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Digitalna zvokovna radiodifuzija (DAB) - Vmesniki za razpošiljanje - Vmesnik DIQ

Digital Audio Broadcasting (DAB); Distribution interfaces; Digital baseband In-phase and Quadrature (DIQ) interface

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Foreword

This European Standard (Telecommunications series) has been produced by the Joint Technical Committee (JTC) of the European Broadcasting Union (EBU), Comité Européen de Normalization Electrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE: The EBU/ETSI JTC was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC 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.

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EUREKA Project 147 (DAB*)

EUREKA Project 147 was established in 1987, with funding from the EC, to develop a system for the broadcasting of audio and data to fixed, portable or mobile receivers. Their work resulted in the publication of a European standard, ETS 300 401 (see bibliography), for DAB which now has world-wide acceptance. The members of the EUREKA 147 Project are drawn from broadcasting organizations and telecommunication providers together with companies from the professional and consumer electronics industry.

* DAB is a registered trademark owned by one of the EUREKA 147 partners.

National transposition dates	
Date of adoption of this EN:	20 February 1998
Date of latest announcement of this EN (doa):	30 June 1998
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 December 1998
Date of withdrawal of any conflicting National Standard (dow):	31 December 1998

Introduction

The present document is one of a set associated with DAB. ETS 300 401 (see bibliography) describes the transmitted signal; the interface between the broadcaster's transmitters and the listener's receiver. The associated documents, EN 300 797 and ETS 300 799 (see bibliography), describe additional interfaces which can be used by broadcasters or network providers to build DAB networks.

Figure 1 shows a DAB network in outline. For convenience, the network is split into a number of different parts, each managed by a different entity. The different entities are; the Programme/Data provider, the Service Component provider, the Ensemble provider and the Transmission Network provider.

NOTE: A Service Component provider may be generating a full DAB service or a component of a DAB service. For the purposes of the present document, the terms Service provider and Service Component provider are interchangeable.

Programme/Data provider

The Programme/Data provider is the originator of the audio programme or the data being carried within the DAB Service Component. The format for the output of the Programme/Data provider may take many different forms and should be agreed between the Programme/Data provider and the Service Component provider.

Service Component provider

The Service Component provider is producing one or more complete Service Components which may form the complete DAB service, but may not. Data from the Service Component provider will comprise three different parts:

- Service Component data which is to be inserted into the DAB Main Service Channel (MSC);
- Service Information related to the Service Component data which is to be inserted into the Fast Information Channel (FIC);
- Other data, not intended for transmission, including status monitoring or control.

The interface between the Service Component provider and the Ensemble provider is known as the Service Transport Interface (STI) and is defined in EN 300 797 (see bibliography).

Ensemble provider

The Ensemble provider receives a set of service components from one or more Service Component providers. He then formats the FIC, and generates an unambiguous description of the full DAB Ensemble.

The ensemble description is passed to the Transmission Network provider via an interface called the ETI which is defined in ETS 300 799 (see bibliography).

Transmission Network provider

The Transmission Network provider generates the DAB Ensemble and transmits it to the receiver. The output of the Transmission provider is defined by ETS 300 401 (see bibliography). The Transmission Network provider is usually the final recipient of the ETI and is responsible for turning it into the DAB transmission signal using an OFDM generator.

In some cases, as an intermediate step, the Transmission provider may find it convenient to generate a baseband representation of the signal to be transmitted. The baseband representation, known as the DIQ, is a set of digital samples defining the In-phase (I) and Quadrature (Q) components of the final carrier. This interface is defined in the present document and provides a convenient interface between digital processing equipment and radio-frequency modulating equipment.

