determined by measuring against a clock. This is then compared against a quantity known as "average mark." Average mark is a quantity which is the computed average time required for two dot lengths. Because a "dot" is a single dot length and a "dash" is three dot lengths, by comparing the inputed mark with the average mark, it can be determined if it is intended to be a dot or a dash. If the inputed mark length is less than the "average mark" length, it is a dot. If the inputed mark length is greater than the average mark length, it is a dash. This separated character element is then averaged with the last character element of its kind which was received, to create a new average element length. The element is then added to any previous elements which have been received. A new "average

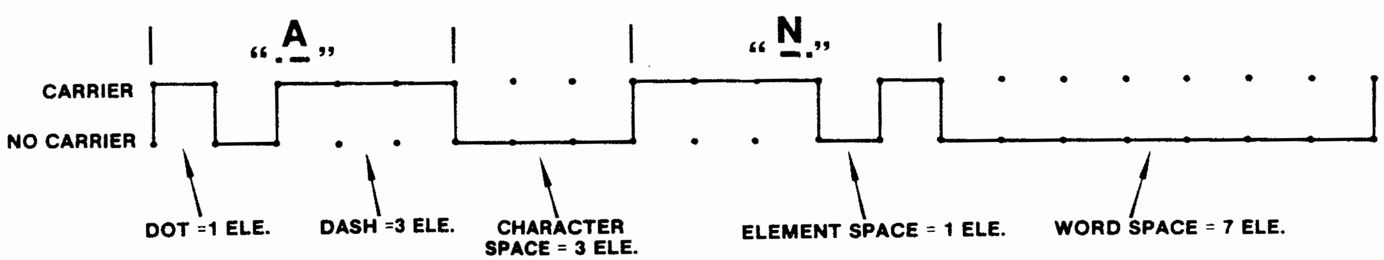


FIG. 5-1. MORSE CODE TIMING.

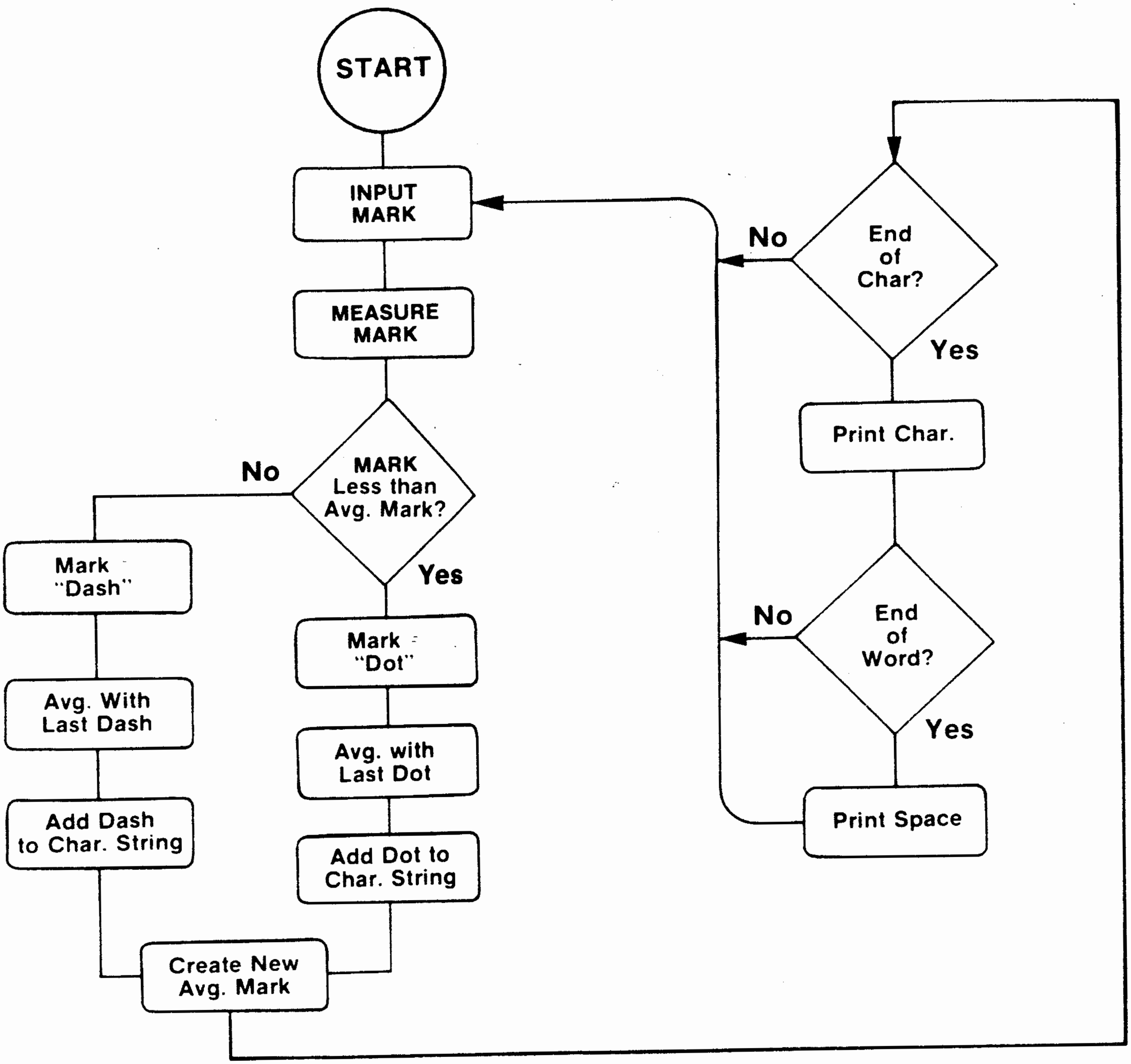


FIG. 5-2. FLOW CHART FOR MORSE CODE INTERPRETER.

SIDE TONE OSCILLATOR-The internal side tone oscillator allows audio indication of the Morse functions. This is useful in the "Morse Trainer" mode. It is also useful when receiving code off the air. The side tone oscillator is connected to the output of the code processor so that what you hear is the "corrected" code as the computer interprets it. It is interesting to compare the incoming code from the radio with the "corrected" version. The SIDE TONE level control on the rear panel of the Model 800 adjusts the volume level of the side tone. The side tone oscillator can be disabled by typing: CTRL-T.

CODE TRANSLATION-The Model 800 will perform code translation from Morse Code into Baudot or ASCII for hard copy printing purposes. In the Morse Code mode, the TTY LOOP keyer output is in the form and speed of the last RTTY mode selected. In other words, if you have a hard copy printer which operates at 110 Baud ASCII, you should put the terminal into this mode before going into the Morse Code mode. This feature operates only in the full screen mode.

TUNE-Typing CTRL-TUNE causes the keyboard to go into a "lock key" state for transmitter tune up. To unlock the key, type: CTRL-TUNE again or type: ESC.

TEST MESSAGES-The "RY" and "Quick Brown Fox" test messages may also be used in the Morse Code mode. To access the "RY" message, type: CTRL-RY. To access the "Quick Brown Fox" test message, type: CTRL-QBF.

AUTOMATIC ID MEMORY-Typing CTRL-ID will cause the terminal to automatically transmit a preprogrammed eight character string. To program this string, type: CTRL-I, followed by the characters in the string, followed by RETURN. It is not necessary to re-program this memory if it was previously programmed in another mode.

AUTOMATIC CQ-This feature sends a string of CQs with your call, taken from the ID memory, automatically inserted. To access this, type CTRL-C (ID memory must be programmed first if not already accomplished).

HERE IS MESSAGES-The Model 800 has two programmable 64 character HERE IS message memories. The first HERE IS message is accessed by pressing the HERE IS key. The second HERE IS message is accessed by typing: SHIFT-HERE IS. To program the first HERE IS message, type: CTRL-H, followed by the contents of the message, followed by RETURN. To program the second HERE IS message, type: CTRL-H twice followed by the contents of the message, followed by RETURN.

SPLIT SCREEN-It is possible to disable the split screen feature to allow text to be displayed on the entire screen. To do this, type CTRL-/ (fraction bar). Typing this again returns to split screen. This is most useful when copying commercial broadcasts or W1AW bulletins.

STATUS LINE-It is possible to erase the Status Line so that all 24 lines of the display can be used for text. To do this, type: CTRL-STATUS. Typing this again will make the Status Line reappear.

WORD WRAP-AROUND-This feature is used in the RECEIVE mode to prevent splitting of words at the end of a line. This is a totally automatic feature which need not be enabled. If the transmitting station begins a new word after the 64th character in a line, and this word is not finished at the end of the line, the Model 800 will erase the first portion of the word at the end of the line and move it all to the beginning of the following line.

TRANSMIT BUFFER-Text may be loaded into the transmit buffer before transmission, or if the typist is typing faster than the machine is sending, a 511 character buffer memory is used (on a first in - first out basis) to store the information until it is transmitted. The number of characters contained in the buffer is displayed on the status line.

SPECIAL FUNCTION KEYS

ESC-Toggles the terminal between transmit and receive.

RETURN-Returns the local cursor to the left hand side of the display and scrolls the display one line. Does not transmit any command to the receiving station.

CAPS LOCK-This is an alternate action key, which is used only in the ASCII mode. This key is inactive in the Morse mode.

DELETE-The DELETE key is used for editing mistakes prior to transmission. When pressed, this key causes the cursor to back up and erases any character which is there. It is not possible to delete any characters which have been transmitted, as this is not a transmittable function. This key would be used primarily in the WORD and LINE transmission modes, where transmission of characters is not immediate. In the CONTINUOUS mode, the DELETE key will backspace over any characters which have not yet been transmitted. When it reaches a character which has been transmitted, it will become inoperative.

REPEAT-This key is used for transmitting a series of the same character or function in succession. To use this key, depress and hold down the key which is to be REPEATed. Depress and hold down REPEAT at the same time and the terminal will begin printing a succession of characters, or implementing the function which has been selected. To discontinue this, release the keys. For example, to backspace and erase an entire line, press and hold the DELETE and REPEAT keys simultaneously.

SHIFT-This key is used to change the function of the keys on the keyboard. In the Morse Code mode, it is used to select figures marked on the upper part of the key.

SPECIAL CHARACTER STRINGS-In Morse Code, there are several special character strings which are used as delineators in messages. These are "hidden" control functions on the Model 800. They are accessed on the keyboard as follows:

AR-(End of Message): CTRL-A

AS-(Wait): CTRL-W

BT-(Pause): CTRL-B

KN-(go ahead, but only the station(s) called): CTRL-K

SK-(Signing off): CTRL-S

mark" (two dot lengths) is then computed by taking the average dot length and the average dash length and averaging them. This "double running average" technique accomplishes several things: it allows for some margin of error in the timing of the incoming code; it automatically tracks incoming code over its entire speed range; tracking adjustments are made with every transmitted character element, allowing for speed variations. The incoming speed measurement (in wpm) is calculated from the "average mark" length and is displayed on the status line.

A timing routine then checks the spacing between transmitted elements to see if the character has been completed. If the spacing between elements is greater than two dot lengths ("average mark") the terminal assumes that the character has been completed, compares the accumulated string of dots and dashes with its character set and prints the result. If the spacing is greater than six dot lengths, it assumes that a word has been completed and prints a space following the character.

As you can see, the Model 800 uses a fairly sophisticated routine for interpreting Morse Code. Keep in mind however, that there are limits to its toleration of "poor code." One of the advantages that we humans have over any machine is the ability to recognize words, thereby compensating for mistakes made by the sending operator.

DISPLAY - To select the MORSE mode, type: CTRL-MORSE. The status line is used to give the operator direct feedback when changing modes or programming message memories. As the operations are described, try them on the terminal taking note of changes in the status line.

TRANSMIT/RECEIVE - To put the unit into the TRANSMIT mode, type: CTRL-XMIT. To put the terminal back into the RECEIVE mode, type: CTRL-RCV. The ESC (Escape) key may also be used to toggle the terminal between transmit and receive. Each time this key is depressed, the terminal will toggle modes.

TRANSMIT MODES - There are four transmit modes which may be selected by the user. CTRL-XMIT is used to select these modes. Typing CTRL-XMIT when in the receive mode will cause the terminal to go into the transmit mode. On "power up" the terminal would use the CONTINUOUS transmit mode where each letter is transmitted as it is typed. Typing CTRL-XMIT when the terminal is already in the transmit mode will cause it to change to a new mode. These modes are displayed on the status line. The first mode change encountered is the WORD mode where the terminal transmits each entire word when it is completed (when the space bar is hit). This allows the operator to use the DELETE key in order to edit mistakes in the word prior to transmission. Typing CTRL-XMIT again causes the terminal to go into the LINE mode, where the terminal transmits each entire line as it is completed, allowing editing of the entire line. Line completion is detected by a RETURN entry or by the automatic carriage return feature. This feature automatically returns the cursor to the left hand side of the display and scrolls the display one line when a word is completed (space entry) between the 64th and 72nd character in a given line. RETURN and LINE FEED are not transmitted in the Morse Code mode. These commands effect the local display only. Typing CTRL-XMIT again will put the terminal into the "random" mode. This causes the terminal to generate and transmit five-character groups of random letters at the selected speed for Morse Code practice purposes. This is an excellent training devise for improving Morse copying proficiency. The operator can turn the monitor off while copying and then turn it back on later to check copy. To stop the terminal, type: ESC (puts the terminal into the receive mode) or CTRL-XMIT (puts the terminal back into the continuous mode).

