

**TANDY®**

# Service Manual

26-3144A

## Speech/Sound Cartridge

Catalog Number: 26-3144A



CUSTOM MANUFACTURED FOR RADIO SHACK, A DIVISION OF TANDY CORPORATION

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# INTRODUCTION

The value of the Color Computer Speech/Sound Cartridge speaks for itself. This versatile Color Computer peripheral lets you use your computer to speak words and sentences, generate complex sound effects, and play music in a 8-octave range on 3 independent voices. It also opens new dimensions for integrating speech and sound effects into all types of applications--from games to educational programs.

The Color Computer Speech/Sound Cartridge is an "intelligent" peripheral with a self-contained microprocessor that facilitates the creation of speech, music, and sound effects. The Speech/Sound Cartridge:

- Converts text output from the Color Computer into speech
- Plays 3-part musical harmony
- Creates complex sound effects
- Interfaces with game, educational, and other applications programs
- Is programmable--with 8 speech and 8 sound storage buffers
- Can be used with disk or cassette programs or Program Paks (Use with a disk drive or Program Pak requires a Radio Shack Multi-Pak Interface.)

# SPECIFICATIONS

## SOUND GENERATOR

3 Voices  
Noise Generator  
Envelope Generator  
Amplitude Control  
1.78 MHz Clock Rate

## SPEECH PROCESSOR

Allophone Based  
Text to Speech Algorithm Included  
3.12 MHz Clock Rate

## MICROPROCESSOR

PIC 7040 8-bit Microcontroller  
4K Internal ROM  
2K RAM  
1.78 MHz Clock Rate

## ANALOG

4 kHz Cut-off, 4 Pole, Low Pass Speech Filter.  
Mixer With Approximately 4V p-p Output for Maximum Input

## OVERALL

Power Required: 5V at 300mA Typical (1.5 Watts)  
40-Pin Interface Compatible with Color Computer Series

# DISASSEMBLY / ASSEMBLY

(See EXPLODED VIEW on page 13.)

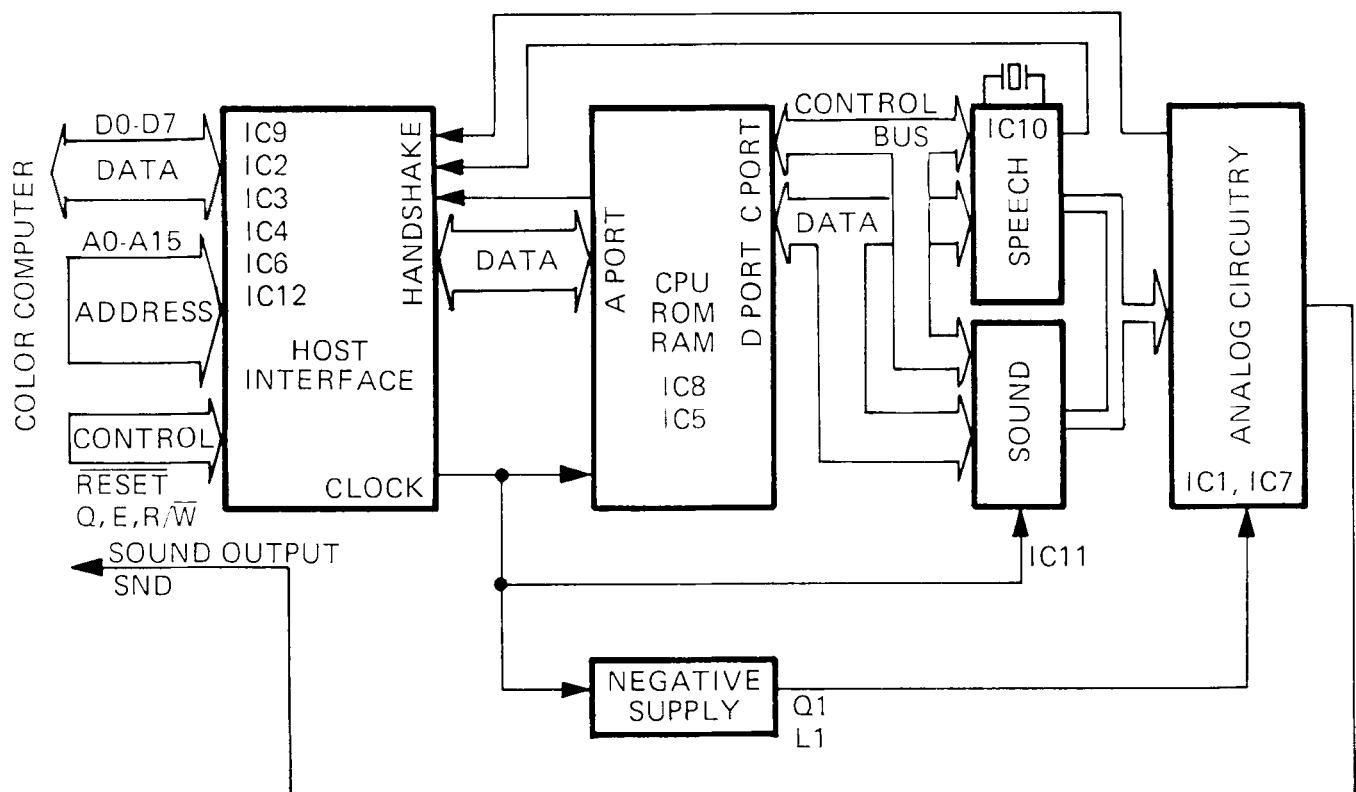
## DISASSEMBLY

1. Carefully peel up the overlay label by one corner and remove the screw **F1**.
2. Using a flat-bladed screwdriver, carefully pry the case top and the case bottom until they snap apart. The case top and the case bottom have 4 tabs that hold them together.
3. Remove the 2 screws from the PCB.
4. Remove the PCB insulator and put to one side. This insulator is necessary to protect the PCB from any possible entry through the vents located on the case bottom.

## ASSEMBLY

1. Ensure the PCB insulator is attached to the PCB with the spring clips.
2. Lay the PCB into the case bottom and replace the 2 screws.
3. Replace the case top and listen for the snap to ensure that the case top is seated correctly.
4. Replace the case top screw.
5. Replace the overlay with a new label.

## BLOCK DIAGRAM



# THEORY OF OPERATION

The Color Computer Speech/Sound Cartridge is an intelligent peripheral. It contains a microprocessor dedicated to the handling of speech and sound effects. The microprocessor is the General Instrument PIC 7040, which contains 4K of internal ROM. The Speech/Sound Cartridge contains a 2K x 8 static RAM for processor use and internal buffering. The 4K of ROM contains a Text-to-Speech algorithm, as well as a mini-interpreter for handling the sound generation. The 7040 has four 8-bit I/O ports used to interface to the Color Computer (the Host), the RAM, and the Speech and Sound generators.

The Host interface section contains the buffering and address decoding necessary to transfer data from the Host to the 7040, and to provide handshaking information back to the Host. The analog circuitry contains a low-pass filter for the speech output, a buffer for the sound output, a mixer to combine the two, and a circuit which determines when the sound chip is active.

## 1. Host Interface

The address decoding portion of the Host interface consists of a thirteen-input NAND gate (IC6) and a eight-line to eight line decoder (IC2). All address lines except A0, A1, and A7 connect to the inputs of IC6, a 74LS133. The output of IC6 will be active (low) when all the inputs are high, or when the address lines are in the following configuration:

A15 - 1	A7 - X
A14 - 1	A6 - 1
A13 - 1	A5 - 1
A12 - 1	A4 - 1
A11 - 1	A3 - 1
A10 - 1	A2 - 1
A9 - 1	A1 - X
A8 - 1	A0 - X

This gives the address ranges of FF7C - FF7F hex and FFFC - FFFF hex. This output is connected to one of the enable inputs of the 74LS138 (IC2). A7 connects to the other active low enable, effectively eliminating FFFC - FFFF from the valid addresses. The active high enable input is connected to the buffered E line from the Host, resulting in the outputs of IC2 being active during the valid portion of the E clock at addresses FF7C - FF7F hex. A0, A1, and the read/write line are connected to the three inputs of the 74LS138, resulting in individual outputs for read and write at each address in the range. Only three of the outputs are used by the Sound/Speech Pak.

A write to FF7D hex with data bit D0 high sets the flip-flop IC4 pin 12. This brings the RESET\* inputs to the 7040, the speech processor, and the sound generator all low. This should be followed by a write to FF7D hex with D0 cleared, in order to allow normal operation. Therefore, this allows the software on the Host to perform a hardware Reset of the peripheral. A write to FF7E hex does two things. First it latches the data into IC9, a 74LS273 8-bit latch. Simultaneously, it sets the flip-flop IC4 pin 8, which is used to interrupt the 7040 processor and inform it that the Host has presented it with another byte of data. This flip-flop remains set until the 7040 retrieves the data and clears the flip-flop. In this manner, the Host can determine if the last byte has been received, and can refrain from sending a new byte until it has.

A read from FF7E hex allows the Host processor to read the status information. The MSB (D7), when low, indicates that the previously stored byte has not yet been processed. Data bit D6, when low, indicates that the speech processor is currently speaking. Thus the Host can tell if a previously sent string is currently being spoken, or if the speech processor is inactive. Data bit D5 is connected to the output of the handshake portion of the analog circuitry, and allows the Host processor to determine if the sound generator chip is currently active. This bit is also active low. The E line from the Color Computer is buffered by IC3. It is used to enable the address decoder, IC2, at the appropriate time, as well as to drive the negative voltage converter. In addition, it is Exclusively ORed with the Q line at IC3 pin 8. Since these two signals are 50% duty cycle and 90° out of phase, the output is a 50% duty cycle signal of twice the input frequency. This signal, 1.78MHz, is used as the clock for the 7040 microprocessor and the 8913 programmable sound generator.

The system RESET\* line from the Host is ORed with the software reset described above, so that either will reset the Sound/Speech pak. In addition, it will clear flip-flop IC4 pin 12, so that if a software reset were half-done at the time a hardware reset occurred the reset process would not have to be completed in software.

## 2. PIC 7040

The PIC 7040 is a Programmable Intelligent Controller, or microprocessor, which contains 4K of ROM. In this ROM resides the intelligence of the device which includes the sound command interpreter and the text-to-speech algorithm. The PIC 7040, which is used in "single chip" mode, has four 8-bit output ports. The A port is used as a data input port to accept data from the Host. The B port is used as a set of eight address lines to go to the Static RAM. The D port is used as an internal data bus to transfer data to and from the RAM, the Speech Processor, and the Programmable Sound Generator. The C port is used for control purposes (device chip selects, data direction control, and Host handshake), and also as the remaining address lines for the RAM. The 7040 has two interrupt inputs. Interrupt 1 is used to tell the 7040 that the Speech processor is ready for another allophone. Interrupt 3 is used to tell the 7040 that another byte has been sent by the Host. (Interrupt 2 is an internal timer interrupt.)

