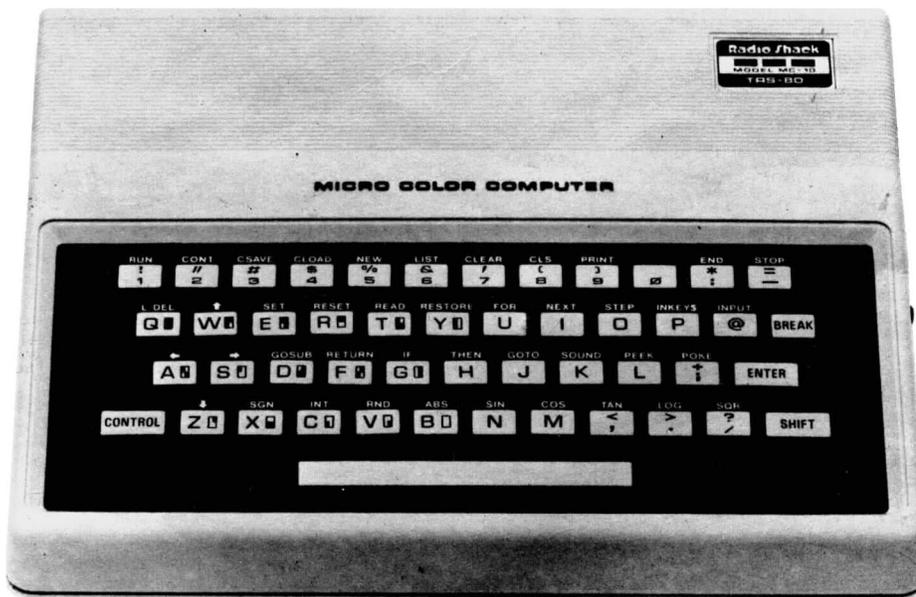


Radio Shack® Service Manual

TRS-80® MICRO COLOR COMPUTER MODEL MC-10 Catalog Number 26-3011



CUSTOM MANUFACTURED FOR RADIO SHACK, A DIVISION OF TANDY CORPORATION

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[Editor's Note: I would also like to express my thanks to RadioShack for permitting the distribution of this manual. I hope you find it useful. I have found a few typos and inconsistencies in the Service Manual that I have noted in an italicized font like this. JMM.]

SECTION I

SYSTEM DESCRIPTION

SYSTEM DESCRIPTION

The MC-10 Micro Color Computer is a fully expandable microprocessor system. It is composed of a 6803 central processing unit, 4K of static RAM, 8K of Basic ROM, and a 6847 video display generator. The microcomputer is also interfaced to a 48-key keyboard and provides the logic to execute a 1500 Baud cassette interface and a RS-232 serial interface. The system operates on a common color burst frequency of 3.579545 MHz. This main clock is divided by 4 in the CPU to yield an operating speed of 0.89 MHz.

In operation, the 4K of static RAM is shared between the CPU and the video display generator. This time multiplexing is based on the processor clock E. The CPU will be granted access to the RAM (upon request) only during the high state of E. This allows efficient usage of the RAM with no waiting by the CPU and no visible conflict on the display.

The 6847 VDG provides a display on a TV screen of 32 characters by 16 rows. It also allows a 64 x 32 semigraphics mode with eight colors. This display utilizes a minimum amount of system RAM (512 bytes).

The final elements of the microcomputer system are the I/O devices. The MC-10 is interfaced to a 48-key keyboard which generates the codes for upper and lower case characters, graphics symbols, and single stroke keyboard entry. The computer also provides a 1500 baud cassette interface for fast and reliable data and program storage and a limited signal RS-232C interface. The RS-232C interface allows either a printer or a modem to be used with the MC-10.

SYSTEM BLOCK DIAGRAM

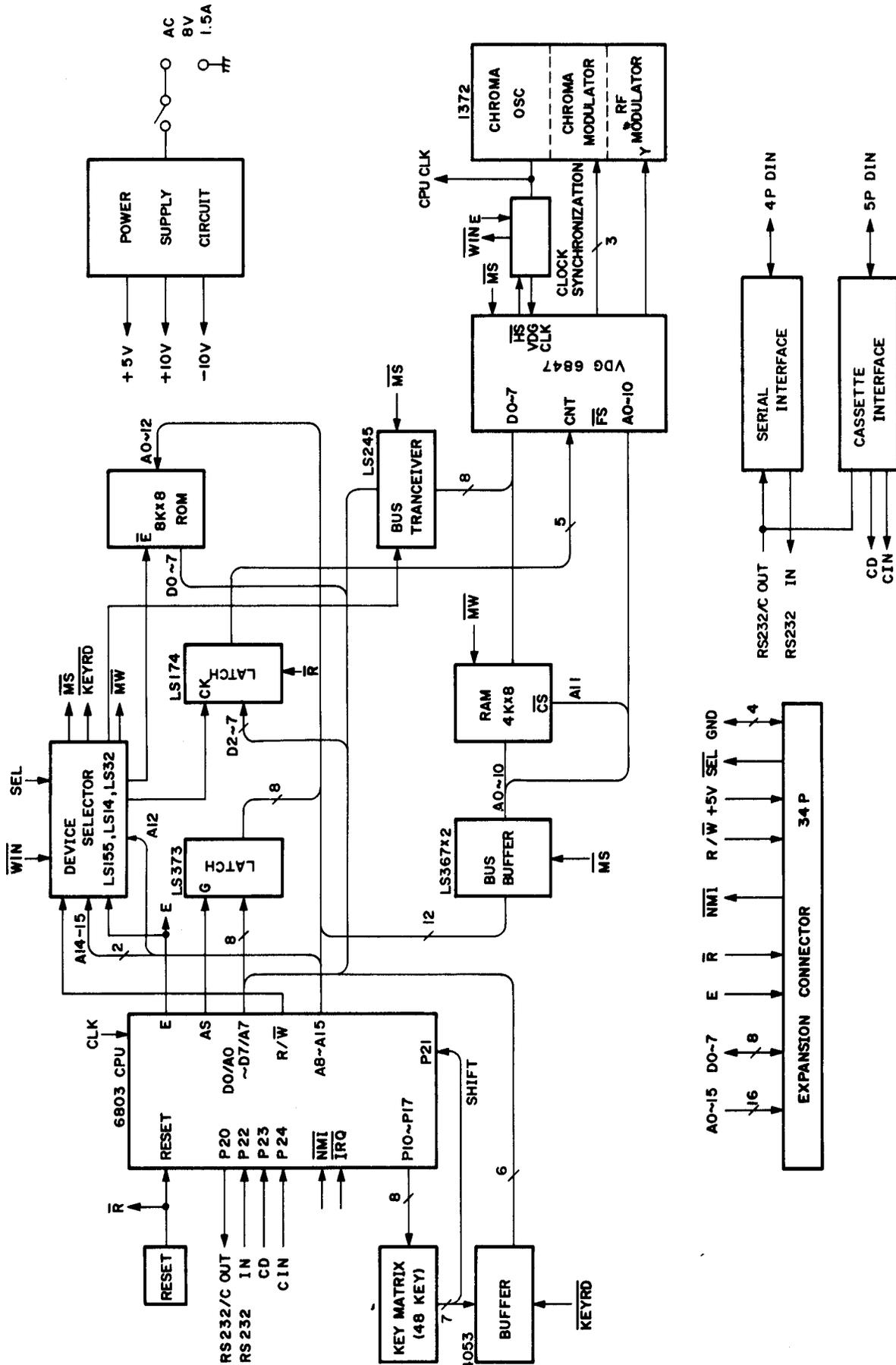


Figure 1

MEMORY MAP

Hex Address

C000 - FFFF	16K ROM (only 8K used)
9000 - BFFF	16K I/O Slot (Keyboard and VDG control)
4000 - 8FFF	16K RAM (4K - 20K used)
0100 - 3FFF	Not Used
0080 - 00FF	RAM internal to the 6803
0015 - 007F	Not Used
0014	RAM Control Register
0013	Not Used
0012	Not Used
0011	Not Used
0010	Not Used
000F	Port 3 Control and Status Register
000E	Input Capture Register (low byte)
000D	Input Capture Register (high byte)
000C	Output Compare Register (low byte)
000B	Output Compare Register (high byte)
000A	Counter (low byte)
0009	Counter (high byte)
0008	Timer Control and Status Register
0007	Not Used
0006	Not Used
0005	Not Used
0004	Not Used
0003	Miscellaneous I/O Data Register
0002	Keyboard Output Lines
0001	Data Direction Register for miscellaneous I/O
0000	Data Direction Register for keyboard lines

SECTION II

SPECIFICATIONS

SPECIFICATIONS

Power Supply AC/AC adaptor	Input	120V/60Hz	
	Output	8.0V/1.5A 16W	
RF Modulator For U.S.A./CANADA	Ch.	FC (MHz)	Fsc (MHz)
	3	61.25 +/-0.25	4.5 +/-0.2
	4	67.65	4.5
Output Impedance		75 ohm	
RF Output Terminal		RCA jack	
RF Output Level		1.5 - 2.8 mV at 75 ohm	
Central Processing Unit 6803 8-bit processor clock speed 0.89 MHz			
Memory Size ROM (for BASIC) RAM		8K 4K (expandable up to 20K-external)	
Video Display Character display		512 (32 x 16) upper case characters	
Semi-Graphic display Color		64 x 32 elements 8 colors - Green, Yellow, Blue, Red, Buff, Cyan, Magenta, Orange	
Interface Printer Cassette Bus line		RS232C, 4 pin DIN 5-pin DIN 1500 baud 34-pin Cartridge connector	
Switch Box Isolation		more than 60 dB	
Dimensions 8-1/2" x 1-7/8" x 7"			
Weight 1.75 lbs (.7875 kilograms)			

SECTION III

DISASSEMBLY / REASSEMBLY

DISASSEMBLY

1. Unplug the units from the AC wall outlet and disconnect all cables from the rear panel.
2. Turn the computer over and remove the four screws from the case bottom. One of the screws is located under the warranty seal in the upper right corner of the case bottom.
3. Turn the computer right side up. Disconnect the snap locks located on the right and left side of the case by placing a slotted screw driver in the groove between the top and bottom cases, approximately 2.7 inches from the rear of case. Push in and turn the screwdriver to pop the case apart.
4. Disconnect Keyboard cable from wire connector. **NOTE:** Pull flat wire upward.
5. Remove three screws that fasten the PC Board to the bottom of the case. Remove the PC Board.
6. Use tweezers to remove eleven clips that fasten the bottom shield to the P.C. Board.
7. Locate the eight positions where the top shield is soldered to the PC Board. Remove this solder with solder wick or a desoldering tool. Bend the protruding edge of the shield upward until it is parallel to the slot and remove top shield.

REASSEMBLY

1. Install the top PC Board shield. Solder the shield to the ground plane at eight points.
2. Install the bottom shield with metal side up. Secure to the PC Board with eleven clips.
3. Install PC Board in bottom of case. Secure with three screws.
4. Install the two keyboard cables in their respective connectors. This will be easier if both hands are used and you are facing rear of unit. Refasten cable restraints.
5. Join the top and bottom cases and push them together at the snap lock positions. This is a tight fit, therefore repositioning of the cases may be required.
6. Install four screws in bottom of case.

1. **Removal of Top Cabinet**
Remove 4 screws as shown in Figure A.

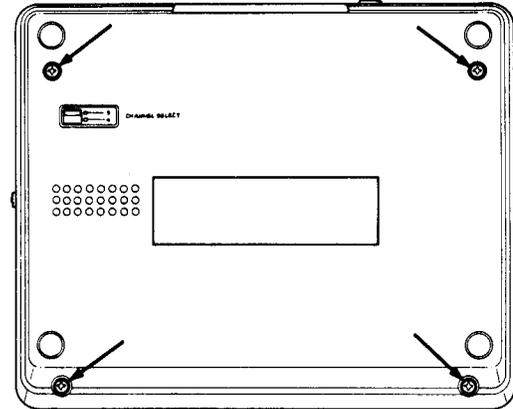


Figure A

2. **Removal of P.C. Board**
Remove flat wires of keyboard from connector.
Remove 3 screws as shown in Figure B.

