VOTRAX®

AUDIO RESPONSE SYSTEM

VS-6.0

Prepared by

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Federal Screw Works
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Troy, Michigan 48084

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Vocal Interface Division
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FOREWORD

The Vocal Interface Division Audio Response System is a new concept in voice synthesis. The complete system was designed and is manufactured by the Vocal Interface Division - Federal Screw Works of Troy, Michigan.

To adapt technical publications to potential variation in customer needs, a separate manual is provided for each of the major assemblies and options. In this way, Vocal Interface Division will be able to supply its customers with specific information needed to install, operate, and service the particular equipment they have purchased.

This book contains the following Manuals:

Part Number	Manual Title	Manual(s) Included
936	Audio Response System	☒
937	Voice Generator	☐
938	Parallel Interface	☐
939	Serial Interface (preliminary)	☒
940	Keyboard Option	☐
941	ROM Vocabulary Storage Unit	☐
942	VOTRAX Programming (preliminary)	☒
943	VOTRAX Vocabulary	☒

TABLE OF CONTENTS

INTRODUCTION

This SYSTEMS - manual is provided to acquaint the user with the VOTRAX Audio Response System. This is accomplished by presenting brief descriptions, explanations, and data on the various major assemblies of the system. Basic system specifications are listed as well as initial installation, check-out, and operating,instructions.

More detailed information on the various assemblies, options, and aspects of the system is presented in separate manuals devoted entirely to the particular subject.

A. SYSTEM

The VOTRAX Audio Response System consists of the basic voice generator and the parallel or serial interface circuitry. A manual keyboard Unit and a ROM vocabulary storage unit are selectable options to the system. The system block diagram is presented below, in Figure 1.

The system solid state circuitry is mounted on seven plug-in type printed circuit boards. The location of these boards is illustrated in Figure 2.

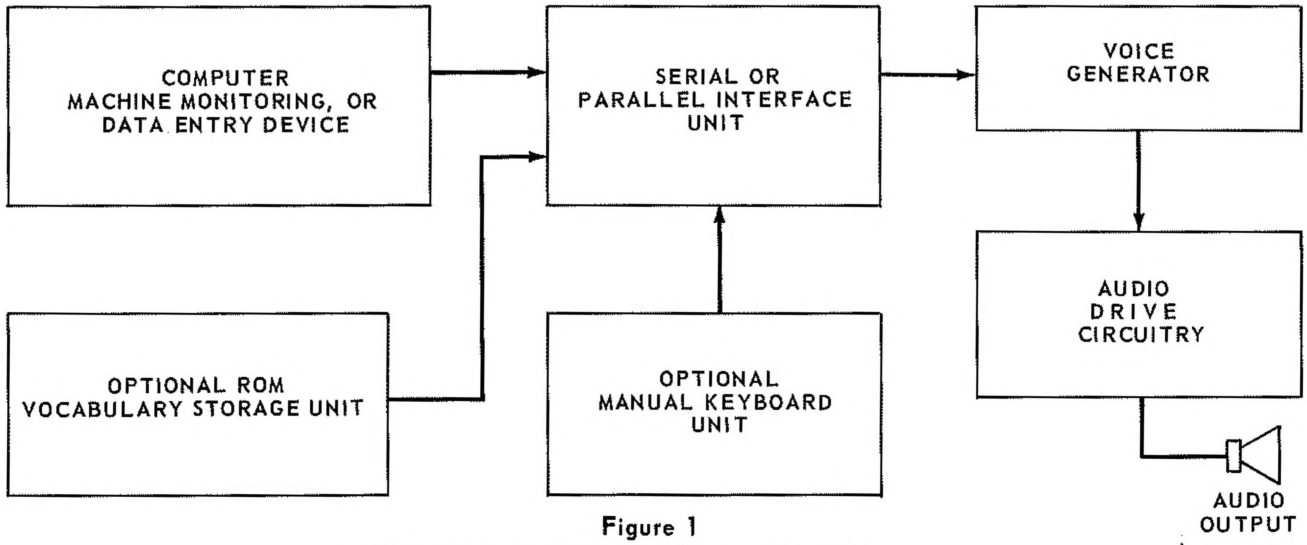


Figure 1
VOTRAX Audio Response System Block Diagram

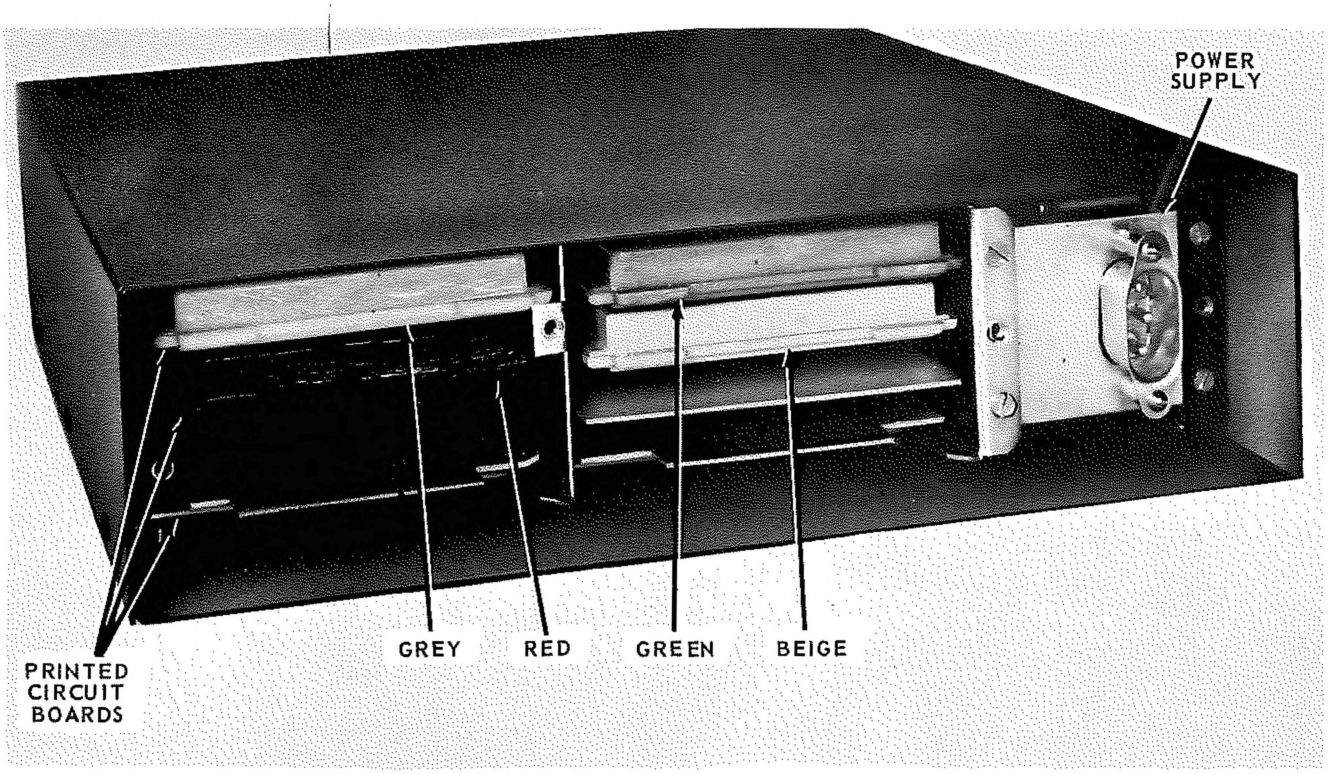


Figure 2
Rearview, VOTRAX Unit

INTRODUCTION

The versatility of the VOTRAX packaging provides a stand-alone bench top configuration, a systems rack mount feature, and a portable suitcase type container. These are illustrated in Figure 3.

B. VOICE GENERATOR

The VOTRAX Voice Generator is a solid state unit designed to synthesize human speech with unlimited vocabulary. It accepts sequences of digital word commands and converts these commands into corresponding phonetic audio signals. It is an electronic simulation of the human brain-vocal system. Thus, any word in the human language may be synthesized by a corresponding appropriate sequence of digital commands.

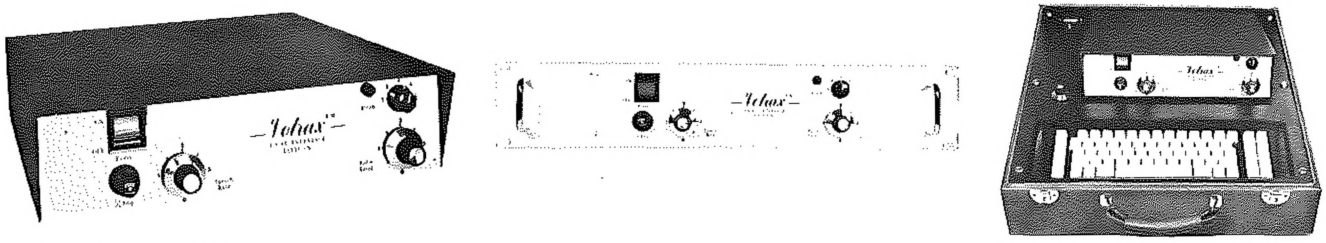
The Voice Generator circuitry is mounted on four plug-in type printed circuit boards. These boards are epoxy encapsulated and are color coded. The location of these boards is illustrated in Figure 4.

More detailed information on the Voice Generator is presented in the VOTRAX Voice Generator Manual P/N 937.

C. PARALLEL INTERFACE

The VOTRAX Parallel Interface Unit accepts an 8 bit parallel byte for each command word and converts it into the digital format required by the Voice Generator Unit. The interface unit is the buffer between the Voice Generator and the outside world. Control signals are also generated for use with outside data entry devices, such as computers. Various types of Parallel Interface Units are available, such as: Buffered, Unbuffered, and FIFO (first in, first out) buffered. Data rates up to 500 Kilohertz are available.

The parallel interface solid state circuitry is mounted on two plug-in type printed circuit boards. These



STAND ALONE BENCH TOP MODEL

HORIZONTAL RACK MOUNT MODEL

PORTABLE SUITCASE MODEL

Figure 3
VOTRAX Audio Response System Packaging Configurations

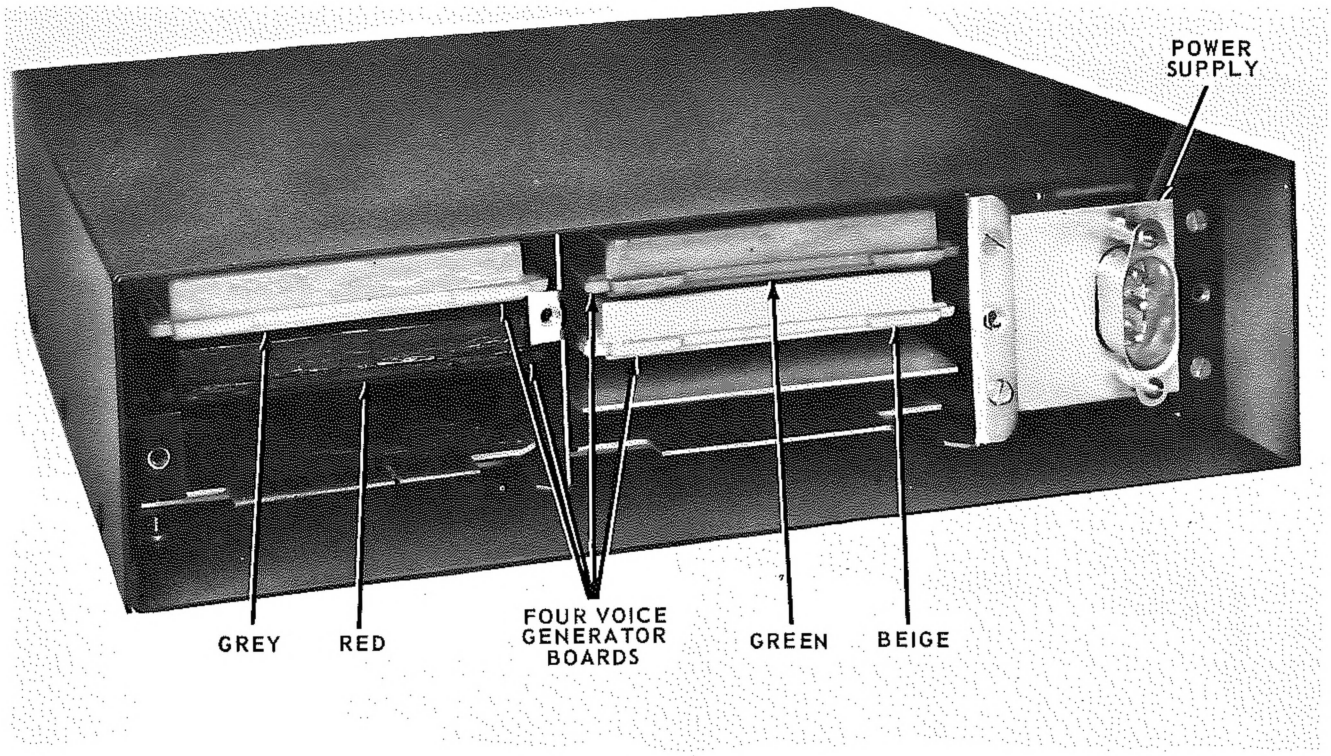


Figure 4
Rear View, VOTRAX Unit

boards are not encapsulated and may be repaired if necessary. The location of these boards is illustrated in Figure 5.

More detailed information on the Parallel Interface Unit is presented in the VOTRAX Parallel Interface Manual P/N 938.

D. SERIAL INTERFACE

The VOTRAX Serial Interface Unit is designed for installation between the asynchronous serial data port of a computer or modem, and the Voice Generator Unit. This serial unit meets E.I.A. specifications RS-232C with respect to all electrical characteristics. The signals implemented in the serial interface circuitry for a VOTRAX/computer installation are:

AA Protective Ground

AB Signal Ground

BA Transmitted Data

BB Received Data

CA Request to Send

CB Clear to Send

CC Data Set Ready

CD Data Terminal Ready

CE Ring Indicator

CF Carrier Detect (same as CC)

Various modes of operation are available with the Serial Interface Unit, such as: 4 bit or 8 bit intelligence words, Half-Dupiex or Full-Duplex operation, parity bit option, and code levels of 5, 6, 7, or 8 bits with 1 or 2 stop bits. Data rates of 110, 150, 300, 600, or 1200 baud are available.

The serial interface circuitry is mounted on two plug-in type printed circuit boards. These boards are not encapsulated and may be repaired if necessary. The location of these boards is illustrated in Figure 6.

More detailed information on the Serial Interface Unit is presented in the VOTRAX Serial Interface Manual P/N 939.

E. KEYBOARD INTERFACE

The optional VOTRAX Keyboard Interface Unit accepts an 8 bit parallel byte for each command word and converts it into the digital format required by the Voice Generator Unit. This interface unit is the buffer between the Voice Generator and the manual VOTRAX exerciser (KEYBOARD UNIT) described in the following section. The required control signals are generated by this interface circuitry to allow manual operation of the VOTRAX Audio Response System.

The solid state Keyboard Interface circuitry is mounted on a single plug-in type printed circuit board. This board is not encapsulated and is repairable if necessary. The location of this board is illustrated in Figure 7.

More detailed data on the Keyboard Interface Unit is presented in the VOTRAX Keyboard Option Manual P/N 940.

