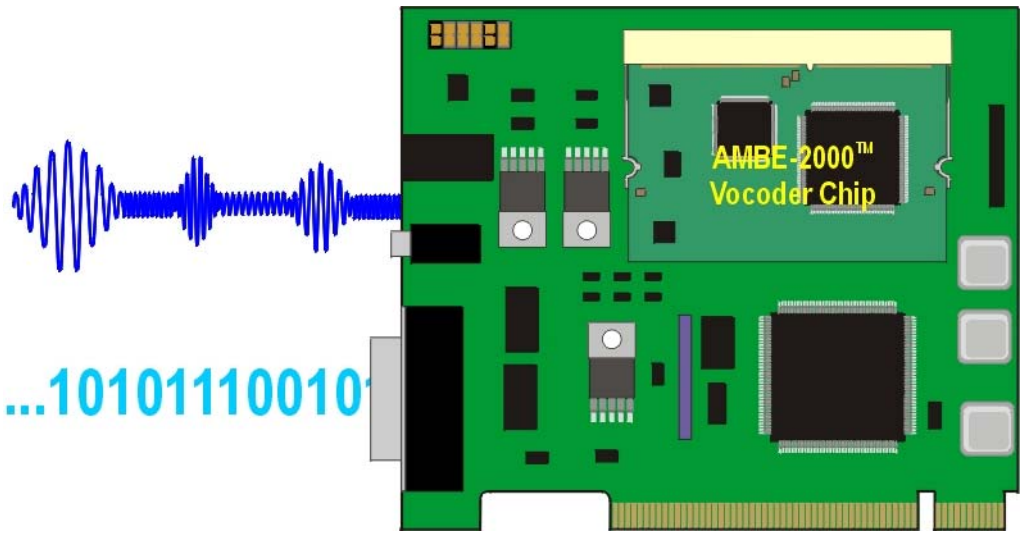
DIGITAL VOICE SYSTEMS, INC.

The Speech Compression Specialists



PC-2000™
Vocoder Board

User's Manual

Version 1.1

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Version 1.1
April, 2002

Digital Voice Systems, Inc
234 Littleton Road
Westford, MA 01886

Trademarks

PC-2000™ Vocoder Board END USER License Agreement

***** Important Read Carefully *****

This end user license agreement is a legal agreement between the customer (the END USER) and Digital Voice Systems, Inc. (DVSI) covering the terms and conditions under which DVSI's proprietary software, documentation and other material which may be provided with the PC-2000™ Vocoder Board is licensed to the END USER.

1.0 Preliminary Statements and Definitions

1.1 "END USER" shall mean the person and/or organization to whom the AMBE-2000™ Vocoder Chip and/or PC-2000™ Vocoder Board was delivered or provided to as specified in the purchase order or other documentation. In the event that the END USER transfers his rights under this license to a third party as specified in section 2.2, then this third party shall become an "END USER".
1.2 Digital Voice Systems, Inc. (DVSI) has developed a voice coding method and algorithm (the "Technology") based on the Advanced Multi-Band Excitation ("AMBE®") voice coder. The technology codes speech at bit rates of 2.4 to 9.6 kilobits per second (kbps) including error correction bits.
1.3 "AMBE® Voice Compression Software" shall mean the speech coding software and/or firmware integrated into the AMBE-2000™ Vocoder chip integrated circuit.
1.4 "Voice Codec" shall mean the AMBE-2000™ Vocoder Chip integrated circuit, the AMBE® Voice Compression Software, firmware and associated documentation, including modifications, enhancements and extensions made by or for Digital Voice Systems, Inc. (DVSI) and including circuit diagrams, timing diagrams, logic diagrams, layouts, operating instructions and user manuals.
1.5 DVSI represents that it owns certain "Proprietary Rights" in the Technology and the AMBE® Voice Compression Software, including patent rights in the Technology, and patent rights, copyrights, and trade secrets in the AMBE® Voice Compression Software.

