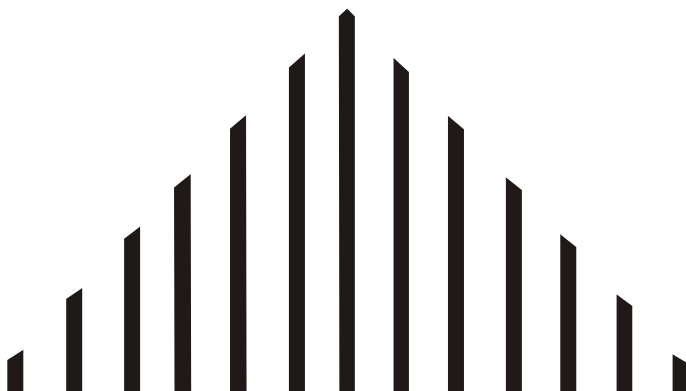




**AMBE-20x0™ HDK
Development Board
Version 1.0**

MSP430 Software User's Guide

Preliminary



AMBE-20x0™ HDK Development Board

MSP430 Software

User's Guide

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

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AMBE-20x0 HDK MSP430 Software - User's Guide

Introduction

The AMBE-20x0™ HDK (HDK) is a single board Hardware Development Kit that provides a reference design showing how to interface a microcontroller to DVSI's AMBE-2000™ Vocoder Chip. The AMBE-20x0™ HDK uses the low cost Texas Instruments MSP430135 microcontroller to serve as a system controller much like a microcontroller would be used in an AMBE-2000™ Vocoder Chip enabled digital radio or cellular phone. On the HDK, the MSP430 controls the AMBE-2000™ Vocoder Chip, processes digital voice packets, controls a channel protocol over an RS-232 link and provides a user interface by employing a keypad and RS-232 user console.

MSP430 Series Microcontrollers

The Texas Instruments 16 bit MSP430 microcontrollers are a broad family of processors with a wide range of memory configurations and peripherals. With speeds up to 16 MHz and very low power, they serve a wide variety of uses. The software and tools community provides a rich set of resources for these processors and they are easy to program.

MSP430 Software

The MSP430 reference software is entirely written in C to facilitate easy modification by customers for their own use. The software is compact, yet includes all necessary code to communicate with the AMBE-2000™ Vocoder Chip, provide interrupts for timing and RS-232 communication, provide a user interface and keypad operation, and provide two channel packet protocols. While the reference software demonstrates useful features of the AMBE-2000™ Vocoder Chip in the context of a working voice communication link, it is expected that customers would use the reference software as a starting point for more complex designs tailored to the customer's needs.

Theory of Operation

The software was written to be compact, easy to read and highlight key features that would ordinarily be included in a system employing an AMBE-2000™ Vocoder Chip. Following reset of the HDK hardware and software initialization, the program cycles through an infinite loop within which all processing occurs. Three interrupts are used: Two for transmit and receive to handle channel data flow over an RS-232 UART and one for a packet timer. As discussed in the following sections, the main loop in conjunction with the interrupt routines allows several real time events to occur.

Pseudo Code for the main processing loop follows:

```
Initialize variables
Initialize UART fifos
Initialize CPU resources
Display Console Menu prompt
Initialize Timer A
Reset the AMBE-2000™ Vocoder Chip

Forever do {
    Wait for 20ms Timer A interrupt to occur
    Configure AMBE-2000™ VOCODER CHIP Decoder Packet parameters
    Transfer Decoder Packet to AMBE-2000™ VOCODER CHIP
    Transfer Encoder Packet from AMBE-2000™ VOCODER CHIP
    Initialize the HWUART Baud rate first time through
    Transfer Decoder Packet from UART output software FIFO
    Transfer Encoder Packet to UART input software FIFO
    Process Console Menus if keypad key pressed
        - via interrupt, send and receive RS232 data
        - via interrupt, generate 20ms timer
}
End
```

Hardware Interaction

The software interacts with the AMBE-2000™ Vocoder Chip, an RS-232 channel interface, an RS-232 output-only console and an on-board keypad. The interface to the AMBE-2000™ Vocoder Chip is via a simple half/duplex 8 bit parallel data port with control lines. This interface connects to parallel-to-serial converter logic in a XLINX FPGA on the HDK. The FPGA in turn communicates to the AMBE-2000™ Vocoder Chip using synchronous serial I/O. The RS-232 channel interface uses an MSP430 Hardware UART. The RS-232 console output is a software transmit-only UART using a single MSP430 general purpose IO pin. The keypad uses 8 MSP430 general purpose IO pins.

