TA Document 1999024

SMPTE Time Code and Sample Count Transmission Protocol Ver.1.0

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Abstract:
This specification defines SMPTE time code and sample count transmission protocol.

Keywords:
Audio and Music, IEC PAS 61883-6, SMPTE, Sample Count.

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1. Overview

1.1 Purpose

The purpose of this document is to define time code and sample count transmission in order to provide a method to locate playback position in time or sample count in a recorded media and synchronize multiple transmitters.

1.2 Scope

This document defines AM824 adaptation layer for SMPTE time code and sample count. The AM824 adaptation layer is defined in 1394 TA Specification 1999014 “Enhancement to Audio & Music Data Transmission Protocol 1.0”, hereafter A&M Protocol Enhancement 1.0.

2. References

The following standards contain provisions, which through reference in this document, constitute provisions of this standard. All the standards listed are normative references. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

[R1] IEEE Std 1394–1995, Standard for a High Performance Serial Bus.

[R2] IEC 61883–6 PAS, Consumer audio/video equipment – Digital interface – Part 6: Audio and music data transmission protocol

[R3] SMPTE 12M–1999, Television, Audio and Film – Time and Control Code

[R4] TA 1999014, Enhancement to Audio and Music Data Transmission Protocol Ver.1.0

3. Definitions

3.1 Conformance levels

3.1.1 expected: A key word used to describe the behavior of the hardware or software in the design models *assumed* by this Specification. Other hardware and software design models may also be implemented.

3.1.2 may: A key word that indicates flexibility of choice with *no implied preference*.

3.1.3 shall: A key word indicating a mandatory requirement. Designers are *required* to implement all such mandatory requirements.

3.1.4 should: A key word indicating flexibility of choice with a strongly preferred alternative. Equivalent to the phrase *is recommended*.

3.1.5 reserved fields: A set of bits within a data structure that are defined in this specification as reserved, and are not otherwise used. Implementations of this specification shall zero these fields. Future revisions of this specification, however, may define their usage.

3.1.6 reserved values: A set of values for a field that are defined in this specification as reserved, and are not otherwise used. Implementations of this specification shall not generate these values for the field. Future revisions of this specification, however, may define their usage.

NOTE — The IEEE is investigating whether the “may, shall, should” and possibly “expected” terms will be formally defined by IEEE. If and when this occurs, draft editors should obtain their conformance definitions from the latest IEEE style document.

3.2 Glossary of terms

3.2.1 AM824: A 32-bit data that has 8-bit label and 24-bit data defined in Audio and Music Data Transmission Protocol Ver.1.0.

3.2.2 Audio Channel Cluster: Group of logical audio channels that carry tightly related synchronous audio information. A stereo audio stream is a typical example of a two-channel audio channel cluster.

3.2.3 Audio data stream: Transport medium that can carry audio information.

3.2.4 Byte: Eight bits of data.

3.2.5 Compound Data Block: The name for the Data Block that consists of AM824 data in any combination.

3.2.6 Conformant Data: A type of AM824 data that carries information equivalent to that defined in external specification such as IEC60958 or MIDI.

3.2.7 CSR Architecture: A convenient abbreviation of the following reference (see clause 2): ISO/IEC 13213 : 1994 [ANSI/IEEE Std 1212, 1994 Edition], Information Technology—Microprocessor systems— Control and Status Register (CSR) Architecture for Microcomputer Buses.

3.2.8 Isochronous: A term that indicates the essential characteristic of a time-scale or signal, such that the time intervals between consecutive instances either have the same duration or duration's that are integral multiples of the shortest duration. In the context of Serial Bus, "isochronous" is taken to mean a bounded worst-case latency for the transmission of data; physical and logical constraints that introduce jitter preclude the exact definition of "isochronous".

3.2.9 Music data: Data generally used for controlling a tone generator. The data defined in the MIDI specification, which may be called MIDI data, is an example of music data.

3.2.10 Nibble: Four bits of data. A byte is composed of two nibbles.

3.2.11 Node: An addressable device attached to Serial Bus with at least the minimum set of control registers defined by IEEE Std 1394–1995.

3.2.12 Node ID: A 16-bit number, unique within the context of an interconnected group of Serial Buses. The node ID is used to identify both the source and destination of Serial Bus asynchronous data packets. It can identify one single device within the addressable group of Serial Buses (unicast), or it can identify all devices (broadcast).

3.2.13 Quadlet: Four bytes of data.

3.2.14 Serial Bus: The physical interconnects and higher level protocols for the peer-to-peer transport of serial data, as defined by IEEE Std 1394–1995 and updates.

3.2.15 Stream: A time-ordered set of digital data originating from one source and terminating at zero or more sinks. A stream is characterized by bounded bandwidth requirements and by synchronization points, or time stamps, within the stream data.

3.2.16 Unit architecture: The formal specification of the format and function of the software-visible resources and behaviors of a class of units. This document, in conjunction with the references above, defines a unit architecture for the class of AV devices.

3.3 Acronyms and abbreviations

A/M Protocol	Audio and Music Data Transmission Protocol
AV/C	Audio Video Control
IEEE	The Institute of Electrical and Electronics Engineers, Inc.
LTC	Longitudinal code
VITC	Vertical interval time code

4. SMPTE time code conformant

4.1 SMPTE time code conformant data

In this chapter, the format for packetization of SMPTE time code, that is the AM824 SMPTE time code conformant data format, is described. SMPTE time code is defined in[R3].