2.0 License Granted

2.1 Subject to the conditions herein and upon initial use of the AMBE-2000™ Vocoder Chip and/or PC-2000™ Vocoder Board, DVSI hereby grants to END USER a non-exclusive, limited license to use the AMBE® Voice Compression Software in machine readable form solely on the AMBE-2000™ Vocoder Chip. Title to the AMBE® Voice Compression Software remains with DVSI. No license is granted for use of the AMBE® Voice Compression Software on other than the AMBE-2000™ Vocoder Chip. No license, right or interest in any trademark, trade name or service mark of DVSI is granted under this Agreement.
2.2 END USER shall not copy, extract, de-compile, reverse engineer or disassemble the AMBE® Voice Compression Software contained in the AMBE-2000™ Vocoder Chip.

3.0 Transfer of License

3.1 The END USER shall have the right to transfer the AMBE-2000™ Vocoder Chip and/or PC-2000™ Vocoder Board and all rights under this Agreement to a third party by either (i) providing the third party with a copy of this Agreement or (ii) providing the third party with an agreement written by the END USER (hereinafter "END USER Agreement") so long as the END USER Agreement is approved in writing by DVSI prior to transfer of the AMBE-2000™ Vocoder Chip and/or PC-2000™ Vocoder Board. The END USER Agreement shall contain comparable provisions to those contained herein for protecting the Proprietary Information from disclosure by such third party. Third parties shall agree to accept all the terms and conditions under either Agreement or the END USER Agreement.

4.0 Term and Termination

4.1 This Agreement is effective upon initial delivery of the Voice Codec and shall remain in effect until terminated in accordance with this agreement.
4.2 This Agreement shall terminate automatically without notice from DVSI if END USER fails to comply with any of the material terms and conditions herein. END USER may terminate this Agreement at any time upon written notice to DVSI certifying that END USER has complied with the provisions of Section 3.3.
4.3 Upon termination of this Agreement for any reason, END USER shall: (i) return all AMBE-2000™ Vocoder Chips and/or PC-2000™ Vocoder Boards purchased or acquired, or in Licensee's possession, to DVSI; (ii) have no further rights to any AMBE® Voice Compression Software or the Technology without a separate written license from DVSI; (iii) discontinue all use of the AMBE-2000™ Vocoder Chips and/or PC-2000™ Vocoder Boards;

5.0 Payments

5.1 In consideration of the materials of the PC-2000™ Vocoder Board, and in consideration of the license and rights in the AMBE® Voice Compression Software granted by DVSI, and in consideration of DVSI's performance of its obligations hereunder, END USER agrees to pay to DVSI the fee specified in DVSI's invoice.

6.0 Proprietary Notices

6.1 END USER shall not remove any copyright or proprietary notice on the AMBE-2000™ Vocoder Chip or on the AMBE® Voice Compression Software and/or PC-2000™ Vocoder Board.

7.0 Proprietary Information

7.1 The parties agree that the AMBE® Voice Compression Software and/or PC-2000™ Vocoder Board shall be considered Proprietary Information.
7.2 Except as otherwise provided in this Agreement, END USER shall not use, disclose, make, or have made any copies of the Proprietary Information, in whole or in part, without the prior written consent of DVSI.

8.0 Limited Warranty

8.1 DVSI warrants the PC-2000™ Vocoder Board to be free from defects in materials and workmanship under normal use for a period of ninety (90) days from the date of delivery.
8.2 Except as stated in Section 7.1, the PC-2000™ Vocoder Board is provided "as is" without warranty of any kind. DVSI does not warrant, guarantee or make any representations regarding the use, or the results of the use, of the Voice Codec with respect to its correctness, accuracy, reliability, correctness or otherwise. The entire risk as to the results and performance of the Voice Codec and/or PC-2000™ Vocoder Board is assumed by the END USER. After expiration of the warranty period, END USER, and not DVSI or its employees, assumes the entire cost of any servicing, repair, replacement, or correction of the Voice Codec and/or PC-2000™ Vocoder Board.
8.3 DVSI represents that, to the best of its knowledge, it has the right to enter into this Agreement and to grant a license to use the AMBE® Voice Compression Software and/or PC-2000™ Vocoder Board to END USER.
8.4 Except as specifically set forth in this Section 7.0, DVSI makes no express or implied warranties including, without limitation, the warranties of merchantability or fitness for a particular purpose or arising from a course of dealing, usage or trade practice, with respect to the Voice Codec and/or PC-2000™ Vocoder Board. Some states do not allow the exclusion of implied warranties, so the above exclusion may not apply to END USER. No oral or written information or advice given by DVSI or its employees shall create a warranty or in any way increase the scope of this warranty, and END USER may not rely on any such information or advice. The limited warranties under this section 7.0 give END USER specific legal rights, and END USER may have other rights which vary from state to state.