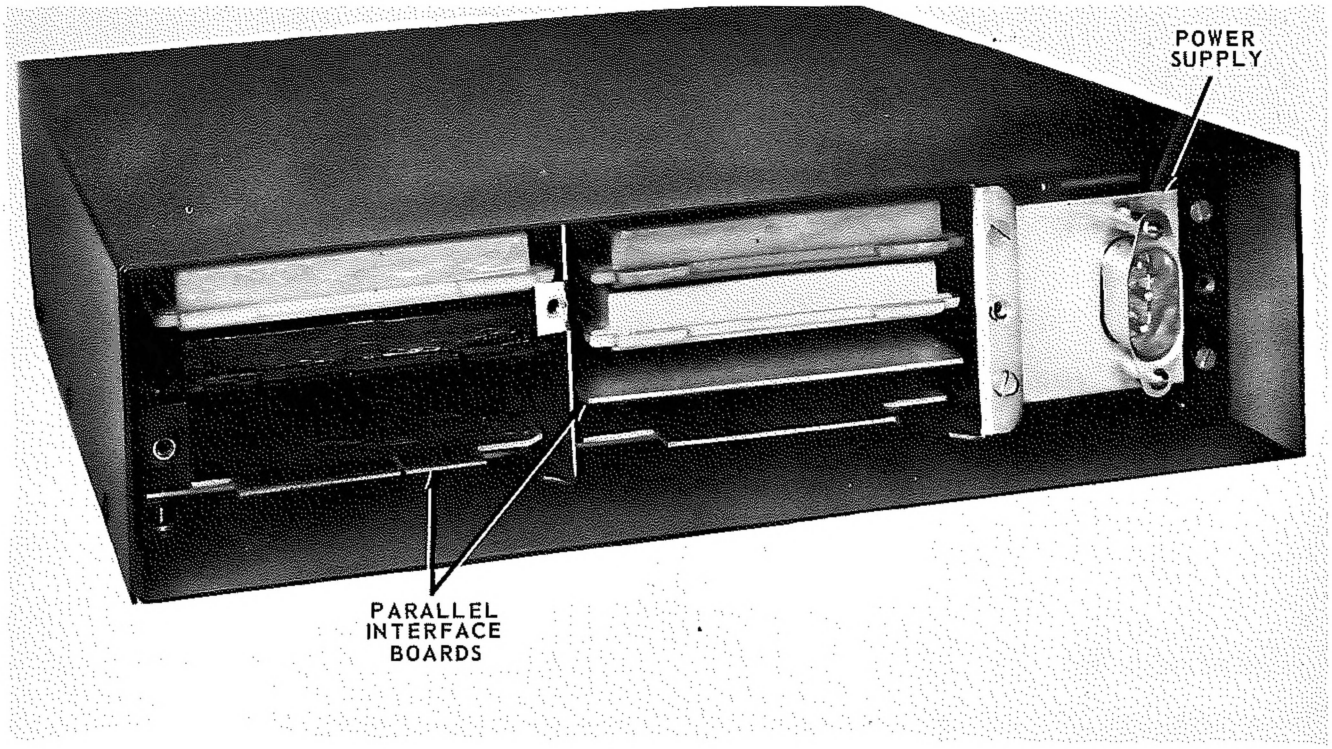


Figure 5
Rear View, VOTRAX Unit

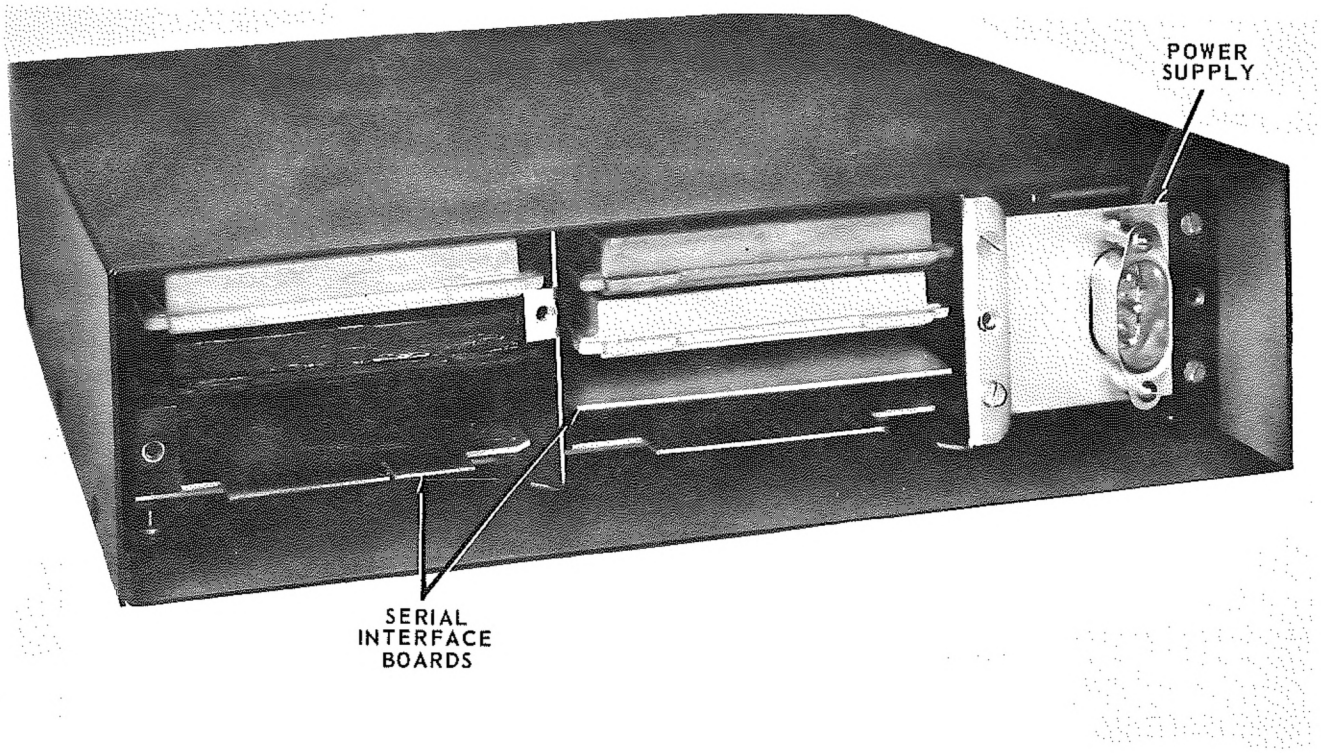


Figure 6
Rear View, VOTRAX Unit

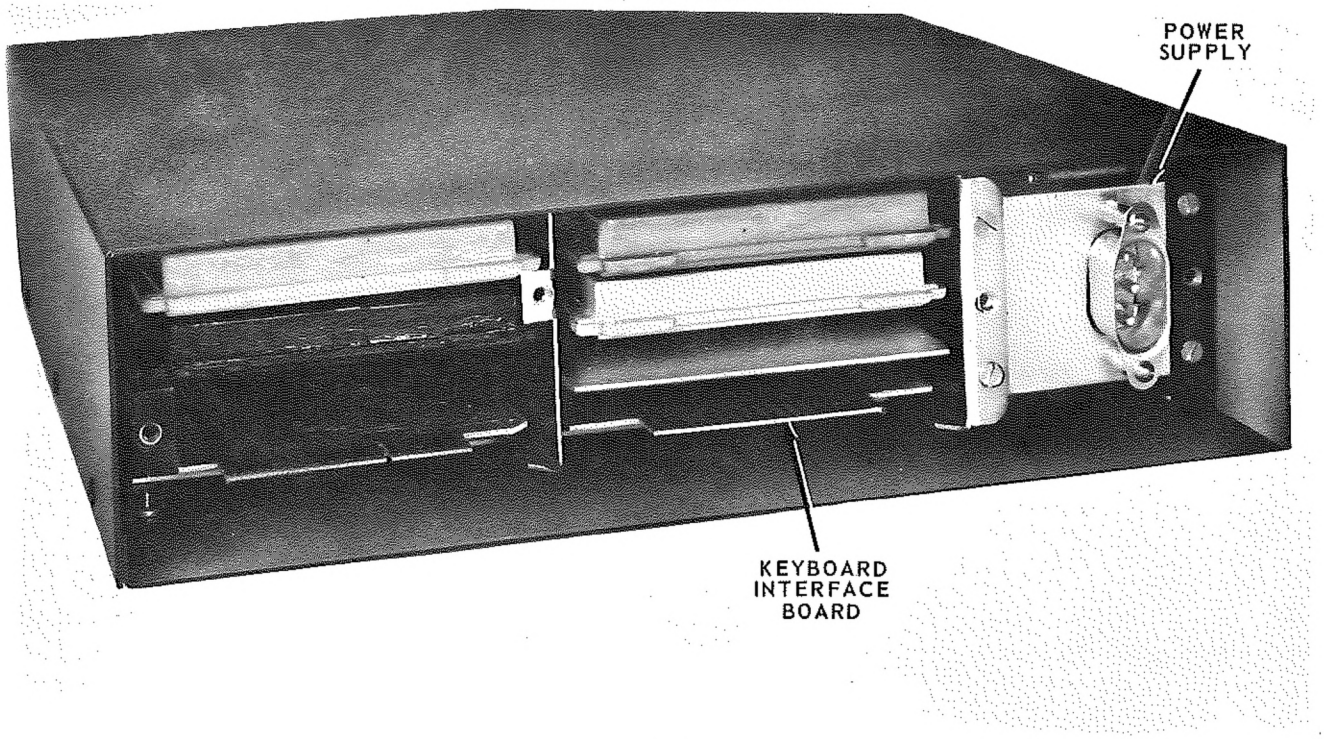


Figure 7
Rear View, VOTRAX Unit

F. KEYBOARD UNIT

The Keyboard Unit is an optional external device which provides the capability of manually operating the VOTRAX Audio Response System when used in conjunction with the Keyboard Interface Unit described in the previous section. The Keyboard Unit is illustrated in Figure 8 in its two package configurations which are the bench top stand-alone model and portable suitcase model. The portable suitcase model includes the VOTRAX Voice Generator Unit.

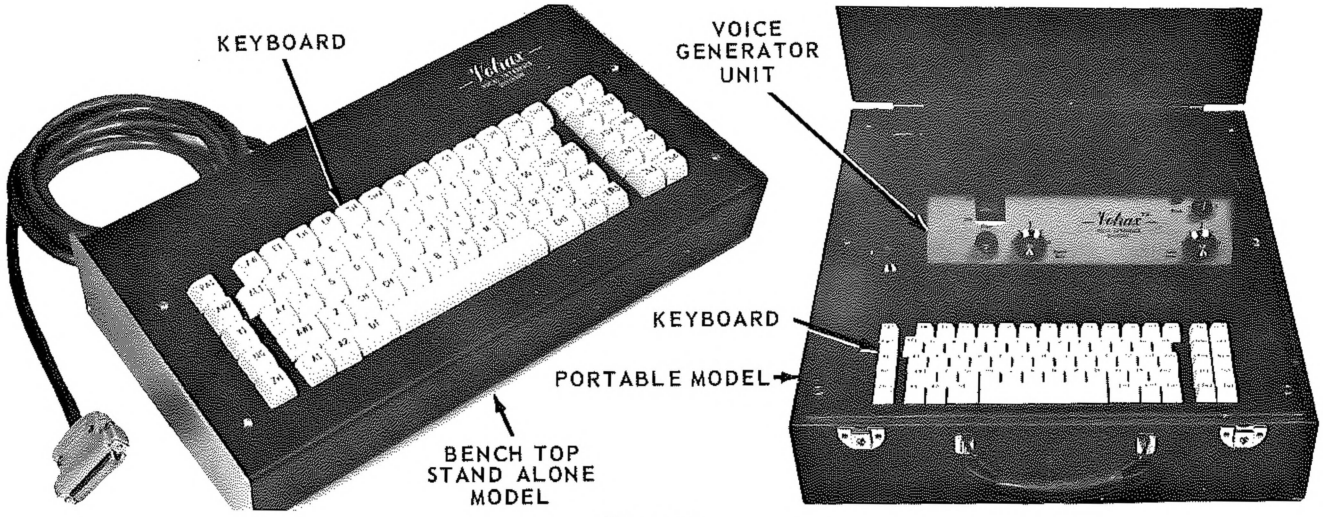


Figure 8
VOTRAX Keyboard Unit Package Configurations

The keys are labeled to identify their particular sounds which are combined to form human speech. When a key is depressed, the unit will generate the required 8 bit command word for the VOTRAX Unit. Thus, the entire VOTRAX Audio Response System can be manually and independently exercised by the Keyboard Unit. The Keyboard is also useful for troubleshooting or in vocabulary generation.

More detailed information on the Keyboard Unit and its operation is presented in the VOTRAX Keyboard Option Manual P/N 940.

G. ROM VOCABULARY STORAGE UNIT

The optional ROM (Read Only Memory) Vocabulary Storage Unit provides digital word storage within the VOTRAX Audio Response System. Sounds, words, phrases, and sentences may be stored in the ROM's. This option allows the use of the VOTRAX Voice Systems in areas where computers are not used. A simple switch closure can select a message from the ROM storage which will automatically be spoken by the VOTRAX Voice Generator. This option also frees computer storage when the system is utilized in computer applications. The ROM programming is provided by the Vocal Interface Division.

The ROM Vocabulary Storage Unit is completely solid state circuitry which is mounted on two plug-in type printed circuit boards. These boards are not encapsulated. Depending upon the application, these boards are either located in the VOTRAX Unit or mounted externally in their own enclosure. The internal location is illustrated in Figure 9.

More detailed information on the ROM Vocabulary Storage Unit is presented in the VOTRAX ROM Vocabulary Storage Unit Manual P/N 941.

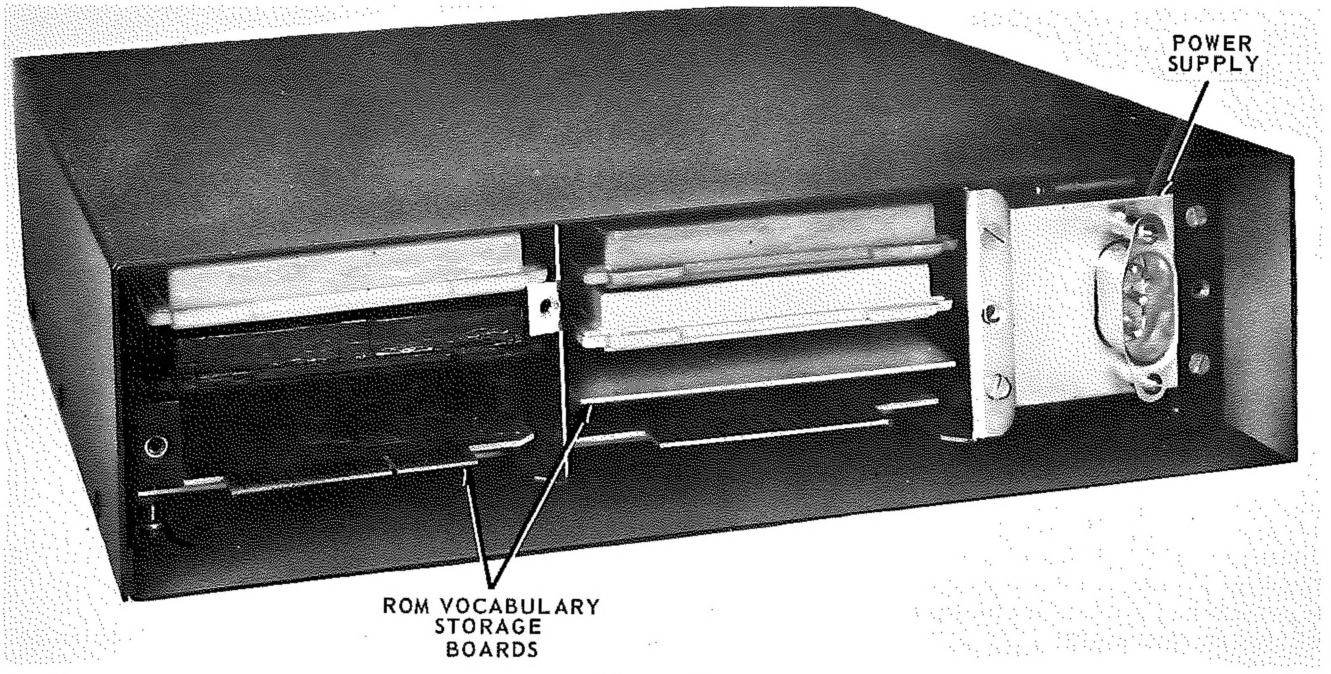


Figure 9
Rear View, VOTRAX Unit

SPECIFICATIONS

The primary power electrical specifications and the VOTRAX Audio Response System physical characteristics are listed below. The specifications for the various interface signals are detailed in their respective manuals.

A. ELECTRICAL CHARACTERISTICS

Input Power Repuirements: 115 V.A.C. ± 10%, 47-420 H_Z , 0.25 Amps
Input Power Fuse: 3AG-1/2 Amp, 125 Volts
Audio Output: 100-5000 H_Z , 6 Volts Peak, Nominal
Audio Output Drive Capability: 0.5 Watts into an 8 ohm load

B. PHYSICAL CHARACTERISTICS

Mounting Configuration	Outside Dimensions	Net Weight	Shipping Weight
Stand-Alone Cabinet	11-7/8"w x 11-1/4"d x 3-1/8" h	11 lb.	14 lb.
19" Horizontal Rack Mount	19"w x 10-1/4"d x 3-1/2" h	11 lb.	14 lb.
Portable Case	18"w x 22-1/2"d x 6"h	20 lb.	23 lb.
Stand-Alone Keyboard Cabinet	15-3/4"w x 8.0"d x 3-1/2"h	6 lb.	9 lb.
Free Standing Speaker	15-1/8"w x 6-3/4"d x 8-1/8"h	10 lb.	11 lb.

C. TEMPERATURE CHARACTERISTICS

Operating Temperature	–	0°c – 50°c
Storage Temperature	–	-20°c – 70°c

INSTALLATION AND CHECKOUT

The following instructions should be adhered to for the most efficient and reliable method of unpacking, installing and initial check out of the VOTRAX Audio Response System. If there are any discrepancies in the shipment or difficulties in the operational checkout, immediately notify:

Vocal Interface Division
Federal Screw Works
500 Stephenson Highway
Troy, Michigan 48084

Attempted repairs which Vocal Interface Division determines damaged the system will void the warranty.

Inflection Key	Sound (Phoneme) Key	
IN1	S	STATES
IN2	T	
IN2	A1	
IN3	AY	
IN3	T	
IN3	S	
IN2	UH1	OF
IN1	V	
IN2	UH1	AMERICA
IN2	M	
IN3	EH1	
IN2	R	
IN2	I2	
IN1	K	
IN1	UH1	
IN1	PA1	PAUSES
IN1	PA1	
IN1	PA1	

5. After the test phrase has been entered, depress the REP key and then the OUT key. These keys are located in the upper right hand corner of the keyboard.

The VOTRAX Audio Response System should now speak the test phrase repeatedly until manually stopped by depressing the OUT, NOR, and ADV keys simultaneously.

If the test phrase sounds clear and intelligible, the unit is working properly for the initial check out procedure.

If the test phrase does not sound clear and intelligible, refer to the trouble shooting section of this manual. The first step is to be sure all the plug-in printed circuit boards are seated properly in their connectors. Refer to the Corrective Maintenance section IV C of this manual for instructions to gain accessibility to the boards.

If the Keyboard Unit is not available for the initial check out of the VOTRAX System, it will have to be connected to your computer, business machine, or data entry device and exercised in your system.

D. PACKAGING FOR SHIPMENT

If, for any reason, the VOTRAX Unit or system needs to be shipped back to the Vocal Interface Division, the packaging instructions should be closely followed.

We have had additional damage to numerous units due to incorrect and unsatisfactory packing. Follow the packing instructions listed below for the various VOTRAX models. The Stand Alone version of the Keyboard Unit is also included.

STAND-ALONE AND RACK MOUNT MODELS

Original Shipping Container

1. Fold shipping container internal side panels and insert in shipping container. NOTE: Internal inserts are reversible to accomodate either rack mount or stand-alone units.
2. Install bottom insert.
3. Fill sides with packing material.
4. Place a layer of plastic packing material in bottom of shipping container. Fill cavity of bottom insert.
5. Insert VOTRAX unit (stand-alone unit is packed with controls down).
6. Place top insert over unit.
7. Fill to top of carton with plastic packing material.
8. Seal top with shipping tape. Banding across the flaps is recommended.

Customers Package

1. Select a carton that affords 3 inches or more of space around VOTRAX unit. See Figure 13.
2. Place a 3 inch layer of packing material in the bottom of the container.
3. Seal carton with shipping tape. Banding across the flaps is recommended.

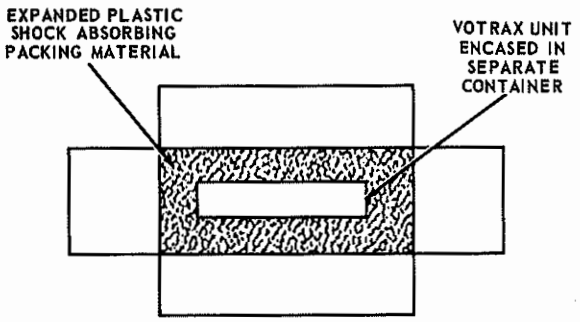


Figure 13
Top View, Packing Container

INSTALLATION AND CHECK-OUT

KEYBOARD STAND-ALONE UNIT

1. A cardboard retainer should be taped in place over the key caps to prevent dislodging during shipment.
2. Place keyboard in container with sufficient packing material on all sides as shown in Figure 14.

PORTABLE MODEL

1. The VOTRAX unit should be removed from the Portable Case and shipped in a separate container.
2. Package VOTRAX unit as described in previous instructions for shipment.
3. A cardboard retainer should be taped over the keyboard key caps to prevent dislodging during shipment.
4. Follow previous packing instructions under Customer's Package to prepare the portable case for shipment.

Vocal Interface Division will not assume the cost of repair of damage caused by shipping of unit.

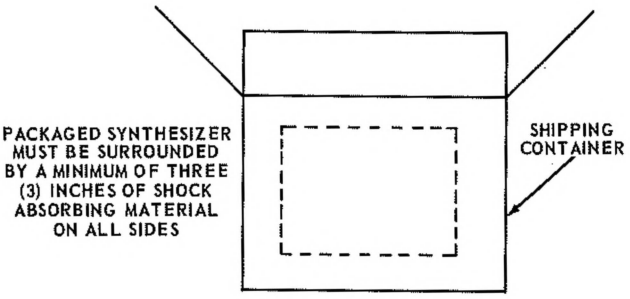


Figure 14
Side View, Shipping Container

ADJUSTMENT AND MAINTENANCE

The VOTRAX Audio Response System has a maximum of three adjustments. The maintenance required is minimal.

A. CONTROLS

All manual adjustments for the VOTRAX unit are located on the front panel. See Figure 15.

The "Speech Rate" control varies the rate at which words are spoken from the Voice Generator Unit. In other words, it controls the output word rate.

The "Audio Level" control adjusts the audio output volume from the Voice Generator Unit.

The optional "Pitch" control varies the center frequency of the audio output bandwidth. Thus, it can vary the pitch of the voice output.

The A.C. power switch is the rocker arm type, and lights when placed in the ON position.

Figure 15
Front Panel, VOTRAX Unit

ADJUSTMENT AND MAINTENANCE

B. PREVENTIVE MAINTENANCE

The VOTRAX Audio Response System is completely solid state circuitry without electro-mechanical devices, such as relays. Due to this solid state circuitry, the preventive maintenance required is virtually non-existent.

If the system is mounted in a rack or cabinetry with other equipment which requires cooling fans, the fans and associated filters will require their normal preventative maintenance. Refer to the manufacturer's maintenance program for these devices.

Whenever installing the VOTRAX Audio Response System units with other equipment, be sure the ambient temperatures are maintained within the VOTRAX System specifications.

C. CORRECTIVE MAINTENANCE

Corrective Maintenance of the VOTRAX Audio Response System is virtually unnecessary. However, if this does occur, the plug-in type printed circuit board packaging technique lends itself to fast board replacement and minimal system down time. See Figure 16.

