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SPECIFICATIONS OF MEASURING EQUIPMENT

EQUIPMENT TO PERFORM IN-SERVICE MONITORING ON 2048, 8448, 34 368 AND 139 264 kbit/s SIGNALS

Recommendation O.162

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

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CCITT NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized private operating agency.

Recommendation O.162

EQUIPMENT TO PERFORM IN-SERVICE MONITORING ON 2048, 8448, 34 368 AND 139 264 kbit/s SIGNALS

(Published in 1980; revised 1988 and 1992)

Abstract

Defines the requirements for an equipment to perform in-service monitoring of digital signals at bit rates of 2, 8, 34 and 140 Mbit/s using the frame alignment signal.

Keywords

– frame alignment signal monitoring;

– frame analyser;

– in-service monitoring;

– measurement;

– tester.

PREAMBLE

Section 1 applies to all four bit rates (2048, 8448, 34 368 and 139 264 kbit/s).

Section 2 provides additional information applicable to 2048 kbit/s signals only.

1 General

1.1 *Application*

This specification describes equipment for performing in-service error tests on digital signals having frame structures that are in accordance with § 2.3 and 2.4 of Recommendation G.704 [1], and Recommendation G.751 [2].

The equipment is required to monitor signals at the first, second, third and fourth hierarchical levels, as defined in Recommendation G.702 [3].

1.2 *Events to be monitored*

The following events shall be monitored:

1.2.1 *Alarm conditions, frame alignment signal errors*

The equipment is required to display any inherent alarm conditions in the signal and to be capable of counting errors in the Frame Alignment Signal (FAS).

1.2.2 *Code violations*

The equipment may also, if so desired, count and display violations of the relevant code as a separate operation.

1.2.3 *Cyclic redundancy check*

The equipment is required to monitor any Cyclic Redundancy Check (CRC) procedure signals, in accordance with Recommendations G.704 [1] and G.706 [4].

1.2.4 *Access to time slots*

As an option, the equipment may provide access to the information bits conveyed in any selected time slot.

1.3 *Decoding strategy*

When necessary, the received digital signal shall be decoded by the equipment in an appropriate manner.

1.3.1 *HDB3 decoding strategy*

When necessary, the received digital signal shall be decoded by the equipment in a manner such that, when sampling the signal, on recognition of 2 consecutive zeros (spaces) followed by a bipolar violation, the decoder shall substitute 4 consecutive zeros in place of the bipolar violation and the 3 preceding digits.

1.3.2 *CMI decoding strategy*

Under study.

1.4 *Functionality, demultiplexing*

The functionality required for more than one bit rate may be provided in a single piece of equipment.

As an option, the functionality for more than one bit rate may be combined with a demultiplexing capability to allow tributaries at higher order rates to be monitored.

1.5 *Digital signal input*

1.5.1 *Interfaces*

The equipment is required to operate at the following interfaces and under the following input conditions:

1.5.1.1 *Recommendation G.703*

Input impedances and levels in accordance with Recommendation G.703 [5].

1.5.1.2 *Recommendation G.772*

Input impedances and levels in accordance with the specifications for protected monitoring points of Recommendation G.772 [6].

1.5.1.3 *Return loss*

The return loss at the digital signal input to the measuring equipment shall comply with Table 1/O.162.

The limits defined in Table 1/O.162 shall be met when measured against a non-reactive resistance equal to the nominal impedance.

1.5.2 *Signal input gating*

The equipment shall incorporate a timing recovery circuit, operated from the incoming digital signal, such that the monitored bit stream is sampled during a short gating period at the mid-point of each unit interval.

1.5.3 *Input jitter tolerance*

The equipment shall operate correctly with an input signal jitter in accordance with the relevant limits as defined in Recommendation G.823 [7].