20ms Packet Timing

The AMBE-2000™ Vocoder Chip processes voice data in 20 ms intervals, or frames. Timing for voice frames is derived from the serial port bit clock for the Burr Brown PCM3500 codec chip connected to the AMBE-2000™ Vocoder Chip. The serial bit clock is also connected to the MSP430 as a source clock for the MSP430 Timer A. Timer A is then used to generate a 20 ms interrupt which is synchronous with the AMBE-2000™ Vocoder Chip packet timing. The MSP430 software processing is, in turn, synchronous with the 20ms packet timing.

HDK Channel Interface

The HDK employs an easy to use RS-232 channel interface which can be connected between HDK boards, to PCs and other off the shelf hardware. The interface uses 8 data bits one start and one stop bit. The added overhead of the start and stop bits, and the reliance on byte-wide transfers makes the use of RS-232 flexible and convenient, but somewhat inefficient for low bit rate applications. Low bit rate applications that use the AMBE-2000™ Vocoder Chip can employ a more efficient channel protocol that relies on less overhead.

HDK Packet Formats

The AMBE-2000™ Vocoder Chip channel protocol requires twenty-four 16 bit word voice & control packet be transferred to and from the AMBE-2000™ Vocoder Chip within the 20ms frame period. The reader should become familiar with the AMBE-2000™ Vocoder Chip packet format to better understand the following discussion. The packet format is described in the AMBE-2000™ Vocoder Chip User's Manual. To demonstrate how the AMBE-2000™ Vocoder Chip can be used

in low bit rate applications, the HDK software supports both the AMBE-2000™ Vocoder Chip packet over RS-232 and a lower overhead *HDK Packet Format*.

The **HDK Packet Format** strips off AMBE-2000™ Vocoder Chip packet words 1-11 and unused data words that do not contain compressed voice when lower voice rates are in use. For example, if an AMBE-2000™ Vocoder Chip data rate of 2400 bps is selected, then three words of voice data, and one word of sync for a total of 8 bytes or $8 \times (8+2) = 80$ bits of RS-232 data would be used. That requires a minimum of 4000 bps, but a standard 4800 baud rate would be used on the HDK. For 9600 bps voice, twelve words of voice and one word of sync are used requiring a minimum RS-232 rate of 13000 bps. The standard RS-232 baud rate of 19200 would be used.

The **AMBE-2000™ VOCODER CHIP Packet Format** sends the standard AMBE-2000™ Vocoder Chip packet over RS-232. This format is a useful demonstration of how a system can remotely control rates and parameters of an AMBE-2000™ Vocoder Chip by sending AMBE-2000™ Vocoder Chip control data over the channel. A simple demonstration of this feature is the PC file mode program which is able to control the voice rate at which the AMBE-2000™ Vocoder Chip on the HDK decodes packets sent to it from a PC file. Since the full 24 word (48 byte), AMBE-2000™ Vocoder Chip packet is sent over RS-232, a minimum bit rate of $48 \times (8+2) / 0.02 = 24000$ bps is needed.

Channel RS-232 Interrupt Operation

The HDK software uses the existence of the AMBE-2000™ Vocoder Chip packet sync word in both packet formats to synchronize with incoming channel packets. By implication, an HDK will process an incoming stream of packets even if the timing of the incoming packets is not synchronized with the timing of packets being transferred from the AMBE-2000™ Vocoder Chip. This asynchronous operation is supported by hardware UART interrupts in combination with a software FIFOs on input and output for the channel RS-232. Data bytes are transferred over the RS-232 channel by momentarily interrupting the main software loop, including packet transfers with the AMBE-2000™ Vocoder Chip.

UART Software FIFOs

Software FIFOs are used in conjunction with UART interrupt service routines to provide input and output buffering of channel data. The receive and transmit software FIFOs each consist of a data structure containing control pointers and a data buffer. UART interrupt service routines and support functions manipulate the FIFO pointers to put data bytes into a FIFO and remove them. The data buffers themselves are sized to hold full AMBE-2000™ packets.

Software UART

An output-only software generated UART is included in the software to display menus and messages on an 115200 baud (8 data bits, 1 start, 1 stop, no parity) terminal. This function cannot be interrupted when sending a character, therefore, it is only used during menu operations.

Keypad Menu Operation

An alphanumeric keypad is used to change some HDK parameters. The main software loop calls a function that determines which key that is pressed on the keypad. When the "# " key is pressed, packet transfers are discontinued, and a text menu is sent out the RS-232 Console out port to be displayed on a PC or similar device. During the menu operation, a 20ms timer A interrupt is used to allow periodic sampling of the keypad to determine when keys are pressed.