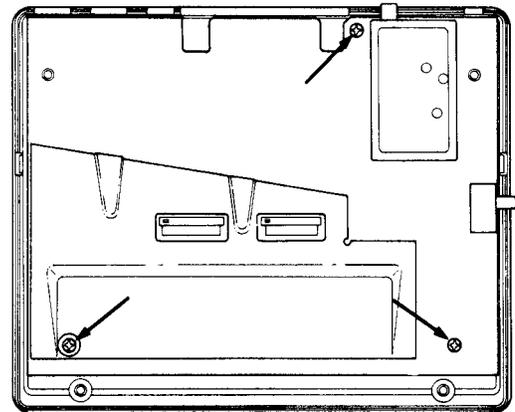


Figure B

3. **Removal of Keyboard**
Remove 4 screws as shown in Figure C.

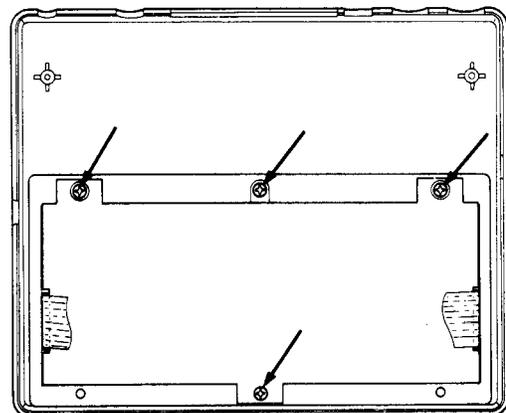


Figure C

SECTION IV

THEORY OF OPERATION

CPU-6803

The main component of this microcomputer system is the 6803 CPU. This is a 40-pin integrated circuit which provides the address, data, and miscellaneous control signals. The CPU receives the main clock frequency of 3.579545 MHz from the modulator assembly and divides this by 4 to produce an operating frequency of 0.89 MHz. This frequency is available as the processor clock E.

This processor chip is designed to be used in a minimum hardware configuration so, I/O lines are provided directly from the CPU chip. In the MC-10 computer these I/O lines are used to address the keyboard and to support the cassette and RS232 interface.

The 6803 CPU is able to support several different modes of operation. For the MC-10 the CPU is operating in mode 2. The CPU mode is selected at power-up by the state of lines P20, P21, and P22. P20 and P22 are connected by a diode to Reset so that during power-up these lines are low. P21 is connected to a pull-up resistor so that during power-up it is high.

Mode 2 operates with 128 bytes of internal RAM, a full 16 line address bus and an 8 bit data bus which is multiplexed with the lower eight address lines. Due to the multiplexed address and data bus, two external devices are required. A 74LS373 is used to latch the address lines. This occurs during the low portion of the E clock when the CPU is not accessing external devices. The latch signal (AS) is provided by the CPU. The other external device is a 74LS245. This bi-directional buffer is required to isolate the RAM output lines, which are providing data to the video display generator during the low portion of the E clock, away from the CPU data bus. This buffer is controlled by the device selection logic.

RESET CIRCUIT

The reset circuit is composed of switch S1 diode D9, resistor R24, capacitor C8, and two gates of IC U12. R24 and C8 form a simple time constant so that during power up or whenever the reset switch is pressed, the reset line will stay low for a few milliseconds before returning to the high state. The reset input to the 6803 does not provide hysteresis so the reset signal must be buffered by U12 before being connected to the CPU. The final component of the circuit is diode D9 which is provided to allow for rapid cycling of the power switch.

ROM

The MC-10 uses a single 8K x 8 ROM to store the BASIC operating language. This is located in a 16K memory map segment between hex C000 - FFFF. This device is connected directly to the multiplexed address/data, however any possible contention is avoided by enabling the ROM only during the high cycle of the E clock.

CASSETTE INTERFACE

The cassette interface is composed of an output attenuator connected to a CPU output line and an input zero crossing detector. Most of the important cassette parameters are controlled by software. However, there is no cassette motor relay in the Micro Color Computer and cassette recorder operation must be manual.

The cassette format chosen uses a sinewave of 2400 or 1200 Hertz to yield a Baud rate of approximately 1500 Baud. In this format, a 0 (or logic low) is represented by one cycle of 1200 Hertz. A 1 (or logic high) is represented by one cycle of 2400 Hertz. A sample of data is shown in Figure 2. A typical program tape would consist of a leader of alternating 1's and 0's, followed by one or more blocks of data. A block of data is composed of 0 to 255 bytes of data with a checksum, sync byte, and the block length.

The output circuit utilizes a CPU output line to produce a sinewave of 1200 or 2400 Baud. This signal is then attenuated to approximately 1 volt and connected to the auxiliary input of the cassette recorder.

The input circuit is a zero crossing detector. R12 is a termination resistor for the cassette output. Resistors R16 and R17 are used to bias one input of the comparator at 1 volt. The other input is also biased at 1 volt by R15 and the series combination of R14 and R13. If the AC input from the recorder goes negative, diode D6 turns on and sets the input to the compara-

tor equal to 1/2 volt. Since the other input is biased at 1 volt, the comparator output is switched to the high state. If the AC input from the recorder is positive, diode D6 is turned off and the input to the comparator will be at some point greater than 1 volt, in which case, the comparator output will be low.

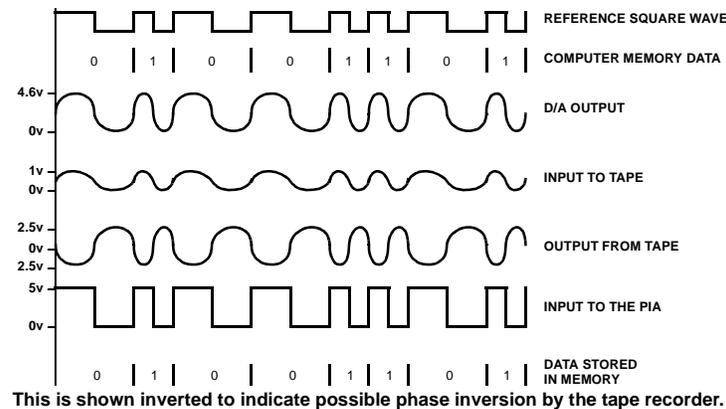


Figure 2. Sample Data of Cassette Format

The comparator output is open-collector so pullup resistor R19 is provided to generate a TTL signal. R18 is used to prevent oscillation of

the comparator. The final portion of the cassette circuit is capacitor C7 which is used to isolate noise from the cassette cable.

DETAILED TAPE FORMAT INFORMATION

The standard MC-10 tape is composed of the following items:

1. A leader consisting of 128 bytes of hex 55
2. A Namefile block
3. A blank section of tape approximately equal to 0.5 seconds in length; this allows BASIC time to evaluate the Namefile.
4. A second leader of 128 bytes of Hex 55
5. One or more Data blocks
6. An End of File block

The block format for Data blocks, Namefile Blocks, or an End of File block is as follows:

1. One leader byte - 55H
2. One sync byte - 3CH
3. One block type byte — 01H = Data, FFH = End of File, 00H - Namefile
4. One block length byte - 00H to FFH
5. Data - 0 to 255 bytes
6. One checksum byte - the sum of all the data plus block type and block length
7. One leader byte - 55H

The End of File block is a standard block with a length of 0 and the block type equal to FFH. The Namefile block is a standard block with a length of 15 bytes (0FH) and the block type equals 00H. The 15 bytes of data provide information to BASIC and are employed as described below:

1. Eight bytes for the program name
2. One file type byte - 00H = BASIC, 01H = Data, 02H = Machine Language
3. One ASCII flag byte - 00H = Binary, FFH = ASCII
4. One Gap flag byte - 01H = Continuous, FFH = Gaps
5. Two bytes for the start address of a machine language program
6. Two bytes for the load address of a machine language program

RS-232C INTERFACE

The RS-232C interface utilizes a 4-pin DIN connector (J2). This interface allows the computer to have serial communication with printers, modem, or other computers. The four signals used by the interface are:

1. CD — a status input line
2. RS232IN — serial data input
3. GROUND — zero voltage reference
4. RS232OUT — serial data out

The pin configuration for the DIN connector is shown in Figure 3.

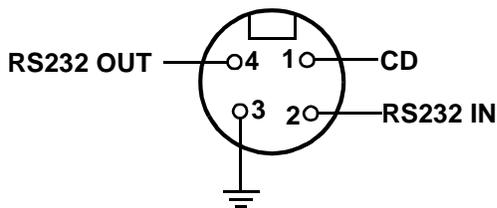


Figure 3. RS-232C Connector Pin-Out

In general, an RS232C signal uses negative logic. Therefore, a voltage greater than +3 volts is defined as a SPACE, or logical 0. A voltage less than -3 volts is defined as a MARK, or logical 1. The range of -3 to +3 volts is undefined.

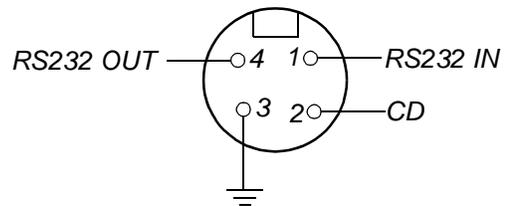
The RS-232C interface circuitry is shown on the upper right corner of the schematic. The output signal from the CPU output P20 is tied to a 741C op-amp (U16). This same output is also used for the cassette output, so care must be taken to ensure that a cassette output does not appear as an RS-232 output. The op-amp is referenced at 1.4 volts by resistors R2 and R3. This reference causes the op-amp to swing between the two power supply voltages (Vcc and Vee) as the TTL input switches states. A 100 ohm resistor (R1) is included to provide a current limit on the output. The two input signals (RS232IN and CD) utilize identical circuits and share a common bias resistor network. RS232IN (pin 4 of U15) is tied to CPU input P22 and CD (pin 6 of U15) is tied to CPU input P23. The inputs from the external device are connected to the positive side of a diode. This diode blocks the application of a negative voltage to the comparator (U15). When a positive voltage is applied, the diode conducts and the voltage is applied to the input. The comparators are referenced at two volts, by R5 and R6,

thus if the input voltage is greater than 2.6 volts, the comparator is turned on. The comparator outputs are open-collector so pull-up resistors R8 and R9 are required.

[I think there is a consistent error in the documentation of the pins here, specifically, CD and RS232IN are reversed.]

1. RS232IN — serial data input
2. CD — a status input line
3. GROUND — zero voltage reference
4. RS232OUT — serial data out

[And the diagram should look like:]



[and the text should read...]

“The two input signals (RS232IN and CD) utilize identical circuits and share a common bias resistor network. CD (pin 4 of U15) is tied to CPU input P22 and RS232IN (pin 6 of U15) is tied to CPU input P23.”

I/O CONNECTOR

In addition to serial interfaces, the MC-10 also provides a full complement of CPU bus signals that are accessible at the 34-pin cartridge connector. This allows expansion of the MC-10 with

external memory modules or ROM software modules. Table 1 provides a complete list of the signals and a brief description of each.

Table 1. I/O Connector Signals

Pin	Signal Name	Description
1	GND	Signal Ground
2	GND	Signal Ground
3	D0	CPU Data Bit 0
4	D1	CPU Data Bit 1
5	D2	CPU Data Bit 2
6	D3	CPU Data Bit 3
7	D4	CPU Data Bit 4
8	D5	CPU Data Bit 5
9	D6	CPU Data Bit 6
10	D7	CPU Data Bit 7
11	R/W	CPU Read/Write Signal
12	A0	CPU Address Bit 0
13	A1	CPU Address Bit 1
14	A2	CPU Address Bit 2
15	A3	CPU Address Bit 3
16	A4	CPU Address Bit 4
17	A5	CPU Address Bit 5
18	A6	CPU Address Bit 6
19	A7	CPU Address Bit 7
20	A8	CPU Address Bit 8
21	A9	CPU Address Bit 9
22	A10	CPU Address Bit 10
23	A11	CPU Address Bit 11
24	A12	CPU Address Bit 12
25	A13	CPU Address Bit 13
26	A14	CPU Address Bit 14
27	A15	CPU Address Bit 15
28	E	Main CPU Clock (0.89 MHz)
29	SEL	Input to Disable Device Selection
30	RESET	Main Reset and Power-up Clear Signal to the System
31	NMI	Non-Maskable Interrupt to the CPU
32	+5v	+5 volts (250 mA)
33	GND	Signal Ground
34	GND	Signal Ground

KEYBOARD INTERFACE

The Keyboard interface for the MC-10 utilizes the I/O lines of the 6803 CPU to reduce the logic required to a single six input CMOS buffer and seven pull-up resistors.

To read the keyboard, only one column is enabled by writing a zero to one of the eight CPU I/O lines that corresponds to that column, and by writing ones to all the other lines. If a key has been pressed in that column, one of the input lines will be a zero and the key location will correspond to the bit that is low. By scanning each column in the keyboard, all of the keys may be checked.

