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(10/98)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA,  
DIGITAL SYSTEMS AND NETWORKS

Digital transmission systems – Terminal equipments –  
Operations, administration and maintenance features of  
transmission equipment

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**Loss of Signal (LOS), Alarm Indication Signal  
(AIS) and Remote Defect Indication (RDI) defect  
detection and clearance criteria for PDH signals**

ITU-T Recommendation G.775

(Previously CCITT Recommendation)

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## ITU-T RECOMMENDATION G.775

### LOSS OF SIGNAL (LOS), ALARM INDICATION SIGNAL (AIS) AND REMOTE DEFECT INDICATION (RDI) DEFECT DETECTION AND CLEARANCE CRITERIA FOR PDH SIGNALS

#### Summary

This Recommendation gives the recommended criteria for the detection and clearance of LOS, AIS and RDI defects at intra-station interfaces conforming to Recommendation G.703 and operating at bit rates described in Recommendation G.702. The information provided complements the information on fault and consequent action given in the G.730-, G.740- and G.750-series Recommendations.

Appendix I contains examples of the criteria used in equipment that has been designed prior to the development of this Recommendation.

#### History

Issue	Notes
10/98	First revision includes a correction to Figure 1, and the addition of text related to the RDI defect detection in a new clause 6 and Appendix I.3. Furthermore, editorial modifications are included to comply with Recommendation A.3.
11/94	Initial version

#### Source

ITU-T Recommendation G.775 was revised by ITU-T Study Group 15 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 13<sup>th</sup> October 1998.

## FOREWORD

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

## NOTE

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

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As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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## **Recommendation G.775**

### **LOSS OF SIGNAL (LOS), ALARM INDICATION SIGNAL (AIS) AND REMOTE DEFECT INDICATION (RDI) DEFECT DETECTION AND CLEARANCE CRITERIA FOR PDH SIGNALS**

*(revised in 1998)*

#### **1 Scope**

This Recommendation provides the recommended criteria for the detection and clearance of LOS, AIS and RDI defects at intra-station interfaces conforming to Recommendation G.703 and operating at bit rates described in Recommendation G.702. The criteria given in this Recommendation should be applied to new equipment designs.

Appendix I contains examples of the criteria used in equipment designed prior to the development of this Recommendation.

#### **2 References**

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- CCITT Recommendation G.702 (1988), *Digital hierarchy bit rates.*
- ITU-T Recommendation G.703 (1998), *Physical/electrical characteristics of hierarchical digital interfaces.*
- ITU-T Recommendation G.704 (1998), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels.*
- CCITT Recommendation G.734 (1988), *Characteristics of synchronous digital multiplex equipment operating at 1544 kbit/s.*
- CCITT Recommendation G.742 (1988), *Second order digital multiplex equipment operating at 8448 kbit/s and using positive justification.*
- CCITT Recommendation G.743 (1988), *Second order digital multiplex equipment operating at 6312 kbit/s and using positive justification.*
- CCITT Recommendation G.747 (1988), *Second order digital multiplex equipment operating at 6312 kbit/s and multiplexing three tributaries at 2048 kbit/s.*
- CCITT Recommendation G.751 (1988), *Digital multiplex equipments operating at the third order bit rate of 34 368 kbit/s and the fourth order bit rate of 139 264 kbit/s and using positive justification.*
- CCITT Recommendation G.752 (1988), *Characteristics of digital multiplex equipments based on a second order bit rate of 6312 kbit/s and using positive justification.*
- CCITT Recommendation G.753 (1988), *Third order digital multiplex equipment operating at 34 368 kbit/s and using positive/zero/ negative justification.*

- CCITT Recommendation G.755 (1988), *Digital multiplex equipment operating at 139 264 kbit/s and multiplexing three tributaries at 44 736 kbit/s.*
- CCITT Recommendation M.20 (1992), *Maintenance philosophy for telecommunication networks.*

### 3 Abbreviations

This Recommendation uses the following abbreviations:

- AIS Alarm Indication Signal
- CAS Channel Associated Signalling
- LOS Loss of Signal
- RDI Remote Defect Indication

### 4 Criteria for detection and clearance of a Loss of Signal (LOS) defect

**4.1** A Loss of Signal (LOS) defect at 64 kbit/s interfaces is detected when the incoming signal has "no transitions", i.e. when the signal level is less than or equal to a signal level of B dB below nominal, for N consecutive pulse intervals, where  $10 \leq N \leq 255$ .

