

T H E U N I V E R S I T Y O F M I C H I G A N

Technical Report 27

THE AUDIO RESPONSE UNIT USER'S GUIDE

Douglas Burr Smith

CONCOMP: Research in Conversational Use of Computers  
F.H. Westervelt, Project Director  
ORA Project 07449

supported by:

ADVANCED RESEARCH PROJECTS AGENCY  
DEPARTMENT OF DEFENSE  
WASHINGTON, D.C.

CONTRACT NO. DA-49-083 OSA-3050

administered through:

OFFICE OF RESEARCH ADMINISTRATION ANN ARBOR

April 1970



## ABSTRACT

This report describes the characteristics and use of the IBM 7772 Audio Response Unit as supported by the University of Michigan's terminal system. The following subjects are discussed: data transmission, device commands, and text-to-speech translation.

Keywords: audio response unit, computer terminal, "touch-tone" telephone



## Contents

1. Introduction . . . . .	1
2. System Input . . . . .	1
2.1 Alphabetic characters . . . . .	2
2.2 Numeric characters . . . . .	2
2.3 Special characters . . . . .	3
2.4 Numeric mode . . . . .	4
2.5 Text insertion mode . . . . .	4
2.6 Editing input lines . . . . .	5
3. System Output . . . . .	6
3.1 Margins and line length . . . . .	7
3.2 Delay mode . . . . .	7
3.3 Blank mode . . . . .	7
3.4 Spelling mode . . . . .	7
3.5 Literal mode . . . . .	8
3.6 Time compression . . . . .	8
3.7 Vocabulary changes . . . . .	8
3.8 Special decomposition . . . . .	8
3.9 Binary transmission . . . . .	8
4. Device Commands . . . . .	9
4.1 Basic device commands . . . . .	9
4.2 Extended device commands . . . . .	10
4.3 Prosodic commands . . . . .	12
5. Bibliography . . . . .	14
6. Appendix A . . . . .	15
7. Appendix B . . . . .	16
8. Appendix C . . . . .	17
9. Appendix D . . . . .	18
10. Appendix E . . . . .	19
11. Appendix F . . . . .	20
12. Appendix G . . . . .	21



## THE AUDIO RESPONSE UNIT USER'S GUIDE

### 1. INTRODUCTION

This guide describes the characteristics and use of the push-button or "touch-tone" telephone as a terminal.<sup>1</sup> By observing the conventions defined herein, any ten or twelve button touch-tone telephone can be used to perform the functions that could be requested of the University of Michigan's terminal system from other types of terminals.

The transmission of information between a telephone's handset and MTS is accomplished via the Direct Distance Dialing network, the University of Michigan centrex telephone system, and 403D data sets connected to an IBM 7772 Audio Response Unit (ARU). The telephone lines served by this device are in a "trunk-hunting" sequence beginning with the number (313) 763-0590.

The following notation is used throughout this guide:

- denotes a single blank or space;
- ... denotes omitted words or letters;
- {|} denotes a choice of options, e.g., {x|y} means choose x or y;
- [ ] denotes optional parameters, e.g., %TAB=i<sup>1</sup>[,i<sup>2</sup>,...,i<sup>8</sup>] indicates that the second through the eighth parameters are optional;
- X'y' denotes the hexadecimal value y.

### 2. SYSTEM INPUT

Information is transmitted via the telephone's keyboard. A twelve button keyboard is depicted in Figure 1. The ten button keyboard lacks the "\*" and "#" buttons. Two types of transmission period exist: the response period and the idle period.

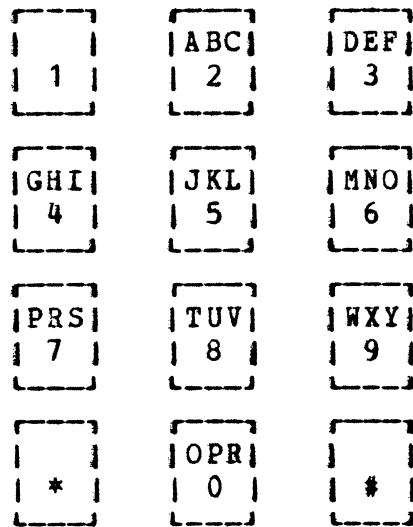
Response periods occur whenever the system or a user's program expects the user to enter data. A spoken prefix, e.g., the word "number," usually denotes the beginning of a response period. The response period extends until terminated by the user or until a twenty minute period, void of interaction, has elapsed. Periodically during the response period, the user will hear a high pitched tone, or beep. The beep is a reminder that a response is outstanding. It will not interfere with transmission.

