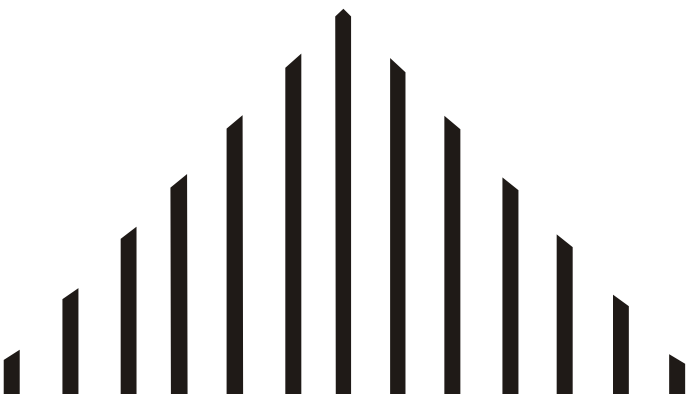
DIGITAL VOICE SYSTEMS, INC.

The Speech Compression Specialists

AMBE-3000™ Vocoder Chip

Users Manual
Version 2.8
August, 2011



DVSI Confidential Proprietary

AMBE-3000™ Vocoder Chip
Users Manual
Version **2.8**
August, 2011

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

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Westford, MA 01886

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Table of Contents

1 PRODUCT INTRODUCTION 1

1.1 Advances in Vocoder Design 1

1.2 AMBE-3000™ Vocoder Chip Features 1

1.3 Typical Applications 2

2 HARDWARE INFORMATION 3

2.1 Special Handling Instructions 3

2.2 Package Details 4

2.2.1 128-pin Low-Profile Quad Flat Pack (LQFP) 4

2.2.2 179 Pin Ball Grid Array (BGA) 5

2.3 Pin Assignment Layouts 6

2.3.1 LQFP Package 6

2.3.2 BGA Package Pins (Bottom View) 7

2.4 AMBE-3000™ Vocoder Chip Markings 8

2.4.1 AMBE-3000™ Vocoder Chip LQFP Markings 8

2.4.2 AMBE-3000™ Vocoder Chip BGA Markings 9

2.5 Pin Out Table 10

2.6 Hardware Configuration Pins 17

2.7 Crystal / Oscillator Usage 18

2.7.1 External Clock Source 18

2.7.2 Crystal Oscillator 19

3 ELECTRICAL CHARACTERISTICS AND REQUIREMENTS 20

3.1 Normal Operating Conditions 20

3.2 Recommended Operating Conditions 20

3.3 Absolute Maximum Ratings 20

3.4 Thermal Resistance Characteristics 21

3.5 Power Sequencing Requirements 21

3.6 Signal Transition Levels 22

3.7 Power-Down Sequencing: 22

3.8 Low Power Modes 23

3.8.1 Run State 24

3.8.2 Idle State 24

3.8.3 Standby State 24

3.8.4 Halt State 24

3.8.5 Power Modes 24

3.8.6 Low power mode when using the UART Packet Interface 25

3.8.7 Low Power Mode when using the McBSP Packet Interface 25

3.8.8 Low Power Mode when using the McBSP Codec Interface 25

3.8.9 Low Power Mode when using the SPI Codec Interface 25

3.8.10 Low Power Mode when using the Parallel Packet Interface 25

3.8.11 Additional Requirements when Low Power Mode is enabled. 26

3.8.12 Typical AMBE-3000™ Vocoder Chip Power Measurements: *26*

4 INITIAL DESIGN CONSIDERATIONS 27

4.1 Vocoder Speech and FEC Rate Selection 27

4.2 Interface Selection 27

4.3 A/D – D/A Codec chip Selection 28

4.4 Special Functions Description 28

4.4.1 Voice Activity Detection & Comfort Noise Insertion 29
4.4.2 Echo Canceller (EC_ENABLE TQFP pin120 BGA pin D5) 29
4.4.3 DTMF Dual Tone Multiple Frequency, Detection and Generation 30
4.4.4 Soft Decision Error Correction 30
4.4.5 Skew Control (SK_ENABLE TQFP pin 6 BGA pin D3) 30
4.4.6 Noise Suppressor (NS_ENABLE TQFP pin 7 BGA pin D2) 30
4.4.7 Companding Using A-Law and μ-Law 31

5 I/O MANAGEMENT 32

5.1 Operating Modes 35

5.1.1 Codec mode 35
5.1.2 I/O Handler in Codec Mode 36
5.1.3 Packet Mode 37
5.1.4 I/O Handler In Packet Mode 38
5.1.5 Switching between codec mode and packet mode using packets 39

5.2 SPI Interface 40

5.3 UART Interface 41

5.4 McBSP Interface 42

5.4.1 McBSP Selected for Codec Interface 42
5.4.2 McBSP Selected for Packet Interface 43

5.5 Parallel Interface 45

5.5.1 Parallel Port Packet Interface 45

5.6 Codec A/D / D/A Interface 46

5.7 Vocoder Front End Requirements 46

5.8 Interfacing a codec to the AMBE-3000™ Vocoder chip 49

5.8.1 The Texas Instruments General purpose TLV320AIC14 49
5.8.2 The Texas Instruments PCM3500 General purpose codec 50

6 DATA AND CONFIGURATION PACKETS 51

6.1 Overview 51

6.2 Codec Mode Operation 51

6.3 Packet Mode Operation 51

6.4 Packet Interfaces 52

6.5 Packet Format 52

6.5.1 START_BYTE (1 byte) 52
6.5.2 LENGTH (2 bytes) 52
6.5.3 TYPE (1 byte) 53
6.5.4 Packet Fields 53
6.5.5 Parity Field (Parity is enabled by default) 54

6.6 Control Packet Format (Packet Type 0x00) 54
6.6.1 Control Packet Fields and Response Fields *54*
6.7 Input Speech Packet Format (Packet Type 0x02) 71
6.7.1 Speech Packet Fields *71*
6.8 Output Speech Packets Format (Packet Type 0x02) 74
6.9 Input Channel Packet Format (Packet Type 0x01) 74
6.9.1 Channel Packet Fields *74*
6.10 Output Channel Packet Format (Packet Type 0x01) 76
6.11 Example Packets 76
6.11.1 Speech Packet Example 1 ..... *76*
6.11.2 Speech Packet Example 2 ..... *77*
6.11.3 Channel Packet Example 1 ..... *78*
6.11.4 Channel Packet Example 2 ..... *79*

7 APPENDICES 80
7.1 Algorithmic and Processing Delays 80
7.2 Vocoder Rate by Index Number 81
7.3 Rate - Control Words / Configuration Pin Settings 83

8 SUPPORT 85
8.1 DVSI Contact Information 85

9 ENVIRONMENTAL SPECIFICATIONS 86

10 IC CHIP SOFTWARE ERRATA 89

11 HISTORY OF REVISIONS 91

List of Figures

Figure 1 TQFP Mechanical Details 4
Figure 2 BGA Mechanical Details 5
Figure 3 AMBE-3000™ Vocoder Chip Pins for LQFP Package 6
Figure 4 AMBE-3000™ Vocoder Chip Pins Bottom View of BGA chip 7
Figure 5 AMBE-3000™ Vocoder Chip LQFP Markings 8
Figure 6 AMBE-3000™ Vocoder Chip Markings for BGA 9
Figure 7 X1/XCLKIN and X2 with TTL/CMOS Clock Source 18
Figure 8 X1/XCLKIN and X2 with Crystal Oscillator 19
Figure 9 Output Levels 22
Figure 10 Input Levels 22
Figure 11 AMBE-3000™ Vocoder Chip Power States 23
Figure 12 Power Mode States Basic Timing 24
Figure 13 Power Modes 25
Figure 14 Basic Operation 27
Figure 15 Typical Echo Path 29
Figure 16 Codec Mode (SPI Interface) 35
Figure 17 Codec Mode (McBSP Interface) 36
Figure 18 Interface BLOCK Diagram Codec Mode 37

Figure 19 Interface Block Diagram Packet Mode 38
Figure 20 Packet Mode..... 39
Figure 21 SPI Timing 40
Figure 22 Timing of SPI_GENSTE 41
Figure 23 Timing of McBSP When Selected as Codec Interface..... 43
Figure 24 Timing of McBSP when Selected as Packet Interface..... 44
Figure 25 PPT Interface Timing 46
Figure 26 Typical Vocoder Implementation 47
Figure 27 Vocoder Front End 47
Figure 28 Front End Input Filter Mask 48
Figure 29 Front End Output Filter Mask 48
Figure 30 AMBE-3000™ Vocoder Chip and TLV320AIC14 Interface Block Diagram 49
Figure 31 AMBE-3000™ Vocoder Chip and PCM3500 Interface Block Diagram 50

List of Tables

Table 1 Pinout List 15
Table 2 Hardware Configuration Settings..... 17
Table 3 Normal Operating Conditions..... 20
Table 4 Recommended Operating Conditions..... 20
Table 5 Absolute Maximum Ratings 21
Table 6 Thermal Resistance Characteristics..... 21
Table 7 Voltage Supply Pins..... 21
Table 8 Typical AMBE-3000™ Vocoder Chip Power Measurements 26
Table 9 Physical Interface Selection 28
Table 10 Soft Decision Error Correction 30
Table 11 Companding Control..... 31
Table 12 Companding Selection 31
Table 13 ECMODE_IN Flags 33
Table 14 ECMODE_OUT FLAGS..... 33
Table 15 DCMODE_IN Flags..... 34
Table 16 DCMODE_OUT Flags 34
Table 17 SPI Interface Pins 40
Table 18 SPI Timing 40
Table 19 UART Interface Pins..... 41
Table 20 UART Baud Rates..... 42
Table 21 McBSP Interface Pins..... 42
Table 22 McBSP Codec Interface Timing 43
Table 23 McBSP Packet Interface Timing 44
Table 24 McBSP Clock Rates..... 45
Table 25 Parallel (PPT) Interface Pins..... 45
Table 26 PPT Timing..... 46
Table 27 Control Register Value for the TLV320AIC14 49
Table 28 General Packet Format WITHOUT Parity Field 52
Table 29 General Packet Format WITH Parity Field..... 52
Table 30 Packet Types..... 53
Table 31 General Field Format 53
Table 32 Control Packet Fields 55
Table 33 PKT_CHANNEL(0) Field Format..... 55
Table 34 PKT_CHANNEL(0) Response Field Format 55
Table 35 PKT_ECMODE Field Format 55
Table 36 PKT_ECMODE Field Response Format..... 56
Table 37 PKT_DCMODE Field Format..... 56

Table 38 PKT_DCMODE Response Field Format 56
Table 39 PKT_COMPAND Field Format 56
Table 40 PKT_COMPAND Field Options 56
Table 41 PKT_COMPAND Response Field Format 57
Table 42 PKT_RATET Field Format 57
Table 43 PKT_RATET Response Field Format 57
Table 44 PKT_RATEP Field Format 57
Table 45 PKT_RATEP Field Example 57
Table 46 PKT_RATEP Response Field Format 58
Table 47 PKT_INIT Field Format 58
Table 48 PKT_INIT Field - Data 58
Table 49 PKT_INIT Response Field Format 58
Table 50 PKT_LOWPOWER Field Format 59
Table 51 PKT_LOWPOWER Field Settings 59
Table 52 PKT_LOWPOWER Response Field Format 59
Table 53 PKT_CODECCFG Field Format 59
Table 54 PKT_CODECCFG Field Example Data 60
Table 55 PKT_CODECCFG Response Field Format 60
Table 56 PKT_CODECSTART Field Format 60
Table 57 PKT_CODECSTART Field Data 60
Table 58 PKT_CODECSTART Response Field Format 60
Table 59 PKT_CODECSTOP Field 61
Table 60 PKT_CODECSTOP Response Field Format 61
Table 61 PKT_CHANFMT Field 61
Table 62 PKT_CHANFMT Data Settings 62
Table 63 PKT_CHANFMT Response Field 62
Table 64 PKT_SPCHFMT Field 62
Table 65 PKT_SPCHFMT Data Settings 63
Table 66 PKT_SPCHFMT Response Field 63
Table 67 PKT_PRODID Field 63
Table 68 PKT_PRODID Response Field 63
Table 69 PKT_VERSTRING Field 63
Table 70 PKT_VERSTRING Response Field 64
Table 71 PKT_READY Field 64
Table 72 PKT_HALT Field 64
Table 73 PKT_RESET Field 64
Table 74 Software Override of Hardware Configuration Pins 65
Table 75 PKT_RESETSOFTCFG Field 66
Table 76 PKT_GETCFG Field 66
Table 77 PKT_GETCFG Response Field 66
Table 78 PKT_READCFG Field 66
Table 79 PKT_READCFG Response Field 66
Table 80 PKT_PARITYMODE Field Format 67
Table 81 PKT_PARITYMODE Response Field 67
Table 82 PKT_ WRITEI2C Field Format 67
Table 83 PKT_WRITEI2C Response Field 67
Table 84 PKT_CLRCODECRESET Field Format 67
Table 85 PKT_CLRCODECRESET Response Field 68
Table 86 PKT_SETCODECRESET Field Format 68
Table 87 PKT_SETCODECRESET Response Field 68
Table 88 PKT_DISCARDCODEC Field Format 68
Table 89 PKT_DISCARDCODEC Response Field 68
Table 90 PKT_DELAYNUS Field Format 69

Table 91 PKT_DELAYNUS Response Field 69
Table 92 PKT_DELAYNUS Field Format 69
Table 93 PKT_DELAYNNS Response Field 69
Table 94 PKT_RTSTHRESH Field Format 69
Table 95 PKT_RTSTHRESH Response Field 70
Table 96 PKT_GAIN Field Format 70
Table 97 PKT_GAIN Response Field 70
Table 98 Speech Packet Fields 71
Table 99 SPEECHD Field Format 71
Table 100 CMODE Field Format 72
Table 101 CMODE Parameters Table 72
Table 102 CMODE Parameters Table Key 72
Table 103 TONE Field Format 72
Table 104 TONE Index Values 73
Table 105 TONE AMPLITUDE Values 73
Table 106 Channel Packet Fields 74
Table 107 CHAND Field - Format 74
Table 108 CHAND4 Field - Format 75
Table 109 SAMPLES Field - Format 75
Table 110 TONE Field Format 76
Table 111 Speech Packet Example 1 77
Table 112 Speech Packet Example 2 78
Table 113 Channel Packet Example 1 78
Table 114 Channel Packet Example 2 79
Table 115 Rate Index Numbers 82
Table 116 Rate Control Words and Pin Settings 84

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 including DMR in Europe and APCO Project 25 in North America. In addition, satellite systems such as Inmarsat, BGAN use this technology because of its superior voice quality at low bit rates.

