DECtalk DTC01

Owner's Manual

digital

DECtalk DTC01

Owner's Manual

digital	DECwriter	RSTS
DEC	DIBOL	RXS
DECmate	LA	UNIBUS
DECnet	MASSBUS	VAX
DECsystem-10	PDP	VMS
DECSYSTEM-20	P/OS	VT
DECtalk	Professional	Work Processor
DECUS	Rainbow	

TELEPHONE COMPANY AND FCC REQUIREMENTS AND RESPONSIBILITIES

FCC regulations require that you provide your local telephone company business office with the following information before you connect DECtalk to the telephone network.

- The particular line(s) to which terminal equipment will be connected (by telephone number)

- The make, model number, and FCC registration number (label on back of unit)

- The ringer equivalence for the registered terminal equipment (label on back of unit)

- The type of jack needed (if not already installed)

You must also notify the telephone company when you permanently disconnect terminal equipment from telephone line(s).

You may not connect terminal equipment to a party line or coin-operated telephone equipment.

If the telephone or telephone line is already equipped with a jack, you should be able to plug in DECtalk without any additional telephone company charge. Otherwise, the telephone company will install a jack, which usually results in a one-time installation charge.

Make: DECtalk
Model: DTC01-AA
Ringer equivalence: 0.3B
Type of jack: USOC RJ11C or USOC RJXA1 for telephone line interference
(refer to the *DECtalk DTC01 Installation Manual*).

If terminal equipment damages the telephone network, the telephone company can, after notifying the customer, temporarily discontinue service. However, when prior notice is not practical, the telephone company can temporarily discontinue service immediately. In such cases, the telephone company shall:

- Promptly notify customers that service has been discontinued

- Give customers the opportunity to correct the situation

- Inform customers of their right to bring a complaint to the FCC according to Subpart E of Part 68 of FCC Telephone Equipment Rules.

The DECtalk DTC01 unit is classified as terminal equipment.

CANADIAN APPLICATION NOTICE

The Canadian Department of Communications label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operational, and safety requirements. The department does not guarantee the equipment will operate to the user's satisfaction.

Before you install this equipment, make sure it is permissible to be connected to the local telecommunictions company's facilities. You must also install the equipment by using an approved connection method. In some cases, the company's inside wiring associated with single line individual service can be extended by a certified jack/plug/cord ensemble (telephone extension cord). Be aware that complying with the above conditions may not prevent degradation of service in some situations. Telecommunications company requirements do not allow you to connect their equipment to customer-provided jacks, except where specified by individual telecommunications company tariffs.

Only authorized Canadian maintenance facilities, designated by the supplier, should repair certified equipment. If you repair or alter certified equipment yourself, or if the equipment malfunctions, the telecommunications company has cause to ask you to disconnect the equipment.

You should ensure (for your own protection) that the electrical ground connections for the power utility, telephone lines, and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

CAUTION: Do not try to make such connections yourself, but contact the appropriate electric inspection authority or electrician, as appropriate.

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INTRODUCTION

DECtalk does not work by itself. It must be connected to a terminal, telephone, or computer. The *DECtalk DTC01 Installation Manual* describes connecting DECtalk to these devices. For more information on the computer, telephone network, or terminal being used, consult the *DECtalk DTC01 Programmer's Reference Manual* or the appropriate operating manual.

This manual provides information of interest to programmers and general users. It is divided into the following chapters and appendices.

- Chapter 1, How DECtalk Works, describes the DECtalk unit and gives an overview of how it operates.

- Chapter 2, Getting Started from a Terminal, introduces you to DECtalk communication and shows you some basic commands.

- Chapter 3, Setup Commands, explains how to change the DECtalk operating parameters to suit your particular application needs.

- Chapter 4, DECtalk Phonemics, describes the sound system of English and shows how you can correct pronunciation errors made by DECtalk to produce natural, human-sounding speech.

- Chapter 5, Modifying the Voices, shows you how to change the voices provided by DECtalk and how to create a new voice. It includes commands to change the speaking rate.

- Appendix A lists common abbreviations and acronyms understood by DECtalk.

- Appendix B lists common words that have two different pronunciations and explains how to produce the alternate pronunciation.

- Appendix C lists the pronunciation symbols used in two popular dictionaries and the corresponding DECtalk phonemes. Using one of the dictionaries and this appendix, you can enter a phonemic spelling for any word that DECtalk mispronounces.

- Appendix D gives service and ordering information.

- Appendix E lists some publications that go into more detail on linguistics and the inner workings of DECtalk.

HOW DECtalk WORKS 1

DECtalk is a text-to-speech converter that provides any computer with a human-sounding voice. You can enter the text from a host computer or a terminal keyboard connected to the unit. You can hear the resulting speech through the built-in speaker, a headset, external speakers with an amplifier, or a telephone. You can also display the spoken output on a monitor screen or print it in hardcopy form.

OPERATING MODES

DECtalk operates in one of three modes, on-line, off-line, and setup. Figure 1-1 shows how the three modes are related.

- In *on-line* mode, DECtalk communicates with a host computer. While on-line, the local terminal cannot directly interact with the DECtalk text-to-speech program or command processor. On-line mode is described in the *DECtalk DTC01 Programmer's Reference Manual*.

- In *off-line* mode, DECtalk acts as a standalone text-to-speech system, reading commands from the local terminal and speaking text as requested. Off-line mode is described in Chapters 2 through 5.

- In *setup* mode, DECtalk lets you set various internal parameters (such as communication line speeds). The setup command processor uses a prompt/request dialogue format. Setup commands are described in Chapter 3.

1
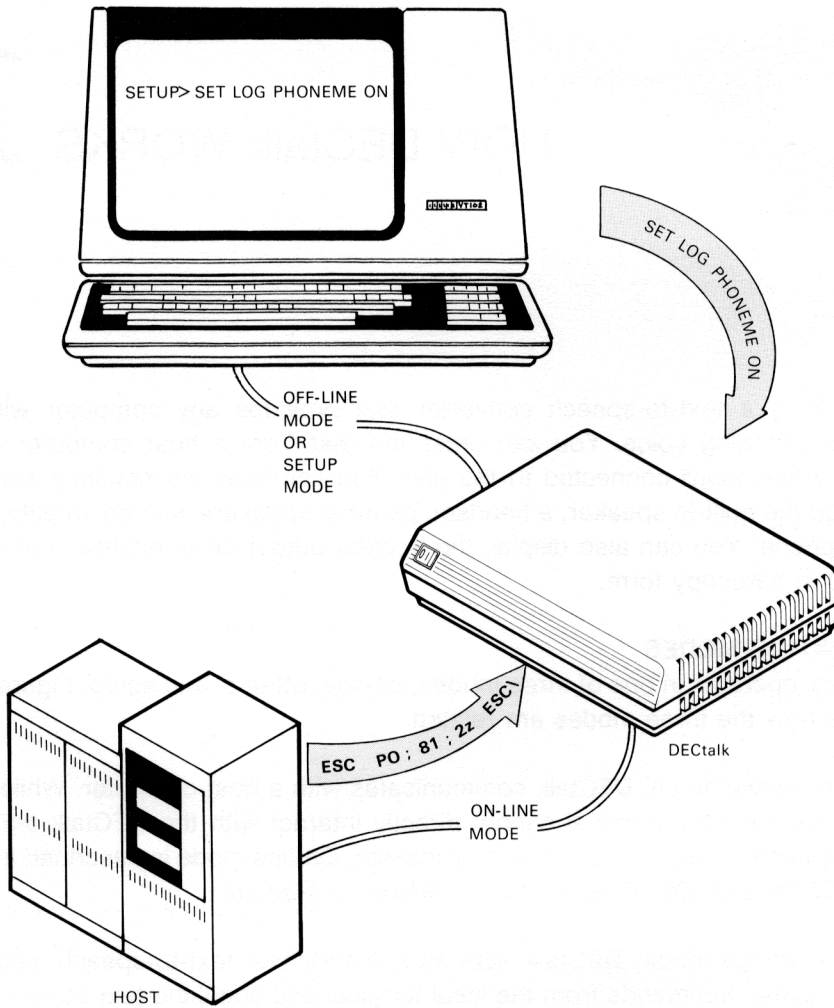
Figure 1-1   DECtalk Operating Modes

CONVERTING TEXT TO SPEECH

Text is converted into speech by a three-level process.

1. DECtalk accepts text from a terminal or host port and converts it from one special computer code into another. The text is in *ASCII format* when it enters DECtalk, and is converted to *phonemic code* for further processing.

    Phonemic code uses the phonemic alphabet, described in Chapter 4. Each symbol in the phonemic alphabet has only one pronunciation. DECtalk uses a large internal dictionary and the rules of English pronunciation to do the conversion.

2. The phonemic code is then converted into *synthesizer control commands*. In this level, several DECtalk internal filters are set to the correct pitch and timbre for the DECtalk voice.

3. Finally, the *speech synthesizer* uses the control commands to generate speech.

In levels 2 and 3, a synthesizer control command is generated every 6.4 milliseconds, and the digital signal processor sends a speech waveform value every 100 microseconds. This process generates "frames" of speech. DECtalk acts somewhat like a TV picture, in that these frames of speech are presented to the listener just as frames of pictures are presented to the viewer. In both cases, the frames appear to be one continuous, unbroken sequence.

In addition to the text-to-speech program, DECtalk contains software to control the host and local terminal ports (by interpreting and executing commands) and the telephone line interface. DECtalk has a startup self-test that automatically checks the unit each time you turn on the power.

Self-tests and tests with the remote loopback cable are described in the *DECtalk DTC01 Installation Manual* and the *DECtalk DTC01 Programmer's Reference Manual*.

DECtalk SOFTWARE PROGRAM

The three-level process described in the last section happens in nine program modules (Figure 1-2). Each module is described briefly in the following paragraphs.

Converting ASCII Text to Phonemic Code

1. A *sentence parser* breaks the input stream into separate words and locates some clause boundaries (such as commas and other pronunciation marks). The sentence parser also recognizes phonemic symbols and commands that you may have added to the input text. Phonemics are discussed in Chapters 4 and 5.

2. A *word parser* breaks compound words into their component parts, yielding words in their final pronounceable form. Strings of text that do not form English words are spelled out letter by letter.

3. A *number formatter* is used if the text contains numerals. The number formatter knows the rules for many common number formats and converts the numbers into English words by these rules. The number formatter also recognizes some abbreviations, such as ''lb.'' for ''pound(s).'' Refer to Appendix A for more information on number-speaking rules.

4. A *dictionary manager* searches the pronunciation dictionaries. DECtalk has a built-in dictionary of many commonly used words. In some cases a single spelling has two different pronunciations and DECtalk gives you a way to indicate which one to use in a particular sentence. The dictionary contains additional space where you may enter special words such as proper names, technical terms, and words that you want pronounced differently from the way DECtalk pronounces them. Chapter 3 of the *DECtalk DTC01 Programmer's Reference Manual* describes how to set up your own dictionary, and Appendix B lists words with more than one pronunciation.

```
            ┌──────────────────┐
            │       TEXT       │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐  SEPARATES CLAUSES BY PUNCTUATION,
            │     SENTENCE     │  ONE CLAUSE AT A TIME.
            │      PARSER      │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐  DIGIT STRINGS CONVERTED TO WORDS.
            │  WORD PARSER AND │  UNPRONOUNCEABLE SYMBOL STRINGS SPELLED OUT.
            │ NUMBER FORMATTER │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐  PHONEMIC REPRESENTATION
            │    DICTIONARY    │  FOR EACH WORD
            │      SEARCH      │  AND SYNTACTIC INFORMATION
            └──────────────────┘
                     │
                     ▼
                 ╱────────╲      NO
                ╱   WORD   ╲──────────────┐
                ╲  FOUND?  ╱              │
                 ╲────────╱               ▼
                     │ YES      ┌──────────────────┐  PHONEMIC REPRESENTATION
                     │          │ LETTER-TO-SOUND  │  FOR EACH UNFAMILIAR WORD
                     │          │ CONVERSION RULES │
                     │          └──────────────────┘
                     │                    │
                     │◀───────────────────┘
                     ▼
            ┌──────────────────┐
            │      PHRASE      │  DURATIONS, PITCH GESTURES, ALLOPHONES
            │  PRONUNCIATION   │
            │      RULES       │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐
            │ PHONEME TO VOCAL │
            │  COMMAND RULES   │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐
            │    SYNTHESIZER   │
            │ CONTROL COMMANDS │
            │   EVERY 6.4 MS   │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐  SINGLE PHONETIC STRING PLUS
            │  DIGITAL SPEECH  │  TIMING AND PITCH SPECIFICATION
            │    SYNTHESIZER   │
            └──────────────────┘
                     │
                     ▼
            ┌──────────────────┐  10,000 WAVEFORM SAMPLES PER SECOND
            │      SPEECH      │
            │     WAVEFORM     │
            └──────────────────┘
```

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Figure 1-2   Text-to-Speech Conversion

5. A *letter-to-sound* module uses a set of English pronunciation rules to assign phonemic form and lexical stress patterns to words not found in the dictionary.

   Refer to Chapter 4 for ways to modify the phonemic form of words, and Chapter 5 for special voice qualities (such as emphasis and singing).

6. A *phrase structure* module recombines all phonemic output from the dictionary search and other modules.

   This module looks for embedded punctuation to construct proper phrasing and intonation of the text (for example, a comma indicates that a slight pause should occur). As each recognizable clause is converted, it is passed to the phoneme-to-voice module. Refer to Chapter 5 for more information on adjusting emphasis and timing.

Converting Phonemic Code to Synthesizer Control Commands

7. The *phoneme-to-voice* module processes clauses passed from the phrase structure module and converts them to control signals for the speech synthesizer.

   This module modifies the clauses by changing the phonemes into parameters that determine the natural resonant frequencies of the vocal tract (formants), sound source, amplitudes, and so on.

8. *Synthesizer control commands* are sent to the *speech synthesizer* for output.

Converting Control Commands to Speech

9. The *digital speech synthesizer* computes a speech waveform with acoustic characteristics that are determined by the synthesizer control commands received.

HOW TO OPTIMIZE THE QUALITY OF SPOKEN TEXT

Sometimes it is important to make a few sentences sound very good because they are used often, for example, to open a dialogue with a customer. Usually DECtalk does a satisfactory job, but sometimes it mispronounces a word or gets the phrasing wrong. In these cases, you may wish to take the time to optimize the quality of one or several sentences. The following steps are recommended.

1. Type the sentence in local mode, then use the **CTRL-R** command (refer to the "Modifying DECtalk Text and Speech" section of Chapter 2) to listen repeatedly, focusing on each word in turn to detect any mispronunciations.

2. For each word that is mispronounced, you can use several methods to get the correct pronunciation.

   - If a word has two alternative pronunciations and DECtalk has chosen the wrong one, place a right parenthesis in front of the word to ask for the second pronunciation. (Refer to the "Verb Phrase Introducer" section of Chapter 4 and Appendix B, which lists the words with two pronunciations in DECtalk.) For example, type the following.

     ```
     I )read yesterday that . . .
     ```

   - Replace the correct spelling of the word by an intentional misspelling. (Refer to the beginning of Chapter 4.)

     ```
     I red yesterday that . . .
     ```

   - If the word is a compound, use a hyphen to help DECtalk recognize its two parts. (Refer to the "Compound Noun" section of Chapter 4.)

     ```
     I met the slide-show host.
     ```

   - Replace the English spelling with a phonemic string using the commands and phonemic symbols described in the "Vowel and Consonant Phonemes" section of Chapter 4. Check that the stress pattern is correct. (Refer to the "Stress and Syntax Markers" section of Chapter 4.) For example, instead of the word Cindy, you could type the following.