-----  
<sup>1</sup> "Touch-tone" is a Bell system trademark.  
The development of the ARU's support was sponsored in part by the Advanced Research Projects Agency under contract # DA-49-083 OSA-3050.

Idle periods occur mainly during program loading and execution. During these periods nothing is required of the user; however, he may enter several of the device commands, e.g., attention. Idle periods are marked by periodic low pitched beeps.

Figure 1

"Touch-Tone" Keyboard



A description of the ARU's transmission facilities follows.

### 2.1 Alphabetic characters

Alphabetic characters are entered by first depressing the key on which the desired letter is engraved, then key 1, 2, or 3 depending on whether the desired letter is the first, second, or third character on its key. "A" is sent by depressing key 2 then key 1 (the strokes 21), "B" by the strokes 22, and "P" by the strokes 71. The letters "Q" and "Z" do not appear on the handset's keyboard. They are sent by depressing the key on which they should have appeared followed by the zero or operator key. Thus "Q" is sent as 70 and "Z" is sent as 90. As a final example, "RUN" is sent with the strokes 728262.

### 2.2 Numeric characters

The digits 0 through 9 are sent by first depressing the zero or operator key and then depressing the key on which the desired digit appears. "1" is sent as 01, "2" as 02, and "105" as 010005.



## 2.3 Special characters

The special characters are encoded by the two stroke mnemonics defined below.

<u>Character</u>	<u>Spoken Form</u>	<u>Mnemonic strokes</u>
&	and	AO
*	asterisk	AS
@	at	AT
■	blank <sup>1</sup>	BL
¢	cents	CX
:	colon <sup>1</sup>	CO
,	comma <sup>1</sup>	88 <sup>2</sup>
/	divided, by <sup>3</sup>	DI
\$	dollars	DO
=	equals	EQ
!	exclamation point <sup>1</sup>	EX
>	greater than	GT
-	horizontal stroke <sup>1</sup>	HS
(	left parenthesis <sup>1</sup>	LP
<	less than	LT
-	minus <sup>1</sup>	MI
*	multiplied by <sup>3</sup>	MU
¬	not	NO
#	number	NO
	or	VO
%	percent <sup>1</sup>	PX
+	plus	PL
.	point <sup>1</sup>	89 <sup>2</sup>
'	prime <sup>1</sup>	IM
?	question mark <sup>1</sup>	QM
"	quote	QU
)	right parenthesis <sup>1</sup>	RP
;	semicolon <sup>1</sup>	87 <sup>2</sup>
/	slash	SH

-----  
<sup>1</sup> May, or may not, be spoken - reference "System Output."

<sup>2</sup> The most commonly required punctuation characters, semicolon, comma, and period, are defined for ease of transmission around key 8.

<sup>3</sup> This form is a mnemonic only - it is not spoken.

Additional codes for several of the special characters are available on twelve button handsets. These characters are sent in the form "\*x" and are defined below. They were selected for use in the numeric mode.

<u>Code</u>	<u>Character Defined</u>
*2	(
*3	)
*4	*
*5	/
*6	-
*7	+
*8	,
*9	.
*0	■

#### 2.4 Numeric mode

A numeric mode may be entered on twelve button handsets to facilitate entry of numeric data.

- The mode is entered and left by the strokes 1# or ## or through the %NUM device command.
- Keys zero through nine transmit their respective values, i.e., EBCDIC codes X'F0'...X'F9'.
- The \* series of special characters is effective.
- The "#x" form of all device commands is effective (see Section 4.1).

#### 2.5 Text insertion mode

The text insertion mode permits the insertion of a record from a line file into the current input line. The mode may be entered and left with the strokes 14 or #4 or through the %INS device command. The attached line file is \*ARUDEF, reference Appendix B, unless another file has been appended through the %DEF device command.