TV SWITCH BOX

The antenna switch box consists of a switch and a balun, with connectors provided for attachment to the computer, the TV antenna, and the home TV. The switch box is connected to the customer's TV through the 300 ohm twin lead output. The TV antenna is attached directly to the switch box. The computer output is connected through a 75-ohm coaxial cable to the phone plug input on the switch box. Figure 4 shows a schematic of the antenna switch box.

From the computer, the signal is connected to a balun in the switch box which matches the modulator's 75-ohm output impedance to a TV's 300 ohm antenna input impedance. This signal is then connected to the switch. The switch is specially designed to provide the 60dB of isolation required between the computer and the TV antenna.

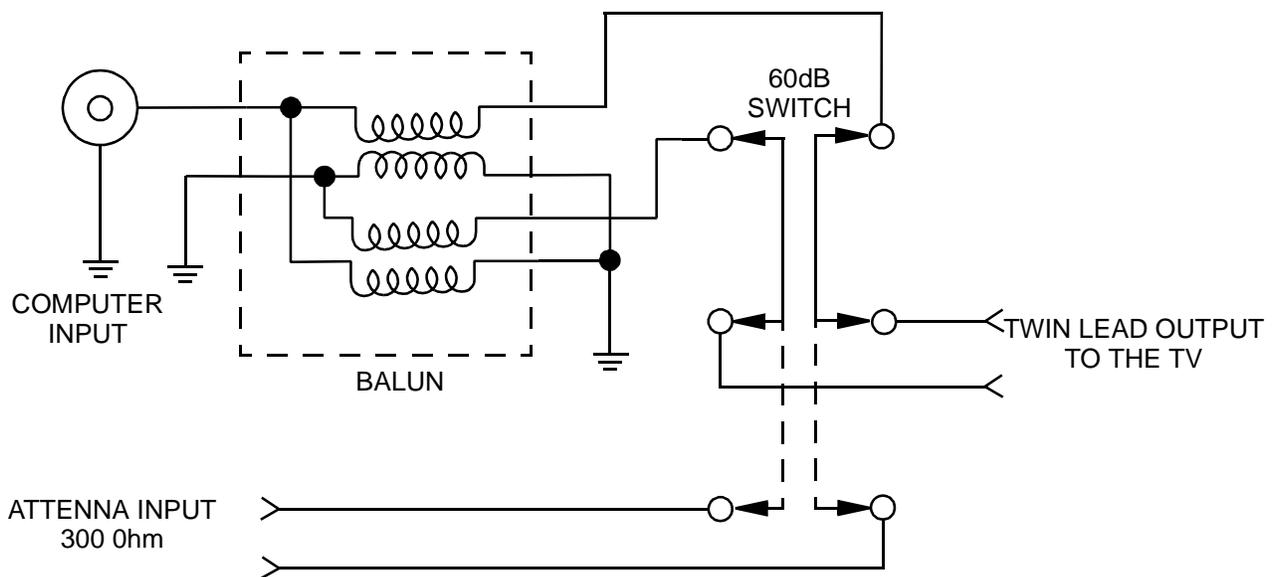


Figure 4. Antenna Switch Box Schematic

POWER SUPPLY

The MC-10 power supply utilizes an external power pack to supply 8 VAC at 1.5 amps. This input AC voltage is connected through the power switch to the bridge rectifier. The MC-10 operates primarily on +5 volts, so the negative output of the bridge is grounded to provide a larger current capability to the positive supply. The output from the bridge is filtered by C1 and C5 and is connected to the +5 volt regulator. The regulator provides +5 volts at a maximum of 1.5 amps to the digital circuitry.

A small amount of negative voltage is required to the RS-232 output op-amp. This current is supplied by the simple circuit composed of D2, D3, C3, C4, and C32. This circuit operates by using capacitor C3 for isolation from the primary bridge circuit. Then the negative voltage is rectified by D2 and D3. The negative supply voltage is then filtered by C4 and C32 before being connected to U16. This is an unregulated output. However, when coupled with the output from the main bridges, it provides a larger differential voltage (that is the source of the positive op-amp voltage) with no detrimental effects on the operation of the op-amp.

VDG

The video interface function in the MC-10 is performed by the MC6847. This is a flexible video display generator that will produce nine colors (eight colors and black), an alphanumeric display mode, and several high resolution graphics modes.

In the MC-10 the VDG is interfaced to 4K of static RAM and the mode control inputs are controlled by a 74LS174 register. However, the only modes of operation which are supported by the machine are the alphanumeric mode and the alpha semigraphic-4 mode. Table 4 lists all of the alphanumeric characters which may be displayed by the VDG along with the hex code which will produce the character. Table 2 lists the required control bit values to produce the MC-10 display modes.

In the MC-10 the 4K of RAM is shared between the CPU and video display generator. This is accomplished by providing buffers between the address lines (U5 and U6) the data line (U7), and synchronizing the operation of the VDG to the CPU.

Normally the three buffers are disabled so that the VDG address is being supplied to the RAM and the RAM data is supplied to the VDG. However, during a CPU access to the RAM, the three buffers are enabled and the MS* line is used to disable the address lines of the MC6847. This provides the CPU address to the RAM chips and allows a CPU read or write cycle to occur.

Table 2. VDG Control Register

Control Register Bits					DMA Bits		Mode Selected
D6 CSS	D5 A*/G	D4 GMD	D3 GM1	D2 GM2 (INT*/EXT)	D6 INV	D7 A*/S	
0	0	X	X	0	0	0	Alphanumeric green
0	0	X	X	0	1	0	Alphanumeric inverted green
1	0	X	X	0	0	0	Alphanumeric orange
1	0	X	X	0	1	0	Alphanumeric inverted orange
X	0	X	X	0	X	1	Semigraphics Four

Table 3

VDG PINS		COLOR			TV SCREEN		VDG DATA BUS	COMMENTS																																																		
CSS	INV	Character Color	Background	Border	Display Mode	Detail																																																				
0	0	Green	Black	Black	32 Characters in columns			The ALPHANUMERIC INTERNAL mode uses an internal character generator which contains the following five dot by seven dot characters @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [\] → → SP ! " # \$ % & ' () * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ?																																																		
0	0	Orange	Black	Black	16 Characters in rows																																																					
x	x	<table border="1"> <tr><td>Lx</td><td>C2</td><td>C1</td><td>C0</td><td>Color</td></tr> <tr><td>0</td><td>x</td><td>x</td><td>x</td><td>Black</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>Green</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>1</td><td>Yellow</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>0</td><td>Blue</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>1</td><td>Red</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>0</td><td>Buff</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>1</td><td>Cyan</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>0</td><td>Magenta</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>Orange</td></tr> </table>	Lx	C2	C1	C0	Color	0	x	x	x	Black	1	0	0	0	Green	1	0	0	1	Yellow	1	0	1	0	Blue	1	0	1	1	Red	1	1	0	0	Buff	1	1	0	1	Cyan	1	1	1	0	Magenta	1	1	1	1	Orange		Black	64 Display elements in columns 32 Display elements in rows			The SEMIGRAPHICS FOUR mode uses an internal "coarse graphics" generator in which a rectangle (eight dots by twelve dots) is divided into four equal parts. The luminance of each part is determined by a corresponding bit on the VDG data bus. The color of illuminated parts is determined by three bits. It requires 512 bytes of display memory.
Lx	C2	C1	C0	Color																																																						
0	x	x	x	Black																																																						
1	0	0	0	Green																																																						
1	0	0	1	Yellow																																																						
1	0	1	0	Blue																																																						
1	0	1	1	Red																																																						
1	1	0	0	Buff																																																						
1	1	0	1	Cyan																																																						
1	1	1	0	Magenta																																																						
1	1	1	1	Orange																																																						

Table 4. AVAILABLE CHARACTERS (00 - 7F)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	SPACE BAR	!	"	#	\$	%	&	'	()	*	+	,	-	.	/	
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[\]	→	⇒
6	ⓐ	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ	ⓕ	ⓖ	ⓗ	ⓘ	ⓙ	ⓚ	ⓛ	ⓜ	ⓝ	ⓞ
7	ⓢ	ⓠ	ⓡ	ⓢ	ⓣ	ⓤ	ⓥ	ⓦ	ⓧ	ⓨ	ⓩ	⓪	⓫	⓬	⓭	⓮

○ = INVERTED CHARACTER
 - = UNDEFINED

DEVICE SELECTION

A 74LS155 is used along with four OR gates and two inverters to provide device selection in the MC-10. The 74LS155 uses A15 and A14 to divide the memory map into four 16K segments. The bottom 16K segment is not used externally to the CPU. The next 16K segment is used for system RAM. The third 16K segment is used to read the keyboard and to write to the VDG control register. The final 16K is reserved for system ROM.

Both sections of the LS155 are used so that all of the device selects may be gated with E, while the CPU write signal for the RAMs is gated with window* (U18 pin 6). The disable inputs to the 74LS155 are tied through an inverter to the cartridge connector and to a pull-up resistor. This

allows an external device to change the MC-10 memory map. Also, the disable signal for the memory write is ORed with A12 to prevent a complete overlap of the 4K of RAM into the 16K memory map segment.

From the output of the 74LS155 the IY1 output is used to switch the tri-state controls for the memory address and data buffers. The IY2 output is ORed with R/W and inverted R/W to provide a write pulse to the VDG control register (U8) and a read enable for the keyboard input buffer. The final output (IY3) is used to select the ROM chip.

SYSTEM TIMING

The main clock frequency of 3.579545 MHz is produced by the oscillator circuit in the modulator. This clock is buffered by one gate of U12 before being connected to the CPU and to the clock synchronization circuitry.

Internal to the CPU chip, the main clock frequency is divided by 4 to produce the processor clock E. This clock is used to synchronize all system operations to the CPU. Figure 5 shows the main clock and timing signals used in the MC-10.

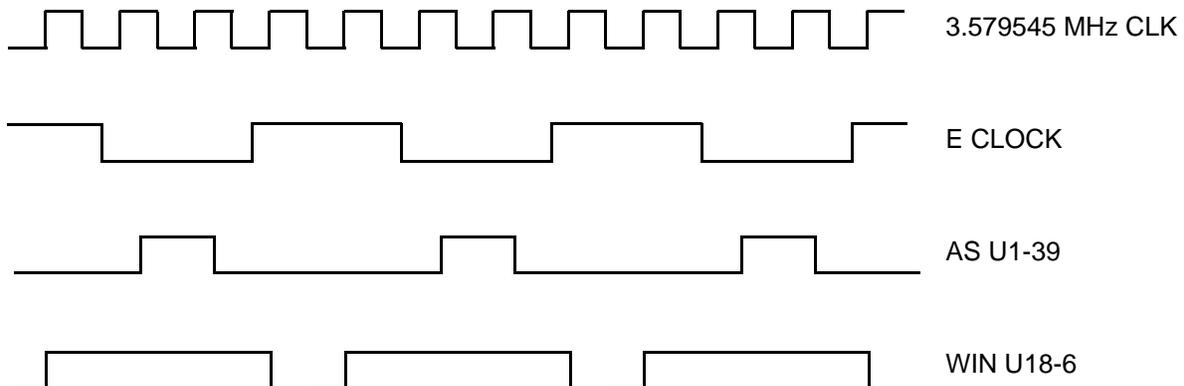


Figure 5

MODULATOR

The MC6847 (VDG) has access to the RAM during the low portion of the E clock. Also during the low portion of E, the signal AS is used to latch the address lines in the latch (U2). During the high portion of E, all CPU address and data lines are valid and any accesses to the RAM or ROM occur during this time.

The signal window is used for two purposes. The first usage is to gate the write signal. The 2K x 8 static RAM requires setup and hold time on the address and data line, during a write cycle. The address and data lines are both valid for the high portion of the E clock. By gating the write pulse with window, a safety margin is created, so that the write pulse will never go low while the address or data is changing.

The second usage of the signal window is for synchronization of the VDG and the CPU. The two devices must be synchronized to allow both the CPU and the VDG to use the system RAM with no conflict. This has been accomplished in the MC-10 by forcing the VDG to latch data at the end of the low portion of the E clock. To do this, low transition of the signal HS* is only allowed to happen during the active portion of the signal window. If HS* occurs during the window, the latching of data will occur at the end of the low portion of the E clock.

