FAA20 Embedded NEXCOM Vocoder
Board Manual

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1.0 INTRODUCTION

This document provides the information needed to integrate and operate the FAA20 embedded NEXCOM vocoder.

1.1 Purpose and Scope

This document serves the following purpose:

- *Describes FAA20 integration and operation*

This manual covers hardware revision B. While the FAA20 software is designed to run on both platforms (revision A and revision B), there are minor differences in control bits and interfaces. Revision B has a larger set of discrete control/status signals and supports a higher serial port data rate. The board revision level is indicated the printed circuit board (PCB) silkscreen as part of the board part number. Revision A has the part number text FA100-00071. Revision B has the part number text FA100-00071B.

1.2 References

Reference information include:

- *DVSI 4.8 kbsp AMBE+TM Vocoder for Air Traffic Communication, Software Release 1.2.0*

1.3 Notational Conventions

While reading this manual, the following notational conventions should be observed:

- *Command Entry.* This manual describes terminal commands. All terminal commands and responses are shown in `courier font`. Although all commands in this manual are shown without the necessary trailing carriage return, i.e., the user must press the Enter key to issue the command.

1.4 Document Organization

This document contains the following sections:

- *Introduction.* This section provides introductory material.
- *General Description.* This section provides a brief overview of the FAA20 and includes a list of features.
- *Connectors, Controls, and Indicators.* This section provides signal pinouts and descriptions for all FAA20 connectors and also describes the operation of FAA20 switches and LEDs.
- *Installation.* This section provides integration guidance.

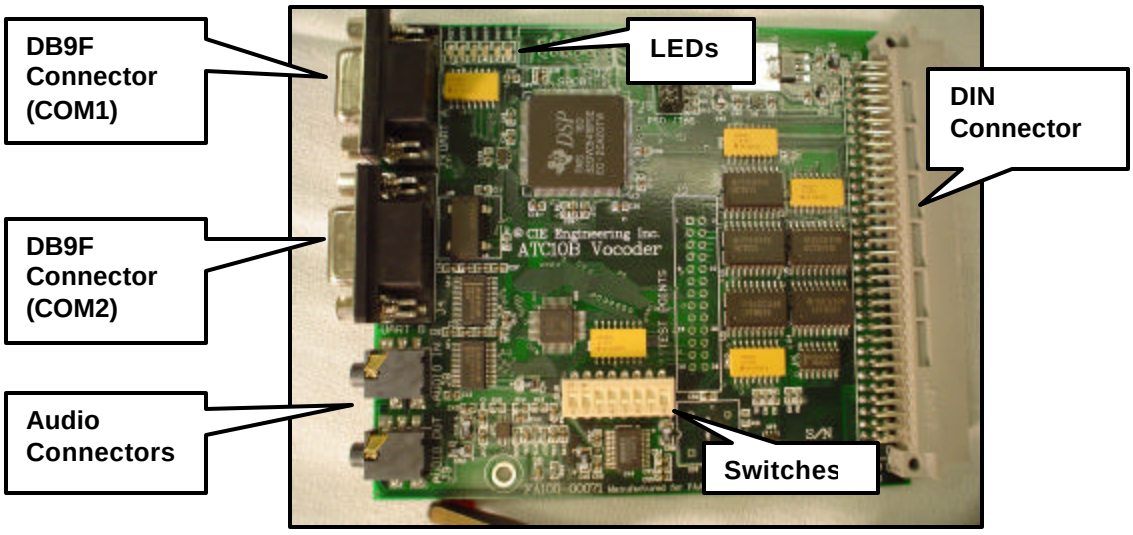
- *Functional Description.* This section covers various topics to provide users with a basic understanding of FAA20 function. It includes interface operation, voice processing flow details, and timing and control information.
- *Architectural Description.* This section describes the hardware and software architectures.
- *Maintenance and Test.* This section includes troubleshooting tips, a description of test and integration tools, and FAA20 software update instructions.
- *Terminal Command Reference.* This section includes detailed FAA20 command information.
- *Glossary.* This section defines abbreviations/acronyms and provides descriptive text for terms used in this report.

2.0 GENERAL DESCRIPTION

2.1 Overview

The FAA20 is a 4" x 5" embedded card designed to provide DVSI 4.8 kbps AMBE+ Vocoder functionality. The card is based on the TMS320C5416 Digital Signal Processor (DSP) manufactured by Texas Instrument. Figure 1 is a photograph of the FAA20.

Figure 1: FAA20 Vocoder Board



The voice interfaces for the FAA20 include the PCM serial audio and compressed nibble interface (available on the DIN connector) as well as an analog voice interface (available on computer audio jacks). Voice data can also be transferred (in ASCII format) over the FAA20 RS-232 serial ports.

The FAA20 was designed as a VC20 upgrade. The VC20 is an embedded board available from DVSI that implements the original floating point version of the AMBE+ vocoder algorithm. After the release of the VC20, DVSI developed a fixed point version of the algorithm that has bit exact properties, i.e. a known input voice vector generates a known output vector. The FAA20 was produced to use this updated algorithm within NEXCOM prototyping equipment and to more easily support truncated timing mode.

2.2 Features

The FAA20 features include:

- *TMS320C5416-160 High Performance DSP Engine*
- *Dual RS-232 serial ports (supports transfer rates up to 921,600 bps)*
- *Downloadable software (via RS-232 ports)*
- *16-bit Linear Audio Codec with external anti-aliasing filters*
- *Pulse Code Modulated (PCM) Digital Linear Voice Interface (supports time division multiplexed frame format, external/internal clocking modes, programmable serial date rates up to 4 Mbps)*
- *Optional Truncated Timing Mode Rate Adapter (adapts standard 8K linear data to truncated 6.6K rate)*
- *Compressed Nibble Interface (VC20 compatible, internal/external clocking modes)*
- *Optional Extended Nibble Interface mode (supports virtual COM3 interface using spare bandwidth in the compressed nibble frame)*
- *Forward Error Correction (FEC) status reporting*
- *Built-in Tone Generator and Detector*
- *Five-Port Linear Voice Mixer (vocoder, analog, PCM, tone generator, and COM port)*
- *Three-Port Compressed Voice Router (vocoder, nibble interface, and COM port)*
- *Terminal Command Processor with built-in help and flash memory configuration retention*
- *Programmable LEDs and 8-position configuration switch bank*

3.0 CONNECTORS, CONTROLS, AND INDICATORS

This section provides detailed information on the FAA20 connectors, controls and indicators. The following topics are included:

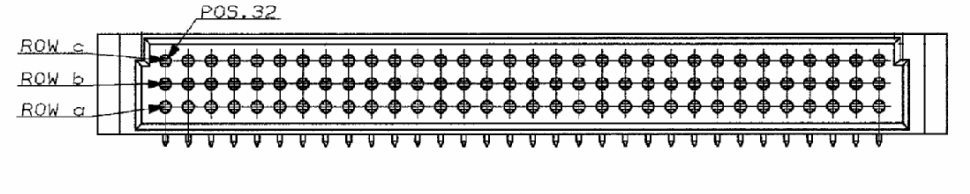
- *Main Signal Connector.* Provides signal pinouts and descriptions for the DIN 41612 connector (96 pins).
- *Terminal Connectors.* Provides signal pinouts and descriptions for the DB9F connectors (9 pins – 2 each).
- *Audio Connectors.* Provides signal pinouts, descriptions, and specifications for the two 1/8" audio jacks.
- *LED Indicators.* Describes the default functions for each of the 6 LED indicators. Note: The FAA20 supports programmable LEDs.
- *Switch Controls.* Describes the function of each of the 8 hardware slide switches.

Figure 1 shows the location of FAA20 connectors, controls and indicators.

3.1 Main Signal Connector

The DIN 41612, 96-pin connector (male) is the main FAA20 signal connector. It includes audio, PCM, nibble, power, and controls/status signals. Figure 2 provides a pin location diagram. Table 1 contains a list of DIN signals. All signals are compatible with standard +5V TTL interfaces.

Figure 2: DIN 41612 Connector Diagram



Note: The FAA20 printed circuit board silkscreen includes the row and pin labels.

Table 1: DIN Signals

SIGNAL	PIN	DIR	DESCRIPTION
NIBBLE SIGNALS			
ENC3 ENC2 ENC1 ENC0	C4 C15 C16 A4	O	Encoder Data: The compressed voice data is proved as a sequence of nibbles from the ATC-10B encoder. A total of 25 nibbles is provided every vocoder frame. The first nibble is a control nibble that is nominally set to 0000 (binary). The subsequent 24 nibbles contain the 96-bit encoded voice data packet. Each nibble is output on the rising edge of ENCCK. The FMEN encoder frame pulse is used to initiate the nibble sequence.
ENCCK	A5	I/O	Encoder Clock: The encoder clock controls the transfer of encoder data (ENCx). This signal must be 9600 Hz ± 0.05%. The ENCx, FMEN, GO and RUN are synchronous with the rising edge of this clock. Either internal or external clock can be used.
FMEN	C6	I/O	Encoder Frame Enable (active high): The frame enable is set high for one ENCCK period to begin the transfer of encoder data. The frame enable is pulsed high once every 20 ms (normal rate) and delineates the encoding window. . Either internal or external frame enable can be used.
DEC3 DEC2 DEC1 DEC0	C9 C18 C19 A9	I	Decoder Data: The compressed voice data is provided as a sequence of nibbles to the ATC-10B decoder. A total of 25 nibbles is provided every vocoder frame. Each nibble is read on the falling edge of DECCK. The FMDE encoder frame pulse is used to initiate the nibble transfer sequence.
DECCK	A10	I/O	Decoder Clock: The decoder clock controls the transfer of decoder data (DECx). This signal must be 9600 Hz ± 0.05%. Either internal or external clock can be used.
FMDE	C11	I/O	Decoder Frame Enable (active high): The frame enable is set high for one ENCCK period to begin the transfer of encoder data. The frame enable is pulsed high once every 20 ms (normal rate) and delineates the decoding window. Either internal or external frame enable can be used.
AUDIO SIGNALS			
AVI	A29	I	Analog Speech Input: The analog voice input signal is filtered with a bandpass filter (100 – 3700 Hz) and sampled at 8 kHz by a 16-bit codec. The signal should not exceed ±1 volts peak-to-peak.
AVO	C29	O	Analog Speech Output: A digital-to-analog converter operating at 8 kHz generates the analog voice output signal. The signal is bandpass filtered (100 – 3700 Hz) and should not exceed ±1 volts peak-to-peak.
PCM SIGNALS			
DX	B6	O	Serial Transmit Data: Linear 16-bit PCM voice is output from the FAA20 at a rate of 8000 samples/second. Each sample is transmitted serially (MSB first) beginning with the rising edge of the SCLK after the FSX signal is detected.

SIGNAL	PIN	DIR	DESCRIPTION
DR	B11	I	Serial Receive Data: Linear 16-bit PCM voice is input to the FAA20 at a rate of 8000 samples/second. Each sample is received serially (MSB first) beginning with the falling edge of the SCLK after the FSR signal is detected.
SCLK	B9	I/O	Serial Shift Clock: The serial shift clock transfers transmit and receive serial data. Transmit data is output on the rising edge of clock. Receive data is sampled on the falling edge of clock.
FSX	B7	I/O	Serial Transmit Frame Sync (active high): The FAA20 samples this signal on the falling edge of SCLK. An active signal begins the transfer of Transmit Data. The FSX signal should be asserted for only one bit period at a rate of 8 kHz.
FSR	B12	I/O	Serial Receive Frame Sync (active high): The FAA20 samples this signal on the falling edge of SCLK. An active signal begins the transfer of Receive Data. The FSR signal should be asserted for only one bit period at a rate of 8 kHz.
SPRDY	C7	O	Serial Port Ready Status: Unlike the VC-20, the FAA20 serial port is dedicated to serial port transfers and is always ready. This signal is tied to +5V with a pull up resistor to insure compatibility with VC-20 implementations.
CONTROL/STATUS SIGNALS			
RUN	A6	O	Run Status (active high): The FAA20 asserts this signal when it actively encoding or decoding voice. The signal is synchronous with ECLK. The FAA20 also lights LED6 when encoding or decoding; however, the LED6 state changes are driven by the FAA20 DSP and are not synchronous with ECLK. *Note: This bit is not functional in TEST mode.*
RESX	A7	O	Reset Status (active low): The FAA20 asserts this signal when reset is active. The signal is driven by the FAA20 hardware signal state and not driven by the FAA20 DSP software. The FAA20 is reset under any of the following conditions: power up, RSTI assertion, and/or FAA20 watchdog timeout.
DINRS	A15	I	Reset Signal (active high): The reset signal can be externally asserted to reset the FAA20. An active signal with a minimum duration of 300 ns resets the board. A built-in pull-up resister disables this signal when the pin is left unconnected.
ECHO	A23	I rsvd	Echo Canceller Enable (active low): The FAA20 does not include a built-in echo canceller. The FAA20 software ignores this signal. A built-in pull-up resister disables this signal when the pin is left unconnected.
VAD	A22	I	Voice Detection Enable (active low): This signal must be asserted to enable FAA20 voice/silence detection and comfort noise generation. This signal is sampled on the falling edge of DCLK. A built-in pull-up resister disables this signal when the pin is left unconnected. *Note: This bit is not functional in TEST mode.*
DDET	A17	O rsvd	DTMF Detection Status (active high): This signal is not used by the FAA20. During power up, it is initialized to the low (inactive) state.

SIGNAL	PIN	DIR	DESCRIPTION
DDAT	A21	O rsvd	DTMF Data Output (active high): This signal is not used by the FAA20. During power up, it is initialized to the low (inactive) state.
GO	C24	I	GO Mode (active high): The GO signal must be active to place the encoder in voice mode. The FAA20 samples this signal on the falling edge of DCLK when the DFS bit is also set. When this signal is inactive, the encoder resets (internally) and outputs silence frames. A built-in pull-up resister enables this signal when the pin is left unconnected. *Note: This bit is not functional in TEST mode.*
TMTX	B32	O	Truncated Timing Status (active high). When set, the FAA20 is in truncated timing mode. *Note: This bit is not functional in TEST mode.*
TMRX	B31	I	Truncated Timing Control (active low). When low, causes the FAA20 to enter truncated timing mode. *Note: This bit is not functional in TEST mode.*
X00 X01 X02 X03	C32 A24 C25 A25	I/O rsvd	Expansion Bits. Reserved for future use.
POWER SIGNALS			
VCC	A1, A2, C1, C2	P	Power (positive rail): The FAA20 requires 400 mA (typ) and 700 mA (max) at +5V ±5%. *Note: Unlike the VC20, the FAA20 does not require an analog circuit voltage rail.*
GND	A3, A8, A13, A20, A26, A31, A32, C3, C8, C13, C20, C26, C31, C32	P	Power (ground rail): Connect to ground.

* Notes: RW = Read/Write, RO = Read Only, SWC = Software Controlled, RSVD = Reserved, CL = Clock Latched, and rsvd = reserved for future use. All unlisted pins are not connected.

3.2 Terminal Connectors

The two DB9F serial connectors are used for terminal control. The connectors labeled UART A and UART B on the silkscreen are the COM1 and COM2 interfaces, respectively. Both/either interface can be used for terminal control and software download with one exception. If the main program is erased and the unit is power cycled, the boot application only uses COM1. The boot application supports main program download.

The default communication setup has the following characteristics:

- *115,200 bps, 8 data bits, 1 stop bit, no parity, no flow control*

While this setup facilitates quick setup with three-pin serial cables, it is recommended that the user enable hardware flow control. Hardware flow control prevents character loss when printing large sets of data and is also required for main software download.

The FAA20 utilizes a data communication equipment (DCE) interface. Figure 3 provides a pin location diagram. Table 2 contains a list of DB9F signals.

Figure 3: DB9F Connector Diagram

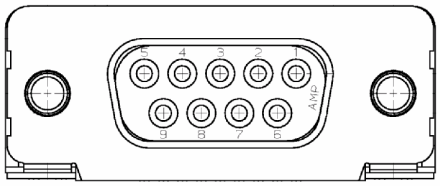


Table 2: DB9F Signals

SIGNAL	PIN	DIR	DESCRIPTION
CD	1	O	Carrier Detect. Always active.
RXD	2	O	Receive Data.
TXD	3	I	Transmit Data.
DTR	4	I	Data Terminal Ready.
GND	5	---	Ground
DSR	6	O	Data Send Ready.
RTS	7	I	Request to Send.
CTS	8	O	Clear to Send.
RI	9	O	Ring Indicator. Always active.

3.3 Audio Connectors

The two 1/8" stereo jacks provide access to the analog audio interface. The FAA20 only supports a single analog interface, i.e. these jack signals are wired in common with the associated DIN connector signals.

Although the internal audio amplifier can drive 8-ohm speakers, the interface is compatible with 600-ohm audio interfaces.

Table 3: Audio Jack Signals

SIGNAL	PIN	DIR	DESCRIPTION
AVI	J8 (tip)	I	Analog Speech Input: The analog voice input signal. Internally connected to DIN signal pin A29. Type: single-ended Impedence: 27K ohms (compatible with 600-ohm) Sinusoidal Overload: +3.0 dBm0 Bandwidth: 100 to 3700 Hz Reference Level: 1 Vpp = 0 dBm0 Nominal Level: -23 dBm0 (avg. speech level)
GND	J8 (sleeve)	---	Ground.
AVO	J9 (tip)	O	Analog Speech Output: The analog voice output signal. Internally connected to DIN signal pin C29. Type: single-ended Drive Capability: 150 mW (8-ohm load) Sinusoidal Overload: +3.0 dBm0 Bandwidth: 100 to 3700 Hz Reference Level: 1 Vpp = 0 dBm0 Nominal Level: -23 dBm0 (avg. speech level)
GND	J9 (sleeve)	---	Ground.

Note: The audio input jack (J8) is labeled as AUDIO IN. The audio output jack (J9) is labeled as AUDIO OUT.

3.4 LED Indicators

Table 4 describes the default LED indicator assignments. The FAA20 supports programmable functions for the LEDs. For more information on LED assignment, see Section 5.4.3.

Table 4: LED Indicators*

LED	ASSIGNMENT	DESCRIPTION
LED1 (red)	LANYP	Audio Peak Indicator. Lights when audio signal level reaches the peak threshold, i.e. +3 dBm0.
LED2 (yellow)	LANYA	Audio Activity Indicator. Lights when audio signal level reaches the peak threshold, i.e. -36 dBm0.
LED3 (green)	TRUN	Truncated Timing Indicator. Lights when truncated timing mode is active.
LED4 (red)	ERR	Error Indicator. Lights when an error is detected. Lights for each sample/packet added or deleted as a result of timing differences..
LED5 (yellow)	VAD	Vocoder Activity Indicator. Lights when voice is detected at the encoder and the encoder is running –OR—when voice is detected at the decoder and the decoder is running.
LED6 (green)	RUN	Run Indicator: Blinks when the FAA20 is operating normally. The blink rate indicates processor loading. Note: This indicator is NOT related to the RUN signal provided on the DIN connector.

* Default assignments shown. For information regarding LED assignment, refer to Section 5.4.3.

3.5 Switch Controls

Table 5 describes the function of FAA20 switches. These switches are read only during power up.

Table 5: Switch Controls

SWITCH	FUNCTION	DESCRIPTION
SW1	PCM_MASTER	PCM Master Timing. When ON, the FAA20 generates PCM timing. When OFF, the external device generates PCM timing.
SW2	NIB_MASTER	Nibble Master Timing. When ON, the FAA20 generates nibble interface timing. When OFF, the external device generates nibble timing.
SW3	ADAPT_EN	Rate Adapter Enable. When ON and the timing mode is TRUNCATED, the FAA20 enables the rate adapter on the PCM interface. Set to ON if the truncated PCM frame rate is 8000. This switch is ignored for TEST mode.
SW4	TRUNC_EN	Truncated Mode Enable. When ON, the FAA20 enters truncated timing mode. When OFF, the FAA20 enters normal timing mode. This switch is ignored for TEST mode.
SW5	PCM_SELECT	PCM Select. When ON, the FAA20 routes PCM audio to the vocoder. When OFF, the FAA20 routes codec audio to the vocoder. This switch is only read when OPMODE is set to VC20. This switch is ignored for all other modes.
SW6	Reserved	Reserved. Set to OFF for future compatibility.
SW7 SW8	OPMODE	Operational Mode: Sets the operational mode of the FAA20. See Section 5.1 for details. SW7 SW8 Mode OFF OFF NORM Mode. OFF ON VC20 Mode. ON OFF DEMO Mode. ON ON TEST Mode.

4.0 INSTALLATION

This section provides FAA20 installation instructions. The following topics are included:

- *Connecting to the FAA20.* Provides guidance for board integration.
- *Setting up Switch Controls.* Provides guidance for configuring the on-board switches.
- *Setting up Flash Configuration Parameters.* Provides guidance for configuring other FAA20 parameters stored in flash memory.

Before installing and operating the FAA20, review the entire contents of this manual.

While the FAA20 does possess a terminal command port for control, configuration and status, the unit is intended to be used as an embedded device. Operational control is implemented with signal conductors and/or control bits in the nibble data stream.

4.1 Connecting to the FAA20

The main signal connector is the primary FAA20 interface. Section 0 contains the main connector pinout and signal descriptions. Section 5.2 provides additional interface details and timing diagrams.

4.2 Setting up Switch Controls

The switch controls are read by the FAA20 during unit power up. The switches control interface timing and operational mode.

To setup the switch controls:

1. Select the operation mode (SW7/SW8).configuration after reviewing the switch descriptions in Table 5.

   Typically, the NORM operational mode is selected (SW7=OFF, SW8=OFF). This mode will also work with systems designed for the DVSI VC20 unit.