Whenever the insertion mode is active, every two strokes entered form a line number. If the attached file contains a line at that number, the line's contents are inserted into the current input record. If no line resides at that number or the expanded line's length exceeds 255 characters, the usual character defined by the two strokes is placed in the input record. If the expanded line's length equals 255 characters an end-of-line is automatically generated and the line is transmitted. Whenever the numeric mode and insertion mode are active together, one stroke forms the line numbers zero through nine and two strokes form the characters of the "\*" series.

Suppose a line file were attached by the %DEF device command. The file has a single line, line 99, whose contents are "\*ASMBLR SCARDS=." While the insertion mode is inactive the strokes 3672826225996481 transmit "\$RUN==-T."

Entering the same strokes while the insertion mode is active will produce "\$RUN#\*ASMBLR#SCARDS=-T."

Note that the entire two stroke code may be redefined through text insertion.

## 2.6 Editing input lines

The preparation of input lines is facilitated by the following device commands:

<u>Code</u>	<u>Description</u>
#6 or 16	backspace: if on an odd stroke boundary, the last stroke is deleted; if on an even stroke boundary, the last two strokes are deleted
**	forward space: no blank inserted
#5 or 15	delete line
#1 or 11	tab: blanks inserted
*1	tab: no blanks inserted
**	reset cursor
#9	end-of-line

The backspace command decrements the input cursor (a pointer to the current text column) by one unless it is at the beginning of the line. The character bypassed is not altered.

The forward space command increments the input cursor by one. The character bypassed is not altered.

The delete line command sets the input cursor to the beginning of the line. The contents of the line are unchanged.

Two forms of the tab command exist. Both move the input cursor to the next column defined in the tab stops that is greater than the current column. If no column meets the preceding criterion, the cursor is incremented by one. One form of the tab command, #1 or 11, inserts blanks in the columns bypassed, while the other form, \*1, does not alter the bypassed text. Tab stops can be set through the %TAB command. Under appropriate circumstances (the "peel" modifier set on), tab stops are normalized by the line number preceding the line, if any. The comma can be used to separate a line number from numeric data: "12,10" is transmitted as "10" with a line number of twelve; "-100.5,,55" is transmitted as ",55" with a line number of -100.5.

The reset cursor command sets the cursor to the greatest value that it has possessed in the current line. For example, the commands #6#6\*\*#5\*\* cause no change in either the text or the cursor.

The end-of-line command causes the text preceding the current cursor to be sent to the system or the user's program.

### 3. SYSTEM OUTPUT

System output is sent to the ARU in the same manner one would "write" on a printer. The ARU's support performs all the conversions necessary to speak the text.

The generation of speech from text is an involved process and the following paragraphs are intended only to acquaint the user with the fundamentals of the translation scheme employed by the ARU's support - a scheme that might be described as morphemic decomposition.

Residing within the ARU's public vocabulary file is the information necessary to produce certain fundamental sounds that occur in English. Each sound is called a morpheme and the information necessary to generate each sound is called its digitally coded voice, DCV. The morpheme has been characterized as the smallest meaningful unit of speech. The spoken word "cat" and the word "pay" are each single morphemes while "cats" and "prepaying" are composed of two and three morphemes respectively.

The morpheme's parallel in text is the "morph." The morph is the smallest meaningful unit of text. The words "cat" and "paying" are composed of one and two morphs respectively.

The ARU's support performs the following operations during translation:

1. recognizes morphs;
2. associates with each detected morph a morpheme;
3. applies rules that relate juxtaposed morphemes to their combined form (morphophonemic rules);
4. adds cues to enhance recognition of words and phrases (the prosodic cues of pitch, intensity, and duration).

The translation scheme is cognizant of regular spelling changes that occur in the formation of plural nouns and the conjugates of verbs.

Approximately ten of the special characters are spoken only in certain situations. For example, "." is spoken as "point" only if it does not terminate a sentence and it is preceded or followed by one of the digits. When "." is not spoken it assumes its prosodic value. Those special characters whose spoken form is dependent on context are identified in Section 2.3. The functions of three of those characters, the left and right parenthesis and the horizontal stroke, are described below.