RAM

The MC-10 uses two 2K x 8 static RAM chips for a total internal memory of 4K. The RAM chips receive their address lines from either the MC6847 (VDG) or the CPU. This switching is accomplished by tri-state buffers which are controlled by the MS* line. The individual RAM chip is selected by VA11, the 12th address line, and since the OE* input is grounded, one RAM is always enabled. The WE* line is generated by the CPU address decoding logic, and is high except when the CPU is writing to RAM.

The outputs from the MC6847 are connected directly to the modulator. The modulator unit is built around the MC1372. This is a linear integrated circuit which is designed to interface to the MC6847 and produce an RF output for connection to the TV. Figure 6 shows a block diagram of the MC1372 chip.

The 3.579545 MHz crystal and associated components are connected between pins 1 and 2. This provides the color burst frequency and the main clock for the MC-10. The duty cycle input is left unconnected to produce a 50% duty cycle clock.

The other inputs to the MC1372 are the luminance input, ϕA , ϕB , and the color reference voltage input. All of these inputs are connected directly to the MC6847 chip.

The chroma modulator output is filtered by an R-C network between pins 8 and 10 of the MC1372. Also the 4.5 MHz frequency modulated sound signal is AC coupled in at pin 10. The sound input to the modulator is used to frequency modulate the 4.5 MHz oscillator composed of Q1 and the associated circuitry.

The channel selection for the modulator is performed by the tank circuit between pins 13 and 14 of the MC1372. This circuit allows the RF output to be switched from channel 3 to 4 by an external switch input.

The final RF output of the modulator is available at pin 12 of the MC1372. However, before this signal is connected to the output jack, a vestigial sideband filter must be used to suppress unwanted harmonics of the signal. This filter is shown in the schematic as the thirteen passive components before the RF output.

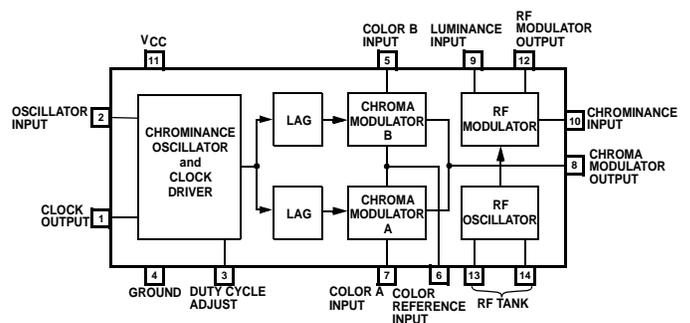


Figure 6. MC1372 Block Diagram

SECTION V

TROUBLESHOOTING

TROUBLESHOOTING

Problems with the MC-10 may be separated into two major areas - I/O problems and dead computer problems. If the computer will display the sign-on message, then a fairly simple set of testing procedures may be used to isolate the problem. If, however, the computer displays random characters on the screen or has no display, then a major failure has occurred.

In the case of a major failure, the first thing to check is the +5-volt power supply. If the voltage level is off by more than 10%, then the power supply is the problem. Refer to the Power Supply section for hints on how to isolate the problem.

If the power supply has a proper +5 volts output, then check the clock output from the modulator at U12 pin 13. If the clock is oscillating at the proper frequency, and you have no display, the problem is in the video area. Refer to the section on the video interface for hints on fixing this problem.

If the MC-10 displays garbage on the screen, then some problem is causing a failure of the CPU. At this point you will have to remove the top and bottom shield. After you have removed the two shields, test the operation of the MC-10 to be sure that the problem was not a short to the shield.

With both of the shields removed, check the address and data lines of the 6803. After the reset switch has been pressed, check for indications that the CPU is operating. If the CPU shows no signs of activity, then one of the input signals is preventing the CPU from operating or the CPU is bad.

If the CPU is operating, then the most likely problems are a memory or buffer chip failure or a short on the address or data bus. In this case you will have to methodically check the address and data lines, while looking for a line that shows a problem.

In the case of a simple I/O problem, please refer to the appropriate interface section discussion.

VIDEO INTERFACE

Almost all of the work for the video interface is performed by the VDG (U11 - MC6847). Therefore, this chip is the most likely source of a video problem. However, it is always a good idea to isolate the source of a problem before trying to desolder chips.

If the problem is no picture or a distorted picture, then a new switch box and cable should be tried. If you still do not have a picture, then use an oscilloscope to look at U11 pin 28. You should have a video signal at this point. If you do not have a video signal, check +5 volts (pin 17) and the 3.579 MHz clock (pin 33) , if you have both of these inputs and no video out, then U11 is bad.

If you have a video signal at pin 28, but no picture on your TV, then there could be a problem with the modulator. Check the +5-volt input before replacing the modulator.

The only other type of video failure which can occur in the MC-10 is the loss of synchronization with the CPU which will cause excess glitches on the screen. If this occurs, then the circuitry composed of U18 and U19 is failing.

KEYBOARD INTERFACE

The keyboard interface is composed of one resistor pack and one IC (U14). A keyboard failure will usually be caused by a mechanical failure of the keyboard, or a short or open in the cable. Mechanical failures will usually be only one or two isolated keys failing. Cable failures will cause an entire keyboard row or column to fail.

RS-232 INTERFACE

The RS-232 interface uses three simple level converter circuits. Isolating the problem will be an easy job of comparing the input to the output.

Connect a DIN-type plug to the serial I/O jack to short together pins 1, 2, and 4. Now, type in the following test program:

```
5 POKE 3,1
10 FOR X=0 TO 10: NEXT X
15 POKE3,0
20 FOR X=0 TO 10: NEXT X
25 GOTO 5
```

Run the program and check pin 2 of U16; a switching TTL waveform should be present. Pin 6 of U16 should have the same waveform except that it will be switching from +Vcc to -Vcc (the supply voltages of pins 4 and 7 of U16). Also check pins 4 and 6 of U15. These pins have the same waveform switching from 0 to +Vcc. The outputs of U15, pins 1 and 2 should show the original TTL signal.

CASSETTE INTERFACE

If you are having problems with the cassette circuit, short together pins 4 and 5 of the cassette DIN plug. Next run the program listed for the RS-232 interface test. The output pin is shared between RS-232 and cassette, so this test program will produce a switching TTL waveform on the output.

The output circuit is a simple attenuator, so the likely failure here should be a short to ground. The output on pin 5 of the DIN connector should be switching for 0 to +1 volt.

The input circuit is a zero crossing detector. It should convert the cassette signal back to the original TTL waveform at pin 13 of U15.

POWER SUPPLY

The power supply circuit in the MC-10 has a minimum component count so that a failure should be readily identifiable.

The first place to check if the computer has no +5-volt supply voltage is the output of the regulator. With the power pack unplugged, measure the resistance between the +5 output and

ground. If this shows zero resistance, the problem is a short to ground.

If the +5 output is not shorted, check the voltage with the power pack plugged in. You should have 8 VAC at the power ON-OFF switch. If this looks good, check the input to the regulator. Here you should see a full wave rectified voltage of 10 volts DC. If you do not, one of the following components could be bad: D1; C1 [C1] or C5; U15, U16, or U17.

The only major remaining component is the +5-volt regulator. If the regulator is receiving the proper input voltage, and there is no +5 volts, the regulator chip is bad.

Also, there is a simple circuit to supply an unregulated negative voltage to the RS-232 interface. If you are missing the negative voltage but the +5 volts is OK, then one of the diodes or the capacitors has failed.

MODULATOR

If clock does not appear at TP 2, there could be a problem with the modulator.

Check the +5 volts (pin 11 of MC1372) and the 3.579 MHz clock (pin 1 of MC1372).

If you cannot see the 3.579 MHz clock, check parts connected to pin 1 and pin 2 (R1, C2, C3, X1) .

If the 3.579 MHz clock is OK but picture is distorted, try to tune TV set by adjusting fine tuning.

If picture is distorted even after fine turning adjustment, replace modulator unit if you do not have Spectrum Analyzer.

If you have a spectrum analyzer, you can adjust inside of modulator.

Remove the modulator first.

Refer to disassembly instruction on page 10 and locate the four positions where modulator is soldered to P.C. Board. Remove this solder with solder wick or desoldering tool.

Bend the protruding edge of modulator until it is parallel to the slot and remove modulator.

ADJUSTMENT OF VSB (vestigial side band) FILTER

Make Connection according to Figure 7

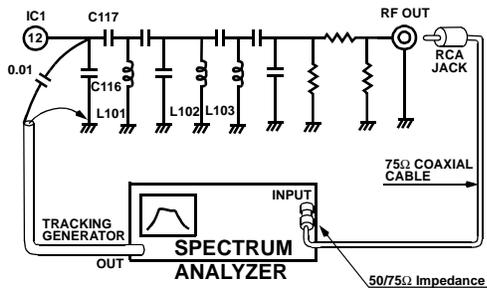


Figure 7

1. Adjust marker of tracking generator at 61.25 MHz (marker - 2)
2. Adjust L102 so lower side band peak point meets 61.25 MHz (marker - 2)
3. Adjust marker of tracking generator at 72.15 MHz (marker - 3)
4. Adjust L103 so higher side peak point meets 72.15 MHz (marker - 3)
5. Repeat steps 1 to 4 until lower and higher side band peaks agree with 61.25 MHz (marker - 2) and 72.15 MHz (marker - 3) Refer to Figure 8
6. Adjust L101 so that filter characteristic of -1 dB stays about within 12 MHz.
7. Adjust marker point of tracking generator at 57 MHz (marker - 1) and check the level difference between 61.25 MHz (lower side peak point - marker 2) and 57 MHz (marker - 1) is more than 20 dB.

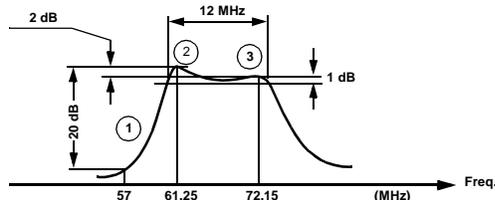


Figure 8

ADJUSTMENT OF VIDEO CARRIER FREQUENCY

Prepare switch, 0.01 μ F capacitor and 2.2K ohm resistor and 75 ohm coaxial cable with RCA and 50/75 ohm converter.

Make connection according to Figure 9.

1. Set switch to CH 4.
2. Adjust T102 core so that frequency counter of spectrum analyzer shows 67.65 MHz
3. Set switch to CH 3.
4. Adjust trimmer capacitor of C113 so that frequency counter of spectrum analyzer shows 61.25 MHz.

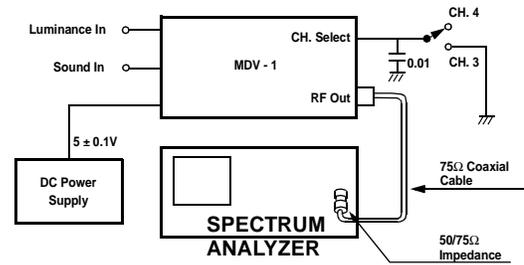
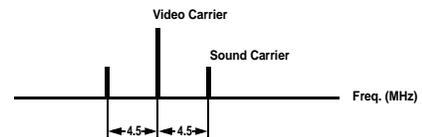


Figure 9



ADJUSTMENT OF SOUND CARRIER FREQUENCY

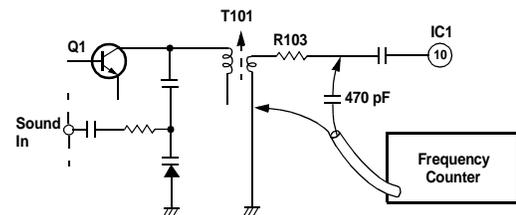


Figure 10

Prepare capacitor of 470 μ F [pF] and make connection according to Figure 10.

Adjust T101 core so that freq. counter shows 4.500 MHz.

ADJUSTMENT OF CHROMATIC FREQUENCY

Make connection according to Figure 11.

Adjust trimmer capacitor C102 so that freq. counter shows 3.579545 MHz.

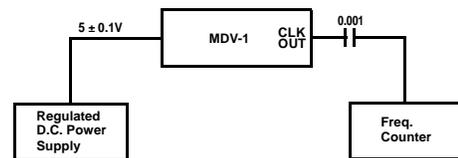


Figure 11

Note: On actual board, unit of hundred of the reference numbers is omitted. Ex. L102 is marked "L2."

