



## DT1050 DIGITALTALKER™ Standard Vocabulary Kit

### General Description

The DIGITALTALKER™ is a speech synthesis system consisting of several 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.

With the addition of an external resistor, on-chip denounce 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.

The DT1050 is a standard DIGITALTALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. (See the Master Word List Table I). The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences.

The "voice" output of the DT1050 is a highly intelligible male voice. The vocabulary is chosen so that it is applicable to many products and markets.

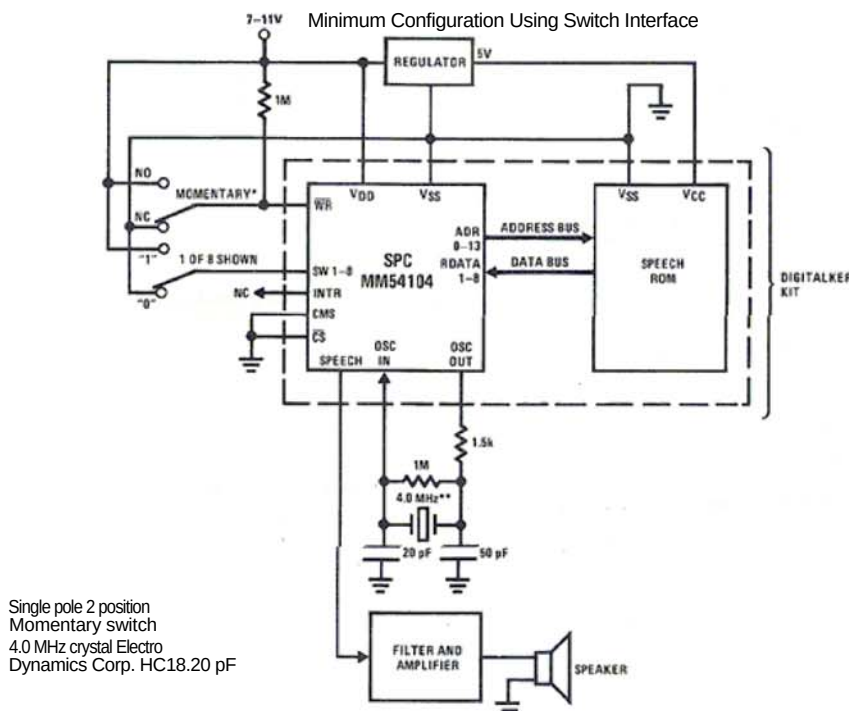
### Features

- COPS™ and MICROBUS compatible
- Designed to be easily interfaced to other popular microprocessors
- 144 addressable expressions, including numbers
- Natural inflection and emphasis of original speech
- Addressees 128k of ROM directly
- TTL Compatible
- On-Chip switch denounce for interfacing to manual switches independent of a microprocessor
- Interrupt capability for cascading words of phrases
- Crystal controlled or eternally driven oscillator

### Applications

- |                      |                        |
|----------------------|------------------------|
| • Telecommunications | * Consumer Products    |
| • Appliance          | * Clocks               |
| • Automotive         | * Language Translation |
| • Teaching Aids      | * Annunciators         |

### Typical Applications



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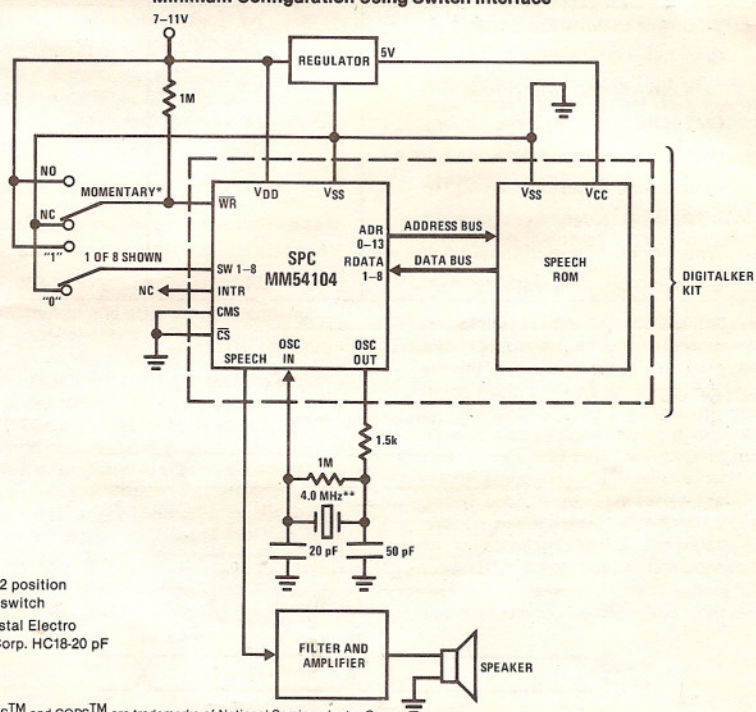
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- |                      |                        |
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## Typical Applications