To obtain circuit board accessibility, follow the procedure listed below:

1. Disconnect all cables from the VOTRAX unit rear panel.

2. Unscrew the four captive thumb screws located on the VOTRAX unit rear panel assembly. (NOTE: These screws are not completely removable.)

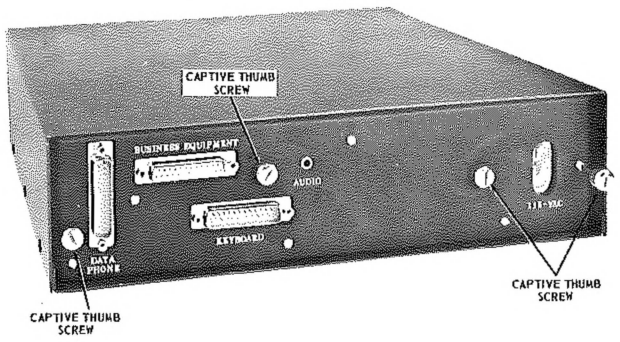
3. Gently pry and pull off the rear panel assembly from the chassis. Use a peeling motion since there are printed circuit boards plugged into connectors on the rear panel assembly internally. The printed circuit boards are exposed for removal after the rear panel assembly is removed.

4. Gently pull on the boards to disengage them from the front mother board inside the chassis. (Note that each board is keyed to prevent the erroneous insertion of a board into the wrong socket.)

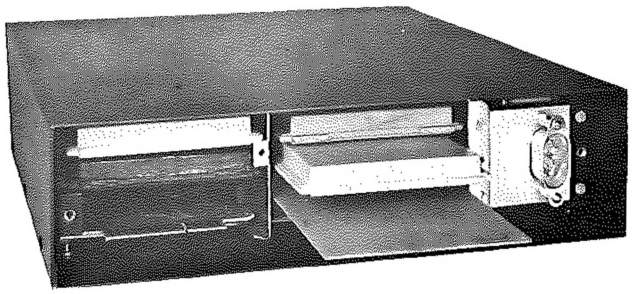
5. To insert a board, line up in the card guide slots and gently push the board in until it starts to engage the front connector. Then gently apply pressure to engage it in the connector. If the board will not engage with gentle pressure, do not force it. Either it is the wrong board hitting the key on the connector or there is an alignment problem. Investigate and try again.

CAUTION: WHEN HANDLING THE PRINTED CIRCUIT BOARDS, DO NOT TOUCH THE CONNECTOR TABS. BODY STATIC CHARGE COULD DAMAGE THE CIRCUITRY IF DISCHARGED THRU THE CONNECTOR TABS.

If the VOTRAX Audio Response System malfunctions, refer to the trouble-shooting chart on Page 15 of this Manual for the step-by-step procedure to isolate the problem. Correction can normally be made by replacing printed circuit boards.



Location of Thumb Screws



Rear Panel Removed

Figure 16
VOTRAX, Rear View

PROGRAMMING INSTRUCTIONS

The following presents introductory information on programming the VOTRAX Audio Response System. Refer to the VOTRAX Programming Manual P/N 942 for detailed instructions and information.

Programming the VOTRAX Audio Response System is quite simple once the phonetic rules for the language are mastered. The basic sounds, the vowels and consonants, are called phonemes. The secret of obtaining good quality pronunciation from the VOTRAX system is proper phonetic programming. The sounds present in a word are often not what we think they are, but by following the VOTRAX programming rules, any word in the English language and some in foreign languages may be synthesized properly.

Sixty-three (63) phoneme commands in concert with the four (4) choices of inflection provide the user with 252 unique VOTRAX unit inputs which may program the Voice Generator in any desired sequential order. The stress on a syllable of a word is determined by the loudness and duration of its vowel or vowels. This is selected by the inflection commands IN1 through IN4 which make up 2 bits of the 8 bit digital command word. There are, for instance, $(252)^4$ or over 4 billion possible utterances containing four (4) phonemes!

The phonetic rules are based on the actual acoustic content of human speech. These rules do not necessarily correlate with dictionary phonetics, nor do they necessarily correlate with phonetics as taught in the public schools. Thus, the programming rules may appear alien to the uninitiated, but once the user becomes acquainted with them, determining the optimum programming for any word or phrase is quite easy.

The VOTRAX unit has been optimized for the Mid-Western or standard American English dialect, which is the dialect used almost exclusively by the nationwide media. It is also the native dialect of the Central United States, West Coast and Mid-Eastern states, excluding the East Coast. This dialect is spoken by the largest majority of U.S. citizens and to a large extent by central and western Canadians. It is important that the programming rules be adhered to closely. The VOTRAX electronics as well as the phonetic alphabet itself have been designed around these phonetic rules. With very few exceptions, the VOTRAX system performance as judged by the majority of U.S. and Canadian residents will be degraded if these rules are not followed.

Such caution is necessary because ultimately the VOTRAX system is subjectively judged by a human listener during manual optimization of a word of phrase. The user may ask the question, "What if breaking the rules produces an apparent improvement in naturalness?". This will occasionally happen, but the user is strongly cautioned in this area. The problem is phonetic substitutions. What is acceptable to one listener, is not necessarily acceptable to the next, particularly one who speaks another dialect.

Thus, it is recommended that an individual given the responsibility of determining the optimum programming for many words have a central dialect, particularly if the synthesized output is to be heard on a nationwide hookup such as a computer audio response system.

Adhering to the VOTRAX programming rules cannot be over emphasized to ensure maximum intelligibility from the VOTRAX system.

Refer to the VOTRAX Programming Manual P/N 942 for further programming and more detailed phonetic information.

THEORY OF OPERATION

The VOTRAX Audio Response System is designed to convert the output of a computer, machine monitoring system, or other data entry device into simulated human speech. This conversion from digital information to simulated speech is accomplished thru a unique patented electronic design which divides each human word into phonemes. A phoneme is a basic sound such as vowels or consonants. For example, the word "hello" consists of the phonemes "H", "EH", "L", "UH" and "O". Thus the VOTRAX Audio Response System breaks human words down into their various basic sounds or phonemes.

Each phoneme is represented digitally by an 8 bit digital word. The VOTRAX system converts these 8 bit phonetic command words into the corresponding phonetic sounds. Actually, 6 of the 8 bits define a particular phoneme, and the 2 remaining bits define the inflection level or loudness of the phoneme.

The block diagram in Figure 17 illustrates the basic function generators and data and control signal flow in the VOTRAX system. The conversion from digital command words to human speech is divided into two basic sub-systems, the interface circuitry and the basic voice generator.

The interface circuit contains the data buffer, control signal generator, and audio amplifier. The exact length and type of parallel 8 bit buffer may vary from one type of interface to another, but in all cases, its purpose is to accommodate the difference in data rates between the input and output data. In order to generate intelligible speech, each successive phonetic command word must be presented to the Voice Generator for the duration of the phoneme, which may be different for each phoneme. Also, the next phonetic command in a human word must follow immediately to avoid gaps or erroneous transistions between phonemes.

WARRANTY POLICY

The following is a statement of the Vocal Interface Division equipment warranty:

The Equipment sold hereunder is warranted against defects in workmanship and materials under normal use and service for a period of 120 days from the date of delivery, when installed and operated in accordance with the Users' Manual provided by FSW. Any defect in such Equipment shall be corrected by FSW at no charge, provided Buyer returns the defective unit, transportation prepaid, to VOCAL INTERFACE DIVISION of FEDERAL SCREW WORKS, at 500 Stephenson Highway, Troy, Michigan 48084. FSW shall pay the cost of returning the repaired equipment to Buyer. Compliance with this provision by Buyer shall be a condition of this Warranty. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS. FSW shall have no responsibility for consequential damages arising out of or in connection with the use or performance of Equipment.

Delivery of Equipment ordered hereunder shall be made F.O.B. Federal's plant. FSW shall not be liable for damages or penalty for delay in delivery, or for failure to give notice of delay, when such delay is due to the elements, acts of God, acts of the Buyer, acts of civil or military authority, fires or floods, riots, strikes, labor disputes, accidents to or failure of machinery, delays in transportation, delays in delivery by FSW's vendors, or any cause of the foregoing or of any other nature beyond the reasonable control of FSW. The delivery date shall be deemed extended for a period of time equal to the time lost due to any delay excusable under this clause.

SECTION II: INPUT/OUTPUT VOTRAX PHONETIC CODES	Bulletin # ETB-6-0406-ME

PHONEME	HEX	OCTAL	* ASCII	DURATION (MS)	PHONEME	HEX	OCTAL	* ASCII
PAØ	Ø3	ØØ3	'C@'	47	EH1	Ø2	ØØ2	'B@'
PA1	3E	Ø76	'NC'	183	EH2	Ø1	ØØ1	'A@'
A	2Ø	Ø4Ø	'@B'	185	EH3	ØØ	ØØØ	'@@'
A1	Ø6	ØØ6	'F@'	103	ER	3A	Ø72	'JC'
A2	Ø5	ØØ5	'E@'	71	F	1D	Ø35	'MA'
AE	2E	Ø56	'NB'	185	G	1C	Ø34	'LA'
AE1	2F	Ø57	'OB'	103	H	1B	Ø33	'KA'
AH	24	Ø44	'DB'	250	I	27	Ø47	'GB'
AH1	15	Ø25	'EA'	146	I1	ØB	Ø13	'K@'
AH2	Ø8	Ø1Ø	'H@'	71	I2	ØA	Ø12	'J@'
AW	3D	Ø75	'MC'	250	I3	Ø9	Ø11	'I@'
AW1	13	Ø23	'CA'	146	IU	36	Ø66	'FC'
AW2	3Ø	Ø6Ø	'@C'	90	J	1A	Ø32	'JA'
AY	21	Ø41	'AB'	65	K	19	Ø31	'IA'
B	ØE	Ø16	'N@'	71	L	18	Ø3Ø	'HA'
CH	1Ø	Ø2Ø	'@A'	71	M	ØC	Ø14	'L@'
D	1E	Ø36	'NA'	55	N	ØD	Ø15	'M@'
DT	Ø4	ØØ4	'D@'	47	NG	14	Ø24	'DA'
E	2C	Ø54	'LB'	185	O	26	Ø46	'FB'
E1	3C	Ø74	'LC'	121	O1	35	Ø65	'EC'
EH	3B	Ø73	'KC'	185	O2	34	Ø64	'DC'

PHONEME	HEX	OCTAL	* ASCII	(ms)	PHONEME	HEX	OCTAL	* ASCII	(ms)
OO	17	Ø27	'GA'	185	UH	33	Ø63	'CC'	185
OO1	16	Ø26	'FA'	103	UH1	32	Ø62	'BC'	103
P	25	Ø45	'EB'	103	UH2	31	Ø61	'AC'	71
R	2B	Ø53	'KB'	90	UH3	23	Ø43	'CB'	71
S	1F	Ø37	'OA'	90	V	ØF	Ø17	'O@'	71
SH	11	Ø21	'AA'	121	W	2D	Ø55	'MB'	80
T	2A	Ø52	'JB'	71	Y	29	Ø51	'IB'	103
TH	39	Ø71	'IC'	71	Y1	22	Ø42	'BB'	80
THV	38	Ø7Ø	'HC'	80	Z	12	Ø22	'BA'	71
U	28	Ø5Ø	'HB'	185	ZH	Ø7	ØØ7	'G@'	90
U1	37	Ø67	'GC'	90	* NULL CODE	FF	377	'OO'	

NOTE: The above table is assuming Inflection Code 4

INFLECTION LEVELS

To add inflection levels, add the selected level below to the phoneme value above. (i.e., 1AH1 = D5 325)

LEVEL	HEX	OCTAL
1	CØ	3ØØ (lowest)
2	8Ø	2ØØ
3	4Ø	1ØØ
4	ØØ	ØØØ (highest)

* ASCII

To Add Inflection Code, Change Second Character (i.e., 1AH1 = 'EM')

FROM @ A B C (Inflection Code) 4

TO L M N O (Inflection Code) 1

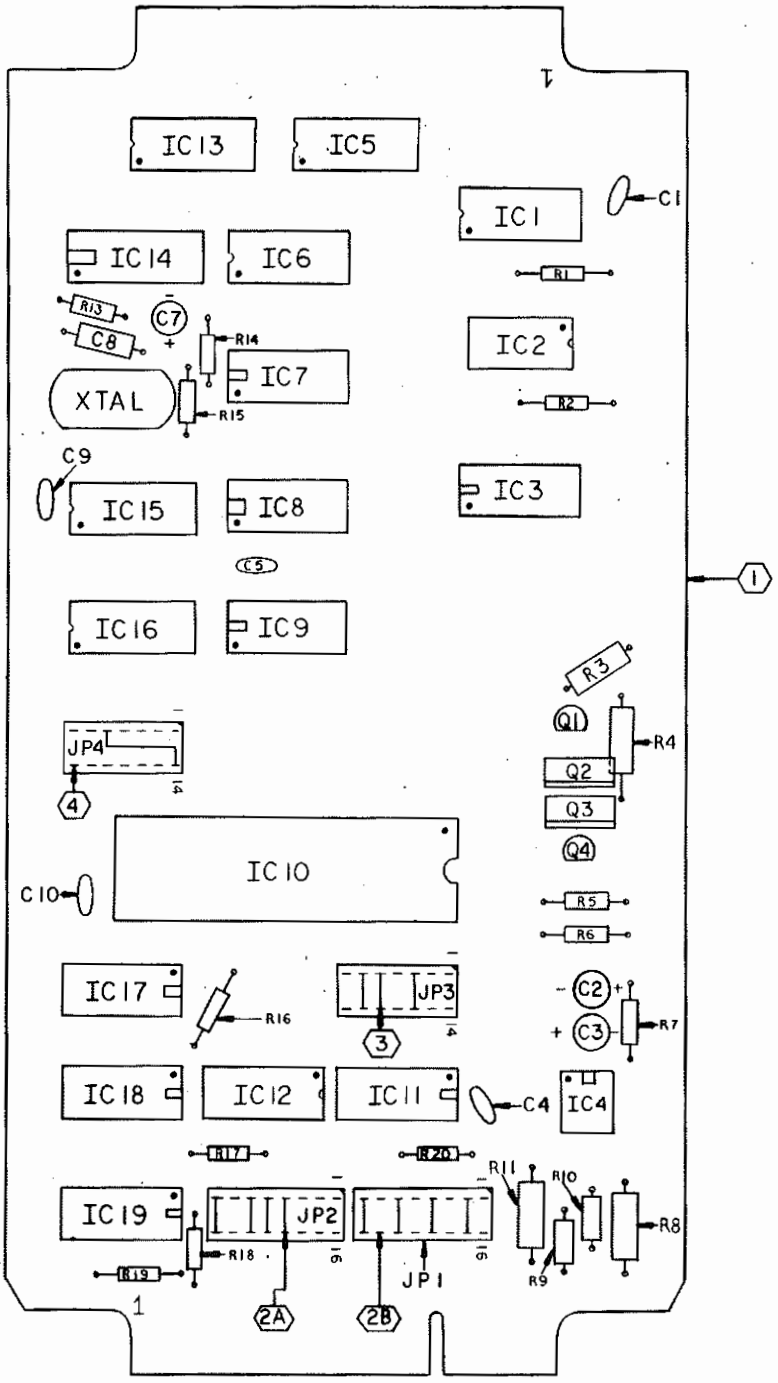
TO H I J K (Inflection Code) 2

TO D E F G (Inflection Code) 3

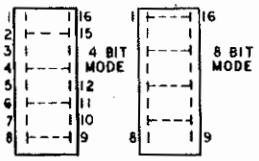
TO @ A B C (Inflection Code) 4

* For use with serial interface only

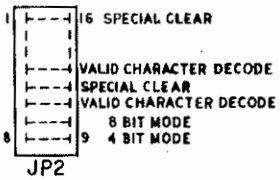
(CONN 9)



NOTE :

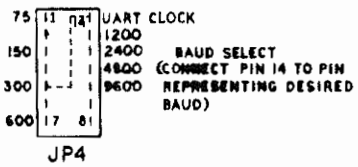


JP1



JP2

JP3



JP4

(CONN. 6)

REVISIONS				
NO.	REMARKS	DATE	DR	REL

MATERIAL			
FINISH			
GENERAL TOLERANCE UNLESS SPECIFIED ± .010		Vocal Interface Division	
THREE PLACE DECIMALS ±		Federal Screw Works	
TWO PLACE DECIMALS ±		Troy, Michigan 48084	
ANGULAR ±			
SCALE: 2X-ORIGINAL	DATE	TITLE	
DR J. LAUDER	5/13/74	PC BOARD ASS'Y RS-232-I	
CK M. KLEIST	5/15/74	FINAL ASS'Y	922
REL J.D. Bar	7/1/74	NEXT ASS'Y	922
		DRAWING NO.	C547AD

VOCAL INTERFACE DIVISION
FEDERAL SCREW WORKS

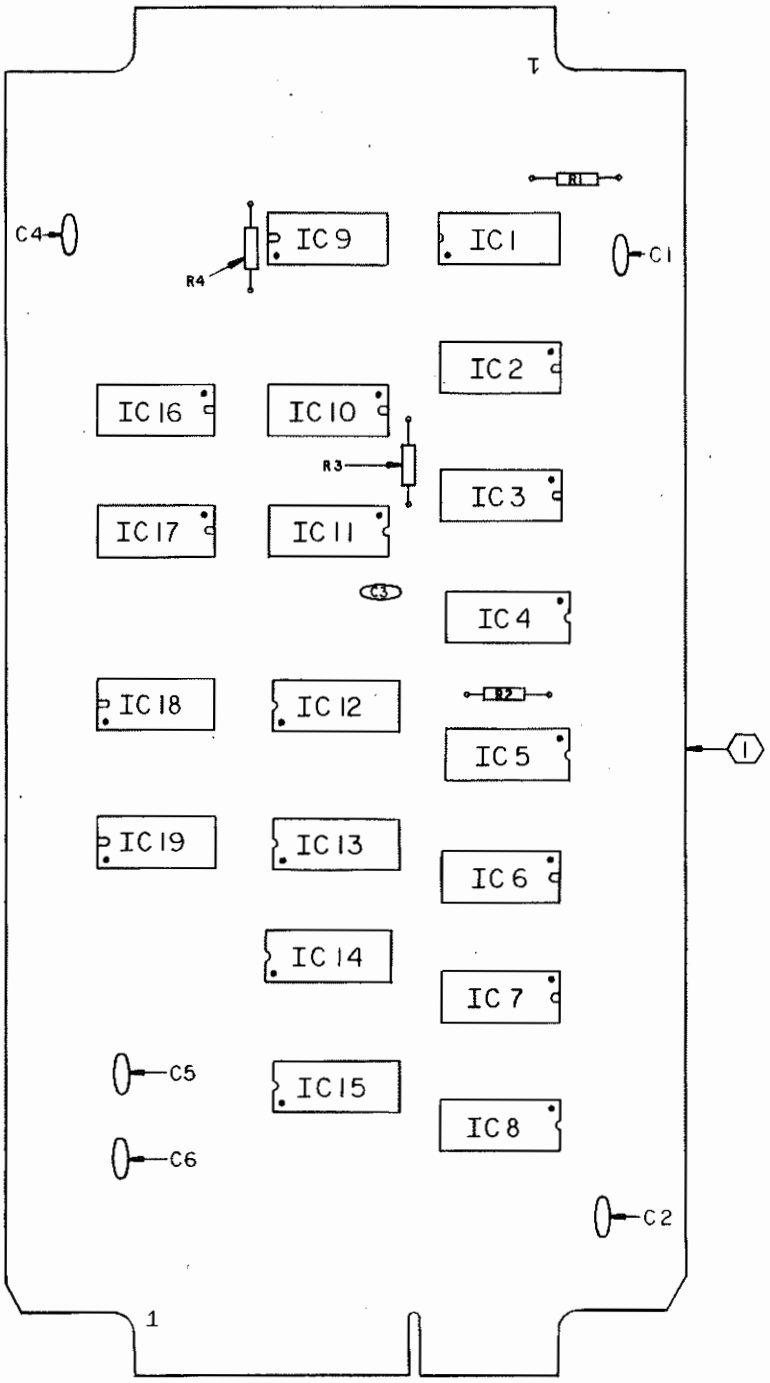
REFERENCE PARTS LIST

June 3, 1974

P.C. Board Assy., RS-232-1 I/O Part No. 547

Symbol or Detail No.	Part No.	Description
1	813	Blank P.C. Board
R1, 2, 16, 17, 18, 19, 20	221	Resistor, 4.7K Ohm, ± 5%, 1/4 Watt
R3, 4	296	" 1 Ohm " 1/2 Watt
R5	297	" 3K Ohm " 1/4 Watt
R6, 7	298	" 51K Ohm " "
R8, 11	299	" 22 Ohm " 1/2 Watt
R9	229	" 18K Ohm " 1/4 Watt
R10	226	" 10K Ohm " "
R14	230	" 22K Ohm " "
R13, 15	209	" 680 Ohm " "
C1, 4, 5, 9, 10	129	Capacitor, .05 MFD, ± 20%, 10V
C2, 3	130	" 100 MFD " 20V
C7	122	" 10 MFD " 35V
C8	100	" 680 p.f. ± 10%, 200V
Q1	357	Transistor, 2N4123
Q2	343	" 2N6111
Q3	344	" 2N6288
Q4	356	" 2N4125
XTAL	334	Crystal, 307.4K ± 2K H_z
JP1, JP2	336	Socket, IC, 16 Pin DIP
JP3, 4	335	" " 14 Pin DIP
2a, 2b	629	4 Bit/8Bit Option Plug
3	630	UART Option Plug
4	630	Baud Option Plug
IC1, 5, 13	333	IC, Linear, 9617, Triple Line Receiver
IC2	330	" " 1488, Quad Line Driver
IC3, 7, 11, 18, 19	316	" TTL, 7400, Quad 2-input NAND
IC4	340	" Linear, 4558, Dual OP. Amp
IC6	318	" TTL, 7402, Quad 2-input NOR
IC8	322	" " 7413, Dual Schmidt Trig.
IC9, 17	327	" " 7474, Dual D-Flip-Flop
IC10	315	" MOS, UART, AY-5-1012
IC12	319	" TTL, 7404, Hex Inverter
IC14	324	" " 74123, Dual Monostable
IC15, 16	329	" " 74193, Binary Counter

