USER MANUAL **U-TALK**

U-MICROCOMPUTERS

IMPORTANT!
Please read this manual before installing card.

U-TALK APPLE SPEECH SYNTHESIS CARD USER MANUAL

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U-TALK Apple Speech Synthesis Card User Manual

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A. INTRODUCTION

The design of the U-TALK Apple compatible speech card is based on the National Semiconductors "DIGITALKER" system chip set. The card contains a speech processor chip (SPC) and two 64K bit ROM's containing speech data. The ROM's supplied with the standard Apple card contain 143 popular words. The system produces high quality speech including emphasis of the original speech and natural inflection.

Also included on the card are a 700Hz and 200Hz filter, power amplifier and Apple interface circuitry. The audio output of the Apple is fed to this card and mixed with the speech output, then routed to the loudspeaker inside the Apple. The speech gain can be adjusted. If better quality speech is required a 3.5mm Jack socket is sited near the back of the card so that either a larger loudspeaker of Hi-Fi system can be connected. All U-Microcomputers products are thoroughly tested and "burned in" prior to leaving the factory.

This card was formerly produced by AML.

B. INSTALLING THE U-TALK

(1) Unpack the Apple speech card and check that the card has not been damaged in transit.

(2) Remove the top panel of the Apple. The speech card software in later section of this manual assumes that the card will be placed in the Apple peripheral card slot 2. However there is no reason why the card cannot reside in any of the other peripheral card slots if the software is altered accordingly.

(3) Unplug the Apple loudspeaker connector from the system PCB. The speaker plug is located near the front of the machine on the right side of the PCB. Then insert the socket into the speech card plug marked PL2. The flying lead from the speech card should then be plugged into the Apple speaker connector. Please note the polarity of this connector. Whilst no damage will result if the connector is fitted the wrong way round, any tones output by the Apple will not be heard.

(4) Set the pre-set resistor (VR1) to its mid way position. Check that the card is fully seated in its socket. Turn the mains switch on at the rear of the machine. You should hear the familiar power-up bleep indicating that the Apple is in Apple Basic mode. You might possibly also hear a random word or sound from the speech card.

(5) If the speech card is located in slot 2 and the machine is operating under Apple Basic enter the following instruction:

```
POKE 49312, 0     (RETURN)
```

If the speech card is working correctly you should hear "This is Digitalker". Repeat this instruction whilst adjusting VR1 for a comfortable listening level.

(6) Since the Apple internal loudspeaker has a limited frequency response the user can connect either a larger loudspeaker or a Hi-Fi system to the speech card. The connection is made via a 3.5mm jack socket obtainable from most electrical or component stores.

C. TECHNICAL DESCRIPTION

Before covering the Apple interface and analogue circuitry, a detailed examination of the National Semiconductors "DIGITALKER" system will be given. The system comprises a speech processor chip and the speech ROM(s). The system uses speech compression synthesis techniques. These techniques dramatically reduce the amount of memory required to store speech when compared to other systems such as digitisation, PCM (Pulse Code Modulation) & ADPCM (Adaptive Code Pulse Code Modulation).

National Semiconductors use a computer program to analyse the tape recording and produce a ROM pattern which will synthesize the original recording. During this process the speech waveform is sampled, digitised and compressed by eliminating symmetrical redundancy and silence periods. During the compression algorithm, the voiced and unvoiced sounds are separated. The signal is adaptive delta modulated and the phase information is adjusted. By using this method, speech elements can be synthesized as phonemes or even complete phrases; this data can then be stored on tape, disc or transferred to ROM or EPROM.

In the English language there are between 36 to 40 phonemes (comprising 14 to 16 vowel sounds and 24 consonants). Together with emphasis, inflection and volume these produce the fundamental building blocks of speech. A phoneme is made up of either voiced (eye) or unvoiced sounds (shy). Unvoiced sounds are usually less frequent and less varied than voiced sounds. A speech synthesizer can exploit this difference. Including silence periods, speech rates are about 10 to 15 phonemes per second. The normal bit rate for phoneme speech is approximately 60 to 90 bits per second. The synthesis model has two driving functions, a grey noise source, which is a hissing sound for unvoiced sounds, and a tone source providing pitch for voiced sounds. The sounds created by the two sources are filtered by time-varying format filters. We can easily relate the synthesizer to the human vocal tract. The lungs are the energy source; when air is passed through the vocal cords a pitch (voiced sound) is produced. Unvoiced sounds reproduced as air is passed through the vocal chambers and not through the vocal chords. The formants are created by the throat, mouth and nasal cavities. By controlling these chambers, tongue and throat size, a phoneme can be generated.

Fricative sounds like "ch" or "sh" are created by pulses of noise normally around 2.5hz to 8Khz. A typical English male voice would require three formant filters and the fricative formant. The "DIGITALKER" system can maintain the original attributes of the speaker, ie data can include inflection.