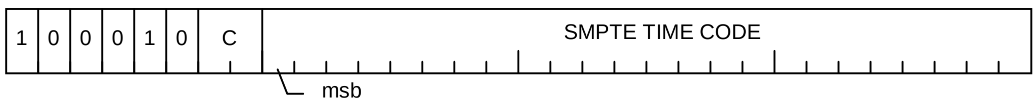

Figure 4.1 – AM824 SMPTE time code conformant data

Table 4.1 – C (Counter) definition for AM824 SMPTE time code conformant data

Value(binary)	Description
00	No Data
01	First Part : FRAMES, SECONDS, MINUTES, etc.
10	Middle Part : HOURS, BINARY GROUP 1..4, etc.
11	Last Part : BINARY GROUP 5..7

One SMPTE time code is divided into three AM824 SMPTE time code conformant data: the first part, the middle part and the last part. The AM824 SMPTE time code conformant data representing “No Data” has no information about time code. FRAMES, SECONDS, MINUTES and HOURS are encoded in BCD format.

4.1.1 No data

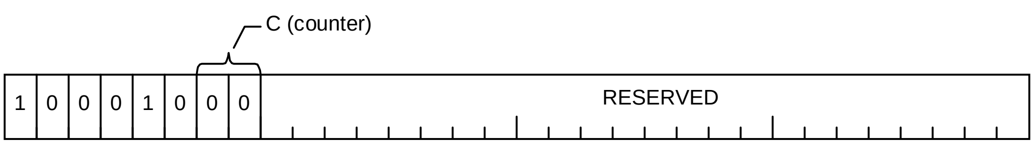

Figure 4.2 – AM824 SMPTE Time code conformant data representing “No Data”

4.1.2 First part

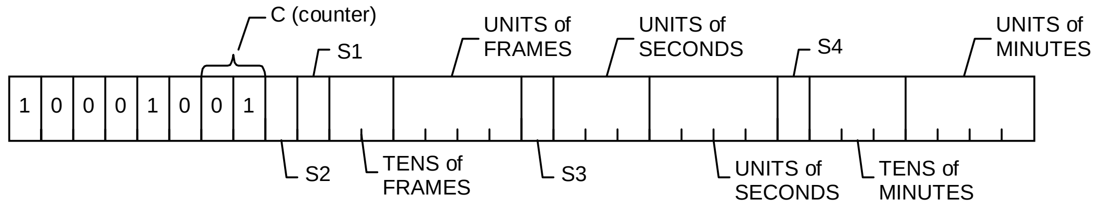

Figure 4.3 – AM824 SMPTE time code conformant data representing the first part

4.1.3 Middle part

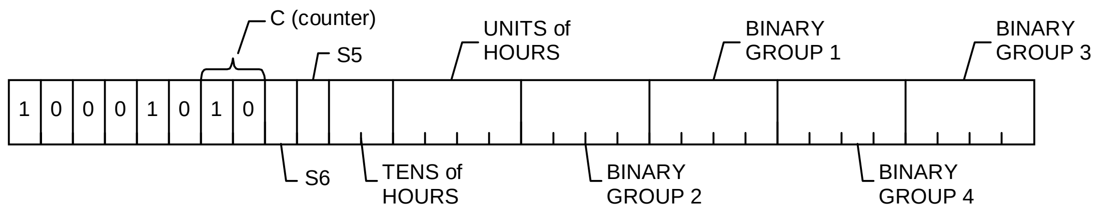

Figure 4.4 – AM824 SMPTE time code conformant data representing the middle part

4.1.4 Last part

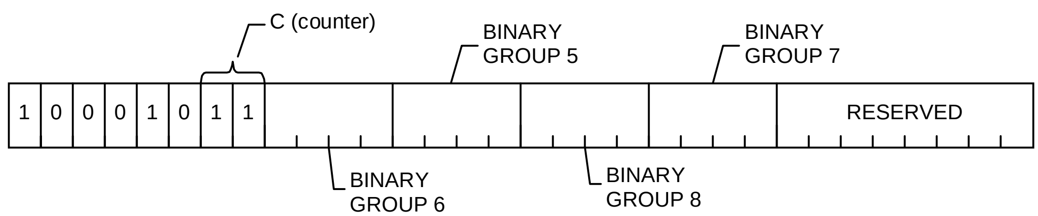

Figure 4.5 – AM824 SMPTE time code conformant data representing the last part

4.1.5 S1 to S6 flags

The following table shows the bit number of LTC or VITC corresponding to the S1 to S6 flags of the AM824 SMPTE time code data.

Table 4.2 – S1 to S6 flags for AM824 SMPTE time code conformant data

Flag	S1	S2	S3	S4	S5	S6
VITC	14	15	35	55	74	75
LTC	10	11	27	43	58	59

4.2 SMPTE time code packetization

SMPTE time code conformant data can be packetized with any other AM824 data type in compound data block described in [R4].

4.2.1 Example 1: Transmission of SMPTE time code with sample data

This section shows an example of transmission of SMPTE time code with sample data under the non-blocking method.