2. Select the timing sources for the PCM (SW1) and NIB (SW2) interfaces.

   Typically, external timing (switch=OFF) is selected for both interfaces when the FAA20 is integrated with a host system. Note: If the PCM interface is not used, the PCM switch setting does not matter. If the DEMO mode is selected (a standalone mode), insure both switches are in the ON position.

3. Select the proper adapter configuration (SW3).

   This switch setting is important for configurations that use the PCM interface. If the host system can support both the 8 ksps and 6.67 ksps digital frame rates, set SW3=OFF. If on the other hand, the host system only supports the standard 8 ksps voice sample rate, enable the adapter, i.e. set SW3=ON.

4. Select the truncated timing switch (SW4) to the OFF position.

   This switch can be used to initially setup the FAA20 in truncated timing mode. This typically is not desirable, but could be helpful for system test or demonstration purposes.

5. If VC20 mode has been selected and the PCM interface will be used with the vocoder, set the PCM route enable switch (SW5) to the ON position. Otherwise, set the position to OFF.

4.3 Setting up Flash Configuration Parameters

It is recommended that the FAA20 flash configuration parameter settings be reviewed and updated as required to insure FAA20 interoperability. The flash configuration parameters settings are accessible via the FAA20 terminal command interface.

To communicate with the FAA20 terminal port for the first time, set up a terminal to work at 115,200 bps, 8 data bits, 1 stop bit, no parity, no flow control. The terminal communication parameters can be changed and saved to flash memory, as required.

To view the current configuration, type the 'CFG' command which lists all configuration parameters. For a list of the default settings, refer to Section 8.3.3.

Since the desired configuration setup is up to the FAA20 integrator, detailed setup instructions are not provided. However, the following sections provide additional information which may be helpful in selecting the appropriate flash configuration.

4.3.1 Timing Configuration

In order to achieve the best audio quality, the proper timing configuration must be used. The following items provide timing configuration guidance.

- *Clocking (CLKSRC, CLKRATE, FRAMESIZE).* Either internal or external clock (CLKSRC) must be selected for the NIB clock interface and the optional PCM interface. Since the FAA20 vocoder is intended to be part of a larger system, external timing is usually selected. If external clock is selected, the CLKRATE and FRAMESIZE can be ignored: CLKRATE and FRAMESIZE. If internal clock is selected, you must insure that the normal and truncated timing modes support 8 ksps and 6.67 ksps for linear voice, respectively. In addition, the frame rates for compressed

voice should be 20 ms and 24 ms, respectively. The nominal nibble clock rates are 9600 and 8000 Hz, respectively, for normal and truncated timing modes. For a special framing nibble framing mode that supports truncated timing at the 9600 Hz rate, see Section 5.2.3

- *Clock Reference (CLKREF).* The CLKREF parameter is used to control the internal linear voice processing task. The parameter should be set to match the primary linear port which will be used with the vocoder, i.e. AUD or PCM.
- *Rate Adapter (ADAPT).* The PCM port rate adapter is designed to support truncated timing connections for host systems that are limited to 8 ksps linear voice rates. If enabled, the rate adapter internally re-samples the PCM audio to create the truncated 6.67 ksps data stream. A rate adapter is not required with the analog interface. The audio codec sample rate is internally adjusted to the truncated timing sample rate; thus, the external interface remains unchanged (except that the signal bandwidth is reduced accordingly).

For applications which require external NIB timing and use the analog linear interface, it should be noted that voice samples will be occasionally added/dropped. This is a result of the small timing differences in the internal timing base (used to drive audio codec) and the external nibble timing. Note: This operation is identical with original VC20 implementation.

Other than the CFG command, there are two status tools that can also be used to verify the timing configuration.

- *ERR LED Indicator.* The ERR LED lights for each sample/add drop. If gross timing errors are present, this light will appear solid. For minor timing variations, this light may blink occasionally.
- *COUNT Terminal Command.* The sample add/delete counters provide the most detailed information about timing differences.

4.3.2 Setting up the Audio Flow

Just as the proper timing is required for good audio quality; the proper signal levels are required for good audio quality. And, signal levels are equally important on the analog and digital audio interfaces. Since audio level matching can be more problematic, the FAA20 provides an additional level setting tool on the analog audio interface.

- *Voice Signal Levels (GAM, MIX).* The recommended average speech level for the vocoder is -23 dBm0. The gain, attenuation, and mute (GAM) feature can be used to digitally adjust the AUD (analog) port signal level. The GAM provides an adjustment of -36 dB to +21 dB. The mixer feature can provide signal attenuation for both analog and PCM audio signals.
- *Voice Signal Flow (MIX, ROUTE).* Insure the voice signal flows are configured, as required. For NORM mode, the flash configurations are used to setup the FAA20 at power up. For the VC20 and DEMO

modes, the flow (MIX & ROUTE) is NOT loaded from flash, but is set to a known, fixed configuration. For the VC20 mode, however, the active linear power can be selected with SW5.

In addition to the GAM and MIX level commands, there are LED status indicators that provide an coarse measure of signal level.

- *LANYP and LANYA LED Indicators.* The audio should cause the LANYA indicator to light and should NOT cause the LANYP peak indicator to light.

5.0 FUNCTIONAL DESCRIPTION

This section provides a functional overview of the FAA20. The following topics are included:

- *Operational Modes.* Discusses the normal operational mode and three other optional modes.
- *Interfaces.* Discusses details for each of the three external voice port types: the audio interface, the digital PCM interface and the nibble interface. Interface timing diagrams are provided.
- *Voice Processing.* Presents the overall voice flow block diagram and describes major blocks/functions in the flow.
- *System Timing and Control.* Discusses truncated timing mode, voice delays, programmable LEDs and the command processor.

5.1 Operational Modes

The FAA20 supports four operational modes. The differences between modes lie in how the FAA20 routes data and handles vocoder control signals.

5.1.1 NORM Mode

The NORM mode is used for most FAA20 embedded applications. It supports the expanded nibble interface and allows flexible routing and voice signal level adjustments.

5.1.2 VC20 Mode

The VC20 mode is designed to allow the FAA20 to be used with minimal effort for applications that have been developed based on the VC20. In this mode, the expanded FAA20 features are disabled and some of the configuration parameters are forced to a known state, i.e. flash settings are ignored. Figure 4 provides a summary of the VC20 forced configuration parameters.

Figure 4: VC20 Forced Configuration Items

VC20 Fixed Configuration Items (SW5=OFF)

```
> ADAPT = OFF
> FRAMESIZE NIB NORM = 192
> FRAMESIZE NIB TRUN = 192
> MIX AUD <- VOC (0x7FFF)
> MIX PCM -- OFF
> MIX VOC <- AUD (0x7FFF)
> MIX COM -- OFF
> MIX TON -- OFF
> ROUTE VOC <- NIB
> ROUTE NIB <- VOC
> ROUTE COM <- COM
```

VC20 Fixed Configuration Items (SW5=ON)

```
> ADAPT = OFF
> FRAMESIZE NIB NORM = 192
> FRAMESIZE NIB TRUN = 192
> MIX AUD -- OFF
> MIX PCM <- VOC (0x7FFF)
> MIX VOC <- PCM (0x7FFF)
> MIX COM -- OFF
> MIX TON -- OFF
> ROUTE VOC <- NIB
> ROUTE NIB <- VOC
> ROUTE COM <- COM
```

5.1.3 DEMO Mode

The DEMO mode is designed to allow the FAA20 to operate in a standalone mode. The AUD port is with the vocoder and the compressed voice packets are internally looped. The software monitors the state of the TMRX signal to enter and exit truncated timing mode. Figure 5 provides a summary of the DEMO forced configuration parameters.

Figure 5: DEMO Forced Configuration Items

```
> MIX AUD <- VOC (0x7FFF)
> MIX PCM -- OFF
> MIX VOC <- AUD (0x7FFF)
> MIX COM -- OFF
> MIX TON -- OFF
> ROUTE VOC <- VOC
> ROUTE NIB <- NIB
> ROUTE COM <- COM
```

5.1.4 TEST Mode

The TEST mode supports FAA20 integration testing. It is especially designed to allow back-to-back FAA20 unit connection (requires adapter board). In this mode, the most of the automatic external vocoder controls are disabled to allow manual control of these items. Specifically, the following vocoder signal conductors are ignored: VAD, GO, TMRX.

5.2 Interfaces

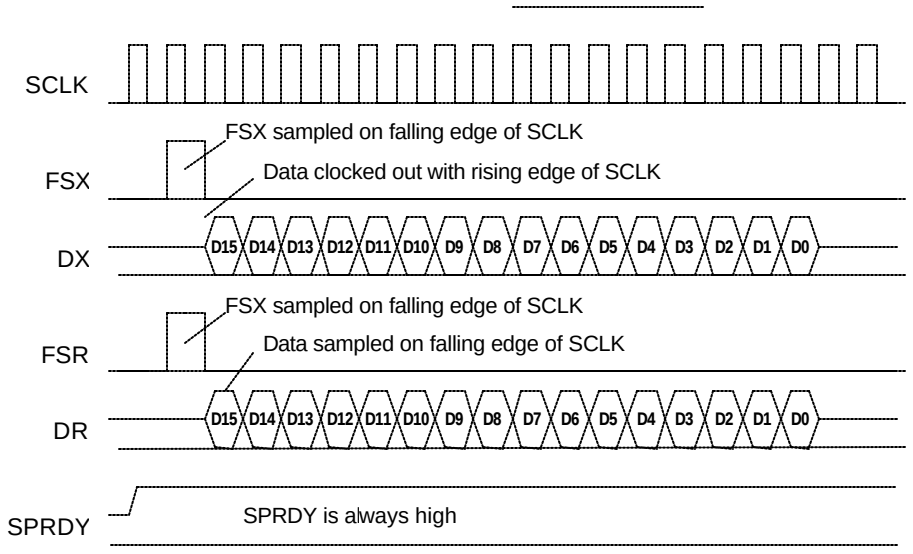
5.2.1 AUD Interface

There are two physical connections to the audio interface: a DIN connection and a jack connection. These signals are internally wired together. If the DIN connector is used as the primary connection interface, the audio jack can still be used to monitor audio signals.

5.2.2 PCM Interface

The digital PCM interface supports serial, time division multiplexed (TDM) transmission of digital voice data. A common clock, SCLK, is used for both data transmission and reception. Frame synchronization signal, FSX and FSR, enable the transmission and reception of a digital data word, respectively. Figure 6 provides a signal timing diagram.

Figure 6: PCM Interface Timing Diagram



The SPRDY signal is a vestige of the VC20 digital PCM interface. While the VC20 required PCM signals to be tri-stated until the unit is ready, the

FAA20 has no such restriction. The SPRDY signal is internally pulled high with a pull-up resistor.

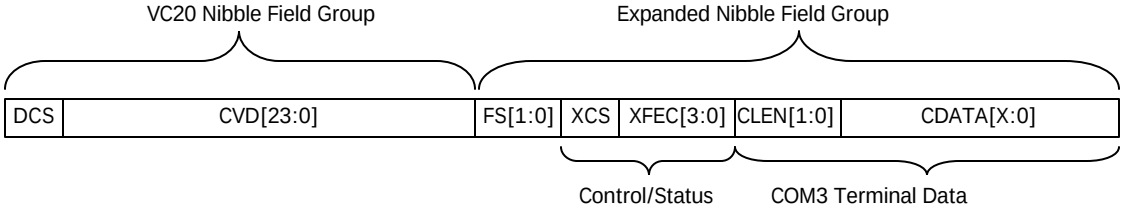
Although the figure shows alignment of the FSX and FSR signals, this is not a requirement. The maximum SCLK rate is 4.096 MHz.

The PCM clock rate can be changed "on-the-fly" to support switching between normal and truncated timing modes; however, the transition should be glitch-free.

5.2.3 NIB Interface

The FAA20 compressed nibble interface supports the exchange of compressed voice data. The interface is based on that used within the VC20; however, the FAA20 supports an expanded set of data and control nibbles appended to the end of the nibble frame. The expanded interface provides truncated timing control, error status, and an additional (virtual) terminal port (COM3). Figure 7 provides the nibble interface frame format.

Figure 7: Nibble Interface Frame Format



DCS DVSI Defined Control/Status Nibble: Vocoder control and status bits. Bit assignments are identical to VC20. The bit assignments are: DEC3=LOST, DEC2=INIT, DEC1=MUTE, DEC0=rsvd.

CVD Compressed Voice Data: Contains 23 nibbles (96-bits) of compressed voice data. Nibble orientation and order are identical to VC20.

FS Flag Sequence: Set equal to 0xFA. Two nibble field that marks beginning of the Expanded Nibble Interface. These flag nibbles must be correct for the FAA20 to interpret the remaining nibbles.

XCS Expanded Control/Status Nibble: Expanded control status nibble used to assert truncation mode and provide error status. The bit assignments are: DEC3=ESTAT, DEC2=ECLEAR, DEC1=TSTAT, DEC0=TRUN. The FAA20 uses bit transitions to set the truncation mode. To enable truncated timing mode, force a zero-to-one bit transition for the TRUN bit in the DECx input data stream. To enable normal timing mode, force a one-to-zero bit transition. The TSTAT bit (in the ENCx output data stream) reflects the current timing mode with a 1 indicating truncation is active. A rising edge on the ECLEAR bit (in the DECx input data stream) forces clearing of any latched errors and clears the FEC counter.

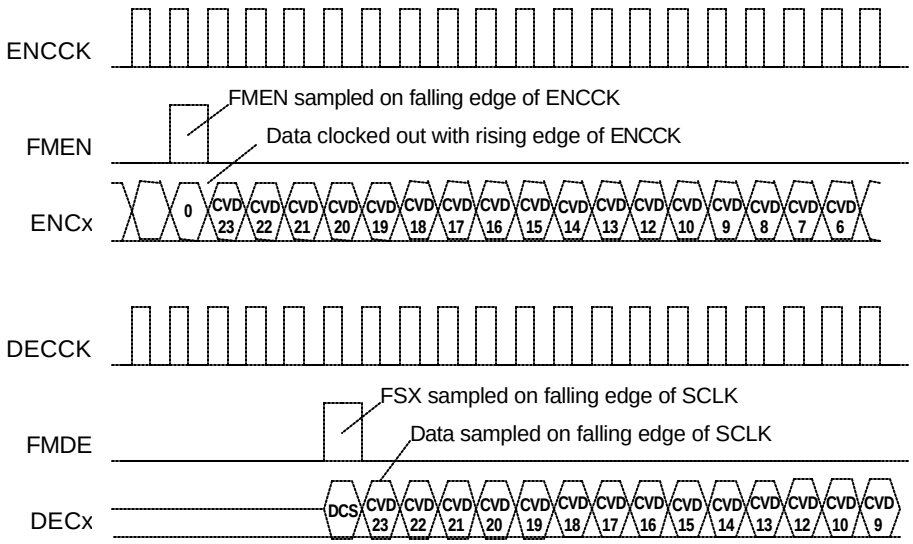
XFEC FEC Error Count: For nibble output, represents 16-bit cumulative FEC decoder bit error counter (4 nibbles). Set input = 0000, for future compatibility.

CLEN Command Length: Length of CDATA expressed as nibbles. Since the CDATA field contains byte information, the CLEN field is always even. The number of nibbles is twice the number of bytes to be transmitted. The maximum CLEN value is 128 nibbles (or 64 bytes).

CDATA Command Data: Variable length field. Contains ASCII (or binary) bytes for terminal type command and control. The first nibble is the most significant nibble (MSN) of the first terminal byte. The second nibble is the least significant nibble (LSN) of the first terminal byte. The next two nibbles contain the next terminal byte. Subsequent, nibbles contain the remaining terminal data.

The FAA20 nibble signaling requirements are identical the VC20 nibble signaling requirements. Figure 8 provides signal timing information.

Figure 8: NIB Interface Timing Diagram



The NIB clock rate can be changed "on-the-fly" to support switching between normal and truncated timing modes; however, the transition should be glitch-free.

The FAA20 supports a special nibble framing mode for a frame size of 230 clocks. This special mode may enable some host systems that have a fixed nibble clock rate to support truncated timing mode. As already presented, the PCM interface provides a rate adapter to perform the required sample rate adjustment. For the nibble interface, the clock rate can remain at 9600 Hz and the frame size can be changed to reflect the truncated timing frame rate. Although the actual frame size required for truncated timing is not an integral frame size, i.e. 230.4 clocks at 9600 Hz, the FAA20 supports alternating frame sizes of 230 and 231 clocks to support an average frame size of 230.4 clocks. Thus, the truncated timing mode can be supported and compressed packets are not accumulated or depleted.

When the FAA20 nibble timing source is set to internal, the frame size is set to 230 for truncated timing mode, and the truncated timing rate is 9600 Hz, then the FAA20 will generate a special set of framing pulses that average the 230.4 frame size. Specifically, the following five frame sizes are repeated sequenced: 230, 231, 230, 230, and 231. Externally timed interfaces can use the same framing sequence. Audio quality is not affected since the vocoder is not affected by data transmission methods.

5.3 Voice Processing

The FAA20 voice processing flow includes the following major functional blocks:

- *AMBE+ Vocoder*
- *Linear Voice Mixer*
- *Packet Voice Router*
- *PCM Rate Adapter*
- *Tone Generator*
- *Gain, Attenuation, and Mute (GAM)*
- *Voice Peak/Activity Detectors*

Figure 9 is a voice processing flow diagram. The diagram is divided into two major areas: linear audio and compressed audio. The AMBE+ vocoder is positioned between these two areas.

5.3.1 AMBE+ Vocoder

The FAA20 uses the optimized, fixed-point implementation of the DVSI 4.8 kbps Advanced Multi-Band Excitation Plus (AMBE+™) Vocoder for Air Traffic Communication. The vocoder is used to compress speech for transmission over low data rate channels. The AMBE+ algorithm has been approved for use with the FAA Next Generation Air-to-Ground Communication System (NEXCOM). The vocoder is also known as the ATC10B vocoder.

The AMBE+ algorithm has been designed to be robust to both acoustic background noise and channel errors. It generally contains sufficient channel error protection to produce high quality speech at bit error rates up to 1-2% and intelligible speech at bit error rates up to 4-5%.

The algorithm includes a number of advanced features such as automatic Voice Silence detection (VAD), adaptive comfort noise generation, and soft-decision decoding.

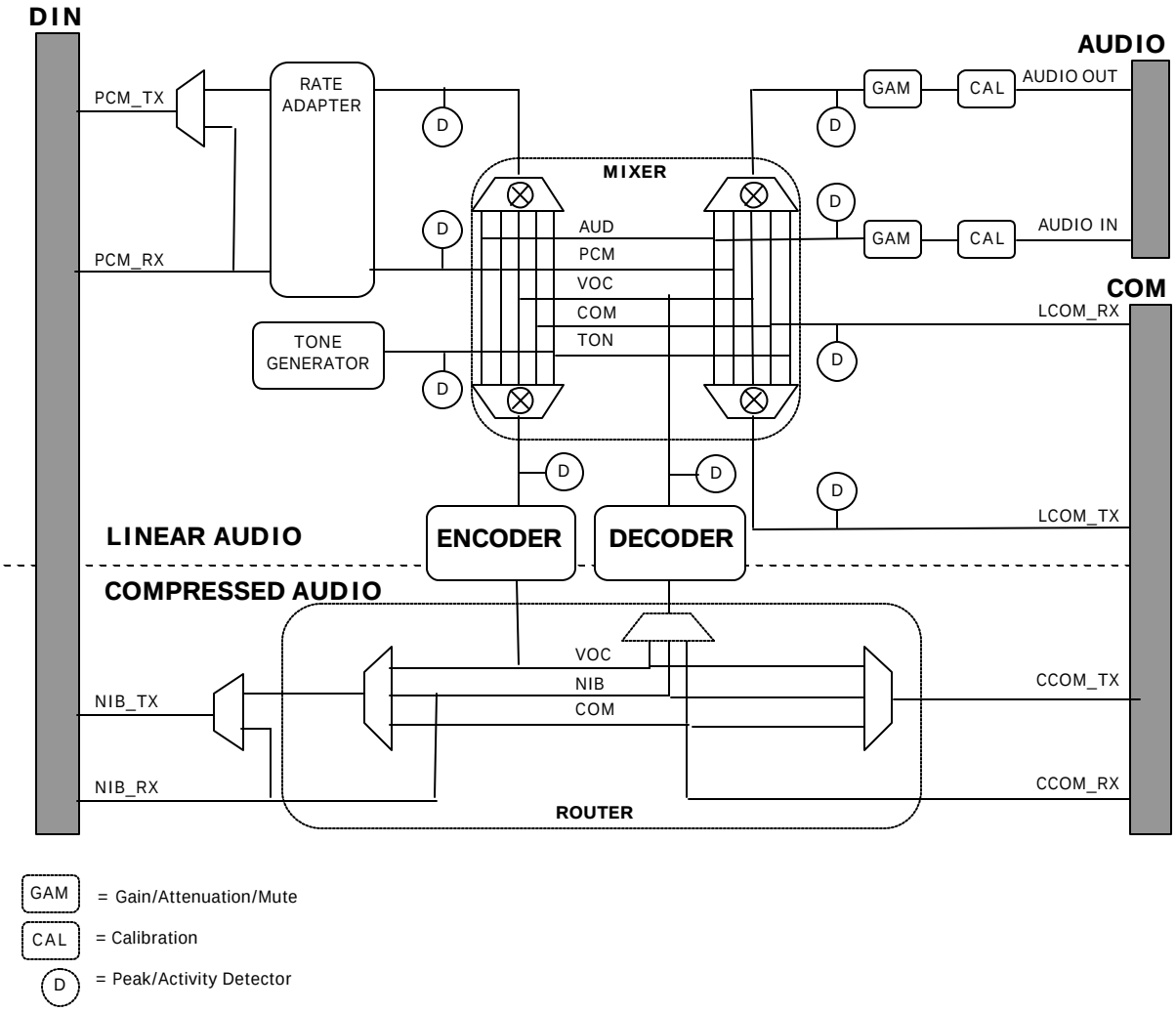
There are three sources of vocoder control:

- *DIN Signal Conductors (GO, VAD)*
- *Control Nibble Bits (INIT, LOST, and MUTE bits)*
- *Terminal Command (VOC command)*

The signal and bit states are sampled during the FMDE signal pulse. The associated control is executed at the beginning of the next call to the vocoder task. The terminal command states are implemented as soon as the command is processed.