SECTION VI

PARTS LIST

PRINTED CIRCUIT BOARD PARTS

CAPACITORS					
Ref.No.	Value (μ F)	Voltage (V)	Tolerance (%)	R/S Part No.	Material
C1	4700	16	± 20		Radial Electrolytic
C2	10	25	± 20		Radial Electrolytic
C3/4	100	16	± 20		Axial Electrolytic
C5	0.1	25	± 20		Radial Ceramic
C6	0.0022	50	+80/-20		Radial Ceramic
C7	0.022	50	+80/-20		Radial Ceramic
C8	4.7	50	± 20		Radial Electrolytic
C9~12	0.022	50	+80/-20		Radial Ceramic
C13	0.1	25	± 20		Radial Ceramic
C14~20	0.1	50	± 5		Radial M-Plastic Capacitor
C21/22	0.022	50	+80/-20		Radial Ceramic
C23	0.022	16	± 30		Axial Ceramic
C24~26	0.022	50	$\pm 80/-20$		Radial Ceramic
C27	0.1	25	± 20		Radial Ceramic
C28	0.022	50	+80/-20		Radial Ceramic
C29	0.022	16	± 30		Axial Ceramic
C30~32	0.022	50	+80/-20		Radial Ceramic
C33	150P	50	± 5		Radial Ceramic
DIODES					
Ref. No.	Description		R/S Part No.	Manufacture	
D1	SIRBA10	RECTIFIER		SHINDENGEN	
D2/3	10E1 or SR1K-2	SI DIODE SI DIODE		NIHONINTER or UNIZON	
D4~9	1N4148	SI DIODE		HITACHI or ITT	
CORE					
Ref. No.	Description		R/S Part No.	Mfr's Part No.	
FB1~5	CORE $\phi 3.5 \times \phi 1.3 \times 5$ or BL01RN1-A61			588010050A 588010060A	
CONNECTORS					
Ref. No.	Description		R/S Part No.	Mfr's Part No.	
J1	5P DIN (For CASSETTE I/O)			193410030A	
J2	4P DIN (For SERIAL I/O)			193410020A	
J3	POWER JACK			196610020A	
J4	WIRE CONNECTOR			193904400A	
J5	WIRE CONNECTOR			193904400A	

RESISTORS					
Ref.No.	Value (ohms)	Wattage	Tolerance (%)	R/S Part No.	Material
R1	100	1/2	±5		Carbon
R2	3.9K	1/6	±5		Carbon
R3	1.5K	1/6	±5		Carbon
R4	10K	1/4	±5		Carbon
R5	15K	1/4	±5		Carbon
R6/7	10K	1/4	±5		Carbon
R8/9	4.7K	1/4	±5		Carbon
R10	75K	1/6	±5		Carbon
R11	24K	1/6	±5		Carbon
R12	220	1/4	±5		Carbon
R13	8.2K	1/4	±5		Carbon
R14	6.8K	1/4	±5		Carbon
R15/16	56K	1/4	±5		Carbon
R17	15K	1/4	±5		Carbon
R18	1.5M	1/4	±5		Carbon
R19	4.7K	1/4	±5		Carbon
R20	10K x 8	1/4	±5		Resistor Array
R21	4.7K	1/4	±5		Carbon
R22/23	4.7K	1/6	±5		Carbon
R24	100K	1/4	±5		Carbon
R25	4.7K	1/4	±5		Carbon
R26	100K	1/4	±5		Carbon
SWITCHES					
Ref. No.	Description	R/S Part No.	Mfr's Part No.		
S1	RESET SW		187010040A		
S2	POWER SW		183110240A		
S3	CHANNEL SW		183110280A		
INTEGRATED CIRCUITS					
Ref. No.	Description	R/S Part No.	Mfr's Part No.		
U1	MC6803G or (MCU) HD6803P		MOTOROLA HITACHI		
U2	SN74LS373N or (D-LATCH) MB74LS373M		MOTOROLA FUJITSU		
U3	MB8364M (MASK ROM)		FUJITSU		
U4	SN74LS155N or (DECODER) MB74LS155M or HD74LS155P		MOTOROLA FUJITSU HITACHI		
U5/6	SN74LS367AN or (DRIVER) MB74LS367AM or HD74LS367AP		MOTOROLA FUJITSU HITACHI		
U7	SN74LS245N or (TRANSCEIVER) MB74LS245M		MOTOROLA FUJITSU		

Ref. No.	Description R/S Part No.	R/S Part No.	Mfr's Part No.
U8	SN74LS174N or (D-TYPE F.F) MB74LS174M or HD74LS174P		MOTOROLA FUJITSU HITACHI
U9/10	μPD4016C-1 or (STATIC RAM) μPD4016D-1 or MB8128-15P or MSM2128-20RS		NEC NEC FUJITSU OKI
U11	MC6847P (VDG)		MOTOROLA
U12	SN74LS14N or (INVERTER) MB74LS14M or HD74LS14P		MOTOROLA FUJITSU HITACHI
U13	SN74LS32N or (OR-GATE) MB74LS32M or HD74LS32P		MOTOROLA FUJITSU HITACHI
U14	MC14503BCP or (BUFFER) HD14503BP or μPD4503BC or MSM4503RS		MOTOROLA HITACHI NEC OKI
U15	LM339N or (COMPARATOR) μPC339C		MOTOROLA NEC
U16	MC1741CP1 or (OP AMP) HA17741PS		MOTOROLA HITACHI
U17	MC7805CT or (VOLTAGE REGULATOR) NJM7805A or μPC7805H		MOTOROLA JRC NEC
U18	SN74LS74AN or (D-F.F) MB74LS74AM or HD74LS74AP		MOTOROLA FUJITSU HITACHI
U19	SN74LS76AN or (JK-F.F) MB74LS76AM or HD74LS76P		MOTOROLA FUJITSU HITACHI
U20	SN74LS32N or (OR-GATE) MB74LS32M or HD74LS32P		MOTOROLA FUJITSU HITACHI

EXPLODED VIEW PARTS LIST

Ref. No.	Description R/S Part No.	R/S Part No.	Mfr's Part No.
1	Cabinet Ass'y, Top Cabinet, Top Plate, Model		M00324 601210420A 711010040A
2	Cover, Connector		851210720A
3	Key Board Ass'y		187510010A
4	Knob, Reset (Red)		659510310A
5	Holder, SW Reset		411101870A
6	Case, Shield		473010160A
7	P.C. Board Ass'y		U32008
8	Modulator, MDV-1 (Custom)		525010030A
9	Connector, Flat Wire		193903430A
10	Sheet, Shield		473310380A
11	Knob, Channel (Black)		659510320A
12	Cabinet, Bottom		601310290A
13	Foot, Rubber		608010080A
F1	Screw, Top Tite 3x12 BT-B For Cabinet		
F2	Screw, Top Tite 3x 8 BT-B For Key Board		
F3	Screw, Top Tite 3x 8 PT-B For P.C. Board		
F4	Screw, Top Tite 3x 6 PT-B For Cover		
F5	Rivet HARRA002SW For Sheet, Shield		

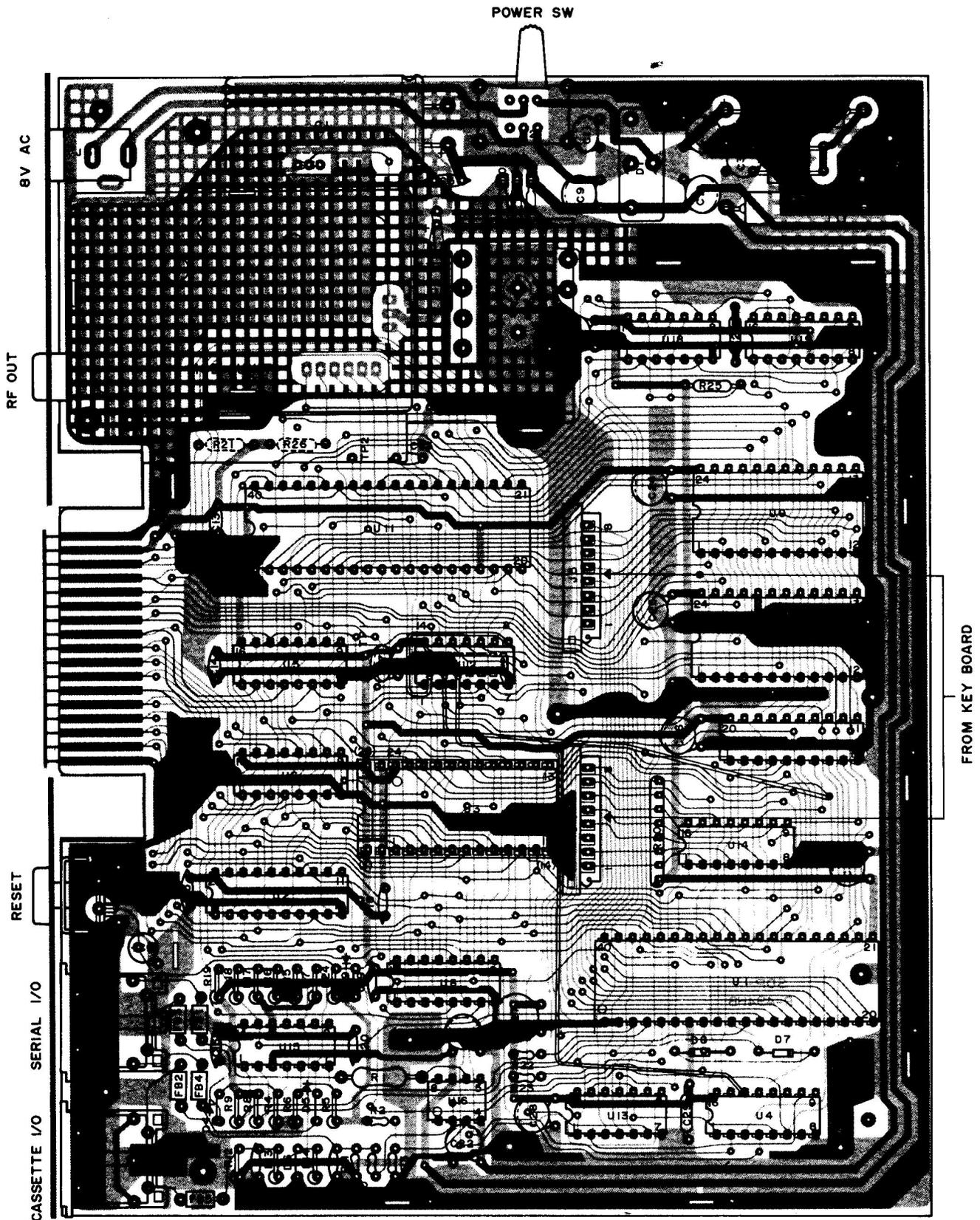
MISCELLANEOUS PARTS LIST

Ref. No.	Description R/S Part No.	R/S Part No.	Mfr's Part No.
	Box, Switch		189510020A
	Adaptor, Power	AC-AC (U.S.A.)	10901008TA
		AC-AC (CA)	10901009TA
	PATCH CORD	RCA-RCA 2M	313510100A

