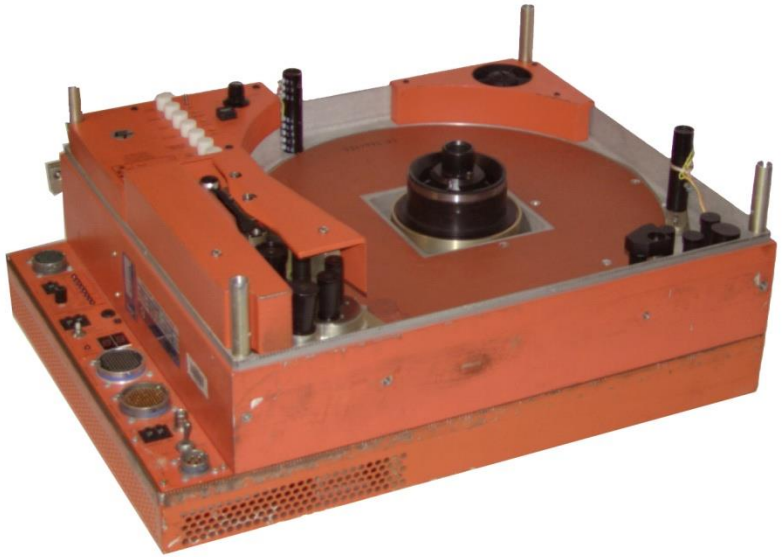
Data Recorders

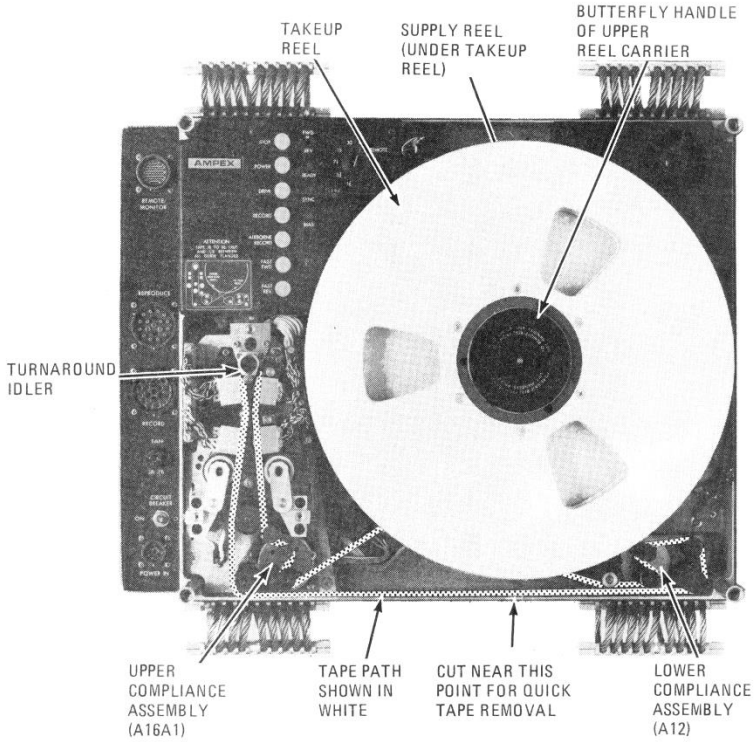
Quick Intro

- **Bob Baggerman, ATAC – JT4 teammate**
  - **TG member for many years**
  - **Retired from GA Tech**
  - **Now part time with ATAC**
- **Slides at https://github.com/pferrill/presentations**
- **IRIG 106 copy: https://irig106.org/wiki/irig_106-19**
- **IRIG 106 Wiki: https://irig106.org/wiki/**
- **Tools: https://irig106.org/wiki/software_download**

Types of Data Recorders

- *Prior to 1990, the Analog Data Recorder was the Solution for recording Flight Test data.*
- *During this era we had Interoperability.*





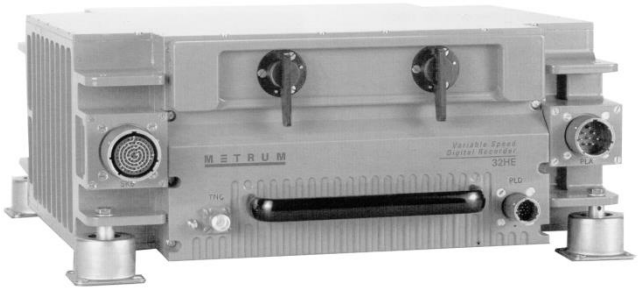
Types of Data Recorders

- *During the 90's new digital recorders started becoming available, however every vendor was coming up with their own unique solution to meet our flight test requirements.*

MERLIN DATA to VIDEO ENCODER

TEAC VIDEO RECORDER

METRUM

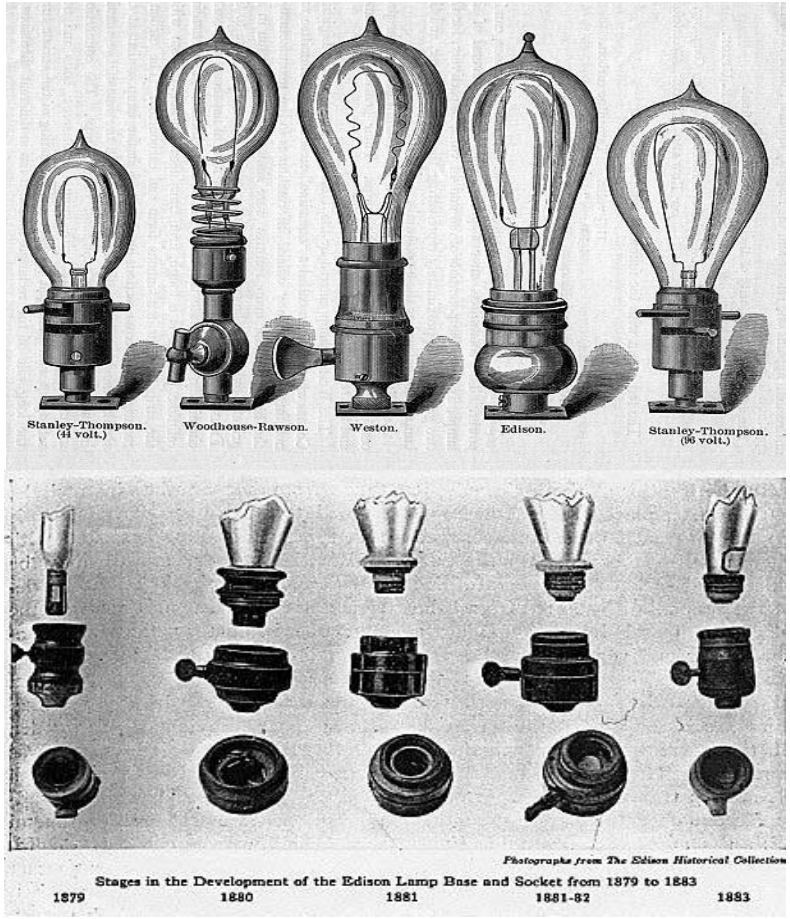


VLDS RECORDER

MARS II RECORDING SYSTEM

We started having issue's with Interoperability and unique or Proprietary Data recording solutions.

Why Again Do We Need Standards?



The light is turned back "ON" for the Flight Test Community!!

Too many solutions to a universal need

Why Do We Need A Recorder Standard?

- Proprietary Data Formats
  - Manufactures keep all business “in-house”
  - Ensures user dependency ensuring increased life-cycle cost.
  - Licensing Revenues – There is more money in developing and maintaining software than in the cost of the original hardware.
- Single Use Approaches
  - Interoperability achieved not by standardization
  - Can you say “Monopoly” $$$$$
- A Need for Common Tools & Processes
  - “Open” development is focused on user requirements
- Multiple Vendor Support Fosters “Best in Breed” Technologies
  - With level playing field vendors must innovate to provide value added to user’s
  - Recorder performance can be independently measured

Open Standards promote Innovation

What Is Needed in a Digital Recording Standard ?