The FAA20 software actively controls the parameters listed in the VOC command. This active control is disabled when TEST BITEXACT mode is enabled. This allows the test vectors supplied at the serial ports to control the vocoder, as required. For test vector support, see Section 7.4.

Figure 9: Voice Processing Flow Diagram



Note: The rate adapter is available only in truncated timing mode.

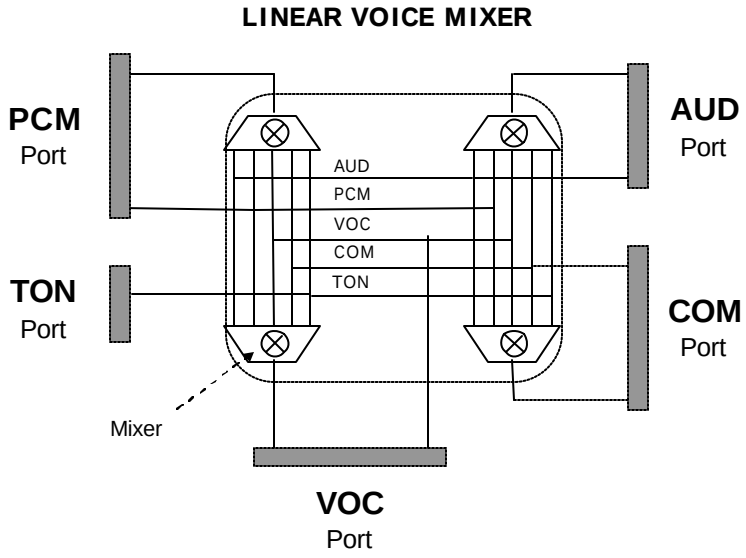
5.3.2 Linear Voice Mixer

The linear voice mixer controls the flow of linear voice through the FAA20. The mixer has five ports: the analog audio port (AUD), the digital PCM port (PCM), the vocoder port (VOC), the tone generator port (TON), and the external communication port (COM).

The mixer supports weighted signal summing with saturation control. For example, if the PCM port is connected to the vocoder, the AUD port can be configured to sum the PCM TX and RX signals to provide full-duplex audio monitoring.

The mixed signals are first multiplied by a weighting factor before summation. The weighting factor is entered as Q1.15 hexadecimal formatted value; thus, the range is from 0x0000 (off) to 0x7FFF (unity gain).

Figure 10: Linear Voice Mixer

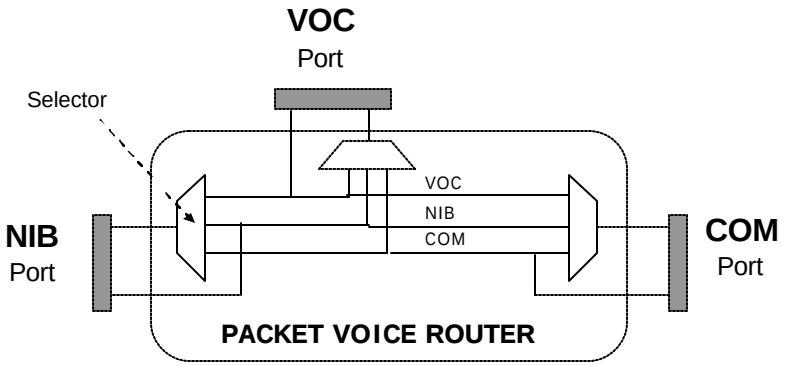


When controlling the mixer, all transmit and receive signal directions are referenced at the mixer. In the diagram above, only a receive mixer port is shown for the tone generator (TON). While an output mixer is provided for the port, it does not connect to anything (dead-ends) and is thus not shown.

5.3.3 Packet Voice Router

The packet voice router controls the flow of compressed voice packets through the FAA20. The router has three ports: the vocoder port (VOC), the nibble port (NIB), and the external communication port (COM).

Figure 11: Packet Voice Router



Unlike the mixer, each output port can be connected to one and only one input port. Although the output port is limited to one connection, the input port can have multiple connections. For example, the VOC input port can be routed to both the NIB port and the COM port.

Although the router contains three ports, only the NIB and VOC ports are functional when not in the TEST mode. Only in TEST mode does the FAA20 software forward packets between the COM queue and the serial port. In this mode and when TEST BITEXACT is enabled, the queue data is forwarded to the serial port for vector testing.

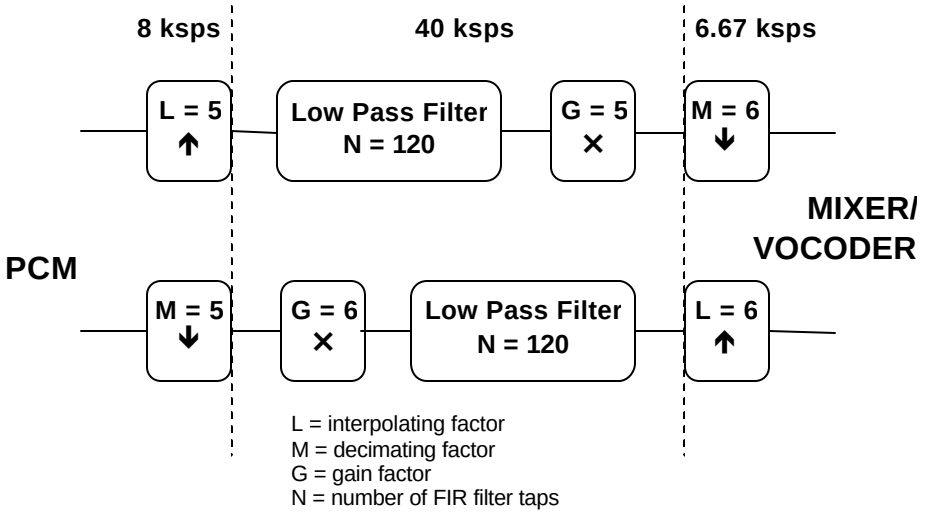
5.3.4 PCM Rate Adapter

The PCM rate adapter converts 8 ksps linear voice data to 6.67 ksps, the sample rate required for truncated timing mode. The rate adapter is useful for implementations that require constant rate PCM interface while supporting both normal and truncated timing modes. For example, external digitally interfaced telecommunication equipment typically supports voice sampled at a fixed rate of 8 kbps. The rate adapter is supported for the PCM linear interface only. The analog linear interface does not require a rate adapter since its sample rate can be adjusted as needed.

The PCM rate adapter is implemented with a multi-rate filter which includes interpolation, decimation, and filter components. The rate adapter adjusts the sample rate by the factor L/M, i.e., a ratio of two integers. Since the truncated timing mode requires a rate reduction from 4.8 kbps to 4.0 kbps

for compressed voice, a rate factor of 5/6 is required. Two filters are required. The receive filter down-converts the 8 ksps to 6.67 ksps before sending the data to the encoder. The transmit filter up-converts the 6.67 ksps decoded voice to 8 ksps before sending the data to the PCM output port. Figure 12 provides a block diagram for the PCM rate adapter.

Figure 12: Rate Adapter Block Diagram



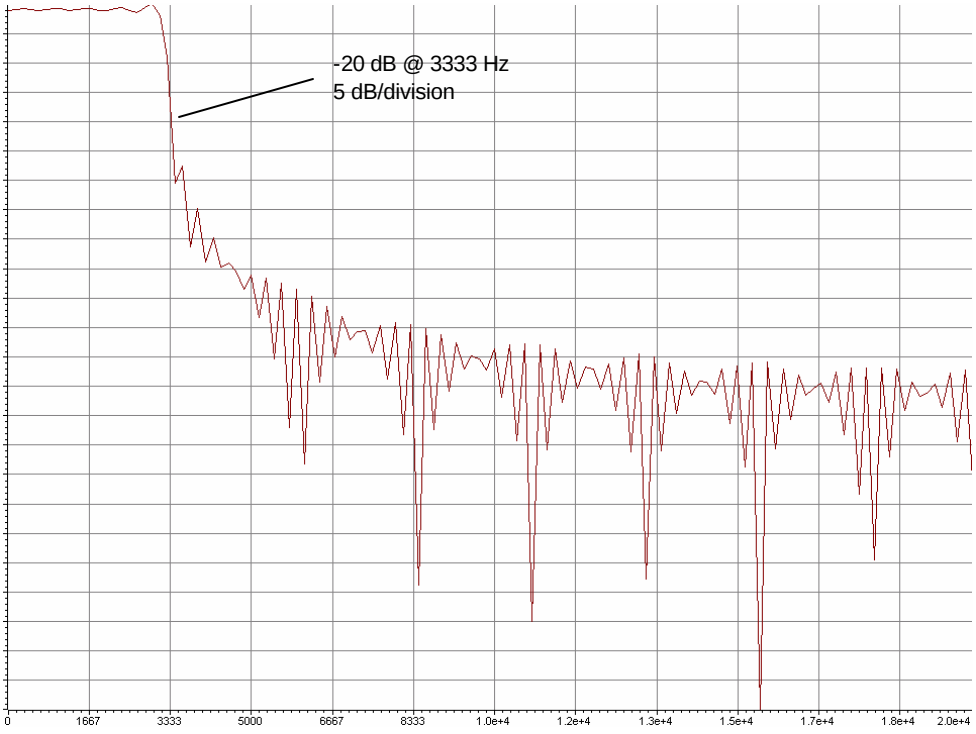
The interpolator uses the zero-insertion method to maintain spectral purity. For example, for an interpolation factor of X, every real data sample is followed by X-1 inserted zero-valued samples. While this approach maintains spectral purity, it reduces the overall signal level (after filtering) by a factor equal to the interpolation rate. Thus, a gain adjustment (G) is required to compensate for signal loss.

The low pass filter characteristics are depicted in Figure 13. The 120-tap finite impulse response (FIR) filter is designed with a reasonably flat pass band, a narrow transition band and a small voice delay, i.e. 1.5 ms.

5.3.5 Tone Generator

The tone generator outputs tones in the frequency range of 0 to 0.5 Fs (where Fs is the sample rate). The resolution is 1 Hz. The output level is set at 3 dBm0. To route a 0 dBm0 tone out another port, use a mixer value of 0x5A9D.

Figure 13: Low Pass Filter Characteristics



5.3.6 Gain, Attenuation, Mute (GAM)

The gain, attenuation, and mute (GAM) block supports a signal adjustment range of -36 dB to +21 dB for audio signals. Unlike the mixer, the GAM block supports entries in Q4.12 format; thus, a setting of 0x1000 represents unity gain.

A calibration GAM block is provided to adjust for gain variations in the analog front end. The calibration settings are programmed at the factory and are stored in protected boot flash.

5.3.7 Voice Activity/Peak Detectors

The voice activity and peak level detectors are used to light FAA20 voice activity indicators. There are activity and peak detectors place on all ports of the mixer. The programmable LEDs can be configured to display any one of the detectors (see Section 5.4.3). The activity and peak digital thresholds are set at 0x0200 and 0x7FF0, respectively.

5.4 System Timing and Control

This section addresses the following timing and control topics:

- *Truncated Timing Mode*
- *Voice Delay*
- *Programmable LEDs*
- *Command Processor*

5.4.1 Truncated Timing Mode

The truncated timing mode enables the FAA20 to produce a 4.0 kbps compressed data stream instead of the nominal 4.8 kbps. This lower data rate is required to support NEXCOM communication when accurate timing is not available from a ground site.

Truncated timing is implemented using the clock slow-down method. With this method, the entire FAA20 voice and vocoder operating rate is reduced by a factor of 5/6. The linear sample rate is reduced from 8.0 ksps to 6.67 ksps. The compressed packet rate is reduced from 50 pps to 41.67 pps.

There are four input controls for truncated timing control:

- *DIN Signal Conductors (TMRX and TMTX signals)*
- *Expanded Control Nibble Bits (TRUN and TSTAT bits)*
- *Terminal Command (TRUN command)*
- *Configuration Switch (TRUN switch – SW4)*

The FAA20 uses a first-come, first-serve approach for controlling timing based on these inputs. For example, the TRUN command can enable truncated timing, and then the TMRX signal can disable it. Control events are processed in the order received.

When the DIN signal conductors or the expanded control nibble is used, the FAA20 switches timing modes during the active state of the FMDE signal. These two input controls do not function in the TEST operational mode.

When the terminal command is used, the FAA20 switches timing modes as soon as the command is processed. When the configuration switch is used, the FAA20 switches timing modes during the power up.

5.4.2 Voice Delay

The software is designed to reduce the overall voice delay through the FAA20. There are many factors to consider in reducing this delay.

- *vocoder execution time*
- *buffering/filtering delays*
- *processor overhead*
- *data transmission speed*
- *vocoder process alignment*

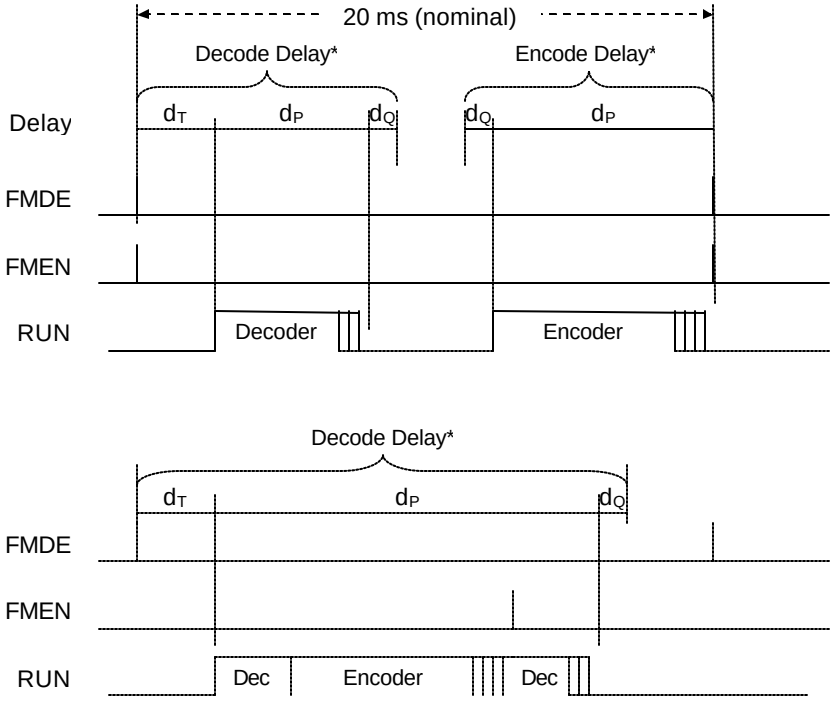
Of these factors, vocoder process alignment is the most significant factor in controlling/minimizing delay. It is controlling the execution start time for the encoding/decoding tasks based on the timing of the frame sync signals on the nibble interface. If proper alignment is not maintained, delays can be easily be increased by up to 20 ms or more, i.e. the width of a compressed nibble frame. For example, the decoder should start processing a frame immediately after the frame has been received. The encoder should start processing voice as late as possible so that the compressed data frame is ready just before it is needed for transmission.

The FAA20 triggers the encoder/decoder tasks based on known execution time requirements and the positioning of the compressed nibble frame sync signals. Execution time requirements for the encoder and decoder vary based on voice content. In addition, execution times must account for overhead and higher priority interrupt processing. The higher priority interrupt processing is required to support hardware data transfers and useful FAA20 features such as the mixer, voice activity/peak detection, and GAM volume control. Finally, if both the encoder and decoder tasks overlap, the FAA20 delays or extends the execution of the decoder task in favor of minimizing the encoder task execution time.

The vocoder RUN signal (DIN signal pin A6) indicates encoder/decoder task execution timing (see Figure 14).

The DELAY command prints throughput delays between the linear (AUD or PCM) and compressed (NIB) interfaces. The reported delay does not include collection delay (nominally 20 ms) and/or AMBE+ algorithm delay (nominally 60 ms). Table 6 provides typical delay values for the normal timing mode.

Figure 14: Vocoder RUN Signal and Voice Delays



Overlapping tasks extend the decoder processing delay

Note: Encode and Decode delays shown above are reported by the DELAY command. The delays DO NOT include collection delay (20 ms) and/or algorithm delay (60 ms).

Table 6: Typical Delay Values*

LED	TYPICAL VALUE	DESCRIPTION
d_T	2.6 ms	Transmission Delay. For normal timing and 9600 Hz clock rate.
d_P	7.5 ms	Encoder Processing Delay. This is an allocated maximum delay. It includes processing delay of higher priority tasks, i.e. interrupts.
	5.0 ms	Decoder Processing Delay. This is an allocated maximum delay. It includes processing delay of higher priority tasks, i.e. interrupts. This delay assumes no task overlap.
d_Q	1.5 ms – 2.0 ms	Queue Delay. This is a measured delay. The queue depths are read at the task trigger point.

* Normal timing mode delays are shown. Truncated timing mode delays are similar.

5.4.3 Programmable LEDs

The FAA20 supports the programmable assignment of virtual indicators to physical LED indicators. There are 40 virtual indicators and 6 physical indicators (LED1..LED6).

The virtual indicators fall into four major categories:

- *Audio Indicators.* The audio indicators are used to display audio energy and peak level events. Two of the most commonly used indicators, LANYP and LANYA, are assigned by default to LED1 and LED2, respectively. The other audio indicators (which are specific to certain mixer ports) are useful in troubleshooting mixer and level setup problems.
- *Program Task Indicators.* The program task indicators are used to measure software task execution times and interrupt latencies. These LEDs are typically used only during program development.
- *Test Indicators.* The test indicators are used to troubleshoot unit integration.
- *General Indicators.* The general indicators display unit operating conditions, e.g. truncated timing mode and runtime health.

Table 7 provides a brief description of the available virtual indicators. The audio TX and RX references in the LEDNAME refer to signal directions with respect to the mixer, i.e. the TX refers a mixer output port and the RX refers to a mixer input port.

Table 7: Virtual Indicator List

BITNAME	TYPE*	DESCRIPTION
OFF	General	OFF. Turns LED off.
ON	General	ON. Turns LED on.
AUD_HWI	Task	Audio Hardware Interrupt.
PCM_HWI	Task	PCM Hardware Interrupt.
NTX_HWI	Task	Nibble Transmit Interrupt.
NRX_HWI	Task	Nibble Receive Interrupt.
RAT_SWI	Task	Rate Adapter Software Interrupt.
LVP_SWI	Task	Linear Voice Processor Software Interrupt.
ENC_SWI	Task	Encoder Software Interrupt.
DEC_SWI	Task	Decoder Software Interrupt.
CVR_SWI	Task	Packet Router Software Interrupt.
COM_SWI	Task	UART Polling Software Interrupt.
TRUN	General	Truncated Timing Mode. When lit, indicates that the FAA20 is in truncated timing mode.

BITNAME	TYPE*	DESCRIPTION
LATE_XFSE	Test	Late Encoder Frame Sync. Winks when the encoder frame size exceeds the associated FRAMESIZE quantity. Used for debugging the nibble interface.
LATE_XFSD	Test	Late Decoder Frame Sync. Winks when the decoder frame size exceeds the associated FRAMESIZE quantity. Used for debugging the nibble interface.
LATE_NFS	Test	Spare Virtual LED. Not Used.
LAUDTXP	Audio	Transmit Audio Peak.
LAUDTXA	Audio	Transmit Audio Activity.
LAUDRXP	Audio	Receive Audio Peak.
LAUDRXA	Audio	Receive Audio Activity.
LPCMTXP	Audio	Transmit PCM Peak.
LPCMTXA	Audio	Transmit PCM Activity.
LPCMRXP	Audio	Receive PCM Peak.
LPCMRXA	Audio	Receive PCM Activity.
LVOCTXP	Audio	Transmit Vocoder Peak.
LVOCTXA	Audio	Transmit Vocoder Activity.
LVOCRXP	Audio	Receive Vocoder Peak.
LVOCRXA	Audio	Receive Vocoder Activity.
LCOMTXP	Audio	Transmit COM (serial port) Peak.
LCOMTXA	Audio	Transmit COM (serial port) Activity.
LCOMRXP	Audio	Receive COM (serial port) Peak.
LCOMRXA	Audio	Receive COM (serial port) Activity.
LANYPL	Audio	Any Voice Signal Peak (Latched). This indicator latches to the on state when a peak is detected at any voice signal interface (AUD, PCM, VOC, TON, or COM).
LANYP	Audio	Any Voice Signal Peak.
LANYA	Audio	Any Voice Signal Activity
VAD	General	Vocoder Voice Activity Detector. Lights when voice is detected at the encoder and the encoder is running – OR—when voice is detected at the decoder and the decoder is running..
RUN	General	Run-time Task Indicator. Blinks at a rate that indicates overall processor loading. Faster blinking indicates lighter loading.
ERR	General	Error LED. Lights during error conditions and winks for sample and packet add/drop events.

