DIGITAL VOICE SYSTEMS, INC.
The Speech Compression Specialists

AMBE-3000F™ Vocoder Chip

Users Manual
Version 3.9
September, 2018

DVSI Confidential Proprietary

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Users Manual
Version **3.9**
September, 2018

(The most up to date version of the manual is always available at www.dvsinc.com)

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

Digital Voice Systems, Inc.
END USER PRODUCT License Agreement

This non-exclusive END USER PRODUCT License Agreement (EUPLA) is a legal agreement between the customer of this PRODUCT (the END USER) and Digital Voice Systems, Inc. (DVSI) covering the terms and conditions under which this DVSI PRODUCT and DVSI's proprietary content (that may consist of and is not limited to software, hardware, documentation and other material) is licensed to the END USER.

1. Preliminary Statements and Definitions

1.1 By installing, or otherwise using this PRODUCT the END USER agrees to be bound by the terms and conditions set forth in this EUPLA. If the END USER does not agree to the terms and conditions set forth in this EUPLA, then the END USER must not install or use the PRODUCT and shall immediately return the PRODUCT to DVSI as set forth in Section 13.

a) The PRODUCT shall mean the Hardware, Software, Documentation and other materials that were provided by DVSI, either directly or indirectly through distributors or third parties, to the END USER as part of a sale, delivery or other transaction.

b) Hardware can be in the form of Integrated Circuits (such as Digital signal Processors), Circuit boards and electronics enclosed in a chassis. DVSI's Vocoder Chips (AMBE-3000™, AMBE-4020™, etc…) are an example of an Integrated Circuit.

c) Software can be in form of computer code, firmware masked into an IC or stored or embedded into ROM or RAM or Flash memory, or software stored on any media (such as CD-ROM, floppy disk, hard drive, solid-state memory or the Internet)

d) Documentation means written or electronic information, including user manuals, technical documents, training materials, specifications or diagrams, that pertain to or are delivered with the PRODUCT in any manner (including in print, on CD-ROM, or on-line).

1.2 DVSI has developed a number of voice coding methods and algorithms (the "Technology") which include DVSI's Advanced Multi-Band Excitation ("AMBE®"), AMBE+™, and AMBE+2™ voice coders. The Technology codes speech at low bit rates and may include error correction, echo cancellation and other auxiliary functions.

1.3 "DVSI Voice Compression Software" shall mean the voice coding Software that implements or embodies the Technology and is embedded into or otherwise provided with the PRODUCT.

1.4 "DVSI Voice Codec" shall mean the DVSI Voice Compression Software, any PRODUCT Hardware into which the DVSI Voice Compression Software is embedded or executed and any associated Documentation.

1.5 DVSI represents that it owns certain "Proprietary Rights" in the PRODUCT including patent rights, copyrights, trademarks and trade secrets. These rights include one or more of the following US Patents #6,912,495; #7,970,606; #8,036,886; #8,200,497, #8,315,860; #8,359,197; #8,433,562; and #8,595,002; and under other US and foreign patents, related patents and patents pending. AMBE®, AMBE+™ and AMBE+2™ are registered trademarks and trademarks of Digital Voice Systems, Inc.

1.6 "END USER" shall mean the person and/or organization to whom the DVSI Vocoder Product (software or hardware) 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 3.0, then this third party shall become an "END USER".

1.7 DVSI reserves the right to make modifications and other changes to its products and services at any time and to discontinue any product or service without notice.

2. License Granted

2.1 Subject to the conditions herein and upon initial use of the DVSI Product, DVSI hereby grants to END USER a non-exclusive, limited license to use the DVSI Voice Compression Software and Technology solely as included by DVSI within the PRODUCT. No license, either expressed or implied, is granted for any use of the DVSI's Proprietary Rights on any other device or Hardware or in any manner other than within the original unmodified PRODUCT purchased from DVSI. No license is granted to copy or modify the DVSI Voice Compression Software or the PRODUCT either in whole or in part.

2.2 No license, right or interest in any trademark, trade name or service mark of DVSI is granted under this Agreement. END USER acknowledges that the PRODUCT may contain trade secrets of DVSI, including but not limited to the specific design, and associated interface information.

2.3 END USER shall not copy, extract, reverse engineer, disassemble, de-compile or otherwise reduce the DVSI Voice Compression Software to human-readable form. END USER shall not alter, duplicate, make copies of, create derivative works from, distribute, disclose, provide or otherwise make available to others, the DVSI Voice Compression Software and Technology and/or trade secrets contained within the PRODUCT in any form to any third party without the prior written consent of DVSI. The END USER shall implement reasonable security measures to protect such trade secrets.

2.4 This is a license, not a transfer of title, to the DVSI Voice Compression Software, Technology and Documentation, and DVSI retains ownership and title to all copies.

3. Transfer of License

3.1 The END USER shall have the right to transfer the rights under this EUPLA to a third party by providing the third party with a copy of this EUPLA and obtaining the third parties agreement to all the terms and conditions under this EUPLA. In the event END USER does transfer their rights to a third party in accordance with this EUPLA, then the third party transferee shall become the new END USER and all rights under this EUPLA shall terminate with respect to the transferor in accordance with Section 4.

4. Term and Termination

4.1 This Agreement is effective upon initial delivery of the PRODUCT 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 13.

4.3 Upon termination of this Agreement for any reason, END USER shall: (a) discontinue all use of the PRODUCT; (b) return the PRODUCT and documentation purchased or acquired, or in Licensee's possession, to DVSI; (c) have no further rights to any DVSI Software or the Technology without a separate written license from DVSI; All confidentiality obligations of Customer and all limitations of liability and disclaimers and restrictions of warranty shall survive termination of this Agreement. In addition, the provisions of the sections titled "U.S. Government End User Purchasers" and

"General Terms Applicable to the Limited Warranty Statement and End User License" shall survive termination of this Agreement.

5. Payments

5.1 In consideration of the materials delivered as part of the PRODUCT, and in consideration of the license granted by DVSI for the PRODUCT, and in consideration of DVSI's performance of its obligations hereunder, the END USER agrees to pay to DVSI the fees as specified in DVSI's invoice. Payments of fees shall be received by DVSI prior to shipment of the PRODUCT.

6. Proprietary Notices

6.1 END USER shall maintain and not remove or alter any copyright or proprietary notice on or in the PRODUCT.

6.2 Reproduction of non-proprietary information found in DVSI Users Manuals or data sheets is permissible only if the END USER reproduces without alteration, and includes all copyright and other proprietary notices, all associated warranties, conditions and limitations on all copies, in any form.

7. Proprietary Information

7.1 The parties agree that the PRODUCT 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. Limited Warranty

8.1 DVSI warrants the PRODUCT to be free from defects in materials and workmanship under normal use for a period of ninety (90) days from the date of delivery. The date of delivery is set forth on the packaging material in which the Product is shipped. This limited warranty extends only to the Customer who is the original purchaser. If the PRODUCT is found to be defective and the condition is reported to DVSI, within the warranty period, DVSI may, at its option, repair, replace, or refund of the purchase price of the PRODUCT. DVSI may require return of the PRODUCT as a condition to the remedy.

Restrictions. This warranty does not apply if the PRODUCT (a) has been altered, (b) has not been installed, operated, repaired, or maintained in accordance with instructions supplied by DVSI, (c) has been subjected to abnormal physical or electrical stress, misuse, negligence, or accident;

8.2 Except as stated in Section 8.1, the PRODUCT 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 PRODUCT with respect to its correctness, accuracy, reliability, speech quality or otherwise. The entire risk as to the results and performance of the PRODUCT 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 PRODUCT.

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 PRODUCT to END USER.

8.4 Except as specifically set forth in this Section 8, 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 PRODUCT. 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 8 give END USER specific legal rights, and END USER may have other rights which vary from state to state.

9. Limitation of Liability

9.1 The END USER agrees that the limitations of liability and disclaimers set forth herein will apply regardless of whether the END USER has accepted the product or service delivered by DVSI.

9.2 In no event shall DVSI be liable for any special, incidental, indirect or consequential damages resulting from the use or performance of the PRODUCT whether based on an action in contract, or for applications assistance, or product support, or tort (including negligence) or otherwise (including, without limitation, damages for loss of business revenue, profits, business interruption, and loss of business information or lost or damaged data), even if DVSI or any DVSI representative has been advised of the possibility of such damages.

9.3 Because some states or jurisdictions do not allow the exclusion or limitation of liability for consequential or incidental damages, the above limitations may not apply to END USER.

9.4 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 PRODUCT that gave rise to the claim or that is the subject matter of, or is directly related to, the cause of action.

10. Taxes

10.1 All payments required under Section 5 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. Export

11.1 DVSI represents that to the best of its knowledge, this PRODUCT has been shipped from the United States in accordance with the US Export Administration Regulations (EAR). The END USER hereby gives its assurance to DVSI that it will comply with all export and re-export restrictions and regulations of all United States government agencies and authorities as well as when applicable, European Union and other export agencies. Export regulations include and are not limited to restrictions, prohibiting export or re-export of this DVSI PRODUCT (a) into an US-embargoed country or (b) to anyone person or entity named on any of the screening lists of the US Departments of Commerce, State and the Treasury. For a list of parties for which the US Government maintains restrictions on exports, re-exports or transfers of items, reference the Consolidated Screening List (CSL) which may be found at: (https://www.export.gov/article?id=Consolidated-Screening-List). By installing, or otherwise using this PRODUCT the END USER represents and warrants that the END USER is not located in any such country or named on any such list.

11.2 DVSI makes no representation that an export or re-export license is or is not required, and if a license is required, that it will or will not be issued by the U.S. Department of Commerce. The END USER is solely responsible, at their own expense, for obtaining any US or other government permits, licenses or approvals required for the importing and/or exporting the PRODUCT. For up-to-date information regarding United States import / export laws and regulations please visit https://www.export.gov/.

12. 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, (USA), 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.

This Agreement has been written in the English language, and the parties agree that the English version will govern.

13.0 Notices

13.1 Any notices to DVSI which may be given hereunder shall be sent in writing to: Digital Voice Systems Inc., 234 Littleton Road, Westford, MA., 01886, U.S.A.

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SECTION 1

1 Product Introduction

Digital Voice Systems Inc.'s AMBE-3000™ Vocoder Chip is an extremely flexible, high-performance speech compression coder. DVSI has implemented its most advanced AMBE+2™ vocoder technology into a single DSP chip solution to achieve unmatched voice quality, with robustness to background noise and channel bit errors. DVSI's AMBE+2™ vocoder technology outperforms G.729 and G.726 while adding additional features and benefits from DVSI's previous industry-leading AMBE+™ Vocoder. The superior performance characteristics of the new AMBE+2™ Vocoder make it ideally suited for mobile radio, secure voice, satellite communications, computer telephony, and other digital voice and storage applications where bandwidth is at a premium and low data rate, and high-quality are both imperative.

The field-proven success of this technology has resulted in it being recognized as the standard for voice quality in communications systems around the globe. DVSI's AMBE+2™ technology is the preferred choice for many mobile radio standards.

The AMBE-3000™ Vocoder Chip offers the affordability and mobility required by virtually all full or half-duplex mobile communication devices. Two versions of the AMBE-3000™ Vocoder Chip are available. The AMBE-3000R™ Vocoder Chip ROM version offers lower power requirements at a lower cost. Where as the AMBE-3000F™ Vocoder Chip Flash version offers a few extra features that maybe useful in certain applications. This manual covers the features and capabilities of the AMBE-3000F™ Vocoder Chip Flash version.

1.1 Advances in Vocoder Design

The AMBE-3000F™ Vocoder Chip voice coder maintains natural voice quality and speech intelligibility at rates as low as 2.0 kbits/sec. The AMBE-3000F™ Vocoder Chip provides a high degree of flexibility in selecting the speech and FEC (Forward Error Correction) data rates. The user can separately select these parameters in 50 bps increments for total rates from 2.0 kbps to 9.6 kbps. Plus, the AMBE-3000F™ Vocoder Chip offers similar features and backwards compatibility to DVSI's AMBE-2000™ and AMBE-1000™ Vocoder Chips allowing it to be incorporated into a system that can be interoperable with these DVSI products.

1.2 AMBE-3000™ Vocoder Chip Features

The AMBE-3000™ Vocoder Chip includes a number of advanced features that are combined with low power consumption to offer the affordability, mobility and power efficiency required by virtually all mobile communication devices.

- ◊ DVSI's full duplex AMBE+2™ Voice coder
- ◊ Superior voice quality, low data rate speech coding
- ◊ Supports variable data rates of 2.0 kbps to 9.6 kbps in 50 bps increments
- ◊ Minimal algorithmic processing delay

- ◊ Codec interfaces available (SPI or McBSP)
- ◊ Packet interfaces available (UART, McBSP, PPT)
- ◊ Configuration via hardware configuration pins and/or configuration packets
- ◊ Supports a-law and µ-law companding

- ◊ Robust to Bit Errors & Background Noise
- ◊ Variable FEC Rates - 50 bps to 7.2 kbps
- ◊ User Selectable Forward Error Correction rates
- ◊ Viterbi Decoder (rate 1/4 or more)

- ◊ Voice Activity Detection (VAD) / Comfort Noise Insertion
- ◊ Echo Cancellation *(not supported in Packet Mode)*
- ◊ Noise Suppression
- ◊ DTMF detection and regeneration with North American call progress tones

- ◊ Very low power consumption with low power- mode
- ◊ Compact single chip solution: 128 pin LQFP or 179 pin PBGA
- ◊ No external memory required
- ◊ Low cost a value for mobile products

1.3 Typical Applications

The AMBE-3000™ vocoder chip's level of performance can lead to the successful development and deployment of wireless communication systems in the most demanding environments. It has been thoroughly evaluated and tested by international manufacturers under various conditions using a variety of languages. This assures the user is getting the best vocoder available and makes the DVSI vocoder the logical choice without the need for additional comparison tests. Plus the fact, that DVSI's voice compression technology has been implemented worldwide for more than 20 years, delivers the added security of a field proven technology that can play a key role in making any communication system an overall success.

- ◊ Satellite Communications
- ◊ Digital Mobile Radio
- ◊ Secure Communications
- ◊ Cellular Telephony and PCS
- ◊ Voice Multiplexing

SECTION 2

2 Hardware Information

The AMBE-3000F™ Vocoder Chip uses Texas Instruments TMS320F2811 core. The TMS320F2811 DSP Design uses High-Performance Static CMOS Technology with a low-power Core (1.8-V @135 MHz), and 3.3-V I/O. This generation of TI DSPs, are highly integrated, high-performance solutions for demanding control applications. For more details on handling, electrical characteristics, packaging, or timing constraints please refer to the TMS320F2811 manual found at http://focus.ti.com/docs/prod/folders/print/tms320f2811.html

2.1 Special Handling and Moisture Sensitivity

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

The length of time the AMBE-3000F™ can be safely exposed to the ambient environment prior to high temperature reflow soldering follows the JEDEC industry standard classification for Moisture Sensitivity Level.

LQFP package
MSL Level-2-260C-1 Year

BGA Package
MSL Level-3-260C-168 hours

NOTE: DVSI recommends the AMBE-3000F™ in the **BGA** package be handled within proper MSL Level 3 guidelines to avoid damage from moisture absorption that could result in yield and reliability degradation. The Moisture Sensitivity Level requirements allow the AMBE-3000F™ to be safely exposed to the ambient environment of <30ºC/60% RH, for **only 168 hours**. Since this is a relatively short period of time, all manufacturers should routinely follow industry standard MSL Level 3 bake-out procedures prior to assembly with these components.

2.2 Package Details

2.2.1 128-pin Low-Profile Quad Flat Pack (LQFP)

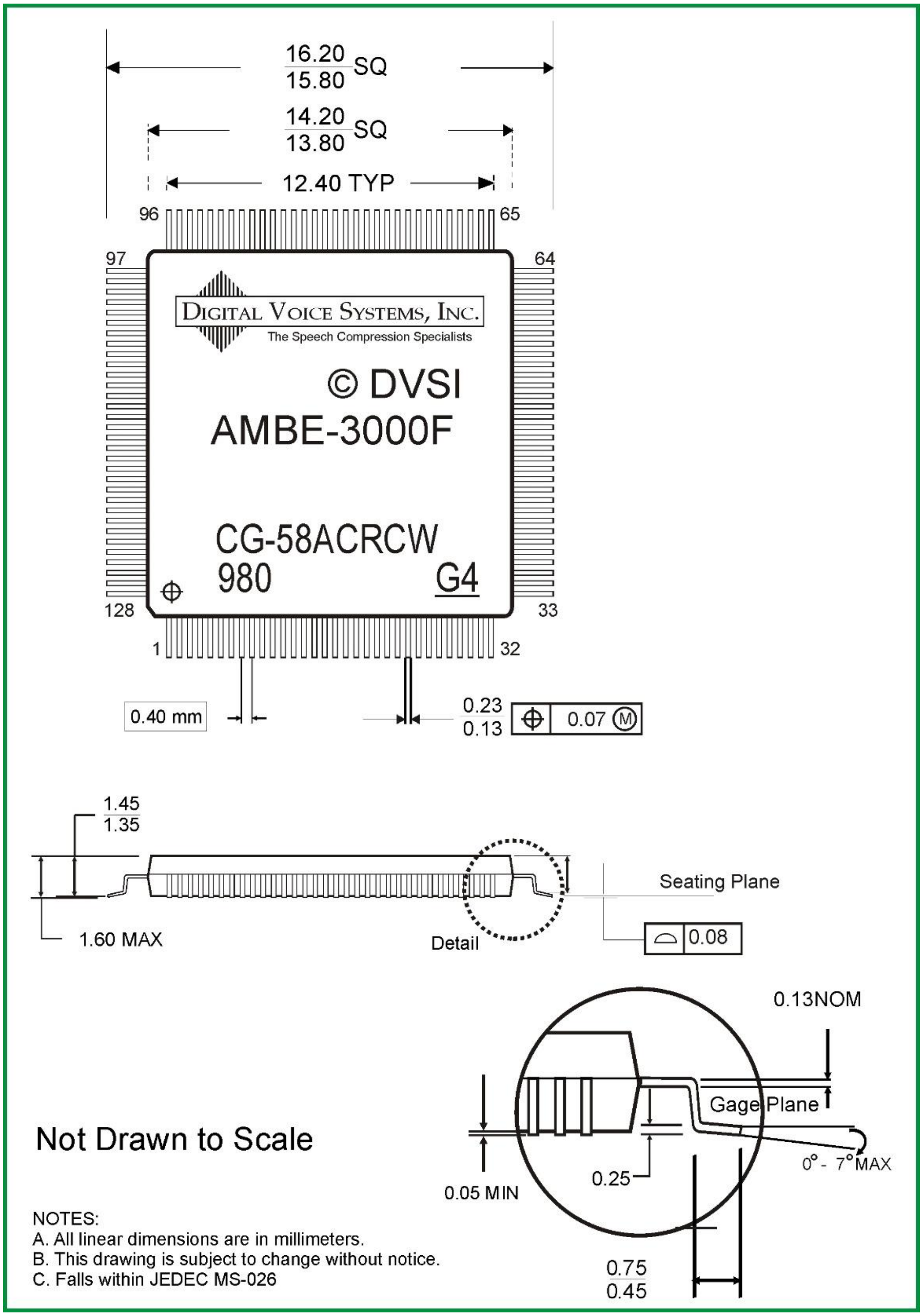

Figure 1 TQFP Mechanical Details

2.2.2 179 Pin Ball Grid Array (BGA)

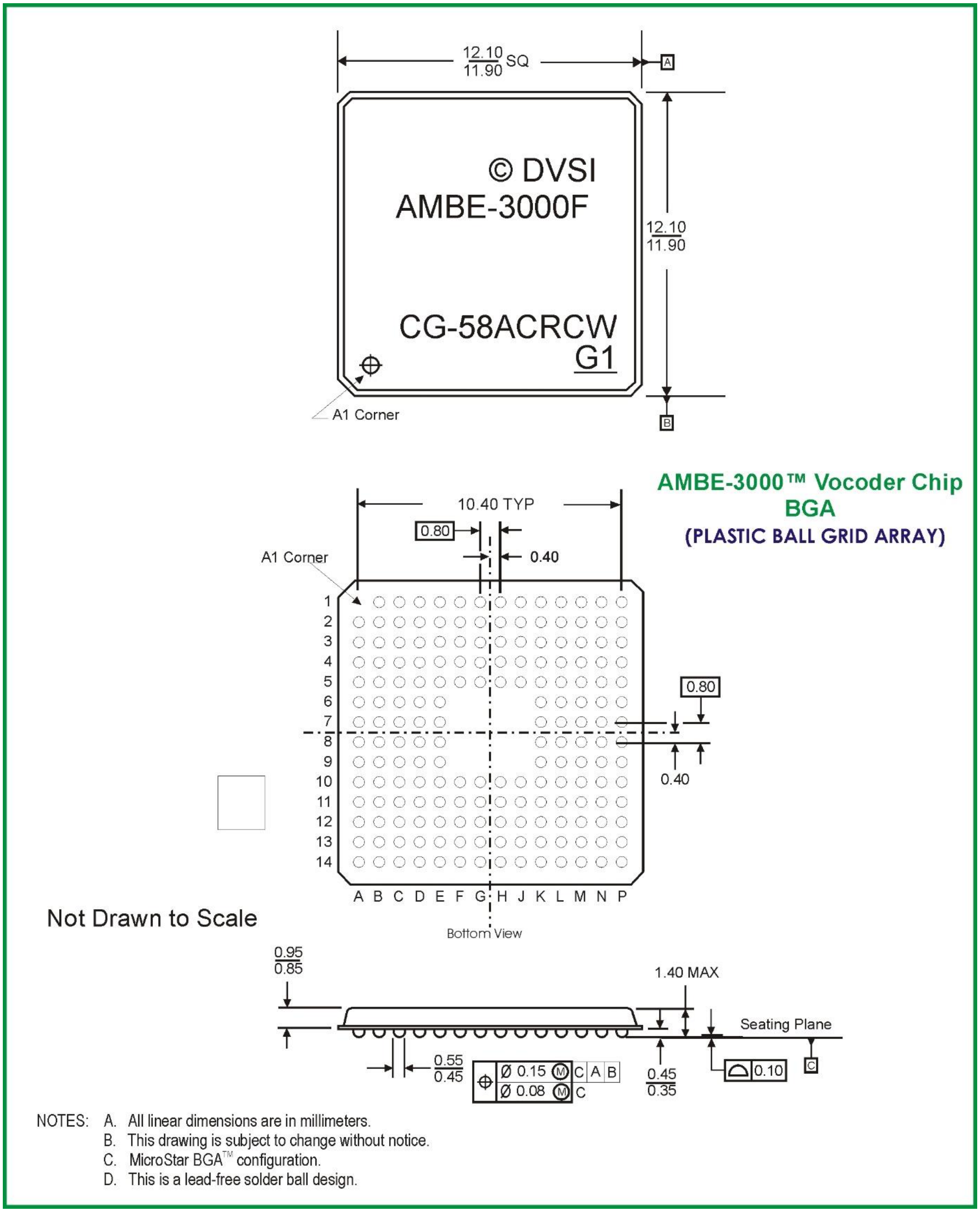

Figure 2 BGA Mechanical Details

2.3 Pin Assignment Layouts

2.3.1 LQFP Package

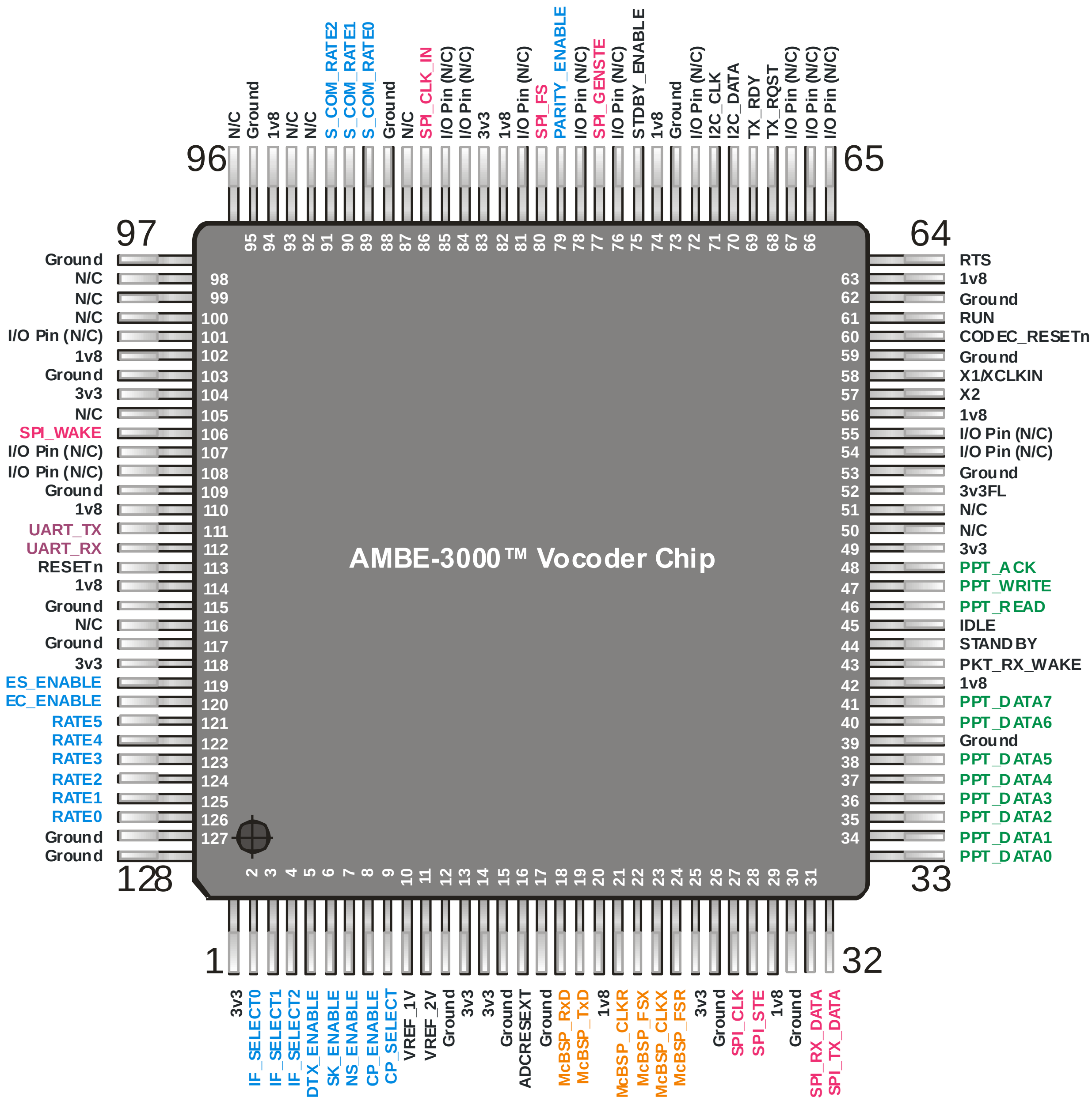

Figure 3 AMBE-3000F™ Vocoder Chip Pins for LQFP Package

All digital inputs are TTL-compatible. All outputs are 3.3 V with CMOS levels. Inputs are not 5-V tolerant. A 100-µA (or 20-µA) pullup/pulldown is used. Note that pins 2 through 9 and 119 through 126 do not have internal pullup/pulldowns.

2.3.2 BGA Package Pins (Bottom View)

	A	B	C	D	E	F	G	H	J	K	L	M	N	P
1		IF_SELECT2	DTX_ENABLE	CP_ENABLE	3v3	N/C	McBSP_TxD	1v8	McBSP_CLKX	Ground	1v8	SPI_RX_DATA	SPI_TX_DATA	N/C
2	Ground	3v3	IF_SELECT0	NS_ENABLE	VREF_2V	ADCRESEXT	McBSP_RxD	McBSP_CLKR	McBSP_FSR	SPI_CLK	Ground	N/C	PPT_DATA0	PPT_DATA1
3	RATE0	Ground	IF_SELECT1	SK_ENABLE	Ground	Ground	N/C	N/C	N/C	N/C	N/C	N/C	PPT_DATA2	PPT_DATA3
4	RATE4	RATE3	RATE2	RATE1	VREF_1V	3v3	Ground	McBSP_FSX	3v3	SPI_STE	PPT_DATA4	PPT_DATA5	N/C	Ground
5	3v3	ES_ENABLE	Ground	EC_ENABLE	RATE5	CP_SELECT	N/C	N/C	N/C	PPT_DATA6	N/C	PKT_RX_WAKE	PPT_DATA7	1v8
6	1v8	N/C	Ground	RESETn	N/C					Ground	PPT_WRITE	STANDBY	PPT_READ	IDLE
7	UART_RX	N/C	UART_TX	N/C	N/C					PPT_ACK	3v3	N/C	N/C	N/C
8	N/C	Ground	1v8	I/O Pin (N/C)	I/O Pin (N/C)					I/O Pin (N/C)	I/O Pin (N/C)	N/C	3v3FL	Ground
9	N/C	N/C	N/C	SPI_WAKE	3v3					X1/XCLKIN	N/C	X2	N/C	1v8
10	N/C	1v8	Ground	Ground	N/C	S_COM_RATE2	I/O Pin (N/C)	I/O Pin (N/C)	N/C	N/C	3v3	Ground	N/C	CODEC_RESETn
11	I/O Pin (N/C)	N/C	N/C	N/C	S_COM_RATE1	N/C	3v3	PARITY_ENABLE	I/O Pin (N/C)	I/O Pin (N/C)	Ground	N/C	N/C	RUN
12	N/C	N/C	N/C	N/C	N/C	N/C	1v8	SPI_FS	N/C	1v8	I2C_DATA	TX_RQST	RTS	1v8
13	Ground	N/C	N/C	N/C	S_COM_RATE0	SPI_CLK_IN	Ground	N/C	SPI_GENSTE	Ground	I2C_CLK	I/O Pin (N/C)	I/O Pin (N/C)	N/C
14	N/C	Ground	1v8	N/C	Ground	I/O Pin (N/C)	N/C	I/O Pin (N/C)	Ground	STDBY_ENABLE	N/C	TX_RDY	3v3	I/O Pin (N/C)

Figure 4 AMBE-3000F™ Vocoder Chip Pins Bottom View of BGA chip

All digital inputs are TTL-compatible. All outputs are 3.3 V with CMOS levels. Inputs are not 5-V tolerant. A 100-µA (or 20-µA) pullup/pulldown is used. Note that pins C2, C3, B1, C1, D3, D2, D1, F5, B5, D5, E5, A4, B4, C4, D4, A3 do not have internal pullup/pulldowns.

2.4 AMBE-3000F™ Vocoder Chip Markings

2.4.1 AMBE-3000F™ Vocoder Chip LQFP Markings

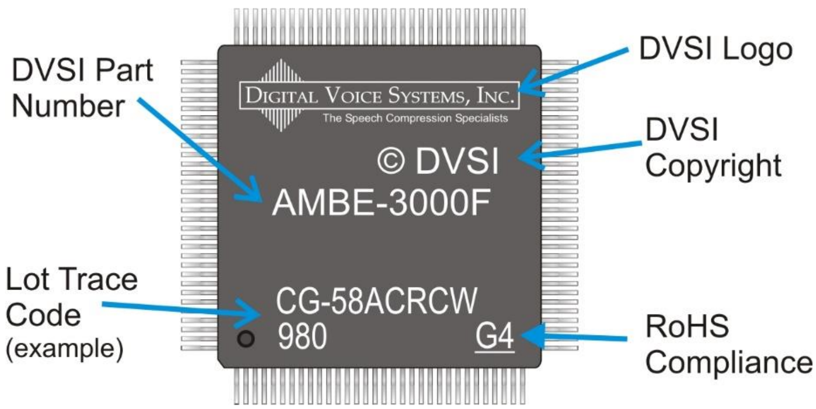

Figure 5 AMBE-3000F™ Vocoder Chip LQFP Markings

DVSI Logo --- Representation of Digital Voice Systems, Inc. Logo.

© DVSI --- Copyright Digital Voice Systems, Incorporated

DVSI Part Number --- The DVSI device part number is **AMBE-3000F™**

Lot Trace Code --- The lot trace code indicates chip manufacturing information.

Example as shown above **CG-58ACRCW 980**

- **CG** --- Chip manufacturer's internal information
- **5** --- Year of manufacture
- **8** --- Month of manufacture - January thru September shall be represented by numbers 1 thru 9, and October thru December shall be represented by the letters A, B, and C
- **ACRC** --- Unique alpha-numeric Lot Code
- **W** --- Chip manufacturer's assigned assembly site code
- **980** --- Chip manufacturer's internal information

RoHSCompliance

G4 Indicates RoHS Compliance.

2.4.2 AMBE-3000F™ Vocoder Chip BGA Markings

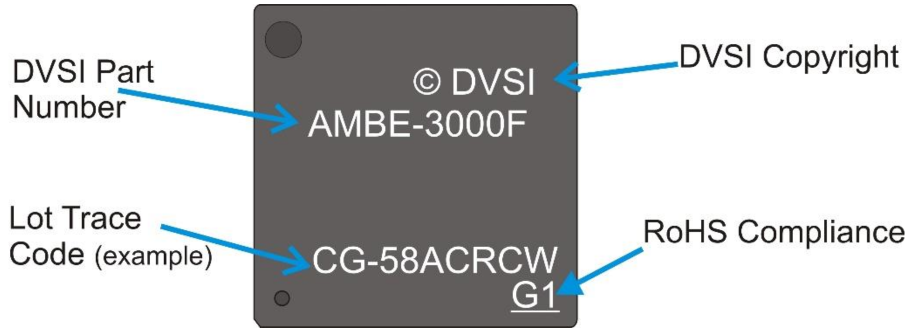

Figure 6 AMBE-3000F™ Vocoder Chip Markings for BGA

© DVSI --- Copyright Digital Voice Systems, Incorporated

DVSI Part Number --- The DVSI device part number is **AMBE-3000F™**

Lot Trace Code --- The lot trace code indicates chip manufacturing information.
Example as shown above **CG-58ACRCW**

- **CG** --- Chip manufacturer's internal information
- **5** --- Year of manufacture
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- **ACRC** --- Unique alpha-numeric Lot Code
- **W** --- Chip manufacturer's assigned assembly site code

RoHSCompliance
G1 Indicates RoHS Compliance.