- **Provides Standardization for:**
  - *Recorder Electrical Interface*
  - *Directory Structure & File Format*
  - *Recorder Data Download*
  - *Recorder Command & Control*
  - *Media Interface, Command & Control*
  - *Data Format*
  - *Timing Correlation*
  - *Memory Declassification/Secure Erase (not really)*

The IRIG 106 Standard

IRIG STANDARD 106-17 ← "106" is the standard, "17" is the year

Maintained by test ranges

TELEMETRY STANDARDS ← IRIG 106 is a **telemetry** standard

ABERDEEN TEST CENTER
DUGWAY PROVING GROUND
REAGAN TEST SITE
REDSTONE TEST CENTER
WHITE SANDS MISSILE RANGE
YUMA PROVING GROUND

NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
NAVAL AIR WARFARE CENTER WEAPONS DIVISION
NAVAL UNDERSEA WARFARE CENTER DIVISION, KEYPORT
NAVAL UNDERSEA WARFARE CENTER DIVISION, NEWPORT
PACIFIC MISSILE RANGE FACILITY

30TH SPACE WING
45TH SPACE WING
96TH TEST WING
412TH TEST WING
ARNOLD ENGINEERING DEVELOPMENT COMPLEX

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

← Lots of organizations participate (not really)

DISTRIBUTION A: APPROVED FOR PUBLIC RELEASE
DISTRIBUTION IS UNLIMITED

← Available to everyone, even foreigners

IRIG 106 Standard(s)...

- **Purpose of IRIG standards is to promote test range interoperability**
- **IRIG 106 has a number of chapters and appendices**
- **Most important chapters are:**
  - **Chapter 4 & 8 – PCM**
  - **Chapter 6 – Status and Control**
  - **Chapter 7 – Packet Telemetry Downlink**
  - **Chapter 9 – TMATS**
  - **Chapters 10/11 – Digital Data Recorder**
  - **Chapters 2x – iNET**

Example's of Chapter 10 Data Recorders

IRIG106 Recorder Defined

Key Elements of an IRIG 106 Recorder

- **Ch 11 – Data Format**
- **Ch 10 – Disk Media Format**
- **Ch 10 – Data Download**
- **Ch 10 – Time Keeping**
- **Ch 9 – Setup**
- **Ch 6 – Command and Control**

IRIG106 Recorder Defined
Data Format

- **Sequential Series of Data Packets**
- **Multiple Data Types**
- **Multiple Channels**
- **One Data Type and Data Channel per Packet**
- **First Data Packet is TMATS Info**
- **Last Data Packet is Index (if supported)**
- **Each Data Packet has...**
  - **Standard Header and Trailer**
  - **Data Payload**

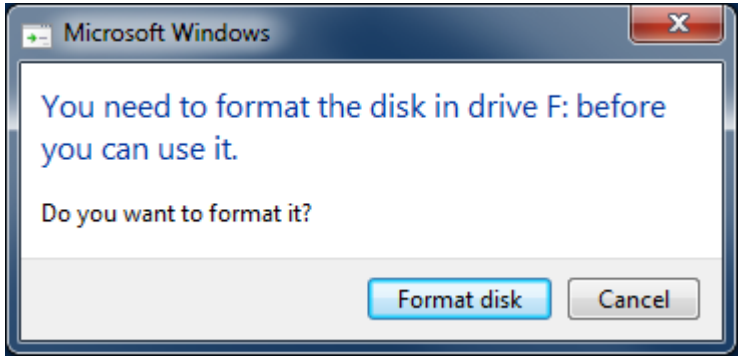
IRIG106 Recorder Defined
Time Keeping

Relative Time Counter (RTC)

- All Packets Have Common Time Stamp
- 10 MHz Relative Time Counter
- 1 GHz Extended Relative Time Counter
- 48 Bits Free Running Counter
- Correlated with Clock Time Later

IRIG106 Recorder Defined
Disk Media Format

- Chapter 10 defines a Removable Media Module (RMM)
- STANAG 4575 is the IRIG 106 standard file system
- Very simple disk file system
- From NATO recon community
- Windows knows nothing about STANAG 4575



IRIG106 Recorder Defined
Data Download

- **RMM**
  - **IEEE 1394 (Firewire) is standard**
  - **eSATA and USB are also common**
  - **Ethernet in a future standard**
- **Download Port**
  - **Ethernet**
    - iSCSI and FTP are standard
  - **IEEE 1394 Firewire**
  - **Fibre Channel**

IRIG106 Recorder Defined
Setup – Ch 9 TMATS
Telemetry Attributes Transfer Standard

- **Two Uses**
  - **Recorder Setup**
  - **Data File Description**
- **Two Formats**
  - **Traditional**
  - **XML**

IRIG recorders are REQUIRED to accept TMATS setup
TMATS is a perfectly acceptable way to configure recorders

IRIG106 Recorder Defined
Setup – Ch 9 TMATS

TMATS is standard… in a proprietary sort of way

Standard TMATS covers the basics

```
R-1\DSI-18:UART-In-9;
R-1\TK1-18:18;
R-1\CHE-18:T;
R-1\CDT-18:UARTIN;
R-1\TK4-18:18;
R-1\CDLN-18:UART-In-9;
R-1\UTF-18:0;
R-1\NUS\N-18:1;
R-1\USCN-18-1:1;
R-1\UCNM-18-1:UART-In-9-1;
```

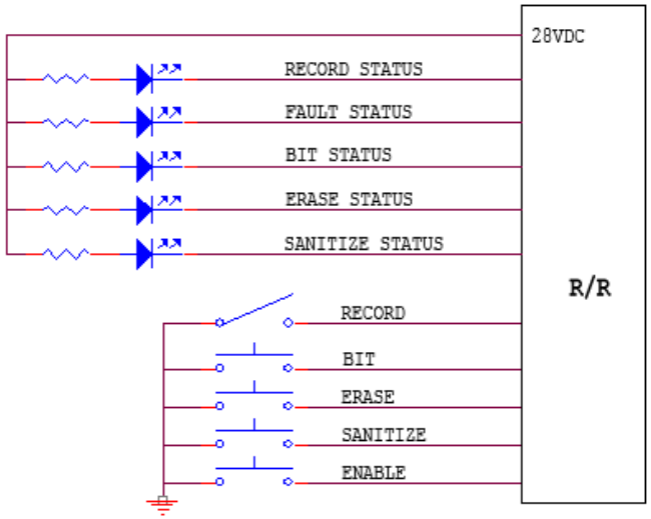
But not everything

```
V-1\HDS\SYS:sU9b11520012pNt2WHg8j8n1;
```

IRIG106 Recorder Defined
Command and Control – Ch 6

- Serial Control defined in Ch 6
  - “Dot” Commands

    `.RECORD  .PLAY  .STATUS`
- Discrete Control defined in Ch 10



Chapter 10 Data File Layout

- **Sequential Series of Data Packets**
- **One Data Type and Data Channel per Packet**
- **First Data Packet is TMATS Info**
- **Last Data Packet is Index (if supported)**
- **Each Data Packet has...**
  - **Standard Header and Trailer**
  - **Multi-Message Data Payload**

Chapter 10 Data Packet Format

Data Packet Composed of

- **“Magic” Number Sync Pattern (0xEB25)**
- **Standard Header**
- **Optional Secondary Header**
- **Data Payload**
  - Channel Specific Data Word
  - Intra-Packet Header
  - One or more Data Words
- **Standard Trailer**

Max Packet Size = 524,288 bytes

Max Packet Time = 100 msec

Chapter 10 Packets

Table 10-7. General Packet Format	
PACKET SYNC PATTERN	Packet Header
CHANNEL ID	
PACKET LENGTH	
DATA LENGTH	
DATA TYPE VERSION	
SEQUENCE NUMBER	
PACKET FLAGS	
DATA TYPE	
RELATIVE TIME COUNTER	
HEADER CHECKSUM	
TIME	Packet Secondary Header (Optional)
RESERVED	
SECONDARY HEADER CHECKSUM	
CHANNEL-SPECIFIC DATA	Packet Body
INTRA-PACKET TIME STAMP 1	
INTRA-PACKET DATA HEADER 1	
DATA 1	
:	
INTRA-PACKET TIME STAMP N	
INTRA-PACKET DATA HEADER N	
DATA n	
DATA CHECKSUM	Packet Trailer

A general Chapter 10 packet has the following fields shown above to identify the contents of the packet body which contains the data. The size of the fields vary in number of bytes.

The order shown above is *the order in which the fields appear in the CH10 file*. These fields are of various lengths and will be described in this section.

Chapter 10 Packets

The fields are placed within 32-bit (4 byte) words in 16-bit little endian order. Bits 15..0 will be written to the file before 31..16. This results in the Packet Sync Pattern appearing before the Channel ID in the file (as shown in the table on the previous slide.