     ```
     [s'ihndiy]
     ```

3. Sometimes a word does not sound quite right even when you select the best alternative phonemic representation. Usually such subtle pronunciation faults are not correctable. However, if they are caused by incorrect phoneme durations, you can specify the duration of each phoneme individually using the commands described in the "Duration and Pitch" section of Chapter 4. This is a difficult procedure, and you should not try it until you have completed the other steps described here.

4. Now that each word has been pronounced in the best possible way, listen to the total sentence rhythm and accent pattern. If it is not right, try each of the following steps.

5. If you think there should be a short pause in a particular sentence location, but DECtalk says the sentence without a pause, try inserting a comma. (Refer to the "Clause Boundaries" section of Chapter 4.)

   `The old man, stares at everyone.`

6. If the comma makes a pause that is too noticeable, try a verb phrase boundary symbol instead. (Refer to the "Verb Phrase Introducer" section of Chapter 4).

   `The old man [)] stares at everyone.`

7. If the wrong word in the sentence is emphasized, indicate the word that should receive most emphasis by placing an emphatic stress symbol before it. (Refer to the "Emphatic Stress" section of Chapter 4.)

   `The ["]old man is the troublemaker, not the younger one.`

8. If none of these procedures results in a satisfactory sentence, you can specify duration and pitch individually for each phoneme using the commands described in the "Duration and Pitch" section of Chapter 4. If possible, you should use speech analysis equipment to study a recording of the way the sentence should sound.

CONVENTIONS USED IN THIS MANUAL

Terminals have many special keys in addition to the standard typewriter keys. These extra keys are not standardized. This section and Table 1-1 list the conventions for keys used in this manual. The keys in Table 1-1 appear in boldface type in this manual.

Table 1-1   **Keyboard Conventions and Key Use**

Key Name	Possible Alternates	Description
RETURN	ENTER EXECUTE NEWLINE	Carriage return key. Returns cursor to left side of screen. Also tells DECtalk that a line has been entered.
DELETE	RUB OUT DEL ⟨X⟩	Delete last character typed.
BACKSPACE	BS HYPH ←	Backspace key. On some computers, used to delete last character typed.
BREAK	ATTN	Break key. Tells DECtalk to enter setup mode.
CTRL-R	–	Repeat key. Redisplays on the terminal the last line typed into DECtalk. Pressing **RETURN** sends the line to DECtalk again. If the line was correctly terminated (with a period, question mark, or exclamation point), DECtalk speaks the line again.
CTRL-K	–	Terminates a clause if DECtalk is currently speaking phonemic text. Stops phonemic mode and returns DECtalk to normal text processing. This function is useful if you are not sure whether DECtalk is in text or phonemic mode.

Control Characters
Terminals have a special set of nonprinting characters called control characters.

Control characters are used to perform special functions. Table 1-1 lists the control characters that have special functions in DECtalk in off-line and setup modes.

Control characters are typed by holding down the **CTRL** key and pressing the correct letter. For example, to type the control character R hold down the **CTRL** key and type R.

Control keys are shown in this manual as **CTRL-n**, where n is the key to use. For example, the control character R is written as **CTRL-R** (pronounced ''control-R'').

Examples
Dot matrix type is used in this manual to show computer dialogue.

GETTING STARTED FROM A TERMINAL 2

The best way to learn to use DECtalk is to experiment with it – by typing on a terminal and listening to the spoken result. If you are reading this manual for the first time, you may find it helpful to have a terminal available and connected to the DECtalk local port. By using the examples in this manual (that is, actually typing them on the terminal), you can hear the result and get a better understanding of how DECtalk operates.

For more information on how to connect DECtalk to a terminal, refer to the *DECtalk DTC01 Installation Manual.*

CONNECTING DECtalk TO A TERMINAL

DECtalk powers up in on-line mode. (Refer to the "Operating Modes" section in Chapter 1.) To connect DECtalk and change to off-line mode, do the following.

1. Connect the terminal to the local DECtalk port (Figure 2-1). Digital Equipment Corporation recommends that you use a BC22D or similar interconnect cable.

2. Turn the terminal and DECtalk on.

   When DECtalk starts, it performs a self-test that takes about seven seconds and then says, "DECtalk version xxx is running" (xxx = a version of DECtalk firmware). If no sound results, check the volume control on the local speaker and restart DECtalk.
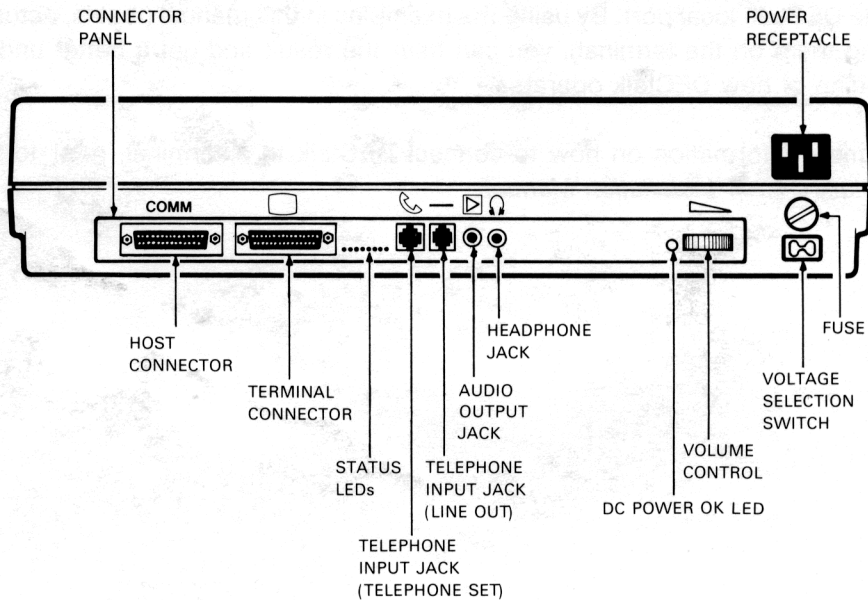
Figure 2-1   DECtalk/Terminal Connections

3. Check that the terminal is set to 9600 baud (the factory-set default baud rate for DECtalk).

   If the baud rate is not correct, or other problems happen, refer to the terminal owner's manual and the *DECtalk DTC01 Installation Manual.*

4. Press the **BREAK** key on the terminal. This places DECtalk in setup mode.

5. Type the OFFLINE command followed by **RETURN** to change to off-line mode. Then enter the commands shown in the following example. (Chapter 3 describes the setup commands.)

   BREAK

   `SETUP>OFFLINE`
   (Enter off-line mode.)

   `SETUP>SET LOG PHONEME ON`
   (Display phonemic text.)

   `SETUP>SET MODE SQUARE ON`
   (Let [ ] delimit phonemic text.)

   `SETUP>EXIT`
   (Exit setup mode.)

   `>`
   (DECtalk is waiting for something to speak.)

HEADPHONES AND AUXILIARY SPEAKERS

DECtalk comes with a built-in loudspeaker and volume control. You may wish to listen with headphones or connect DECtalk to a high-fidelity system.

You can connect headphones or an auxiliary speaker to the DECtalk unit through the headphone jack in the back of DECtalk. Plugging in the headphones or speaker turns off DECtalk's internal speaker.

You can connect an amplifier to DECtalk through the audio output jack. The output jack does not disconnect the DECtalk internal speaker. You can disable the internal speaker by turning down the DECtalk volume control.

DECtalk speech is easier to understand on a hi-fi system, especially if you set the bass control low.

TELEPHONE OUTPUT

You can make DECtalk work on a telephone line. Because of the limited frequency range of the telephone, speech heard over a phone line is not as clear as that heard through the DECtalk speaker. Keep this limitation in mind if you are preparing text for telephone transmission.

See the *DECtalk DTC01 Programmer's Reference Manual* for more information on DECtalk telephone communications.

ENTERING TEXT ON DECtalk

Unless otherwise advised by special commands, DECtalk assumes that everything you type at the keyboard is to be spoken. DECtalk processes what you type, but will not speak until

1. you type a period, comma, semicolon, colon, question mark, or exclamation point, followed by **RETURN**, or

2. DECtalk's internal buffers fill.

Type the following.

```
>The sum of $45.98 is too much to pay RETURN
>for a pair of shoes. RETURN
```

This results in DECtalk saying, "The sum of forty-five dollars and ninety-eight cents is too much to pay for a pair of shoes." The speech will begin after you type the period and second **RETURN**. (For more information on spoken numbers, refer to Chapter 4 and Appendix A.)

You do not need to wait for the speech to stop before typing more input text.

You can force internally buffered text to be spoken by pressing **RETURN** twice (adding a blank line). This is useful if you forgot to type a period before a carriage return.

When you enter a long string of words, DECtalk may have to begin processing the speech before it reaches a terminating punctuation mark to prevent overflowing the internal buffers. However, the limit is about 50 words, and most spoken sentences are much shorter. Extremely long words are also broken into smaller word pieces by DECtalk.

If you want to type in a long sentence, you can prevent DECtalk from speaking the sentence early by typing it as one line, without a carriage return or punctuation. (DECtalk has a built-in word wrap, and sentences that would go off the edge of the terminal screen are automatically "wrapped" to the next line.) However, if you embed a comma in the sentence, DECtalk may still begin speaking before the sentence is completed.

MODIFYING DECtalk TEXT AND SPEECH

This section describes how to correct typing and pronunciation errors, and how to add emphasis to DECtalk speech.

Correcting Typing Errors

You can correct typing mistakes before pressing the **RETURN** key.

- You can delete a single character with the **DELETE** or **BACKSPACE** keys.

- You can delete the entire line by pressing **CTRL-U**. When the line is erased, a new ">" prompt will appear.

Repeating a Line of Text

Sometimes you want to hear a sentence over without having to retype it. If you typed the sentence on a single line (no **RETURN** until the end of the sentence), you can recall it with the **CTRL-R** command. You will hear the sentence as soon as you type **RETURN**.

You can keep repeating the sentence, using **CTRL-R** and **RETURN**. You can edit the sentence before typing **RETURN** by erasing the unwanted text with the **DELETE** key and retyping it.

You can redisplay a line by typing **CTRL-R**. This lets you see a line you have just edited or redisplays the current line (useful on a hardcopy terminal).

>`Hello.` **RETURN**
(You type this line.)

`hxehl'ow.`
(DECtalk echoes when it speaks.)

>`CTRL-R`
(You type **CTRL-R**.)

>`Hello.`
(DECtalk retypes the line.)

>`RETURN`
(DECtalk repeats the spoken line.)

SETUP COMMANDS 3

Setup mode allows you to set the parameters for your unit, such as the transmission speed. Examples of some useful setup commands are given in the "Setup Command Examples" section.

Setup is available in off-line mode (connected to a local terminal) or on-line mode (connected to a computer). Refer to the *DECtalk DTC01 Programmer's Reference Manual* for information on using setup mode on-line.

SETUP COMMAND SYNTAX

A setup mode command consists of a sequence of words, separated by spaces and terminated by **RETURN**. You can always abbreviate a command word to its shortest unambiguous form.

When DECtalk is in setup mode, all local terminal input is processed one line at a time. No commands are processed until you press **RETURN**.

You can edit a single line before typing a carriage return. Table 1-1 lists the edit keys.

ENTERING SETUP MODE

When a terminal is connected to DECtalk, you enter setup mode by pressing the **BREAK** key. DECtalk will respond with the setup prompt.

> **> BREAK**

(You press the **BREAK** key from off-line mode.)

> SETUP>

(The setup prompt appears.)

Once you are in setup mode, you can give commands to change the DECtalk environment.

LEAVING SETUP MODE

You can return to off-line or on-line mode by typing the EXIT command.

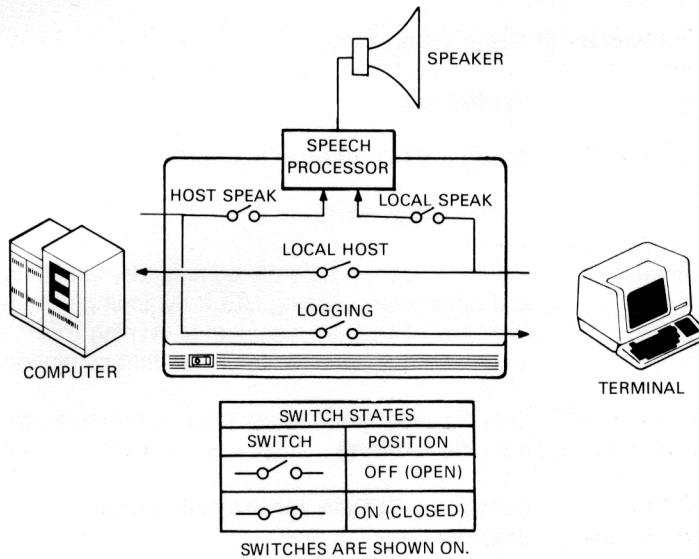> SETUP>EXIT

(Command to leave setup mode.)

> >

(Off-line mode prompt.)

Any commands you enter while in setup mode work after you type EXIT.

Figure 3-1 shows how the modes and commands are related.

To make any setup changes permanent, use the SAVE command, described in Table 3-1 and the ''SAVE'' section.

Figure 3-1   DECtalk Modes and Commands

SWITCH STATES

SWITCH	POSITION
—o⟋o—	OFF (OPEN)
—o–o—	ON (CLOSED)

SWITCHES ARE SHOWN ON.

SPEECH PROCESSOR COMMANDS

SET MODE SQUARE
SET MODE MINUS
SET MODE ASKY
SET LOG INHOST
SET LOG ERROR
SET LOG TRACE

LOGGING COMMANDS

SET LOG TEXT
SET LOG PHONEME
SET LOG RAWHOST
SET LOG OUTHOST

LOCAL SPEAK COMMANDS

SET LOCAL FORMAT
SET LOCAL SPEED
SET LOCAL HOST
SET LOCAL SPEAK
SET LOCAL EDITED
SET LOCAL HARDCOPY
SET LOCAL SPOKENSETUP

HOST SPEAK COMMANDS

SET HOST FORMAT
SET HOST SPEED
SET HOST SPEAK

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Table 3-1   Summary of Setup Commands

Command	Description
BREAK	Sends a short break to the host.
EXIT	Leaves setup mode.
HELP [command]	Provides help on DECtalk commands, functions, and parameters. Typing HELP by itself gives an overview of DECtalk commands. Typing HELP and a command gives information on that command.
LBREAK	Sends a long break to the host (shift-break on a VT100 terminal).
OFFLINE	Configures DECtalk for use with a local terminal.
ONLINE	Configures DECtalk for use with a host computer.
RECALL [memory]	Resets DECtalk parameters to the ones specified. The [memory] must be USER or FACTORY. If you omit [memory], the parameters in USER memory are used.
SAVE	Stores the current DECtalk setup parameters in USER memory. Since this command resets the startup parameters, use it carefully.
SET [parameter, parameter . . .]	Sets the DECtalk modes of operation. Separate each parameter by a comma. Table 3-2 lists the parameters.
SHOW [parameter]	Displays the value of a parameter. If the parameter has multiple values, all values are given. Table 3-2 lists the parameters.
TEST [test_code]	Runs DECtalk self-tests. [test_code] specifies which test to run. Table 3-3 lists the test parameters.

SETUP MODE COMMANDS

Table 3-1 lists the setup mode commands. The commands are described in detail in the paragraphs that follow.

All commands are actual words entered while in setup mode. For example, you type the word BREAK; you do not press the **BREAK** key.

