DIGITAL VOICE SYSTEMS, INC.
The Speech Compression Specialists

600 Cleveland St. STE 795
Clearwater, FL 33755 USA

Tel: (978) 392-0002
Fax: (978) 392-8866

e-mail: techsupport@dvsinc.com
www.dvsinc.com

Migrating from the AMBE-2000™ Vocoder Chip to the AMBE-4020™

Version 1.0

April, 2022

1 Brief Vocoder Product History

The AMBE-2000™ Vocoder Chip was introduced in 1999 Incorporating DVSI's AMBE+™ Vocoder Technology. The AMBE-2000™ is built using Texas Instruments TMS320C541, a proven DSP core. Based on this design there were two models available, the full-duplex AMBE-2000™ and the half-duplex AMBE-2020™.

The AMBE-4020™ Vocoder Chip was introduced in 2014 and implements DVSI's patented AMBE+2™ Voice Compression Algorithm. It is built on the MK10DX128VLK7 chip from NXP. It was designed to allow for backwards interoperability with DVSI's older vocoder chips the AMBE -2000™, AMBE-2020™ and the AMBE-1000™. However, the AMBE-4020™ implements advanced features that the other chips do not offer including: a built-in 16-bit ADC and 12-bit DAC, an interface for a low-cost digital mic, very low-power operation as well as push-to-talk (half-duplex) capability.

DVSI's Vocoder Chips offer numerous advanced design features such as, automatic Voice/Silence Detection (VAD), adaptive comfort noise insertion (CNI), DTMF and Call Progress Tone detection/regeneration, and echo cancellation (in full-duplex models), low power modes and frame-by-frame on-the-fly rate switching.

2 Reason for Migrating from the AMBE-2000™ Vocoder Chip

The base integrated circuit (TMS320C541 from Texas Instruments) for which the AMBE-2000™ is made, has been sunset by TI and is no longer in production. DVSI has sold out completely of all AMBE-2000™ vocoder chip stock and there is no direct replacement. For this reason, designers are forced to look at other DVSI options for a low cost non-standards based vocoder chip. The AMBE-4020™ vocoder chip can fulfill the role (**it is not a direct replacement)** of the unavailable AMBE-2000™ vocoder chip and at the same time, possibly improve on what the AMBE-2000™ vocoder chip had to offer.

3 Reason for Migrating to the AMBE-4020™

The AMBE-4020™ vocoder chip was designed as a low-cost vocoder hardware solution with more features, flexibility, and advantages than the AMBE-2000™.

1. The AMBE-4020™supports the latest version of the AMBE technology the AMBE+2 vocoder.
2. The AMBE-4020™has flexible input options including an internal AD/DA and the input for a digital mic.
3. The AMBE-4020™ has a much more powerful and adaptable packet interface for controlling the operation of the vocoder.

4. The AMBE-4020™ can be operated on power supplies as low as 1.8v for low power applications.
5. The AMBE-4020™ has a smaller chip footprint and lower pin count saving valuable board real estate.
6. The AMBE-4020™ is available in both an LQFP and BGA package.
7. The AMBE-4020™ has a flexible simple UART channel interface for direct connection to low cost MCUs.

4 Vocoder Technology Differences

The AMBE-2000™ vocoder chip supported the AMBE® and AMBE+™ generations of the DVSI vocoder. The AMBE-4020™ vocoder chip maintains interoperability by also supporting all the rates of these vocoders. In addition, the AMBE-4020™ vocoder chip supports the industry leading latest generation AMBE+2™ vocoder.

Vocoder Technology	AMBE-2000™	AMBE-4020™
AMBE	Included	Included
AMBE+	Included	Included
AMBE+2	Not Included	Included