TUNING CW - To receive Morse Code, set your receiver to either UPPER or LOWER SIDEBAND, not CW. Most CW filters have a different center frequency than the filters in the Model 800 and would not allow proper reception. Receivers that have "IF" shift capability may be able to use their CW filter. However, the Model 800 has a built-in 90Hz filter, so a CW filter does little to improve performance. Enter the Morse receive mode by holding down the "CTRL" key while pressing the "2" key. Tune the receiver to a quiet, no signal, spot on the band and set the receiver audio gain to a comfortable level. Adjust the input level pot, located on the cover, clockwise until the Model 800 just starts printing E's and T's and the sidetone starts "clicking". Now, decrease the input level pot (counter clockwise) until the Model 800 sidetone is quiet and the unit stops printing E's and T's. Once the input level has been set, the Model 800 will be ready to receive Morse Code. It may be necessary to reset the input level when changing bands or if you read just your receiver audio or RF gain controls. Now, tune the receiver to a moderately strong CW station. A good station to practice tuning on is W1AW, as it is usually quite strong and has a good "fist". Tune the receiver such that the Model 800 starts repeating the incoming code through its sidetone oscillator and the turning bar is at maximum length on dots and dashes and minimum on spaces. It will be easiest if you tune down on the signal (e.g., as you tune across the CW station the pitch changes from high to low). Be sure to tune slowly as the Model 800 filters are quite narrow. Once properly tuned, the Model 800 will take a few characters to "lock on" to the incoming code before it starts copying properly. In the MORSE mode, the receiver AGC should be set to slow.

SPEED SELECTION - In the MORSE mode, you may transmit between 3 and 99 wpm. At the higher speeds, you will notice that the Model 800 "rounds off" the speed to a slightly different number than that which was selected. These speeds are much more convenient for the 800 to generate accurately in software. On "Power-up," the Model 800 will transmit at 13 wpm. To select the desired speed, type: CTRL-SPEED, followed by a numerical entry for the speed desired. There is no setting required for the received speed. The Model 800 terminal will automatically track the incoming code at any speed within its range. The incoming code speed is indicated on the status line.

SECTION SIX
SSTV OPERATION

6.1 BACKGROUND INFORMATION

Slow scan TV differs significantly from Morse, ASCII and Baudot in the method of transmission. SSTV was designed for communication of grey scale pictures as opposed to alphanumeric characters only. Instead of transmitting a binary code, SSTV transmits a raster directly, line by line, as in broadcast television. SSTV uses an audio FM subcarrier which, like AFSK is inputed to the transmitter through its microphone jack. This audio FM is modulated to sweep through the picture according to the grey level content of the picture being transmitted. The amateur SSTV standards use a 128 line picture which is transmitted in 8.5 seconds at a bandwidth of just over 1 KHz. Because this standard differs drastically in speed from that of broadcast television, it is necessary to have a device such as the Model 400 which is capable of storing an entire grey scale picture in a memory in order to do the speed conversion necessary for displaying on a standard TV set.

On SSTV, the Model 800 Terminal has a supportive role as a message generation and transmission device. According to SSTV operating conventions, in order to have a confirmed two-way SSTV contact, the stations need to have successfully transmitted and received each other's call letters. With the Model 800 you can do this simply by typing the characters as opposed to the use of "menu boards" or hand lettered graphics. This is especially handy for those who are doing contest or DX work on SSTV.

The display in the SSTV mode is drastically different from that in the RTTY and the Morse modes. There is a maximum of only six characters along each line and up to six total lines of characters. There are two reasons for this. First, the TV display in the SSTV mode has only 128 lines of resolution as opposed to the 525 lines of normal TV. Second, it is important that the letters be large enough to be clearly readable by that overseas DX you are trying to work!

Because SSTV is used in conjunction with voice transmission, it is necessary to be able to switch back and forth between voice (microphone) operation and video operation when on SSTV. SSTV equipment such as the Model 400 Scan Converter is set up to do this by means of front panel switching. When used on SSTV, the Model 800 would normally be interfaced to the

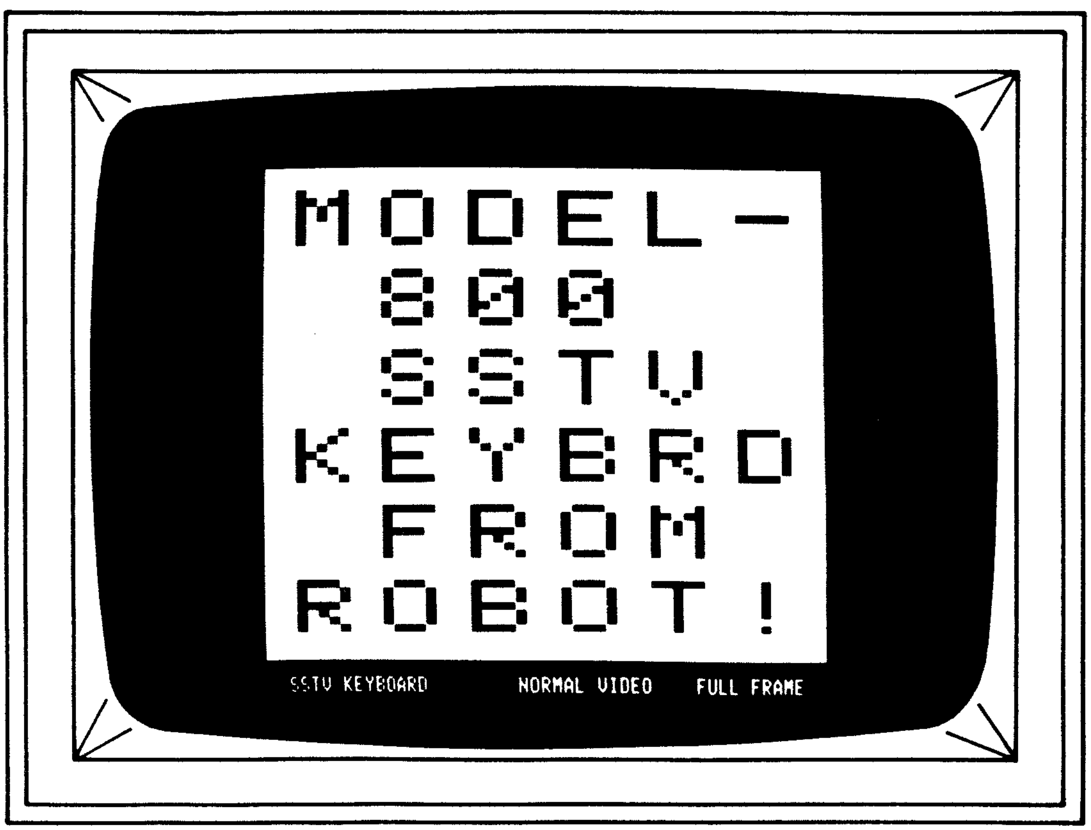


FIG. 6-1. MODEL 800 DISPLAY IN THE SSTV MODE.

transmitter through this SSTV gear so that it can be switched in and out also. It is not necessary for you to own other SSTV gear in order to try your terminal out on this mode, however. The same interface to the transmitter for RTTY may be used for transmissions on SSTV. Tune to one of the common SSTV frequencies (such as 14.230) and establish communication with another station as you would for any other SSB contact. When you wish to transmit the SSTV graphic, you will have to unplug your station microphone and plug in the patch cable coming from the Model 800. The transmitter would have to be keyed manually or by VOX, as the PTT line is not keyed by the terminal in the SSTV mode.

6.2 TRANSMITTING SSTV GRAPHICS

In the SSTV mode, the Model 800 transmits only. Other Slow Scan TV equipment is necessary for receiving SSTV pictures. Upon selection of the SSTV mode, the Model 800 immediately goes into the transmit mode. The PTT line on the TO XMTR jack is not keyed in the SSTV mode. To select the SSTV mode, type: CTRL-SSTV. The control functions along the top row of keys now take on the new functions described in the top row of silk screening on the panel. As you can see, the display in the SSTV mode is totally different from that of the other modes in the terminal. The raster area is a square (1:1 aspect ratio) in order to conform to the amateur SSTV standard picture format. The status line in this mode is at the bottom of the picture. A black horizontal line runs through the display from top to bottom. This line indicates to the operator exactly what portion of the slow scan TV frame is being transmitted. The "winking" cursor line tells the operator which character position is to be filled next.

6.3 SSTV OPERATING FUNCTIONS

GREY SCALE-Typing CTRL-GRY SCL key causes the Model 800 Terminal to transmit a Slow Scan TV six bar grey scale. This is indicated by the status line at the bottom of the display. The keyboard display remains the same, allowing the operator to compose a message while transmitting the test pattern. To return to the SSTV keyboard mode, type CTRL-GRY SCL again.

CHECKERBOARD-Typing CTRL-CHECKER key causes the Model 800 Terminal to transmit a checkerboard test pattern. This is indicated on the status line on the bottom of the display. The local display is again not affected so that the operator can compose messages during the checkerboard transmission. To return to the SSTV keyboard mode, type CTRL-CHECKER again.

PARTIAL FRAME-This feature allows the operator to transmit a portion of a frame when the message does not use the full six line field. Transmitting partial frames reduces transmission time (i.e. transmitting three lines instead of six requires four seconds instead of eight). The operator can select any number of lines between a minimum of one and maximum of six for transmission. To do this, type: CTRL-LINES, followed by a numerical entry between one and six (i.e. three). To return to full frame mode type: CTRL-LINES followed by six. Using this feature allows the operator to transmit the top portion of a given graphic while composing the bottom portion.

BLACK/WHITE REVERSAL-Typing CTRL-REVERSE causes a black/white reversal of the SSTV output. This is indicated on the status line and not on the local display. To return to normal video type: CTRL-REVERSE again.

LARGE CHARACTERS-The Model 800 Terminal has two character formats in the SSTV mode: 6 lines of 6 "square" characters and three lines of 6 "tall" characters. The terminal is normally in the 6 X 6 mode. Typing CTRL-CHARS key will toggle the terminal into the 3 X 6 "tall" characters mode. Typing: CTRL-CHARS again will return the terminal to the normal 6 X 6 characters mode.

SCREEN CLEAR-Typing CTRL-CLEAR erases the entire screen of characters and moves the cursor to the upper left hand corner.

CURSOR CONTROL-These features allow the operator to move the cursor around the screen for editing purposes. Typing CTRL-HOME causes the cursor to move to the upper left hand corner without erasing the screen. Typing CTRL followed by one of the three directional arrow keys, causes the cursor to move one space in the direction of the arrow. The LINE FEED is used for moving the cursor downwards. The right hand arrow key is used when the operator wishes to move the cursor to the right without erasing text. Using the space bar for this will erase characters which are already on the screen. Typing RETURN causes the terminal to move the cursor down one line and to the left side of the display. The DELETE key moves the cursor back one space and erases any character which is present. The REPEAT key, when used in conjunction with another character key will continue entering a string of those characters as long as it is held down.

MODEL 800
TECHNICAL MANUAL

TECHNICAL
DESCRIPTION

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FUNCTION

The Robot Model 800 is a complete communications terminal for transmission and reception of Baudot, ASCII and Morse codes. In addition, the Model 800 will transmit an alphanumeric display via Slow Scan Television.

The heart of the Model 800 is an 8085 microcomputer. This microcomputer consists of the 8085 microprocessor supported by 6144 bytes of read only memory (ROM), 2048 bytes of video display memory, 512 bytes of random access memory (RAM), 7 parallel input/output ports (I/O), 1 serial I/O port and 2 14-bit timers. In addition to the microcomputer, the Model 800 contains an RTTY FSK (frequency shift keyed) demodulator, a sine wave synthesizer and a video display generator. Other than the actual demodulation of the RTTY FSK and Morse signals and the generation of the 72 character by 24 line display, all functions are performed by software in the microcomputer.

Received RTTY and Morse signals are fed to the Model 800 demodulator where they are filtered, conditioned and made compatible with the components in the microcomputer. They are then input to the microcomputer where they are decoded and displayed. Characters to be transmitted are read from the keyboard by the microcomputer. They are then converted into their corresponding codes and transmitted. In the Morse mode, transmission takes the form of keying the CW circuits of the users transmitter. In the RTTY and SSTV modes the signals take the form of audio tones formed by the sine wave synthesizer for transmission thru the audio circuitry of a transmitter.

Characters, received and transmitted, as well as all status information is displayed by the 72 character by 24 line video display generator. Additionally, in the SSTV mode, it provides a graphic display of the slow scan image being transmitted. The video display generator provides a composite video output for use with a conventional closed circuit television (CCTV) monitor. Vertical sync pulses from the display generator also act as an interupt to the microcomputer for software synchronization purposes and for SSTV timing.