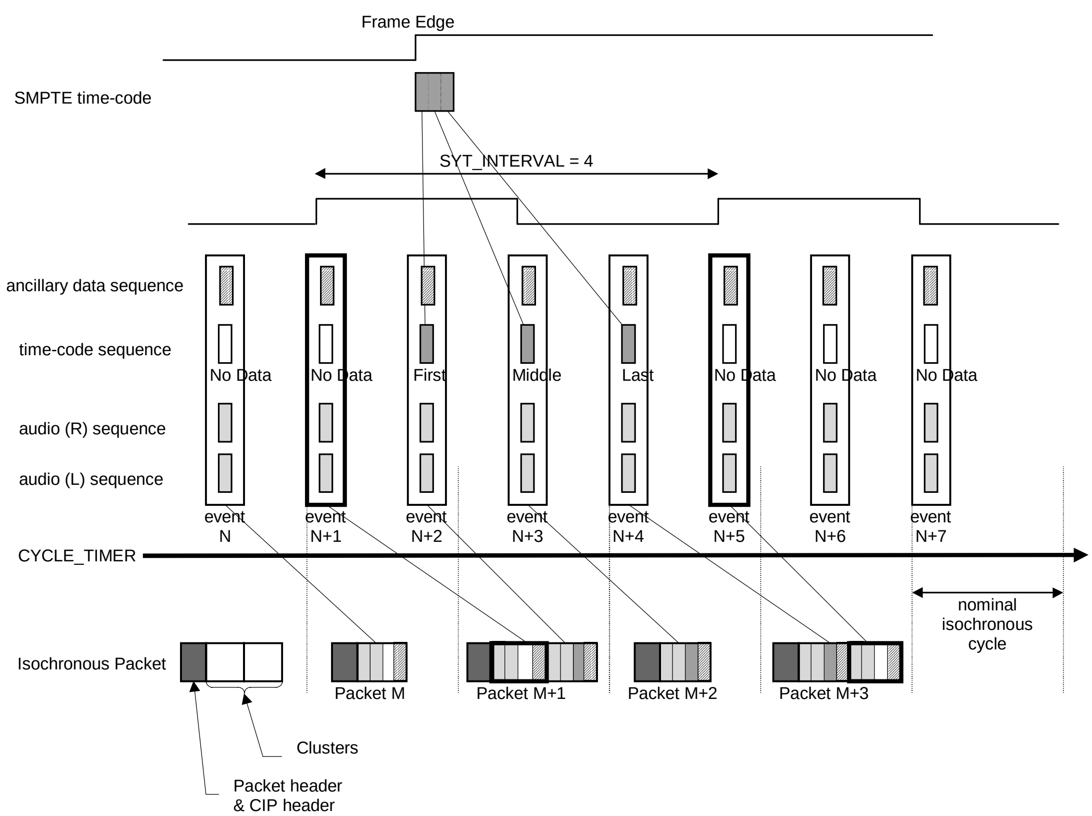

Figure 4.6 – Transmission of SMPTE time code with sample data

CLUSTER_DIMENSION=4, UNIT_DIMENSION=1, UNIT_SIZE=4, and DBS=4.

A SMPTE time code is transmitted once each frame. One SMPTE time code is divided into three AM824 SMPTE time code data. Each of the three data constitutes part of a cluster. A cluster contains two IEC60958 conformant data and one AM824 SMPTE time code data followed by one Ancillary Not Data for padding to make the data block size even number according to the order rule and size rule defined in [R4].

NOTE: Although other examples in this document may have a data block in odd number size, Ancillary Not Data should be appended to make a data block even number size.

The cluster containing the first part, the cluster containing the middle part and the cluster containing the last part occur in succession. The clusters containing AM824 SMPTE time code data representing “No Data” may occur in succession.

The events, or AM824 data in a cluster, are considered to be simultaneous. In this example, the AM824 SMPTE time code data and IEC60958 conformant data in a cluster are considered to be simultaneous.

An application may regard the presentation time of the first part of the AM824 SMPTE time code data as the edge of frame. In this case, even though the middle part or the last part of AM824 SMPTE time code data does not relate to the IEC60958 conformant data in the same cluster, they are considered to be simultaneous for the sake of convenience.

The following figure shows the data fields of the Packet M+1 by way of example.

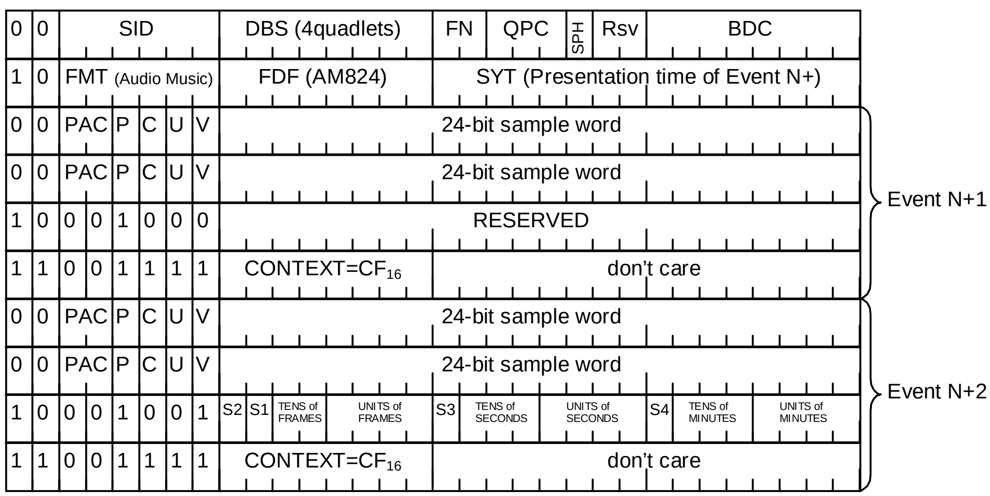

Figure 4.7 – Example of data fields including sample data with SMPTE time code

4.2.2 Example 2: Transmission of SMPTE time code under the blocking method

An example of non-blocking transmission was given above. Clusters are made in a similar way under the blocking transmission method.