9.0 Limitation of Liability

9.1 In no event shall DVSI be liable for any special, incidental, indirect or consequential damages resulting from the use or performance of the Voice Codec and/or PC-2000™ Vocoder Board whether based on an action in contract, tort (including negligence) or otherwise (including, without limitation, damages for loss of business profits, business interruption, and loss of business information), even if DVSI or any DVSI representative has been advised of the possibility of such damages.
9.2 Because some states do not allow the exclusion or limitation of liability for consequential or incidental damages, the above limitations may not apply to END USER.
9.3 DVSI's maximum liability for damages arising under this Agreement shall be limited to 20% (twenty percent) of the fees paid by END USER for the particular Voice Codec and/or PC-2000™ Vocoder Board which caused the damages or that is the subject matter of, or is directly related to, the cause of action.

10.0 Taxes

10.1 All payments required under Section 4.0 or otherwise under this Agreement are exclusive of taxes and END USER agrees to bear and be responsible for the payment of all such taxes (except for taxes based upon DVSI's income) including, but not limited to, all sales, use, rental receipt, personal property or other taxes which may be levied or assessed in connection with this Agreement.

11.0 Export

11.1 United States export laws and regulations prohibit the exportation of certain products or technical data received from DVSI under this Agreement to certain countries except under a special validated license. As of November 30, 1999 the restricted countries are: Libya, Cuba, North Korea, Iraq, Serbia, Taliban in Afghanistan, Sudan, Burma, Yugoslavia and Iran. The END USER hereby gives its assurance to DVSI that it will not knowingly, unless prior authorization is obtained from the appropriate U.S. export authority, export or re-export, directly or indirectly to any of the restricted countries any products or technical data received from DVSI under this Agreement in violation of said United States Export Laws and Regulations. DVSI neither represents that a license is not required nor that, if required, it will be issued by the U.S. Depar™ent of Commerce. Licensee shall assume complete and sole responsibility for obtaining any licenses required for export purposes.

12.0 Governing Law

12.1 This Agreement is made under and shall be governed by and construed in accordance with the laws of the Commonwealth of Massachusetts, except that body of law governing conflicts of law. If any provision of this Agreement shall be held unenforceable by a court of competent jurisdiction, that provision shall be enforced to the maximum extent permissible, and the remaining provisions of this Agreement shall remain in full force and effect.

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1. Product Introduction

1.1 General Information

The Digital Voice Systems, Inc. (DVSI) PC-2000™ board is a PCI evaluation board for the AMBE-2000™ Vocoder Chip. The AMBE-2000™ Vocoder Chip contains proprietary software which implements the Advanced Multi-Band Excitation AMBE®voice compression algorithm. DVSI's AMBE-2000™ Vocoder Chip is an extremely flexible high-performance vocoder. The AMBE-2000™ Vocoder Chip provides superior voice quality at low data rates and a high degree of flexibility in selecting the speech and FEC data rates in 50 bps increments, from 2.0 Kbps to 9.6 Kbps. It provides a real-time, full-duplex implementation of the standard-setting AMBE® voice compression technology. This technology patented by DVSI has been proven to outperform CELP and other competitive technologies. Numerous evaluations have shown its ability to provide performance equal to today's digital cellular systems at under half the data rate. The AMBE® voice compression algorithm is used in applications throughout the world, including the next generation of digital mobile communication systems.

1.2 PC-2000™ Features

- High Quality Low Data Rate Speech Coding
- Real Time
- Extremely Flexible Bit Rate Selection
- Encode / Decode PC based files
- Encode / Decode with Handset
- Windows 98 Compatible
- Plug and Play PCI Card Design

1.3 AMBE-2000™ Vocoder Chip Features

- High Quality Low Data Rate Speech Coding
- DVSI's Full Duplex AMBE® Voice Coder
- Supports Data Rates of 2.0 Kbps to 9.6 Kbps in 50 bps increments
- User Selectable Forward Error Correction rates
- Viterbi Decoder (rate 1/4 or more)
- 16 Level Soft Decision Decoding
- Voice Activity Detection (VAD) / Comfort Noise Insertion
- 16 ms. Echo Cancellation
- Single and Dual Tone (DTMF) Detection and Generation

