# SSI 263 SPEECH SYNTHESIZER

# CHIP & ALGORITHM

C C I

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CIRCUIT CELLAR

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# NOTICES

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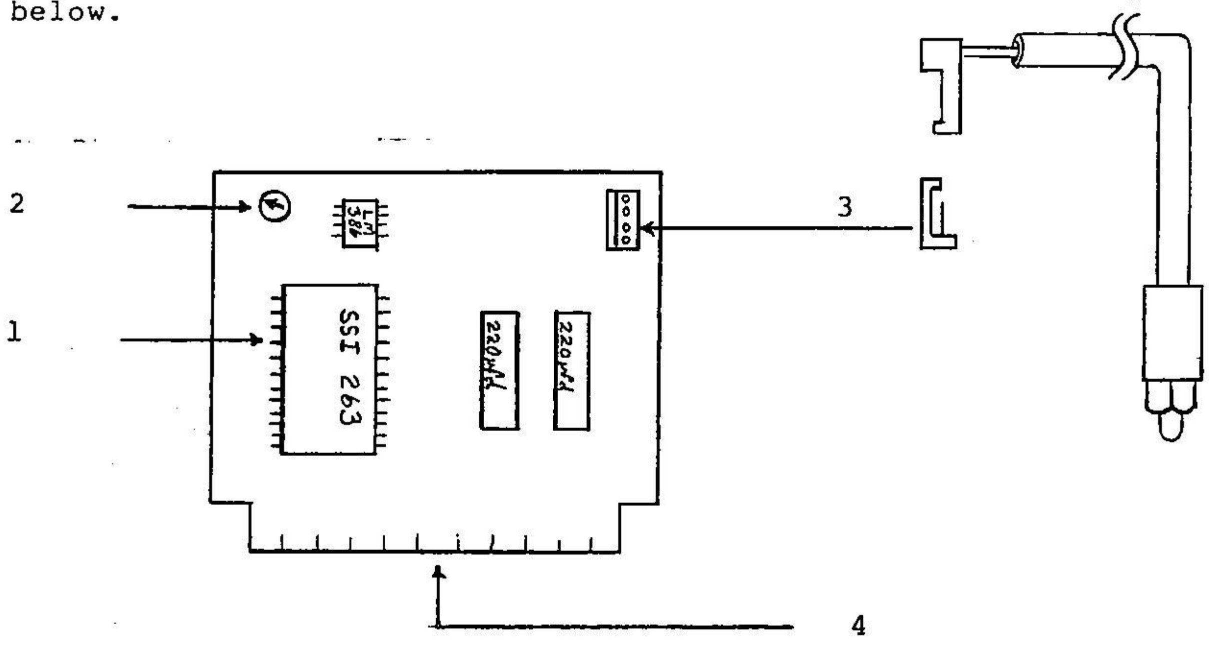
# INSTALLATION

The numbers in the SETUP instructions refer to the drawing below.



1. Speech Synthesizer - SSI 263

2. Volume Control

3. Audio Cable Connector

4. Gold Card Edge Connector

## SETUP

Turn off your computer and remove its cover.

Discharge any static electricity by touching the metal power supply casing.

Remove THE SSI-263 DEMO BOARD and audio cable from the package. Hold the board by its edges. Avoid touching the gold plated edge connector (4). The oil from your hands may contaminate the connector and cause a poor electrical connection.

Extend the audio cable fully.

Connect the four pin receptacle (3) end of the cable to the audio cable connector located on THE SSI-263 DEMO BOARD.

Insert THE SSI-263 DEMO BOARD into slot 4 of the Apple's peripheral slots located at the rear of the Apple. Gently rock the board until it is properly seated. THE SSI-263 DEMO BOARD is slot dependent. While THE SSI-263 DEMO BOARD can be configured for any slot except slot 0, the demonstration disk was specifically written for slot 4.

Connect the RCA phono plug of the audio cable to the speaker. THE SSI-263 DEMO BOARD has a 1/2 watt amplifier chip on board to directly connect it to your speaker. You may also use an external amplifier. Connect the RCA phono plug of the cable to the amplifier AUXiliary input. The MICrophone input will overload and cause distortion.

## GETTING STARTED

Leave the cover off the computer until you have had a chance to adjust the volume. The volume control knob is a grey disk located at the top rear of the board (2). This knob is a thumbwheel device. No tool is necessary to make adjustments, just your thumb. Simply roll the wheel back and forth to adjust the volume.

Place the demonstration disk in the drive and boot the disk. Select the Demonstration from the menu. This demonstration contains several examples of THE SSI-263 DEMO BOARD'S capabilities.

When the demonstration is complete, you may elect to hear it again or you may go back to the main menu. From the main menu you will probably want to go to the Rule Editor/Text to Speech Algorithm.

In order that you may progress at your own pace, this manual has been separated into sections. You will learn to develop different personalities for MOCKINGBOARD in the first section using interesting expressions and voices. If you would like to delve deeper, learn to correct mispronounced words.

The second section is programming. Learn how to include the speech you created into your own programs. If you don`t have a program in mind, you probably will after you explore the many possibilities for speech enhancements.

The final section contains some of the tables which will make your programming and rule editing life a little easier.

# SPEECH

THE SSI-263 DEMO BOARD gives your computer the power of speech. Like a human, it will read text aloud pronouncing each word according to a series of rules. THE SSI-263 DEMO BOARD will allow you to introduce expression into the voice. Expression is important to the intelligibility and the meaning of the words spoken. The Sweet Micro Systems text to speech program automatically sets the speech parameters for general use and allows you to introduce stress and intonation to text by using special markers. You may change these parameters to create interesting voices.

There are many exceptions to standard pronunciation rules. Names are especially difficult and are frequently mispronounced. Remember how your teacher stumbled through her class list on the first day of school? How disappointed you must have been if your name was incorrectly announced to the class!

If THE SSI-263 DEMO BOARD has trouble with your name or names of family members and friends, you can easily correct it and we'll show you how! We know the name, Robert, is mispro nounced. We will step through the corrections necessary, and in the process tell you about THE SSI-263 DEMO BOARD's features, capabilities and our method of converting text into speech.

A special section explains how to enhance your programs with speech you create using the Rule Editor or using the text to speech program right in a program of your own creation.

## ADD INFLECTION WITH THE DIRECTOR'S CUES

THE SSI-263 DEMO BOARD is all set to start talking. With a little bit of assistance, THE SSI-263 DEMO BOARD will express itself with the use of inflection or pitch patterns, and show emotion. Limited use of inflection is automatically performed by the program. For example, it recognizes punctuation marks and responds accordingly. You will be able to employ inflection more creatively as you compose your sentences.

Boot your demonstration disk and select the Rule Editor. You will be asked to SELECT CHARACTER TABLE TO EDIT. Type A and the A rule table will appear. Type T for Test Mode at ENTER COMMAND. Now we are ready to proceed.

The cursor, next to the question mark, is ready for you to type in a word. After you type the word, press the return key. The word will be spoken at an average speed, in an average voice with minimal variation or emotional coloring. These speech characteristics have been preset to normally used values. If you would like THE SSI-263 DEMO BOARD to be more expressive, you may take advantage of its interpretive talents. SWEETTALKER II's theatrical abilities are not to be underestimated.

Fine actors, regardless of their talent, require good directors. THE SSI-263 DEMO BOARD may be directed by inserting special markers into the text as it is typed in. These markers will tell THE SSI-263 DEMO BOARD when to show emotion. It already recognizes normal punctuation marks, such as commas, periods and question marks, and will respond with an appropriate pause, or raise or lower its voice. You may also place emphasis on a particular word or syllable, by inserting slash key stress markers (/) as cues to indicate when THE SSI-263 DEMO BOARD should play up a scene.

From the Test Mode, enter the word, "HELLO," at the prompt. Think, like a good director, of the different ways that HELLO can be interpreted. When an actor speaks, he conveys emotion by changing the pitch, volume, and rate at which he speaks. Press return and listen. How could you make this word more expressive? Try typing in the following examples. Each time you wish to clear an entry, type N for new entry. Should you wish SWEETTALKER II to repeat itself, type R for repeat. The comments to the right explain what effect the markers have on the word. (Note: You do not have to type the question mark, it will appear automatically.)

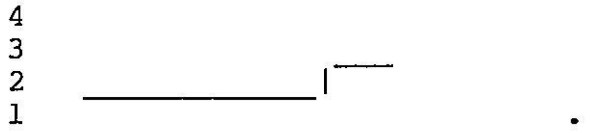
```
? HELLO          ....would have no variation in stress
? /HE/LLO        ....would stress HE
? HELL/O/        ....would stress O
? HELLO?         ....would cause a rise in pitch at the end
? HELLO.         ....would cause a drop in pitch at the end
```

Other combinations of punctuation marks and stress marks are also possible. Stress markers generally work in pairs, but you may insert any number of them into a text. The number of stress markers and their position will determine how each word or syllable will be spoken. Be experimental!

Try typing the following examples, and listen to THE SSI-263 DEMO BOARD perform.

INFLECTION DIAGRAM 1: DECLARATIVE SENTENCE

Mary had a /li/ttle lamb.



THE SSI-263 DEMO BOARD has just described Mary's pet. Diagram 1 shows the inflection pattern, or the rate of change of pitch, for a basic declarative sentence, which emphasizes the lamb's size.

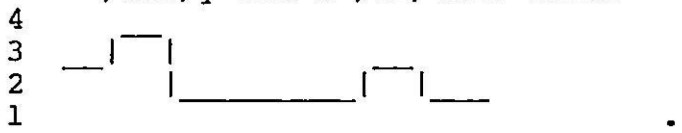
The English language has several levels of pitch. Our text to speech method approximates these levels by using four main pitch levels. These levels are designated by the digits which appear on the left side of the diagram.

"Mary had a little lamb" is spoken at pitch level two until the first stress marker is encountered. At the first stress marker, the pitch rises from level 2 to level 3. It will remain at level three until another marker is encountered. At the second stress marker, the pitch will glide up or down depending on the final punctuation. A period at the end of a sentence, as in this example, indicates a drop in pitch. If no final punctuation mark exists, then a period is assumed.

If we want THE SSI-263 DEMO BOARD to show more feeling, we must give it additional direction. Try typing, "/Mar/y had a /li/ttle lamb."

INFLECTION DIAGRAM 2

/Mar/y had a /li/ttle lamb.