The LOS defect is cleared when the incoming signal has "transitions", i.e. when the signal level is greater than or equal to a signal level of A dB below nominal, for N consecutive pulse intervals, where  $10 \leq N \leq 255$ .

NOTE – The values of A and B are for further study. (Values of A = 6 and B = 35 have been proposed.)

**4.2** A LOS defect at 2048 kbit/s, 6312 kbit/s, 8448 kbit/s, 34 368 kbit/s and 139 264 kbit/s interfaces is detected when the incoming signal has "no transitions", i.e. when the signal level is less than or equal to a signal level of Q dB below nominal, for N consecutive pulse intervals, where  $10 \leq N \leq 255$ .

The LOS defect is cleared when the incoming signal has "transitions", i.e. when the signal level is greater than or equal to a signal level of P dB below nominal, for N consecutive pulse intervals, where  $10 \leq N \leq 255$ .

A signal with "transitions" corresponds to a G.703 compliant signal.

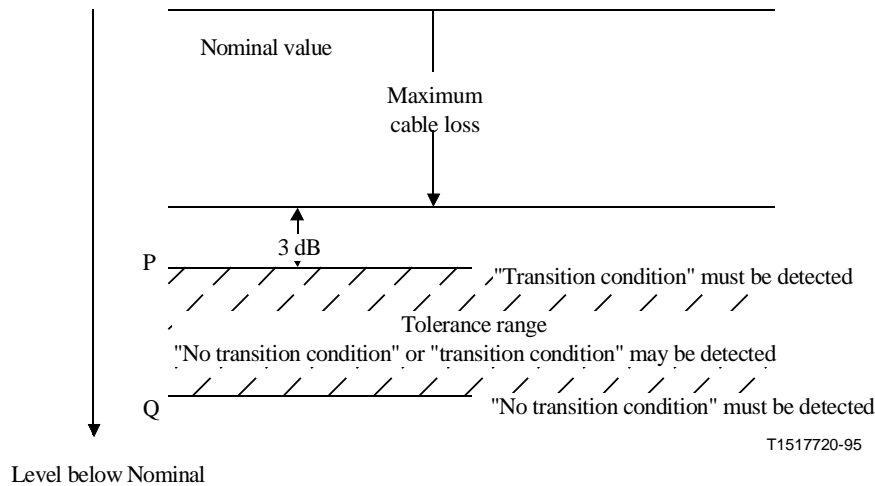
Values for P and Q are given in Table 1.

Figure 1 illustrates the relationship of the various signal levels.

**Table 1/G.775 – Signal levels P and Q for detection/clearance of a LOS defect**

Bit rate (kbit/s)	P (dB)	Q (dB)
2 048	9	35
6 312	9	35
8 448	9	35
34 368	15	35
139 264	15	35





NOTE 1 – The signal level P is (maximum cable loss +3) dB below nominal.  
 NOTE 2 – The signal level Q is greater than the maximum expected cross-talk level.

**Figure 1/G.775 – Criteria for determination of transition conditions**

**4.3** A LOS defect at a 1544 kbit/s interface is detected when the incoming signal has no transitions over a period of  $175 \pm 75$  contiguous pulse intervals.

The LOS defect is cleared when the incoming signal has an average pulse density of at least 12.5% over a period of  $175 \pm 75$  contiguous pulse intervals starting with the receipt of a pulse.

**4.4** A LOS defect at a 44 736 kbit/s interface is detected when the incoming signal has no transitions over a period of  $175 \pm 75$  contiguous pulse intervals.

The LOS defect is cleared when the incoming signal has an average pulse density of at least 33% over a period of  $175 \pm 75$  contiguous pulse intervals starting with the receipt of a pulse. Other equivalent algorithms that are based on the 33% average pulse density criteria are also acceptable.

## **5 Criteria for detection and clearance of an Alarm Indication Signal (AIS) defect condition**

**5.1** The criteria for detection of an AIS defect at a 64 kbit/s interface, other than for the channel associated signalling Time Slot (TS) which is described in 5.1.1, is for further study.