Minimum Configuration Using Switch Interface



\* Single pole 2 position momentary switch

\*\* 4.0 MHz crystal Electro Dynamics Corp. HC18-20 pF

## Absolute Maximum Ratings\*

Storage Temperature Range -65°C to +150°C  
 Operating Temperature Range 0°C to 70°C  
 $V_{DD}-V_{SS}$  12V

Voltage at Any Pin 12V  
 Operating Voltage Range,  $V_{DD}-V_{SS}$  7V to 11V  
 Lead Temperature (Soldering, 10 seconds) 300°C

## DC Electrical Characteristics\* $T_A = 0^\circ\text{C}$ to $70^\circ\text{C}$ , $V_{DD} = 7\text{V}-11\text{V}$ , $V_{SS} = 0\text{V}$ , 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             | $I_{OL} = 1.6\text{ mA}$                               |      |               | 0.4      | V             |
| $V_{OH}$  | Output High Voltage            | $I_{OH} = -100\text{ }\mu\text{A}$                     | 2.4  |               | 5.0      | V             |
| $V_{ILX}$ | Clock Input Low Voltage        |                                                        | -0.3 |               | 1.2      | V             |
| $V_{IHx}$ | Clock Input High Voltage       |                                                        | 5.5  |               | $V_{DD}$ | V             |
| $I_{DD}$  | Power Supply Current           |                                                        |      |               | 45       | mA            |
| $I_{IL}$  | Input Leakage                  |                                                        |      |               | $\pm 10$ | $\mu\text{A}$ |
| $I_{ILX}$ | Clock Input Leakage            |                                                        |      |               | $\pm 10$ | $\mu\text{A}$ |
| $V_S$     | Silence Voltage                |                                                        |      | 0.45 $V_{DD}$ |          | V             |
| $V_{OUT}$ | Peak to Peak Speech Output     | $V_{DD} = 11\text{V}$                                  |      | 2.0           |          | V             |
| $R_{EXT}$ | External Load on Speech Output | $R_{EXT}$ Connected Between Speech Output and $V_{SS}$ | 50   |               |          | k $\Omega$    |

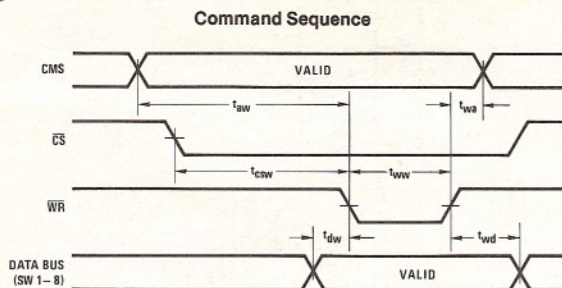
## AC Electrical Characteristics\* $T_A = 0^\circ\text{C}$ to $70^\circ\text{C}$ , $V_{DD} = 7\text{V}-11\text{V}$ , $V_{SS} = 0\text{V}$ , unless otherwise specified.