Table 10-8. 32-Bit Packet Format Layout

MSB 31		16 15	LSB 0	
CHANNEL ID		PACKET SYNC PATTERN		
PACKET LENGTH				
DATA LENGTH				
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION	Packet Header
RELATIVE TIME COUNTER				
HEADER CHECKSUM		RELATIVE TIME COUNTER		
TIME (LEAST SIGNIFICANT LONG WORD [LSLW])				(Optional) Packet Secondary Header
TIME (MOST SIGNIFICANT LONG WORD [MSLW])				
SECONDARY HEADER CHECKSUM		RESERVED		
CHANNEL-SPECIFIC DATA				
INTRA-PACKET TIME STAMP 1				
INTRA-PACKET TIME STAMP 1				
INTRA-PACKET DATA HEADER 1				
DATA 1 WORD 2		DATA 1 WORD 1		
DATA 1 WORD N		:		
INTRA-PACKET TIME STAMP 2				
INTRA-PACKET TIME STAMP 2				
INTRA-PACKET DATA HEADER 2				
DATA 2 WORD 2		DATA 2 WORD 1		Packet
DATA 2 WORD N		:		Body
:				
INTRA-PACKET TIME STAMP N				
INTRA-PACKET TIME STAMP N				
INTRA-PACKET DATA HEADER N				
DATA N WORD 2		DATA N WORD 1		
DATA N WORD N		:		
[FILLER]				Packet Trailer
DATA CHECKSUM				

Note: when you see fields described in **32-bit words** throughout the Chapter 10 standard, you need to do the 16-bit swap to see how they appear in the actual Chapter 10 file.

Chapter 10 Packets

Fields within the 32-bit words can be 8, 16, or 32 bits in length. The entire packet is limited to the lengths described below.

Table 10-8. 32-Bit Packet Format Layout

MSB 31		16	15		LSB 0	
CHANNEL ID			PACKET SYNC PATTERN			
PACKET LENGTH						
DATA LENGTH						
DATA TYPE	PACKET FLAGS		SEQUENCE NUMBER	DATA TYPE VERSION		Packet Header
RELATIVE TIME COUNTER						
HEADER CHECKSUM			RELATIVE TIME COUNTER			
TIME (LEAST SIGNIFICANT LONG WORD [LSLW])						(Optional) Packet Secondary Header
TIME (MOST SIGNIFICANT LONG WORD [MSLW])						
SECONDARY HEADER CHECKSUM			RESERVED			
CHANNEL-SPECIFIC DATA						
INTRA-PACKET TIME STAMP 1						
INTRA-PACKET TIME STAMP 1						
INTRA-PACKET DATA HEADER 1						
DATA 1 WORD 2			DATA 1 WORD 1			
DATA 1 WORD N			:			
INTRA-PACKET TIME STAMP 2						
INTRA-PACKET TIME STAMP 2						
INTRA-PACKET DATA HEADER 2						
DATA 2 WORD 2			DATA 2 WORD 1			Packet
DATA 2 WORD N			:			Body
:						
INTRA-PACKET TIME STAMP N						
INTRA-PACKET TIME STAMP N						
INTRA-PACKET DATA HEADER N						
DATA N WORD 2			DATA N WORD 1			
DATA N WORD N			:			
[FILLER]						Packet Trailer
DATA CHECKSUM						

Packet Lengths:

Computer-Generated packets: no longer than 134,217,728 (2^{27}) bytes or no longer than 1 sec in duration.

All other packets: no longer than 524,288 (2^{19}) bytes or no longer than 100 msec in duration.

Chapter 10 Packet Header

MSB 31		16 15	LSB 0	
CHANNEL ID		PACKET SYNC PATTERN		
PACKET LENGTH				
DATA LENGTH				
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION	Packet Header
RELATIVE TIME COUNTER				
HEADER CHECKSUM		RELATIVE TIME COUNTER		

The packet header has a fixed length of 24 bytes. The Packet Sync Pattern will always have the value EB 25 (hex). The Packet Sync Pattern is at the *beginning* of each packet in the Chapter 10 file. Below is in an example Ch10 file.

25012010_15085002.CH10

Offset	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
000032737	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
000032766	E3	E5	EB	25	40	0C	00	24	00	00	00	0A	00	00	DD	03	11	02	96	19	7A	49	00	06	29	CC	00	01	00
000032795	00	39	00	15	53	00	25	4E	79	EB	25	8C	64	07	CC	00	00	07	B0	00	00	00	03	21	02	F6	00	7A	58
000032824	00	06	18	68	01	40	00	04	02	40	00	04	03	40	00	04	04	40	00	04	81	D8	81	B7	81	A5	84	92	81

Packet Sync Patterns indicating the beginning of a packet.

Let's decode the first packet header recorded to a Chapter 10 file.

Ch10 Packet Header – Sync Pattern

25012010_15085002.CH10

Offset	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
000000000	EB	25	00	00	80	00	00	00	40	6C	00	00	00	03	01	02	00	00	00	00	00	00	AC	96	00	08	00	00	5C
000000029	47	41	54	31	3A	34	31	0D	3B	47	0A	50	5C	3A	4E	69	6D	6E	6E	3B	52	0A	0D	5C	47	4E	46	6D	3A

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

Shown above are the very first 24 bytes of a Ch10 file. The first two Bytes of the packet are the Packet Sync Pattern of EB25. This cannot be changed and will be the sync pattern for all the packet types in a Ch10 file.

Note the order of the bits in the file and in the packet structure to see the 16-bit little endian order. Remember, bits 15..0 will show up in the file before bits 31..16.

Now we will decode the rest of the Packet Header.

Ch10 Packet Header – Channel ID

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31		16 15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

All channels (input streams) must have a unique Channel ID. For example, if you are monitoring three 1553 busses, what distinguishes them from one another is the Channel ID.

Channel ID 0000 identifies a “System” channel used for internally generated packets.

The remaining IDs from 0001 through FFFF will be assigned to the various input streams to the recorder.

Ch10 Packet Header – Packet Length

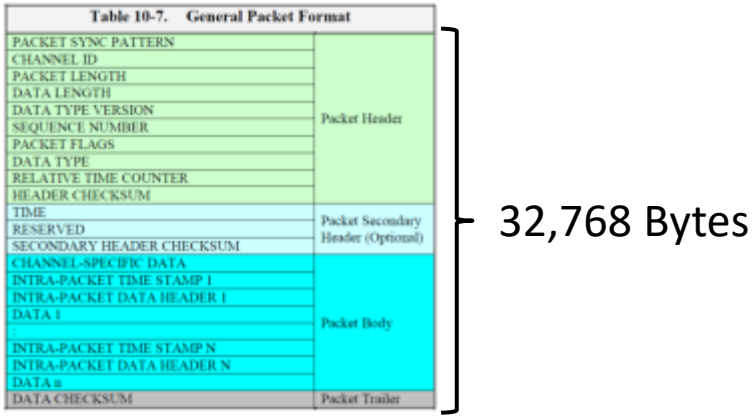
MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31		16 15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Packet Length provides the number of Bytes included in the entire packet.

For this example, 0000 8000h tells us the entire packet is 32,768 Bytes in length.

This value should always be a multiple of four because each word within the packet must be 32 bits (4 bytes).



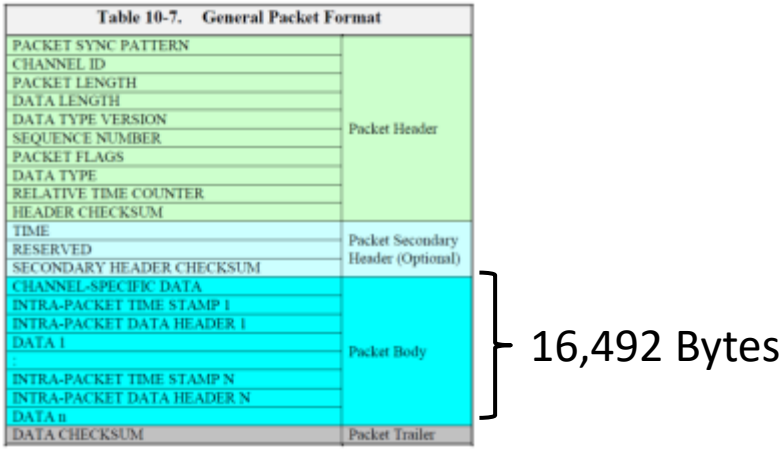
Ch10 Packet Header – Data Length

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Data Length provides the number of bytes included in the Packet Body of the packet.

For this example, 0000 406Ch tells us that there are 16,492 Bytes of data contained within this packet.



Ch10 Packet Header – Data Type Version

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Data Type Version contains a value at or below the release version of the standard applied to the data types.

00h = Reserved
01h = Initial Release (RCC 106-04)
02h = RCC 106-05

03h = RCC 106-07
04h = RCC 106-09
05h = RCC 106-11
06h = RCC 106-13
etc.
Others are Reserved

This packet falls under release -07 (2007) of the IRIG-106 standard. This means that software written according to IRIG 106-07 or later will be able to play the Ch10 file.