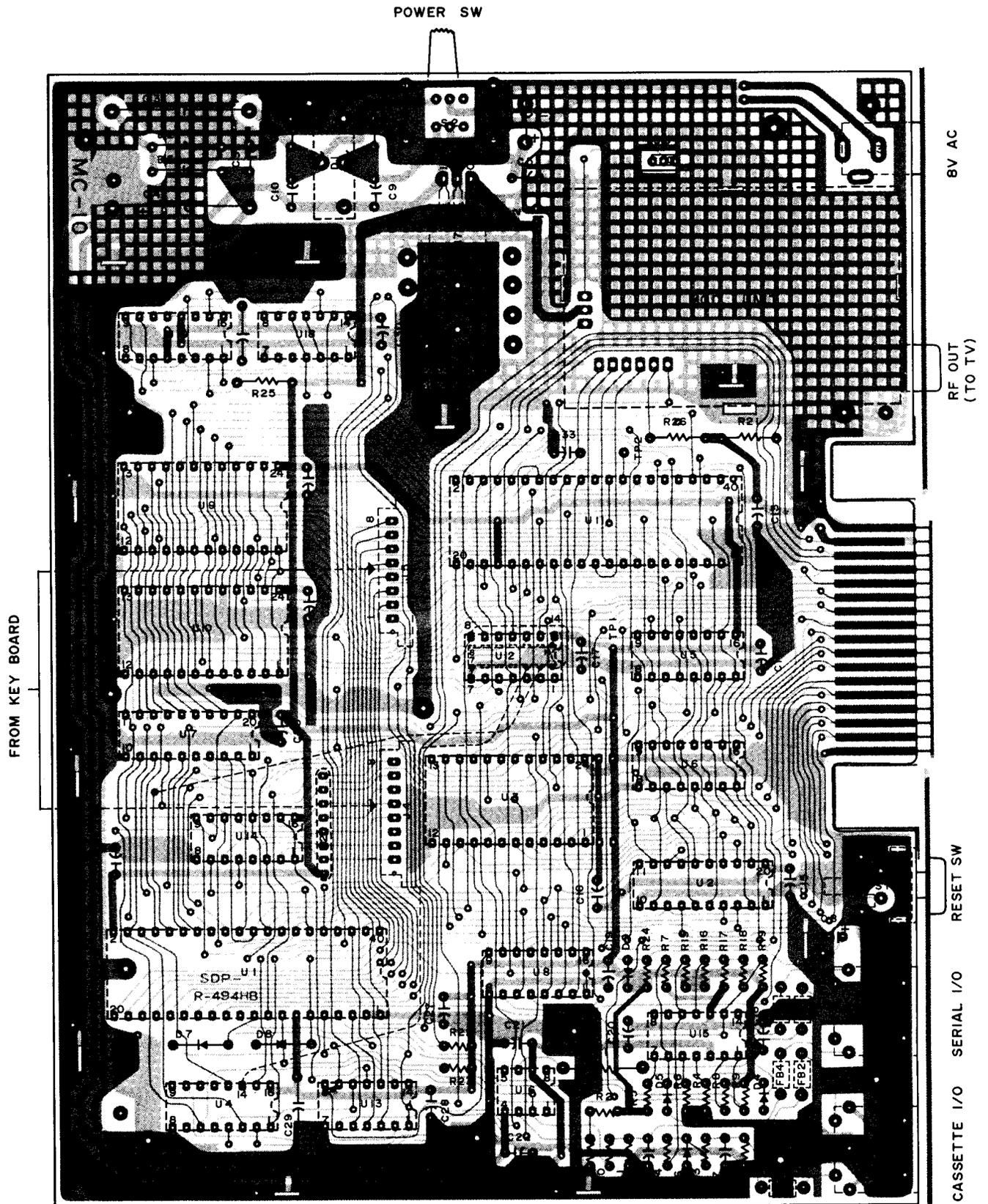
SECTION VII

PRINTED CIRCUIT BOARDS

MAIN P.C.B.
(TOP VIEW)



(BOTTOM VIEW)

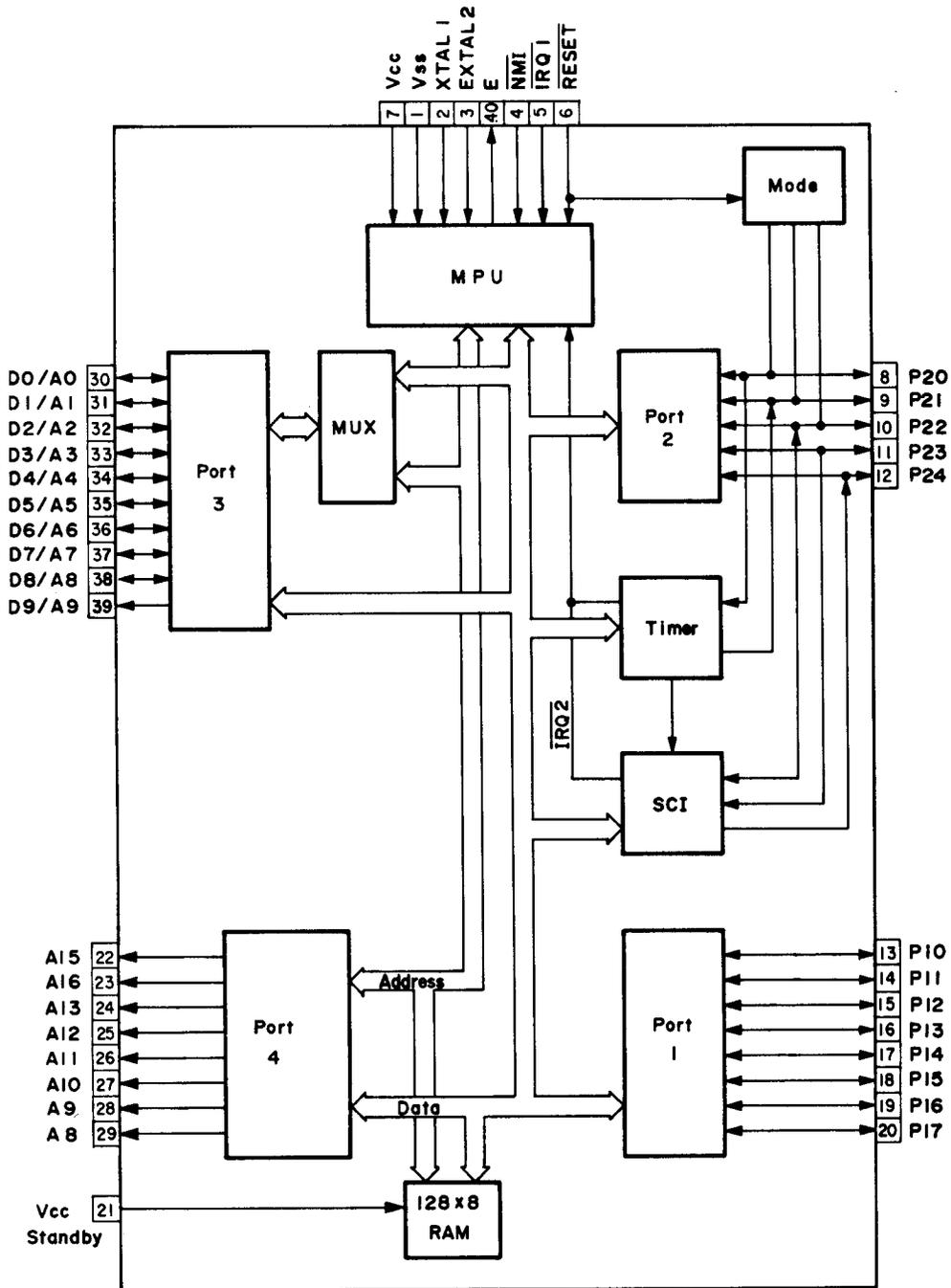
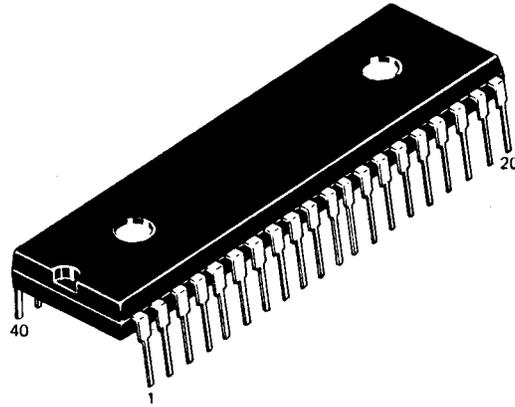


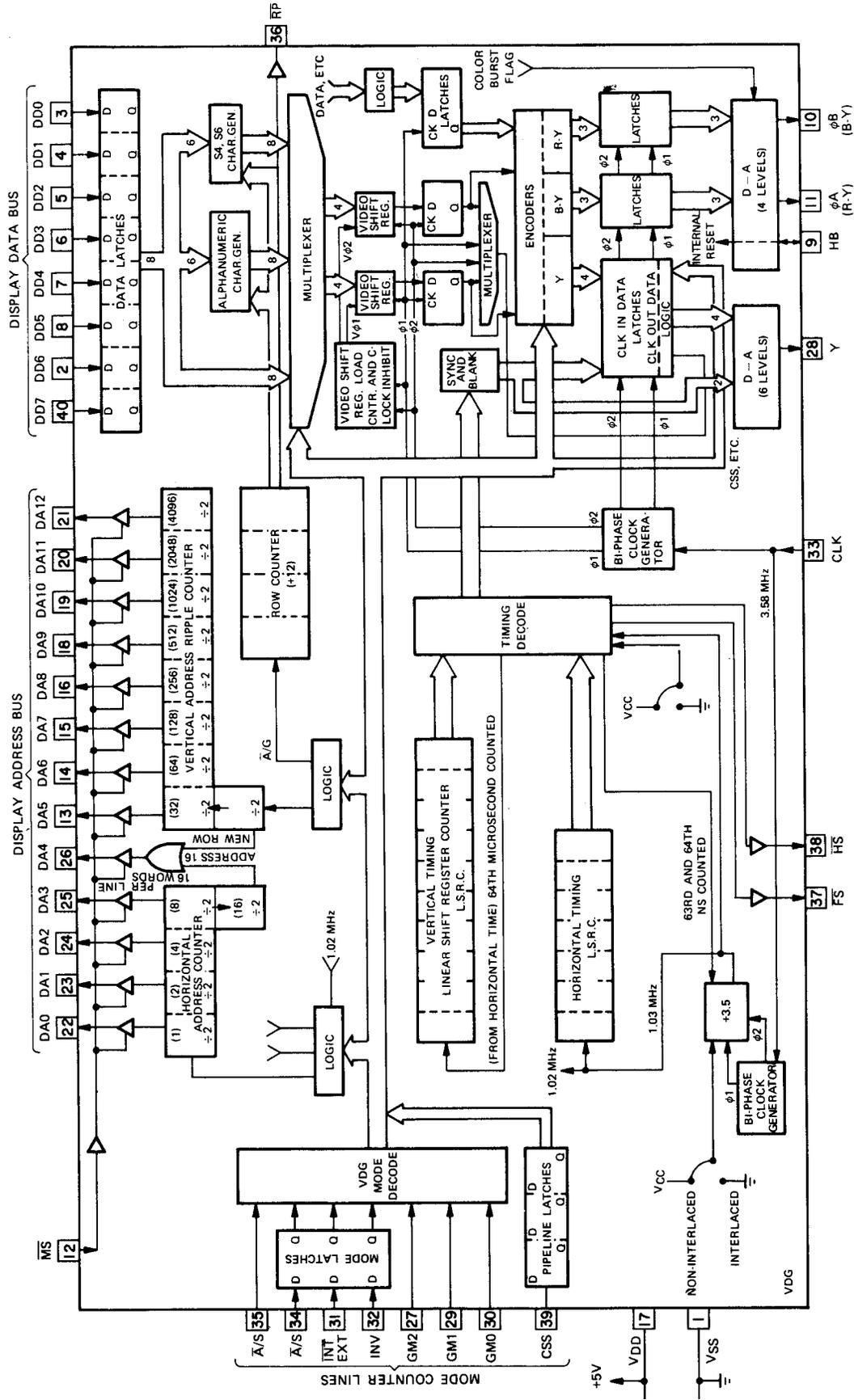
SECTION VIII

IC INTERNAL CONNECTIONS

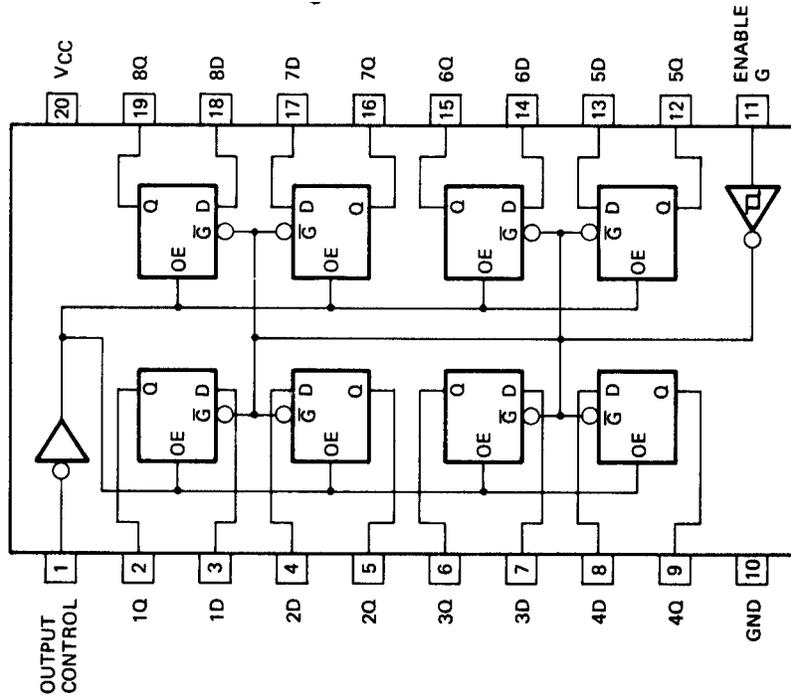
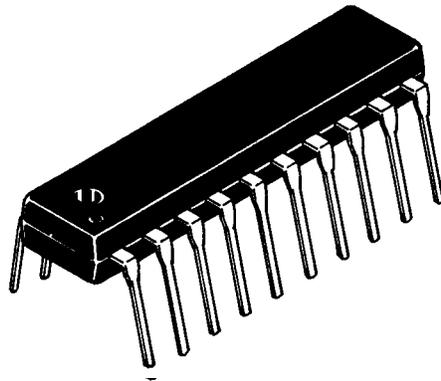
IC INTERNAL CONNECTIONS