The left and right parenthesis are spoken unless they occur within a prosodic device command. The prosodic commands are described in Section 4.3.

The horizontal stroke, "\_", functions as a concatenation character. It is not spoken unless it is the last character in the text. When unspoken, its value is null.

The facilities that control the speech generated by the ARU are described below.

### 3.1 Margins and line length

Sections of output lines - not echoed input lines - may be deleted by adjusting the left margin and the line length through the %MAR and the %LEN device commands. If the left margin were set to M and the line length to L, only the Mth character and the following "L minus one" characters, if they exist, would be spoken. Normally the left margin is set to one and the line length to 255.

### 3.2 Delay mode

The initial mode of operation might be termed one of minimum delay. Successive output lines are formed and spoken with a minimum delay between lines. This mode provides the most rapid response but may not allow the user to interrupt or ask for a line to be repeated. If the user wishes an opportunity to enter device commands at the end of each line of spoken output, a delay mode may be entered, and left, by strokes 1\* or #\* or through the %DEL device command. When entered, a five second pause follows every output line. During this pause the user may request repetition of the preceding line, enter attention, etc. The pause may be terminated prematurely by the strokes 19 or #9.

### 3.3 Blank mode

Usually each blank or space generates a short pause, 216 microseconds. Whenever the blank mode is enabled in conjunction with the literal mode all blanks are spoken as "blank." The %BLA command controls the blank mode.

### 3.4 Spelling mode

Whenever the spelling mode is active in conjunction with the literal mode, all output is spelled. The %SPE device command controls the spelling mode.

### 3.5 Literal mode

The literal mode disables the prosodic decomposition of output lines and "conditions" the spelling mode and the blank mode. Whenever it is enabled all prosodic decomposition ceases, e.g., the "." and "?" are spoken as "point" and "question mark" rather than controlling prosody. The literal mode is controlled by the #7, 17, and %LIT commands.

Note that neither the blank mode nor the spelling mode is activated until the literal mode is enabled. Thus a user may enable blank mode and at a later time enter "HI#." followed by #7#2 to discover the number of blanks following HI. He might then enter #6 followed by "THERE" producing "HI#THERE."

### 3.6 Time compression

Increased rates of speech can be obtained through the %TIM device command and the %TIM prosodic command. The compression induced by the %TIM device command occurs in all output lines and is independent of that specified by the %TIM prosodic command. Five levels of compression are available.

### 3.7 Vocabulary changes

The user may append an alternate vocabulary to the master vocabulary or he may substitute an alternate vocabulary for the master vocabulary. The %VOC and %MVO device commands control these modifications.

### 3.8 Special decomposition

Whenever an output record is accompanied by the special modifier, @SP, the record is decomposed but not spoken. Instead, the address of a buffer containing the record's digitally coded voice, DCV, replaces the first four characters of the output record and the DCV's length, in bytes, replaces the second four characters of the record. If an error is detected, the address and length will be zero. The user may modify the buffer and should eventually release it via the subroutine FREESPAC.

### 3.9 Binary transmission

Whenever an output record is accompanied by the binary modifier, @BIN, the record is sent to the ARU without modification. The record's length must be less than 65,536 bytes. This option permits transmission of DCV directly to the ARU.

## 4. DEVICE COMMANDS

Three types of device /command exist: the basic command, the extended command, and the prosodic command.

### 4.1 Basic device commands

Through the basic device commands, users can control the fundamental processes of the ARU. The basic commands are defined below and are summarized in Appendix C.

<u>Code</u>	<u>Description</u>
## or 1#	enter (or leave) numeric mode
#0 or 10	attention
** or 1*	enter (or leave) delay mode
#9 or 19	a, end-of-line; or b, continue a. Signifies that the current input line is complete and should be sent to the system b. Terminates the pause inserted in the delay mode
#8 or 18	end-of-file
#7 or 17	enter (or leave) literal mode
#6 or 16	backspace: if on an odd stroke boundary, the last stroke is deleted; if on an even stroke boundary, the last two strokes are deleted
#5 or 15	delete line
#4 or 14	enter (or leave) text insertion mode
#3 or 13	repeat the last line that was spoken
#2 or 12	echo the current input line - the input image remains unaltered after the echo except for the deletion of odd strokes
#1 or 11	tab: blanks inserted
##	reset cursor
**	forward space: no blank inserted
*1	tab: no blanks inserted

The ARU does not generate a comment acknowledging receipt of the basic device commands; however, the extended forms of the device commands, defined subsequently, are acknowledged.