Under the blocking method, unlike the non-blocking method, the number of data blocks in a packet is fixed, so the number of clusters in a packet is fixed as well.

Under the blocking method, an empty packet or a non-empty packet with a “NO-DATA” code in its FDF may be transmitted. Such a packet contains no clusters, so it likewise contains no AM824 SMPTE time code data.

4.2.3 Example 3: Transmission of SMPTE time code only

This section shows an example of transmitting SMPTE time code only without sample data.

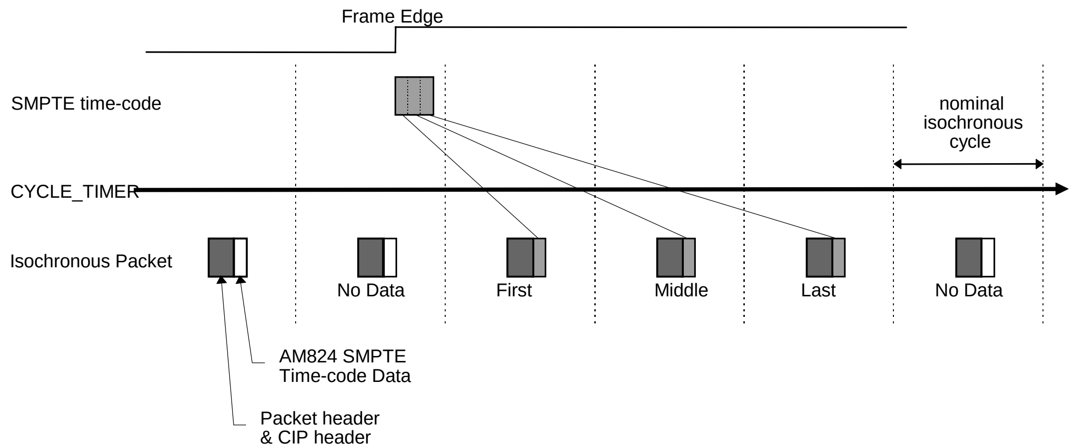

Figure 4.8 – Transmission of SMPTE time code only

0	0	SID				DBS (1quadlet)	FN	QPC	SPH	Rsv	BDC
1	0	FMT (Audio Music)				FDF (AM824)	SYT				
1	0	0	0	1	0	C	SMPTE TIME CODE				

Figure 4.9 – Data fields for SMPTE time code only

CLUSTER_DIMENSION=1, UNIT_DIMENSION=1, UNIT_SIZE=1, and DBS=1.

One SMPTE time code is transmitted once each frame. The SMPTE time code is divided into three AM824 SMPTE time code conformant data. One packet contains one data block, that contains one AM824 SMPTE time code conformant data.

The presentation time of SMPTE time code can be specified with SYT. In this case, the valid SYT value is assigned to the packet containing the first part of the AM824 SMPTE time code conformant data. The packet containing the middle part or the last part has “no-information” code in its SYT field.

In the case such as punctuality is not required so much, SMPTE time code may be transmitted or received ignoring SYT. In this case, each packet containing AM824 SMPTE time code conformant data has “no-information” code in its SYT field.

The first part, the middle part, and the last part of AM824 SMPTE time code conformant data are placed for successive three isochronous cycles in order. For the other cycle, the packet representing that it has no valid data is placed.

There are three kinds of packets representing that it has no valid data. The following figures shows the data fields.

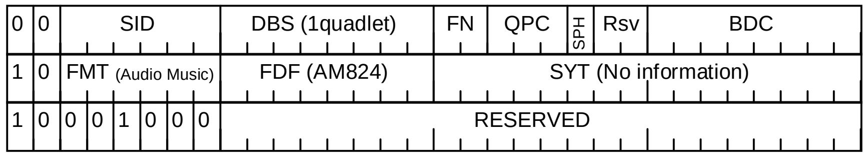

Figure 4.10 – Data fields including AM824 SMPTE time code conformant data representing “No Data”

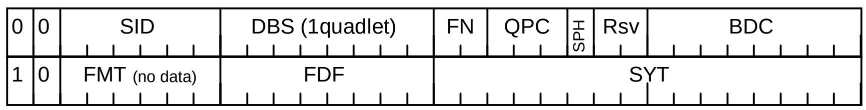

Figure 4.11 – Data fields of empty packet

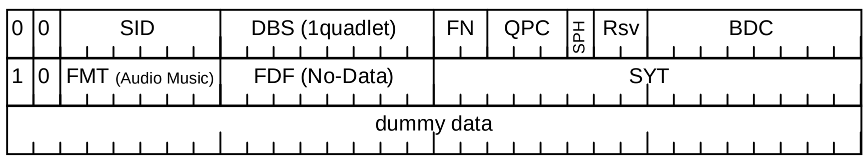

Figure 4.12 – Data fields of special non-empty packet with “No-Data” code in FDF

5. Sample count

5.1 Sample count data

In this chapter, the format for packetization of the sample count, that is the AM824 sample count data type, is described.