U1 MC6803G (Motorola) or HD6803P (Hitachi)

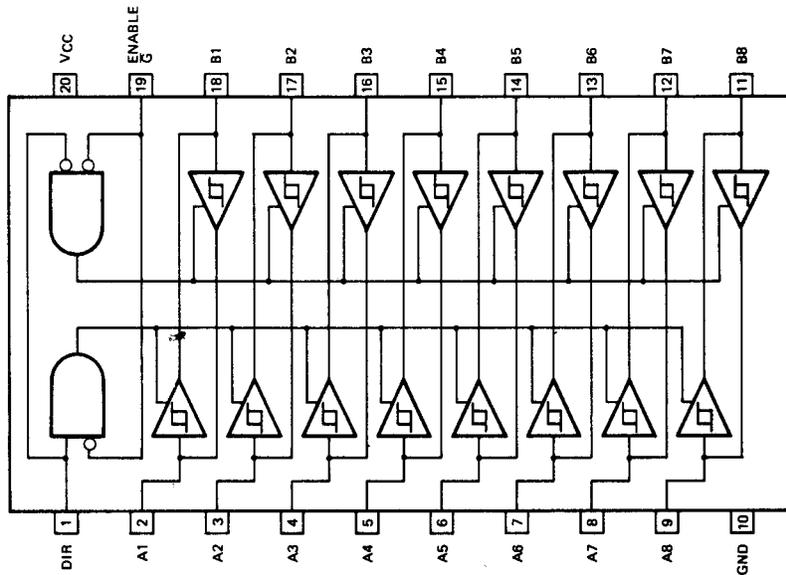




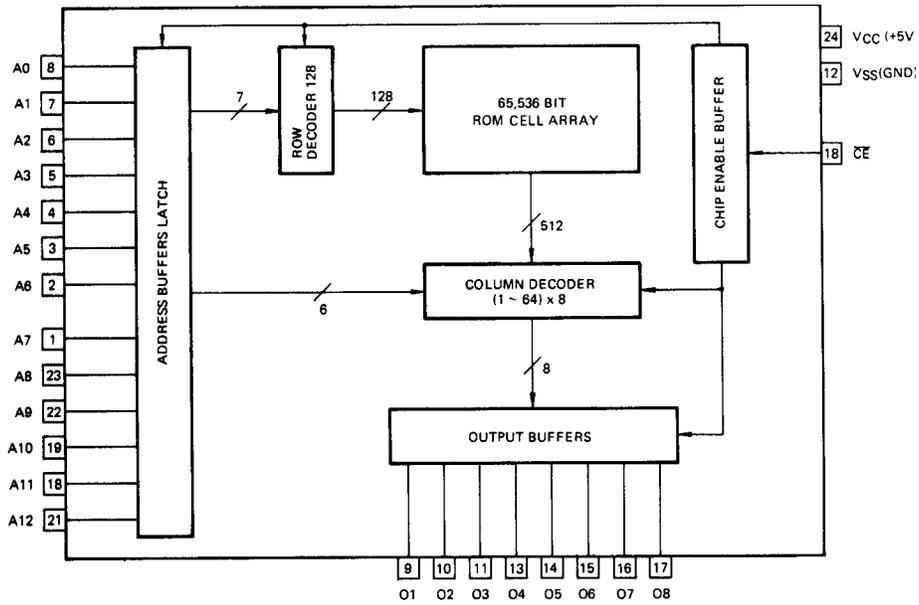
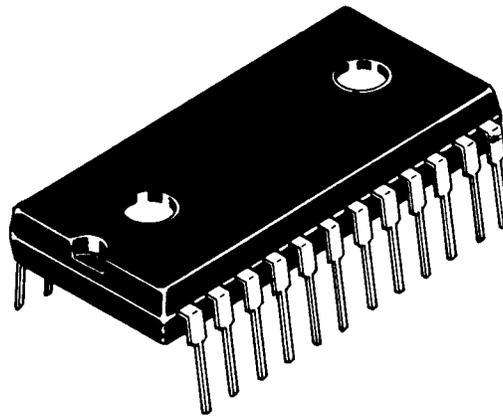
U2 SN74LS373N (Motorola) or MB74LS373M (Fujitsu)



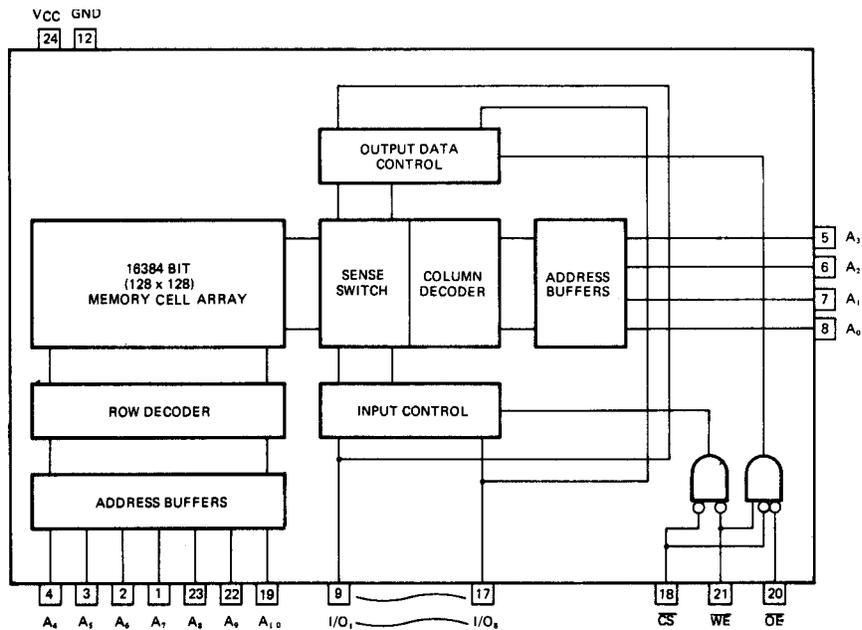
U7 SN74LS245N (Motorola) or MB74LS245M (Fujitsu)



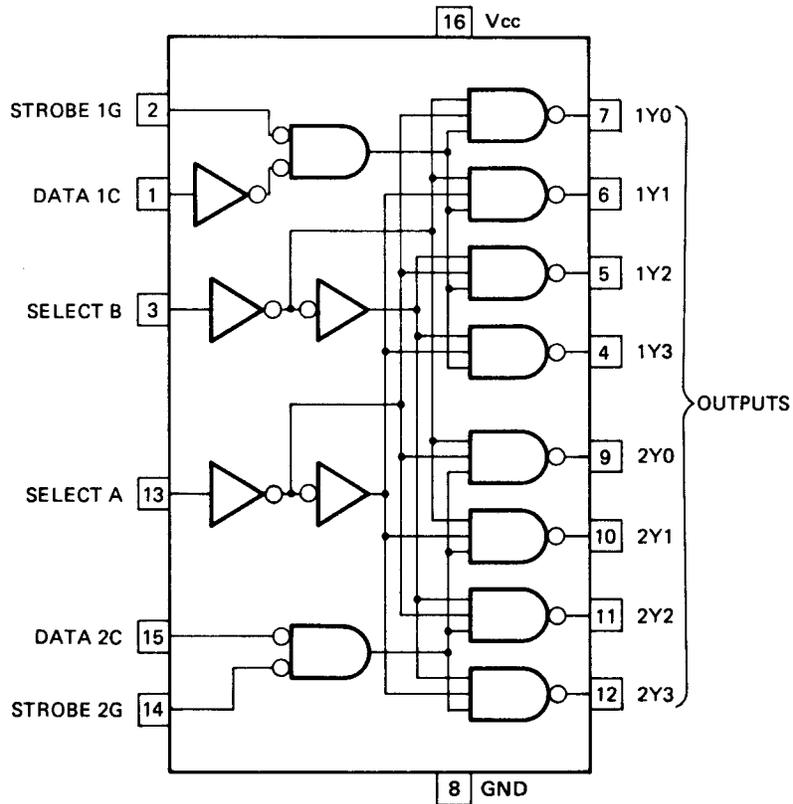
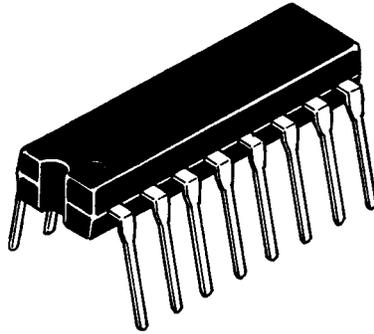
U3 MB8364M (Fujitsu)



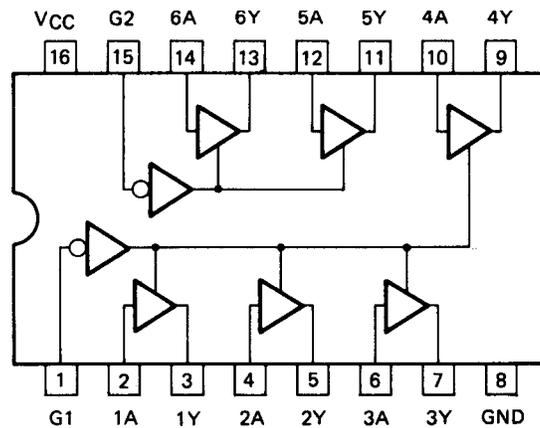
U9/10 μ PD4016C-1 (NEC) or μ PD4016D-1 (NEC) or MB8128-15P (Fujitsu) or MSM2128-20RS (Oki)



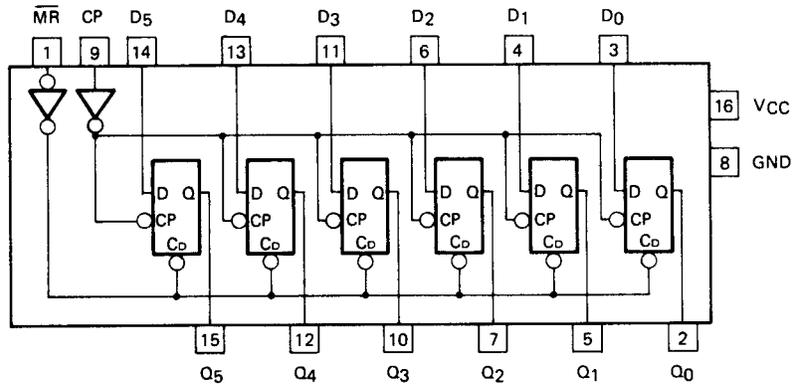
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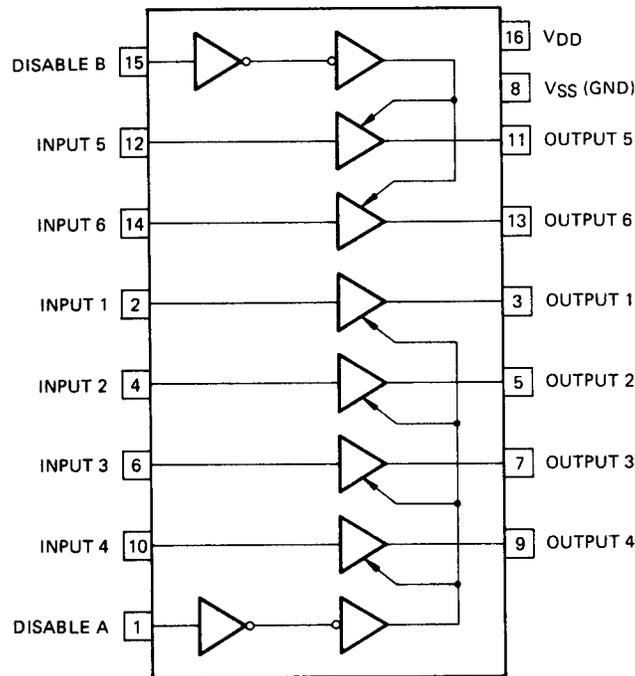
U5/6 SN74LS367AN (Motorola) or MB74LS367AM (Fujitsu) or HD74LS367AP (Hitachi)