### 3. SPO256-AL2 Speech Processor

The SPO256-AL2 Speech processor (IC10) contains a digital filter, a microcontroller, a pulse width modulator, and a ROM which is pre-programmed to provide 64 allophones of sound. An allophone is a small segment of sound -- frequently less than one letter. For example, the word "I" can be thought of as a combination of the sounds "ah" and "ee". This manual does not enter a detailed discussion of allophones, however using these 64 allophones, virtually any word in the English language can be produced.

The speech processor must have a clock, since it contains a microcontroller. The clock for IC10 is provided by a ceramic resonator, C01, which is resonant at a frequency of 3.12 MHz. The ceramic resonator works much like a crystal, but with reduced accuracy. However, its accuracy is more than adequate for speech work.

The 7040 data bus is connected to the address inputs of the SPO256. When the 7040 brings IC10's ALD\* (Address Load) line low, the address of the desired allophone is latched into the speech processor. The processor then produces this sound by modulating the pulse width of a 40 kHz signal which comes out of pin 24. As different allophones take different amounts of time, the SPO256 must tell the 7040 when it is ready for the next address, which it does with the LRQ\* (Load Request) line, which is connected to the 7040's interrupt input. The data transfer process is therefore a full handshake process.

The STDBY (standby) pin of the speech processor was designed to signal the circuitry to enter a power down mode when not speaking, for the purpose of reducing current consumption. It is used to inform the Host of whether or not the SPO256 is currently speaking and connects to pin 4 of IC12.

### 4. AY3-8913 Programmable sound Generator

The General Instrument AY3-8913 (IC11) is a programmable sound generator (PSG) with three channels for either tone or noise production, and built-in envelope and amplitude control. It contains thirteen internal registers used to control these functions. The BDIR (bus direction) input is analogous to a read/write line. The BCl (bus control) line is used to select whether the address of a specific register or the desired data to that register is passed on the data bus. The data lines, DA0 - DA7 are bidirectional, and are connected to the 7040's D port. The clock input to the 8913 is 1.78 MHz, and comes from the Exclusive ORing of E and Q from the Host processor. The A, B and C outputs are analog output, capable of sourcing up to 2 mA maximum.

### 5. Sound Buffer

R20 serves as a current to voltage converter for the outputs of the PSG. IC1 pin 7 is a non-inverting follower which then buffers this voltage to drive the "sound activity" circuit and the mixer.

### 6. Sound Activity Circuit

The output of the sound buffer is AC-coupled into the sound handshake circuit by C9. IC1 pin 1 then amplifies this signal by a factor of 10. IC1 pin 14 is a half-wave rectifier, also with a gain of 10. The rectified output of the sound circuit is stored in C25. This voltage is compared to a 0.8 volt reference by IC1 pin 10. If the reference voltage is higher, the output of this comparator goes high, D3 conducts, and the handshake pin (IC12 pin 2) is high. If, however, the voltage on C25 is higher than the reference voltage, the output of the comparator drops to a voltage almost equal to the negative supply, D3 is



reverse biased (shut off), and resistor R4 pulls IC12 pin 2 to a logic low level. It should be noted that the threshold on the comparator is set sufficiently high to prevent noise from falsely triggering this circuit. This results in the lower amplitudes of the registers (amplitudes of 3 or less, on a scale of 1 to 15) not always triggering the comparator. This is not considered much of a handicap, since these amplitudes are barely audible over the TV speaker, and will probably not be used very extensively.

## 7. Speech Filter

Two sections of IC7 (output pins 1 and 14) form a four pole, active low-pass filter, with a cutoff frequency of approximately 4 kHz. This is used to remove the 40 kHz carrier and other unwanted noise from the output of the speech processor, which leaves only the audio signal that was pulse width modulated onto the carrier.

## 8. Mixer

The last section of IC7 (output pin 8) is a summing amplifier which serves to mix the speech and sound signals. The sound signal is amplified by a factor of about two, and the speech signal is amplified by a factor of about one and one-half. The amplitude of the speech signal is fixed. The amplitude of the PSG can be programmed from a scale of 1 to 15 for each voice. The ratio of the mixer results in a signal that has sound and voice about equal in amplitude when the selected amplitude for the PSG is about 10 or 11. Thus the sound can be either louder or softer than the voice. The output of the mixer is AC-coupled through capacitor C8 to pin 35 of the Host connector, which is the sound input to the Color Computer.

## 9. Negative Supply

The op-amps of the analog section require a bi-polar supply to operate. Since the input is only positive voltage, it is necessary to generate a negative voltage for the op-amps. However, the current requirement is quite low, and the supply need not be very elaborate. Transistor Q1 is turned on by the negative transition of the buffered "E" signal from the Host. When it conducts, a magnetic field is built-up in inductor L1. At the leading edge of E, resistor R17 turns Q1 off, allowing the magnetic field of L1 to collapse. This collapsing magnetic field induces current into L1, which is rectified by diode D4, producing a negative voltage which is filtered by electrolytic capacitor C7. The supply is not regulated, and is designed to provide approximately -5 volts. The magnitude of the negative voltage is not critical, as long as it does not fall below -4.5 VDC nor exceed the -18V absolute maximum rating of the op-amps.

# TROUBLESHOOTING AND TESTS

The SSC should be serviced by qualified technicians. In this section, a basic knowledge of electronics, computers, and use of an oscilloscope is assumed.

## 1. Quick Checks

Any peripheral needs power to run and SSC is no exception. Check for +5 volts at the power pins to the chips. If this is not present anywhere, then possibly the computer is at fault. If +5 volts are on some chips and not others, then a circuit trace must be open. The -5 volts is generated on board and should be present at pin 11 of both op-amps (IC1 and IC7). If this voltage is not present, check the base and collector of Q1 for a signal about 894 kHz in frequency. Then troubleshoot the diode (D4) and capacitor (C7) as in any supply. One other possibility exists if -5 volts is not present: if either of the op-amps is shorted, it could pull the supply to ground quite easily, as it is a very low current supply. Clock signals should be checked next. Check for an 894 kHz signal at IC3 pins 9, 10, 11 and 12. Note that the signal on pin 9 is "Q" while the others come from "E". Check for a 1.78 MHz signal at pin 8 of IC3, pin 20 of IC11, and also at pin 17 of IC8. If any of these signals are missing, the microprocessor will not work. Locate the component or PC trace causing the problem and replace or repair it. Check for a 3.12 MHz signal at pin 28 of IC10, and a 40 kHz signal at pin 24 of IC10. If either of these signals is missing, the speech portion will not work. Note that the signal on pin 24 is an output from IC10. If it is not present, then either the input clock is not present (pin 28), the chip is bad, or for some reason the reset input to IC10 is being held active (low). Identify and repair.

## 2. Host-To-Peripheral Interface

If the SSC "hangs up" in the status check routine (see owner's manual), something is wrong with the Host to peripheral communication. To troubleshoot, it is helpful to enter a short machine-language routine to continually write to or read from the peripheral.

Run the following basic routine:

```
10 READ A
20 FOR X = 0 TO A
30 READ D
40 POKE 8192 + X, D
50 NEXT X
60 EXEC 8192
70 DATA, 4, 183, 255, 126, 32, 251
```

This routine is a continuous write loop to the peripheral device and will cause low-going pulses on IC2 pin 11, IC4 pin 5, and high-going pulses on IC9 pin 11. If the pulses are missing from IC2 pin 11, then either IC6 or IC2 is at fault. If the pulses are at IC2 but missing elsewhere, then IC3 or a circuit trace is at fault. Changing the "183" to a "182" in line 70 and re-running the program starts a continuous read loop, which will cause low-going pulses on IC2 pin 10 and IC12 pin 1. Again, if these are missing, check IC2 and IC6.

The write should also set the flip-flop IC4 pin 9, and bring IC4 pin 8 low. This low should interrupt processor IC8, and after the character is processed, IC8 should bring C7 low to clear the flop IC4. If the read and write pulses are all correct and the SSC still "hangs up" in the status read portion, then possibly IC8 is not processing the incoming character. The other thing to check is buffer IC12.

To test the reset hardware, first depress the reset button on the computer, then using an oscilloscope, look at IC3 pin 3. It should go low when the button is pressed and becomes high when the button is

released. This should also happen at IC8 pin 14, IC11 pin 21, IC10 pin 2 and IC10 pin 25. To test the software reset function, alter line 70 of the above program to read:

```
70 DATA 5, 74, 183, 255, 125,  
32, 250
```

Running this program should put a low going pulse on pin 13 of IC2 and pin 1 of IC4. The output of IC4 (pin 12) should be a square wave of half the frequency of the pulse on IC2 pin 13. This square wave should also be seen on all the pins mentioned in the previous paragraph.

### 3. Speech Section

If the Host interface portion is working correctly, and the unit does not speak, the speech section should be checked. If the sound portion works but the speech does not, then the mixer (IC7 pins 8, 9 and 10) is probably not at fault. In this case, either the speech chip is not generating output or the filter is not passing the speech. Run a speech program (you will find one listed in the Appendices) and scope pin 24 of IC10.

You should see the duty cycle of the pulse wave vary in step with the speech. If it does, then follow the speech path through both sections of the low pass filter (pins 1 and 14 of IC7) to find out where the speech stops. If the pulse wave does not vary in duty cycle, then either the speech chip is defective, or the microprocessor is not sending information to it. Verify this by scoping for signals on LRQ\* and ALD\*. If there is activity, replace IC10. If not, replace IC8 and/or IC5 as necessary.