| Symbol    | Parameter                                      | Min  | Max  | Units         |
|-----------|------------------------------------------------|------|------|---------------|
| $t_{aw}$  | CMS Valid to Write Strobe                      | 350  |      | ns            |
| $t_{csw}$ | Chip Select ON to Write Strobe                 | 310  |      | ns            |
| $t_{dw}$  | Data Bus Valid to Write Strobe                 | 50   |      | ns            |
| $t_{wa}$  | CMS Hold Time after Write Strobe               | 50   |      | ns            |
| $t_{wd}$  | Data Bus Hold Time after Write Strobe          | 100  |      | ns            |
| $t_{ww}$  | Write Strobe Width (50% Point)                 | 430  |      | ns            |
| $t_{red}$ | $\overline{\text{ROMEN}}$ ON to Valid ROM Data |      | 2    | $\mu\text{s}$ |
| $t_{wss}$ | Write Strobe to Speech Output Delay            |      | 410  | $\mu\text{s}$ |
| $f_t$     | External Clock Frequency                       | 3.92 | 4.08 | MHz           |

Note: Rise and fall times (10% to 90%) of MICROBUS signals should be 50 ns maximum.

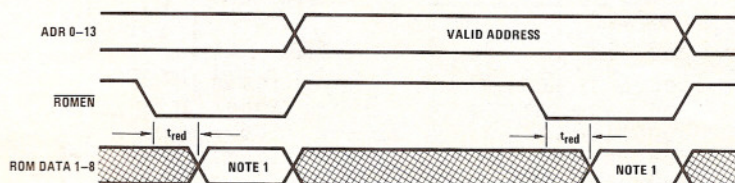
\*SPC characteristics only. ROM characteristics covered by separate data sheet for MM52164.

## Timing Waveforms



## Timing Waveforms (Continued)

### ROM Data Timing



**Note 1:** ROM Data 1-8 can go valid any time after ADR 0-13 changes, however it must be valid within the  $t_{red}$  spec and remain valid until  $\overline{ROMEN}$  goes high.

## 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.

Data bus inputs SW 1-SW 8 accept an 8-bit binary address which is the address of the word which is to be "spoken" from the DIGITALKER output. See the Master Word List (Table I) for the complete listing of words and their respective addresses. If the entire word list is not used, unused inputs must be connected to  $V_{SS}$ .

**Command Select (CMS):** This line specifies 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 (SW 1-SW 8) 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. When connecting  $\overline{WR}$  to a switch, it must be a single pole 2 position switch as shown on page 1.

**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 (ADR 0-ADR 13):** This is a 14-bit parallel bus that supplies the address of the speech data to the speech ROM.

**ROM Enable ( $\overline{ROMEN}$ ):** 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 (OSC IN, OSC OUT):** These two pins connect the main timing reference (crystal) to the SPC.

### PHRASE QUALITY

In normal human speech, the brain puts durations of silence between the words to make the sentence flow smoothly. Since several durations of silence are provided in the Master Word List, the actual quality of any phrase can be significantly improved by adding durations of silence (also assigned addresses) between the words. As one thinks about how the phrase is actually spoken, one might assume the approximate duration of silence between each word, and insert the closest duration of silence from the word list. A hint in this area would be that for words beginning with the letters, K, T, P, B, D, and G insert 80 milliseconds silence prior to the words, and for words ending in the same letters as above, 40 milliseconds silence following the word is recommended.