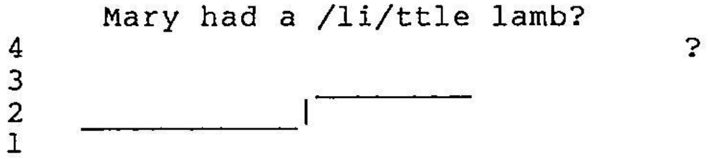


This diagram shows the change of pitch for a declarative sentence with more than two stress markers. In this example, the pitch starts at level 3 and rises to level 4 upon reaching the first marker. The second marker signals a drop in pitch to level 2. Upon reaching the next pair of markers, the pitch level will again rise and then fall until the period is encountered.

THE SSI-263 DEMO BOARD's recitation of "Mary had a little lamb" deserves an ovation. The dual stress pattern was interpreted with greater emphasis on the first pair of markers than on the second. Such a stress pattern, in which the initial stress is more emphatic than stresses which follow, is typical of the English language.

Perhaps you would like THE SSI-263 DEMO BOARD to ask some questions about Mary? Let's change some of the cues and try some interogatives. Type "Mary had a /li/ttle lamb?"

INFLECTION DIAGRAM 3, INTEROGATORY STATEMENT



If you compare this recitation with INFLECTION DIAGRAM 1, you will see that the performance differs only at the end where the different cue has caused a rise in pitch instead of a drop. The difference in pitch may appear to be insignificant, but we must remember that pitch assists us in interpreting a speaker's intent and helps us to recognize when he is stating or questioning. We are now doubting the lamb's small size.

The director's cues are actually much more sophisticated than they may appear. The stress markers not only cause THE SSI-263 DEMO BOARD to change its pitch, but also its volume, the number of words spoken per second and finally, the voice itself. When a syllable is stressed, it generally becomes louder, the speech rate slows to make the syllable longer, and the voice quality changes slightly. You can achieve all of these theatrical effects simply by typing in normal punctuation and experimenting with the stress markers.

## ADD TEXTURE TO THE VOICE

As Director, you have only begun to utilize SWEETTALKER II's many talents. With your assistance THE SSI-263 DEMO BOARD can change its voice. THE SSI-263 DEMO BOARD's voice is described by four parameters: amplitude, inflection, filter frequency and speech rate. These parameters have been preset to values which will appear in the lower half of the Test Mode screen.

```
=========================================
           CURRENT PARAMETERS
=========================================
 11 -AMPLITUDE      232-FILTER FREQUENCY
  8  -INFLECTION     8  -SPEECH RATE
=========================================
```

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Should you wish to change any of these parameters, the commands in Table 1-4 will allow you to do so. The ^ mark is defined as the control key (or CTRL).

| | COMMAND | RANGE | | COMMAND | RANGE |
|---|---|---|---|---|---|
| ^A | AMPLITUDE | 0-11 | ^F | FILTER FREQUENCY | 0-253 |
| ^I | INFLECTION | 0-25 | ^R | SPEECH RATE | 0-13 |

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Table 1-4 Test Mode Parameter Commands

NOTE: If you typed a word or phrase to be spoken and have not cleared it with an N for new entry, you will not be permitted to make any changes. The CURRENT PARAMETERS display is replaced by an ENTER COMMAND: prompt which will only accept R for repeat, N for new entry or Control-S for save the word. Type N for new entry and you will be returned to an entry mode to make changes.

### SOFT TO LOUD VOICES, ^A, AMPLITUDE

THE SSI-263 DEMO BOARD can speak in a variety of voices. It can speak in a barely audible whisper, or for stage purposes, in a deep sonorous voice.

Volume or amplitude, may be adjusted with the ^A command. Type Control-A. The program will respond with a prompt:

```
=========================================
ENTER NEW AMPLITUDE SETTING:
=========================================
```

You may enter any setting from 0 to 11. The normal setting is set at 11. Try 4 and press return.

The new setting will be reflected in the CURRENT PARAMETERS Table.

```
========================================
           CURRENT PARAMETERS
========================================
 4  -AMPLITUDE       232-FILTER FREQUENCY
 8  -INFLECTION      8  -SPEECH RATE
========================================
```

Now type in "Hello." If THE SSI-263 DEMO BOARD spoke too softly, type N for new entry, and ^A for amplitude. This time, try typing in 8, press return, and check for the new value in the CURRENT PARAMETERS Table. Direct SWEETTALKER II to speak again. When you are satisfied that THE SSI-263 DEMO BOARD is speaking at a proper volume, you may turn your attention elsewhere.

## LOW TO HIGH VOICE, ^I, INFLECTION

Different roles or personalities require different voices. A child speaks in a high pitched voice, an adult male in a low pitch. With your direction, THE SSI-263 DEMO BOARD can utilize its talents and do impersonations.

Suppose that THE SSI-263 DEMO BOARD was asked to play an evil villain in a theatrical production. Its normal voice won't do at all. In order to change pitch or inflection, type Control-I in the Test Mode. A prompt will appear to assist you.

```
========================================
ENTER NEW INFLECTION SET NUMBER:
========================================
```

You may enter any value from 0 to 25. When you change the inflection set, you are moving the four main pitch levels up or down on a musical scale. An evil character requires a very low voice, so let's type in 0, and press return. The new value will appear in the CURRENT PARAMETERS Table. Now type, "/WEL/COME TO MY DOMAIN" press return, and meet your villain.

THE SSI-263 DEMO BOARD's talents are far too great to play only evil character types. Let's create another role. Type N for new entry, ^I for inflection and set the inflection set to 25. Press return.

THE SSI-263 DEMO BOARD will now speak like a little child in a very high pitched voice. Type "M/OMM/Y? " and press return. THE SSI-263 DEMO BOARD's versatility will amaze you.

## SLOW TO FAST VOICE, ^R, SPEECH RATE

Some roles will require that THE SSI-263 DEMO BOARD speak very quickly. The speech rate may be adjusted on a scale from 0 to 13, from excruciatingly slow to incredibly fast. Type Control-R for the prompt:

```
========================================
ENTER NEW SPEECH RATE:
========================================
```

Set the speech rate to 1 and press return. Also, type ^I for inflection and change it back to 8. THE SSI-263 DEMO BOARD's new line is, "I am s/o/ tired," and it is spoken as though THE SSI-263 DEMO BOARD will be asleep before it reaches the word "tired." (Don't forget to type the stress markers around the O.) On the other hand, type in a speech rate of 11, and press return. Now type "Peter Piper picked a peck of pickled peppers," and press return. THE SSI-263 DEMO BOARD never stutters.

## ALTER THE VOICE QUALITY, ^F, FILTER FREQUENCY

The last parameter you may adjust is the Filter Frequency or voice quality. One of THE SSI-263 DEMO BOARD's greatest virtues is its ability to change its voice. If you type Control- F in the Test Mode, the prompt will read:

```
========================================
ENTER NEW FILTER FREQUENCY NUMBER:
========================================
```

By typing in any number from 0 to 253, and pressing return, you may direct THE SSI-263 DEMO BOARD to speak in a different voice. Type in 242 and press return. Change the speech rate back to 8. Type "TAKE ME TO YOUR LEADER." THE SSI-263 DEMO BOARD could play a creature from outer space.

Let's try another. Type N and Control F. Suppose we type 220 and press return. THE SSI-263 DEMO BOARD's voice acquires a previously undiscovered dignity. If THE SSI-263 DEMO BOARD now says, "YOU ARE A /GREAT/ DIRECTOR," we can believe it.

# PULLING IT ALL TOGETHER

THE SSI-263 DEMO BOARD's abilities may be further explored by changing more than one parameter at a time. Try changing Filter Frequency and Inflection together. Any combination of the four parameters is possible, so you may create an unlimited number of voices.

Let's go back to the evil villain and make his voice more convincing. What the voice lacked earlier was the appropriate filter frequency. Change the inflection to 0 and the filter frequency to 220, giving the speech a lower and deeper voice quality. Also slow the speech rate to 6. Now, type "/WELCOME/ TO MY DOMAIN. HA, HA, HA."

The child's whimper was high in pitch, but the voice quality was too strained. Change the voice quality to produce a softer, more innocent cry. Type 20 for inflection, 240 for filter frequency and 2 for speech rate. You may also lower the amplitude, if you wish. Type "/MOMM/Y? /I/ LOVE YOU."

## SAVE THE WORDS CREATED, ^S, SAVE

As you develop words or phrases using the above methods, you may wish to save them. While the words and speech parameters are still on the screen, type CONTROL-S for save. DO NOT TYPE N FOR NEW ENTRY BEFORE YOU TYPE CONTROL-S. This will erase your words. Remember that after you enter a word, the only acceptable commands are N for new entry, R for repeat and ^S for save.

When you type ^S you will be asked to enter a filename.

```
========================================
ENTER FILENAME:
========================================
```

You may enter any filename up to eight characters in length beginning with a letter A-Z. The following message will appear while the new file is written to your disk.

```
=========================================
PLEASE WAIT - SAVING COMPOSITE FILE
=========================================
```

The words you save may be used for current or future programs you may wish to enhance with speech. Please refer to the section on programming information for samples and an explanation of how you incorporate speech into your work.

We have only whetted your appetite. With all the features presented in the previous pages, you may create whatever creature or character your imagination dictates. THE SSI-263 DEMO BOARD's talents are constrained only by your imagination.

# THE RULE TABLE

Sweet Micro Systems' method of converting text to speech is rule based. Words are broken into sound patterns, which are represented by rules. THE SSI-263 DEMO BOARD matches these rules to characters in words or phrases. When a match is made, THE SSI-263 DEMO BOARD speaks.

The quality of rules developed in each character table will determine the accuracy of the resulting speech. Our language presents a formidable challenge in developing a comprehensive rule table. The Sweet table should be considered a base rule table, which may be personalized to suit your particular application. Sweet Micro Systems has made an effort to free you from a predetermined vocabulary and pronunciation, by including a utility called the Rule Editor. The Rule Editor will allow you to alter the Sweet table. New rules may be added, existing rules may be edited or redefined, and nonessential rules may be deleted from the tables. Personalize the Sweet table and let THE SSI-263 DEMO BOARD tell you what you want to hear.

## A WORD ABOUT PHONEMES

THE SSI-263 DEMO BOARD produces speech using a building block method of combining basic sound units called phonemes. In order to teach THE SSI-263 DEMO BOARD to speak intelligibly, we must train our ears to hear individual phonemes in our own speech. THE SSI-263 DEMO BOARD can produce 64 speech sounds in all, more than enough to reproduce any speech you care to hear.