The following RTTY speeds and codes are supported by the Model 800 as listed in Table A-1. The WPM figure listed, is that which is referred to by the industry and in some instances may be inconsistent with the remaining data.

CODE TYPE	WPM	BAUD	UNIT LENGTH	UNITS	START PULSE	STOP PULSE	TOTAL LENGTH
Baudot	60	45.5	22.0ms	5	22.0ms	33.0ms	165.0ms
Baudot	66	50.0	20.0ms	5	20.0ms	30.0ms	150.0ms
Baudot	75	56.8	17.6ms	5	17.6ms	26.4ms	132.0ms
Baudot	100	74.1	13.5ms	5	13.5ms	20.3ms	101.3ms
Baudot	132	100.0	10.0ms	5	10.0ms	15.0ms	75.0ms
ASCII	100	110.0	9.1ms	8	9.1ms	18.2ms	100.1ms

Table A-1
RTTY CODE AND SPEED STANDARDS

Transmission and reception of RTTY signals in the Model 800 is via a series of keyed electronic pulses. These pulses take the form of a serial stream of binary digits called bits, each bit consisting of either a binary "1" or mark, or a binary "0" or space. Each character as it is transmitted is preceeded by a space pulse called a start bit. This start bit aids in the synchronization of the transmitter and receiver. The start bit is followed by either a 5 bit code in the case of Baudot or 8 bits in Ascii. Each code consists of a series of mark and space bits that uniquely define a character. The extra bits in the Ascii code allow for the lower case alphabet and some additional punctuation not available in the Baudot code. Following the 5 or 8 bit code is a mark pulse called the stop bit. The stop bit signifies the end of the character. Any gap between the end of one character and the start of the next is filled with a continuous stream of mark pulses.

For ease of transmission the mark and space pulses are converted to audio tones. The mark pulse keys one tone, and the space another. The mark and space tones can then be directly fed into the audio input of a transmitter for transmission and can be received from the audio output of the receiver. This greatly simplifies the installation of the Model 800 as it is equivalent to adding an additional microphone and speaker to your station.

The difference between the mark and space tones is referred to as the "shift." There are three such shifts commonly in use. These are 170, 425 and 850 Hz shift. 170 and 850 Hz shift are commonly used by amateur radio operators and the 425 Hz shift typically used by commercial stations. The Model 800 has a set of filters, called discriminators, for reception of both 170 and 850 Hz shift. The 425 Hz commercial shift can be received using the 850 Hz shift discriminator by a process known as "straddle tuning". The signal to be received is tuned such that it falls in between the 850 Hz mark and space frequencies and is straddling the midpoint of the 850 Hz shift. The Model 800 however, only transmits 170 Hz and 850 Hz shift signals.

The standard Model 800 uses the IARU standard for the frequency of the mark and space tones. This standard is called "low-tone". The Model 800H uses the common American VHF-FM RTTY tone standard referred to as "high-tone". Table A-2 lists the mark and space frequencies employed for both the "low-tone" and "high-tone" frequency standards.

Low-Tone Pairs:
  170 Hz SHIFT - 1275 Hz MARK, 1445 Hz SPACE
  850 Hz SHIFT - 1275 Hz MARK, 2125 Hz SPACE
High-Tone Pairs:
  170 Hz SHIFT - 2125 Hz MARK, 2295 Hz SPACE
  850 Hz SHIFT - 2125 Hz MARK, 2975 Hz SPACE

Table A-2
LOW-TONE AND HIGH-TONE FREQUENCY STANDARDS

The existence of the two frequency standards gives rise to an apparent compatibility problem. This problem exists on VHF-FM where the actual audio tone is transmitted and tuning will not change the pitch of the received tones. However, the incompatibility does not exist on the HF bands. Here the AFSK signal is transmitted via a single sideband transmitter with the carrier and opposite sideband suppressed. This results in an RF signal that shifts an amount equal to the AFSK shift used. On reception the single sideband receiver reinserts a carrier so as you tune across the RTTY signal you can change the pitch of the received audio tones to any frequency desired.

The low-tone standard came into existence due to the limited audio bandwith of single sideband equipment. In some equipment the bandpass has been limited to that which is just necessary for normal speech (approximately 300-2400 Hz). The low-tones fall nearly in the middle of this audio bandpass, whereas the high-tones are quite near the edge and are often attenuated if not eliminated entirely as in the case of the 850 Hz space tone (2975 Hz). Straddle tuning of the 425 Hz commercial RTTY can be difficult if not impossible in some instances with high-tones.

Reception of Morse code in the Model 800 is accomplished by using the RTTY 170 Hz shift mark filter in conjunction with some software processing. The software algorithm tracks the incoming code over the range of 4 to 99 words per minute (WPM). The received code speed is displayed in the status line and is computed according to formula A-1. The Morse transmit timing is also related to this formula.

$$\text{Speed (WPM)} = 1200/\text{Dot Time (ms)} \qquad \text{(A-1)}$$

Slow scan television generation is a software function in the Model 800. The SSTV image is continuously displayed by the video display generator in real time allowing for easy composition. The only auxiliary hardware used in this mode is the sine wave synthesizer circuitry for frequency modulation. Actual slow scan transmission takes the form of an audio FM signal that deviates between 1500 Hz (black) and 2300 Hz (white). Slow scan synchronization pulses are at 1200 Hz. Standards for SSTV timing are slightly different for 50 Hz countries than those for 60 Hz. The Model 800 will support either one of these standards as specified at time of purchase. Table A-3 lists the SSTV timing for both 60 Hz and 50 Hz units.

	60 Hz	50 Hz
Line Time	66.6ms	60.0ms
Frame Time	8.5s	7.7s
Horz Sync Time	6.1ms	6.1ms
Vert Sync Time	66.6ms	60.0ms

Table A-3
60 Hz and 50 Hz SSTV Timing

BLOCK DIAGRAM

An overview of the internal operation of the Model 800 is shown in Figures B-1 and B-2. For clarity the block diagram is divided into two sections, Figure B-1, the digital section and Figure B-2, the analog section. The digital section can be subdivided as the microcomputer and video display sections, the microcomputer being shown in the top half of Figure B-1 and the video display on the lower half.

DIGITAL SECTION (Figure B-1)

The heart of the microcomputer section is the central processing unit (CPU) as shown in Block 1. It executes the preprogrammed instructions contained in the read only memory (ROM) of Block 3. The preprogrammed instructions called software, perform the operational functions of the Model 800 such as the decoding of the Morse and RTTY characters after they are demodulated, transmitting characters to be sent, reading the keyboard for character entries, controlling the video display, etc.

Random access memory (RAM) is used for temporary storage and for the buffering of incoming and outgoing information. The RAM is found in Blocks 5 and 6 as well as input/output channels (I/O) and the two 14-bit programmable interval timers.

The input/output channels or ports, are used to interface the microcomputer to other hardware modules in the Model 800. The input/output function in Block 5 is dedicated to interfacing the microcomputer to the keyboard. This allows the microcomputer to scan the keys for entry and subsequent decoding of keyboard entries as shown in Block 5a. The input/output section of Block 6 is used to interface the analog demodulator, tuning indicator, sidetone oscillator, sine wave synthesizer and various solid state switches.

The two 14-bit timers of Blocks 5 and 6 provide almost all of the timing functions within the microcomputer. The timer in Block 5 is typically used as the USART (universal syncronous/asyncronous receiver/transmitter) clock for the reception of demodulated RTTY signals or as a programmable frequency source for the sine wave synthesizer. The timer in Block 6 is tied to an Interrupt line on the CPUand allows for the accurate timing and control of some of the more dynamic software rountines, such as Morse receive and transmit speed control, RTTY transmit baud rate generation and SSTV pixel and sync pulse timing.

All information between devices in the microcomputer is transferred over information buses. There are three such buses in the Model 800 microcomputer, an address bus for the selection of devices, a data bus for the transfer of information between devices and a control bus for the orderly transfer of information and issuance of addresses on their respective buses.

The video display memory, shown as Block 14, is a 2048 byte random access memory. The entire 2048 bytes can be accessed by the microcomputer through the data bus controller and the address multiplexer, Blocks 8 and 13 respectively. The bus controller assures that the microcomputer does not access the memory at the same time as the video display generator thereby eliminating disturbances on the video display. The conflict is avoided by only allowing the microcomputer to access the memory during video display sync times. The address multiplexer switches between the microcomputer address bus and the video display addressing circuits so that only one set of addresses are present at any one time to the video display memory. Again the addresses are only switched at sync times to avoid display interference.

The display size of 24 lines of 72 characters yields a total display of 1728 characters. Video display memory is arranged such that the first 1728 bytes of the total 2048 are those that store the characters to be displayed. These characters are stored in ASCII code (American Standard Code for Information Interchange) with an added bit, the most significant bit, to indicate the video polarity of the displayed character. Characters can be displayed as a matrix of white dots on a black background or as black dots on a white background as dictated by the video polarity bit. The remaining 320 bytes at the end of the video display memory are never displayed and therefore are available for temporary storage and information buffering.

The video display generation is controlled by the horizontal and vertical timing generators shown as Blocks 10 and 11 respectively. Both generators are directly referenced to the system clock, a crystal controlled frequency source, to assure display stability. The timing generators provide horizontal and vertical synchronization and blanking signals as well as addresses for accessing the video display memory.

The horizontal and vertical addresses are routed to the linear address generator where they are processed for proper control of the display memory. The linear address generator, Block 12, must address the display memory consistent with a horizontal raster scan format of character display. This format is illustrated in figure B-3. Each scan line forms one line of a character row, each character row containing 72 characters. A total of 9 scan lines are required to complete one row of characters. The linear address generator must therefore sequentially generate the address of each of the 72 characters in the row as the raster is scanned from left to right. Upon completion of the scan line the linear address generator must repeat this sequence, again starting with the address of the first character in the row. The sequence is repeated a total of 9 times, completing the character row. Instead of starting with the address of the first character of the completed row, the address generator will continue on to the address of the first character of the next character row. This procedure is carried out for all 24 character rows of the display for each frame of the video display. A microcomputer loaded base register is examined at the beginning of the video frame and is used as the starting address of the first character row displayed. This allows for easy hardware scrolling of the display information.

As the display memory is being addressed its data is presented to the character generator, as illustrated in Block 15. The character generator is a 2048 byte read only memory programmed with the dot patterns representing each character. This dot pattern takes the form of a 7 by 9 dot matrix as shown in Figure B-3. The actual form of storage in the ROM allows one byte, or 8 bits, for every line of dots in the character. Since only 7 bits are required to store one line, the 8th bit is discarded. Each character is comprised of 9 lines of dots and therefore requires a 9 byte block of storage in the ROM.

The character data from the display memory acts as an address to the ROM, to select the actual 9 byte block of dots representing the character to be displayed. Signals from the vertical timing generator also act as addresses to select the proper line of dots, or byte, in the 9 byte block to be displayed. The selected line of dots appears at the output of the character generator ROM and is then loaded into a shift register, Block 16. The shift register, loaded with the 7 dots, shifts them out serially, a dot at a time as video information. On completion, the shift register once again is loaded with a line of dots representing one line of the next character to be displayed. This sequence is repeated for every line of every character in the display.

The resulting video information output by the shift register is combined with horizontal and vertical sync and blanking signals in the video combiner, as shown in block 17. The composite video output of the combiner is an EIA RS-270 compatible signal supplying 1.4 V p-p video into a 75 ohm load. Figure C-5 illustrates the characteristics of the video output. Horizontal and vertical timing specifications for 60 Hz and 50 Hz units are found in Table B-1.

	60Hz	50 Hz
Line Time	63.86us	63.86us
Line Freq.	15660Hz	15660Hz
Frame Time	16.67ms	19.99ms
Frame Freq.	60.00Hz	50.03Hz
Lines/Frame	261	313
Horz Sync	5.00us	5.00us
Horz Blanking	18.78us	18.78us
Vert Sync	574.7us	574.7us
Vert Blanking	2.87ms	6.19ms

Table B-1
60 Hz and 50 Hz Video Timing

ANALOG SECTION (Figure B-2)

RTTY and Morse audio signals enter the Model 800 through the input level control. The input level control allows continuous attenuation of the input audio to provide for limiterless reception in the RTTY modes and to control threshold detection of the Morse signal. Following the input level control, the signal enters into a high-pass filter, as shown in Block 1. The high-pass filter suppresses lower frequency signals that may interfere with the signal of interest by capturing the limiter.

After passing through the high-pass filter the audio signal may take one or two paths. In the 170 Hz shift mode the signal deviates such a small percentage of the typical receiver's bandwidth that additional filtering above the frequency of interest is also helpful, therefore a low-pass filter is also provided in this mode, as shown in Block 2. This has the effect of a bandpass filter centered around the 170 Hz shift signal and in effect eliminates troublesome signals that may have been passed by the receiver's broad bandwidth. However, the 850 Hz space signal is so close to the upper frequency limit of the receiver bandwidth that further filtering would accomplish little. Therefore, in the 850 Hz mode, the signal is routed directly to the limiter stage, Block 3.