BREAK

The BREAK command sends a short break (230 milliseconds) to the host.

EXIT

The EXIT command ends setup mode. DECtalk returns to off-line or on-line mode, depending on which mode was current before setup.

HELP

Use the HELP command when you need information about DECtalk functions or commands. Typing HELP without a specific command gives you a description of the HELP command itself. Specifying a command along with HELP gives you a description of that command. You can further specify a particular parameter; this gives you a description of that parameter. The following are examples of using the HELP command.

SETUP>HELP
(Describes the HELP command.)

SETUP>HELP SHOW LOCAL
(Describes the SHOW LOCAL command and gives parameters.)

SETUP>HELP SHOW LOCAL SPEED
(Describes the LOCAL SPEED parameter.)

SETUP>HELP SHOW LOCAL SPEAK ON
(Describes the SPEAK ON parameter.)

LBREAK

The LBREAK command sends a long break (3.5 seconds) (a VT100 shift-break) to the host.

OFFLINE

The OFFLINE command configures DECtalk for use without a host computer. In off-line mode, lines of text are read from the local terminal and sent to the DECtalk text-to-speech converter.

ONLINE

The ONLINE command configures DECtalk for use with a host computer. When you exit from setup mode, all characters typed on the local terminal are sent to the host line, and all characters received on the host line are spoken or executed as commands. Refer to the *DECtalk DTC01 Programmer's Reference Manual* for more information.

RECALL [memory]

The RECALL command recalls the DECtalk parameters from nonvolatile memory. The memory parameter specifies which memory to use. It must be either USER (the memory set by the SAVE command) or FACTORY (the read-only memory containing the factory defaults). If you omit the memory parameter, the USER memory is used.

SAVE

The SAVE command stores the current DECtalk parameters in the USER nonvolatile memory. When DECtalk is turned on, it will start with the values stored by SAVE.

Note: Using the SAVE command erases any parameters previously stored in USER memory.

SET

The SET command takes one or more parameters and lets you control a large number of DECtalk modes. Table 3-2 lists the parameters you may use.

Many SET parameters control flags that may be set on or off. For example, to log spoken phonemes on the local terminal, enter this command.

```
SETUP>SET LOG PHONEME ON
```

By abbreviating this command to the shortest form needed to prevent ambiguity, you can enter it as follows.

```
SETUP>SE LOG PH ON
```

Table 3-2   SET Command Parameters

Parameter	Subparameter	Description
LOG		Controls whether text received from the host is printed on the local terminal. Takes the following subparameters.
	TEXT	Prints all spoken text.
	PHONEME	Converts spoken text to its phonemic equivalent and then prints it on the terminal.
	RAWHOST	Transmits all data received from the host, including escape sequences, to the terminal in exactly the form in which it is received.
	INHOST	Prints all text received from the host, including escape sequences, on the terminal. First translates control characters to a readable form.
	OUTHOST	Prints all characters sent to the host at the terminal. Converts control characters to a readable form before printing.
		The readable form sometimes is as a mnemonic (ESC for escape) and sometimes as a caret-letter (^C for **CTRL-C**).
	ERROR	Prints all DECtalk error messages on the terminal.
	TRACE	Works like INHOST, except that escape sequences are first converted into their symbolic meaning before printing.

Table 3-2   SET Command Parameters (Cont)

Parameter	Subparameter	Description
HOST FORMAT		Sets the communications line protocol for the host line. Takes a required subparameter as follows.
	EVEN	The line sends and receives even parity.
	ODD	The line sends and receives odd parity.
	NONE	Parity is ignored on the host line.
HOST SPEED		Sets the speed of the host terminal line. Speed values are as follows. 75/1200, 110, 150, 300, 600, 1200, 2400, 4800, 9600 It is recommended that you set the line speed to at least 1200 baud. Speeds less than 300 baud will not supply text to the text-to-speech system quickly enough for natural speech. The factory default value is 1200 baud.
HOST SPEAK		Determines whether DECtalk speaks text transmitted from the host computer. The default setting is on.
LOCAL		Sets the characteristics of the terminal, DECtalk, and the host connection. Takes a required subparameter and a switch (on or off) as follows.
	HOST	When on, characters typed on the local terminal are transmitted to the host computer.
	SPEAK	Characters typed on the local terminal are spoken by DECtalk. (Note that they will be interspersed with characters sent from the host.)

Table 3-2   SET Command Parameters (Cont)

Parameter	Subparameter	Description
	EDITED	Text entered from the local terminal is processed one line at a time. Editing control characters (such as **DELETE** and **CTRL-R**) are processed as described in Chapter 1.
	HARDCOPY	Causes text to be echoed on the local terminal in a way appropriate for hardcopy terminals. When off, echoing is appropriate for video display terminals.
	SPOKENSETUP	Controls whether DECtalk speaks the setup dialogue.
LOCAL SPEED		Sets the baud rate of the local terminal. The speed values are as follows.
		75/1200, 110, 150, 300, 600, 1200, 2400, 4800, 9600
		If you connect DECtalk to a computer, the local speed should be at least as high as the host speed. The factory default setting is 9600 baud.
LOCAL FORMAT		Sets the communications line protocol for the local line. Takes a required subparameter as follows.
	EVEN	The line sends and receives even parity.
	ODD	The line sends and receives odd parity.
	NONE	Parity is ignored on the local line.

Table 3-2   SET Command Parameters (Cont)

Parameter	Subparameter	Description
MODE		Sets how DECtalk processes text. The subparameter listed may be set on or off.
	SQUARE	Treat square brackets ([ ]) as phonemic text delimiters. Also, let ''\)'' before a word select an alternative pronunciation from the built-in dictionary. Appendix B lists the words with alternate pronunciations.
	ASKY	Use single-letter phonemic translation instead of the multiletter ARPAbet translation.
	MINUS	The ''-'' character is normally spelled out as ''dash.'' When this subparameter is on, it is pronounced ''minus.''
INTERRUPT [char]		Specifies that you can use [char] in addition to **BREAK** to halt DECtalk. The INTERRUPT OFF command removes the special character.

SHOW

The SHOW command displays the current setting of a DECtalk parameter. If the specified parameter refers to a class of parameters, then all the parameters in the class are displayed.

Parameters are displayed in the same format as the SET command. For example, the following line displays all SET LOG parameters.

```
SETUP>SHOW LOG
LOG TEXT IS OFF
.
.
.
```

The SHOW command can display the state of the following SET commands (Table 3-2).

LOG
LOCAL
HOST
MODE

TEST [test_code]
The TEST command runs DECtalk self-tests. The test_code specifies the test to run (Table 3-3).

The LDATA test works only when DECtalk is connected to a host computer. It cannot be run off-line through a terminal.

To run the HDATA and HCONTROL tests, you must attach a loopback connector to the host line. Refer to the *DECtalk DTC01 Installation Manual* for more information.

You may also have to set other mode switches during testing, such as SPOKENSETUP or SPEED.

Table 3-3   TEST Command Parameters

Option	Description
POWER	Power-up self-test.
HDATA	Host line data loopback test. Data is sent and received through the host port and checked for correctness.
HCONTROL	Host line control loopback test. Control commands are sent and received through the host port and checked for correctness.
LDATA	Local line data loopback test. Data is sent and received through the local (terminal) port and checked for correctness.
SPEAK	Speaks a built-in test message.

DEBUGGING

Using setup mode, you can control a variety of built-in debugging features that will simplify application development. For example, you can display host and telephone interaction on the local terminal in a variety of ways.

- All characters received from the host
- All characters sent to the host
- Escape sequences (by name)
- Phonemic text (after letter-to-phoneme conversion)
- Errors (unknown phonemes, control characters)

SETUP COMMAND EXAMPLES

This section shows several setup commands used in combination to configure DECtalk for special operations and purposes. These examples all assume that you have given a SET LOG command.

Figure 3-1 shows the setup commands used by DECtalk in local mode.

Speech Debugging

When using DECtalk to develop an application, the programmer begins debugging by entering the following setup commands.

```
SETUP>SET MODE SQUARE ON
SETUP>ONLINE
SETUP>EXIT
```

Setting MODE SQUARE on lets you transmit phonemic text using square bracket delimiters. This command also enables selection of correct pronunciation for the words listed in Appendix B.

While debugging the application, the programmer may wish to log text and escape sequence commands as follows.

```
SETUP>SET LOG TEXT ON
SETUP>SET LOG OUTHOST ON
SETUP>SET LOG ERROR ON
SETUP>SET LOG TRACE ON
```

This logs text that is to be spoken, all characters sent by DECtalk to the host computer, error messages, and interpreted escape sequences. While debugging the application, the programmer also logs telephone interaction.

While testing the application, the programmer may discover that escape sequences are not being interpreted as the programmer intended, either by DECtalk or by the host computer. To find the location of the error, the programmer extends this debugging mode to see all characters sent from the host as follows.

```
SETUP>SET LOG TEXT OFF
SETUP>SET LOG INHOST ON
```

If you set text logging off, DECtalk will not display spoken text twice.

Inhost logging is useful to see if line speed (or line quality) problems are destroying data.

When the communications problems have been solved, the programmer may wish to tune DECtalk's output for the best possible speech quality. The following commands are given.

```
SETUP>SET LOG INHOST OFF
SETUP>SET LOG TRACE OFF
SETUP>SET LOG OUTHOST OFF
SETUP>SET LOG TEXT ON
SETUP>SET LOG PHONEME ON
```

Figures 3-2 and 3-3 show how the internal logic paths of DECtalk are configured when these commands are entered.

The spoken text and its phonemic translation are now logged. (Errors are still being logged.) The programmer now tunes the application for the best quality speech and, before releasing the application for production, removes logging and saves these parameters in DECtalk's nonvolatile memory.

```
SETUP>SET LOG TEXT OFF
SETUP>SET LOG PHONEMIC OFF
SETUP>SET LOG ERROR OFF
SETUP>SAVE
```
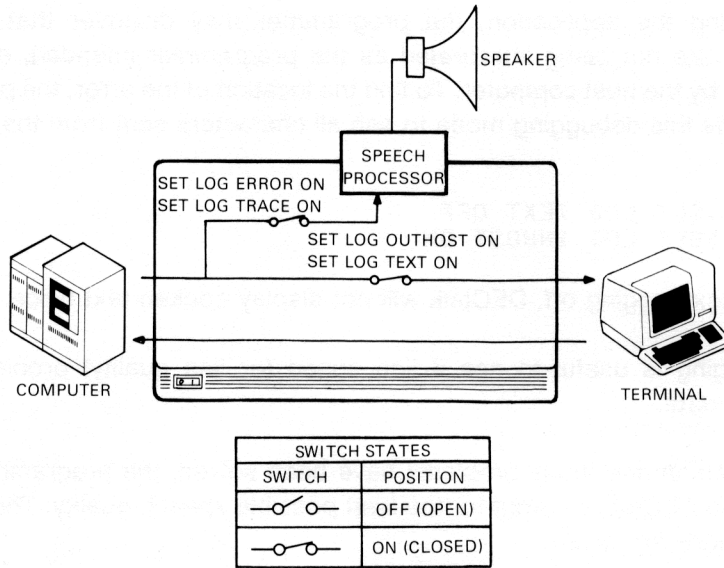
Figure 3-2   Debugging Setup: Logging DECtalk Actions
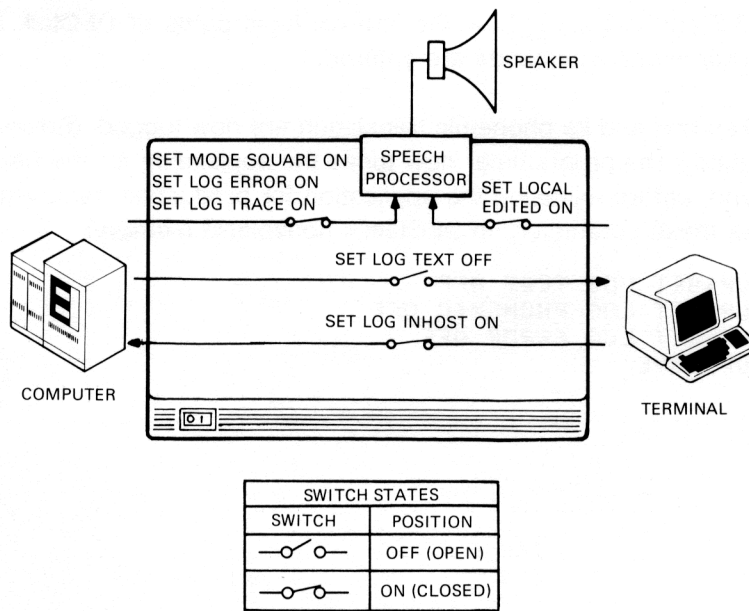
Figure 3-3   Debugging Setup: Logging Spoken Text

DECtalk As a Workstation for a Blind Professional

When DECtalk is used to deliver speech to a worker with a visual disability, it acts as a "line splice" in the terminal-to-host communication path. The terminal is connected to DECtalk's local port, and the host computer is connected to the remote port. The setup modes are selected as follows.

SETUP>ONLINE
(Link DECtalk to the host computer instead of the local terminal.)

SETUP>SET MODE SQUARE OFF
(Type all input exactly as received, since the user does not directly control DECtalk.)

SETUP>SET HOST SPEAK ON
(DECtalk will say all text sent from the host.)

SETUP>SET LOCAL SPEAK ON
(DECtalk will say all text typed at the terminal. If the host echoes received text, this command is not needed.)

SETUP>SAVE
(Store these parameters in DECtalk.)

Figure 3-4 shows the internal configuration and logical setup of DECtalk as a speaking terminal workstation.
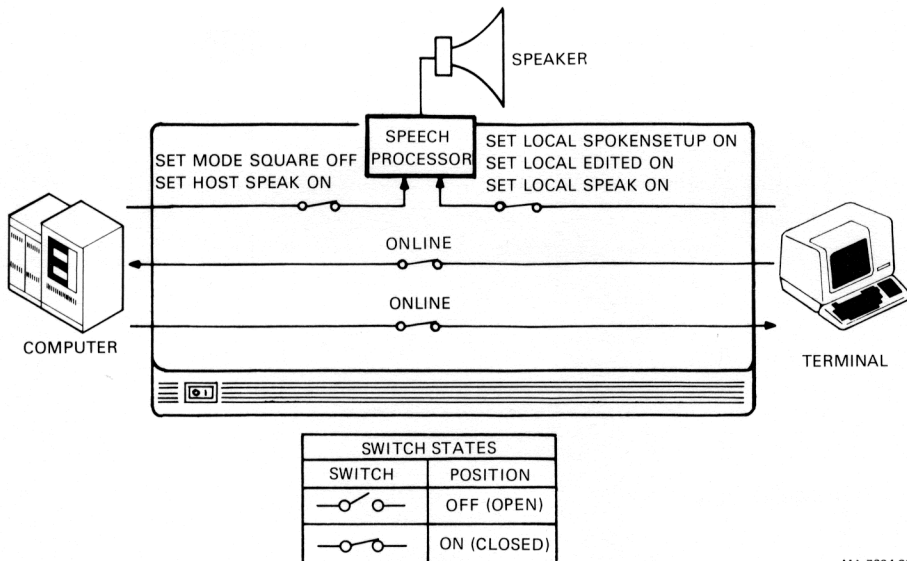
Figure 3-4   DECtalk Set Up as a Speaking Terminal

DECtalk PHONEMICS 4

Most users do not need to know anything about DECtalk phonemics. However, in order to understand how DECtalk works and to make it correctly pronounce any English word, you need to know something about speech sounds and how to represent them on a keyboard. Since spelling in English does not always show exactly how words are pronounced, dictionaries use symbols to show how words really sound. Sometimes these symbols are the same as letters used in spelling. A word written the way it is pronounced is said to be written in *phonemic transcription.*

PRONUNCIATION ERRORS

DECtalk tries to pronounce all the text it receives according to the rules of English pronunciation and punctuation. DECtalk also knows the rules of many special cases of pronunciation and tries to follow all the rules and exceptions.