To obtain speech from the card, an eight bit word chosen from the master word list on page 2-1 is written to a memory address which corresponds to the Apple peripheral card slot in which the speech card is sited (see later). The sixteen memory locations relating to each Apple peripheral card slot are not decoded by the speech card. Therefore the speech card will accept data from all sixteen memory locations.

When the operating software sends a speech data word, the Apple bus signals R-/W and /Device select become active. /Device select is connected directly to the SPC (U1) /CS input (pin 3), which only needs to be active during a command to the SPC. The Apple R-/W signal is connected to the SPC /WR input (pin 4). When both of these signals become active the start address code is loaded into the control word register. The SPC then fetches the control word for the first block of speech data. The control word contains repeat and waveform information and the address of the speech data. This address is loaded into the phoneme register and is used to recreate the speech waveform. Further decording takes place, voiced or unvoiced, half-period zeroed or not, male or female and silence. When the decoding is complete, synthesis then takes place. When using SSR1 (U2) and SSR2 (U3) ROM's access of both chips during a single word can occur, therefore they should be used together. To detect the completion of a word or phrase, the host computers software should read the same memory address that the data word was sent to and scan data line 0 (bit 1). This bit will be logic low during speech and high on completion. This signal from the speech card originates from the SPC Interrupt (INTR pin 6) line which is routed to a tri-state buffer 74LS126 (U4). This buffer is enabled by the open collector configuration of D1 and D2 going high.

The sound output of the SPC (pin 39) is fed to two filers and a buffer amplifier based around a quad programmable Op-amp U5, LM346. The first stage is a 7Khz filter. This filter is used to reduce sampling noise. The second stage is a 200z low-pass filter with an attenuation characteristic of 20 db per decade. This filter is used to compensate for the high frequency pre-emphasis used in this speech decoding technique. The output of this filter is then fed to the buffer, pin 14. Its output is fed to VR1, which controls the gain of the speech. R14 sums the speech output and R13 the sound from the Apple itself. The lead which connects the Apple speaker to the computer is removed from the Apple and inserted into PL2 on the speech card. The speaker output from the Apple is connected via a flying lead from the speech card (PL3), attenuated (R15 and R16) and taken to R13. The power amplifier U6, an LM386 is set by C12 and R17 to have a gain of approximately 100. The gain can be altered, however if the gain is increased too much the current required will exceed the limit of 400ma on the Apple +12v supply which will cause the Apple's DRAM to fail.

A 3.5 Jack plug can be connected to SKT 1, on the edge of the card. This will turn off the loudspeaker in the Apple. Better sound quality can be accomplished if the speaker card is connected to either a Hi-Fi system or larger loudspeaker.

D. U-TALK SOFTWARE INFORMATION

The speech card can be inserted into Apple peripheral card slots 0 to 7. These slots are decoded by circuitry on the main card as 16 memory locations per cardslot. Below is a table showing which memory locations relate to each card slot:

Slot No.	Hexi decimal	Decimal
0	C080 to C08F	49280 to 49295
1	C090 to C09F	49296 to 49311
2	C0A0 to C0AF	49312 to 49327
3	C0B0 to C0BF	49328 to 49343
4	C0C0 to C0CF	49344 to 49359
5	C0D0 to C0DF	49360 to 49375
6	C0E0 to C0EF	49360 to 49391

The following Basic program causes the speech card to recite its entire vocabulary. The speech ROM's supplied with the card are the DT1050 set, which contain 143 words. If the DT1057 set is used then change line ten numbers 143 to 255.

```
10 FOR  I=0 TO 143          : 0 is the first phrase & 143 the last
20 POKE 49312,I             : Output the value of I to card slot 2
30 WAIT 49312,1             : Wait till not busy
40 FOR T=0 TO 200: NEXT T : Delay
50 NEXT I                   : Output next word
```

The second Basic program allows words not contained in the speech ROM's to be generated. The parameters provided by the data statements determine the particular word spoken and the length of time that word is used. The message contained in the data statements is "The AML SPEECH UNIT".

```
100   READ A              :  Get word number.
110   IF A=0 THEN 500     :  Finished?
120   READ B              :  Get delay
130   POKE 49312,A        :  Output word to speech card in slot 2.
140   IF B [illegible] 0 GOTO 170 :  Early interrupt?
150   WAIT 49312,1        :  No! wait till done.
160   GOTO 100            :  Get next.
170   FOR C=0 TO B        :  Yes do delay.
180   NEXT C              :
190   GOTO 100            :  Get next.

400   DATA 138, 0, 70, 0, 32, 0, 69, 0, 44, 0, 69, 0
410   DATA 43, 0, 70, 0, 133, 200, 67, 0, 73, 36, 70, 0
420   DATA 52, 100, 111, 100, 69, 0, 51, 10, 67, 0
430   DATA 0
500   END
```


The following section presents a 6502 machine code routine to perform data output to the Speech Card. It uses a different data format from the BASIC programs, in the way that it deals with sound cut-off. It is more efficient in data storage if most of the sounds to be output are complete Digitalker words. The approach of the BASIC programs could, of course, be implemented in machine code if required.

