

Recommendation Q.542**DIGITAL EXCHANGE DESIGN OBJECTIVES – OPERATIONS AND MAINTENANCE****1 General**

This Recommendation applies to digital local, combined, transit and international exchanges for telephony in Integrated Digital Networks (IDN) and mixed (analogue/digital) networks, and also to local, combined, transit and international exchanges in an Integrated Services Digital Network (ISDN).

The field of application of this Recommendation is more fully defined in Recommendation Q.500. Some objectives only apply to a certain type (or types) of exchange. Where this occurs, the application is defined in the text. Where no such qualification is made, the objective applies to all exchange applications.

2 Maintenance design objectives

The exchange shall be arranged so that normal maintenance activities can be easily performed by maintenance personnel. It should be capable of providing all information necessary for the identification of trouble conditions and the direction of repair activities.

2.1 Status and other information

The exchange shall provide information to maintenance personnel so that they can quickly ascertain:

- equipment/system status,
- critical load levels,
- trouble conditions,
- network management controls in effect.

2.2 Inputs and outputs

The exchange shall be able to transmit and receive maintenance information and respond to commands from on-site and if appropriate, from remote maintenance centre(s) or systems over the recommended interface(s) (Recommendation Q.513).

In performing operations and maintenance functions, the exchange shall use CCITT MML at its input/output terminals as covered in the Z.300-series of Recommendations.

2.3 Routine testing

The exchange shall have facilities for performing or directing routine test activities on its component parts and possibly with interfacing equipment or systems.

2.4 Trouble localization

The exchange shall have adequate facilities for diagnosing and locating faults within the exchange.

2.5 Fault and alarm detection and actions at interfaces A, B, V₂, V₃ and V₄

The exchange shall interact with transmission systems as required to detect fault and alarms and take appropriate actions.

2.5.1 Fault detection

The following fault conditions should be detected:

- failure of local power supply (if practicable);
- loss of incoming signal;

Note – The detection of this fault condition is required only when the fault does not result in an indication of loss of frame alignment.

- loss of frame alignment (see Recommendations G.706; the loss of frame alignment will also be assumed if no CRC multiframe alignment can be achieved or if the proportion of corrupted CRC checks exceeds a certain value);
 - excessive error ratio (without CRC procedure). The criteria for activating and deactivating the indication of the fault condition are given in draft Recommendation G.707. Consequent actions are given in § 2.5.3;
 - CRC error reporting, if applicable:
 - a) every time a received CRC block is detected errored by the exchange termination:
 - a report will be transmitted to the error monitoring function;
 - the information “one multiframe errored” is transmitted in the outgoing signal at the interface using an E bit (see Recommendation G.704, § 2.3.3.4);
 - b) every time that an E bit in the binary state 0 is received, a report will be transmitted to the error monitoring functions.
- (On a provisional basis the considerations related to the E bit may only apply to V interfaces – for further study.)

2.5.2 Alarm signal detection

The following alarm indications should be detected:

- Alarm indication (remote alarm) received from the remote end.
- AIS (alarm indication signal). The equivalent binary content of the alarm indication signal (AIS) is a continuous stream of “1”s at 2048 or 8448 kbit/s.

The strategy for detecting the presence of the AIS should be such that the AIS is detectable even in the presence of an error ratio of 1 in 10^3 . However, a signal with all bits except the frame alignment bit in the 1 state should not be mistaken as an AIS.

2.5.3 Consequent actions

2.5.3.1 Generation of alarm signals for action within the exchange

- The service alarm indication should be generated to signify that the service is no longer available (see Table 1/Q.542).
- The prompt maintenance alarm indication should be generated to signify that performance is below acceptable standards and that immediate maintenance attention is required locally (see Table 1/Q.542).

2.5.3.2 Generation of alarm signals transmitted by the exchange

- Alarm signals sent in the outgoing direction at the exchange interface. The relevant alarm bits for the remote alarm indication, as recommended in G.704 should be effected as soon as possible (see Table 1/Q.542).
- Alarm signals sent towards the switching function. Alarm indication signal applied in all received time-slots containing speech, data and/or signalling should be applied as soon as possible and not later than 2 ms after the detection of the fault condition (see Table 1/Q.542).

2.5.3.3 Removal of alarm indications

When all fault conditions have been cleared and alarm indication signal is no longer received, the alarm indication signal and remote alarm indication should be removed within the same respective time limits as specified in § 2.5.3.4 after the conditions have cleared.