(CONN. 11)



(CONN. 5)

REVISIONS
REMARKS

DATE	DR	REL

CHG. NO.	E.C.N. NO.	DESCRIPTION	DATE	DR	CK

MATERIAL
FINISH

GENERAL TOLERANCE UNLESS SPECIFIED ± .010
THREE PLACE DECIMALS ±
TWO PLACE DECIMALS ±
ANGULAR ±

Votrax™
Vocal Interface Division
Federal Screw Works
Troy, Michigan 48084

SCALE: 2X-ORIGINAL
DR J. LAUDER 5/14/84
CK M. KLEIST 5/15/84
REL. [illegible] 7/1/84

TITLE: PC BOARD ASS'Y RS-232-2
FINAL ASS'Y 922
NEXT ASS'Y 922
DRAWING NO. C548AD

VOCAL INTERFACE DIVISION

FEDERAL SCREW WORKS

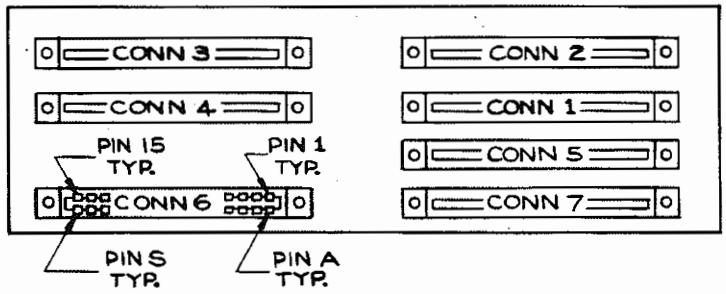
REFERENCE PARTS LIST

June 3, 1974

P.C. Board Assy., RS-232-2 I/O Part No. 548

Symbol or Detail No.	Part No.	Description
1	814A	Blank P.C. Board
R1, 2, 3, 4	221	Resistor, 4.7K Ohm, ± 5%, 1/4 Watt
C1, 2, 3, 4, 5,	129	Capacitor, 0.05 MFD, ± 20%, 10V
C6	154	" " " 20V
IC1	360	IC, TTL, 7420, Dual 4-input NAND
IC2, 7, 10, 17	327	" " 7474, Dual D Flip-Flop
IC3, 6, 9, 16	316	" " 7400, Quad 2-input NAND
IC4, 5	329	" " 74193, Binary Counter
IC8, 11	318	" " 7402, Quad 2-input NOR
IC12, 13, 14, 15	331	" MOS, FIFO, 3341
IC18, 19	325	" TTL, 7426, Quad 2-input NAND

FRONT MOTHER BOARD



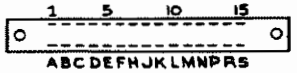
VIEW FROM REAR, LOOKING INTO UNIT.

CONNECTORS 1 THRU 7 AND 9 THRU 11 ARE 15 POSITION DOUBLE READOUT (TOP AND BOTTOM OF EACH POSITION ARE SEPARATE CONTACTS) EDGE CONNECTORS.

CONNECTORS 8, 12 AND 13 ARE 25 POSITION SUBMINIATURE EQUIPMENT CONNECTOR PLUGS.

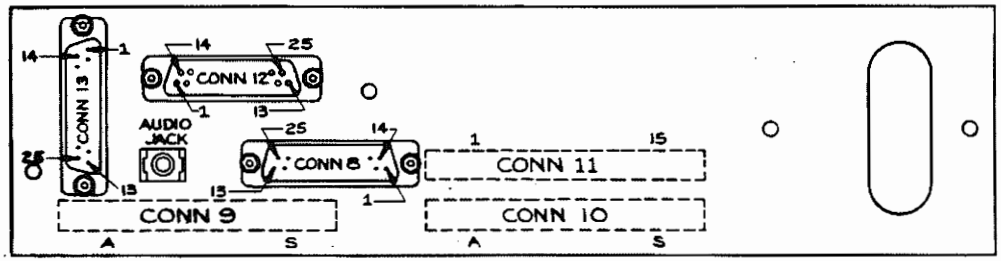
CONNECTOR 14 IS A.C. PLUG (NOT SHOWN).

EDGE CONNECTOR



VIEW OF WIRING SIDE

REAR MOTHER BOARD



VIEW FROM OUTSIDE, REAR OF UNIT.

MATERIAL							
FINISH							
	CHG. NO.	E.C.O. NO.	DESCRIPTION	DATE	BY	CK

UNLESS OTHERWISE SPECIFIED ± .010
THREE PLACE DECIMALS ±
TWO PLACE DECIMALS ±
ANGULAR ±

Votrax™ Vocal Interface Division
Federal Screw Works
Troy, Michigan 48084

SCALE: N/A DATE
DR M. KLEIST 7/[illegible]
CK [illegible]
REL. [illegible]

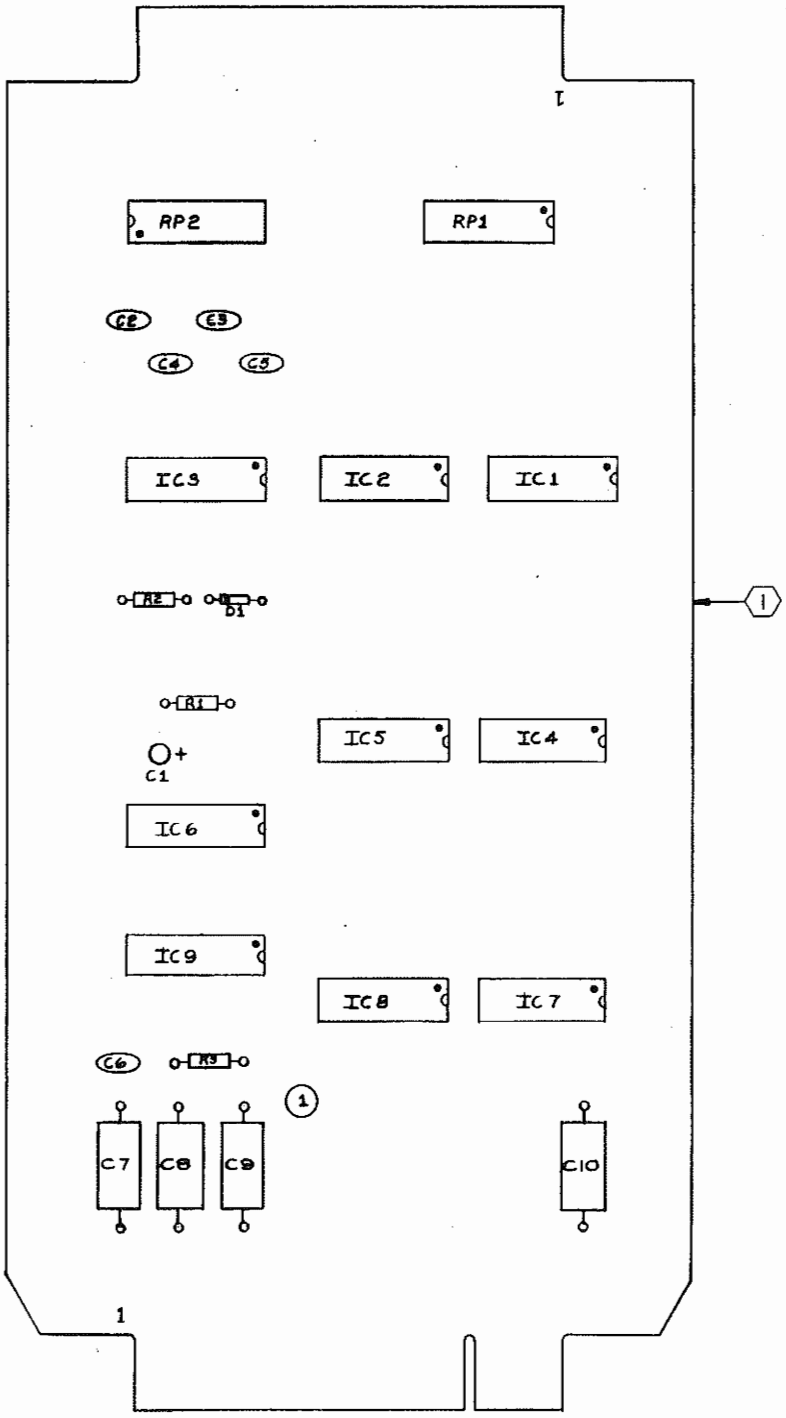
TITLE: SERIAL INTERFACE (RS232) OPTION ~CONNECTOR IDENTIFICATION~

FINAL ASSY VS 6.0 (922)
NEXT ASSY 922

DRAWING NO. C 922 SC SHEET 2 of 2

SHEET 1 IS "E" SIZE

(CONN 10)



(CONN 7)

REVISIONS															
NO.	REMARKS	DATE	DR.	REL.											

MATERIAL
FINISH
CHG. NO. 1 — E.C.N. NO. — CHANGED CAPACITOR NUMBERING C7-C10 — DATE 5/1/78 — DR MK — CK

GENERAL TOLERANCE UNLESS SPECIFIED ± .010
THREE PLACE DECIMALS ±
TWO PLACE DECIMALS ±
ANGULAR ±

Votrax™ Vocal Interface Division
Federal Screw Works
Troy, Michigan 48084

SCALE: 2X
DR B TROSPER 5/1/78
CK M. KLEIST 5/1/78
REL. J.D. 5/1/78

TITLE: KEYBOARD I/O ASS'Y

FINAL ASS'Y	923 VS 6.0
NEXT ASS'Y	923 VS 6.0

DRAWING NO. C534AD

VOCAL INTERFACE DIVISION

FEDERAL SCREW WORKS

REFERENCE PARTS LIST

P.C. Board Assy., Keyboard I/O Part No. 534

Symbol or Detail No.	Part No.	Description
1	811	Blank P. C. Board
IC 1, 2	326	IC, MOS, 2532, Quad 80 Bit Shift Reg.
IC 3	316	" TTL, 7400, Quad 2-input NAND
IC 4, 5	319	" " 7404, Hex Inverter
IC 6	322	" " 7413, Dual NAND Schmidt Trig.
IC 7, 8	325	" " 7426, Quad 2-input NAND O. C.
IC 9	328	" " 74121 MONO
RP1	273	Resistor Pack, 22K, 34A2234
RP2	274	" " 4. 7K, 34A4724
R1	219	" 3. 3K Ohm, ± 5%, 1/4 Watt
R2	224	" 6. 8K Ohm, " "
R3	211	" 4. 3K Ohm, " "
D1	300	Diode, 1N914
C1	138	Capacitor, 0. 47 MFD, ± 20%, 35V DC
C2, 3, 4, 5	110	" 0. 001 MFD, " 1KV
C6	101	" 100 p. f. ± 10%, "
C7	119	" 0. 047 MFD, " 200V DC
C8, 9, 10	140	" 0. 10 MFD, " 80V DC

VOTRAX Audio Response System

Serial Interface Preliminary Manual

Part Number 939

DESCRIPTION OF INPUT/OUTPUT CHARACTERISTICS
REF. MODELS #5-2219-301-01 and #5-2219-301-02

INTRODUCTION

The VOTRAX voice synthesizer with RS-232C interface option is designed for installation between the asynchronous serial data port of a computer and a modem such as the Bell 403E6. VOTRAX emulates the functions of the Bell 103 or 113 dataset to the computer.

When the VOTRAX unit is installed with option RS-232, it becomes a voice response input/output terminal. A remote user, using a telephone can interrogate a computerized data base and receive a verbal reply. In addition, the RS-232 option can also be used to implement asynchronous serial transmission of voice output for a local site. This configuration is activated by applying a permanent Data Set Ready signal to the data set connector. In this form, the VOTRAX voice response system could be used as a vocal output device at the computer site.

There are many advantages to voice response computer communications. The availability of a fast, inexpensive, and world-wide communications network is certainly foremost among these. There are presently 120 million telephones installed; each of these represents one of the simplest and cheapest computer terminals ever produced. The privacy of the system response is another asset. Only the person requiring information receives the information. The "humanizing" influence of the voice answer back is another attribute. In addition, there is the benefit of being able to dynamically update data files (through telephone key entry) and receive an immediate voice response of timely, accurate information that is critical to decision making.

INTERFACE SIGNALS

The VOTRAX asynchronous serial interface meets E. I. A. specifications RS-232C with respect to all electrical characteristics. The following circuits are implemented in the VOTRAX/computer interface:

AA	Protective Ground	CB	Clear to Send
AB	Signal Ground	CC	Data Set Ready
BA	Transmitted Data	CD	Data Terminal Ready
BB	Received Data	CE	Ring Indicator
CA	Request to Send	CF	Carrier Detect (same as CC)

The VOTRAX/dataset interface is designed to connect directly to a Bell 403E6 or equivalent modem.

See Bulletin ETB-5-0410-MD for signals implemented and connector pin assignments for the business machine, data set and keyboard connectors.

OPERATION

This commentary describes the data flow and control operations encountered in using the VOTRAX synthesizer in a telephone inquiry-voice response system. The same commentary, without reference to answering calls and inputting data, would apply to the unit when it is interfaced for local use (P. A. systems) of the voice output.

Figure 1 is an illustration of the components and signals encountered in this description.

When used to answer and respond to calls, the computer may either wait for signal CE (Ring Indicator) and then turn on signal CD (Data Terminal Ready), which tells the data set to answer the call and respond with signal CC (Data Set Ready); or the computer may turn on CD initially, in which case the data set will automatically answer the incoming call and turn on CC. The presence of both CC and CD enables the interface circuitry. This phase is commonly referred to as the ENABLE operation performed by the computer. The interface may now pass decoded touch-tone data to the computer and will pass these codes as long as the computer does not go into output mode when the break option is installed (refer to Table 1 for a complete list of these codes).

These codes are sent to the computer as asynchronous serial characters with parameters as assigned by the customer. These parameters are: length of the data character, parity of the data character, and rate (baud) of the serial transfer. These codes will be passed to the computer at all times except when the computer enters output mode, and the break option has been installed.

When the computer is ready to send output data to the VOTRAX voice synthesizer, it must turn on signal CA (Request to Send). When VOTRAX can accept data, signal CB (Clear to Send) is asserted. The computer may now send data to the VOTRAX synthesizer. The codes for the phonemes may be found in Bulletin ETB-5-0406-ME. While in the output mode (signal CA on) with the break option, the depression of a touch-tone key will cause a BREAK or ATTENTION signal to be sent to the computer. This signal will tell the computer to terminate its current output, and typically the computer will enter an input mode. The receipt of a touch-tone input during output will always clear any phonemes currently buffered, even if the BREAK option is not installed.

Since Request to Send must be raised before output and dropped after output, the computer port must have a half-duplex protocol to the VOTRAX synthesizer. The port itself may be full-duplex, as long as control over the Request to Send, Clear to Send, interlock is maintained. If the port is full-duplex, the BREAK feature is, in most cases, undesirable. On true half-duplex ports, the BREAK will be desired as long as the port has a BREAK recognition capability. If the BREAK option is not installed, the computer will receive the touch-tone codes even as it is outputting phonemes. This mode requires a full duplex asynchronous computer port to operate. If a full duplex port is not available, and the port does not have BREAK recognition, the effect of input while outputting will be dependent upon the port and computer characteristics. To avoid any undesirable action, the 403 can be made half-duplex avoiding the input while outputting problem. This will cause the output from the computer to be uninterruptable and, therefore, all output operations will proceed to completion before the computer will enter an input mode.

If the data characters sent from the computer contain less than eight bits of intelligence, they will be assembled two at a time to form VOTRAX phoneme codes. In this mode, the phoneme codes are broken up into two characters, in which the low four bits of the two characters are combined to create the eight bit phoneme code. The first character contains the low order four bits of the phoneme and the second character contains the high order four bits of the phoneme (including the inflection). Also, in this mode, the two high order bits next to the parity bit will be used as CONTROL/DATA bits. Using this option, control codes sent by the computer software or hardware will be ignored by the synthesizer, and only the users data will be accepted and stored into the synthesizer buffer (See Table 2 for a list of valid data codes). It is recommended that data be sent in blocks of 64 VOTRAX codes or less. If this is done and the user checks Clear to Send between transfers, the interface will prevent buffer overrun and subsequent loss of data.

Voice output will begin as soon as a null code (all ones) is encountered in the output data stream. It is recommended that a null character be transmitted at the end of every word. This allows output to be enabled on a word basis, and if the computer for any reason cannot keep up with speech rates, the vocal output will stop and wait for data only at the end of words. The system can produce continuous speech at 150 baud for eight bit non-parity codes, and 300 baud for codes with lesser numbers of intelligence bits.

If at any time signal CD is dropped, the 403 dataset will be put ON HOOK, thereby disconnecting the current user. This phase is commonly referred to as the DISABLE operation performed by computers. If the user hangs up, the computer is immediately notified by signal CC dropping.

ORDER INFORMATION

The VOTRAX voice synthesizer with RS-232C interface is designed to cover a wide range of user interfacing requirements. The user can specify data rates of 110, 150, 300, 600 or 1200 baud. The code level may be specified as 5, 6, 7 or 8 bits with 1 or 2 stop bits. A selectable parity option provides for odd, even or no parity at the user interface.

Break or normal operation upon receipt of input while outputting must be selected. Definition of these parameters is required at the time of order; in addition, please specify the computer system and interface being used.