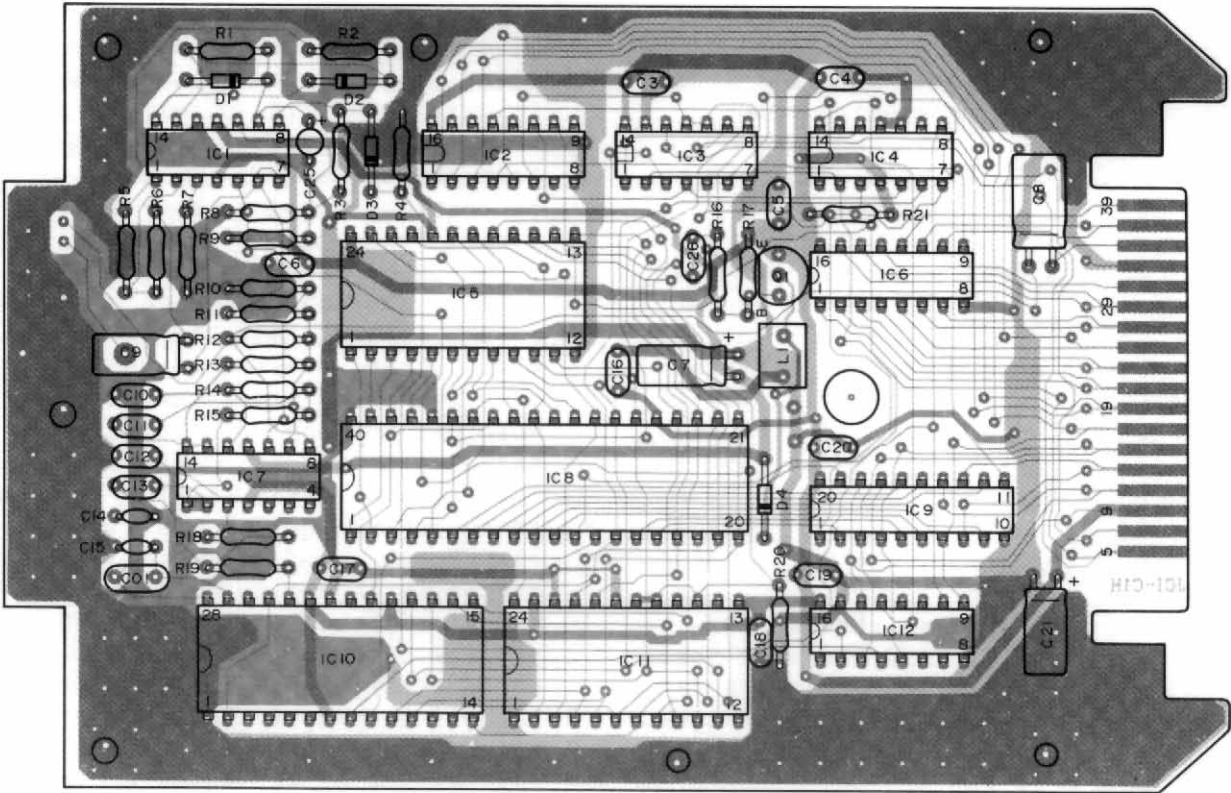
Finally, as the speech chip (IC10) is talking, the STDBY line (pin 8) should go low. When speech is finished, this line should return to a high condition. If it does not, change IC10 or check for PC faults, such as a short to ground on this line. This line is used for handshake back to the Host computer.

### 4. Sound Section

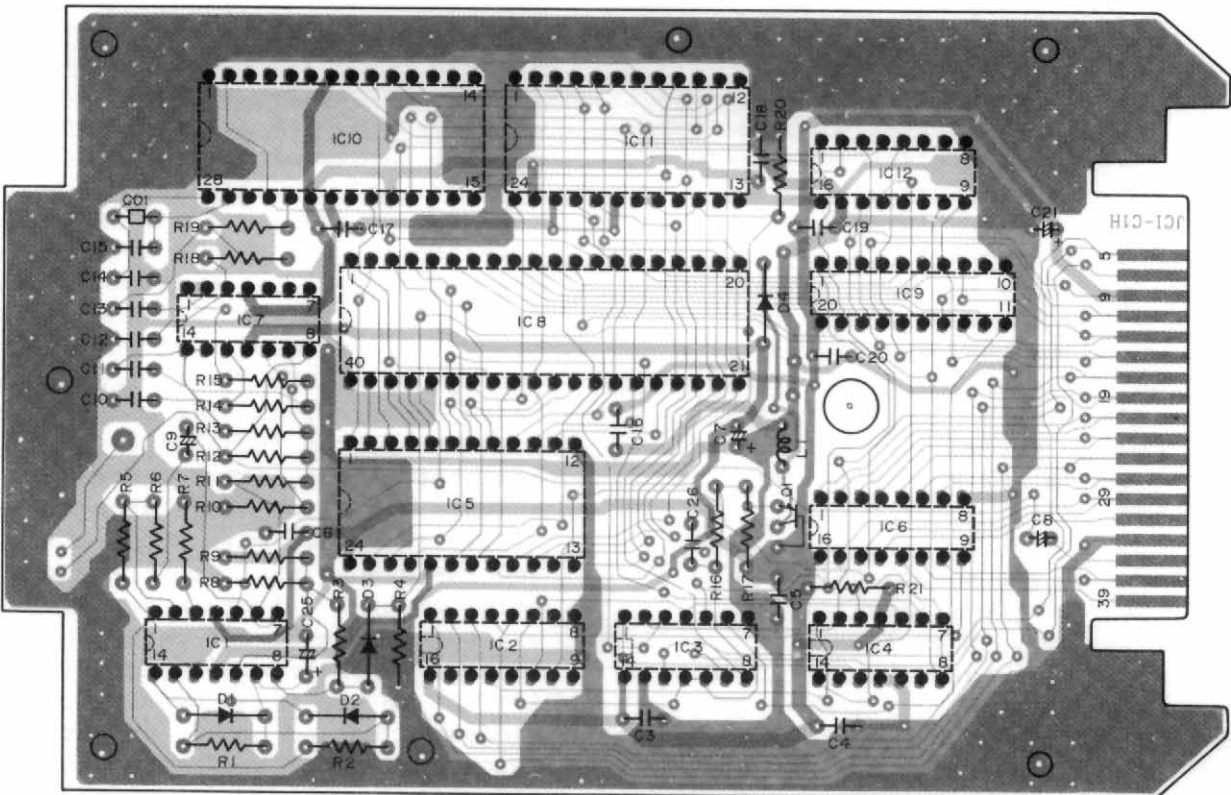
If the sound section is inoperative, first check the speech section. If it works, then the mixer (IC7 pins 8, 9 and 10) is probably all right. Next check the sound chip for output by running a program that activates a single tone while scoping the junction of pins 15, 17 and 18 of IC11. (You can find such a program in the Appendices). If there is an audio signal present at these pins, then the sound generator chip is working, and the problem lines in the buffer (IC1 pin 7) or the resistor input to the mixer (R11). If there is no output at IC11 pin 15, then either the sound generator chip is bad or it is not being programmed by the microprocessor. Re-run the program (several times if necessary) while checking for the control signals at pins 2, 3 and 24 of IC11. If these are not present, then replace IC8 or IC5 as necessary, or check for PC shorts or opens. If the signals are present, then replace IC11. Finally, the sound handshake must be checked. While running the program that generates a sound, check for a gain of ten from IC1 pin 7 to IC1 pin 1. IC1 pins 12, 13 and 14 should rectify the signal (make it positive with respect to ground), and the voltage level present at the positive end of C25 should be greater than one volt while sound is being generated. This should make IC1 pin 8 negative, reverse biasing D3 and letting resistor R4 pull the handshake line down. If there is any problem here, the first check should be to replace IC1. The diodes should also be checked for shorts, and resistor values within tolerance. For example, if D1 or D2 is shorted, the active rectifier will not rectify, and the signal will go both above and below ground. If resistors R9 and R8 are not in the proper ratio, then the threshold of the comparator (IC1 pin 10) may be too high, causing the handshake not to occur, or too low, which causes the handshake bit to be low continuously.