U-TALK output routine

This is a fully relocatable routine to output a sequence of words/sounds from the U-TALK.

The user may place the routine in any suitable part of store and it is called by executing:

JSR addr of start of routine
ie. HEX 20 02 03 in this example

Before entering routine, index register Y should be loaded with byte address of first data block. In this example data must be placed in page zero starting at location $0000, but by changing bytes 309, 30A and 311, 312 to load data relative to a higher base address, data may be placed in any part of store.

Each sound code may take one or two possible forms:

1) ss (1 byte)
2) ss 00 dd (3 bytes)

Where ss is the byte code of one of the Digitalker words, 00 is a null byte and dd is a delay factor. The data block is terminated by 00 00.

In case 1) the code ss is sent to the Speech card, and the next code is not sent until the card indicates 'not busy'.

In case 2) the code is sent to the card, the routine then delays for a time proportional to dd, then sends the next code to the card, regardless of the busy status - thus possibly cutting off the sound currently being output, and replacing it with a new sound.

An example of a legal data block:

ss' ss' ss 00 dd' ss' ss' 00 dd' ss 00 dd' ss' 00 00
where ss and dd are in the range 01 - FF hex.

NOTE: If the data finishes 'ss 00 dd 00 00 then the final sound will not be cut off, since there is not further data to be sent. Sending one of the 'silence' codes as the final sound, would have the desired effect.

The only register to be modified by this routine is Y which is left pointing at the byte following the terminating '00 00'. This could be the start of the next sound sequence.

An example data block

Hex codes to produce sentence 'THE AML SPEECH UNIT'.

```
8A  46  20  45  2C  45  2B  46
85  00  80  43  49  00  20  46
34  00  40  6F  00  40  45  33
00  10  43  00  00
```

```
302   08              PHP              : save status
303   48              PHA              : save acc
304   8A              TXA              : save
305   48              PHA              : X register
306   A2   00         LDX  £$00        : initialise delay flag
308   B9   00   00    LDA   $0000,Y    : get data
30B   C8              INY              : inc data pointer
30C   29   FF         AND  £$FF        : Test for null data
30E   D0   20         BNE   $0330      : no - it is sound code
310   B9   00   00    LDA   $0000,Y    : yes- get next byte
313   C8              INY              : inc data pointer
314   29   FF         AND  £$FF        : test if delay or end
316   D0   05         BNE   $031D      : delay - go to it
318   68              PLA              : end - so
319   AA              TAX              : restore X reg
31A   68              PLA              : restore ACC
31B   28              PLP              : restore status
31C   60              RTS              : return
           : delay routine
31D   48              PHA              : save acc
31E   A2   7F         LDX  £$7F        : load idle counter
320   48              PHA              : delay
321   68              PLA              : by
```

continued....


```
322   48              PHA              : stacking and
323   68              PLA              : unstacking acc
324   CA              DEX              : dec idle counter-test
                                       : if finished idle
325   D0   F9         BNE   $0320      : no - so cycle
327   E9   01         SBC  £$01        : test if finished delay
329   D0   F3         BNE   $031E      : no - so cycle
32B   68              PLA              : restore acc
32C   A2   FF         LDX  £$FF        : set delay flag for
                                       : wait finished
32E   30   D8         BMI   $0308      : uncond relative
                                       : branch to get next
                                         data
                      :output speech routine
330   E8              INX              : test if finished delay
331   F0   08         BEQ   $033B      : yes - so do not wait
333   48              PHA              : save code
334   AD   A0   C0    LDA   $C0A0      : wait for
337   6A              ROR
338   90   FA         BBC   $0334      : not busy on slot 2
33A   68              PLA              : get code back
33B   8D   A0 C0      STA   $C0A0      : send to card
33E   E8              INX              : uncond relative
33F   10   C5         BPL   $0306      : branch to get next
                                         data
```

National Semiconductor DT1050 Master word list (ROM's SSR1 & SSR2)