1.1 Advances in Vocoder Design

The AMBE-3000™ Vocoder Chip voice coder maintains natural voice quality and speech intelligibility at rates as low as 2.0 kbits/sec. The AMBE-3000™ 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-3000™ 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
- ◊ 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

2 Hardware Information

The AMBE-3000™ 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 Instructions

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-3000™ 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-168hr

2.2 Package Details

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

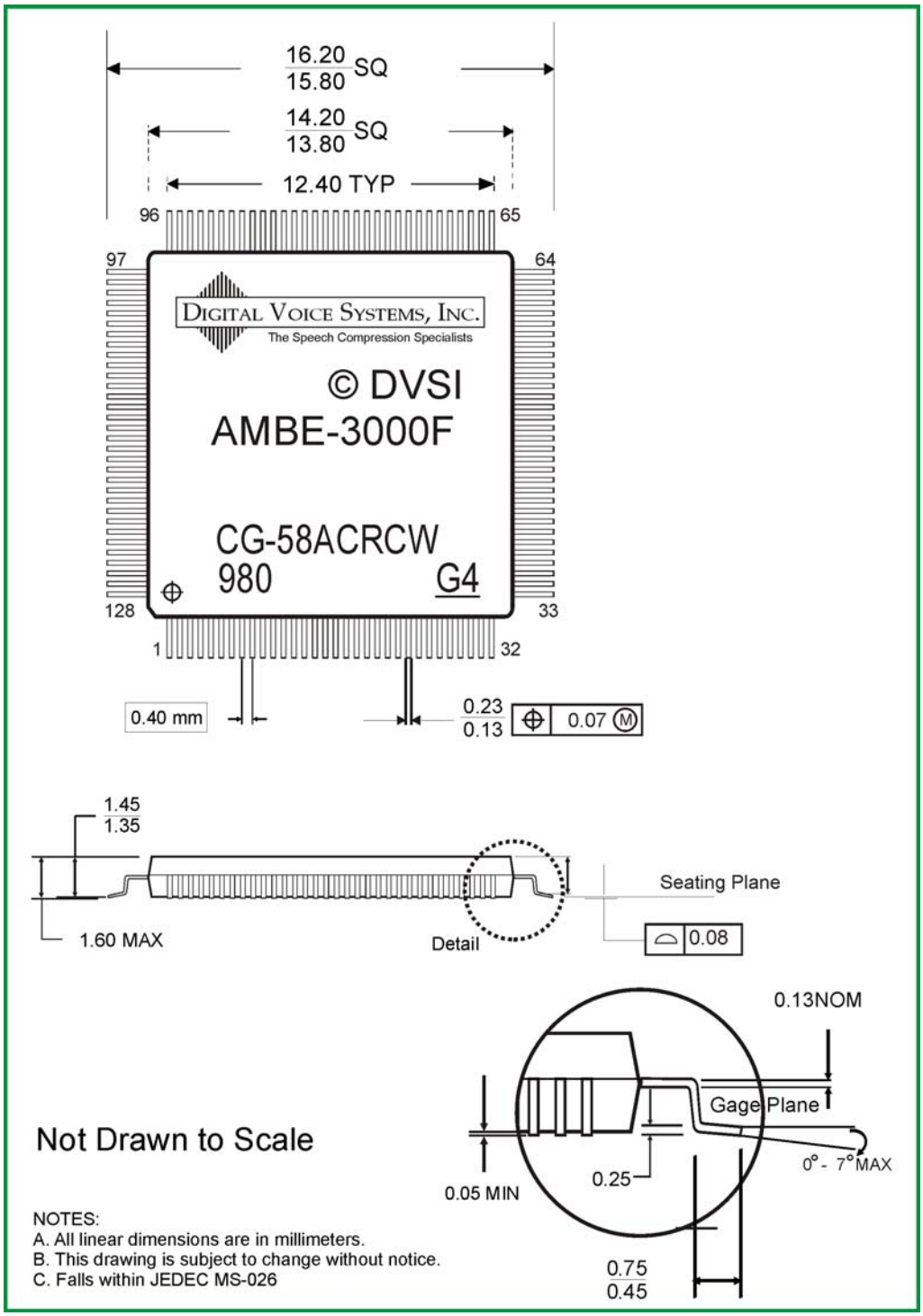


Figure 1 TQFP Mechanical Details

2.2.2 179 Pin Ball Grid Array (BGA)

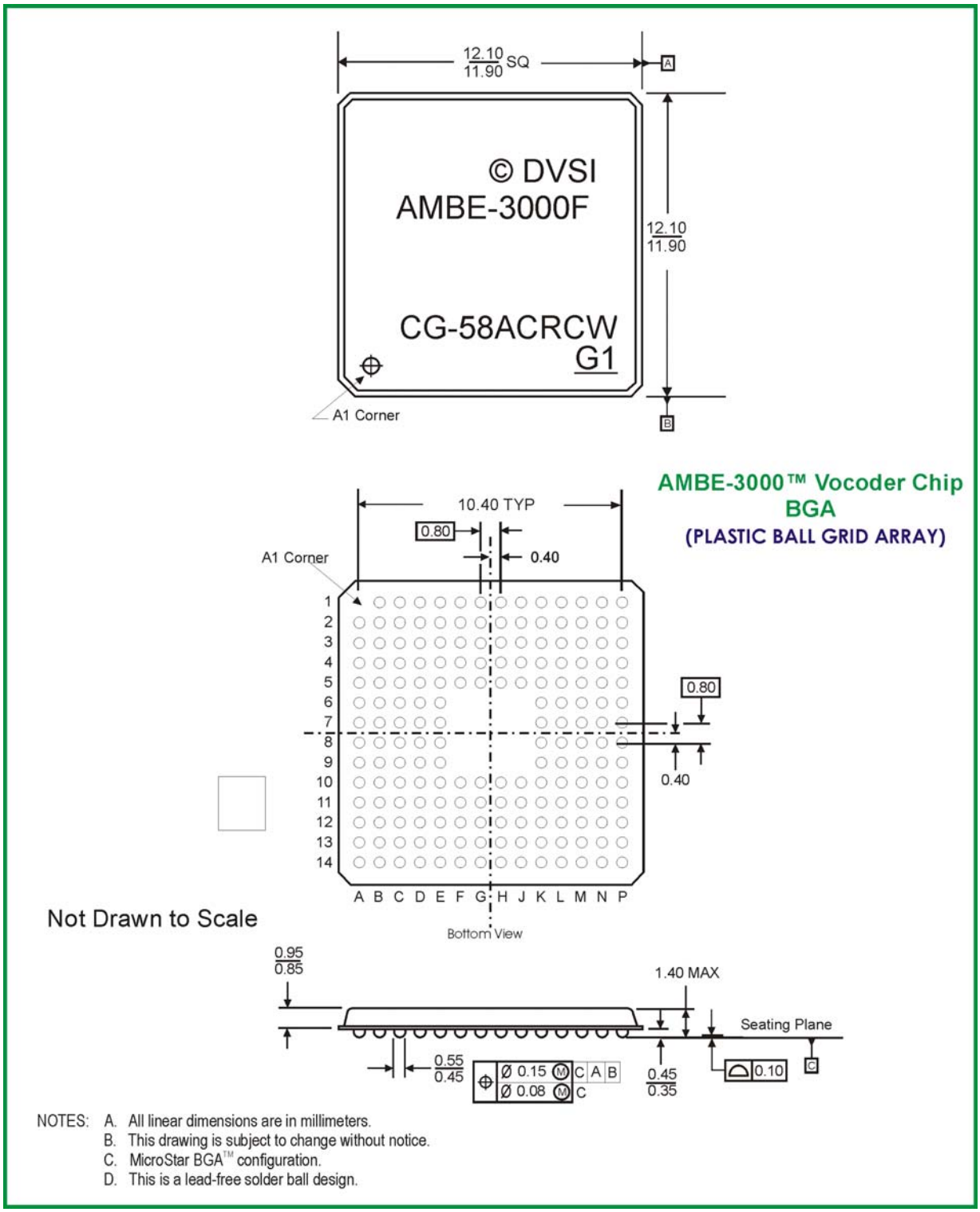


Figure 2 BGA Mechanical Details

2.3 Pin Assignment Layouts

2.3.1 LQFP Package

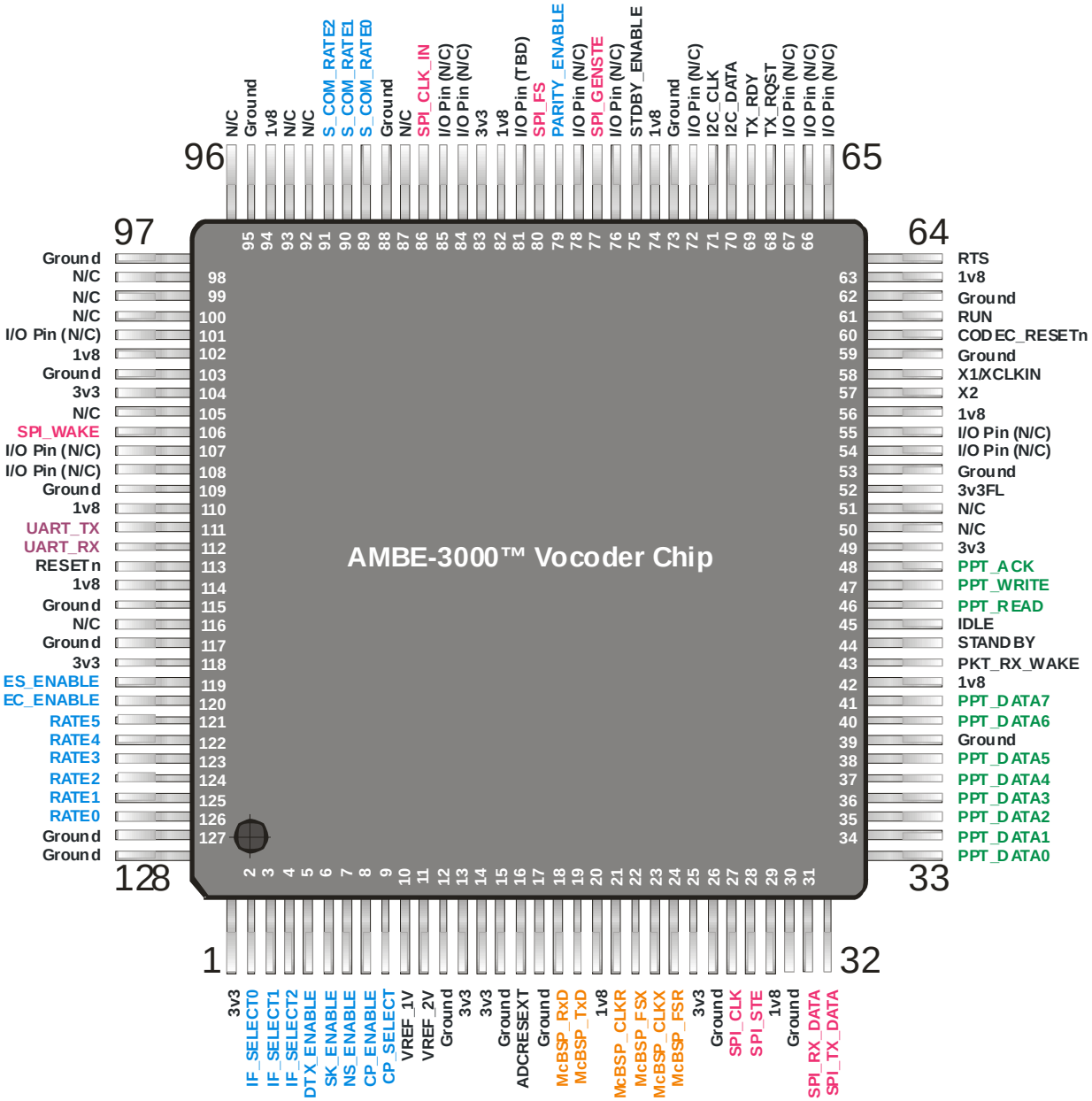


Figure 3 AMBE-3000™ Vocoder Chip Pins for LQFP Package

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)