1.4 AMBE-2000™ Vocoder Chip Applications

- Cellular Telephony and PCS
- Satellite Communications
- Digital Mobile Radio
- Secure Communications
- Voice Multiplexing
- Voice Mail
- Multimedia Applications
- Video Conferencing

2. PC-2000™ Vocoder Board Overview

2.1 Advanced Multi-Band Excitation (AMBE® Vocoder)

The Digital Voice Systems, Inc. (DVSI) PC-2000™ board is an evaluation board for the AMBE-2000™ voice codec chip. The AMBE-2000™ Vocoder Chip contains proprietary software which implements the Advanced Multi-Band Excitation AMBE® voice compression algorithm. The AMBE® voice coder (vocoder) was first developed in the mid 1990's by Digital Voice Systems, Incorporated. This vocoder maintains speech intelligibility and naturalness at rates as low as 2.0 Kbps. The AMBE® Vocoder system is less complex than either CELP or VSELP, and therefore, it has been integrated into a low-cost, low-power integrated circuit, the AMBE-2000™ Vocoder Chip. Finally, the AMBE® voice coder can be easily scaled to virtually any data rate above 2.4 Kbps. The AMBE-2000™ Vocoder Chip includes a number of advanced features such as an automatic Voice/Silence detection (VAD), adaptive comfort noise generation, DTMF detection and signaling, low power modes, and echo cancellation. Enabling these features of the AMBE-2000™ Vocoder Chip is described in Section 5. The AMBE® Vocoder technology is based on the Multi-Band Excitation (MBE) speech model. This speech model provides a unique speech coding framework which results in a number of advantages over linear prediction based speech coders such as CELP, RELP, VSELP, MELP,ECELP, MP-MLQ, and LPC-10, etc.

2.2 PC-2000TM Vocoder Board Basic Operation

DVSI grants a license to its customers to use this software according to the terms established in the attached PC-2000™ Vocoder Board END USER License Agreement Section 7. Use of the PC-2000™ Vocoder Board, or any portion thereof, signifies acceptance of these licensing terms.

The PC-2000™ Vocoder Board can encode data from one of two sources. The first is by digitizing an analog speech signal using an on-board A-to-D converter connected to a handset. The second source is a 16 bit signed little endian 8 kHz sampled speech file (PCMFILE with a .pcm sufix) from the PC. The speech data is then processed by the encoder and converted into a AMBE-2000™ Formatted Data bit stream which contains the respective 2.0 to 9.6 Kbps data bit stream (the data rate depends on the software setting). This bit stream is output to the PC and stored in a file. The file format for the encoded speech (BITFILE with a .bit sufix) is 16 bit little endian.

Decoded data can then be stored as a PCMFILE in a PC while being played back to the handset via the 16 bit D-to-A converter. This is accomplished by the PC-2000™ decoding a previously generated BITFILE. This BITFILE is processed by the decoder and converted into a synthetic speech signal which is both sent to the PC's hard drive and converted into an analog signal using the on-board D-to-A converter. The encoder and decoder are fully asynchronous.

Digitized speech is received from or sent to an external A/D-D/A through a serial interface. Digitized speech from the A-to-D on the external A/D-D/A chip is processed by the AMBE-2000™ Vocoder Chip encoder and converted into compressed digital data. This data is output to the channel interface, which is connected to a processor, controller, modem or similar device. Simultaneously, the AMBE-2000™ Vocoder Chip receives compressed digital data from the channel interface. This received data is processed by the AMBE-2000™ Vocoder Chip decoder and synthesized into a digital speech signal which is then converted into an analog signal using a D-to-A on an external A/D-D/A chip. The encoder and decoder are fully asynchronous.

2.3 Special Handling and Storage Precautions

CAUTION: To avoid damage from the accumulation of static charge, industry standard electrostatic discharge precautions and procedures must be employed during handling and installing.

To insure maximum shelf life in long term storage, the PC-2000™ should be kept in a moisture controlled package at <40_C and <90% RH.

3. PC-2000™ Vocoder Board Installation and Test

3.1 Hardware Installation

NOTE: Before installing or removing PC-2000™ Vocoder Board read and carefully follow the handling precautions described in Section 2.3.