TABLE 1/O.162

Return loss at the input

Bit rate	Measurement Bandwidth	Nominal Impedance	Return Loss
2 048 kbit/s	0,04 to 2,5 MHz	75/120 Ω	$\geq$ 20 dB
8 448 kbit/s	0,2 to 0,4 MHz 9 to 13 MHz 0,4 to 9 MHz	75 Ω	$\geq$ 15 dB $\geq$ 15 dB $\geq$ 20 dB
34 368 kbit/s	0,8 to 1 MHz 35 to 52 MHz 1 to 35 MHz	75 Ω	$\geq$ 15 dB $\geq$ 15 dB $\geq$ 20 dB
139 264 kbit/s	7 to 210 MHz	75 Ω	$\geq$ 15 dB

Note – The non-reactive portion of the input impedance shall deviate less than $\pm$ 1 % from the nominal impedance.

1.6 *Fault and error indications*

The equipment shall incorporate fault indications to meet the alarm strategies of equipment in accordance with the requirements of Recommendations G.732 [8], G.742 [9] and G.751 [2].

A possible fault indication plan is illustrated in § 1.6.1. All fault indications are normally in the quiescent state, for example if indicator lamps are used they will be extinguished.

1.6.1 *Fault indication plan*

1.6.1.1 *Loss of signal*

A fault indication shall be given if more than *x* consecutive zeros are detected.

The value of x requires further study.

1.6.1.2 *Alarm indication signal*

The equipment shall recognize a signal containing less than y consecutive zeros as a valid alarm indication signal (AIS) and the appropriate indication shall be given.

The strategy for the detection of the presence of an AIS shall be such that the AIS is detectable even in the presence of a code violation ratio of 1 in 10^3. However, a signal with all bits in the ONEs state, except the FAS, shall not be mistaken for a valid AIS.

The value of y requires further study.

1.6.1.3 *Loss and recovery of frame alignment*

In the event of a loss of frame alignment, as defined in the G.700-Series Recommendations, the equipment shall recognize the loss and the appropriate indication shall be given.

In the event of recovery of frame alignment, as defined in the G.700-Series Recommendations, an indication shall be given or cancelled, as appropriate.

Note – If applicable, the equipment shall be able to synchronize to frames with or without CRC bits.

1.6.1.4 *Distant alarm*

The appropriate indication shall be given if the distant alarm condition is detected.

1.6.2 *Error indications*

1.6.2.1 *Frame alignment signal errors*

The equipment shall indicate the equivalent binary error ratio of the incoming digital signal based on the number of detected incorrect FAS. It is assumed that the FAS is a satisfactory sample and the error ratio based on FAS is valid for the whole decoded signal. Error ratios from $1 \cdot 10^{-3}$ to $1 \cdot 10^{-9}$ (minimum range) shall be indicated.

1.6.2.2 *Cyclic redundancy check procedure*

The equipment shall indicate the equivalent binary error ratio detected by means of the CRC procedures. Error ratios from $1 \cdot 10^{-5}$ to $1 \cdot 10^{-7}$ (minimum range) shall be indicated.

1.6.2.3 *Total error count*

The equipment shall indicate a count of the total errors monitored. The capacity of the counter shall be at least 99999. An indication shall be given if the maximum count total is exceeded.

1.7 *Display*

1.7.1 *Count control*

It shall be possible to manually control the duration of an error count sequence by means of "start" and "stop" controls.

It shall be possible to reset the error counters and associated displays.

1.7.2 *Indicator lock, indicator auto-reset*

A facility shall be provided whereby a fault indication either clears automatically when the fault condition clears or remains until a manual reset is operated.

1.8 *Alarm function check*

A method of introducing fault conditions into the incoming digital signal, in order to check the correct functioning of the equipment, shall be considered.

1.9 *Output to external recording devices (optional)*

As an option, an interface/interfaces shall be provided to enable external recording (e.g. by means of a printer) of the following data:

– alarm indications;

– error indications;

– status of the digital signal input to the instrumentation.

This interface shall be in accordance with Recommendations V.24 [10] and V.28 [11]. At the interface, suitably abbreviated, plain text message in ASCII/T.50 coded format according to the requirements of Recommendation V.4 [12] is preferred.