DECtalk knows how to pronounce many words, but if it is unfamiliar with a word, it has to guess at its pronunciation. If it gets a word wrong and the error is serious enough that you want to correct it, there are three ways to do this.

1. Change the input text to "misspell" the word in a way that sounds correct.

    >Thomas.
    (Mispronounced [th'aamaxz].)

    >Tomass.
    (Correct pronunciation.)

    An appropriate misspelling may not be easy to find. In some cases, no satisfactory misspelling exists.

2. Enter the word as a string of phonemes.

    >[t'aamaxs] Edison.

3. If your DECtalk unit is under computer control, you can enter the word and its correct pronunciation into the user dictionary. You can only load the user dictionary through a computer application program. The *DECtalk DTC01 Programmer's Reference Manual* describes how to create and load a user dictionary.

INTRODUCTION TO PHONEMIC THEORY

At one time long ago, English was pronounced as it was spelled, with each letter (or pair of letters) representing one sound, or *phoneme*. Because of historical sound changes (such as the dropping of sounds like the "gh" of "bought") and word borrowing from other languages, English pronunciation rules have become complex and include many exceptions.

For example, "of" is pronounced with a *v* sound, while all other English words spelled with "f" are pronounced with an *f* sound. The vowel digraph "ea" can be pronounced in at least a half-dozen different ways, as illustrated by the sounds in the words "cheap," "head," "earth," and "cochlea." The letters "th" can be pronounced with a voiceless phoneme, as in "thin"; or with a voiced phoneme, as in "the"; or the "th" can represent the *t* phoneme followed by the *h* phoneme in compound words such as "outhouse."

Figure 4-1 shows how English phonemes are classified by linguists, according to how the speaker forms them.
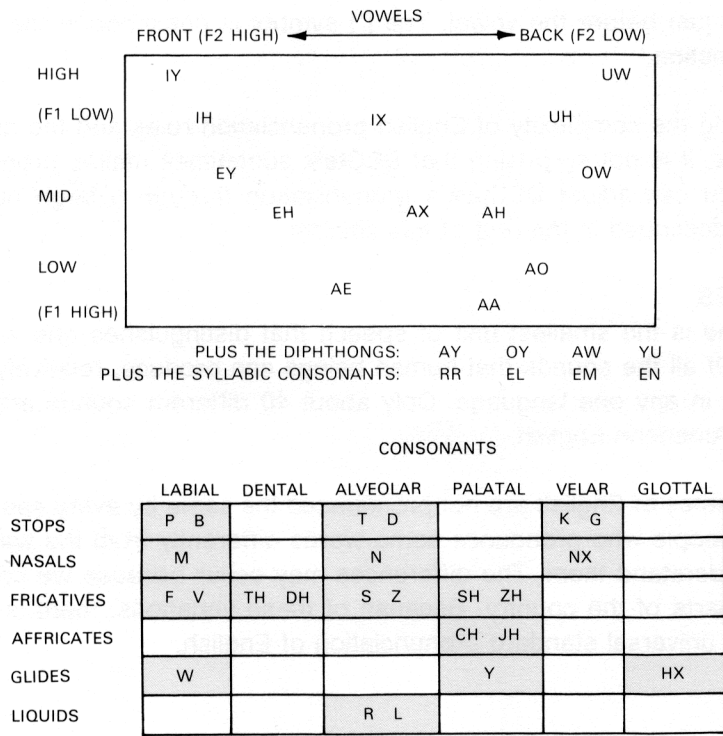

Figure 4-1   Phonemes Classified by Their Position in the Mouth Cavity

Some words have two pronunciations, for example, "read." Correct pronunciation of a sentence such as "Will you read the book or have you read it already?" requires understanding the meaning of the sentence – a task beyond DECtalk's capability. Therefore, DECtalk speaks words with alternate pronunciations by choosing the most frequently used pronunciation.

You can give the alternate pronunciation in several ways.

- By misspelling the word: "red" for "read"

- By phonemic spelling: [r''ed]

- By using the alternate pronunciation symbol [)], as described in the "Verb Phrase Introducer" section.

Stress is an important part of phonemic representation. Stress alone gives the two different pronunciations of words like "insert." English words usually have one syllable that is spoken with more emphasis than the other syllables in the word. You can indicate this emphasis to DECtalk by placing the phonemic symbol ['] just before the vowel. The ['] symbol is described in the "Primary Stress" section.

Considering the complexity of English pronunciation rules and the number of exceptions, it is not surprising that DECtalk sometimes makes pronunciation errors. You can adjust DECtalk's pronunciation through a large number of symbols, described in the rest of this chapter.

PHONEMES

A phoneme is the smallest unit of speech that distinguishes one word from another. Of all the sounds that human beings can produce, relatively few are significant in any one language. Only about 40 different sounds are used in standard American English.

The phonemes of English are not pronounced the same by every speaker. We all know people who pronounce some words differently from the way we do, yet we understand them. The differences may occur because we come from different parts of the country. Because of these variations, there is no such thing as a universal standard pronunciation of English.

DECtalk will pronounce a phoneme in only one standard way, so that it is not possible to imitate all English dialects (although some dialectical differences can be approximated by phonemic spelling).

Tables 4-1 and 4-2 list the symbols used in DECtalk and the sounds they represent. These tables contain all the sound distinctions needed for talking in English. Linguists normally prefer to list phonemes according to how they are produced, as shown in the diagrams in Figure 4-1. However, the symbols in Tables 4-1 and 4-2 are alphabetized for ease of use for the nonlinguist DECtalk user.

Sounds tend to be influenced by other sounds near them, a process called *assimilation*. For example, the *t* sound in water tends to sound like a *d* because it is between two vowels, the second unstressed. DECtalk uses an extensive set of pronunciation rules to produce these subtle differences in pronunciation. Because the rules are so complex, they are an internal feature of DECtalk not available to the DECtalk user.

Table 4-1   English Vowel Phonemes

	2-Char Symbol	1-Char Symbol	Example	2-Char Symbol	1-Char Symbol	Example
Vowels	aa	a	b*o*b	ih	I	b*i*t
	ae	@	b*a*t	iy	i	b*ee*t
	ah	^	b*u*t	ow	o	b*oa*t
	ao	c	b*ou*ght	uh	U	b*oo*k
	eh	E	b*e*t	uw	u	b*oo*t
	ey	e	b*ai*t			
Unstressed Vowels	ax	x	*a*bout	ix		Denn*i*s
Dipthongs	ay	A	b*i*te	oy	O	b*oy*
	aw	W	b*ou*t	yu	Y	bea*u*ty
Syllabic Consonants	rr	R	b*ir*d	el	L	bott*le*
	em	M	rans*om*	en	N	Mart*in*

Table 4-2   English Consonant Phonemes

2-Char Symbol	1-Char Symbol	Example	2-Char Symbol	1-Char Symbol	Example
b	b	*b*in	p	p	*p*in
ch	C	*ch*in	r	r	*wr*en
d	d	*d*in	s	s	*s*in
dh	D	*th*is	sh	S	*sh*in
f	f	*f*in	t	t	*t*in
g	g	*g*ift	th	T	*th*in
hx	h	*h*en	v	v	*v*an
jh	J	*j*am	w	w	*w*in
k	k	*k*in	y	y	*y*en
l	l	*l*en	z	z	*z*en
m	m	*m*et	zh	Z	a*z*ure
n	n	*n*et	—	—	(silence)
nx	G	si*ng*			

VOWEL AND CONSONANT PHONEMES

Linguists have identified 17 vowel phonemes and 24 consonant phonemes in English, all of which are recognized by DECtalk. Table 4-1 lists the vowels, and Table 4-2 lists the consonants.

DECtalk uses a two-character symbol for each English phoneme. DECtalk also recognizes a one-character system of representing phonemes. Using the one-character system is discouraged, because it is not widely used and may not be supported in future releases of DECtalk. You can set DECtalk to the one-character system by a command described in the "Changing to One-Character Mode" section.

Dictionaries use other methods of representing pronunciation (usually with symbols over the words, and accent marks). You can convert dictionary phonemic markings into DECtalk phonemic symbols using the guidelines in Appendix C.

Vowels

When linguists want to set up a phonemic system for English, they must decide whether to represent vowels by sound or spelling analogies. DECtalk uses a sound-based, two-character system. This is the default phonemic symbol system and the recommended sound representation for DECtalk. It takes time to get used to the symbols for vowel phonemes, but once you learn them you can easily apply them when correcting pronunciation errors. Table 4-1 lists the phonemic vowels used by DECtalk.

Consonants

Because there is little difference between the spelling and pronunciation of consonants, their phonemic representation is fairly simple. There are a few exceptions: some English consonants are represented by combining two letters. Table 4-2 lists the phonemic consonants used by DECtalk.

DECtalk speaks an English dialect that does not distinguish between voiced and voiceless w, so that words like "which" and "witch" are pronounced alike as [w'ihch].

The letter "g" can be pronounced in two ways. In words like "gift," the consonant phoneme g is used. In words like "gin," the affricate phoneme jh is used.

Syllabic Consonants

Words like "butter," "bottle," "bottom," and "button" end in consonants that act as vowels in that they form syllables by themselves. These are called *syllabic consonants*. A word such as "button" sounds better if you represent it [b'ahten] rather than [b'ahtaxn].

The Silence Phoneme [_]

DECtalk automatically inserts a silence (brief pause) whenever punctuation appears in the text. The phonemic silence symbol [_] is useful for controlling silences while in phonemic mode. Silences and other pauses are described in more detail in the "Duration and Pitch" section.

CHANGING TO ONE-CHARACTER MODE

DECtalk uses the two-character system as the default sound representation and recognizes phonemic symbols in uppercase or lowercase. If you want to use the one-character system shown in Tables 4-1 and 4-2, enter the following commands.

```
>BREAK
SETUP>SET MODE ASKY ON
SETUP>EXIT
```

Only one mode is active at a time. You cannot type two-character phonemes in one-character mode, or the reverse.

To return to two-character mode, type the following commands.

```
>BREAK
SETUP>SET MODE ASKY OFF
SETUP>EXIT
```

STRESS AND SYNTAX MARKERS

Although vowel and consonant phonemes specify the sound composition of words, they do not convey the emphasis and flow of spoken words. The stress and syntax symbols add these features. Some examples of stress and syntax markings were shown in the "Introduction to Phonemic Theory" section.

Written words do not indicate emphasis. Punctuation marks, such as commas, periods, question marks, and exclamation points, help to suggest proper phrasing. The stress and syntax markers also add character and meaning to spoken words. In most cases, the stress and syntax markers are necessary for correct intonation.

Table 4-3 lists the stress and syntax markers. They are described in the sections that follow.

Table 4-3   Symbols Used to Indicate Stress and Syntax

Symbol	Explanation
Stress Symbols	
'	Primary stress ("butter" = [b'ahtrr])
`	Secondary stress
''	Emphatic stress
Syntax Symbols	
-	Syllable boundary
*	Morpheme boundary
#	Noun compound boundary ("pothole" = [p'aat#h'owl])
SPACE	Word boundary ("the ball" = [dhax b'aol])
)	Beginning of verb phrase
,	End of clause, same as written comma (forces output)
.	End of declarative sentence (forces output)
?	End of question (forces output)
!	End of exclamation (forces output)

Primary Stress [']

All content words of English (nouns, verbs, adjectives, and adverbs) contain one primary stressed syllable. DECtalk represents primary stress syllables with an apostrophe ['] placed before the sressed vowel phoneme of the word as in the following example.

>[bahtrr].
(No stress, flat intonation, too rapid.)

>[baht'rr].
(Stress on wrong syllable – "butt*er*.")

>[b'ahtrr].
(Correct stress – "*butt*er.")

Secondary Stress [`]

The secondary stress symbol [`] is used to indicate a degree of stress that is between full primary stress and unstressed. Secondary stress is appropriate in the following cases.

- To highlight the next strongest syllable of polysyllabic words, such as "demonstration."

    ```
    >[d`ehmaxnstr'eyshaxn].
    ```

- On second parts of compounds, as in "pushover."

    ```
    >[p'uhsh#`owvrr].
    ```

- In the strongest syllable of polysyllabic function words, as in "after."

    ```
    >[`aeftrr].
    ```

DECtalk produces secondary stress by lengthening the vowel sound more than unstressed but less than primary stress. However, even this small change can be too much. In most cases, it is better to leave out the secondary stress symbol.

Emphatic Stress ["]

The emphatic stress symbol ["] can be placed before any vowel to give emphasis to that syllable of the word. Good readers of English text understand the message of the sentence well enough to pick out the most important word and emphasize it. DECtalk merely pronounces words; it does not understand the sentences it is saying. DECtalk cannot place emphasis on words to give a completely different meaning to the sentence unless you use the emphatic stress symbol. Here is an example.

```
>Dennis loves Mary.
```
(Usual "neutral" pronunciation.)

```
>[d"ehnihs] loves Mary.
```
(*Dennis* (not Frank) loves Mary.)

```
>Dennis loves [m"ehriy].
```
(Dennis loves *Mary* (not Jill).)

The exclamation point has the same effect in a one-syllable sentence.

```
>Help!
```

Unstressed Syllables

DECtalk stresses only one vowel phoneme in a word. All other vowels are unstressed (they are spoken with no emphasis). Spoken English tends to follows a stressed/unstressed sentence rhythm, and most English sentences are spoken in this way.

This is partly because English contains a set of words that are always unstressed, called *syntactic function* words. These include the following.

- Prepositions (for, over)
- Conjunctions (and, but)
- Determiners (the, some)
- Auxiliary verbs (is, has)
- Pronouns (her, myself)
- Clause introducers (complementizers) (which, that)

These words have no stress symbols in their dictionary entries. It is sometimes necessary to emphasize a function word that is stored in DECtalk's dictionary without stress. You can do this by including a primary stress symbol or an emphatic stress symbol in the phonemic transcription as in the following example.

```
>He went ['owvrr] the fence, not under it.
```

Word Boundaries

Any whitespace character (**SPACE**, **TAB**, or **RETURN**) in the text you enter indicates a word boundary. DECtalk uses word boundary symbols to help select the word-beginning or word-ending version of a phoneme.

Some host computers automatically insert **RETURN** into lines that are too long (and would go off the edge of the screen or paper). This may cause DECtalk to pronounce text incorrectly. You can prevent this problem by breaking long sentences with **RETURN** at an appropriate place.

Syllable Boundaries [-]

DECtalk uses a set of rules to determine where words break into syllables, so that consonants within words are assigned to their correct syllable. Use the phonemic symbol [-] to tell DECtalk where to assign the consonants within ambiguous words. (This type of error is rare in DECtalk.)

Morpheme Boundaries [*]

Many English words are made up of meaningful pieces called *morphemes*. For example, "spell" has only one morpheme, while "misspelling" is made up of three: "mis," "spell," and "ing."

In most cases, the pronunciation of a word does not depend on morpheme boundaries. There are exceptions, however, and then the morpheme boundary symbol [*] can force the correct morpheme boundary to be recognized. For example, "misspelling" should be pronounced with a double "s." Adding the morpheme boundary symbol improves the pronunciation of the word.

```
>misspelling.
mixsp'ehlixnx
```
(The single "s" is too short.)

```
>[mixs*sp'ehlixnx]
```
(Better.)