Ch10 Packet Header – Sequence Number

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Sequence Number contains a value representing the packet sequence number for each channel ID. This is simply a counter that increments by 1 to a maximum value of FFh for every packet transferred from a particular channel and is not required to start at 00h for the first occurrence of a packet for the channel ID. This identifies if a packet is dropped when a sequence number skips by 2.

In this example file, this header is the very first packet in the Ch10 file. For this particular channel ID of 0000h, the counter started at 00h. The next packet occurrence of this channel ID would have a Sequence Number of 01h.

Ch10 Packet Header – Packet Flags

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Packet Flags field contains bits representing information on the content and format of the packet. This field contains 8 bits and are defined below.

bit: 7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0

bit 7: Indicates the presence or absence of the packet secondary header.

★ 0 = Packet secondary header is not present.

1 = Packet secondary header is present.

bit 6: Indicates the Intra-Packet Time Stamp (IPTS) time source.

★ 0 = Packet header 48-bit Real Time Counter (RTC).

1 = Packet secondary header time (bit 7 must be 1).

Ch10 Packet Header – Packet Flags

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Packet Flags field contains bits representing information on the content and format of the packet. This field contains 8 bits and they are defined below.

bit:	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	1	0

bit 5: Relative Time Counter (RTC) sync error.

0 = No RTC sync error.

1 = RTC sync error has occurred.

bit 4: Indicates a data overflow error.

0 = No data overflow.

1 = Data overflow has occurred.

Ch10 Packet Header – Packet Flags

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Packet Flags field contains bits representing information on the content and format of the packet. This field contains 8 bits and they are defined below.

bit: 7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0

bits 3-2: Indicates the header time format of the optional packet secondary header.

00 = Chapter 4 binary weighted 48-bit time format. The two LSBs of the 64-bit packet secondary header time and IPTS shall be zero-filled.

01 = IEEE 1588 time format

10 = 64-bit binary Extended Relative Time Counter (ERTC) with 1-nanosecond resolution.

11 = Reserved

Ch10 Packet Header – Packet Flags

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Packet Flags field contains bits representing information on the content and format of the packet. This field contains 8 bits and they are defined below.

bit: 7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0

bits 1-0: Indicate data checksum existence and how it is calculated.

00 = No data checksum present

01 = 8-bit data checksum present

★ 10 = 16-bit data checksum present

11 = 32-bit data checksum present

Ch10 Packet Header – Data Type

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31 16		15 0	
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Data Type contains a value representing the type and format of the data. For our example this packet is Computer-Generated Data, Format 1, Setup Record.

Table 10-10. Data Type Names and Descriptions

Packet Header Value	Data Type Name	Data Type Description	Current Data Type Version
0x00	Computer-Generated Data, Format 0	User-Defined	0x06
0x01	Computer-Generated Data, Format 1	Setup Record	0x06
0x02	Computer-Generated Data, Format 2	Recording Events	0x06
0x03	Computer-Generated Data, Format 3	Recording Index	0x06
0x04 - 0x07	Computer-Generated Data, Format 4-Format 7	Reserved for future use	0x06
0x08	PCM Data, Format 0	Reserved for future use	0x06
0x09	PCM Data, Format 1	Chapter 4 or 8	0x06
0x0A - 0x0F	PCM Data, Format 2 - Format 7	Reserved for future use	0x06
0x10	Time Data, Format 0	Reserved for future use	0x06

Chapter 10 Data Types

Type Num	Data Type Name	Data Type Description
0x00	Computer Generated Data, Format 0	User Defined
0x01	Computer Generated Data, Format 1	Setup Record (TMATS)
0x02	Computer Generated Data, Format 2	Recording Events
0x03	Computer Generated Data, Format 3	Recording Index
0x09	PCM Data, Format 1	IRIG 106 Chapter 4/8
0x11	Time Data, Format 1	IRIG/GPS/RTC
0x12	Time Data, Format 2	Network Time
0x19	MIL-STD-1553 Data, Format 1	Mil-Std-1553B Data
0x1A	MIL-STD-1553 Data, Format 2	16PP194 Bus
0x21	Analog Data, Format 1	Analog Data
0x29	Discrete Data, Format 1	Discrete Data
0x30	Message Data, Format 0	Generic Message Data
0x38	ARINC 429 Data, Format 0	ARINC429 Data
0x40	Video Data, Format 0	MPEG-2/H.264 Video
0x41	Video Data, Format 1	ISO 13818-1 MPEG-2
0x42	Video Data, Format 2	ISO 14496 MPEG-4 Part 10 AVC/H.264
0x48	Image Data, Format 0	Image Data
0x49	Image Data, Format 1	Still Imagery
0x50	UART Data, Format 0	UART Data
0x58	IEEE-1394 Data, Format 0	IEEE-1394 Transaction
0x59	IEEE-1394 Data, Format 1	IEEE-1394 Physical Layer
0x60	Parallel Data, Format 0	Parallel Data
0x68	Ethernet Data, Format 0	Ethernet Data
0x69	Ethernet Data, Format 1	ARINC 664
0x70	TSPI/CTS, Format 0	Serial TSPI
0x78	CAN Bus, Format 0	CAN Bus
0x79	Fibre Channel, Format 0	Fibre Channel

Ch10 Packet Header – Relative Time Counter

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Relative Time Counter (RTC) is made up of 6 bytes containing a value representing the 10-MHz RTC. This is a free-running 10-MHz binary counter represented by 48 bits that are common to all data channels. The counter shall be derived from a 10-MHz internal crystal oscillator and shall remain free-running during each recording.

For this example, the real time counter hasn't begun counting at the beginning of this Ch10 file.

Ch10 Packet Header – Header Checksum

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

31	16	15	0
00	00	EB	25
00	00	80	00
00	00	40	6C
01	02	00	03
00	00	00	00
AC	96	00	00

The Header Checksum is made up of 2 bytes containing a value representing a 16-bit arithmetic sum of all 16-bit words in the header excluding the header checksum word itself.

```
  0000
+ EB25
+ 0000
+ 8000
+ 0000
+ 406C
+ 0102
+ 0003
+ 0000
------
 1AC96
```

Summing all the 16-bit words in the header, the result comes to 1AC96. Only the last four least significant characters are placed in the checksum.

Chapter 10 Packet Secondary Header

Table 10-8. 32-Bit Packet Format Layout		
MSB 31 16	15 LSB 0	
TIME (LEAST SIGNIFICANT LONG WORD [LSLW])		(Optional) Packet Secondary Header
TIME (MOST SIGNIFICANT LONG WORD [MSLW])		
SECONDARY HEADER CHECKSUM	RESERVED	

The Packet Secondary Header is optional. As defined earlier in the example Header packet flag section, this packet did not contain a Packet Secondary Header.

However, we will go through the fields to get an understanding of them. Lets say the values in the fields are as follows:

31 16		15 0	
0B	DE	00	00
3C	95	A0	8E
E0	91	00	00

Chapter 10 Packet Secondary Header - Time

Table 10-8. 32-Bit Packet Format Layout		
MSB 31 16	15 LSB 0	
TIME (LEAST SIGNIFICANT LONG WORD [LSLW])		(Optional) Packet Secondary Header
TIME (MOST SIGNIFICANT LONG WORD [MSLW])		
SECONDARY HEADER CHECKSUM	RESERVED	

31 16	15 0
0B DE	00 00
3C 95	A0 8E
E0 91	00 00

The packet flags indicated that the time would be in the Chapter 4 binary weighted 48-bit time format.

MSB 31 16	15 LSB 0
Micro-Seconds Word	Reserved
High Order Time Word	Low Order Time Word

Figure 10-12. Secondary Header Chapter 4 Time

High Time: 3C95
Low Time: A08E
Micro-Second Time: 0BDE

Entering these values in the IRIG time Calculator, you get the time of 117:15:26:29.263068.

Chapter 10 Packet Secondary Header - Time

The other two allowable time formats are formatted as shown below.

When IEEE 1588 time is used time shall be stored as shown in Figure 10-13.

MSB 31	LSB 0
Nanoseconds Word	
Seconds Word	

Figure 10-13. Secondary Header IEEE 1588 Time

When ERTC time is used time shall be stored as shown in Figure 10-14.