# Functional Description (Continued)

TABLE I. DT1050 MASTER WORD LIST

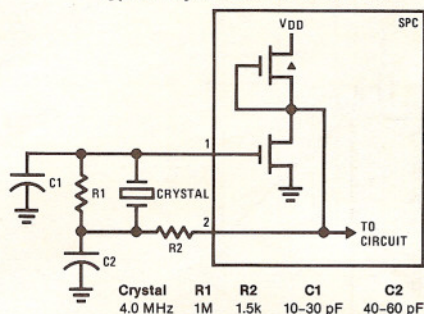
| Word               | 8-Bit Binary Address |     |               | 8-Bit Binary Address |     |                 | 8-Bit Binary Address |     |
|--------------------|----------------------|-----|---------------|----------------------|-----|-----------------|----------------------|-----|
|                    | SW8                  | SW1 |               | SW8                  | SW1 |                 | SW8                  | SW1 |
| THIS IS DIGITALKER | 00000000             |     | Q             | 00110000             |     | IS              | 01100000             |     |
| ONE                | 00000001             |     | R             | 00110001             |     | IT              | 01100001             |     |
| TWO                | 00000010             |     | S             | 00110010             |     | KILO            | 01100010             |     |
| THREE              | 00000011             |     | T             | 00110011             |     | LEFT            | 01100011             |     |
| FOUR               | 00000100             |     | U             | 00110100             |     | LESS            | 01100100             |     |
| FIVE               | 00000101             |     | V             | 00110101             |     | LESSER          | 01100101             |     |
| SIX                | 00000110             |     | W             | 00110110             |     | LIMIT           | 01100110             |     |
| SEVEN              | 00000111             |     | X             | 00110111             |     | LOW             | 01100111             |     |
| EIGHT              | 00001000             |     | Y             | 00111000             |     | LOWER           | 01101000             |     |
| NINE               | 00001001             |     | Z             | 00111001             |     | MARK            | 01101001             |     |
| TEN                | 00001010             |     | AGAIN         | 00111010             |     | METER           | 01101010             |     |
| ELEVEN             | 00001011             |     | AMPERE        | 00111011             |     | MILE            | 01101011             |     |
| TWELVE             | 00001100             |     | AND           | 00111100             |     | MILLI           | 01101100             |     |
| THIRTEEN           | 00001101             |     | AT            | 00111101             |     | MINUS           | 01101101             |     |
| FOURTEEN           | 00001110             |     | CANCEL        | 00111110             |     | MINUTE          | 01101110             |     |
| FIFTEEN            | 00001111             |     | CASE          | 00111111             |     | NEAR            | 01101111             |     |
| SIXTEEN            | 00010000             |     | CENT          | 01000000             |     | NUMBER          | 01110000             |     |
| SEVENTEEN          | 00010001             |     | 400HERTZ TONE | 01000001             |     | OF              | 01110001             |     |
| EIGHTEEN           | 00010010             |     | 80HERTZ TONE  | 01000010             |     | OFF             | 01110010             |     |
| NINETEEN           | 00010011             |     | 20MS SILENCE  | 01000011             |     | ON              | 01110011             |     |
| TWENTY             | 00010100             |     | 40MS SILENCE  | 01000100             |     | OUT             | 01110100             |     |
| THIRTY             | 00010101             |     | 80MS SILENCE  | 01000101             |     | OVER            | 01110101             |     |
| FORTY              | 00010110             |     | 160MS SILENCE | 01000110             |     | PARENTHESIS     | 01110110             |     |
| FIFTY              | 00010111             |     | 320MS SILENCE | 01000111             |     | PERCENT         | 01110111             |     |
| SIXTY              | 00011000             |     | CENTI         | 01001000             |     | PLEASE          | 01111000             |     |
| SEVENTY            | 00011001             |     | CHECK         | 01001001             |     | PLUS            | 01111001             |     |
| EIGHTY             | 00011010             |     | COMMA         | 01001010             |     | POINT           | 01111010             |     |
| NINETY             | 00011011             |     | CONTROL       | 01001011             |     | POUND           | 01111011             |     |
| HUNDRED            | 00011100             |     | DANGER        | 01001100             |     | PULSES          | 01111100             |     |
| THOUSAND           | 00011101             |     | DEGREE        | 01001101             |     | RATE            | 01111101             |     |
| MILLION            | 00011110             |     | DOLLAR        | 01001110             |     | RE              | 01111110             |     |
| ZERO               | 00011111             |     | DOWN          | 01001111             |     | READY           | 01111111             |     |
| A                  | 00100000             |     | EQUAL         | 01010000             |     | RIGHT           | 10000000             |     |
| B                  | 00100001             |     | ERROR         | 01010001             |     | SS (Note 1)     | 10000001             |     |
| C                  | 00100010             |     | FEET          | 01010010             |     | SECOND          | 10000010             |     |
| D                  | 00100011             |     | FLOW          | 01010011             |     | SET             | 10000011             |     |
| E                  | 00100100             |     | FUEL          | 01010100             |     | SPACE           | 10000100             |     |
| F                  | 00100101             |     | GALLON        | 01010101             |     | SPEED           | 10000101             |     |
| G                  | 00100110             |     | GO            | 01010110             |     | STAR            | 10000110             |     |
| H                  | 00100111             |     | GRAM          | 01010111             |     | START           | 10000111             |     |
| I                  | 00101000             |     | GREAT         | 01011000             |     | STOP            | 10001000             |     |
| J                  | 00101001             |     | GREATER       | 01011001             |     | THAN            | 10001001             |     |
| K                  | 00101010             |     | HAVE          | 01011010             |     | THE             | 10001010             |     |
| L                  | 00101011             |     | HIGH          | 01011011             |     | TIME            | 10001011             |     |
| M                  | 00101100             |     | HIGHER        | 01011100             |     | TRY             | 10001100             |     |
| N                  | 00101101             |     | HOUR          | 01011101             |     | UP              | 10001101             |     |
| O                  | 00101110             |     | IN            | 01011110             |     | VOLT            | 10001110             |     |
| P                  | 00101111             |     | INCHES        | 01011111             |     | WEIGHT (Note 2) | 10001111             |     |