DEC	HEX	WORD	DEC	HEX	WORD
00	00	This is Digitalker	48	30	Q
01	01	One	49	31	R
02	02	Two	50	32	S
03	03	Three	51	33	T
04	04	Four	52	34	U
05	05	Five	53	35	V
06	06	Six	54	36	W
07	07	Seven	55	37	X
08	08	Eight	56	38	Y
09	09	Nine	57	39	Z
10	0A	Ten	58	3A	Again
11	0B	Eleven	59	3B	Ampere
12	0C	Twelve	60	3C	And
13	0D	Thirteen	61	3D	At
14	0E	Fourteen	62	3E	Cancel
15	0F	Fifteen	63	3F	Case
16	10	Sixteen	64	40	Can
17	11	Seventeen	65	41	443Hz tone
18	12	Eighteen	66	42	89 Hz tone
19	13	Nineteen	67	43	20 mS Silence *
20	14	Twenty	68	44	40 mS Silence *
21	15	Thirty	69	45	80 mS Silence *
22	16	Forty	70	46	160mS Silence *
23	17	Fifty	71	47	320mS Silence *
24	18	Sixty	72	48	Centi
25	19	Seventy	73	49	Check
26	1A	Eighty	74	4A	Comma
27	1B	Ninety	75	4B	Control
28	1C	Hundred	76	4C	Danger
29	1D	Thousand	77	4D	Degree
30	1E	Million	78	4E	Dollar
31	1F	Zero	79	4F	Down
32	20	A	80	50	Equal
33	21	B	81	51	Error
34	22	C	82	52	Feet
35	23	D	83	53	Flow
36	24	E	84	54	Fuel
37	25	F	85	55	Gallon
38	26	G	86	56	Go
39	27	H	87	57	Gram
40	28	I	88	58	Great
41	29	J	89	59	Greater
42	2A	K	90	5A	Have
43	2B	L	91	5B	High
44	2C	M	92	5C	Higher
45	2D	N	93	5D	Hour
46	2E	O	94	5E	In
47	2F	P	95	5F	Inches

Dec	Hex	Word	Dec	Hex	Word
96	60	Is	120	78	Please
97	61	It	121	79	Plus
98	62	Kilo	122	7A	Point
99	63	Left	123	7B	Pound
100	64	Less	124	7C	Pulses
101	65	Lesser	125	7D	Rate
102	66	Limit	126	7E	Re
103	67	Low	127	7F	Ready
104	68	Lower	128	80	Right
105	69	Mark	129	81	Ss **
106	6A	Meter	130	82	Second
107	6B	Mile	131	83	Set
108	6C	Milli	132	84	Space
109	6D	Minus	133	85	Speed
110	6E	Minute	134	86	Star
111	6F	Near	135	87	Start
112	70	Number	136	88	Stop
113	71	Of	137	89	Than
114	72	Off	138	8A	The
115	73	On	139	8B	Time
116	74	Out	140	8C	Try
117	75	Over	141	8D	Up
118	76	Parenthesis	142	8E	Volt
119	77	Percent	143	8F	Weight

Notes

(*) Silence periods (Hex 43 to 47), have been included to improve the quality of speech phrasing. As a rough guide as to their use, words beginning with the letters B, D, G, K, P and T insert eighty milliseconds of silence period prior to the word. For words ending in the above letters insert forty milliseconds of silence.

(**) "Ss" (Hex 81) makes any singular word plural.

NOTE If a data number higher than 8F hexidecimal is sent to the speech card, unintelligable invalid speech will be output. Other speech ROM's may allow all 256 codes to be used

E. EXAMPLE PROGRAMS

Packed with your U-TALK is a diskette with the following programs on:

HANGMAN AND SPEAK AND SPELL (HANGSPELL)

This is a Basic program which incorporates two well know games.

To play Hangman, guess the word by pressing the letters which you think may make up the word. To help you, the computer will show you how many letters there are in the word. For every incorrect letter you press, the closer you become to being hung.

To play Speak and Spell, the computer will ask you to spell a word, for a repitition of the word simply press "?". Type in the word by pressing the appropriate keys. You are allowed three attempts at spelling the word, after the third attempt, the word will be spoken and spelt out for you.

SIMONSAYS

The computer will pick a letter at random which it will speak out and display for a short period of time. You must then echo the letter spoken by pressing the corresponding key. The computer will then pick another random letter which it will add to the previous letter used. You must then repeat this sequence as explained above. Each time the sequence is performed correctly the computer will add a letter lengthening the sequence for each correct answer given.

When an incorrect answer is given the computer will display and speak the sequence. It will then revert back to display one letter and you have to begin to build up a new sequence.