# PCB VIEWS

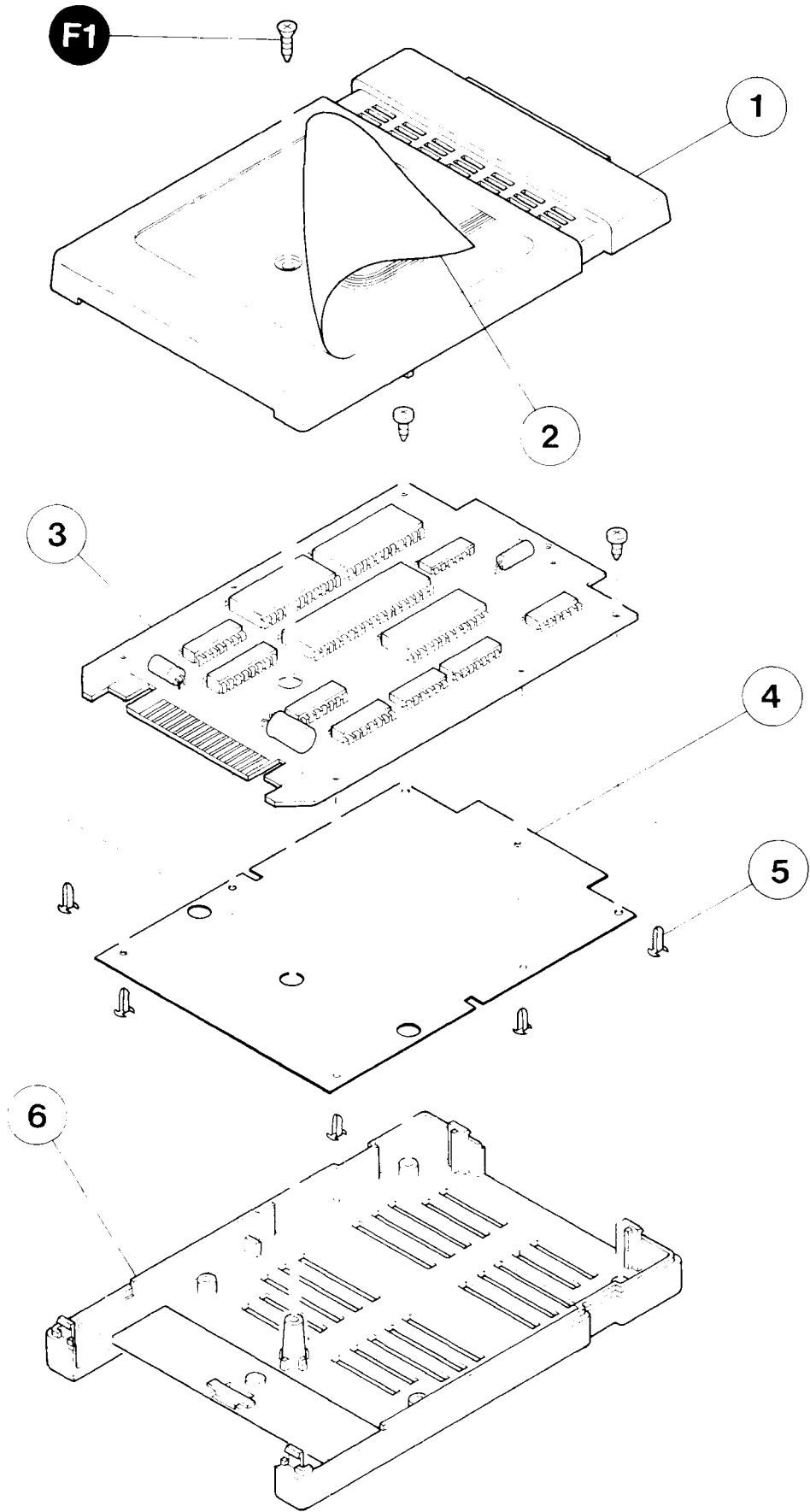
Top View



Bottom View



# EXPLODED VIEW



# PARTS LIST

## Electrical Parts List

Capacitors						
Ref. No.	Description				RS Part No.	Mfr's Part No.
C1/C2	Not used					
C3-C6	M-Plastic	0.1 $\mu$ F	50V	+5%		CFQMK104JL
C7	Electrolytic	10 $\mu$ F	25V	+20%		CEACI106M*
C8	Elec. Non-P	1 $\mu$ F	50V	+20%		CENCK105M*
C9	Elec. Non-P	1 $\mu$ F	50V	+20%		CENCK105M*
C10	Mylar*	4700pF	50V	+5%		CQQMK472JL or
	M-Plastic	4700pF	50V	+5%		CFQMK472JL
C11	M-Plastic	0.01 $\mu$ F	50V	+5%		CFQMK103JL or
	Mylar	0.01 $\mu$ F	50V	+5%		CQQMK103JL
C12	Mylar	4700pF	50V	+5%		CQQMK472JL or
	M-Plastic	4700pF	50V	+5%		CFQMK472JL
C13	M-Plastic	0.01 $\mu$ F	50V	+5%		CFQMK103JL or
	Mylar	0.01 $\mu$ F	50V	+5%		CQQMK103JL
C14/C15	Ceramic NPO	20pF	50V	+5%		CCJBK200J*
C16-C20	M-Plastic	0.1 $\mu$ F	50V	+5%		CFQMK104JL
C21	Electrolytic	10 $\mu$ F	16V	+20%		CEACG106M*
C22-C24	Not used					
C25	Tantalum	1.5 $\mu$ F	35V	+20%		CSEEJ155M*
C26	Ceramic	30pF	50V	+5%		CCJVK300J*

NOTE: \*Mylar is a registered trademark of E. I. Du Pont de Nemours and Company.

Diodes						
Ref. No.	Description				RS Part No.	Mfr's Part No.
D1	Silicon	1N4148	Rect/Shift			SDSI00064-
D2	Silicon	1N4148	Rect/Shift			SDSI00064-
D3	Silicon	1N4148	Rect/Shift			SDSI00064-
D4	Silicon	1N4148	Rect/Shift			SDSI00064-

ICs					
Ref. No.	Description			RS Part No.	Mfr's Part No.
IC1	NJM2058D	Linear	OP-Amp		SINM2058D-
IC2	SN74LS138N	TTL	Decoder	or	SISNS138N- or
	HD74LS138P			or	SIRNS138N- or
	MB74LS138M				SIHDS138P- or
IC3	SN74LS86N	TTL	EX-OR	or	SIMBS138M-
	HD74LS86P				SIRNS86N-- or
IC4	SN74LS73AN	TTL	JK Flip-Flop		SISNS86N-- or
IC5	HM6116P-4	C-MOS	RAM	or	SIHDS86P--
	HM6116P-3			or	SIRNS73AN- or
	MSM2128-20RS			or	SISNS73AN-
	μPD4016C-1			or	SIHM6116P4 or
	μPD4016C-2			or	SIHM6116P3 or
	MB8128-15P				SIOM#0001- or
IC6	SN74LS133N	TTL	NAND-Gate	or	SIPD4016C1 or
	SN74S133N			or	SIPD4016C2 or
	HD74LS133P				SIMB#0005-
IC7	NJM2058D	Linear	OP-Amp		SIRNS133N- or
IC8	PIC7040-510	N-MOS	CPU		SISNT133N- or
IC9	SN74LS273N	TTL	Latch	or	SIHDS133P-
	HD74LS273P			or	SINM2058D-
IC10	SP0256-AL2	N-MOS	CPU		SIPG#0001-
IC11	AY-3-8913	N-MOS	Generator		SIRNS273N- or
IC12	SN74LS367AN	TTL	Buffer	or	SISNS273N- or
	HD74LS367AP			or	SIHDS273P- or
	MB74LS367AM				SIMBS273M-
					SISG0256-A
					SIA38913--
					SIRNS367AN or
					SISNS367AN or
					SIHDS367A- or
					SIMBS367A-

Coil					
Ref. No.	Description			RS Part No.	Mfr's Part No.
L1	Inductor	120μH			142012160A

Transistor					
Ref. No.	Description			RS Part No.	Mfr's Part No.
Q1	2SA984K(E)	PNP	Switching		ST2A984K-E

**Resistors**

Ref. No.	Description	RS Part No.	Mfr's Part No.
R1	Carbon 100kohm 1/4W +-5%		RCSQP104J*
R2	Carbon 10kohm 1/4W +-5%		RCSQP103J*
R3	Carbon 2.4Mohm 1/4W +-5%		RCSQP245J*
R4	Carbon 4.7kohm 1/4W +-5%		RCSQP472J*
R5	Carbon 100kohm 1/4W +-5%		RCSQP104J*
R6	Carbon 10kohm 1/4W +-5%		RCSQP103J*
R7	Carbon 9.1kohm 1/4W +-5%		RCSQP912J*
R8	Carbon 10kohm 1/4W +-5%		RCSQP103J*
R9	Carbon 56kohm 1/4W +-5%		RCSQP563J*
R10	Carbon 27kohm 1/4W +-5%		RCSQP273J*
R11	Carbon 82kohm 1/4W +-5%		RCSQP823J*
R12	Carbon 150kohm 1/4W +-5%		RCSQP154J*
R13	Carbon 100kohm 1/4W +-5%		RCSQP104J*
R14/R15	Carbon 4.7kohm 1/4W +-5%		RCSQP472J*
R16	Carbon 3.6kohm 1/4W +-5%		RCSQP362J*
R17	Carbon 3.9kohm 1/4W +-5%		RCSQP392J*
R18/R19	Carbon 4.7kohm 1/4W +-5%		RCSQP472J*
R20	Carbon 820 ohm 1/4W +-5%		RCSQP821J*
R21	Carbon 1.0kohm 1/4W +-5%		RCSQP102J*

**Resonator**

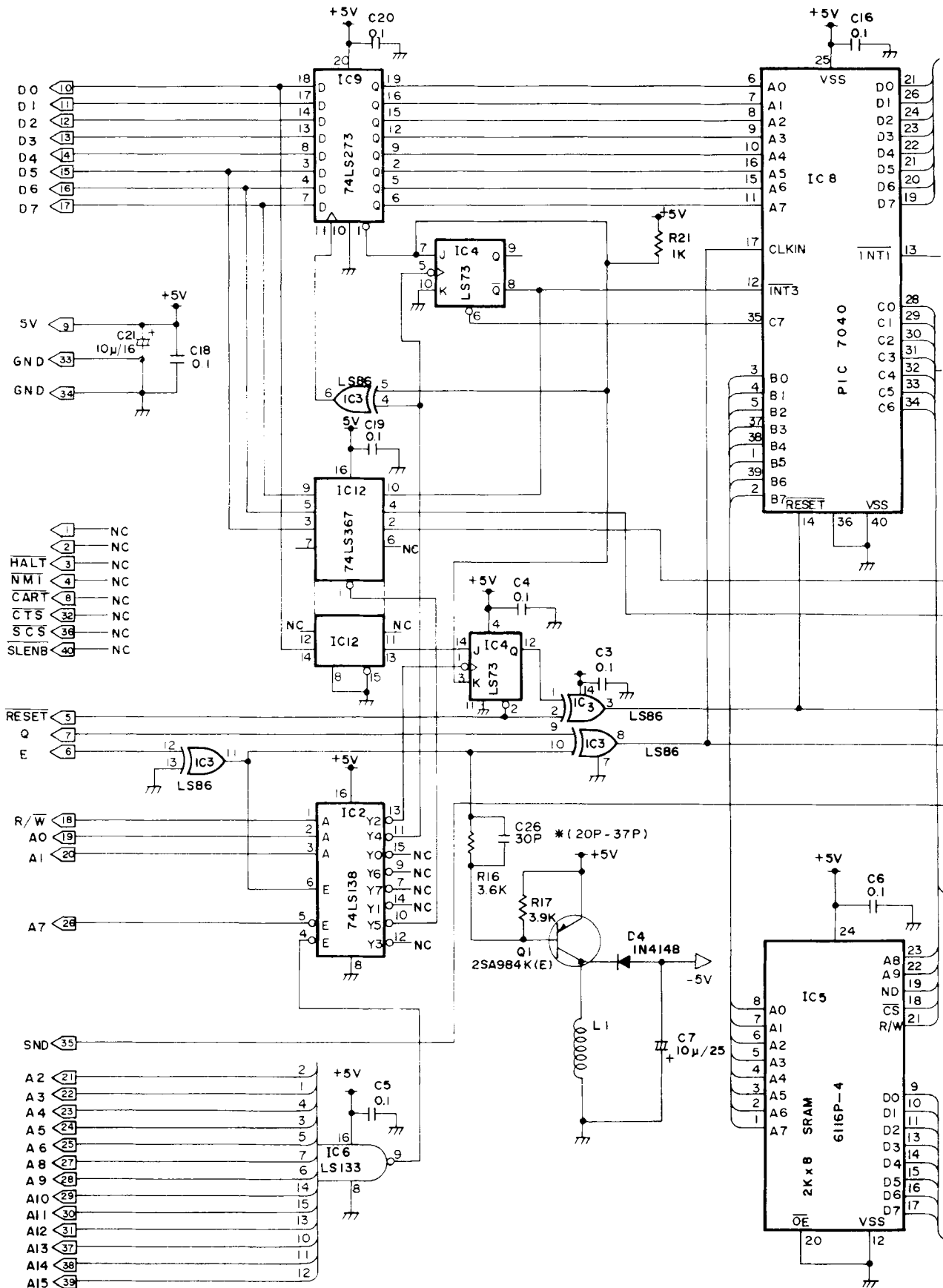
Ref. No.	Description	RS Part No.	Mfr's Part No.
CO1	3.12MHz		391110110A

**Exploded View Parts List**

Ref. No.	Description	RS Part No.	Mfr's Part No.
1	Cabinet, Top		601211070A
2	Label	US	739010730A
		CA	739010730A
		UK	739010740A
		BG	739010740A
		AU	739010740A
3	Main PCB Unit		U-32043
4	Sheet, Shield		473310770A
5	Spring Clip		HARRA003SN
6	Cabinet, Bottom		601310930A
F1	Screw Taptite 3.5x12FCT-B		HCCB3512SY
	Hardware Kit		HW2603144A
	Screw Taptite 3.5x12FCT-B		HCCB3512SY