2.5 Pin Out Table

Pin Name	Pin Number		Pin Type	Notes
	TQFP	BGA		
IF_SELECT0	2	C2	Input	Interface selection configuration
IF_SELECT1	3	C3	Input	Interface selection configuration
IF_SELECT2	4	B1	Input	Interface selection configuration
DTX_ENABLE	5	C1	Input	Enables VAD and CNI
SK_ENABLE	6	D3	Input	Skew Control enable / disable
NS_ENABLE	7	D2	Input	Noise Suppression enable / disable
CP_ENABLE	8	D1	Input	Companding enable / disable
CP_SELECT	9	F5	Input	Select a-law / µ-law
VREF_1V	10	E4	-	Voltage Reference Output (1 V). Requires a low ESR (50 mΩ - 1.5 Ω) ceramic bypass capacitor of 10 µF to analog ground.
VREF_2V	11	E2	-	Voltage Reference Output (2 V). Requires a low ESR (50 m Ω - 1.5 Ω) ceramic bypass capacitor of 10 µF to analog ground.
ADCRESEXT	16	F2	-	ADC External Current Bias Resistor (24.9kΩ) to Ground
McBSP_RxD	18	G2	Input	McBSP Serial Packet/Codec Receive Data
McBSP_TxD	19	G1	Output	McBSP Serial Packet/Codec Transmit Data
McBSP_CLKR	21	H2	Input	McBSP Serial Packet/Codec receive clock
McBSP_FSX	22	H4	I/O	McBSP Serial Packet/Codec transmit frame This signal is an input if the McBSP is used for Codec interface. This signal is an output if the McBSP is used for Packet interface.
McBSP_CLKX	23	J1	I/O	McBSP Serial Packet/Codec transmit clock. This signal is an Input if the McBSP is used for the Codec Interface. This signal is an Output if the McBSP is used for Packet interface.
McBSP_FSR	24	J2	Input	McBSP Serial packet/Codec receive frame
SPI_CLK	27	K2	Input	This is the Serial clock from Codec. It also should be connected to SPI_CLK_IN
SPI_STE	28	K4	Input	This is the framing signal generated from SPI_GENSTE. This pin need to be connected to Pin #77 on the AMBE-3000F™ Vocoder Chip.
SPI_RX_DATA	31	M1	Input	PCM Data from A/D Converter to AMBE-3000F™ Vocoder Chip
SPI_TX_DATA	32	N1	Output	PCM Data from AMBE-3000F™ Vocoder Chip to D/A Converter
PPT_DATA0	33	N2	I/O	Parallel Packet Data
PPT_DATA1	34	P2	I/O	Parallel Packet Data
PPT_DATA2	35	N3	I/O	Parallel Packet Data

PPT_DATA3	36	P3	I/O	Parallel Packet Data
PPT_DATA4	37	L4	I/O	Parallel Packet Data
PPT_DATA5	38	M4	I/O	Parallel Packet Data
PPT_DATA6	40	K5	I/O	Parallel Packet Data
PPT_DATA7	41	N5	I/O	Parallel Packet Data
PKT_RX_WAKE	43	M5	Input	When the UART interface is used and low-power mode is enabled, this pin must be connected to UART_RX. When the McBSP packet interface is used this signal should be connected to the inverted McBSP_FSR signal.
STANDBYn	44	M6	Output	For debugging purposes only. This signal is low while the AMBE-3000F™ Vocoder Chip is in standby mode. Standby mode is entered only when Low power mode is enabled and there is no activity.
IDLEn	45	P6	Output	For debugging purposes only. This signal is low while the AMBE-3000F™ Vocoder Chip is in Idle mode. Idle mode is entered when there is no activity and low power mode is disabled.
PPT_READ	46	N6	Input	Read data from PACKET_DATA pins
PPT_WRITE	47	L6	Input	Write data to PACKET_DATA pins
PPT_ACK	48	K7	Output	Used to Acknowledges the transitions of PPT_READ and PPT_WRITE
3v3FL	52	N8	PWR	3.3-V Flash Core Power Pin. This pin should be connected to 3.3 V at all times after power-up sequence requirements have been met.
X2	57	M9	Output	Output from internal oscillator for use with a crystal. If the internal oscillator is not used this pin should be unconnected.
X1/XCLKIN	58	K9	Input	29.4912 MHz Clock input. The AMBE-3000 may be operated using the internal oscillator by connecting a crystal between X1 and X2 or with an external clock source. The AMBE-3000F™ Vocoder Chip can be operated with an external clock source, provided that the proper voltage levels are driven on the X1/XCLKIN pin. It should be noted that the X1/XCLKIN pin is referenced to the 1.8-V core digital power supply (VDD), rather than the 3.3-V I/O supply (VDDIO). A clamping diode may be used to clamp a buffered clock signal to ensure that the logic-high level does not exceed VDD (1.8 V) or a 1.8-V oscillator may be used.
CODEC_RESETn	60	P10	Output	Output to Reset the Codec. This signal is active low.
RUNn	61	P11	Output	For debugging purposes only. This signal is low while the either encoder or decoder is executing otherwise it is high.

RTSn	64	N12	Output	The Request-To-Send (RTSn) pin is an output that is active low. The signal is used by the AMBE-3000F™ Vocoder Chip to control the flow of input packet data. The Chip has a receive buffer where incoming packets are stored until they have been processed. The AMBE-3000F™ Vocoder Chip sets RTSn low to indicate that it is ready to receive data. When RTSn is high, the Chip is not ready to receive packet data. RTSn is set high if there are less than thresh_hi bytes of free space in the receive buffer. RTSn is set low if there are more than thresh_lo bytes of free space in the receive buffer. After a reset thresh_hi is set to 20 and thresh_lo is set to 40, by default. These thresholds can be changed by sending a PKT_RTSTHRESH field as part of a control packet after reset. The thresholds may need to be set to higher values if the device connected to RTSn does not stop sending packet data quick enough after RTSn goes high. The RTSn signal follows the conventions commonly used for RS-232 flow control. If the MCBSP or the parallel port is selected for the packet interface, rather than the UART, then the RTSn signal is still generated. The RTSn signal can also be used for flow control if the McBSP or the PPT interface is used.
TX_RQST	68	M12	Input	Channel Transmit Data Strobe TX_RQST is used to control the encoder timing, when skew control is enabled. It must be high for at least 250 us. The period must be 20+/-1 ms. When skew control is enabled the time between rising edges of TX_RQST is used to determine the number of speech samples per frame.
TX_RDY	69	M14	Output	Transmit Packet Ready goes high as soon as the AMBE-3000F™ Vocoder Chip is ready to transmit a channel packet. Goes low after the entire packet is read. Regardless of the packet interface selected, whenever the AMBE-3000F™ Vocoder Chip has a packet ready for transmission it sets TX_RDY to high.
I^2C_DATA	70	L12	Output	I^2C_DATA (output from AMBE-3000F™ Vocoder Chip to codec)
I^2C_CLK	71	L13	Output	I^2C_CLK (output from AMBE-3000F™ Vocoder Chip to codec)
STDBY_ENABLEn	75	K14	Input	STDBY_ENABLEn is active low and is only used when low power mode is Enabled. This signal is required for proper function of low power mode and must be set low at least 500ns prior to sending a packet to the AMBE-3000F™ Vocoder Chip. If low power mode is not enabled then signal can be left unconnected and not used.
SPI_GENSTE	77	J13	Output	Required when using the SPI interface. This is used to generate the SPI_STE signal. This pin should be connected to SPI_STE (pin# 28).
PARITY_ENABLE	79	H11	Input	Enable parity bit
SPI_FSn	80	H12	Input	SPI_FSn is active low. If the SPI interface is used SPI_FSn must be connected to the active low frame sync signal from the codec.
SPI_CLK_IN	86	F13	Input	For SPI Interface to function properly this pin must be connected to the Serial clock from Codec. (pin #27 SPI_CLK)

S_COM_RATE0	89	E13	Input	LSB of Serial Communications Rate selection
S_COM_RATE1	90	E11	Input	Serial Communications Rate selection
S_COM_RATE2	91	F10	Input	MSB of Serial Communications Rate selection
SPI_WAKE	106	D9	Input	Must be connected to the active low frame sync signal from the codec if the SPI interface is used and low power mode is enabled. The signal is used to wake the AMBE-3000F™ Vocoder Chip from stand-by mode.
UART_TX	111	C7	Output	Channel Transmit Data from AMBE-3000F™ Vocoder Chip SCI asynchronous serial port. This pin must be held HIGH during a Hard Reset.
UART_RX	112	A7	Input	Channel Receive Data to AMBE-3000F™ Vocoder Chip asynchronous serial port.
RESETn	113	D6	I/O	AMBE-3000F™ Vocoder Chip Reset pin. Active LOW. The RESET pin is considered an I/O port and will function as such when a SOFT RESET packet (PKT_RESET or PKT_RESETSOFTCFG) is sent to the device. For more details see Section 3.6 Reset Behavior
ES_ENABLE	119	B5	Input	Echo Suppressor enable / disable *(not supported in Packet Mode)*
EC_ENABLE	120	D5	Input	Echo Canceller enable / disable *(not supported in Packet Mode)*
RATE5	121	E5	Input	Vocoder Bit Rate Control Word
RATE4	122	A4	Input	Vocoder Bit Rate Control Word
RATE3	123	B4	Input	Vocoder Bit Rate Control Word
RATE2	124	C4	Input	Vocoder Bit Rate Control Word
RATE1	125	D4	Input	Vocoder Bit Rate Control Word
RATE0	126	A3	Input	Vocoder Bit Rate Control Word
1v8	20, 29, 42, 56, 63, 74, 82, 94, 102, 110, 114	B10, C8, C14, G12, H1, K12, L1, P5, P9, P12, A6	PWR	Supply Voltage 1.8-V Core Digital Power Pins. (V_{DD})

3v3	1, 13, 14, 25, 49, 83, 104, 118	B2, E1, F4, E9, G11, J4, L7, A5, L10, N14,	PWR	3.3 V I/O Digital Power Pins.
Ground	12, 15, 17, 26, 30, 39, 53, 59, 62, 73, 88, 95, 97, 103, 109, 115,117, 127, 128	E3, F3, B8, B14, C10, D10, E14, G4, G13, J14, K1, K6, A13, K13, L2, C6, C5, B3, A2, L11, M10, P4, P8,	GND	Core and Digital I/O Pins to Ground. (V_{SS})
I/O Pin	54, 55, 65, 66, 67, 72, 76, 78, 81, 84, 85, 101, 107, 108	L8, K8, N13, P14, M13, K11, J11, H10, H14, G10, F14, A11, E8, D8	I/O	No Connection

N/C	50, 51, 87, 92, 93, 96, 98, 99, 100, 105, 116	N7, M7, F11, D13, D12, C13, B12, A12, D11, C9, E6	-	No Connection

N/C		B6, B13, E7, F1, K10, M3, N4, N11, P1, P13, A8, A10, A14, B7, B9, C11, C12, D7, D14, E10, E12, F12, G5, G14, H13, J12, M2, M11, N10, A9, B11, G3, H3, H5, J3, J5, J10, K3, L3, L5, L9, L14, M8, N9, P7,	-	No Connection

Table 1 Pinout List

NOTE:
Other than the power supply pins, no pin should be driven before the 3.3-V rail has reached recommended operating conditions. However, it is acceptable for an I/O pin to ramp along with the 3.3-V supply.

The following pins have internal pullup
18/G2, 21/H2, 22/H4, 23/J1, 24/J2, 33/N2, 34/P2, 35/N3, 36/P3, 37/L4, 38/M4, 40/K5, 41/N5, 43/M5, 44/M6, 45P6, 46/N6, 47/L6, 48/K7, 54/L8, 55/K8, 60/P10, 61/P11, 64/N12, 65/N13, 68/M12, 69/M14, 70/L12, 71/L13, 72/K11, 75/K14, 76/J11,

77/J13, 78/H10, 79/H11, 80/H12, 81/H14, 84/G10, 85/F14, 86/F13, 89/E13, 90/E11, 91/F10, 92/D13, 96/C13, 99/A12, 100/D11, 101/A11, 105/C9, 107/E8, 111/C7, 112/A7, 113/D6

The following pins have internal Pulldown
98/B12

2.6 Hardware Configuration Pins

There is a set of configuration pins that allows the user to set-up the most common chip configurations. The chip boots up according to the configuration pins. Then after booting up, if any configuration packets are received, the configuration is changed accordingly. The configuration pins are only checked at boot time.

Hardware Configuration Pins

Pin Number		Name	Description
TQFP	BGA		
2	C2	IF_SELECT0	See Section 4.2
3	C3	IF_SELECT1	
4	B1	IF_SELECT2	
5	C1	DTX_ENABLE	See Section 4.5.4
6	D3	SK_ENABLE	See Section 4.5.5
7	D2	NS_ENABLE	See Section 4.5.6
8	D1	CP_ENABLE	See Section 4.5.7
9	F5	CP_SELECT	
79	H11	PARITY_ENABLE	See Section 6.5.5
89	E13	S_COM_RATE0	See Table 20 UART Baud Rates
90	E11	S_COM_RATE1	
91	F10	S_COM_RATE2	
119	B5	ES_ENABLE	Echo suppressor enable Pin *(not supported in Packet Mode)*
120	D5	EC_ENABLE	Echo Cancellation enable Pin *(not supported in Packet Mode)*
121	E5	RATE5	See Table 120 Rate Control Words and Pin Settings
122	A4	RATE4	
123	B4	RATE3	
124	C4	RATE2	
125	D4	RATE1	
126	A3	RATE0	

Table 2 Hardware Configuration Settings

2.7 Crystal / Oscillator Usage

The AMBE-3000F™ Vocoder Chip has an on-chip, PLL-based clock module and requires an input clock frequency of 29.4912 MHz. The PLL-based clock module provides all the necessary clocking signals for the device, as well as control for low-power mode entry. The AMBE-3000F™ Vocoder Chip two modes of operation:

External clock source operation (See Figure 7 X1/XCLKIN and X2 with TTL/CMOS Clock Source)

◊ This mode allows the internal oscillator to be bypassed. The device clocks are generated from an external clock source input on the X1/XCLKIN pin.

Crystal-operation (See Figure 8 X1/XCLKIN and X2 with Crystal Oscillator)

◊ This mode allows the use of an external crystal/resonator to provide the time base to the device.

The following points should be noted when designing any printed circuit board layout:

◊ Keep X1/XCLKIN and X2 away from high frequency digital traces to avoid coupling.

◊ Keep the crystal and external capacitors as close to the X1/XCLKIN and X2 pins as possible to minimize board stray capacitance.

2.7.1 External Clock Source

When an external source is used as the clock input. Connect X1/XCLKIN and X2 as follows:

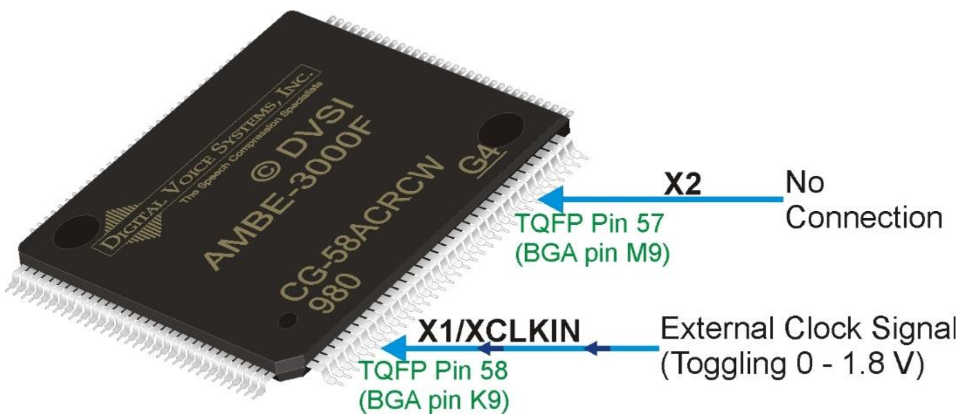


Figure 7 X1/XCLKIN and X2 with TTL/CMOS Clock Source

2.7.2 Crystal Oscillator

To use a crystal oscillator with the AMBE-3000F™ Vocoder Chip, connect the crystal across X1/XCLKIN and X2 along with one external capacitor from each of these pins to ground.

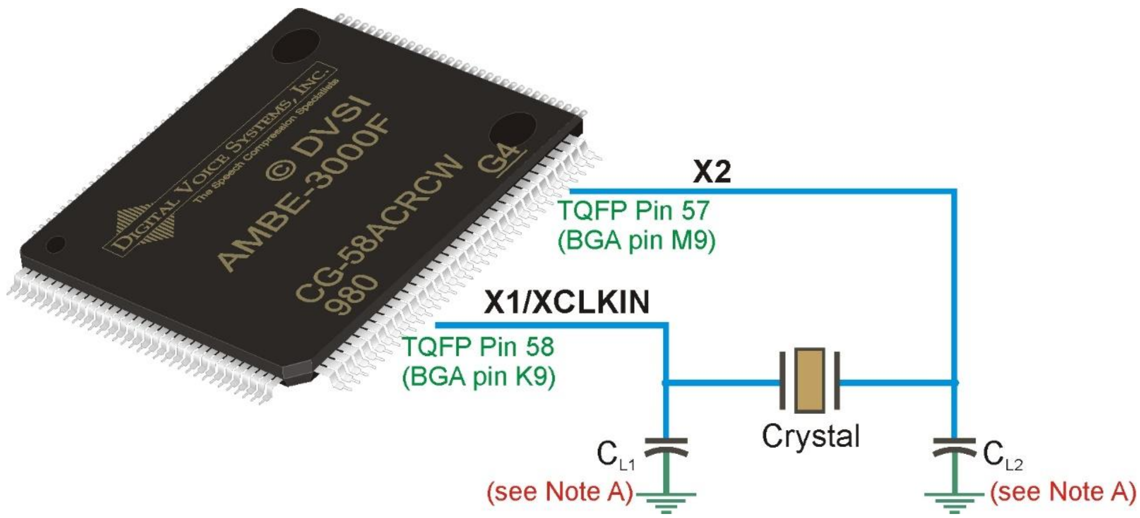


Figure 8 X1/XCLKIN and X2 with Crystal Oscillator

> NOTE A: It is recommended that the resonator/crystal vendor characterize the operation of their device with the chip. The resonator/crystal vendor has the equipment and expertise to tune the tank circuit. The vendor can also advise regarding the proper tank component values that will ensure start up and stability over the entire operating range.

The typical specifications for the external quartz crystal for a frequency of 30 MHz are listed below:

- ◊ Fundamental mode, parallel resonant
- ◊ CL (load capacitance) = 12 pF
- ◊ $C_{L1} = C_{L2}$ = 24 pF
- ◊ Cshunt = 6 pF
- ◊ ESR range = 25 to 40 Ohms
- ◊ +/- 30 ppm

2.7.3 Input Clock Requirements

The clock provided at XCLKIN pin generates the internal CPU clock cycle.

ID	Parameter	Min.	Max.	Unit
A	$t_{c(Cl)}$ Cycle time, XCLKIN	6.67	250	ns
B	$t_{r(Cl)}$ Rise time, XCLKIN		6	ns
C	$t_{f(Cl)}$ Fall time, XCLKIN		6	ns
	$t_{w(ClL)}$ Pulse duration XCLKIN **Low** as a percentage of $t_{c(Cl)}$	40	60	%
	$t_{w(ClH)}$ Pulse duration XCLKIN **High** as a percentage of $t_{c(Cl)}$	40	60	%

	Parameter	**Min**	**Nom**	**Max**	**Unit**
V_{IH}	High-level input voltage X1/XCLKIN (@50uA max)	.7 (1v8)	-	1v8	V
V_{IL}	Low-level input voltage X1/XCLKIN (@50uA max)			0.3 (1v8)	V

Figure 9 Input Clock Requirements

SECTION 3

3 Electrical Characteristics and Requirements

Unless otherwise noted, the list of absolute maximum ratings is specified over operating temperature ranges. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated are not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. All voltage values are with respect to Vss.

3.1 Normal Operating Conditions

Normal Operating Conditions	
Operating Voltage	1.8-V Core, (135 MHz), 3.3-V I/O
Operating Ambient Temperature Range	-40°C to 85°C
Storage Temperature Range	-65°C to 150°C
Junction Temperature Range	-40°C to 150°C

Table 3 Normal Operating Conditions

Long-term high-temperature storage and/or extended use at maximum temperature conditions may result in a reduction of overall device life. For additional information, see IC Package Thermal Metrics Application Report (TI literature number SPRA953) and Reliability Data for additional information; see IC Package Thermal Metrics Application Report and Reliability Data (TI literature number SPRA953).

3.2 Recommended Operating Conditions

Parameter		Min	Nom	Max	Unit
3v3	Device Supply Voltage, I/O	3.14	3.3	3.47	V
1v8	Device Supply Voltage, CPU 1.8 V (135MHz)	1.71	1.8	1.89	V
V_{IH}	High-level input voltage All inputs except X1/XCLKIN	2.0	-	3v3	V
V_{IL}	Low-level input voltage All inputs except X1/XCLKIN		0.8		V
V_{IH}	High-level input voltage X1/XCLKIN (@50uA max)	.7(1v8)	-	1v8	V
V_{IL}	Low-level input voltage X1/XCLKIN (@50uA max)			0.3(1v8)	V
$f_{SYSCLKOUT}$	Device clock frequency (system clock) = 1.8 V ± 5%		29.4912		MHz
I_{OH}	High-level output current source current, V_{OH} = 2.4 V		-4		mA
I_{OH}	High-level output current source current, V_{OH} = 2.4 V (See Note) ††		-8		mA
I_{OL}	Low-level output sink current V_{OL} = V_{OL} MAX		4		mA
I_{OL}	Low-level output sink current V_{OL} = V_{OL} MAX (Group 2)		8		mA

Table 4 Recommended Operating Conditions

†† Note Applies to the following pin: SPI_WAKE (TQFP Pin 106, BGA Pin D9).

3.3 Absolute Maximum Ratings

Stresses in excess of the Absolute Maximum Ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to Absolute Maximum Ratings for extended periods can adversely affect device reliability.

Absolute Maximum Ratings	
3v3 Supply voltage range	-0.3 V to 4.6 V
1v8 Supply voltage range	-0.5 V to 2.5 V
Input voltage range, V_{IN}	-0.3 V to 4.6 V
Output voltage range, V_O	-0.3 V to 4.6 V
Input clamp current I_{IK} ($V_{IN} < 0$ or $V_{IN} > 3v3$)†	± 20 mA
Output clamp current I_{OK} ($V_O < 0$ or $V_O > 3v3$)	± 20 mA

Table 5 Absolute Maximum Ratings

†Continuous clamp current per pin is ± 2 mA

3.4 Thermal Resistance Characteristics

Thermal Resistance Characteristics			
Parameter	**Package Type**		**Unit**
	TQFP	**BGA**	
PsiJT	0.271	0.658	°C/W
Θ_{JA}	41.65	42.57	°C/W
Θ_{JC}	10.76	16.08	°C/W

Table 6 Thermal Resistance Characteristics

Unless otherwise noted, the list of absolute maximum ratings is specified over operating temperature ranges. All voltage values are with respect to Vss.

3.5 Power Sequencing Requirements

The AMBE-3000F™ Vocoder Chip silicon requires dual voltages (1.8-V and 3.3-V) to power up the CPU, Flash, ROM, ADC, and the I/Os. To ensure the correct reset state for all modules during power up, there are some requirements to be met while powering up/powering down the device.

Enable power to all 3.3-V supply pins and then ramp 1.8 V supply pins (Table 7 Voltage Supply Pins). Other than the power supply pins, no pin should be driven before the 3.3-V rail has been fully powered up.

	Voltage Supply Pins	
	Package Type	
	TQFP	BGA
3.3 V Supply Pins	1, 13, 14, 25, 49, 83, 104, 118	B2, E1, F4, E9, G11, J4, L7, A5, L10, N14
1.8 V Supply Pins	20, 29, 42, 56, 63, 74, 82, 94, 102, 110, 114	B10, C8, C14, G12, H1, K12, L1, P5, P9, P12, A6

Table 7 Voltage Supply Pins

1.8 V supply voltage should not reach 0.3 V until 3v3 has reached 2.5 V. This ensures the reset signal from the I/O pin has propagated through the I/O buffer to provide power-on reset to all the modules inside the device.

3.6 Reset Behavior

To avoid startup latency problems the system should be designed to supply a cascading reset. This means that once the system host processor is fully functional it should bring the AMBE-3000™ Vocoder Chip out of reset using RESETn signal. The AMBE-3000™ Vocoder Chip should then supply the CODEC_RESETn signal to bring the codec out of reset. Employing reset in this cascading fashion will allow each device to be up and running in proper sequence so that no data is lost.

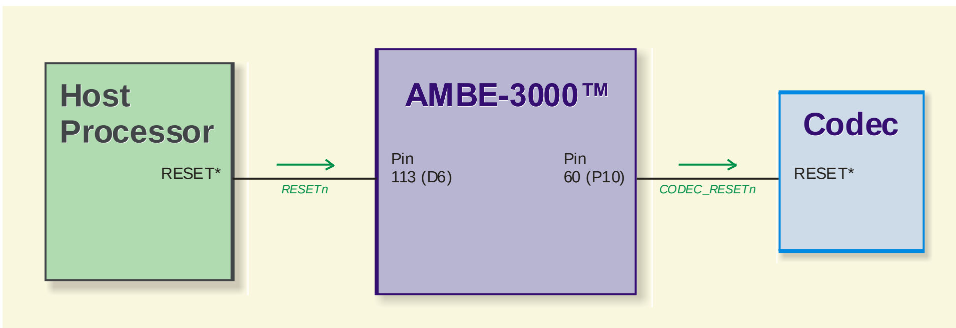


Figure 10 Cascading Resets

Care should be taken with the AMBE-3000™ Vocoder Chip RESET pin (LQFP pin 113, BGA pin D6). The RESET pin is considered an I/O port and will function as such when a SOFT RESET packet (PKT_RESET or PKT_RESETSOFTCFG) is sent to the device. This means that when a SOFT RESET packet is issued, the AMBE-3000™ Vocoder Chip will pull the RESET pin low for a short period of time (approximately 20 µsec). The designer should avoid having the AMBE-3000™ Vocoder Chip's RESET pin be shared on the system reset line or a reset with other components on the board if there is a chance that a SOFT RESET may be called for in the design.

3.6.1 Reset to Ready Packet Timing

RESET release to PKT_ READY is 20 msec MAX, 17 msec TYPICAL.
SOFT reset to PKT_READY = ~ 7 msec

3.6.2 Behavior of RTSn and TX_RDY following a RESET

Following a RESET, there is a short period where the TX_RDY signal is set high by the AMBE-3000. During this short period reading of the TX_RDY should be avoided. The TX_RDY hold off period is approximately 1 msec following a reset.

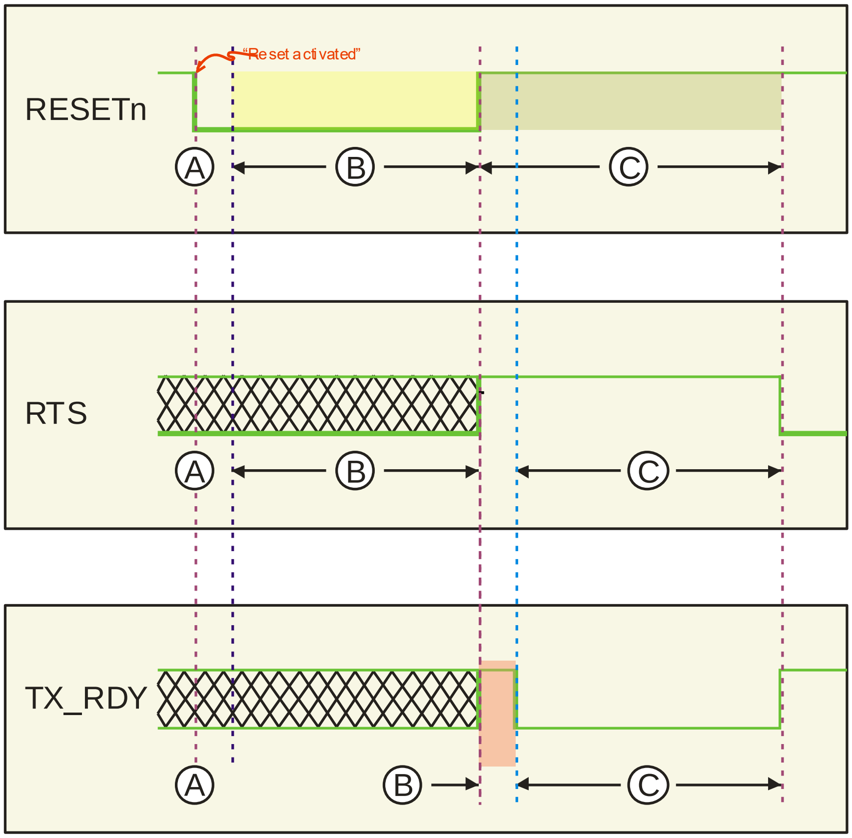


Figure 11 TX_RDY after Reset

3.7 Signal Transition Levels

Note that some of the signals use different reference voltages, see Table 4 Recommended Operating Conditions. Output levels are driven to a minimum logic-high level of 2.4 V and to a maximum logic-low level of 0.4 V.

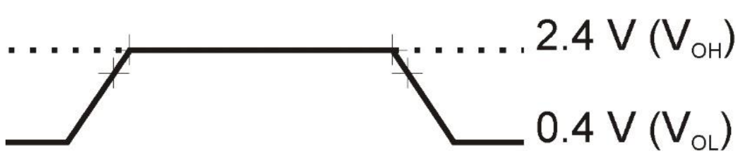


Figure 12 Output Levels

Output transition times are specified as follows:

- ◊ For a high-to-low transition, the level at which the output is said to be no longer high is below $V_{OH(MIN)}$ and the level at which the output is said to be low is $V_{OL(MAX)}$ and lower.
- ◊ For a low-to-high transition, the level at which the output is said to be no longer low is above $V_{OL(MAX)}$ and the level at which the output is said to be high is $V_{OH(MIN)}$ and higher.

Figure 13 Input Levels

Input levels are as follows 0.8 V (V_{IL}) and 2.0 V (V_{IH})
Input transition times are specified as follows:

- ◊ For a high-to-low transition on an input signal, the level at which the input is said to be no longer high is below $V_{IH(Min)}$ and the level at which the input is said to be low is $V_{IL(Max)}$ and lower.

- ◊ For a low-to-high transition on an input signal, the level at which the input is said to be no longer low is above $V_{IL(Max)}$ and the level at which the input is said to be high is $V_{IH(Min)}$ and higher.

3.8 Power-Down Sequencing:

During power-down, the device reset should be asserted low (8 µs, minimum) before the 1.8 V supply reaches 1.5 V. This will help to keep on-chip flash logic in reset prior to the 3v3and 1.8 V power supplies ramping down. It is recommended that the device reset control from “Low-Dropout (LDO)” regulators or voltage supervisors be used to meet this constraint. LDO regulators that facilitate power-sequencing (with the aid of additional external components) may be used to meet the power sequencing requirement.

3.9 Low Power Modes

The AMBE-3000F™ Vocoder Chip has four power states as shown in Figure 14 AMBE-3000F™ Vocoder Chip Power States.

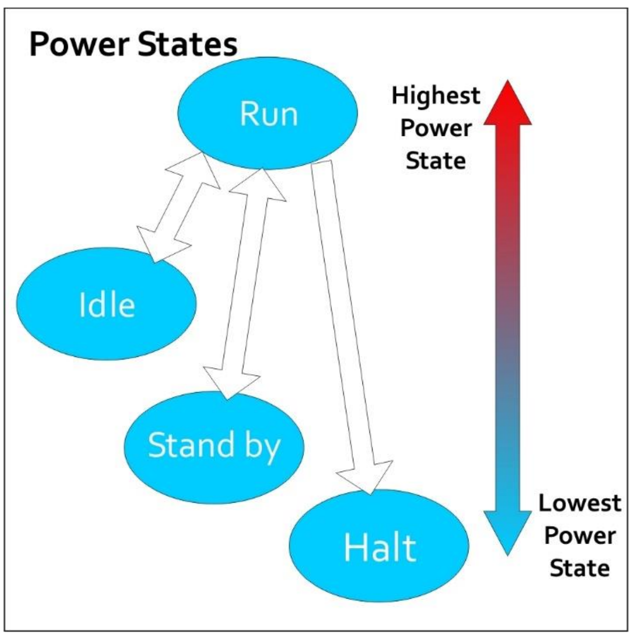


Figure 14 AMBE-3000F™ Vocoder Chip Power States

In order to reduce power consumption the AMBE-3000F™ Vocoder Chip automatically switches to lower power states when possible. The AMBE-3000F™ Vocoder Chip may switch power states many times during each 20 ms frame. For instance, during periods when the AMBE-3000F™ Vocoder Chip is not actively executing code, the AMBE-3000F™ Vocoder Chip will be in a low power state. When a codec interrupt occurs the AMBE-3000F™ Vocoder Chip will briefly switch into the run state and then switch back to the lower power state. If the codec interface is in use, then the AMBE-3000F™ Vocoder Chip will never remain in the low power state for more than 125 us at a time.