F. REFERENCES

1. Smith, Jim., Speech Synthesis application note number 252. National Semiconductors. July 1980.

2. Weinrich, David., A Speech Synthesis chip using compression techniques. Electronics (USA). April 1980.

3. Smith and Weinrich., Designers guide to Speech Synthesis. Digital Design (USA). February 1981.

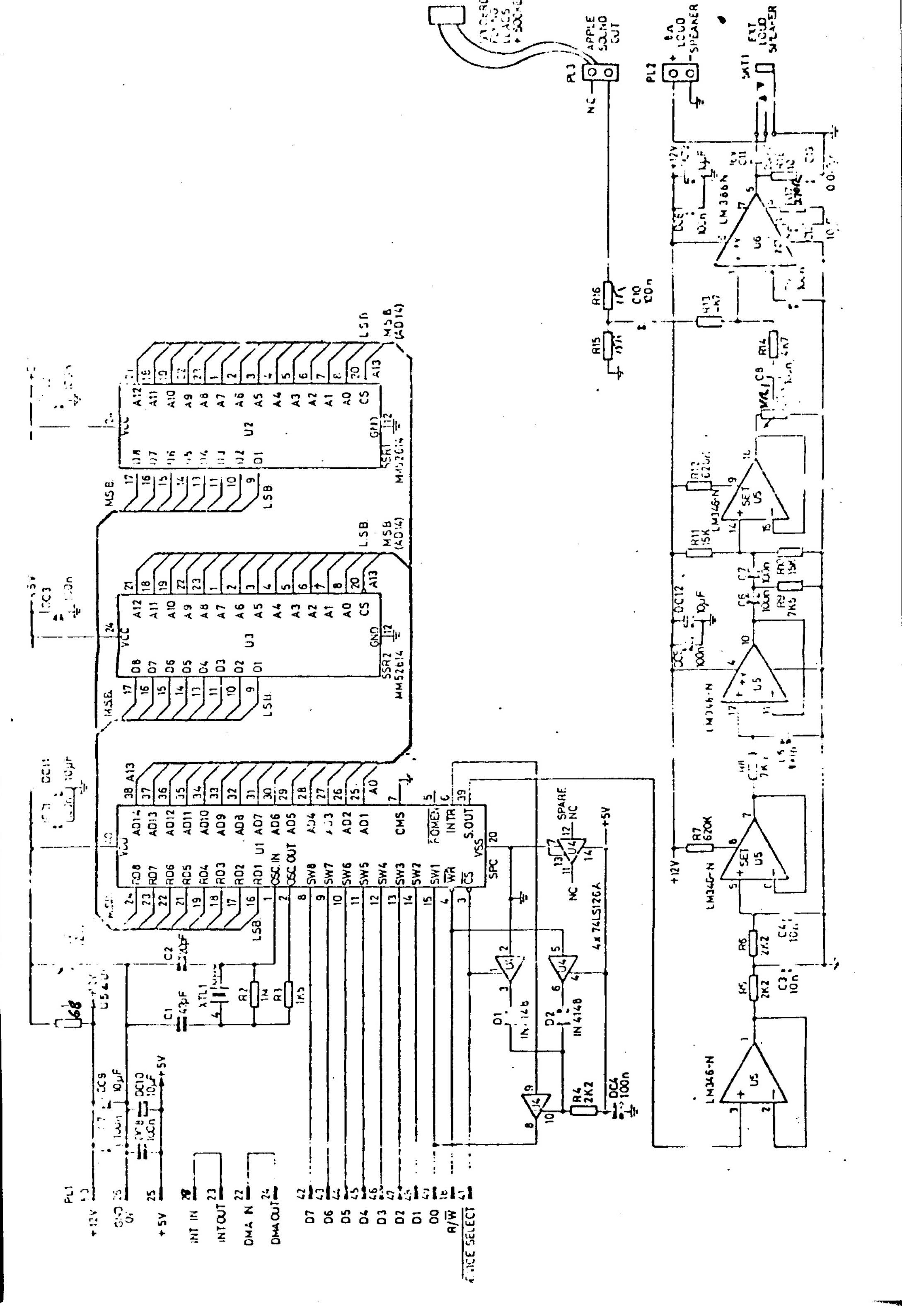
4. "Chattering chips". Elektor (UK) edition. September 1981.

APPENDICES

A. Circuit Diagram

B. Parts List

C. Digitalker data sheet



COMPONENT LIST

No	Qty	Description	Circuit Ref.
INTEGRATED CIRCUITS			
01	1	MM54104 MOS Speech Processor	U1
02	1	MM52614 DT1050 SSR-1 64K bit ROM	U2
03	1	MM52614 DT1050 SSR-2 64K bit ROM	U3
04	1	74LS126A Quad tri-state buffer	U4
05	1	LM-346-N Programmable Quad Op-amp	U5
06	1	LM386-N Audio Power Amplifier	U6
DIODES			
07	2	1N4148 High speed silicons diode	D1 & D2
08	1	10v BZY88 Zener diode	ZD1
RESISTORS			
09	1	68R 25 watt Hystab carbon	R1
10	1	1M " " " "	R2
11	1	1k5 " " " "	R3
12	3	2k2 " " " "	R4, R5, & R6
13	2	620k " " " "	R7 & R12
14	2	7k5 " " " "	R8 & R9
15	3	15k " " " "	R10, R11 & R15
16	2	4k7 " " " "	R13 & R14
17	1	1k " " " "	R16
18	1	270R " " " "	R17
19	1	10R " " " "	R18
20	1	47k Vertical present resistor.1"	VR1
CAPACITORS			
21	1	47pf 30v Sub. Min. plate ceramic	C1
22	1	20pf 30v Sub. Min. plate ceramic	C2
23	2	10n 16v Metallised polyester layer	C3 & C4
24	3	100n 16v Metallised polyester layer	C5, C6 & C7
25	1	220mf16v Axial elecrolytic	C11
26	1	47n 30v Sub. Min. plate ceramic	C13
27	11	100n 36v Monolithic	DC1-8 & C8-10
28	6	10mf 16v Min. Solid tantalum bead	DC9-13 & C12
IC SOCKETS			
29	1	40pin .6" DIL Bicc-Burndy	U1
30	2	24pin .6" DIL Bicc-Burndy	U2 & U3
MISCELLANEOUS			
31	1	AML SS2 PCB. DS-PTH-Screen-Mask	
32	1	Set of Documentation	
33	1	4.0 Mhz Crystal	XTL1
34	1	3.5 mm PCB mounting Jack socket	SKT1
35	1	2 pin Molex.1 PCB plug	PL2
36	1	10" Flying lead to a 2pin.1" socket	PL3