The limiter is a high gain amplifier that increases the input signal to a known level in preparation for demodulation. The limited signal is passed on to the mark and space discriminators, as illustrated in Blocks 4a through 4d. The discriminators separate the mark and space signals by passing the tone of interest and suppressing the other. The output of each discriminator is fed to the tuning indicator, as shown in Block 5. The tuning indicator is controlled by the microcomputer and processes the mark and space signals for display as the on screen tuning bar. The output of each discriminator also feeds a full wave rectifier to detect the mark and space pulses. The full wave rectifiers are shown in Blocks 6a and 6b. The mark is detected as a positive voltage and the space as a negative voltage. The mark and space voltages are then combined and filtered in the low-pass filter shown in Block 7. The low-pass filter removes the high frequency carrier component of the mark and space signals and yields a bipolar base-band signal containing only mark and space information.

The base-band mark and space information is corrected such that the positive and negative excursions are of equal amplitude. This function is accomplished by the automatic threshold computer shown in Block 8. The action of the automatic threshold computer helps correct amplitude distortion due to selective fading. The corrected base-band information is presented to the slicer, Block 9. The slicer, an open loop amplifier, squares up the distorted but amplitude corrected pulses and conditions them for TTL (Transistor Transistor Logic) compatibility. Once TTL compatible, the signal is input to the serial channel of the microcomputer for decoding and display.

The sidetone oscillator, shown in Block 10, is used for several purposes. In the Morse receive mode it can be used as a tuning aid by zero-beating the incoming signal with the sidetone output. It also acts as a morse code regenerator and indicates exactly what the microcomputer is receiving at any given moment. In the Morse transmit mode it acts as a sidetone oscillator and indicates the code being transmitted. In the RTTY mode it acts as an end of line indicator and beeps upon entry of the 64th character in a line. It also is used to indicate a buffer full condition when typing ahead in the transmit buffer.

The sine wave synthesizer, shown in Block 11, is used in the generation of the audio tones for the audio frequency shift keying of the RTTY signal. It is also used for the generation of the audio FM slow scan television signal. The sine wave synthesizer provides a clean, low distortion audio output for subsequent transmission through the audio circuitry of the host transmitter.

CIRCUIT DESCRIPTION

DIGITAL SECTION

BLOCK 1. CENTRAL PROCESSING UNIT

The central processing unit (CPU) is the 8085A microprocessor. The 8085A (U1) controls all functions within the Model 800. The 8085A transfers data on an 8-bit bi-directional tri-state bus (AD0-AD7). This bus is time multiplexed to also provide the least significant 8 bits of address. The most significant 8 address bits are provided directly and are labeled as A8-A15. The 16 bits of address provided allows the addressing of up to 64K bytes of memory although only a fraction of this is actually used in the Model 800.

The 8085A CPU also generates a set of controls that are used to select various peripheral devices and to perform read and write to these devices and memory. A maximum of 255 input/output (I/O) devices can be addressed using AD0-AD7, the IO/M line determining whether the address is for I/O or memory.

Five interrupts are available on the 8085A, RST 7.5, RST 6.5, RST 5.5, INT and TRAP. The Model 800 only exercises the first three. Both the INT and TRAP interrupts are tied to ground and therefore disabled. RST 7.5 is tied to the timer output of U2 and provides a programmable time interrupt for the CPU. RST 6.5 is tied to the RxRDY output of U7, the 8251A USART (Universal Syncronous/Asyncronous Receiver/Transmitter), and interrupts the CPU when ever the 8251A has a received character to transfer. RST 5.5 is tied to VERT LOAD (U44-4) and interrupts the CPU at the start of vertical blanking in the video display generator.

The CPU READY/WAIT line is attached to U35-6 and allows the reading and writing of display memory information without disturbing the display. This is accomplished by forcing the CPU to wait until horizontal sync before accessing the display memory.

The combination of R4 and C2 provide a power on reset of the CPU and insure an orderly start-up.

A 5.6MHz clock source is provided at U38-12 and serves as the processor clock for the 8085A.

All 8085A control signals and busses are brought out to connectors at the main PC board edge for possible future expansion.

BLOCK 2. ADDRESS LATCH

U4 performs the demultiplexing of the lower 8 bits of address multiplexed with data on the AD0-AD7 lines of the 8085A. On the trailing of ALE (Address Latch Enable) the lower 8 bits of address are stable on the data bus. U4 latches this address data on the trailing edge of ALE and provides address bits A0-A7. These bits in conjunction with A8-A15 on the 8085A provide a full 16-bit address bus. The 8085A signal HLDA (Hold Acknowledge) is connected to U4-1, tri-state enable. This allows the 8085A to tri-state U4 along with A8-A15 and AD0-AD7 during processor HOLD states.

BLOCK 3. ADDRESS DECODER

Device selection is accomplished by decoding the address of the device as it is placed on the address bus. U19, a 1-of-8 decoder, accomplishes this task by decoding 8 2048-byte blocks of address space. Outputs CS0-CS7 indicate the block being addressed at any given time. U42 combines CS0 and CS1 to form a chip select for 4096-byte memorys.

BLOCK 4. ROM—READ ONLY MEMORY

The Model 800 presently incorporates 6K (6144) bytes of program memory stored in ROM. The 6K memory is composed of U5 a 4K ROM and U6 a 2K ROM. U5 resides in the first two 2048 blocks of memory and therefore is selected by the combination of CSO and CS1 formed by U42. U6 is selected directly by CS2 and resides in the third block of memory. The 8085A RD (Read) control line assures that U5 and U6 only output information on the data bus at read times.

BLOCK 5. 8155—RAM, I/O AND TIMER (#1)

U3, an 8155, is a combination peripheral chip that performs several functions. Included is a 256-byte random access memory (RAM), two 8-bit input/output (I/O) ports, one 6-bit I/O port and a 14-bit programmable interval timer. The 256-byte RAM is used for temporary storage by various software routines and for keyboard character buffering.

The first 8-bit I/O port, Port A, is an output port and is used to scan one side of the key matrix of the keyboard. The second 8-bit I/O port, Port B, is an input port and is connected to the other side of the matrix. By scanning Port A, while reading Port B, a depressed switch can be isolated and decoded. The layout of the key matrix is illustrated in Figure C-1.

The 6-bit I/O port, Port C, is an input port and is used to read the special keys not included in the key matrix. PCO (KO) is connected to the two shift keys. PC1 (K1) is connected to the control (CTRL) key. PC2 (K2) is connected to the escape (ESC) key. PC3 (K3) is connected to the repeat key. PC4 (K4) is connected to the upper case CAPS LOCK key. PC5 is not used and is spare.

The 14-bit programmable interval timer is used by the software for external timing purposes. The timer clock input is tied to the 8085A clock output CLK which has a period of 358ns. The output of the timer, DATA CLK, is connected to the clock input of the 8251A USART (U7) and the clock input of the sine wave synthesizer (U48). Thus it can become either a programmable baud rate generator for USART operations or a programmable frequency generator for frequency shift keying or frequency modulation with the sine wave synthesizer.

CS6 enables this device for transfer of information on the 8085A data bus.

BLOCK 6. 8155—RAM, I/O AND TIMER (#2)

U2, an 8155, is a combination peripheral chip that performs several functions. Included is a 256-byte random access memory (RAM), two 8-bit input/output (I/O) ports, one 6-bit I/O port and a 14-bit programmable interval timer. The 256-byte RAM is used for temporary storage by various software routines and for keyboard character buffering.

The first 8-bit I/O port, Port A, is an input port. PAO is tied to the tuning indicator end of conversion, or EOC, pin. This signal indicates that analog-to-digital (A/D) conversion is complete. PA1 is connected to RxD (Received Data) of U64 in the demodulator and allows the computer to examine incoming demodulated data. PA2 looks at the ZERO output of the sine wave synthesizer allowing the microcomputer to change the sine wave frequency at zero-crossing times. PA3 through PA6 are not used presently and are spare. PA7 receives the keypressed (KP) strobe from the keyboard interface, indicating that a key has been depressed and should be read.

The second 8-bit I/O port, Port B, is an output port. PBO is tied to RCV/XMT of Q5 and controls the receive/transmit switching. PB1 is connected to 170/850 of U51 and U58 and controls the 170 Hz and 850 Hz filter selection. PB2 is connected to REV/NOR of U64 and controls received mark and space polarity. PB3 is tied to RESET of U48 and disabled and resets the sine wave synthesizer. PB4 through PB7 are not used and are spare.

The 6-bit I/O port, Port C, is an output port. PC0-PC2 are labeled B1, B2 and B3 and are the three data lines that connect to the tuning indicator D/A (Digital Analog) converter, U47. PC3 labeled BELL is connected to the sidetone oscillator and controls the bell function and the Morse code sidetone. PC5 is not used and is spare.

The 14-bit programmable interval timer is used by the software for internal timing purposes. The timer clock is the first term of the character counter, H0 of U14. This signal provides a 1.2521us clock. The output of the timer is connected to RST 7.5 of the 8085A and therefore provides a programmed interrupt.

CS7 enables this device for transfer of information on the 8085A data bus.

BLOCK 7. USART—UNIVERSAL SYNCHRONOUS/ASYNCRONOUS RECEIVER/TRANSMITTER

U7 is an 8251A USART and provides a serial input/output channel for the 8085A. In the receive mode information from the demodulator through U64 is loaded serially into the 8251A and transferred over the data bus to the 8085A. In the transmit mode, information from the 8085A is sent serially through the USART to the TTY LOOP keyer (Q5) for hard copy output. The U3 timer output provides a receive and transmit clock for the USART.

CS3 enables this device for transfer of information on the 8085A data bus.

BLOCK 8. BUS CONTROLLER

Bi-directional bus drivers U20 and U21 allow for the sharing of the video display memory data bus between the 8085A and the video display generator. At horizontal blanking times U36 and U37 allow the 8085A data bus to extend to the video display memory through the bi-directional bus drivers for display read and write. By limiting access to blanking time, display disturbance is eliminated.

U35 forces the 8085A to wait until sync time before executing the actual read or write operation via the 8085A READY/WAIT line.

CS4 enables this device for transfer of information on the 8085A data bus.

BLOCK 9. SYSTEM CLOCK

The system clock is a 11.181240 MHz crystal controlled oscillator that is used to control all timing functions in the Model 800. U45 is configured as a non-inverting amplifier with Y1, a series resonant crystal providing the feedback path for oscillation. U38 buffers the system clock which is used directly by the video display circuitry as a character dot clock. This signal is divided in half by U39 to 5.590620 MHz for use as the 8085A processor clock (PCLK).

BLOCK 10. HORIZONTAL TIMING

The 11.181240 MHz dot clock is fed to U13, a divide-by-7 counter. U13 allows 7 dot times to occur for the transmission of serial video out of video shift register U23. Upon completion of 7 dot times U13 reloads and the load pulse forms the character clock (CC).

Figure C-2 illustrates the horizontal timing relationships.

U14 and U15 are initially loaded to 226 at the start of horizontal blanking by U33. Horizontal blanking is generated by term H7. The counter then counts up a character at a time by clock CC. U34-6 decodes the start of horizontal sync at state 236 and sets flip-flop U37. U34-12 decodes the end of sync at state 244 and resets U37. At state 256 the counter overflows to state 0, horizontal blanking ends and horizontal live time begins. A line of 72 characters is displayed during states 0-71. U33 decodes state 71 and causes the loading of the counter and the beginning of blanking at the next state.

BLOCK 11. VERTICAL TIMING
—60 Hz UNITS

Horizontal blanking, term H7, is fed as a clock to the character row line counter U16. U16 is a divide-by-9 counter and generates the 9 line addresses required to access the 9 byte character dot pattern in the character generator ROM. U31 decodes the first line, LINE 0, of each character row. At the end of 9 lines U16 reloads and generates a character row clock for the character row counter, U17 and U18.

The character row counter is initially loaded to a count of 251 at the start of vertical blanking by U44. Vertical blanking is generated by term V7. The counter then counts up a character row at a time. U34 decodes the start of vertical sync at line 4 of state 252 and sets flip-flop U40. U40-11 decodes the end of sync at line 4 of state 253 and resets U40. At state 256 the counter overflows to state 0, vertical blanking ends, and vertical live time begins. 24 rows of characters are displayed during states 0-23. U44 decodes state 23 and causes the loading of the counter and the beginning of blanking at the next state.

Figure C-3 illustrates 60 Hz vertical timing relationships.

—50 Hz UNITS

Horizontal blanking, term H7, is fed as a clock to the character row line counter U16. U16 is a divide-by-9 counter and generates the 9 line addresses required to access the 9 byte character dot pattern in the character generator ROM. U31 decodes the first line, LINE 0, of each character row. At the end of 9 lines U16 reloads and generates a character row clock for the character row counter, U17 and U18.

