Modem Frame Types and Applications

Application Note

Part # AN/ModemFrameTypes.doc

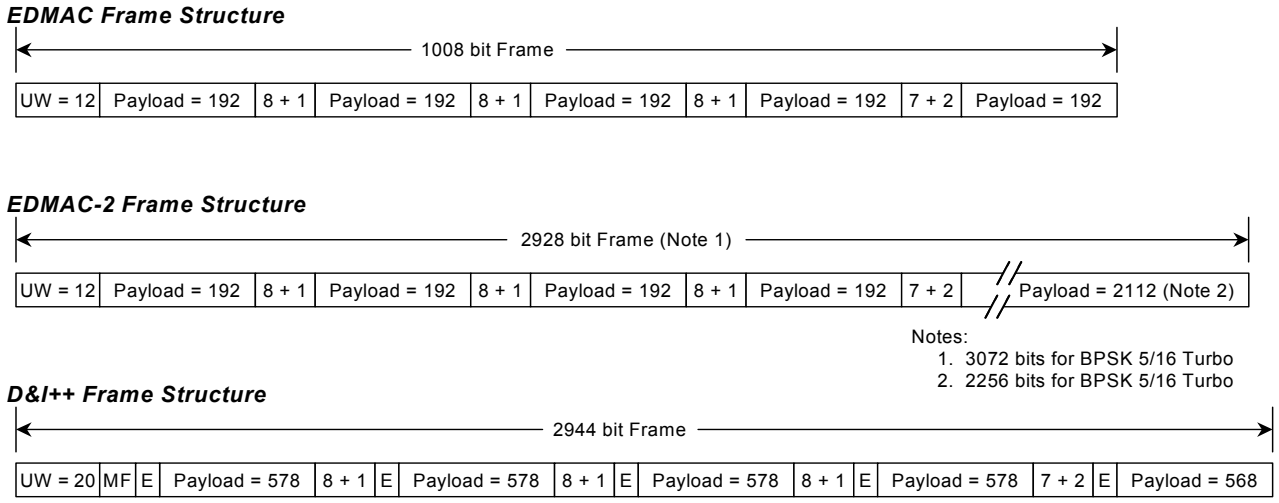
Introduction

Several frame types are used in Comtech EF Data (CEFD) modems. Included are those compliant with Intelsat IBS (IESS-309), IDR (IESS-308) and Drop & Insert (IESS-308) to support open network communications. The overhead for IBS and Drop & Insert is 6.7% and for IDR it ranges from 6.2% (T1) to 1.1% (E2) depending upon data rate. Notice, the lower data rates are burdened with a higher overhead.

Over the years, CEFD has developed proprietary framing to provide new features. The proprietary framing is more efficient than the structures based upon Intelsat framing. For example, embedded distant end monitor and control (EDMAC) framing supports management of the modem, RF transceiver or BUC, and automatic uplink power control (AUPC). By comparison, its overhead is 1.67% or 5% depending upon the mode of operation. Further description of the proprietary framing and supported applications is in the sections that follow.

Frame Types

The structure of the proprietary frames is illustrated in **Figure 1**. The EDMAC and EDMAC-2 frame types are nearly identical, differing only by the amount payload. The frame begins with a 12 bit unique word (UW) used for synchronization followed by a payload slot carrying user data. The next slot (8 + 1) is overhead containing an EDMAC data byte for passing monitor and control information between two ends of the link plus a flag bit. The flag bit indicates the presence or absence of EDMAC data in each overhead slot.



Item	Description
UW	Unique Word
Payload	User Data
8 + 1	EDMAC Data + 1 Flag bit
7 + 1	AUPC Data + 2 Flag bits
MF	Multi-frame Count, 3 bits
E	ESC Channel, 1 bit

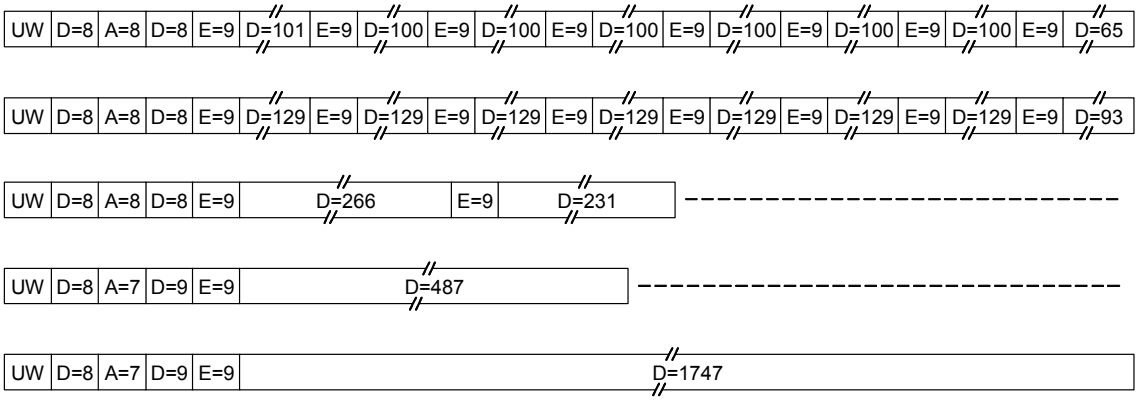
Figure 1. EDMAC, EDMAC-2 and D&I++ Frame Types