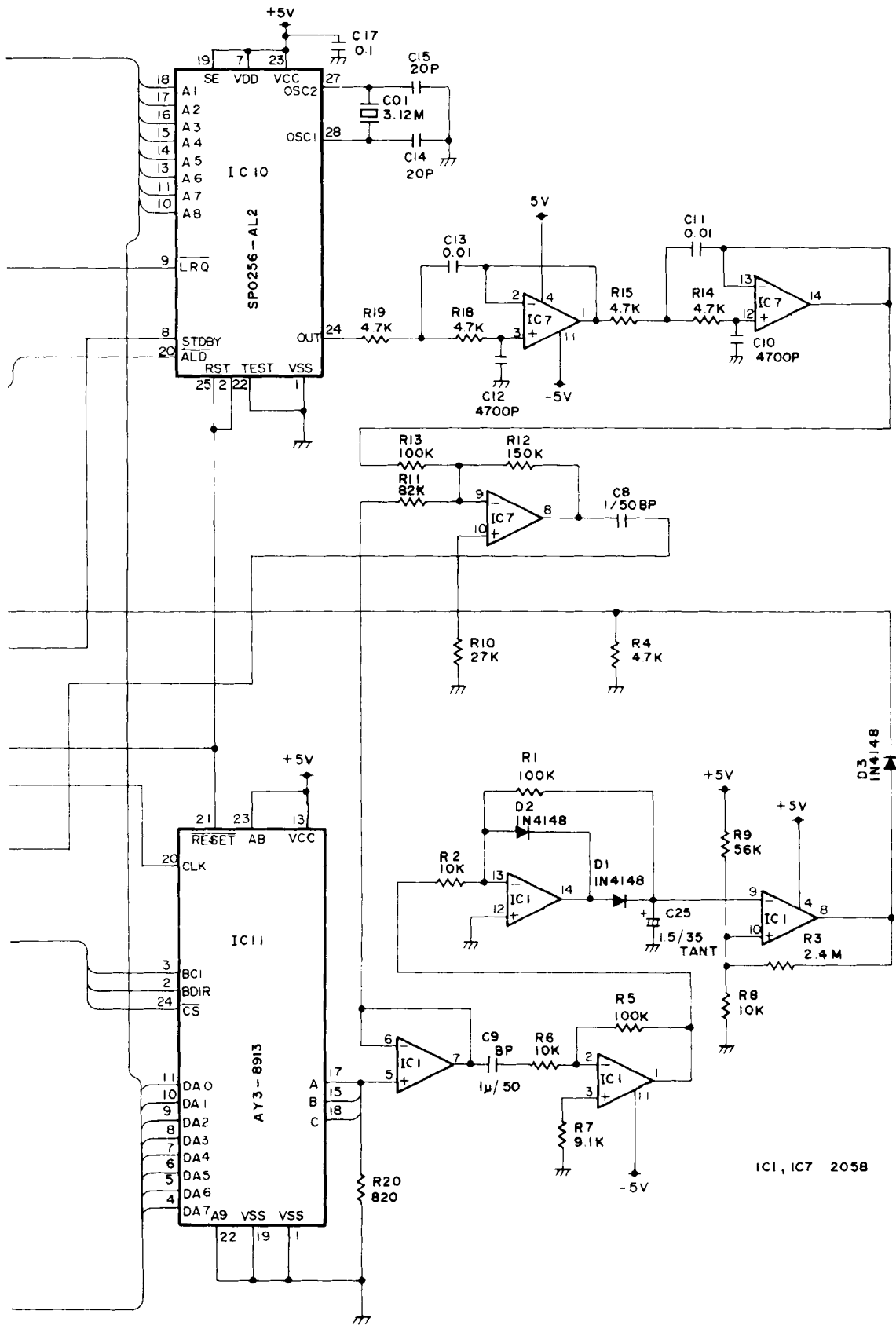


# SCHEMATI



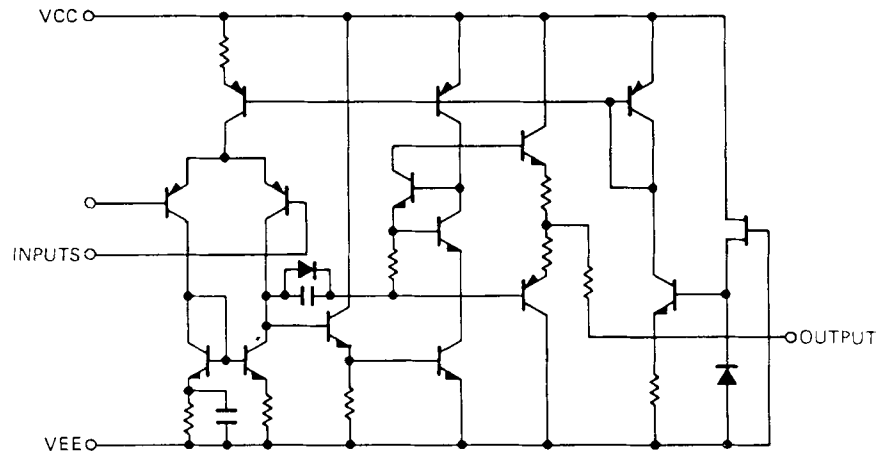
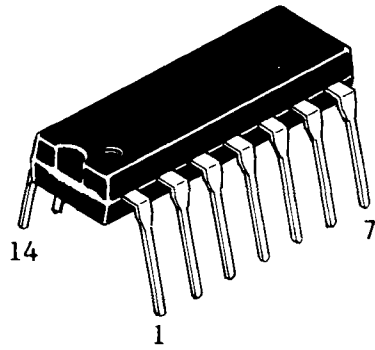
NOTES: (1) ALL RESISTANCE VALUES ARE INDICATED IN "OHM" (K = 10<sup>3</sup> OHM, M = 10<sup>6</sup> OHM).  
 (2) ALL CAPACITANCE VALUES ARE INDICATED IN "μF" (P = 10<sup>-6</sup> μF).

# C DIAGRAM

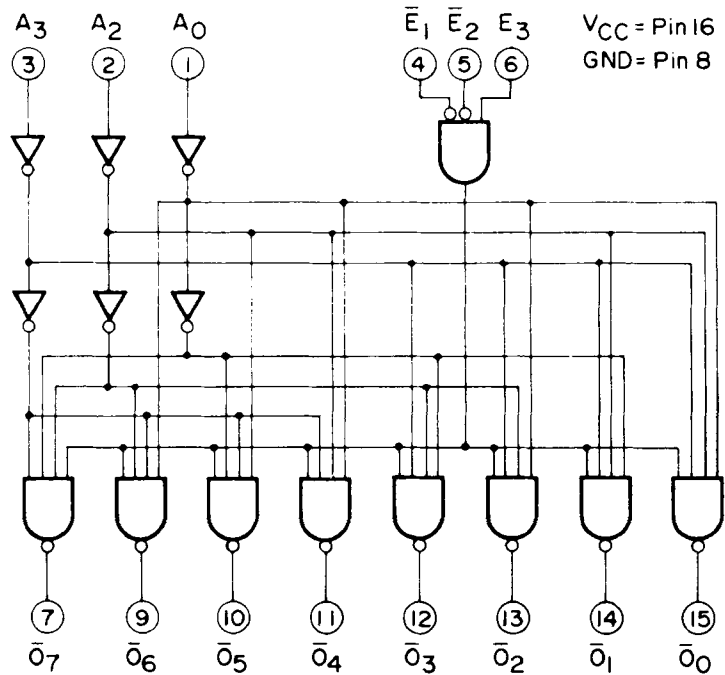
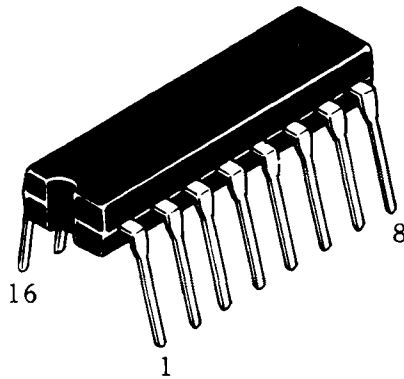


# IC INTERNAL CONNECTION AND IC TRANSISTOR LEAD IDENTIFICATION

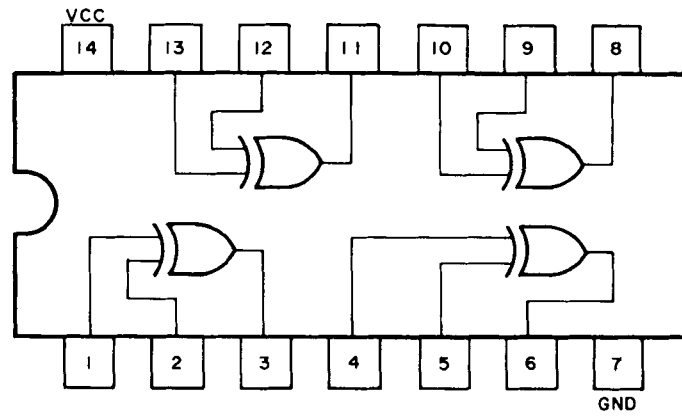
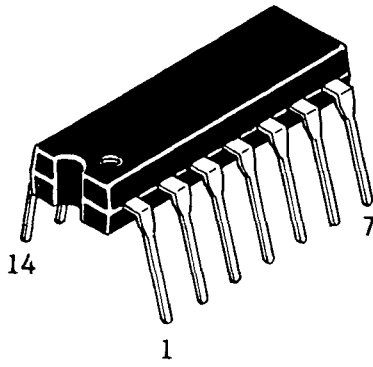
IC1, IC7...NJM2058D