TABLE 1/Q.542

Fault conditions and alarms detected by exchange termination functions and consequent actions
(excluding interface V₁)

Fault conditions and alarm signals detected	Consequent actions (see § 2.5.3)			
	Service alarm indication generated	Prompt maintenance alarm indication generated	Alarm indication to remote end generated	AIS towards the switching stages
Failure of power supply	Yes	Yes	Yes, if practicable	Yes, if practicable
Loss of incoming signal	Yes	Yes	Yes	Yes
Loss of frame alignment	Yes	Yes	Yes	Yes
Excessive error ratio	Yes	Yes	Yes	Yes
Alarm indication received from remote end	2048 + 8448 kbit/s: Yes 1544 + 6312 kbit/s: optional	1544 + 6312 kbit/s: Yes		
AIS received	Yes		Yes	Yes

Note — A *Yes* in the table signifies that an action should be taken. An open space in the table signifies that the relevant action should *not* be taken if this condition is the only one present. If more than one fault condition or alarm is simultaneously present, action should be taken if for at least one of the conditions a *Yes* is shown, except in the case of AIS received for which § 2.5.3.4 applies. The use of error performance monitoring in this table is for further study.

2.5.3.4 Alarm processing

The following items are required to ensure that equipment is not removed from service due to short breaks in transmission (e.g. due to noise or transient fault) and to ensure that maintenance action does not result where no direct maintenance action is required.

- The persistence of service alarm and of the prompt maintenance alarm indications may be verified for 100 ms before action is taken.
- When the AIS is detected, the prompt maintenance alarm indication, associated with loss of frame alignment and excessive error rate in the frame alignment pattern, should be inhibited.
- When the fault conditions cease, the service alarm and prompt maintenance alarm indications, if given, should be removed. Again, the persistence of this change in condition may be verified for 100 ms before action is taken.

- It is possible that some systems could suffer from frequent transient faults resulting in an unacceptable quality of service. For this reason, if a persistence check is provided, fault rate monitoring should also be provided for each digital transmission system. This monitoring will result in permanent removal from service of digital transmission system which are frequently removed from the service or frequently produce transient alarm conditions. The threshold for removal from service needs study. When this action is taken the service alarm indication and the prompt maintenance alarm indication shall be given.

2.5.4 Error performance monitoring using CRC

2.5.4.1 General

When the CRC procedure is implemented at the interface, the exchange should monitor the error performance of the interface to report on the performance (see Recommendation G.821).

2.5.4.2 Error performance parameters

The exchange should derive the following information from CRC checks in the incoming signal and received E bits:

- degraded minutes (DM),
- severely errored seconds (SES),
- error-free seconds (EFS).

Note 1 — These parameters are defined in Recommendation G.821.

Note 2 — The definition of a value for the suitable time interval during which the parameters should be assessed needs further study.

Note 3 — The choice has to be made between the association of one type of parameter to each direction of transmission and the integration of the two directions in one type of parameter. This needs further study.

Note 4 — The correlation between the results of CRC checks and the parameters quoted above requires further study.

2.5.4.3 Error performance evaluation

Each of the performance parameters will be processed separately in order to evaluate the performance of the interface.

The following classification of the interface maintenance conditions has to be made by the exchange (see I.600-series of Recommendations):

- correct functioning interface;
- degraded transmission interface;
- unacceptable transmission interface.

Note 1 — This section may only apply to V interfaces (for study).

Note 2 — The level at which an interface for ISDN access enters the degraded transmission condition may be dependent on the quality of service provided to the customer.

Note 3 — The levels at which an interface enters the degraded or unacceptable transmission conditions are for further study and are outside the scope of this Recommendation.

2.5.4.4 Consequent actions

For further study.

2.6 Fault and alarm signal detection and actions at interface V_1

The exchange shall interact with transmission systems as required to detect fault and alarm signals and take appropriate actions.

- a) Fault detection
- b) Alarm detection
- c) Consequent actions

To be specified

2.7 *Fault and alarm signal detection and actions at interface Z*

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|---|---|-----------------|
| <ul style="list-style-type: none"> a) Fault detection b) Alarm detection c) Consequent actions | } | To be specified |
|---|---|-----------------|

2.8 *Fault and alarm signal detection and actions for transmission systems*

Faults and alarms which cannot be directly detected by the exchange termination function but which are detected by transmission equipment (e.g., group pilot failure) should be accepted by the exchange as needed to take appropriate action.

2.9 *Fault and alarm signal detection and actions for channel associated signalling (2048 and 8448 kbit/s)*

2.9.1 *Fault detection*

The exchange signalling function should detect the following fault conditions for each multiplex carrying a 64-kbit/s signalling channel:

- failure of local power supply (if practicable),
- loss of 64 kbit/s incoming signal,

Note — The detection of this fault condition is required only when the fault does not result in an indication of loss of multiframe alignment.

- loss of multiframe alignment.

The criteria for activating and deactivating the indication of the fault condition are given in Recommendations G.732 and G.744.