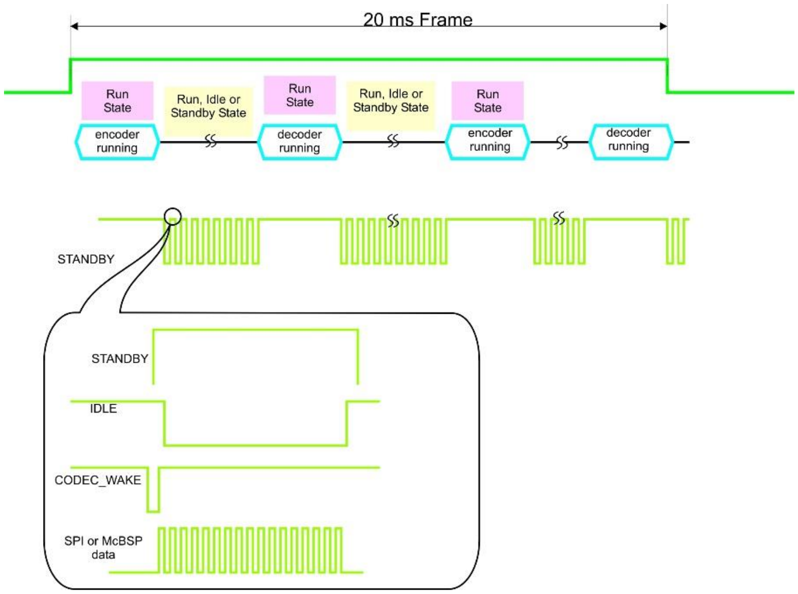


Figure 15 Power Mode States Basic Timing

3.9.1 Run State

This is the highest power state. The AMBE-3000F™ Vocoder Chip is in this state whenever it is actively executing code. The AMBE-3000F™ Vocoder Chip is in the run state if the encoder is running or if the decoder is running or other processing is being performed.

3.9.2 Idle State

This state uses less power than the run state. The AMBE-3000F™ Vocoder Chip is in this state whenever it is not actively executing code, but peripherals are active. Peripherals are active when packets are being transmitted or received or when codec samples are being clocked in/out.

3.9.3 Standby State

This state uses even less power than the Idle State. However, no peripherals can be sending or receiving data while in this state. The AMBE-3000F™ Vocoder Chip will only enter this state if low power mode is enabled, AND the AMBE-3000F™ Vocoder Chip is not actively executing code, AND no peripherals are in use. Peripheral activity causes the AMBE-3000F™ Vocoder Chip to re-enter the run state. When low power mode is enabled, some extra hardware connections are required. The required connections are dependent upon which interfaces are in use.

3.9.4 Halt State

This is the lowest power state. The AMBE-3000F™ Vocoder Chip does not automatically enter in and out of this state. The only way to get into this state is to send a packet containing a PKT_HALT field. The only way to get out of this state is via a hard reset. During a hard reset be sure to hold UART_TX HIGH (LQFP pin 111, BGA pin C7)

3.9.5 Power Modes

The AMBE-3000F™ Vocoder Chip has two power modes:

(1) Normal Power Mode: In this mode the AMBE-3000F™ Vocoder Chip switches between the Run State and the Idle State.
(2) Low Power Mode: In this mode the AMBE-3000F™ Vocoder Chip switches between the Run State, the Idle State, and the Standby State. Lower power is consumed because the AMBE-3000F™ Vocoder Chip is in the Standby state a large percentage of the time. low power mode is enabled or disabled by sending a packet containing PKT_LOWPOWER field to the AMBE-3000F™ Vocoder Chip. After reset, low power mode is always disabled.

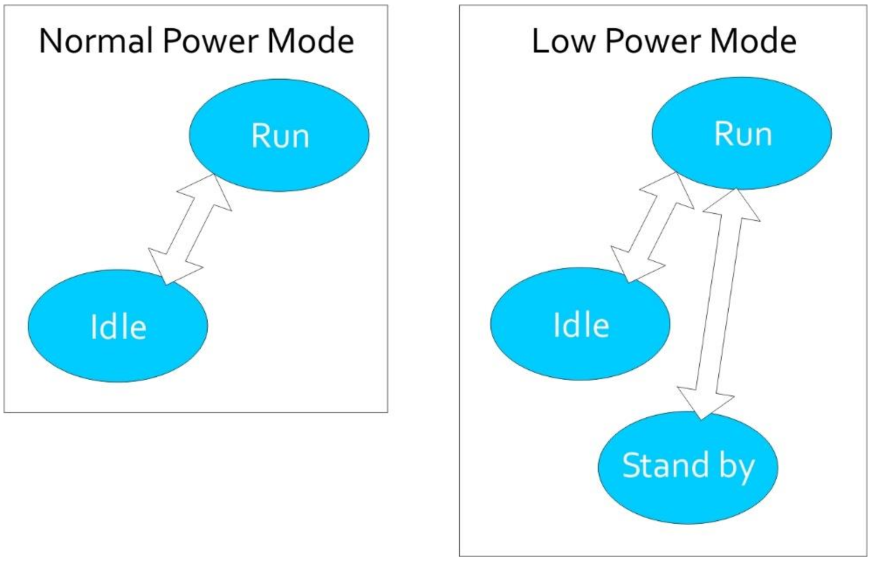


Figure 16 Power Modes

The AMBE-3000F™ Vocoder Chip outputs three signals that are related to its current power state. The STANDBYn (TQFP pin 44 / BGA pin M6) signal goes low whenever the AMBE-3000F™ Vocoder Chip is in the Standby State, otherwise the signal is high. The IDLEn (TQFP pin 45 / BGA pin P6) signal is low whenever the AMBE-3000F™ Vocoder Chip is in the Idle State, otherwise the signal is high. The RUNn (TQFP pin 61 / BGA pin P11) signal is low whenever, either the encoder or the decoder is running, otherwise the signal is high.

3.9.6 Low power mode when using the UART Packet Interface

When the UART packet interface is used and low-power mode is enabled, PKT_RX_WAKE (TQFP pin 43 / BGA pin M5) must be connected to UART_RX (TQFP pin 112 / BGA pin A7). The signal is used to make sure that the standby state is not entered while UART_RX is active.

3.9.7 Low Power Mode when using the McBSP Packet Interface

When the McBSP packet interface is used the PKT_RX_WAKE (TQFP pin 43 / BGA pin M5) signal must be connected to the inverted McBSP_FSR signal (TQFP pin 24 / BGA pin J2). The signal is needed in order to wake the chip from the standby state.

3.9.8 Low Power Mode when using the McBSP Codec Interface

When the McBSP codec interface is used the SPI_WAKE (TQFP pin 106 / BGA pin D9) signal must be connected to the inverted McBSP_FSR signal (TQFP pin 24 / BGA pin J2). The signal is needed in order to wake the chip from the standby state.

Note: The higher the frequency of the MCBSP clock the better power consumption will be when low-power mode is enabled.

3.9.9 Low Power Mode when using the SPI Codec Interface

When the SPI codec interface is used the SPI_WAKE (TQFP pin 106 / BGA pin D9) signal must be connected to the inverted frame sync signal from the codec. The signal is needed in order to wake the chip from the standby state.

3.9.10 Low Power Mode when using the Parallel Packet Interface

No additional connections are required to use low power mode with the parallel interface.

3.9.11 Additional Requirements when Low Power Mode is enabled.

If low power mode is enabled, there are some restrictions on when a packet can be sent to the AMBE-3000F™ Vocoder Chip. One of the following methods most be chosen.

Method 1: Prior to the start of any packet transfer to the AMBE-3000F™ Vocoder Chip, the STDBY_ENABLEn (TQFP pin 75 / BGA pin K14) pin must be set low at least 500ns prior to sending the first byte of a packet via UART, McBSP, or Parallel Port. The signal should be set high anytime after the first byte of the packet has been transferred to the AMBE-3000F™ Vocoder Chip. When the STDBY_ENABLEn is held low, the AMBE-3000F™ Vocoder Chip is prevented from entering the standby state, so it is important that the STDBY_ENABLEn signal is set high prior to the end of the last byte of the packet.

OR

Method 2: STDBY_ENABLEn (TQFP pin 75 / BGA pin K14) must be pulled high or left disconnected. Prior to the start of any packet transfer to the AMBE-3000F™ Vocoder Chip, wait for a transition of the STANDBYn (TQFP pin 44 / BGA pin M6) signal from the high state to the low state. After the transition is detected begin sending the first byte of the packet to the AMBE-3000F™ Vocoder Chip via UART, McBSP, or Parallel Port within 100μs after the transition was detected.

OR

Method 3: A packet may be sent to the AMBE-3000F™ Vocoder Chip at anytime after the AMBE-3000F™ Vocoder Chip has begun transmitting a packet up until the time the AMBE-3000F™ Vocoder Chip has just finished transmitting the packet. It is important that the first byte of the packet being sent to the AMBE-3000F™ Vocoder Chip be sent before the last byte of the packet is received from the AMBE-3000F™ Vocoder Chip.

3.9.12 Typical AMBE-3000F™ Vocoder Chip Power Measurements:

Test Conditions	Power Measurement			
	Low Power Mode **NOT** Enabled		Low Power Mode Enabled	
Codec Mode (SPI Interface) UART Packet Interface 50% Voice Activity	1.8v uses 154 mW 3.3v uses 26 mW	**Total** 180 mW	1.8v uses 62 mW 3.3v uses 23 mW	**Total** 85 mW (DTX enabled)
Packet Mode UART Packet Interface Not receiving packets	125 mW (AMBE-3000F™ Vocoder Chip is in the idle state)		22 mW (AMBE-3000F™ Vocoder Chip is in the standby state)	
Maximum Current Values	1.8v = 193 mW 3.3v = 171 mW			

Table 8 Typical AMBE-3000F™ Vocoder Chip Power Measurements

SECTION 4

4 Initial Design Considerations

Some of the initial design considerations the application engineer will face are the following:

- Speech and FEC rates. (2000 – 9600 bps)
- Mode of operation (codec mode or packet mode)
- Choice of codec interface. (SPI, McBSP) - for codec mode only!
- Choice of packet interface. (UART, McBSP, PPT)
- Choice of A/D-D/A chip. - for codec mode only!

Implementing the AMBE-3000F™ Vocoder Chip into a communication system requires the selection of various components. The AMBE-3000F™ Vocoder Chip offers multiple interfaces for flexibility in integration into a variety of design configurations.

In its simplest model, the AMBE-3000F™ Vocoder Chip can be viewed as two separate components, the Encoder and the Decoder. The Encoder receives an 8 kHz sampled stream of speech data (16-bit linear, 8-bit A-law, or 8-bit µ-law) and outputs a stream of channel data at the desired rate. Simultaneously, the AMBE-3000F™ Vocoder Chip receives compressed voice channel data. This data is decoded by the AMBE-3000F™ Vocoder Chip, then reconstructed into a digital speech signal and sent to the D/A. The encoder and decoder functions are fully asynchronous.

The special functions of the AMBE-3000F™ Vocoder Chip, such as echo cancellation, voice activity /detection, power mode control, data/FEC rate selection, etc. can be controlled either through hardware control pins and/or through the packet interface.

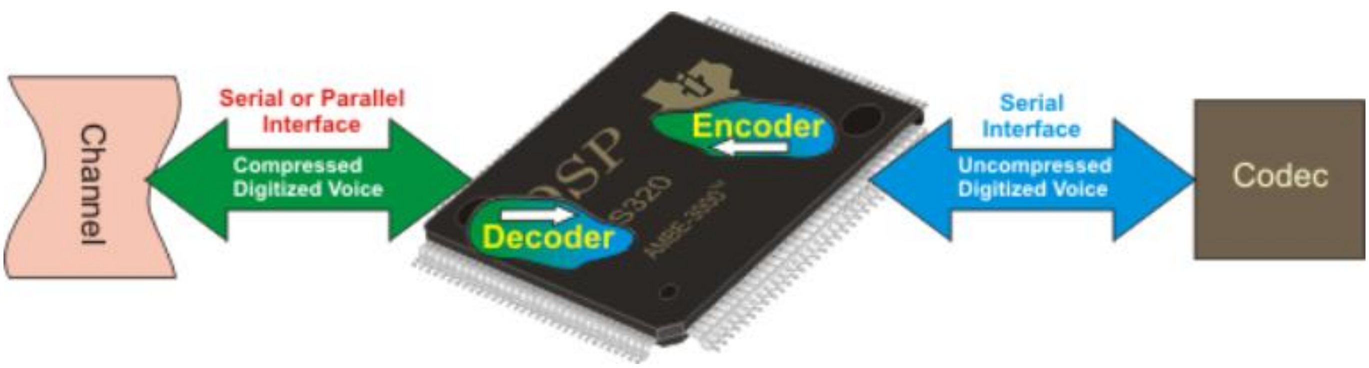


Figure 17 Basic Operation

4.1 Vocoder Speech and FEC Rate Selection

The voice coding rate as well as the FEC coding rate can be selected individually on the AMBE-3000F™ Vocoder Chip. These rates are selected by using a configuration control packet, or through hardware configuration pins. The hardware configuration pins provide the user with 62 pre-configured voice/FEC rates. If rates other than these are desired, then a configuration control packet can be used to configure voice and FEC rates in 50 bps increments.

4.2 Interface Selection

Basic communication to/from the AMBE-3000F™ Vocoder Chip consists of input digitized speech data samples, output digitized speech data samples, input compressed speech data and output compressed speech data. There are four physical interfaces (SPI, McBSP, UART and Parallel) used to transfer the data to/from the AMBE-3000F™ Vocoder Chip.

For codec mode, the user must select two physical interfaces: one for the codec data and one for the packet data. The choices for the codec interface are SPI or McBSP. The choices for the packet interface are McBSP or UART or Parallel Port. The McBSP can not be used for both the codec interface and the packet interface.

For packet mode, the user must select one physical interface to be used for packet data. The packet interface is used to transfer both the speech data samples and the compressed channel data. The choices for the packet interface are McBSP or UART or Parallel Port.

The AMBE-3000F™ Vocoder Chip supports four separate physical interfaces: SPI, UART, Parallel port, and McBSP serial port. The user must select a codec interface and a packet interface using hardware configuration pins IF_SELECT0 (TQFP pin2, BGA pin C2), IF_SELECT1 (TQFP pin3, BGA pin C3), and IF_SELECT2 (TQFP pin4, BGA pin B1). The available interface combinations are shown in Table 9 Physical Interface Selection

Interface Configurations					
Mode	IF_SELECT Configuration Pin #'s (TQFP / BGA)			Codec Interface	Packet Interface
	4 / B1	3 / C3	2 / C2		
Codec Mode	0	0	0	SPI	UART
Codec Mode	0	0	1	SPI	PPT
Codec Mode	0	1	0	SPI	McBSP*
Codec Mode	0	1	1	McBSP*	UART
Codec Mode	1	0	0	McBSP*	PPT
Packet Mode	1	0	1	Not used	UART
Packet Mode	1	1	0	Not used	PPT
Packet Mode	1	1	1	Not used	McBSP*

Table 9 Physical Interface Selection

*Note: McBSP Interface may be used for codec interface or the packet interface but not both.

4.3 A/D – D/A Codec chip Selection

The AMBE-3000F™ Vocoder Chip can be configured to transmit and receive digitized speech to and from most linear, a-law, or u-law A/D-D/A codecs. The format of the incoming and outgoing speech data streams are coupled, that is to say they must be the same format (16-bit linear, 8-bit a-law, or 8-bit μ-law). The digitized speech from the external A/D is converted into compressed digital data (encoded) by the AMBE-3000F™ Vocoder Chip and the channel data is output to the packet interface. Alternatively, speech data can be sent to/from the AMBE-3000F™ Vocoder Chip via a packet interface.

The choice of the A/D-D/A chip is critical to designing a system with superior voice quality. Given that a-law and μ-law companding chips are already incorporating some compression to reduce the number of bits per sample, it is recommended that, when possible, a 16-bit linear device be used for maximum voice quality. When choosing a device, pay particular attention to signal to noise ratios and frequency responses of any filters that may be present on the analog front end of these chips. Generally speaking, the flatter the frequency response over the voice spectrum (20-4000Hz) the better the overall system will sound. The a-law and μlaw interfaces are mainly provided for the design engineer who is trying to fit to pre-existing conditions or is under cost savings restraints.

4.4 Vocoder State

In systems that require the ability to encode/decode different subsequent audio streams the vocoder state in the AMBE-3000™ Vocoder Chip would need to be reset back to the initial state. This will ensure that new audio streams will not be using state data from a previous unrelated audio stream. To clear out any old vocoder state information the designer should send a PKT_INIT to the AMBE-3000™ Vocoder Chip in between each different audio stream. This will reset the chip back to the default state and allow it to encode/decode properly.

Issue a PKT_CODECSTOP:
`0x61 0x00 0x01 0x2B`

Issue PKT_INIT:
`0x61 0x00 0x02 0x0B 0x03`

Issue a PKT_CODECSTART
`0x61 0x00 0x02 0x00 0x2A XxXX`*****
*****See Table 57 PKT_CODECSTART Field Data

4.5 Special Functions Description

The special functions of the AMBE-3000F™ Vocoder Chip, such as voice activity detection, echo cancellation, DTMF, data/FEC rate selection, power mode control, etc. can be controlled either through hardware control pins and/or through the packet interface. The hardware inputs are only accessed for input during the first 7 milliseconds after a hardware reset on RESETn. For predictable operation these signals must remain stable over this time period. After this 7 milliseconds initialization period changes on these pins are ignored, unless another reset is performed.

4.5.1 Voice Activity Detection & Comfort Noise Insertion

(DTX_ENABLE TQFP pin5, BGA pin C1)
The Voice Activity Detection (VAD) algorithm along with the Comfort Noise Insertion (CNI) feature of the AMBE-3000F™ Vocoder Chip performs useful functions in systems trying to convert periods of silence, that exist in normal conversation, to savings in system bandwidth or power. VAD and CNI can be enabled by either hardware configuration pin (DTX_ENABLE TQFP pin5 BGA pin C1) or as part of a control packet.

With the VAD functions enabled, when periods of silence occur, the encoder will output a silence frame (in-band). This silence frame contains information regarding the level of background noise, which allows the corresponding decoder to synthesize a "Comfort Noise" signal at the other end. The comfort noise is intended to give the listener the feeling that the call is still connected, as opposed to producing absolute silence, which can give the impression that, the call has been "dropped". The decoder will produce a comfort noise frame if it receives an in-band silence frame (produced only by an encoder with VAD enabled). The synthesis of a Comfort Noise frame by the decoder is not dependent on VAD being enabled.

If the VAD features are being used to reduce transmit power during times of conversational silence, DVSI recommends that a silence frame be transmitted at the start of the period and approximately each 500-1000 milliseconds thereafter. This is to ensure that the parameters regarding the levels of background noise are transmitted to the decoder for the smoothest audible transitions between synthesized speech and synthesized silence.

The silence threshold value is -25 dBm0 in the VAD algorithm. Each frame that exceeds this level will be classified as voice. If the frame level is less than -25 dBm0 the voice/silence decision will be determined based upon various adaptive thresholds.

4.5.2 Echo Canceller (EC_ENABLE TQFP pin120 BGA pin D5)

(not supported in Packet Mode)
The AMBE-3000F™ Vocoder Chip's voice coder contains an echo canceller that can be selectively enabled or disabled via either hardware pin or setting of control command packet. The echo canceller is suitable for canceling the local echo caused by a 2-to-4 wire hybrid and can achieve echo cancellation of approximately 30dB or more. Only the linear portion of the echo can be cancelled, so circuits should be designed to minimize nonlinearities. The Echo Return Loss (ERL) of the analog circuit must be 6dB or more for proper echo canceller operation. Linear Codecs will generally provide better performance than μ-law or a-law codecs due to lower quantization noise.

The AMBE-3000F™ Vocoder Chip employs an adaptive echo cancellation algorithm to cancel echoes of the decoder output present at the encoder input. The echo canceller is an Adaptive LMS echo canceller with a 16 ms (128 samples) filter. It exceeds all the performance requirements specified by ITU-T recommendation G.165.

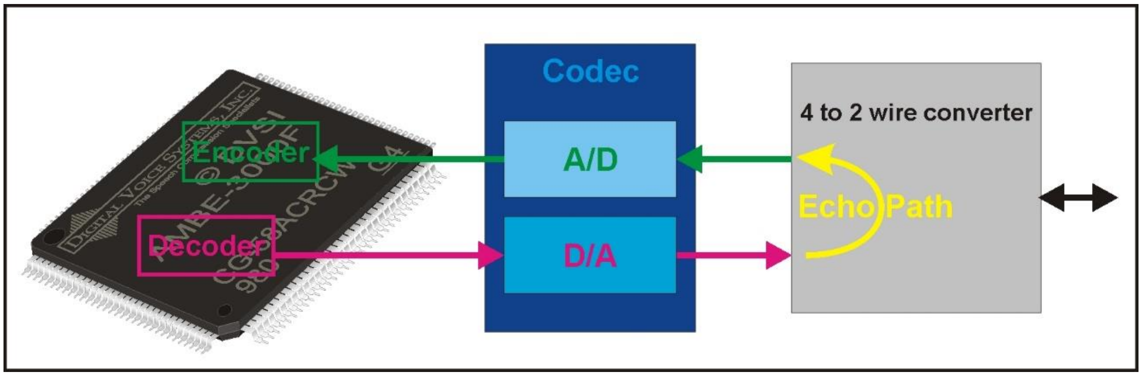


Figure 18 Typical Echo Path

The echo canceller can be activated either through the hardware pin, or through the packet interface.

4.5.3 DTMF Dual Tone Multiple Frequency, Detection and Generation

The AMBE-3000F™ Vocoder Chip is capable of detecting, transmitting, and synthesizing DTMF tones. When the encoder detects DTMF tones the voice data field will contain the DTMF tone data. Additionally, the encoder passes the DTMF data in-band (within the regular voice data bits) so that normal DTMF tones pass seamlessly from the encoder to the decoder for synthesis. The decoder synthesizes a DTMF tone in response to reception of an in-band DTMF tone frame or reception of a control packet with the DTMF word set. When this voice data is received by an AMBE-3000F™ Vocoder Chip decoder, it will regenerate the inband tone. The AMBE-3000F™ Vocoder Chip can also generate "Dual Tones" at many different frequencies. Each tone packet generates 20 milliseconds of output tones. The length of the output tones can be extended by repeating the tone packet. DTMF may be enabled or disabled through a control packet. DTMF is enabled by default.

The AMBE-3000F™ Vocoder Chip can also generate Single Frequency Tones. This can be done by using the TONE_IDX Field (see **Error! Reference source not found.**. Each packet with TONE_IDX generates 20 milliseconds of output tones. The length of the output tones can be extended by repeating the packet. Tones that can be generated by the AMBE-3000F™ Vocoder Chip are shown in Table 104 TONE Index Values.

4.5.4 Soft Decision Error Correction

Significant improvement in FEC performance can be added by setting up a receiver so that the demodulator is making a finer estimation of the received energy prior to sending it to the decoder, this is called soft-decision decoding. To use Soft Decision Error Correction use the CHAND4 (ID 0x17) field in the channel packet. The AMBE-3000F™ Vocoder Chip utilizes a 4-bit soft decision decoder. The bits are defined as follows:

Decision Value (Binary)	Interpretation
0000	Most confident 0
0111	…
1000	…
1111	Most confident 1

Table 10 Soft Decision Error Correction

The user must implement circuitry at the receive end of the channel for making a finer (4 bit) estimation of the received energy. The AMBE-3000F™ Vocoder Chip uses a different channel data field (CHAND4) to specify channel data represented by 4 soft decision (SD) bits. The decoder will make the decision of whether or not a 1 or a 0 is represented by the SD bits.

4.5.5 Skew Control (SK_ENABLE TQFP pin 6 BGA pin D3)

The AMBE-3000F™ Vocoder Chip processes speech in voice frames that are approximately 20 ms in duration. Skew control can provide the designer with flexibility in dealing with clock drift. The AMBE-3000F™ Vocoder Chip skew control feature allows the vocoder chip to compensate for drift between the frame and sample rate clocks.

Codec Mode
When skew control is enabled, the AMBE-3000F™ Vocoder Chip adjusts the frame boundaries so that they occur on the rising edge of the TX_RQST signal. The user must generate the TX_RQST signal such that the frame size varies between 156 and 164 samples.

Packet Mode Skew Control Enable
In packet mode the normal length of the input speech packets is 160 samples. However this can vary between 156 and 164 samples in length. Output speech packets can also vary in length from 156 to 164 samples.

4.5.6 Noise Suppressor (NS_ENABLE TQFP pin 7 BGA pin D2)

The integrated Noise suppressor feature of the AMBE-3000F™ Vocoder Chip is used to reduce the effect of background noise in the encoder input signal. The Noise suppressor is applied to both silence frames and voice frames, but not tone frames. When the noise suppressor is started it may take up to a few seconds to converge allowing for it to begin fully working.

4.5.7 Companding Using A-Law and µ-Law

The format of the digital speech I/O is critical to designing a system with superior voice quality. It is recommended that, when possible, 16-bit linear PCM data sampled at 8 kHz, be used for maximum voice quality. The AMBE-3000F™ Vocoder Chip supports either 16-bit linear, 8-bit A-law, or 8-bit µ-law formats. Given that a-law and µ–law companding formats already incorporate some compression to reduce the number of bits per sample, when choosing either format, pay particular attention to Signal to Noise ratios and Frequency Responses of any filters that may be present on the analog front end. The a-law and µ–law interfaces are provided for the design engineer who is trying to fit to pre-existing conditions or is under other cost type restraints. To enable/disable companding and select the format, use either hardware pins as described in the following tables or the COMPAND field (ID 0x32) as part of a Control packet.

CP_ENABLE	TQFP pin 8 BGA pin D1
Companding Disabled	0
Companding Enabled	1

Table 11 Companding Control

CP_SELECT	TQFP pin 9 BGA pin F5
Select µ-law	0
Select a-law	1

Table 12 Companding Selection

SECTION 5

5 I/O Management

The AMBE-3000F™ Vocoder Chip offers a variety of interfaces that can be configured in a variety of ways. Selection of the physical interface and the operating Mode is determined from the configuration pins after reset. The AMBE-3000F™ Vocoder Chip uses an I/O Handler to manage data to/from the encoder/decoder according to the selected interfaces and operating mode. The I/O handler is also used to schedule calls to the encoder and decoder.

The I/O handler passes 160±4 Codec samples to the encoder for each 20 ms frame. In addition to passing the speech samples to the encoder for every 20 ms frame, the I/O Handler passes a 16-bit control word named ECMODE_IN to the encoder. ECMODE_IN is used to control various encoder features. Features set by ECMODE_IN will override the state as set by the corresponding hardware configuration pins. Each bit of ECMODE_IN is summarized in Table 13 ECMODE_IN Flags:

Bit Number	Bit Name	Bit Description	Initial Value
0 (LSB)	Reserved.0	Reserved	0 at reset
1	Reserved.1	Reserved	0 at reset
2	Reserved.2	Reserved	0 at reset
3	Reserved.3	Reserved	0 at reset
4	Reserved.4	Reserved	0 at reset
5	Reserved.5	Reserved	0 at reset
6	NS_ENABLE	Noise Suppressor Enable. If this bit is set the noise suppressor is enabled, otherwise the noise suppressor is disabled.	After reset, this bit is initialized using the setting from the NS_ENABLE pin.
7	CP_SELECT	Compand Select. If companding is enabled and CP_SELECT=0, then µ-law companding is selected. If companding is enabled, and CP_SELECT=1 then a-law companding is selected. If companding is not enabled, then this bit has no effect.	After reset, this bit is initialized using the setting from the CP_SELECT pin.
8	CP_ENABLE	Compand Enable If CP_ENABLE=1, then companding is enabled (either a-law or u-law, depending on the setting of CP_SELECT). If CP_ENABLE=0, then companding is disabled and all speech samples are 16-bit linear.	After reset, this bit is initialized using the setting from the CP_ENABLE pin.
9	ES_ENABLE	Echo suppressor Enable. If ES_ENABLE=1, the echo suppressor is enabled, otherwise the echo suppressor is disabled.	After reset, this bit is initialized using the setting from the ES_ENABLE pin.
10	Reserved.10	Reserved	0 at reset
11	DTX_ENABLE	Discontinuous Transmission Enable. If DTX_ENABLE=1, then the encoder outputs a special silence frame whenever silence is detected. If DTX_ENABLE=0, then the encoder does not output special silence frames when silence is detected.	After reset, this bit is initialized using the setting from the DTX_ENABLE pin.
12	TD_ENABLE	Tone Detect Enable. If TD_ENABLE=1, then tone detection is enabled, otherwise tone detection is disabled.	This bit is initialized to 1 (tone detection enabled) at reset.
13	EC_ENABLE	Echo Canceller Enable. If EC_ENABLE=1, then the echo canceller is enabled, otherwise the echo canceller is disabled.	After reset, this bit is initialized using the setting from the EC_ENABLE pin.
14	TS_ENABLE	Tone Send Enable. If TS_ENABLE=1, then the encoder produces a tone frame in place of the frame that it would normally produce.	This bit is initialized to 0 at reset.

15 (MSB)	Reserved.15	Reserved	0 at reset.

Table 13 ECMODE_IN Flags

ECMODE_IN is initialized at reset as determined by various configuration pins. It is also possible to directly specify the value for ECMODE_IN by sending a PKT_ECMODE field within a configuration control packet prior to starting up the codec interface or running the encoder. In addition, it is possible to specify ECMODE_IN every 20 ms by passing the value in every packet (or selected packets). Note that ECMODE_IN will retain its value until it is changed.

The encoder produces channel data for every 20 ms frame. The I/O handler places the channel data into an outgoing channel packet. The encoder also outputs a 16-bit status word named ECMODE_OUT, for each 20 ms frame. The ECMODE_OUT flags are as specified in the following Table 14 ECMODE_OUT FLAGS

Note: **ECMODE_IN will retain its value until it is changed.**

Bit Number	Bit Name	Bit description
0	Reserved.0	Reserved
1	VOICE_ACTIVE	If DTX is enabled, via the DTX_ENABLE bit of ECMODE_IN, then the encoder sets VOICE_ACTIVE=1 if the channel data for that frame must be transmitted. For frames which do not need to be transmitted, the encoder sets VOICE_ACTIVE=0. Note that when VOICE_ACTIVE=0, the encoder still produces a frame of channel data which may be transmitted if desired.
2-14	Reserved.2-Reserved.14	
15	TONE_FRAME	The encoder sets this bit if the output frame contains either a single frequency tone, a DTMF tone, a KNOX tone, or a call progress tone.

Table 14 ECMODE_OUT FLAGS

By default, the ECMODE_OUT flags are not output within the channel packets. If access to the flags is needed, it is possible to configure the AMBE-3000F™ Vocoder Chip so that it will output the ECMODE_OUT flags in every channel packet that is output or only when the ECMODE_OUT flags change. The PKT_CHANFMT field within a configuration control packet is used to specify when/if the ECMODE_OUT flags are output.

For each 20 ms frame, the I/O handler also passes a 16-bit control word named DCMODE_IN to the decoder. DCMODE_IN is used to control various decoder features. Each bit of DCMODE_IN is summarized in Table 15 DCMODE_IN Flags. DCMODE_IN is initialized at reset as determined by various configuration pins. It is also possible to directly specify the value for DCMODE_IN by sending a PKT_DCMODE field within a configuration control packet prior to starting up the codec interface or running the decoder. In addition, it is possible to specify DCMODE_IN every 20 ms by passing the value in every packet (or selected packets). Features set by DCMODE_IN will override the state as set by the corresponding hardware configuration pins.

Note: **DCMODE_IN will retain its value until it is changed.**

Bit Number	Bit Name	Bit Description	Initial Value
0	Reserved.0		
1	Reserved.1		
2	LOST_FRAME	Frame repeat enable. If LOST_FRAME=1, then the Decoder ignores any channel data provided to it and performs a frame repeat.	0 at reset.

3	CNI_FRAME	Comfort Noise Insertion Enable. If CNI_FRAME=1, then the Decoder ignores any channel data provided to it and inserts comfort noise using the latest silence frame that was received by the decoder. (or the default silence frame if no silence frames have been received yet).	0 at reset.
4-6	Reserved.4-Reserved.6		
7	CP_SELECT	Compand Select. If companding is enabled and CP_SELECT=0, then u-law companding is selected. If companding is enabled, and CP_SELECT=1 then a-law companding is selected. If companding is not enabled, then this bit has no effect.	After reset, this bit is initialized using the setting from the CP_SELECT pin.
8	CP_ENABLE	Compand Enable If CP_ENABLE=1, then companding is enabled (either a-law or u-law, depending on the setting of CP_SELECT). If CP_ENABLE=0, then companding is disabled and all speech samples are 16-bit linear.	After reset, this bit is initialized using the setting from the CP_ENABLE pin.
9-13	Reserved.9-Reserved.13		
14	TS_ENABLE	Tone Synthesis Enable. If TS_ENABLE=1, then the Decoder ignores any channel data provided to it and synthesizes the specified tone.	0 at reset.
15	Reserved.15		

Table 15 DCMODE_IN Flags

The I/O handler also passes a frame of channel data, if available, to the decoder once every 20 ms. The decoder produces 160±4 speech samples for every 20 ms frame. In addition to outputting speech samples for each 20 ms frame, the decoder outputs a 16-bit status word named DCMODE_OUT. The DCMODE_OUT flags are as specified in Table 16 DCMODE_OUT Flags. If the I/O handler does not have a frame of channel data to pass to the decoder at the scheduled time, then the I/O Handler forces the decoder to perform a frame repeat by setting the appropriate bit in DCMODE_IN for that frame only.

Bit Number	Bit Name	Bit description
0	Reserved.0	Reserved
1	VOICE_ACTIVE	The decoder sets VOICE_ACTIVE=1 if the decoder synthesized a voice frame or a tone frame. If the decoder synthesized a comfort noise frame, then it sets VOICE_ACTIVE=0. The decoder can synthesize comfort noise in the following circumstances: (a) a comfort noise frame (silence frame) was received by the decoder. (b) The decoder FEC (if enabled) found too many errors. (c) more than 2 consecutive frame repeats were requested.
2-4	Reserved.2-Reserved.4	
5	DATA_INVALID	The decoder sets this bit whenever it performs a frame repeat. It also sets this bit if it inserted comfort noise due to channel errors or missing frames. The decoder will set DATA_INVALID=0 if it received a valid (voice, silence, or tone frame).
6-14	Reserved.6-Reserved.14	
15	TONE_FRAME	The decoder sets this bit whenever it decodes a tone frame.

Table 16 DCMODE_OUT Flags

5.1 Operating Modes Introduction

There are two modes (codec mode and packet mode) for the AMBE-3000F™ vocoder chip. Both modes can take advantage of the variety of interfaces available.

A good technique for smooth operation and data transfer is to design the system so that the AMBE-3000™ Vocoder Chip boots into Packet Mode on start-up. This will allow the AMBE-3000™ Vocoder Chip to be sitting idle and ready to receive configuration packets, independent of the channel interface being used. The user can then configure the AMBE-3000™ Vocoder Chip as needed. This method is beneficial because it puts the chip in a known state until it is ready to be utilized. Figure 19 Switching between Packet and Codec Modes shows a flow chart of the events needed to switch between the two modes.