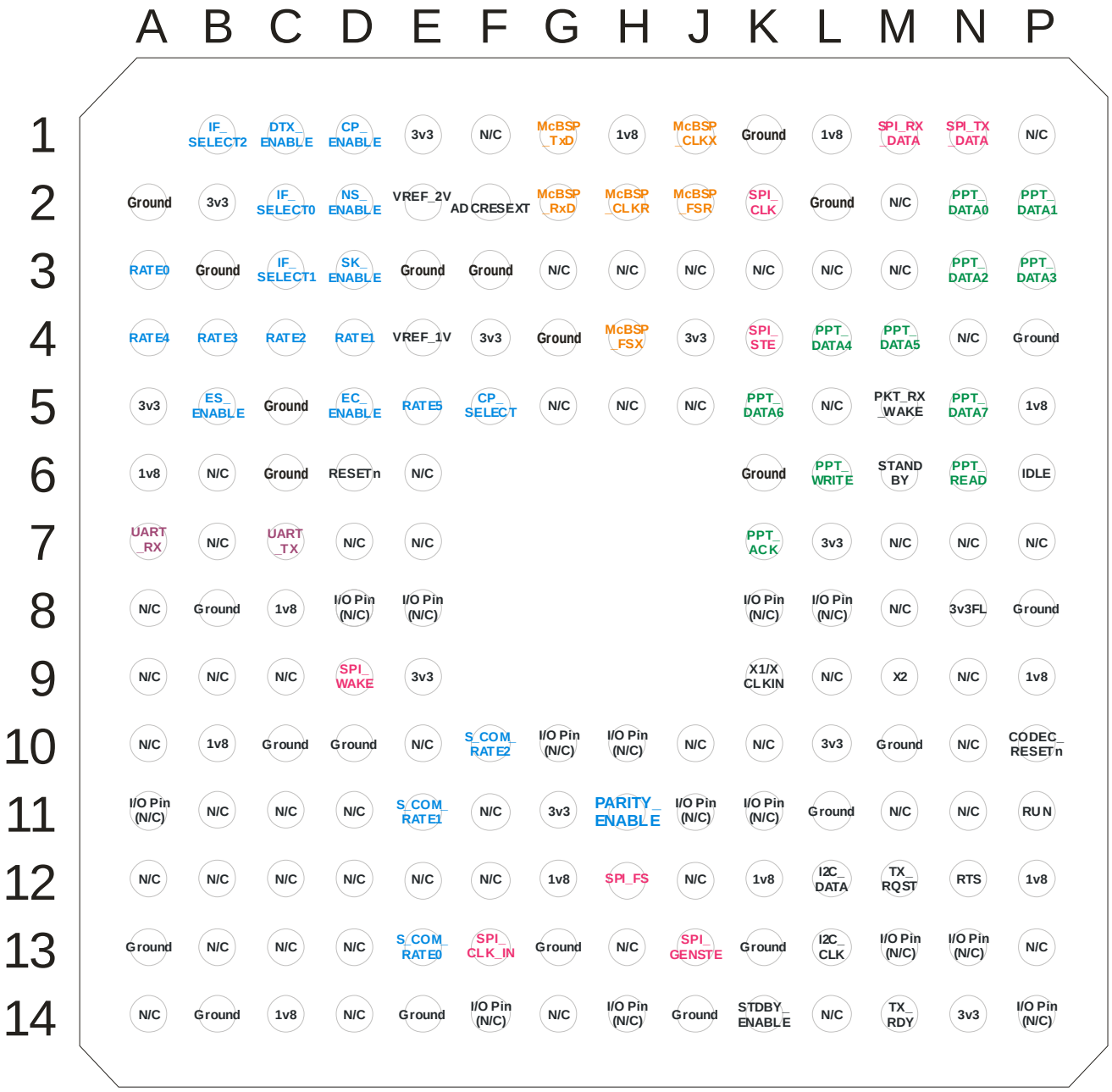


Figure 4 AMBE-3000™ Vocoder Chip Pins Bottom View of BGA chip

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-3000™ Vocoder Chip Markings

2.4.1 AMBE-3000™ Vocoder Chip LQFP Markings

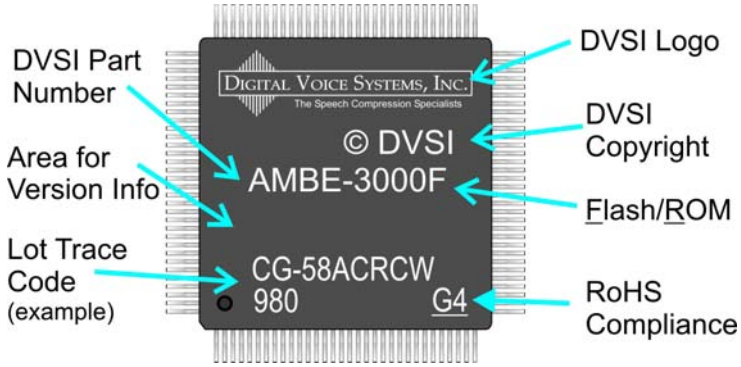


Figure 5 AMBE-3000™ Vocoder Chip LQFP Markings

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-3000™**

Flash / ROM --- This letter (F or R) indicates the internal memory type. F= Flash Memory R = ROM Memory

Area for Version Info
Indicates the software version on the chip. The version number is only written on chips that are ROM (R) based parts -- indicated by the letter R as described above. To verify the version of a Flash chip (F) refer to the **PKT_VERSTRING** field as described in Table 69 PKT_VERSTRING Field

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-3000™ Vocoder Chip BGA Markings

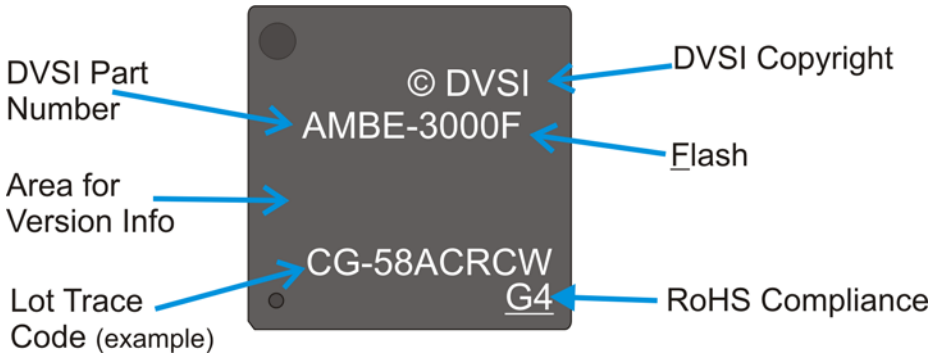


Figure 6 AMBE-3000™ Vocoder Chip Markings for BGA

© DVSI --- Copyright Digital Voice Systems, Incorporated

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

Flash / ROM --- This letter (F or R) indicates the internal memory type. F= Flash Memory R = ROM Memory

Area for Version Info
Indicates the software version on the chip. The version number is only written on chips that are ROM (R) based parts -- indicated by the letter R as described above. To verify the version of a Flash chip (F) refer to the **PKT_VERSTRING** field as described in Table 69 PKT_VERSTRING Field

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
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

RoHSCompliance
G4 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-3000™ Vocoder Chip.
SPI_RX_DATA	31	M1	Input	PCM Data from A/D Converter to AMBE-3000™ Vocoder Chip
SPI_TX_DATA	32	N1	Output	PCM Data from AMBE-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ Vocoder Chip to codec)
I^2C_CLK	71	L13	Output	I^2C_CLK (output from AMBE-3000™ 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-3000™ 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-3000™ Vocoder Chip from stand-by mode.
UART_TX	111	C7	Output	Channel Transmit Data from AMBE-3000™ 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-3000™ Vocoder Chip asynchronous serial port.
RESETn	113	D6	Input	AMBE-3000™ Vocoder Chip Reset pin. Active LOW
ES_ENABLE	119	B5	Input	Echo Suppressor enable / disable
EC_ENABLE	120	D5	Input	Echo Canceller enable / disable
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 4.4.4
6	D3	SK_ENABLE	See Section 4.4.5
7	D2	NS_ENABLE	See Section 4.4.6
8	D1	CP_ENABLE	See Section 4.4.7
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
120	D5	EC_ENABLE	Echo Cancellation enable Pin
121	E5	RATE5	See Table 116 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-3000™ 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-3000™ 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:

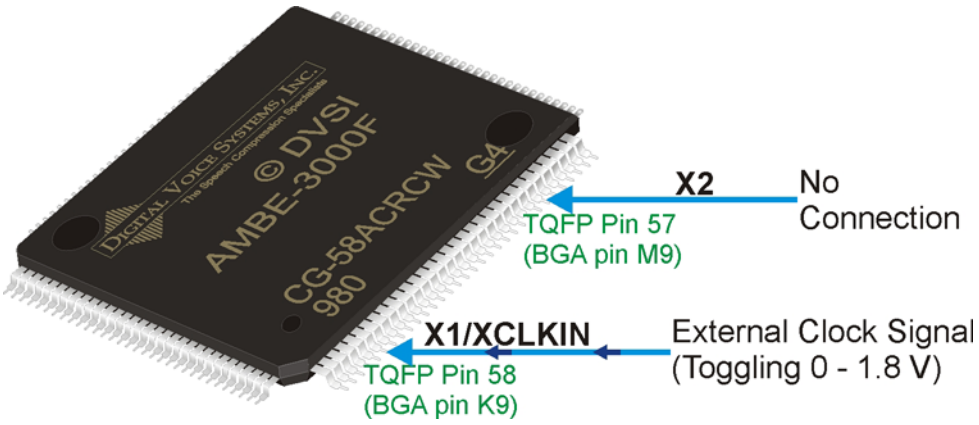


Figure 7 X1/XCLKIN and X2 with TTL/CMOS Clock Source

2.7.2 Crystal Oscillator

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

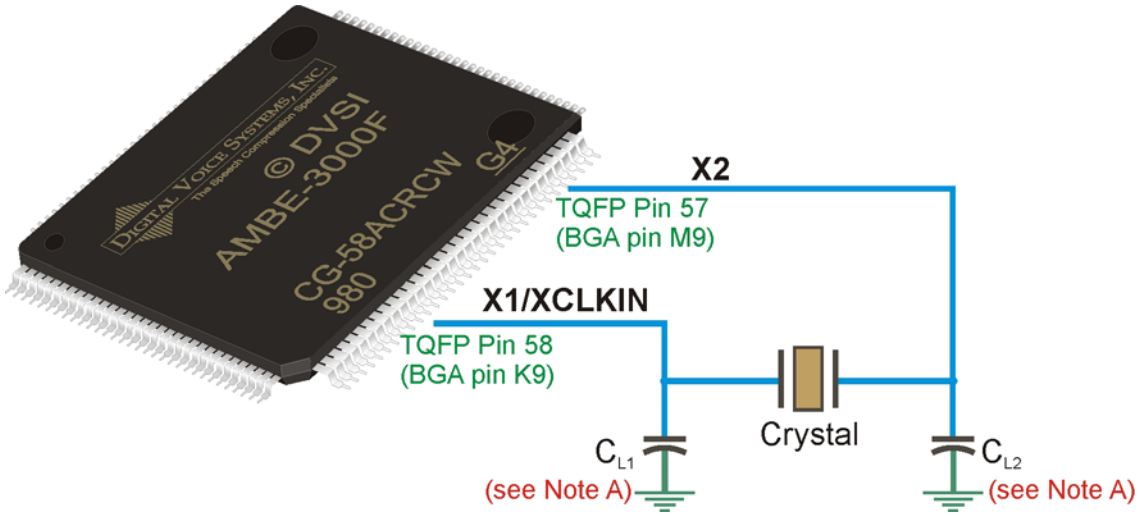


Figure 8 X1/XCLKIN and X2 with Crystal Oscillator

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

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-3000™ 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.
In other words, 3.3-V and 1.8-V can ramp together.

3.6 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.

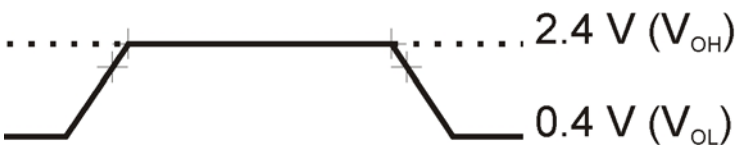


Figure 9 Output Levels

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.

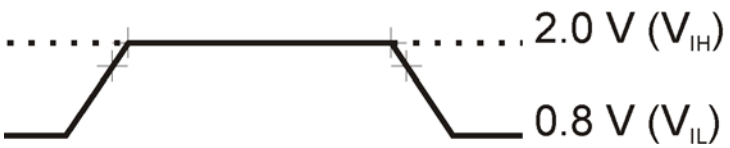


Figure 10 Input Levels

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.

3.7 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.

3.8 Low Power Modes

The AMBE-3000™ Vocoder Chip has four power states as shown in Figure 11 AMBE-3000™ Vocoder Chip Power States.

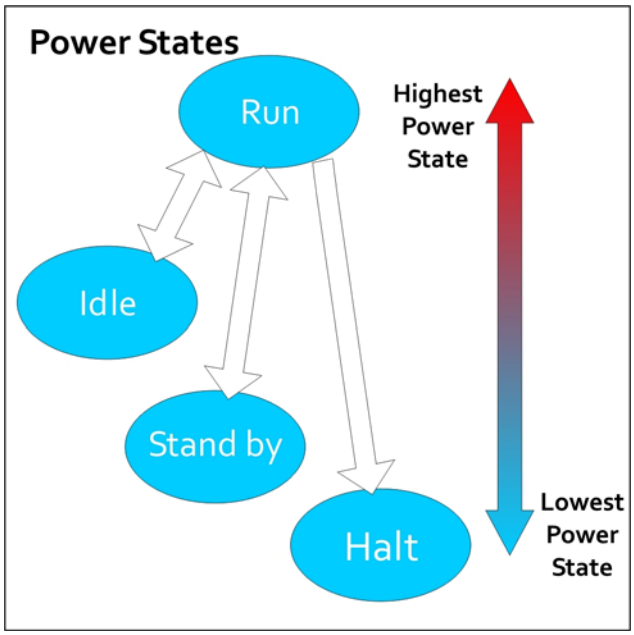


Figure 11 AMBE-3000™ Vocoder Chip Power States

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

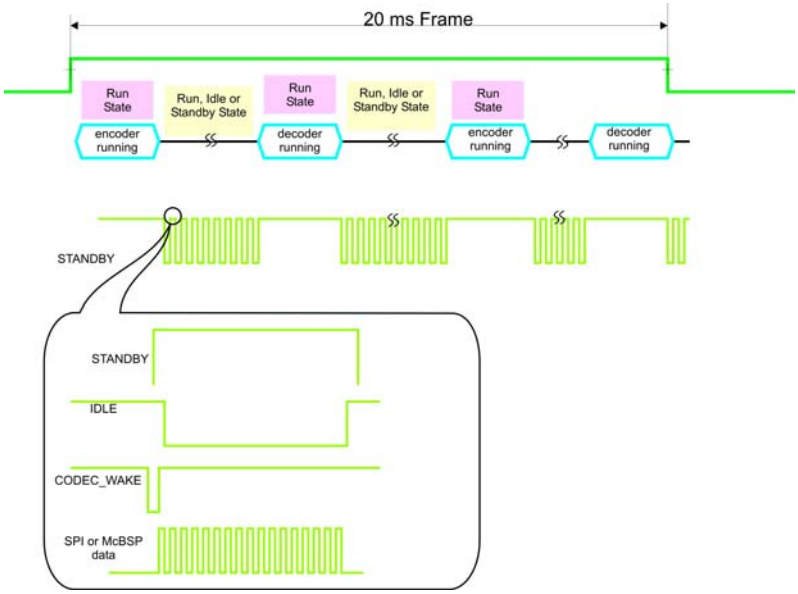


Figure 12 Power Mode States Basic Timing

3.8.1 Run State

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

3.8.2 Idle State

This state uses less power than the run state. The AMBE-3000™ 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.