Phonemes may be divided into two distinct categories, consonants and vowels. A list of THE SSI-263 DEMO BOARD's phonemes, codes, and a key to their pronunciation are provided in Appendix A, pages A-1 and A-2. The chart is divided into two tables, one for vowels and the other for consonants. The phonemes are listed in the first column of each table. Each phoneme has four possible codes, which allow the user to select different durations for each sound. By referring to the examples and experimenting with phoneme length, anyone can produce highly intelligible speech.

Depending on where you live, your pronunciation of certain words may vary from SWEETTALKER II's pronunciation. You will find that some words pronounced by THE SSI-263 DEMO BOARD will conflict with what you would normally expect to hear. Don't hesitate to change the pronunciation of any word you wish. THE SSI-263 DEMO BOARD has a great capacity to learn.

Boot the demo disk and select Text to Speech. Type your name following the question mark and press return. How did THE SSI-263 DEMO BOARD do? If THE SSI-263 DEMO BOARD pronounced your name correctly -- great! If not, let's correct the rule table so THE SSI-263 DEMO BOARD will always get it right.

Type QUIT to exit the Text to Speech mode and select the Rule Editor. The Rule Table has been designed to generate correct pronunciation for a majority of words. It operates using a text to speech method which allows the computer to analyze text, much in the way a person talks. Should the computer not be informed about a particular rule for pronunciation it will, like a human, make mistakes. Errors will occur because our alphabet is not an accurate representation of our phonemic system. There is not a one-to-one relationship between an alphabet letter and a particular phoneme. If you think back to your grade school days, you will remember the difficulties first graders have with the rules for silent e, the e which is not pronounced but signals a change in the preceding vowel.

## HOW TO MAKE CHANGES TO THE RULE TABLE

^Z, SELECT

When the Rule Editor is ready, you will see the following prompt at the top of the screen:

```
SELECT CHARACTER TABLE TO EDIT
```

The Rule Table consists of all alphabet letters, all digits and their upper case symbols, and all punctuation marks. In order to demonstrate how to correct the Rule Table, we have selected the name, "Robert," which we know is mispronounced. Type R for the R character table. The R table will appear on the screen. It should look like Figure 1-1.

The first two lines tell you where you are in the rule table and the present status. The number of rules [B], address [C], and bytes [D] will constantly change as you edit the table.

Ten rules will appear on the screen at a time. If the character table contains more than ten rules, press the space bar to advance to the next ten. When you reach the end of the table, press the space bar to return to the first ten rules.

```
[A]     RULE TABLE - R       NUMBER OF RULES - 16          [B]
        ========================================
[C]     ADDRESS - 34494        LENGTH - 160 BYTES          [D]
        ========================================
         1 !(R)!=0E5C
         2 !(READY)!=1D4A4A2501
         3 !(READ)=1D414125
[E]      4 !(REC)+=1D0130
         5 !(REC)=1D0A29
         6 !(RE)^#=1D01
         7 (RE)D=1D0A
         8 (RHY)TH=1D07
         9 (RH)=1D
        10 (RINE)!=1D0138

        ========================================
[F]     ENTER COMMAND:
        ========================================
```

KEY TO THE RULE TABLE

[A] Indicates which character table you are viewing
[B] Indicates the total number of rules contained in this table
[C] Indicates the starting address in memory where this table can be found
[D] Indicates the total length (in bytes) of this table
[E] The first ten rules
[F] Type one of the editor commands in Table 1-1

Figure 1-1 Screen Display of a Character Rule Table

| KEY | FUNCTION | KEY | FUNCTION |
|---|---|---|---|
| ^Z | Select new character table | U | Update Main Rule Table |
|  |  | ^S | Save Rule Table to disk |
| E | Edit an entry | ^L | Load Rule Table |
| I | Insert a new rule | ^P | Print Character Table |
| D | Delete an entry | ^Q | Quit or exit program |
| T | Test mode | ^X | Help Menu |
| SPACE | Advance to next page of current Character Table |  |  |

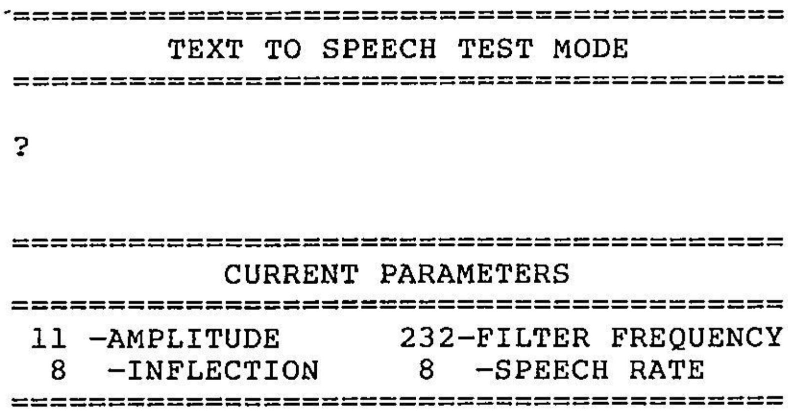
Table 1-1 List of Rule Editor Commands

## LET'S HEAR IT

The Rule Editor has a test mode which allows you to evaluate THE SSI-263 DEMO BOARD's pronunciation of a word or phrase. You will be able to access this mode from any character table, and once in this mode, you may type any word or phrase.

### T, TEST MODE

Type T for the Test Mode and a screen similar to that of Figure 1-2 will appear. The Test Mode will allow you to enter 239 characters or about six and a half lines of characters at the question mark prompt. A beep will tell you that you have reached the limit. Type the letter U until you hear a beep. Press return and listen to the results. The sequence of two digit numbers at the lower half of the screen are the phoneme codes selected from the rule table by the text to speech conversion program. When you typed the return, the U's were converted to code using the rule(s) matching this character string.



```
========================================
        TEXT TO SPEECH TEST MODE
========================================

?


========================================
           CURRENT PARAMETERS
========================================
 11 -AMPLITUDE       232-FILTER FREQUENCY
  8  -INFLECTION      8  -SPEECH RATE
========================================
```

Figure 1-2 Test Mode Screen Display

| KEY | FUNCTION | KEY | FUNCTION |
|---|---|---|---|
| R | Speak again | ^A | Set amplitude |
| N | New entry | ^I | Set inflection |
| ^S | Save word of phrase | ^F | Set filter frequency |
| ^Z | Return to Editor | ^R | Set speech rate level |
|  |  | ^X | Help menu |
| SPACE | Advance to next phoneme page |  |  |

Table 1-2 Test Mode List of Commands

## LOCATE THE SOURCE OF THE PROBLEM

Type N, to clear the input area for a new entry. Type Robert next to the question mark prompt and press return. It sounds close, but not quite right. The sequence of two digit numbers at the bottom half of the screen represents the phoneme codes selected for Robert. If you compare each of these phoneme codes with those of the Phoneme List in Appendix A, page A-1 and 2, you will find that this name is pronounced as /ROWBERT/ and not as /RAHBERT/, which is correct.

```
  1D 11 A3 64 5C 68 C0
/ R  O  W  B ER  T  PAUSE/
```

In order to change the /OW/ sound to an /AH/ sound we must first determine which rule caused the error. Let us return to the rule table. Type N to clear for a new entry. Type Control-Z to return to the table from which you entered the Test Mode. Rather than go directly to the O rule table, we must first search the R rule table. The rules in the R table always define how the letter R will be pronounced, but the next character(s) in sequence may also be included in the R rule. It is possible that a rule which exists for (RO) caused the error.

## HOW TO READ A RULE

Each rule in the table consists of three main parts, the rule definition on the left, the equals sign, and the phoneme codes on the right. The first rule of the R table states that R [1], which is preceded and also followed by a nonalphabetic character [2], is to be pronounced [3] as the composite sound of /AH-ER/, which is equal to the code 0E5C [4].

```
          [1]
           |
  1    !(R)!=0E5C
       | _/ |  \
      [2]  [3]  [4]
```

[1] Parentheses serve as boundary markers. They act to identify the particular character or characters which are to be matched. In this rule, only R will be pronounced.

[2] The exclamation points indicate a nonalphabetic character which can be a space, punctuation mark, digit, or any other symbol except those which have been reserved as classification symbols (See Table 1-3).

[3] The equal sign acts to assign the phoneme code to the contents of the parentheses.

[4] If all the conditions on the left are met, then a match is achieved and the contents of the parentheses will be pronounced as indicated by the phoneme code(s) to the right. The codes are set aside in a buffer (a temporary memory location) until the entire word or phrase has been converted.

Other symbols used in rules are given in Table 1-3a. The symbols help to generalize rules to encompass as many words with the same pronunciation pattern as possible. For example, a rule states that the letter A, preceded by any single consonant (^) and followed by the letter T, is to be pronounced as a short A. This rule may match the word BAT, CAT, FAT, HAT, MAT, PAT, RAT, SAT, etc. It will also match BATTLE, CATTLE, RATTLE, BATCH, CATCH, HATCH and so forth. This single rule will insure that the letter A, in all these words and many more like them, will be pronounced correctly.

How does the program know that B, C, F, etc. are consonants? The program is told. Each letter in the alphabet is classified as shown in Table 1-3b. When Robert was typed, the program converted it to these symbols and set it aside for reference.

| Symbols for VOWELS | Symbols for CONSONANTS |
|---|---|
| # one or more vowels | ^ one consonant |
| + vowels: E I Y | . consonants: BDGJLMNRVWZ |
| | : zero or more consonants |

| Symbol for CHARACTER | Symbol for ALL OTHERS |
|---|---|
| use the character | ! nonalphabetic |

Table 1-3a Classification Symbols: used in rule

| A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | . | ^ | . | + | ^ | . | ^ | + | . | ^ | . | . |

| N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| . | # | ^ | ^ | . | ^ | ^ | # | . | . | ^ | + | . |

Table 1-3b Classification Symbols: used in conversion

Rule number 1 does not apply to Robert, because the O in Robert fails to match the exclamation point on the right of R.

```
/ ROBERT /
 |||
 !R!
```

If we had typed in "R" alone, a match would have been achieved. The text to speech program automatically inserts a space on either side of a word or phrase to be converted, to mark where it begins and ends. Therefore, the exclamation point on the left matches the space which precedes the name, Robert. A match is not achieved on the right, because the letter O is a vowel, not a nonalphabetic character.