Compound Noun [#]

Compound words, such as "baseball," should have less stress on the second word and should be spoken as two words rather than one. DECtalk's dictionary includes an extensive list of compound words. You can use the compound noun stress symbol [#] to correct words that are not in the dictionary. For example, for "sideache," type the following.

```
>[s'ayd#eyk].
```

Using a hyphen in compound words produces the correct pronunciation most of the time. You rarely need the [*] and [#] symbols.

SENTENCE PHRASING AND SYNTACTIC STRUCTURE

Correct speech is more than just stringing together a series of words. The meaning of a sentence is carried by the words, plus rhythm, stress, and intonation (pitch change). We recognize a question by the rising intonation of the voice, while a statement of fact is usually accompanied by falling intonation. A speaker can give certain words in a sentence more importance by adding stress (loudness and length) to them. Pitch often reveals the emotional state of the speaker. For effective communication, we need to consider these expressive features as well as the verbal features of speech.

DECtalk uses syntactic symbols to represent rhythm and intonation patterns. Orthographic symbols, such as commas, periods, and exclamation marks, are recognized by DECtalk as marking special phrasing requirements. The following sections and Table 4-3 show how you can use orthographic and phonemic symbols to augment this information.

As any good actor knows, punctuation alone is not enough to indicate the full meaning of a sentence. Some fine points of expression cannot be indicated by using orthographic and phonemic symbols. Full control of the expression of a sentence is gained by directly changing the duration and pitch of words and phrases. These direct control techniques are discussed in the ''Duration and Pitch'' section.

Period [.]

A sentence is usually a single, complete thought. It is also the longest utterance that you can comfortably speak in one breath. DECtalk inserts a pause when it finds a period that marks the end of the sentence, duplicating the human speaker's pause to take a breath.

The [.] symbol also tells DECtalk to begin speaking. DECtalk will not speak a phrase until it finds a comma or sentence terminator. DECtalk also tests each period to make sure that it is not part of a known abbreviation.

CTRL-K also ends a phrase, causing DECtalk to process (and speak) the phrase. Use **CTRL-K** to stop speech when DECtalk is not pronouncing words correctly, for example, because phonemic mode is on.

Question Mark [?]

The simplest way to signal a question in English is by a rising tone at the end of a sentence. Although true question intonation is not that simple, the rising tone is all that DECtalk does to indicate a question. The pattern of intonation depends largely on the meaning of the question, but DECtalk does not understand the sentences it is pronouncing.

There are many cases in English where a question tone is not used, even though the sentence ends with a question mark.

- Rhetorical questions or quotations may contain a question mark, but the speaker ends with a period (falling tone).

- Sentences that begin with "wh" words usually end with a falling tone, even if they are questions.

Although DECtalk is smart enough to recognize "wh" questions and speak them correctly, you should send question marks to DECtalk only when the statement really is a question. Here are some examples.

```
>Laura ate her broccoli?
```
(DECtalk asks a question.)

```
>What time is it?
```
(DECtalk recognizes "wh" and does not ask a question.)

```
>I asked when could he come?
```
(Wrong: DECtalk asks a question.)

```
>I asked when could he come.
```
(Correct: question tone removed.)

Exclamation Point [!]

Exclamations are short statements spoken with special emphasis. DECtalk interprets an exclamation point to mean that the last stressed syllable in the sentence should have extra emphasis.

```
>Stop!
```

Long sentences ending with an exclamation point typically have a single word that receives extra stress. DECtalk has no way of knowing which word to stress and chooses the last word by default. Use the emphatic stress symbol ["] to emphasize a different word when the last word is not appropriate.

>Joan won the marathon!
(DECtalk emphasizes the last word.)

>[jh"own] won the marathon.
(Correct.)

Clause Boundaries [,]

When a sentence is composed of more than one clause, it should be spoken in such a way that the listener can easily separate the sentence into its component clauses. The comma [,] is the symbol used to indicate clause boundaries.

Inserting a comma improves the quality of spoken sentences in the following cases.

- Following an introductory prepositional phrase:

    >In particular cars cause pollution.
    (Poor phrasing.)

    >In particular, cars cause pollution.
    (Correct.)

- Surrounding a parenthetical remark:

    >A picture it seems is worth . . .
    (Poor phrasing.)

    >A picture, it seems, is worth . . .
    (Correct.)

- In a list of more than two items:

    >They ate apples oranges and bananas.
    (Poor phrasing.)

    >They ate apples, oranges and bananas.
    (Correct.)

Verb Phrase Introducer [)]

Moderately long declarative sentences are usually spoken as if they contain two units: a noun phrase and a verb phrase. There is no pause between these two phrases, but the pitch tends to fall and then rise at this syntactic boundary. DECtalk searches for this boundary in order to change pitch. However, the complex meaning of sentences can cause confusion.

>`The old man in the chair was rocking slowly.`
(Correct verb phrase detected.)

>`The old man in the chair sat rocking slowly.`
(Verb phrase not detected; pure mechanical analysis of the sentence does not show where "sat" belongs.)

>`The old man in the chair [)s'aet] rocking slowly.`
(Phonemic correction.)

The [)] symbol is useful where a separation is needed between phrases but a comma is not appropriate. For example, you can use [)] to indicate a dangling prepositional phrase.

>`She hit the man with the umbrella.`
(Man carries umbrella.)

>`She hit the man [)] with the umbrella.`
(She uses umbrella.)

The [)] symbol has a second purpose: it is used to indicate how noun/verb words should be pronounced. Words such as "insert" are either nouns or verbs, depending on their use. DECtalk pronounces these words as nouns in all cases.

Appendix B lists the ambiguous noun/verb words that DECtalk knows. Placing the [)] symbol in front of these words will change the pronunciation from noun to verb.

>`The experienced secretary )inserts more inserts per hour.`

DIRECT CONTROL OF DURATION AND PITCH

Good speakers use a variety of techniques to hold their audience. Stage actors, for example, overemphasize key words, pause longer than normal, and wave their arms to convey a feeling to the audience that otherwise would be lost through distance.

DECtalk has the same problem when addressing an audience – even if it is an audience of one person. You cannot make DECtalk wave its arms or change its facial expression to make a point, but you can add dramatic emphasis and feeling through several special commands.

Duration and Pitch [<>]

Sometimes emphasis is added to a phrase through extended syllable length ("Goooood evening.") or dramatic rise in pitch ("What?!??"). You can add this emphasis through values enclosed in angle brackets [<>].

The format is

    <duration,pitch>

where duration is the length of the phoneme in milliseconds and pitch is the fundamental frequency of the phoneme in hertz (Hz).

Any phoneme may be followed by angle brackets to alter the default duration and pitch. If either value is omitted, or specified as zero, the default value is used. Multiple values are separated by commas.

    >[ow]
(Normal phonemic specification.)

    >[ow<1000>]
(1,000 ms duration.)

    >[ow<,90>]
(Default duration, 90 Hz pitch.)

    >[ow<1000,90>]
(1,000 ms duration, 90 Hz pitch.)

The specified pitch is a target pitch. DECtalk reaches this pitch only at the end of the phoneme. If the specified pitch was held throughout the phoneme, the result would be a monotone, or at least a strange inflection of the word.

Displaying the correct emotion through voice alone is a difficult task, as any radio actor will tell you. The best method is to experiment with phonemic symbols until you achieve the quality you want. Emotional content is usually connected to the sentence content, so varying both contents together is the best way to convey feelings.

For example, you can have DECtalk say a simple phrase like "Good morning" in several different ways.

```
>Good morning.
```
(Normal tone.)

```
>Good morning!
```
(Emphatic.)

```
>Good morning?
```
(Questioning.)

```
>[g"uhd] morning.
```
(Emphasize "good.")

If these alternatives do not produce what you need, you can use direct prosodic control. You must represent the entire sentence phonemically, specifying a duration for each phoneme that does not match the natural model. You should also give some or all phonemes specific target pitch values. DECtalk will compute smooth transitions between pitch values, where the specified pitch is reached at the end of the phoneme.

For example, to say "Oh?" with a greater degree of skepticism than DECtalk normally imparts, you could type the following.

```
>[_<,90>ow<400,150>].
```

The [ow] phoneme begins at 90 Hz and ends (after 400 ms) at 150 Hz.

Note the use of the silence symbol [_] in the example just given. Pitch and duration values must always be attached to a preceding phoneme. The silence symbol is used so that the value (90 Hz in this example) is applied to the beginning tone of the next spoken phoneme.

Many of the phonemes listed in Tables 4-1 and 4-2 (all except the stop conso-
nants p, t, k, b, d, and g) can be sustained in a monotone for an arbitrarily long
duration by using direct prosodic control. For example, to sustain "ah" for a
duration of ten seconds (10,000 ms) at a pitch of 120 Hz, type this.

```
>[_<,120>ah<10000,120>].
(Produces "ahhhhhhh · · ·")
```

To produce a prolonged sigh, you might type

```
>[_<100,150>ah<2500,80>].
```

where the silence phoneme causes the pitch contour to start at 150 Hz at the
beginning of the "ah" and end at 80 Hz at the end of the "ah."

Singing
Obviously singing uses different voice control techniques than conversation.
Even untrained singing voices tend to add richness to sung notes by varying
the pitch slightly, a quality called *vibrato.* Singing in DECtalk sounds mechani-
cal without vibrato. For example, to sing the first four notes of Beethoven's
Fifth Symphony using the syllable "da," type the following.

```
>[d<100,192>aa<250>  d<100,192>aa<250>]
>[d<100,192>aa<250>  d<120,161>aa<500>].
```

Each word or syllable is defined phonemically. The first number following a
phoneme is the duration in milliseconds, and the second number is the pitch in
hertz. Vowels and consonants not assigned a pitch remain at the same pitch as
preceding segments. You can intersperse silence phonemes if you wish.

DECtalk stays exactly on pitch when the pitch is specified phonemically. You
can add vibrato (to give a realistic singing quality) by specifying notes with pitch
values from 1 to 37. Note 1 is C2 and 37 is C5 on an equal tempered scale as
shown in Table 4-4. C2 is the second C below middle C on a piano, C4 is
middle C, and so on.

When you specify tones, DECtalk reaches the pitch you want within about 100
ms after the start of the phoneme and adds vibrato while changing to this pitch.
When you give a specific pitch, DECtalk reaches the pitch you want at the very
end of the phoneme with no vibrato. The following example makes DECtalk
sing the first four notes of Beethoven's Fifth Symphony.

```
>[d<100,20>aa<400>  d<100,20>aa<400>]
>[d<100,20>aa<400>  d<120,17>aa<700>].
```

Table 4-4   Tone Values

Value	Note	Pitch (Hertz)	Voice Range				
1	C2	64.0					
2	C#	67.8					
3	D	71.8					
4	D#	76.1					
5	E	80.6	B				
6	F	85.4	A				
7	F#	90.5	S				
8	G	95.9	S	B			
9	G#	101.6		A			
10	A	107.6		R			
11	A#	114.0		I			
12	B	120.8		T			
13	C3	128.0		O	T		
14	C#	135.6		N	E		
15	D	143.7		E	N		
16	D#	152.2			O		
17	E	161.3			R		
18	F	170.9				A	
19	F#	181.0				L	
20	G	191.8				T	
21	G#	203.2				O	
22	A	215.2					
23	A#	228.0					
24	B	241.6					S
25	C4	256.0					O
26	C#	271.2					P
27	D	287.4					R
28	D#	304.4					A
29	E	322.6					N
30	F	341.8					O
31	F#	362.0					
32	G	383.6					
33	G#	406.4					
34	A	430.4					
35	A#	456.0					
36	B	483.2					
37	C5	512.0					

User Dictionaries

Since there are so many exceptions to English pronunciation rules, DECtalk uses a built-in dictionary that lists the most common exceptions in standard speech. DECtalk also has a separate dictionary, called the user dictionary, that can be maintained by the user. However, the user dictionary is too difficult to build and maintain under off-line (terminal) control.

When your DECtalk unit is connected to a host computer, the user dictionary can be loaded by a computer application program. If the user dictionary is present, DECtalk will search this dictionary before it uses its own dictionary. The user dictionary overrides the built-in dictionary.

The *DECtalk DTC01 Programmer's Reference Manual* describes loading and maintaining the user dictionary.

MODIFYING THE VOICES 5

DECtalk has a set of simple commands that you can use to change the speaking rate, or to change the voice to one of seven different male, female, or child voices or a user-definable voice as shown in Figure 5-1. You can use other, more complex commands to modify the characteristics of each voice, or to create a new voice or special effects. The complex commands require skill and experience to use effectively, but the simple commands are easy to use in DECtalk applications.

When using the telephone, we can usually tell whether the voice of a stranger is that of a man, woman, or child. There are slight differences in voice quality that are characteristic of these different speakers. The size of the head and vocal tract account for some of the differences. For example, women's and children's voices are usually higher pitched than men's voices. We also notice that some people talk faster than others, and that some people speak more clearly than others.

Chapter 4 described ways you can modify DECtalk pronunciation. This chapter shows how you can change the DECtalk voice itself by selecting the speaking rate, sex, and other voice characteristics.

ROUGH RITA

FRAIL FRANK

HUGE HARRY

KIT THE KID

PERFECT PAUL

BEAUTIFUL BETTY

VARIABLE VAL

UPPITY URSULA

MA-0264-84

Figure 5-1   The DECtalk Voices

DECtalk has five commands that you can use to modify voice characteristics (Table 5-1). Since the commands are entered within phonemic brackets ([ ]), you must first enter setup mode and set MODE SQUARE on (Chapter 3). (A MODE SQUARE option is provided, and the default is off, so that DECtalk does not try to interpret text appearing normally between brackets as phonemes.) The commands are as follows.

1. Speaking rate [:ra]
2. Comma pause duration [:cp]
3. Period pause duration [:pp]
4. New voice [:n_]
5. Design voice [:dv]

Each of the first four commands has a single, simple function. The design voice command introduces the parameters used to produce the standard DECtalk voices. You can use the [:dv] command to create a completely new voice.

The sections that follow describe the voice modification commands in detail.

Table 5-1   Voice Modification Commands

Command	Min	Max	Unit/Parameter
:ra	120	350	Words/min
:cp	0	9000	ms
:pp	0	9000	ms
:n_	–	–	pbhfkruwv
:dv	–	–	Parameter(s)

SPEAKING RATE [:ra]

DECtalk reads text at about 180 words per minute. This is a typical reading rate that is comfortable for most situations. You can use the [:ra] command to make this reading rate faster or slower.

The [:ra] command takes a single numeric parameter, between 120 and 350 words per minute. For example, the following command changes the speaking rate to 120 words per minute.

```
>[:ra 120]
```

This is a slow rate of speech useful for students learning English or customers copying information over a phone. DECtalk produces slower speaking rates partly by breaking the speech into small phrases bounded by pauses.

You might use a faster speaking rate to skim electronic mail until you find a particular message. The following command changes the speaking rate to 250 words per minute.

```
>[:ra 250]
```

Words per minute is a relative measurement. DECtalk adjusts its speech rate for average-length words. It does not count the number of words in a sentence before speaking them. Sentences with long words take longer to speak than sentences with short words.

THE PAUSE COMMANDS [:cp] AND [:pp]
DECtalk pauses for 160 milliseconds after commas and 640 milliseconds between sentences. In human speakers, this pause allows the speaker to take a breath and plan the next thought.

You can make longer pauses between commas and sentences with the [:cp] and [:pp] commands. These commands change the pause durations, thus affecting the current words-per-minute [:ra] rate.