3.8.3 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-3000™ Vocoder Chip will only enter this state if low power mode is enabled, AND the AMBE-3000™ Vocoder Chip is not actively executing code, AND no peripherals are in use. Peripheral activity causes the AMBE-3000™ 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.

3.8.4 Halt State

This is the lowest power state. The AMBE-3000™ 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)

3.8.5 Power Modes

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

(1) Normal Power Mode: In this mode the AMBE-3000™ Vocoder Chip switches between the Run State and the Idle State.
(2) Low Power Mode: In this mode the AMBE-3000™ Vocoder Chip switches between the Run State, the Idle State, and the Standby State. Lower power is consumed because the AMBE-3000™ 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-3000™ Vocoder Chip. After reset, low power mode is always disabled.

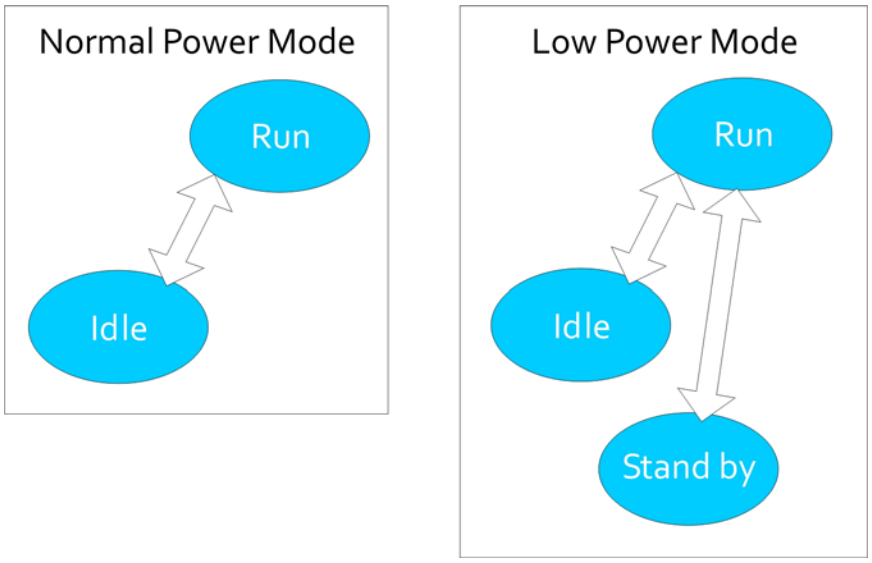


Figure 13 Power Modes

The AMBE-3000™ 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-3000™ 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-3000™ 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.

3.8.6 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.

3.8.7 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.

3.8.8 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.

3.8.9 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.

3.8.10 Low Power Mode when using the Parallel Packet Interface

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

3.8.11 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-3000™ Vocoder Chip. One of the following methods most be chosen.

Method 1: Prior to the start of any packet transfer to the AMBE-3000™ 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-3000™ Vocoder Chip. When the STDBY_ENABLEn is held low, the AMBE-3000™ 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-3000™ 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-3000™ 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-3000™ Vocoder Chip at anytime after the AMBE-3000™ Vocoder Chip has begun transmitting a packet up until the time the AMBE-3000™ Vocoder Chip has just finished transmitting the packet. It is important that the first byte of the packet being sent to the AMBE-3000™ Vocoder Chip be sent before the last byte of the packet is received from the AMBE-3000™ Vocoder Chip.

3.8.12 Typical AMBE-3000™ 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 162 mW 3.3v uses 10 mW	**Total** 172 mW	1.8v uses 74 mW 3.3v uses 9 mW	**Total** 83 mW (DTX enabled)
Packet Mode UART Packet Interface Not receiving packets	129 mW (AMBE-3000™ Vocoder Chip is in the idle state)		3 mW (AMBE-3000™ Vocoder Chip is in the standby state)	
Maximum Current Values	1.8v = 230 mW 3.3v = 125 mW			

Table 8 Typical AMBE-3000™ Vocoder Chip Power Measurements

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

In its simplest model, the AMBE-3000™ 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-3000™ Vocoder Chip receives compressed voice channel data. This data is decoded by the AMBE-3000™ 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-3000™ 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.

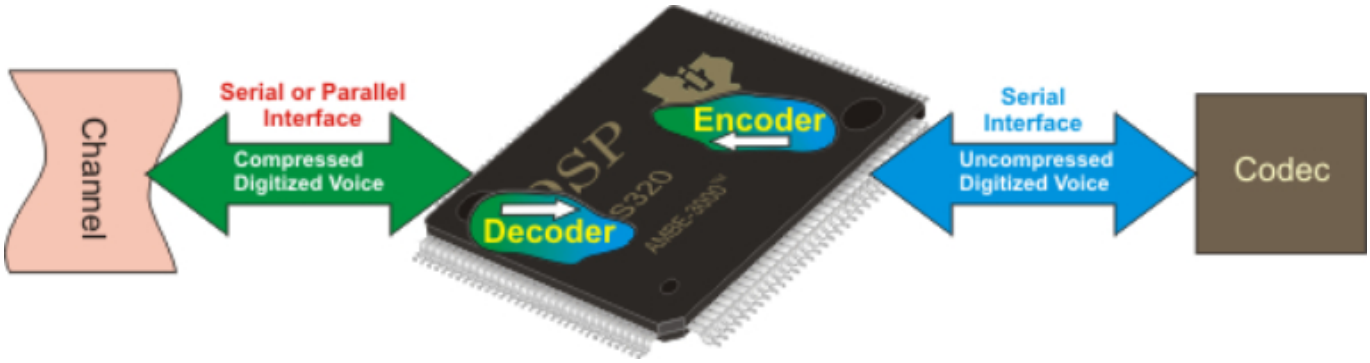


Figure 14 Basic Operation

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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ Vocoder Chip and the channel data is output to the packet interface. Alternatively, speech data can be sent to/from the AMBE-3000™ 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 Special Functions Description

The special functions of the AMBE-3000™ 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.

4.4.1 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-3000™ 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.

4.4.2 Echo Canceller (EC_ENABLE TQFP pin120 BGA pin D5)

The AMBE-3000™ 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-3000™ 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.

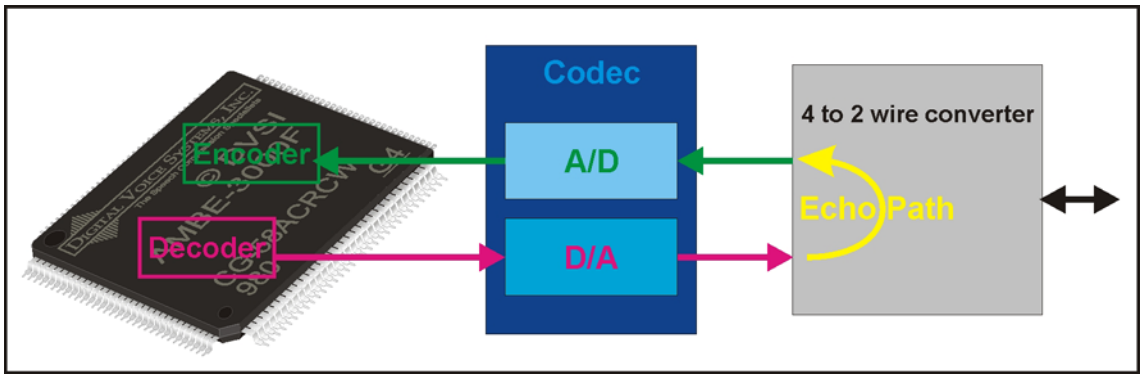


Figure 15 Typical Echo Path

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

4.4.3 DTMF Dual Tone Multiple Frequency, Detection and Generation

The AMBE-3000™ 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-3000™ Vocoder Chip decoder, it will regenerate the inband tone. The AMBE-3000™ 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.

4.4.4 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-3000™ 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-3000™ 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.

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

The AMBE-3000™ 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-3000™ 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-3000™ 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.

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

The integrated Noise suppressor feature of the AMBE-3000™ 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.

4.4.7 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-3000™ 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

5 I/O Management

The AMBE-3000™ 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-3000™ 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

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-3000™ 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 that 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	0 at reset.

		silence frame if no silence frames have been received yet).	
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

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

5.1.1 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.

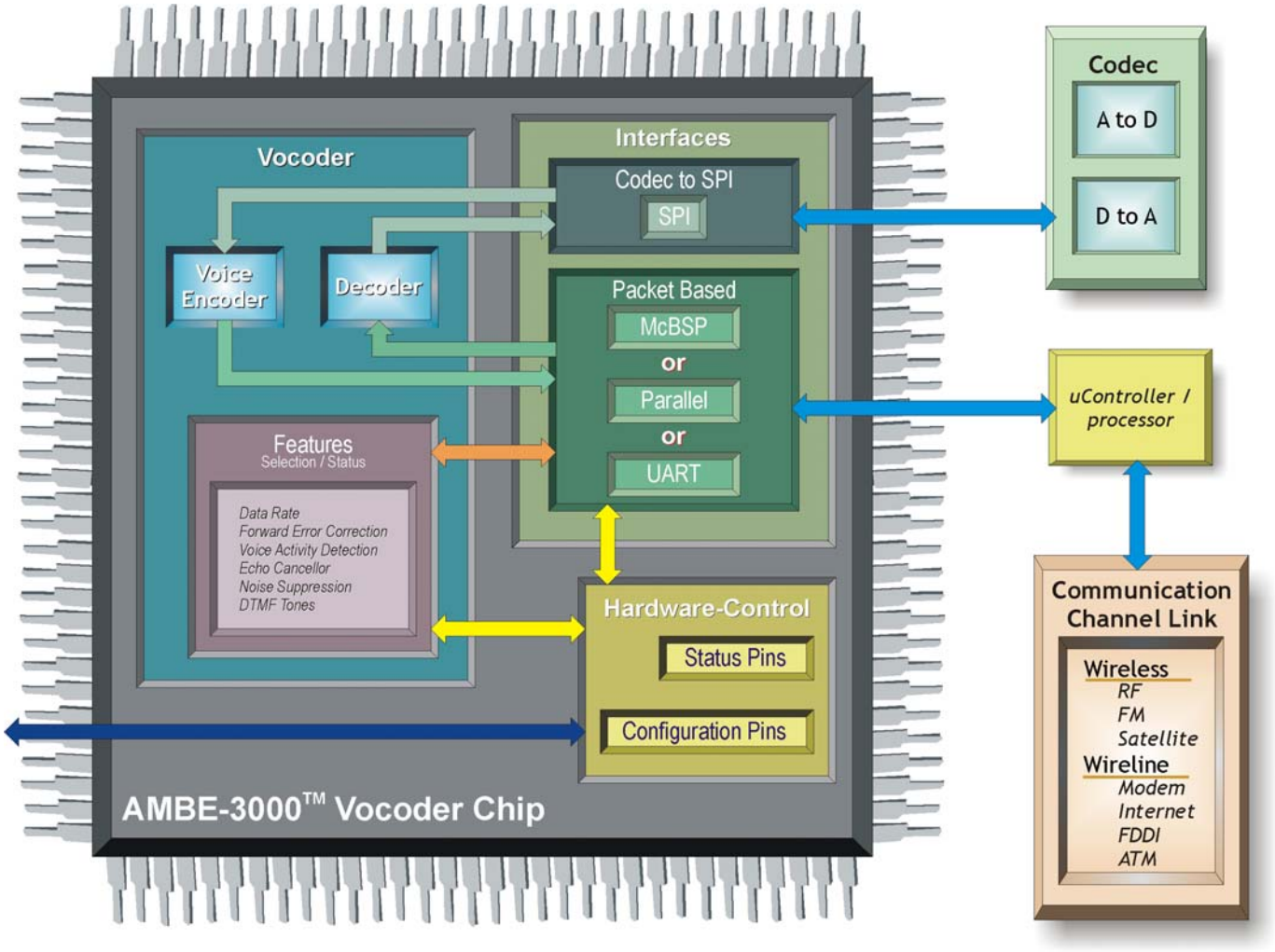


Figure 16 Codec Mode (SPI Interface)

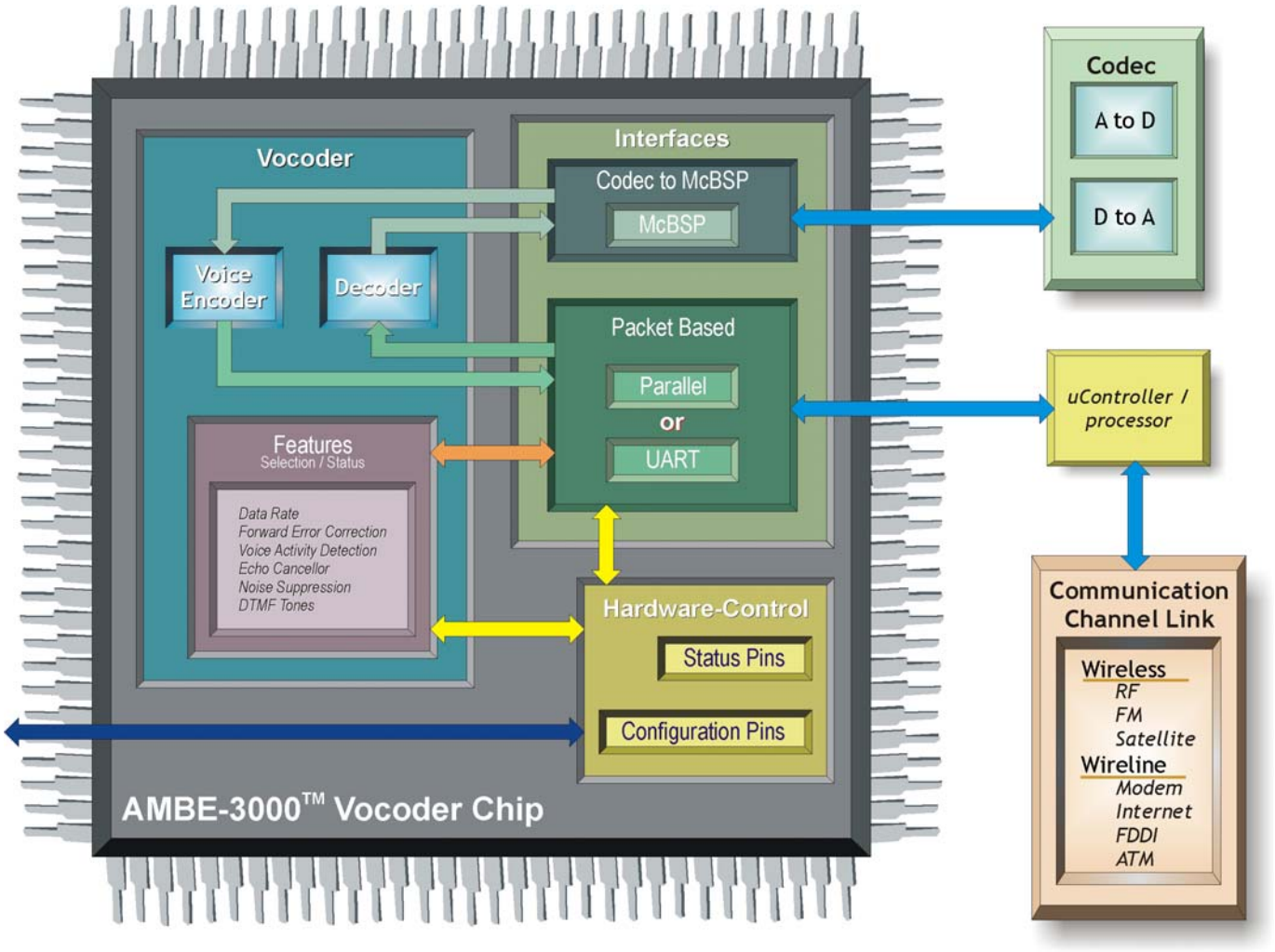


Figure 17 Codec Mode (McBSP Interface)

5.1.2 I/O Handler in Codec Mode

When the AMBE-3000™ 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.