Compare the name, Robert, to the remaining rules in the R table. Each letter could be represented by its own character or a general symbol defining a vowel or a consonant. The letters in the name, Robert, may be represented by these symbols:

| R | O | B | E | R | T |
|---|---|---|---|---|---|
| . | # | . | + | . | ^ |
| ^ |  | ^ | # | ^ |  |
|  |  |  |  | : |  |

Upon examination, we will see that a match will not occur until the last rule: (R)=1D.

The last rule states that R in any environment, excluding the rules preceding it, will be pronounced as the R in the word, "rat." Rule number 16 only defines the pronunciation for the letter R, and not the sound of the letter O. Therefore, we must look to the next letter in sequence, the letter O, to locate the source of the mispronunciation.

We now proceed to the O table. Type Control-Z to select a new character table and then O. If you page through the O table looking for a match, you should find a page of rules similar to Figure 1-3.

```
RULE TABLE - O       NUMBER OF RULES - 88
=========================================
ADDRESS - 34420        LENGTH - 849 BYTES
=========================================
61  (O)^AGE=0E
62  (O)^A=1163
63  (O)^E=11A3
64  (O)^I#=1163
65  (O)^ICE=51A3
66  (O)^L#=11
67  (O)^R#=11
68  (O)^U=11
69  (O)^Y=11
70  (OUGHT)=1028
=========================================
ENTER COMMAND:
=========================================
```

Figure 1-3 The O Rule Table

A quick glance over the table indicates that all of these rules, with the exception of number 70, define a sequence of letters in which O must be followed by one consonant. To the left of O no symbol or character exists. This means that the rule is not affected by what precedes O and this position is left unconstrained.

So far any rule from 61 to 69 could match Robert. Since it does not matter what precedes O and it is the only character within parentheses, we check for a consonant to the right and find B. To the right of B is the vowel E. Search the rules, starting with 61, for ^E, ^+ or ^#. Rules 61 and 62 can be eliminated since A follows ^. Rule 63 matches the ^E. Since the rule boundary ends here, a match is made.

```
/ ROBERT /
   |||
   O^E
```

This rule states that whenever an O is followed by any single consonant and the letter E, the O will be spoken as the O in "boat." If we try to change this particular rule so that Robert is pronounced correctly, we will find that this change affects other words, such as ROBE, ROPE, VOTE, and HOTEL. In order to avoid the possibility of such a side effect, let us create a rule just for Robert, since it appears to be an exception to this rule.

## CREATE A NEW RULE

In order to create a rule we first have to decide where to place it. The placement of a rule is very important, not only within a character table, but also among the rule tables. Always place your rule in the table represented by the first character to be pronounced (within the parentheses). Since the purpose of creating the rule is to insure that the name Robert will be pronounced correctly, we will enclose all the letters within the parentheses. This rule will be placed in the R Table.

### I, INSERT

Type Control-Z (^Z) to select a new character table. Type R and the R rule table will appear on the screen.

First, we must determine where this new rule should be inserted. The program will search through the tables sequentially in its conversion process, so it is important that all exceptions be listed before the general case. Otherwise, the search may end prematurely with a rule for a more general case. We could not, for example, place Robert at the end of the table after

```
(R)=1D.
```

If we tried to do so, our search would end with the above rule. This is a default rule which will match any word with an R since it does not specify what is to the left or right of R. The program would proceed to the next character search without ever reaching our Robert rule.

In the event that you are working with a table of many exceptions, it is wise to alphabetize the exceptions without violating the exception to general case order. In this manner it is easier to locate and examine a particular rule.

Since only the name Robert will match the rule we wish to create, it may be placed anywhere as long as it is before the last rule. For this example, let's place it in alphabetical order. Search through the table and find:

```
14  (RI)V=1D07
15  TH(ROUGH)=1D16
```

The Robert rule could be placed between these two rules. (Note: This is an example. These rules may not appear in this manner or consecutively.)

Now that we know where we would like to place the rule, let's write it. Type I for Insert. You will be prompted with the instruction:

```
========================================
ENTER RULE TO INSERT AT PROMPT BELOW
========================================
```

Type the first part of the rule as it appears below next to the > prompt. DO NOT PRESS RETURN! If you did press return, just press return again to display the Enter Command prompt, and begin once more by typing I for Insert.

```
> !(ROBERT)!
```

If while entering the rule, you make a typographical error, you may back space using the left arrow key and correct the error. However, if you type past the equal sign, you will not be permitted to back past it. If this happens, press the return. Press it again in response to the next prompt in order to cancel your entry. No rule will be inserted until you type in the location to insert. Now type the equal sign. DO NOT PRESS RETURN!

The exclamation points in this rule represent spaces. In this way we may exclude the possibility of altering the pronunciation of the same sequence of letters which may happen to be contained in a larger word. If, for example, we write a rule for the name, ROB, and leave both sides of the word unspecified it would affect the pronunciation of words such as stROBe. To avoid this, we may define a space to the left and right, !(ROB)!, so that only these three letters would match this rule. Even ROBert would not match, since there are more letters to the right.

Refer to the phoneme list on page A-1 and A-2 and look for the phoneme code for an /AH/ sound to pronounce Robert correctly. A portion of that table has been reproduced below. Sometimes there may be more than one possibility. The list of phonemes contains two /AH/ sounds, specified by the phoneme codes beginning with 0E and 0F.

PHONEME LIST (PORTION)

| PHONEME | CODE | | | | EXAMPLES |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| AE | 0C | 4C | 8C | CC | dad |
| AE1 | 0D | 4D | 8D | CD | laugh |
| AH | 0E | 4E | 8E | CE | top, about |
| AH1 | 0F | 4F | 8F | CF | father |
| AW | 10 | 50 | 90 | D0 | saw, caught |

Notice, that for each sound in the phoneme list, there are four possible phoneme codes. As the value is changed from that of column 1 to columns 2, 3, or 4, the duration of the sound is shortened by approximately twenty-five percent. You may select the length which sounds best to you. If you wish to lengthen a sound, place two phoneme codes for the same sound together.

Try the /AH1/ sound from the first column. Type the codes as indicated below, replacing only 11 and A3 with 0F for the O sound. The rule to be inserted should appear as follows:

```
> !(ROBERT)!=1D0F645C68C0
```

All phoneme codes are comprised of two digits. Leading zeros are necessary. Should you make an error, you will be allowed to back space over the phoneme code. The back space works a little differently with phoneme codes. A single back space will move back and erase two digits rather than just one. This will prevent you from entering odd numbers of phoneme code digits. Please note that you will only be permitted numbers and the letters A-F on the right side of the equal sign. Now press return, if you have not already done so.

The program will ask you where you would like to insert the rule:

```
========================================
ENTER BEFORE RULE NUMBER:
========================================
```

Insert the Robert rule before rule 15, TH(ROUGH)=1D16. This new rule will now be part of the table. The Editor will return to the first page of the table after inserting the rule. Press the space bar and find the new rule 15.

## MAKE CORRECTIONS

Now, let's hear it. Type T for the Test Mode. Type Robert after the question mark prompt and press return. How does it sound? It sounds much better, but let's try the other /AH/ sound, 0E. Type N for New Entry and ^Z to return to the R table.

### E, EDIT

To make changes to a rule, type E for edit. You will be prompted with the following:

```
========================================
ENTER NUMBER OF RULE TO EDIT:
========================================
```

Type in the number of the rule, 15. Press return. The Robert rule will now appear at the bottom of the screen above a prompt, so that you may refer to it during the edit. The entire rule MUST be reentered, not just the corrections. Partially typed rules will replace the original rule, in the manner typed. The rule number is not necessary. As was the case for the Insert command, any typographical errors must be corrected before the equal sign is typed. You will not be permitted to back space beyond the equal sign. If you type the equal sign, complete the rule, press return and type E to begin again. The rule should be completed so that you will not have to reconstruct the entire rule from your memory.

Topographical errors on the right hand side of the equal sign may also be corrected using the back space. Remember that in order to preserve the two digit code for a phoneme, a single back space will move back two digits, not one, and that you will only be allowed to type numbers and the letters A-F. Retype the rule with 0E, in place of 0F.

```
= !(ROBERT)!=1D0E645C68C0
```

Press return and the edited rule will replace the old one. The display will show the first ten rules. Press the space bar and make sure the rule was edited properly. Test it once more. It should sound better and more intelligible. Once you are satisfied that this new rule functions correctly, type U to Update the table.

## SAVE THE CHANGES

### U, UPDATE

When you select a character table, this one table is copied into a "buffer" area. A buffer area is like a temporary work space or scratch pad. You may make additions, deletions and changes to the rules while they are in this area. Once you are satisfied that the character table is correct, the Update command replaces the old table with the new table. Eventually, all the character tables will be saved permanently to disk.

The buffer area can only hold one character table at a time. If you select another character table, the current table in the buffer will be written over by the new table. Any changes made will be lost unless an update was performed. Therefore, if you would like to see another character table, and you are not sure if you updated the current table, type U to update. No harm will be done if you did update earlier or made no changes.

### ^S, SAVE

Once your work is updated, type Control-S to save the new table on your disk. The following prompt will appear at the bottom of the screen:

```
========================================
ENTER FILE NAME:
========================================
```

You have an option to save the corrections in the rule table you are currently working with or save them under another name and create a new rule table. If you would like to create a new table, enter any file name up to eight characters in length, beginning with a letter from A-Z and press return. If you want to save the corrections in the current rule table, type Control-N. No file name is necessary. The standard rule table, provided on the demonstration disk, is called MKB:RULE. After entering the name or ^N, the Rule Editor will respond with:

```
========================================
PLEASE WAIT - SAVING RULE TABLE FILES
========================================
```

## DELETE A RULE

If you find that you have no use for a Robert rule, you may delete it. Any rule in any table may be deleted with the exception of the last rule. Each table must have at least one rule.

### D, DELETE

Assuming that you are still in the R table, type D for Delete at the ENTER COMMAND prompt. The program will respond with:

```
========================================
ENTER NUMBER OF RULE TO DELETE:
========================================
```

Type 15 and press return. The screen will display the following prompt along with the rule you selected. The rule will appear near the bottom of the screen.

```
========================================
CONTINUE WITH DELETION? (Y/N)
========================================
```

Every attempt has been made to avoid mishaps, so you must confirm your intentions. If you respond Y, the deletion will proceed and all the rules following this rule will move up one position. The display will revert back to rules 1-10. Scroll through with the space bar to make sure the correct rule was deleted. Also check the last rule number to confirm the new rule count at the top of the screen display.