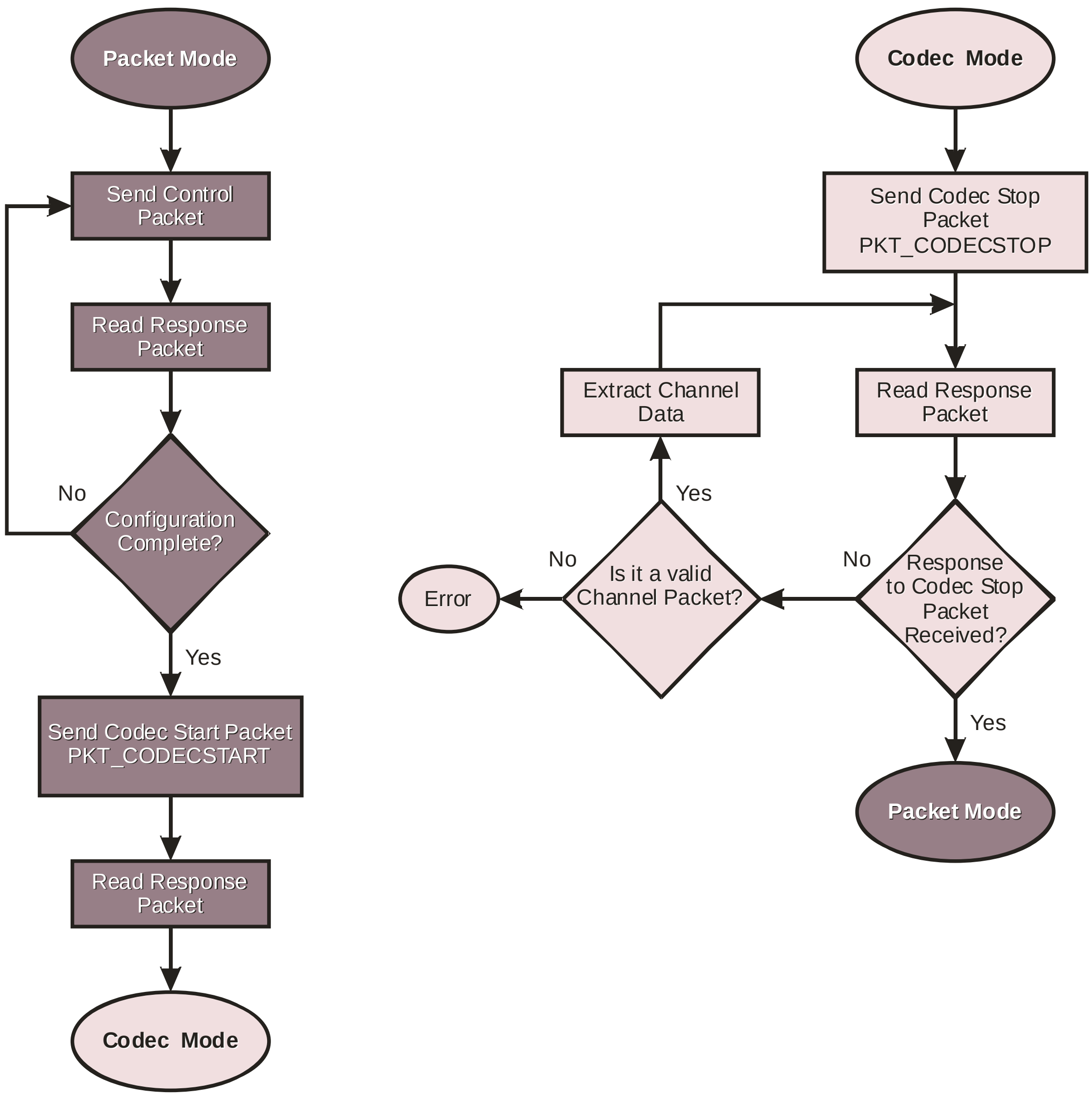


Figure 19 Switching between Packet and Codec Modes

5.2 Codec mode

In codec mode the speech data I/O (to/from codec) is a serial stream of samples that uses either the SPI or the McBSP interface and the channel data is configured into data packets that are sent across either the UART, parallel port, or McBSP (when not used as the codec interface). When using codec mode, the speech and channel data use separate interfaces. Packets containing channel data are sent and received every 20 ms.

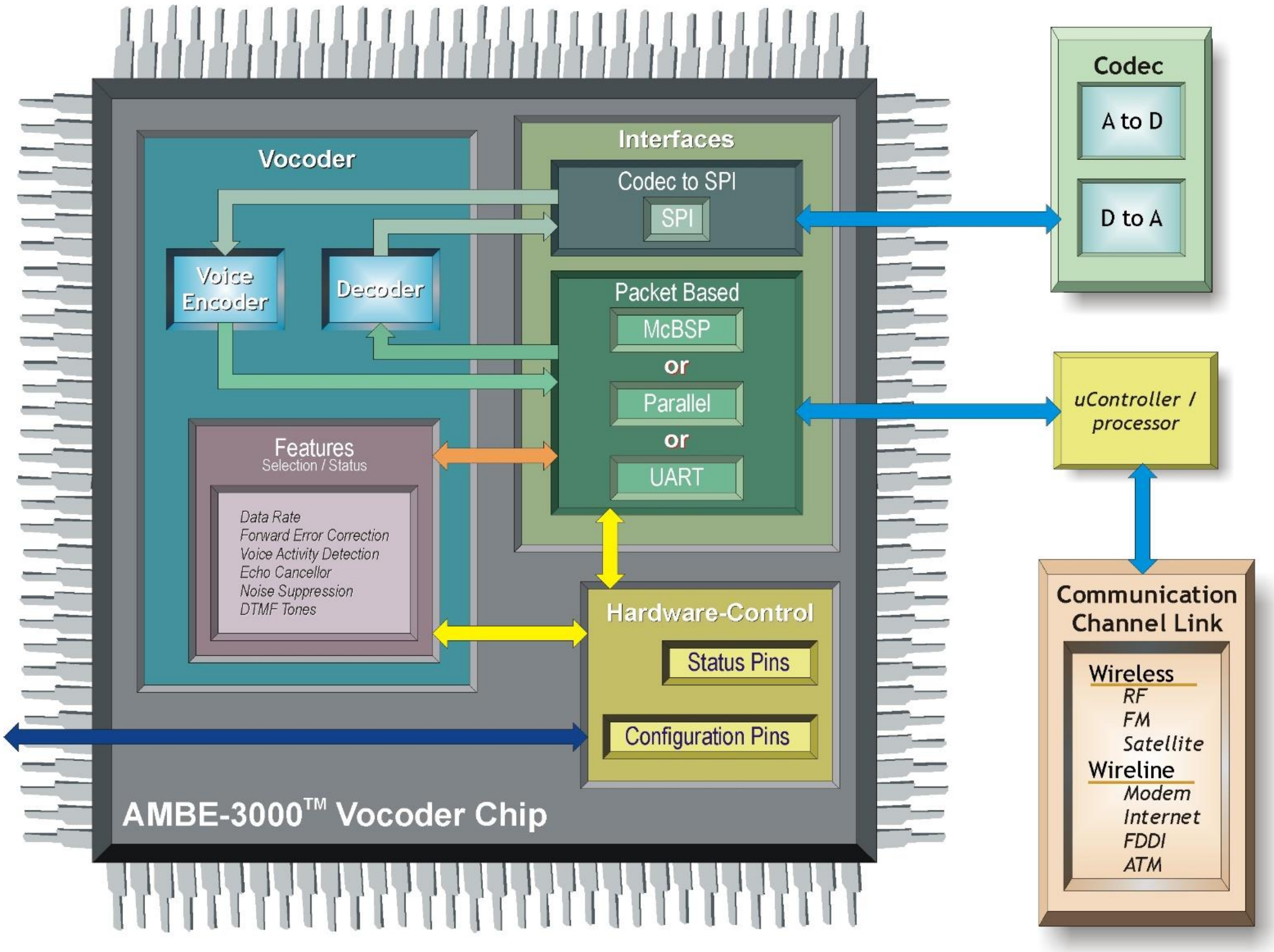


Figure 20 Codec Mode (SPI Interface)

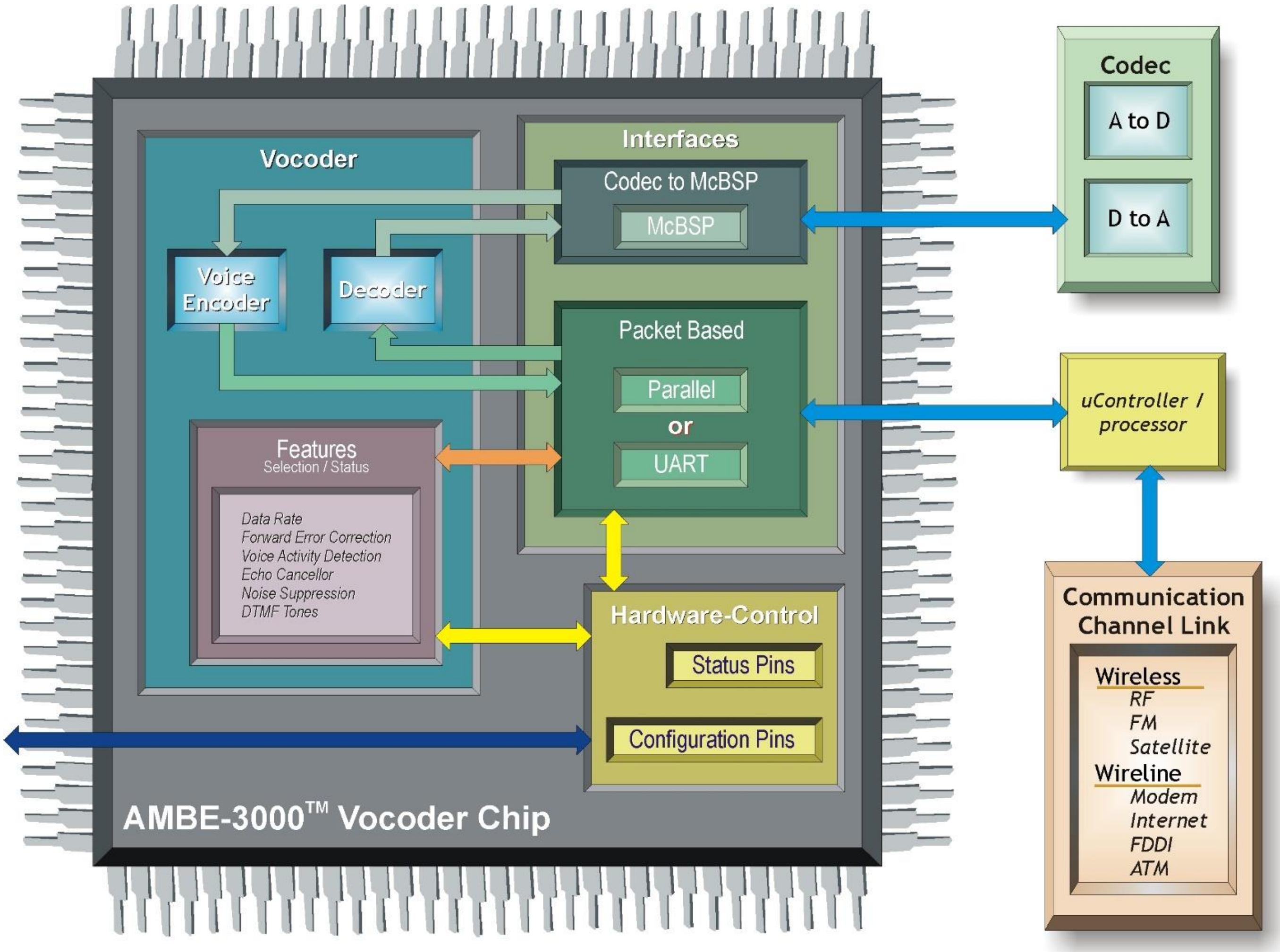


Figure 21 Codec Mode (McBSP Interface)

5.2.1 Timing of channel transmit packets in Codec Mode

When Skew Control is not used

The AMBE-3000™ vocoder chip outputs one packet per 20 ms. TX_RDY goes high once every 20 ms.

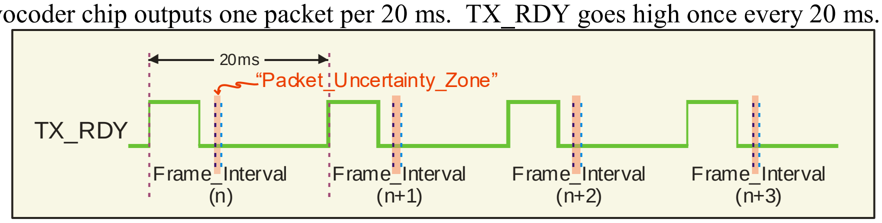


Figure 22 TX_RDY with Skew Control Off

When Skew Control is used

The AMBE-3000™ vocoder chip outputs one packet per each TX_RQST 0 to 1 transition. TX_RDY goes high approximately 5.625 ms after TX_RQST 0 to 1 transition. TX_RDY goes high once every 20 ms.

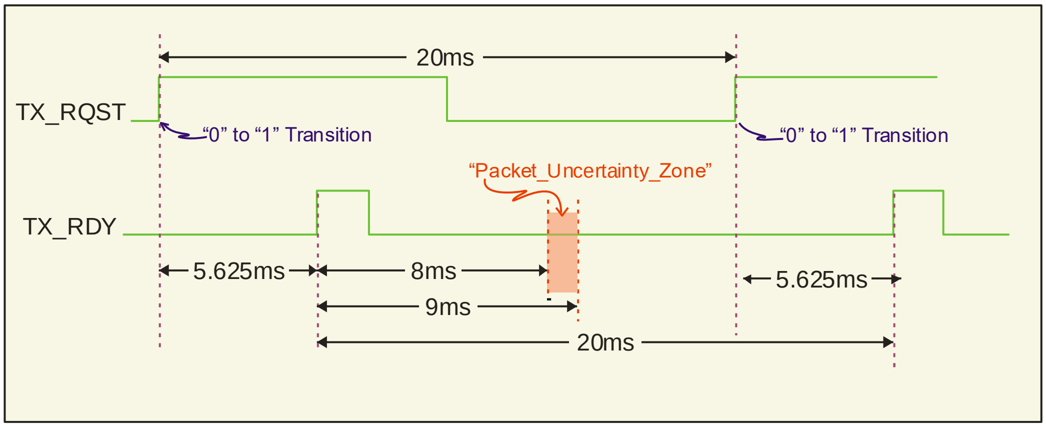


Figure 23 TX_RDY with Skew Control On

5.2.2 Timing of channel receive packets in Codec Mode

In general, every time the AMBE-3000™ vocoder chip transmits a packet it should also receive a packet.

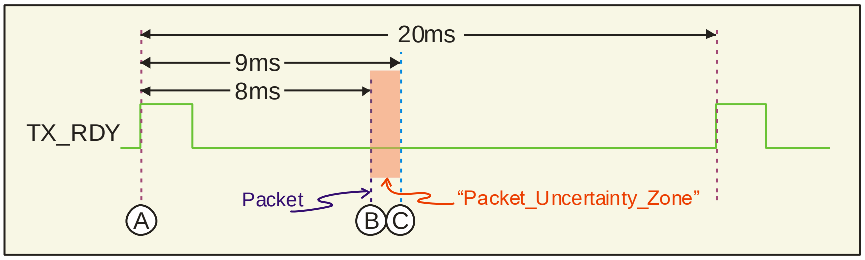


Figure 24 TX_RDY Timing

At time "A" the AMBE-3000™ Vocoder Chip sets TX_RDY high

When using the PPT packet interface
the reading of a packet from the PPT can begin.

When using the UART or MCBSP packet interface
the AMBE-3000™ Vocoder Chip will begin transmitting a channel packet.

During each 20 ms frame interval as indicated by the TX_RDY signal, the decoder should receive exactly one packet. Between time "B" and "C" (the "Packet_Uncertainty_Zone") the vocoder should not receive any channel packets.

The following figure illustrates the simplest way to send packets to the AMBE-3000™ Vocoder Chip

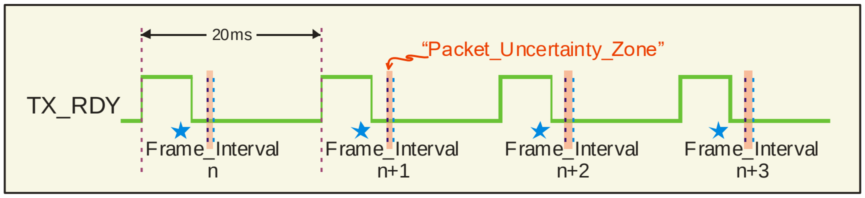


Figure 25 TX_RDY Frame Interval

In the above figure packets are transmitted to the AMBE-3000™ Vocoder Chip with a fixed-period of 20 ms. The AMBE-3000™ Vocoder Chip must receive exactly one channel packet per frame period and the "Packet_Uncertainty_Zone" should be avoided.

The following figure shows some examples of packet timing that are aperiodic

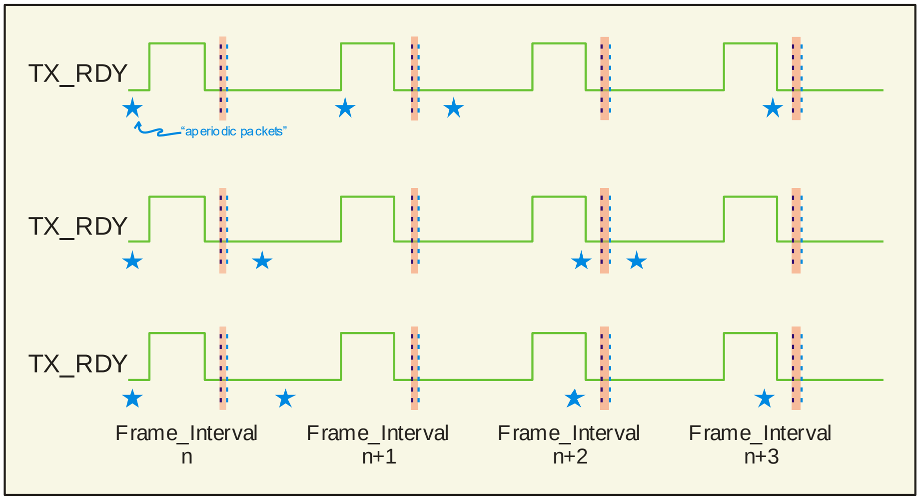


Figure 26 TX_RDY Frame interval Examples

When the AMBE-3000™ Vocoder Chip receives a packet during the "Packet_Uncertain_Zone" it is indeterminate which frame interval will be assigned to the packet. If the AMBE-3000™ Vocoder Chip does not receive any packets during a frame interval, then the decoder will fill in the gap by synthesizing a frame of speech using the model parameters from the prior speech frame. This is known as a frame repeat. If two packets are received during a frame interval then the older channel packet will be discarded.

Note that infrequent "erasure frames" and "frame repeats" can be acceptable in a system and may be a suitable way to account for differences in the transmit and receive clocks.

Note that the frame intervals are defined relative to TX_RDY which is assumed to be synchronous with transmitted frames.

5.2.3 I/O Handler in Codec Mode

When the AMBE-3000F™ Vocoder Chip is in codec mode, speech samples are received and transmitted via the codec interface. In codec mode, the schedule for the encoder is based upon the codec clock or the TXRQST signal, if skew control is enabled.

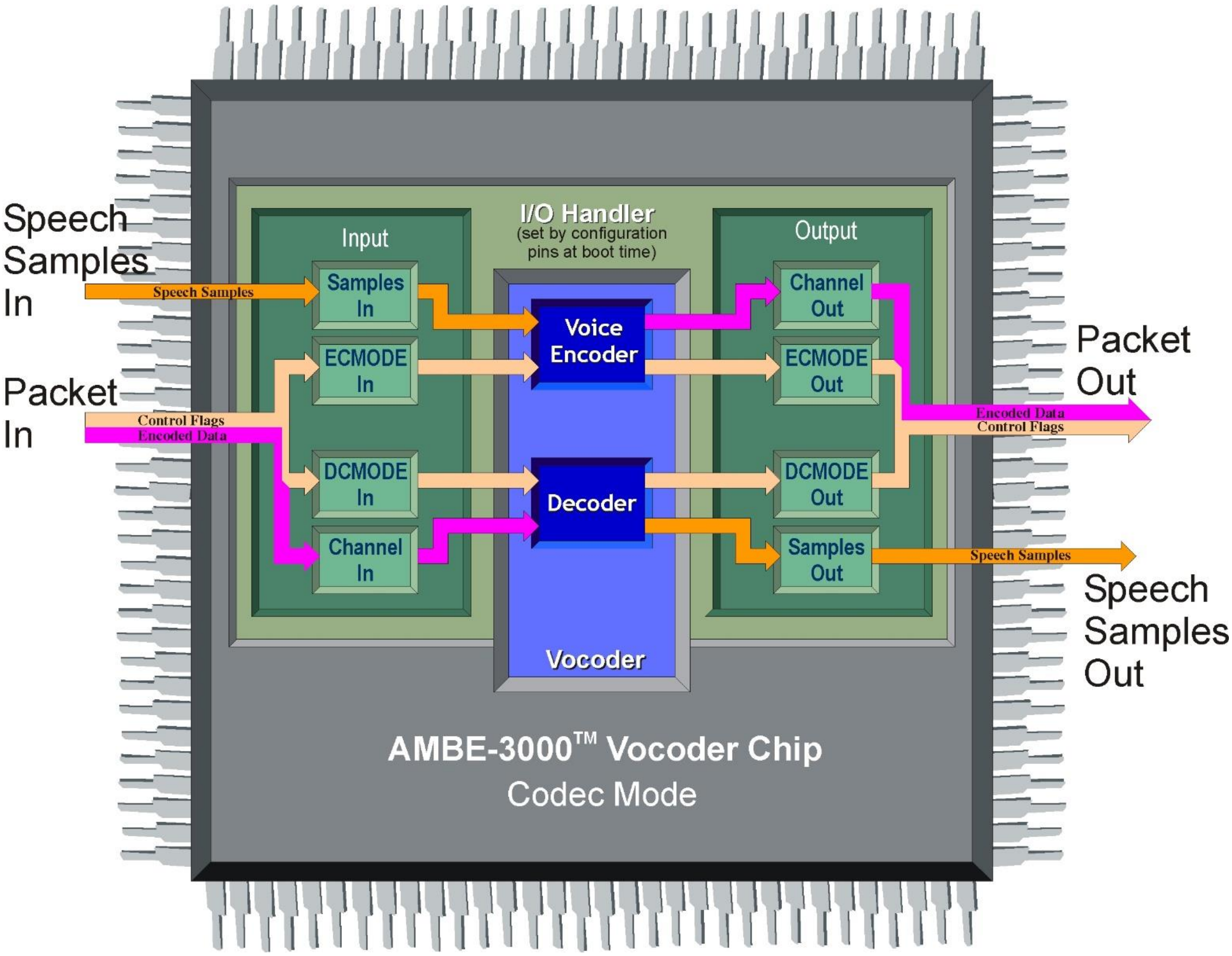


Figure 27 Interface BLOCK Diagram Codec Mode

For codec mode, DCMODE_OUT can be output within every outgoing channel packet. By default, outgoing channel packets do not contain DCMODE_OUT flags. The PKT_CHANFMT field used within a configuration control packet can be used to tell the I/O handler to put DCMODE_OUT flags into subsequent outgoing channel packets.

5.3 Packet Mode

In packet mode, the speech and channel data use the same interface (either UART, parallel port, or McBSP serial port). All of the speech and channel data to/from the AMBE-3000F™ Vocoder Chip is formatted into packets. It is the responsibility of the designed system to extract the speech/channel data from these packets in order to pass the information to/from the codec/channel interface.

The AMBE-3000F™ Vocoder Chip sends a packet in response to every packet received. When a control packet is received it will respond with a control response packet. When a speech packet is received the AMBE-3000F™ Vocoder Chip responds with a channel packet. When a channel packet is received it responds with a speech packet.

5.3.1 I/O Handler In Packet Mode

When the AMBE-3000F™ Vocoder Chip is in packet mode speech samples are received and transmitted via the packet interface. In packet mode, the encoder is scheduled whenever the I/O handler receives a speech packet and the decoder is scheduled each time a channel packet is received. In packet mode, multiple packets may be in the packet queue. The encoder is scheduled when a speech packet is taken off the queue and the decoder is scheduled when a channel packet is taken off the queue. Note that packets are taken off the queue in the order that they were received.

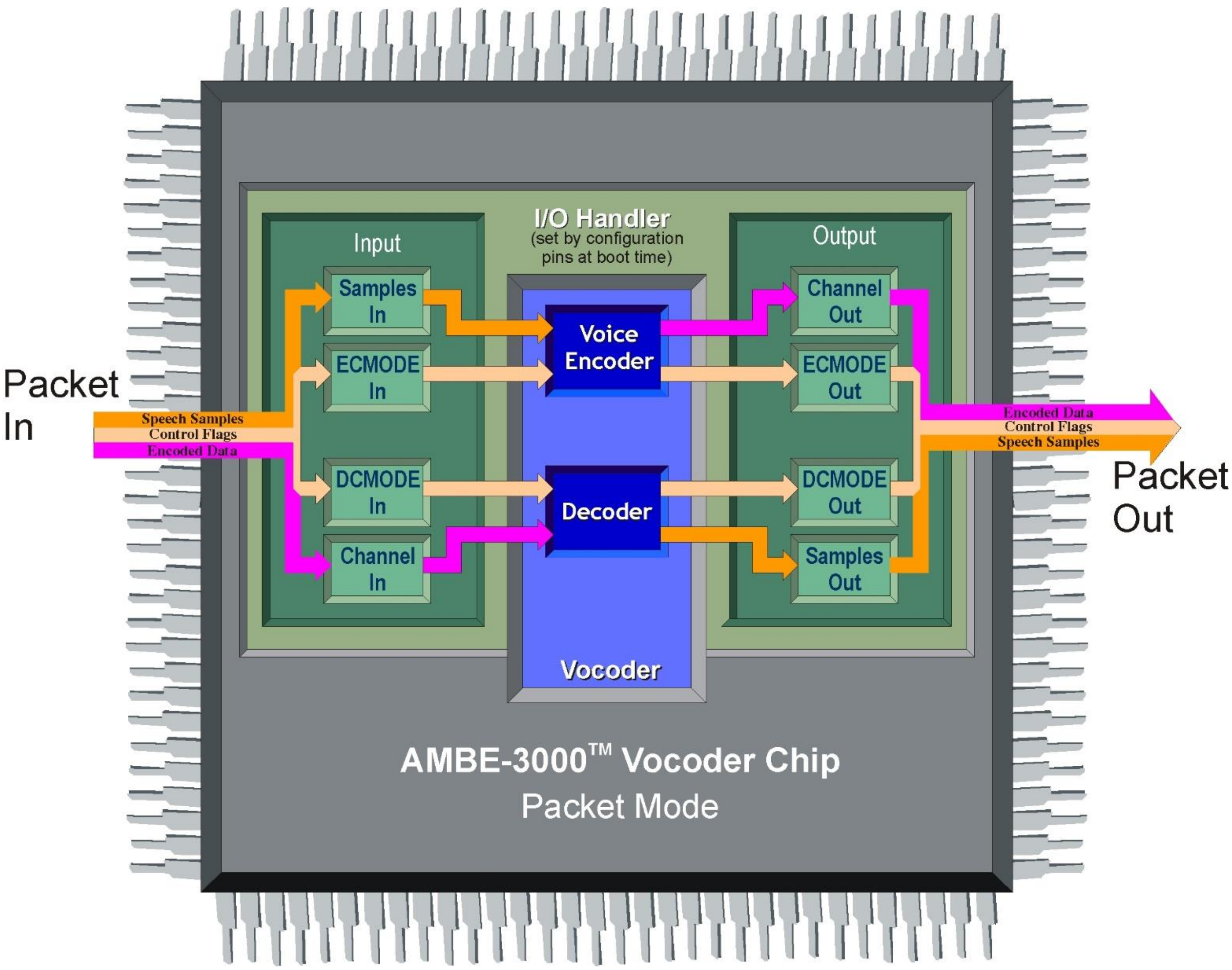


Figure 28 Interface Block Diagram Packet Mode

For packet mode DCMODE_OUT can be output within PKT_CMODE fields within outgoing speech packets. By default, speech packets do not contain PKT_CMODE fields, but the PKT_SPEECHFMT field used within a configuration control packet, can be used to tell the I/O handler to put DCMODE_OUT flags into subsequent outgoing speech packets. For packet mode, the I/O handler outputs the speech samples using a PKT_SPEECHD field within an outgoing speech packet.

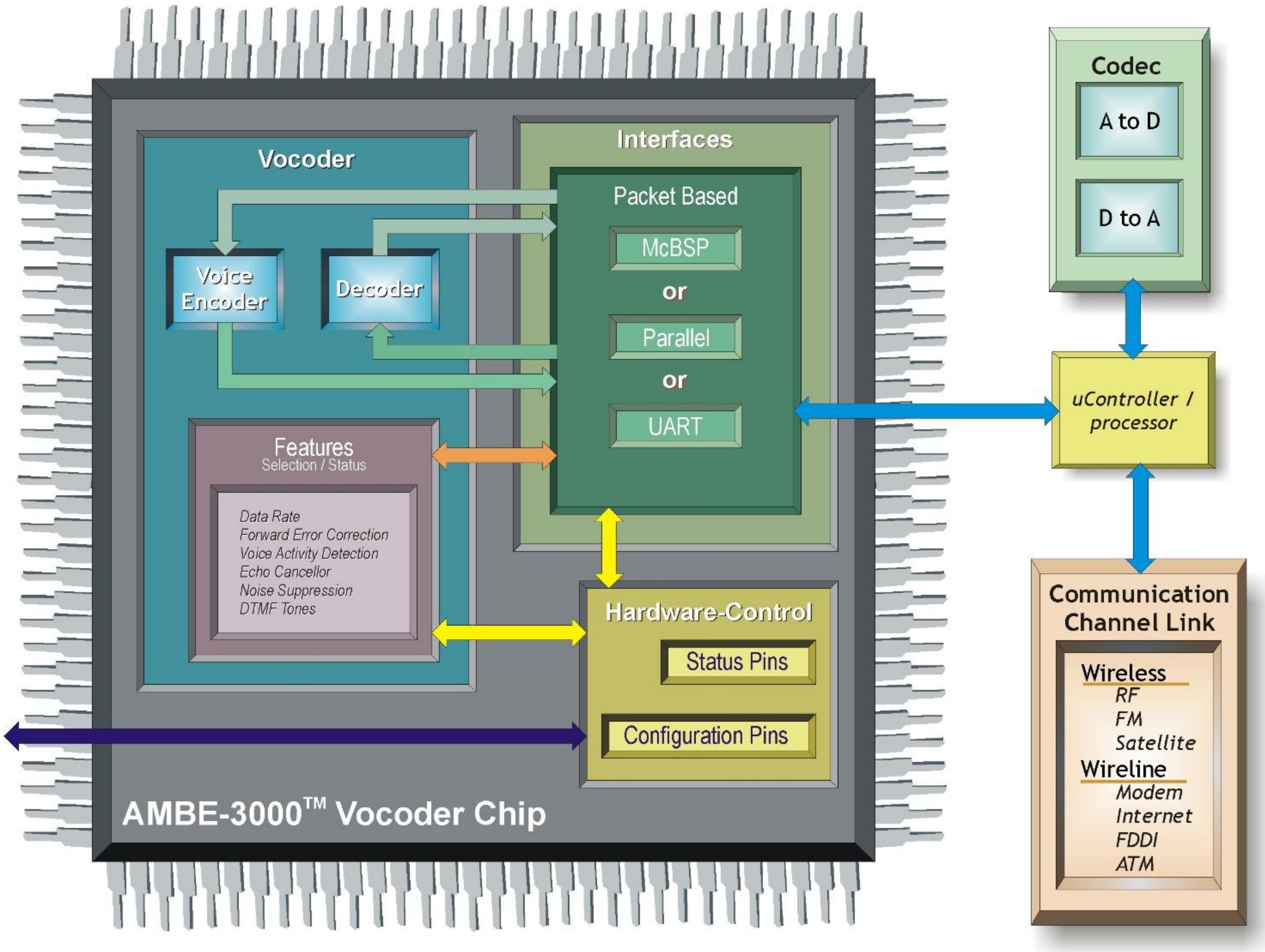


Figure 29 Packet Mode

Received packets are placed into a queue and response packets are generated in the order that the packets were received. If the AMBE-3000F™ Vocoder Chip stops receiving packets, then it will stop sending packets after responding to the final packet received.

5.4 Switching between codec mode and packet mode using packets

Upon boot up or after a reset the AMBE-3000F™ Vocoder Chip is set to the mode (either codec mode or packet mode) corresponding to the interface configuration pins (see Table 9 Physical Interface Selection). Switching the AMBE-3000F™ Vocoder Chip from packet mode into codec mode or from codec mode into packet mode can be done through software using configuration packets. The user can switch the AMBE-3000F™ Vocoder Chip between modes at any time using control packets. (See Section Data and Configuration Packets)

To switch the AMBE-3000F™ Vocoder Chip from packet mode into codec mode using packets, a control packet with the field identifier of 0x2A "PKT_STARTCODEC" (See Section Data and Configuration Packets) must be sent to the AMBE-30000™ Vocoder Chip. The data byte in the PKT_START CODEC packet selects either SPI or McBSP for the codec interface. When the AMBE-3000F™ Vocoder Chip is in codec mode it outputs channel packets automatically, once every 20 ms. It also expects to receive a channel packet once every 20 ms. All timing is relative to the codec clock

To switch the AMBE-3000F™ Vocoder Chip from codec mode into packet mode using packets, a control packet with the field identifier of 0x2B "PKT_CODECSTOP" (See Table 59 PKT_CODECSTOP Field) must be sent to the AMBE-30000™

Vocoder Chip. When in packet mode the AMBE-3000F™ Vocoder Chip no longer outputs channel packets automatically every 20 ms and the codec interface is inactive.