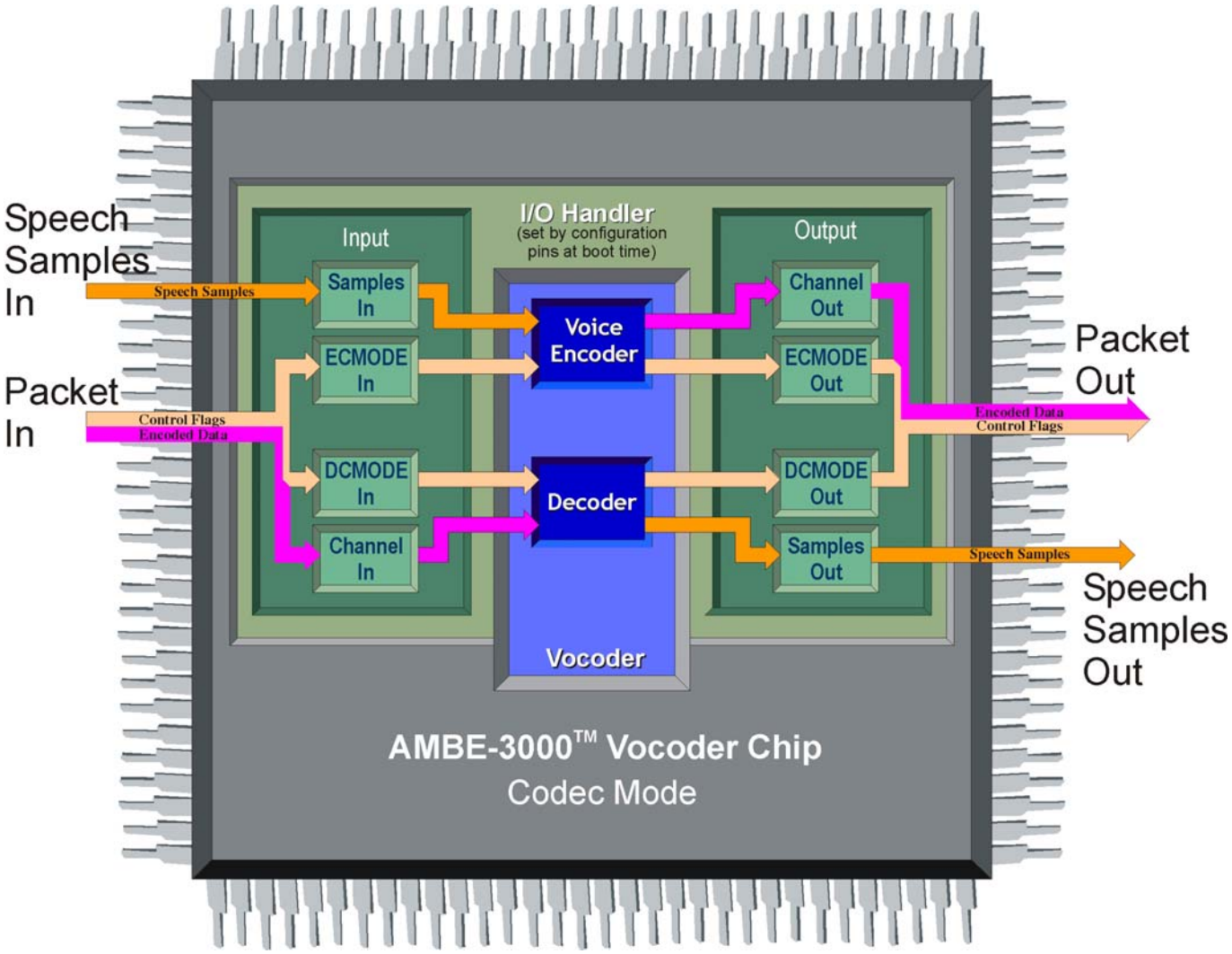


Figure 18 Interface BLOCK Diagram Codec Mode

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.

5.1.3 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-3000™ 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-3000™ 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-3000™ Vocoder Chip responds with a channel packet. When a channel packet is received it responds with a speech packet.

5.1.4 I/O Handler In Packet Mode

When the AMBE-3000™ 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.

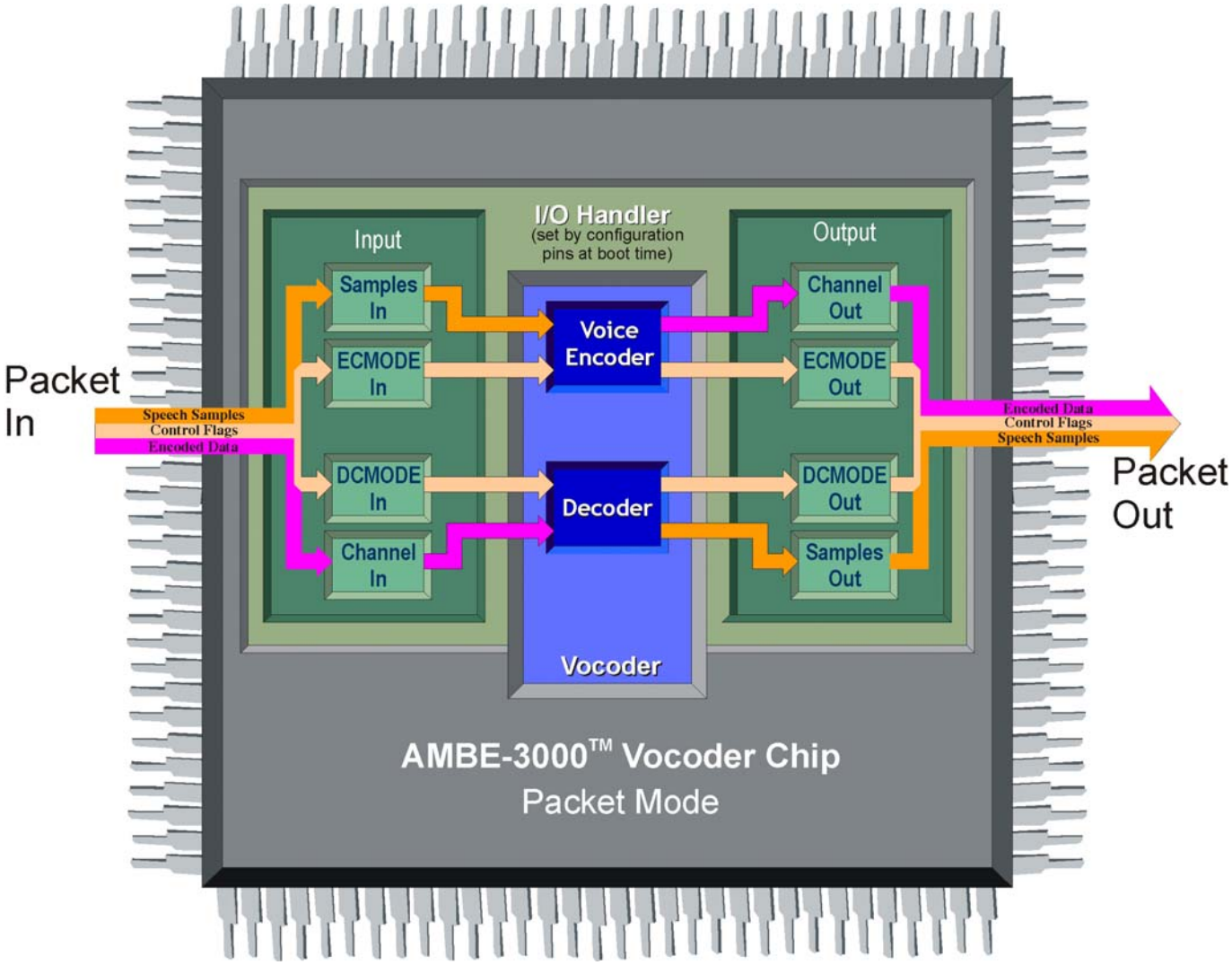


Figure 19 Interface Block Diagram Packet Mode

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.

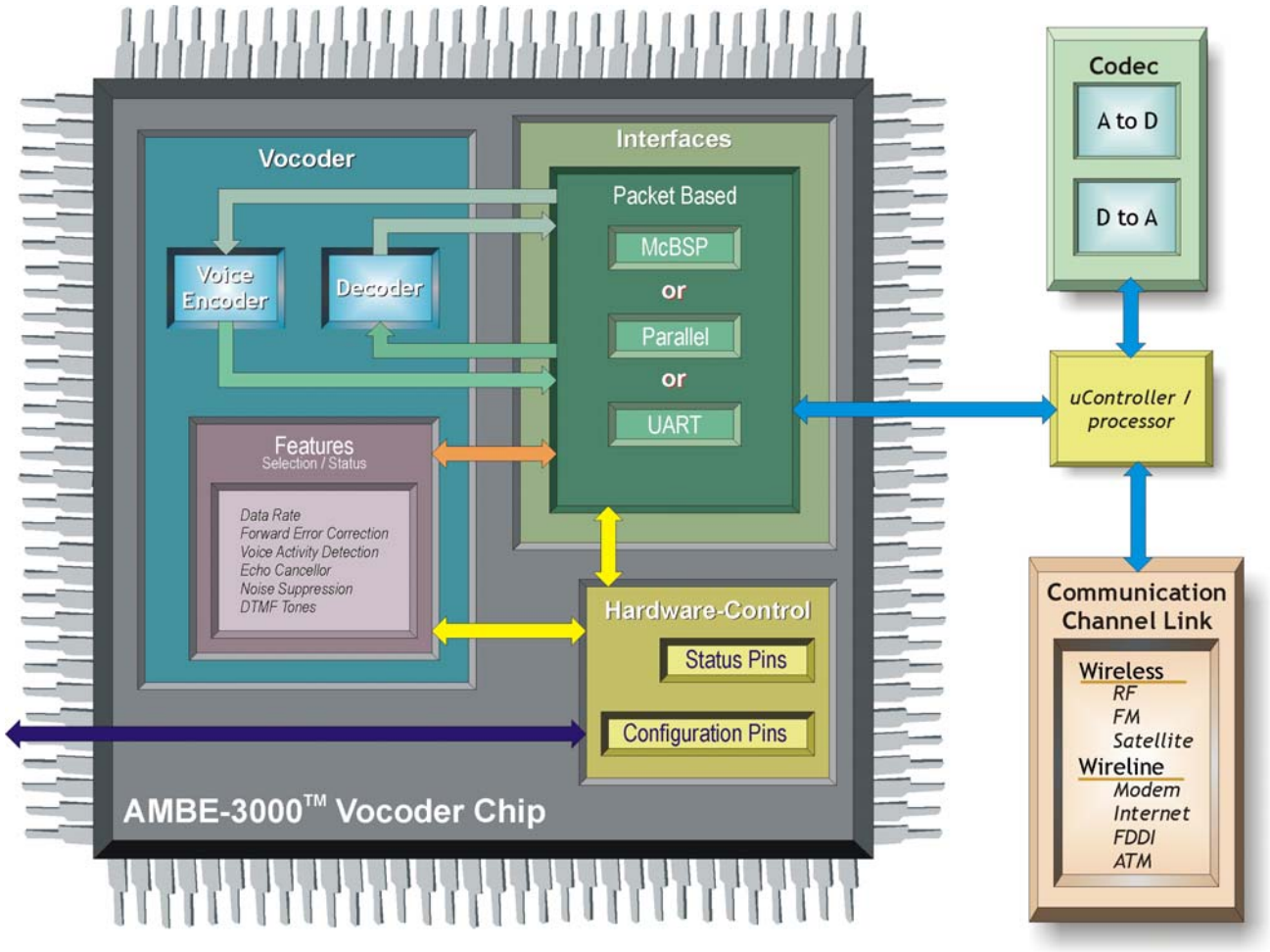


Figure 20 Packet Mode

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

5.1.5 Switching between codec mode and packet mode using packets

Upon boot up or after a reset the AMBE-3000™ 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-3000™ 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-3000™ Vocoder Chip between modes at any time using control packets. (See Section Data and Configuration Packets)

To switch the AMBE-3000™ 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-3000™ 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-3000™ 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-3000™ Vocoder Chip no longer outputs channel packets automatically every 20 ms and the codec interface is inactive.