If you do not want to delete this rule, respond N, and the ENTER COMMAND prompt will reappear.

## OTHER USEFUL COMMANDS

### ^L, LOAD

After you become more familiar with the Rule Editor, you may discover more interesting applications for the text to speech capabilities. For example, you may be interested in foreign languages and might like SWEETTALKER II to speak, maybe German? Or perhaps, you are writing a program which could use some speech. The standard rule table may be too bulky to be used with your program. The solution is to create a new rule table for your application. You don't have to give this one up to get another. The demonstration disk contains a semi-blank rule table called MKB:EMPT. It contains the required one rule in each character table.

If you do not wish to start from scratch, you may use the standard rule table (MKB:RULE), edit it and save it under another file name. This is done with the ^S, Save command.

You may select a new rule table from any rule table. When you select the Rule Editor from the main menu, the standard rule table (MKB:RULE) will automatically be loaded. Select any character table and type Control-L (^L) at the ENTER COMMAND prompt.

```
========================================
ENTER TABLE NAME:
========================================
```

Type the name of the rule table you wish to access. When a rule table is saved, three files are saved, the table itself, the total length of the table, and an index used to locate the character tables within the rule table. When a rule table is saved, .TABLE, .LENGTH, and .INDEX are appended to the file name automatically.

The Text To Speech Rule Editor is used to develop words or phrases for use in your programs. Enter the Test Mode from any character rule table and type in the word or phrase you wish to use. Adjust the pronounciation, using the parameter controls and stress markers. Once you are satisfied with the quality of speech, save the word or phrase by typing control-S from the Test Mode. Name the file using a maximum of eight characters, beginning with a letter (A-Z).

The word or phase saved is a composite file of all the speech parameters. However, the composite file contains only data. This data is similar to the 16 sound parameters needed to produce a sound effect. While the sound parameters are finite, the speech parameters consist of four parameters for each phoneme code generated to produce the speech. If a word consists of 20 phoneme codes, then the composite file of that word contains 100 parameters (including the phoneme codes).

From the Rule Editor, a word or phase is spoken using the Text To Speech Algorithm. Outside of the Rule Editor, another type of program must be employed to generate speech. The Text To Speech Algorithm is no longer necessary, because the conversation from text to phoneme codes has already been done and saved. A program called the Composite Driver, included on the demonstration disk, acts as a messenger and transmits speech codes to the speech chip from the composite data file.

The Composite Driver has a pointer which tells it where the speech data is located. Starting from the data at the pointer, the Composite Driver scans the table, giving phoneme parameters to the synthesizer until the end of the table is reached.

These similarities standardize the programming method employed in generating both sound and speech. Let's enhance a short program with speech. Load the following files in memory prior to running the sample program or at the beginning of the sample program:

```
BLOAD  COMPOSITE  DRIVER
BLOAD<composite data file NAME1 >,A < address in memory >
```

The composite data file may be stored in any unused memory space. The pointer location for the beginning address of the speech data is stored in location 249 and 250. The high byte of the address is stored in 250 and the low byte is stored in 249. If you are unfamiliar with high and low bytes, the high byte is obtained by dividing the address by 256 and the low byte is the remainder of this division. If the data is stored at 33024, then the high byte is 33024/256 or 129. The low byte is zero since there is no remainder.

The following phrase was created using the Rule Editor and saved on the demonstration disk as CLOSING:

THANK YOU FOR LISTENING TO ME

Type in the program below on your copy of the demonstration disk. If you are using a fresh disk, copy the COMPOSITE DRIVER and CLOSING files onto your disk.

```
10 HOME
20 D$=CHR$(4)

25 REM *** LOAD COMPOSITE DRIVER
30 PRINT D$"BLOAD COMPOSITE DRIVER"

35 REM *** LOAD THE DATA FILE CLOSING AT LOCATION 35072
40 PRINT D$"BLOAD CLOSING ,A 35072"

45  REM   *** TELL  COMPOSITE  DRIVER  WHERE  THE  DATA
          FILE  CLOSING  RESIDES.  CONVERT  35072:  HIGH
          BYTE=INT(35072/256)  OR  137, PUT IT IN LOCATION
          250; LOW BYTE=INT(35072/256)-137 OR 0, PUT IT IN
          LOCATION 249.
50 POKE 249,0:POKE 250,137

55  REM  ***  TELL  COMPOSITE DRIVER TO BEGIN SPEAKING.
          COMPOSITE DRIVER IS LOCATED AT 27904.
60 CALL 27904

70 END
```

This program will speak the entire phrase and then end at line 70. In most cases, the program would not speak and then end, it would continue on with other tasks. If this program did not end at line 70, the speech could be interrupted prematurely by an input from the keyboard or program code. In order to protect against such an interruption, the program should check to determine if the speech chip is finished speaking.

When THE SSI-263 DEMO BOARD speaks, a busy flag is set. This flag is located at location 255. When THE SSI-263 DEMO BOARD is finished speaking, the flag is cleared by the Composite Driver program. Your program can monitor this flag. A standard BASIC programming command called PEEK may be used to look at the contents of this location. Type the following lines into the above program. Delete line 70. Save the new version of the program and run it.

```
80  VTAB 6:HTAB 1:PRINT "WOULD YOU LIKE TO HEAR IT AGAIN?
          ;: GET A$
90 IF A$="Y" THEN GOTO 60
100 IF A$="N" THEN GOTO 120
110 GOTO 80
120 END
```

The question, "WOULD YOU LIKE TO HEAR IT AGAIN? " appears on the screen almost at the same time as the speech begins. If you respond to this question before the speech ends, you will interrupt it. Try it. Hit the Y key several times in quick succession. The phrase is not allowed to finish until you stop hitting the key. To prevent this, insert the following lines in this program. Save and run it. You will no longer be permitted to interrupt the speech.

```
65  REM  ***  CHECK  TO SEE IF FINISHED SPEAKING. IF NOT,
          KEEP CHECKING UNTIL IT IS.
70 IF PEEK (255)>0 THEN 70
```

To incorporate more than one phrase in your program, load each file at the beginning of the program. Load each one at a different location, so you will be able to call them at will. Change the pointers, 249 and 250, to point to the phrase you will wish spoken just before calling the composite driver. Let's try it with ENDIT, WHICH SAYS:

THAT'S ALL FOR NOW

This time, let's print the phrases on the screen.

```
10    HOME
20    D$=CHR$(4)
30    PRINT D$"BLOAD COMPOSITE DRIVER"
40    PRINT D$"BLOAD CLOSING,A 35072"
42    REM
         ***LOAD THE SECOND PHRASE AT 36864

45    PRINT D$BLOAD ENDIT,A 36864"
47    PRINT "THANK YOU FOR LISTENING TO ME.
50    POKE 249,0:POKE 250,137
60    CALL 27904
70    IF PEEK (255)>0 THEN 70

80    VTAB 6:HTAB 1:PRINT "WOULD YOU LIKE TO HEAR IT
      AGAIN ?";:GET A$
90 IF A$="Y" THEN GOTO 60
100 IF A$="N" THEN GOTO 120
110 GOTO 80

120 VTAB 10:HTAB 1:PRINT "WOULD YOU LIKE TO HEAR ANOTHER
        PHRASE? ";:GET B$
130 IF B$="Y" THEN GOTO 152
140 IF B$="N" THEN GOTO 170
150  GOTO  120
152 VTAB 10:HTAB 1:PRINT "THAT'S ALL FOR NOW..."

155  REM  *** CHANGE THE POINTERS TO POINT  TO  ENDIT  AT
        36864:HIGH  BYTE=INT(36864/256)  OR  144, PUT IN
        250;  LOW  BYTE= 36864/256-144 OR 0, PUT IN 249.
        TELL COMPOSITE DRIVER TO SPEAK THIS PHRASE.

160 POKE 249,0:POKE 250,144:CALL 27904
170  END
```

Save and run this program. If you would like to try out a different phrase, change line 40 and/or 45 to load your file. Don't forget to change the phrase printed on the screen in lines 47 or 152. Why not make all the prompts in this program speak?

## USING TEXT TO SPEECH AND THE RULE TABLE IN YOUR PROGRAM

The above programming method is a very convenient way to generate speech, provided you know what vocabulary will be required in your program. This is not always possible or desirable. You may wish to have a person using your program type in his own responses. These words could also be spoken by MOCKINGBOARD. However, unless the response is limited to a predefined vocabulary, words not previously coded will be left unsaid.

Another method of generating speech will allow MOCKINGBOARD to speak an unlimited vocabulary. This program incorporates the Text to Speech program included on the demonstration disk. It uses a table of rules (also included on the disk) to convert text into speech. The text may consist of characters typed from the keyboard or characters assigned to a string variable. It may also be text saved in a text file.

If your program is very large, this method may not be economically implemented, due to the size of the rule table. However, if you can anticipate the vocabulary that may be used in your program, including responses from the user, an empty rule table may be used to build a custom list of words. The empty rule table will allow you to enter only rules which may pertain to your program. If you prefer, you may also trim the current rule table to a size more suitable to your program and save the revised version under another name.

Any rule table may be included in your program along with Text to Speech. A sample program using this method is given below. Regardless of whether you are converting input from the keyboard or assigning it to a string variable within your program, you must assign the input to the variable MB$. The program, which Text to Speech uses to retrieve the text data, looks for this variable. This program is called MB$ GETTEXT.

```
10  HOME
20  D$=CHR$(4)
30  PRINT D$"BLOAD TEXT TO SPEECH"
40  PRINT D$"BLOAD MB$ GETTEXT"
45  REM
         *** LOAD THE RULE TABLE

50  PRINT D$"BLOAD MKB:RULE.TABLE"
60  PRINT D$"BLOAD MKB:RULE.LENGTH"
70  PRINT D$"BLOAD MKB:RULE.INDEX"
75  REM
         *** ASSIGN THE PHRASE TO BE SPOKEN TO MB$

80  MB$="WITH THE SSI-263 DEMO BOARD YOU'LL NEVER BE SPEECHLESS"
85  REM
  *** TELL TEXT TO SPEECH TO BEGIN SPEAKING THE PHRASE
90  CALL 26123

95  REM  *** CHECK TO SEE IF FINISHED SPEAKING.  IF NOT,
             KEEP CHECKING UNTIL IT IS.

100 IF PEEK(255)>0 THEN 100
110 END
```

MKB:RULE is the standard rule table designed by Sweet. You may replace this with your rule table file name. These files monitor the expansion and reduction of the rule table as well as where all the characters reside in memory. They are always updated and saved when you save a rule table.