BUTTON	CODE SENT TO COMPUTER	ASC II
1	0 1 0 0 1 0 1 0	'J'
2	0 1 0 0 1 0 0 1	'I'
3	0 1 0 0 1 0 1 1	'K'
4	0 1 0 0 0 1 1 0	'F'
5	0 1 0 0 0 1 0 1	'E'
6	0 1 0 0 0 1 1 1	'G'
7	0 1 0 0 1 1 1 0	'N'
8	0 1 0 0 1 1 0 1	'M'
9	0 1 0 0 1 1 1 1	'O'
0	0 1 0 0 0 0 0 1	'A'
*	0 1 0 0 0 0 1 0	'B'
#	0 1 0 0 0 0 1 1	'C'
Column 4 Row 1	0 1 0 0 1 0 0 0	'H'
Column 4 Row 2	0 1 0 0 0 1 0 0	'D'
Column 4 Row 3	0 1 0 0 1 1 0 0	'L'
Column 4 Row 4	0 1 0 0 0 0 0 0	'@'

THE FOUR HIGH ORDER BITS MAY BE ALTERED BY CHANGING JUMPERS ON THE CIRCUIT CARD. IN ADDITION, THE CHARACTER SIZE MAY BE CHANGED TO 5, 6 OR 7 DATA BITS, AND THE HIGH BIT MAY BE EVEN OR ODD PARITY. THE FOUR LOWER ORDER BITS ARE THE CODES GENERATED BY THE 403E6 DATA SET.

TABLE 1
TOUCH-TONE DECODE CHART

BINARY CODE	HEX	OCTAL	ASC II
X 1 0 X 0 0 0 0	40 or 50	100 or 120	@ or P
X 1 0 X 0 0 0 1	41 or 51	101 or 121	A or Q
X 1 0 X 0 0 1 0	42 or 52	102 or 122	B or R
X 1 0 X 0 0 1 1	43 or 53	103 or 123	C or S
X 1 0 X 0 1 0 0	44 or 54	104 or 124	D or T
X 1 0 X 0 1 0 1	45 or 55	105 or 125	E or U
X 1 0 X 0 1 1 0	46 or 56	106 or 126	F or V
X 1 0 X 0 1 1 1	47 or 57	107 or 127	G or W
X 1 0 X 1 0 0 0	48 or 58	110 or 130	H or X
X 1 0 X 1 0 0 1	49 or 59	111 or 131	I or Y
X 1 0 X 1 0 1 0	4A or 5A	112 or 132	J or Z
X 1 0 X 1 0 1 1	4B or 5B	113 or 133	K or [
X 1 0 X 1 1 0 0	4C or 5C	114 or 134	L or \
X 1 0 X 1 1 0 1	4D or 5D	115 or 135	M or]
X 1 0 X 1 1 1 0	4E or 5E	116 or 136	N or ↑
X 1 0 X 1 1 1 1	4F or 5F	117 or 137	O or ←

X = O or 1

THE ABOVE CODES ARE THE ONLY CODES ACCEPTED AS DATA BY VOTRAX WHEN OPERATING WITH LESS THAN EIGHT DATA BITS PER CHARACTER.

NOTE THAT ONLY THE LOW ORDER FOUR BITS ARE STORED BY VOTRAX, AND THAT TWO CONSECUTIVE CHARACTERS ARE ASSEMBLED TO CREATE A VOTRAX COMMAND. (See Bulletin #ETB-5-0406-ME for the codes to use to create the commands).

TABLE 2
VALID DATA CODES

REF.: MODELS #5-2219-301-01 and #5-2219-301-02

RS-232 Interface Pin Assignments

Business Equipment Connector

Pin #	Signal	Pin #	Signal
1 *	Protective Ground	6	Data Set Ready
2	Transmitted Data	7	Signal Ground
3	Received Data	8	Received Line Sig. Det.
4	Request to Send	20	Data Terminal Ready
5	Clear to Send	22 **	Ring Indicator

Data Set Connector ***

Pin #	Signal	Pin #	Signal
1*	Protective Ground	18	Audio Grnd. (Voice Ans'Bk)
3	Received Data 1	21	Data Receive
4	Received Data 2	22	Data Terminal Ready
5	Received Data 3	23	Data Set Ready
6	Received Data 4	24	Signal Ground
14 **	Ring Indicator		
16	Data Carrier Detect		
17 ****	Audio Out (Voice Ans'Bk)		

* Ground to VOTRAX Chassis
** Jumper from Data Set Connector to Business Equip. Conn.
*** Connects to Bell 403E6 or compatible
**** Audio Out is also available at Mini-phone Jack

Keyboard Connector (Applies only to Model 5-2219-301-02)

Pin #	Signal	Pin #	Signal
21	Ground	23	2^7 - Data In (Infl. MSB)
5	2^0 - Data In	10	Input Set
9	2^1 - Data In	14	Output Set
7	2^2 - Data In	2	Normal Set
1	2^3 - Data In	6	Repeat Set
15	2^4 - Data In	12	Advance (clear)
3	2^5 - Data In	16	Mem. (Alter Phoneme)
4	Keyboard Strobe	17	Keyboard Reference Volt.
11	2^6 - Data In (Infl. LSB)	20	RS-232 Disable
		22 ****	Audio Out

NOTE: Pin 20, RS-232 Disable, should be bussed to ground if this connector is used.
**** Audio out is also available at Mini-phone Jack

SECTION II: INPUT/OUTPUT VOTRAX PHONETIC CODES	Bulletin # ETB-6-0406-ME

PHONEME	HEX	OCTAL	* ASCII	PHONEME	HEX	OCTAL	* ASCII
PAØ	Ø3	ØØ3	'C@'	EH1	Ø2	ØØ2	'B@'
PA1	3E	Ø76	'NC'	EH2	Ø1	ØØ1	'A@'
A	2Ø	Ø4Ø	'@B'	EH3	ØØ	ØØØ	'@@'
A1	Ø6	ØØ6	'F@'	ER	3A	Ø72	'JC'
A2	Ø5	ØØ5	'E@'	F	1D	Ø35	'MA'
AE	2E	Ø56	'NB'	G	1C	Ø34	'LA'
AE1	2F	Ø57	'OB'	H	1B	Ø33	'KA'
AH	24	Ø44	'DB'	I	27	Ø47	'GB'
AH1	15	Ø25	'EA'	I1	ØB	Ø13	'K@'
AH2	Ø8	Ø1Ø	'H@'	I2	ØA	Ø12	'J@'
AW	3D	Ø75	'MC'	I3	Ø9	Ø11	'I@'
AW1	13	Ø23	'CA'	IU	36	Ø66	'FC'
AW2	3Ø	Ø6Ø	'@C'	J	1A	Ø32	'JA'
AY	21	Ø41	'AB'	K	19	Ø31	'IA'
B	ØE	Ø16	'N@'	L	18	Ø3Ø	'HA'
CH	1Ø	Ø2Ø	'@A'	M	ØC	Ø14	'L@'
D	1E	Ø36	'NA'	N	ØD	Ø15	'M@'
DT	Ø4	ØØ4	'D@'	NG	14	Ø24	'DA'
E	2C	Ø54	'LB'	O	26	Ø46	'FB'
E1	3C	Ø74	'LC'	O1	35	Ø65	'EC'
EH	3B	Ø73	'KC'	O2	34	Ø64	'DC'

PHONEME	HEX	OCTAL	* ASCII
OO	17	Ø27	'GA'
OO1	16	Ø26	'FA'
P	25	Ø45	'EB'
R	2B	Ø53	'KB'
S	1F	Ø37	'OA'
SH	11	Ø21	'AA'
T	2A	Ø52	'JB'
TH	39	Ø71	'IC'
THV	38	Ø7Ø	'HC'
U	28	Ø5Ø	'HB'
U1	37	Ø67	'GC'

PHONEME	HEX	OCTAL	* ASCII
UH	33	Ø63	'CC'
UH1	32	Ø62	'BC'
UH2	31	Ø61	'AC'
UH3	23	Ø43	'CB'
V	ØF	Ø17	'O@'
W	2D	Ø55	'MB'
Y	29	Ø51	'IB'
Y1	22	Ø42	'BB'
Z	12	Ø22	'BA'
ZH	Ø7	ØØ7	'G@'
* NULL CODE	FF	377	'OO'

NOTE: The above table is assuming Inflection Code 4

INFLECTION LEVELS

To add inflection levels, add the selected level below to the phoneme value above. (i.e., 1AH1 = Hex D5 Octal 325)

LEVEL	HEX	OCTAL
1	CØ	3ØØ (lowest)
2	8Ø	2ØØ
3	4Ø	1ØØ
4	ØØ	ØØØ (highest)

* ASCII

To Add Inflection Code, Change Second Character (i.e., 1AH1 = 'EM')

FROM	@	A	B	C	(Inflection Code) 4
TO	L	M	N	O	(Inflection Code) 1
TO	H	I	J	K	(Inflection Code) 2
TO	D	E	F	G	(Inflection Code) 3
TO	@	A	B	C	(Inflection Code) 4

* For use with serial interface only

VOTRAX Preliminary Programming Manual

Part Number 942

VS-6 Programming Rules

The sixty-three (63) phoneme commands in concert with the four (4) choices of inflection provide the user with 252 unique synthesizer inputs which may program the synthesizer in any desired sequential order. There are, for instance, $(252)^4$ or over 4 billion possible utterances containing four (4) phonemes! The phonetic rules are based on the actual acoustic content of human speech. These rules do not necessarily correlate with dictionary phonetics nor do they necessarily correlate with phonetics as taught in the public schools. Thus, the following rules may appear alien to the uninitiated, but once the user becomes acquainted with them, determining the optimum programming for any word or phrase is quite easy and considerably easier than in previous synthesizer models.

The VS-6 has been optimized for the Mid-Western or standard American English dialect which is the dialect used almost exclusively by the nationwide media. It is also the native dialect of the Central United States, West Coast and Mid-Eastern states excluding the East Coast. This dialect is spoken by the largest majority of U.S. citizens and to a large extent by central and western Canadians. It is important that the following programming rules be adhered to closely. The VS-6 electronics as well as the phonetic alphabet itself have been designed around these phonetic rules. With very few exceptions, the VS-6 performance as judged by the majority of U.S. and Canadian residents will be degraded if these rules are not followed.

Such caution is necessary because ultimately the synthesizer is

subjectively judged by a human listener during manual optimization of a word or phrase. The user may ask the question, "What if breaking the rules produces an apparent improvement in naturalness?". This will occasionally happen, but the user is strongly cautioned in this area. The problem is phonetic substitutions. What is acceptable to one listener, is not necessarily acceptable to the next, particularly one who speaks another dialect. A dialect trains our ears as well as our mouths.

For instance, in the Great Lakes area, many people consider OTTO an acceptable pronunciation of the word AUTO. People from other areas will perceive this alternative pronunciation as an error. Another example is the New York City area's pronunciation of the NG phoneme. In this substitution, the word THING becomes THING-G with a hard G at the end of the word. A New Yorker could perceive this alternate substitution as perfectly acceptable, but the rest of the North American Continent would not.

A Southerner would accept the prefix NON - as an acceptable pronunciation of the number NINE, but people in other areas would not.

Thus, it is recommended that an individual given the responsibility of determining the optimum programming for many words have a central dialect, particularly if the synthesizer output is to be heard on a nation-wide hook-up such as a computer audio response system.

The phonetic structure of any language is much more complicated than most of us realize. There are many pronunciation habits which we acquire as we grow up of which we are not aware, but we use them anyway. Proper

synthesized speech must take into account all subconscious or automatic articulatory habits as well as the rules of which we are consciously aware.

Perhaps the most common of these unlearned habits of English is gliding of vowels, particularly the long vowels. This gliding is called dipthongization. It means that a vowel ends as a different sound than it was when it started. The "long" vowels A, E, I, O, U have glides which are sounded independently of preceeding and following phonemes, even if these sounds are spoken alone. These vowels are programmed as follows on the VS-6:

Vowel	Typical Usage	VS-6 Equivalent
A	name	A, AY
E	tree	E or I3 E1
I	high	AH, E1
O	note	UH1, O1
U	two	IU, U

The "short" vowels are as follows:

Vowel	Typical Usage
AW	awful
EH	ten
ER	her (R, usually a consonant, can be a vowel in some cases)
UH	but
AE	hat
Y	Mary
I	kit
AH	hot
OO	book

These vowels also glide from beginning to end, but their glides are normally determined by the preceeding and following phonemes. These glides are generated automatically by the VS-6. However, the programmer may find occasional use of coupling vowels I3, EH3, or UH3 in conjunction with a short vowel is an aid to naturalness or intelligibility.

The numbered vowels such as UH1, UH2, and UH3 are of increasingly shorter duration. The higher the number, the shorter the duration. As a syllable is stressed less and less, a higher and higher number must be selected. The numbered vowels are also used in the "long" vowel phoneme pairs. For instance, A,AY is the vowel in MAIN; A1,AY or A2,AY would be the vowel in the same syllable in the word MAINTAIN. This rule applies to all numbered vowels except Y1.

Y1 is Y used as a consonant such as in the word YES. It is also found at the beginning of a syllable such as the second syllable in the word UNUSUAL. Y1 is a different kind of sound than Y as is evidenced when these phonemes are sounded continuously. However, all other numbered vowels are exactly like their unnumbered, fully stressed counterparts if sounded continuously. As the number on a vowel increases, its time interval shortens, and its dynamic interaction between the preceeding and following phoneme commands changes. Thus, two short duration phonemes will not have quite the same sound as one longer one of equal time duration. These differences are not evident if the phoneme is sounded continuously.

In addition to the syllabic stress factor affecting vowel length, the

following phoneme is also a factor. If it is a sustained fricative such as S, the preceeding vowel may be shortened. If it is a fricative stop such as T, the vowel may be shortened still further. Of course, subjective judgment should still be the final determiner of vowel stress.

There are three classes of dipthongs, or distinctively two - part vowels:

Dipthong	Typical Usage	VS-6 Equivalents
I	high	AH, El
I	height	AH2, El
OW, OU	cow	AH1, Ol *
		AH1, Ul
OI, OY	noise	Ol, EH3, El *
		Ol, I3, El
		O, El
		* preferred

The consonants are as follows:

Consonant	Typical Usage	Notes
TH	three	
THV	then (the voiced TH)	
W	won	
R	area	
T	tea	
P	pot	
Yl	yes	
S	see	
D	day	

Consonant	Typical Usage	Notes
F	fire	
G	get (not the G in George)	
H	hay, ahead	
J	jet, George (J is D, J or DT, J)	
K	key, sick, car	
	queer (Q is KW)	
L	lie, well	
NG	bring	
Z	zero	
SH	shy	
CH	match, chair (CH is T, CH or DT, CH)	
V	seven	
B	bob	
N	nine	
M	my	
ZH	azure (the Z)	
	measure (the S)	
DT	butter (DT is merely a tongue flap in this word)	

There are two affricates in English. An affricate is a two-consonant combination with a fricative stop.

The voiced affricate J is programmed D, J or DT, J. The unvoiced affricate CH is programmed T, CH or DT, CH.

All phonemes in English fall into seven (7) categories as follows:

1. voiced

   A. All vowels and dipthongs of vowels.

      A, E, I, O, U, AW, EH, ER, UH, AE, Y, I, AH, OO, and

      OI, OY, OU, OW dipthongs.

   B. All liquid consonants

      R, L, W, Yl

2. voiced stops B, D, G

3. nasal closures M, N, NG

4. unvoiced

   A. fricatives S, SH, F, TH

   B. Aspirant H

5. voiced fricatives Z, ZH, V, THV

6. fricative stops T, P, K

7. affricates

   A. voiced J

   B, unvoiced CH

There are several particular cases of interest which should be mentioned. The letter combination NG doesn't necessarily call for the NG phoneme. This is true if the N forms the end of one syllable and the G forms the beginning of the following syllable. In the word ENGAGE, the N and G are sounded separately. Thus, in this case, NG is programmed N, G.

In the word FINGER, the NG can be programmed as N, G, or as NG, G.

In the word THANK, the N can be programmed as N or NG. The A in thank is half way between A and AE. It is best programmed as AE1, I3. This is a classical example of an aliphone.

An aliphone is a variation of a basic phoneme. All phonemes in speech context are modified by their phonetic "environment". That is, whatever is going on before and after the phoneme affects its characteristics - its duration, amplitude, frequency components, etc. This effect is what we call the dynamic continuum of which speech is made. A phoneme is merely an operator on the human acoustic output which, in turn, gets operated upon.

To produce intelligible synthetic speech, the proper aliphone must be generated. This is done automatically in the VS-6. Another example of aliphones (perhaps the most extreme) is the numerous forms of K: the K in KEY, the K in LOOK, and the K sound in Q which is programmed K, W such as in the word QUIT. At times, the VS-6 needs some help from the programmer to produce the proper aliphone.

A particular class of phonemes, the liquids - R, L, W, and Y1, largely depend on the transitions into and out of these sounds for their recognition. These transitions, important as they are, depend a great deal on dialect. It is therefore necessary for the programmer to insert transitional phonemes around these

sounds in some cases to maximize naturalness and intelligibility.

Transitions around W and Y1 are dependent enough on surrounding phonemes for the VS-6 to generate them automatically.

The pre-vocalic R (R at the beginning of an utterance) normally doesn't require a transitional phoneme after it. However, the post-vocalic R (R at the end of an utterance) may require it, depending on the preceeding vowel such as in the word AIR. This is programmed A,I3,R. Note similarity to spelling. EH3 in place of I3 is also acceptable here.

The pre-vocalic L is enhanced by following it with UH3, EH3, or I3, depending on the following vowel. For instance, the word LAY is programmed L, EH3, A1, AY. The post-vocalic L is likewise enhanced by preceeding it with UH3, EH3, or I3 such as in the word AIL. This is programmed as A,I3, L. Again, note similarity to spelling. EH3 instead of I3 is also acceptable here.

The above suggests a possible need for more phonemes. Surely increasing the phoneme vocabulary size would enhance naturalness, but at the expense of increased hardware costs and greatly increased programming effort.

The phonetic keyboard layout was chosen to be as consistent as possible with the ubiquitous typewriter keyboard. At the same time, a phonetic labeling system had to be chosen which used alphanumerics so that regular typewriters and computer interface equipment could be used in describing programming. For those who are interested in the equivalency with the I. P. A.

or international phonetic alphabet, consult the I. P. A. phoneme equivalents table.

Inflection is extremely important for VS-6 speech to avoid a machine-like quality. Although ideal inflection is a subjective matter, a few simple rules will make this job easy. First determine the relative stress on various syllables in a word and on various words in a statement. Stronger stresses get longer phonemes and higher inflection pitches. Unlike previous synthesizer models, the VS-6 infle tion is completely independent from phoneme timing, but it still affects loudness as well as pitch. The VS-6 is designed so that the nominal pitch is half way between inflection levels 2 and 3. The nominal pitch has a frequency of 125 to 130 Hertz which is equivalent to the average pitch of an adult Caucasion male.

Thus, the VS-6 is designed for most frequent use of inflections 2 and 3. The user may choose to depart from this rule at his discretion. However, unnatural pitch contours may be produced. Higher inflections and longer vowels should be used on stressed syllables and words; lower inflections and shorter vowels on unstressed syllables.

The pitch from any inflection command appears in the VS-6 output - $\frac{1}{2}$ a phoneme to a full phoneme later. Thus, if it is desired to stress a given phoneme, that phoneme should be a long one (if a vowel) and the highest inflection might need to be put on the preceding phoneme..

The VS-6 has the capability of having its inflection under computer

or software control. This allows the user to assemble a sentence out of a pre-stored vocabulary of words and have these words inflected according to sentence grammar. This is a complex technique and it is often sufficient to store a vocabulary including nominal inflection commands for these words. When these words are assembled into sentences, the resulting speech may not be inflected perfectly but, more importantly, it will be intelligible and the pitch will vary smoothly from word to word. Thus, there will be no pitch discontinuities at word boundaries, an inevitable shortcoming of systems utilizing pre-stored human speech.