**5.1.1** An AIS defect for the 64 kbit/s channel associated signalling signal in TS-16, in the frame format of Recommendation G.704, is detected when the incoming TS-16 signal has three (3) or less ZEROs in each of two consecutive multiframe periods.

The defect is cleared when each of two consecutive multiframe periods contains four (4) or more ZEROs, or when the multiframe alignment signal has been found.

**5.2** An AIS defect at a 2048 kbit/s interface is detected when the incoming signal has two (2) or less ZEROs in each of two consecutive double frame periods (512 bits).

The defect is cleared when each of two consecutive double frame periods contains three (3) or more ZEROs or when the Frame Alignment Signal (FAS) has been found.

**5.3** An AIS defect at 6312 kbit/s (frame format per Recommendation G.747 ), 8448 kbit/s, 34 368 kbit/s and 139 264 kbit/s interfaces is detected when the incoming signal has X or less ZEROs in each of two consecutive frame periods (Y bits per frame).

The defect is cleared when each of two consecutive frame periods contains Z or more ZEROs, or when the frame alignment signal has been found. The values of X, Y and Z are given in Table 2.

**Table 2/G.775 – Number of ZEROs for detection/clearance of AIS defect**

Bit rate (kbit/s)	X (No. of ZEROs)	Y (bit/frame)	Z (No. of ZEROs)
6 312	4	840 (G.747)	5
8 448	4	848 (G.742)	5
34 368	4	1536 (G.751)	5
34 368	5	2148 (G.753)	6
139 264	5	954 (G.755)	6
139 264	5	2928 (G.751)	6

**5.4** An AIS defect at a 1544 kbit/s interface (frame format per Recommendation G.704 or Recommendation G.734) is detected when the incoming signal is an unframed signal with ONEs density of at least 99.9% present for a time equal to or greater than T, where T is 3 ms to 75 ms.

The AIS defect is cleared within a time period T when the incoming signal does not meet either the ONEs density or the unframed signal criteria, where T is 3 ms to 75 ms.

**5.5** An AIS defect at a 6312 kbit/s (frame format per Recommendation G.704 or Recommendation G.743) interface is detected when the incoming signal has two (2) or less ZEROs in a sequence of 3156 bits (0.5 ms).

The AIS signal defect is cleared when the incoming signal has three (3) or more ZEROs in a sequence of 3156 bits (0.5 ms).

**5.6** An AIS defect at a 44 736 kbit/s interface (frame format per Recommendation G.704 or Recommendation G.752) is detected when the AIS signal (defined in Recommendation G.704 for a frame format per Recommendation G.704 and defined in Recommendation M.20 for a frame format per Recommendation G.752) is present in contiguous M-frames for a time equal to or greater than T, where T is 0.2 ms to 100 ms.

The AIS defect is cleared when AIS signal is not detected in contiguous M-frames for a time equal to or greater than time T, where T is 0.2 ms to 100 ms.

**5.7** An AIS defect at a 32 064 kbit/s interface is detected when the incoming signal has two (2) or less ZEROs in a sequence of 1920 bits (see Recommendation G.752).

The AIS defect is cleared when the incoming signal has three (3) or more ZEROs in a sequence of 1920 bits.

**5.8** An AIS signal at a 97 728 kbit/s interface is detected when the incoming signal has two (2) or less ZEROs in a sequence of 1152 bits (see Recommendation G.752).

The AIS signal defect is cleared when the incoming signal has three (3) or more ZEROs in a sequence of 1152 bits.

## **6 Criteria for detection and clearance of a Remote Defect Indication (RDI) defect**

**6.1** A Remote Defect Indication (RDI) defect at 2048 kbit/s TS-16 path termination functions is detected when the incoming signal has the "alarm indication to the remote end" bit set to binary ONE ("1") for  $z = 1 \dots 5$ .  $z$  is not provisionable.

The RDI defect is cleared when the incoming signal has the "alarm indication to the remote end" bit set to binary ZERO ("0") for  $z$  consecutive CAS multiframe periods.

NOTE – The alarm indication to the remote end bit is the "y bit" in TS-16's frame 0 of the CAS multiframe defined in 5.1.3.2.2/G.704.