Some indicators are static and others are dynamic. For example, the TRUN indicator is statically lit when the FAA20 enters truncated timing mode and the LANYP indicator is dynamically winked (briefly lit for a 100 ms period) when a peak event is detected.

The LED assignments are saved in flash configuration memory by the CFG command. To reassign the LEDs, see Section 8.3.20.

5.4.4 Command Processor

The FAA20 accepts commands from three COM ports, i.e., COM1 through COM3. The first two command ports are physical RS-232 serial ports. The third command port is a virtual command port supported over the NIB data stream. The virtual command port allows host systems to access terminal control and status without the need for another physical connection.

Three instances of a command processor are run in round-robin fashion. Characters are collected on each port until a carriage return is detected, i.e. a full command line has been entered. Then, the command is interpreted by the command processor. Only one command can be processed per service event. This guarantees all ports have command access even if one port heavily loads the system.

The command processor supports a variety of terminal commands. These commands are described in the terminal command reference (see Section 8.0). All commands are entered in ASCII format and are converted to uppercase. All responses are preceded by a greater than symbol. A built-in help feature can be accessed to list available command. For each command, a brief description and valid parameters also can be accessed.

The command processor also handles data transfer required for software download and vocoder test vector transfer. These data transfers are also conducted in ASCII format. For software download instructions, see Section 7.3. For vocoder test vector support, see Section 7.4.

6.0 ARCHITECTURAL DESCRIPTION

This section provides an architectural overview of the FAA20. The following topics are included:

- *Hardware Architecture.* Provides a hardware block diagram and memory maps.
- *Software Architecture.* Provides a software block diagram and a description of software tasks and interrupts. Also discusses queues, packets and data management.

6.1 Hardware Architecture

This section presents an overview of the FAA20 hardware design and includes a set of memory maps.

6.1.1 Hardware Block Diagram

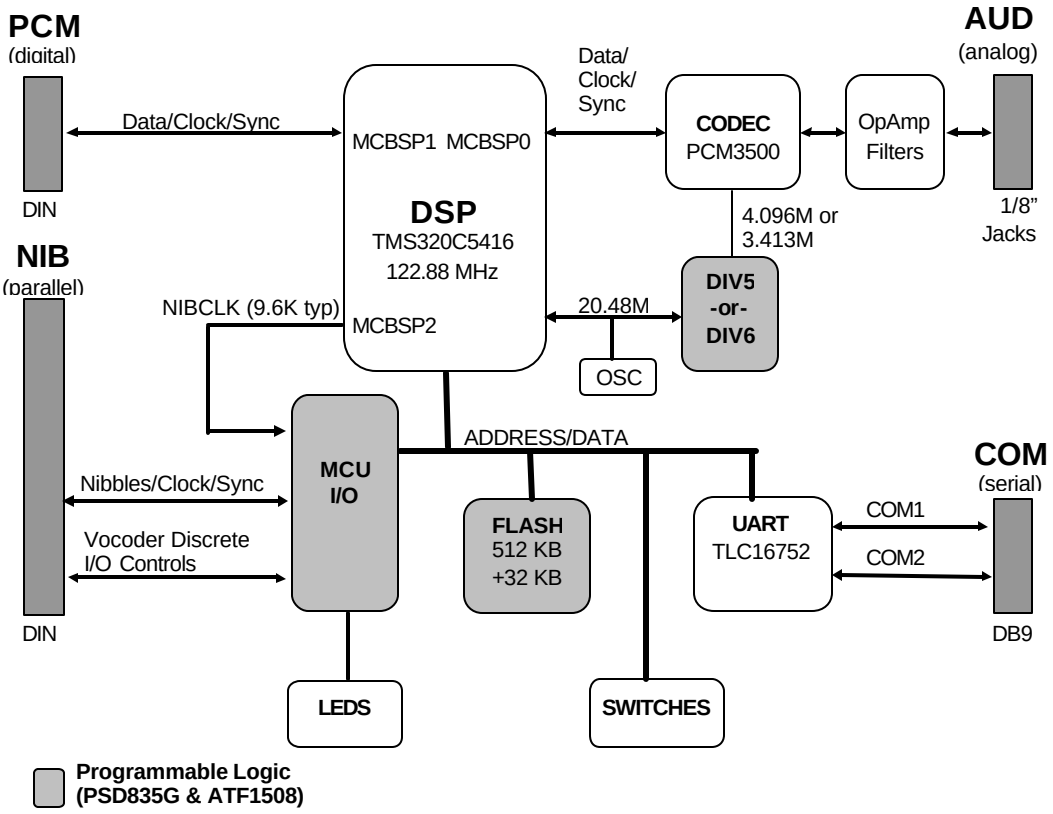
The FAA20 hardware design is based on a TI DSP processor, i.e., the TMS320VC5416. This processor is required in order to execute the DVSI optimized software vocoder written in C54x assembly. Figure 15 is a block diagram of the FAA20 hardware.

The FAA20 supports three voice interfaces: an analog voice interface (AUD), a digital PCM interface (PCM), and a compressed nibble interface (NIB).

The analog voice interface is provided by a TI PCM3500 16-bit linear voice codec. The codec is configured to sample analog voice at either a 8 ksps (normal timing) or a 6.67 ksps (truncated timing) rate. External operational amplifiers enable the FAA20 to drive loads as low as 8 ohms. Feedback components in the front end circuit form a third-order low pass filter used to band limit the analog voice signal (100 to 3700 Hz). The codec connects to a DSP multi-channel buffered serial port (MCBSP) and serially shifts data into and out of the DSP.

The digital PCM interface is used to serially shift data samples directly into and out of the DSP via MCBSP #1. While not shown in the figure, the signals are actually buffered through a 5V complex programmable logic device (CPLD) to provide TTL compatible signaling. The serial port requires a clock and frame synchronization signals to control data flow. The frame synchronization signal also functions as a time slot enable signal for a multi-drop time division multiplexed serial bus.

Figure 15: FAA20 Hardware Block Diagram



The nibble interface is supported via a CPLD. The nibble data sampled with the nibble clock and passed through a double-buffered latch. Data is transferred out on the rising edge of the nibble clock and transferred in on the falling edge of the nibble clock. Many of the vocoder discrete control signals are also sampled by the nibble clock.

The FAA20 includes two different programmable logic devices (PLD): a CPLD device (Atmel ATF1508) and a combo memory/PLD device (ST Microelectronics PSD835). The nibble and PCM interface logic is contained in the CPLD. The address decoding logic and the codec clock divider circuit is contained in the combo device.

The FAA20 includes a dual port universal asynchronous receiver/transmitter (UART) device to support two external RS-232 terminal interfaces.

The UART and PLD devices are located in the DSP IO memory space. The flash memory is accessed through the DSP data memory space.

6.1.2 Memory Maps

The DSP has three primary address spaces (program memory, data memory, and IO memory) and four internal memory arrays (DARAM03, DARAM47, SARAM03, and SARAM47). The DARAM03 array is used in both the program and data memory spaces. The DARAM47 is presently unused. The SARAM03 and SARAM47 arrays are used exclusively in the program memory space.

The flash memory stores the boot application the main application and configuration parameters. The flash memory is accessed by the DSP in the data space. The PLD devices support flash memory paging to allow access to blocks in excess of 32 kbytes.

Memory maps for the three address spaces and the flash device are provided in Figure 16 through Figure 19.

Figure 16: Program Memory Map

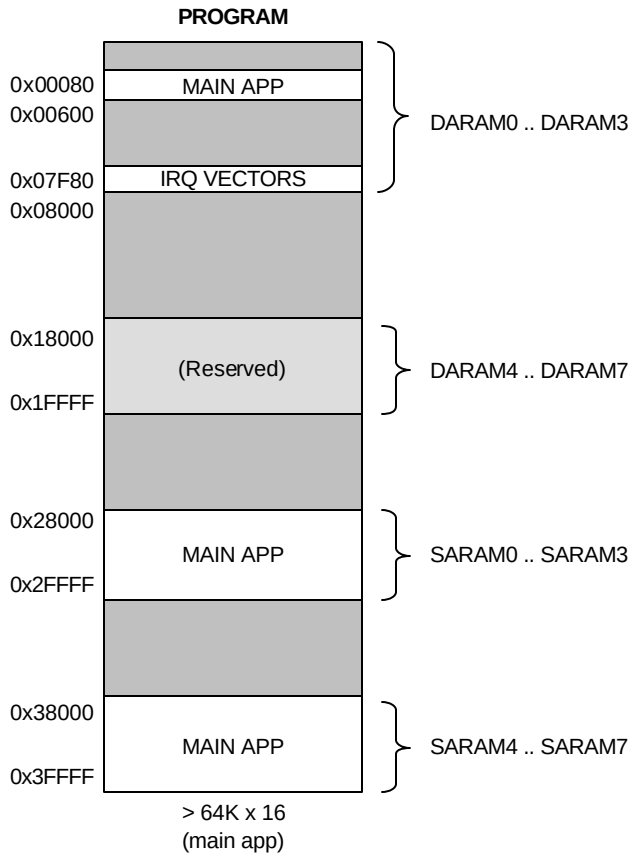


Figure 17: Data Memory Map

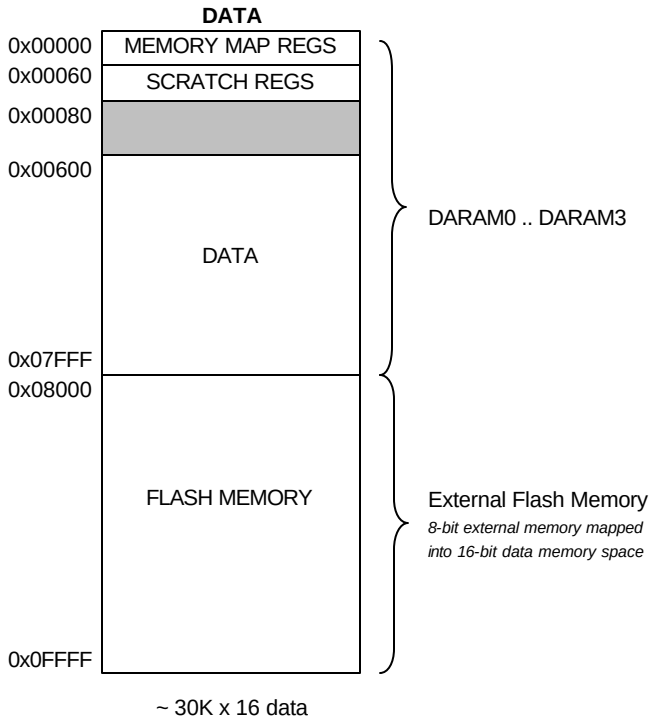


Figure 18: Input/Output Memory Map

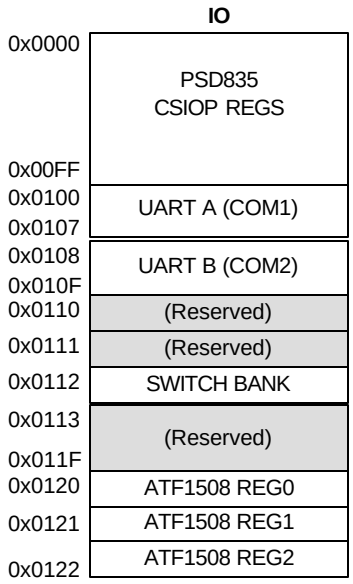
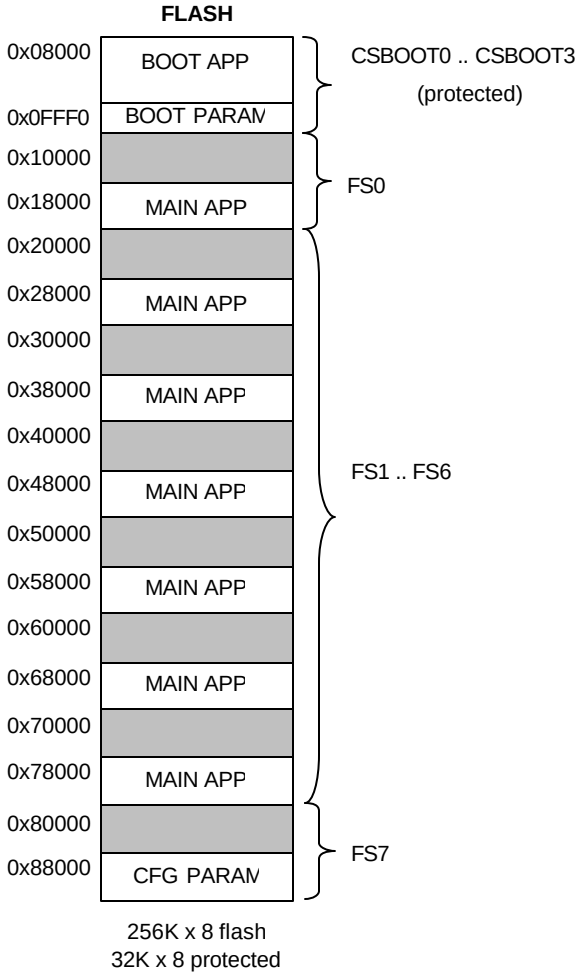


Figure 19: Flash Memory Map



6.2 Software Architecture

The FAA20 hardware platform houses two different applications: the Boot Application and the Main Application.

After reset the Boot Application is loaded from protected flash memory using the built-in, ROM-based boot loader in the 'C54 processor. This program then loads and executes the Main Application. The ROM-based boot loader only supports relatively small programs. The Boot Application supports large programs loaded from multiple pages of flash memory. In addition, this protected application supports the upgrade/reprogramming of the Main Application. The FAA20 always has this core program that can be used to reload main flash memory, as required.

The remainder of this section describes the FAA20 Main Application.

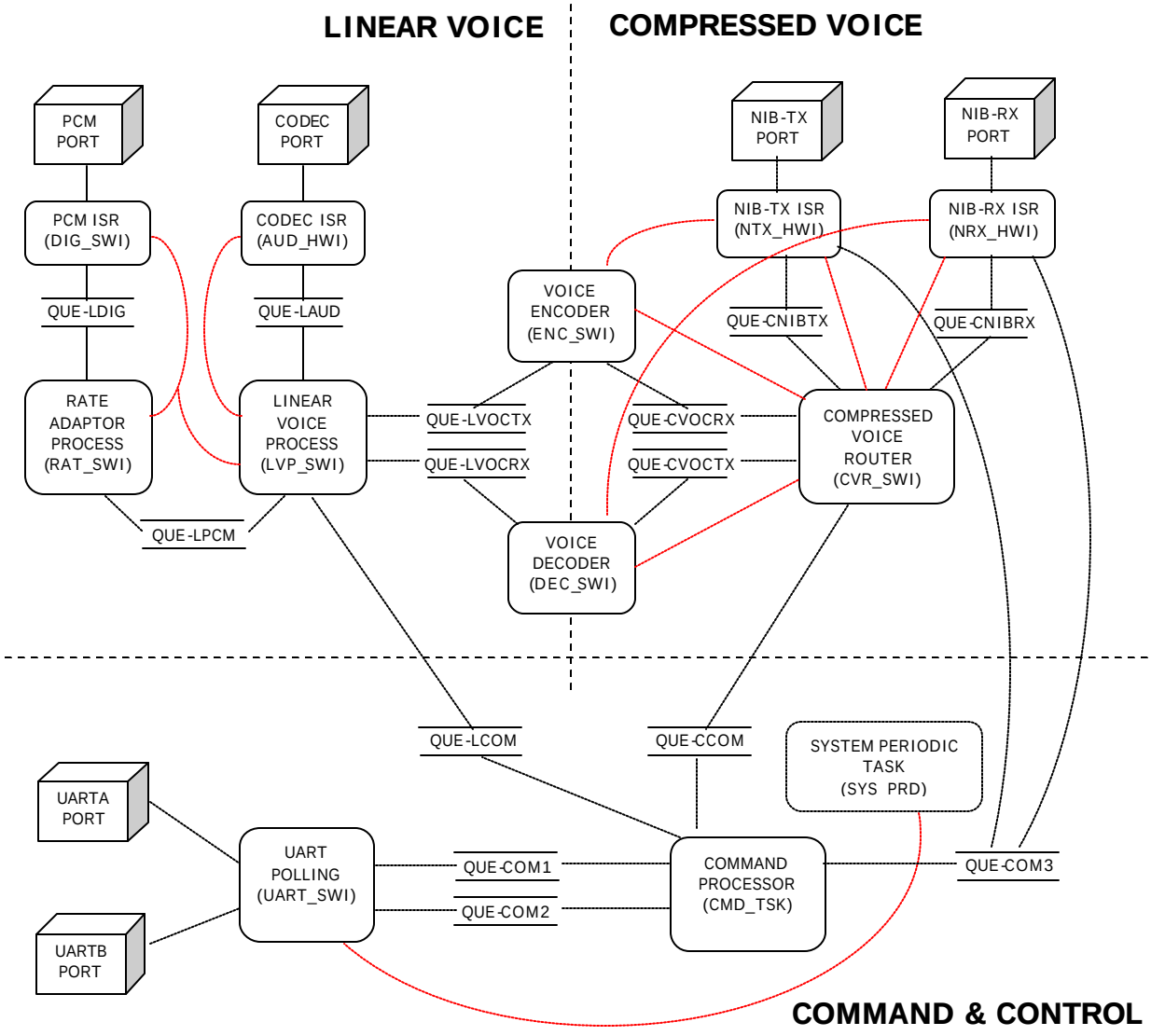
6.2.1 Software Block Diagram

The FAA20 software is built on the DSP/BIOS operating system. It utilizes all three types of available interrupts: hardware (HWI), software (SWI), and periodic (PRD). It has one major runtime task (TSK) that runs the command processor. Thus, most of the normal operating functions are executed in the interrupt environment.

Figure 20 is a software architecture diagram for the FAA20 main application. Software threads (interrupts or tasks) are indicated with rounded boxes. Queues are indicated with an open box (no sides). Hardware devices that are external to the software are indicated with three-dimensional (3D) boxes. Data communication between threads and queues are indicated with solid black lines. Control flows are indicated with red dotted lines.

From a functional standpoint, Figure 20 is divided into three major sections: Linear Voice, Compressed Voice, and Command & Control. The functions in the first two sections (the voice processing portion of software architecture flow) are understandably similar to the voice processing flow diagram (refer to Figure 9). These functions operate entirely in the interrupt environment. The last section of the diagram shows the command and control functions of the software. It contains the only runtime task in the FAA20 software architecture, i.e., the Command Processor (CMD_TSK).

Figure 20: Software Architecture Diagram



6.2.2 Tasks and Interrupts

Each thread or is briefly described in Table 8. The relative priority of the task, when active, is also presented. Threads are triggered by hardware events or by other threads.

Table 8: Thread List

THREAD	–	DESCRIPTION
RESET_HWI*	1	LED #1 (red). Typically indicates peak audio events.
NTX_HWI	2	Transmit Nibble Interrupt. This thread writes nibble data to nibble interface. It also triggers the ENC_SWI based on data produced by a vocoder synchronizing function which monitors unit configuration and the position of the FMEN signal conductor. This thread is triggered at the falling edge of the ENCCK signal conductor, i.e. every 106 us (normal timing mode).
NRX_HWI	3	Receive Nibble Interrupt. This thread reads nibble data from nibble interface. It also triggers the DEC_SWI as soon as a voice packet is completely received. This thread is triggered at the falling edge of the DECCK signal conductor, i.e. every 106 us (normal timing mode).
TMR_HWI*	4	Timer Interrupt. This interrupt is managed by the DSP/BIOS.
AUD_HWI	5	Audio Codec Interrupt. This interrupt accesses the MCBSP #0 serial port data holding register. It is triggered when an entire data sample has been received, i.e. every 125 us (normal timing). It transfers both RX and TX data.
DIG_HWI	6	Digital PCM Interrupt. This interrupt accesses the MCBSP #1 serial port data holding register. It is triggered when an entire data sample has been received, i.e. every 125 us (normal timing). It transfers both RX and TX data.
RAT_SWI	7	Rate Adapter Interrupt. This interrupt performs data rate adaptation when it is enabled. Otherwise, it passes the data through unaltered. When the rate adapter is enabled, it is triggered after the DIG_HWI thread after 6 samples are collected; otherwise, it is triggered after 5 samples are collected.
LVP_SWI	8	Linear Voice Processor. This thread executes all linear voice processing functions including the mixer, GAM, and activity detection. Note: The TEST signal functions (like FFT, TONDET, and SWEEP) are run in the CMD_TSK after a sufficient amount of data is collected in the COM queue. The LVP_SWI interrupt is triggered by the AUD_HWI or DIG_HWI when CLKREF is set to AUD or PCM, respectively. It is triggered for once for every 5 samples.
CVR_SWI	n/a	Packet Voice Router. This thread is presently implemented as function, i.e. it is not a true thread. It is called by other threads, i.e. NTX_HWI, NRX_HWI, ENC_SWI, and DEC_HWI. The function is called by a thread at the entry or exit depending on whether the thread reads or writes compressed voice packets, respectively.
PRD_SWI	9	Periodic Interrupt. This thread is configured to run every 1 ms.
COM_SWI	n/a	COM Port Polling Service Routine. This thread is presently implemented as function, i.e. it is not a true thread. It is called within the SYS_PRD thread. It is runs once every 1 ms.
ENC_SWI	10	Encoder. This thread calls the vocoder analysis functions (encoder). It converts linear voice data to compressed voice data. It typically completes execution within 7.5 ms (includes the execution time for higher priority threads). It is triggered once every 20 ms (normal timing).