Additional segments of the frame alternate with payload and EDMAC overhead until the final overhead slot labeled 7+2, and this slot contains the signaling for AUPC operation. The remainder of the payload is appended to the final overhead slot, and the size of the trailing payload accounts for difference in overhead between EDMAC and EDMAC-2 frames. The table at the bottom of the figure summarizes the components of the frames.

The D&I++ frame is also shown in **Figure 1**. It begins with a 20 bit UW followed by a 3 bit Multi-frame (MF) count that allows for a different number of frames depending upon the number of channels dropped from a T1 or E1 bearer for transmission over the satellite link. The E bit carries engineering service channel (ESC) data followed by repeating segments of payload, overhead and ESC. The payload slots are 578 bits except for the trailing payload segment, which is 568 bits. The 8+1 and 7+ 2 overhead slots transfer the EDMAC and AUPC data over the D&I++ frame as described earlier.

Figure 2 illustrates the ESC++ framing. The ESC++ mode provides a relatively high rate Asynchronous ESC channel ranging from 1200 baud to 38,400 baud along with support for AUPC. The overhead for the ESC and AUPC is added to the primary data rate so the user gets the full-programmed user data rate plus an end-to-end management channel via pins 5 and 6 of connector P3A. Because the higher ESC rate it is necessary to take into account the higher bit rate transmitted over the satellite channel. The manual provides guidance on this in the chapter describing ESC++ operation. Note that in ESC++ mode EDMAC operation is not available. All of the available overhead was allocated to support the data channel, AUPC and the ESC channel.

ESC++ Frame Structure



Frame Size (bits)	Data Rate (kbps)	OH (%)
874	64 to <768	11.76
1104	768 to 1500	9.09
551	>1500 to 2500	7.4
532	>2500 to 7000	5.56
1792	>7000	1.58

Item	Description
UW	Unique Word, 12 bits
D	User Data in bits
A	AUPC Data in bits
E	ESC++ Channel in bits

Figure 2. ESC++ Frame Structure

Table 1 provides some comparative information for each frame type. Intelsat modes are included for contrast:

Table 1. Framing Information

Frame Type	Frame (bits)	Payload (bits)	OH% (OH Ratio)		Applies To	Modem
Comtech Proprietary Modes						
EDMAC	1008	960	5%	(21/20)	Data Rate ≤2048 kbps	CDM-550, -600, -600L, -570L
EDMAC-2	2928	2880	1.67%	(61/60)	BPSK 21/44 Turbo or Data Rate >2048 kbps	CDM-550, -600, -600L, -570L
	3072	3024	1.59%	(64/63)	BPSK 5/16 Turbo	
EDMAC-2	2928	2880	1.67%	(61/60)	All data rates and modulation types	CDM-570L Set to EDMAC-2
D&I++	2944	2880	2.22%	(46/45)	D&I++ mode for E1 or T1	CDM-600, -600L
ESC++	874	782	11.76%	(19/17)	Data rates 64 kbps and higher and all modulation types	CDM-600, -600L
	1104	1012	9.09%	(12/11)		
	551	513	7.4%	(29/27)		
	532	504	5.56%	(19/18)		
	1792	1764	1.58%	(64/63)		
Comtech Proprietary – Modified Open Network Mode						
IBS	Per IESS-309 High Rate ESC and No AUPC		6.67%	(16/15)	Nx64 IBS. Uses reserved sections of standard IESS frame. See Table 2.	CDM-600, -600L
D&I	Per IESS-308 / 309 Applies To E1-CCS Only. High Rate ESC and AUPC		6.67%	(16/15)	Nx64 D&I. Uses reserved sections of standard IESS frame. See Table 2.	CDM-600, -600L
Open Network Modes						
IBS	Per IESS-309		6.67%	(16/15)	Nx64 IBS	CDM-600, -600L
D&I	Per IESS-308 / 309		6.67%	(16/15)	Nx64 D&I	CDM-600, -600L
IDR	Per IESS-308		6.22%	(205/193)	T1, 1544 kbps	CDM-600, -600L
			4.69%	(67 /64)	E1, 2.048 kbps	
			1.52%	(267/263)	T2, 6312 kbps	
			1.14%	(267/264)	E2, 8448 kbps	

The overhead ratio is useful for estimating the total data rate transmitted over the link and carrier spacing. However, when overhead is so small, 2% or less, there is usually little consequence for ignoring it.

