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Technical Report

Digital Video Broadcasting (DVB); Professional Interfaces: Guidelines for the implementation and usage of the DVB Asynchronous Serial Interface (ASI)

European Broadcasting Union

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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

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NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

European Broadcasting Union
CH-1218 GRAND SACONNEX (Geneva)
Switzerland
Tel: +41 22 717 21 11
Fax: +41 22 717 24 81

Founded in September 1993, the DVB Project is a market-led consortium of public and private sector organizations in the television industry. Its aim is to establish the framework for the introduction of MPEG-2 based digital television services. Now comprising over 200 organizations from more than 25 countries around the world, DVB fosters market-led systems, which meet the real needs, and economic circumstances, of the consumer electronics and the broadcast industry.

Introduction

The DVB Asynchronous Serial Interface (ASI) [1] is a very popular standard interface for conveying MPEG-2 transport streams between professional equipment. However, there are concerns over interoperability in the market place, based on system integrators' experiences with available equipment from multiple suppliers. The present document is intended to explain some of the causes of problems and to offer guidelines to ASI implementers that will encourage maximum interoperability.

1 Scope

The present document addresses interoperability issues specific to ASI data transmission links, and explicitly is *not* concerned with general MPEG-2 interoperability issues.

An example of an ASI interoperability problem is where equipment receiving an ASI data stream occasionally drops out of lock, or never achieves lock at all.

An example of a problem *not* addressed by these guidelines is where the video and audio on the output of a decoder have poor clock stability, because of PCR clock recovery problems at some point in the end-to-end equipment chain, for example resulting in LF wander in a regenerated PAL/NTSC subcarrier.

The present document contains a clause providing a description of the design issues confronting ASI equipment designers. The present document also contains a recommendation clause, which provides simple measures to improve interoperability between ASI equipment. There may be situations where systems will work outside these recommendations, depending on precise system and equipment implementation.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] EN 50083-9: "Cabled distribution systems for television, sound and interactive multimedia signals; Part 9: Interfaces for CATV/SMATV headends and similar professional equipment for DVB/MPEG-2 transport streams" (DVB Blue Book A010), Annex B, Asynchronous Serial Interface.

[2] ETSI ETR 290: "Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ASI	Asynchronous Serial Interface
tx-clk	transmission clock
rx-clk	receiver clock

4 ASI transmission links

The ASI is a uni-directional transmission link to transfer data between professional digital video equipment. Figure 1 presents an abstract model of an ASI transmission link. The model represents signals at the Layer 1/Layer0 interface of figure B.1 of EN 50083-9 [1].

Figure 1: Abstract ASI transmission model

The diagram contains an ASI transmission node, where data are held in a transmission buffer T. Data are read from this buffer at a constant rate determined by the transmission clock (tx-clk). This generates an isochronous data stream. One should keep in mind that the ASI is asynchronous. This gives implementers the freedom to deviate from isochronous data delivery. The diagram models this explicitly by including a "Variable Delay" function. The modified stream is transported over the ASI link to arrive at the receiver buffer R. Data are removed from this buffer at a constant rate, determined by the receiver clock (rx-clk).

The abstract ASI delivery model is used to make sure that the isochronous output stream from the receiver buffer is similar to the isochronous input stream to the variable delay function. A design issue in this transmission model is that bytes need to be removed from the receiver buffer at a high enough data rate. To achieve this, the receiver clock frequency needs to be equal to or greater than the transmission clock frequency. If this is not the case, the receiver buffer will overflow.

The present document assumes that the receiver clock is linked to the transmission clock, but is silent about how to achieve this in practice.

When the receiver clock is linked to the transmission clock, the remaining design issue is to remove any aperiodicity introduced in the isochronous data stream. On the ASI link, the bytes can be displaced in time with respect to their isochronous position. This displacement can occur for a variety of reasons, e.g. technical convenience at the generating end of the link. The ASI specification allows for unlimited time displacement of data bytes. To improve interoperability, ASI implementations need to be subject to certain restrictions on the data transmission.