The function of the device commands that "enter (or leave)" modes is dependent on the current state of the mode. For example, the commands "####" cause no change in the setting of the numeric mode.

The device commands must be initiated with the stroke 1 on ten button handsets. If the user should accidentally omit one of a pair of strokes, transmitting an odd number of strokes, the 1 prefix of a device command will be received as the second stroke of an unfinished pair. The device command will thus appear to have been ignored. This may be corrected by sending an arbitrary stroke and then the desired device command.

As an example suppose that "HI" followed by "echo-input-line" is sent as 42(4)312 - the second 4 having been omitted. The ARU has actually received 42312 or "HD" followed by the stroke 2. If the user then keys 112, the ARU has received 42312112 and will echo "HDA". The user may then backspace over the two incorrect characters by entering 1616. Finally by keying 4312, the ARU will echo "HI" as desired.

Users of twelve button handsets may avoid the above alignment problem by using the # prefix stroke for device commands. The # form of the command is recognized in most environments; if it is recognized on an odd stroke boundary a backspace of one stroke is automatically made.

Suppose that one desires to enter "HI" followed by "echo-input-line" from a twelve button handset and makes the same error as before, sending 42(4)3#2. The #2 device command will be recognized, "H" will be echoed, and the spurious stroke of 3 will be deleted. If the user then enters 43#2, the ARU will echo "HI" as desired.

#### 4.2 Extended device commands

Through the extended device commands, a user can select and modify the optional facilities at his disposal. The extended commands are recognized in both input and output lines.

Any input line of the form %x..., x being a character other than %, is interpreted as a device command. An input line of the form %%... is transmitted as %... .

Any output line received with the "upper case" modifier set on, @UC, and initiated by %x, x being a character other than %; is interpreted as a device command. An output line of the form %%... is transmitted as %... .

The legal device commands are described below and are summarized in Appendix D.

%BLA={ON|OFF} (blank mode)

This command controls the spoken form of the blank or space. Whenever the blank mode is enabled in conjunction with the literal mode, all blanks occurring in an output line are spoken as "blank." The default setting is off.

%DEC={ON|OFF} (decomposition mode)

This command controls the processing of echoed input lines. Normally prosodic decomposition is disabled for speech evoked by the #2 or 12 command. Thus ".", "?", and "%SEG(1,2,HI)" are echoed as point, question mark and "%SEG(1,2,HI)." Whenever the decomposition mode is enabled and the literal mode is disabled, prosodic decomposition occurs for echoed lines.



`%DEF={filename|OFF}` (definition file)

This command appends, or deletes, a definition file for use in the text insertion mode. Accessible line file names and OFF comprise valid parameters. The file specified by "filename" replaces the active definition file, if any. The default definition file, \*ARUDEF, is attached initially and after the %RES command.

`%DEL={ON|OFF}` (delay mode)

Like the \*\* command, this command controls the delay mode of output presentation. This facility is described in Section 3.2. The default setting is off.

`%HEL` (help)

This command produces a report of the status of those control facilities that differ from their default values.

`%INS={ON|OFF}` (text insertion mode)

Like the #4 command, this command controls the text insertion facility described in Section 2.5. The default setting is off.

`%LEN=i` (length)

This command sets the maximum number of characters recognized in output lines. The character occurring at the left margin, if any, and the i-1 characters following it are processed. The value of i may range from 1 to 255 and its default value is 255.

`%LIT={ON|OFF}` (literal mode)

Like the #7 command, this command controls the literal mode of decomposition. Section 3.5 describes this facility. The default setting is off.

`%MAR=i` (margin)

This command sets the left margin to column i. All characters preceding the ith character of an output line are ignored. The value of i may range from 1 to 255 and the default value is 1.