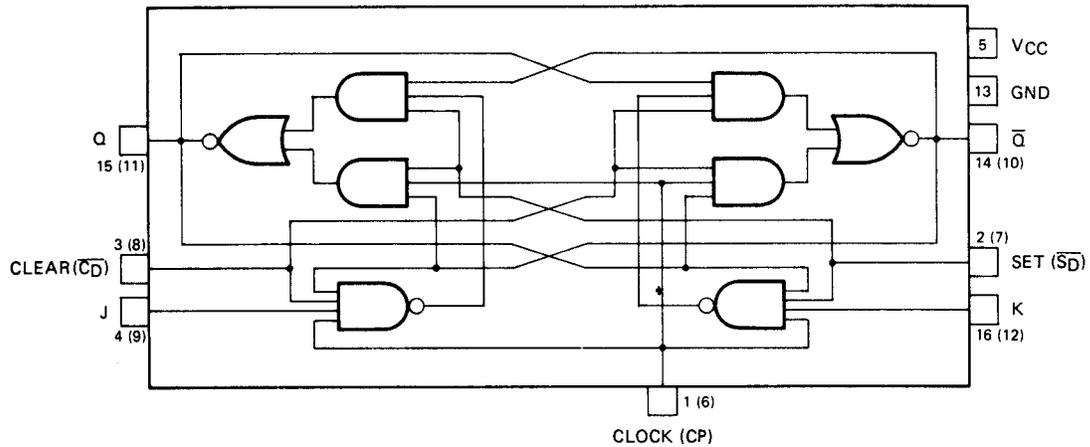
U8 SN74LS174N (Motorola) or MB74LS174M (Fujitsu) or HD74LS174P (Hitachi)



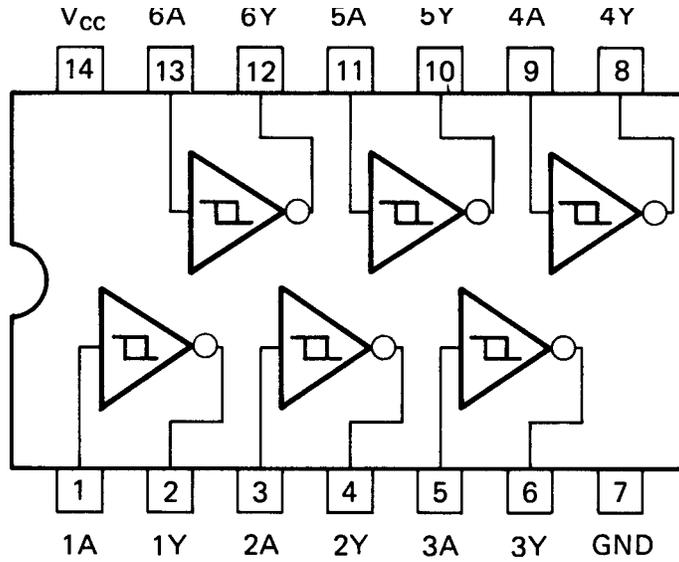
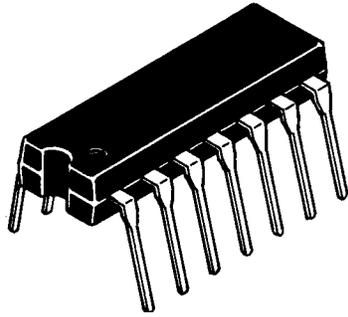
U14 MC14503BCP (Motorola) or HD14503BP (Hitachi) or μ PD4503BC (NEC) or MSM4503RS (Oki)



U19 SN74LS76AN (Motorola) or MB74LS76AM (Fujitsu) or HD74LS76P (Hitachi)

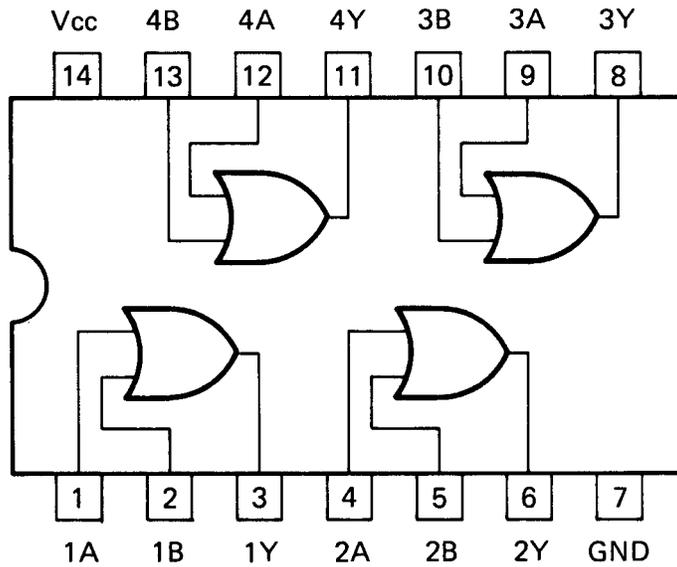


U12 SN74LS14N (Motorola) or MB74LS14M (Fujitsu) or HD74LS14P (Hitachi)

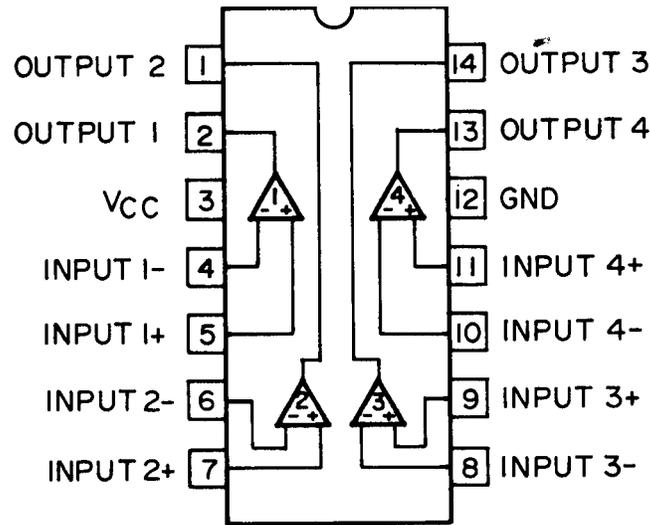


U13 SN74LS32N (Motorola) or MB74LS32M (Fujitsu) or HD74LS32P (Hitachi)

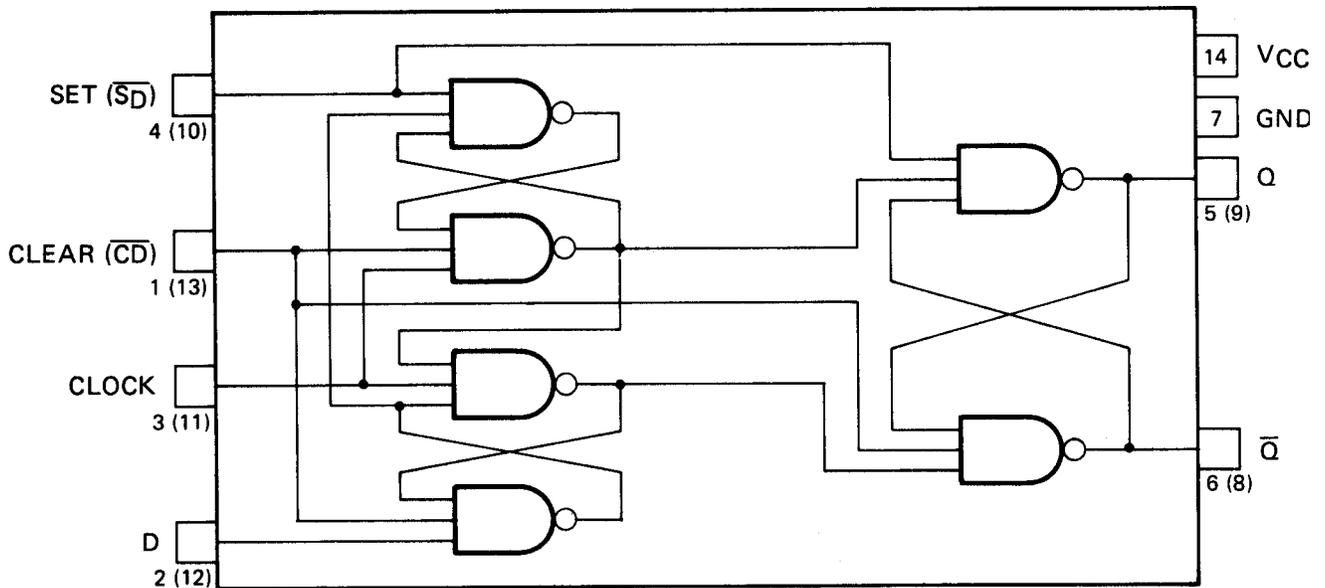
U20 SN74LS32N (Motorola) or MB74LS32M (Fujitsu) or HD74LS32P (Hitachi)



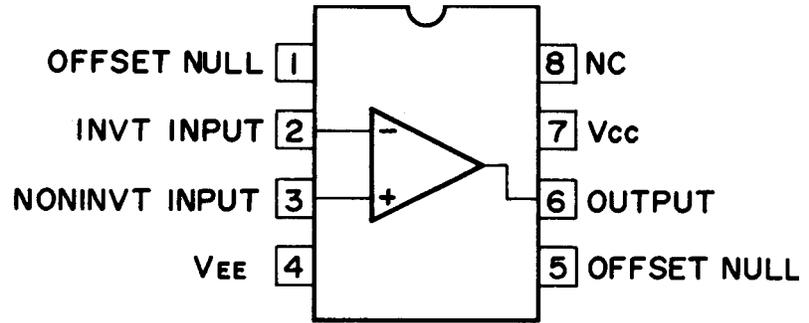
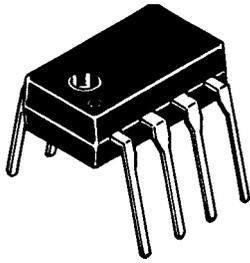
U15 LM339N (Motorola) or μ PC339C (NEC)



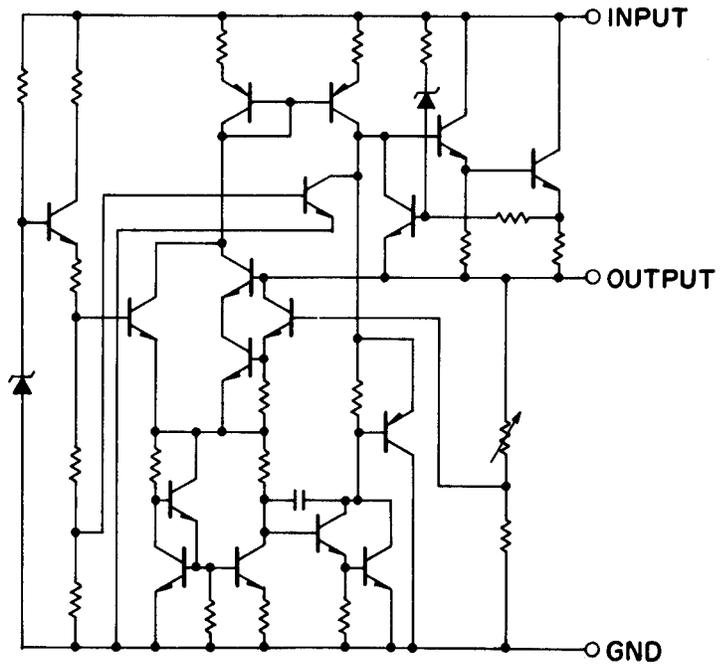
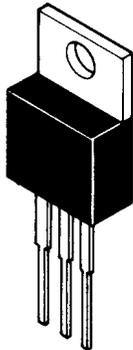
U18 SN74LS74AN (Motorola) or MB74LS74AM (Fujitsu) or HD74LS74AP (Hitachi)



U16 MC1741CP1 (Motorola) or HA17741PS (Hitachi)



U17 MC7805CT (Motorola) or NJM7805A (JRC) or μ PC7805H (NEC)



SECTION IX

SCHEMATIC DIAGRAM

SECTION X

EXPLODED VIEW

RADIO SHACK, A DIVISION OF TANDY CORPORATION

**U.S.A.: FORT WORTH, TEXAS 76102
CANADA: BARRIE. ONTARIO L4M 4W5**

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