If you wish to speak a response from the user change line 80 to:

```
80  INPUT "ENTER TEXT: ";MB$
```

The INPUT statement may be any question or prompt.

# APPENDIX A PHONEME CHART

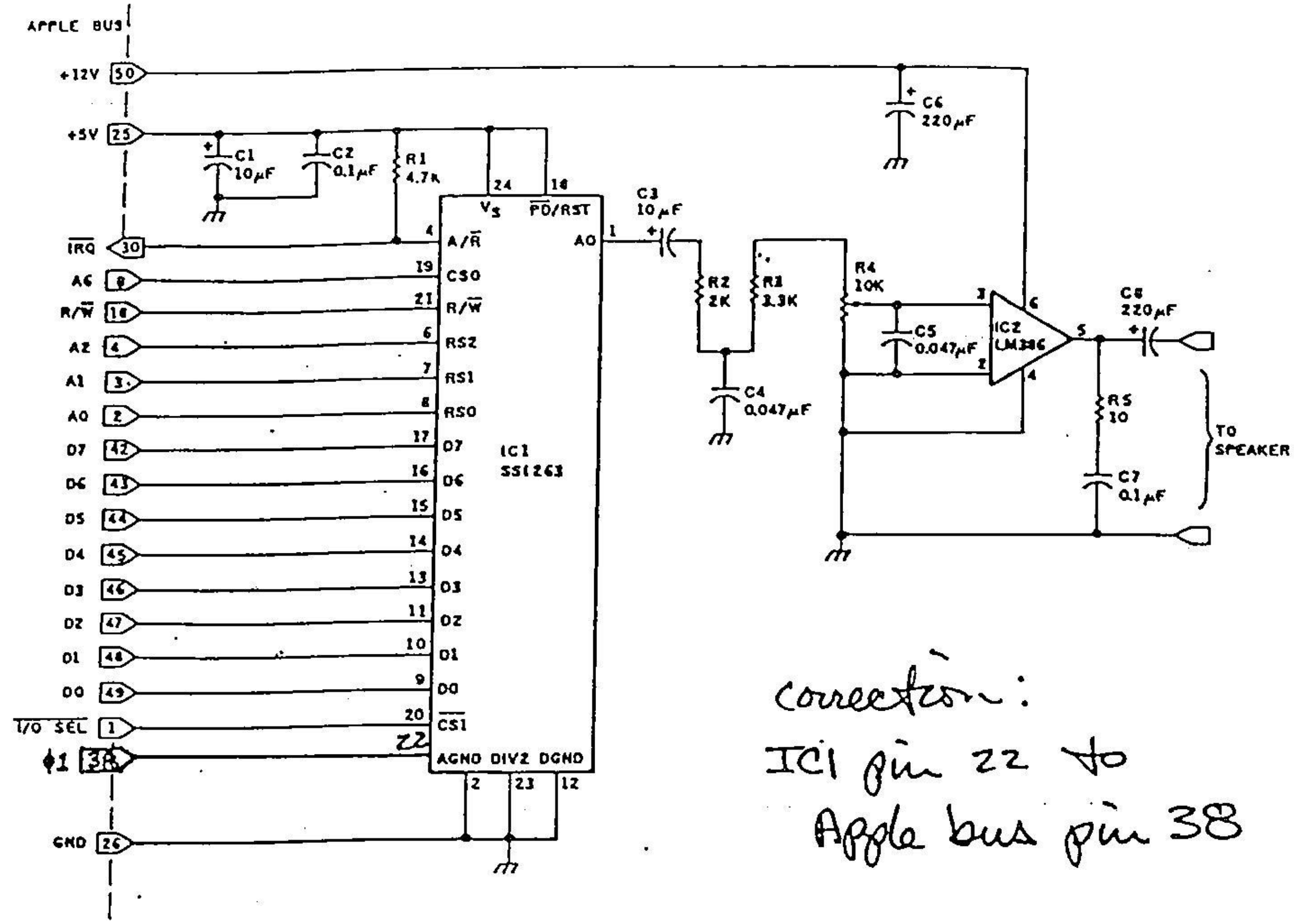
## LIST OF CONSONANT PHONEMES

| | CODE | | | | |
|---|---|---|---|---|---|
| PHONEME | 1 | 2 | 3 | 4 | EXAMPLES |
| B | 24 | 64 | A4 | E4 | bat, tab |
| D | 25 | 65 | A5 | E5 | dub, bud |
| F | 34 | 74 | B4 | F4 | fat, ruff, photo, laugh |
| HV | 2A | 6A | AA | EA | eh? |
| HVC | 2B | 6B | AB | EB | d(h)ouble |
| HF | 2C | 6C | AC | EC | hat,home |
| HFC | 2D | 6D | AD | ED | p(h)ad, fluff(h), black(h) |
| HN | 2E | 6E | AE | EE | hnh-hnh |
| J | 31 | 71 | B1 | F1 | job, rage |
| K | 29 | 69 | A9 | E9 | kit, tick |
| KV | 26 | 66 | A6 | E6 | big, gag |
| L | 20 | 60 | A0 | E0 | lab, ball |
| L1 | 21 | 61 | A1 | E1 | plan, club, slam |
| LF | 22 | 62 | A2 | E2 | bottle, channel |
| M | 37 | 77 | B7 | F7 | mad, dam |
| N | 38 | 78 | B8 | F8 | not, ton |
| NG | 39 | 79 | B9 | F9 | ring, rang |
| P | 27 | 67 | A7 | E7 | pat, tap |
| R | 1D | 5D | 9D | DD | rat |
| S | 30 | 70 | B0 | F0 | sat, lass |
| SCH | 32 | 72 | B2 | F2 | shop, push |
| T | 28 | 68 | A8 | E8 | tap, pat |
| THV | 35 | 75 | B5 | F5 | bathe, the |
| TH | 36 | 76 | B6 | F6 | bath, theory |
| V | 33 | 73 | B3 | F3 | vow, pave |
| W | 23 | 63 | A3 | E3 | why, quake |
| Y1 | 04 | 44 | 84 | C4 | you |
| Z | 2F | 6F | AF | EF | zap, maze |
| | 00 | 40 | 80 | C0 | [pause] |

The 4 columns of code for each phoneme allow you to alter the length of any sound, and choose the version which provides the most intelligibility and natural quality. Each successive column represents a phoneme which is approximately 25% shorter than its predecessor. For most purposes, column 1 will serve as a standard value.

LIST OF VOWEL PHONEMES

| | CODE | | | | | |
|---|---|---|---|---|---|---|
| PHONEME | 1 | 2 | 3 | 4 | EXAMPLES | |
| A | 08 | 48 | 88 | C8 | day | |
| A1 | 09 | 49 | 89 | C9 | care | |
| AE | 0C | 4C | 8C | CC | dad | |
| AE1 | 0D | 4D | 8D | CD | laugh | |
| AH | 0E | 4E | 8E | CE | top, about | |
| AH1 | 0F | 4F | 8F | CF | father | |
| AW | 10 | 50 | 90 | D0 | saw, caught | |
| E | 01 | 41 | 81 | C1 | beet, be | |
| E1 | 02 | 42 | 82 | C2 | advent | |
| EH | 0A | 4A | 8A | CA | leg, said | |
| EH1 | 0B | 4B | 8B | CB | silent | |
| ER | 1C | 5C | 9C | DC | third, urn, heard | |
| I | 07 | 47 | 87 | C7 | sit, bid | |
| O | 11 | 51 | 91 | D1 | boat | |
| OO | 13 | 53 | 93 | D3 | put, pull, look | |
| OU | 12 | 52 | 92 | D2 | orb | |
| U | 16 | 56 | 96 | D6 | boot, you | |
| U1 | 17 | 57 | 97 | D7 | poor | |
| UH | 18 | 58 | 98 | D8 | cup | |
| UH1 | 19 | 59 | 99 | D9 | circus | |
| UH2 | 1A | 5A | 9A | DA | nation | |
| UH3 | 1B | 5B | 9B | DB | nation | |
| FOREIGN SOUNDS | | | | | | |
| AY | 05 | 45 | 95 | C5 | francais | French |
| A | 3A | 7A | BA | FA | e^tre | French or umlauted A in German |
| E2 | 3E | 7E | BE | FE | schon | German |
| IE | 06 | 46 | 86 | C6 | il | French |
| IU | 14 | 54 | 94 | D4 | peut | French |
| IU1 | 15 | 55 | 95 | D5 | Goethe | German |
| OH | 3B | 7B | BB | FB | menu, tu | French |
| U | 3C | 7C | BC | FC | fuhlen | German |
| UH | 3D | 7D | BD | FD | menu, tu | French |
| Y | 03 | 43 | 83 | C3 | y | French |
| LB | 3F | 7F | BF | FF | il | French |
| R1 | 1E | 5E | 9E | DE | reponse | French |
| R2 | 1F | 5F | 9F | DF | richtig | German |
| il | | | | | | French |
| R1 | 1E | 5E | 9E | DE | reponse | |



correction:
IC1 pin 22 to
Apple bus pin 38

**Figure 2:** *Schematic diagram of the Sweet Talker II circuitry.*

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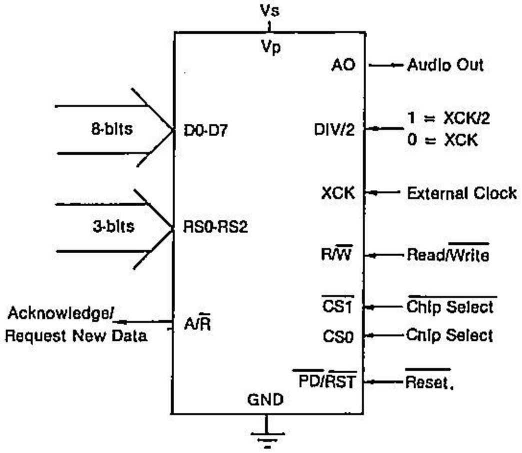
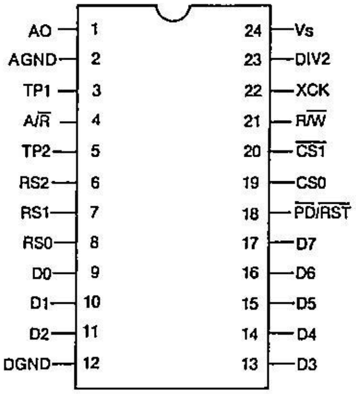
# Speech Synthesizer SSI 263

## Preliminary Data Sheet



Flow Diagram



SSI 263 Pin Out
(Top View)

### FEATURES

- Low power CMOS
- Extremely low data rate
- Controlled inflection and pitch
- Controlled amplitude and rate
- 8-bit bus compatible
- Variety of voice effects
- Sound effects and music
- Analog output
- Selectable handshaking modes
- Non-dedicated speech

### DESCRIPTION

The SSI 263 is a monolithic CMOS integrated circuit designed for user synthesis of voice, music and sound effects. Continuous speech of unlimited vocabulary can be generated at extremely low data rates.