The variable delay block in the diagram models the asynchronous transmission characteristics of the ASI. The aperiodicity can be expressed as a short-term change in the transport rate. A good starting point is the definition of data rate from the DVB Measurement Group that is contained in ETR 290 [2]. In this DVB specification, the data rate is averaged over a fixed time gate (called "window"). Each window contains a fixed number of N "time slices". For the time slice number k, the notation D_k represents the number of bytes transferred in that period of time. The average data rate (in bytes per second) is then given by the formula:

$$ASI\_rate_k = \frac{\sum_{n=0}^{n=N-1} D_{k-n}}{T} \qquad \text{(bytes/second)}$$

Where:

N	is the integer number of time slices in the time gate window.
T	the duration of the time gate window

After each measurement the time gate window is shifted by one time slice unit of time, denoted by $\tau = T/N$. The rate specification permits different values for N and T.

For this analysis, it is assumed that the transmission clock equals the average rate expressed by the formula. As the actual rate may deviate from the average, we introduce the peak rate as the highest rate found in the N time slices.

The highest rate then fills the receiver buffer more rapidly than the average rate at which data is removed from the buffer. A temporary higher rate is followed by a temporary lower rate. The combined effect is that the receiver buffer should be empty at the end of the time gate window. An example is shown in figure 2.

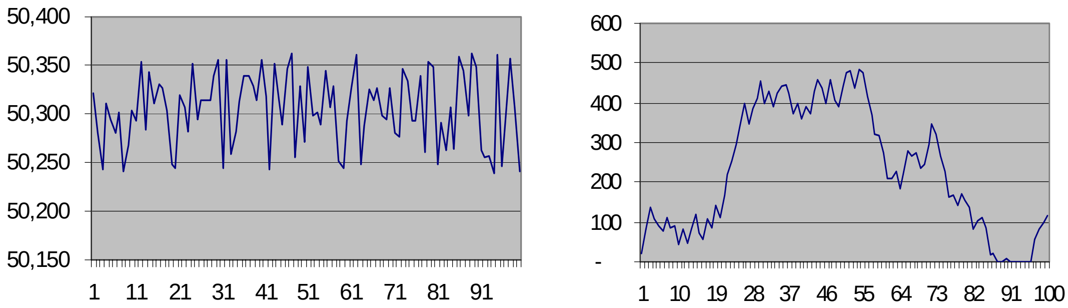


Figure 2: Random aperiodic transport stream rate and buffer utilization

In this example, a simulated data transport is shown with an average data rate of 50 kbit/s. The time gate window consists of 100 time slices. The number of bytes transferred in each time slice is shown in the left curve of figure 2. The rate varies from 45 kbit/s to 55 kbit/s. As the bytes are removed from the ASI receiver buffer at the average rate, the buffer occasionally fills with excess bytes. The number of bytes in the receiver buffer is shown in the right-hand curve. One can see that the buffer occasionally underflows. Both the buffer underflow and the relatively large buffer size should be avoided in practical situations.

Another example uses a more well-behaved stream. Here each transport packet is played out with a constant delay between the Sync bytes. The packets are transmitted in a burst with a constant data rate of 8 Mbit/s. After every packet a small gap is present where no data bytes arrive at the receiver. The data rate is much more constant, and the required receiver buffer also is much lower.

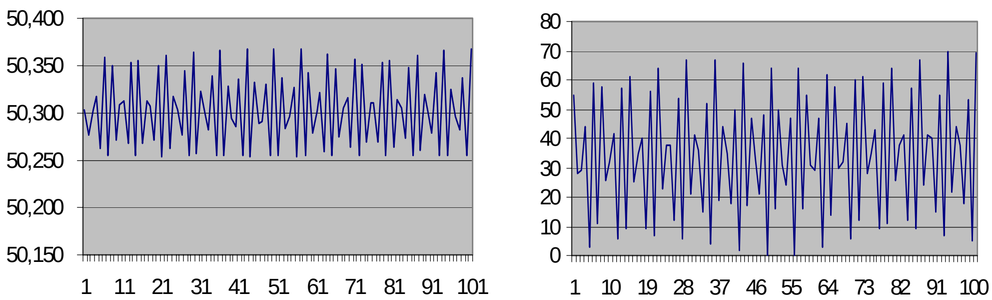


Figure 3: Deterministic aperiodic transport stream rate and buffer utilization

Figure 3 shows that a deterministic aperiodic transport stream has a lower and more predictable buffer utilization for approximately the same variations in transport rate.