`%MVC=filename` (master vocabulary)

This command alters the master vocabulary to the file specified by the parameter. Only accessible line files may be attached. Unless the appended vocabulary contains definitions of X'40'...X'FF', it will produce an immediate error and be replaced by the ARU's public vocabulary.

`%NUM={ON|OFF}` (numeric mode)

Like the `##` command, this command controls the numeric mode of data entry. Section 2.4 contains a description of this facility. The default setting is off.

`%RES` (reset)

This command resets all control facilities, except those related to appended definition and vocabulary files, to their default values.

`%RST` (reset)

This command resets all control facilities to their default values.

`%SPE={ON|OFF}` (spelling mode)

This command controls the decomposition of output lines. When the spelling mode is enabled in conjunction with the literal mode, all "words" are spelled. The default setting is off.

`%TAB=i1[,i2,...,i8]` (tabulation)

This command sets tab stops at the columns specified by  $i^1, \dots, i^8$ . The value of each  $i$  may range from 1 to 255 and should be greater than the value of every preceding  $i$ . The default value of  $i$  is 1. From one to eight tab stops can be set.

`%TIM=i` (time compression)

This command sets an ordinal time compression factor effective for all speech. This compression factor is independent of that specified by the `%TIM` prosodic control command. The value of  $i$  may range from 1 to 5: increasing values represent increasing compression - "3" is approximately twice as fast as "1." The default value of  $i$  is 1.

`%VOC={filename|OFF}` (vocabulary)

This command appends a vocabulary to the master vocabulary. Deference is given to the definitions found in the appended vocabulary. The master vocabulary remains active and is referenced for definitions that are unavailable in the appended vocabulary. An appended vocabulary will be detached if an erroneous entry is encountered.

### 4.3 Prosodic commands

The prosodic device commands control the decomposition of portions of an output line - altering the spoken form of those portions. They are recognized in any output line unless the literal mode is enabled. They are not effective in echoed input lines unless the decomposition mode is enabled and the literal mode disabled. They may be "stacked" to a depth of five

commands. The prosodic commands are never acknowledged: illegal commands are repeated as they appear in the output line.

The legal prosodic commands are described below and are summarized in Appendix D.

`%FRE` (frequency)

This command remains to be implemented.

`%INT` (intensity)

This command remains to be implemented.

`%SEG(i1,i2,text)` (segmentation)

This command selects the i<sup>1</sup>th through the i<sup>2</sup>th aggregate and excitation functions<sup>1</sup> (inclusive) from the text - the remainder of the DCV is discarded. The value of i<sup>1</sup> and i<sup>2</sup> may range from 1 to 255. The right parenthesis terminates the command whenever the text does not contain i<sup>2</sup> aggregate functions. The output line "`%SEG(1,16,VERTICAL)%SEG(16,38,ACTUAL)`" generates "virtual pages."

`%TIM(i,text)` (time compression)

This command increases the rate of speech for the characters that replace the "text." The value of i may range from one to five: increasing values represent increased compression.

An example: "`HI=%TIM(2,THERE!#HOW#ARE#%TIM(2,YOU)).`"

-----

<sup>1</sup> Reference Appendix E.

## 5. BIBLIOGRAPHY

- Allen, J. "Machine-to-Man Communication by Speech Part II: Synthesis of Prosodic Features of Speech by Rule." AFIPS Conference Proceedings. 32(1968):339
- Chomsky, N., Halle, M. The Sound Pattern of English. New York:Harper and Row, 1968.
- Clarke, D.C., Wall, R.E. "An Economical Program for the Limited Parsing of English." AFIPS Conference Proceedings. (1965):307
- IBM 7772 Audio Response Unit. Form A27-2711.
- IBM 7772 Theory of Operation. Form 226-2072.
- Lee, F.F. "Machine-to-Man Communication by Speech Part I: Generation of Segmental Phonemes from Text." AFIPS Conference Proceedings. 32(1968):333
- Mattingly, I.G. "Synthesis by Rule of Prosodic Features." Language and Speech. 9(1966):1-13
- Rothausser, E.H. "The Integrated Vocoder and Its Application in Computer Systems." IBM Journal. (1966):455