Note 1: "SS" makes any singular word plural

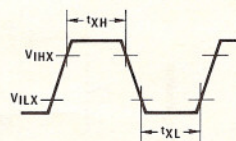
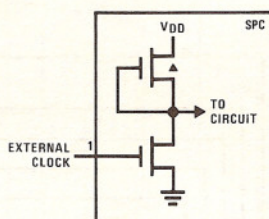
Note 2: Address 143 is the last legal address in this particular word list. Exceeding address 143 will produce pieces of unintelligible invalid speech data.

# Crystal Circuit Information

Typical Crystal Oscillator Network

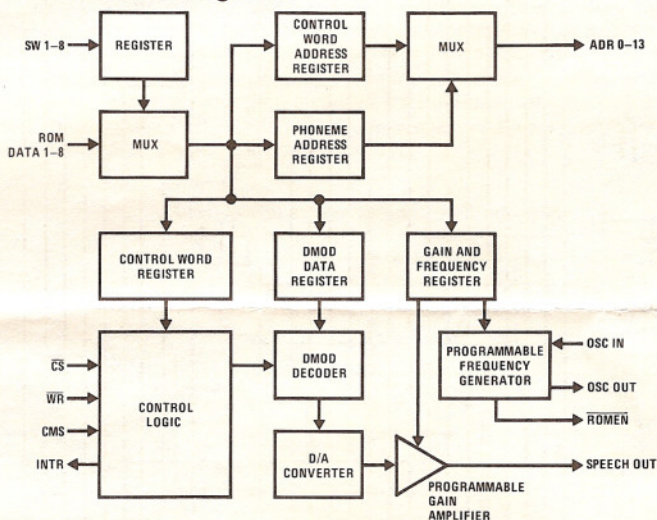


External Clock Input (4.0 MHz)

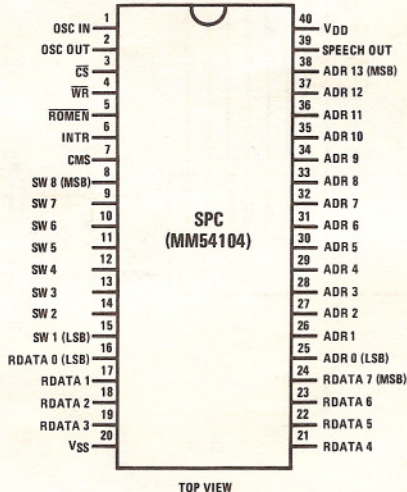


| Timing          | Min | Units |
|-----------------|-----|-------|
| t <sub>XH</sub> | 100 | ns    |
| t <sub>XL</sub> | 100 | ns    |