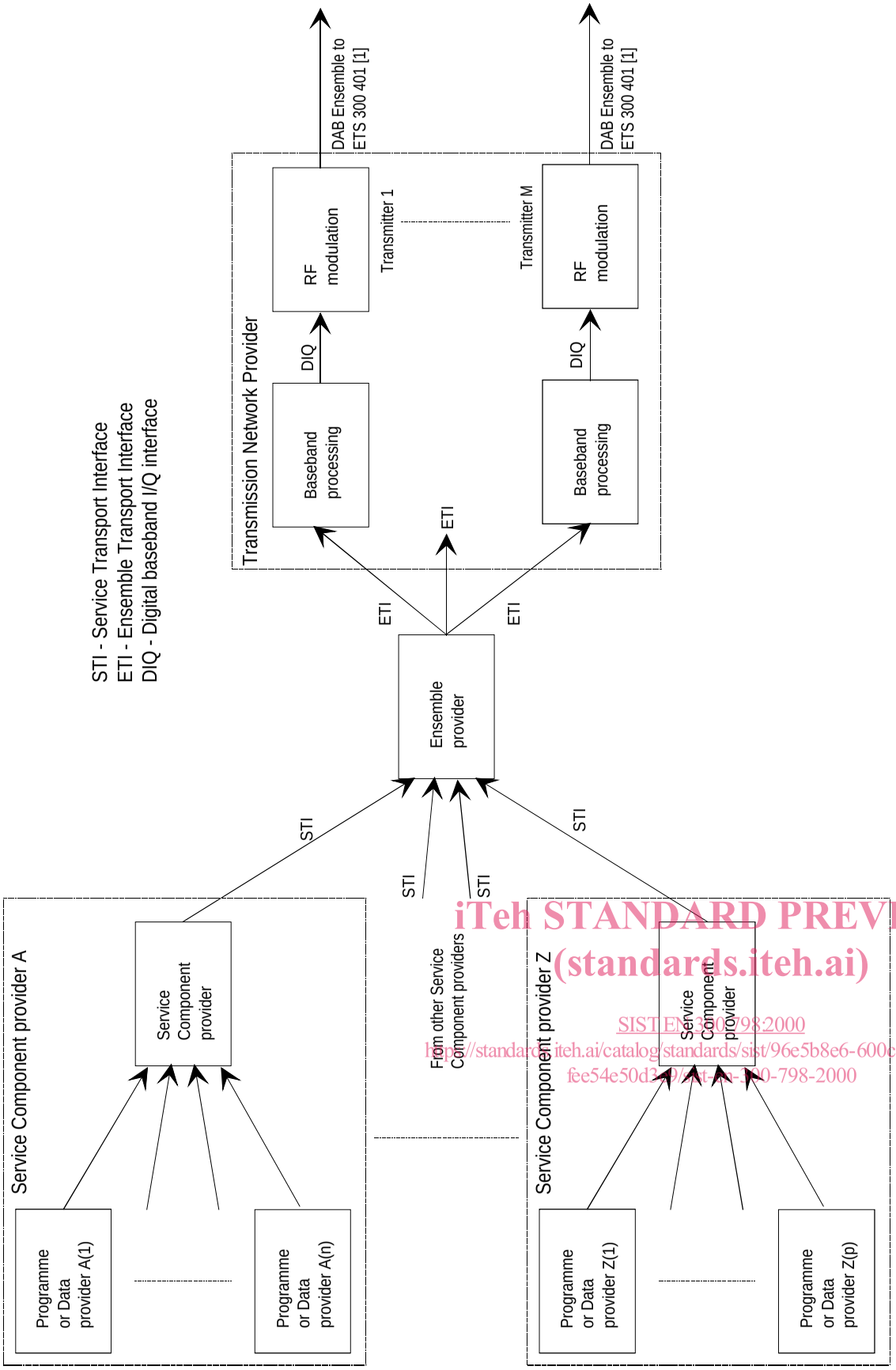

Figure 1: DAB network outline

1 Scope

The present document establishes a standard method for the connection of digital processing equipment (which is producing DAB baseband I/Q signals) and Radio Frequency (RF) modulation equipment in a DAB system. It can also be used to provide access to baseband I/Q signals for test purposes.

ETS 300 401 established a broadcasting standard for a DAB system. Broadcasters who implement DAB networks require standardized interfaces for the connection of different equipment in the DAB chain.

The present document is applicable to DAB channel coding equipment. It describes the characteristics of a suitable interface for the connection of the two major elements of the DAB OFDM generator; the baseband processing equipment and the RF modulator. The interface provides an interconnection between a single source (the baseband processor) and a single destination (the RF modulator).

The present document does not cover the generation of the digital I/Q baseband signals. This is covered in ETS 300 401. The digital baseband I/Q interface is unidirectional and does not cover the provision of status nor control information in the reverse direction (i.e. from the modulator back to the baseband processing section of the equipment).

2 References

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ITU-R BT.656-2 (November 1994): "Interfaces for digital component video signals in 525-line and 625-line television systems".

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purposes of the present document, the definitions of ETS 300 401 (see bibliography) and the following definitions apply:

baseband I/Q: A representation of the DAB transmission signal using I and Q components of the carrier which represent the amplitude of the in-phase and quadrature components of the transmission signal.

baseband processing: When applied to the DIQ interface, this is taken to mean that part of the OFDM generator which receives the ETI signal and produces the DIQ signal.

CIFcount: The Common Interleaved Frame (CIF) counter as defined in ETS 300 401 (see bibliography).