5.2 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-3000™ 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-3000™ Vocoder Chip
32	N1	SPI_TX_DATA	Output	PCM Data from AMBE-3000™ Vocoder Chip to D/A Converter

Table 17 SPI Interface Pins

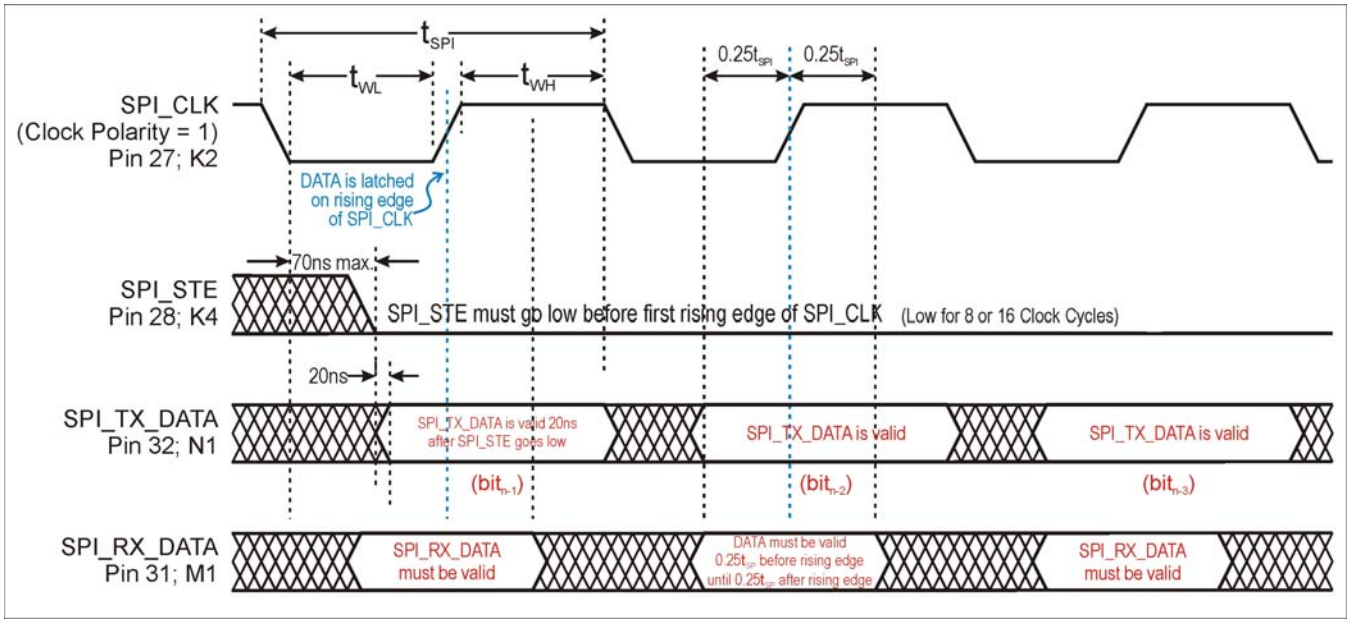


Figure 21 SPI Timing

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-3000™ Vocoder Chip can generate the signal SPI_GENSTE from signals SPI_FSn and SPI_CLK_IN. See Figure 22 Timing of SPI_GENSTE for the timing relationship between these signals.

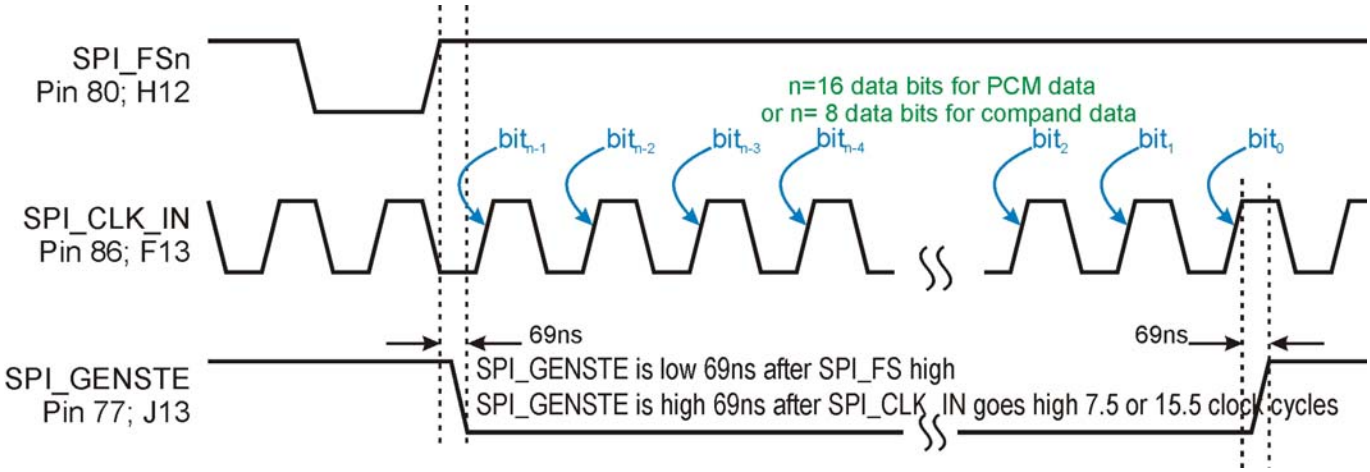


Figure 22 Timing of SPI_GENSTE

5.3 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-3000™ 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

5.4 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-3000™ 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

5.4.1 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 23 N=8). If companding is not used then there are 16 data bits (In Figure 23 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.

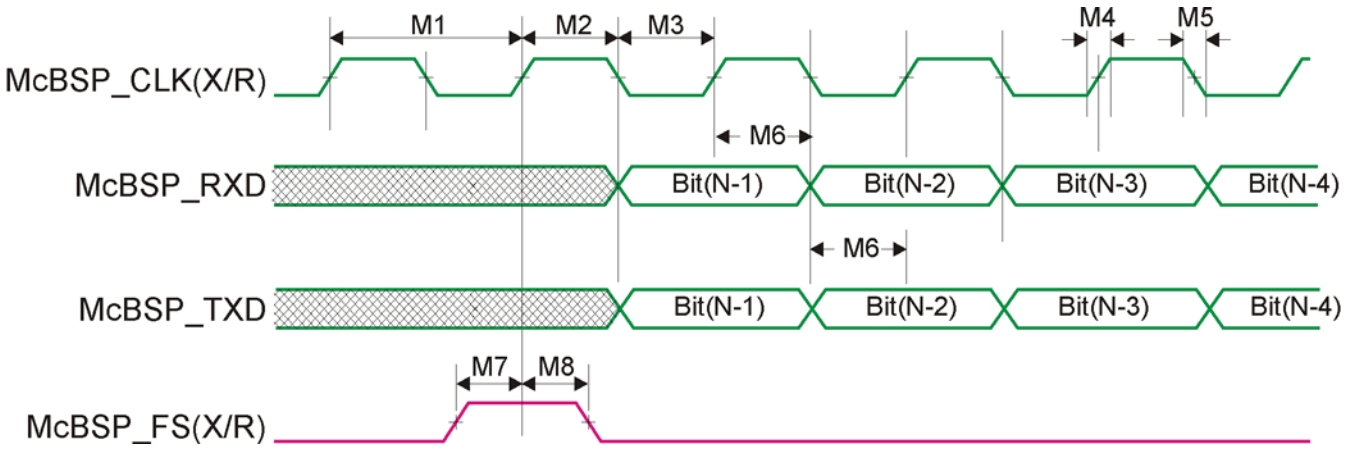


Figure 23 Timing of McBSP When Selected as Codec Interface

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

5.4.2 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.

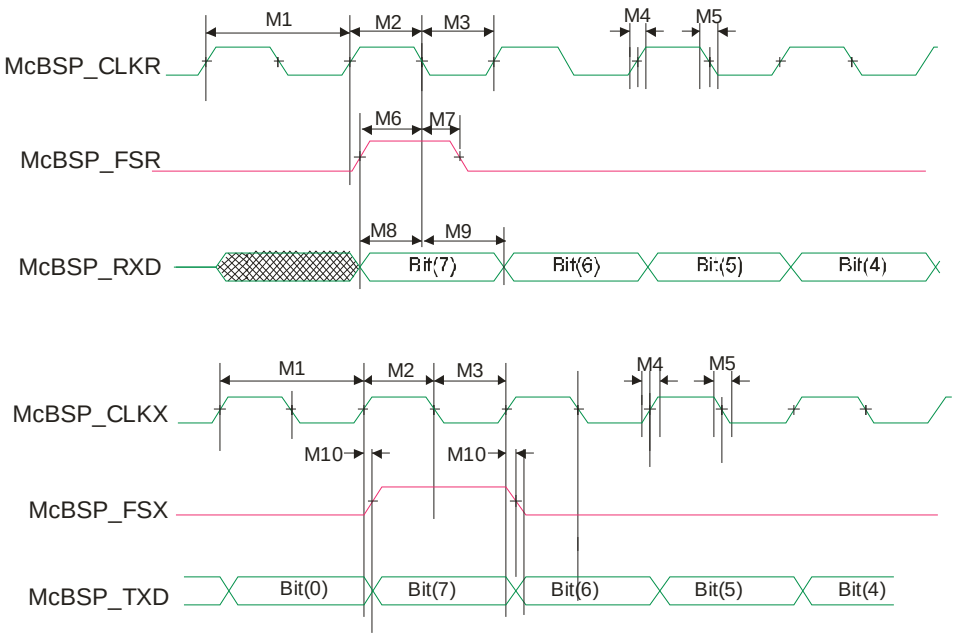


Figure 24 Timing of McBSP when Selected as Packet Interface

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-3000™ Vocoder Chip. The receive clock supplied to the AMBE-3000™ Vocoder Chip must be between 28,000 Hz. and 921,600 Hz. See Table 24 McBSP Clock Rates for available rates and configuration.

5.5 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

5.5.1 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-3000™ Vocoder Chip will set TX_RDY high when data is available to be read from the parallel port.

The packet data from the AMBE-3000™ Vocoder Chip is read by setting the pin PPT_READ low, then waiting for the AMBE-3000™ 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-3000™ Vocoder Chip will set PPT_ACK high.

To write packet data to the AMBE-3000™ 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-3000™ Vocoder Chip reads the data from the pins and sets PPT_ACK

low. After the AMBE-3000™ Vocoder Chip sets PPT_ACK low, PPT_WRITE pin must set high, at which time, the AMBE-3000™ Vocoder Chip will set PPT_ACK high.

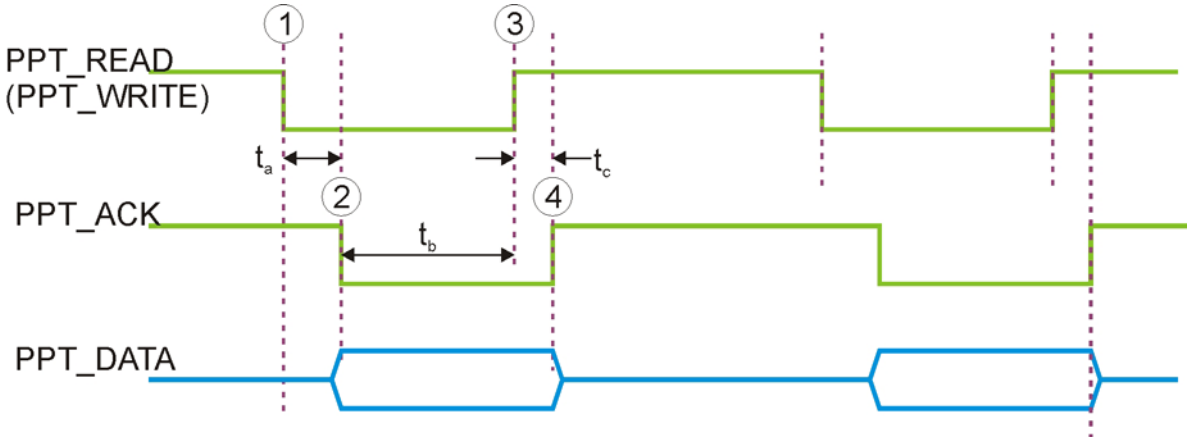


Figure 25 PPT Interface Timing

	PPT Timing
t_a	t_a <= 5µs (600ns typical)
t_b	System Dependent
t_c	< 275 ns

Table 26 PPT Timing

The time between when the AMBE-3000™ 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-3000™ 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-3000™ Vocoder Chip sets the PPT_ACK high after the PPT_READ (PPT_WRITE) goes back to high.

For Example: If the designed system uses $t_b < 0.5$µs the parallel port can transfer data, at rates exceeding 3.5 Mbps.

5.6 Codec A/D / D/A Interface

The AMBE-3000™ 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-3000™ 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.

5.7 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 26 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.

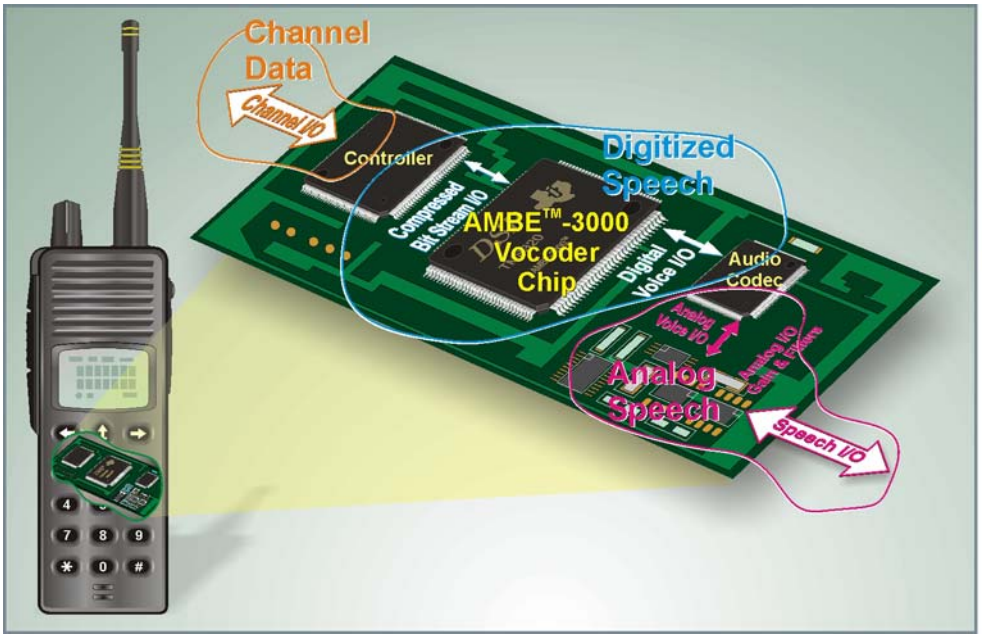


Figure 26 Typical Vocoder Implementation

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 27 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.