Whether sentence programming is determined by software or manually by a programmer, the inflection level during any pause commands as well as the binary zero position should be inflection 1. Use of successive pause commands to produce long pauses may result in a slight background noise during the protracted pause interval - this effect is normal.

To produce prepausal lengthening of the last phoneme in an utterance (lengthening of the time duration of the last phoneme), the PA1 or pause one must be placed at the end of the utterance. The PAØ or short pause may be used instead but the last phoneme in the utterance will be a little shorter. The PAØ is normally used between words in a sentence where very short pauses are desired. The PA1 is normally used at the end of an entire utterance, even if there is only a single word in the utterance. A word must not be followed by a binary zero (Null) command. If nulls are part of a phonetic data stream driving the synthesizer such as in the RS232 interface, a PAØ or PA1 must precede a null to prevent chopping off part of the last phoneme before the null.

The synthesizer is designed to generate continuous speech which means that the words in a sentence have little or no gap in between. This is consistent with conversational English habits. In conversation it is usual for words within a phrase or clause to be strung together while phrases and clauses are separated by a gap. There is no doubt that intelligibility in either human or synthesized speech is enhanced by short gaps between words. This is accomplished merely by placing a PAØ after each word. The resulting speech is acceptable but somewhat choppy, though highly intelligible. Use of such gaps will slow the output rate of the synthesizer accordingly. Of course, the speech rate may be increased to compensate for this but the resulting speech segments will be articulated faster than normal.

In continuous speech the synthesizer's built-in speech rules correspond to those in human speech. For instance, if two stop phonemes are adjacent, only the second phoneme is sounded. In the word FACT the K sound of the letter C and T are both fricative stops and thus only the second one in the pair is sounded. In this case the only acoustic output attributable solely to these phonemes is the voiceless release of the T. The same rule applies if two adjacent stop phonemes are each in a different word. Examples of this are TACK-BOARD and CREDIT-BALANCE. If a pause command is programmed in between the two words in each pair, then both stop phonemes are sounded - the K and B in the first example and the T and B in the second set. Note that in these examples, the first phoneme of the pair in question is voiceless while the second phoneme is voiced. However, this is irrelevant - the rule still applies. It is optional whether or not to sound both stop phonemes. It is

certainly natural in human speech not to sound the first stop phoneme. Although it is more natural, it is less intelligible whether the speech is human or synthetic. This example is a classic case of naturalness being opposed to intelligibility. Thus, the option is left to the user.

We are thus given several choices of programming at word boundaries:

1. PA1 for separation of phrases and clauses and sentences.
2. PAØ for optional separation of words.
3. PAØ for enhancement of pronunciation of closure phoneme pairs.
4. PAØ or PA1 followed by a null as a word boundary indicator.

VOTRAX Voice Synthesizer (VS-6) Word Vocabulary

Index

Able	2/PA1, 2/A2, 1/A2, 1/Y, 1/B, 1/L
Account	1/PA1, 1/UH2, 2/K, 1/AH1, 1/U1, 1/N, 1/T
Active	2/PA1, 2/AE1, 2/EH3, 1/K, 1/PAØ, 1/T, 1/I2, 1/V
Add	2/PA1, 1/AE, 1/EH3, 1/D
Address	1/PA1, 1/UH2, 2/D, 2/R, 1/EH1, 1/S, 1/S
Adjust	1/PA1, 1/UH2, 1/D, 2/J, 2/UH3, 1/UH1, 1/S, 1/T
Advance	1/PA1, 1/EH2, 1/D, 2/V, 1/AE1, 1/EH3, 1/N, 1/S
After	2/PA1, 1/AE, 1/F, 1/T, 1/ER
Afternoon	1/PA1, 1/AE1, 1/F, 2/T, 1/R, 2/N, 1/IU, 1/U, 1/N
Again	1/PA1, 1/UH1, 2/G, 1/EH, 1/N
Air	2/PA1, 1/A2, 1/EH2, 1/ER
All	2/PA1, 1/AW, 1/UH3, 1/L
Am	2/PA1, 1/AE1, 1/EH3, 1/UH3, 1/M
A.M.	1/PA1, 1/A2, 2/AY, 2/Y, 2/PAØ, 2/PAØ, 2/EH3, 1/EH1, 1/UH3, 1/M
America	1/PA1, 1/UH2, 3/M, 2/EH2, 1/EH2, 1/R, 1/EH3, 1/K, 1/UH1
Amount	1/PA1, 1/UH2, 2/M, 2/UH3, 1/AH1, 1/U1, 1/N, 1/T
An	2/PA1, 1/AE1, 1/EH3, 1/I3, 1/N
And	2/PA1, 1/AE1, 1/EH3, 1/I3, 1/N, 1/D
Answer	2/PA1, 2/AE1, 1/I3, 2/N, 1/S, 1/R, 1/R
Application	1/PA1, 1/AE1, 2/P, 1/L, 1/UH3, 3/K, 1/A1, 1/Y1, 1/SH, 1/UH3, 1/N

Approve	1/PA1, 1/UH2, 3/P, 2/R, 1/U, 1/V
April	1/PA1, 1/A1, 2/AY, 1/P, 1/R, 1/UH3, 2/L
Are	2/PA1, 1/AH1, 1/UH3, 1/ER
Assign	1/PA1, 1/UH2, 3/S, 1/AH1, 1/E1, 1/N
Assist	1/PA1, 1/UH2, 3/S, 1/I, 1/S, 1/T
At	2/PA1, 1/AE1, 1/EH3, 1/T
Atlantic	1/PA1, 1/EH2, 1/T, 2/L, 1/AE1, 1/N, 1/T, 1/I3, 1/K
August	2/PA1, 1/AW, 2/G, 1/EH2, 1/S, 1/T
Available	2/PA1, 1/UH2, 2/V, 2/A1, 2/AY, 1/L, 1/UH3, 1/B, 1/UH3, 1/L
Average	2/PA1, 1/AE1, 1/I3, 1/V, 1/R, 1/I2, 1/D, 1/J
Away	1/PA1, 1/UH2, 2/W, 1/A1, 1/AY, 1/AY

Back	1/PA1, 3/B, 2/AE1, 1/EH3, 1/K
Be	1/PA1, 2/B, 1/E1, 1/E1
Because	1/PA1, 1/B, 1/Y1, 2/K, 1/UH1, 2/UH2, 1/Z
Been	1/PA1, 3/B, 1/EH3, 1/EH1, 1/N
Before	1/PA1, 1/B, 1/E1, 3/F, 1/O, 1/R
Begin	1/PA1, 1/B, 1/E1, 3/G, 1/I3, 1/I1, 1/N
Benefit	1/PA1, 3/B, 1/EH1, 1/N, 1/EH3, 2/F, 1/I3, 1/T
Between	1/PA1, 1/B, 1/I2, 3/T, 1/W, 1/E1, 1/E1, 1/N
But	1/PA1, 1/B, 1/UH1, 2/UH3, 2/T
By	1/PA1, 2/B, 1/AH1, 1/E1

Call	2/PA1, 2/K, 1/AW, 1/L
Can	2/PA1, 2/K, 1/AE, 1/EH3, 1/EH3, 1/N
Car	2/PA1, 3/K, 1/AH, 1/R
Care	2/PA1, 2/K, 1/A2, 1/EH2, 1/R
Careful	2/PA1, 2/K, 1/A2, 2/EH2, 2/R, 1/F, 1/UH3, 1/L
Case	2/PA1, 2/K, 1/A1, 1/AY, 1/Y1, 1/S
Cash	2/PA1, 2/K, 1/AE, 1/EH3, 1/SH
Caution	2/PA1, 2/K, 2/AW, 1/SH, 1/UH3, 1/N
Cents	2/PA1, 2/S, 2/EH3, 1/EH1, 1/N, 1/S
Change	2/PA1, 2/T, 2/CH, 2/EH3, 1/A1, 1/Y, 1/N, 1/D, 1/J
Charge	2/PA1, 2/T, 2/CH, 1/AH, 1/R, 1/D, 1/J
Check	2/PA1, 2/T, 2/CH, 1/EH, 1/K
City	2/PA1, 3/S, 1/I1, 1/DT, 1/E1
Class	2/PA1, 2/K, 1/L, 1/AE, 1/UH3, 1/S
Classification	2/PA1, 2/K, 2/L, 1/AE1, 2/S, 1/I3, 2/F, 1/I3, 2/K, 2/A1, 1/Y1, 1/SH, 1/UH3, 1/N
Clear	2/PA1, 2/K, 2/L, 2/I3, 1/I1, 1/R
Clearance	2/PA1, 2/K, 2/L, 2/I3, 1/I2, 1/R, 1/EH3, 1/N, 1/S
Clock	2/PA1, 2/K, 2/L, 1/AH1, 1/UH3, 1/K
Close *	2/PA1, 2/K, 2/L, 1/UH3, 1/O1, 1/U1, 1/Z
Close *	2/PA1, 2/K, 2/L, 1/UH3, 1/O1, 1/U1, 1/S

Code	2/PA1, 2/K, 1/O2, 1/O1, 1/U1, 1/D
Collect	1/PA1, 1/K, 1/UH2, 3/L, 2/UH3, 1/EH2, 1/EH2, 1/K, 1/PAØ, 1/T
Commit	1/PA1, 1/K, 1/UH2, 3/M, 1/I1, 1/T
Complete	1/PA1, 1/K, 1/UH3, 1/M, 3/P, 1/L, 1/E, 1/T
Condition	1/PA1, 1/K, 1/UH3, 1/N, 2/D, 1/I2, 1/SH, 1/UH3, 1/N
Confirm	1/PA1, 1/K, 1/UH3, 1/N, 3/F, 1/R, 1/R, 1/M
Contact	2/PA1, 2/K, 1/AH1, 1/N, 1/T, 1/AE1, 1/EH3, 1/K, 1/PAØ, 1/T
Correct	2/PA1, 1/K, 1/R, 2/R, 1/EH1, 1/K, 1/PAØ, 1/T
Cost	2/PA1, 2/K, 1/AW, 1/S, 1/T
Customer	2/PA1, 2/K, 2/UH2, 1/S, 1/T, 1/UH3, 1/M, 1/R

Daily	2/PA1, 2/D, 2/A1, 1/Y, 1/L, 1/Y
Data	2/PA1, 3/D, 1/A1, 1/AY, 1/DT, 1/UH2
Date	2/PA1, 3/D, 1/A1, 1/AY, 1/Y1, 1/T
Day	2/PA1, 3/D, 1/EH3, 1/A1, 1/AY
December	2/PA1, 1/D, 2/Y1, 3/S, 2/EH2, 2/EH2, 1/M, 1/B, 1/R
Deduct	2/PA1, 1/D, 1/I3, 3/D, 1/UH2, 1/UH2, 1/K, 1/PAØ, 1/T
Defer	2/PA1, 1/D, 1/Y1, 3/F, 1/ER, 1/R
Deliver	2/PA1, 1/D, 1/UH3, 2/L, 1/I2, 1/V, 1/ER
Demand	2/PA1, 1/D, 1/EH3, 2/M, 1/AE1, 1/AE1, 1/N, 1/N, 1/D
Departure	2/PA1, 1/D, 1/I3, 2/P, 2/AH1, 1/R, 1/T, 1/CH, 1/R
Deposit	2/PA1, 1/D, 1/I3, 3/P, 1/AH1, 1/UH3, 1/Z, 1/I2, 1/T
Determine	2/PA1, 1/D, 1/I2, 3/T, 2/R, 1/R, 1/M, 1/I3, 1/N
Did	2/PA1, 2/D, 1/I, 1/D
Difference	2/PA1, 2/D, 1/I2, 1/F, 1/R, 1/EH3, 1/N, 1/S
Direct	1/PA1, 1/D, 1/ER, 2/EH1, 2/K, 2/PAØ, 1/T
Direction	2/PA1, 2/D, 2/ER, 1/EH1, 1/K, 1/SH, 1/UH3, 1/N
Distance	2/PA1, 2/D, 2/I1, 1/S, 1/T, 1/EH2, 1/N, 1/S
Divide	1/PA1, 1/D, 1/I3, 3/V, 1/AH1, 1/UH3, 1/E1, 1/D
Do	2/PA1, 3/D, 1/IU, 1/U
Dollar	2/PA1, 3/D, 2/UH3, 1/AH1, 1/L, 1/UH3, 1/R
Down	2/PA1, 2/D, 1/UH3, 1/AH1, 1/U1, 1/N

East	2/PA1, 1/E, 1/Y1, 1/S, 1/T
Economic	1/PA1, 1/EH2, 1/K, 1/UH3, 2/N, 1/AH1, 1/M, 1/I2, 1/K
Effective	1/PA1, 1/UH2, 3/F, 1/EH1, 1/K, 1/PAØ, 1/T, 1/I3, 1/V
Eight	1/PA1, 1/A1, 1/AY, 2/Y1, 2/T
Eighteen	2/PA1, 1/A1, 1/AY, 2/Y1, 2/T, 2/PAØ, 1/E1, 1/E1, 1/N
Eighty	2/PA1, 2/A1, 1/AY, 1/Y1, 1/D, 1/Y
Electric	1/PA1, 1/UH3, 3/L, 1/EH1, 1/K, 1/PAØ, 1/T, 1/R, 1/I3, 1/K
Eleven	1/PA1, 1/UH3, 3/L, 1/EH1, 1/V, 1/EH3, 1/N
Employee	1/PA1, 1/EH2, 1/M, 3/P, 2/L, 2/O1, 1/I3, 1/E1, 1/E1
Enter	2/PA1, 1/EH1, 1/N, 1/T, 1/ER
Even	2/PA1, 1/E, 1/V, 1/EH2, 1/N
Ever	2/PA1, 2/EH1, 1/V, 1/R, 1/R
Except	1/PA1, 1/EH2, 1/K, 2/S, 1/EH1, 1/P, 1/PAØ, 1/T
Exception	1/PA1, 1/EH2, 1/K, 3/S, 1/EH1, 2/P, 1/SH, 1/UH3, 1/N
Exchange	1/PA1, 1/EH3, 1/K, 1/S, 2/T, 3/CH, 1/A1, 1/AY, 1/Y1, 1/N, 1/D, 1/J
Excuse *	1/PA1, 1/EH2, 1/K, 1/S, 2/K, 1/Y1, 1/IU, 1/U1, 1/Z
Expand	1/PA1, 1/EH3, 1/K, 3/S, 2/P, 1/AE1, 1/EH3, 1/N, 1/D

Expense	1/PA1, 1/EH3, 1/K, 3/S, 2/P, 1/EH, 1/N, 1/S
Experience	1/PA1, 1/EH3, 1/K, 3/S, 3/P, 1/I1, 1/R, 1/Y1, 1/UH3, 1/N, 1/S
Express	1/PA1, 1/EH2, 1/K, 3/S, 2/P, 1/R, 1/EH1, 1/S
Extend	1/PA1, 1/EH2, 1/K, 3/S, 2/T, 1/EH1, 1/I3, 1/N, 1/D
Extensive	1/PA1, 1/EH2, 1/K, 2/S, 2/T, 1/EH1, 1/N, 1/S 1/I2, 1/V

Face	2/PA1, 3/F, 1/A1, 1/AY, 1/Y1, 1/S
Far	2/PA1, 3/F, 1/AH1, 1/UH3, 1/R
Fast	2/PA1, 2/F, 1/AE, 1/EH3, 1/S, 1/T
February	2/PA1, 1/F, 2/EH1, 1/B, 2/Y1, 1/U1, 1/EH3, 1/I3, 1/R, 2/E1
Feet	2/PA1, 2/F, 1/E, 1/T
Few	2/PA1, 3/F, 1/Y, 1/IU, 1/U1
Fifteen	1/PA1, 1/F, 1/I1, 2/F, 2/T, 1/E1, 1/E1, 1/N
Fifty	2/PA1, 2/F, 2/I1, 1/F, 1/T, 1/Y
Fight	2/PA1, 2/F, 1/UH3, 1/AH2, 1/E1, 1/T
File	2/PA1, 3/F, 1/AH1, 1/E1, 1/UH3, 1/L
Fill	2/PA1, 3/F, 1/I1, 1/UH3, 1/L
Find	2/PA1, 3/F, 1/AH1, 1/I3, 1/E1, 1/N, 1/D
Five	2/PA1, 3/F, 1/UH3, 1/AH1, 1/E1, 1/V
For	2/PA1, 2/F, 1/O, 1/R
Force	2/PA1, 2/F, 1/O, 1/R, 1/S
Form	2/PA1, 2/F, 1/O, 1/R, 1/M
Forty	2/PA1, 2/F, 1/O1, 1/R, 1/DT, 1/Y
Forward	2/PA1, 3/F, 1/O1, 1/R, 1/W, 1/ER, 1/D
Fourteen	1/PA1, 1/F, 1/O, 2/R, 2/T, 2/PAØ, 1/E1, 1/E1, 1/N
Fourth	2/PA1, 3/F, 1/O, 1/R, 1/TH
Friday	2/PA1, 1/F, 2/R, 1/AH1, 1/E1, 1/D, 1/A1, 1/AY
From	2/PA1, 3/F, 1/R, 1/UH1, 1/M

Front	2/PA1, 3/F, 1/R, 1/UH1, 1/N, 1/T
Future	2/PA1, 3/F, 2/Y1, 1/U1, 2/T, 1/CH, 1/ER

Gasoline	2/PA1, 1/G, 1/AE1, 1/S, 2/UH3, 3/L, 1/E, 1/N
Glide	2/PA1, 2/G, 1/L, 1/AH1, 1/E1, 1/D
Government	2/PA1, 2/G, 2/UH1, 1/V, 1/R, 1/M, 1/EH3, 1/N, 1/T
Grade	2/PA1, 3/G, 1/R, 1/A1, 1/AY, 1/Y1, 1/D
Great	2/PA1, 2/G, 1/R, 1/A1, 1/E1, 1/T
Ground	2/PA1, 3/G, 1/R, 1/AH1, 1/U1, 1/N, 1/D
Guarantee	1/PA1, 1/G, 1/EH3, 1/R, 1/UH3, 2/N, 3/T, 1/E, 1/E1
Guard	2/PA1, 3/G, 1/AH1, 1/UH3, 1/R, 1/D
Guess	2/PA1, 3/G, 1/EH, 1/S
Guide	2/PA1, 2/G, 1/AH1, 1/E1, 1/D

Had	2/PA1, 2/H, 1/AE, 1/EH3, 1/D
Hair	2/PA1, 2/H, 1/A2, 1/EH2, 1/R
Hand	2/PA1, 3/H, 1/AE, 1/EH3, 1/N, 1/D
Handle	2/PA1, 2/H, 2/AE1, 1/EH3, 1/N, 1/D, 1/UH3, 1/L
Happen	2/PA1, 3/H, 2/AE1, 1/EH3, 1/P, 1/I3, 1/N
Hardware	2/PA1, 3/H, 1/AH1, 1/R, 1/D, 1/W, 1/EH2, 1/R
Has	2/PA1, 2/H, 1/AE, 1/I3, 1/Z
Have	2/PA1, 2/H, 1/AE, 1/UH3, 1/V
He	2/PA1, 2/H, 1/E
Headlight	2/PA1, 2/H, 1/EH1, 2/D, 1/L, 1/UH3, 1/AH2, 1/Y1, 1/T
Hear	2/PA1, 2/H, 1/E, 1/R
Heard	2/PA1, 2/H, 1/ER, 1/R, 1/D
Heart	2/PA1, 2/H, 1/AH1, 1/R, 1/T
Hello	2/PA1, 3/H, 1/EH1, 1/UH3, 1/L, 1/UH3, 1/O2, 2/U1
Help	2/PA1, 3/H, 1/EH1, 1/UH3, 1/L, 1/P
Her	2/PA1, 2/H, 1/ER, 1/R
High	2/PA1, 2/H, 1/AH1, 1/E1
Him	2/PA1, 2/H, 1/I1, 1/M
Hire	2/PA1, 2/H, 1/AH1, 1/Y1, 1/ER
His	2/PA1, 2/H, 1/I, 1/Z
How	2/PA1, 3/H, 1/AH1, 1/O2, 1/U1