THREAD	–	DESCRIPTION
DEC_SWI	11	Decoder. The function converts linear voice data to compressed voice data. It typically completes execution within 7.5 ms (includes the execution time for higher priority threads). It is triggered once every 20 ms (normal timing).
KNL_SWI*	12	Kernel. The DSP/BIOS
CMD_TSK	13	Command Task. This thread implements the multi-port command processor. The thread services each COM port in round-robin fashion. When a complete command line has been received, the command is executed. A maximum of 1 command is executed each time a port is serviced.
IDLE_TSK*	14	Idle Task. This idle task runs when no other thread is running.

* This hardware interrupt is not shown in Figure 20.

6.2.3 Queues, Packets and Data Management

Queues are used extensively to pass data between threads. This approach provides flexible data flows when processes run at different rates. Queues are sized and controlled to minimize voice delays while still providing some execution economy.

The processing threads work with data packets, i.e. a set of data. The queues contain data only, i.e., no headers, footers, or other information. For the linear voice process (LVP_SWI), the packet size is 5 samples. For the rate adapter thread (RAT_SWI), the packet size is 5 or 6 samples for normal or truncated timing, respectively. For the vocoder threads (ENC_SWI and DEC_SWI), the packet size is 160 samples (nominal). The COM queues are fairly large to accommodate the amount of binary data needed to work with the predefined ASCII data formats.

The compressed voice router works with voice frames. Typically, the compressed frame (packet) size is 12 bytes (96-bits); however, during BITEXACT testing the frame (packet) size is 48 bytes to allow for up to 4 soft detection bits.

The FAA20 software actively manages queue depths to minimize voice delays and to compensate for slight timing differences. Both coarse and fine adjustments are made, as required. Coarse adjustments add/drop data packets. Fine adjustments add/drop data samples. Together, these events are referred to as SPAD (sample/packet add/drop) events. Fine adjustments are only made on linear voice queues, since compressed queues must work on a complete frames

The management of the QUE_LVOCTX and QUE_LVOCRX queue depths is the most important since the potential delay impact is large, i.e., the 160 sample frame (packet) represents a 20 ms delay. The queue size is a multiple of this value. The other queues in the primary voice flow paths are small, i.e. 13 samples or less.

Queue management also handles slight differences in interface timing via single sample add/drop events. Figure 20 shows that voice processing

tasks are triggered by different events. If the event timing is not directly related, timing differences can cause the accumulation/depletion of voice samples. For example, the AUD_HWI timing is derived from the FAA20 DSP clock and the nibble interface is externally timed, the timing references are not related. For most queues, if the packet ready or empty size is one less than required, a sample is added (repeated) or dropped, respectively. When the vocoder functions (ENC_SWI and DEC_SWI) access the queue, the built-in, linear window size, calling parameter is used (see DVSI software vocoder documentation).

For some configurations, SPAD events are normal. For example, when the analog interface is used with the vocoder and external nibble timing is enabled, SPAD events normally occur somewhere in the voice path. Alternatively, when the PCM interface is used with the vocoder and external timing is used for both the PCM and nibble interface, SPAD events should not occur.

7.0 MAINTENANCE AND TEST

This section provides an maintenance and test information. The following topics are included:

- *Troubleshooting Tips.* Includes a troubleshooting table to assist with problem solving.
- *Test and Integration Tools.* Discusses audio, PCM, and nibble interface test and integration tools.
- *Upgrading the FAA20 Software.* Provides instructions for loading new software.
- *Vocoder Test Vector Support.* Provides instructions for running test vectors through the FAA20. Also includes a description of ASCII test vector conversion utilities.

7.1 Troubleshooting Tips

Table 9 provides troubleshooting tips.

Table 9: Troubleshooting Table

SYMPTOM	POTENTIAL PROBLEMS	TROUBLESHOOTING TIPS
No Audio	Improper Mixer Setup Improper Router Setup Failed Front End Improper Timing Setup	• Use the CFG command to verify current audio flow and clock settings. • Starting at one end of the audio flow, use the MIX/ROUTE commands to setup loopbacks to confirm flows through points in the system. Insure you have proper levels setup. • Use the TONE/MIXER commands to send a tone out an interface that doesn't appear to be working. • Insure you have proper timing signals for digital interfaces. If the timing is working, you will get interrupts. Use the PROG command to send interrupt status to the LEDs, i.e. DIG_HWI, LVP_SWI, etc. • If the vocoder is in the path, the nibble interface MUST have timing. The nibble interface triggers the vocoder tasks. Thus, you need nibble timing EVEN IF you are not using that interface.
Bad Audio	Improper Timing Improper Signal Level	• Insure that the audio peak LED indicator (typically LED1) is not blinking. If blinking, refer to associated troubleshooting tips below. • Use the COUNT command to check for

SYMPTOM	POTENTIAL PROBLEMS	TROUBLESHOOTING TIPS
		sample/packet add/drop (SPAD) events. SPADs should occur no more frequently than once every few seconds to a minute. Identify which queues are affected to locate the timing port problem source. • Use the MIX/ROUTE commands to setup loopbacks to isolate the area that is causing the bad audio. • If the vocoder is in the voice path, check the vocoder FEC error counter to insure it is not incrementing, i.e. VOC FEC. • Try lowering or raising the audio levels to see if the condition improves. Note: While there are peak detectors on the mixer ports, audio clipping could occur on the far side of the rate adapter. The adapter filter may remove the peak levels, but the audio may still sound bad.
ERR LED ON Solid	Large timing offset. Spurious error. Flash Configuration Empty	• Check the power up message banner on COM1 to see if the flash parameter configuration is empty. If empty, configure the unit and use the 'CFG SAVE' command to update the flash. • Determine the LED appears solid due to high number of momentary events or has been latched on by a spurious event. To do this, use the command 'BIT LED4 0'. If this command clears the condition, a spurious event occurred (during power up, incidental events can cause the ERR LED to light. This is off no concern. If the command does not clear the LED, used the COUNT command to see if SPAD events are occurring.
ERR LED occasionally blinks	Small timing offsets are present	• Use the COUNT command to check for sample/packet add/drop (SPAD) events. SPADs should occur no more frequently than once every few seconds to a minute. Identify which queues are affected to locate the timing port problem source. For some system configurations, SPAD events are normal. See Section 6.2.3.
LANYP LED Blinks	Audio Level too high	• To isolate the signal causing the peak event, use the PROG command to reassign the general peak LED to specific mixer port indicators. Adjust the MIX and/or GAM settings to fix the high audio level problem.
No serial port comm. (COM1/ COM2)	Improper terminal setup Failed hardware	• The most typical problem may be incompatible baud rate or hardware flow control setup. The default setting is 115200 bps,8 data bits,1 stop bit, no parity, and no flow control.

7.2 Test and Integration Tools

The FAA20 includes three categories of test and integration tools:

- *Audio Tools*
- *Nibble Tools*
- *PCM Tools*

7.2.1 Audio Tools

There are three types of audio test and integration tools:

- *Mixer/Router*
- *Tone Generator*
- *Signal Analysis Tools*

The mixer and router (see the MIX/ROUTE commands) can be used to insert loopbacks in the voice processing flow and thus isolate configuration and timing setup problems.

The tone generator (see the TONE command) can be used to isolate problems to the transmit or receive path for as specific voice port. Since the tone generator internally sourced, it is usually used to verify the function of an output port.

The signal analysis tools, while powerful, are rarely needed to isolate FAA20 integration problems; however, the tools can provide additional information. Typically, these tools are used by the factory to isolate incorrect filter components in the analog front end.

There are three signal analysis tools: a tone detector (TEST TONDET), a spectrum analyzer (TEST FFT), and a sweep generator/detector (TEST SWEEP). All three tools use a 64-point fast fourier transform (FFT) algorithm for frequency analysis. The FAA20 uses the mixer COM port to collect data needed for analysis because of its large data capacity. Thus, to use these tools, the signal to be evaluated must be mixed (routed) to the COM port. The sweep generator has an additional routing requirement. In order to test the audio front end, it requires that the tone generator be routed to the AUD mixer port. Figure 21 is a command example illustrating the use of the sweep generator.

Figure 21: TEST SWEEP Example

```
COM1: mix off
 > MIX AUD -- OFF
 > MIX PCM -- OFF
 > MIX VOC -- OFF
 > MIX COM -- OFF
 > MIX TON -- OFF
COM1: mix aud ton 5a9d
 > MIX AUD <- TON (0x5A9D)
COM1: mix com aud 7fff
 > MIX COM <- AUD (0x7FFF)
COM1: test sweep b
 > FREQ 0000 Hz = -81.29 (dBm0)
 > FREQ 0125 Hz =  -2.07 (dBm0)
 > FREQ 0250 Hz =  -0.46 (dBm0)
 > FREQ 0375 Hz =  -0.21 (dBm0)
 > FREQ 0500 Hz =  -0.14 (dBm0)
 > FREQ 0625 Hz =  -0.07 (dBm0)
 > FREQ 0750 Hz =  +0.03 (dBm0)
 > FREQ 0875 Hz =  +0.08 (dBm0)
 > FREQ 1000 Hz =  -0.01 (dBm0)
 > FREQ 1125 Hz =  -0.23 (dBm0)
 > FREQ 1250 Hz =  -0.50 (dBm0)
 > FREQ 1375 Hz =  -0.71 (dBm0)
 > FREQ 1500 Hz =  -0.80 (dBm0)
 > FREQ 1625 Hz =  -0.88 (dBm0)
 > FREQ 1750 Hz =  -1.04 (dBm0)
 > FREQ 1875 Hz =  -1.35 (dBm0)
 > FREQ 2000 Hz =  -1.77 (dBm0)
 > FREQ 2125 Hz =  -2.22 (dBm0)
 > FREQ 2250 Hz =  -2.67 (dBm0)
 > FREQ 2375 Hz =  -3.13 (dBm0)
 > FREQ 2500 Hz =  -3.61 (dBm0)
 > FREQ 2625 Hz =  -4.14 (dBm0)
 > FREQ 2750 Hz =  -4.74 (dBm0)
 > FREQ 2875 Hz =  -5.40 (dBm0)
 > FREQ 3000 Hz =  -6.15 (dBm0)
 > FREQ 3125 Hz =  -6.93 (dBm0)
 > FREQ 3250 Hz =  -7.68 (dBm0)
 > FREQ 3375 Hz =  -8.39 (dBm0)
 > FREQ 3500 Hz =  -9.23 (dBm0)
 > FREQ 3625 Hz = -10.61 (dBm0)
 > FREQ 3750 Hz = -12.92 (dBm0)
 > FREQ 3875 Hz = -16.28 (dBm0)
COM1:
```

7.2.2 Nibble Tools

There are three types of NIB test and integration tools:

- *Nibble Data*
- *COM3 Monitor*
- *BIT Command*

For the nibble data interface, the FAA20 supports the generation of a known nibble test pattern when TEST NTX is enabled. The first voice nibble is set to 0xF and the remaining nibble values are an incrementing sequence beginning with 0x1. In addition, the FAA20 also can print the received nibble frame (see DUMP NRX). Finally, the nibble data interface supports an external data loopback, e.g. LOOP NIB.

The COM3 monitor is used to troubleshoot the COM3 virtual terminal interface. When TEST COM3 is enabled, the FAA20 prints all COM3 traffic to the COM2 port.

The BIT command can be used to manually toggle IO signal conductors; however, the TEST operational mode must first be enabled to disable automatic software control.

7.2.3 PCM Tools

The most useful PCM test tool is the external data loopback, i.e LOOP PCM. In addition, the FAA20 also supports the transmission of an incrementing data pattern (TEST PCMO).

7.3 Upgrading FAA20 Software

The FAA20 main application software can be upgraded via any one of the three terminal ports. Two programming modes are supported: standard mode (for COM1 or COM2) and acknowledgement mode (for COM3). The FAA20 application software is provided as an ASCII Motorola S-record file. The FAA20 includes software to read and interpret S-record command lines.

7.3.1 Standard Mode Upgrade

The standard upgrade is performed using the plain text file transfer capability available with most terminal emulation programs.

To upgrade the FAA20 software using COM1 or COM2, complete the following steps.

1. Verify hardware handshaking is enabled on the terminal and on the COM port. The COMCFG command can be used to display the current setup. The last token should be the letter 'H' indicating that hardware handshaking is enabled.

2. Record the current configuration parameter settings. The CFG command can be used to print the current settings.

   If the size of the configuration block in the new software matches that of the old software, the configuration block is unaffected. If the sizes are different, the new software will erase the configuration block. An empty configuration block is reported in the banner message during FAA20 power up. Typically, the configuration block does not change with software releases.

3. Enter the PROG command (without any parameters).

   The FAA20 erases the main application flash memory to prepare memory to be reprogrammed. The FAA20 prints READY when this process has been completed. The FAA20 also temporarily disables COMECHO and COMPROMPT, if enabled.

4. Send the new S-record file using the terminal file transfer capability. For example, when TeraTerm Pro is used, this is accomplished by clicking *File®Send File* and then selecting the *faa20.s* file.

   The FAA20 updates the terminal display with the number of records processed. When all records have been transferred without error, the FAA20 prints a DONE message.

   If any error is detected during the programming process, the FAA20 aborts the flash programming and prints an error message. If this occurs, the file transfer should be stopped and the ESC key should

be pressed to restore the command prompt. The file transfer can be initiated again by beginning again at step #3.

5. Enter the RESET command to force the FAA20 to load the new program.

   After a few seconds, the FAA20 restarts and prints the banner message providing the new software build details. Note: If the new software erases the configuration block (see step #2), the FAA20 prints a configuration memory error, i.e. “ERR FLASH_CFG - using default”.

6. Reconfigure the FAA20, as necessary, using the information recorded in step #2.

Figure 22 provides a sample terminal programming session.

Figure 22: Software Upgrade (Standard Mode)

```
COM1: comcfg
 > COMCFG COM1 = 115200,8,1,N,H
 > COMCFG COM2 = 115200,8,1,N,D
COM1: prog
 > ERASING FLASH (wait for READY)
 > READY
 > #Records = 1472
 > DONE
COM1: reset
 > RESET OK
COM1:
Booting...!

 > ************************************************************************
 > *   FAA20: AMBE 4.8 kbps Vocoder (for Air Traffic Communication)   *
 > ************************************************************************
 > Copyright 2004. CIE Engineering, Inc. All rights reserved.
 > For more information, contact: www.cie-eng.com
 > Version: 1.0.0
 > Built:   Feb 18 2004 15:53:17
 > Serial#: 617
 >
 > Type ? for help

COM1:
```

7.3.2 Acknowledgement Mode Upgrade

The FAA20 supports a virtual command (COM3) port over the nibble interface (see Section 5.2.3). The acknowledgement mode configures the FAA20 to print an acknowledgement message after each S-record is successfully processed. This allows the host equipment to insure the previous S-record has been successfully processed before transmitting the next S-record. Note that the COM3 transmission rate is depending on the nibble interface clock rate and frame size. For a typical setup (9600 Hz and 192 clocks/frame), the average byte transmission rate (not including flash programming time) is 3000 char/sec.

To upgrade the FAA20 software using COM3, complete the following steps.

1. Send the PROG ACK command.

   The FAA20 erases the main application flash memory to prepare memory to be reprogrammed. The FAA20 prints an ERASING FLASH message and then prints a READY message when this process has been completed. The host software should wait for the READY message before transmitting any S-record lines. Note also that any other command traffic should be disabled before attempting a software upgrade.

2. Send the first S-record line.

   The FAA20 programs data associated with the record and then prints an acknowledgement message, > ACK 0000. Always wait for the FAA20 to acknowledge receipt of the current record before transmitting the next record.

3. Send the next S-record line.

   The FAA20 programs data associated with the line and then prints an acknowledgement message, > ACK xxxx where xxxx is an incrementing hex value for each record.

4. Repeat step #3 as necessary until all records are transmitted and programmed.

   The FAA20 continues to print ACK messages. After the last ACK message, the FAA20 also prints a DONE message. The last record (an S8 record) in the file indicates the end of the file and includes a file checksum sequence.

5. Enter the RESET command to force the FAA20 to load the new program.

   After waiting 5 seconds for the power up sequence to complete, a test command can be issued to the FAA20 to insure the unit has rebooted.

If any errors are detected during programming (or if an acknowledgement is not received within 100 ms), send the ESC character (0x1B) followed by a carriage return (0x0D) to terminate the programming process. The FAA20 does not support S-record retransmission. After insuring the FAA20 has successfully terminated the process, the programming process can be reinitiated. To insure the FAA20 has stopped programming, send any other status command and insure the expected response is provided.

The acknowledgement mode can also be used with COM1 or COM2. The impact to configuration parameters is the same as described in the standard mode upgrade (above). In addition, the FAA20 also temporarily disables COMECHO and COMPROMPT (as above). Also note that the data transfer rate for COM

Figure 23 provides a sample terminal programming session using COM3. Note: This sample assumes that COMECHO and COMPROMPT are enabled on COM3 before beginning the programming sequence. Note: A banner message is never printed to COM3.

Figure 23: Software Upgrade (Acknowledgement Mode)

```
COM3: prog ack
 > ERASING FLASH (wait for READY)
 > READY
 > ACK 0000
 > ACK 0001
 > ACK 0002

      …
      …
      …

 > ACK 1470
 > ACK 1471
 > ACK 1472
 > ACK 1472
 > DONE
COM3: reset
 > RESET OK
COM3:
```

7.4 Vocoder Test Vector Support

Test vectors are used to insure proper vocoder integration. The vectors include linear and compressed voice files that are sent through the AMBE encoder and decoder, respectively. The test vector set also includes a few vocoder control files that are used to assert controls (e.g. mute, lost, data window sizes) during test vector execution.

The FAA20 serial interface is designed to work with ASCII commands and data streams. The binary voice test vector files must be converted to an ASCII format compatible with the FAA20. There are two MS-DOS style utilities that perform the conversion.

- *DAT2LIN Utility.* This utility creates ASCII formatted linear voice files.
- *BIT2CMP Utility.* This utility creates ASCII formatted compressed voice files.

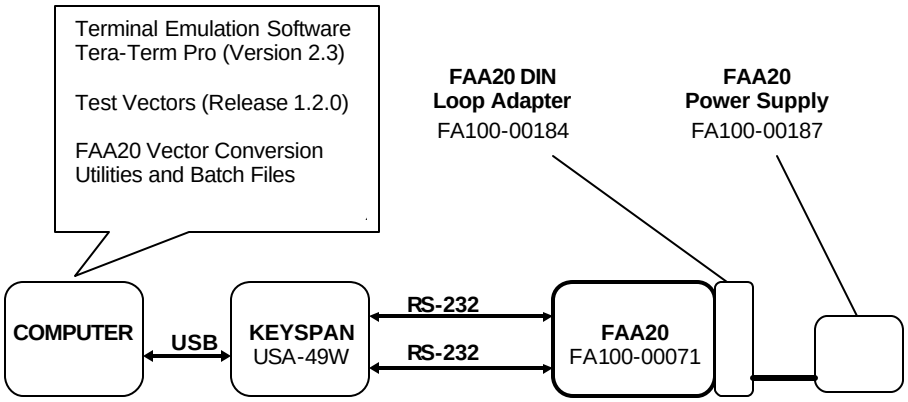
Both of these utilities support an option to include a vocoder control file. If a control file is specified, the utility will interleave FAA20 vocoder setup commands with the voice data at specified data frame boundaries. The utilities are designed to accept DVSI-provided ASCII control files (e.g. lost.ctl). The FAA20 CDROM includes these utilities as well as a batch file is used to translate all of the necessary vector files.

This section provides the test vector execution procedure and details for the two MS-DOS utilities.

7.4.1 Test Vector Execution

The FAA20 supports test vector input/output via two RS-232 serial ports. The test vector execution involves sending an input test vector files into one serial port of the FAA20 and capturing the converted vector output data at the other serial port. All output files are compared to insure they are identical to ones supplied on DVSI software distribution CDROM. Figure 24 shows a typical test vector setup which uses a multi-port serial adapter.

Figure 24: FAA20 Test Vector Setup



To execute test vectors on the FAA20, complete the following steps:

1. Convert all binary files (from the DVSI software release 1.2.0 CDROM) to ASCII files using the FAA20 ASCII conversion utilities. For additional information, see Section 7.4.2 and Section 7.4.3.
2. Insure that both command ports, COM1 and COM2, have hardware flow control enabled. Insure the terminal emulation program also has hardware flow control enabled.
3. Enter the command 'TEST BITEXACT ON' to configure the FAA20 to accept test vectors.

   This command stops the real time flow of data to the vocoder, configures the mixer/router to use the COM ports, and initializes the vocoder.
4. If the test vector requires DTX mode, manually enter the command 'VOC DTX ON'.
5. If the test vector requires soft detection bits, manually enter the command 'VOC SDBITS x' where 'x' is the required number of bits.
6. Configure the terminal emulation program to capture COM2 terminal traffic to a file, i.e., the output file.
7. Configure the terminal emulation program to send the ASCII input file to COM1.
8. When the vector transmission is complete, close the captured output file and compare it with an ASCII version of the supplied reference test vector file.

7.4.2 DAT2LIN Utility

The DAT2LIN utility converts binary linear voice files (*.dat and *.syn) to ASCII linear voice files (*.lin and *.lon). Figure 25 provides the DAT2LIN command syntax. Figure 26 provides the ASCII linear format.