Generally, the frame type is automatically programmed into the modem based upon the mode of operation selected, with the exception of the CDM-570L where there is a menu to select EDMAC or EDMAC-2.
Standard EDMAC provides interoperability between the CDM-570L and other CEFD modems while selection of EDMAC-2 permits operation with negligible overhead for all data rates, types of modulation and code rates. EDMAC-2, at 1.67% overhead, is considerably smaller than the older Intelsat IBS frame at 6.67% overhead while providing increased functionality.

Applications

The CEFD frames support a number of applications including those listed in **Table 2**:

Table 2. CEFD Frames And Applications

Frame	Application

EDMAC & EMDAC-2	• CDM-550, CDM-600 70 / 140 MHz Modems
	  o Monitor and control of the distant end of the link including the modem and CSAT-xxxx or KST-xxxx transceiver.
	• CDM-570L, CDM-600L L-Band Modems
	  o Monitor and control of the distant end of the link including the modem and FSK capable BUCs.
	• Automatic uplink power control (AUPC) maintains the Eb/No (and BER) over a link by varying the transmit power out a modem.
	• CDM-570L allows selection of
	  o EDMAC frame for interoperability with previous CEFD modems
	  o EDMAC-2 for low overhead 1.67% (61/60)

D&I++	• CDM-600 / 600L Modem
	  o Selection of any N channels between 1 and 24.
	  ▪ Operates in T1 or E1 mode. Note, no CAS support for E1
	  ▪ T1 supports rob a bit signaling
	  o ESC channel at 1/576 of the N x 64 kbps channels
	  o AUPC
	  o EDMAC
	  o Low OH, 2.22% (46/45)
	• Applications include
	  o GSM / cellular backhaul
	  o Low overhead Drop & Insert

ESC++	• CDM-600 / 600L Modem
	  o Primary data rates 64 kbps and higher
	  o AUPC
	  o ESC rates as a function of primary data rates:
	  ▪ 64 to 127.999 kbps — 1200, 2400, 4800 baud
	  ▪ 128 to 191.999 kbps — 1200 to 9600 baud
	  ▪ 192 to 255.999 kbps — 1200 to 14400 baud
	  ▪ 256 to 383.999 kbps — 1200 to 19200 baud
	  ▪ 384 to 511.999 kbps — 1200 to 28800 baud
	  ▪ 512 kbps and above — 1200 to 38400 baud
	  o OH, 11.76% (19/17) to 1.58% (64/63), decreasing with increasing data rate. See **Figure 2**.
	• Applications include
	  o End to end Management via asynchronous RS-232 port
	  o With AUPC

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Frame	Application
IBS With High Rate ESC Channel Modifies the normally reserved sections of the Standard IESS frame	• CDM-600 / 600L Modem o Nx64 IBS o Standard IESS Values: N = 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 30 o No AUPC o Supports the following High Rate ESC data rates: DATA — Max ESC Baud Rate ▪ 64 kbps — 2400 baud ▪ > 127.999 kbps — 4800 baud ▪ > 255.999 kbps — 9600 baud ▪ > 383.999 kbps — 14400 baud ▪ > 511.999 kbps — 19200 baud ▪ > 767.999 kbps — 28800 baud ▪ > 1280 kbps — 38400 baud o OH, 16/15 per 309 • Applications include o End to end Management via asynchronous RS-232 port
D&I With High Rate ESC Channel Modifies the normally reserved sections of the Standard IESS frame Applies To E1-CCS mode Only	• CDM-600 / 600L Modem o Standard IESS Values: N = 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 30 o AUPC o Supports the following High Rate ESC data rates: DATA — Max ESC Baud Rate ▪ 64 kbps — 2400 baud ▪ > 127.999 kbps — 4800 baud ▪ > 255.999 kbps — 9600 baud ▪ > 383.999 kbps — 14400 baud ▪ > 511.999 kbps — 19200 baud ▪ > 767.999 kbps — 28800 baud ▪ > 1280 kbps — 38400 baud o OH, 16/15 per IESS-308 / 309 • Applications include o End to end Management via asynchronous RS-232 port o With AUPC

Summary

The proprietary CEFD framing offers additional features with reduced satellite overhead. Features like EDMAC, AUPC, D&I++ and ESC++ are available when these frame types used. When the CEFD framing is activated in conjunction with Turbo coding, the combination yields satellite links with reduced power and minimal bandwidth.