The PC-2000™ Vocoder Board installation steps are as follows:

1. Make sure the host computer is turned off and the AC power source is disconnected.
2. Insert the PC-2000™ Vocoder Board in the host computer PCI slots. As the board is inserted into the host computer PCI slot make sure that the back end of the PC-2000TM Board slips into the back plane bracket on the back end of the host computer chassis.
3. The board must be seated properly and securely in its PCI slot. Screw the metal end bracket of the PC-2000TM Board to the computer chassis.
4. Reinstall the host computer cover and reconnect the power source.
5. Insert the handset into the RJ-11 connector on the PC-2000TM Vocoder Board.

3.2 Software Installation

The PC-2000TM software installation steps are as follows:

1. Power on the computer.
2. Windows-98 will open.
3. "Update Device Driver" Wizard will appear.
4. Insert the floppy-disk included with the PC-2000™.
5. Press "Next".
6. Press "Finish".
7. Remove the floppy disk.
8. Press "Yes" to restart the computer.
9. The PC-2000™ software is installed by copying the installation disks to the hard disk.

3.3 Testing

1. Start DOS.
2. Change to your "PC-2000"\demo\ directory.
3. At DOS prompt type:
   encode1.bat 17 dam.pcm dam.bit
   The file dam.bit should now exist.

4. Listen to handset and at DOS prompt type:
   decode1.bat dam.bit dam_dec.pcm

You should here dam.bit being decoded with the output playing on the handset, also dam_dec.pcm should now exist.

5. At DOS prompt type:

   en_w_cf1.bat cfg.bit dam.pcm dam_w_cfg.bit

   The file dam_w_cfg.bit should now exist.

6. At DOS prompt type:

   decode1.bat dam_w_cfg.bit dam_w_cfg_dec.pcm

   You should here dam_w_cfg.bit being decoded with the output playing on the handset, also dam_w_cfg dec. should now exist.

7. Holding handset at DOS prompt type:

   a_enc1.bat 17 a_voice.bit

   and begin speaking into the handset. Hit Control-C to stop. The file a_voice.bit should now exist.

8. At DOS prompt type:

   decode1.bat a_voice.bit a_voice_dec.pcm

   You should hear a_voice.bit being decoded with the output playing on the handset, also a_voice_dec.pcm should now exist.

9. Holding handset at DOS prompt type:

   ae_w_cf1.bat cfg.bit a_v_cfg.bit
   and begin speaking into the handset. Hit Control-C to stop. The file a_v_cfg.bit should now exist.

10. At DOS prompt type:

    decode1.bat a_v_cfg.bit a_v_cfg_dec.pcm

    You should here a_v_cfg.bit being decoded with the output playing on the handset, also a_v_cfg_dec.pcm should now exist.

4. Software

The PC-2000™ software includes the following batch files located in your "PC-2000"\demo\ directory:

1. encode1.bat
2. decode1.bat
3. en_w_cf1.bat
4. a_enc1.bat
5. ae_w _cf1.bat

These batch files are designed to run from your dos prompt in the demo directory.

4.1 Definition of Terms

1. standard rate : Is a number ranging from 0 to 31, which corresponds to one of the 32 standard rate settings for the PC-2000™. Refer to Table 1 for more info.
2. input : Indicates a file which already exists and will be processed by the PC-2000™.
3. output : Indicate a file which does not exist and will be generated by the PC-2000™.
4. pcm speech file : Is a 8 kHz 16 bit little endian formatted file which contains speech data.
5. ambe speech file : Is a 16 bit little endian formatted file which is in AMBE-2000TMdata format.
6. ambe configuration file : Is in the same format as the AMBE speech file. It is used to refer to a file that allows the user to take advantage of the AMBE-2000™'s advanced features, such as enabling VAD or changing to a custom data rate and FEC.

4.2 encode1.bat

This file should be called with the following format from the DOS prompt.

encode1.bat <standard rate> <input pcm speech file> <output ambe speech file>

For example to encode the pcm speech file dam.pcm in AMBE® format at 4.0 Kbps with the file name dam.bit type:

encode1.bat 17 dam.pcm dam.bit

Refer to Section 4.1 to clarify any misunderstood terms.