However	2/PA1, 2/H, 1/AH1, 1/U1, 1/EH1, 1/V, 1/R, 2/R
Hundred	2/PA1, 3/H, 1/UH1, 1/N, 1/D, 1/R, 1/EH2, 1/D
Hurry	2/PA1, 2/H, 1/ER, 1/R, 1/Y

I	2/PA1, 1/AH1, 1/EH3, 1/E1
If	2/PA1, 1/I, 1/F
Impatient	1/PA1, 1/I1, 2/M, 3/P, 2/A1, 1/AY, 1/SH, 1/EH3, 1/N, 1/T
Imperative	1/PA1, 1/I2, 2/M, 2/P, 2/EH1, 1/R, 1/EH3, 1/T 1/I3, 1/V
Imply	1/PA1, 1/I1, 2/M, 2/P, 2/L, 1/AH1, 1/Y
Impossible	1/PA1, 1/I2, 2/M, 3/P, 1/AH1, 1/S, 1/UH3, 1/B, 1/L
Impress	1/PA1, 1/I2, 1/M, 2/P, 2/R, 1/EH1, 1/S
Improvement	1/PA1, 1/I3, 1/M, 3/P, 1/R, 2/U1, 1/V, 1/M, 1/EH3, 1/N, 1/T
In	2/PA1, 1/I, 1/N
Inch	2/PA1, 1/I1, 1/N, 1/T, 1/CH
Include	1/PA1, 1/I3, 1/N, 3/K, 1/L, 1/IU, 1/U1, 1/D
Inconsistent	2/PA1, 2/I1, 1/N, 1/K, 1/UH3, 2/N, 3/S, 1/I2, 1/S, 1/T, 1/EH3, 1/N, 1/T
Inconvenience	2/PA1, 2/I1, 1/N, 1/K, 1/UH3, 2/N, 3/V, 1/E1, 1/N, 1/Y1, 1/UH3, 1/N, 1/S
Increase	1/PA1, 1/I2, 1/N, 3/K, 1/R, 1/E, 1/S
Independent-	2/PA1, 1/I2, 1/N, 1/D, 1/Y1, 3/P, 1/EH1, 1/N, 1/D, 1/I3, 1/N, 1/T
Indicate	2/PA1, 2/I2, 1/N, 1/D, 1/I3, 1/K, 1/A1, 1/AY, 1/T
Inferior	1/PA1, 1/I2, 1/N, 3/F, 2/E1, 1/R, 1/Y, 1/ER
Influence	2/PA1, 2/I1, 1/N, 2/F, 1/L, 1/U1, 1/I3, 1/N, 1/S

Inform	1/PA1, 1/I2, 1/N, 3/F, 1/O, 1/R, 1/M
Information	2/PA1, 1/I2, 1/N, 1/F, 2/R, 3/M, 1/A1, 1/AY, 1/SH, 1/UH3, 1/N
Initial	1/PA1, 1/I2, 2/N, 2/I1, 1/SH, 1/UH3, 1/L
Inquire	1/PA1, 1/I3, 2/N, 3/K, 1/W, 1/AH2, 1/E1, 1/R
Insert	1/PA1, 1/I2, 2/N, 2/S, 1/ER, 1/R, 1/T
Inside	2/PA1, 1/I3, 1/N, 2/S, 1/AH1, 1/E1, 1/D
Instead	1/PA1, 1/I2, 2/N, 2/S, 1/T, 1/EH, 1/D
Instruct	1/PA1, 1/I2, 1/N, 3/S, 2/T, 1/R, 1/UH1, 1/K, 1/T
Insufficient	2/PA1, 1/I2, 2/N, 1/S, 1/UH3, 2/F, 1/I2, 1/SH, 1/EH3, 1/N, 1/T
Insurance	1/PA1, 1/I1, 1/N, 3/SH, 1/R, 1/R, 1/EH3, 1/N, 1/S
Intelligibility	1/PA1, 1/I2, 2/N, 1/T, 1/EH3, 2/L, 1/UH3, 2/D, 2/J, 1/UH3, 2/B, 1/I2, 1/L, 1/I3, 1/T, 2/Y
Intend	1/PA1, 1/I2, 2/N, 3/T, 1/EH1, 1/I3, 1/N, 1/D
Interest	2/PA1, 2/I2, 2/N, 1/T, 1/R, 1/EH2, 1/S, 1/T
Interrupt	1/PA1, 1/I2, 2/N, 1/T, 1/ER, 2/UH1, 2/P, 2/T
Into	1/PA1, 1/I1, 1/N, 2/T, 1/U
Introduced	1/PA1, 1/I2, 1/N, 1/T, 2/R, 1/UH3, 2/D, 1/IU, 1/U1, 1/S, 1/T
Investigate	1/PA1, 1/I2, 2/N, 2/V, 2/EH1, 1/S, 1/T, 1/I3, 1/G, 1/A2, 2/Y1, 2/T
Is	1/PA1, 1/I, 2/Z
It	1/PA1, 1/I1, 1/T

Jacket	2/PA1, 2/D, 2/J, 1/AE1, 1/EH3, 1/K, 1/EH3, 1/T
January	2/PA1, 2/D, 1/J, 2/AE1, 1/I3, 1/N, 2/Y1, 1/U1, 1/EH3, 1/I3, 1/R, 2/E1
Joint	2/PA1, 2/D, 2/J, 1/O1, 1/I3, 1/AY, 2/N, 1/T
July	1/PA1, 1/D, 1/J, 1/IU, 3/L, 1/AH1, 1/E1
June	1/PA1, 2/D, 3/J, 1/IU, 1/U, 1/N
Justice	2/PA1, 2/D, 2/J, 1/UH1, 1/S, 1/T, 1/I3, 1/S

Keep	2/PA1, 2/K, 1/E1, 1/Y, 1/P
Kind	2/PA1, 2/K, 1/AH1, 1/I1, 1/N, 1/D
Knew	2/PA1, 1/N, 1/IU, 1/U
Know	2/PA1, 1/N, 1/UH3, 1/O1, 1/U1
Knowledge	2/PA1, 2/N, 1/AH1, 1/L, 1/EH3, 1/D, 1/J

Lead *	2/PA1, 2/L, 1/EH1, 1/I3, 1/D
Least	1/PA1, 2/L, 1/E1, 1/Y, 1/S, 1/T
Leave	1/PA1, 2/L, 1/E1, 1/Y1, 1/V
Leeway	2/PA1, 2/L, 2/E1, 1/W, 1/A1, 1/AY
Left	2/PA1, 2/L, 1/EH2, 1/UH3, 1/F, 1/T
Life	2/PA1, 2/L, 1/AH1, 1/E1, 1/F
Light	2/PA1, 2/L, 1/UH3, 1/AH2, 1/Y1, 1/T
Limit	1/PA1, 2/L, 1/I2, 1/M, 1/I3, 1/T
List	2/PA1, 1/L, 1/I1, 1/S, 1/T
Live	2/PA1, 2/L, 1/I1, 1/V
Location	2/PA1, 1/L, 1/UH3, 1/O2, 2/K, 1/A2, 1/Y1, 1/SH, 1/UH3, 1/N

Made	1/PA1, 1/M, 2/A1, 1/AY, 1/Y1, 1/D
Manage	2/PA1, 2/M, 1/AE1, 1/EH3, 1/N, 1/I3, 1/D, 1/J
March	2/PA1, 2/M, 1/AH1, 1/UH3, 1/R, 1/T, 1/CH
Mark	2/PA1, 2/M, 1/AH1, 1/UH3, 1/R, 1/K
Material	2/PA1, 1/M, 1/EH3, 3/T, 2/I1, 1/R, 1/E1, 1/UH3, 1/L
Maximum	2/PA1, 2/M, 1/AE1, 2/K, 1/S, 1/EH3, 1/M, 1/UH3, 1/M
May	2/PA1, 1/M, 2/EH3, 1/A1, 1/AY
Measurement	2/PA1, 2/M, 2/EH1, 1/ZH, 1/R, 1/M, 1/EH3, 1/N, 1/T
Mechanic	1/PA1, 1/M, 1/EH2, 3/K, 1/AE1, 1/EH3, 1/N, 1/I3, 1/K
Medium	2/PA1, 2/M, 2/E1, 1/D, 1/E1, 1/UH2, 1/M
Member	1/PA1, 2/M, 2/EH1, 1/M, 1/B, 1/ER
Men	2/PA1, 2/M, 1/EH1, 1/I3, 1/N
Merge	2/PA1, 2/M, 1/ER, 1/R, 1/D, 1/J
Mile	1/PA1, 2/M, 1/AH1, 1/I3, 1/UH3, 1/L
Million	2/PA1, 1/M, 2/I1, 1/L, 1/Y1, 1/UH3, 1/N
Mind	2/PA1, 2/M, 1/AH1, 1/E1, 1/N, 1/D
Minutes	2/PA1, 2/M, 1/I1, 1/N, 1/I3, 1/T, 1/S
Mistake	2/PA1, 1/M, 1/I3, 2/S, 2/T, 1/A1, 1/AY, 1/Y1, 1/K
Monday	2/PA1, 2/M, 1/UH1, 1/N, 1/D, 1/A1, 1/AY

Month	2/PA1, 2/M, 1/UH1, 2/N, 1/TH
Mr.	2/PA1, 2/M, 2/I2, 1/S, 1/T, 1/ER
Mrs.	1/PA1, 1/M, 2/I1, 1/S, 1/I2, 1/Z
Much	1/PA1, 2/M, 1/UH1, 1/T, 1/CH
Must	1/PA1, 2/M, 1/UH1, 1/S, 1/T

Nation	2/PA1, 1/N, 2/A1, 1/AY, 1/SH, 1/EH2, 1/N
Necessitate	2/PA1, 1/N, 1/EH3, 2/S, 2/EH1, 1/S, 1/I3, 1/T 1/A1, 1/AY, 1/T
Never	2/PA1, 1/N, 2/EH1, 1/V, 1/ER
Newspaper	2/PA1, 1/N, 2/IU, 1/U1, 2/Z, 1/P, 1/A1, 1/AY, 1/P, 1/R
Nine	2/PA1, 2/N, 1/AH1, 1/I3, 1/Y, 1/N
Nobody	2/PA1, 1/N, 2/O1, 1/B, 1/UH1, 1/D, 1/Y
North	2/PA1, 2/N, 1/O, 1/R, 1/TH
Not	2/PA1, 1/N, 2/AH1, 1/T
November	1/PA1, 1/N, 1/O1, 3/V, 2/EH2, 1/EH3, 1/M, 1/B, 1/ER
Now	2/PA1, 2/N, 2/UH3, 1/AH1, 1/O2, 1/U1
Number	2/PA1, 1/N, 2/UH1, 1/M, 1/B, 1/ER

Objected	1/PA1, 1/UH2, 1/B, 2/D, 2/J, 1/EH1, 1/K, 1/PAØ, 1/T, 1/I3, 1/D
Observe	1/PA1, 1/UH2, 2/B, 1/Z, 1/ER, 2/R, 1/V
O'Clock	1/PA1, 1/O1, 3/K, 1/L, 1/AH1, 1/K
October	1/PA1, 1/AH1, 1/K, 2/PAØ, 3/T, 1/O2, 1/U1, 1/B, 1/R
On	2/PA1, 1/AH, 1/UH3, 1/N, 1/N
Once	2/PA1, 2/W, 1/UH1, 1/UH3, 1/N, 1/T, 1/S
One	2/PA1, 2/W, 1/UH, 1/N
Operate	2/PA1, 2/AH1, 1/P, 1/ER, 1/A1, 1/AẎ, 1/T
Our(s)	2/PA1, 1/AH1, 1/U1, 1/ER, (1/Z)
Over	2/PA1, 2/O1, 1/U1, 1/V, 1/ER

Pacific	1/PA1, 1/P, 2/EH2, 3/S, 1/I1, 1/F, 1/I3, 1/K
Page	2/PA1, 1/P, 2/A1, 1/AY, 1/AY, 1/D1, 1/J
Paper	2/PA1, 1/P, 2/A1, 1/AY, 1/P, 1/ER
Parallel	2/PA1, 2/P, 2/EH1, 1/R, 2/UH3, 1/L, 1/EH3, 1/UH3, 1/L
Part(s)	2/PA1, 2/P, 1/AH1, 1/R, 1/T, (1/S)
Pass	2/PA1, 2/P, 1/AE, 1/EH3, 1/S
Pattern	2/PA1, 2/P, 1/AE1, 1/EH3, 1/DT, 1/ER, 1/N
Pavement	2/PA1, 1/P, 2/A1, 1/AY, 1/V, 1/M, 1/EH3, 1/N, 1/T
Pay	2/PA1, 2/P, 1/EH3, 1/A1, 1/AY
Percent	1/PA1, 1/P, 1/R, 3/S, 1/EH1, 1/N, 1/T
Percentage	1/PA1, 1/P, 1/R, 3/S, 1/EH1, 1/N, 1/T, 1/I3, 1/D, 1/J
Performance	1/PA1, 1/P, 1/R, 3/F, 1/O2, 1/R, 1/M, 1/EH3, 1/N, 1/S
Period	2/PA1, 2/P, 2/I2, 1/R, 1/E1, 1/UH3, 1/D
Pertain	1/PA1, 1/P, 1/ER, 3/T, 1/A1, 1/AY, 1/Y1, 1/N
Phone	2/PA1, 2/F, 1/O, 1/U1, 1/N
Phrase	2/PA1, 2/F, 1/R, 1/A1, 1/AY, 1/Y1, 1/Z
Place	2/PA1, 2/P, 1/L, 1/A1, 1/AY, 1/Y1, 1/S
Placement	2/PA1, 2/P, 2/L, 1/A2, 1/AY, 1/S, 1/M, 1/EH3, 1/N, 1/T
Plan	2/PA1, 2/P, 2/L, 1/AE1, 1/EH3, 1/N

Please	2/PA1, 2/P, 2/L, 1/E1, 1/E1, 1/Z
P.M.	1/PA1, 1/P, 1/E1, 2/E1, 2/PAØ, 2/EH1, 1/EH3, 1/UH3, 1/M
Policy	2/PA1, 2/P, 1/AH1, 1/L, 1/I3, 1/S, 1/Y
Position	1/PA1, 1/P, 2/UH3, 2/Z, 1/I1, 1/SH, 1/UH3, 1/N
Possible	2/PA1, 2/P, 1/AH1, 1/S, 1/UH3, 1/B, 1/L
Postage	2/PA1, 2/P, 1/O1, 1/S, 1/T, 1/I3, 1/D, 1/J
Potential	1/PA1, 1/P, 2/O2, 2/T, 2/EH1, 1/N, 1/SH, 1/UH3, 1/L
Practice	2/PA1, 1/P, 2/R, 1/AE1, 2/K, 1/PAØ, 1/T, 1/I3, 1/S
Preference	2/PA1, 2/P, 2/R, 1/EH2, 1/V, 1/R, 1/EH3, 1/N, 1/S
Preparation	2/ PA1, 1/P, 1/R, 1/EH3, 2/P, 1/ER, 2/A1, 1/AY, 1/SH, 1/UH3, 1/N
Prepare	2/PA1, 2/P, 1/R, 1/EH3, 3/P, 1/EH3, 1/A1, 1/R
Present	1/PA1, 1/P, 1/R, 2/I3, 2/Z, 1/EH2, 1/EH2, 1/N, 1/T
Pressure	2/PA1, 1/P, 2/R, 1/EH1, 1/SH, 1/ER
Price	2/PA1, 2/P, 1/R, 1/UH3, 1/AH2, 1/E1, 1/S
Print	2/PA1, 2/P, 1/R, 1/I1, 1/N, 1/T
Problem(s)	2/PA1, 2/P, 2/R, 1/AH1, 1/B, 1/L, 1/EH3, 1/M, (1/Z)
Produce	2/PA1, 1/P, 1/R, 2/UH3, 1/D, 1/IU, 1/U1, 1/S
Program	2/PA1, 1/P, 2/R, 1/O1, 1/G, 1/R, 1/AE1, 1/EH3, 1/M
Progress	2/PA1, 2/P, 2/R, 2/AH1, 1/G, 1/R, 1/EH1, 1/S
Public	2/PA1, 1/P, 2/UH1, 1/B, 1/L, 1/I3, 1/K
Pupil	2/PA1, 1/P, 2/Y1, 2/U1, 1/P, 1/UH3, 1/L

Quantity	2/PA1, 2/K, 1/W, 2/AH2, 1/EH3, 2/N, 1/DT, 1/I2, 1/DT, 1/Y
Quart	2/PA1, 2/K, 2/W, 1/O2, 1/R, 1/T
Question	1/PA1, 2/K, 2/W, 1/EH1, 1/S, 2/T, 2/CH, 2/UH3, 1/N
Quick	2/PA1, 2/K, 1/W, 1/I1, 1/K
Quiet	2/PA1, 2/K, 1/W, 1/AH1, 1/Y, 1/EH3, 1/T
Quite	2/PA1, 2/K, 1/W, 1/UH1, 1/Y, 1/T
Quotation	2/PA1, 1/K, 1/W, 1/O1, 3/T, 2/A2, 1/Y, 1/SH, 1/UH3, 1/N
Quote	2/PA1, 2/K, 1/W, 1/O1, 1/U1, 1/T

Range	1/PA1, 1/R, 2/A1, 1/AY, 1/I3, 1/N, 1/D, 1/J
Rapid	2/PA1, 2/R, 1/AE1, 1/P, 1/I3, 1/D
Reaction	1/PA1, 1/R, 2/E1, 1/AE1, 1/EH3, 1/K, 1/SH, 1/UH3, 1/N
Read *	2/PA1, 2/R, 1/EH3, 1/I3, 1/D
Read *	2/PA1, 2/R, 1/E1, 1/E1, 1/D
Receive	1/PA1, 1/R, 1/E1, 3/S, 1/E, 1/E1, 1/V
Recognition	2/PA1, 1/R, 1/EH3, 2/K, 1/I2, 2/G, 3/N, 1/I2, 1/SH, 1/UH3, 1/N
Recommend	2/PA1, 1/R, 1/EH3, 2/K, 1/UH3, 3/M, 1/EH, 1/N, 1/D
Recommendation	2/PA1, 2/R, 1/EH3, 2/K, 1/EH2, 1/M, 1/EH2, 1/N, 3/D, 1/A1, 1/AY, 1/SH, 1/UH3, 1/N
Refund	2/PA1, 2/R, 1/E1, 1/F, 1/UH3, 1/UH1, 1/N, 1/D
Register	2/PA1, 2/R, 1/EH2, 1/D, 1/J, 1/I3, 1/S, 1/T, 1/R
Release(d)	1/PA1, 1/R, 1/E1, 2/L, 1/E1, 1/Y1, 1/S, (1/T)
Remark	2/PA1, 1/R, 1/E1, 3/M, 1/AH1, 1/R, 1/K
Remember	2/PA1, 1/R, 1/E1, 3/M, 2/EH3, 2/UH3, 1/M, 1/B, 1/R
Remind	2/PA1, 1/R, 1/E1, 3/M, 1/AH1, 1/E1, 1/N, 1/D
Reorganize	2/PA1, 1/R, 1/E1, 3/O1, 1/R, 2/G, 1/UH3, 1/N, 1/AH1, 1/Y1, 1/Z
Repeat	1/PA1, 1/R, 1/E1, 3/P, 1/E1, 1/Y1, 1/T
Replace	1/PA1, 1/R, 1/E1, 3/P, 1/L, 1/A1, 1/AY, 1/S
Replacement	1/PA1, 1/R, 1/E1, 3/P, 1/L, 2/A1, 1/Y1, 1/S, 1/M, 1/EH3, 1/N, 1/T