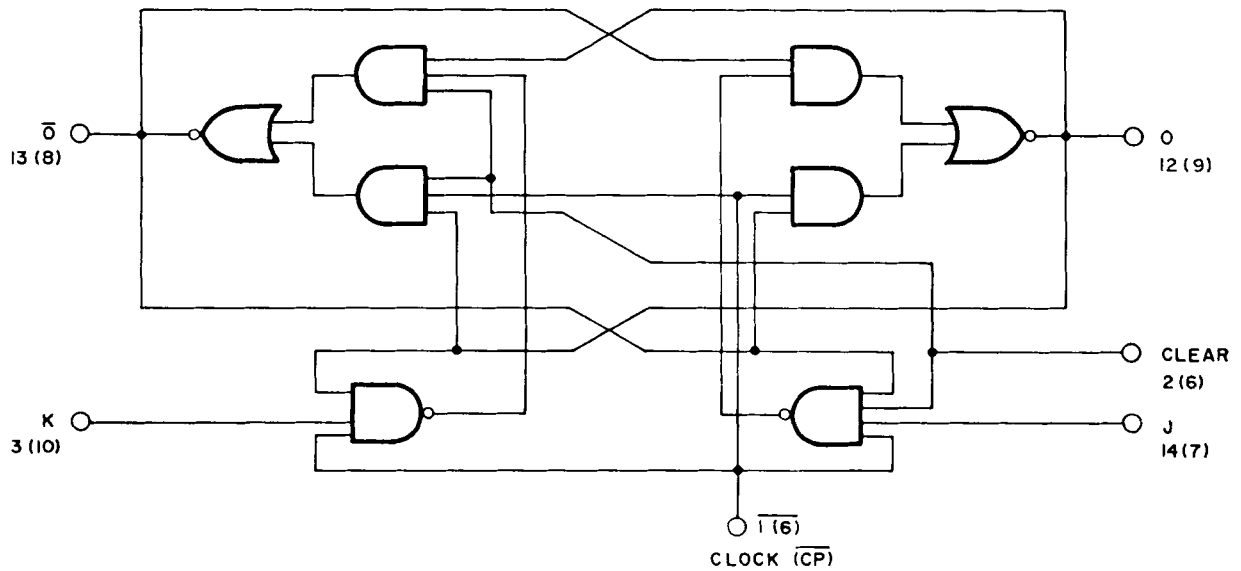
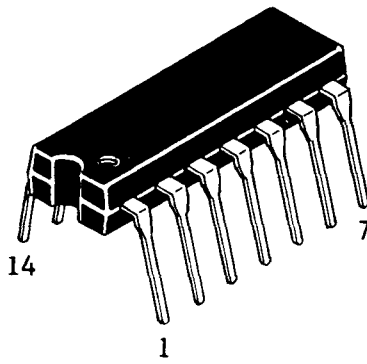
IC2...SN74LS138N or MB74LS138M or HD74LS138P



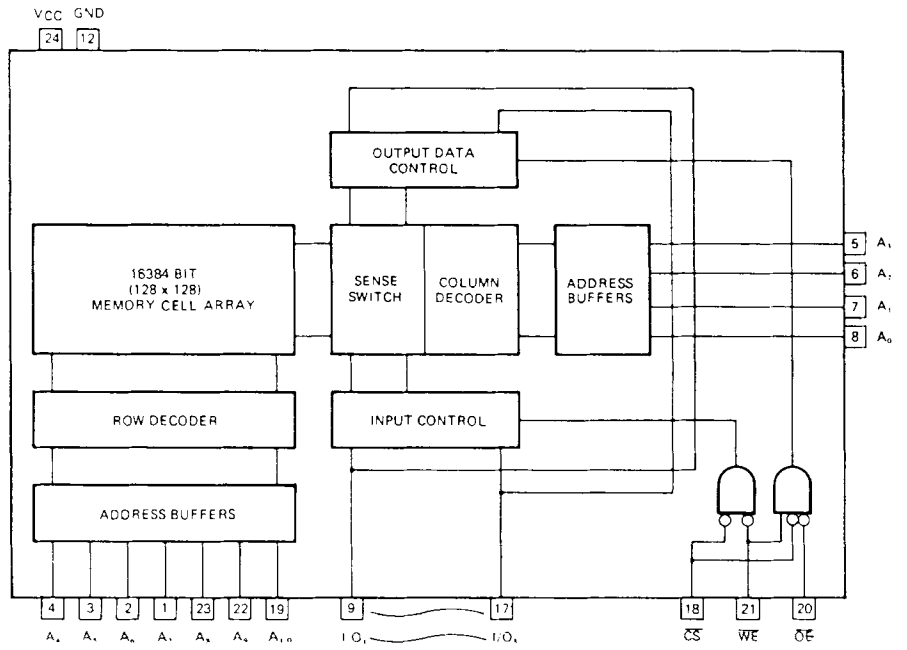
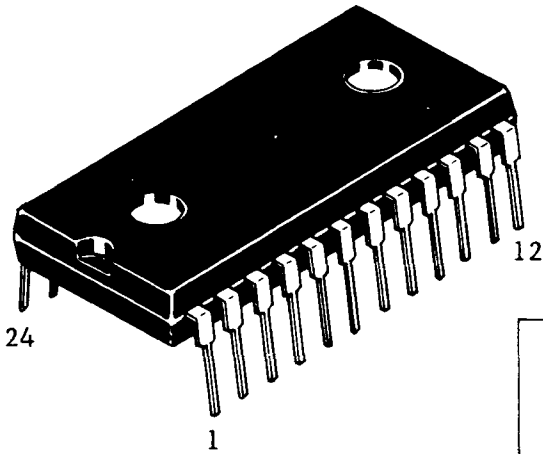
IC3...SN74LS86N or HD74LS86P



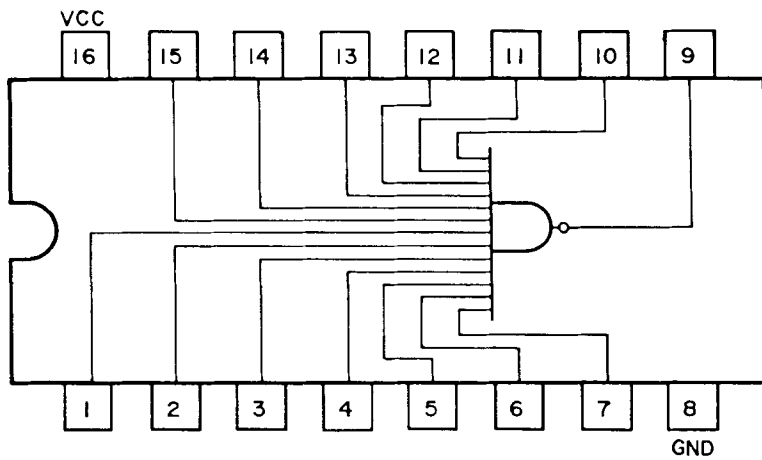
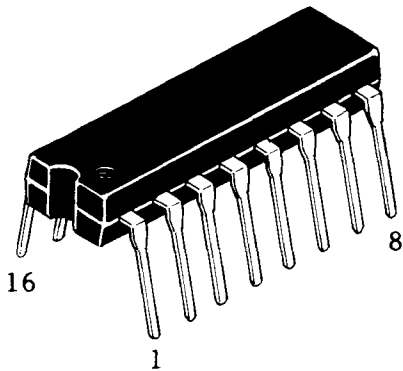
IC4...SN74LS73AN

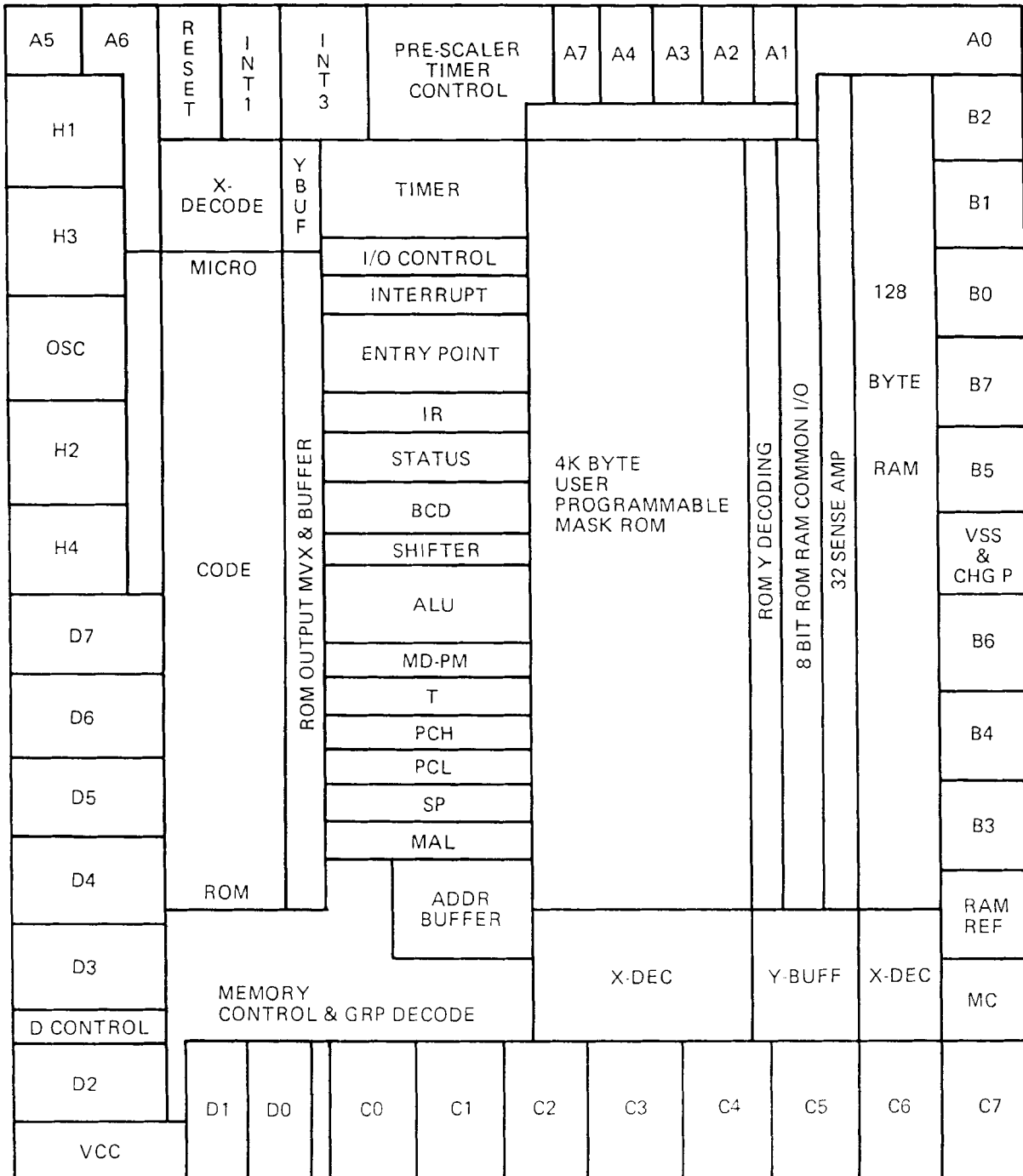
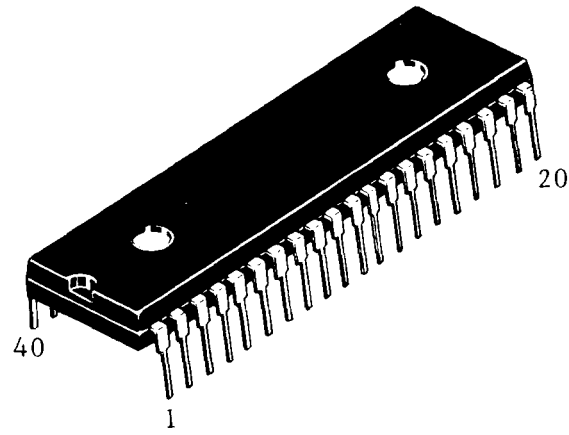