The sample count is an integer number that increases by one for each word clock period. The sample count can be assigned to each data of a stream synchronizing with the word clock. (Hereafter, such data is referred to as sample data.)

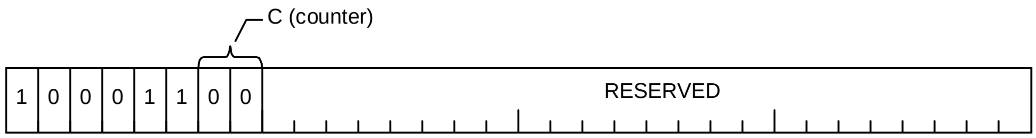

Figure 5.1 – AM824 sample count data

Table 5.1 – C (Counter) definition for AM824 sample count data

Value(binary)	Description
00	No Data
01	- Reserved -
10	Upper 24 Bits of Sample Count
11	Lower 24 Bits of Sample Count

The sample count is encoded in binary form. One sample count is divided into two AM824 sample count data: the upper 24 bits and the lower 24 bits. The AM824 SMPTE time code data representing "No Data" has no information about the sample count.

5.1.1 No data

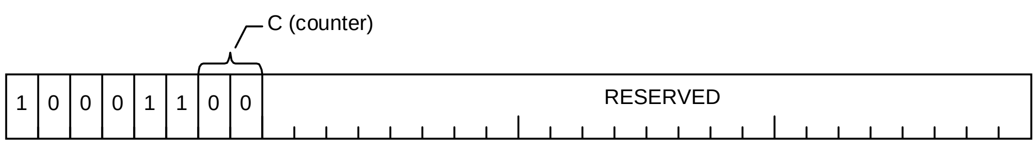

Figure 5.2 – AM824 sample count data representing "No Data"

5.1.2 Upper 24 bits

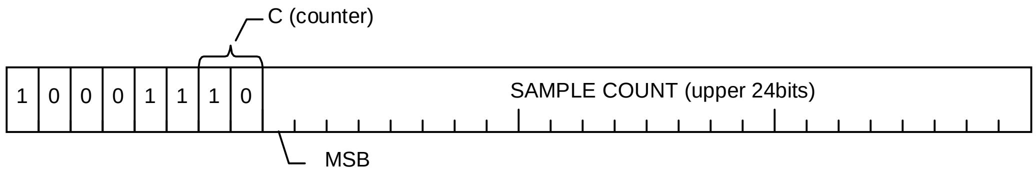

Figure 5.3 – AM824 sample count data representing the upper 24 bits

5.1.3 Lower 24 bits

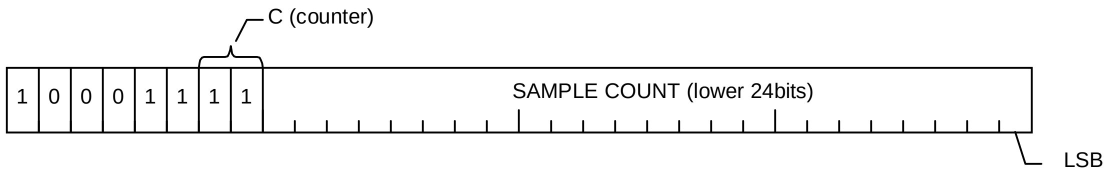

Figure 5.4 – AM824 sample count data representing the lower 24 bits

5.2 Sample count packetization

Sample count data can be packetized with any other AM824 data type in compound data block described in [R4].

5.2.1 Example 1: Transmission of sample count assigned to every sample data

This section shows an example of transmission of sample count assigned to every sample data under non-blocking method.

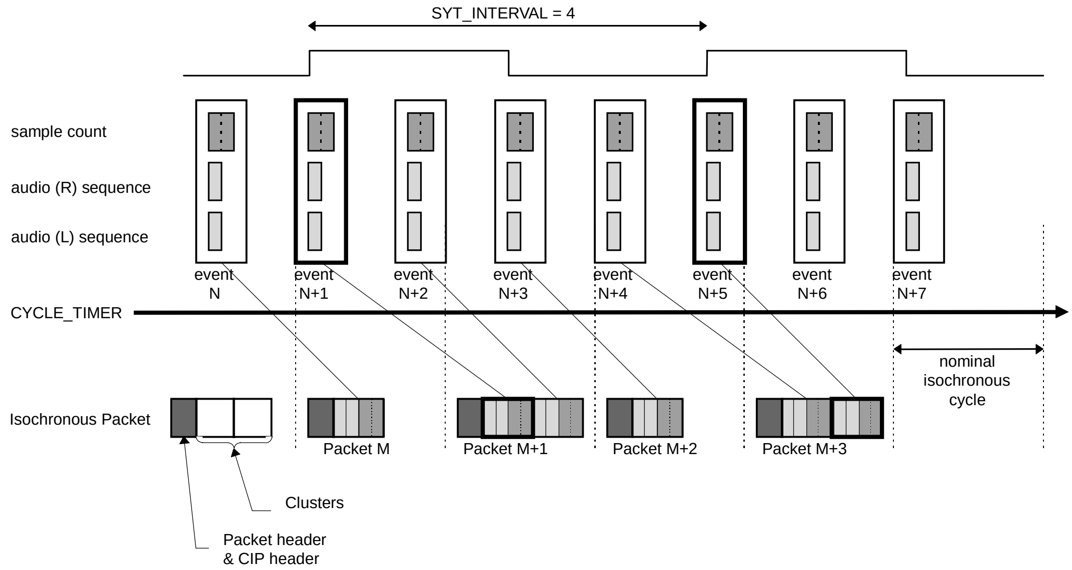

Figure 5.5 – Transmission of sample count assigned to every sample data

CLUSTER_DIMENSION=3, UNIT_DIMENSION=1, UNIT_SIZE=3, and DBS=3.