National Semiconductor

DIGITALKER™ Speech Synthesis System

General Description

The DIGITALKER is a speech synthesis system consisting of multiple N-channel MOS integrated circuits. It contains a speech processor chip (SPC) and speech ROM and when used with external filter, amplifier, and speaker, produces a system which generates high quality speech including the natural inflection and emphasis of the original speech. Male, female, and children's voices can be synthesized.

The SPC communicates with the speech ROM, which contains the compressed speech data as well as the frequency and amplitude data required for speech output. Up to 128k bits of speech data can be directly accessed. This can be expanded with minimal external logic.

With the addition of an external resistor, on-chip debounce is provided for use with a switch interface.

An interrupt is generated at the end of each speech sequence so that several sequences or words can be cascaded to form different speech expressions.

Encoding (digitizing) of custom word or phrase lists must be done by National Semiconductor. Customers submit to the factory high quality recorded magnetic reel to reel tapes containing the words or phrases to be encoded. National Semiconductor will sell kits consisting of the SPC and ROM(s) containing the digitized word or phrases.

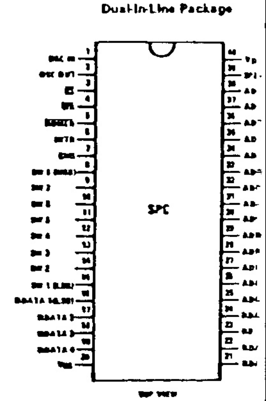
Features

- Designed to be easily interfaced to most popular microprocessors
- 256 possible addressable expressions
- Male, female, and children's voices
- Natural inflection and emphasis of original speech
- Addresses 128k of ROM directly
- Communicates with static or clocked dynamic ROMs
- TTL compatible
- MICROBUS™ compatible
- On-chip switch debounce for interfacing to manual switches independent of a microprocessor
- Easily expandable to greater than 128k ROM
- Interrupt capability for cascading words or phrases
- Crystal controlled or externally driven oscillator
- Ability to store silence durations for timing sequences

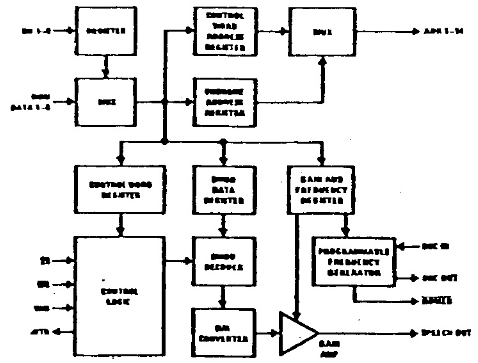
Applications

- Telecommunications
- Appliance
- Automotive
- Teaching aids
- Consumer products
- Clocks
- Language translation
- Annunciators

Dual-In-Line Package

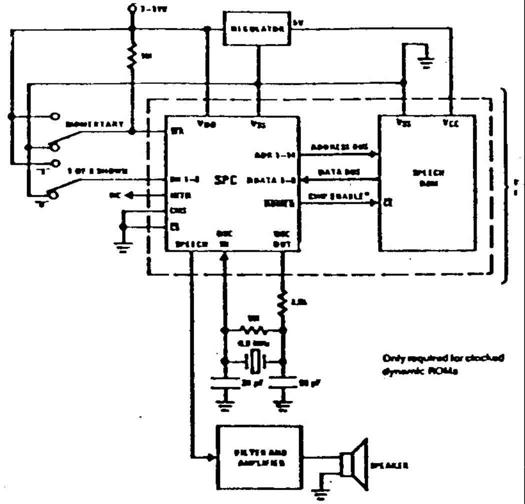


Block and Connection Diagrams



Typical Application

Minimum Configuration Using Switch In



Absolute Maximum Ratings

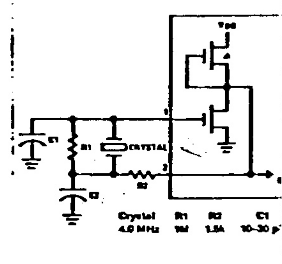
Storage Temperature Range	−65°C to +150°C	Voltage at Any Pin	12V
Operating Temperature Range	0°C to 70°C	Operating Voltage Range, V_{DD}-V_{SS}	7V to 11V
V_{DD}-V_{SS}	12V	Lead Temperature (Soldering, 10 seconds)	300°C