5.5 SPI Interface

The serial peripheral interface (SPI) is a high-speed, synchronous serial I/O port that can be used as the speech interface to the codec. This interface allows a serial bit stream to be transferred between the AMBE-3000F™ Vocoder Chip and an audio codec. The interface includes four-pins. The SPI interface is designed for speech data only and may be used only in codec mode.

Pin		Pin Name	Direction	Description
TQFP	BGA			
27	K2	SPI_CLK	Input	A/D Serial clock.
28	K4	SPI_STE	Input	The framing signal generated from SPI_GENSTE.
31	M1	SPI_RX_DATA	Input	PCM Data from A/D Converter to AMBE-3000F™ Vocoder Chip
32	N1	SPI_TX_DATA	Output	PCM Data from AMBE-3000F™ Vocoder Chip to D/A Converter

Table 17 SPI Interface Pins

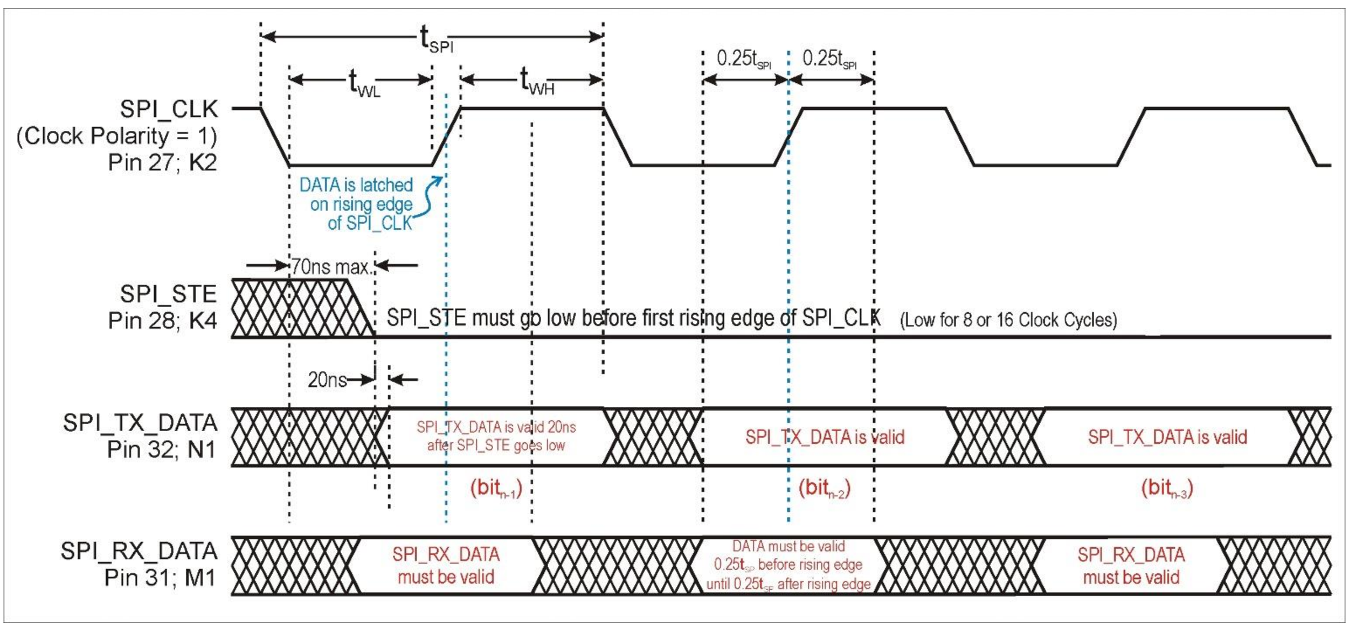


Figure 30 SPI Timing

The SPI_STE signal is asserted low at least 136 ns before the valid SPI_CLK edge and remains low for at least 136 ns after the receiving edge of the last data bit.

		MIN	MAX
	SPI_CLK Cycle time (t_{SPI})	272 ns	7.8 µs
	SPI_CLK low Pulse duration (t_{WL})	126 ns	3.9 µs
	SPI_CLK high Pulse duration (t_{WH})	126 ns	3.9 µs

Table 18 SPI Timing

The AMBE-3000F™ Vocoder Chip can generate the signal SPI_GENSTE from signals SPI_FSn and SPI_CLK_IN. See Figure 31 Timing of SPI_GENSTE for the timing relationship between these signals.

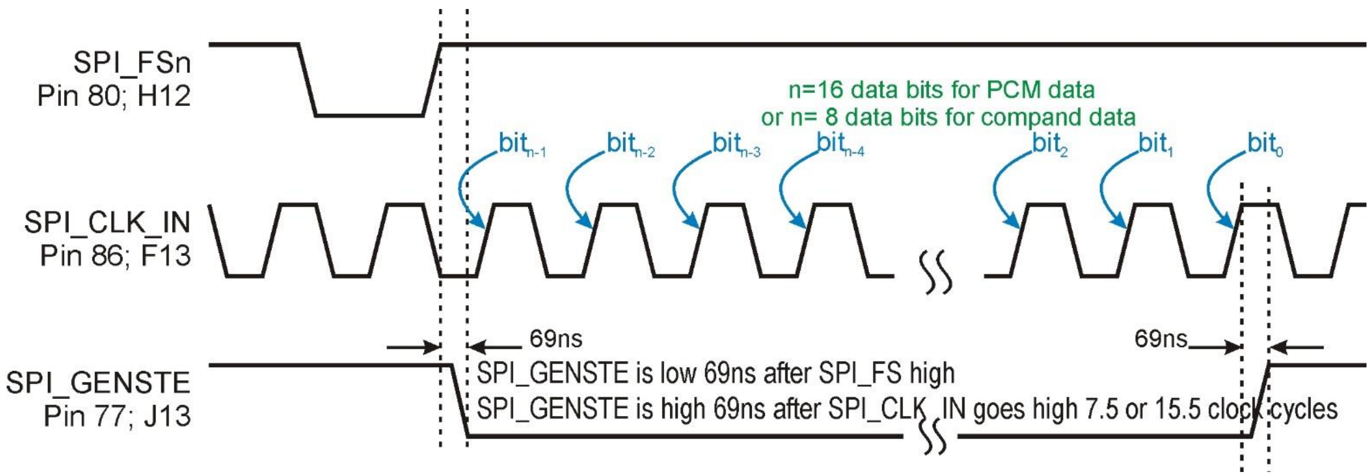


Figure 31 Timing of SPI_GENSTE

5.6 UART Interface

The serial interface supports asynchronous communication of real-time compressed voice data to other asynchronous peripherals that use the standard non-return-to-zero (NRZ) format. The UART interface is designed for packet data only. If the UART interface is used when running in codec mode the interface provides only channel data. If the UART interface is used when running in packet mode the UART provides both speech data and channel data.

When UART interface is used for the packet interface neither the McBSP nor the parallel interface can be used.

Pin		Pin Name	Direction	Description
TQFP	BGA			
111	C7	UART_TX	Output	UART Transmit Data
112	A7	UART_RX	Input	UART Receive Data

Table 19 UART Interface Pins

The AMBE-3000F™ Vocoder Chip transmits packets using pin UART_TX and receives packets using pin UART _RX. Each serial word transmitted or received uses 8 data bits, no parity bits, and one stop bit. The serial port operates at baud rates from 28800 up to 460,800 baud. See Table 20 UART Baud Rates for available rates and configuration.

Baud Rate (baud)	S_COM_RATE2 TQFP Pin 91 BGA Pin F10	S_COM_RATE1 TQFP Pin 90 BGA Pin E11	S_COM_RATE0 TQFP Pin 89 BGA Pin E13
28,800	0	0	0
57,600	0	0	1

115,200	0	1	0
230,400	0	1	1
460,800	1	0	0

Table 20 UART Baud Rates

5.6.1 UART_TX Pin State

When designing a system using the UART interface on the AMBE-3000™ Vocoder Chip it is necessary that the UART_TX pin (pin 111 QFP – pin C7 BGA) be held high at boot. This will ensure the AMBE-3000™ Vocoder Chip will start in the proper configuration. If the UART is not used in your design it can be left unconnected (there is an internal pull up resistor).

5.7 McBSP Interface

The Multichannel Buffered Serial Port (McBSP) is a synchronous serial communication port. The beginning of a word of data is indicated by a frame signal. The receive frame signal and receive clock are inputs and must be generated by the device interfacing to the AMBE-3000F™ Vocoder Chip. The McBSP interface can be used as either the codec interface or the packet interface. When the McBSP interface is used as the codec interface for speech data it is not available for packet data. When operating as the packet interface the McBSP interface is used for packet data.

Pin		Pin Name	Direction	Description
TQFP	BGA			
18	G2	McBSP_RxD	Input	Serial Receive Data
19	G1	McBSP_TxD	Output	Serial Transmit Data
21	H2	McBSP_CLKR	Input	Serial Receive Clock
22	H4	McBSP_FSX	I/O	Serial Transmit Frame
23	J1	McBSP_CLKX	I/O	Serial Transmit Clock
24	J2	McBSP_FSR	Input	Serial Receive Frame

Table 21 McBSP Interface Pins

5.7.1 McBSP Selected for Codec Interface

If the McBSP is selected as the codec interface and companding is selected there are 8 data bits (In Figure 32 N=8). If companding is not used then there are 16 data bits (In Figure 32 N=16). The bits are order from N-1 to 0, where bit N-1 is the MSB and bit 0 is the LSB. McBSP_RxD is sampled on the rising edge of McBSP_CLKR and McBSP_TxD is sampled on the falling edge of McBSP_CLKR. The signals McBSP_CLKX, McBSP_CLKR, McBSP_FSX and McBSP_FSR are all inputs generated by the codec. McBSP_CLKX and McBSP_CLKR should be connected together. McBSP_FSX and McBSP_FSR should also be connected together.

Note: The higher the frequency of the MCBSP clock the more power consumption is reduced when low-power mode is enabled.

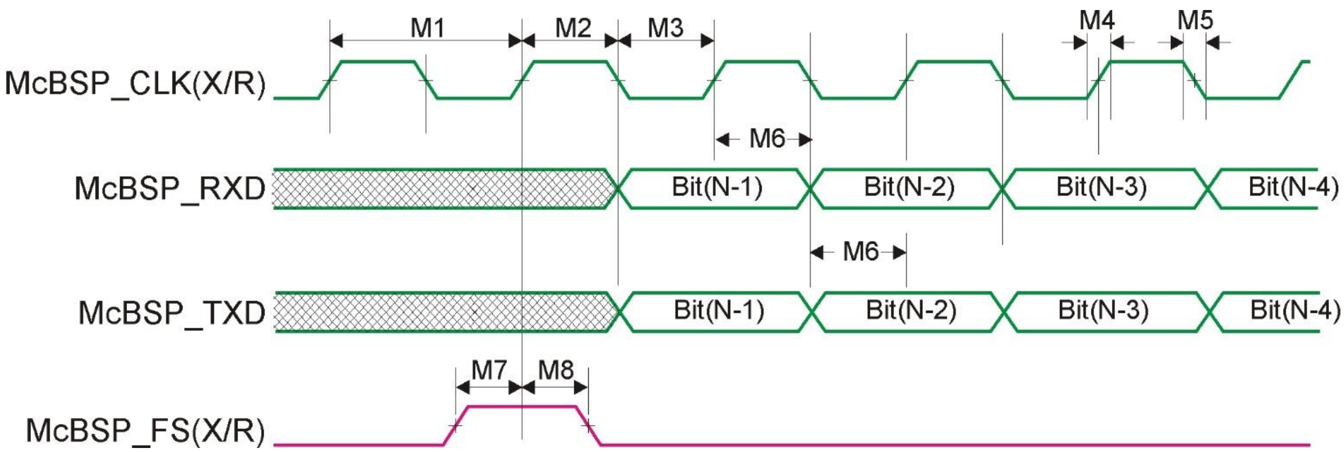


Figure 32 Timing of McBSP When Selected as Codec Interface

No.	Parameter	MIN	MAX	
			N=8	N=16
M1	Cycle time, for McBSP_CLK(X/R)	300 ns	16 µs	8 µs
M2	Pulse duration, for McBSP_CLK(X/R) High	150 ns	8 µs	4 µs
M3	Pulse duration, for McBSP_CLK(X/R) Low	150 ns	8 µs	4 µs
M4	Rise Time, for McBSP_CLK(X/R)		7 ns	
M5	Fall Time, for McBSP_CLK(X/R)		7 ns	
M6	Hold time McBSP_RXD valid after McBSP_CLK(X/R) high	6 ns		
M7	Setup time McBSP_FS(X/R) valid before McBSP_CLK(X/R) high	2 ns		
M8	Hold time McBSP_FS(X/R) high after McBSP_CLK(X/R) high	6 ns		

Table 22 McBSP Codec Interface Timing

5.7.2 McBSP Selected for Packet Interface

If the McBSP is selected for the packet interface, packets are transmitted using data pin McBSP_TXD, clock pin McBSP_CLKX, and framing pin McBSP_FSX. Packets are received using data pin McBSP_RXD, clock pin McBSP_CLKR, and framing pin McBSP_FSR. There are 8 data bits per frame pulse. McBSP_RXD is sampled on the falling edge of McBSP_CLKR and McBSP_TXD is sampled on the rising edge of McBSP_CLKX. McBSP_CLKR and McBSP_FSR are inputs. McBSP_CLKX, McBSP_FSX are outputs. The clock frequency on McBSP_CLKX is determined from S_COM_RATE(2-0) as shown in Table 24 McBSP Clock Rates.

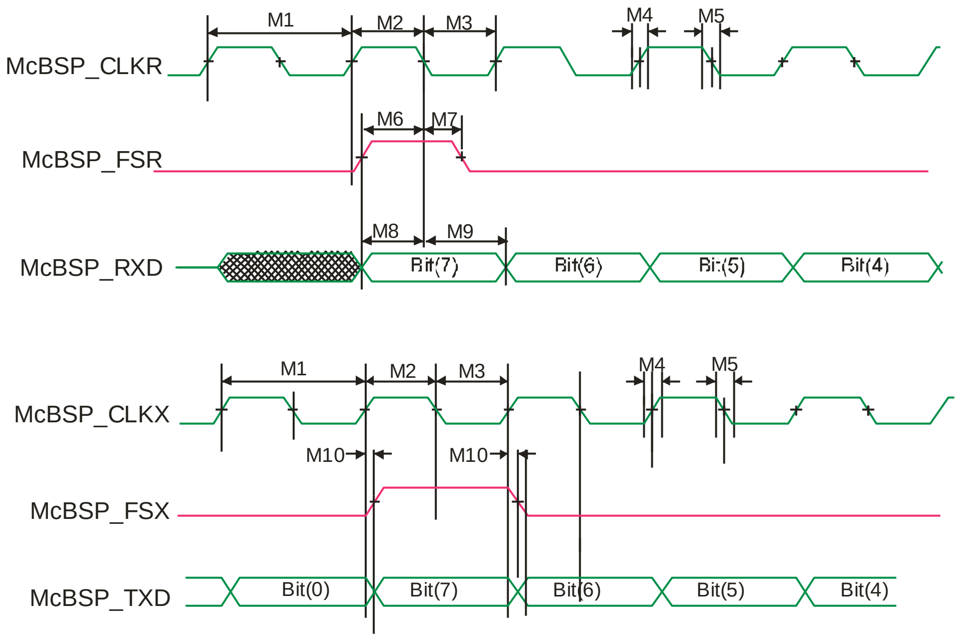


Figure 33 Timing of McBSP when Selected as Packet Interface

No.	Parameter	MIN	MAX
M1	Cycle time, for McBSP_CLKR and McBSP_CLKX	1.085 µs	69.44 µs
M2	Pulse duration, for McBSP_CLKR and McBSP_CLKX High	535.53 ns	34.72µs
M3	Pulse duration, for McBSP_CLKR and McBSP_CLKX Low	535.53 ns	34.72µs
M4	Rise Time, for McBSP_CLKR and McBSP_CLKX		7 ns
M5	Fall Time, for McBSP_CLKR and McBSP_CLKX		7 ns
M6	Set-up Time, for McBSP_FSR high before McBSP_CLKR low	2 ns	
M7	Hold Time, for McBSP_FSR high after McBSP_CLKR low	6 ns	
M8	Setup time McBSP_RXD valid before McBSP_CLKR low	2 ns	
M9	Hold time McBSP_RXD valid after McBSP_CLKR low	6 ns	
M10	Delay time McBSP_CLKX high to McBSP_FSX transission and McBSP_TXD transission	3 ns	27 ns

Table 23 McBSP Packet Interface Timing

Rate	S_COM_RATE2 TQFP Pin 91 BGA Pin F10	S_COM_RATE1 TQFP Pin 90 BGA Pin E11	S_COM_RATE0 TQFP Pin 89 BGA Pin E13
28,800 Hz.	0	0	0
57,600 Hz.	0	0	1
115,200 Hz.	0	1	0
230,400 Hz.	0	1	1

460,800 Hz.	1	0	0
921,600 Hz.	1	0	1

Table 24 McBSP Clock Rates

The McBSP port operates at clock rates from 28,800 up to 921,600 Hz. Note that this specifies the rate at which the packet will be transmitted. The receive clock and frame signals must generated by the device being interfaced to the AMBE-3000F™ Vocoder Chip. The receive clock supplied to the AMBE-3000F™ Vocoder Chip must be between 28,000 Hz. and 921,600 Hz. See Table 24 McBSP Clock Rates for available rates and configuration.

5.8 Parallel Interface

Pin #		Description	Direction	Description
TQFP	BGA			
33	N2	PPT_DATA0	I/O	Parallel Port Transmit/Receive Data
34	P2	PPT_DATA1	I/O	
35	N3	PPT_DATA2	I/O	
36	P3	PPT_DATA3	I/O	
37	L4	PPT_DATA4	I/O	
38	M4	PPT_DATA5	I/O	
40	K5	PPT_DATA6	I/O	
41	N5	PPT_DATA7	I/O	
46	N6	PPT_READ	Input	PPT Read Request (Active Low)
47	L6	PPT_WRITE	Input	PPT Write Request (Active Low)
48	K7	PPT_ACK	Output	PPT Transfer Acknowledge

Table 25 Parallel (PPT) Interface Pins

5.8.1 Parallel Port Packet Interface

The parallel interface runs asynchronously and allows all packet data transfers to be performed on an 8-bit wide bus. The parallel port interface (PPT) requires 11 pins total. When parallel port is used for the packet interface the UART or the McBSP serial interface can not be used. The parallel interface is designed for packet data. This means that in codec mode the parallel interface can be used for channel data only. In packet mode the parallel interface is used for both speech data and channel data as well as control packets.

The AMBE-3000F™ Vocoder Chip will set TX_RDY high when data is available to be read from the parallel port.

The packet data from the AMBE-3000F™ Vocoder Chip is read by setting the pin PPT_READ low, then waiting for the AMBE-3000F™ Vocoder Chip to set PPT_ACK low. After PPT_ACK goes low, the 8 data pins are valid, after the pins are read PPT_READ should be set high. After PPT_READ goes high, the AMBE-3000F™ Vocoder Chip will set PPT_ACK high.

To write packet data to the AMBE-3000F™ Vocoder Chip first the data is transferred to the 8 data pins and then the PPT_WRITE pin must be set low. Then the AMBE-3000F™ Vocoder Chip reads the data from the pins and sets PPT_ACK low. After the AMBE-3000F™ Vocoder Chip sets PPT_ACK low, PPT_WRITE pin must set high, at which time, the AMBE-3000F™ Vocoder Chip will set PPT_ACK high.

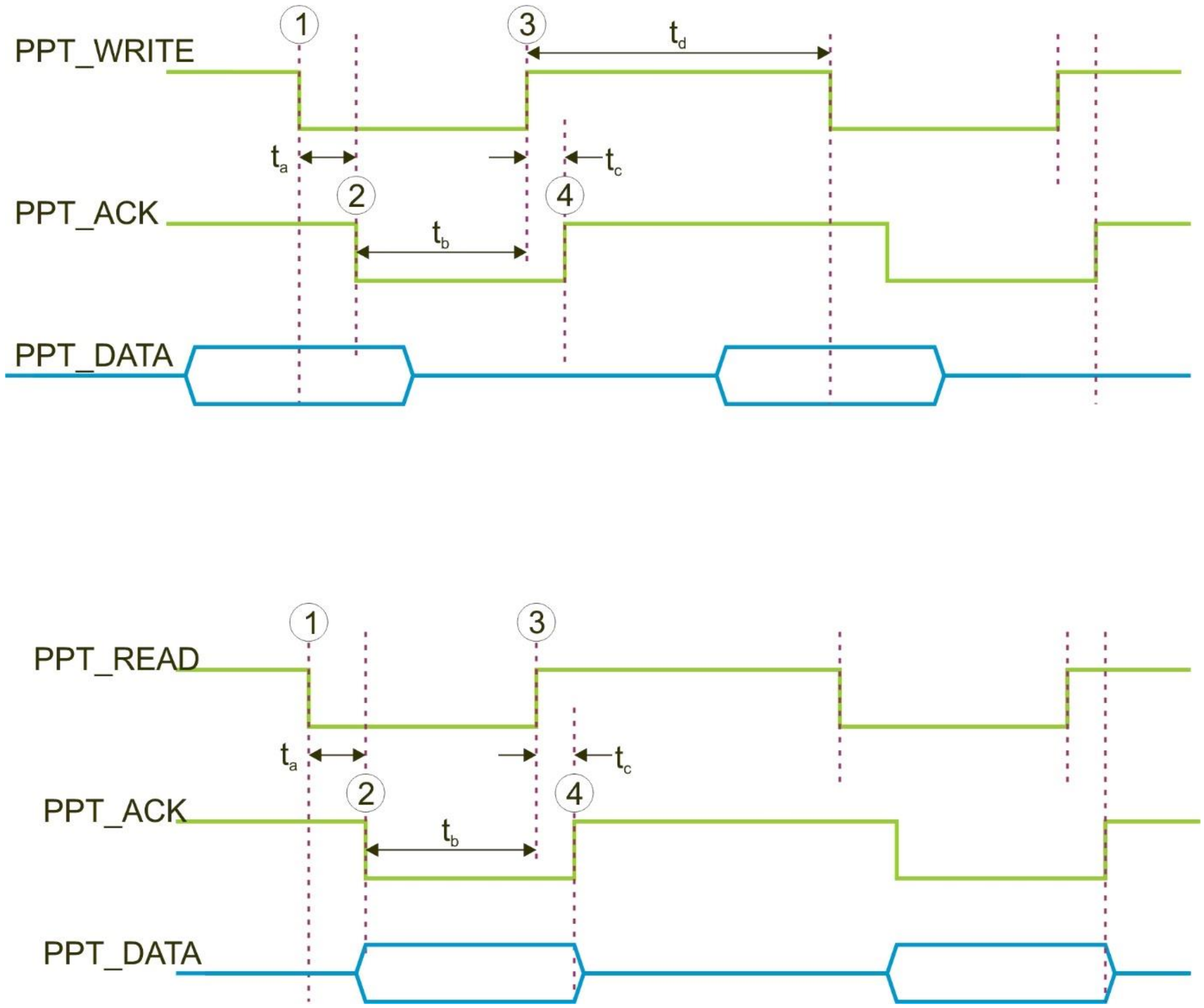


Figure 34 PPT Interface Timing

	PPT Timing
t_a	t_a <= 5 µs (1.12 µs typical)
t_b	System Dependent
t_c	< 320 ns
t_d	850 ns min.

Table 26 PPT Timing

The time between when the AMBE-3000F™ Vocoder Chip sets PPT_ACK Low and the user sets PPT_WRITE high has to be >0. Times $t_a + t_b + t_c$ all determines what the maximum rate is. The lower t_b is the faster the transfer rate. The transfer rate is as follows:
Transfer Rate (bits/sec) = $8 / (t_a + t_b + t_c)$

At time 1 controller sets PPT_READ (PPT_WRITE) low to request to read (write) from the PPT interface.
At time 2 the AMBE-3000F™ Vocoder Chip sets the PPT_ACK low and the PPT_DATA is valid.
At time 3 the controller has read (written) the data and now sets the PPT_READ (PPT_WRITE) high.
At time 4 the AMBE-3000F™ Vocoder Chip sets the PPT_ACK high after the PPT_READ (PPT_WRITE) goes back to high.

For Example: If the designed system uses $t_b < 0.5\mu s$ the parallel port can transfer data, at rates exceeding 4.1 Mbps.

5.9 Codec A/D / D/A Interface

The AMBE-3000F™ Vocoder Chip operates with a speech data sample rate of 8kHz for both the A/D and D/A interfaces. This 8kHz data is input and output using a serial port on the AMBE-3000F™ Vocoder Chip. The user can choose between hardware configuration pins or software control in order to the process of configuring the interface to the A/D-D/A chip.

5.10 Vocoder Front End Requirements

In order to ensure proper performance from the voice coder, it is necessary for the vocoder front end to meet a set of minimum performance requirements. For the purposes of this section the vocoder front end is considered to be the total combined response between microphone/speaker and the digital PCM interface to the vocoder, as shown in Figure 35 Typical Vocoder Implementation. This includes any analog electronics plus the A-to-D and D-to-A converters as well as any digital filtering performed prior to the voice encoder or after the voice decoder.

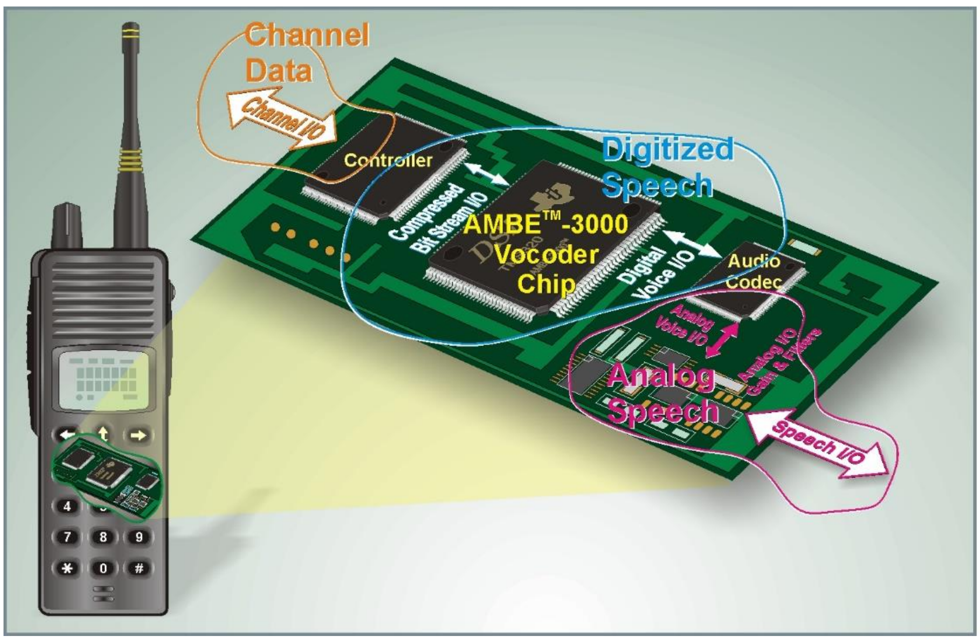


Figure 35 Typical Vocoder Implementation

The AMBE+™ voice encoder and decoder operate with unity (i.e. 0 dB) gain. Consequently the analog input and output gain elements shown in Figure 36 Vocoder Front End are only used to match the sensitivity of the microphone and speaker with the A-to-D converters and D-to-A converters, respectively.

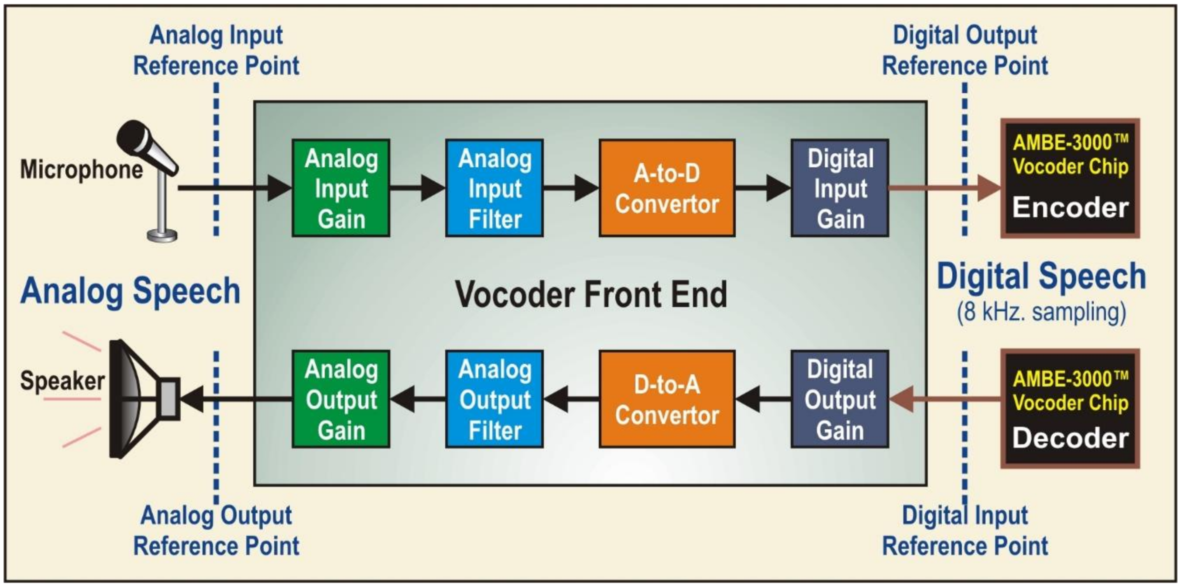


Figure 36 Vocoder Front End

It is recommended that the analog input gain be set such that the RMS speech level under nominal input conditions is 25 dB below the saturation point of the A-to-D converter (+3 dBm0). This level, which equates to -22 dBm0, is designed to provide sufficient margin to prevent the peaks of the speech waveform from being clipped by the A-to-D converter.

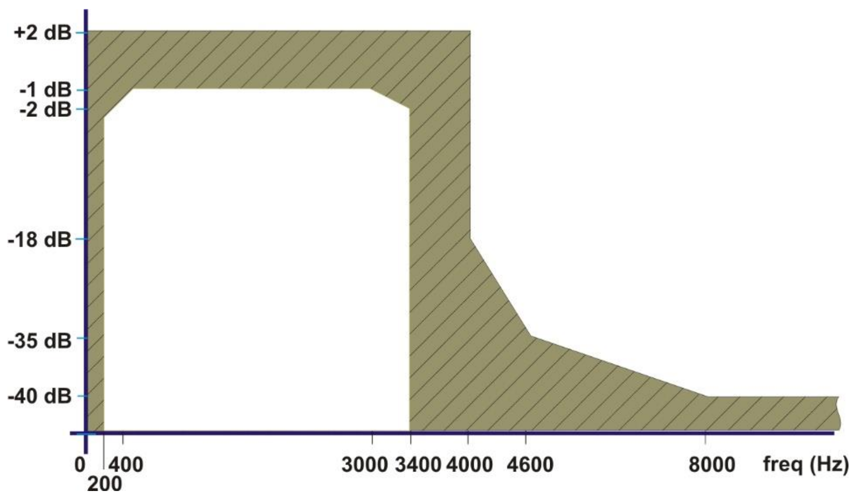


Figure 37 Front End Input Filter Mask

The voice coder interface requires the A-to-D and D-to-A converters to operate at an 8 kHz sampling rate (i.e. a sampling period of 125 microseconds) at the digital input/output reference points. This requirement necessitates the use of analog filters at both the input and output to eliminate any frequency components above the Nyquist frequency (4 kHz). The recommended input filter mask is shown in Figure 37 Front End Input Filter Mask, and the recommended output filter mask is shown in Figure 38 Front End Output Filter Mask. For proper operation, the shaded zone of the respective figure should bound the frequency response of the front-end input and output.

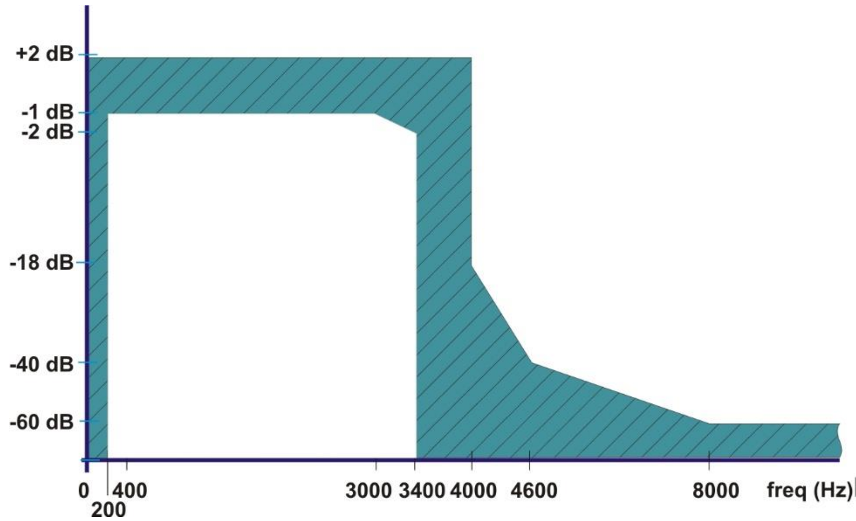


Figure 38 Front End Output Filter Mask

This document assumes that the A-to-D converter produces digital samples where the maximum digital input level (+3 dBm0) is defined to be +/- 32767, and similarly, that the maximum digital output level of the D-to-A converter occurs at the same digital level of +/- 32767. If a converter is used which does not meet these assumptions then the digital gain elements shown in Figure 36 Vocoder Front End should be adjusted appropriately. Note that these assumptions are automatically satisfied if 16 bit linear A-to-D and D-to-A converters are used, in which case the digital gain elements should be set to unity gain.

An additional recommendation addresses the maximum noise level measured at the output reference points shown in Figure 36 Vocoder Front End with the corresponding inputs set to zero. DVSI recommends that the noise level for both directions should not exceed -60 dBm0 with no corresponding input. In addition, the isolation from cross talk (or echo) from the output to the input should exceed 45 dB which can be achieved via either passive (electrical and/or acoustic design) or active (echo cancellation and/or suppression) means.