Table 1 Vocoder Technology

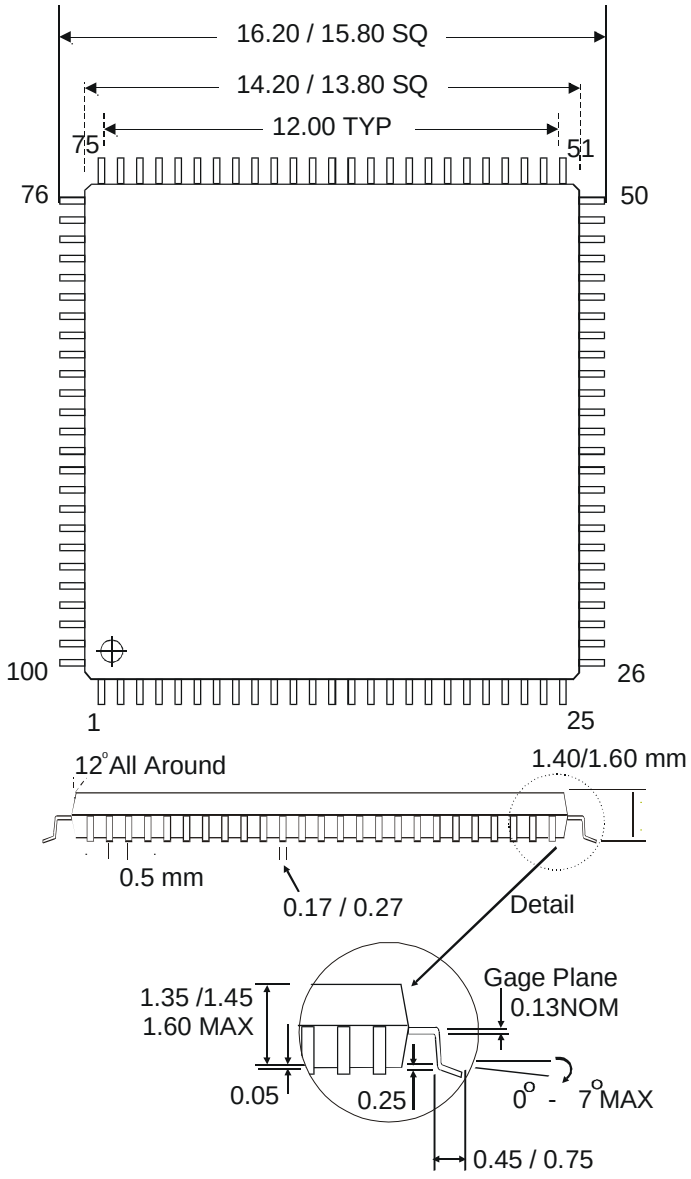
5 Chip Topology

Because of the discontinuation of the AMBE-2000™ base silicon and to accommodate an expanded feature set, a new hardware platform was chosen for the AMBE-4020™ vocoder chip. While the AMBE-2000™ and the AMBE-4020™ support the same vocoder rates and can be inter-operable with each other, the AMBE-4020™ vocoder chip is **not a direct replacement**.

Unfortunately, this means that any existing AMBE-2000™ implementation will require a re-design in order to use the AMBE-4020™ vocoder chip. Because the AMBE-2000™ and the AMBE-4020™ use a completely different silicon core their dimensions and pinouts are also completely different from one another as detailed below.

5.1 The AMBE-2000™ vocoder chip TQFP Package Dimensions

The AMBE-2000™ vocoder chip has a unique chip topography and unique pin outs. The AMBE-2000™ is a 14mm x 14mm TQFP with 100 pins.



All Dimensions are in millimeters

Figure 1 AMBE-2000™ Vocoder Chip 100 pin TQFP (Thin Quad Flat Pack)

1.1 The AMBE-4020™ (LQFP) Package Dimensions

The Package Dimensions for the AMBE-4020™ vocoder chip's 80-pin LQFP package is shown in figure. An even smaller form factor 121 MAP BGA package is also available.