**6.2** A Remote Defect Indication (RDI) defect at 2048 kbit/s path termination functions is detected when the incoming signal has the "Remote alarm indication" bit set to binary ONE ("1") for  $z$  consecutive double frame periods, where  $z = 2 \dots 5$ .  $z$  is not provisionable.

The RDI defect is cleared when the incoming signal has the "Remote alarm indication" bit set to binary ZERO ("0") for  $z$  consecutive double frame periods.

NOTE – The Remote alarm indication bit is the "A bit" in the 2048 kbit/s frame defined in Recommendation G.704.

**6.3** A Remote Defect Indication (RDI) defect at 8448 kbit/s, 34 368 kbit/s and 139 264 kbit/s path termination functions is detected when the incoming signal has the "Alarm indication to the remote digital multiplex equipment" bit set to binary ONE ("1") for  $z$  consecutive frame periods, where  $z = 3 \dots 5$ .  $z$  is not provisionable.

The RDI defect is cleared when the incoming signal has the "Alarm indication to the remote digital multiplex equipment" bit set to binary ZERO ("0") for  $z$  consecutive frame periods.

NOTE – The Alarm indication to the remote digital multiplex equipment bit is bit 11 of Set I for the 8448 kbit/s frame defined in Recommendation G.742 and the 34 368 kbit/s frame defined in Recommendation G.751. It is bit 13 of Set I for the 139 264 kbit/s frame defined in Recommendation G.751. It is bit 4 of Set IV for the 139 264 kbit/s frame defined in Recommendation G.755.

## **APPENDIX I**

### **Other criteria that have been used for the detection/clearance of LOS, AIS or RDI defects**

The following provides information on a number of other criteria for the detection of AIS, LOS and RDI that have been implemented in equipment (components) designed prior to the development of this Recommendation:

#### **I.1 LOS defect detection/clearance criteria**

A LOS defect at a 64 kbit/s interface is detected by the absence of signal transitions on the incoming signal for a period of 31  $\mu$ s to 30 ms.

A LOS defect at a 2048 kbit/s interface is detected by the absence of signal transitions on the incoming signal for a period of 5  $\mu$ s to 1 ms.

A LOS defect at a 8448 kbit/s interface is detected by the absence of signal transitions on the incoming signal for a period of 1.2  $\mu$ s to 1 ms.

A LOS defect at a 34 368 kbit/s interface is detected by the absence of signal transitions on the incoming signal for a period of 0.3  $\mu$ s to 1 ms.

A LOS defect at a 139 264 kbit/s interface is detected by the absence of signal transitions on the incoming signal for a period of 36 ns to 1 ms.

NOTE – For all of the above signals, the LOS defect is cleared on the detection of signal transitions. The termination of the defect should be declared within the same time periods identified for the onset of the defect.

A LOS defect at 2048 kbit/s, 8448 kbit/s, 34 368 kbit/s, and 139 264 kbit/s interfaces is also detected in some implementations by a drop in incoming signal level below a reference level "x". In such cases, the LOS defect is cleared on an increase of signal level above a threshold of "x + h" ( $h > 1$  dB).

## **I.2 AIS defect detection/clearance criteria**

The following two different criteria for detection of an AIS defect at a 64 kbit/s interface have been used:

- 1) The incoming 64 kbit/s signal has five (5) or less ZEROs in a sequence of 128 ONEs.
- 2) The incoming 64 kbit/s signal is an unframed ONEs signal lasting at least 15.6 ms containing not more than  $0.2 \pm 0.1\%$  ZEROs.

The following two different criteria for the detection of an AIS defect at a 1544 kbit/s interface have been used:

- 1) The incoming 1544 kbit/s signal has one (1) or less ZEROs in a sequence of 24 frames (3 ms/4632 bits).
- 2) The AIS signal defect is cleared on detection of two (2) or more ZEROs in a sequence of 24 frames (3 ms/4632 bits).

The following three different criteria for detection of an AIS defect at a 2048 kbit/s interface have been used:

- 1) The incoming 2048 kbit/s signal has two (2) or less ZEROs in a sequence of 512 bits (250  $\mu$ s).
- 2) The incoming 2048 kbit/s signal is an unframed ONEs signal lasting at least 0.5 ms and containing not more than  $0.2 \pm 0.1\%$  ZEROs.