One cluster consists of two IEC60958 Conformant Data and two AM824 Sample Count Data.

The following figure shows the data fields of the Packet M+1 by way of example.

<table>
<tr><td>0</td><td>0</td><td colspan="6">SID</td><td>DBS (4quadlets)</td><td>FN</td><td>QPC</td><td>SPH</td><td>Rsv</td><td>BDC</td><td></td></tr>
<tr><td>1</td><td>0</td><td colspan="6">FMT (Audio Music)</td><td>FDF (AM824)</td><td colspan="5">SYT (Presentation time of Event N+)</td><td></td></tr>
<tr><td>0</td><td>0</td><td>PAC</td><td></td><td>P</td><td>C</td><td>U</td><td>V</td><td colspan="6">24-bit sample word</td><td rowspan="4">Event N+1</td></tr>
<tr><td>0</td><td>0</td><td>PAC</td><td></td><td>P</td><td>C</td><td>U</td><td>V</td><td colspan="6">24-bit sample word</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td colspan="6">SAMPLE COUNT (upper 24bits)</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td colspan="6">SAMPLE COUNT (lower 24bits)</td></tr>
<tr><td>0</td><td>0</td><td>PAC</td><td></td><td>P</td><td>C</td><td>U</td><td>V</td><td colspan="6">24-bit sample word</td><td rowspan="4">Event N+2</td></tr>
<tr><td>0</td><td>0</td><td>PAC</td><td></td><td>P</td><td>C</td><td>U</td><td>V</td><td colspan="6">24-bit sample word</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td colspan="6">SAMPLE COUNT (upper 24bits)</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td colspan="6">SAMPLE COUNT (lower 24bits)</td></tr>
</table>

Figure 5.6 – Example of data fields including sample count assigned to every sample data

5.2.2 Example 2: Transmission of sample count assigned to every other sample data

This section shows an example of transmission of sample count assigned to every other sample data under non-blocking method.

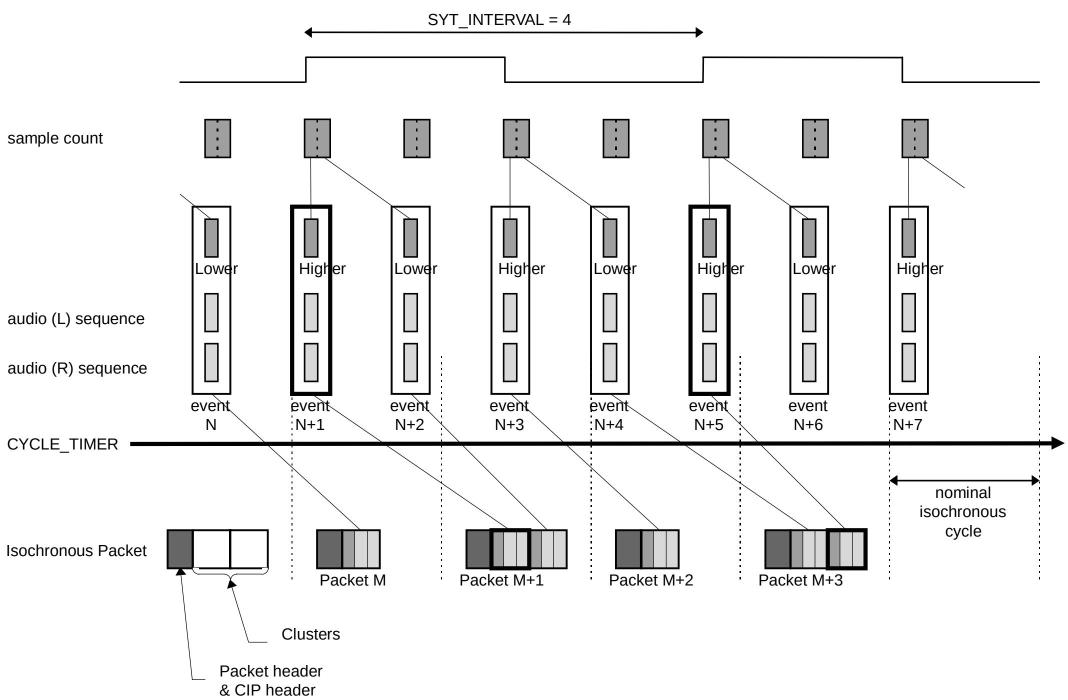

Figure 5.7 – Transmission of sample count assigned to every other sample data

CLUSTER_DIMENSION=3, UNIT_DIMENSION=1, UNIT_SIZE=3, and DBS=3.

One cluster consists of two IEC60958 conformant data and one AM824 sample count data.

In the figure, a valid SYT value is assigned to the cluster containing the upper 24 bits data. Even though the lower 24 bits data does not relate to the IEC60958 conformant data in the same cluster, they are considered to be simultaneous for the sake of convenience.

The following figure shows the data fields of the Packet M+1 by way of example.