MSB 31	LSB 0
LSLW	
MSLW	

Figure 10-14. Secondary Header ERTC Time

Chapter 10 Packet Secondary Header Checksum

Table 10-8. 32-Bit Packet Format Layout		
MSB 31 16	15 LSB 0	
TIME (LEAST SIGNIFICANT LONG WORD [LSLW])		(Optional) Packet Secondary Header
TIME (MOST SIGNIFICANT LONG WORD [MSLW])		
SECONDARY HEADER CHECKSUM	RESERVED	

31 16	15 0		
0B	DE	00	00
3C	95	A0	8E
E0	91	00	00

The Secondary Header Checksum is made up of 2 bytes containing a value representing a 16-bit arithmetic sum of all secondary header bytes excluding the secondary header checksum word itself.

```
  0BDE
+ 0000
+ 3C95
+ A08E
+ 0000
------
  E091
```

Summing all the 16-bit words in the packet secondary header, the result comes to E091. If it were more than 4 hex characters, only the last four least significant characters would be placed in the checksum.

Chapter 10 Packet Trailer

Table 10-8. 32-Bit Packet Format Layout			
MSB 31	16 15	LSB 0	
[FILLER]			Packet Trailer
DATA CHECKSUM			

The packet trailer may contain filler, a data checksum, both filler and a data checksum, or neither filler nor a data checksum. In the latter case, the packet trailer has zero length. The checksum can be 0, 8, 16, or 32 bits in length.

25012010_15085002.CH10

Offset	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
000032737	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
000032766	E3	E5	EB	25	40	0C	00	24	00	00	00	0A	00	00	DD	03	11	02	96	19	7A	49	00	06	29	CC	00	01	00
000032795	00	39	80	15	53	00	25	4E	79	EB	25	8C	64	07	CC	00	00	07	B0	00	00	00	03	21	02	F6	00	7A	58

Last Byte (#32767) of the packet before the next sync pattern.

The packet in this example has 32,768 Bytes as defined in the packet length field. The first byte is numbered as byte 0.

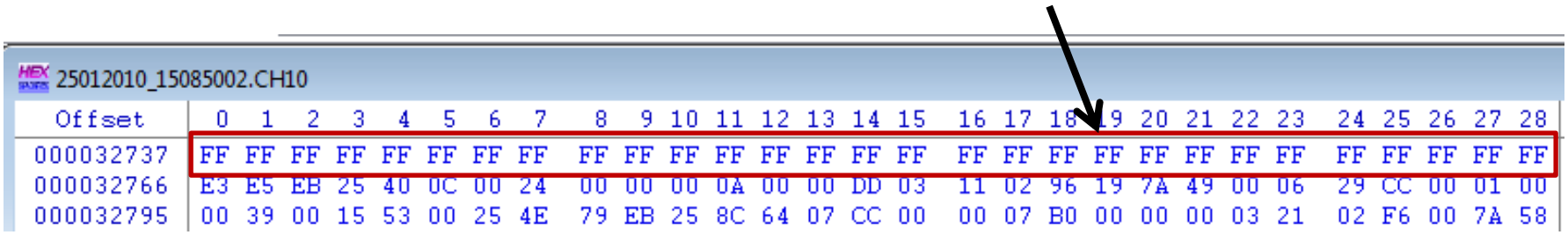
Chapter 10 Packet Trailer – [Filler]

Table 10-8. 32-Bit Packet Format Layout			
MSB 31	16 15	LSB 0	
[FILLER]			Packet Trailer
DATA CHECKSUM			

The reason a packet trailer would have a zero filler length is best explained by understanding the reason for inserting filler. The purpose of the filler is twofold:
a) To keep all packets aligned on 32-bit boundaries (i.e., make all packet lengths a multiple of 4 bytes), and
b) To optionally keep all packets from a particular channel the same length.

If both of the above requirements are already met without adding filler, then filler shall not be added.

Any filler that is added should have the values of 00h or FFh.



Chapter 10 Packet Trailer – Data Checksum

Table 10-8. 32-Bit Packet Format Layout

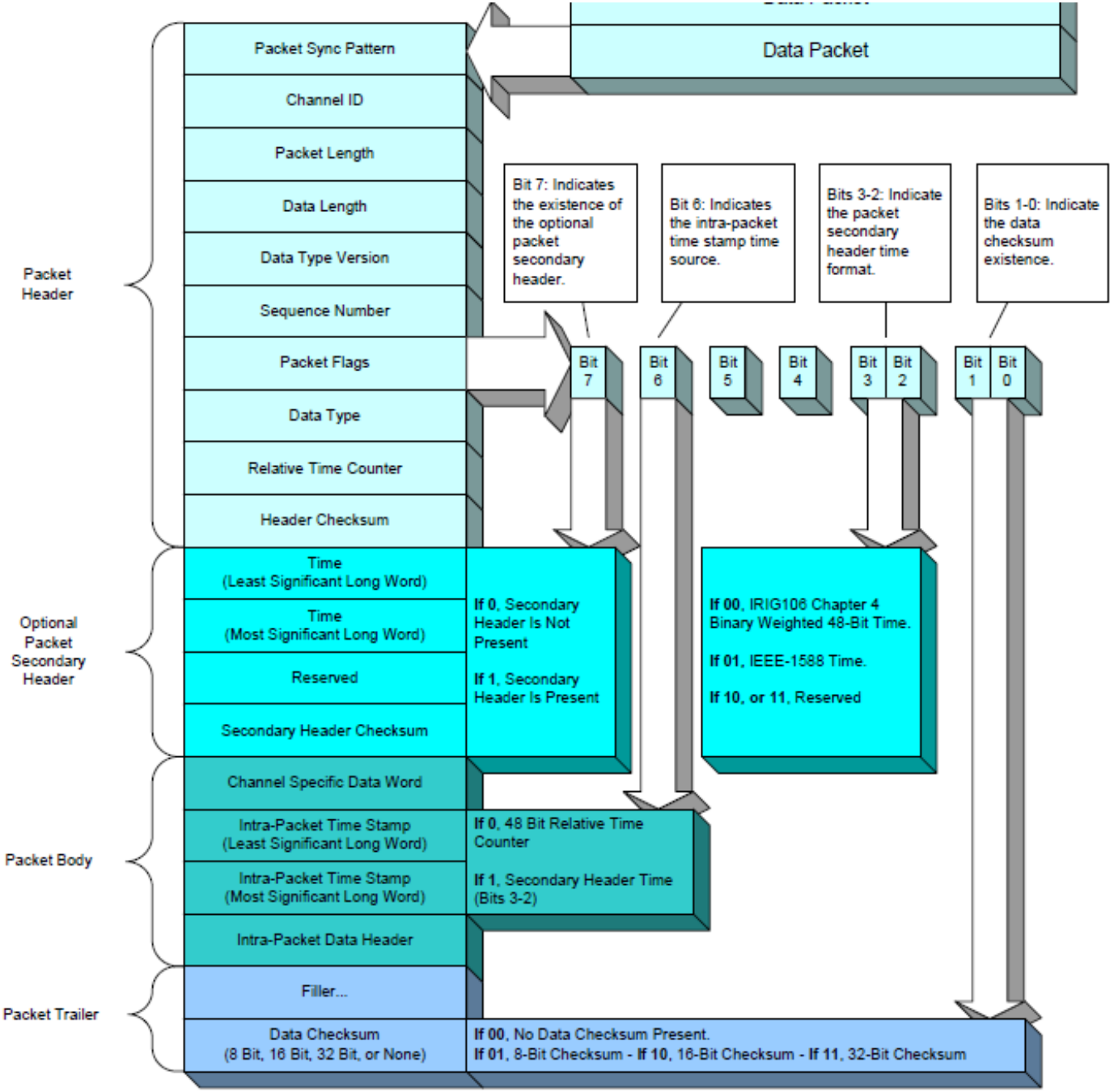
MSB 31	16	15 LSB 0	
[FILLER]			Packet Trailer
DATA CHECKSUM			

The inclusion of the data checksum is optional as well and is indicated by the packet flags setting. When included, the packet trailer contains either an 8-bit, 16-bit, or 32-bit data checksum. Depending on the packet flags option selected, the data checksum is the arithmetic sum of all of the bytes (8 bits), words (16 bits), or long words (32 bits) in the packet excluding the 24 bytes of packet header, packet secondary header (if enabled), and the data checksum. Stated another way, the data checksum includes everything in the packet body plus all added filler.