6. APPENDIX A

Summary of the Two Stroke Code

Second Stroke

	1	2	3	4	5	6	7	8	9	*	0	#
1	tab	ech	rep	ins	del	bac	lit	eof	eol	dly	att	num
2	A	B	C	■	■	:	*	@	¢		&	
3	D	E	.F	/	■	\$	=	■	!		■	
4	G	H	I	■	■	'	_	>	■		■	
5	J	K	L	■	■	■	(	<	■		■	
6	M	N	O	-	■	#	■	*	■		-	
7	P	R	S	/	+	?	)	"	%		Q	
8	T	U	V	■	■	■	;	,	.			
9	W	X	Y	■	■	■	■	■	■		Z	
*	tab	(	)	*	/	-	+	,	.	for	■	res
0	1	2	3	4	5	6	7	8	9		0	
#	tab	ech	rep	ins	del	bac	lit	eof	eol	dly	att	num

First  
Stroke

## 7. APPENDIX B

### The Contents of \*ARUDEF

<u>Line_#</u>	<u>Contents</u>
	Note: ■ signifies a blank
24	\$COPY■
30	\$CREATE■
35	\$DESTROY■
38	\$EMPTY■
40	\$GET■
44	\$LIST■
45	\$NUMBER■
49	\$RUN■
50	\$SET■
54	\$SIG■
55	\$SOURCE■
56	\$UNNUMBER■
59	%DEF=
65	%DEL=
67	%TAB=
69	CANCEL
84	*DUMMY*■
85	*SINK*■
86	*SOURCE*■
94	■PAR=
95	■PW=
96	■SCARDS=
97	■SERCOM=
98	■SPRINT=
99	■SPUNCH=

## 8. APPENDIX C

### Summary of the Device Commands

<u>Code</u>	<u>Description</u>
# # or 1 #	enter (or leave) numeric mode
# 0 or 1 0	attention
* # or 1 *	enter (or leave) delay mode
# 9 or 1 9	a, end-of-line; or b, continue a. Signifies that the current input line is complete and should be sent to the system b. Terminates the pause inserted in the delay mode
# 8 or 1 8	end-of-file
# 7 or 1 7	enter (or leave) literal mode
# 6 or 1 6	backspace: if on an odd stroke boundary, the last stroke is deleted; if on an even stroke boundary, the last two strokes are deleted
# 5 or 1 5	delete line
# 4 or 1 4	enter (or leave) text insertion mode
# 3 or 1 3	repeat the last line that was spoken
# 2 or 1 2	echo the current input line - the input image remains unaltered after the echo except for the deletion of odd strokes
# 1 or 1 1	tab: blanks inserted
* #	reset cursor
* *	forward space: no blank inserted
* 1	tab: no blanks inserted

## 9. APPENDIX D

### Summary of the Extended Device Commands

%BLA= {ON OFF}	blank mode
%DEC= {ON OFF}	decomposition mode
%DEF= {filename OFF}	definition file
%DEL= {ON OFF}	delay mode
%HEL	help
%INS= {ON OFF}	text insertion mode
%LEN=i	line length
%LIT= {ON OFF}	literal mode
%MAR=i	margin
%MVO=filename	master vocabulary
%NUM= {ON OFF}	numeric mode
%RES	reset;partial
%RST	reset;total
%SPE= {ON OFF}	spelling mode
%TAB=i <sup>1</sup> [,i <sup>2</sup> ,...,i <sup>n</sup> ]	tabulation
%TIM=i	time compression
%VOC= {filename OFF}	vocabulary

### Summary of the Prosodic Commands

%FRE	frequency
%INT	intensity
%SEG(i <sup>1</sup> ,i <sup>2</sup> ,text)	segmentation
%TIM(i,text)	time compression



## 10. APPENDIX E

### Speech Synthesis by the IBM 7772

The speech you hear from the ARU is generated by fifteen filters. Each filter resembles a key on a piano: it is capable of producing tones in a specific frequency range. The frequencies covered by the fifteen filters coincide with the audible frequencies transmitted by a telephone (50 to 3500 Hz). By controlling the intensity of the tone generated by each filter and the time at which the tones are emitted, one can generate speech.