DC Electrical Characteristics T_A = 0°C to 70°C, V_{DD} = 7V-11V, V_{SS} = 0V, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{IL}	Input Low Voltage		−0.3		0.8	V
V_{IH}	Input High Voltage		2.0		V_{DD}	V
V_{OL}	Output Low Voltage	I_{OL} = 1.6 mA			0.4	V
V_{OH}	Output High Voltage	I_{OH} = −100 μA	2.4		5.0	V
V_{CIL}	Clock Input Low Voltage		−0.3		0.6	V
V_{CIH}	Clock Input High Voltage		4.0		V_{DD}	V
I_{DD}	Power Supply Current				50	mA
I_{IL}	Input Leakage				±10	μA
I_{CIL}	Clock Input Leakage				±10	μA
V_S	Silence Voltage			0.45 V_{DD}		V
V_{OUT}	Peak to Peak Speech Output	V_{DD} = 11V		2.0		V

Crystal Circuit Information

Typical Crystal Oscillator Network

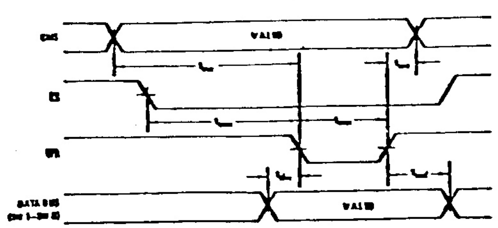


AC Electrical Characteristics T_A = 0°C to 70°C, V_{DD} = 7V–11V, V_{SS} = 0V, unless otherwise specified

Symbol	Parameter	Min	Max	Units
[illegible]	CMS Valid to Write Strobe	350		ns
[illegible]	Chip Select ON to Write Strobe	310		ns
[illegible]	Data Bus Valid to Write Strobe	50		ns
[illegible]	CMS Hold Time after Write Strobe	50		ns
[illegible]	Data Bus Hold Time after Write Strobe	100		ns
[illegible]	Write Strobe Width (50% Point)	430		ns
[illegible]	$\overline{ROMEN}$ ON to Valid ROM Data		2	µs
[illegible]	Write Strobe to Speech Output Delay		410	µs
f_t	External Clock Frequency Tolerance		±2	%

Timing Waveforms

Command Sequence



Functional Description

The following describes the function of all SPC input and output pins.

Note: In the following descriptions, a low represents a logic 0 (0.4V nominal), and a high represents a logic 1 (2.4V nominal).

INPUT SIGNALS

Chip Select ($\overline{CS}$): The SPC is selected when $\overline{CS}$ is low. It is only necessary to have $\overline{CS}$ low during a command to the SPC. It is not necessary to hold $\overline{CS}$ low for the duration of the speech data.

Data Bus (SW 1–8): This is an 8-bit parallel data bus which contains the starting address of the speech data.

Command Select (CMS): This line is used to define the two commands to the SPC.

CMS	Function
0	Reset Interrupt and start speech sequence
1	Reset Interrupt only

Write Strobe ($\overline{WR}$): This line latches the starting address (SW1-SW8) into a register. On the rising edge of the $\overline{WR}$, the SPC starts execution of the command specified by CMS. The command sequence is shown in the timing waveform section. If a command to start a new speech sequence is issued during a speech sequence, the new speech sequence will be started immediately.

ROM Data (RDATA 1–8): This is an 8-bit parallel data bus which contains the speech data from the speech ROM.

OUTPUT SIGNALS

Interrupt (INTR): This signal goes high at the completion of any speech sequence. It is reset by the next valid command. It is also reset at power up.

ROM Address (ADR1–ADR14): This is a 14-bit parallel bus that supplies the address of the speech data to the speech ROM.

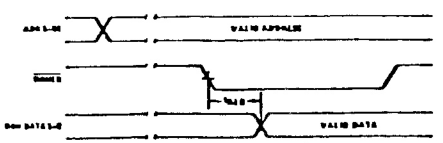
ROM Enable ($\overline{ROMEN}$): This line is for use with clocked dynamic ROMs. When used, the high to low transition must cause the speech ROM to generate a cycle and place the speech data on the RDATA lines. Data must remain on the RDATA lines while $\overline{ROMEN}$ is low. For low power applications, this line can be used to drive a transistor that switches the supply for static speech ROMs. See ROM data timing.