The character row counter is initially loaded to a count of 245 at the start of vertical blanking by U44. Vertical blanking is generated by term V7. The counter then counts up a character row at a time. U34 decodes the start of vertical sync at state 250 and sets flip-flop U40. U40-11 decodes the end of sync at state 251 and resets U40. At state 256 the counter overflows to state 0, vertical blanking ends, and vertical live time begins. 24 rows of characters are displayed during states 0-23. U44 decodes state 23 and causes the loading of the counter and the beginning of blanking at the next state.

Figure C-4 illustrates 50 Hz vertical timing relationships.

BLOCK 12. LINEAR ADDRESS GENERATOR

The linear address generator consists of three basic sections, the base register, the row address register and the character counter. U8 is an 8-bit latch, selected by CS5. The 8085A loads the address of the character row to be displayed as the bottom row of the display into U8. The linear address generator uses this as a base for all video display addressing thus providing an efficient form of display scrolling.

U10 is the row address register and contains the address of the first character of the present character row being displayed. This address will be loaded into the character counter at the beginning of each of the 9 lines of a character row.

U9 and U11 compose the character counter. At the beginning of a scan line the counter is loaded with the starting address of the first character in the present character row. It then counts up 72 characters from that point 8 characters at a time with the aid of U42 and U32 as a clock. Only address bits of a higher order than the first 3 need be linearized as the first 3 bits (H0, H1 and H2) follow a linear sequence from line to line. The first three bits will always start at 000 at the beginning of a line and therefore can be used directly for memory addressing. The other bits C0-C7 must be stored as they have a unique value for the start of each character row. At the completion of the 72 character line the starting address stored in U10 is loaded into the counter for the next scan line. This is repeated for the 9 lines comprising a character row. At the end of the 9th scan line of the character row, the address is allowed to increment to the address of the first character of the next row under the control of U40. The new address is stored in U10 replacing the starting address of the last row. The storage operation is executed by the clocking action of U37. This sequence is repeated for all 24 character rows.

U12 detects an end of memory situation at address 1728 (24 X 72) and resets the character counter.

At vertical blanking U10 is disabled and U8 the base address register, is again loaded starting the address sequence.

BLOCK 13. ADDRESS MULTIPLEXER

U24, U25 and U26 form the video display memory address multiplexer. At horizontal blanking times control signal HB switches the 8085A address bus on to the video display memory address inputs. This allows the 8085A to address the memory for read write purposes during blanking. At all other times the multiplexer switches the linear address generator and H0, H1 and H2 on to the video display memory address bus for video display generation.

BLOCK 14. VIDEO DISPLAY MEMORY

U27 through U30 comprise the video display memory. The memory chips are 1K-by-4 bit static random access memories and are configured as a 2048-by-8 bit memory.

BLOCK 15. CHARACTER GENERATOR

U22 is a 2K-by-8 bit read only memory and is programmed as a character generator for addressing by the video display circuitry. U22 contains the dot matrix patterns for all alphanumeric and graphic characters displayed by the Model 800.

Lines D0-D6 provided by the video display memory data outputs, select the character to be displayed. Lines R0-R3 are generated by the vertical timing generator and select the proper line of dots within the character to be output by the generator.

BLOCK 16. VIDEO OUTPUT SHIFT REGISTER

U23 loads the parallel dot information from U22 the character generator and shifts it out serially a dot at a time. Every seventh character the character clock CC loads the shift register with new information from the character generator. The dot clock shifts a new dot out of the shift register every 89ns. The output of the shift register is exclusive—or'd with D7, the video polarity bit, from the video display memory and provides normal/reverse video switching. The output of the exclusive or gate U32 is re-clocked for final video output by U39 and the 11.181240 MHz dot clock.

Horizontal and vertical blanking is combined and generated by clearing U23 during blanking times. U36 combines the two blanking signals while U39 synchronizes them with the operations of U23.

BLOCK 17. VIDEO COMBINER

Video and sync signals are combined for final video output by the video combiner U41. U41 is an open collector gate and allows the video and sync signals to be combined by the resistor network containing R5, R6 and R8. The composite video signal is buffered by emitter follower Q1. The network R7, C3 and C4 provide power supply isolation of the output stage. Video output is taken across emitter resistor R9 through R24 and provides a 1.4 V P-P output into 75 ohms. The composite video output is illustrated in figure B-4.

ANALOG SECTION

BLOCK 1. HIGH-PASS FILTER

U50 is configured as a fourth order 1dB Chebyshev high-pass filter. The 3dB point is approximately 1200 Hz for low-tone Model 800's and 2000 Hz for high-tone units. The filter has a gain of 5. Diodes CR5 and CR6 are for protection from excessive input signal amplitude.

BLOCK 2. LOW-PASS FILTER

U52 is configured as a fourth order 1dB Chebyshev low-pass filter. The 3db point is approximately 1540 Hz for low-tone Model 800's and 2430 Hz for high-tone units. The filter has a gain of 5.

BLOCK 3. LIMITER

U54 and U53 form a limiting amplifier with a gain of 10. The actual signal limiting is accomplished by diodes CR7 and CR8. Limiting occurs at 1.4 V p-p. The overall gain of the input stages is 250 at 170 Hz shift and provides limiting at a 5mV signal level. At 850 Hz low-pass filter U52 is switched out by analog switch U51 and the input gain correspondingly drops by a factor of 5 to a gain of 50. This still provides adequate limiting of 850 Hz signals down to a 25mV input signal level.

BLOCK 4. DISCRIMINATORS

U59 through U62 are the 170 Hz and 850 Hz mark and space discriminators. Each discriminator filter is a second order positive feedback bandpass filter. U59 is the 850 Hz mark filter, U60 the 170 Hz mark, U61 the 850 Hz space and U62 the 170 Hz space. 170 Hz mark and space filters have a bandwidth of approximately 96 Hz while the 850 Hz filters have a bandwidth of about 212 Hz. The low-tone filters have a gain of 6, high-tone units a gain of 18.

R69 and R96 are the discriminator balance controls and allow for the accurate compensation for possible differences in gain between the mark and space filters.

BLOCK 5. TUNING INDICATOR

The tuning indicator is comprised of two major components, a peak detector and an analog-to-digital (A/D) converter. The peak detector samples the outputs of the mark and space discriminators while the A/D measures the resultant peak voltage. The computer supervises the A/D conversion by outputing a 3-bit binary value (B0-B2) to the digital-to-analog (D/A) network comprised of resistors R37-R40. This analog voltage is compared with the mark and space voltage from the peak detector with comparator U47. When the microcomputer outputs the proper 3-bit value equal to the peak detected voltage the comparator trips indicating the proper value has been found. The microcomputer uses this value for display in the tuning bar.

BLOCK 6. FULL WAVE RECTIFIERS

The two sections of U57 form full wave rectifiers for the detection of the mark and space information. The two sections of analog switch U58 switch between the 170 Hz and 850 Hz filter outputs for input to the full wave rectifiers.

BLOCK 7. LOW-PASS FILTER

U56 is configured as a low-pass filter for the recovery of the baseband mark and space information. This filter is a fourth order Butterworth filter with a cutoff frequency of 70 Hz and a gain of 2.6.

BLOCK 8. AUTOMATIC THRESHOLD COMPUTER

The output of low-pass filter U56 is input to the automatic threshold computer comprised of capacitors C33 and C34, diodes CR11-CR14 and resistors R114 and R115. This network peak detects the mark and space pulses and biases the signal such that the positive mark and negative space pulses are symetrical about zero volts.

BLOCK 9. SLICER

U54 is an open loop amplifier, called a slicer. The slicer converts the incoming bi-polar mark and space signal to a 24V p-p square wave. This square wave is then made TTL (Transistor Transistor Logic) compatible by the network containing R119, CR15 and CR16. The TTL compatible signal is input to exclusive or gate U64 and subsequently input to the microcomputer.

BLOCK 10. SIDETONE OSCILLATOR

U49 is a Schmidt trigger nand gate used as a gated oscillator. When a BELL signal is commanded by the microcomputer, U49 goes into oscillation. The frequency of operation is equivalent to the frequency of the mark tone and allows zero beating of the input signal for tuning purposes in the Morse code receive mode. Q6 and Q7 buffer the output of U49 for presentation to the speaker.

BLOCK 11. SINE WAVE SYNTHESIZER

Shift register U48 is used as digital sine wave synthesizer by summing its outputs in a weighted resistor network. The result is a 16 step sine wave approximation. The input clock is 16 times the desired output frequency and is provided by the U3 timer output. U63 forms a second order lowpass filter for smoothing the discrete voltage steps produced by the sine wave generator.

ACTIVE DEVICE LIST

IC LIST

SYMBOL	TYPE	FUNCTION
U1	8085A	MICROPROCESSOR
U2	8155	RAM, I/O, TIMER
U3	8155	RAM, I/O, TIMER
U4	74LS373	ADDRESS LATCH
U5	2732	READ ONLY MEMORY
U6	2716	READ ONLY MEMORY
U7	8251A	USART
U8	74LS374	BASE ADDRESS REGISTER
U9	74LS163	CHARACTER ADDRESS GENERATOR
U10	74LS374	ROW ADDRESS REGISTER
U11	74LS163	CHARACTER ADDRESS GENERATOR
U12	74LS30	END OF MEMORY DECODER
U13	74LS163	DOT COUNTER
U14	74LS163	CHARACTER COUNTER
U15	74LS163	CHARACTER COUNTER
U16	74LS163	CHARACTER DOT LINE COUNTER
U17	74LS163	CHARACTER ROW COUNTER
U18	74LS163	CHARACTER ROW COUNTER
U19	74LS138	ADDRESS DECODER
U20	74LS243	BUS CONTROLLER
U21	74LS243	BUS CONTROLLER
U22	2316	CHARACTER GENERATOR ROM
U23	74166	VIDEO SHIFT REGISTER
U24	74LS157	ADDRESS MULTIPLEXER
U25	74LS157	ADDRESS MULTIPLEXER
U26	74LS157	ADDRESS MULTIPLEXER
U27	2114	1K X 4 VIDEO DISPLAY RAM
U28	2114	1K X 4 VIDEO DISPLAY RAM
U29	2114	1K X 4 VIDEO DISPLAY RAM
U30	2114	1K X 4 VIDEO DISPLAY RAM
U31	74LS74	CHARACTER LINE-0 DECODER
U32	74LS86	BLANKING GATE, VIDEO INVERT GATE
U34	74LS10	HORIZONTAL AND VERTICAL SYNC DECODER
U35	74LS32	CPU READY/WAIT GATE
U36	74LS02	BLANKING COMBINER, BUS CONTROL GATE
U37	74LS00	HORIZONTAL SYNC FLIP-FLOP, BUS CONTROL GATE
U38	74LS04	CLOCK BUFFER, HORIZONTAL AND VERTICAL TIMING GATE
U39	74LS175	PROCESSOR CLOCK, CLOCK RETIMING
U40	74LS00	VERTICAL SYNC FLIP-FLOP, ADDRESS GENERATOR
U41	7438	VIDEO COMBINER
U42	74LS20	4K ROM ENABLE, ADDRESS GENERATOR GATE
U44	74LS02	HORIZONTAL AND VERTICAL TIMING GATE
U45	7404	SYSTEM CLOCK, HORIZONTAL AND VERTICAL TIMING GATE
U46	74LS30	KEYPRESS DECODER
U47	1458	TUNING INDICATOR
U48	74LS164	SINE WAVE GENERATOR
U49	74LS132	SIDETONE OSCILLATOR, REPEAT KEY OSCILLATOR AND GATE
U50	1458	HIGH-PASS FILTER
U51	TL191	170HZ/850HZ FILTER SELECT
U52	1458	LOW-PASS FILTER
U53	1458	LIMITER
U54	1458	SLICER
U56	1458	LOW-PASS FILTER
U57	1458	FULL WAVE RECTIFIER
U58	TL191	170HZ/850HZ FILTER SELECT

U59	1458	850HZ MARK BANDPASS FILTER
U60	1458	170HZ MARK BANDPASS FILTER
U61	1458	850HZ SPACE BANDPASS FILTER
U62	1458	170HZ SPACE BANDPASS FILTER
U63	1458	LOW PASS FILTER
U64	74LS86	DATA REVERSE/NORMAL GATE, SINE WAVE GENERATOR GATE

TRANSISTOR LIST

SYMBOL	TYPE	FUNCTION
Q1	2N4124	VIDEO OUTPUT
Q2	MJE350	CW KEYER DRIVER
Q3	MJE340	CW KEYER
Q4	TIP48	TTY LOOP KEYER
Q5	MJE340	TRANSMIT/RECEIVE SWITCH
Q6	2N4124	SIDETONE DRIVER
Q7	2N4126	SIDETONE DRIVER

