

REPORT 956-2

DATA BROADCASTING SYSTEMS: SIGNAL AND SERVICE QUALITY, FIELD TRIALS AND THEORETICAL STUDIES

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(1982-1986-1990)

1. Introduction

Data broadcasting systems utilizing television networks are already implemented in different countries for providing a multitude of services. The quality of these services depends on:

- the characteristics of the data transmission channel;
- the effect of these characteristics on the intended services.

To provide a suitable service, measurements on data transmission channels are necessary and appropriate methods have to be devised.

Part I of this Report deals with the measurement of the quality of broadcast digital data channels, Part II discusses the effects of the transmission channel on the service quality in the case of teletext*.

PART I

MEASUREMENT OF THE QUALITY OF BROADCAST DIGITAL DATA CHANNELS

1. General

Data packets inserted in some lines (data lines) of a video signal are corrupted, like the video signal itself, by noise and distortion. Given the digital nature of a data signal, the effects of these impairments are different from those produced on the analogue video signal and cannot be easily deduced on the basis of measurements carried out on conventional television test signals, such as described in Recommendation 473 (Insertion test signals) [CCIR, 1978-82a].

The quality of a digital data channel and the data acquisition circuit of its decoder may be defined in terms of percentage of data which, at the receiving site, are lost or discarded, or are accepted with errors. In this light, it is possible to define parameters representing loss or error ratios, some of which provide an indication of the performance of a data channel and the data acquisition circuit of its decoder irrespective of its use. Others refer only to particular applications, such as teletext.

In addition, the following analogue measurements can be carried out on a data signal:

- measurement of data levels,
- measurements related to eye pattern displays,
- measurement of decoding margin.

2. Digital measurements

2.1 Data packet loss- and bit error ratios

Digital data, inserted in a data line, consists of three parts:

- the initial run-in signal for bit synchronization;
- the framing code for byte synchronization;
- the data packet, which differs from system to system (see Recommendation 653).

* The terms "teletext" and "broadcast videography" are, at present, used interchangeably (see Appendix II to Recommendation 662).

In the case of certain data broadcasting systems, the data block is followed by a suffix for error-correction purposes.

Two impairments which can occur to the data packet [CCIR, 1978-82b, 1986-90] are:

- misinterpretation of the prefix, which results in the loss of the whole packet or a part of it, or its assignment to a wrong data channel,
- errors in the data block.

Since the data channel address is usually protected by special techniques (such as Hamming codes) the probability of a data packet being assigned to a wrong channel is usually very low. Thus, the most important parameter which quantifies the first type of impairment is the data packet loss-ratio. If the data packet does not contain a format description, it can be either totally lost or totally retained. In this case, the data packet loss-ratio can be simply defined as the percentage of transmitted data packets which has not been received. On the other side, when a format description is contained in the prefix, a misinterpretation of it can cause the loss of only part of the data, or the incorrect read-out of non-existing data. For this more complex case a convenient measurement method has not yet been proposed.

The second type of impairment (errors in the data block) is mainly characterized by the parameter "bit error ratio", defined as the percentage of the *received** bits that are affected by error. For the definition of a suitable error-correcting strategy, the knowledge of the statistical properties of errors may also be useful (for example, the probability of consecutive errors, or the distribution of errors along the data line).

2.2 Measurements on particular data sequences

It may be interesting, in order to investigate certain phenomena, to use fixed data sequences, so chosen as to be particularly sensitive to the distortions introduced by the system under test. An example of the fixed sequence is the "clock cracker", namely a sequence including as frequently as possible the maximum distance between transitions. This is used to test a type of clock-recovery circuit which makes use of all the data sequence, rather than solely the run-in sequence. It is also used to measure data levels [Croll, 1977].

Another example is a data sequence made of bytes, each of which contains a parity bit. This sequence allows the quality of the data broadcasting channel to be measured on a byte basis. It is also possible to make a rough estimate of the distribution of errors, which may be either random or concentrated on those bytes which produce a bit configuration particularly sensitive to inter-symbol interference.

Measurements of various types of error and loss ratios in conventional and specially protected (bi-phase) teletext signals are described in [Cominetti *et al.*, 1976]. These parameters may also be calculated using a comprehensive mathematical model [Vardo, 1977; Cominetti *et al.*, 1978].

3. Analogue measurements

A list of analogue parameters relating to measurements of data levels and eye pattern of a data signal is given in Appendix I.

4. Data test signals

Various data test signals have been defined for digital and analogue measurements.

Pseudo-random sequences: These are used for the measurement of bit error-ratio and packet loss-ratio and for the display of eye pattern [Dublet, 1977; Noirel, 1978].

* When a data block is lost, the contained bits are not taken into account when determining the bit error ratio.

Fixed data sequences: These are used for various purposes. An example is the sequence used in [Cominetti *et al.*, 1976] for the measurement of various types of error ratios and loss ratios. Another example is the "clock cracker sequence". This is a data line containing a character sequence including as frequently as possible the maximum distance between transitions. It is used to test the clock recovery circuit in the data receiver and to measure data levels [Croll, 1977; CCIR, 1978-82c and d].

Data pulse and bar: This signal is made up of an isolated data positive pulse, followed by a data bar (sequence of 1's), containing an isolated data negative pulse. It is used to obtain an eye-shaped diagram by superimposition of the two pulses, to measure data levels, and to analytically derive the eye pattern, in the presence of purely linear distortion [Croll, 1977].

Combined test sequence: A combination of clock run-in, data pulse and bar and a fixed data-sequence including all combinations of 7 successive bits, to provide a test half-line for inclusion in the field-blanking interval, complemented on alternate fields, has been illustrated [Holder, 1977].

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[1978-82]: a. 11/8 (EBU); b. 11/2 (EBU); c. 11/11 (Germany (Federal Republic of)); d. 11/35 (UK).

[1986-90]: JIWP 10-11/5-65 (EBU).

APPENDIX I TO PART I

PROPOSED DATA SIGNAL PARAMETERS – CONCEPTUAL DEFINITIONS

1. **All-zeros level:** the level resulting from a continuous stream of "zero" pulses.
2. **All-ones level:** the level resulting from a continuous stream of "one" pulses.
3. **Mid-level:** the level midway between all-zeros and all-ones levels.
4. **Basic amplitude:** the difference between the all-zeros and the all-ones levels.
5. **Zeros overshoots:** the amount by which the peak value of the signal extends beyond the all-zeros level.
6. **Ones overshoots:** the amount by which the peak value of the signal extends beyond the all-ones level.
7. **Peak-to-peak amplitude:** the sum of basic amplitude, zeros overshoots and ones overshoots.
8. **Eye height:** in a noise-free data signal, the eye height reflects the smallest difference which may exist between any "zero" pulse and any "one" pulse over all signal sampling positions. It is expressed as a proportion of the basic amplitude. (In practice, the sampling positions depend on the type of clock used, which must be specified).