4.3 decode1.bat

This file should be called with the following format from the DOS prompt while (optionally) listening to the handset.

decode1.bat <input ambe speech file> <output pcm speech file>

For example to decode AMBE® formatted speech file named dam.bit and save the output to a pcm speech

file type:

decode1.bat dam.bit dam_dec.pcm

Refer to Section 4.1 to clarify any misunderstood terms.

4.4 en_w_cf1.bat

This file should be called with the following format from the DOS prompt.

en_w_cf1.bat <input ambe configuration file> <input pcm speech file> <output ambe speech file>

For example to encode the pcm speech file dam.pcm in AMBE® format with the file name dam_w_cfg.bit using the custom data rate specified in the file cfg.bit type:

en_w_cf1.bat cfg.bit dam.pcm dam_w_cfg.bit

Refer to Section 4.1 to clarify any misunderstood terms.

4.5 a_enc1.bat

This file should be called with the following format from the DOS prompt while speaking into the handset. Hit Control-C to quit.

a_enc1.bat <standard rate> <output ambe speech file>

For example to encode your speech from the handset in to AMBE® format at 4.0 Kbps with the file name a_voice.bit type:

a_enc1.bat 17 a_voice.bit

Refer to Section 4.1 to clarify any misunderstood terms.

4.6 ae_w_cf1.bat

This file should be called with the following format from the DOS prompt while speaking into the handset. Hit Control-C to quit.

ae_w_cf1.bat <input ambe configuration file> <output ambe speech file>

For example to encode your speech from the handset in to AMBE® format with file name a_v_cfg.bit using the custom data rate specified in the file cfg.bit type:

ae_w_cf1.bat cfg.bit a_v_cfg.bit

Refer to Section 4.1 to clarify any misunderstood terms.

Format n Speech Rate FEC Rate Total Rate

	Total Rate (bps)	Speech Rate (bps)	FEC Rate (bps)	n
AMBE-1000 Rates	2400	2400	0	0
		2350	50	5
	3600	3600	0	1
		3350	250	11
	4000	4000	0	15
		3750	250	14
	4800	4800	0	3
		4550	250	7
		3600	1200	2
		3100	1700	8
	6400	4150	2250	10
	7200	4400	2800	9
	8000	7750	250	12
		4650	3350	13
	9600	9600	0	4
		4850	4750	6
	Total Rate (bps)	Speech Rate (bps)	FEC Rate (bps)	n
AMBE-2000 Rates	2000	2000	0	31
	2400		0	25
	3600	3600	0	16
	4000	4000	0	17
		2400	1600	22
	4800	4800	0	18
		4000	800	24
		3600	1200	23
		2400	2400	1
	6400	6400	0	19
		4000	2400	26
	7200	4400	2800	27
	8000	8000	0	20
		4000	4000	28
	9600	9600	0	21
		3600	6000	30
		2400	7200	29