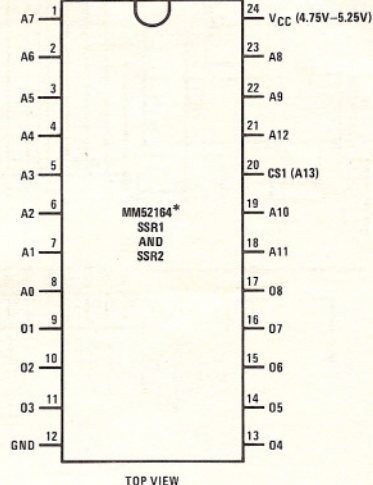
## SPC Block and Connection Diagrams



Dual-In-Line Package

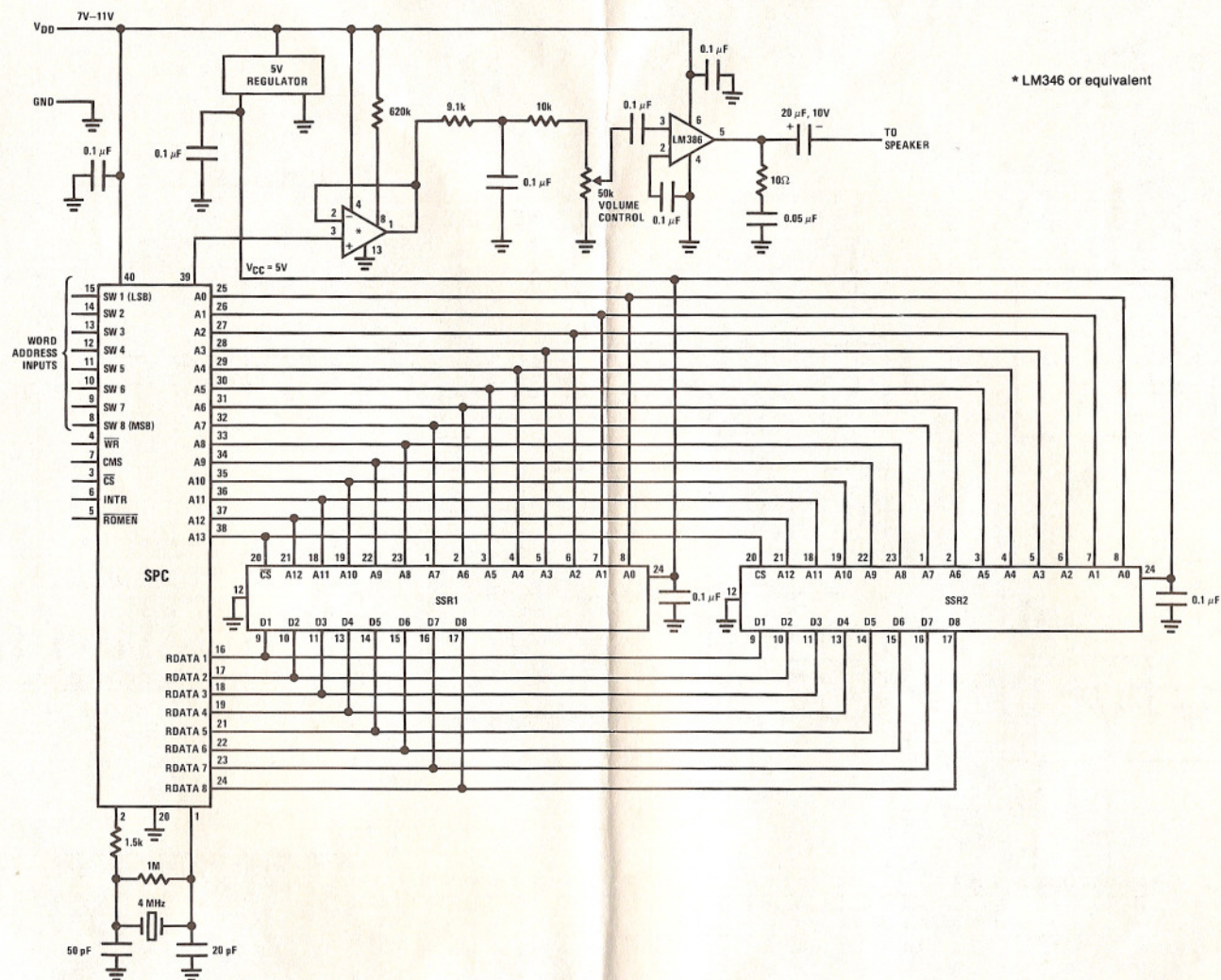


Dual-In-Line Package



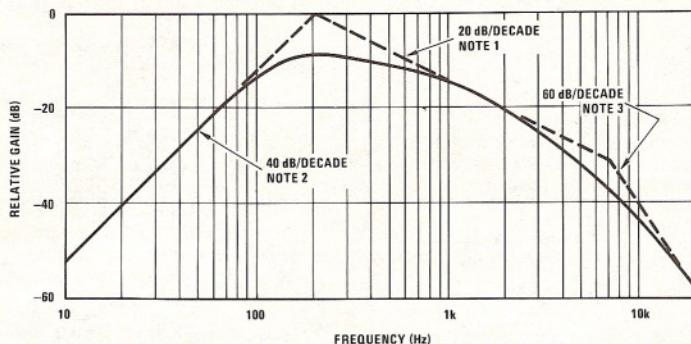
\* For specific ROM device information, see MM52164 data sheet.

# Recommended Schematic Diagram



## Applications Information

Frequency Response of Combined Amplifier and Speaker



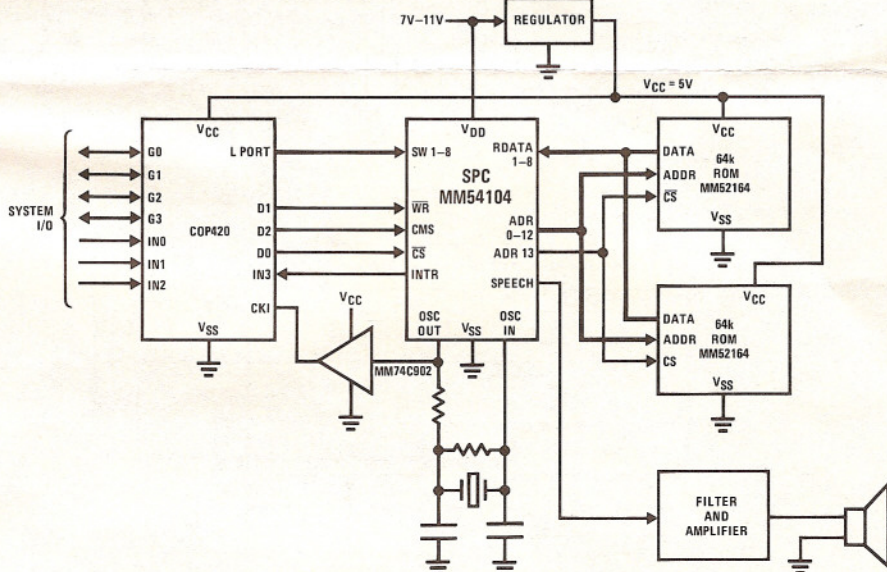
**Note 1:** This curve is the desired response of the entire audio system including speaker. Minimum response is a low pass filter with a cutoff frequency of 200 Hz. For an audio system with a natural cutoff frequency around 200 Hz, this filter can be eliminated. This cutoff frequency may be tuned for 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 this 2 pole response is electronically produced, it should be adjusted as described in Note 1.

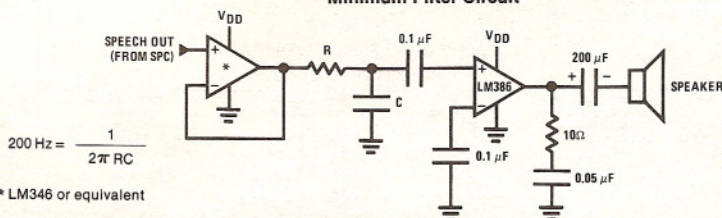
**Note 3:** This is optional filtering that can be eliminated for simpler systems. The acceptable range for this cutoff frequency is 6000 Hz-8000 Hz.