The [:cp] command changes the pause rate when DECtalk finds a comma. For example, the following command changes the comma pause from the default of 160 milliseconds to (160 ms + 250 ms), or 410 milliseconds.

>[:cp 250]

Changing the pause length after commas might be useful if you are transcribing lists of information given by DECtalk.

The period pause can be changed in the same way. For example, this command would change the period pause from 640 milliseconds to (640 ms + 2000 ms), or 2640 milliseconds.

>[:pp 2000]

Educational research has shown that listeners take between five and eight seconds to assimilate a new thought. If you are using DECtalk to pass on a lot of information, increasing the period pause is one way to help the listener grasp all that is being said. Changing the period pause, rather than the speech rate, keeps DECtalk sentences from sounding bored or draggy.

The pause values are exact only for the standard speaking rate. The actual pause duration changes if you adjust the speaking rate.

VOICE SELECTION

DECtalk has seven built-in voices and one voice that is user definable. You can refer to each voice by the command [:n__] where "__" is a letter representing one of the DECtalk voices. Table 5-2 lists the [:n__] parameters.

You can change voices with the new voice command as in this example.

```
>[:nb] Hello.  I'm Betty.
```

You can also change voices in the middle of a sentence.

```
>[:np] This is a demo [:nb] of a sudden change in
voice.
```

Table 5-2   New Voice Commands

:n__ Parameter	Voice Name	Characteristics
:np	Perfect Paul	Standard male voice
:nb	Beautiful Betty	Standard female voice
:nh	Huge Harry	Deep male voice
:nf	Frail Frank	Older male voice
:nk	Kit the Kid	Child's voice (10-year-old)
:nr	Rough Rita	Deep female voice
:nu	Uppity Ursula	Light female voice
:nv	Variable Val	User-definable voice

DECtalk needs a brief silence in order to change to a new voice. If a voice change occurs in the middle of a sentence, DECtalk automatically pauses slightly. The pause is the equivalent of inserting a comma before (or after) the midsentence command. For example, you could type the previous sentence as follows.

```
>[:np] This is a demo, [:nb] of a sudden change in
voice.
```

It is good practice to always end a sentence (insert a period) before changing voices. This allows the listener to prepare for a new speaker.

CUSTOM VOICE DESIGN [:dv]

If one of the DECtalk voices does not suit you, you can design your own voice by using the [:dv] command. Designing a voice is not easy. As you will see, individual voices have many subtle characteristics.

One easy way to modify the way DECtalk sounds is to change the pronunciation and inflection of words and sentences. Actors and character impersonators actually mimic a person's way of speaking more than his or her voice characteristics.

To design a new voice, start by modifying a current voice to give it new characteristics. You can set a voice by using the new voice [:n_] command and then modify that voice using [:dv] parameters.

Table 5-3 lists the parameters for the design voice [:dv] command. You can string these parameters together as a series to give the voice characteristics you want, or you can enter them one at a time with separate [:dv] commands.

The paragraphs that follow describe the parameters you need to know in detail.

Table 5-3   Design Voice [:dv] Parameters

Parameter	Min	Max	Unit	Action
list	–	–	–	List current speaker definition.
listall	–	–	–	List all parameters.
save	–	–	–	Save current speaker definition in variable buffer.
ap	50	300+	Hz	Average pitch.
as	0	100	%	Assertiveness.
b4	100	2048	Hz	Fourth formant bandwidth.
b5	100	2048	Hz	Fifth formant bandwidth.
bf	50	200	Hz	Beginning pitch baseline fall.
br	0	60	dB	Breathiness.
ef	50	200	dB	End pitch baseline fall.
f4	2500	f5−250	Hz	Fourth formant frequency.
f5	4900	f4+250	Hz	Fifth formant frequency.
fo	0	100	%	Forte voice.
ft	0	100	%	F0 dependent spectral tilt.
g1	0	80	dB	Synthesizer gain 1.
g2	0	80	dB	Synthesizer gain 2.
g3	0	80	dB	Synthesizer gain 3.
g4	0	80	dB	Synthesizer gain 4.
g5	0	80	dB	Synthesizer gain 5.
gf	0	80	dB	Gain of frication source.
gh	0	80	dB	Gain of aspiration source.
gn	0	80	dB	Gain of nasal resonator.
gv	0	80	dB	Gain of voicing source.
hs	75	150	%	Head size.
la	0	100	%	Laryngealization.
nf	0	60	–	Samples in glottal pulse open phase.
p4	–	–	–	Parallel formant 4 frequency.
p5	–	–	–	Parallel formant 5 frequency.
pr	0	250	%	Pitch range.
ri	0	100	%	Richness.
sex	0	1	–	Set sex to female (0 or f) or male (1 or m).
sm	0	24	dB	Smoothness (high frequency attenuation).

The [list] and [listall] Parameters

The voice-modifying commands only act on the current voice definition buffer, which is not a permanent buffer. If you want to know what values are stored for the current voice, use the [list] parameter. The following example gives the values for the Perfect Paul voice.

```
sex      1     (    0  ..     1)   Speaker sex
sm      34 %   (    0  ..   100)   Smoothness
as     100 %   (    0  ..   100)   Assertiveness
ap     120 Hz  (   30  ..   300)   Average pitch
pr     100 %   (    0  ..   250)   Pitch range
br       0 dB  (    0  ..    70)   Breathiness
ri      20 %   (    0  ..   100)   Richness
nf       0     (    0  ..   100)   Samples in open period
la       0%    (    0  ..   100)   Laryngealization
hs     100%    (   40  ..   200)   Head size
f4    3300 Hz  (2000  ..  4650)   Cascade formant 4 frequency
b4     160 Hz  ( 100  ..  2048)   Cascade formant 4 bandwidth
f5    3900 Hz  (2500  ..  4950)   Cascade formant 5 frequency
b5     130 Hz  ( 100  ..  2048)   Cascade formant 5 bandwidth
p4    3300 Hz  (2500  ..  4950)   Parallel formant 4 frequency
p5    4050 Hz  (2500  ..  4950)   Parallel formant 5 frequency
gf      73 dB  (    0  ..    80)   Gain of frication source
gh      70 dB  (    0  ..    80)   Gain of aspiration source
gv      71 dB  (    0  ..    80)   Gain of voicing
gn      69 dB  (    0  ..    80)   Gain of nasal resonator
g1      72 dB  (    0  ..    80)   Gain of resonator 1
g2      61 dB  (    0  ..    80)   Gain of resonator 2
g3      50 dB  (    0  ..    80)   Gain of resonator 3
g4      59 dB  (    0  ..    80)   Gain of resonator 4
g5      72 dB  (    0  ..    80)   Gain of resonator 5
ft      35 %   (    0  ..   100)   F0 dependent spectral tilt
bf     115 Hz  (   50  ..   200)   Beginning pitch baseline fall
ef     100 Hz  (   50  ..   200)   End pitch baseline fall
```

To prevent communication line problems, [list] is recognized only when you entered it from the local terminal in off-line mode. No list is transmitted to the host computer.

The list contains six columns of information as follows.

- Parameter name
- Current value
- Unit (hertz, percent, decibel, or integer)
- Minimum permitted value of the parameter
- Maximum permitted value of the parameter
- A brief explanation of the parameter

The [listall] parameter lists the values for all the DECtalk voices.

The [save] Parameter and [:nv] Voice

You can save a modified speaker definition in a semipermanent buffer while synthesizing speech with one of the other voices. The Variable Val voice [:nv] is either male (Prince Valiant) or female (Valerie) depending on what values are stored in it. If you call Val before storing any values in the buffer, DECtalk uses the Perfect Paul voice [:np]. The following commands store a modified Betty voice in Val and then recall it.

>[:nb :dv sex m save]
(Store the modified Betty voice in Val.)

>[:np] I am Paul.
(Use another voice.)

>[:nv] I am Val.
(Recall the Val [modified-Betty] voice.)

You must reenter new voice characteristics if you turn off DECtalk.

The [sex] Parameter

Speakers Paul, Harry, and Frank are male (sex = 1), while speakers Rita, Betty, and Ursula are female (sex = 0). Kit the kid can be considered either male or female, since children younger than 10 years old have similar voices for both sexes.

You can also enter the [sex] parameter as [m] or [f].

You can change the sex of any of DECtalk's built-in voices by making the voice current and then changing the male/female parameter. For example, the following command gives Paul some of the speaking characteristics of a woman.

>[:np] Hello. [:dv sex f] Good-bye.

Many characteristics determine the sex of a speaker, including pitch, head size, breathiness, and dialect patterns.

If you change the sex of the speaker, some phonemes may cause DECtalk's filters to overload, producing a squawk. (While the squawk is unpleasant, it will not damage DECtalk.) The "Synthesizer Gain" section describes how to correct this problem.

Average Pitch [ap]

You can use the angle bracket qualifier [<>] described in Chapter 4 to change the pitch and duration of a phoneme. The average pitch [ap] parameter changes the pitch for the entire voice and for all phonemes after you enter it.

Every voice has a different average pitch. To find the average pitch value for the current voice, type the following command.

```
>[:dv list]
```

As the example in "The [list] and [listall] Parameters" section shows, the [ap] parameter is included in the resulting list. You can then adjust the average pitch up or down in hertz. For example, if the current voice has an average pitch of 120 Hz, you can raise the pitch to 180 Hz by typing the following.

```
>[:np] Hello.  [:dv ap 180] Hello.
```

Pitch Range [pr]

Pitch range is expressed as a percentage change relative to the current average pitch [ap] value, and has a default value corresponding to the pitch range of a typical moderately expressive voice.

As explained in the last section, every voice is centered around a particular pitch. For example, the default average pitch of Paul is 120 Hz, and the normal pitch range is 100 percent. This means that Paul's voice may vary in pitch over the entire frequency range of a male baritone: from about 50 Hz to 180 Hz.

The best way to determine a good pitch range for a new voice is by trial and error. The paragraphs that follow describe some effects of altering the pitch range.

You can create a monotone or robotlike voice by setting the pitch range to zero. For example, to create a monotone with Betty at exactly 180 Hz, type the following.

```
>[:nb :dv ap 180 pr 0] Hello.
```

Reducing the pitch range tends to reduce the dynamics of the voice, producing emotions such as sadness.

```
>[:np :dv ap 100 pr 20] There is little hope.
```

Increasing the pitch range while setting the average pitch steady or slightly higher produces excitement.

```
>[:nb :dv ap 250 pr 200] I am [r"iyliy] excited.
```

To return Betty to her normal voice, simply type the default value.

```
>[:nb] Now I am calm again.
```

Head Size [hs]
Head size is specified with respect to the average size for an adult man (if sex = 1) or an adult woman (if sex = 0).

Real human head size has a strong influence on a person's normal speaking voice. Larger musical instruments tend to produce lower notes, and humans with larger heads tend to have lower, more resonant voices. For example, to make Betty sound like a larger woman, type this command.

```
>[:nb :dv hs 120]
```
(Betty now has a 20 percent larger head.)

Head size is one of the best variables to use if you want to achieve dramatic changes in voice quality. For example, Paul has a head size of 100 percent of normal, while Harry's deep voice is caused in part by a head size value of 115, or 15 percent greater than normal. Decreasing head size produces a higher voice, such as in a child or adolescent.

Synthesizer Gain [g1 to g5]

Changes in head size can sometimes produce overloads in the synthesizer circuits. If this occurs, there are several gain controls inside the synthesizer (normally unchanged) that you can adjust to attenuate the signal at critical points and then amplify it back to normal later in the synthesis.

Use the following procedure to correct an overload (typically indicated by a squawk during part of a word). First, synthesize the word or phrase several times to make sure that the squawk occurs consistently. Then use the same test word each time one of the following changes to a gain is made.

First type the [list] command to get a printout of the current speaker definition.

```
>[:dv list]
        .
        .
        .
g1  60 dB  Resonator 1 gain
g2  59 dB  Resonator 2 gain
g3  55 dB  Resonator 3 gain
g4  60 dB  Resonator 4 gain
g5  58 dB  Resonator 5 gain
        .
        .
        .
```

Note especially the values for g1, g2, g3, g4, and g5. Reduce the number printed for g1 by an increment of 2 at a time until the squawk goes away.

```
>[:dv g1 58]
>Yellow.
```
(Test utterance causing squawk.)

```
>[:dv g1 56]
>Yellow.
```

When the squawk goes away, note the reduction that was needed (4 in this example). Now try removing the squawk by using g2 rather than g1 (reducing the gain later in the synthesis).

```
>[:dv g1 60 g2 55]
```
(Return original value to g1, decrement g2 by 4.)

If the squawk is still gone, repeat the procedure by resetting g2 and decrementing g3, then g4 and g5, until you find the resonator that overloaded.

After you find the farthest gain control (the largest number in the set g1 to g5) that removes the squawk, try to return the output signal to its full value by adding the decrement you used to one of the gain controls farther down the chain. For example, suppose that the 4 dB decrement of the example just given succeeds for g3, but not for g4. Then first try to increase g4 by the decrement amount as follows.

```
>[:dv list]
              .
              .
              .
    g1  60 dB  Resonator 1 gain
    g2  59 dB  Resonator 2 gain
    g3  51 dB  Resonator 3 gain
    g4  60 dB  Resonator 4 gain
    g5  58 dB  Resonator 5 gain
              .
              .
              .
>[:dv g3 51 g4 64]
```

If you are not successful, try g5.

```
>[:dv g4 60 g5 62]
```

If you are still not successful, then increase g5 by as much as possible (perhaps none at all).

NOTE: You should keep a list of test words and phrases that cause squawks. Then, when you modify a voice, you can systematically confirm that you have not fixed one problem and caused two others.

Breathiness [br]

Some voices can be characterized as breathy in that the vocal folds vibrate in such a way that some breath noise is generated as well. Breathiness is a characteristic of many female voices, but it is also common under certain circumstances for all voices.

The range of [br] is from 0 dB (no breathiness) to 70 dB (strong breathiness). By experimenting, you can learn what intermediate values sound like. Listing breathiness values for each of the predefined speakers may also help.

For example, to turn Paul into a whispering speaker, type the following.

```
>[:np :dv br 60 gv 0 g5 80 sm 0 ri 0] This is a
whispering voice.
```

This voice is not as loud as the others, but it is quite intelligible and human sounding.

Smoothness [sm]
Breathy voices often need an increase in the [sm] parameter to sound best. Smoothness is caused by a decrease in voicing energy at higher frequencies, while its opposite, brilliance, comes from an increase.

The range of [sm] is from 0 (least smooth and most brilliant) to 100 (most smooth and least brilliant). For most breathy voices, a good value is about 50.

To make Paul breathy and smooth, type the following.

```
>[:np :dv br 50 sm 50]
```

Professional singing voices that are trained to be able to sing above an orchestra are usually brilliant, while anyone who talks softly or in a whisper tends to become both breathy and smooth. Smoothness has little effect on voice quality, but changes in smoothness can be heard in quiet surroundings.

Richness [ri]
Richness is similar to brilliance. The opposite of richness is softness. Brilliant rich voices carry well and are more intelligible in noisy environments, while smooth soft voices sound more friendly. For example, typing the following command produces a soft smooth voice.

```
>[:dv sm 50 ri 0]
```

The following produces a rich and brilliant (forceful) voice.

```
>[:dv sm 0 ri 100]
```

Smoothness and richness can often be adjusted together, and these two parameters do not influence the speaker's identity very much. For example, to turn Betty into a nonbreathy, maximally brilliant and rich voice, type the following.

```
>[:nb :dv br 0 sm 0 ri 100]
```

Laryngealization [la]

Many speakers tend to speak irregularly at the beginnings and ends of sentences, which gives a querulous tone to the voice. This is called *laryngealization* or creaky voice quality.