Figure 25: DAT2LIN Utility Command Syntax

dat2lin [options] infile outfile

Where:

-nocmd	disables printing of FAA20 control commands within output stream
-ctl filename	Reads control file and uses controls to create output file
-h	Print help
-q	Run in quite mode
-qb	Disable banner printing only

Figure 26: ASCII Linear Format (L0)

L0MSSSSXXXX…XXXXEEEE

Where:

M	=	Timing Mode (Always = 0 for test vectors)
SSSS	=	Sequence number (incrementing hexdata value)
X…X	=	Linear Sample Data (20 samples x 4 char/sample = 80 char)
EEEE	=	Checksum

7.4.3 BIT2CMP Utility

The BIT2CMP utility converts binary compressed voice files (*.bit) to ASCII compressed voice files (*.cmp). The command syntax is shown in Figure 27.

This utility generates two different ASCII output files: one designed for hard decision detection (1 bit/symbol, format type C0) and one designed for soft decision detection (4 bits/symbol, format type C1). The vocoder compressed voice frame contains 96 symbols. The ASCII output formats are shown in Figure 28.

Figure 27: BIT2CMP Utility Command Syntax

bit2cmp [options] infile outfile

Where:

-nocmd	disables printing of FAA20 control commands within output stream
-ctl filename	Reads control file and uses controls to create output file
-c1	Selects C1 output format (default is C0 format)
-h	Print help
-q	Run in quite mode
-qb	Disable banner printing only

Figure 28: ASCII Compressed Formats (C0 and C1)

C0MSSSSXX…XXEEEE
C1MSSSSYYYY…YYYYEEEE

Where:

M	=	Timing Mode (Always = 0 for test vectors)
SSSS	=	Sequence number (incrementing hexdata value)
X…X	=	Compressed Data (96 symbols x 0.25 char/symbol = 24 char)
Y…Y	=	Compressed Data (96 symbols x 1 char/symbol = 96 char)
EEEE	=	Checksum

8.0 TERMINAL COMMAND REFERENCE

This section provides FAA20 terminal command information. The following topics are included:

- *Command Overview.* Describes general usage information and a command list.
- *Built-in Help.* Describes how to access and use the built-in help feature.
- *Command Reference.* Provides detailed syntax and operating information for each of the FAA20 commands.

8.1 Command Overview

The FAA20 accepts commands via the serial RS-232 ports or via the virtual command port (supported over the nibble interface). Commands are available to control unit clocking, truncation mode, and the routing of compressed and linear audio. A number of commands are also available to support troubleshooting and software upgrades.

Table 10 provides a brief description of the available commands. The more frequently used commands are indicated with a check. After configuration, the FAA20 operates without any additional terminal control and can be deeply embedded into host systems.

Table 10: FAA20 Command Summary

COMMAND	TYP*	DESCRIPTION OR USE
ADAPT	✓	Enables/disables the rate adapter during truncated timing mode.
BIT	✓	Sets/gets state of control bits.
CFG	✓	Saves/Restores configuration parameters to/from flash memory.
CLKDET		Prints the detected symbol rates for the internal codec, the PCM interface and the NIB interface.
CLKRATE	✓	Sets/gets the normal/truncated clock rates for the PCM and NIB interfaces.
CLKREF	✓	Sets/gets the interface used to control linear voice processing.
CLKSRC	✓	Sets/gets clock source (internal or external) for the PCM and NIB interfaces.
COMCFG	✓	Sets/gets communication parameters (baud, start bits, stops bits, parity, etc) for the two serial RS-232 ports. Note: The virtual COM port has fixed characteristics.
COMECHO		Controls the echo of typed characters for the three command ports.
COMPROMPT		Controls the printing of the prompt for the three command ports.

COMMAND	TYP*	DESCRIPTION OR USE
REM		Forwards command text to virtual COM port.
COUNT	✓	Prints (or clears) queue-related statistical counters.
DELAY	✓	Prints current vocoder processing delays.
DM		Writes/reads to/from DSP data memory space.
DUMP		Prints named memory blocks
FRAMESIZE	✓	Sets/gets the frame size for the PCM and NIB interfaces .
FM		Writes/reads to/from flash memory.
GAM	✓	Sets/gets audio interface gain/attenuation/mute level in Q4.12 format.
IO		Writes/reads to/from DSP IO memory space.
LED	✓	Controls mapping of virtual LEDs to the six available physical LEDs.
LOOP	✓	Controls audio, PCM, and nibble external loop status.
MACRO		Enables the user to build a command sequence which can be played on command or continuously.
MIX	✓	Controls the linear voice mixer. Data values are entered in Q1.15 format.
PROG	✓	Prepares the FAA20 to accept a new software program.
RESET	✓	Forces a hardware reset by stopping service to the on-board watchdog timer.
ROUTE	✓	Controls the compressed voice router
TEST	✓	Accesses a number of FAA20 test features.
TONE	✓	Controls the frequency of the on-board tone generator.
TRUN	✓	Enables/disables truncated timing mode.
VERSION	✓	Prints software version information and unit serial number.
VOC	✓	Access vocoder controls and status.
WAIT		Causes the command processor to wait (units = ms).

* TYP = Typical. The checked commands are used by typical FAA20 integrators. The unchecked commands are primarily used at the factory and are rarely used by FAA20 integrators.

Many commands enable you to set/get parameter status. Typically, to set the parameter an additional token is provided in the command line, i.e. the new parameter value. If this token is omitted the current parameter status is retrieved and displayed. For example, the command 'ADAPT', gets the current parameter setting. The command 'ADAPT ON' sets the parameter, enabling the rate adapter for truncated timing.

Some parameter settings can be saved to flash memory (non-volatile) and are thus retained between power cycles. These settings are explicitly saved to flash when the user enters the 'CFG SAVE' command. Each command syntax tables contain a flash attribute which indicates whether the parameter is saved to flash memory.

Either lower or upper case can be used to enter commands. The FAA20 converts all lines to upper case. All FAA20 responses are prefixed with the greater than symbol (>). All commands and responses are terminated by a carriage return and all communication is conducted in ASCII format.

8.2 Built-In Help

The FAA20 supports built-in help. The help feature provides command syntax; thus, it provides a quick reference for using the terminal command port. The following command reference section not only provides command syntax, but also provides detailed parameter descriptions.

To access help, type a question mark (?) followed by the ENTER key. When no additional parameters are specified, a complete list of commands is printed. For an example of the printed command list, see Figure 29.

Figure 29: Built-In Help (Command List)

```
COM1: ?
 > ****************************************************************
 > COMMAND LIST:
 >   ADAPT          BIT            CFG            CLKDET
 >   CLKRATE        CLKREF         CLKSRC         COMCFG
 >   COMECHO        COMPROMPT      COUNT          DELAY
 >   DM             DUMP           FLASH          FM
 >   FRAMESIZE      GAM            IO             LED
 >   LOOP           MACRO          MCBSP          MIX
 >   OPMODE         PROG           REM            RESET
 >   ROUTE          TEST           TONE           TRUN
 >   VERSION        VOC            WAIT
 > Type ? followed by space then command for more info
 > ****************************************************************
COM1:
```

To get help on a specific command, type ? followed by the command name. For example, see Figure 30.

Figure 30: Built-In Help (Command List)

```
COM1: ? adapt
 > ****************************************************************
 > ADAPT [ON|OFF] - Controls rate adapter
 >****************************************************************
```

The command help includes parameters and a brief functional description.

8.3 Command Reference

This section provides command syntax and detailed parameter descriptions. Optional parameters are enclosed in square brackets. Command parameters that can be saved to flash configuration memory are noted, accordingly. Command examples are also provided. Commands are described in alphabetical order.

8.3.1 ADAPT

The ADAPT command enables/disables the PCM rate adapter for truncated timing mode. The adapter is never enabled in normal timing mode.

Table 11: ADAPT Command Syntax

ATTRIBUTE	DESCRIPTION		
SYNTAX	ADAPT [onstate]		
PARAMETERS	onstate	ON	Enables rate adapter during truncated timing mode.
		OFF	Disables rate adapter during truncated timing mode.
FLASH	YES		

EXAMPLES	*Request the current setting*
	`COM1: adapt`
	`> ADAPT OFF`		

	Enable the rate adapter
	`COM1: adapt on`
	`> ADAPT ON`		

The rate adapter sits in the path between the PCM interface and the linear mixer. It allows the PCM interface to continue to operate at the nominal sample rate (8 ksps) while the FAA20 is in truncated timing mode. When enabled and truncated timing is activated, the audio is converted from the 8 ksps rate to the truncated timing rate of 6.67 ksps, i.e. the sample rate is adjusted by 5/6. The rate adaptation is achieved through the use of an interpolating multi-rate filter followed by a decimator. The rate adapter is only available in truncated timing mode. See Section 5.3.4 for additional details.

8.3.2 BIT

The BIT command sets/gets bit-based hardware input and output signals. Typically, bit signals are controlled by the FAA20 software or are used for factory test purposes. There are some signals that are reserved for future use, but can be read and/or controlled by the BIT command. Examples include X03..X00, X03E..X00E, DDAT, DDET, and ECHO. Table 13 provides descriptions for each of the 46 individual bit controls.

Table 12: BIT Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	BIT [bitname [state]]	
PARAMETERS	bitname	See Table 13 for list
	state	0 Inactive 1 Active
FLASH	NO	

EXAMPLES	*Request current bit states.*
	`COM1: bit`
	`> LED1 = 0 LED2 = 0 LED3 = 0 LED4 = 0`
	`> LED5 = 0 LED6 = 1 LPCM = 1 LCVM = 1`
	`> LFSD = 0 LFSE = 0 PWDN = 0 LOOP = 0`
	`> TRUN = 0 WDOG = 1 XFSD = 0 XFSE = 0`
	`> RUN = 1 DDAT = 0 DDET = 0 GO = 1`
	`> VAD = 0 ECHO = 0 TMTX = 0 TMRX = 0`
	`> XOE = 0 TS2 = 0 CS1 = 0 CS0 = 1`
	`> X03 = 1 X02 = 1 X01 = 1 X00 = 1`
	`> X03E = 0 X02E = 0 X01E = 0 X00E = 0`
	`> DINR = 0 SPRD = 1 RTS1 = 0 CTS1 = 1`
	`> DTR1 = 0 DSR1 = 1 RTS2 = 0 CTS2 = 0`
	`> DTR2 = 0 DSR2 = 0`	

	Set DDAT output to active state.
	`COM1: bit ddat 1`
	`> BIT DDAT = 1`	

.

Table 13: BIT Command Parameters

BITNAME	ATTRIBUTES*	DESCRIPTION
LED1	RW, SWC	LED #1 (red). Typically indicates peak audio events.
LED2	RW, SWC	LED #2 (yellow). Typically indicates audio activity.
LED3	RW, SWC	LED #3 (green). Typically indicates truncated timing mode.
LED4	RW, SWC	LED #4 (red). Typically indicates errors or sample add/drop events.
LED5	RW, SWC	LED #5 (yellow). Typically indicates vocoder activity.
LED6	RW, SWC	LED #6 (green). Typically indicates FAA20 runtime status.
LPCM	RW, SWC	PCM Timing Master. When set, configures the FAA20 to drive the PCM clock and framing signals. *Note: While the BIT command will directly control the associated signal direction, other timing dependent FAA20 functions are not updated by the BIT command. Therefore, the preferred control method for PCM master timing is SW1.*
LCVM	RW, SWC	Nibble Timing Master. When set, configures the FAA20 to drive the nibble clock and framing signals. *Note: While the BIT command will directly control the associated signal direction, other timing dependent FAA20 functions are not updated by the BIT command. Therefore, the preferred control method for PCM master timing is SW2*
LFSD	RW, SWC	Local Decoder Frame Sync Control. When LCVM=1, this bit controls the decoder frame sync signal, FMDE.
LFSE	RW, SWC	Local Encoder Frame Sync Control. When LCVM=1, this bit controls the encoder frame sync signal, FMEN.
PWDN	RW	Codec Power Down Control. When set, it powers down the codec.
LOOP	RW	Codec External Loop Control. When set, the codec loops received audio out the transmit port. *Note: When this bit is set, any output provided by the internal mixer is summed with the looped back input signal.*
TRUN	RW, SWC	Codec Truncated Timing Control. When set, the codec sample rate is set to 6.67 ksps.
WDOG	RW, SWC	Watch Dog Tickle Control. Toggling of this bit keeps the watchdog from resetting the processor.
XFSD	RO	External Decoder Frame Sync Bit. This read-only bit displays the current state of the decoder frame sync signal, FMDE.
XFSE	RO	External Encoder Frame Sync Bit. This read-only bit displays the current state of the encoder frame sync signal, FMEN.
RUN	RW, SWC	Vocoder Run Status Signal. When set, indicates that the encoder and/or decoder process is executing. *Note: For all operational modes except the TEST mode, this bit is software controlled.*
DDAT	RW, CL, RSVD	DDAT Signal Control Bit (DTMF Data). Reserved for future use.

BITNAME	ATTRIBUTES*	DESCRIPTION
DDET	RW, CL, RSVD	DDET Signal Control Bit (DTMF Detect). Reserved for future use.
GO	RO, CL	GO Signal Input State. Displays the current state of the GO input signal.
VAD	RO, CL	VAD Signal Input Bit (Voice Activity Detect). Displays the current state of the VAD input signal.
ECHO	RO, CL	ECHO Signal Input Bit. Displays the current state of the ECHO input signal.
TMTX	RW, SWC, CL	Truncated Mode Status Bit. When set, it indicates that the TMTX signal is active (high). *Note: For all operational modes except the TEST mode, this bit is software controlled.*
TMRX	RO, CL	Truncated Mode Control Bit. When set, it indicates that the TMRX signal is active (low).
XOE	RW, RSVD	Expansion Output Group Enable. Reserved for future use.
TS2	RW, SWC, RSVD	Time Slot Enable. When set, it enables two PCM slots. Use of this bit is reserved for future expansion.
CS1	RW, SWC, RSVD	CPLD Clock Mode Bit #1. This bit is reserved for factory use.
CS0	RW, SWC, RSVD	CPLD Clock Mode Bit #0. This bit is reserved for factory use.
X03	RW, RSVD	Expansion Bit #3 State. Reserved for future use.
X02	RW, RSVD	Expansion Bit #3 State. Reserved for future use.
X01	RW, RSVD	Expansion Bit #3 State. Reserved for future use.
X00	RW, RSVD	Expansion Bit #3 State.. Reserved for future use.
X03E	RW, RSVD	Expansion Bit #3 Output Enable. Reserved for future use.
X02E	RW, RSVD	Expansion Bit #2 Output Enable. Reserved for future use.
X01E	RW, RSVD	Expansion Bit #1 Output Enable. Reserved for future use.
X00E	RW, RSVD	Expansion Bit #0 Output Enable. Reserved for future use.
DINR	RO	DINR Signal State. Displays the state of the DINRS signal.
SPRD	RO	SPRD Signal State. Displays the state of the SPRDY signal.
RTS1	RW, SWC	Request-to-Send Signal (COM1).
CTS1	RO	Clear-to-Send Signal State (COM1).
DTR1	RW, SWC	Data Terminal Control Signal (COM1).
DSR1	RO	Data Send Ready Signal (COM1).
RTS2	RW, SWC	Request-to-Send Signal (COM2).
CTS2	RO	Clear-to-Send Signal State (COM2).
DTR2	RW, SWC	Data Terminal Control Signal (COM2).
DSR2	RO	Data Send Ready Signal (COM2).

* RW = Read/Write, RO = Read Only, SWC = Software Controlled, RSVD = Reserved, CL = Clock Latched

8.3.3 CFG

The CFG command displays a list of important FAA20 configuration settings. It is also used to save and restore flash parameter settings. When CFG parameters are displayed, all important settings are displayed, not just the flash configuration parameters.

Table 14: CFG Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	CFG [fparam]]	
PARAMETERS	fparam	Configuration Parameter. SAVE = Saves settings to flash memory. RESTORE = Restores settings from flash memory. DEFAULT = Sets FAA20 to factory default. *Note: The SAVE and RESTORE parameters access the flash, but the DEFAULT parameter does not.*
FLASH	The CFG command reads/writes flash memory.	

EXAMPLES	*Save parameters to flash.*
	`COM1: cfg save`
	`> CFG SAVE OK`	

	Restore parameters from flash.
	`COM1: cfg restore`
	`> CFG RESTORE OK`	

	Setup FAA20 to factory default.
	`COM1: cfg default`
	`> CFG DEFAULT OK`	

	Request current configuration information (default settings shown).
	`COM1: cfg`
	`> ADAPT = ON`
	`> CLKRATE PCM NORM = 3840000`
	`> CLKRATE PCM TRUN = 3840000`
	`> CLKRATE NIB NORM = 9600`
	`> CLKRATE NIB TRUN = 9600`
	`> CLKREF = AUD`
	`> CLKSRC PCM = INT`
	`> CLKSRC NIB = INT`
	`> COMCFG COM1 = 115200,8,1,N,D`
	`> COMCFG COM2 = 115200,8,1,N,D`
	`> COMECHO COM1 = ON`
	`> COMECHO COM2 = ON`
	`> COMECHO COM3 = OFF`
	`> COMPROMPT COM1 = ON`
	`> COMPROMPT COM2 = ON`
	`> COMPROMPT COM3 = OFF`
	`> FRAMESIZE PCM NORM = 480`
	`> FRAMESIZE PCM TRUN = 480`
	`> FRAMESIZE NIB NORM = 192`
	`> FRAMESIZE NIB TRUN = 230`
	`> GAM AUD TX = 0x1000`
	`> GAM AUD RX = 0x1000`
	`> LED 1 = LANYP`	

ATTRIBUTE	DESCRIPTION
	> LED 2 = LANYA > LED 3 = TRUN > LED 4 = ERR > LED 5 = VAD > LED 6 = RUN > MIX AUD <- VOC (0x7FFF) > MIX PCM <- VOC (0x7FFF) > MIX VOC <- AUD (0x7FFF) > MIX VOC <- PCM (0x7FFF) > MIX COM -- OFF > MIX TON -- OFF > OPMODE = TEST *Note: OPMODE not saved in flash.* > ROUTE VOC <- NIB > ROUTE NIB <- VOC > ROUTE COM <- COM > TONE = 0 Hz > TRUN = OFF *Note: TRUN not saved in flash.* > VOC DTX = 0

8.3.4 CLKDET

The CLKDET command displays measured sampling, frame, and clock rates for the audio, PCM, and nibble interfaces, respectively.

Table 15: CLKDET Command Syntax

ATTRIBUTE	DESCRIPTION
SYNTAX	CLKDET
PARAMETERS	None
FLASH	NO
EXAMPLES	*Print measured rates* `COM1: clkdet` `> CLKDET AUD = 8000.00 symbols/sec` *sampling rate* `> CLKDET PCM = 7999.99 symbols/sec` *frame rate* `> CLKDET NTX = 9600.00 symbols/sec` *clock rate* `> CLKDET NRX = 9599.97 symbols/sec` *clock rate*

The rates are determined by measuring the average time between interrupt events. Since interrupt latencies affect results, a rate is determined over an average of at least 100 events. The clock accuracy is estimated to be within 1 symbol/second under normal/typical processor loading.

8.3.5 CLKRATE

The CLKRATE command sets/gets the PCM and NIB interface clock rates used when internal interface timing is enabled. Two different rates can be assigned for each interface: one for normal timing mode and one for truncated timing mode.

Table 16: CLKRATE Command Syntax

ATTRIBUTE	DESCRIPTION		
SYNTAX	CLKRATE [interface [tmode [rate]]]		
PARAMETERS	interface	PCM	Selects the PCM interface
		NIB	Selects the NIB interface
	tmode	NORM	Selects normal timing mode
		TRUN	Selects truncated timing mode
	rate	Desired clock rate (Hz) entered as a decimal integer.	
FLASH	YES		

EXAMPLES	*Print current clock rate settings.*
	`COM1: clkrate`
	`> CLKRATE PCM NORM = 3840000`
	`> CLKRATE PCM TRUN = 3840000`
	`> CLKRATE NIB NORM = 9600`
	`> CLKRATE NIB TRUN = 9600`		

	Print PCM clock rate settings.
	`COM1: clkrate pcm`
	`> CLKRATE PCM NORM = 3840000`
	`> CLKRATE PCM TRUN = 3840000`		

	Change NIB clock rate settings for the truncated timing mode.
	`COM1: clkrate nib trun 8000`
	`> CLKRATE NIB TRUN = 8000`		

The FAA20 uses the processor's Multi-channel Buffered Serial Ports (MCBSPs) to generate interface timing; therefore, clock rates are limited to values that can be generated using the processor execution clock and a fixed number of dividers. Note: When external timing is provided, these limitations do not apply. The FAA20 software automatically determines if the requested rate can be generated. If the rate cannot be generated, a parameter error message is printed.

The available PCM clock rates (PCMCLK) are governed by the following equation:

$$PCMCLK = \frac{122{,}880{,}000}{X}$$

$$where: \quad X = \{1 \ldots 127\}$$

The available NIB clock rates (NIBCLK) are governed by the following equation:

$$NIBCLK = \frac{122{,}880{,}000}{X \times Y}$$

$$where: \quad X = \{1 \ldots 256\}$$
$$Y = \{1 \ldots 512\}$$

8.3.6 CLKREF

The CLKREF command sets the port which will be used to control timing for the linear voice processor (LVP) task. The LVP is called after 5 samples are received on the reference port.