2.9.2 *Alarm detection*

The exchange signalling function should detect the alarm indication (remote alarm) received from the remote end.

2.9.3 *Consequent actions*

2.9.3.1 *Generation of alarm signals for action within the exchange*

- The Service Alarm indication should be generated by the exchange signalling function to signify that the service is no longer available (see Table 2/Q.542).
- The prompt maintenance alarm indication should be generated to signify that performance is below acceptable standards and that immediate maintenance attention is required locally (see Table 2/Q.542).

2.9.3.2 *Alarm transmitted by the exchange*

An alarm indication (remote alarm) should be applied in the outgoing direction at the transmission/switching interface as soon as possible (see Table 2/Q.542). The relevant alarm bit for the remote alarm indication is given in Recommendation G.732.

2.9.3.3 *Removal of alarm indication*

When all fault conditions have been cleared and AIS is no longer received, the remote alarm indication should be removed as soon as possible.

2.9.3.4 *Alarm processing*

Same as in § 2.5.3.4.

TABLE 2/Q.542

Fault conditions and alarms detected by the exchange signalling function and consequent actions

Fault conditions and alarms detected)	Consequent actions (see § 2.9.3)		
	Service alarm indication generated	Prompt maintenance alarm indication generated	Alarm indication to remote end generated
Failure of power supply	Yes	Yes	Yes, if practicable
Loss of 64 kbit/s incoming signal	Yes	Yes	Yes
Loss of multiframe alignment	Yes	Yes	Yes
Alarm indication received from remote end	Yes		

Note — A *Yes* in the table signifies that an action should be taken. An open space in the table signifies that the relevant action should *not* be taken if this condition is the only one present. If more than one fault condition or alarm is simultaneously present, action should be taken if for at least one of the conditions a *Yes* is shown.

2.10 *Fault and alarm signal detection and actions for channel associated channel signalling (1544 kbit/s)*

Requires further study.

2.11 *Fault and alarm signal detection and actions for common channel signalling*

Requirements specified in relevant Recommendations apply.

2.12 *Fault and alarm detection and consequent actions — other functions of the exchange*

2.12.1 *Faulty circuits*

The exchange should not switch any new calls to a detected faulty circuit.

The exchange should remove from service all circuits found to be permanently faulty as detailed in §§ 2.5, 2.8, 2.9, 2.10 and 2.11.

2.12.2 *Master clock distribution*

The absence of timing information distributed from a master clock located at the exchange or received from an external master clock shall be recognized and a prompt maintenance alarm shall be given.

Changeover to an alternate timing source shall be operated so as to fulfil the requirements of §§ 2.7.2 and 2.7.3 of Recommendation Q.543.

2.12.3 *Internal timing distribution*

The distribution of timing information to the major elements of the exchange shall be supervised as required. A service alarm shall be given when a failure is detected. A maintenance alarm shall be given if it is appropriate.

Note — Remote elements may have to be taken into consideration.

2.13 *Supervision or testing of interface function*

The exchange shall have the capability of verifying the proper operation of the interface functions, including the fault detection and supervision functions.

Routine tests, statistical tests, manual activities and/or other means may be used to verify proper operation of these functions.

Information shall be given to the far end exchange when new calls cannot be established on the circuits on which routine tests are being initiated. Established calls, including semi-permanent connections, must not be interrupted. During the tests, the generation of alarms at the far end exchange due to the removal of circuits from service should be avoided, if possible.

2.13.1 *ET functions — Interfaces A, B, V₂, V₃ and V₄*

The verification of the proper operation of exchange termination functions can be performed by the means of statistical observations or by testing. Testing may be manual or automatic.

2.13.2 *ET functions — Interfaces C and Z*

- i) Failures of codecs (except those covered in ii) below) should be recognized by the exchange using the criteria defined in Recommendation G.732.
- ii) Supervision or testing of codecs of one or a small number of channels may be accomplished according to i) above or by inter-office transmission measurement and testing on circuits between exchanges or by statistical measurements.

2.13.3 *ET functions — Interface V₁*

To be specified.

2.14 *Supervision or testing of signalling functions*

In addition to fault detection required in § 2.7, the following applies.

2.14.1 *Channel associated signalling*

The exchange should be able to verify the proper operation of the signalling functions by generating and responding to test calls or by a statistical observation.

2.14.2 *Common channel signalling*

The exchange should be able to verify the proper operation of the signalling functions as required by common channel signalling recommendations.

2.15 *Supervision or testing of exchange connections*

Checking the different portions of the path individually in a digital exchange network helps to ensure the continuity of the connections overall. In this respect the exchange has to verify:

- the continuity across the exchange, as covered in this section;
- the continuity in the transmission links terminating on the exchange as covered in §§ 2.16 and 2.17.