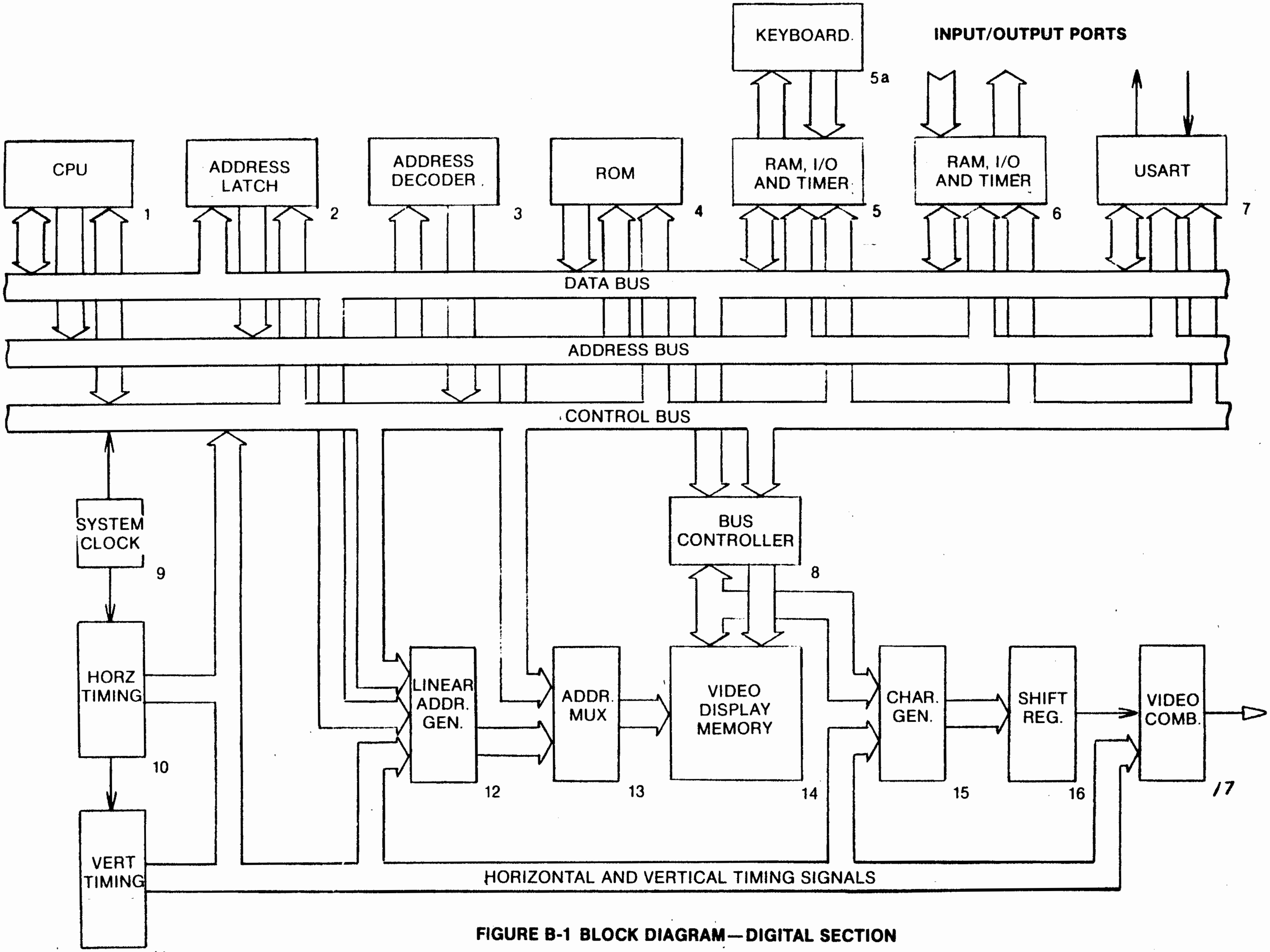


FIGURE B-1 BLOCK DIAGRAM—DIGITAL SECTION

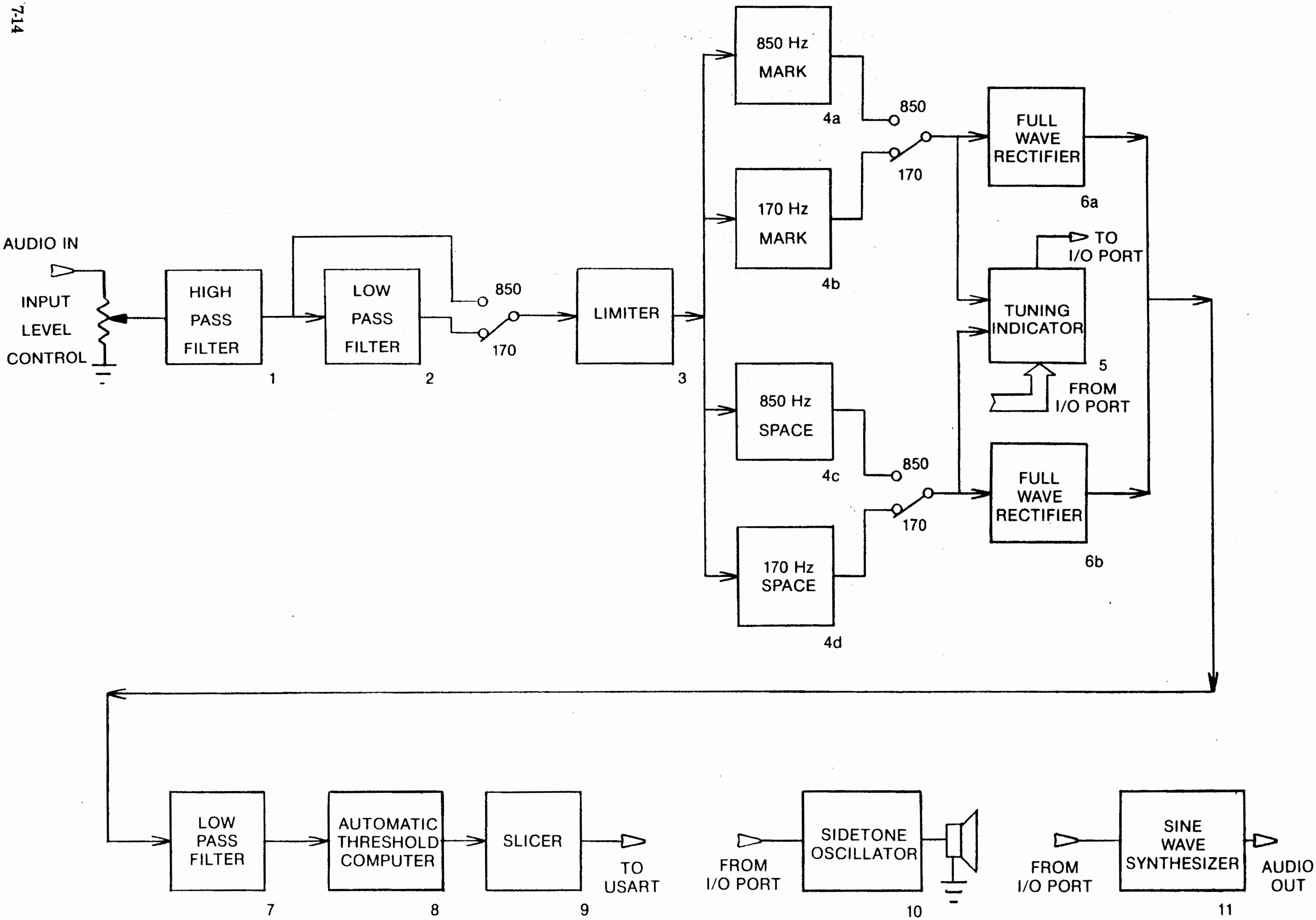


FIGURE B-2 BLOCK DIAGRAM—ANALOG SECTION

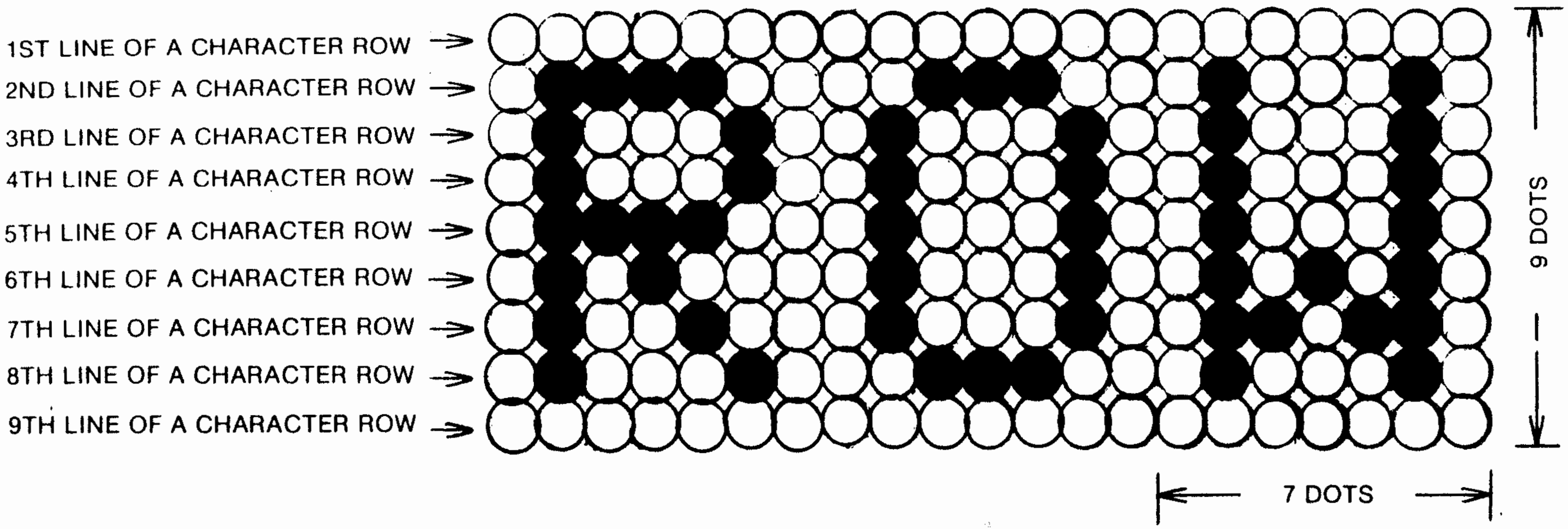


FIGURE B-3 CHARACTER GENERATION

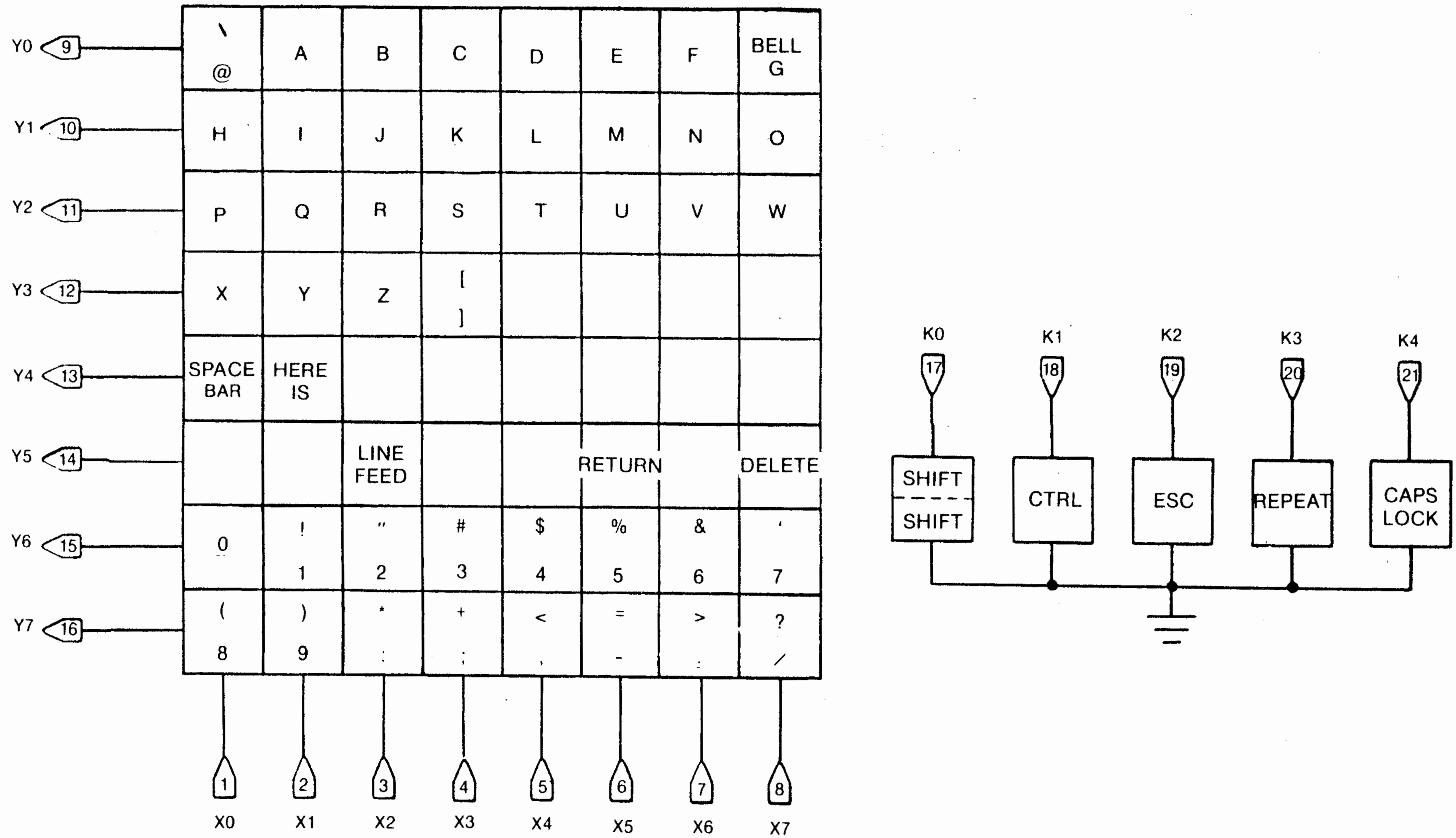


FIGURE C-1 KEYBOARD MATRIX

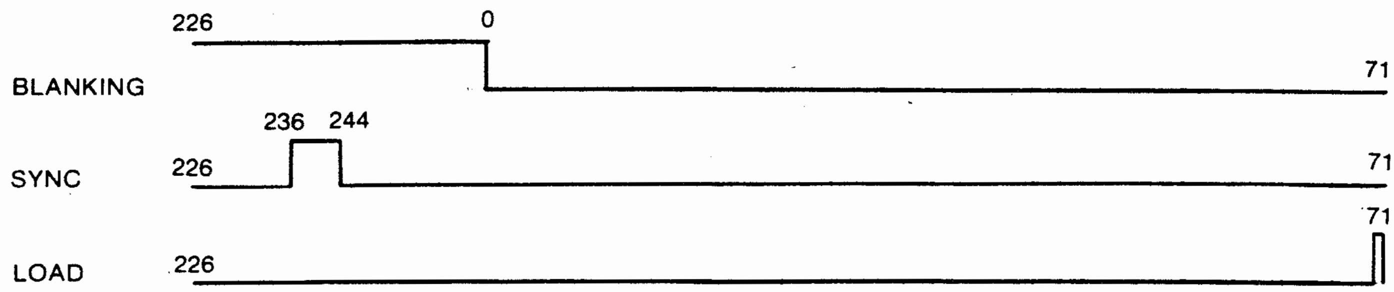


FIGURE C-2 HORIZONTAL TIMING

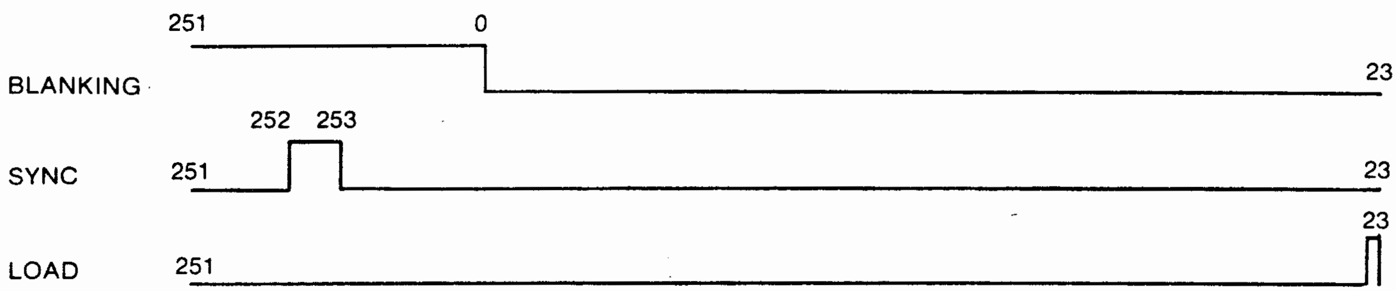


FIGURE C-3 VERTICAL TIMING—60 Hz

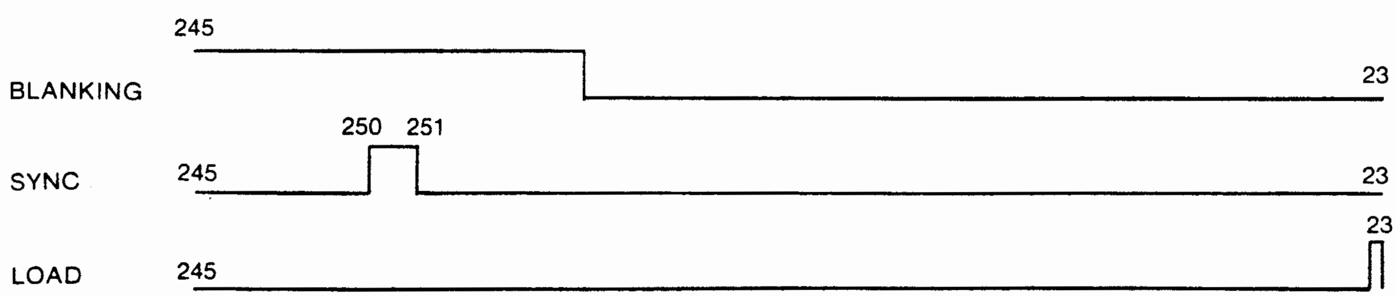


FIGURE C-4 VERTICAL TIMING—50 Hz

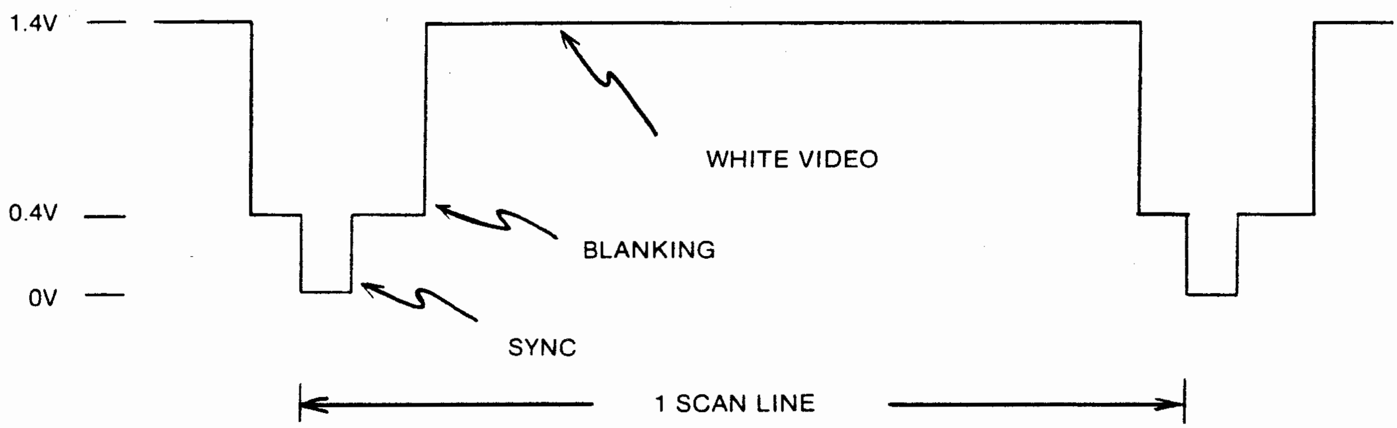


FIGURE C-5 COMPOSITE VIDEO OUTPUT

The standard Model 800 is shipped with the IARU "LOW TONE" filter set specified below and is optimum for use with most SSB equipment.

Low Tone Pairs:
170Hz SHIFT - 1275Hz MARK, 1445Hz SPACE
850Hz SHIFT - 1275Hz MARK, 2125Hz SPACE

Optionally, the Model 800 is available in the "Model 800H" configuration using the "HIGH TONE" filter set specified below which is commonly used on VHF.

High Tone Pairs:
170Hz SHIFT - 2125Hz MARK, 2295Hz SPACE
850Hz SHIFT - 2125Hz MARK, 2975Hz SPACE

ADDENDUM TO MODEL 800 SCHEMATIC DWG #800931 FOR MODEL 800H (HIGH TONE 2125Hz MARK)

The following changes apply to all Model 800's with "800H" serial numbers.

PART #	PART VALUE
R22	8.2K 1/4W 5%
R23	8.2K "
R47	6.19K 1/8W 1%
R48	6.19K "
R51	11.3K "
R52	11.3K "
R55	18.7K "
R56	18.7K "
R59	10.2K "
R60	10.2K "
R72	34.8K "
R73	4.42K "
R75	34.8K "
R76	34.8K "
R77	200 K "
R78	118K "
R79	2.74K "
R81	51.1K "
R82	51.1K "
R83	200 K "