5.11 Interfacing a codec to the AMBE-3000F™ Vocoder chip

5.11.1 The Texas Instruments General purpose TLV320AIC14

The Texas Instruments' TLV320AIC14 codec presents a simple low cost solution for use with DVSI's AMBE-3000F™ vocoder chip. This example provides information on interfacing theTLV320AIC14 to the AMBE-3000F™ Vocoder chip SPI interface.

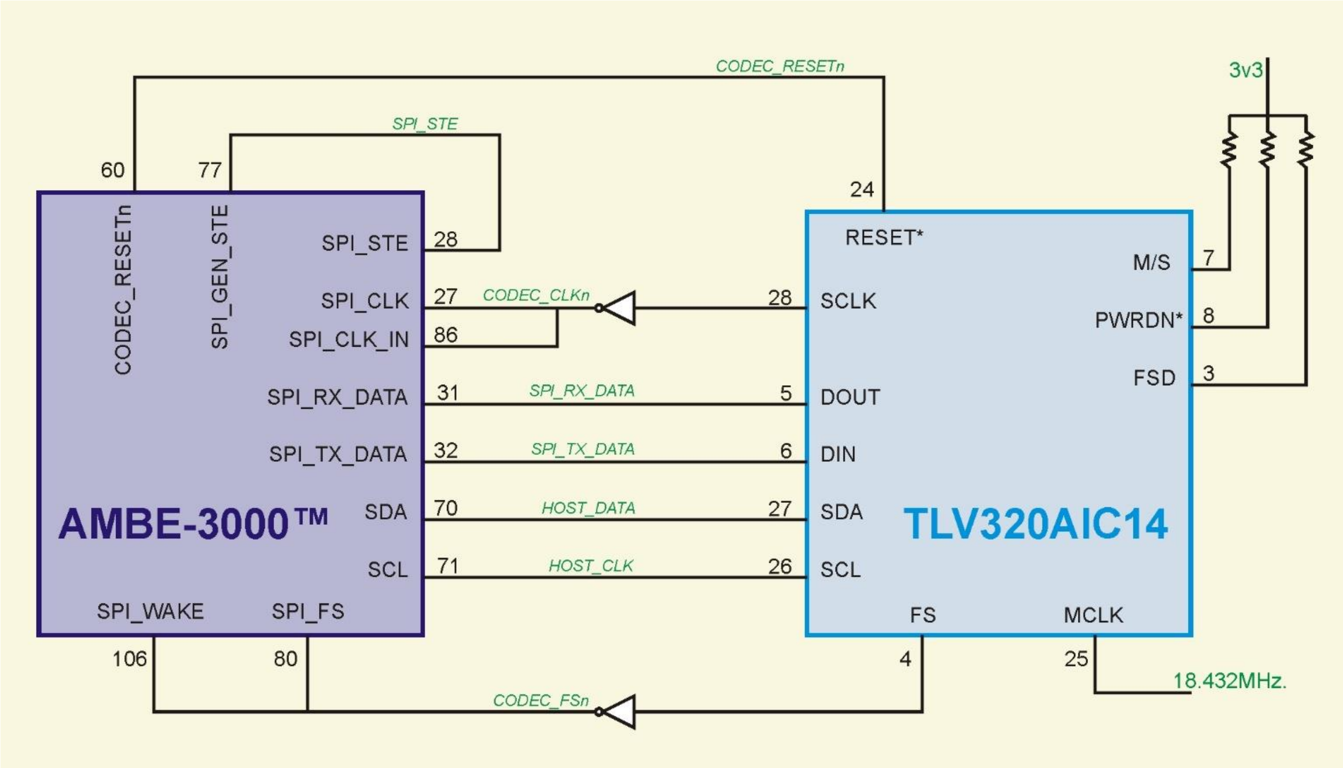


Figure 39 AMBE-3000F™ Vocoder Chip and TLV320AIC14 Interface Block Diagram

The control registers in the TLV320AIC14 codec must be initialized for proper operation. The recommended procedure is to initialize the TLV320AIC14 by writing data to 5 control registers via packet from the AMBE-3000F™ Vocoder Chip.

Control Register	Configuration Data	Notes:
1	0x41	set 16 bit DAC mode, set continuous data transfer mode
2	0xA0	set TURBO=1 (SCLK=MCLK/P), keep I2C addr=4
4	0x83	set M=3
5C	0xB8	sidetone=MUTE
6	0x02	set input MICIN self biased at 1.35 V

Table 27 Control Register Value for the TLV320AIC14

Various configuration data can be used to control the operation of the TLV320AIC14 codec (see its data sheet for more information), however for reference the AMBE-3000F™ Vocoder Chip has been tested with the TLV320AIC14 configured using the register values shown in Table 27 Control Register Value for the TLV320AIC14. A reset to the TLV320AIC14 codec will reset all of the internal registers. As a result, the TLV320AIC14 must be reconfigured following a reset.

5.11.2 The Texas Instruments PCM3500 General purpose codec

Another example of a low cost general purpose codec is the Texas Instruments. This example provides information on interfacing the PCM35000 to the AMBE-3000F™ Vocoder chip's McBSP interface.

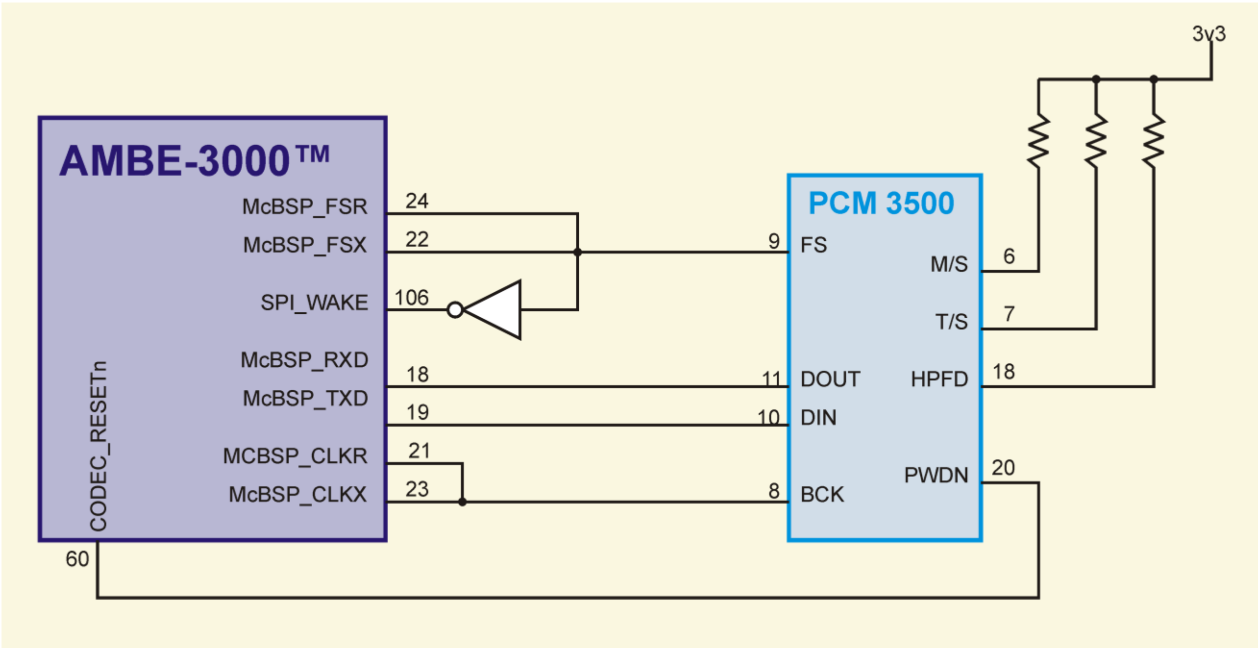


Figure 40 AMBE-3000F™ Vocoder Chip and PCM3500 Interface Block Diagram

SECTION 6

6 Data and Configuration Packets

6.1 Overview

Interfacing to the AMBE-3000F™ Vocoder Chip is engineered to provide as much flexibility as possible. The AMBE-3000F™ Vocoder Chip always uses a packet format for the compressed voice data bits and for the chip configuration/control. The packets can be transferred using the UART port, parallel port or McBSP serial port for a physical interface based on the setting of hardware configuration pins. Packets are designed such that they can be as small as possible.

The AMBE-3000F™ Vocoder Chip uses packets whether it is running in codec mode or packet mode. When in codec mode the packets are used for communicating with the AMBE-3000F™ Vocoder Chip to configure the vocoder, poll vocoder status information, as well as, transferring compressed voice bits from the encoder or to the decoder. When running in packet mode the packets provide the same capabilities as codec mode plus they have the ability to transfer speech data samples to the encoder or from the decoder.

Every packet includes a HEADER that consists of a START byte for identification of the beginning of the packet, LENGTH data to indicate how many bytes are in the packet and a TYPE byte that specifies what to do with the packet. Packets are processed in a first-in-first-out manner.

6.2 Codec Mode Operation

When the AMBE-3000F™ Vocoder Chip is in codec mode the chip uses separate interfaces for the digitized speech data samples and the compressed data bits. In this mode the AMBE-3000F™ Vocoder Chip automatically sends out compressed data bits (channel data) packets every 20ms and expects to receive compressed data bits (channel data) packets every 20ms. The timing of the data transfer depends on the codec clock.

6.3 Packet Mode Operation

In packet mode the AMBE-3000F™ Vocoder Chip uses the same interface for the digitized speech data samples and the compressed data bits. In this mode, when the AMBE-3000F™ Vocoder Chip receives packets, it processes the packets and sends response packets as soon as the data is ready. The AMBE-3000F™ Vocoder Chip sends response packets in the same order that the packets are received. The AMBE-3000F™ Vocoder Chip maintains a FIFO for received packets and a separate FIFO for packets that are awaiting transmission. The FIFOs are each large enough to accommodate up to two speech packets and two channel packets. The AMBE-3000F™ Vocoder Chip can continue to transmit/receive packets while it is still processing prior packets.

When the AMBE-3000F™ Vocoder Chip receives a speech packet, it takes the speech samples from the packet, encodes them and sends back a channel packet.

When the AMBE-3000F™ Vocoder Chip receives a channel packet, it takes the channel data from the packet, decodes the channel data, and sends back a speech packet.

When the AMBE-3000F™ Vocoder Chip receives a configuration control packet, it makes the requested configuration changes and sends back a configuration response packet.

6.4 Packet Interfaces

The AMBE-3000F™ Vocoder Chip supports three separate physical interfaces that handle packets: UART, parallel port, and McBSP serial port. The user selects one of the three ports via configuration pins which are read by the AMBE-3000F™ Vocoder Chip after power-up or reset. The packet formats are identical regardless of which physical interface is selected. Only one port is active at a time.

6.5 Packet Format

The AMBE-3000F™ Vocoder Chip supports packets with a parity field or packets without a parity field. The packet format is as shown in Table 28 General Packet Format WITHOUT Parity Field and Table 29 General Packet Format WITH Parity Field . A packet always starts with a PACKET HEADER byte. The next two bytes contain the PACKET LENGTH and the next byte contains the PACKET TYPE. Each packet can contain one or more fields which are shown as FIELD0 through FIELDn in Table 28 and Table 29. By default, parity fields are enabled after reset.

General Packet Format WITHOUT Parity Field					
Packet Header			Fields		
START_BYTE	**LENGTH**	**TYPE**	**FIELD$_0$**	**…**	**FIELD$_{N-1}$**
1 byte	2 bytes	1 byte	L_0 bytes	…	L_{N-1} bytes
0x61	LLLL	TT			

Table 28 General Packet Format WITHOUT Parity Field

General Packet Format WITH Parity Field							
Packet Header			Fields			Parity	
START_BYTE	**LENGTH**	**TYPE**	**FIELD$_0$**	**…**	**FIELD$_{N-1}$**	PKT_PARITY	PARITY_BYTE
1 byte	2 bytes	1 byte	L_0 bytes	…	L_{N-1} bytes	1 byte	1 byte
0x61	LLLL	TT				0x2F	PP

Table 29 General Packet Format WITH Parity Field

6.5.1 START_BYTE (1 byte)

Referring to Table 28 General Packet Format WITHOUT Parity Field, the START_BYTE byte always has a fixed value of 0x61.

6.5.2 LENGTH (2 bytes)

Referring to Table 28 General Packet Format WITHOUT Parity Field and Table 29 General Packet Format WITH Parity Field , the PACKET LENGTH occupies the second two bytes of the packet. The MS byte of the packet length is the second byte of the packet and the LS byte of the packet length is the third byte of the packet. To calculate the PACKET LENGTH take the sum of L_0 through L_{N-1} plus the parity bytes (if parity is used). Do not include the 4 bytes (START_BYTE, PACKET LENGTH, and PACKET TYPE) from the Packet Header in the PACKET LENGTH. Therefore in Table 28 General Packet Format WITHOUT Parity Field the PACKET LENGTH is the sum of L_0 through L_{N-1}. With Parity field Enabled as shown in Table 29 General Packet Format WITH Parity Field , the PACKET LENGTH is the sum of L_0 through L_{N-1} plus the Parity bytes.
Note that the PACKET LENGTH excludes the first 4 bytes taken up by the START_BYTE, PACKET LENGTH, and PACKET TYPE. PACKET LENGTH is therefore the total length (in bytes) of the entire packet minus 4 bytes.

6.5.3 TYPE (1 byte)

Referring to Table 28 General Packet Format WITHOUT Parity Field, the PACKET TYPE occupies the fourth byte of every packet.

There are 3 different packet types for the AMBE-3000F™ vocoder chip.

Packet Types		
Packet Name	Description	Type Value (Hex)
Control / Configuration Packet	Used to setup chip modes, rates, configure hardware, initialize encoder/decoder, enable low-power mode, specify output packet formats, etc. When a control packet is received the chip returns a control packet with response fields that contain response data for some control packets or indication of errors in the control packet.	0x00
Speech Packet	These packets are used to input speech data to encoder and to output speech data from the decoder. In addition to speech data, the packet can provide flags to control the encoder operation on a frame-by-frame basis. The speech packet also can have a field that forces the encoder to produce a tone frame.	0x02
Channel Packet	These packets are used to input channel data to the decoder and to output channel data from the encoder. In addition to channel data the packet can provide flags that control the decoder operation on a frame-by-frame basis. A channel packet can also contain a field that forces the decoder to produce a tone frame.	0x01

Table 30 Packet Types

6.5.4 Packet Fields

Referring to Table 28 General Packet Format WITHOUT Parity Field, the remainder of a packet after the START_BYTE, LENGTH, and TYPE is made up of packet fields. The packet fields contain the useful packet information. Various different packet fields each with their own format are defined in the next sections, however, the general format of a field is shown in Table 31 General Field Format.

A field consists of a field identifier followed by field data. The length of field data is dependent upon the field identifier. Many fields have fixed lengths. Some fields, such as those that contain speech samples or channel data are variable in length; and in such cases the length of the field data is embedded inside field data.

Field - Packet Format	
Field Identifier	Field Data
1 byte	L_n-1 bytes

Table 31 General Field Format

6.5.5 Parity Field (Parity is enabled by default)

When parity fields are enabled the AMBE-3000F™ Vocoder Chip inserts a 2-byte field at the end of all output packets. The first byte of the parity field is the parity field identifier and is always equal to 0x2f. The second byte of the parity field is the parity byte. It is obtained by "Exclusive-oring" every byte in the packet, except for the START_BYTE and the PARITY_BYTE, together. If parity fields are enabled, the AMBE-3000F™ Vocoder Chip checks the parity byte for all received packets and discards any packet that has an incorrect parity byte. Parity fields can be enabled or disabled (for all future input and output packets) by sending a PKT_PARITYMODE field in a control packet.

6.6 Control Packet Format (Packet Type 0x00)

A control packet uses the format as shown in either Table 28 General Packet Format WITHOUT Parity Field or Table 29 General Packet Format WITH Parity Field where the PACKET TYPE is equal to 0x00.
Control packets can be used to configure the chip prior to operation and also to query for information from the chip. A control packet must contain one or more control fields. For each control packet received, the AMBE-3000F™ Vocoder Chip sends back a response packet. The response packet for most fields just echoes back the control field identifier followed by a 0x00 byte to indicate that the control field was received successfully. For control fields that query for information, the response packet contains the Requested information (1 or more bytes depending upon the control field identifier).

6.6.1 Control Packet Fields and Response Fields

The control packet supports the following packet fields:

Control Packet – Fields					
Field Identifier Name	Field Identifier Code	Control Field Data Length (bytes)	Response Field Data Length (bytes)	Direction	Description
PKT_CHANNEL0	0x40	none	none	I/O	The subsequent fields are for channel 0
PKT_ECMODE	0x05	2	none	I/O	Encoder cmode flags for current channel
PKT_DCMODE	0x06	2	none	I/O	Decoder cmode flags for current channel
PKT_COMPAND	0x32	1	none	I/O	Companding ON/OFF and a-law/µ-law selection
PKT_RATET	0x09	1	none	I/O	Select rate from table for current channel
PKT_RATEP	0x0A	12	none	I/O	Select custom rate for current channel
PKT_INIT	0x0B	1	none	I/O	Initialize encoder and/or decoder for current channel
PKT_LOWPOWER	0x10	1	none	I/O	Enable or disable low-power mode
PKT_CODECCFG	0x38	varies	none	I/O	Sends configuration packet to codec
PKT_CODECSTART	0x2A	1	none	I/O	Switches from packet mode to codec mode
PKT_CODECSTOP	0x2B	none	none	I/O	Switches from codec mode to packet mode
PKT_CHANFMT	0x15	2	none	I/O	Sets the format of the output channel packet
PKT_SPCHFMT	0x16	2	none	I/O	Sets the format of the output speech packet
PKT_PRODID	0x30	none	varies	I/O	Query for product identification
PKT_VERSTRING	0x31	none	48	I/O	Query for product version string
PKT_READY	0x39	none	none	O	Indicates that the device is ready to receive packets
PKT_HALT	0x35	none	none	I	Sets AMBE-3000F™ Vocoder Chip into lowest power mode

PKT_RESET	0x33	none	none	I	Reset the device using hard configuration via pins.
PKT_RESETSOFTCFG	0x34	6	none	I	Reset the device with software configuration.
PKT_GETCFG	0x36	none	3	I/O	Query for configuration pin state at power-up or reset.
PKT_READCFG	0x37	none	3	I/O	Query for current state of configuration pins.
PKT_PARITYMODE	0x3F	1	none	I/O	Enable (default) / disable parity fields
PKT_WRITE I2C	0x44	varies	none	I/O	Writes to an IC^2 device such as a codec
PKT_CLRCODECRESET	0x46	none	none	I/O	Sets the codec reset signal to Low
PKT_SETCODECRESET	0x47	none	none	I/O	Sets the codec reset signal to High
PKT_DISCARDCODEC	0x48	2	none	I/O	Number of codec samples to discard
PKT_DELAYNUS	0x49	2	none	I/O	Delays the next control field processing (in microsecs)
PKT_DELAYNNS	0x4A	2	none	I/O	Delays the next control field processing (in nanosecs)
PKT_RTSTHRESH	0x4E	5	none	I/O	Sets the flow control thresholds
PKT_GAIN	0x4B	2	none	I/O	Used to set Input gain and output gain to be anywhere between +90 and -90 dB

Table 32 Control Packet Fields

PKT_CHANNEL0 field (1 bytes) indicates that subsequent control fields pertain to channel 0.

PKT_CHANNEL0 Field - Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x40	No Data Needed

Table 33 PKT_CHANNEL(0) Field Format

PKT_CHANNEL0 Response Field - Format	
Field Identifier	Response Field Data
1 Byte	0 Byte
0x40	No Data Needed

Table 34 PKT_CHANNEL(0) Response Field Format

PKT_ECMODE field (3 bytes total) contains the cmode flags to be passed to the encoder to enable/disable advanced features of the encoder. Values set by the PKT_ECMODE field will override the state as set by the corresponding hardware configuration pin.

Note: **ECMODE_IN will retain its value until it is changed.**

PKT_ECMODE Field - Format	
Field Identifier	Control Field Data
1 Byte	1 Word
0x05	Table 13 ECMODE_IN Flags

Table 35 PKT_ECMODE Field Format

PKT_ECMODE Response field (1 byte total) indicates encoder cmode flags were received.

PKT_ECMODE Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x05	0x00 (anything different indicates error)

Table 36 PKT_ECMODE Field Response Format

PKT_DCMODE field (3 bytes total) contains the cmode flags to be passed to the decoder to enable/disable advanced features of the decoder. Values set by the PKT_DCMODE field will override the state as set by the corresponding hardware configuration pin.

Note: **DCMODE_IN will retain its value until it is changed.**

PKT_DCMODE Field - Format	
Field Identifier	Control Field Data
1 Byte	1 Word
0x06	Table 15 DCMODE_IN Flags

Table 37 PKT_DCMODE Field Format

PKT_DCMODE field (1 byte total) indicates decoder cmode flags were received.

PKT_DCMODE Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x06	0x00 (anything different indicates error)

Table 38 PKT_DCMODE Response Field Format

PKT_COMPAND field (2 bytes total) Enables/Disables the use of companded data and allows for selection or either a-law or µ-law companding.

PKT_COMPAND Field - Format	
Field Identifier	Control Field Data
1 Byte	1 Byte
0x32	Table 40 PKT_COMPAND Field Options

Table 39 PKT_COMPAND Field Format

Options for PKT_COMPAND Field		
Description	**Value**	
	Bit 1	Bit 0
Select µ-law companding	0	1
Select a-law companding	1	1
Companding Disabled	X	0

Table 40 PKT_COMPAND Field Options

PKT_COMPAND Response field (1 byte total) indicates compand command was received.

PKT_COMPAND Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x32	0x00 (anything different indicates error)

Table 41 PKT_COMPAND Response Field Format

PKT_RATET field (2 bytes total) specifies one of the built-in rates. Sets a built-in Rate from Table 119 Rate Index Numbers

PKT_RATET Field - Format	
Field Identifier	Control Field Data
1 Byte	1 Byte
0x09	Rate Index Value From Table 119 Rate Index Numbers

Table 42 PKT_RATET Field Format

PKT_RATET Response field (1 byte total) indicates receipt of a rate field.

PKT_RATET Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x09	0x00 (anything different indicates error)

Table 43 PKT_RATET Response Field Format

The rate of the AMBE-3000F™ Vocoder Chip can be set through hardware pins or control words. After resetting the device, the coding rate can be modified for both the encoder and the decoder by sending a PKT_RATET or PKT_RATEP packet. Table 120 Rate Control Words and Pin Settings shows standard Rate / FEC combinations

The AMBE-3000F™ Vocoder Chip uses these six words to set the source and FEC coding rates. Table 119 Rate Index Numbers and Table 120 Rate Control Words and Pin Settings lists the predefined values for various source and FEC rates that are built into the AMBE-3000F™ Vocoder Chip. These tables also indicate what rates are compatible with older DVSI vocoder chips such as the AMBE-2000™ Vocoder Chip (using AMBE™+ technology) and the AMBE-1000™ Vocoder Chip (using AMBE™ technology). These are a representation of the most commonly requested rates. Please contact DVSI for additional rate information if the desired rates are not listed.

PKT_RATEP field (13 bytes total) Custom Rate words

If rates other than those indicated in Table 119 Rate Index Numbers and Settings are desired then the PKT_RATEP field must be used to specify a custom rate.

PKT_RATEP - Field Format						
Field Identifier	Control Fields Data					
1 Byte	Rate Control Words (6 Words)					
0x0A	RCW 0	RCW 1	RCW 2	RCW 3	RCW 4	RCW 5

Table 44 PKT_RATEP Field Format

Example of a PKT_RATEP field with the custom rate of 2800 bps voice and 0 bps FEC

Field Identifier	RCW 0	RCW 1	RCW 2	RCW 3	RCW 4	RCW 5
0x0A	0x0038	0x0765	0x0000	0x0000	0x0000	0x0038

Table 45 PKT_RATEP Field Example

PKT_RATEP Response field (1 byte total) indicated receipt of custom rate words

PKT_RATEP Response- Field Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x0A	0x00 (anything different indicates error)

Table 46 PKT_RATEP Response Field Format

Vocoder Rate table with Rate - Control Words / Configuration Pin Setting are shown in Section Rate - Control Words / Configuration Pin Settings

PKT_INIT field (2 bytes total) sets the ecmode and dcmode initialization flags for the encoder and the decoder respectively as well as initializes the echo canceller.
When bit 0 of byte 1 is set the encoder is initialized to the following:

- TONE_DET_ENABLE_FLAG is on
- Noise suppression is enabled/disabled depending on configuration pin
- Echo canceller and echo suppressor are enabled/disabled depending on configuration pin or bit 2 of the PKT_INIT control field data.
- Companding is enabled/disabled and the companding type is selected depending upon the configuration pins.
- All other bits in ecmode are initialized to zero.

When bit 1 of byte 1 is set the decoder is initialized to the following:

- Companding is enabled/disabled and the companding type is selected depending upon the configuration pins.
- All other bits in dcmode are initialized to zero.

When bits 0 and 1 of byte 1 are both set, the encoder and decoder are both initialized.

When bit 2 of the PKT_INIT field is set to 1 then the echo canceller is initialized.

PKT_INIT Field - Format	
Field Identifier	Control Field Data
1 Byte	1 Byte
0x0B	Table 48 PKT_INIT Field - Data

Table 47 PKT_INIT Field Format

Options for PKT_INIT Control Field Data	
Description	**Value**
Encoder Initialized	0x1
Decoder Initialized	0x2
Echo Canceller Initialized	0x4
Encoder and Decoder Initialized	0x3
Encoder, Decoder and Echo Canceller Initialized	0x7

Table 48 PKT_INIT Field - Data

PKT_INIT Response field (1 byte total) indicated receipt of encoder and/or decoder initialization.

PKT_INIT Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x0B	0x00 (anything different indicates error)

Table 49 PKT_INIT Response Field Format

PKT_LOWPOWER field (2 bytes)
Tells the AMBE-3000F™ Vocoder Chip to enable or disable low-power mode. The AMBE-3000F™ Vocoder Chip will go into a mode, which conserves power, when no voice packets are being processed. By default, low power mode is disabled. After a LOWPOWER packet is received, the chip uses the least power possible by entering standby mode **whenever all of the following is true:**

- ◊ the encoder is not running,
- ◊ the decoder is not running,
- ◊ a packet is not being received and a packet is not being transmitted.

PKT_LOWPOWER Field - Format	
Field Identifier	Control Field Data
1 Byte	1 Byte
0x10	Table 51 PKT_LOWPOWER Field Settings

Table 50 PKT_LOWPOWER Field Format

Bit 0 of byte 1 enables and disables low power mode.

Options for PKT_LOWPOWER Field	
Description	**Value**
Low Power Mode Disabled	0x0
Low Power Mode Enabled	0x1

Table 51 PKT_LOWPOWER Field Settings

PKT_LOWPOWER Response field (1 byte total) Indicates that the AMBE-3000F™ Vocoder Chip will enter standby whenever it is idle.

PKT_LOWPOWER Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte

0x10	0x00 (anything different indicates error)

Table 52 PKT_LOWPOWER Response Field Format

PKT_CODECCFG field (varies bytes) this field contains configuration data that the ABME-3000™ will send to the codec after it receives a PKT_CODECSTART packet.

PKT_CODECCFG Field - Packet Format						
Field Identifier	Control Field Data					
1 Byte	(R) +1 Bytes					
0x38	# of regs (R)	reg#	regdata	…	reg#	regdata

Table 53 PKT_CODECCFG Field Format

#of regs (R) bytes contains the number of control registers that will be programmed (where $0 \le R \le 10$)
reg# byte is the value of the control register the following byte of data is to be used for.
regdata byte is the value that will be placed in the preceding control register number.

PKT_CODECCFG Field (default values)- Packet Example											
Field Identifier	Control Field Data										
1 Byte	11 Bytes										
0x38	0x05	0x01	0x41	0x02	0xA0	0x04	0x83	0x05	0xBB	0x06	0x04

Table 54 PKT_CODECCFG Field Example Data (default values shown)

PKT_CODECCFG field (1 byte total) Indicates that the AMBE-3000F™ Vocoder Chip sent a configuration packet to the Codec.

PKT_CODECCFG Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x38	0x00 (anything different indicates error)

Table 55 PKT_CODECCFG Response Field Format

PKT_CODECSTART field (2 bytes total) this will switch the AMBE-3000F™ Vocoder Chip from packet mode to codec mode. It also causes the Codec Reset signal to be set. Then the codec configuration words that were set using the PKT_CODECCFG field, are sent via the I^2C pins. After entering Codec mode the AMBE-3000F™ Vocoder Chip will output packets containing channel data every 20ms. The channel data is obtained by encoding the speech samples received from the selected codec interface.

PKT_CODECSTART Field - Packet Format	
Field Identifier	Control Field Data
1 Byte	1 Byte
0x2A	See Table 57 PKT_CODECSTART Field Data

Table 56 PKT_CODECSTART Field Format

PKT_CODECSTART Flag Values

Value	Description		
	Codec Interface	Pass thru	Skew Control
0x0	SPI	Disabled	Disabled
0x1	SPI	Disabled	Enabled
0x2	SPI	Enabled	Disabled
0x3	SPI	Enabled	Enabled
0x4	McBSP	Disabled	Disabled
0x5	McBSP	Disabled	Enabled
0x6	McBSP	Enabled	Disabled
0x7	McBSP	Enabled	Enabled

Table 57 PKT_CODECSTART Field Data

PKT_CODECSTART field (2 bytes) Indicates that the AMBE-3000F™ Vocoder Chip will switch from packet mode to codec mode.

PKT_CODECSTART Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x2A	0x00 (anything different indicates error)

Table 58 PKT_CODECSTART Response Field Format

PKT_CODECSTOP field (1 byte) this will switch the AMBE-3000F™ Vocoder Chip from codec mode to packet mode and the codec reset signal is set low. After entering packet mode the AMBE-3000F™ Vocoder Chip will stop outputting packets containing channel data every 20ms.

PKT_CODECSTOP Field - Packet Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x2B	No Data Needed

Table 59 PKT_CODECSTOP Field

PKT_CODECSTOP field (1 byte total) Indicates that the AMBE-3000F™ Vocoder Chip will stop outputting channel data packets.

PKT_CODECSTOP Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x2B	0x00 (anything different indicates error)

Table 60 PKT_CODECSTOP Response Field Format

PKT_CHANFMT field (3 bytes total) this field will set the format of the **channel packets output** from the AMBE-3000F™ Vocoder Chip.

PKT_CHANFMT Field - Format								
Field Identifier	Control Field Data							
1 Byte	2 Bytes							
	15|14	13|12	11|10	9|8	7|6	5|4	3|2	1|0
						samples	dcmode	ecmode

0x15	Reserved (bits set to 0)	See Table 62 PKT_CHANFMT Data Settings

Table 61 PKT_CHANFMT Field

NOTE: All Reserved data bits in the PKT_CHANFMT Field (bits 6 through bit 15) must be set to 0 in order to avoid unexpected results.

Options for PKT_CHANFMT Field		
Description	**Value**	
ecmode	**bit 1**	**bit 0**
Output Channel packets never contain ecmode field	0	0
Output Channel packets always contain ecmode field	0	1
Output Channel packets only contain ecmode field when changed	1	0
Reserved	1	1
dcmode	**bit 3**	**bit 2**
Reserved	0	0
Reserved	0	1
Reserved	1	0
Reserved	1	1
samples	**bit 5**	**bit 4**
Output Channel packets NEVER include the number of samples used in the current frame.	0	0
Output Channel packets ALWAYS include the number of samples used in the current frame.	0	1
Output Channel packets include the number of samples used in the current frame ONLY WHEN IT IS DIFFERENT FROM THE LAST FRAME.	1	0
Output Channel packets include the number of samples used in the current frame ONLY WHEN THE NUMBER OF SAMPLES DOES NOT EQUAL 160.	1	1

Table 62 PKT_CHANFMT Data Settings

PKT_CHANFMT Response field (1 byte) this field indicates the output channel packet format has been changed.

PKT_CHANFMT Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x15	0x00 (anything different indicates error)

Table 63 PKT_CHANFMT Response Field

PKT_SPCHFMT field (3 bytes total) this field will set the format of the **Speech packets output** from the AMBE-3000F™ Vocoder Chip

PKT_SPCHFMT Field - Format								
Field Identifier	Control Field Data							
1 Byte	2 Bytes							
	15|14	13|12	11|10	9|8	7|6	5|4	3|2	1|0
							samples	dcmode
0x16	Reserved (bits set to 0)						See Table	

Table 64 PKT_SPCHFMT Field

NOTE: All Reserved data bits in the PKT_SPCHFMT Field (bits 4 through bit 15) must be set to 0 in order to avoid unexpected results.

Options for PKT_SPCHFMT Field		
Description	**Value**	
dcmode	**bit 1**	**bit 0**
Output Speech packets never contain dcmode field	0	0
Output Speech packets always contain dcmode field	0	1
Output Speech packets only contain dcmode field when changed	1	0
Reserved	1	1
samples	**bit 3**	**bit 2**
Output Speech packets NEVER include the number of samples contained in the current speech frame.	0	0
Output Speech packets ALWAYS include the number of samples contained in the current speech frame.	0	1
Output Speech packets include the number of samples contained in the current speech frame ONLY WHEN IT IS DIFFERENT FROM THE LAST FRAME.	1	0
Output Speech packets include the number of samples contained in the current speech frame ONLY WHEN THE NUMBER OF SAMPLES DOES NOT EQUAL 160.	1	1

Table 65 PKT_SPCHFMT Data Settings

PKT_SPCHFMT Response field (1 byte) this field indicates the **output Speech packet** format has been changed.

PKT_SPCHFMT Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x16	0x00 (anything different indicates error)

Table 66 PKT_SPCHFMT Response Field

PKT_PRODID field (1 byte total) this field will cause the AMBE-3000F™ Vocoder Chip to respond with a string that contains the product identification.

An easy way to verify the AMBE-3000™ Vocoder Chip is running and ready to process data is to check for the output of the READY packet. However, in order to prove the communication to the AMBE-3000™ Vocoder Chip is operating properly it is best to send a packet to the chip and verify the AMBE-3000™ Vocoder Chip returns the expected value. Two good known packets to send are the PKT_PRODID and PKT_VERSTRING. These two packets have known return values and can easily be compared to validate proper operation.