The user can control the intensity of each filter's tone by setting one of eight intensity factors. The intensity factors range from zero to thirty-five decibels in steps of five decibels, i.e., eight "shades of gray." The information necessary to set the fifteen filters' intensities is called an "aggregate function."

The user controls the time at which the filters generate their tones through a series of integers - each integer having a value between zero and 127. The series of integers is called an "excitation function." When the ARU receives an excitation function it performs one of the following operations on each integer in the series:

1. It selects the next integer and increments it by one every 216 microseconds. When the value of the integer equals 127, the ARU activates (pulses) the filters, selects the next integer, and repeats the process.
2. It selects the next integer and increments it by one every 216 microseconds. During the period it is incrementing the integer, the ARU randomly pulses the filters. When the value of the integer equals 127, the ARU selects the next integer and repeats the process.

The user can select the operation performed by setting a "statistics" switch in the aggregate function. When the excitation function is expended the user can send a new aggregate function to the ARU and then send an excitation function to activate the filters. By transmitting repeated aggregate and excitation functions, one can generate speech.

## 11. APPENDIX F

### Statistics of the ARU's Filters

<u>FILTER NUMBER</u>	<u>CENTRAL FREQUENCY</u>	<u>FUNDAMENTAL<sup>1</sup></u>	<u>2ND<sup>1</sup></u>	<u>3RD<sup>1</sup></u>	<u>4TH<sup>1</sup></u>	<u>5TH<sup>1</sup></u>
1	244	108	89	51		
2	346	114	100	73	20	
3	452	117	107	86	45	
4	565	119	111	94	61	
5	697	120	114	100	74	21
6	841	121	116	105	83	39
7	998	122	118	108	90	53
8	1170	123	119	111	95	64
9	1366	124	120	113	100	73
10	1600	124	121	115	104	81
11	1851	124	122	117	107	87
12	2155	125	123	118	110	93
13	2500	125	123	120	112	97
14	2907	125	124	121	114	102
15	3425	126	124	122	116	105

-----

<sup>1</sup> Entries appearing in this column are the values of the excitation functions (base 10) whose nth harmonics are nearest the central frequencies displayed.

## 12. APPENDIX G

### Files and Subroutines Supporting the ARU

The following files and subroutines support the ARU. Their descriptions appear in volumes two and three of the MTS manual.

<u>File</u>	<u>Description</u>
*ARUVOC	contains a list of the public vocabulary's entries
*CREVOC	contains a program that creates and modifies vocabularies
*DCVDEC	contains a program that lists the DCV of the text passed to it
*IM20	contains a master vocabulary that translates all output to International Morse Code
*MOUNT	contains a program that allocates an ARU line to a job
*VLIST	contains a program that lists the definitions occurring in a vocabulary

<u>Subroutine</u>	<u>Description</u>
DCVC	composes DCV from a string of integers passed to it
DCVD	decomposes DCV into a string of integers
DCVG	obtains the DCV of the text passed to it



## DOCUMENT CONTROL DATA - R &amp; D

(Security classification of title, body of abstract and indexing information must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

UNIVERSITY OF MICHIGAN  
COMCOMP PROJECT

2a. REPORT SECURITY CLASSIFICATION

Unclassified

2b. GROUP

3. REPORT TITLE

THE AUDIO RESPONSE UNIT USER'S GUIDE

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Technical Report 27

5. AUTHOR(S) (First name, middle initial, last name)

Douglas Burr Smith

6. REPORT DATE

April 1970

7a. TOTAL NO. OF PAGES

14

7b. NO. OF REFS

3

8a. CONTRACT OR GRANT NO.

DA-49-083 OSA-3050

b. PROJECT NO.

8a. ORIGINATOR'S REPORT NUMBER(S)

Technical Report 27

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned  
this report)

10. DISTRIBUTION STATEMENT

Qualified requesters may obtain copies of this report from DDC.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY

Advanced Research Projects Agency

13. ABSTRACT

This report describes the characteristics and use of the IBM 7772 Audio Response Unit as supported by the University of Michigan's terminal system. The following subjects are discussed: data transmission, device commands, and text-to-speech translation.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
audio response unit computer terminal "touch-tone" telephone						



UNIVERSITY OF MICHIGAN



**3 9015 03524 5037**