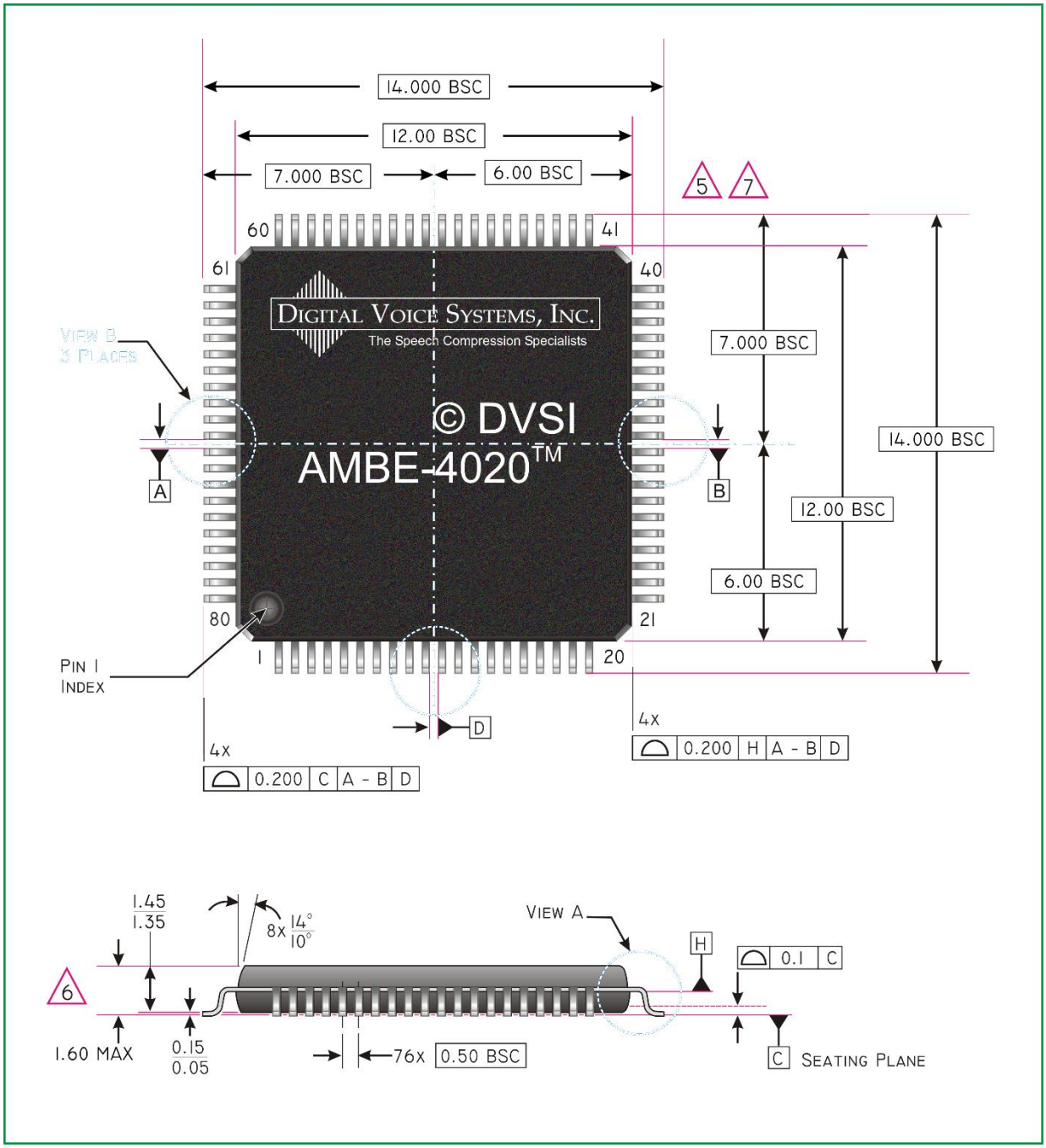


Figure 2 AMBE-4020™ LQFP 80-pin Low-Profile Quad Flat Pack Mechanical Details

5.2 The AMBE-2000™ vocoder chip LQFP Pin Assignments

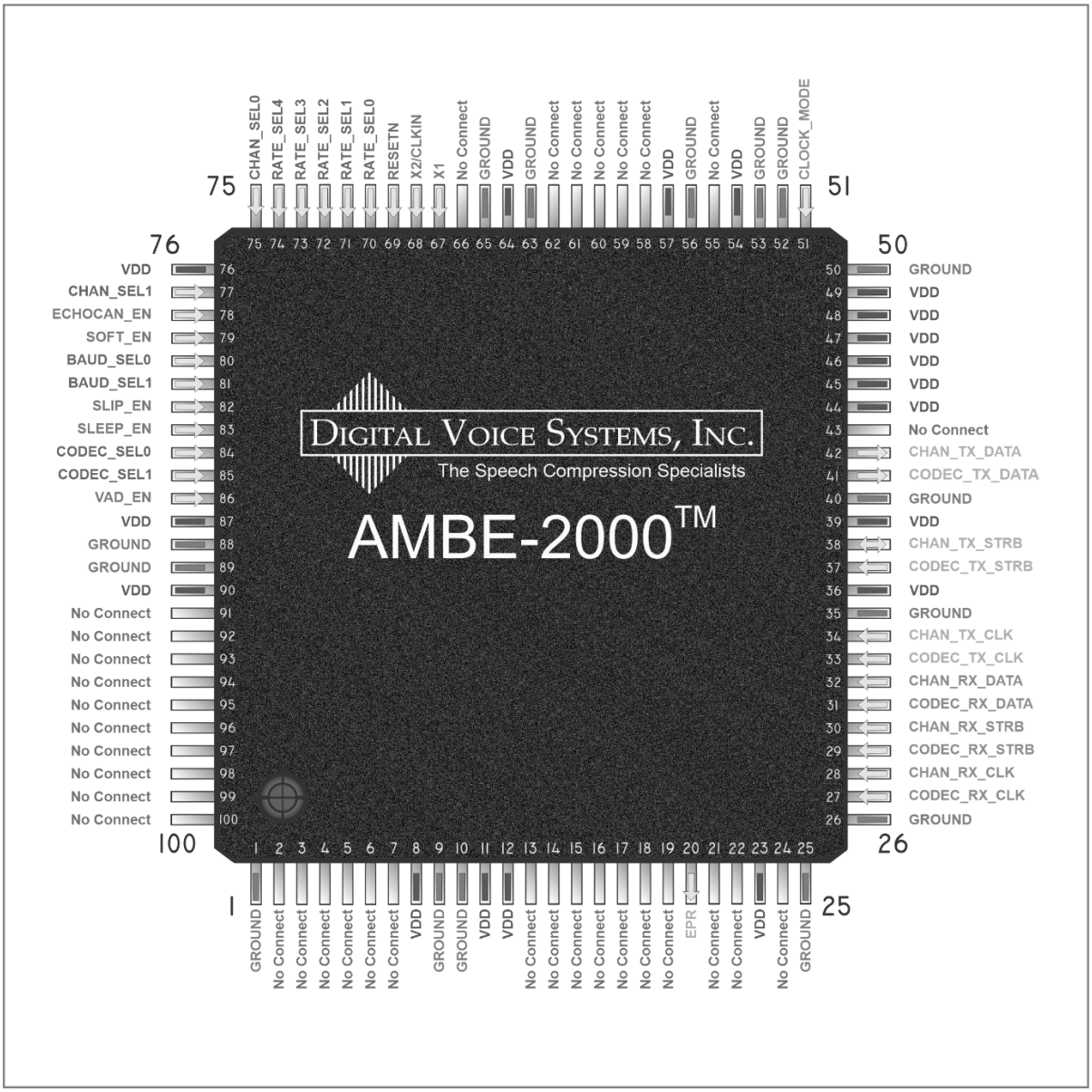


Figure 3 AMBE-2000™ Vocoder Chip Pins for TQFP Package

5.3 AMBE-4020™ Vocoder Chip TQFP Pin Assignments

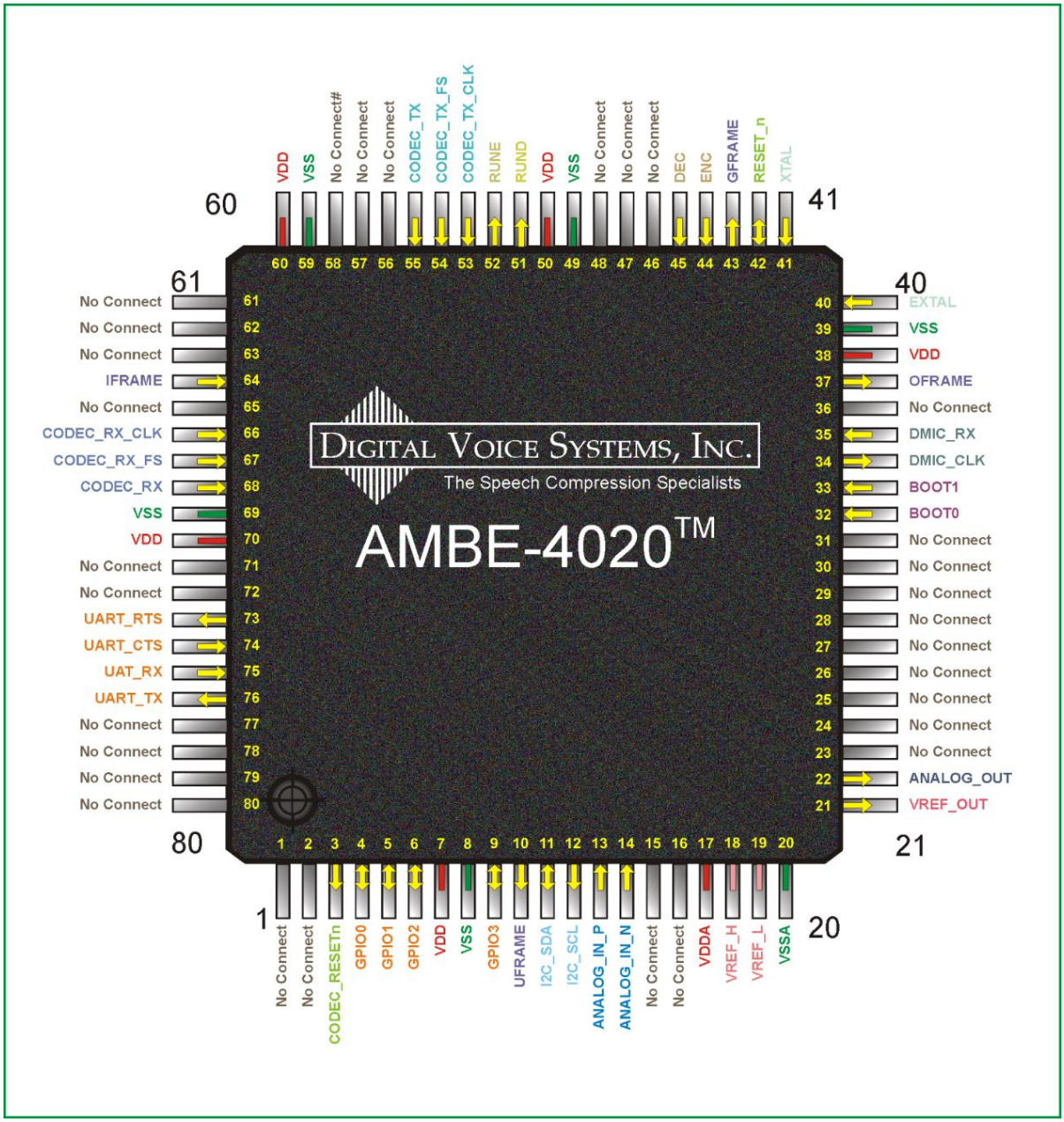


Figure 4 AMBE-4020™ Vocoder Chip Pins for TQFP Package

6 Electrical Specification Differences

Power Requirements

	Parameter	Min	Nom	Max	Unit
AMBE-2000™ Vocoder Chip	Vdd	3	3.3	3.6	V
AMBE-4020™ Vocoder Chip	Vdd/Vdda	1.71	-	3.8	V

Note: The AMBE-4020™ supply voltage can be 1.8 v to 3.3 v.

Table 2 Vocoder Chip Power Requirements

7 Clock

	Clock Rate (MHz)	Clock and Reset Timing Parameters
AMBE-2000™ Vocoder Chip	16.384	See section 3.3 on page 17 of the Users Manual
AMBE-4020™ Vocoder Chip	4.0	See section 2.15.1 on page 23 of the Users Manual

Table 3 Vocoder Chip Clock Requirements

8 Storage - Moisture Handling Ratings

AMBE-2000™ Vocoder Chip

To ensure maximum shelf life in long term storage, AMBE-2000™ Vocoder Chips should be kept in a moisture controlled package at <40°C and <90% Relative Humidity. The AMBE – 2000 is MSL level 1 /260C/Unlimited.