IC5...HM6116P-4 or HM6116P-3 or MSM2128-20RS or  
 $\mu$ PD4016C-1 or  $\mu$ PD4016C-2 or MB8128-15P

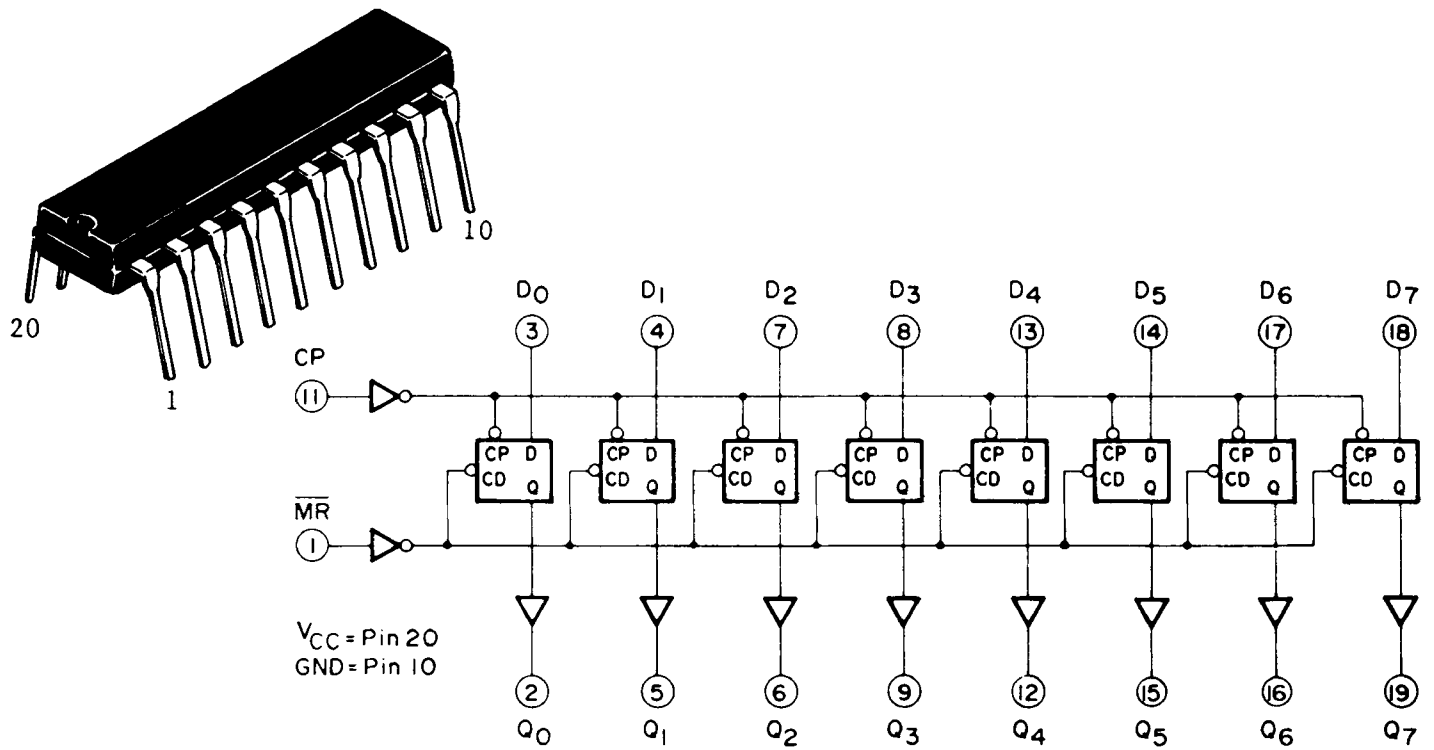


IC6...SN74LS133N or HD74LS133P

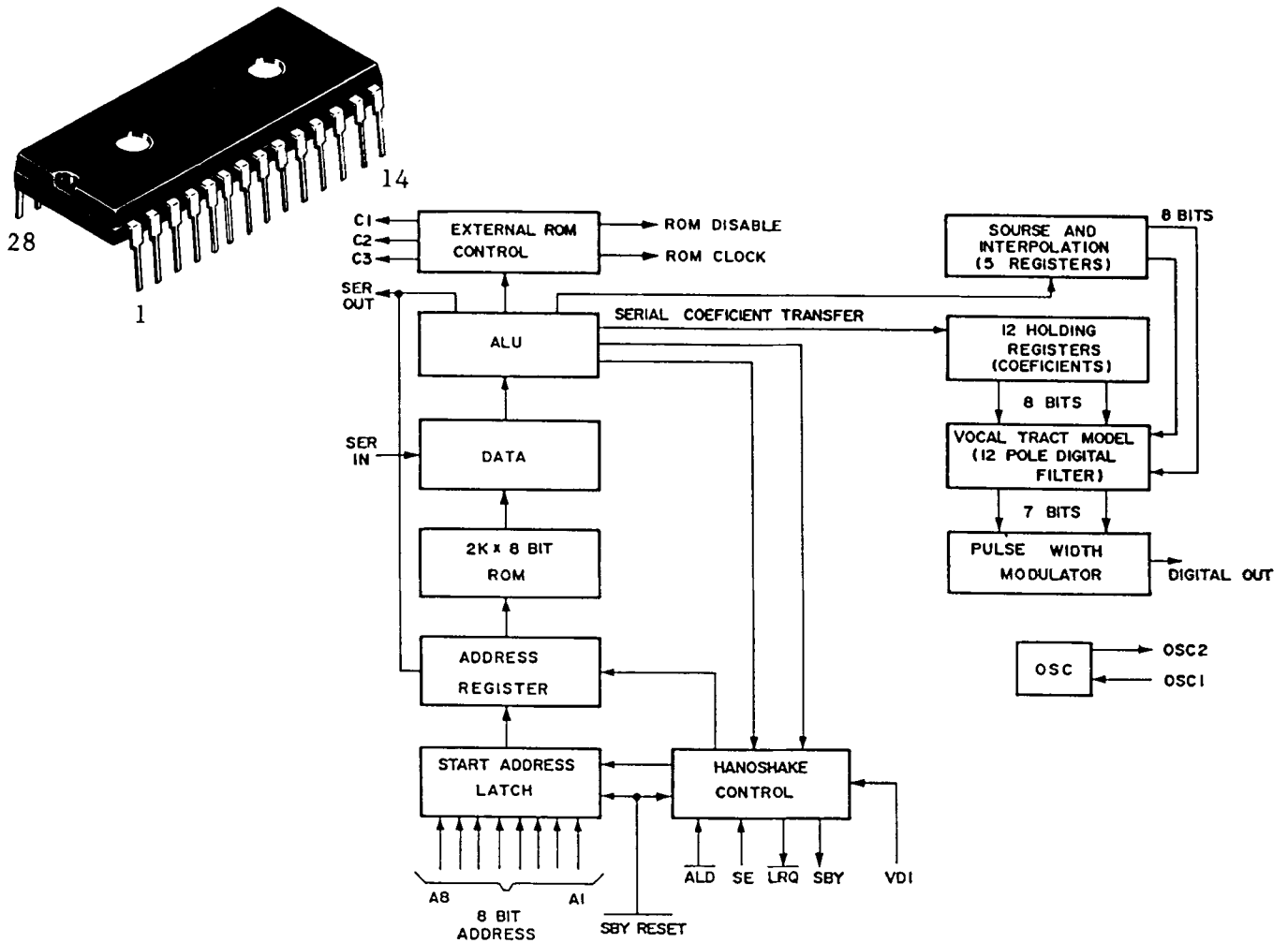


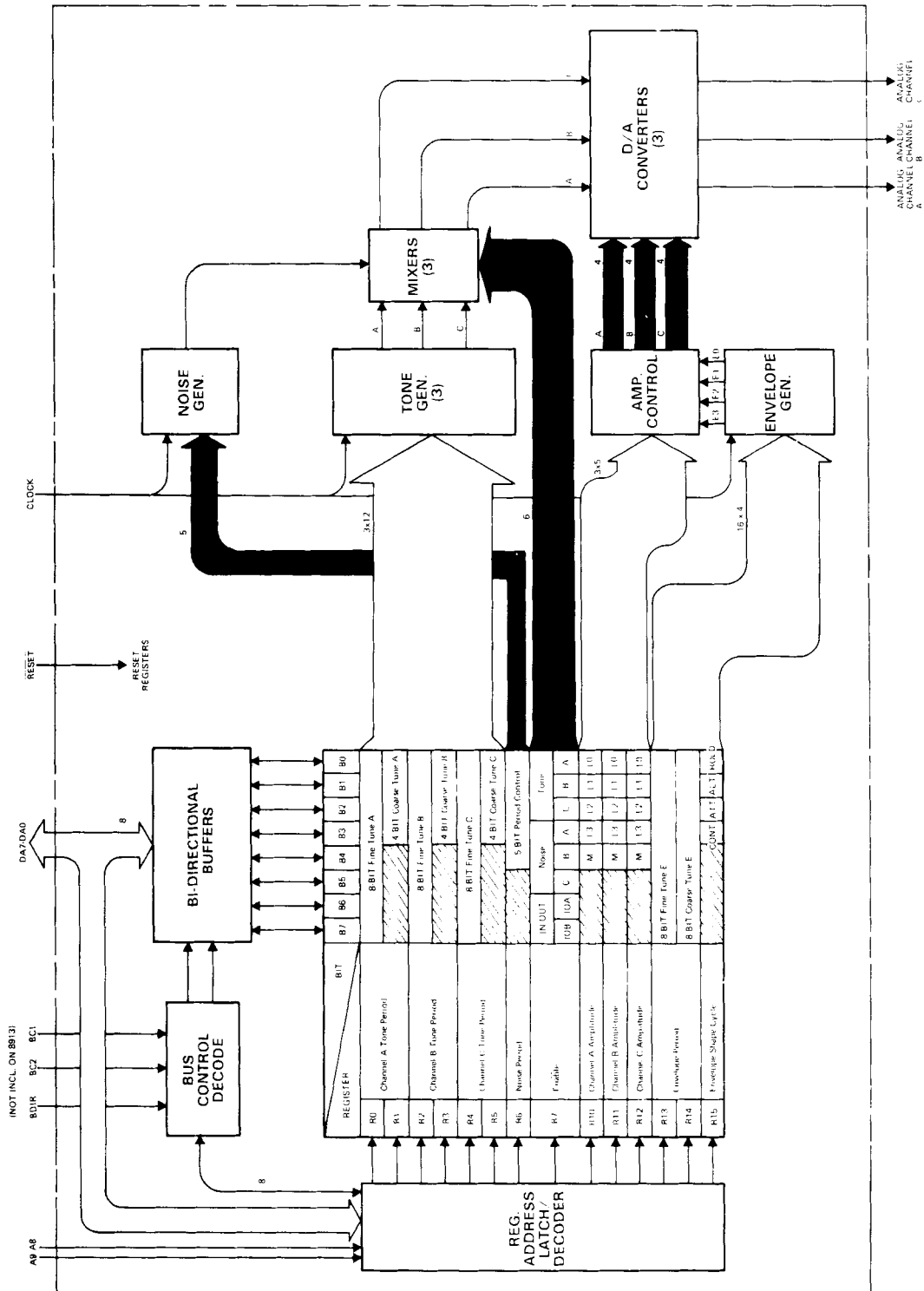
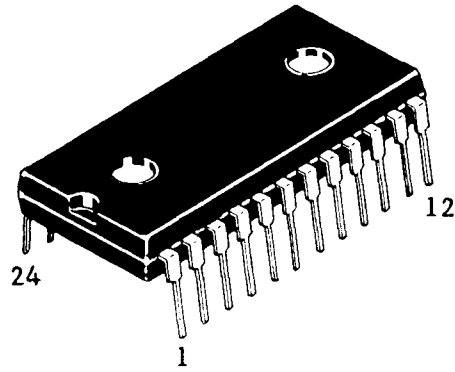