The [la] parameter controls the amount of laryngealization in the voice. A value of 0 results in no laryngealized irregularity, a value around 50 restricts laryngealization to sentence beginnings and ends, while a value of 100 (the maximum) produces some laryngealization at all times.

For example, to make Betty moderately laryngealized, type this command.

```
>[:nb :dv la 50]
```

Other Commands

Human voices are made up of many frequencies, even in the "purest" singing voice. These frequencies have been identified and grouped into categories (such as formants) by linguists and voice specialists. Table 5-3 lists the values for all DECtalk voice parameters, including these special values. These additional values are of interest to linguists.

Because adjusting the parameters not already discussed requires specialized measuring instruments, they are best left as they are. However, you may wish to experiment with these values to see what influence they have on the voice.

Table 5-3 lists the values alphabetically. If you use the [list] command, the values are listed in a different order. The example in "The [list] and [listall] Parameters" section shows a DECtalk parameter list.

VOICE COMMAND SYNTAX

Like the phonemic symbols, the voice commands are enclosed in square brackets. However, voice commands start with a colon (:) and include parameters. For example, the following command changes the speaking rate.

```
>[:ra 150] Hello, how are you?
```

In this example, [:ra] is the command, and [150] is the parameter. The parameter changes the speaking rate to 150 words per minute. The "Speaking Rate" section discussed the [:ra] command in detail.

DECtalk uses the following voice command syntax rules.

1. Every command begins with a colon (:).

2. You must separate each command and its parameter(s) from the text by a valid word boundary marker such as **SPACE**, **TAB**, or **RETURN**.

3. You can include several commands in the same square bracket set.

```
>[:ra 150 :nb] Hello.  How are you?
```

4. You can include several parameters in the same set if the command allows more than one parameter. If you use several parameters, they must all be given before a second command in the same bracket set.

```
>[:dv ap 160 pr 50 save :nv] Hi there.
```
(parameter group modifies the [:dv] command.)

```
>[:dv ap 160 save :nv pr 50] Hi there.
```
(Wrong. Parameter group is out of place.)

5. If you give two conflicting parameters or commands, DECtalk will use the last command in the sequence. For example, if you type

```
>[:nb :np] Hello.
```

DECtalk will use Paul's voice.

6. You can use phonemic symbols in the same square brackets with voice commands.

   ```
   >Now I'm [:dv ap 90 pr 130; r"iyliy] thrilled!
   ```

7. If the value in a [:dv] command is too low, DECtalk will use the minimum valid value. If the value is too high, the maximum valid value will be used.

8. Once you give a command, that command applies to all further text until overridden by another command. For example, the command

   ```
   >[:nk]
   ```

   will make DECtalk use Kit's voice on all entered text until you enter another new voice command.

9. All [:dv] commands are lost when you power down DECtalk.

10. Invalid commands are ignored.

ABBREVIATIONS AND ACRONYMS **A**

This appendix describes how DECtalk processes numbers, abbreviations, and acronyms, and how it decides whether a word is pronounceable. It also includes suggestions for correcting spoken output problems.

DECtalk processes text to be spoken by applying the following rules in this order.

1. The input text stream is broken into groups of letters delimited by "white-space" (spaces, tabs, end-of-line characters, and control characters).

2. If the letter string is not already phonemic text and is to be converted, any understandable numbers are first expanded to their word equivalents.

3. Some abbreviations are expanded to their full-word equivalents using a list of number abbreviations and rules for a few special cases. The user dictionary cannot override this conversion.

4. Each letter string is broken into pronounceable entities. Punctuation – including parentheses and quotation marks, hyphenated words, and sequences that must be spelled out – is analyzed. Some abbreviations and acronyms are recognized, plus any entries from the user dictionary.

5. Any text that cannot be pronounced is spelled out.

A few rules operate on sequences of words. Interspersing phonemic symbols or DECtalk commands (certain escape sequences, for example) will block these rules. Therefore, make sure that spoken text is as contiguous as possible and keep breaks in structure (from English spelling to phonemic transcription) to a minimum.

The following definitions are used in this appendix.

Character   Any of the printable ASCII characters, including letters, digits, and punctuation.

Digit string   A string of digit characters (0 through 9). DECtalk decides whether these should be pronounced as numbers or independent characters.

Number   A string of characters (containing digits) that is processed as a group by DECtalk.

                   For example, "123" is pronounced "one hundred twenty-three," while "1(2)3" is pronounced "one left-parenthesis two right-parenthesis three."

NUMBER PROCESSING

DECtalk recognizes six general number classes, and a large number of special cases and subclasses. The general classes are as follows.

- *Cardinal numbers* are the set of numbers that people think of when numbers are discussed. Examples include "123," "123,456," "12.345," "01234," "+1.2E-4," and "12%."

- *Ordinal numbers* are simple strings of numbers with "st," "nd," "rd," or "th" added, for example, "1st," "23rd."

- *Fractions* include "1/2," "2/3," and "44/100%."

- *Money* is recognized by the presence of a dollar sign ($) as part of the number string or as an immediately preceding word.

- *Dates*, when written in Digital's standard format ("23-Sep-1983"), are expanded to their English equivalent.

- *Time of day*, when written in the 24-hour format used by the VAX/VMS operating system ("11:04:03.01"), is spoken in its English equivalent.

When processing numbers and number words, DECtalk first removes leading and trailing punctuation. Thus, DECtalk translates "(123)" into "one hundred twenty-three."

The sections that follow discuss these classes of numbers in detail.

Cardinal Numbers

A cardinal number is a string of digits. If commas are included, they must break numbers into groups of three. For example, "123,456" is correct, but "1234,56" is not. The latter will be spelled out as "one two three four comma five six."

Cardinal numbers may also include decimal fractions ("12.34") and scientific notation ("12.34E56"). In scientific notation, the exponent must be less than 100.

A cardinal number preceded by "+" or "−" will be spoken as "plus" or "minus" whether or not MODE MINUS is on.

If the first digit is 0 ("01234"), the number will be spoken as a string of digits as would be appropriate when reading postal zip codes.

If the number is greater than 999,999,999, it will be spoken as a string of digits with pauses between each group of three digits. If commas are provided, they will control the pause behavior. If not, the output will pause after each group of three digits, provided six or more digits remain. Thus, "12345678901" will be spoken as "123, 456, 78901" rather than "12,345,678,901."

Four-digit numbers without commas are spoken in a variety of formats. For example, "5000" becomes "five thousand," while "1984" becomes "nineteen eighty-four." This yields reasonable behavior when processing years.

Sometimes DECtalk does not understand the text well enough to pronounce the number correctly. Here are some examples.

- The telephone number "(617) 493-8255" will be spoken as "six hundred seventeen, four nine three dash eight two five five." You can correct this by:

  1. Spelling out the digits as "six one seven, four nine three, eight two five five" (notice the commas to make DECtalk pause at appropriate places), or

  2. Separating the digits with spaces and commas: "6 1 7, 4 9 3, 8 2 5 5."

- The software cannot easily distinguish between "dash" and "minus."

  >How much is 10-15?

  >Bake this 10-15 minutes.

  The SET MODE MINUS setup option determines whether the "−" is pronounced as dash or minus.

Some number formats are difficult to recognize out of context. For example, the International Standard Date format (83.09.20) and the United States telephone number format (noted previously) are sometimes used by manufacturers for part numbers. These ambiguous formats are not recognized by DECtalk and you must correct them.

Following a cardinal number, DECtalk recognizes a set of standard numeric abbreviations that are expanded to their English equivalent. These abbreviations are hardwired into DECtalk and cannot be modified by the applications programmer. DECtalk correctly generates singular and plural forms of these abbreviations.

Table A-1 lists the numeric abbreviations recognized by DECtalk following a cardinal number. You can write them in either uppercase or lowercase letters, but you must follow them by a period, as the table shows.

Other abbreviations, such as "cc.," are spelled out by DECtalk. This may cause problems, because the period following such an abbreviation is pronounced ("cc." becomes "see see period") and terminates the clause, while the period in number abbreviations does not terminate the clause.

Table A-1   Numeric Abbreviations Recognized by DECtalk

Abbrev	Word	Abbrev	Word
Length and Distance			
cm.	centimeter(s)	m.	meter(s)
ft.	foot (feet)	mi.	mile(s)
in.	inch(es)	mm.	millimeter(s)
ins.	inches	yd.	yard(s)
km.	kilometer(s)	yds.	yards.
Area			
ha.	hectare(s)		
Volume			
l.	liter(s)	tsp.	teaspoon(s)
ml.	milliliter(s)	tbsp.	tablespoon(s)
qt.	quart(s)		
Mass, Weight			
g.	gram(s)	lbs.	pounds
gm.	gram(s)	mg.	milligram(s)
kg.	kilogram(s)	oz.	ounce(s)
lb.	pound(s)	ozs.	ounces
Time			
hr.	hour(s)	sec.	second(s)
msec.	millisecond(s)	secs.	seconds
min.	minute(s)	usec.	microsecond(s)
nsec.	nanosecond(s)		
Miscellaneous			
deg.	degree(s)	kts.	knots
kt.	knot(s)		

Ordinal Numbers

Ordinal numbers are formed from a string of digits (that may contain appropriate commas) followed by "st," "nd," "rd," or "th." Ordinal numbers are also generated by DECtalk when fractions and dates (in standard Digital format) are processed.

DECtalk requires that the word portion of the ordinal number be correct. For example, "1st" will be processed correctly, but "2th" will not.

Fractions

Fractions consist of one or two digits in the numerator, the "/" character, and one to three digits in the denominator. The numerator may range from 1 to 99, while the denominator may range from 1 to 100. DECtalk correctly generates singular (1/3) and plural (2/3) forms.

Fractions can also use the ordinal abbreviations described in the "Ordinal Numbers" section, for example, "2/3rds."

Money

DECtalk assumes a digit string is money when it is introduced by the currency symbol "$." (DECtalk does not recognize the English pound, yen, or international currency symbols.) The "$" may be a separate word; for example, "$ 123.45" is equivalent to "$123.45."

When the "$" is recognized, DECtalk allows two forms of number strings.

- General digit strings have optional decimal fractions ("$12.345").

- Digit strings are in dollars and cents format ("$12.34").

DECtalk recognizes a list of number quantity words that modify number processing if they immediately follow the money word. For example, "$1.23" million is pronounced "one point two three million dollars." The following words are recognized.

thousand	undecillion
million	duodecillion
billion	tredecillion
trillion	quatturodecillion
quadrillion	quindecillion
quintillion	sexdecillion
sextillion	septdecillion
septillion	octodecillion
octillion	novemdecillion
nonillion	vigintillion
decillion	zillion

Dates

DECtalk recognizes dates written in Digital's standard date format, such as "23-Sep-1983," "23-Sep," or "23-Sep-83." It does not recognize the format "Sep. 23, 1983."

Time of Day

DECtalk recognizes the time of day when written in the format used by Digital operating systems. Because this format can easily be confused with part number formats, DECtalk does not try to convert the digit string. Instead, it speaks the string with appropriate punctuation. Thus, "12:00" becomes "twelve, oh oh," rather than "twelve noon."

DECtalk correctly processes VAX/VMS time values, including the fractional second value when it is present.

ABBREVIATIONS

DECtalk recognizes and expands a set of abbreviations. Those abbreviations that follow standard pronunciation rules are processed by DECtalk directly (for example, "governor" for "gov."). The built-in dictionary contains many abbreviations that are exceptions to these rules, such as "RSTS." Abbreviations found in the user dictionary override the built-in values.

Abbreviations Processed by DECtalk

In addition to the abbreviations that are recognized only when following cardinal numbers, DECtalk recognizes two special cases, "Dr." and "St.," whose pronunciation differs depending on whether the next word is capitalized.

- If the next word is not capitalized or if there is no next word (the clause has ended), then "Dr." is pronounced "drive" and "St." is pronounced "street." The next word must be on the same input line for the rule to work properly.

- If the next word is capitalized, then "Dr." is pronounced "doctor" and "St." is pronounced "saint."

Following these rules, DECtalk correctly pronounces "Dr. Zhivago Dr." and "St. Louis St." in running text.

Abbreviations in the Built-in Dictionary

Table A-2 lists the abbreviations stored in the built-in dictionary. Some of the abbreviations listed are also found in Table A-1.

If the abbreviation can be recognized by DECtalk during number processing, then the English text form of the abbreviation is spoken. Otherwise, the built-in dictionary form is spoken. Abbreviations stored in the user dictionary override the built-in dictionary only. The number abbreviations can be blocked by including a dummy phonemic string; for example, "1 [ ]ft. 3."

Dictionary entries that contain uppercase letters only match text words that contain uppercase letters in the same position. Thus, "Apr." matches "APR." but not "apr." This is necessary to distinguish between words at the end of a sentence and valid abbreviations, such as "mar" (to damage) and "Mar." (for March).

If a word in Table A-2 is written with a terminating period, you must include that period in the input text. (It will not terminate the current clause.)

Table A-2 Abbreviations Recognized by DECtalk

Abbrev	Word	Abbrev	Word
all-in-1	All in one	Ltd.	Limited
all-in-one	All in one	Mar.	March
Apr.	April	mg.	milligrams
Assoc.	Associates	mgs.	milligrams
Aug.	August	misc.	miscellaneous
Av.	Avenue	ml.	milliliters
Ave.	Avenue	Mon.	Monday
Blvd.	Boulevard	mr.	mister
ca.	approximately	mrs.	missus
CH.	Chapter	ms.	miz
Ch.	Chapter	msec.	milliseconds
cm.	centimeters	msecs.	milliseconds
cms.	centimeters	mss.	manuscripts
Co.	Company	Mt.	Mount
cont.	continued	Nov.	November
cu.	cubic	nt.wt.	net weight
dec	DEC (as·in Digital)	Oct.	October
Dec.	December	op.cit.	op cit
deg.	degrees	oz.	ounces
Dept.	Department	ozs.	ounces
doz.	dozen	p.p.d.	post paid
Dr.	Doctor or Drive*	pat.pend.	patent pending
e.g.	E G (not for example)	Pl.	Place
esp.	especially	pp.	pages
est.	established	ppd.	post paid
etc.	et cetera	Pres.	President
ext.	extension	Rd.	Road
Feb.	February	recd.	received
fig.	figure	Rep.	Representative
fn.	footnote	Rev.	Reverend
Fr.	Father	rsts	"ris-tis"
Fri.	Friday	rsts/e	"ris-tis-ee"
ft.	feet (not foot)	Sat.	Saturday
Ft.	Fort (not Foot)	Sen.	Senator
Gen.	General	Sep.	September
gm.	grams	Sept.	September
Gov.	Governor	sq.	square
hrs.	hours	Sr.	Senior
i.e.	I E (not that is)	St.	Saint or Street*

* See the "Abbreviations Processed Internally" section.

Table A-2   Abbreviations Recognized by DECtalk (Cont)

Abbrev	Word	Abbrev	Word
Inc.	Incorporated	Sun.	Sunday
Jan.	January	Thu.	Thursday
Jr.	Junior	Thurs.	Thursday
Jul.	July	Tue.	Tuesday
Jun.	June	Tues.	Tuesday
kg.	kilograms	Univ.	University
kgs.	kilograms	Vol.	Volume
km.	kilometers	vs.	versus
lb.	pounds	Wed.	Wednesday
lbs.	pounds	yds.	yards

WORD SPELLOUT STRATEGIES

After number processing, DECtalk must decide whether to pronounce a string of characters as a single word or a compound word, or if it must be spelled out. DECtalk uses the built-in and user dictionaries and a series of word transformations to make this decision.