Table 17: CLKREF Command Syntax

ATTRIBUTE	DESCRIPTION		
SYNTAX	CLKREF [port]		
PARAMETERS	port	PCM	= Digital Data Port
		AUD	= Audio Port (default).
FLASH	YES		

EXAMPLES	*Print current clock reference setting.*
	`COM1: clkref`
	`> CLKREF AUD`		

	Set clock reference to PCM port.
	`COM1: clkref pcm`
	`> CLKREF PCM`		

For best vocoder results, this reference should be set equal to the primary port being used with the vocoder. For example, when the PCM port is routed to the vocoder, the CLKREF parameter should be set to PCM.

If this setting is not configured properly, timing differences may cause the FAA20 to insert or delete samples in the primary voice data path. For example, if the FAA20 is configured to receive voice data on the PCM port (in external timing mode) and the CLKREF parameter is set to AUD, the LVP will be timed to the AUD interface (internal timing). With two different timing references, samples will be accumulated or depleted eventually causing an insert or drop on a periodic basis that is related to the timing difference.

This setting does not affect FAA20 operation when the TEST BITEXACT parameter is set. When this parameter is set, the vocoder does not operate in real time; thus, adjustments for timing differences are not required.

8.3.7 CLKSRC

The CLKSRC command configures the timing source for timing for the PCM and NIB ports. Either internal or external timing can be selected. When internal timing is selected, the FAA20 drives the clock and frame sync signals for the port. The CLKRATE and FRAMESIZE settings are used to determine clock and frame rates, respectively.

Table 18: CLKSRC Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	CLKSRC [port [dir]]	
PARAMETERS	port	PCM = Digital Data Port AUD = Audio Port (default).
	dir	INT = internal timing EXT = external timing
FLASH	NO	

EXAMPLES	*Print current clock source settings.*
	`COM1: clksrc`
	`> CLKSRC PCM = INT`
	`> CLKSRC NIB = INT`	

	Set nibble clock to external.
	`COM1: clkref nib ext`
	`> CLKREF NIB = EXT`	

During power up, the FAA20 always configures the PCM and NIB interface clock sources based on switches SW1 and SW2, respectively. This can be changed after power up by using the CLKSRC command.

8.3.8 COMCFG

The COMCFG command configures ASCII communication settings for serial ports COM1 and COM2, i.e., baud rate, data bits, stop bits, parity, and flow control. All five parameters must be supplied when updating any setting.

Table 19: COMCFG Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	COMCFG [pid [brate,dbits,sbits,parity,flow]]	
PARAMETERS	pid	COM Port Identifier 1 = COM1 2 = COM2
	brate	Baud Rate. Two rates are available. 115200 = Standard rate (default) 921600 = High speed rate.
	dbits	Data Bits. Must be set to 8.
	sbits	Stop Bits. Must be set to 1.
	parity	Parity. Must be none. N = None.
	flow	Hardware Flow Control. D = Disabled (default) H = Hardware flow enabled.
FLASH	YES	

EXAMPLES	*Print current communication settings.*
	`COM1: comcfg`
	`> COMCFG COM1 = 115200,8,1,N,D`
	`> COMCFG COM2 = 115200,8,1,N,D`	

	Enable hardware flow control on COM2.
	`COM1: comcfg 2 115200,8,1,n,h`
	`> COMCFG COM2 = 115200,8,1,N,H`	

This serial port configuration command only applies to the physical ports COM1 and COM2. The virtual command port (COM3) uses the synchronous nibble interface, so ASCII communication settings are not applicable.

While hardware flow control is disabled to allow quick connection with three-wire terminal interfaces, it is recommended that hardware flow control be enabled for best performance. Hardware flow control is required for software download and will insure that characters are not dropped for large printouts, i.e. CFG command response.

8.3.9 COMECHO

The COMECHO command enables/disables local character echo for terminal interfaces.

Table 20: COMECHO Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	COMECHO [pid [onstate]]	
PARAMETERS	pid	COM Port Identifier 1 = COM1 2 = COM2 3 = COM3 (virtual terminal over nibble interface)
	onstate	ON Enables local character echo. OFF Disables local character echo.
FLASH	YES	

EXAMPLES	*Print current echo settings (default settings shown).*
	`COM1: comecho`
	`> COMECHO COM1 = ON`
	`> COMECHO COM2 = ON`
	`> COMECHO COM3 = OFF`	

	Disable character echo on COM2.
	`COM1: comecho 2 off`
	`> COMECHO COM2 = OFF`	

8.3.10 COMPROMPT

The COMPROMPT command enables/disables the printing of a prompt string at the terminal interface.

Table 21: COMPROMPT Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	COMPROMPT [pid [onstate]]	
PARAMETERS	pid	COM Port Identifier 1 = COM1 2 = COM2 3 = COM3 (virtual terminal over nibble interface)
	onstate	ON Enables prompt. OFF Disables prompt.
FLASH	YES	

EXAMPLES	*Print current prompt settings (default settings shown).*
	`COM1: comprompt`
	`> COMPROMPT COM1 = ON`
	`> COMPROMPT COM2 = ON`
	`> COMPROMPT COM3 = OFF`	

	Disable prompt on COM2.
	`COM1: comprompt 2 off`
	`> COMPROMPT COM2 = OFF`	

8.3.11 COUNT

The COUNT command prints counters associated with internal message queues.

Table 22: COUNT Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	COUNT [cvalue]	
PARAMETERS	cvalue	Clear Count Value. 0 = Zero clears all counters
FLASH	NO	

EXAMPLES	*Print current counter settings.*
	`COM1: count`
	`> QUEID SADD SDEL PADD PDEL NRDY #PUTITEMS`
	`> LDIGTX 0002 0000 0000 0000 0002 05FEF706`
	`> LDIGRX 0001 0000 0001 0000 0005 05FEF705`
	`> LPCMTX 0001 0000 0002 0000 0006 05FEF6E6`
	`> LPCMRX 0001 0000 0000 0000 0006 05FEF6EB`
	`> LAUDTX 0000 0000 0000 0000 0001 05FEF6E6`
	`> LAUDRX 0007 0000 0000 0000 0005 05FEF6E9`
	`> LVOCTX 0000 0005 0000 0C57 00AB 05FEB937`
	`> LVOCRX 0016 0000 0C8B 0000 002F 05FEB8D5`
	`> LCOMTX 0000 0001 0000 FDEE 0000 0000013F`
	`> LCOMRX 0000 0000 FE2E 0000 0000 00000000`
	`> CVOCTX 0002 0000 0000 0001 0018 0009978D`
	`> CVOCRX 0000 0000 0000 0000 0000 0009978D`
	`> CNIBTX 0000 0000 0065 0003 0018 00099791`
	`> CNIBRX 0000 0000 0000 0061 0000 00099791`
	`> CCOMTX 0000 0000 0000 0000 0000 00000000`
	`> CCOMRX 0000 0000 0000 0000 0000 00000000`	

	Clear counter settings.
	`COM1: count 0`
	`> QUEID SADD SDEL PADD PDEL NRDY #PUTITEMS`
	`> LDIGTX 0000 0000 0000 0000 0000 00000000`
	`> LDIGRX 0000 0000 0000 0000 0000 00000000`
	`> LPCMTX 0000 0000 0000 0000 0000 00000000`
	`> LPCMRX 0000 0000 0000 0000 0000 00000000`
	`> LAUDTX 0000 0000 0000 0000 0000 00000000`
	`> LAUDRX 0000 0000 0000 0000 0000 00000000`
	`> LVOCTX 0000 0000 0000 0000 0000 00000000`
	`> LVOCRX 0000 0000 0000 0000 0000 00000000`
	`> LCOMTX 0000 0000 0000 0000 0000 00000000`
	`> LCOMRX 0000 0000 0000 0000 0000 00000000`
	`> CVOCTX 0000 0000 0000 0000 0000 00000000`
	`> CVOCRX 0000 0000 0000 0000 0000 00000000`
	`> CNIBTX 0000 0000 0000 0000 0000 00000000`
	`> CNIBRX 0000 0000 0000 0000 0000 00000000`
	`> CCOMTX 0000 0000 0000 0000 0000 00000000`
	`> CCOMRX 0000 0000 0000 0000 0000 00000000`	

Counters are provided for sample add/drop events, packet add/drop events, and the number of items written to queues. The counters are especially helpful for diagnosing improper timing setups. When interface timing relationships are not exact, voice samples can be added or dropped. For example, if the PCM interface is used with the vocoder and the relative timing between the PCM data interface and NIB data interface isn't maintained voice samples are added/dropped can be added the linear LVOCTX and/or LVOCRX queues. Samples and packets may added/dropped during FAA20 power up.

The NRDY field indicates the depth of the queue measured when the vocoder frame sync signals are detected. This is used to update vocoder delay measurements (see DELAY command).

For more information on queues, see Section 6.2.3.

8.3.12 DELAY

The DELAY command prints the measured voice delays through the FAA20. The delay includes processing and queue delay and does not include native algorithm delay. Delay is measured with respect to the vocoder frame sync signals.

Table 23: DELAY Command Syntax

ATTRIBUTE	DESCRIPTION
SYNTAX	DELAY
PARAMETERS	None.
FLASH	NO

EXAMPLES	*Print delays (normal timing mode).*
	`COM1: delay`
	`> DELAY AUD <- NIB = 9 ms`
	`> DELAY PCM <- NIB = 9 ms`
	`> DELAY NIB <- AUD = 10 ms`
	`> DELAY NIB <- PCM = 10 ms`

	Print delays (truncated timing mode).
	`COM1: delay`
	`> DELAY AUD <- NIB = 11 ms`
	`> DELAY PCM <- NIB = 13 ms`
	`> DELAY NIB <- AUD = 10 ms`
	`> DELAY NIB <- PCM = 12 ms`

Delays are displayed for external linear to compressed voice paths. Delays are not optimized or displayed for standalone operation, i.e. DEMO mode.

For more information on delays, see Section 5.4.2.

8.3.13 DM

The DM command is used to access processor data memory. A single memory location can be read/written or a block of memory can be printed.

Table 24: DM Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	DM addr [hexdata] DM startaddr [.. endaddr | + length]	
PARAMETERS	addr	Data Memory Address (hexadecimal). Data memory addresses are 16-bit.
	startaddr	Starting Address for a block print (hexadecimal).
	endaddr	Ending Address for a block print (hexadecimal).
	length	Length of block to print (hexadecimal).
	hexdata	Hexadecimal data value (16-bit).
FLASH	NO	

EXAMPLES	*Read from location 0x0000.*
	`COM1: dm 0`
	`> DM 0000 = 041B`	

	Write to location 0x0000 (example disables codec, PCM and nibble interrupts).
	`COM1: dm 0 8`
	`> DM 0000 = 0008`	

	Print memory block from address 0x1406 to 0x140E
	`COM1: dm 1406 .. 140e`
	`> DM 1406 = BEEF BEEF BEEF BEEF BEEF BEEF BEEF BEEF`
	`> DM 140E = BEEF`	

	Print memory block starting at address 0x0A00 with a length of 0x10
	`COM1: dm a00 + 10`
	`> DM 0A00 = 0010 0004 5DA7 0A18 0000 0000 0A14 054F`
	`> DM 0A08 = 0002 83C5 0001 06CD 0000 054F 0000 0000`	

Note: Do not enter any leading '0x' characters.

Note: Insure you add spaces to separate '+' and '..' character strings.

8.3.14 DUMP

The DUMP command prints a named memory block or a section of memory.

Table 25: DUMP Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	DUMP [bname] DUMP startaddr length	
PARAMETERS	bname	Block Name NRX = Nibble Receive Frame Data LRX = Linear Receive Mixer Data LTX = Linear Transmit Mixer Data
	startaddr	Starting Address for a block print (hexadecimal).
	length	Length of block to print (hexadecimal).
FLASH	NO	

EXAMPLES	*Print NRX block. Note: The expanded nibble flag sequence is printed at address locations 0x5BEB..0x5BEC*
	`COM1: dump nrx`
	`> 5BD2: 0000 0009 0001 0005 0001 0009 0000 0008`
	`> 5BDA: 000D 0008 000B 0006 000F 0001 0000 000B`
	`> 5BE2: 0000 000F 000C 0000 000B 000F 000E 000A`
	`> 5BEA: 0002 000F 000A 000B 0000 0000 0001 0000`
	`> 5BF2: 0000 0000 0000 0000 0000 0000 0000 0000`
	`> 5BFA: 0000 0000 0000 0000 0000 0000 0000 0000`
	`> 5C02: 0000 0000 0000 0000 0000 0000 0000 0000`
	.
	.	

	Print LRX block. The columns represent the 5 sample values (data chunk) that are processed by the mixer at a time.
	`COM1: dump lrx`
	`> AUD = 0003 FFFC FFFE 0000 0000`
	`> PCM = 0000 0000 0000 FFFB 0000`
	`> VOC = FFFF FFFF 0001 0001 FFFF`
	`> COM = 0000 0000 0000 0000 0000`
	`> TON = 0000 0000 0000 0000 0000`	

	Print section of memory starting at address 0x0000..
	`COM1: dump 0 20`
	`> 0000: 041B 08A0 6485 6485 0000 6485 160D 411D`
	`> 0008: 6485 0000 0000 0008 0000 0000 0004 0444`
	`> 0010: 0000 0001 5D54 5D94 0622 0000 0017 0009`
	`> 0018: 1A04 0288 0000 C4D4 C4D6 7FA0 0002 0002`	

8.3.15 FLASH

The FLASH command accesses the three parameters that are stored in the protected flash boot block: the serial number, the analog receive calibration value, and the analog transmit calibration value. These parameters are configured at the factory and cannot be changed without a JTAG programming cable.

Table 26: FLASH Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	FLASH [fparam | [data]]	
PARAMETERS	fparam	Protected Flash Parameters SN = FAA20 Serial Number CALRX = Receive Audio Interface Calibration Value CALTX = Transmit Audio Interface Calibration Value
	data	Data to write. The SN data is entered as a decimal value. The CALRX/CALTX data is entered as a Q3.12 format hexadecimal value.
FLASH	NO	

EXAMPLES	*Print protected flash parameters.*
	`COM1: flash`
	`> FLASH SN = 601`
	`> FLASH CALRX = 1887`
	`> FLASH CALTX = 0D39`	

8.3.16 FM

The FM command is used to access flash memory.

Although the flash memory data bus is one byte wide, the FAA20 software always accesses word values, i.e. two sequential locations are accessed to form a 16-bit word. A single word can be read/written or a block of memory can be printed. Only blank memory locations (value = 0xFFFF) can be written.

Flash memory addresses are two words long (32-bits total). The first word represents the flash page (valid values 0 to 8) and the second word represents the data memory offset location (valid values 0x8000 to 0xFFFF). Flash page 0 is the protected flash segment (see FLASH command). Flash pages 1 through 7 contain the main software application. Flash page 8 contains flash configuration parameters (see CFG command).

Table 27: FM Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	FM addr [hexdata] FM startaddr [.. endaddr | + length] FM ERASE [pageno]	
PARAMETERS	Addr	Long Data Memory Address (hexadecimal). Data memory addresses are 32-bit.
	startaddr	Long Starting Address for a block print (hexadecimal).
	endaddr	Long Ending Address for a block print (hexadecimal).
	length	Length (number of words) of block to print (hexadecimal).
	hexdata	Hexadecimal data value (16-bit).
FLASH	This low level command directly accesses flash memory.	

EXAMPLES	*Read the protected flash configuration area (e.g. serial number and calibration values).*
	`COM1: fm fff0 + 4`
	`> FM 0000FFF0 = 0259 1887 0D39 FFFF`	

	Erase the flash configuration parameter block.
	`COM1: fm erase 8`
	`> FM ERASE 8`	

Note: Do not enter any leading '0x' characters.

Note: Insure you add spaces to separate '+' and '..' character strings.

8.3.17 FRAMESIZE

The FRAMESIZE command sets/gets the PCM and NIB frame sizes used when internal interface timing is enabled. Two different rates can be assigned for each interface: one for normal timing mode and one for truncated timing mode.

Table 28: FRAMESIZE Command Syntax

ATTRIBUTE	DESCRIPTION		
SYNTAX	FRAMESIZE [interface [tmode [rate]]]		
PARAMETERS	interface	PCM	Selects the PCM interface
		NIB	Selects the NIB interface
	tmode	NORM	Selects normal timing mode
		TRUN	Selects truncated timing mode
	size	Desired frame size entered as a positive decimal clock count. The maximum PCM frame size is 4096.	
FLASH	YES		

EXAMPLES	*Print current frame size settings (default settings shown).*
	`COM1: framesize`
	`> FRAMESIZE PCM NORM = 480`
	`> FRAMESIZE PCM TRUN = 480`
	`> FRAMESIZE NIB NORM = 192`
	`> FRAMESIZE NIB TRUN = 230`		

	Change NIB framesize setting.
	`COM1: clkrate nib trun 192`
	`> FRAMESIZE NIB TRUN = 192`		

	Print NIB frame sizes
	`COM1: clkrate nib`
	`> FRAMESIZE NIB NORM = 192`
	`> FRAMESIZE NIB TRUN = 192`		

Note: Do not enter any leading '0x' characters.

The FAA20 uses the processor's Multi-channel Buffered Serial Ports (MCBSPs) to generate interface timing; therefore, frame sizes are limited to values that can be generated using the processor execution clock and a fixed number of dividers. Note: When external timing is provided, these limitations do not apply.

The FAA20 supports a special framing mode when the truncated nibble frame size is set to 230 and the nibble clock source is set to internal (INT). For more information on this mode, see Section 5.2.3.

8.3.18 GAM

The GAM command sets/gets the gain, attenuation and mute characteristics for linear voice ports. Presently, the FAA20 only supports GAM adjustment on the analog audio (AUD) interface. This command allows the audio interface to be level-adjusted to match external analog audio equipment and still comply with vocoder audio level requirements.

Table 29: FRAMESIZE Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	GAM [interface [dir [gvalue]]]	
PARAMETERS	interface	PCM Selects the PCM interface NIB Selects the NIB interface
	tmode	NORM Selects normal timing mode TRUN Selects truncated timing mode
	gvalue	Gain value entered as a Q3.12 format hexadecimal value. Valid range is 0x0000 to 0x7FFF. For example, a unity gain (0 dB power adjustment) is represented by the value 0x1000. A +3 dB power adjustment is represented by the value 0x2000. A -3dB power adjustment is represented by the value 0x0800. The full range supports power adjustments from -36 dB to +21 dB.
FLASH	YES	

EXAMPLES	*Print current GAM settings (default settings shown).*
	`COM1: gam`
	`> GAM AUD TX = 0x1000`
	`> GAM AUD RX = 0x1000`	

	Change audio transmit GAM settings.
	`COM1: gam aud tx 2000`
	`> GAM AUD TX = 0x2000`	

Note: Do not enter any leading '0x' characters.

8.3.19 IO

The IO command is used to access processor IO memory. A number of hardware devices are mapped into processor IO memory including the UART and CPLD.

Table 30: IO Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	IO addr [hexdata]	
PARAMETERS	addr	IO Memory Address (hexadecimal). IO memory addresses are 16-bit.
	hexdata	Hexadecimal data value (16-bit).
FLASH	NO	

EXAMPLES	*Read from switch bank.*
	`COM1: io 112`
	`> IO 0112 = 0058`	

	Write to UART A scratch register
	`COM1: io 107 55`
	`> IO 0107 = 0055`	

Note: Do not enter any leading '0x' characters.

8.3.20 LED

The LED command is used to assign virtual LEDs to physical LEDs.

Table 31: LED Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	LED [ledid [vled] LED LIST	
PARAMETERS	ledid	LED Identifier. Valid Range is 1 through 6 representing LED1 through LED6, respectively.
	vled	Virtual LED Function Name.
FLASH	YES	

EXAMPLES	*Display current LED assignments (default setting shown).*
	`COM1: led`
	`> LED 1 = LANYP`
	`> LED 2 = LANYA`
	`> LED 3 = TRUN`
	`> LED 4 = ERR`
	`> LED 5 = VAD`
	`> LED 6 = RUN`	

	Assign OFF to LED4
	`COM1: led 4 off`
	`> LED 4 = OFF`	

	Display list of virtual LEDs.
	`COM1: led list`
	`>`
	`**********`
	`> LED Parameter List`
	`> OFF ON AUD_HWI PCM_HWI NTX_HWI NRX_HWI`
	`> RAT_SWI LVP_SWI ENC_SWI DEC_SWI CVR_SWI COM_SWI`
	`> TRUN LATE_XFSE LATE_XFSD LATE_NFS LAUDTXP LAUDTXA`
	`> LAUDRXP LAUDRXA LPCMTXP LPCMTXA LPCMRXP LPCMRXA`
	`> LVOCTXP LVOCTXA LVOCRXP LVOCRXA LCOMTXP LCOMTXA`
	`> LCOMRXP LCOMRXA LCOMRXP LCOMRXA LANYPL LANYP`
	`> LANYA VAD RUN ERR`
	`>`
	`**********`	

For default assignment information, see Section 3.4. For a description of virtual LEDs see Section 5.4.3.

8.3.21 LOOP

The LOOP command is used to enable/disable external interface loops and is used during system troubleshooting. The loop back is implemented in the hardware interrupt service routine.

Table 32: LOOP Command Syntax

ATTRIBUTE	DESCRIPTION		
SYNTAX	LOOP [port [onstate]		
PARAMETERS	port	AUD	= Audio Port (default)
		NIB	= Nibble Port
		PCM	= Digital Data Port
	onstate	ON	Enables port external loopback.
		OFF	Disables port external loopback.
FLASH	NO		

EXAMPLES	*Display current LED assignments (default setting shown).*
	`COM1: loop`
	`> LOOP AUD = OFF`
	`> LOOP NIB = OFF`
	`> LOOP PCM = OFF`		

	Enable AUD loopback
	`COM1: loop aud on`
	`> LOOP AUD = ON`		

The loopback delay for each port is provided below.