Table 1: Standard Rate Table for PC-2000™

5. Creating AMBE-2000™ Configuration Files

5.1 cfg.bit

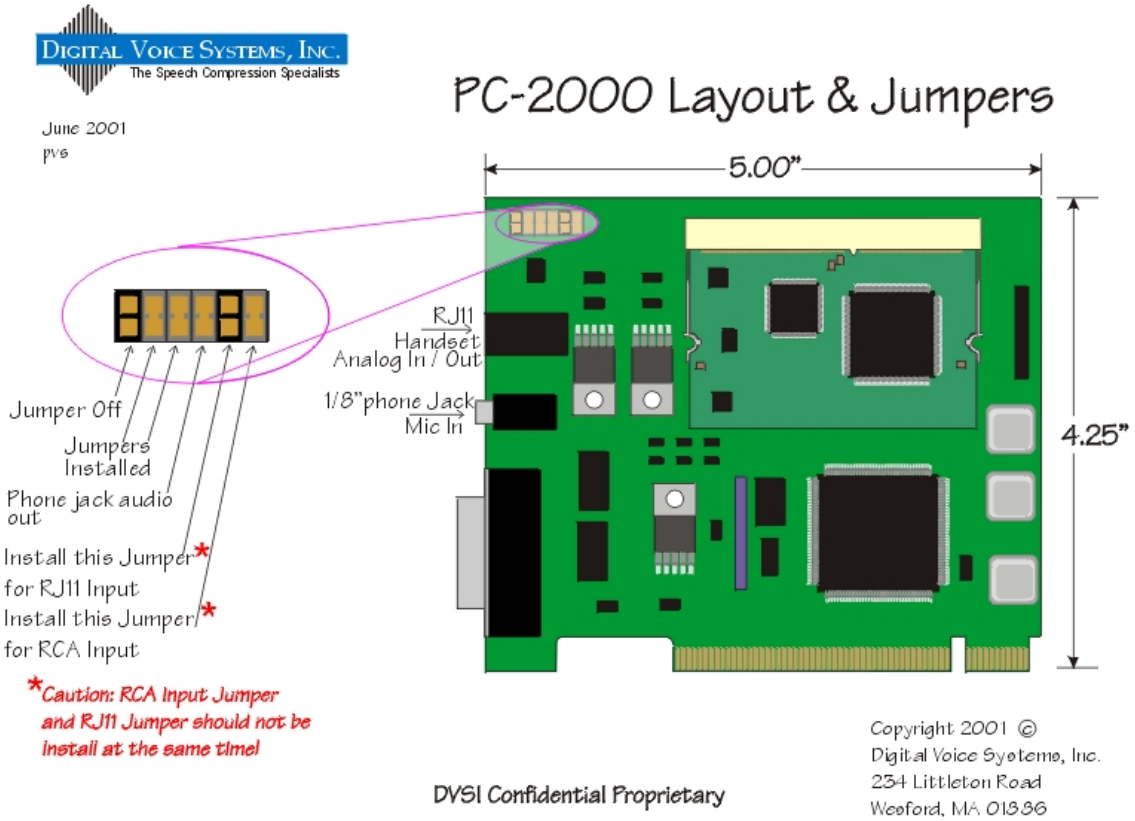
The file config.bit contains the following data in hexadecimal format:

13ec	0002	5250	2010	0000	0000	7460	0000	0000	0000	00ff	8000
ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff
13ec	0002	5250	2010	0000	0000	7460	0000	0000	0000	00ff	8000
ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff	ffff

These are two frames of AMBE-2000™ formatted data which include the header information and data. Note each frame begins with the sync word 0x13ec followed by 11 more words of header information in then twelve words of data information. Since, this configuration packet is not concerned with sending data the value 0xffff is inserted, this tells the decoder to ignore the data. The following items should be noted in these packets:

1. Word 1 in packets 1 and 2 is 0x0002 which tell the decoder to generate a frame of comfort noise.
2. Words 2-6 in packets 1 and 2 are 0x5250 0x2010 0x0000 0x0000 0x7460 respectively which corresponds to the data rate 4000 bps with 800 bps FEC in AMBE-2000™ format.
3. Word 10 in packets 1 and 2 is 0x00FF in order to disable DTMF tone generation.
4. Finally Word 11 in packets 1 and 2 is 0x8000 in which the RIS bits are 00 in order for both the encoder and decoder to be configured with the same data rate. This must be done in order for the PC-2000™ to operate properly.

Additional information regarding the AMBE-2000™ format can be referred in the AMBE-2000™users manual



6. DVSI Services and Support Solutions

If you have problems or questions about the PC-2000™ Vocoder Board please contact:

Digital Voice Systems, Inc.
234 Littleton Road
Westford, MA 01886 USA

Developer support engineers are available

Monday through Friday, 8:30 AM to 5:30 PM eastern time and can be contacted by:
Phone: (978) 392-0002
Fax: (978) 392-8866
Email: info@dvsinc.com
World Wide Web: http://www.dvsinc.com

6.1 Upgrade Software to Version 2.0

If you have already purchased the PC-2000™ and still have software version 1.0, you can download the update from http://www.dvsinc.com/software/pc2000/pc2000 upgrade 2-0.zip

1. Extract pc2000 upgrade 2-0.zip file into your \PC-2000 demo directory.
2. Follow the instructions in Section 3.3.

6.2 Cool Edit 2000

In order to generate and listen to a PCM FILE. DVSI recommends using Cool Edit 2000 from Syntrillium Software Corporation.
Phone: (888) 941-7100
Fax: (480) 941-8170
World Wide Web: http://www.syntrillium.com
World Wide Web: http://www.cooledit.com

History of Revisions			
Revision Number	Date of Revision	Description	Pages