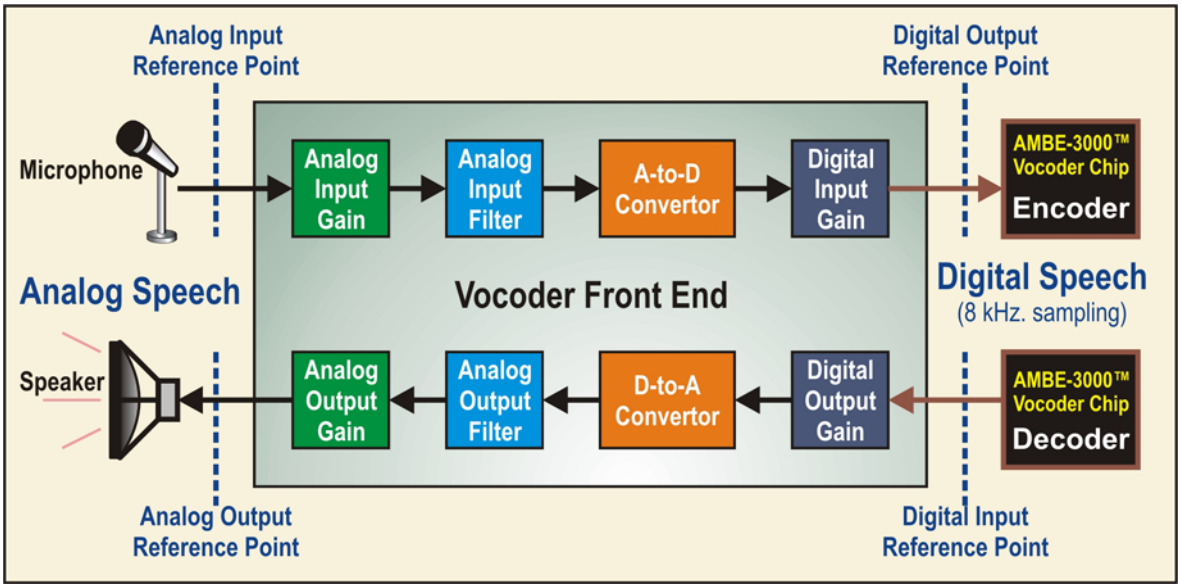


Figure 27 Vocoder Front End

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.

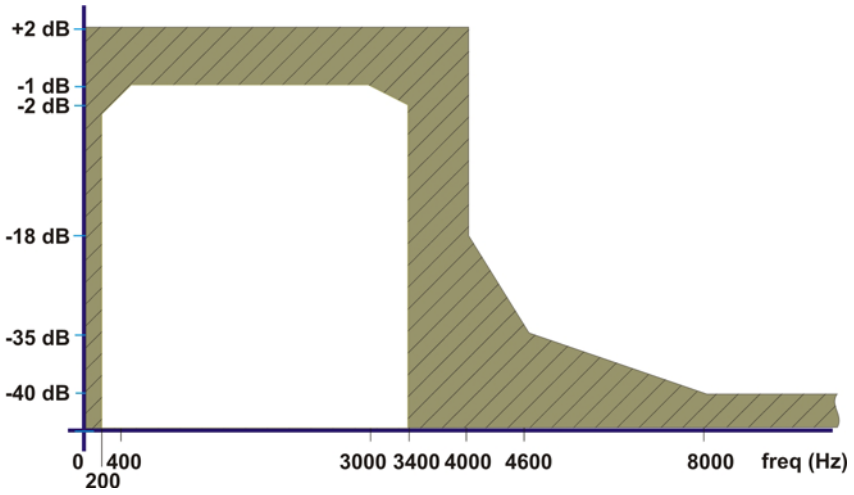


Figure 28 Front End Input Filter Mask

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 28 Front End Input Filter Mask, and the recommended output filter mask is shown in Figure 29 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.

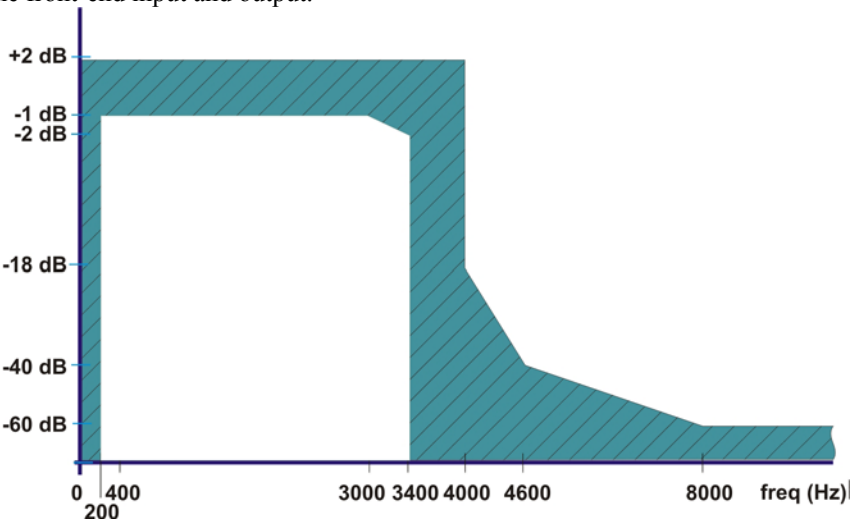


Figure 29 Front End Output Filter Mask

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 27 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 27 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.

5.8 Interfacing a codec to the AMBE-3000™ Vocoder chip

5.8.1 The Texas Instruments General purpose TLV320AIC14

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

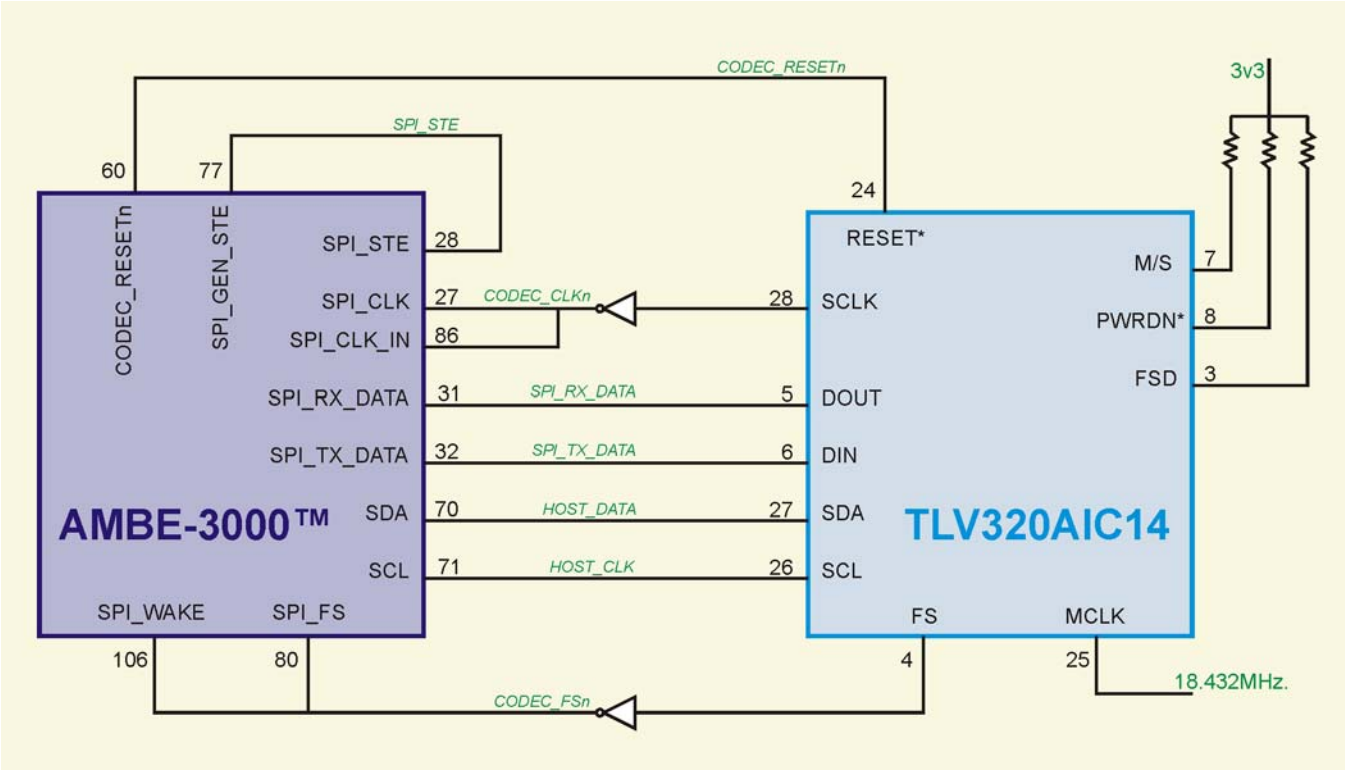


Figure 30 AMBE-3000™ Vocoder Chip and TLV320AIC14 Interface Block Diagram

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-3000™ 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-3000™ 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.

5.8.2 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-3000™ Vocoder chip's McBSP interface.

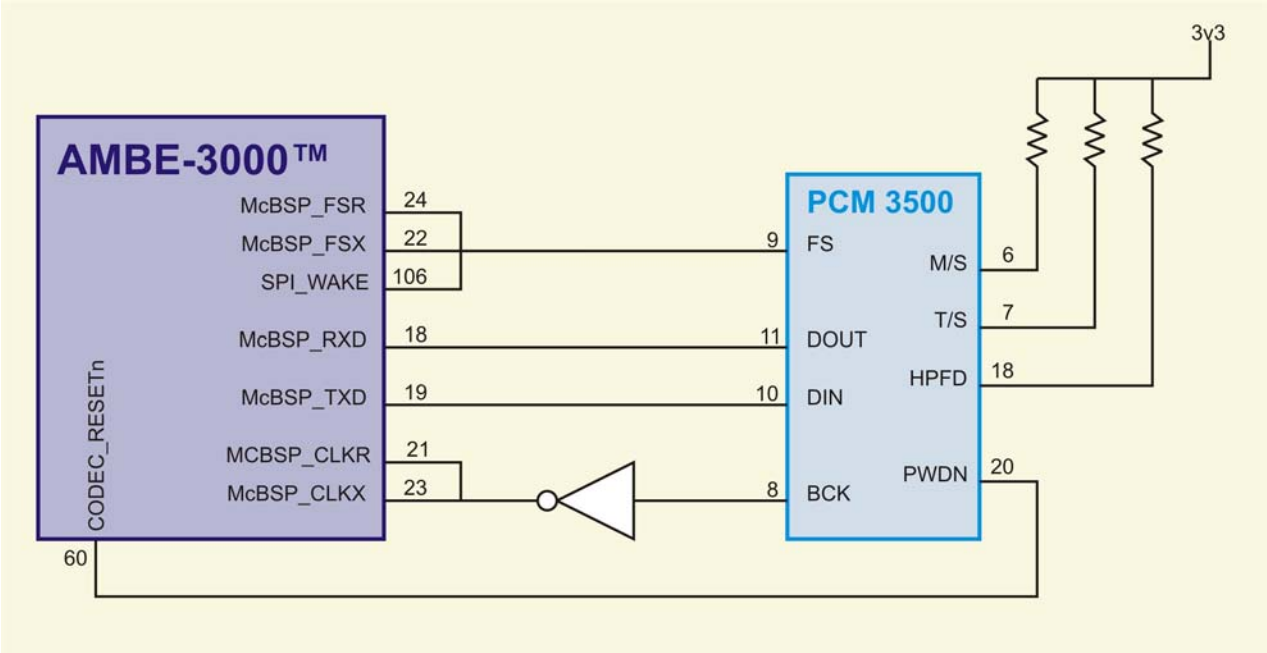


Figure 31 AMBE-3000™ Vocoder Chip and PCM3500 Interface Block Diagram

6 Data and Configuration Packets

6.1 Overview

Interfacing to the AMBE-3000™ Vocoder Chip is engineered to provide as much flexibility as possible. The AMBE-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ Vocoder Chip uses the same interface for the digitized speech data samples and the compressed data bits. In this mode, when the AMBE-3000™ Vocoder Chip receives packets, it processes the packets and sends response packets as soon as the data is ready. The AMBE-3000™ Vocoder Chip sends response packets in the same order that the packets are received. The AMBE-3000™ 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-3000™ Vocoder Chip can continue to transmit/receive packets while it is still processing prior packets.

When the AMBE-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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.

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	0 Byte
0x05	No Data Needed

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.

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	0 Byte
0x06	No Data Needed

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	0 Byte
0x32	No Data Needed

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 115 Rate Index Numbers

PKT_RATET Field - Format	
Field Identifier	Control Field Data
1 Byte	1 Byte
0x09	Rate Index Value From Table 115 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	0 Byte
0x09	No Data Needed

Table 43 PKT_RATET Response Field Format

The rate of the AMBE-3000™ 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 116 Rate Control Words and Pin Settings shows standard Rate / FEC combinations

The AMBE-3000™ Vocoder Chip uses these six words to set the source and FEC coding rates. Table 115 Rate Index Numbers and Table 116 Rate Control Words and Pin Settings lists the predefined values for various source and FEC rates that are built into the AMBE-3000™ 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 115 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	0 Byte
0x0A	No Data Needed

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. 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.
- 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.

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 Field	
Description	**Value**
Encoder Initialized	0x1
Decoder Initialized	0x2
Encoder and Decoder Initialized	0x3

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	0 Byte
0x0B	No Data Needed

Table 49 PKT_INIT Response Field Format

PKT_LOWPOWER field (2 bytes)

Tells the AMBE-3000™ Vocoder Chip to enable or disable low-power mode. The AMBE-3000™ 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-3000™ Vocoder Chip will enter standby whenever it is idle.