- *Audio Loopback. There is a three sample delay.*
- *Nibble Loopback. There is a one frame delay.*
- *PCM Loopback. This is a three sample delay.*

Note: Version 1.0.0 of software has a status reporting b ug. While the command correctly enables/disables the port loopback, the loopback state may be displayed incorrectly. At power up, all loopbacks are disabled. This bug will be fixed in the next release of the FAA20 software.

8.3.22 MACRO

The MACRO command is used to create or playback a command sequence. This command is typically used for factory troubleshooting of FAA20 hardware device interfaces.

Table 33: MACRO Command Syntax

ATTRIBUTE	DESCRIPTION		
SYNTAX	MACRO mcmd		
PARAMETERS	mcmd	BEGIN	= Begin recording a list of commands.
		END	= Stop recording a list of commands.
		PLAY	= Play the list of commands, once.
		LOOP	= Play the list of commands, continuously.
FLASH	NO		

EXAMPLES	*Create macro to toggle the truncated timing state every 3 seconds.*
	`OM1: macro begin`
	`> MACRO BEGIN OK`
	`COM1: trun on`
	`> TRUN = ON`
	`COM1: wait 3000`
	`> WAIT = 3000`
	`COM1: trun off`
	`> TRUN = OFF`
	`COM1: wait 3000`
	`> WAIT = 3000`
	`COM1: macro end`
	`> MACRO END OK`		

	Loop the macro
	`COM1: macro loop`
	`> MACRO LOOP OK`
	`COM1: trun on`
	`> TRUN = ON`
	`COM1: wait 3000`
	`> WAIT = 3000`
	`COM1: trun off`
	`> TRUN = OFF`
	`COM1: wait 3000`
	`> WAIT = 3000`
	`COM1: MACRO LOOP`
	`> MACRO LOOP OK`
	`COM1: trun on`
	`> TRUN = ON`
			Command entered at terminal
			FAA20 response.
			Start of command sequence
			…
			FAA20 repeats command sequence until the ESC key is pressed at the terminal.

To stop a looping macro, press the escape (ESC) key. The macro is stopped after the current command sequence is completed.

The macro storage buffer is 100 characters. Command sequences must fit within the available buffer space. Any previously stored macro is erased when the MACRO BEGIN command is entered.

8.3.23 MCBSP

The MCBSP command is used to access the TMS320VC5416 Multi-Channel Buffered Serial Port (MCBSP) configuration registers. This command is used for FAA20 software development and test.

Table 34: MCBSP Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	MCBSP [mcbspid [subaddr [hexdata]]]	
PARAMETERS	mcbspid	0 = MCBSP #0 (connected to codec) 1 = MCBSP #1 (connected to PCM interface) 2 = MCBSP #2 (generates NIBCLK)
	subaddr	Sub-Address. Valid range is 0x0 through 0xF.
	hexdata	Hexadecimal data value (16-bit).
FLASH	NO	

EXAMPLES	*Display all registers for MCBSP #1.*
	`COM1: mcbsp 1`
	`> MCBSP 1 0 = 0001`
	`> MCBSP 1 1 = 00CD`
	`> MCBSP 1 2 = 0040`
	`> MCBSP 1 3 = 0001`
	`> MCBSP 1 4 = 0040`
	`> MCBSP 1 5 = 0001`
	`> MCBSP 1 6 = 001F`
	`> MCBSP 1 7 = 31DF`
	`> MCBSP 1 8 = 0000`
	`> MCBSP 1 9 = 0000`
	`> MCBSP 1 A = 0000`
	`> MCBSP 1 B = 0000`
	`> MCBSP 1 C = 0000`
	`> MCBSP 1 D = 0000`
	`> MCBSP 1 E = 0F00`
	`> MCBSP 1 F = 0000`	

	Change contents of sub-address register 2.
	`COM1: mcbsp 1 2 41`
	`> MCBSP 1 2 = 0041`	

Note: Do not enter any leading '0x' characters.

8.3.24 MIX

The MIX command controls the routing and amplitude level of linear audio signals. The mixer only supports unity and negative gain adjustments, i.e. attenuation and mute.

Table 35: MIX Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	MIX [lintx [linrx [xamp]]]	
PARAMETERS	lintx linrx	Linear Mixer Port: The *lintx* is the mixer output port, and the *linrx* is the mixer input port AUD = Audio Port PCM = Digital Data Port VOC = Vocoder Port COM = COM Port TON = Tone Generator Port OFF = OFF *Note: The selection of TON for LINTX has no practical effect, since this port is only an input.*
	xamp	Amplitude: The amplitude in Q1.15 hex data format. Valid range: 0 to 7FFF (hex). Sets the amplitude of the *linrx* port signal to mix into the *lintx* output port. Unity gain is 0x7FFF. A gain factor of 0.5 (or -6 dB power adjustment) is 0x3FFF.
FLASH	YES for all modes EXCEPT the DEMO mode.	

EXAMPLES	*Print current mixer settings (default settings shown).*
	`COM1: mix`
	`> MIX AUD <- VOC (0x7FFF)`
	`> MIX PCM <- VOC (0x7FFF)`
	`> MIX VOC <- AUD (0x7FFF)`
	`> MIX VOC <- PCM (0x7FFF)`
	`> MIX COM -- OFF`
	`> MIX TON – OFF`	

	Disable all mixer routing paths.
	`COM1: mix off`
	`> MIX AUD -- OFF`
	`> MIX PCM -- OFF`
	`> MIX VOC -- OFF`
	`> MIX COM -- OFF`
	`> MIX TON -- OFF`	

	Route the tone generator output to the AUD output port (at 0 dBm0)
	`COM1: mix aud ton 5a9d`
	`> MIX AUD <- TON (0x5A9D)`	

For more information, see Section 5.3.2.

8.3.25 OPMODE

The OPMODE command sets/gets the operational mode. The operational mode is configured at power up based on switches SW7 and SW8, i.e. it is not a flash parameter. The mode can be changed after power up with the OPMODE command.

Table 36: OPMODE Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	OPMODE [mode]	
PARAMETERS	mode	Operational Setting. NORM = Normal Mode (supports expanded feature set) VC20 = VC20 Emulation Mode (quick compatibility) DEMO = Demo Mode (standalone operation) TEST = Test Mode
FLASH	NO	

EXAMPLES	*Print current OPMODE setting (initial setting configured by SW7/SW8)*
	`COM1: opmode`
	`> OPMODE = NORM`	

	Change mode to DEMO mode.
	`COM1: opmode demo`
	`> OPMODE = DEMO`	

For more information, see Section 5.1

8.3.26 PROG

The PROG command is used to update the FAA20 main application program.

Table 37: PROG Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	PROG [ACK]	
PARAMETERS	ACK	Acknowledgement Mode. Causes FAA20 to print an acknowledgement after each S-record line is transmitted.
FLASH	NO. Although this command reprograms the flash software blocks, it does not affect flash configuration parameters.	

EXAMPLES	*Program the FAA20 main flash memory..*
	`COM1: prog`
	`> ERASING FLASH (wait for READY)`
	`> READY`
	`> #Records = 1472`
	`> DONE`	

For more information, see Section 7.3.

8.3.27 REM

The REM command is used to forward a command line from COM1 or COM2 to the nibble interface. Any responses from the nibble interface, i.e. command lines beginning with the greater than symbol, are forwarded to the original command port.

Table 38: REM Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	REM [cmd_str]	
PARAMETERS	cmd_str	Command String. Any sequence of characters and spaces.
FLASH	NO	

EXAMPLES	*Send the string 'ABC 123' to the nibble interface. Since the FAA20 doesn't process the command, no response is provided directly by the FAA20.*
	`COM1: rem ABC 123`
	`COM1:`	

Typically, this command is only used for special back-to-back vocoder testing using a special adapter card. The back-to-back adapter card enables a master FAA20 to communicate with a slave FAA20. The REM command issued at the master is forwarded to the slave via the nibble interface. The slave responds back to the master over the nibble interface. The master reads the response and forwards it to the command port than last issued the REM command.

While the scenario described above covers the master/slave FAA20 configuration, the REM command can be used to test the COM3 interface with other host equipment. Note: Only command strings starting with a greater than symbol (as the first no blank character) and ending with a carriage return are forwarded from the nibble interface to the COM1/COM2 port.

8.3.28 RESET

The RESET command is forces a hardware reset by causing the program to stop servicing the watchdog timer.

Table 39: REM Command Syntax

ATTRIBUTE	DESCRIPTION
SYNTAX	RESET
PARAMETERS	None.
FLASH	NO

EXAMPLES	*Reset the board.*
	`COM1: reset`
	` > RESET OK`
	`COM1:`
	`Booting...!`
	
	` >`
	`**********************************************************************`
	` > *   FAA20: AMBE 4.8 kbps Vocoder (for Air Traffic Communication)`
	`*`
	` >`
	`**********************************************************************`
	` > Copyright 2004. CIE Engineering, Inc. All rights reserved.`
	` > For more information, contact: www.cie-eng.com`
	` > Version: 1.0.0`
	` > Built:   Feb 18 2004 15:53:17`
	` > Serial#: 617`
	` >`
	` > Type ? for help`

8.3.29 ROUTE

The ROUTE command controls the routing of compressed voice packets.

Table 40: ROUTE Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	ROUTE [cmptx [cmprx]]	
PARAMETERS	cmptx cmprx	Linear Mixer Port: The *cmptx* is the router output port, and the *cmprx* is the router input port VOC = Vocoder Port NIB = Nibble Port COM = COM Port OFF = OFF
FLASH	YES* (see Note)	

EXAMPLES	*Print current router settings (default settings shown).*
	`COM1: route`
	`> ROUTE VOC <- NIB`
	`> ROUTE NIB <- VOC`
	`> ROUTE COM <- COM`	

	DEMO Mode router settings
	`COM1: route`
	`> ROUTE VOC <- VOC`
	`> ROUTE NIB <- NIB`
	`> ROUTE COM <- COM`	

	Route the vocoder to the nibble interface
	`COM1: route nib voc`
	`> ROUTE NIB <- VOC`	

	Turn off all routes
	`COM1: route off`
	`> ROUTE VOC <- OFF`
	`> ROUTE NIB <- OFF`
	`> ROUTE COM <- OFF`	

*Note: The route is always stored in flash memory with the CFG SAVE command. For the DEMO and VC20 modes, the restored routing configuration is always overwritten at with mode specific settings at power up. The fixed VC20 mode routing is identical to the default setting. The fixed DEMO mode routing is in an example shown above.

For more information, see Section 5.3.3.

8.3.30 TEST

The TEST command is used to access test/integration tools, signal processing functions, and built-in hardware test functions. Test/integration tools include a COM3 monitor, port test pattern controls, and a vocoder bit exactness test mode. The signal processing functions include a tone detector and a coarse spectrum analyzer. These signal processing functions are 'connected' to the COM port of the linear mixer, thus any signal to be evaluated must be mixed into this port. Hardware test functions are used at the factory and require a special external loop back adapter.

The command syntax for all test functions is provided below. For operational details, see Section 7.2.

Table 41: TEST Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	TEST [param [onstate]]	*Test/Integration Tools*
	TEST TRIG [noff toff]	*Test/Integration Tool*
	TEST FFT [uopt]	*Signal Processing Function*
	TEST SWEEP [uopt]	*Signal Processing Function*
	TEST CALRX	*Signal Processing Function*
	TEST TONDET	*Signal Processing Function*
	TEST htest [hopt]	*Hardware Test Functions*
PARAMETERS	param	Test Parameters. BITEXACT= Bit Exact Test Mode (supports vocoder tests) COM3 = COM3 Port Monitor (prints traffic to COM2) NTX = Nibble Test (enables nibble TX test pattern) PTX = PCM Test (enables PCM TX counting pattern) TXINIT = Vocoder Control Nibble Initialize Bit TXMUTE= Vocoder Control Nibble Mute Bit TXLOST= Vocoder Control Nibble Lost Bit TXCLEAR=Expanded Control Nibble Error Clear Bit C1FMT = ASCII Compressed Voice Long Format (C1)
	onstate	ON Enables the test feature. OFF Disables the test feature.
	noff	FMDE→FMEN Offset (Normal Timing). When the NIBCLK source is internally generated (master mode), normal timing is enabled, and the unit is in TEST mode, this controls the positioning of the FMEN pulse relative to the FMDE pulse. The value represents the number of NIBCLKs to wait before asserting the FMEN pulse.
	toff	FMDE→FMEN Offset (Truncated Timing). When the NIBCLK source is internally generated (master mode), truncated timing is enabled, and the unit is in TEST mode, this controls the positioning of the FMEN pulse relative to the FMDE pulse. The value represents the number of NIBCLKs to wait before asserting the FMEN pulse.

ATTRIBUTE	DESCRIPTION	
	htest	Hardware Test Function. LED = LED test. SW = Switch test AUD = Audio Port Test NIB = Nibble Port Test PCM = PCM Port Test BIT = Bit Control/Status Test COM = Serial Port Test (COM1/COM2) ALL = Run all hardware tests.
	hopt	Hardware Test Options. V = Verbose Mode
	uopt	Unit Option. H = Print hex values F = Print fractional values B = Print dBm0 values D = Print decimal values (default)
FLASH	NO	

EXAMPLES	*Print current test parameter settings (default settings shown).*
	`COM1: test`
	` > TEST BITEXACT = OFF`
	` > TEST C1FMT = OFF`
	` > TEST COM3 = OFF`
	` > TEST NTX = OFF`
	` > TEST PTX = OFF`
	` > TEST TXINIT = OFF`
	` > TEST TXLOST = OFF`
	` > TEST TXMUTE = OFF`
	` > TEST TXCLEAR = OFF`	

	Run the hardware NIB test (requires external adapter).
	`COM1: test nib v`
	` > Testing NIB... PASS`
	`> Signal Test ENC0/DEC0: PASS`
	`> Signal Test ENC1/DEC1: PASS`
	`> Signal Test ENC2/DEC2: PASS`
	`> Signal Test ENC3/DEC3: PASS`	

	Route a tone to the tone detector and measure it.
	`COM1: mix off`
	` > MIX AUD -- OFF`
	` > MIX PCM -- OFF`
	` > MIX VOC -- OFF`
	` > MIX COM -- OFF`
	` > MIX TON -- OFF`
	`COM1: mix com ton 7fff`
	` > MIX COM <- TON (0x7FFF)`
	`COM1: tone 1000`
	` > TONE = 1000 Hz`
	`COM1: test tondet`
	` > TEST TONDET = 1000 Hz, dResult= +3.00 (dBm0)`	

For more TEST command information, see Section 7.2.

8.3.31 TONE

The TONE command sets/gets the frequency of the tone generator.

Table 42: TONE Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	TONE [freq]	
PARAMETERS	freq	Tone Frequency. Entered as a decimal value. It is recommended that the frequency be set to range between 0 and 0.45 Fs where Fs is the sample rate. The normal timing sample rate is 8000 Hz. The truncated timing sample rate is 6667 Hz.. The default frequency is 0 Hz.
FLASH	YES	

EXAMPLES	*Print current frequency setting (default value shown).*
	`COM1: tone`
	`> TONE = 0 Hz`	

	Set the tone to 440 Hz.
	`COM1: tone 440`
	`> TONE = 440 Hz`	

The test tone level is set to +3.00 dBm0. This level can be adjusted by the linear voice mixer.

8.3.32 TRUN

The TRUN command enables/disables truncated timing.

Table 43: TRUN Command Syntax

ATTRIBUTE	DESCRIPTION		
SYNTAX	TRUN [onstate]		
PARAMETERS	onstate	ON	Enables truncated timing.
		OFF	Disables truncated timing.
FLASH	NO		

EXAMPLES	*Request the current timing state.*
	`COM1: trun`
	`> TRUN OFF`		

	Enable truncated timing.
	`COM1: trun on`
	`> TRUN ON`		

8.3.33 VERSION

The VERSION command displays software version information and the unit serial number.

Table 44: VERSION Command Syntax

ATTRIBUTE	DESCRIPTION
SYNTAX	VERSION
PARAMETERS	None
FLASH	NO

EXAMPLES	*Print version information*
	`COM1: version`
	`> Version: 1.0.0`
	`> Built: Feb 18 2004 15:53:17`
	`> Serial#: 601`

8.3.34 VOC

The VOC command sets/gets vocoder parameters. Generally, these parameters are used for vocoder testing; however, the FEC counter may be useful during operation to assess the performance of the communication channel. Table 46 provides brief VOC parameter descriptions. Refer to DVSI vocoder software documentation for additional details.

Table 45: VOC Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	VOC [param [tmode [rate]]]	
PARAMETERS	param	PCM Selects the PCM interface NIB Selects the NIB interface
	tmode	NORM Selects normal timing m ode TRUN Selects truncated timing mode
	rate	Desired clock rate (Hz) entered as a decimal integer.
FLASH	YES	

EXAMPLES	*Print current vocoder parameter settings.*
	`COM1: voc`
	`> VOC EMODE = 0x0000`
	`> VOC DMODE = 0x0000`
	`> VOC FEC = 5`
	`> VOC EWS0 = 80`
	`> VOC EWS1 = 80`
	`> VOC DWS0 = 80`
	`> VOC DWS1 = 80`
	`> VOC MUTE = 0`
	`> VOC LOST = 0`
	`> VOC DTX = 0`
	`> VOC SDBITS = 1`	

	Clear the FEC error counter.
	`COM1: voc fec 0`
	`> VOC FEC = 0`	

	Change NIB clock rate settings for the truncated timing mode.
	`COM1: clkrate nib trun 8000`
	`> CLKRATE NIB TRUN = 8000`	

Table 46: VOC Command Parameters

PARAMETER	DESCRIPTION
EMODE	Encoder Control Word (hex). This control word is a calling parameter *cmode* for the vocoder encoder function. Refer to DVSI documentation for details.
DMODE	Decoder Control Word (hex). This control word is a calling parameter *cmode* for the vocoder decoder function. Refer to DVSI documentation for details.
FEC	Forward Error Correction Error Counter (decimal). Each time the FEC decoder function is called, the FAA20 software adds returned errors to this accumulating error counter.
EWS0	Encoder Sub-Frame #0 Window Size (decimal). The valid value is 79 to 81 samples with 80 samples being the nominal value. The equivalent DVSI function calling parameter is *ws.*
EWS1	Encoder Sub-Frame #1 Window Size (decimal). The valid value is 79 to 81 samples with 80 samples being the nominal value. The equivalent DVSI function calling parameter is *ws.*
DWS0	Decoder Sub-Frame #0 Window Size (decimal). The valid value is 79 to 81 samples with 80 samples being the nominal value. The equivalent DVSI function calling parameter is *ws.*
DWS1	Decoder Sub-Frame #1 Window Size (decimal). The valid value is 79 to 81 samples with 80 samples being the nominal value. The equivalent DVSI function calling parameter is *ws.*
MUTE	Decoder Mute Control. Valid values are 0 and 1. This bit corresponds to bit #3 of the DMODE word. Normally, this bit is controlled by the control nibble; however, when the TEST BITEXACT mode is set, this bit can be controlled by the VOC command.
LOST	Decoder Lost Control. Valid values are 0 and 1. This bit corresponds to bit #2 of the DMODE word. Normally, this bit is controlled by the control nibble; however, when the TEST BITEXACT mode is set, this bit can be controlled by the VOC command.
DTX	Encoder Discontinuous Transmission Control. Valid values are 0 and 1. This bit corresponds to bit #4 of the DMODE word. Nominally this bit is controlled by the VAD signal conductor; however, when the operational mode is set to TEST, this bit can be controlled by this command. Note: This soft control bit is stored as a flash configuration parameter.
SDBITS	Soft Detection Bit Quantity. The default setting is hard detection (SDBITS=1). The valid range is 1 to 4 bits. The sizes 2 through 4 are ONLY used during vocoder bit exactness testing, i.e. when the BITEXACT is set. When this testing is conducted, the C1FMT option (long compressed voice format) should be enabled.

8.3.35 WAIT

The WAIT command causes the FAA20 main software to wait for the specified number of milliseconds. The command response is printed after the wait is complete. This command may be used with the MACRO command to insert delays between commands.

Table 47: WAIT Command Syntax

ATTRIBUTE	DESCRIPTION	
SYNTAX	WAIT num_ms	
PARAMETERS	num_ms	Number of Milliseconds (decimal). If the wait period exceeds ~5 seconds, the watchdog timer will reboot the FAA20.
FLASH	NO	

EXAMPLES	*Wait 3 seconds*
	`COM1: wait 3000`
	`> WAIT = 3000`	

	Enable the rate adapter
	`COM1: adapt on`
	`> ADAPT ON`	

9.0 GLOSSARY

AMBE	Advanced Multi-Band Excitation.
C54x	TMS320C54x Digital Signal Processor.
CCS	Code Composer Studio. A TI DSP software development tool used to build, execute and test DSP application programs.
CDROM	Compact Disk Read Only Memory.
CPLD	Complex Programmable Logic Device
DSP	Digital Signal Processor. A processor designed for signal processing applications, e.g., voice compression.
FAA	Federal Aviation Administration.
mA	milliamps
NEXCOM	Next Generation Communication. An FAA program and/or system designed to replace current analog double-side band amplitude modulated (DSB-AM) radio communication with digital time division multiple access (TDMA) radio communication.
PLD	Programmable Logic Device
SPAD	sample/packet add/drop.
TI	Texas Instruments.
vocoder	A vocoder performs voice coding and decoding using a voice compression algorithm.