0	0	SID						DBS (3quadlets)	FN	QPC	SPH	Rsv	BDC	
1	0	FMT (Audio Music)						FDF (AM824)	SYT (Presentation time of Event N+)					
0	0	PAC		P	C	U	V	24-bit sample word						Event N+1
0	0	PAC		P	C	U	V	24-bit sample word						
1	0	0	0	1	1	1	0	SAMPLE COUNT (upper 24bits)						
0	0	PAC		P	C	U	V	24-bit sample word						Event N+2
0	0	PAC		P	C	U	V	24-bit sample word						
1	0	0	0	1	1	1	1	SAMPLE COUNT (lower 24bits)						

Figure 5.8 – Example of data fields including sample count assigned to every other sample data

5.2.3 Example 3: Transmission of sample count assigned to sample data at SYT_INTERVAL

This section shows an example of transmission of sample count Assigned to sample data at SYT_INTERVAL under non-blocking method.

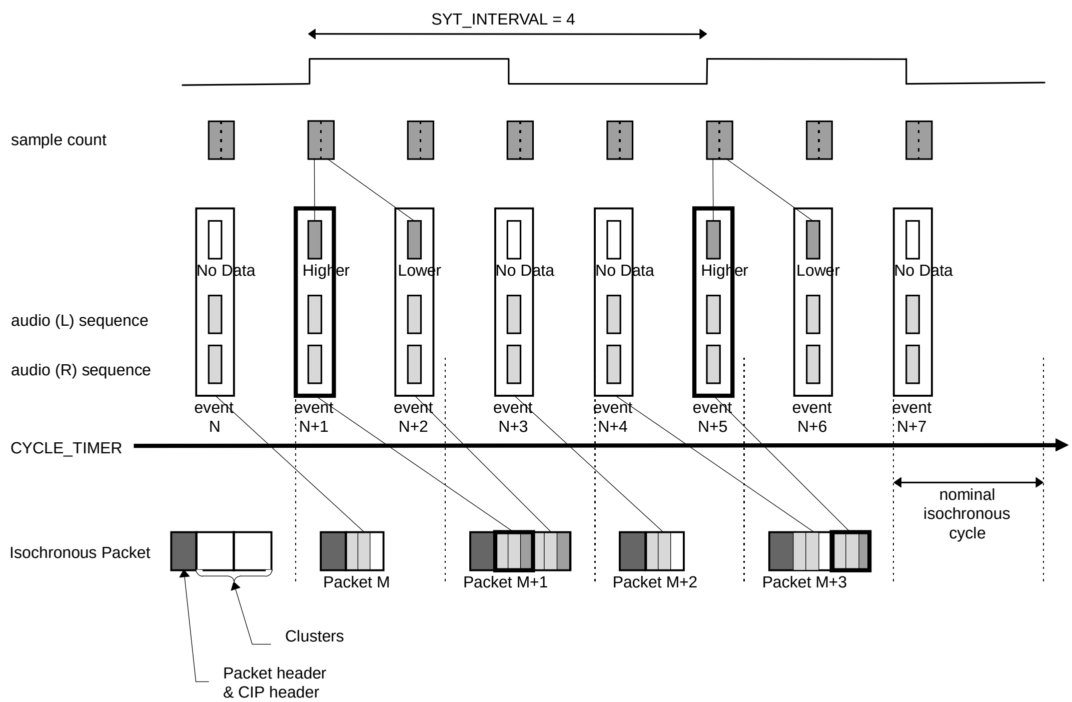

Figure 5.9 – Transmission of sample count assigned to sample data at SYT_INTERVAL

CLUSTER_DIMENSION=3, UNIT_DIMENSION=1, UNIT_SIZE=3, and DBS=3.

One cluster consists of two IEC60958 conformant data and one AM824 sample count data .

The cluster containing sample data , or IEC60958 conformant data, at SYT_INTERVAL contains the upper 24 bits data of the corresponding sample count, and the following cluster contains the lower 24 bits data. Several AM824 sample count data representing “No Data” can be successive.

The lower 24 bits data does not relate to the sample data in the same cluster, they are considered to be simultaneous for the sake of convenience. Also, the AM824 sample count data representing “No Data” and the sample data in the same cluster are considered to be simultaneous.

The following figure shows the data fields of the Packet M+1 by way of example.

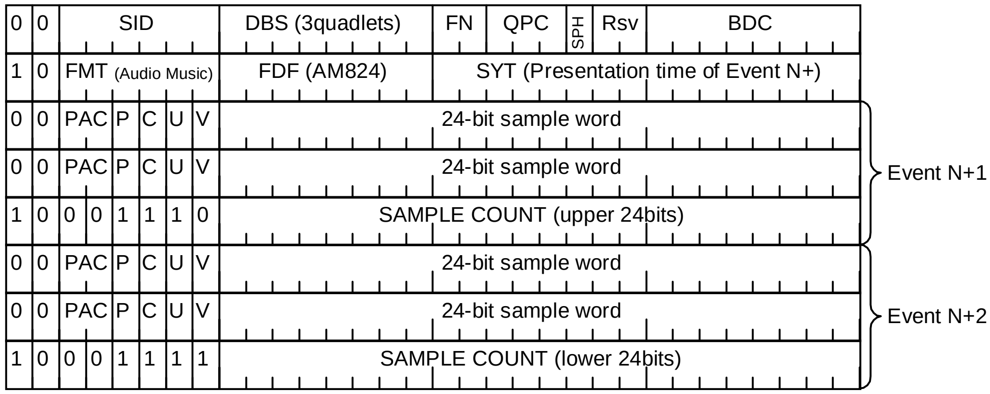

Figure 5.10 – Example of data fields including sample count assigned to sample data at SYT_INTERVAL

5.2.4 Example 4: Transmission of sample count under the blocking method

The example of the non-blocking transmission was mentioned above. In a similar way, clusters are made under the blocking transmission method.