Number conversion, number abbreviations, and the "Street/Saint" test have all been performed before DECtalk begins the decision tests. Punctuation has not yet been removed.

1. DECtalk looks for the word in the dictionaries. First the user dictionary is scanned, then the built-in dictionary. (Note that the user dictionary takes precedence. If the word is found in that dictionary, the search stops.)

   The dictionary lookup procedure involves stripping prefixes and suffixes such as pre-, -ed, and -ing. If the word is found in the dictionary, DECtalk speaks the associated phonemic transcription.

2. If the word is not found, any punctuation around the word is removed. If present, the punctuation symbols " ' ({ are removed from the front of the word, and the punctuation symbols " ') } . : ; ? are removed from the end of the word. The square brackets [ ] are removed only if MODE SQUARE is off.

3. A special test is performed to see if the ")" (alternate pronunciation character) is present. If MODE SQUARE is off and the word starts with ")," it is considered unpronounceable and spelled out.

4. If some punctuation was removed, DECtalk performs a special test for abbreviations. This is necessary because the trailing "." would otherwise be processed as a clause-terminating punctuation mark. If this fails, DECtalk searches the dictionaries for the word without any punctuation.

   For example, DECtalk processes the text string "(foo.)" as follows.

(foo.)	(Without change.)
foo.	(Abbreviation test.)
foo	(Without punctuation.)

5. Next, DECtalk looks for acronyms (words written as a string of uppercase letters separated by "."). For example, the string "A.P.O." is pronounced "aye pea oh." Other strings with embedded periods are spelled out. Thus, "a.p.o." would be pronounced "aye period pea period oh period."

   If an acronym is recognized, the last "." will terminate the clause, unless it is followed by some other punctuation.

6. If the acronym test fails, all uppercase letters are converted to lowercase and DECtalk searches the dictionaries again (if some letter was modified).

7. If the word is still not found, it is examined for hyphenation (as in compound nouns) and the single-quote character. There is also a test to make sure any word or word fragment has both consonants and vowels (the letter y is considered to be both). Those few English words that lack consonants are stored in the built-in dictionary. If the test fails, the word is spelled out.

   This test makes sure that the word does not contain embedded punctuation. Thus a word like "sys$system" is spelled out.

8. If DECtalk decides the word is pronounceable, it processes each part of a compound noun independently. If the word is not in the dictionary, it is processed by the letter-to-sound rules.

9. If the word was pronounced, DECtalk examines the punctuation after the word for silence or clause terminators. The punctuation marks " ')] } produce a brief silence (only one silence is produced, even if several characters are processed). The punctuation marks ; : ! , . ? terminate a clause.

   There is a special test for a string of periods at the end of a word, as in "Hello · · ·" This is equivalent to "Hello."

10. If DECtalk decides that the word must be spelled out, the entire word is spelled, including left and right punctuation. If the last letter of the word is "." or ",", it is considered punctuation and is not spelled.

Multinational Letters

Characters in the Digital Multinational Character Set are either ignored or converted into the appropriate English letter without any diacritical marks ("ö" becomes "o").

The Digital Multinational Character Set is in Appendix A of the *DECtalk DTC01 Programmer's Reference Manual*.

WORDS WITH MORE THAN ONE PRONUNCIATION B

Table B-1 lists the words that have alternate pronunciations in DECtalk. The alternate pronunciation is given in two-character phonemic form. This is the pronunciation for the form given after the slash in the Morphology column. For example, *con*duct (first syllable stressed) is the noun form of the word. Typing the word as "conduct" makes DECtalk pronounce the word as the verb con*duct*, the pronunciation shown in Table B-1.

For DECtalk to use the alternate pronunciation form, MODE SQUARE must be on.

Table B-1   Second Pronunciation for Words with Alternate Pronunciations

English Spelling	2-Character Representation	Morphology
a	'ey	Det/letter
abstract	aebstr'aekt	Noun/verb
advocate	'aedvaxkeyt	Noun/verb
affix	axf'ihks	Noun/verb
august	aog'ahst	Noun/Adj
compress	kaxmpr'ehs	Noun/verb
conduct	kaxnd'ahkt	Noun/verb
conflict	kaxnfl'ihkt	Noun/verb
console	kaxns'owl	Noun/verb
construct	kaxnstr'ahkt	Noun/verb
contract	kaxntr'aekt	Noun/verb
convert	kaxnv'rrt	Noun/verb
convict	kaxnv'ihkt	Noun/verb
coordinate	kow'aordeneyt	Noun/verb
decrease	diykr'iys	Noun/verb
deliberate	daxl'ihbrreyt	Noun/verb
digest	dayjh'ehst	Noun/verb
duplicate	d'uwplixkeyt	Noun/verb
elaborate	axl'aebrreyt	Noun/verb
estimate	'ehstixmeyt	Noun/verb
excuse	ixksk'yuz	Noun/verb
export	ehksp'owrt	Noun/verb
extract	ehkstr'aekt	Noun/verb
implant	ixmpl'aent	Noun/verb
import	ixmp'owrt	Noun/verb
incense	ixns'ehns	Noun/verb
incline	ixnkl'ayn	Noun/verb
increase	ihnkr'iys	Noun/verb
insert	ixns'rrt	Noun/verb
insult	ixns'ahlt	Noun/verb
interchange	ixntrrch'eynjh	Noun/verb
intimate	'ihntaxmeyt	Noun/verb
lead	l'ehd	Noun,verb1/verb2
lives	l'ihvz	Noun/verb
misuse	mixsy'uwz	Noun/verb
moderate	m'aadaxreyt	Noun/verb
object	axbjh'ehkt	Noun/verb
overrun	owvrrr'ahn	Noun/verb

Table B-1   Second Pronunciation for Words with Alternate Pronunciations (Cont)

English Spelling	2-Character Representation	Morphology
permit	prrm'iht	Noun/verb
pervert	prrv'rrt	Noun/verb
predicate	pr'ehdixkeyt	Noun/verb
proceeds	praxs'iydz	Noun/verb
produce	praxd'uws	Noun/verb
project	praxjh'ehkt	Noun/verb
read	r'ehd	Verb1/verb2
recall	rixk'aol	Noun/verb
record	rixk'owrd	Noun/verb
recount	riyk'awnt	Noun/verb
refill	riyf'ihl	Noun/verb
refund	riyf'ahnd	Noun/verb
refuse	rixf'yuz	Noun/verb
reject	rixjh'ehkt	Noun/verb
relapse	rixl'aeps	Noun/verb
rerun	riy*r'ahn	Noun/verb
retake	riyt'eyk	Noun/verb
rewrite	riyr'ayt	Noun/verb
segment	sehgm'ehnt	Noun/verb
separate	s'ehpaxreyt	Noun/verb
subject	saxbjh'ehkt	Noun/verb
subordinate	saxb'owrdeneyt	Noun/verb
syndicate	s'ihndixkeyt	Noun/verb
tear	t'eyr	Noun1/noun2,verb
torment	towrm'ehnt	Noun/verb
transform	traensf'owrm	Noun/verb
transplant	traenspl'aent	Noun/verb
transport	traens*p'owrt	Noun/verb
transpose	traensp'owz	Noun/verb
upset	axps'eht	Noun/verb
use	y'uws	Noun/verb
0	'ow	Zero/oh

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† By permission. From Webster's Ninth New Collegiate Dictionary © 1983 by Merriam-Webster, Inc., publisher of the Merriam-Webster © Dictionaries.

DECtalk/DICTIONARY PHONEMIC CORRESPONDENCE C

Several English phonemic alphabets are widely used today. Table C-1 lists the phonemic alphabets that DECtalk uses, together with the phonemic alphabets from two well-known dictionaries. It also gives an example of each sound.

Dictionaries put the stress marker after the vowel nucleus. DECtalk requires that the stress symbol appear before the vowel.

Table C-1 DECtalk and Dictionary Phonemic Alphabets

DECtalk 2-Character Alphabet	DECtalk 1-Character Alphabet	American Heritage Dictionary*	Webster's Third International Dictionary†	English Example
aa	a	ä	ä	father
ae	@	ā	a	bat
ah	^	ŭ	ə	but
ao	o	ō	ȯ	bought
aw	W	ou	au̇	bout
ax	x	ə	ə	about
ay	A	ī	ī	bite
b	b	b	b	bet
ch	C	ch	ch	chin
d	d	d	d	debt
dh	D	*th*	th	this
eh	E	ĕ	e	bet
el	L	l	əl	bottle
en	N	ən	ᵊn	button
ey	e	ā	ā	bake
f	f	f	f	fin
g	g	g	g	guess
hx	h	h	h	head
ih	I	ĭ	i	bit
ix	|	ə	ə	kisses
iy	i	ē	ē	Pete
jh	j	j	j	gin
k	k	k	k	Ken
l	l	l	l	let

Table C-1   DECtalk and Dictionary Phonemic Alphabets (Cont)

DECtalk 2-Character Alphabet	DECtalk 1-Character Alphabet	American Heritage Dictionary*	Webster's Third International Dictionary†	English Example
m	m	m	m	met
n	n	n	n	net
nx	G	ng	ŋ	sing
ow	o	ō	ō	boat
oy	O	oi	ȯi	boy
p	p	p	p	pet
r	r	r	r	red
rr	R	ûr	ər	bird
s	s	s	s	sit
sh	S	sh	sh	shin
t	t	t	t	test
th	T	th	th	thin
uh	U	o͝o	u̇	book
uw	u	o͞o	ü	lute
v	v	v	v	vest
w	w	w	w	wet
y	y	y	y	yet
yu	Y	yo͞o	yü	cute
z	z	z	z	zoo
zh	Z	zh	zh	leisure

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SERVICE AND DOCUMENTATION D

DIGITAL SERVICES
Your DECtalk unit comes with a warranty that gives you access to the best of Digital's resources including our technical expertise, spare parts inventories, and worldwide service organization.

After warranty, Digital's support continues through a range of on-site and off-site service alternatives for as long as you own your Digital hardware. These services are designed to help you get the maximum performance from your system.

DIGITAL On-Site Service
Our on-site services provide fast response and full support including the cost of all parts and labor. You can choose among programs that offer around-the-clock service, committed response time, problem escalation, and engineering changes, as needed.

DECservice
DECservice is Digital's most comprehensive on-site service. It provides committed response time including a four-hour service response if your system is located within 100 miles of a Digital service location. DECservice also provides continuous repairs until the problem is solved, a preventive maintenance program, installation of the latest engineering changes, and automatic escalation for complex problems.

DECservice lets you choose the hours of coverage you need to support your application, up to 24 hours a day, 7 days a week.

Basic Service

Basic service offers economical yet full service coverage. Your calls for service receive priority, second only to DECservice calls. You also receive preventive maintenance, installation of the latest engineering changes, and automatic escalation of complex problems.

Basic service is available during standard business hours, from 8:00 a.m. to 5:00 p.m., Monday through Friday.

Per Call Service

If your application does not demand comprehensive support, you can take advantage of one of Digital's per call programs.

Per call service is available on-site and off-site on a noncontractual basis. Service is available Monday through Friday during standard business hours, from 8:00 a.m. to 5:00 p.m.

For on-site per call service, you pay for the time and materials needed for each service call. Off-site per call service is available through mail-in board replacement and carry-in system repairs.

Carry-In Service

This is Digital's low cost alternative to on-site support. You can carry your terminal into any of the 150 Digital service centers throughout the United States and pick up the repaired system within two days. Or, if you perform your own maintenance, you can carry in your faulty module and receive an immediate exchange.

Carry-in service is available through a one-year, fixed cost agreement or on a per call basis that includes a flat rate for labor, plus the cost of all parts used in the repair. All carry-in service and parts come with a 90-day warranty.

DECmailer Service

DECmailer is a factory replacement service for Digital customers who maintain their equipment to the module or subassembly level. It provides 5-day turn-around, free return shipping, 90-day warranty, 24-hour emergency service, monthly billing, and quarterly activity reports.

Whichever Digital service option you select, you will receive high quality, reliable service delivered by one of the largest service organizations in the industry.

Digital International Field Service Information Numbers

For more information on any of Digital's services, call the service information number in your area during normal business hours.

Australia	(02)-4125555
Austria	(222)-6776410
Belgium	(02)-242-5095
Canada	(800)-267-5251
Denmark	(2)-889666
Finland	(0)-423511
France	(6)-077-8292
Holland	(30)-640293
Ireland	(1)-308433
Italy	(02)-617961
Japan	(03)-989-7161
Norway	(2)-160290
Portugal	351-1-725402
Spain	(1)-733 1900
Sweden	(08)-7338000
Switzerland	(01)-8169111
United Kingdom	(734)-868711
USA	1-(800)-554-3333
West Germany	(089)-95910

RELATED DOCUMENTS

The following DECtalk documents are available from Digital.

Title	Order Number	Description
DECtalk DTC01 Owner's Manual	EK-DTC01-OM	Gives an overview of DECtalk operations and describes in detail DECtalk off-line (local) operation, phonemic codes, and spoken text conventions.
DECtalk DTC01 Programmer's Reference Manual	EK-DTC01-RM	Describes DECtalk/computer connections, DECtalk escape sequences, and programming methods for interfacing DECtalk with a host computer and telephone.
DECtalk DTC01 Programmer's Reference Card	EK-DTC01-RC	Summarizes DECtalk phonemic codes, commands, and escape sequences.
DECtalk DTC01 Installation Manual	EK-DTC01-IN	Describes installing and maintaining the DECtalk unit.

ORDERING INFORMATION

You can order documents or supplies by telephone from 8:30 a.m. to 6:00 p.m. (EST) or by mail.

Continental USA and Puerto Rico

Call 1-(800)-258-1710 or write to:

Digital Equipment Corporation
P.O. Box CS2008
Nashua, NH 03061

New Hampshire, Alaska, Hawaii

Call 1-(603)-884-6660 or write to the above address.

Outside the USA and Puerto Rico

Write to:

Digital Equipment Corporation
Attn: Accessories and Supplies Business Manager
c/o Local Subsidiary or Digital-Approved Distributor

REFERENCES E

You may find the following references useful if you want to know more about how DECtalk operates.

Fairbanks, G. *Voice and Articulation Drillbook*. Second Edition. Harper and Row, 1960.

This book is intended for speech therapists and includes an introduction to phonetics and acoustics. One of its diagnostic tests, the amplifier passage (p. 114), was used to adjust DECtalk's speech rate parameters.

Bruckert, E., Minow, M., and Tetschner, W. "Three-Tiered Software and VLSI Aid Developmental System to Read Text Aloud." *Electronics*, Vol. 56, No. 8, April 21, 1983, pp. 133-138.

The inner workings of DECtalk are described by its implementors.

Klatt, D. H. "Software for a Cascade/Paralleled Formant Synthesizer." *Journal of the Acoustical Society of America*, Vol. 67, pp. 971-995.

Describes the speech synthesizer that is the model for the one used in DECtalk.

Klatt, D. H. "Review of the Science and Technology of Speech Synthesis." In *Overviews of Emerging Research Techniques in Hearing, Bioacoustics, and Biomechanics*, Proceedings of the 1981 Meeting, National Academy Press, Washington, D.C., pp. 15-38. (See also *Speech Group Working Papers*, MIT Research Laboratory of Electronics, Vol. III.)

Describes several speech synthesis technologies.

Klatt, D. H. "The Klattalk Text-to-Speech System." Proceedings of the International Conference on Acoustics, Speech, and Signal Processing, 1982, IEEE Catalog No. 82CH1746-7, pp. 1589-1592.

The linguist responsible for DECtalk describes its operation.

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