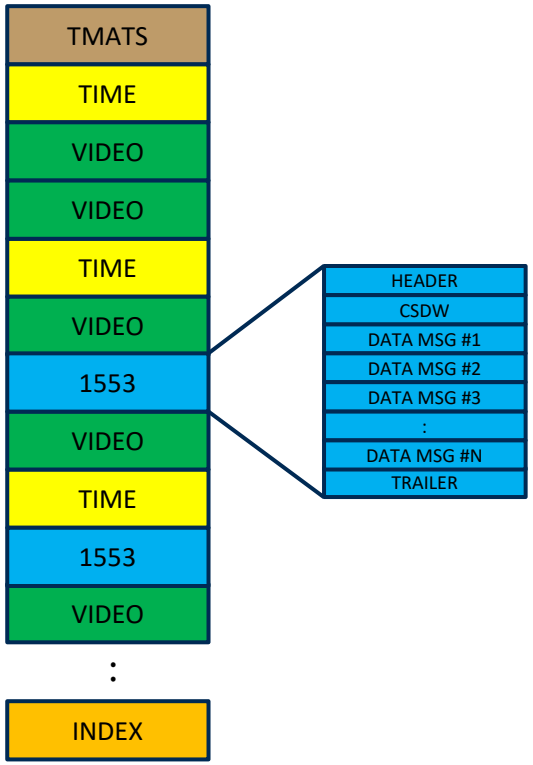
25012010_15085002.CH10

Offset	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
000032737	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
000032766	E3	E5	EB	25	40	0C	00	24	00	00	00	0A	00	00	DD	03	11	02	96	19	7A	49	00	06	29	CC	00	01	00
000032795	00	39	00	15	53	00	25	4E	79	EB	25	8C	64	07	CC	00	00	07	B0	00	00	00	03	21	02	F6	00	7A	58

The Data Checksum is E3E5 in this example packet. The packet flag bits defined it to be an 16-bit data checksum present in the packet trailer.


Data Packet
Packet Header
Packet Sync Pattern
Channel ID
Packet Length
Data Length
Data Type Version
Sequence Number
Packet Flags
Data Type
Relative Time Counter
Header Checksum
Optional Packet Secondary Header
Time (Least Significant Long Word)
Time (Most Significant Long Word)
Reserved
Secondary Header Checksum
Packet Body
Channel Specific Data Word
Intra-Packet Time Stamp (Least Significant Long Word)
Intra-Packet Time Stamp (Most Significant Long Word)
Intra-Packet Data Header
Packet Trailer
Filler...
Data Checksum (8 Bit, 16 Bit, 32 Bit, or None)
Bit 7: Indicates the existence of the optional packet secondary header.
Bit 6: Indicates the intra-packet time stamp time source.
Bits 3-2: Indicate the packet secondary header time format.
Bits 1-0: Indicate the data checksum existence.
Bit 7
Bit 6
Bit 5
Bit 4
Bit 3
Bit 2
Bit 1
Bit 0
If 0, Secondary Header Is Not Present
If 1, Secondary Header Is Present
If 00, IRIG106 Chapter 4 Binary Weighted 48-Bit Time.
If 01, IEEE-1588 Time.
If 10, or 11, Reserved
If 0, 48 Bit Relative Time Counter
If 1, Secondary Header Time (Bits 3-2)
If 00, No Data Checksum Present.
If 01, 8-Bit Checksum - If 10, 16-Bit Checksum - If 11, 32-Bit Checksum

Chapter 10 Data Message Layout



- **Multiple messages per packet**
- **Data Packet Composed of**
  - **“Magic” Number Sync Pattern (0xEB25)**
  - **Standard Header**
  - **Optional Secondary Header**
  - **Data Payload**
    - Channel Specific Data Word
    - Intra-Packet Header
    - One or more Data Words
  - **Standard Trailer**
- **Max Packet Size = 524,288 bytes**

Chapter 10 Data Packet Constraints

- **Each Packet Has Data From One Channel Only**
- **Each Packet Must Contain Data**
- **Minimal Filler Allowed**
- **No more than 100 msec of Data per Packet**
- **Packet Must Be Committed To Disk Within 1 Sec**
- **All Data Is Time Stamped with a Common Relative Time Counter (RTC)**

Time Data Packets

Packet Header

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

The Data Type in the packet header will indicate that the packet contains Time data.

There are eight Time Data Format types:

10h = Time Data, Format 0 (reserved for future use)

11h = Time Data, Format 1 (RCC/GPS/RTC)

12h = Time Data, Format 2 (Network Time)

13h = Time Data, Format 3 (reserved for future use)

14h = Time Data, Format 4 (reserved for future use)

15h = Time Data, Format 5 (reserved for future use)

16h = Time Data, Format 6 (reserved for future use)

17h = Time Data, Format 7 (reserved for future use)

Time Data Packets

Channel Specific Data

msb 31	16	15	12	11	8	7	4	3	lsb 0
Reserved		ITS		DATE		FMT		SRC	

Reserved [bits 31..16]

ITS: IRIG Time Source [bits 15..12] Indicates dynamic information about time

0000 = IRIG TCG freewheeling (no or loss of time source)
0001 = IRIG TCG freewheeling from .TIME command
0010 = IRIG TCG freewheeling from RMM time
0011 = IRIG TCG locked to external IRIG time signal
0100 = IRIG TCG locked to external GPS
0101 = IRIG TCG locked to external Network Time Protocol (NTP)
0110 = IRIG TCG locked to external Precision Time Protocol (PTP)
0111 = IRIG TCG locked to external embedded time from input track/channel such as PCM or MIL-STD-1553
1000-1111 = Reserved

Time Data Packets

Channel Specific Data

msb 31	16	15	12	11	8	7	4	3	lsb 0
Reserved		ITS		DATE		FMT		SRC	

DATE: Date Format [bits 11..8] Indicates the format of the date in the Time Data.

bits 11..10 - Reserved

bit 9 - Date Format

0 – IRIG Day Available

1 – Month and Year Available

bit 8 – Leap Year

0 – Not a Leap Year

1 – Is a Leap Year

Time Data Packets

Channel Specific Data

msb 31	16	15	12	11	8	7	4	3	lsb 0
Reserved		ITS		DATE		FMT		SRC	

FMT: Time Format [bits 7..4] Indicates the time source format

- 0000 – IRIG-B
- 0001 – IRIG-A
- 0010 – IRIG-G
- 0011 – Real Time Clock
- 0100 – UTC Time from GPS
- 0101 – Native GPS Time
- 0110 → 1110 – Reserved
- 1111 – None (Time Packet Data Invalid)

SRC: Time Source [bits 3..0] Indicates the source of the time

- 0000 – Internal (time derived from a clock in the recorder)
- 0001 – External (time derived from a clock not in the recorder)
- 0010 – Internal from RMM (time derived from the clock in the RMM)
- 0011 → 1110 – Reserved
- 1111 – None

Time Data Packets

Time Data

msb 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	lsb 0
0	TSn			Sn				Hmn				Tmn			
0	0	THn		Hn				0	TMn			Mn			
0	0	0	0	0	0	HDn		TDn				Dn			

Figure 11-13. Time Data-Packet Format, Day Format

msb 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	lsb 0
0	TSn			Sn				Hmn				Tmn			
0	0	THn		Hn				0	TMn			Mn			
0	0	0	Ton	On				TDn				Dn			
0	0	OYn		HYn				TYn				Yn			

Figure 11-14. Time Data-Packet Format, Day, Month, and Year Format

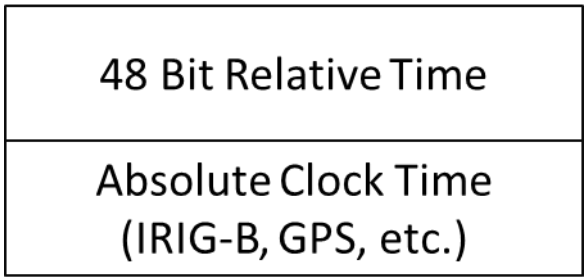
Two types of date supported

- Day/Month/Year (MDY) `10/2/2018:09:30:21`
- Day of the Year (DOY) `282:09:30:21`

Relative Time Counter (RTC)