## Typical Applications (Continued)

DIGITAL TALKER System Using COP420 Interface

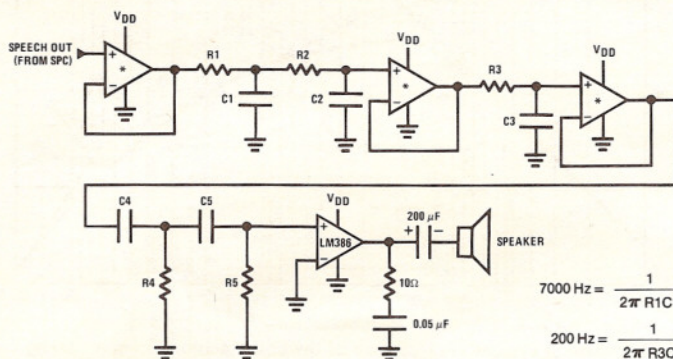


Minimum Filter Circuit



## Typical Applications (Continued)

## Filter Circuit to Produce Maximum Frequency Response

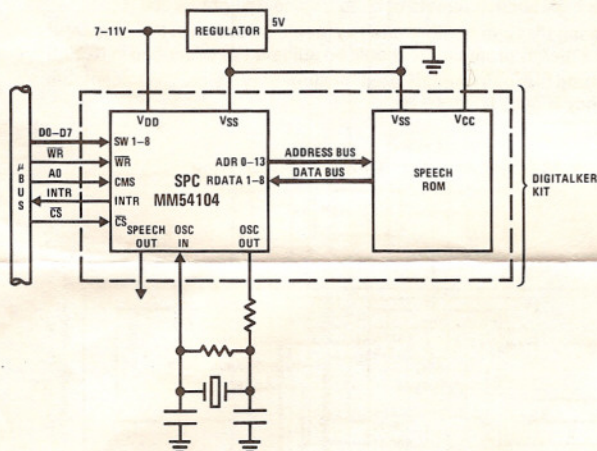


$$7000 \text{ Hz} = \frac{1}{2\pi R1C1} = \frac{1}{2\pi R2C2}$$

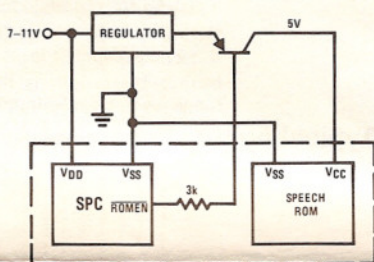
$$200 \text{ Hz} = \frac{1}{2\pi R3C3} = \frac{1}{2\pi R4C4} = \frac{1}{2\pi R5C5}$$

\* LM346 or equivalent

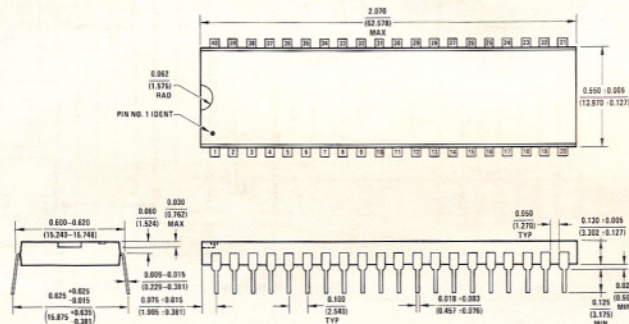
## DIGITALALKER System Utilizing MICROBUS™ Interface



## Low Power Configuration Using Static ROM



## Physical Dimensions inches (millimeters)

Molded Dual-In-Line Package (N)  
NS Package Number N40A

National Semiconductor Corporation  
2900 Semiconductor Drive  
Santa Clara, California 95051  
Tel.: (408)737-5000  
TWX: (910)339-9240

National Semiconductor GmbH  
Eisenheimerstrasse 61/II  
8000 München 21  
West Germany  
Tel.: (089)576091  
Telex: 05-22772

NS International Inc., Japan  
Miyake Building  
1-9 Yotsuya, Shinjuku-ku 160  
Tokyo, Japan  
Tel.: (03)355-3711  
TWX: 232-2015 NSCJ-J

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