Speech Output (Speech Out): This is the analog output that represents the speech data. See frequency response section.

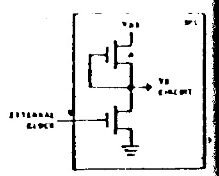
INPUT/OUTPUT SIGNALS

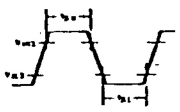
Clock Input/Output (OSCIN, OSCOUT): These two pins connect the main timing reference (crystal) to the SPC.

ROM Data Timing



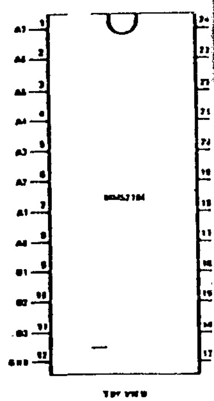
External Clock Input (4.0 MHz)





Timing	Min	Units
t_{CH}	100	ns
t_{CL}	100	ns

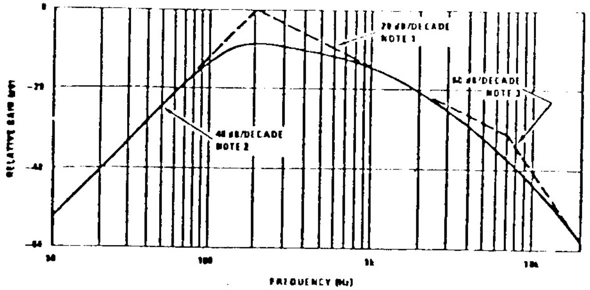
Dual-In-Line Package



64k

Applications Information

Frequency Response of Combined Amplifier and Speaker

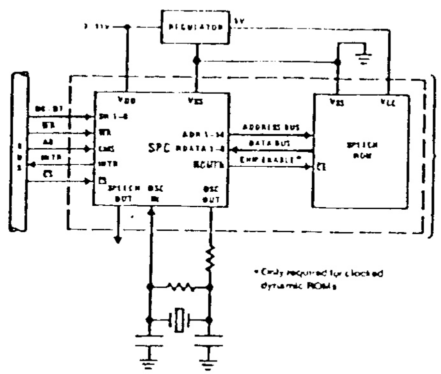


Note 1: This curve is the desired response of the entire audio system including speaker. Minimum response is a low pass filter with a cutoff frequency of 200 Hz. For an audio system with a natural cutoff frequency around 200 Hz, this filter can be eliminated. This cutoff frequency may be tuned for the particular voice being synthesized. For a low pitched male voice it may be 100 Hz, while for a high pitched female or child's voice it might be 300 Hz.

Note 2: This is optional filtering that can be eliminated by proper selection of the speaker. If the response is electronically produced, it should be adjusted as described in Note 1.

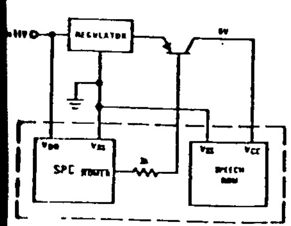
Note 3: This is optional filtering that can be eliminated for simpler systems. The acceptable range for this cutoff frequency is 6000 Hz–8000 Hz.

Complete Applications Schematic for High Quality Voice Reproduction

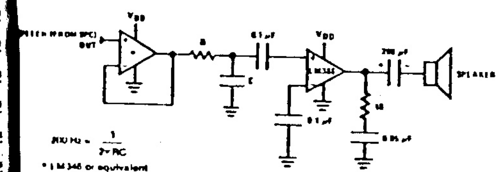


* Only required for clocked dynamic ROMs

Low Power Configuration Using Static ROM



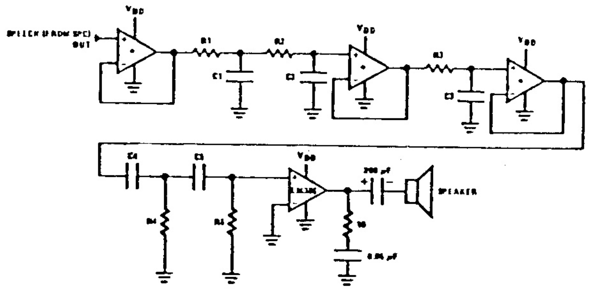
Minimum Filter Circuit



$200\ Hz = \frac{1}{2\pi RC}$

* LM348 or equivalent

Filter Circuit to Produce Maximum Frequency Response



$7000\ Hz = \frac{1}{2\pi R1C1} = \frac{1}{2\pi R2C2}$

$200\ Hz = \frac{1}{2\pi R3C3} = \frac{1}{2\pi R4C4} = \frac{1}{2\pi R\ldots}$

* LM348 or equivalent

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