AMBE-4020™ Vocoder Chip

The AMBE-4020™ is a moisture sensitive part. The AMBE-4020™ is MSL level 3/260C/168 hours.

9 Channel Packet Structure

Another major difference between the AMBE-2000™ and the AMBE-4020™ is the packet structure used by each device. Designers will need to re-engineer any software that was designed to handle the channel data packets (see table) into or out of the AMBE-2000™ to accommodate the configuration of the AMBE-4020™ packet (see table).

20 ms frame	24 sixteen-bit words = 48 bytes = 384 bits		Word #	Description
		(12) 16 bit words of overhead (192 bits)	0	Header always set to 0x13EC
			1	Power Control ID (8bits) | Control Word 1 (8 bits)
			2	Rate info 0
			3	Rate info 1
			4	Rate info 2
			5	Rate info 3
			6	Rate info 4
			7	Unused in Input
			8	Unused in Input
			9	Unused in Input
			10	DTMF Control
			11	Control Word 2
		(12) 16 bit words of data (192 bits)	12	Channel Data
			13	Channel Data
			14	Channel Data
			15	Channel Data
			16	Channel Data
			17	Channel Data
			18	Channel Data
			19	Channel Data
			20	Channel Data
			21	Channel Data
			22	Channel Data
			23	Channel Data

Table 4 AMBE-2000™ Channel Packet Example

Following is an example channel packet (hexadecimal) for input to the AMBE-4020™ Vocoder Chip:

Channel Packet					
Header			CHAND Field		
StartByte	Length	Type	CHAND Field Identifier	CHAND No. of Bits	CHAND Data
61	000C	01	01	50	00112233445566778899

Table 5 AMBE-4020™ Channel Packet Example

Additional details for each packet structure can be found in the AMBE-2000™ and AMBE-4020™ User Manuals.

10 Vocoder Standards Support

Both the AMBE-2000™ and the AMBE-4020™ were designed to provide a low-cost implementation of the AMBE, AMBE+ and AMBE+2 vocoders. In order to meet these cost constraints, the AMBE-2000™ and AMBE-4020™ only support the DSTAR standard.

A detailed list of all DVSI vocoder chip attributes, data rates and standards support can be found at the following link:

https://www.dvsinc.com/products/compare.shtml

11 Possible Usage of the AMBE-2020™

In some cases, instead of redesigning to use the AMBE-4020™ vocoder chip, it may be possible to substitute an AMBE-2020™ vocoder chip for an AMBE-2000™. However, in order to implement the AMBE-2020™ the application must meet the following criteria:

1. The application must be able to operate with half-duplex communication. If the existing system does not require full-duplex communications (real-time simultaneous encode/decode operations) then the AMBE-2020™ (capable of encode and decode but not simultaneously) can be used.
2. The current implementation must be able to accommodate a small hardware difference between the AMBE-2000™ and the AMBE-2020™. On the AMBE-2000™ pin 24 is not used. This pin is used in the AMBE-2020™ as the EE pin. For the AMBE-2020™ this pin should be connected to 3v3.
3. The current implementation must be able to allow for software modifications. The AMBE-2020™ also repurposes bit 2 of Control Word 2. The EC enable flag (AMBE-2000™) is repurposed as the EE flag. The EE flag controls whether the encoder or decoder are enabled in the AMBE-2020™. A value of 1 enables the encoder. A value of 0 enables the decoder.

Please click the links below to see the AMBE-2000™ Manual and the AMBE-2020™ Manual for further details.

12 Additional Resources

For the full details and additional information about the products mentioned above, visit the following links that refer to DVSI's website.

AMBE-4020™ product page:	https://www.dvsinc.com/products/a4020.shtml
AMBE-2000™ Manual	https://www.dvsinc.com/manuals/AMBE-2000_manual.pdf
AMBE-2020™ Manual	https://www.dvsinc.com/manuals/AMBE-2020_manual.pdf
AMBE-4020™ Manual	https://www.dvsinc.com/manuals/AMBE-4020_manual.pdf
AMBE Chip Comparison	https://www.dvsinc.com/products/compare.shtml