PKT_PRODID
`0x61 0x00 0x01 0x00 0x30`

Response Example:
`0x61 0x00 0x0E 0x00 0x30 0x41 0x4D 0x42 0x45 0x33 0x30 0x30 0x30 0x53 0x41 0x54 0x46 0x00`

PKT_PRODID Field - Packet Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x30	No Data Needed

Table 67 PKT_PRODID Field

PKT_PRODID Response field (11 byte) this field is a null-terminated string that contains the product identification for example "AMBE3000"

PKT_PRODID Response Field - Format	
Field Identifier	Response Field Data
1 Byte	varies <= 16 Bytes
0x30	Product ID Data

Table 68 PKT_PRODID Response Field

PKT_VERSTRING field (1 byte total) this field will cause the AMBE-3000F™ Vocoder Chip to respond with a string that contains the product version number.

PKT_VERSTRING
`0x61 0x00 0x01 0x00 0x31`

PKT_VERSTRING Field - Packet Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x31	No Data Needed

Table 69 PKT_VERSTRING Field

PKT_VERSTRING Response field (n + 2 bytes) this field is a null-terminated string that contains the product version number for example
"`V100.E100.XXXX.C106.G514.R007.A0030608.C0020208`"
Where the value after the "`R`" indicates the software release. For more detailed information on software modifications see Section IC Chip Software Errata.

PKT_VERSTRING Response Field - Format	
Field Identifier	Response Field Data
1 Byte	varies <= 48 Bytes
0x31	Version Data

Table 70 PKT_VERSTRING Response Field

PKT_READY field (1 byte total) a packet containing this field is output by the AMBE-3000F™ Vocoder Chip after a hard reset (TQFP pin 113 / BGA pin D6) or packet reset (using a PKT_RESET or PKT_RESETSFTCFG field) when it is ready to receive packets.

PKT_READY Field - Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x39	No Data Needed

Table 71 PKT_READY Field

PKT_HALT field (1 byte total) this field will cause the AMBE-3000F™ Vocoder Chip to enter halt mode. In this mode the AMBE-3000F™ Vocoder Chip will consume the least amount of power possible. The only way to exit this mode is to perform a hardware reset.

PKT_HALT Field - Packet Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x35	No Data Needed

Table 72 PKT_HALT Field

The PKT_HALT field does not return a Response field.

PKT_RESET field (1 byte total) this field will cause the AMBE-3000F™ Vocoder Chip to be reset. As a result, the AMBE-3000F™ Vocoder Chip will lose all prior configuration settings and reset itself to the default power up state. Note that the AMBE-3000F™ Vocoder Chip will re-read the configuration pins.

PKT_RESET Field - Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x33	No Data Needed

Table 73 PKT_RESET Field

The PKT_RESET field does not return a Response field; however, the AMBE-3000F™ Vocoder Chip does output a PKT_READY packet after every reset (including both hard resets and packet resets). The PKT_READY packet can therefore be viewed as a response packet to the packet containing a PKT_RESET field.

PKT_RESETSOFTCFG field (7 bytes total) this field will cause the AMBE-3000F™ Vocoder Chip to be reset. As a result, the AMBE-3000F™ Vocoder Chip will lose all prior configuration settings and reset itself to the default power up state. This is similar to PKT_RESET; however the hardware configuration pins can be overridden by the settings specified by the packet. The PKT_RESETSOFTCFG packet contains 6 additional bytes of data which specify the settings for the 24 configuration pins. CFG0 – CFG2 specify the software settings for each of the 24 configuration pins. MASK0-MASK2 specify whether the hardware setting or the software setting for each pin is used. If all The MASK bits are 0, then no software configuration is used and the packet behaves the same as a PKT_RESET packet (all the configuration settings come from the hardware pins at reset). If all the MASK bits are 1, then all the configuration pins are ignored upon the resulting reset and replaced with the configuration specified by CFG0 – CFG2. It is possible to individually mask the bits and select some configuration to come from hardware pins and some configuration to come from CFG0-CFG2.

CFG Byte	Bit	Configuration Description	Pin Number	
			TQFP	BGA
CFG0	0 (LSB)	IF_SELECT0	2	C2
	1	IF_SELECT1	3	C3
	2	IF_SELECT2	4	B1
	3	DTX_ENABLE	5	C1
	4	SK_ENABLE	6	D3
	5	NS_ENABLE	7	D2
	6	CP_ENABLE	8	D1
	7 (MSB)	CP_SELECT	9	F5
CFG1	0 (LSB)	RATE0	126	A3
	1	RATE1	125	D4
	2	RATE2	124	C4
	3	RATE3	123	B4
	4	RATE4	122	A4
	5	RATE5	121	E5
	6	EC_ENABLE	120	D5
	7 (MSB)	ES_ENABLE	119	B5
CFG2	0 (LSB)	S_COM_RATE0	89	E13
	1	S_COM_RATE1	90	E11
	2	S_COM_RATE2	91	F10
	3	Reserved		
	4	PARITY_ENABLE	79	H11
	5	Reserved		
	6	Reserved		
	7 (MSB)	Reserved		

Table 74 Software Override of Hardware Configuration Pins

For more information regarding configuration pins refer to Table 2 Hardware Configuration Settings

PKT_RESETSOFTCFG Field - Format						
Field Identifier	Control Field Data					
	CFG0	CFG1	CFG2	MASK0	MASK1	MASK2
1 Byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte
0x34						

Table 75 PKT_RESETSOFTCFG Field

The PKT_RESETSOFTCFG field does not return a Response field; however, the AMBE-3000F™ Vocoder Chip does output a PKT_READY packet after every reset (including both hard resets and packet resets). The PKT_READY packet can therefore be viewed as a response packet to the packet containing a PKT_RESETSOFTCFG field.

PKT_GETCFG field (1 byte) this field will cause the AMBE-3000F™ Vocoder Chip to output a response field which contains the 3 bytes reflecting the current status of the configuration registers. Note that this does not cause the configuration pins to be re-read, it merely reports back what the state of the pins were upon power-up or reset.

PKT_GETCFG Field – Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x36	No Data Needed

Table 76 PKT_GETCFG Field

PKT_GETCFG Response Field – Format			
	Response Fields Data		
Field Identifier	CFG0	CFG1	CFG2
1 Byte	1 Byte	1 Byte	1 Byte
0x36			

Table 77 PKT_GETCFG Response Field

PKT_READCFG field (1 byte total) this field will cause the AMBE-3000F™ Vocoder Chip to output a response field which contains the 3 bytes which are read from the configuration pins after the PKT_READCFG field is received. Note that if the signal levels on the configuration pins have changed since their reset levels, then CFG0-CFG2 reported by the response packet will reflect that change. Note that although this packet causes the configuration pins to be re-read and sent back in a response packet, the AMBE-3000F™ Vocoder Chip does not change its configuration as a result of receiving this packet.

PKT_READCFG Field – Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x37	No Data Needed

Table 78 PKT_READCFG Field

PKT_READCFG Response field (4 bytes total) this contains the 3 bytes of data which was read from the configuration pins after the PKT_READCFG field is received.

PKT_READCFG Response Field – Format			
	Response Fields Data		
Field Identifier	CFG0	CFG1	CFG2
1 Byte	1 Byte	1 Byte	1 Byte
0x37			

Table 79 PKT_READCFG Response Field

PKT_PARITYMODE field (2 bytes total) This field can be used to enable or disable parity fields at the end of every packet.

PKT_PARITYMODE Field - Format	
Field Identifier	Control Field Data
1 Byte	1 Byte
0x3F	mode

Table 80 PKT_PARITYMODE Field Format

If mode is 0 then parity fields will be disabled for all output packets beginning with the response to this packet. The AMBE-3000F™ Vocoder Chip will not require a valid parity byte for future received packets.

If mode is 1 then parity fields will be enabled for all output packets beginning with the response to this packet. The AMBE-3000F™ Vocoder Chip will reject all future received packets that do not have a valid parity field.

All other values for mode are reserved and should not be used.

PKT_PARITYMODE Response field (2 bytes) this field indicates that the PKT_PARITYMODE field in the corresponding control packet was received without error.

PKT_PARITYMODE Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x3F	0x00 (anything different indicates error)

Table 81 PKT_PARITYMODE Response Field

PKT_WRITEI2C field (n bytes plus 2) this field writes to an I²C device such as a codec.

PKT_WRITEI2C Field - Format		
Field Identifier	Control Fields Data	
	Length	LenBytes
1 Byte	1 Byte	
0x44	n	Codec Data

Table 82 PKT_ WRITEI2C Field Format

PKT_WRITEI2C Response field (2 byte) this field indicates that the PKT_WRITEI2C field in the corresponding control data was received without error.

PKT_WRITEI2C Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x44	0x00 (anything different indicates error)

Table 83 PKT_WRITEI2C Response Field

PKT_CLRCODECRESET field (1 byte total) this field sets the codec reset signal to low.

PKT_CLRCODECRESET Field - Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x46	No Data Needed

Table 84 PKT_CLRCODECRESET Field Format

PKT_CLRCODECRESET Response field (2 bytes) this field indicates that the PKT_CLRCODECRESET packet was received without error.

PKT_CLRCODECRESET Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte

0x46	0x00 (anything different indicates error)

Table 85 PKT_CLRCODECRESET Response Field

PKT_SETCODECRESET field (1 byte total) This field sets the codec reset signal to low.

PKT_SETCODECRESET Field - Format	
Field Identifier	Control Field Data
1 Byte	0 Byte
0x47	No Data Needed

Table 86 PKT_SETCODECRESET Field Format

PKT_SETCODECRESET Response field (2 bytes) this field indicates that the PKT_SETCODECRESET packet was received without error.

PKT_SETCODECRESET Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x47	0x00 (anything different indicates error)

Table 87 PKT_SETCODECRESET Response Field

PKT_DISCARDCODEC field (3 bytes total) This field specifies the number of codec samples that are discarded when the codec interface is started.
Default is 0. 128 is recommended for the Texas Instrument AIC14 codec.

PKT_DISCARDCODEC Field - Format	
Field Identifier	Control Field Data
1 Byte	2 Bytes
0x48	Number of samples to discard

Table 88 PKT_DISCARDCODEC Field Format

PKT_DISCARDCODEC Response field (2 bytes) this field indicates that the **PKT_DISCARDCODEC** packet was received without error.

PKT_DISCARDCODEC Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x48	0x00 (anything different indicates error)

Table 89 PKT_DISCARDCODEC Response Field

PKT_DELAYNUS field (3 bytes total) This field specifies the amount of delay in microseconds prior to processing the next control field.

PKT_DELAYNUS Field - Format	
Field Identifier	Control Field Data
1 Byte	2 Bytes
0x49	Number of microseconds delay

Table 90 PKT_DELAYNUS Field Format

PKT_DELAYNUS Response field (2 bytes) this field indicates that the **PKT_DELAYNUS** packet was received without error.

PKT_DELAYNUS Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x49	0x00 (anything different indicates error)

Table 91 PKT_DELAYNUS Response Field

PKT_DELAYNNS field (3 bytes total) This field specifies the amount of delay in nanoseconds prior to processing the next control field.

PKT_DELAYNNS Field - Format	
Field Identifier	Control Field Data
1 Byte	2 Bytes
0x4A	Number of nanoseconds delay

Table 92 PKT_DELAYNUS Field Format

PKT_DELAYNNS Response field (1 byte) this field indicates that the **PKT_DELAYNNS** packet was received without error.

PKT_DELAYNNS Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x4A	0x00 (anything different indicates error)

Table 93 PKT_DELAYNNS Response Field

PKT_RTSTHRESH field (5 bytes total) This field can be used to set the number of threshold high and threshold low free space bytes in the receive buffer.

PKT_RTSTHRESH Field - Format		
Field Identifier	Control Fields Data	
	thresh_hi	thresh_lo
1 Byte	2 Bytes	2 Bytes
0x4E		

Table 94 PKT_RTSTHRESH Field Format

The Ready-To-Send (RTSn) pin is output by the AMBE-3000F™ Vocoder Chip. The output is active low. The signal is used by the AMBE-3000F™ Vocoder Chip to control the flow of packet data to the AMBE-3000F™ Vocoder Chip. The AMBE-3000F™ Vocoder Chip has a receive buffer where incoming packets are stored until they have been processed. When RTSn is low, the AMBE-3000F™ Vocoder Chip indicates that it is ready to receive packet data. When RTSn is high, the AMBE-3000F™ Vocoder Chip is not ready to receive packet data. The AMBE-3000F™ Vocoder Chip sets RTSn high if there are less than thresh_hi bytes of free space in the receive buffer. The AMBE-3000F™ Vocoder Chip sets RTSn low if there are more than thresh_lo bytes of free space in the receive buffer. By default, after reset thresh_hi is set to 20 and thresh_lo is set to 40. These thresholds can be changed by sending a PKT_RTSTHRESH field as part of a control packet after reset. The thresholds may need to be set to higher values if the device connected to RTSn does not stop sending packet data quickly enough after RTSn goes high.

The RTSn signal follows the conventions commonly used for RS-232 flow control. If the MCBSP or the parallel port is selected for the packet interface, rather than the UART, then the RTSn signal is still generated. The RTSn signal can also be used for flow control if the McBSP or the PPT interface is used.

Format of the PKT_RTSTHRESH field is as follows. 5 bytes total. 1 byte code is 0x4e followed by 2 bytes for thresh_hi two bytes for thresh_lo

PKT_RTSTHRESH Response field (2 bytes) this field indicates that the PKT_ **RTSTHRESH** field in the corresponding control packet was received without error.

PKT_RTSTHRESH Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x4E	0x00 (anything different indicates error)

Table 95 PKT_RTSTHRESH Response Field

Note: "PKT_GAIN" and "PKT_GAIN Response" are ONLY effective for 16 bit Linear Samples when in Packet Mode. PKT_GAIN has no effect in Codec Mode.

PKT_GAIN field (3 bytes total) This field can be used to set the input gain and output gain to anywhere between +90 and -90 dB. The default input gain and output gain are each 0 dB.

PKT_GAIN Field - Format		
Field Identifier	Control Fields Data	
	Input Gain	Output Gain
1 Byte	1 Byte	1 Byte
0x4B		

Table 96 PKT_GAIN Field Format

If the input gain is < 0 dB then the input speech samples are attenuated prior to encoding.
If the input gain is > 0 dB then the input speech samples are amplified prior to encoding.
If the output gain is < 0 dB then the output speech samples are attenuated after decoding.
If the output gain is > 0 dB then the output speech samples are amplified after decoding.

It is recommended that the input and output gain are both 0 dB. Different values can be used for testing purposes.

PKT_GAIN Response field (2 bytes total) this field indicates that the PKT_GAIN field in the corresponding control packet was received without error.

PKT_GAIN Response Field - Format	
Field Identifier	Response Field Data
1 Byte	1 Byte
0x4B	0x00 (anything different indicates error)

Table 97 PKT_GAIN Response Field

6.7 Input Speech Packet Format (Packet Type 0x02)

A speech packet uses the general packet format where the PACKET TYPE is equal to 0x02. For every speech packet input (packet type 0x02) to the AMBE-3000F™ Vocoder chip, the chip will output channel packet (packet type 0x01). Speech packets are used only when the AMBE-3000F™ Vocoder Chip is operating in packet mode.

6.7.1 Speech Packet Fields

The speech packet supports the following packet fields:

Speech Packet - Fields			
Field Name	Field Identifier	Data Length	Description
PKT_CHANNEL0	0x40	1 byte	The vocoder for subsequent fields
SPEECHD	0x00	Variable bytes	The speech data to be encoded for current vocoder
CMODE	0x02	2 bytes	cmode flags for current vocoder's encoder
PKT_TONEXMT	0x50	3 bytes	Force current encoder to transmit tone frames

Table 98 Speech Packet Fields

PKTCHANNEL_ID field (2 bytes) indicates the vocoder the control is intended for. It is the same as described in the Table 33 PKT_CHANNEL(0) Field Format

A **SPEECHD** field (variable number of bytes) contains the speech data to be encoded for the current channel or the decoded speech data for the current channel.
When using 16 bit linear PCM Raw Speech data to be input to the encoder or output from the decoder there will be 16 bits per sample, this means at 160 samples there are 320 bytes of data. When using companded data (a-law or µ-law there are 8 bits of data per sample, this results in 160 bytes of data in 160 samples. The speech is denoted as Speech[0] thru Speech[2*{samples} -1].Speech[0] is the MS byte of the first sample. Speech[1] is the LS byte of the first sample. Speech[2*{samples}-2] is the MS byte of the last sample. Speech[2*{samples}-1] is the LS byte of the last sample.

SPEECHD Field - Packet Format		
Field Identifier	Number of Samples	Data
1 Byte	**1 Byte**	**Variable Number of Samples**
0x00	156 <= {samples} <= 164	Speech[0] … Speech[2*{samples}-1]

Table 99 SPEECHD Field Format

CMODE fields (3 bytes total) may be used to change the mode of the encoder on a frame-by-frame basis. The CMODE field will enable/disable advanced features of the encoder when sent as part of a speech packet.

CMODE will overwrite any values set by the PKT_ECMODE field as well as, the state as set by the corresponding hardware configuration pin. In order not to inadvertently turn off or on features that were originally set by ECMODE_IN or set via hardware configuration pins to be sure that CMODE is or'd with the correct value of the desired ECMODE_IN. Except for Tone Generation, typically, once these values are set they do not change. So it is not necessary to send CMODE fields on a frame-by-frame basis.

For example, to enable tone detection, DTX and noise suppression, CMODE data value would be 0x1840. In order to generate a tone and retaining all of the other settings then CMODE data value would be 0x5840.

CMODE Field - Format	
Field Identifier	Data
1 Byte	1 Word
0x02	See Table 102 CMODE Parameters Table

Table 100 CMODE Field Format

CMODE Field - Parameters																
1 Word																
Bit Number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Parameter	**R**	TS_E	**R**	TD_E	DTX_E	**R**	**R**	CP_E	CP_S	NS_E	**R**	**R**	**R**	**R**	**R**	**R**

Table 101 CMODE Parameters Table

CMODE Field – Parameters Key		
Parameter	Description	CMODE Name
R	**ALL RESERVED BITS SHOULD BE SET TO ZERO**	Reserved
NS_E	Noise Suppression Enable	NS_Enable
CP_S	Compand Select	CP_Select
CP_E	Compand_Enable	CP_Enable
DTX_E	Discontinous Transmit Enable	DTX_ENABLE
TD_E	Tone Detection Enable	TD_ENABLE

Table 102 CMODE Parameters Table Key

PKT_TONEXMT (0x50) is followed by 3 bytes (idx, amp, dur).

The field specifies that the encoder produce a tone.

PKT_TONEXMT Field – Format			
Field Identifier	Control Field Data		
	3 Bytes		
1 Byte	Idx (1 byte)	amp (1byte)	dur (1byte)
0x50	See Table 104 TONE Index Values	See Table 105 TONE AMPLITUDE Values	0x0 to 0xFF

Table 103 PKT_TONEXMT Field Format

Idx specifies the index of the tone. See Table 104 TONE Index Values for detailed information. Refer to the tone table for idx. Amp specifies the level of the tone in dbm0 (-90 <= amp <= +3). See Table 105 TONE AMPLITUDE Values for detailed information regarding the tone amplitude values table.
Dur specifies the duration of the tone in 20 ms frames. The value set in dur will indicate the number of 20ms frames to make the tone last. As a special case, the value of dur=255 (0xFF) requests that the encoder output a tone indefinitely, or until a new PKT_TONEXMT field with a duration of less than 255 is received.

For packet mode, it can be used for input speech packets.
For codec mode, it can be used for input channel packets.

TONE_IDX (Field ID 0x00)
Can specify the index of a desired tone or identify the index of a detected or received tone.

Tone Index Values				
Parameter Name	Description		TONE Index Value	
	Frequency 1 (Hz)	Frequency 2 (Hz)		
			For Rate Index Values 0 to 32	For Rate Index Values 33 to 61
Single Tones (The single tones span from 156.25 Hz to 3812.5 Hz in 31.25 Hz Increments)				
Single tone	156.25	N/A	0x05	
	187.5	N/A	0x06	
	218.75	N/A	0x07	
	…	…	…	
	…	…	…	
	3812.5	N/A	0x7A	
DTMF Tones				
1	1209	697	0x80	0x81
2	1336	697	0x84	0x82
3	1477	697	0x88	0x83
4	1209	770	0x81	0x84
5	1336	770	0x85	0x85
6	1477	770	0x89	0x86
7	1209	852	0x82	0x87
8	1336	852	0x86	0x88
9	1477	852	0x8A	0x89
0	1336	941	0x87	0x80
A	1633	697	0x8C	0x8A
B	1633	770	0x8D	0x8B
C	1633	852	0x8E	0x8C
D	1633	941	0x8F	0x8D
*	1209	941	0x83	0x8E
#	1477	941	0x8B	0x8F
Call Progress				
Dial Tone	440	350	0xA0	
Ring Tone	480	440	0xA1	
Busy Tone	620	480	0xA2	
Inactive	N/A	N/A	0xff	
Invalid				

Table 104 TONE Index Values

TONE Amplitude Values (Field)
Can specify the amplitude of a desired tone or identify the index of a detected or received tone.
The DTMF Amplitude runs from 3 to –90 dBm0. This value is a signed byte (example: 0x03 = 3, 0x00 = 0, 0xC4 = -60).

TONE Amplitude Values	
Description	TONE Amplitude Value
Max Amplitude Level = +3	0x03
…	…
…	…
Min. Amplitude Level = -90	0xA6

Table 105 TONE AMPLITUDE Values

6.8 Output Speech Packets Format (Packet Type 0x02)

A speech packet (packet type 0x02) is output from the AMBE-3000F™ Vocoder chip, whenever the chip receives an input channel packet (packet type 0x01). The format of the output speech packet can be configured using PKT_SPCHFMT control field see Table 64 PKT_SPCHFMT Field.

6.9 Input Channel Packet Format (Packet Type 0x01)

A channel packet uses the format as shown in Table 28 General Packet Format WITHOUT Parity Field where the PACKET TYPE is equal to 0x01. For every channel packet input (packet type 0x01) to the AMBE-3000F™ Vocoder chip, the chip will output speech packet (packet type 0x02).

6.9.1 Channel Packet Fields

The channel packet supports the following packet fields:

Channel Packet Fields			
Field Name	Field Identifier	Field Length	Description
PKT_CHANNEL0	0x40	2 bytes	The vocoder for subsequent fields
CHAND	0x01	Variable bytes	Compressed speech data to be decoded for current vocoder
CHAND4	0x17	Variable bytes	Compressed speech data with four bit soft decision error correction enabled to be decoded for current vocoder
SAMPLES	0x30	2 bytes	Number of samples to generate for current decoder frame
CMODE	0x02	3 bytes	CMODE flags for current vocoder's decoder
PKT_TONEGEN	0x51	3 bytes	Force current vocoder's decoder to generate tone frame

Table 106 Channel Packet Fields

PKT_CHANNEL0 field (2 bytes) indicates the vocoder the control is intended for. It is the same as described in the Table 33 PKT_CHANNEL(0) Field Format

CHAND (variable number of bytes) channel bits to be decoded, packet 8 bits per byte.
Compressed data bits from the encoder or to the decoder (packed 8 bits per byte). The data is denoted by Chand[0] to Chand[(Bits-1)/8]. Chand[0] contains the bits which are most sensitive to bit errors. Chand[(Bits-1)/8] contain the bits which are least sensitive to bit errors. 2 thru 1+(Bits+7)/8 bytes

CHAND Field - Format		
Field Identifier	Number of Bits	Data
1 Byte	**1 Byte**	**Variable Number of Channel Data Bits**
0x01	40 ≤ {bits} ≤ 192	chand[0] – chand[(bits-1)/8]

Table 107 CHAND Field - Format

CHAND4 (variable number of bytes) channel bits to be decoded, with soft decision error correction enabled.
Compressed data bits from the encoder or to the decoder (packed 2 bits per byte). The data is denoted by Chand[0] to Chand[(bits-1)/2].

CHAND4 Field - Format		
Field Identifier	Number of Bits	Data
1 Byte	**1 Byte**	**Variable Number of Channel Data Bits**
0x17	40 ≤ {bits} ≤ 192	chand[0] – chand[(bits-1)/2]

Table 108 CHAND4 Field - Format

SAMPLES field (2 bytes) denotes the number of samples to generate for current decoder frame. The second byte, contains the data for the number of samples. The normal number of samples is 160 but the number can range between 156 to 164 when it produces the resulting speech packet.

SAMPLES Field - Format	
Field Identifier	Number of Samples
1 Byte	**1 Byte**
0x03	156 ≤ {number of samples} ≤ 164

Table 109 SAMPLES Field - Format

CMODE fields (3 bytes total) may be used to change the mode of the decoder on a frame-by-frame basis. The CMODE field will enable/disable advanced features of the decoder when sent as part of a channel packet.

CMODE will overwrite any values set by the PKT_DCMODE field as well as, the state as set by the corresponding hardware configuration pin. In order not to inadvertently turn off or on features that were originally set by DCMODE_IN or set via hardware configuration pins to be sure that CMODE is or'd with the correct value of the desired DCMODE_IN. Except for Tone Synthesis Enable, once these values are set they typically do not change. So it is not necessary to send CMODE fields on a frame-by-frame basis.

For example, to enable both LOST_FRAME and CNI_FRAME CMODE data value would be 0xXXXC.

CMODE Field - parameters		
Decoder Input Flag Parameters		CMODE Value
LOST_FRAME	Frame repeat enable.	0xXXX4
CNI_FRAME	Comfort Noise Insertion Enable.	0xXXX8
TS_ENABLE	Tone Synthesis Enable.	0x4XXX

PKT_TONEGEN (0x51) is followed by 3 bytes (idx, amp, dur).
The field specifies that the decoder synthesize a tone (the channel data is ignored).

PKT_TONEGEN Field – Format			
Field Identifier	Control Field Data		
	3 Bytes		
1 Byte	Idx (1 byte)	amp (1byte)	dur (1byte)
0x51	See Table 104 TONE Index Values	See Table 105 TONE AMPLITUDE Values	0x0 to 0xFF

Table 110 PKT_TONEGEN Field Format

Idx specifies the index of the tone. Amp specifies the level of the tone in dbm0 (-90 <= amp <= +3). Dur specifies the duration of the tone in 20 ms frames. The value set in dur will indicate the number of 20ms frames to make the tone last. As a special case, the value of dur=255 (0xFF) requests that the encoder output a tone indefinitely, or until a new PKT_TONEGEN field with a duration of less than 255 is received.

For packet mode it can be used for input channel packets.
For codec mode, it can be used for input channel packets

6.10 Output Channel Packet Format (Packet Type 0x01)

A channel packet (packet type 0x01) is output from the AMBE-3000F™ Vocoder chip, whenever the chip receives an input speech packet (packet type 0x02). The format of the output channel packet can be configured using PKT_CHANFMT control field see Table 61 PKT_CHANFMT Field.

PKT_TONEDET (0x52) is followed by 2 bytes (idx, amp).
It occurs in output channel packets only if enabled using a preceding PKT_TONEMODE field. The packet indicates the index and the amplitude of a tone detected by the encoder. PKT_TONEMODE field is used to specify when PKT_TONEDET is output. The choices are “never”, “always”, “only when the index changes”, or “only when the index is a valid tone”.

Note that by default the tone mode is “never” meaning that PKT_TONEDET will not occur in the output channel packets. If the mode is set to “always” then every channel packet output will contain this field. Packets for which there was no tone detected will contain idx=0xFF (255) and amp=0xA6 (-90).

PKT_TONEDET Field – Format		
Field Identifier	Control Field Data	
	2 Bytes	
1 Byte	idx (1 byte)	amp (1byte)
0x52	See Table 104 TONE Index Values	See User’s Manual

Table 111 PKT_TONEDET Field Format

PKT_TONERCV (0x53) is followed by 2 bytes (idx, amp). PKT_TONEMODE field is used to specify when PKT_TONERCV is output. The choices are “never”, “always”, “only when the index changes”, or “only when the index is a valid tone”.

PKT_TONERCV Field – Format		
Field Identifier	Control Field Data	
	2 Bytes	
1 Byte	idx (1 byte)	amp (1byte)
0x53	See Table 104 TONE Index Values	See Table 105 TONE AMPLITUDE Values

Table 112 PKT_TONERCV Field Format

Note that by default the tone mode is “never” meaning that PKT_TONERCV will not occur in the output packets. If the mode is set to “always” then every channel packet (codec mode) / speech packet (packet mode) output will contain this field. Packets for which there was no tone received will contain idx=0xFF (255) and amp=0xA6 (-90).

For packet mode, it occurs in output speech packets only if enabled using a preceding PKT_TONEMODE field. The packet indicates the index and the amplitude of a tone received by the decoder.
For codec mode, it occurs in output channel packets only if enabled using a preceding PKT_TONEMODE field.

PKT_TONEMODE (0x54) is followed by a single byte named "mode".
This is a control packet. The response field will have PKT_TONEMODE followed by 0. The mode byte specifies the tone reporting mode. This field determines when/if PKT_TONEDET and PKT_TONERCV fields are output. By default, PKT_TONEDET and PKT_TONERCV fields are not output.

Bits 1 and 0 determine when PKT_TONEDET is output.
Bits 5 and 4 determine when PKT_TONERCV is output.

The remaining bits in mode are reserved and should be input as "0".

PKT_TONEMODE Field – Format	
Field Identifier	Control Field Data "Mode"
1 Byte	1 Byte
0x54	See Table 114 PKT_TONEMODE Field Values for "Mode"

Table 113 PKT_TONEMODE Field Format

Values for PKT_TONEMODE Control Field "Mode"	
Description	**Mode (**1 byte)
	Bits
	7 6 5 4 3 2 1 0
encoder tone detection status is **never** reported by PKT_TONEDET	R R X X R R 0 0
encoder tone detection status is **always** reported by PKT_TONEDET	R R X X R R 0 1
encoder tone detection status is **only** reported by PKT_TONEDET when the tone idx **changes**	R R X X R R 1 0
encoder tone detection status is **only** reported by PKT_TONEDET when the tone idx indicates a **valid** tone	R R X X R R 1 1
decoder tone reception status is **never** reported by PKT_TONERCV	R R 0 0 R R X X
decoder tone reception status is **always** reported by PKT_TONERCV	R R 0 1 R R X X
decoder tone reception status is **only** reported by PKT_TONERCV when the tone idx **changes**	R R 1 0 R R X X
decoder tone reception status is **only** reported by PKT_TONERCV when the tone idx indicates a **valid**	R R 1 1 R R X X

Table 114 PKT_TONEMODE Field Values for "Mode"

Note that R = reserved for future use and should be set to 0
Note that X = don't care.

6.11 Example Packets

6.11.1 Speech Packet Example 1

The simplest way to operate the AMBE-3000F™ Vocoder Chip in packet mode is to send it a packet and then wait for a response packet. But using this method, the vocoder is idle during the time when a packet is being received by the

AMBE-3000F™ Vocoder Chip and during the time in which the AMBE-3000F™ Vocoder Chip is transmitting the response packet.

Following is an example speech packet (hexadecimal) for input to the AMBE-3000F™ Vocoder Chip:

Speech Packet						
Header			**CHANNEL Field**	**SPEECHD Field**		
StartByte	Length	Type	CHANNEL0 field identifier	SPEECHD field identifier	SPEECHD No. of Samples	SPEECHD Data
61	0143	02	40	00	A0	0000000100020003000400050006000700080009000 A000B000C000D000E000F00100011001200130014 00 150001601700180019001A001B001C001D001E001F0 020002100220023002400250026002700280029002A 002B002C002D002E002F0030003100320033003400 3 5003600370038003900 3A003B003C003D003E003F00 4000410042004300440045004600470048004900 4A0 04B004C004D004E004F00500051005200530054005 5 0056005700580059005A005B005C005D005E005F006 00061006200630064006500660067006800 69006A00 6B006C006D006E006F00700071007200730074007 50 0760077007800 79007A007B007C007D007E007F0080 0081008200830084008500860087008800 89008A008 B008C008D008E008F00900091009200930094009500 9600970098009900 9A009B009C009D009E009F

Table 115 Speech Packet Example 1

The first byte (0x61) is the packet header byte. The next two bytes (0x0143) specify the total length of the packet fields is 323 bytes. Note that the total packet length including the header, length,, and type is 327 bytes. The next byte (0x02) specifies that the packet type is a speech packet. The next byte (0x40) is the field identifier for a ChannelID field. The next byte (0x00) is a SPEECHD field identifier and the following byte (0xA0) tells the AMBE-3000F™ Vocoder Chip that the SPEECHD Data field contains 160 speech samples, occupying 320 bytes. The final 320 bytes contain the speech samples. For this particular example the speech samples increment from 0 to 159. Note that the MS byte of each sample is transmitted/received prior to the LS byte of each sample. This convention is used whenever a 16-bit number is contained in a packet.

Also note that the default vocoder number, if no VOCODERID fields occur in the packet, is vocoder 0. So for this example, since vocoder 0 is specified in the VOCODERID field, the VOCODERID field could have been omitted.

6.11.2 Speech Packet Example 2

The following packet is another example of speech input

Speech Packet												
Header			**VOCODER ID Field**	**SPEECHD Field**			**CMODE Field**		PKT_TONEXMT **Field**			
StartByte	Length	Type	VOCODERID Field Identifier	SPEECHD Field identifier	SPEECHD No. of Samples	SPEECHD Data	CMODE Field identifier	CMODE flags	PKT_TONEXMT Field identifier	TONE Index Value	TONE Amplitude Value	FONE - Duration
61	014A	02	40	00	A0	0000000100020003000400 05000600070008000900 0A000B000C000D000E000 F0010001100120013001400 15001601700180019001A001B001C001D001E00 1F002000210022002300240025002600270028002900 2A002B002C002D002E0 02F003000310032003300 34003500360037003800 39003A003B003C003D003E 003F004000410042004300 44004500460047004800 49004A004B004C004D004 E004F005000510052005300 54005500560057005800 59005A005B005C005D00 5E005F006000610062006 30064006500660067006800 69006A006B006C006D0 06E006F007000710072007 300740075007600770078 0079007A007B007C007D 007E007F0080008100820 0830084008500860087008 80089008A008B008C008 D008E008F0090009100920 0930094009500960097009 80099009A009B009C00 9D009E009F	02	0000	5 0	0 3	0 0	0 1

Table 116 Speech Packet Example 2

This is the similar to the prior example except that a CMODE field and a PKT_TONEXMT field were added to the end of the packet. The packet indicates that the speech samples will be passed to the encoder for channel 0. The length field changed to 0x0149 because the packet length increased by 6 bytes. For the new bytes at the end of the packet (0x02) is the CMODE field identifier. The following two bytes (0x0000) specifies that the encoder cmode flags should be set to 0x0000. The next byte (0x50) is a PKT_TONEXMT field identifier. The next two bytes (0x03 and 0x00) specify tone index of 3 and tone amplitude of 0 dBm0.