Speech is synthesized by combining phonemes in the appropriate sequence. The SSI 263 Speech Synthesizer contains 64 phonemes with 4 different duration settings each, giving an equivalent of 256 phonemes accessed by an 8-bit code.

The SSI 263 contains 5 registers, each 8-bits wide, selected by a 3-bit address (RS0, RS1, RS2). These registers give the user access to 256 phonemes, 4096 levels of pitch (32 levels of pitch at 8 speeds of inflection), 16 speed or overall rate settings, 16 levels of amplitude, 8 rates of articulation and 255 settings of the vocal tract filter response.

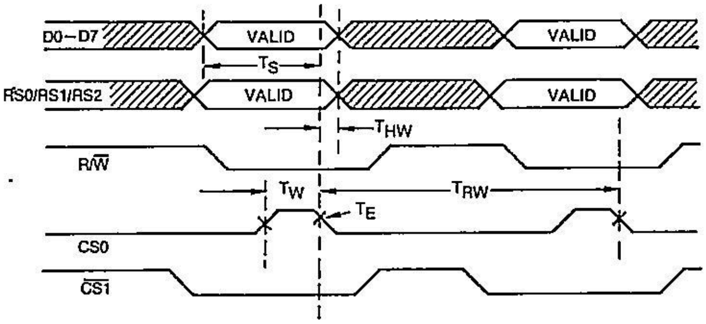
ELECTRICAL CHARACTERISTICS (VDD = 5.0V ± 5%, $T_A$ = −40°C to +85°C)

| Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Input High Voltage (VIH) | | 1.5V | | VDD + 0.5 | V |
| Input Low Voltage (VIL) | | −0.5V | | 0.8 | V |
| Input Leakage Current | | | | 5 | μA |
| Output Low Voltage (VOL) | $I_{LOAD}$ = 3.2 mA | | | 0.4 | V |
| Output High Voltage (VOH) D-7 only | $I_{LOAD}$ = 205 μA | 2.4V | | | |
| Tri-State Input Current | R/W = 1 (D0-D6 only)<br>CS0 = 0, $\overline{CSI}$ = 1 (D0-D7) | | 2.0 | 5 | μA |
| Capacitance | Vin = 0, $T_A$ = 25°C, F = 1.0MHz | | | 8 | pF |
| Audio Output Swing | "Aw" Phoneme | 0.39 × VDD | | 0.58 × VDD | V |
| Audio DC Bias | | | VDD/2 | | V |
| External Clock Input (XCK) | XCK/2 = Low | 1.79 | | 2.0 | MHz |
| External Clock Input (XCK) | XCK/2 = High | 0.85 | | 1.0 | MHz |
| Supply Current | VDD = 4.5 to 6.6V | | | TBD | mA |
| Standby Supply Current | $\overline{PD}/\overline{RST}$ = Low | | | TBD | mA |

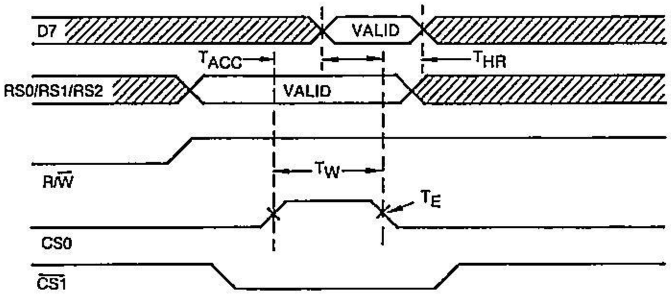
PIN ASSIGNMENT DESCRIPTIONS

| Pin No. | Symbol | Active Level | Description |
|---|---|---|---|
| 1 | AO | | Analog Audio Output biased @ VDD/2 requires an external audio amp for speaker drive |
| 2 | AGND | | Analog Ground |
| 3 | TP1 | | Do not use |
| 4 | $A/\overline{R}$ | | Acknowledge/Request Not — open collector output a low requests new data (see also pin 17) |
| 5 | TP2 | | Do not use |
| 6 | RS2 | | Register Select — used to select one of five internal registers in conjunction with RS1 and RS0 |
| 7 | RSI | | Register Select (See pin 6) |
| 8 | RS0 | | Register Select (See pin 6) |
| 9 | D0 | | LSB of 8-bit data bus — input only |
| 10 | D1 | | Data Input |
| 11 | D2 | | Data Input |
| 12 | DGND | | Digital Ground |
| 13 | D3 | | Data Input |
| 14 | D4 | | Data Input |
| 15 | D5 | | Data Input |
| 16 | D6 | | Data Input |
| 17 | D7 | | MSB of 8-bit data bus. Bi-directional, inverse of pin 4 when read is high |
| 18 | $\overline{PD}/\overline{RST}$ | Low | Power Down Control — Silences audio output and retains DC bias without disturbing register contents. Disables $A/\overline{R}$ output. |
| 19 | CSO | High | Chip Select |
| 20 | $\overline{CSI}$ | Low | Chip Select |
| 21 | $R/\overline{W}$ | | Read/Write Control — Write is active low for loading internal registers. Read is active high but enables D7 only. |
| 22 | XCK | | Clock Input (≃ 2MHz) |
| 23 | DIV2 | High | Clock Divide by Two — used when external clock is ≃ 1MHz |
| 24 | VDD | | Positive Voltage Supply |

### WRITE TIMING DIAGRAM



### READ TIMING DIAGRAM



*Valid data latched on first rise or fall of $R/\overline{W}$, CS0 or $\overline{CS1}$ into inactive.

### TIMING CHARACTERISTICS (V$_{DD}$ = 5.0 VAC ± 5%, T$_A$ = 25°C)

| Characteristics | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Data Set Up Time | $T_S$ | 130 | | | nS |
| Data Hold Time (Write) | $T_{HW}$ | 10 | | | nS |
| Pulse Width of $R/\overline{W}$, CS0, $\overline{CS1}$ | $T_W$ | 200 | | | nS |
| Edge Time, Rise or Fall of $R/\overline{W}$, CS0, $\overline{CS1}$ | $T_E$ | | | 100 | nS |
| Time Between Writes | $T_{RW}$ | 2.25* | | | µS |
| Read D7 Access Time | $T_{ACC}$ | | | 180 | nS |
| D7 Hold Time (Read) | $T_{HR}$ | | | 180 | nS |

*Based on color burst derivative into XCK

### REGISTER INPUT FORMATS

| Register Address | | | Register Name | Bus Input Bit Position | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RS2 | RS1 | RS0 | | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| LO | LO | LO | Duration/Phoneme (DR/P) | DR1 | DR0 | P5 | P4 | P3 | P2 | P1 | P0 |
| LO | LO | HI | Inflection (I) | I10 | I9 | I8 | I7 | I6 | I5 | I4 | I3 |
| LO | HI | LO | Rate/Inflection (R/I) | R3 | R2 | R1 | R0 | I11 | I2 | I1 | I0 |
| LO | HI | HI | Control/Transition/Amplitude (C/T/A) | C | T2 | T1 | T0 | A3 | A2 | A1 | A0 |
| HI | X | X | Filter Frequency (F) | F7 | F6 | F5 | F4 | F3 | F2 | F1 | F0 |

DR1, DR0 . . Define the phoneme duration.
P5 ← P0 . . . Address the phoneme required.
I11 ← I0 . . . . Define inflection target frequencies and rate of change.
R3 ← R0 . . . Define the rate or speed of speech.
C . . . . . . . . . Define the mode of A/R response in conjunction with DR1 and DR0.
T2 ← T0 . . . . Define the rate of movement of the formant position for articulation purposes.
A3 ← A0 . . . Define the amplitude of the output audio.
F7 ← F0 . . . Define the frequency of all vocal tract filters per text.