R84	110 K "
R85	2.55K "
R87	29.4K "
R88	29.4K "
R89	143 K "
R90	82.5K "
R91	2.43K "
R93	49.9K "
R94	182 K "
R95	102 K "
R128	49.9K "
R129	51.1K "
R132	29.4K "
R133	49.9K "
R69	2K POT
R96	"

SECTION EIGHT

QUICK REFERENCE GUIDE

PROGRAMMING

	Keystrokes
HERE IS message #1	CTRL-H; (message); RETURN
HERE IS message #2	CTRL-H; CTRL-H; (message); RETURN
ID memory	CTRL-I; (call); RETURN
WRU memory	CTRL-W; (code); RETURN
Selcal Memory	CTRL-S: (code); RETURN

RTTY FUNCTIONS

Function	Keystrokes
Select **RTTY** Mode	CTRL-RTTY
Transmit	CTRL-XMIT or ESC
Receive	CTRL-RCV or ESC
Change **Shift**	CTRL-SHIFT
Reverse Shift **Polarity**	CTRL-REVERSE
RY Test Message	CTRL-RY
Quick Brown Fox Test Message	CTRL-QBF
Change Speed	CTRL-SPEED*
Disable Split Screen	CTRL-/ (fraction bar)
Enable Split Screen	CTRL-/ (fraction bar)
Disable **Status** Line	CTRL-STATUS
Enable **Status** Line	CTRL-STATUS
Lock CW Key	CTRL-TUNE
Unlock CW Key	CTRL-TUNE
Send **ID**	CTRL-ID
Continuous Transmit	CTRL-XMIT*
Word Transmit	CTRL-XMIT*
Line Transmit	CTRL-XMIT*
AUTOSTART	CTRL-RCV*
SELCOM	CTRL-RCV*
HERE IS Message #1	HERE IS
HERE IS Message#2	SHIFT-HERE IS
Automatic CQ	CTRL-C
ASCII Operation	CTRL-SPEED*
Carrage Return, Line Feed	RETURN
Backspace and Delete	DELETE
Repeat a letter or function	REPEAT + desired key
BELL	CTRL-BELL
Send Baudot LTRS Character	CTRL-L
Send Baudot FIGS Character	CTRL-F
Send Baudot Blank Character	CTRL-B

*This feature is enabled by repeated depressions of the key indicated. The status line shows which mode has been selected.