An Example

Time Packet

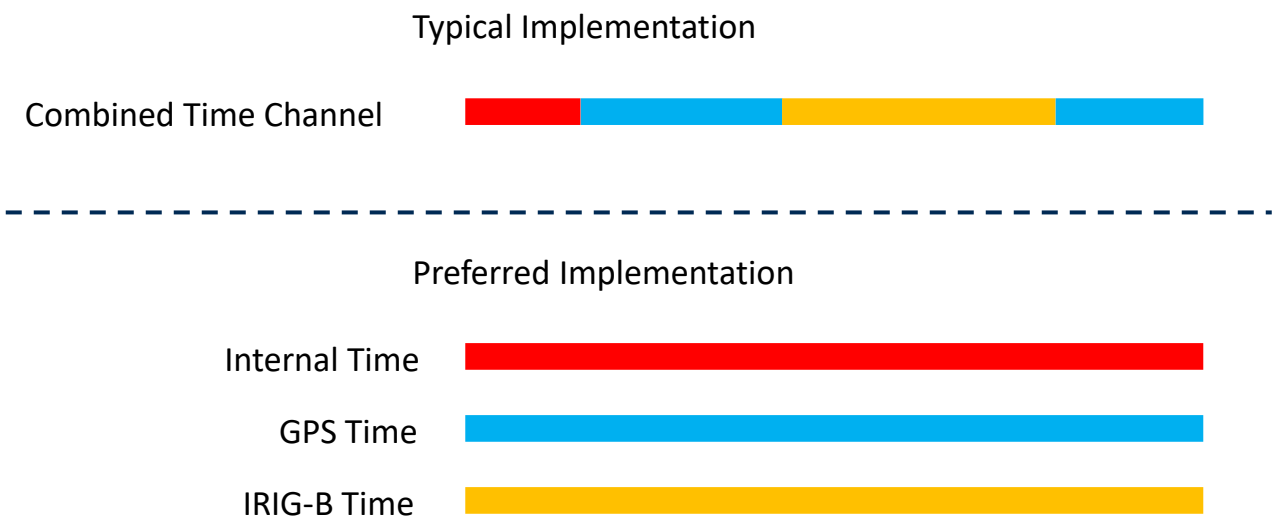


Time packet is recorded with a RTC value of 1,000,000
Absolute time value of 100:12:30:25.000

Subsequent data packet with an RTC value of 1,150,000
Absolute time value 100:12:30:25.015
(150,000 clock tics x 100 nsec per tic = 15 msec).

Multiple Time Sources

- **Ch 10 treats time as just another data channel**
- **Different time sources should be recorded in different channels**
- **Vendors usually merge time sources into one time channel**



Computer-Generated Data Packets

Channel Specific Data – Format 1, Setup Record

Format 1 defines a setup record that describes the hardware, software, and data channel configuration used to produce the other data packets in the file. The organization and content of a Format 1 setup record is indicated in the CSDW FRMT field.

MSB				LSB
31 – 10	9	8	7 – 0	
RESERVED	FRMT	SRCC	CH10VER	

Figure 10-36. Computer-Generated Format 1 Channel-Specific Data Word Format

R: Reserved [bits 31..10]

FRMT: Setup Record Format [bit 9]

0 – Setup in accordance with TMATS ASCII

1 – Setup in accordance with TMATS XML

SRCC: Setup Record Configuration Change [bit 8]

0 – Record Configuration has not changed

1 – Record Configuration has changed

CH10VER: IRIG Version [bit 7..0]

00 → 06h – Reserved

07h – IRIG-106-07

08h – IRIG-106-09

09h – IRIG-106-11

0Ah – IRIG-106-13

0Bh – IRIG-106-15

0C → FFh - Reserved

This describes the TMATS file contained in this packet.

Computer-Generated Data Packets

Channel Specific Data – Format 1, Setup Record

Format 1 defines a setup record that describes the hardware, software, and data channel configuration used to produce the other data packets in the file. The organization and content of a Format 1 setup record is indicated in the CSDW FRMT field.

MSB				LSB
31 – 10	9	8	7 – 0	
RESERVED	FRMT	SRCC	CH10VER	

Figure 10-36. Computer-Generated Format 1 Channel-Specific Data Word Format

CH10VER: IRIG Version [bit 7..0]

00 → 06h – Reserved
07h – IRIG-106-07
08h – IRIG-106-09
09h – IRIG-106-11
0Ah – IRIG-106-13
0Bh – IRIG-106-15
0Ch – IRIG-106-17
0Dh – IRIG-106-19
0Eh → FFh - Reserved

Within TMATS record

G\106 - TMATS Revision Level

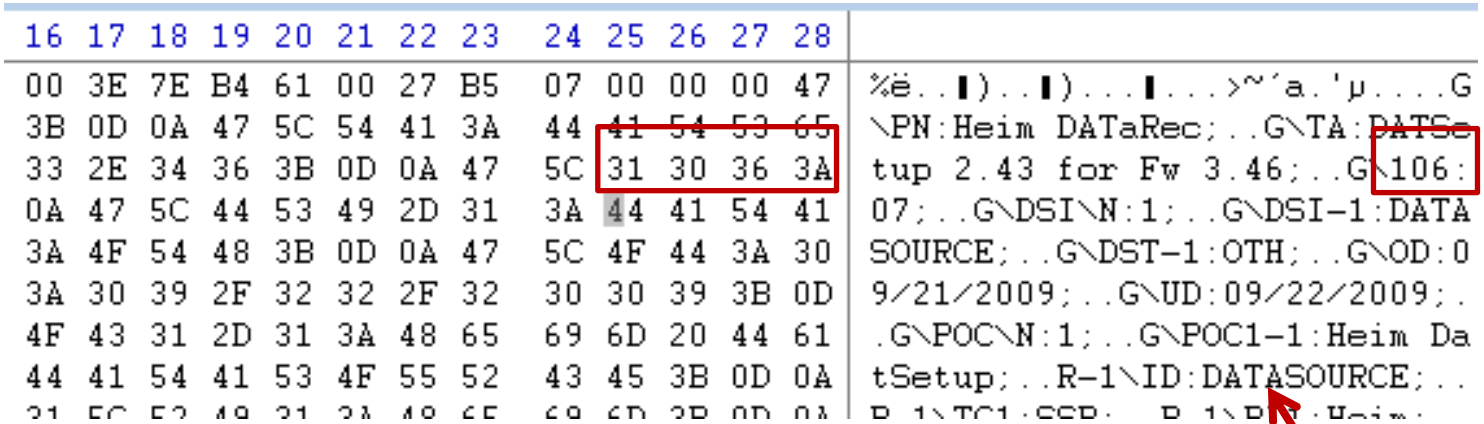
Example:
G\106:19;

Computer-Generated Data Packets

Packet Body – Format 1, Setup Record

Within the first Chapter 10 packet of the file is the TMATS information. The TMATS information (displayed in ASCII) only describes the input streams to the recorder, not the data within those streams. This allows the playback software to automatically identify the input streams and display the raw data appropriately.

The packet containing the TMATS information has a Data Type of “01” in the packet header – identifying the packet body as Setup Record information.



16	17	18	19	20	21	22	23	24	25	26	27	28	
00	3E	7E	B4	61	00	27	B5	07	00	00	00	47	%ë..▮)..▮)...▮...>~´a.'µ....G
3B	0D	0A	47	5C	54	41	3A	44	41	54	53	65	\PN:Heim DATaRec;..G\TA:DATSe
33	2E	34	36	3B	0D	0A	47	5C	31	30	36	3A	tup 2.43 for Fw 3.46;..G\106:
0A	47	5C	44	53	49	2D	31	3A	44	41	54	41	07;..G\DSI\N:1;..G\DSI-1:DATA
3A	4F	54	48	3B	0D	0A	47	5C	4F	44	3A	30	SOURCE;..G\DST-1:OTH;..G\OD:0
3A	30	39	2F	32	32	2F	32	30	30	39	3B	0D	9/21/2009;..G\UD:09/22/2009;.
4F	43	31	2D	31	3A	48	65	69	6D	20	44	61	.G\POC\N:1;..G\POC1-1:Heim Da
44	41	54	41	53	4F	55	52	43	45	3B	0D	0A	tSetup;..R-1\ID:DATASOURCE;..

For example, the word “DATA” is encoded as 44 41 54 41 in ASCII.
44 is the ASCII code for “D”
41 is the ASCII code for “A”
54 is the ASCII code for “T”

TMATS Labels

PCM Data Packets

Packet Header

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

The Data Type in the packet header will indicate that the packet contains PCM data.

There are eight PCM Data Format types:
08h = PCM Data, Format 0 (reserved for future use)
09h = PCM Data, Format 1 (Chapter 4 or Chapter 8 PCM)
0Ah = PCM Data, Format 2 (PCM DQE)
0Bh = PCM Data, Format 3 (reserved for future use)
0Ch = PCM Data, Format 4 (reserved for future use)
0Dh = PCM Data, Format 5 (reserved for future use)
0Eh = PCM Data, Format 6 (reserved for future use)
0Fh = PCM Data, Format 7 (reserved for future use)

PCM Data Packets

Channel Specific Data Mode Bits – Throughput Mode

The PCM can be formatted into the packet body three different ways: throughput, unpacked, and packed. This is indicated in the mode bits of the Channel Specific Data.

1) Throughput – In throughput mode, the PCM data is not frame synchronized so the first data bit in the packet can be any bit within the major frame.

You may not see the sync pattern of the PCM stream if it happens to not aligned on a 4-bit boundary.