PKT_LOWPOWER Response Field - Format	
Field Identifier	Response Field Data
1 Byte	0 Byte
0x10	No Data Needed

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 $0 \leq R \leq 10$)
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	0xB8	0x06	0x20

Table 54 PKT_CODECCFG Field Example Data

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

PKT_CODECCFG Response Field - Format	
Field Identifier	Response Field Data
1 Byte	0 Byte
0x38	No Data Needed

Table 55 PKT_CODECCFG Response Field Format

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

PKT_CODECSTART Response Field - Format	
Field Identifier	Response Field Data
1 Byte	0 Byte
0x2A	No Data Needed

Table 58 PKT_CODECSTART Response Field Format

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

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

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-3000™ 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	0x0

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-3000™ 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	0	0

current speech frame.		
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	0 Byte
0x16	No Data Needed

Table 66 PKT_SPCHFMT Response Field

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

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-3000™ Vocoder Chip to respond with a string that contains the product version number.

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-3000™ 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-3000™ Vocoder Chip to enter halt mode. In this mode the AMBE-3000™ 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-3000™ Vocoder Chip to be reset. As a result, the AMBE-3000™ Vocoder Chip will lose all prior configuration settings and reset itself to the default power up state. Note that the AMBE-3000™ 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-3000™ 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-3000™ Vocoder Chip to be reset. As a result, the AMBE-3000™ 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-3000™ 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-3000™ Vocoder Chip to output a response field which contains the 3 bytes which were read from the configuration pins after reset. 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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	0 Byte
0x3F	No Data Needed

Table 81 PKT_PARITYMODE Response Field

PKT_WRITEI2C field (n bytes plus 2) this field writes to an I^2C 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	0 Byte
0x44	No Data Needed

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	0 Byte
0x46	No Data Needed

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	0 Byte
0x47	No Data Needed

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	0 Byte
0x48	No Data Needed

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	0 Byte
0x49	No Data Needed

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	0 Byte
0x4A	No Data Needed

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-3000™ Vocoder Chip. The output is active low. The signal is used by the AMBE-3000™ Vocoder Chip to control the flow of packet data to the AMBE-3000™ Vocoder Chip. The AMBE-3000™ Vocoder Chip has a receive buffer where incoming packets are stored until they have been processed. When RTSn is low, the AMBE-3000™ Vocoder Chip indicates that it is ready to receive packet data. When RTSn is high, the AMBE-3000™ Vocoder Chip is not ready to receive packet data. The AMBE-3000™ Vocoder Chip sets RTSn high if there are less than thresh_hi bytes of free space in the receive buffer. The AMBE-3000™ 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	0 Byte
0x4E	No Data Needed

Table 95 PKT_RTSTHRESH Response Field

Note: PKT_GAIN and PKT_GAIN Response are only effective in Packet 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	0 Byte
0x4B	No Data Needed

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-3000™ Vocoder chip, the chip will output channel packet (packet type 0x01). Speech packets are used only when the AMBE-3000™ 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
TONE	0x08	2 bytes	Force current encoder to generate 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
TS_E	***Tone Send Enable	TS_ENABLE

Table 102 CMODE Parameters Table Key

*** Note: Tone generation can only be used when operating in packet mode.**

TONE fields (3 bytes) can be used to force the encoder to transmit a tone frame. The frequency (or frequencies) and amplitude of the tone are specified by this field. For durations of greater than 20 ms, the TONE field must be repeated for consecutive frames. (DTMF Code Value and Amplitude Value are in Hex)

TONE Field - Format		
Field Identifier	DTMF TONE Data	Amplitude Data
1 Byte	1 Byte	1 Byte
0x08	See Table 104 TONE Index Values	See Table 105 TONE AMPLITUDE Values

Table 103 TONE Field Format

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

	Frequency 1 (Hz)	Frequency 2 (Hz)	Index Value	
			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-3000™ 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-3000™ 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
TONE	0x08	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	$40 \leq \{bits\} \leq 192$	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

TONE
TONE fields (3 bytes total) can be used to force the decoder to synthesize a tone frame. The frequency (or frequencies) and amplitude of the tone are specified by this field. For durations of greater than 20 ms, the TONE field must be repeated for consecutive frames. (DTMF Code Value and Amplitude Value are in Hex)

TONE Field - Format		
Field Identifier	DTMF TONE Data	Amplitude Data
1 Byte	1 Byte	1 Byte
0x08	See Table 104 TONE Index Values	See Table 105 TONE AMPLITUDE Values

Table 110 TONE Field Format

6.10 Output Channel Packet Format (Packet Type 0x01)

A channel packet (packet type 0x01) is output from the AMBE-3000™ 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.

6.11 Example Packets

6.11.1 Speech Packet Example 1

The simplest way to operate the AMBE-3000™ 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-3000™ Vocoder Chip and during the time in which the AMBE-3000™ Vocoder Chip is transmitting the response packet.

Following is an example speech packet (hexadecimal) for input to the AMBE-3000™ 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	0144	02	40	00	A0	000000010002000300040005000600070008000900 A000B000C000D000E000F001000110012001300140 0150001601700180019001A001B001C001D001E001F0 020002100220023002400250026002700280029002A 002B002C002D002E002F003000310032003300340003 500360037003800390003A003B003C003D003E003F00 400041004200430044004500460047004800490004A0 04B004C004D004E004F005000510052005300540055 005600570058005900 5A005B005C005D005E005F006 000610062006300640065006600670068006900 6A00 6B006C006D006E006F007000710072007300740075 076007700780079007A007B007C007D007E007F0080 008100820083008400850086008700880089008A008 B008C008D008E008F009000910092009300940095 00 960097009800990 09A009B009C009D009E009F

Table 111 Speech Packet Example 1

The first byte (0x61) is the packet header byte. The next two bytes (0x0144) specify the total length of the packet fields is 324 bytes. Note that the total packet length including the header, length,, and type is 328 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 and the following byte (0x00) specifies channel 0 for subsequent fields. The next byte (0x00) is a SPEECHD field identifier and the following byte (0xA0) tells the AMBE-3000™ 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		TONE Field			
StartByte	Length	Type	VOCODERID Field Identifier	SPEECHD Field identifier	SPEECHD No. of Samples	SPEECHD Data	CMODE Field identifier	CMODE flags	TONE Field identifier	TONE Index Value	TONE Amplifier Value
61	014A	02	40	00	A0	0000000100020003000400500060007000800090000A000B000C000D000E000F001000110012001300140015000160170018001900001A001B001C001D001E001F002000210022002300240025002600270028002900002A002B002C002D002E002F003000310032003300340035003600370038003900003A003B003C003D003E003F004000410042004300440045004600470048004900004A004B004C004D004E004F0050005100520053	02	0000	08	03	00

						0054005500560057005800590059005A005B005C005D005E005F0060006100620063006400650066006700680069006A006B006C006D006E006F00700071007200730074007500760077007800790079007A007B007C007D007E007F00800081008200830084008500860087008800890089008A008B008C008D008E008F009000910092009300940095009600970098009900990 09A009B009C009D009E009F					

Table 112 Speech Packet Example 2

This is the similar to the prior example except that a CMODE field and a TONE 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 0x014a 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 (0x08) is a TONE 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-3000™ 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 113 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-3000™ Vocoder Chip:

Channel Packet										
Header			**VOCODERID Field**	**CHAND Field**			**SAMPLES Field**		**CMODE Field**	
StartByte	Length	Type	VOCODERID Field Identifier	CHAND Field Identifier	CHAND Number of Bits	CHAND Data	SAMPLES Field Identifier	SAMPLES Number of Samples	CMODE Field	CMODE Value
61	0010	01	40	01	38	00112233445566	03	A1	02	0000

Table 114 Channel Packet Example 2

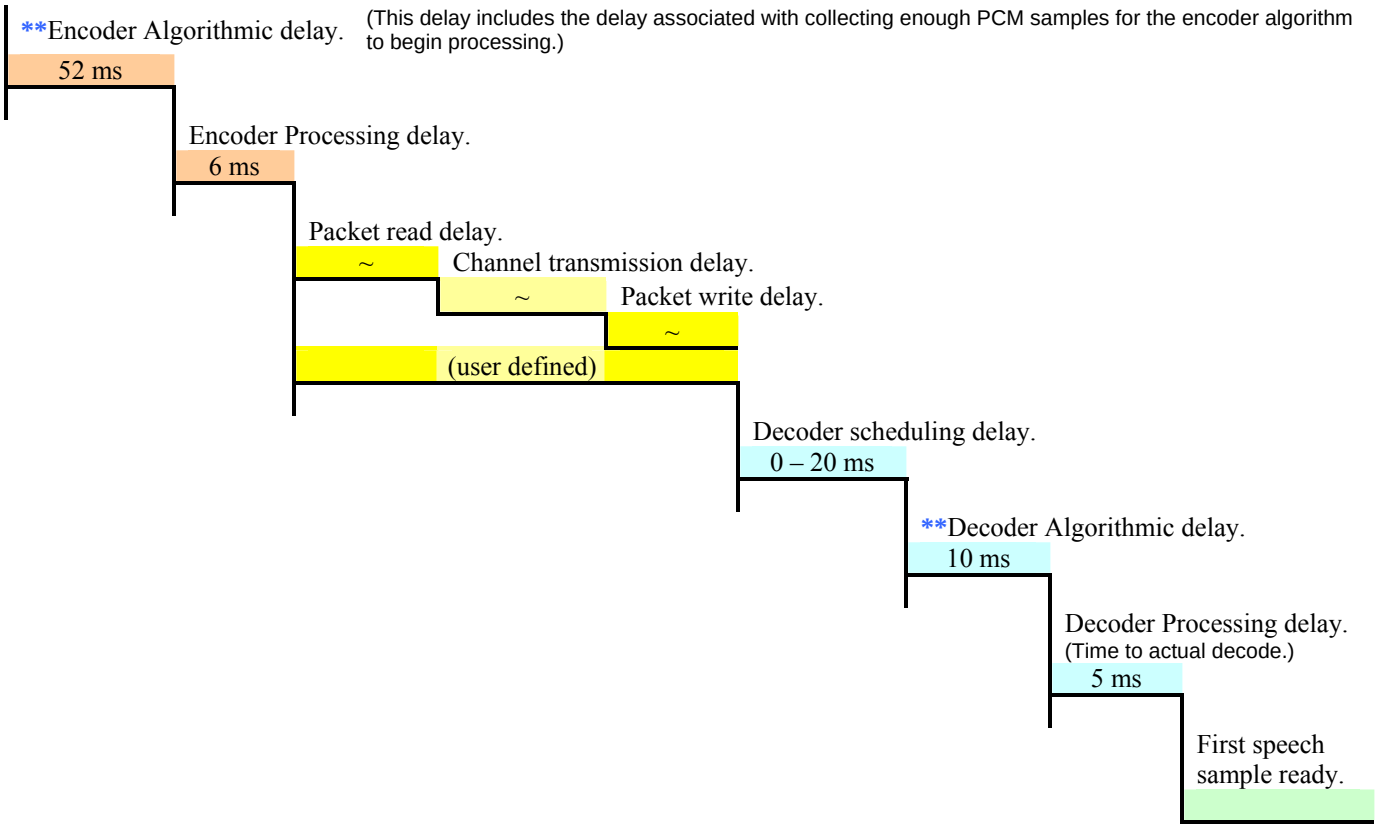
The first byte (0x61) is the packet header byte. The next two bytes (0x0010), specify that the length of the packet (excluding the header, length, and type bytes) is 16 bytes. The next byte (0x01) specifies that the packet type is a channel packet. The next byte (0x40), is a ChannelID field identifier and the byte that follows (0x00) specifies vocoder 0 for subsequent fields. 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.

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-3000™ 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 115 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 116 Rate Control Words and Pin Settings

Table Key for and Table 116 Rate Control Words and Pin Settings	
AMBE-1000™ Rates (AMBE® Vocoder)	
AMBE-2000™ Rates (AMBE+™ Vocoder)	
AMBE-3000™ 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).**

8 Support

8.1 DVSI Contact Information

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

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

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

email: mailto:info@dvsinc.com
web site: http://www.dvsinc.com/

9 Environmental Specifications

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

Part Number Details

DVSI Part Number	AMBE-3000™ 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

*Part Number
No material contents are available for this part.

**Pb-Free or Green Alternative BGA Parts
A Pb-Free or Green version of this BGA device may be available under a new part number. Typically, the package code for a device is embedded in the part number. Package codes Gxx, YEx (where x can be any letter), YE and WAS will be changed to new codes during the conversion to Pb-Free and Green. The new codes are Zxx, YZx, YZ and WAZ. Using this new package nomenclature in the part number you may locate information on the Pb-Free and Green version of the device. To learn more, contact your TI sales rep.

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

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10 IC Chip Software Errata

DVSI reserves the right to make modifications, enhancements, improvements and other changes to the AMBE-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ 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-3000™ in packet mode.

Packets should only be sent to the AMBE-3000™ when RTSn is low. If the AMBE-3000™ 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.

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-3000™ 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 30 AMBE-3000™ 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 23 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 115 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 116 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-3000™ 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 Instructions	3
1.10	October 2009	Edited PKT_VERSTRING Response field description	61
		Added Section IC Chip Software Errata	86

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	18
		Edits to Sections 3.3 to 3.6	20-22
		Edits to Section 5.2 SPI Interface	40
		Edits to Section 5.4 McBSP Interface	42
		Edits to Section 6.5 Packet Format	52
		Edits to Table 32 Control Packet Fields	55
		Edits to Table 62 PKT_CHANFMT Data Settings	62
		Edits to Table 65 PKT_SPCHFMT Data Settings	63
2.1	May 2010	Edited TX_RDY description in table 2.5	12
2.2	May 2010	Edited DTMF description Section 4.4.3	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 116 Rate Control Words and Pin Settings	83
2.5	December 2010	Moved Custom Rate Interoperable with DSTAR in Table 116 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 27 Vocoder Front End, Figure 28 Front End Input Filter Mask and Figure 29 Front End Output Filter Mask	47-48
		Edited D-Star rate in Note for Table 116 Rate Control Words and Pin Settings	83
2.7	April 2011	Edited Figure 31 AMBE-3000™ Vocoder Chip and PCM3500 Interface Block Diagram	50
		Added Note to **PKT_GAIN** and **PKT_GAIN Response** Packets	70
		Edited Table 104 TONE Index Values to show Tone Index value for various Rate Indexes	73
		Added Algorithmic and Processing delay details	80
2.8	August 2011	Removed (pin 57 TQFP) and (pin M9 BGA) from the No Connection section of Table 1 Pinout List	15
		Edited dcmode information in Table 62 PKT_CHANFMT Data Settings	62
		Edited data response byte -- Table 63 PKT_CHANFMT Response Field	62