Report	1/PA1, 1/R, 1/E1, 3/P, 1/O1, 1/R, 1/T
Represent	2/PA1, 2/R, 1/EH3, 1/P, 1/R, 1/I3, 3/Z, 1/EH1, 1/N, 1/T
Request	1/PA1, 1/R, 1/I3, 3/K, 1/W, 1/EH1, 1/S, 1/T
Return	1/PA1, 1/R, 1/E1, 3/T, 1/ER, 1/R, 1/N
Right	2/PA1, 2/R, 1/AH2, 1/UH3, 1/E1, 1/T
Rotation	1/PA1, 1/R, 1/O2, 3/T, 1/A1, 1/AY, 1/SH, 1/UH3, 1/N
Runway	2/PA1, 2/R, 1/UH1, 1/N, 1/W, 1/A1, 1/AY

Said	2/PA1, 3/S, 1/EH1, 1/I3, 1/D
Same	2/PA1, 2/S, 1/EH3, 1/A1, 1/AY, 1/Y1, 1/M
Saturday	2/PA1, 2/S, 1/AE1, 2/EH3, 1/DT, 1/R, 1/D, 1/A1, 1/AY
Save	2/PA1, 2/S, 1/EH3, 1/A1, 1/AY, 1/Y1, 1/V
Say	2/PA1, 2/S, 1/EH3, 1/A1, 1/AY
School	2/PA1, 2/S, 2/K, 1/U1, 1/U1, 1/L
Screen	2/PA1, 2/S, 2/K, 2/R, 1/E1, 1/E1, 1/N
Search	2/PA1, 2/S, 1/ER, 1/R, 1/T, 1/CH
Season	2/PA1, 3/S, 1/E, 1/Z, 1/EH2, 1/N
Second(s)	2/PA1, 1/S, 2/EH1, 1/K, 1/UH2, 1/N, 1/T, (1/S)
Section	2/PA1, 1/S, 2/EH1, 2/K, 1/SH, 1/UH3, 1/N
Secure	1/PA1, 1/S, 1/I3, 2/K, 2/Y1, 1/ER, 1/R
See	2/PA1, 2/S, 1/E1, 1/E1
Seen	2/PA1, 2/S, 1/E1, 1/E1, 1/N
Select	1/PA1, 1/S, 2/UH3, 2/L, 1/UH3, 1/EH1, 1/K, 1/T
Self	2/PA1, 2/S, 1/EH1, 1/UH3, 1/L, 1/F
Sell	2/PA1, 2/S, 1/EH1, 1/UH3, 1/L
Send	2/PA1, 2/S, 1/EH1, 1/I3, 1/N, 1/D
Sent	2/PA1, 2/S, 2/EH3, 1/EH1, 1/N, 1/T
Separate	2/PA1, 2/S, 1/EH1, 1/P, 1/R, 1/EH3, 1/T

Separation	2/PA1, 1/S, 1/EH1, 2/P, 1/ER, 2/A1, 1/AY, 1/SH, 1/UH3, 1/N
September	1/PA1, 1/S, 1/EH2, 2/P, 3/T, 1/EH1, 1/M, 1/B, 1/R
Serve	2/PA1, 1/S, 2/ER, 1/R, 1/V
Seven	2/PA1, 2/S, 1/EH1, 1/V, 1/EH3, 1/N
Seventeen	2/PA1, 2/S, 1/EH1, 1/V, 1/EH3, 2/N, 2/T, 1/E1, 1/E1, 1/N
Seventy	2/PA1, 2/S, 1/EH1, 1/V, 1/EH3, 1/N, 1/D, 1/Y
Several	2/PA1, 1/S, 2/EH1, 1/V, 1/R, 1/UH3, 1/L
She	2/PA1, 2/SH, 1/E1, 1/E1
Shipment	2/PA1, 2/SH, 2/I2, 1/P, 1/M, 1/EH3, 1/N, 1/T
Short	2/PA1, 2/SH, 1/O1, 1/R, 1/T
Shortage	2/PA1, 2/SH, 1/O2, 1/R, 1/T, 1/I2, 1/D, 1/J
Should	2/PA1, 2/SH, 1/IU, 1/IU, 1/IU, 1/D
Side	2/PA1, 2/S, 1/AH1, 1/E1, 1/D
Sign	2/PA1, 2/S, 1/AH1, 1/I3, 1/E1, 1/N
Signal	2/PA1, 2/S, 2/I1, 1/G, 1/N, 1/UH3, 1/L
Signature	2/PA1, 3/S, 2/I1, 1/G, 1/N, 1/I3, 1/T, 1/CH, 1/ER
Significant	1/PA1, 1/S, 1/I2, 2/G, 3/N, 1/I2, 1/F, 1/I3, 1/K, 1/EH3, 1/N, 1/T
Since	2/PA1, 2/S, 1/I, 1/N, 1/S
Single	2/PA1, 2/S, 2/I1, 1/NG, 1/G, 1/L
Situation	2/PA1, 2/S, 1/I2, 1/T, 1/CH, 1/IU, 2/U1, 1/A2, 1/AY, 1/SH, 1/UH3, 1/N

Six	2/PA1, 2/S, 1/I1, 1/K, 1/S
Sixteen	2/PA1, 1/S, 1/I1, 2/K, 2/S, 2/T, 1/E1, 1/E1, 1/N
Sixty	2/PA1, 2/S, 1/I1, 1/K, 1/S, 1/T, 1/Y
Size	2/PA1, 2/S, 1/AH1, 1/I3, 1/E1, 1/Z
Sketch	2/PA1, 2/S, 2/K, 1/EH1, 1/I3, 1/T, 1/CH
Slow	2/PA1, 2/S, 2/L, 1/UH3, 1/O1, 1/U1
Sort	2/PA1, 2/S, 1/O, 1/R, 1/T
Sound	2/PA1, 2/S, 1/AH1, 1/UH3, 1/U1, 1/N, 1/D
South	2/PA1, 2/S, 1/AH1, 1/O2, 1/U1, 1/TH
Speaker	2/PA1, 2/S, 2/P, 1/E, 1/K, 1/ER
Specific	1/PA1, 1/S, 1/EH2, 2/S, 1/I1, 1/F, 1/I3, 1/K
Speed	2/PA1, 2/S, 2/P, 1/E1, 1/E1, 1/D
Spend	2/PA1, 2/S, 2/P, 1/EH1, 1/I3, 1/N, 1/D
Spring	2/PA1, 2/S, 2/P, 1/R, 1/I1, 1/NG
Square	1/PA1, 1/S, 2/K, 2/W, 1/EH3, 1/I3, 1/R
Stamp	2/PA1, 2/S, 2/T, 1/AE1, 1/EH3, 1/M, 1/P
Standard	2/PA1, 2/S, 3/T, 1/AE1, 1/EH3, 1/N, 1/D, 1/ER, 1/D
State(s)	2/PA1, 2/S, 2/T, 1/A1, 1/AY, 1/Y1, 1/T, (1/S)
Statement	2/PA1, 2/S, 3/T, 1/A1, 1/AY, 2/T, 1/M, 1/EH3, 1/N, 1/T
Station	2/PA1, 2/S, 1/T, 2/A1, 1/AY, 1/SH, 1/UH3, 1/N
Statistics	2/PA1, 1/S, 1/T, 1/EH2, 3/T, 2/I1, 1/S, 1/T, 1/I3, 1/K, 1/S

Stock	2/PA1, 2/S, 2/T, 1/AH1, 1/AW2, 1/K
Stop	2/PA1, 2/S, 2/T, 1/AH, 1/UH3, 1/P
Store	2/PA1, 2/S, 2/T, 1/O, 1/R
Subject	2/PA1, 2/S, 2/UH1, 1/B, 1/D, 1/J, 1/EH1, 1/K, 1/T
Subjective	2/PA1, 1/S, 1/UH2, 2/B, 3/D, 2/J, 2/EH1, 1/K, 1/T, 1/I3, 1/V
Substitute	2/PA1, 2/S, 1/UH1, 1/B, 2/S, 1/T, 1/EH3, 1/T, 1/IU, 1/U1, 1/T
Success	2/PA1, 1/S, 1/UH2, 2/K, 2/S, 1/EH1, 1/S
Such	2/PA1, 2/S, 1/UH, 1/T, 1/CH
Sufficient	1/PA1, 1/S, 1/UH2, 3/F, 1/I1, 1/SH, 1/EH3, 2/N, 1/T
Suggest	1/PA1, 1/S, 1/UH2, 2/G, 2/D, 2/J, 1/EH, 1/S, 1/T
Sunday	2/PA1, 2/S, 2/UH1, 1/N, 2/N, 1/D, 1/A2, 1/AY
Supply	2/PA1, 1/S, 1/UH2, 2/P, 2/L, 1/AH1, 1/E1,
Support	2/PA1, 1/S, 1/UH2, 2/P, 1/O, 1/R, 1/T
Surplus	2/PA1, 2/S, 2/ER, 1/P, 1/L, 1/UH2, 1/S

Taught	1/PA1, 3/T, 1/AW, 1/T
Teacher	2/PA1, 2/T, 1/E1, 1/T, 1/CH, 1/ER
Technical	2/PA1, 1/T, 2/EH1, 1/K, 1/N, 1/I3, 1/K, 1/UH3, 1/L
Technique	1/PA1, 1/T, 1/EH1, 2/K, 1/N, 1/E, 1/K
Telephone	2/PA1, 2/T, 2/EH1, 1/L, 2/UH3, 1/F, 1/O1, 1/U1, 1/N
Television	2/PA1, 2/T, 2/EH1, 1/L, 2/UH3, 1/V, 1/I2, 1/ZH, 1/UH3, 1/N
Ten	2/PA1, 2/T, 2/EH3, 1/EH1, 1/N
Terminate	2/PA1, 2/T, 2/ER, 1/M, 1/I3, 1/N, 1/A2, 1/Y1, 1/T
Test	2/PA1, 2/T, 1/EH, 1/S, 1/T
That	2/PA1, 2/THV, 1/AE1, 1/EH3, 1/T
The	2/PA1, 1/THV, 1/UH3, 2/UH3, 3/UH3
Them	2/PA1, 2/THV, 1/EH1, 1/EH3, 1/M
Then	2/PA1, 2/THV, 1/EH1, 1/EH3, 1/N
There	2/PA1, 2/THV, 1/EH2, 1/A2, 1/R
These	2/PA1, 2/THV, 1/E1, 1/E1, 1/Z
Third	2/PA1, 2/TH, 1/ER, 1/R, 1/D
Thirteen	2/PA1, 3́/TH, 1́/R, 2/ER, 2/T, 2/PAØ, 1/E1, 1́/E1, 1/N
This	2/PA1, 1/THV, 2/I, 1/S
Three	2/PA1, 2/TH, 2/R, 1/E1, 1/Y
Thursday	2/PA1, 2/TH, 2/TH, 2/ER, 1/R, 2/Z, 1/D, 1/A1, 1/AY

Time	2/PA1, 2/T, 1/AH1, 1/E1, 1/M
To	2/PA1, 2/T, 1/IU, 1/U
Topic	2/PA1, 2/T, 1/AH1, 1/P, 1/I3, 1/K
Touch	2/PA1, 2/T, 1/UH, 1/T, 1/CH
Traffic	2/PA1, 2/T, 2/R, 1/AE1, 1/EH3, 1/F, 1/I3, 1/K
Transaction	2/PA1, 1/T, 1/R, 1/AE1, 2/N, 3/Z, 1/AE1, 2/EH3, 1/K, 1/SH, 1/UH3, 1/N
Transfer	2/PA1, 2/T, 2/R, 1/AE1, 2/I3, 1/N, 2/S, 1/F, 1/ER
Tuesday	2/PA1, 2/T, 2/IU, 2/U1, 1/U1, 2/Z, 1/D, 1/A1, 1/AY

Unconscious	1/PA1, 1/UH2, 1/N, 2/K, 2/AH1, 1/N, 1/SH, 1/UH3, 1/S
Understand	1/PA1, 1/UH2, 2/N, 1/D, 1/R, 2/S, 2/T, 1/AE1, 1/EH3, 1/N, 1/D
Understood	1/PA1, 1/UH2, 2/N, 1/D, 1/R, 2/S, 2/T, 1/IU, 1/IU, 1/D
Uniform	2/PA1, 2/Y, 2/IU, 1/U1, 1/N, 2/UH3, 1/F, 1/O1, 1/R, 1/M
Unite	1/PA1, 1/Y1, 1/IU, 2/U1, 2/N, 1/AH1, 1/Y1, 1/T
Unknown	1/PA1, 1/UH2, 1/N, 3/N, 1/UH3, 1/O1, 1/U1, 1/N
Unlimited	1/PA1, 1/UH2, 2/N, 2/L, 2/I2, 1/M, 1/I3, 1/T, 1/I3, 1/D
Until	1/PA1, 1/UH2, 1/N, 2/T, 2/I1, 1/UH3, 1/L
Unusual	1/PA1, 1/UH2, 1/N, 2/Y1, 1/IU, 2/U1, 1/ZH, 1/IU, 1/U1, 1/UH3, 1/L
Upon	1/PA1, 1/UH1, 3/P, 1/AH1, 1/UH3, 1/N
Urgent	2/PA1, 2/R, 1/R, 1/D, 1/J, 1/EH2, 1/N, 1/T
Use *	2/PA1, 2/Y1, 1/IU, 1/U, 1/S
Use *	2/PA1, 2/Y1, 1/IU, 1/U, 1/Z

Vacancy	2/PA1, 2/V, 2/A1, 1/AY, 1/K, 1/EH3, 1/N, 1/S, 1/Y
Valid	1/PA1, 2/V, 1/AE1, 1/UH3, 1/L, 1/UH3, 1/D
Verify	2/PA1, 2/V, 1/EH1, 1/R, 1/EH3, 1/F, 1/AH1, 1/E1
Very	2/PA1, 2/V, 1/EH, 1/R, 1/Y
Voice	2/PA1, 2/V, 1/O1, 1/UH3, 1/E1, 1/S
Volume	2/PA1, 2/V, 1/AH1, 1/L, 1/Y1, 1/U1, 1/M
VOTRAX	2/PA1, 2/V, 1/O, 1/T, 1/R, 1/AE1, 1/EH3, 1/K, 1/S

Walk	2/PA1, 2/W, 1/AW, 1/K
Want	2/PA1, 2/W, 1/AH1, 1/UH3, 1/N, 1/T
Warehouse	2/PA1, 1/W, 2/EH1, 1/R, 1/H, 1/UH3, 1/AH2, 1/U1, 1/S
Watch	2/PA1, 2/W, 1/AW2, 1/AH1, 1/T, 1/CH
Wednesday	2/PA1, 2/W, 1/EH1, 2/N, 1/Z, 1/D, 1/A1, 1/AY
Weigh(t)	2/PA1, 2/W, 1/EH3, 1/A2, 1/AY, 1/Y1, (1/T)
Welcome	2/PA1, 2/W, 1/EH1, 2/L, 1/K, 1/UH1, 1/M
Well	2/PA1, 2/W, 1/EH1, 1/UH3, 1/L
Went	2/PA1, 2/W, 1/EH1, 1/N, 1/T
Were	2/PA1, 2/W, 1/ER, 1/R
West	2/PA1, 1/W, 2/EH1, 1/S, 1/T
What	1/PA1, 1/W, 2/UH1, 1/T
When	1/PA1, 1/W, 2/EH1, 1/N
Where	2/PA1, 1/W, 2/EH2, 1/A2, 1/R
Which	1/PA1, 2/W, 2/I1, 1/T, 1/CH
White	2/PA1, 1/W, 2/UH3, 1/AH2, 1/E1, 1/T
Why	1/PA1, 2/W, 2/UH3, 1/AH1, 1/E1
Will	2/PA1, 2/W, 1/I2, 1/UH3, 1/L
Wind *	2/PA1, 2/W, 1/AH1, 1/E1, 1/N, 1/D
Wind *	2/PA1, 2/W, 1/I1, 1/N, 1/D
Within	1/PA1, 2/W, 1/I2, 2/TH, 3/I2, 1/I3, 1/N

Without	1/PA1, 2/W, 1/I2, 2/TH, 3/UH3, 1/AH2, 1/U1, 1/T
Work	1/PA1, 1/W, 1/ER, 2/R, 2/K
Would	1/PA1, 2/W, 1/U1, 1/IU, 1/IU, 1/D
Wound *	1/PA1, 2/W, 2/UH3, 1/AH1, 1/U1, 1/N, 1/D
Wrap	1/PA1, 2/R, 1/AE1, 1/EH3, 1/P

X-ray 2/PA1, 2/EH3, 2/K, 1/S, 1/R, 1/AY, 1/AY

Yes	1/PA1, 2/Y, 1/EH1, 1/EH3, 1/S
Yesterday	1/PA1, 2/Y, 2/EH1, 2/S, 1/T, 1/R, 1/D, 1/A1, 1/AY
You	2/PA1, 2/Y, 1/IU, 1/U

Zero	2/PA1, 2/Z, 1/I1, 1/R, 1/UH3, 1/O1
Zone	2/PA1, 2/Z, 2/UH3, 1/O1, 1/U1, 1/N

NOTES - -

1. This list consists primarily of verbs, adverbs and adjectives found with some frequency in spoken English. Those nouns included were selected due to their frequency of occurrence, but may not be adequate to accommodate the vocabulary needs of any one specific environment. Words with specific application, categorized by area (factory, office, home, classroom, etc.), subject (business, education, medicine, etc.), or reason (announcements, instructions, information, general, etc.) for use, will be programmed on request.

2. In general, single syllable words--those words containing only one vowel sound with or without consonant sounds--are to be considered of low intelligibility when presented in isolation. Words like CODE, EIGHT, LIFE, SELF, GUESS are included in this category. Even though they are recognizable out of context, their intelligibility is enhanced when used in context, as it would be with a human speaker. Words like BE, A, THE, OF, IS (open-ended single syllable words) are, by the nature of spoken English, short in duration and take on characteristics to enhance the word(s) they modify. Often, this may require a change in their pronunciation to accommodate the rhythm and accent of the contextual flow. Thus, these words are low in intelligibility when presented in isolation. When words are selected for VS 6 use, it is recommended that single syllable words be given the advantage of a contextual environment for maximizing their intelligibility, whenever possible.

3. The Asterisk (*) following certain words indicate that there is more than one pronunciation for that spelling or more than one meaning for that spelling.

4. The following list is made up of words <u>not</u> found on the 500 list, but whose programs are. (Followed by their location word)

accept	(except)	"C"	(see)
ate	(eight)	cell	(sell)
awl	(all)	cent	(sent)
"B"	(be)	dew	(do)
bee	(be)	due	(do)
buy	(by)	eye	("I")
bye	(by)	fore	(for)

forth	(fourth)	scene	(seen)
four	(for)	sea	(see)
grate	(great)	sense	(cents)
hart	(heart)	sine	(sign)
herd	(heard)	their	(there)
here	(hear)	they're	(there)
hi	(high)	too	(to)
higher	(hire)	two	(to)
hour(s)	(our(s))	"U"	(you)
Inn	(in)	wait	(weigh(t))
knot	(not)	way	(weigh(t))
leased	(least)	wear	(where)
maid	(made)	witch	(which)
no	(know)	wood	(would)
new	(knew)	wright	(right)
"R"	(are)	write	(right)
rap	(wrap)	won	(one)
red	(read (*))	"Y"	(why)
reed	(read (*))		
rite	(right)		