Table 10-16. PCM Data-Throughput (16-Bit Alignment Mode) Sample Packet

MSB 15	LSB 0
Packet Header	
Channel-Specific Data (Bits 15-0)	
Channel-Specific Data (Bits 31-16)	
Data (Bits 15-0)	
Data (Bits 31-16)	
Data (Bits 47-32)	
:	
Packet Trailer	

Table 10-17. PCM Data-Throughput(32-Bit Alignment Mode) Sample Packet

MSB 15	LSB 0
Packet Header	
Channel-Specific Data (Bits 15-0)	
Channel-Specific Data (Bits 31-16)	
PCM Stream Bits 17-32	
PCM Stream Bits 1-16	
PCM Stream Bits 49-64	
PCM Stream Bits 33-48	
:	
Packet Trailer	

PCM Data Packets

Channel Specific Data Mode Bits – Unpacked Mode

2) Unpacked (word aligned) – aligns the PCM words with the LSB of a 16 or 32-bit word boundary. The remaining MSBs are filled with zeroes. The first data word in the packet is the sync word of the PCM minor frame.

Table 10-12. PCM Data-Unpacked (16-Bit Alignment Mode) Sample Packet

MSB 15															LSB 0
Packet Header															
Channel-Specific Data (Bits 15-0)															
Channel-Specific Data (Bits 31-16)															
Intra-Packet Time Stamp (Bits 15-0)															
Intra-Packet Time Stamp (Bits 31-16)															
Intra-Packet Time Stamp (Bits 47-32)															
Intra-Packet Time Stamp (Bits 63-48)															
Intra-Packet Data Header (Bits 15-0)															
4 Bits Pad				12 Bits Sync (Bits 23-12)											
4 Bits Pad				12 Bits Sync (Bits 11-0)											
4 Bits Pad				12 Bits Word 1 Data											
16 Bits Word 2 Data															
8 Bits Pad								8 Bits Word 3 Data							
:															
Word N Data Bits + Pad if Needed															
Intra-Packet Time Stamp (Bits 15-0)															
Intra-Packet Time Stamp (Bits 31-16)															
Intra-Packet Time Stamp (Bits 47-32)															
Intra-Packet Time Stamp (Bits 63-48)															
Intra-Packet Data Header (Bits 15-0)															
:															
Repeat for each minor frame.															
:															
Packet Trailer															

Table 10-13. PCM Data-Unpacked (32-Bit Alignment Mode) Sample Packet

MSB 15															LSB 0
Packet Header															
Channel-Specific Data (Bits 15-0)															
Channel-Specific Data (Bits 31-16)															
Intra-Packet Time Stamp (Bits 15-0)															
Intra-Packet Time Stamp (Bits 31-16)															
Intra-Packet Time Stamp (Bits 47-32)															
Intra-Packet Time Stamp (Bits 63-48)															
Intra-Packet Data Header (Bits 15-0)															
Intra-Packet Data Header (Bits 31-16)															
4 Bits Pad				12 Bits Sync (Bits 11-0)											
4 Bits Pad				12 Bits Sync (Bits 23-12)											
16 Bits Word 2 Data															
4 Bits Pad				12 Bits Word 1 Data											
6 Bits Pad				10 Bits Word 4 Data											
8 Bits Pad								8 Bits Word 3 Data							
:															
Word N Data Bits + Pad If Needed															
Intra-Packet Time Stamp (Bits 15-0)															
Intra-Packet Time Stamp (Bits 31-16)															
Intra-Packet Time Stamp (Bits 47-32)															
Intra-Packet Time Stamp (Bits 63-48)															
Intra-Packet Data Header (Bits 15-0)															
Intra-Packet Data Header (Bits 31-16)															
:															
Repeat for each minor frame.															
:															
Packet Trailer															

Note the order of the bits

PCM Data Packets

Channel Specific Data Mode Bits – Packed Mode

3) Packed – The next PCM word is packed into the remaining bits (if they exist). Padding bits are not used; however, filler bits may be required to maintain minor frame alignment at the end of the PCM minor frame.

In packed mode, the packet is minor frame synchronized, where the first data bit in the packet is the first bit in the minor frame.

Table 10-14. PCM Data-Packed (16-Bit Alignment Mode) Sample Packet

MSB 15	LSB 0
Packet Header	
Channel-Specific Data (Bits 15-0)	
Channel-Specific Data (Bits 31-16)	
Intra-Packet Time Stamp (Bits 15-0)	
Intra-Packet Time Stamp (Bits 31-16)	
Intra-Packet Time Stamp (Bits 47-32)	
Intra-Packet Time Stamp (Bits 63-48)	
Intra-Packet Data Header (Bits 15-0)	
Data (Bits 15-0)	
Data (Bits 31-16)	
Data (Bits 47-32)	
:	
Y Filler Bits	
Y Filler Bits	X Data Bits
Intra-Packet Time Stamp (Bits 15-0)	
Intra-Packet Time Stamp (Bits 31-16)	
Intra-Packet Time Stamp (Bits 47-32)	
Intra-Packet Time Stamp (Bits 63-48)	
Intra-Packet Data Header (Bits 15-0)	
:	
Repeat for each minor frame.	
:	
Packet Trailer	

Table 10-15. PCM Data-Packed (32-Bit Alignment Mode) Sample Packet

MSB 15	LSB 0
Packet Header	
Channel-Specific Data (Bits 15-0)	
Channel-Specific Data (Bits 31-16)	
Intra-Packet Time Stamp (Bits 15-0)	
Intra-Packet Time Stamp (Bits 31-16)	
Intra-Packet Time Stamp (Bits 47-32)	
Intra-Packet Time Stamp (Bits 63-48)	
Intra-Packet Data Header (Bits 15-0)	
Intra-Packet Data Header (Bits 31-16)	
Data Word 2	
Data Word 1	
Data Word 4	
Data Word 3	
:	
Filler Bits	X Data Bits
16 Filler Bits (If Required to Maintain 32-Bit Alignment)	
Intra-Packet Time Stamp (Bits 15-0)	
Intra-Packet Time Stamp (Bits 31-16)	
Intra-Packet Time Stamp (Bits 47-32)	
Intra-Packet Time Stamp (Bits 63-48)	
Intra-Packet Data Header (Bits 15-0)	
Intra-Packet Data Header (Bits 31-16)	
:	
Repeat for each minor frame.	
:	
Packet Trailer	

Video Data Packets

Packet Header

MSB 31		16 15	LSB 0
CHANNEL ID		PACKET SYNC PATTERN	
PACKET LENGTH			
DATA LENGTH			
DATA TYPE	PACKET FLAGS	SEQUENCE NUMBER	DATA TYPE VERSION
RELATIVE TIME COUNTER			
HEADER CHECKSUM		RELATIVE TIME COUNTER	

The Data Type in the packet header will indicate that the packet contains Video data. The 15th byte that shows up in the file is the Data Type having the value 0x40 to 0x44. This identifies the type of video being encoded.

There are eight Video Data Format types:

40h = Video Data, Format 0 (MPEG-2/H.264 Video Data)

41h = Video Data, Format 1 (ISO 13818-1 MPEG-2 Video Data)

42h = Video Data, Format 2 (ISO 14496 MPEG-4 Part 10 110 AVC/H.264 Video Data)

43h = Video Data, Format 3 (MJPEG)

44h = Video Data, Format 4 (MJPEG-2000)

45h = Video Data, Format 5 (reserved for future use)

46h = Video Data, Format 6 (reserved for future use)

47h = Video Data, Format 7 (reserved for future use)

Interpreting IRIG 106 Data Files

www.irig106.org

Program	Description
i106stat	Generate a summary of data channels and message types
i106trim	Trim a data file based on start and/or stop time.
i106udprcv	Receive, display, and write a Ch 10 UDP data stream
i106vid	Extract Video Fmt 0 data a channel
idmp16pp194	Read and dump 16PP194 bus messages in a humanly readable format
idmp429	Read, decode, and dump ARINC 429 messages in a humanly readable format
idmp1553	Read and dump 1553 messages in a humanly readable format
idmparinc664	Read and dump ARINC 664 messages in a humanly readable format
idmpcan	Read, decode, and dump CAN Bus packets
idmpeth	Read, decode, and dump Ethernet messages in a humanly readable format
idmpgps	Read, decode, and dump GPS NMEA messages from a UART channel in a humanly readable format
idmpindex	Read, decode, and dump Chapter 10 index packets
idmpins	Read, decode, and dump INS messages in a humanly readable format. See the idmpins page for more details
idmppcm	Read, decode, and dump PCM F1 messages in a humanly readable format. Only throughput mode is supported.
idmptime	Read, decode, and dump time messages in a humanly readable format
idmptmat	Read and print out the TMATS record in various formats
idmpuart	Read and dump UART messages in a humanly readable format

Questions?