The worst case receiver buffer size occurs when all data in the peak rate time slice is transmitted in one burst at the maximum ASI link rate of 27 Mbit/s. In such a worst case scenario, the peak time slice transports all data and all other time slices carry no data.

Both examples shown above highlight the fact that in an ASI design careful consideration needs to be given to the properties of the delay variation of the link. The receiver buffer size, which is required to properly receive the data stream when the transmit and receive rates are linked, should be specified. Hence this measure is used in the recommendations below.

5 Recommendations

It is recommended that equipment manufacturers include the following information on their product data sheets:

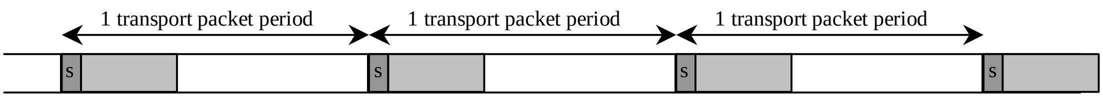
- For equipment with an ASI input, the size of the ASI receiver buffer in transport packets that is available to remove ASI transmission aperiodicity should be stated;
- For equipment with an ASI output, the minimum ASI receiver buffer size in transport packets required to remove the ASI transmission aperiodicity it creates should be stated.

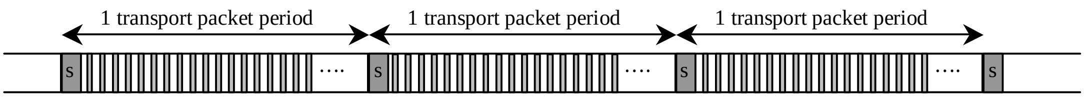
To maximize equipment interoperability, it is suggested that equipment with an ASI output should be designed to work with equipment with a small ASI receiver buffer.

Additionally, an ASI input should be designed with a receiver buffer that accommodates as wide a variety of ASI outputs as possible within appropriate commercial constraints.

The aperiodicity of some ASI output streams and the receiver buffer size they require for proper reception is illustrated in the following diagrams. The signals represented in these diagrams occur at the Layer 1/Layer0 interface of figure B.1 in EN 50083-9 [1].

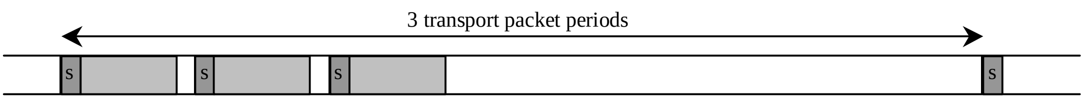
In the first two diagrams below, the ASI receiver buffer size required would be one MPEG-2 transport packet:





Key: MPEG sync byte MPEG transport byte(s) ASI stuffing byte(s): K28,5 characters.

In the following example, an ASI receiver buffer of three packets would be required to remove the ASI aperiodicity:



6 Clarifications

Note that if the equipment can accept 204-byte transport packets (optional) in addition to 188-byte packets (mandatory), then the size of the required buffer in bytes would have to be larger than if only 188-byte packets are supported.

In some cases, an ASI output may work with an ASI input with a smaller buffer than is specified for the output, however ASI interoperability under these circumstances cannot be guaranteed. In order to establish whether such inputs and outputs will interface to each other correctly, it is necessary to understand precisely the distribution of transport packet bytes and ASI stuffing bytes, and the detailed operation of the equipment. A general solution for this cannot be given.

Requirements for the ASI input will vary depending on the equipment function, for example a decoder may not need as flexible an ASI input as a remultiplexer.

History

Document history		
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