The AIS defect for both of the above conditions is cleared on receipt of a signal not conforming to the AIS defect criteria.

- 3) The incoming signal has one (1) or less ZEROs in each of two consecutive double frame periods (512 bits per double frame), and the FAS is not detected.

The defect is cleared if each of two consecutive double frame periods contains three (3) or more ZEROs or FAS has been found.

The following criterion for detection of an AIS defect at a 6312 kbit/s (see Recommendation G.704) interface has been implemented: an AIS defect is declared, when two (2) or less ZEROs are detected in a sequence of 3156 bits.

The AIS signal defect is cleared on detection of three (3) or more ZEROs in a sequence of 3156 bits.

The following three different criteria for detection of an AIS defect at a 8448 kbit/s interface have been used:

- 1) The incoming 8448 kbit/s signal has four (4) or less ZEROs in a sequence of 848 bits (100  $\mu$ s).
- 2) The incoming 8448 kbit/s signal is an unframed ONEs signal lasting at least 100  $\mu$ s containing not more than  $0.2 \pm 0.1\%$  ZEROs.

The AIS defect for both of the above conditions is cleared on receipt of a signal not conforming to the AIS defect criteria.

- 3) The incoming signal has four (4) or less ZEROs in each of two consecutive frame periods (848 bits per frame), and the FAS is not detected.

The defect is cleared if each of six consecutive frame periods contains five (5) or more ZEROs or FAS has been found.

The following three different criteria for detection of an AIS defect at a 34 368 kbit/s interface have been used:

- 1) The incoming 34 368 kbit/s signal has six (6) or less ZEROs in a sequence of 1536 bits.
- 2) The incoming signal is an unframed all ONEs signal lasting at least 45  $\mu$ s and containing no more than  $0.2 \pm 0.1\%$  ZEROs.

The AIS defect for both of the above conditions is cleared on receipt of a signal not conforming to the AIS defect criteria.

- 3) The incoming signal has six (6) or less ZEROs in each of two consecutive frame periods (1536 bits per frame), and the FAS is not detected.

The defect is cleared if each of three consecutive frame periods contains seven (7) or more ZEROs or FAS has been found.

The following three different criteria for detection of an AIS defect at a 139 264 kbit/s interface have been used:

- 1) The incoming 139 264 kbit/s signal has five (5) or less ZEROs in a sequence of 2928 bits.
- 2) The incoming 139 264 kbit/s is an unframed all ONEs signal lasting at least 21  $\mu$ s and containing not more than  $0.15 \pm 0.05\%$  ZEROs.

The AIS defect for both of the above conditions is cleared on receipt of a signal not conforming to the AIS defect criteria.

- 3) The incoming signal has five (5) or less ZEROs in each of two consecutive frame periods (2928 bits per frame), and the FAS is not detected.

The defect is cleared if each of three consecutive frame periods contains six (6) or more ZEROs or FAS has been found.

### **I.3 RDI defect detection/clearance criteria**

The following criterion for detection of an RDI defect at TS-16 level has been used:

- The RDI defect is raised at a single y bit set to binary ONE ("1") during a 5 ms sample period. The defect is cleared when the y bit is set to binary ZERO ("0") during the 5 ms sample period.

The following criterion for detection of an RDI defect at a 2048 kbit/s interface has been used:

- The RDI defect is raised at a single A bit set to binary ONE ("1") during a 5 ms sample period. The defect is cleared when the A or y bit is set to binary ZERO ("0") during the 5 ms sample period.

The following two different criteria for detection of an RDI defect at a 8448, 34 368 and 139 264 kbit/s interface have been used:

- 1) The "Alarm indication to the remote digital multiplex equipment" bit is extracted each frame. If this bit is active binary ONE ("1"), the remote alarm anomaly is detected. If the bit is active in two consecutive polls, the Remote Alarm defect is declared. A poll is done every 20 to 50 ms. When the Remote Alarm defect is declared, it is held at least for 1 second.
- 2) A Remote Defect Indication (RDI) defect is detected when the incoming signal has the "Alarm indication to the remote digital multiplex equipment" bit set to binary ONE ("1") for two consecutive frame periods.

The RDI defect is cleared when the incoming signal has the "Alarm indication to the remote digital multiplex equipment" bit set to binary ZERO ("0") for two consecutive frame periods.

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