1.10 *Demultiplexing capability (optional)*

As an option, it shall be possible to select a tributary from a higher order signal for subsequent analysis of the frame alignment signal in accordance with the requirements of § 1.6 of this Recommendation. Where the tributary signal contains further lower level tributaries, additional demultiplexing to recover and analyse one selected lower order tributary per hierarchical level shall be provided.

For each selected tributary at each hierarchical level all of the fault and error indications defined in § 1.6 of this Recommendation shall be provided.

1.11 *Performance indications (optional)*

As an option, the equipment shall be capable of providing performance information in accordance with Recommendation G.821 [13].

1.12 *Operating conditions*

The electrical performance requirements of this Recommendation shall be met when the equipment is operated within the environmental conditions defined in Recommendation O.3 [14].

2 Requirements for equipment operating at 2048 kbit/s

2.1 *Events to be monitored*

2.1.1 *Loss and recovery of frame alignment*

In the event of a loss of frame alignment, as defined in § 3 of Recommendation G.706 [4], the equipment shall recognize the loss and the appropriate indication shall be given.

In the event of recovery of frame alignment, as defined in § 3 of Recommendation G.706 [4], an indication shall be given or cancelled, as appropriate.

2.1.2 *Errors in the frame alignment signal*

The indication of binary error ratios occurring in the received decoded signal shall comply with the limits given in Table 2/O.162. The binary error ratios are calculated from detected incorrect FAS. It is assumed that the FAS is a satisfactory sample and the error ratio calculated is valid for the whole of the counter's measurement period.

TABLE 2/O.162

Probability of occurrence of binary error ratio indications (from FAS)

Binary error ratio indication	Average binary error ratio in decoded signal	Probability of indication being given or cancelled within the periods stated below	
		Indication given	Indication cancelled
$1 \cdot 10^{-3}$	$1 \cdot 10^{-3}$ $5 \cdot 10^{-4}$ $1 \cdot 10^{-4}$	50% within 0.3 s 5% within 0.3 s –	5% within 0.3 s – 95% within 0.3 s
$1 \cdot 10^{-4}$	$1 \cdot 10^{-4}$ $5 \cdot 10^{-5}$ $1 \cdot 10^{-5}$	50% within 3 s 5% within 3 s –	5% within 3 s – 95% within 30 s
$1 \cdot 10^{-5}$	$1 \cdot 10^{-5}$ $5 \cdot 10^{-6}$ $1 \cdot 10^{-6}$	50% within 30 s 5% within 30 s –	5% within 30 s – 95% within 30 s

2.1.3 *Loss and recovery of multiframe alignment*

In the event of a loss of multiframe alignment, as defined in § 5.2 of Recommendation G.732 [8], the equipment shall recognize the loss and an appropriate indication shall be given.

In the event of recovery of multiframe alignment, as defined in § 5.2 of Recommendation G.732 [8], an indication shall be given or cancelled, as appropriate.

Note – If time slot 16 is used for common channel signalling, the multiframe alignment signal is not present in a nominal input signal to the equipment. In this case it shall be possible to inhibit the loss of multiframe indicator in order to prevent false alarm indications.

2.1.4 *Distant alarm*

The equipment shall recognize the distant alarm condition as defined in Recommendation G.732 [8], as conveyed by the state of bit 3 of time slot 0 in frames alternate to those containing the FAS. The distant alarm condition shall be considered to be active, and the appropriate indication given, when bit 3 is set to state ONE in four or more consecutive occurrences, and shall be considered to be inactive, and the appropriate indication not given, when bit 3 is set at state ONE in less than two consecutive occasions.

2.1.5 *Distant multiframe alarm*

The equipment shall recognize the distant multiframe alarm condition as defined in Recommendation G.732 [8], as conveyed by the state of bit 6 of time slot 16 of frame 0. The distant multiframe alarm condition shall be considered to be active, and the appropriate indication given, when bit 6 is set at state ONE in three consecutive occurrences, and shall be considered to be inactive, and the appropriate indication not given, when bit 6 is set at state ONE in less than two consecutive occasions.