6.11.3 Channel Packet Example 1

Following is an example channel packet (hexadecimal) for input to the AMBE-3000F™ 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 117 Channel Packet Example 1

The first byte (0x61) is the packet header byte. The next two bytes (0x000C) specify that the length of the packet (excluding the header, length, and type bytes) is 12 bytes. The next byte (0x01) specifies that the packet type is a channel packet. The next byte (0x01) is the field identifier for a CHAND field. The next byte (0x50) specifies that 80 bits of channel data follow. The bits are packed 8 bits per byte such that the 80 bits are contained in the 10 bytes that follow. The final 10 bytes contain the channel data. The bits are output with the most significant (and most sensitive to bit-errors) bits in the first byte and the least significant (and least sensitive to bit-errors) bits in the last byte. For bit-rates that are not an even multiple of 400 bps, the MSBs of the last byte are used to hold the channel data, and the LSBs will be padded with zeros.

Note that in this example, the packet contains no VOCODERID field, and therefore channel 0 is assumed.

6.11.4 Channel Packet Example 2

Following is another example of a channel packet for input to the AMBE-3000F™ Vocoder Chip:

Channel Packet														
Header			PKT_CHANNEL0 **Field**	**CHAND Field**			**SAMPLES Field**		**CMODE Field**		**PKT_TONEGEN Field**			
StartByte	Length	Type	PKT_CHANNEL0 Field Identifier	CHAND Field Identifier	CHAND Number of Bits	CHAND Data	SAMPLES Field Identifier	SAMPLES Number of Samples	CMODE Field	CMODE Value	PKT_TONEGEN Field identifier	TONE Index Value	TONE Amplitude Value	Tone - Duration
61	000F	01	40	01	38	0011223 3445566	03	A1	02	0000	51			

Table 118 Channel Packet Example 2

The first byte (0x61) is the packet header byte. The next two bytes (0x000F), specify that the length of the packet (excluding the header, length, and type bytes) is 15 bytes. The next byte (0x01) specifies that the packet type is a channel packet. The next byte (0x40), is a ChannelID field identifier. The next byte (0x01) is a CHAND specifier and the following byte (0x38) specifies that 56 bits (7 bytes) of channel data follow. The next 7 bytes contain the channel data to be decoded by the decoder. The next byte (0x03), is a field identifier for a SAMPLES field. The next byte (0xA1), specifies that the decoder will output 161 samples rather than the normal 160 samples when it produces the resulting speech packet. The next byte (0x02), is the field identifier for a CMODE field. The final 2 bytes (0x0000), are used to control the decoder mode.

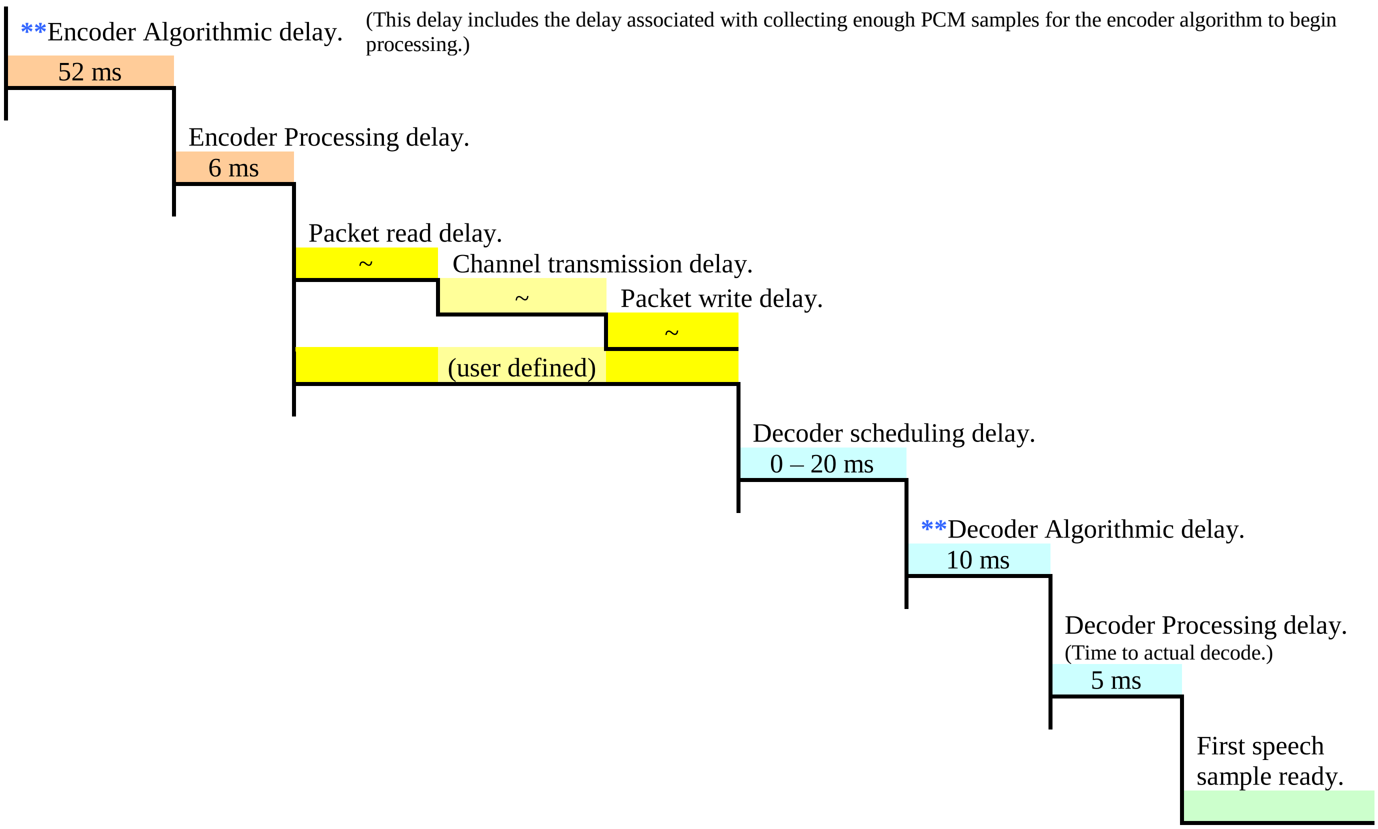
SECTION 7

7 Appendices

7.1 Algorithmic and Processing Delays

The total delay due to the coding/decoding algorithm is = 62 ms

Encoder Time (58 ms)	**Transmit**	**Channel**	**Receive**	**Decoder Time (up to 35 ms)**	**Begin Speech out**
Algorithm + Processing delay	Transmission + Channel + Receive delay			Scheduling + Algorithm + Processing delay	



**Note:	The total algorithmic delay for the encoder and decoder combined is 62 msec. The breakdown in this chart is somewhat arbitrary but it represents a close estimate.

7.2 Vocoder Rate by Index Number

Vocoder Rates by Index Number				
AMBE-1000™ Rates				
Rate Index #	**Total Rate**		**Speech Rate**	**FEC Rate**
0	2400		2400	0
1	3600		3600	0
2	4800		3600	1200
3	4800		4800	0
4	9600		9600	0
5	2400		2350	50
6	9600		4850	4750
7	4800		4550	250
8	4800		3100	1700
9	7200		4400	2800
10	6400		4150	2250
11	3600		3350	250
12	8000		7750	250
13	8000		4650	3350
14	4000		3750	250
15	4000		4000	0
AMBE-2000™ Rates				
Rate Index #	**Total Rate**		**Speech Rate**	**FEC Rate**
16	3600		3600	0
17	4000		4000	0
18	4800		4800	0
19	6400		6400	0
20	8000		8000	0
21	9600		9600	0
22	4000		2400	1600
23	4800		3600	1200
24	4800		4000	800
25	4800		2400	2400
26	6400		4000	2400
27	7200		4400	2800
28	8000		4000	4000
29	9600		2400	7200
30	9600		3600	6000
31	2000		2000	0
32	6400		3600	2800
AMBE-3000F™ Vocoder Chip Rates				
Rate Index #	**Total Rate**		**Speech Rate**	**FEC Rate**
33	3600		2450	1150
34	2450		2450	0
35	3400		2250	1150
36	2250		2250	0
37	2400		2400	0
38	3000		3000	0

39	3600		3600	0
40	4000		4000	0
41	4400		4400	0
42	4800		4800	0
43	6400		6400	0
44	7200		7200	0
45	8000		8000	0
46	9600		9600	0
47	2700		2450	250
48	3600		3350	250
49	4000		3750	250
50	4800		4550	250
51	4400		2450	1950
52	4800		2450	2350
53	6000		2450	3550
54	7200		2450	4750
55	4000		2600	1400
56	4800		3600	1200
57	4800		4000	800
58	6400		4000	2400
59	7200		4400	2800
60	8000		4000	4000
61	9600		3600	6000

Table 119 Rate Index Numbers

Note

Rate Index #32 is compatible with the AMBE-2000™ Vocoder chip however; it is not part of the AMBE-2000™ Vocoder chip standard rate table.

Index rates #32 to #63 are AMBE+2 mode rates

Index rate #33 is interoperable with APCO P25 Half Rate and DMR (Europe)

7.3 Rate - Control Words / Configuration Pin Settings

Total Rate (bps)	Speech Rate (bps)	FEC Rate (bps)	RCW 0	RCW 1	RCW 2	RCW 3	RCW 4	RCW 5	Hardware Pin Numbers					
									121 / E5	122 / A4	123 / B4	124 / C4	125 / D4	126 / A3
2000	2000	0	0x0128	0x0663	0x0000	0x0000	0x0000	0x6428	0	1	1	1	1	1
2250	2250	0	0x042D	0x0754	0x0000	0x0000	0x0000	0x722D	1	0	0	1	0	0
2400	2400	0	0x0030	0x0763	0x0000	0x0000	0x0000	0x4330	0	0	0	0	0	0
	2350	50	0x002F	0x0763	0x0000	0x0000	0x0000	0x6930	0	0	0	1	0	1
	2400	0	0x0430	0x0754	0x0000	0x0000	0x0000	0x6930	1	0	0	1	0	1
2450	2450	0	0x0431	0x0754	0x0000	0x0000	0x0000	0x7031	1	0	0	0	1	0
2700	2450	250	0x0431	0x0754	0x0080	0x0000	0x0000	0x3936	1	0	1	1	1	1
3000	3000	0	0x043C	0x0766	0x0000	0x0000	0x0000	0x673C	1	0	0	1	1	0
3400	2250	1150	0x042D	0x0754	0x2400	0x0000	0x0000	0x7944	1	0	0	0	1	1
3600	3600	0	0x0048	0x0767	0x0000	0x0000	0x0000	0x6F48	0	0	0	0	0	1
	3350	250	0x0043	0x0765	0x0080	0x0000	0x0000	0x5348	0	0	1	0	1	1
	2400[1]	1200	0x0130	0x0763	0x0001	0x0000	0x4230	0x0048	-	-	-	-	-	-
	2400[2]	1200	0x0130	0x0763	0x4000	0x0000	0x0000	0x0048	-	-	-	-	-	-
	2400[3]	1200	0x0030	0x0664	0x4000	0x0000	0x0000	0x0048	-	-	-	-	-	-
	3600	0	0x0248	0x0763	0x0000	0x0000	0x0000	0x3948	0	1	0	0	0	0
	2450[4]	1150	0x0431	0x0754	0x2400	0x0000	0x0000	0x6F48	1	0	0	0	0	1
	3600	0	0x0448	0x0766	0x0000	0x0000	0x0000	0x6848	1	0	0	1	1	1
	3350	250	0x0443	0x0766	0x0080	0x0000	0x0000	0x3948	1	1	0	0	0	0
4000	4000	0	0x0050	0x0887	0x0000	0x0000	0x0000	0x3950	0	0	1	1	1	1
	3750	250	0x004B	0x0767	0x0080	0x0000	0x0000	0x3950	0	0	1	1	1	0
	4000	0	0x0250	0x0765	0x0000	0x0000	0x0000	0x4150	0	1	0	0	0	1
	2400	1600	0x0130	0x0763	0x0001	0x0000	0x341A	0x6750	0	1	0	1	1	0
	4000	0	0x0450	0x0986	0x0000	0x0000	0x0000	0x7450	1	0	1	0	0	0
	3750	250	0x044B	0x0766	0x0080	0x0000	0x0000	0x4150	1	1	0	0	0	1
	2600	1400	0x0434	0x0754	0x2480	0x0000	0x0000	0x6850	1	1	0	1	1	1
4400	4400	0	0x0458	0x0986	0x0000	0x0000	0x0000	0x4458	1	0	1	0	0	1
	2450	1950	0x0431	0x0754	0x0001	0x0000	0x4221	0x6C58	1	1	0	0	1	1
4800	4800	0	0x0060	0x0887	0x0000	0x0000	0x0000	0x7960	0	0	0	0	1	1
	4550	250	0x005B	0x0887	0x0080	0x0000	0x0000	0x6860	0	0	0	1	1	1
	3600	1200	0x0048	0x0767	0x2030	0x0000	0x0000	0x7060	0	0	0	0	1	0
	3100	1700	0x003E	0x0765	0x2800	0x0000	0x0000	0x7460	0	0	1	0	0	0
	4800	0	0x0260	0x0767	0x0000	0x0000	0x0000	0x6C60	0	1	0	0	1	0
	4000	800	0x0250	0x0765	0x2010	0x0000	0x0000	0x7460	0	1	1	0	0	0
	3600	1200	0x0248	0x0763	0x0001	0x0000	0x2412	0x6860	0	1	0	1	1	1
	2400	2400	0x0130	0x0763	0x0005	0x180C	0x3018	0x7360	0	1	1	0	0	1

	4800	0	0x0460	0x0986	0x0000	0x0000	0x0000	0x5660	1	0	1	0	1	0
	4550	250	0x045B	0x0986	0x0080	0x0000	0x0000	0x6C60	1	1	0	0	1	0
	2450	2350	0x0431	0x0754	0x0002	0x0000	0x471E	0x5260	1	1	0	1	0	0
	3600	1200	0x0448	0x0766	0x4000	0x0000	0x0000	0x7460	1	1	1	0	0	0
	4000	800	0x0450	0x0986	0x2010	0x0000	0x0000	0x7360	1	1	1	0	0	1
6000	2450	3550	0x0431	0x0754	0x0002	0x0000	0x6625	0x6978	1	1	0	1	0	1
6400	4150	2250	0x0053	0x0887	0x2C00	0x0000	0x0000	0x5680	0	0	1	0	1	0
	6400	0	0x0280	0x0887	0x0000	0x0000	0x0000	0x6C80	0	1	0	0	1	1
	4000	2400	0x0250	0x0765	0x0001	0x0000	0x542A	0x5280	0	1	1	0	1	0
	3600	2800	0x0248	0x0763	0x0001	0x0000	0x6E3C	0x4380	1	0	0	0	0	0
	6400	0	0x0480	0x0986	0x0000	0x0000	0x0000	0x5380	1	0	1	0	1	1
	4000	2400	0x0450	0x0986	0x8000	0x0000	0x0000	0x5280	1	1	1	0	1	0
7200	4400	2800	0x0058	0x0887	0x3000	0x0000	0x0000	0x4490	0	0	1	0	0	1
	4400	2800	0x0258	0x0765	0x0009	0x1E0C	0x4127	0x7390	0	1	1	0	1	1
	7200	0	0x0490	0x0986	0x0000	0x0000	0x0000	0x4990	1	0	1	1	0	0
	2450	4750	0x0431	0x0754	0x0003	0x0000	0x7E25	0x6790	1	1	0	1	1	0
	4400	2800	0x0458	0x0986	0x8020	0x0000	0x0000	0x7390	1	1	1	0	1	1
8000	7750	250	0x009B	0x0997	0x0080	0x0000	0x0000	0x49A0	0	0	1	1	0	0
	4650	3350	0x005D	0x0887	0x3400	0x0000	0x0000	0x31A0	0	0	1	1	0	1
	8000	0	0x02A0	0x0997	0x0000	0x0000	0x0000	0x52A0	0	1	0	1	0	0
	4000	4000	0x0250	0x0765	0x0005	0x2010	0x6834	0x72A0	0	1	1	1	0	0
	8000	0	0x04A0	0x0986	0x0000	0x0000	0x0000	0x31A0	1	0	1	1	0	1
	4000	4000	0x0450	0x0986	0x0005	0x2412	0x6432	0x72A0	1	1	1	1	0	0
9600	9600	0	0x00C0	0x0997	0x0000	0x0000	0x0000	0x72C0	0	0	0	1	0	0
	4850	4750	0x0061	0x0887	0xE400	0x0000	0x0000	0x67C0	0	0	0	1	1	0
	9600	0	0x02C0	0x0997	0x0000	0x0000	0x0000	0x69C0	0	1	0	1	0	1
	3600	6000	0x0248	0x0763	0x000E	0x4010	0x6A2E	0x65C0	0	1	1	1	1	0
	2400	7200	0x0130	0x0763	0x000E	0x681A	0x511B	0x76C0	0	1	1	1	0	1
	9600	0	0x04C0	0x0986	0x0000	0x0000	0x0000	0x39C0	1	0	1	1	1	0
	3600	6000	0x0448	0x0766	0x000A	0x3612	0x6C24	0x76C0	1	1	1	1	0	1

Table 120 Rate Control Words and Pin Settings

Table Key for and Table 120 Rate Control Words and Pin Settings	
AMBE-1000™ Rates (AMBE® Vocoder)	
AMBE-2000™ Rates (AMBE+™ Vocoder)	
AMBE-3000F™ Vocoder Chip Rates (AMBE+2™ Vocoder)	

NOTE:
[1] **FEC is a convolutional code**
[2] **This rate is interoperable with DSTAR**
[3] **FEC is a block code**
[4] **This rate is interoperable with APCO P25 Half Rate and DMR / dPMR (Europe).**

SECTION 8

8 Support

8.1 DVSI Contact Information

If you have questions regarding the AMBE-3000™- Vocoder Chip please contact:

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Westford, MA 01886 USA

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SECTION 9

9 Environmental Specifications

(As stated by Texas Instruments Inc. Material Declaration Certificate for Semiconductor Products)

Part Number Details

DVSI Part Number	AMBE-3000F™ Vocoder Chip
TI Part Number1	TMS320F2811PBKA
PN Type1A	Std.

Pb-Free (RoHS) Details

RoHS & High-Temp Compatible	Yes
Conversion Date2	10, October 2005 (DC 0541)
Available Supply Date3	30, March 2006

Green (RoHS & no Sb/Br) Details

Green Compliant	Yes
Conversion Date2	10, October 2005 (DC 0541)
Available Supply Date3	30, March 2006

JIG Rating

JIG Material Content Compliance4	Level A & B

Package Details

Package Type	PBK
Pins	128
Assembly Site	TI PHILIPPINES A/T
Current Lead/Ball Finish	CU NIPDAU
Planned Lead/Ball Finish	
Current MSL/Reflow Ratings	Level-2-260C-1YR
Device Mass (mg)	615.000

RoHS Restricted Substances4 (JIG Level A)5

Cadmium (Cd)	ppm	0
	Amount (mg)	0
Hex.Chromium (Cr6+)	ppm	0
	Amount (mg)	0
Lead (Pb)	ppm	300
	Amount (mg)	0.0185
Mercury (Hg)	ppm	0
	Amount (mg)	0
PBB's (RoHS defined)	ppm	0
	Amount (mg)	0
PBDE's (RoHS defined)	ppm	0
	Amount (mg)	0

JIG Level A

All other JIG Level A Substances	ppm	0
	Amount (mg)	0

Green Reportable Substances (JIG Level B)5

Antimony (Sb)	ppm	0
	Amount (mg)	0
Brominated Flame Retardants (Other than PBBS or PBDEs)	ppm	0
	Amount (mg)	0

JIG Level B

Bismuth (Bi)	ppm	0
	Amount (mg)	0
Nickel-Exposed (Ni)	ppm	0
	Amount (mg)	0
All Other JIG Level B Substances	ppm	0
	Amount (mg)	0

Recyclable Metals6

Copper (Cu)	ppm	99739
	Amount (mg)	60.2303
Gold (Au)	ppm	4990
	Amount (mg)	3.0692
Magnesium (Mg)	ppm	0
	Amount (mg)	0
Nickel-Not Exposed (Ni)	ppm	4065
	Amount (mg)	2.5002
Palladium (Pd)	ppm	338
	Amount (mg)	0.2084
Silver (Ag)	ppm	4666
	Amount (mg)	2.8701

Last Update7

17, February 2007

Note (1) - Check the Available Supply Dates before ordering. Orders cannot be placed by assembly site.
Note (1A) - PN Type indicates whether a part number is a "Pb-Free" unique PN or a standard TI PN. If you need to order RoHS & high-temp compatible parts and don't want to hassle with date codes, use the "Pb-Free" unique PN when placing orders.

Note (2) - The forecasted or actual conversion date for the specific device package, pin count, & assembly site. See Glossary of Terms for more details. (http://focus.ti.com/quality/docs/prdcntglossary.jsp?templateId=5909)

Note (3) - The forecasted or actual date that the device will be available for purchase.

Note (4) - If a device's material content is less than the thresholds in the Joint Industry Guide (JIG) Level A & Level B substances tables, then "Level A & B" will be displayed. Other options are "Level A ONLY" or "None". For availability of "Level A & B" devices, use the Green Available Supply Date (ASD). For "Level A ONLY" devices, use the Pb-Free ASD.

Note (5) - ppm calculations are at the homogeneous material level. See Glossary of Terms for more details.
http://focus.ti.com/quality/docs/prdcntglossary.jsp?templateId=5909

Note (6) - ppm calculations are at the component level. See Glossary of Terms for more details.
http://focus.ti.com/quality/docs/prdcntglossary.jsp?templateId=5909

Note (7) - Reflects the date when a change was last detected in the associated row of information. Change monitoring began 2005-08-11.

Important Part Information
There is a remote possibility the Customer Part Number (CPN) your company uses could reference more than one TI part number. This is due to two or more users (EMSIs or subcontractors) using the same CPN for different TI part numbers. If this occurs, please check your Customer Part Number and cross reference it with the TI part number seen on this page.

Product Content Methodology

For an explanation of the methods used to determine material weights, See Product Content Methodology,
http://focus.ti.com/quality/docs/gencontent.tsp?templateId=5909&navigationId=11220&path=templatedata/cm/ecoinfo/data/esh_methodology

Important Warranty and Disclaimer Information
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10 IC Chip Software Errata

DVSI reserves the right to make modifications, enhancements, improvements and other changes to the AMBE-3000F™ Vocoder Chip at any time without notice. This errata section provides updated information on software developments as it pertains to the release number and release date. To identify the software release number of the AMBE-3000F™ Vocoder Chip refer to the PKT_VERSTRING field in Section Packet Fields.

Release 002 — 7/28/2008

Original AMBE-3000F release.

Release 003 — 9/28/2008

Modified the AMBE-3000F™ to set TXRDY low after a packet is transmitted, and then set it high again if there is already another packet in the buffer awaiting transmission. This prevents the AMBE-3000F™ from having multiple packets in it's transmit buffer when using the PPT interface and assures that the TXRDY pin is set.

Modified the PPT interface so that if an attempt to read from the PPT is made when the AMBE-3000F™ Vocoder Chip does not have any data available, then the user will read a fixed value (0x34). This should only happen if the user attempts to read from the PPT when TXRDY is low.

To better meet the specifications of Texas Instruments AIC14 Codec the I^2C interface was modified to insert a delay between SCL and SDA transitions.

Added more control packet fields as described in the users manual: PKT_WRITEI2C, PKT_SETCODECRESET, PKT_CLEARCODECRESET, PKT_DISCARDCODEC, PKT_DELAYNUS, and PKT_DELAYNNS

Release 004 — 11/14/2008

Improved the performance of the FEC decoder when Golay codes are used.

Release 005 — 06/02/2009

Added RTSn signal to support flow control. Flow control allows for better throughput when the AMBE-3000F™ is operated in packet mode.

Added PKT_RTSTHRESH and PKT_GAIN control packet fields. See sections in the user's manual.

As another form of flow control. If a packet to be transmitted will not fit in the transmit buffer, then wait until it fits. The encoding or decoding of packets is stopped if the transmit is not keeping up. Primarily needed if consecutive channel packets are passed to the AMBE-3000F™ in packet mode.

Packets should only be sent to the AMBE-3000F™ when RTSn is low. If the AMBE-3000F™ receives a packet that does not fit into the receive buffer, it discards the oldest packet, and acts as if it had never received it.

Optimizations to increase speed and reduce power usage.

Allow the use of TXRQST signal for skew control, when the number of samples in a frame is less than 160.
Call Progress tones work around based on rate.

Release 007 09/10/2009

Release 007 Improves the quality of single frequency tones and call progress tones for AMBE-1000™ Vocoder Chip compatible rates.

In Release 007 the FEC error mitigation thresholds are set properly regardless of the order the PKT_RATE(T/P) and PKT_INIT fields are sent. When an FEC rate is selected via the rate configuration pins, the error mitigation thresholds are also set to the appropriate value for the selected FEC.

In prior releases, PKT_INIT resets the FEC error mitigation thresholds to 0. Therefore, after sending PKT_INIT it is always necessary to send PKT_RATET or PKT_RATEP to set the error mitigation thresholds to the appropriate value for the selected FEC. For prior releases, if FEC is used, it is necessary to send PKT_RATET or PKT_RATEP in order for the FEC error mitigation thresholds to be set properly. In Release 007, it is not necessary to send PKT_RATET or PKT_RATEP when FEC is used.

For Release 007, packet parity bytes can be disabled at reset using the parity enable pin. Parity can also be disabled using a soft-reset packet (using a PKT_RESETSOFTCFG field) to specify that parity should be disabled.

The parity enable pin can be used to disable parity bytes. This feature was not available in Release 005.

Release 014 08/31/2012

Product ID = <AMBE3000F>
Version String = <V121.E100.XXXX.C110.G514.R014.A0030608.C0020208>

Skew Control. In Release 014, the Skew Control works as described in this manual. This affects customers using codec mode who are using TXRQST to control frame boundaries. No simple workaround is available for older releases.

MCBSP Initialization modification. In Release 014, the MCBSP initialization is properly synchronized with the frame sync signal. This only affects customers who are using codec mode and who have selected the MCBSP as the codec interface. Workarounds are available for older releases.

SPI @ 128 KHz modification. Release 014, resolves the issue of glitches in some decoder output samples when running the SPI @ 128 KHz. This affects customers who are using codec mode and have selected the SPI as the codec interface. A workaround is available for older releases.

cmode LOST_FRAME bit ignored. In this Release 014, the cmode LOST_FRAME bit works as described in this manual. In prior releases the only way to cause a frame repeat was to omit a packet. This affects customers who are using codec mode and who use the cmode LOST_FRAME bit to make the decoder do a frame repeat.

11 History of Revisions

History of Revisions			
Revision Number	Date of Revision	Description	Pages
1.02	Oct 7, 2008	Edited Table 39 PKT_COMPAND Field Format	54
		Edited Table 45 PKT_RATEP Field Example Custom rate words	55
1.03	Oct 14, 2008	Revised Table 17 SPI Interface Pins pin 31 and pin 32	16
		Revised Timing Diagram	16
		Revised Figure 3 AMBE-3000F™ Vocoder Chip Pins for LQFP Package- pin 31 pin 32 and pin106	35
		Revised Table 1 Pinout List Pins 24 Input description	37
		Revised Table 1 Pinout List Pins 31 and Pin 32 descriptions	37
		Revised Table 1 Pinout List Pin 106 Name	40
		Revised Figure 39 AMBE-3000F™ Vocoder Chip and TLV320AIC14 Interface Block Diagram	47
1.04	Dec 9 2008	Added Skew Control (SK_ENABLE TQFP pin 6 BGA pin D3)	14
		Revised Figure 32 Timing of McBSP When Selected as Codec Interface	34
		Added Table 22 McBSP Codec Interface Timing	34
		Revised Table 23 McBSP Packet Interface Timing	35
		Re-ordered parts of Sections 2 and 3	
1.05	Feb 19 2009	Edited Skew Control Codec Mode Description	17
1.06	April 20, 2009	Edited Table 119 Rate Index Numbers to indicate rate #32 is compatible to the AMBE-2000™ Vocoder chip	75
		Edited Note to explain that the rate require custom Control words for the AMBE-2000™ Vocoder chip	75
		Edited Table 120 Rate Control Words and Pin Settings to indicate rate #32 is compatible to the AMBE-2000™ Vocoder chip	77
1.07	June 2009	Added BGA information	-
		Added PKT_RTSTHRESH and PKT_GAIN to Control Packet Fields	60
1.08	July 2009	Added Single Tone Information to table Table 104 TONE Index Values	77
		Added information on which pins have internal pullup or pulldown	37
		Edited Table 8 Typical AMBE-3000F™ Vocoder Chip Power Measurements	35
		Removed references to Parity Enable Pin 79	
1.09	September 2009	Edited table Table 22 McBSP Codec Interface Timing	50
		Edited Section Special Handling	3

1.10	October 2009	Edited PKT_VERSTRING Response field description	61
		Added Section IC Chip Software Errata	86
History of Revisions			
Revision Number	Date of Revision	Description	Pages
1.11	November 2009	Edited Table 104 TONE Index Values	79
		Edited CMODE Field description	
		Edited PKT_INIT Field description	
2.0	April 2010	Various Typographical and Formatting edits	
		Edits to Section 2.7 Crystal / Oscillator Usage	19
		Edits to Sections 3.3 to 3.7	21-24
		Edits to Section 5.5 SPI Interface	46
		Edits to Section 5.7 McBSP Interface	48
		Edits to Section 6.5 Packet Format	59
		Edits to Table 32 Control Packet Fields	62
		Edits to Table 62 PKT_CHANFMT Data Settings	69
		Edits to Table 65 PKT_SPCHFMT Data Settings	70
2.1	May 2010	Edited TX_RDY description in table 2.5	12
2.2	May 2010	Edited DTMF description Section 4.5.3	30
2.3	August 2010	Highlighted Note for Rate Table.	83
		Added Notes to PKT_CHANFMT and PKT_SPCHFMT Fields	61-62
		Added Table 101 CMODE Parameters Table	72
2.4	October 2010	Added Custom Rate Interoperable with DSTAR in Table 120 Rate Control Words and Pin Settings	83
2.5	December 2010	Moved Custom Rate Interoperable with DSTAR in Table 120 Rate Control Words and Pin Settings to show it is a AMBE+™ Vocoder Rate	83
2.6	March 2011	Corrected hyperlink cross-references and edited Figure 36 Vocoder Front End, Figure 37 Front End Input Filter Mask and Figure 38 Front End Output Filter Mask	47-48
		Edited D-Star rate in Note for Table 120 Rate Control Words and Pin Settings	83
2.7	April 2011	Edited Figure 40 AMBE-3000F™ Vocoder Chip and PCM3500 Interface Block Diagram	56
		Added Note to **PKT_GAIN** and **PKT_GAIN Response** Packets	78
		Edited Table 104 TONE Index Values to show Tone Index value for various Rate Indexes	81
		Added Algorithmic and Processing delay details	90
2.8	August 2011	Removed (pin 57 TQFP) and (pin M9 BGA) from the No Connection section of Table 1 Pinout List	16
		Edited dcmode information in Table 62 PKT_CHANFMT Data Settings	69
		Edited data response byte -- Table 63 PKT_CHANFMT Response Field	69

History of Revisions			
Revision Number	Date of Revision	Description	Pages
2.9	May 2012	Edited Table 26 PPT Timing	53
		Edited Response Field Tables	57-70
		Added Section 3.6 Reset Behavior	23
		Added Section 4.4 Vocoder State	31
		Edited Section 5.1 Operating Modes Introduction	35
		Added Section 5.2.1 Timing of channel transmit packets in Codec Mode	40
		Added Section 5.6.1 UART_TX Pin State	48
		Edited PKT_PRODID and PKT_VERSTRING description	71
		Modified Table 8 Typical AMBE-3000F™ Vocoder Chip Power Measurements	28
		Edited Chip Markings Information	8 - 9
3.0	June 2012	Added section 2.7.3 Input Clock Requirements	20
3.1	September 2012	Added description of Version Release 014	98
		Added information on Echo canceller initilization	66
3.2	December 2012	Edited Figure 40 AMBE-3000F™ Vocoder Chip and PCM3500 Interface Block Diagram	57
		Edited Table 54 PKT_CODECCFG Field Example Data (default values shown)	67
		Added note regarding moisture sensitivity of the AMBE-3000F™ BGA chip in section 2.1 Special Handling and Moisture Sensitivity	3
3.3	March 2013	Edited length field and description text for the following tables: Table 115 Speech Packet Example 1; Table 116 Speech Packet Example 2; Table 118 Channel Packet Example 2	86 - 89
		Edited PKT_GAIN note	78
3.4	April 2014	Edited Figure 40 AMBE-3000F™ Vocoder Chip and PCM3500 Interface Block Diagram	57
3.5	December 2015	Edited Section 3.5 Power Sequencing Requirements	22
3.6	April 2016	Edited Echo Canceller and Ech Suppressor descriptions to include *(not supported in Packet Mode)*	various
3.7	October 2016	Edited **PKT_GETCFG** field description	74
3.8	August 2018	Added information regarding Tone generation and detection in Sections 6.7.1, 6.9.1, 6.10, and 6.11	various
3.9	September 2018	**Edited END USER PRODUCT License Agreement**	