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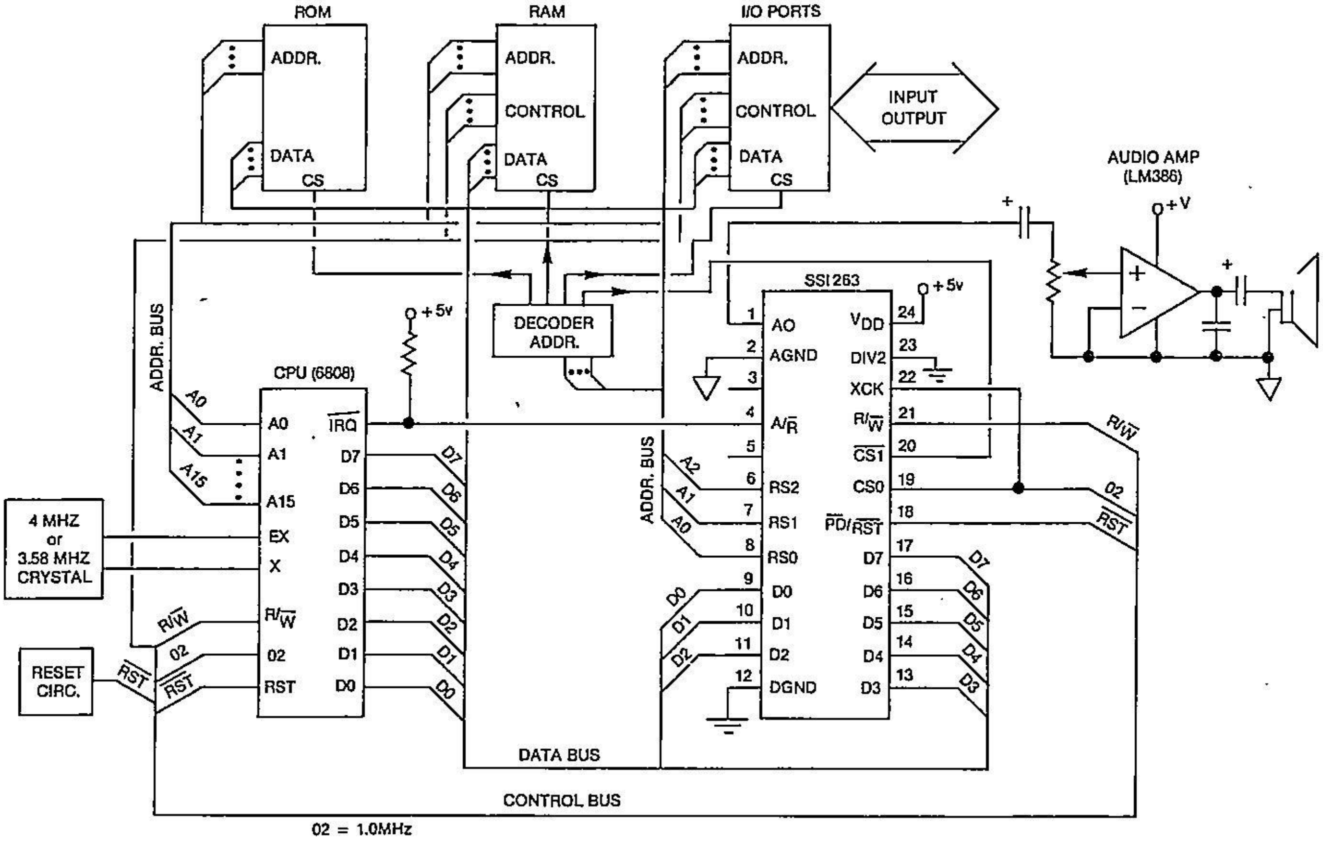
## TYPICAL MICROPROCESSOR IMPLEMENTATION



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# PHONEME CONVERSION CHART

| HEX CODE | PHONEME SYMBOL | EXAMPLE WORD |
|---|---|---|
| 08 | A | made |
| 09 | A1 | same |
| 0C | AE | dad |
| 0D | AE1 | after |
| 0E | AH | got |
| 0F | AH1 | father |
| 10 | AW | office |
| 05 | AY | made |
|  | (T,SCH) | (church) |
| 24 | B | bag |
| 25 | D | paid |
| 01 | E | meet |
| 02 | E1 | before |
| 3E | E2 | bitte |
| 0A | EH | nest |
| 0B | EH1 | belt |
| 1C | ER | bird |
| 34 | F | four |
|  | (KV,HVC) | (got) |
|  | (D,J) | (George) |
| 2C | HF | heart |
| 2D | HFC | (K) |
| 2E | HN | (m,n,ng) |
| 2A | HV | (finals) |
| 2B | HVC | (g) |
| 07 | I | six |
| 06 | IE | any |
| 14 | IU | you |
| 15 | IU1 | could |
| 31 | J | measure |
|  | (D,J) | (Judge) |
| 29 | K | kit |
| 26 | KV (HVC) | got |
| 20 | L | lift |
| 21 | L1 | allure |
| 3F | LB | lube |
| 22 | LF | fall |
| 37 | M | more |
| 38 | N | nine |
| 39 | NG | rang |
| 11 | O | store |
| 13 | OO | look |
| 12 | OU | boat |
| 27 | P | pen |
| 00 | PA | pause |
|  | (K,W) | (quick) |
| 1D | R | roof |
| 1E | R1 | rug |
| 1F | R2 | Mutter |
| 30 | S | same |
| 32 | SCH | ship |
| 28 | T | tart |
| 36 | TH | with |
| 35 | THV | there |
| 16 | U | tune |
| 17 | U1 | cartoon |
| 18 | UH | wonder |
| 19 | UH1 | love |
| 1A | UH2 | what |
| 1B | UH3 | nut |
| 33 | V | very |
| 23 | W | water |
|  | (K,S) | exit |
| 03 | Y | very |
| 04 | YI | year |
| 2F | Z | zero |
|  | (J) | (azure) |
| 3A | :A | Marchen |
| 3B | :OH | Lowe |
| 3C | :U | funf |
| 3D | :UH | bluhen |

## DIPHTHONG CONVERSION CHART

| PHONEME SEQUENCE | EXAMPLE WORDS |
|---|---|
| A AY Y | rain, became, stay |
| A IE EH1 UH3 LF | mail, hale, avail |
| AH1 AE1 EH1 Y | time, rhyme, sky |
| AH1 EH1 IE AW UH3 LF | smile, style, while |
| AH1 EH1 IE UH3 ER | fire, liar, inspire |
| UH3 AH1 Y | mice, right, sniper |
| O U | road, stone, lower |
| OU O O | tore, four, floor |
| AH1 AW O U | loud, flower, hour |
| UH3 AH1 O U | house, about, ouch |
| O UH1 AH1 I IE | boy, noise, annoy |
| O UH3 EH1 I OO LF | boil, spoil, doily |
| IU U U | tune, spoon, do |
| YI IU U U | you, few, music |

## MULTI-UNIT CONVERSION CHART

| PHONEME SEQUENCE | EXAMPLE WORDS |
|---|---|
| T HFC SCH | church, latch, |
| KV HVC HF | good, lag, angry |
| D J | just, ledge, wage |
| KV HF HFC | lake, corn, check |
| P HF | pipe, pay, poor |
| K HF W | quest, quick, aqua |
| T HF | top, trip, strain |
| HFC K HF HVC S | six, exit, taxi |

## COMPLETE WORD EXAMPLES FOR SSI263

### 1. HELLO:

| | | | | REGISTER VALUES | | |
|---|---|---|---|---|---|---|
| PHON | DUR | D/P | I | R/I | CTA | F |
| PA | .4 | 00 | 68 | A8 | 5C | E9 |
| PA | .4 | 00 | 68 | A8 | 5C | E9 |
| EH | .4 | 0A | 68 | D8 | 50 | E9 |
| HF | .3 | 6C | 60 | 78 | 54 | E9 |
| EH1 | .3 | 4B | 72 | D8 | 5C | E9 |
| UH3 | .2 | 9B | 84 | C8 | 5A | E9 |
| LF | .4 | 22 | 70 | C8 | 5A | E9 |
| UH3 | .2 | 9B | 3F | 98 | 5C | E9 |
| O | .2 | 91 | 2C | 98 | 5C | E9 |
| OU | .4 | 12 | 38 | A8 | 5C | E9 |
| U | .2 | 96 | 67 | C8 | 5A | E9 |
| U | .1 | D6 | 4F | 78 | 50 | E9 |
| PA | .4 | 00 | 2C | A8 | 5C | E9 |
| PA | .4 | 00 | 0C | A8 | 5C | E9 |
| PA | .4 | 00 | 08 | A8 | 5C | E9 |
| PA | .4 | 00 | 00 | A8 | 5C | E9 |

### 2. COMPUTERIZED

| | | | | REGISTER VALUES | | |
|---|---|---|---|---|---|---|
| PHON | DUR | D/P | I | R/I | CTA | F |
| PA | .4 | 00 | 36 | A8 | 5C | E9 |
| PA | .4 | 00 | 30 | A8 | 5A | E9 |
| KV | .4 | 26 | 30 | D8 | 50 | E9 |
| HFC | .3 | 6D | 30 | B8 | 50 | E9 |
| HF | .1 | EC | 28 | E8 | 5A | E9 |
| UH3 | .3 | 5B | 34 | E8 | 5A | E9 |
| M | .4 | 37 | 30 | A8 | 57 | E9 |
| P | .2 | A7 | 40 | 78 | 52 | E9 |
| HF | .1 | EC | 54 | C8 | 57 | E9 |
| IE | .3 | 46 | 50 | C8 | 55 | E9 |
| U | .2 | 96 | 62 | 88 | 5A | E9 |
| OU | .1 | D2 | 60 | 68 | 5A | E9 |
| W | .1 | E3 | 60 | E8 | 50 | E9 |
| D | .2 | A5 | 60 | E8 | 50 | E9 |
| HF | .1 | EC | 4E | D8 | 51 | E9 |
| IU1 | .1 | D5 | 48 | D8 | 56 | E9 |
| ER | .2 | 9C | 48 | A8 | 59 | E9 |
| R | .1 | DD | 40 | A8 | 5A | E9 |
| AH1 | .4 | 0F | 3C | A8 | 59 | E9 |
| EH1 | .1 | CB | 38 | C8 | 56 | E9 |
| Y | .3 | 43 | 38 | A8 | 55 | E9 |
| Z | .3 | 6F | 54 | A8 | 55 | E9 |
| D | .2 | A5 | 50 | A8 | 54 | E9 |

### 3. SPEECH

| | | | | REGISTER VALUES | | |
|---|---|---|---|---|---|---|
| PHON | DUR | D/P | I | R/I | CTA | F |
| PA | .2 | 80 | 50 | A8 | 56 | E9 |
| S | .3 | 70 | 36 | 88 | 58 | E9 |
| P | .3 | 67 | 30 | C8 | 54 | E9 |
| E | .3 | 41 | 42 | A8 | 59 | E9 |
| IE | .3 | 46 | 52 | A8 | 59 | E9 |
| T | .4 | 28 | 42 | A8 | 57 | E9 |
| SCH | .4 | 32 | 30 | A8 | 55 | E9 |

SPEECH CONTINUED

|  |  |  | REGISTER VALUES |  |  |  |
|---|---|---|---|---|---|---|
| PHON | DUR | D/P | I | R/I | CTA | F |
| PA | .4 | 00 | 28 | A8 | 50 | E9 |
| PA | .4 | 00 | 4C | A8 | 50 | E9 |

REGISTERS

| RS2 | RSI | RSO | SYMBOL | REGISTER NAME |
|---|---|---|---|---|
| LO | LO | LO | D/P | DURATION/PHONEME |
| LO | LO | HI | I | INFLECTION |
| LO | HI | LO | R/I | RATE/INFLECTION |
| LO | HI | HI | C/T/A | CONTROL/TRANSITION/AMPLITUDE |
| HI | X | X | F | FILTER FREQUENCY |