COFDM: Coded Orthogonal Frequency Division Multiplex; the combination of channel coding and OFDM as used in the DAB system.

data transfer time: The instant at which data is read by the DIQ receiver.

digital baseband I/Q: A version of the baseband I/Q signal using digital samples to represent the amplitudes of I and Q.

DAB transmission signal: The radio frequency signal radiated from a DAB transmitter.

DAB transmission frame: The transmitted frame, specific to the four transmission modes used by the DAB system, conveying the DAB data.

ensemble: The DAB transmission signal, comprising a set of regularly and closely-spaced orthogonal carriers. The ensemble is the entity which is received and processed by the DAB receiver. In general, it contains programme and data services. Also sometimes used loosely to describe the package of data (or Ensemble Multiplex) representing that signal.

null symbol: The first Orthogonal Frequency Division Multiplex (OFDM) symbol of the DAB transmission frame.

OFDM: Orthogonal Frequency Division Multiplex, the modulation method employed by the DAB system.

OFDM generator: The equipment which is the final recipient of the ETI signal and which generates the OFDM signal from it. The OFDM generator is taken to have two major parts - baseband processing, which generates a baseband I/Q signal as an intermediate step, followed by RF modulation.

RF modulator: When applied to the DIQ interface, this is taken to mean that part of the OFDM generator which receives the DIQ signal and produces a DAB transmission signal.

3.2 Abbreviations

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

CLK	Clock
COFDM	Coded Orthogonal Frequency Division Multiplex
DAB	Digital Audio Broadcasting
DIQ	Digital baseband I/Q interface
ECL	Emitter-Coupled Logic
ETI	Ensemble Transport Interface
FFT	Fast Fourier Transform
FIC	Fast Information Channel
FSYNC	Frame Synchronization
GND	Ground
I(t)	the time variant, In-phase component of the modulated signal
I/Q	In-phase and Quadrature components of the modulated signal
I_n	the n^{th} sample of I(t)
$I_{TII}(t)$	the time variant, In-phase component of the modulated signal during the TII symbol
ITU	International Telecommunications Union
LSb	Least Significant bit
MSb	Most Significant bit
NRZ	Non-Return-to-Zero
OFDM	Orthogonal Frequency Division Multiplex
Q(t)	the time variant, Quadrature component of the modulated signal
Q_n	the nth sample of Q(t)
$Q_{TII}(t)$	the time variant, Quadrature component of the modulated signal during the TII symbol
$\overline{Q}$ / I	an alternating signal which identifies a DIQ sample as either an I_n or Q_n sample
RF	Radio Frequency
rms	root-mean-square
s(t)	the time variant DAB transmission signal
s_n	the sampled version of the DAB transmission signal
STI	Service Transport Interface
TII	Transmitter Identification Information

3.3 Symbols

For the purposes of the present document, the following mathematical symbols apply:

3.3.1 Numerical ranges

[m.n] denotes the numerical range m, m + 1, m + 2,..., n, where m and n are positive integers with n > m.

3.3.2 Bit numbering

b_n denotes bit number *n*. *n* is usually in the range [0..7].

3.3.3 Arithmetic operators

+	Addition
×	Multiplication

3.3.4 Functions

cos x	Cosine of x
sin x	Sine of x
j	Imaginary unit with $j^2 = -1$
σ	rms value

3.3.5 Constants

π 3,141 592 653 59...

4 Conceptual location of the DIQ interface

Figure 2 is a modified version of a diagram taken from ETS 300 401 (see bibliography) and shows the conceptual block diagram of the emission part of the DAB system. The conceptual location of the DIQ is shown on the diagram.

The DIQ interface may also be used directly at the output of the baseband processing part of the OFDM generator, as shown in figure 2, in circumstances where the TII is not required, or is to be added at a later stage.

5 General description of the DIQ signal

5.1 Mathematical definition

The time variant DAB transmission signal, s(t), at a carrier frequency f_c, shall be given as follows:

$$s(t) = I(t)\cos(2\pi f_c t) - Q(t)\sin(2\pi f_c t)$$

where I(t) and Q(t) represent the In-phase and Quadrature, time variant, components of the carrier signal.

The signal carried by the DIQ, s_n, shall be the sampled version of the In-phase and Quadrature components of the DAB transmission signal, I(t) and Q(t), sampled at the frequency f_s. The sampled values, I_n and Q_n, at time $t_n = (n/f_s)$ shall be given by the following expression:

$$S_n = I_n + j\,Q_n$$

where n is 0, 1, 2, ...
and f_s is the sampling frequency.