Note – The text above is only applicable if time slot 16 is not carrying a payload e.g. common channel signalling. If time slot 16 is used for common channel signalling, bit 6 will be continuously in state ONE. In this case, it shall be possible to inhibit the distant multiframe alarm in order to prevent false alarm indications.

2.1.6 *Cyclic redundancy check procedure*

Where a CRC procedure in accordance with Recommendation G.704 [1] is implemented within the 2048 kbit/s signal, the equipment shall provide the features detailed in this sub-section.

The equipment shall indicate the presence of CRC framing bits.

The indications of binary error ratios occurring in the received decoded signal (detected by means of the CRC procedure) shall comply with the limits given in Table 3/O.162. The indication shall be provided accordingly.

TABLE 3/O.162

Probability of occurrence of binary error ratio indications (from CRC)

Binary error ratio indication	Average binary error ratio in decoded signal	Probability of indication being given or cancelled within the periods stated below	
		Indication given	Indication cancelled
$1 \cdot 10^{-5}$	$1 \cdot 10^{-5}$ $5 \cdot 10^{-6}$ $1 \cdot 10^{-6}$	50% within 1 s 5% within 1 s –	5% within 1 s – 95% within 1 s
$1 \cdot 10^{-6}$	$1 \cdot 10^{-6}$ $5 \cdot 10^{-7}$ $1 \cdot 10^{-7}$	50% within 10 s 5% within 10 s –	5% within 10s – 95% within 10s
$1 \cdot 10^{-7}$	$1 \cdot 10^{-7}$ $5 \cdot 10^{-8}$ $1 \cdot 10^{-8}$	50% within 100 s 5% within 100 s –	5% within 100 s – 95% within 100 s

2.1.7 *Code violation detection*

2.1.7.1 *Definition of an **HDB3 code violation***

Two consecutive bipolar violations of the same polarity constitute a code violation. This may not be the absolute number of errors. (see Annex A of Recommendation G.703 [5]).

2.1.7.2 *Indication of code violations*

When used as an HDB3 code violation detector, the equipment shall given an indication of the presence of a digital signal of correct amplitude and bit rate.

The code violation ratio shall be indicated in the range $1 \cdot 10^{-3}$ to at least $1 \cdot 10^{-6}$. Indications of code violations occurring in the input signal and detected as defined in § 2.1.7.1 above, shall be determined by counting the number of code violations that occur during the period of at least 10^6 time slots.

It shall be possible to indicate the sum of the code violations. This facility will not be required at the same time as the code violation ratio is being counted and displayed.

2.1.8 *Time slot access (optional)*

As an option, it shall be possible to access, at an external interface, the contents of any selected time slot, including time slot 16. An external interface meeting the requirements of a co-directional interface, as defined in Recommendation G.703 [5], is preferred.

References

[1] CCITT Recommendation G.704 *Synchronous frame structures of hierarchical digital interfaces.*

[2] CCITT Recommendation G.751 *Principal characteristics of higher order multiplex equipment.*

[3] CCITT Recommendation G.702 *Digital hierarchy bit rates.*

[4] CCITT Recommendation G.706 *Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in Recommendation G.704.*

[5] CCITT Recommendation G.703 *Physical/electrical characteristics of hierarchical digital interfaces.*

[6] CCITT Recommendation G.772 *Protected monitoring points provided on digital transmission systems.*

[7] CCITT Recommendation G.823 *The control of jitter and wander within digital networks which are based on the 2048 kbits/s hierarchy.*

[8] CCITT Recommendation G.732 *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s.*

[9] CCITT Recommendation G.742 *Second order digital multiplex equipment operating at 8448 kbit/s and using positive justification.*

[10] CCITT Recommendation V.24 *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment.*

[11] CCITT Recommendation V.28 *Electrical characteristics of unbalanced, double-current interchange circuits.*

[12] CCITT Recommendation V.4 *General structure of signals of international alphabet No. 5 code for character-oriented data transmission over public telephone networks.*

[13] CCITT Recommendation G.821 *Error performance of an international digital connection forming part of an integrated services digital network.*

[14] CCITT Recommendation O.3 *Climatic conditions and relevant tests for measuring equipment.*