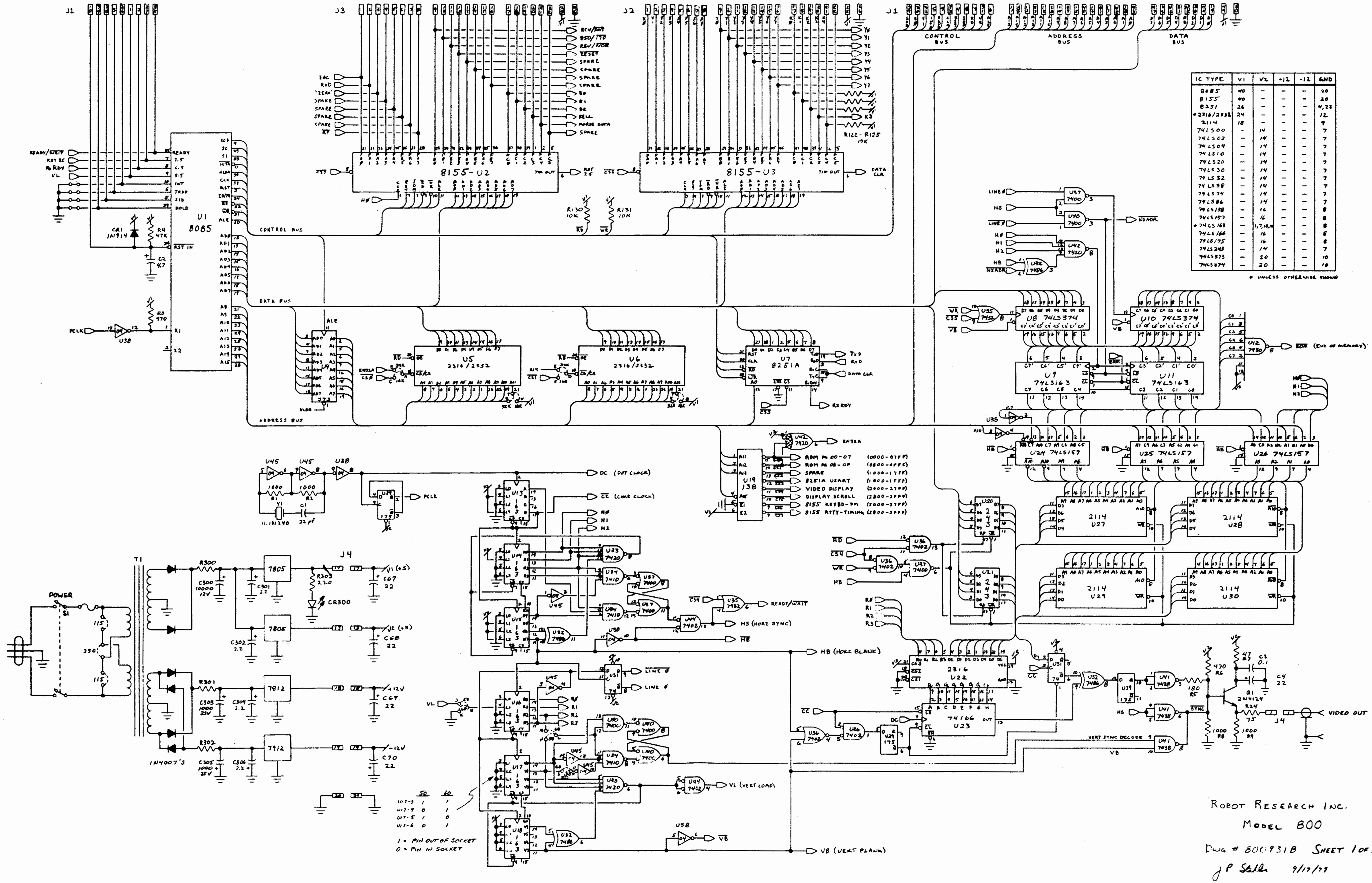
MORSE CODE FUNCTIONS

Function	Keystrokes
Select **Morse Code** Mode	CTRL-MORSE
Transmit	CTRL-XMIT or ESC
Receive	CTRL-RCV or ESC
Quick Brown Fox Test Message	CTRL-QBF
Change Transmit **Speed**	CTRL-SPEED; (number); RETURN
Disable Split Screen	CTRL-/ (fraction bar)
Enable Split Screen	CTRL-/ (fraction bar)
Disable **Status** Line	CTRL-STATUS
Enable **Status** Line	CTRL-STATUS
Lock CW Key	CTRL-TUNE
Send **ID**	CTRL-ID
Continuous Transmit Mode	CTRL-XMIT*
Word Transmit Mode	CTRL-XMIT*
Line Transmit Mode	CTRL-XMIT*
Random Transmit mode (Morse practice)	CTRL-XMIT*
Disable **Sidetone** Oscillator	CTRL-T
Enable **Sidetone** Oscillator	CTRL-T
HERE IS Message #1	HERE IS
HERE IS Message #2	SHIFT-HERE IS
Automatic CQ	CTRL-C
Repeat a letter or function	REPEAT + desired key
AR (end of message)	CTRL-A
AS (wait)	CTRL-W
BT (pause)	CTRL-B
KN (go ahead, station called)	CTRL-K
SK (end of communication)	CTRL-S

*This feature is enabled by repeated depressions of the key indicated. The status line shows which mode has been selected.

SSTV FUNCTIONS

Function	Keystrokes
Select **SSTV** Mode	CTRL-SSTV
Transmit **Grey Scale** Pattern	CTRL-GRY SCL
Return to SSTV Keyboard	CTRL-GRY SCL
Transmit **Checkerboard** Pattern	CTRL-CHECKER
Return to SSTV Keyboard	CTRL-CHECKER
Change **number of lines** transmitted	CTRL-LINES; (number)
Black/White **Reversal**	CTRL-REVERSE
Change Character **Size**	CTRL-CHARS
Clear Screen	CTRL-CLEAR
Home Cursor to upper left	CTRL-HOME
Move Cursor **Left**	CTRL-←
Move Cursor **up**	CTRL-↑
Move Cursor **right**	CTRL-→
Move Cursor **down**	LINE FEED
Carrage Return and line feed	RETURN
Backspace and Delete	DELETE



IC TYPE	V1	V2	+12	-12	GND
8085	40	–	–	–	20
8155	40	–	–	–	20
8251	26	–	–	–	4,22
*2316/2332	24	–	–	–	12
2114	18	–	–	–	9
74LS00	–	14	–	–	7
74LS02	–	14	–	–	7
74LS04	–	14	–	–	7
74LS10	–	14	–	–	7
74LS20	–	14	–	–	7
74LS30	–	14	–	–	7
74LS32	–	14	–	–	7
74LS38	–	14	–	–	7
74LS74	–	14	–	–	7
74LS86	–	14	–	–	7
74LS138	–	16	–	–	8
74LS157	–	16	–	–	8
*74LS163	–	1,7,10,16	–	–	8
74LS166	–	16	–	–	8
74LS175	–	16	–	–	8
74LS243	–	14	–	–	7
74LS373	–	20	–	–	10
74LS374	–	20	–	–	10

* UNLESS OTHERWISE SHOWN

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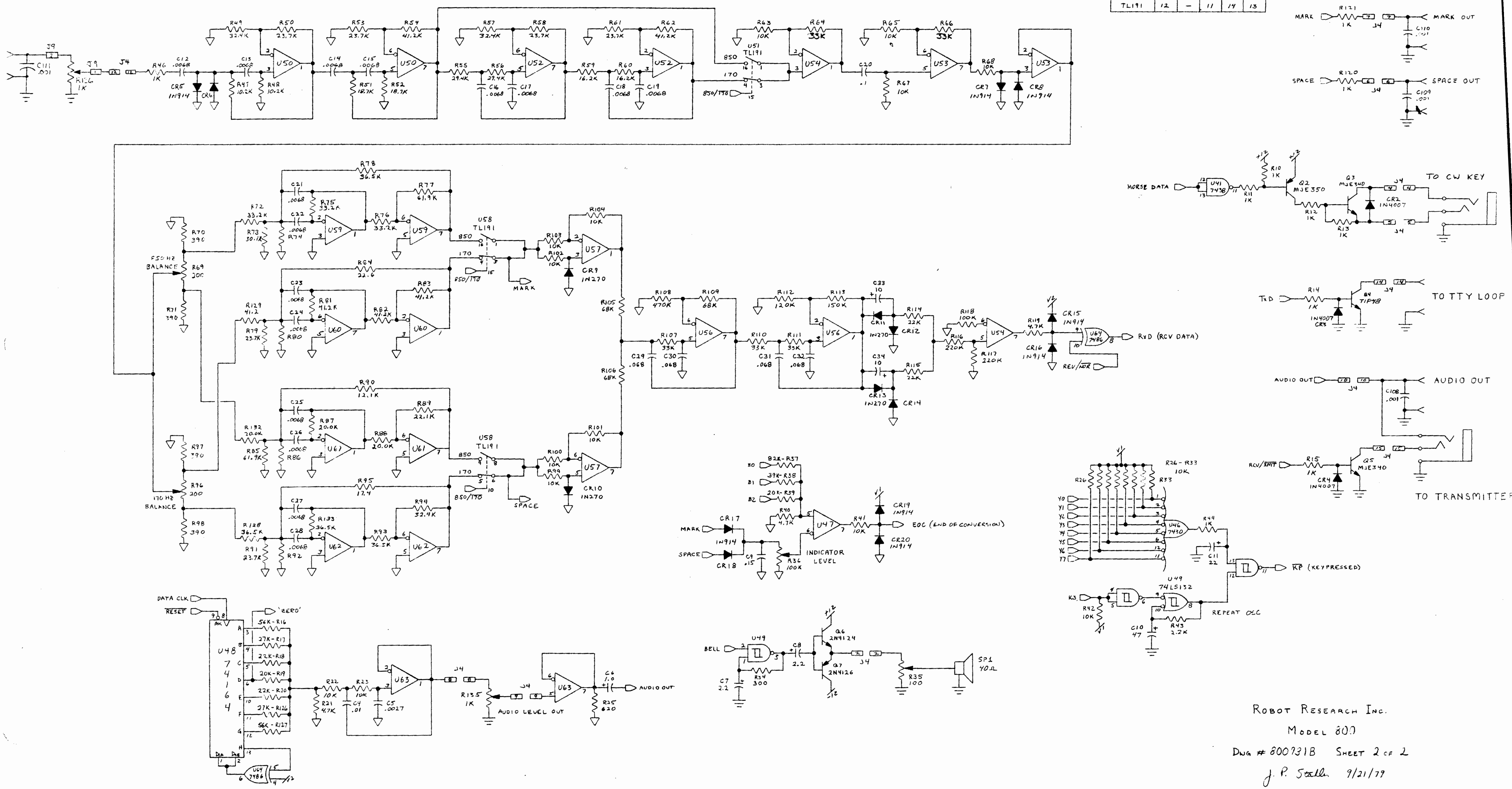
MODEL 800

DWG # 800931B SHEET 1 OF 2

J P Stalla 9/17/79

IC TYPE	V1	V2	+12	-12	GND
1458	—	—	8	4	—
74LS86	—	14	—	—	7
74LS30	—	14	—	—	7
74LS132	—	14	—	—	7
74LS164	—	14	—	—	7
TL191	12	—	11	14	13

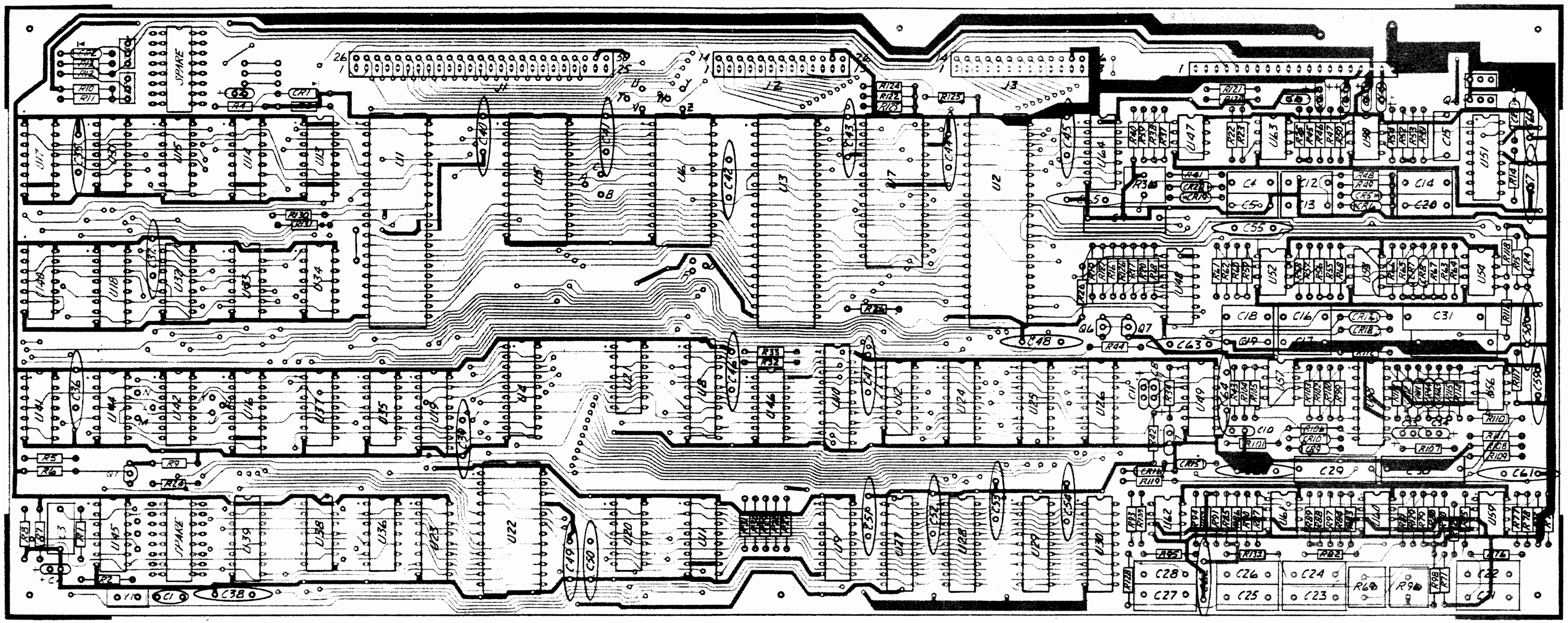


Robot Research Inc.

Model 800

Dwg # 800731B Sheet 2 of 2

J. P. Staller 9/21/79



NOTES: UNLESS OTHERWISE SPECIFIED

1. CAPACITORS C35 THRU C65 ARE .1µf BY-PASS

DASH NO.	NEXT ASSY	USED ON
APPLICATION		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

FRACTIONS	.XX	.XXX	ANGLES
±	±	±	±

MATERIAL

FINISH

CONTRACT NO.

PREPARED	TEX	12-18-79
CHECKED		
APPROVED		
APPROVED		

ROBOT RESEARCH INC.

PRINTED WIRING BOARD MODEL 800

SIZE	CODE IDENT NO.	NUMBER
D		800250A

SCALE 2/1 SHEET 1 OF 1