IC9...SN74LS273N or HD74LS273P or MB74LS273M



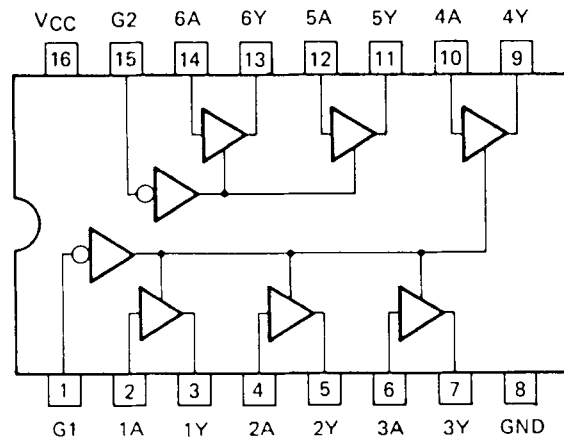
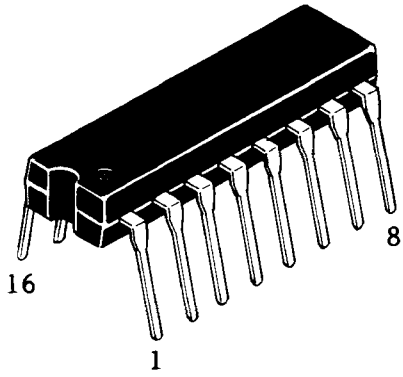
IC10...SP0256-AL2







IC12...SN74LS367AN or MB74LS367AM or HD74LS367AP



Q1...2SA984K(E)



# APPENDICES

## A/Speech Program

To use the Speech program as a troubleshooting tool, enter in the program listed below. Answer the prompt by typing in what you want the cartridge to say and hit <ENTER>. (See the example below the program.)

```
10 X=&HFF00: Y=&HFF7E
20 POKE X+1,52: POKE X+3,63
30 POKE X+35,60
40 INPUT A$
50 GOSUB 70
60 GOTO 40
70 FOR I=1 TO LEN(A$)
80 IF PEEK(Y) AND 128=0 THEN 80
90 POKE Y, ASC(MID$(A$,I,1))
100 NEXT I
110 IF PEEK(Y) AND 128=0 THEN 110
120 POKE Y,13
130 RETURN
```

Run the program. At the ? prompt, type:

Example: I CAN TALK <SPACE BAR> <ENTER>

## B/Tone Program

To use the Tone program as a troubleshooting tool, enter the program listed below. This program will allow you to manipulate a tone on Channel A by directly controlling the SSC's registers:

```
10 POKE &HFF7D,1: POKE &HFF7D,0
20 X=&HFF00: Y=&HFF7E
30 POKE X+1,52: POKE X+3,63: POKE X+35,60
40 GOSUB 200
50 POKE Y,&HAF
60 GOSUB 200
70 POKE Y,0
80 INPUT "ENTER A VALUE FOR A TONE ON CHANNEL A";T
90 GOSUB 200
100 POKE Y,T
110 GOSUB 200
120 POKE Y,7
130 GOSUB 200
140 POKE Y,62
150 GOSUB 200
160 POKE Y,8
170 GOSUB 200
180 POKE Y,15
190 GOTO 70
200 IF PEEK(Y) AND 128 = 0 THEN 200
210 RETURN
```

To stop the program, press <BREAK>. Line 10 resets the SSC to silence.

## Speech-Sound Pak 1.78 MHz. Modifications

This text attempts to explain how to modify the Radio Shack/Tandy Speech-Sound Pak (catalog numbers 26-3144 and 26-3144A) to work with the COCO3 at 1.78 MHz.

Please note that the level 1 version 02.00.00 COCO OS-9 SSC-PAK driver doesn't work properly with a modified Speech-Sound Pak. The drivers can be found at:

[ftp://os9archive.rtsi.com/OS9/OS9\\_6X09/SYSMODS/SS\\_Pak\\_Driver.lzh](ftp://os9archive.rtsi.com/OS9/OS9_6X09/SYSMODS/SS_Pak_Driver.lzh)

The hardware modifications are fairly straightforward, but vary slightly between the two models (26-3144 & 26-3144A). Make sure that your Speech-Sound Pak is one of the Paks described, and that you make the correct modifications.

Externally, the 26-3144's that we have seen have a Radio Shack label, while the 26-3144A's have a Tandy label. Internally, the 26-3144 uses a 2N907 transistor and the inductor (marked L1) is in a resistor-style (axial) package. The 26-3144A uses a different transistor, and the inductor (also marked L1) is in a small plastic box. In both Paks the transistor & inductor (coil) are close to the post hole in the circuit board.

It is necessary to change the transistor in order for the Speech-Sound Pak to work properly in most cases. We have seen only one unmodified Pak which worked when the COCO3 was running at 1.78 MHz. The voltage inverter circuit used must supply at least -5VDC in order for the output OP-AMPS to function. Unfortunately, the transistor used is sensitive to the frequency input to the circuit. The input signal used is derived from the bus E clock. When the COCO3 runs at 1.78 MHz, the circuit typically produces only -2.5VDC, which is not sufficient for the OP-AMPS.

The 2N3906 is a PNP transistor. Looking at the flat face, with the pins pointing down, the pin out should be Emitter, Base, Collector from left to right. The 2N2907 transistor should have the same pin out as the 2N3906. The transistor in the 26-3144A Pak should have a pin out of Emitter, Collector, Base when viewed in the same manner as the 2N3906. When installing the 2N3906 transistor into a 26-3144A circuit board you must swap the Base and Collector pins so that they match the original transistor's pin out. 26-3144 Voltage Inverter Transistor Change:

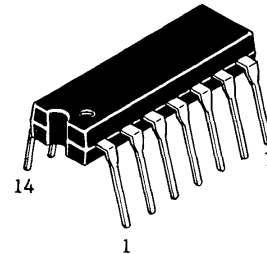
- 1) Make note of the 2N2907's pin out & orientation. Most manufacturers should use the same pin out, but its worth checking.
- 2) De-solder the 2N2907 transistor & remove it from the Speech-Sound Pak circuit board.
- 3) Solder a new 2N3906 transistor into the Pak's circuit board. The 2N3906 should be oriented the same as the 2N2907 that was removed, but again its worth checking the pin out!

26-3144A Voltage Inverter Transistor Change:

- 1) Make note of the transistor's pin out & orientation. Most manufacturers should use the same pin out, but its worth checking.
- 2) De-solder the transistor & remove it from the Speech-Sound Pak circuit board.
- 3) Carefully bend a new 2N3906 transistor's base and collector pins so as to swap the holes they fit into. Make sure that they do not touch each other or anything else that could cause a short circuit.
- 4) Solder the new 2N3906 transistor into the Pak's circuit

board. The 2N3906 should be oriented the same as the transistor that was removed (except 2 pins swapped), but again its worth checking the pin out!

The other hardware change required alters the clock frequency of the Pak's micro-controller and sound effects chips. The Speech-Sound Pak uses a frequency doubling circuit to provide the clock signal for these ICs. These chips use a typical clock of 2 MHz, and the old COCO's clock of .89 MHz was doubled to 2 MHz that the Pak runs properly. However, when the COCO3 runs at 1.78 MHz, this frequency is doubled to 3.56 MHz, which is well above the ideal 2 MHz clock. We've found that most Paks will work at this speed as long as the voltage inverter has been modified. If the clock doubler isn't modified, the speech synthesizer will sound normal, but the sound effects will be one octave higher than they should be. That is, sound effects will not sound as they should, with the result that software which uses the Pak for sound effects will probably disappoint you.



Here is an illustration of the 74LS86.

Here are two alternatives to fixing the Speech-Sound Pak's clock rate. The first will limit your Pak to use at 1.78 MHz, unless you restore the Pak to its original state before using it at .89 MHz. The second will allow you to switch the Pak to operate at either .89 MHz or 1.78 MHz. Both fixes will work on either the 26-3144 or 26-3144A Speech-Sound Pak.

### 1.78 Mhz COCO3 Clock Frequency:

- 1) Cut the trace leading from the Pak's bus Q signal (card-edge pin 7) to pin 9 on the 74LS86.
- 2) Connect pin 9 of the 74LS86 to the Pak's ground.

### .89/1.78 MHz COCO Switchable Clock Frequency:

- 1) Cut the trace leading from the Pak's bus Q signal (card-edge pin 7) to pin 9 on the 74LS86.
- 2) Connect pin 9 of the 74LS86 to the centre (common) pole of a small SPDT (Single Pole Double Throw) switch.
- 3) Connect one outside pole of the SPDT switch to the Pak's ground.
- 4) Connect the remaining pole of the SPDT switch to the Pak's bus Q signal.
- 5) Mount the SPDT switch on or in the Pak, wherever its convenient, and will not accidentally short to anything.

We hope that your Speech-Sound Pak modification goes as smoothly and successfully as ours did (once we figured out the voltage inverter problem it was all downhill!). Thanks to Kevin Darling and others who believed that there was no good reason why it wouldn't work!

Speech-Sound Pak modification by Bill Boogaart (CIS 72075,615), Mario Dilallo, and Bruce Isted (CIS 76625,2273). Radio Shack TM Tandy Corporation, OS-9 TM Microware & Motorola, Inc.

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