Under the blocking method, dislike the non-blocking method, the number of data blocks in a packet is fixed, so the number of clusters in a packet is fixed as well.

Under the blocking method, an empty packet or a non-empty packet with “NO-DATA” code in its FDF may be transmitted. Such a packet contains no cluster, so it contains no AM824 sample count data as well.

5.2.5 Example 5: Transmission of sample count only at SYT_INTERVAL

This section shows an example of transmission of sample count only without sample data.

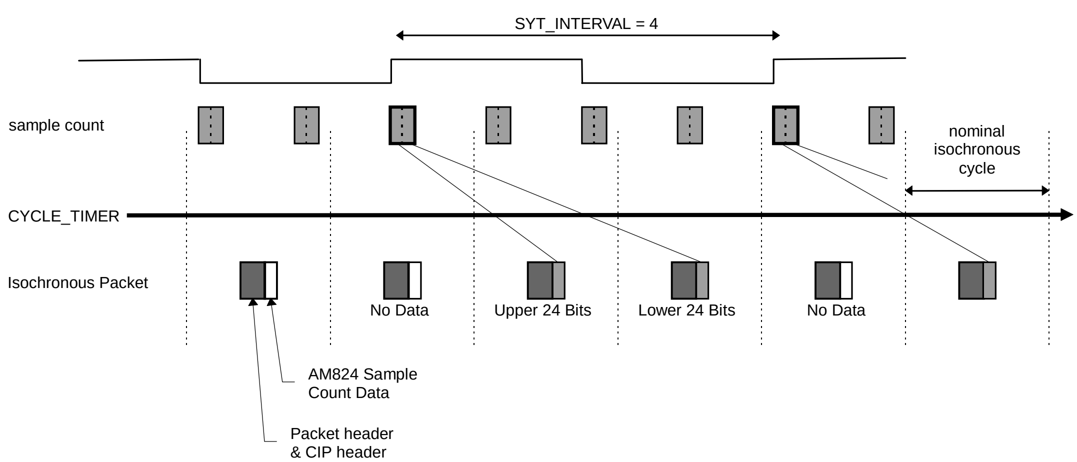

Figure 5.11 – Transmission of sample count only

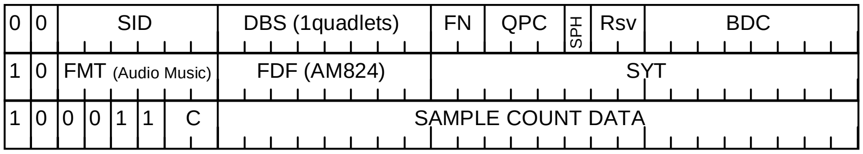

Figure 5.12 – Data fields for sample count only

CLUSTER_DIMENSION=1, UNIT_DIMENSION=1, UNIT_SIZE=1, and DBS=1.

One packet contains one data block that contains one AM824 sample count data.

The presentation time of sample count can be specified with SYT. In this case, the valid SYT value is Assigned to the packet containing the upper 24 bits of AM824 sample count data. The packet containing the lower 24 bits has "no-information" code in its SYT field.

The upper 24 bits and the lower 24 bits of AM824 sample count data are placed for successive two isochronous cycles in order. For the other cycle, the packet representing that it has no valid data is placed.

There are three kinds of packets representing that it has no valid data. The following figures shows the data fields.

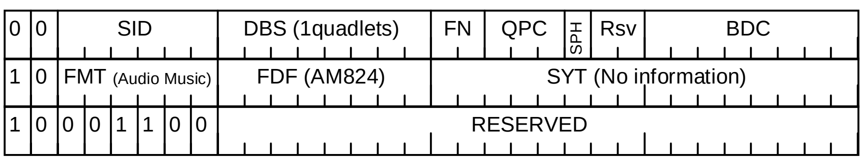

Figure 5.13 – Data fields including AM824 sample count data representing "No Data"

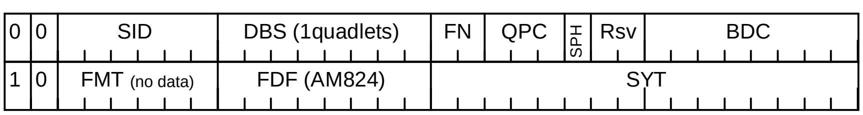

Figure 5.14 – Data fields of empty packet

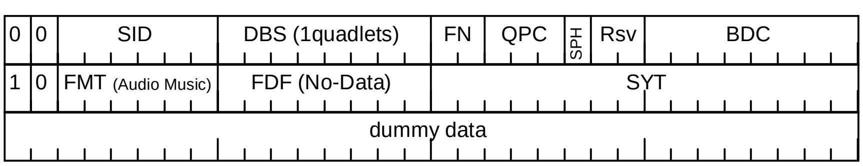

Figure 5.15 – Data fields of special non-empty packet with "No-Data" code in FDF