INTERNATIONAL TELECOMMUNICATION UNION

ITU-T G.963

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(03/93)

DIGITAL SECTIONS AND DIGITAL LINE SYSTEMS

ACCESS DIGITAL SECTION FOR ISDN PRIMARY RATE AT 1544 kbit/s

ITU-T Recommendation G.963

(Previously "CCITT Recommendation")

FOREWORD

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The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation G.963 was prepared by the ITU-T Study Group XVIII (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR, or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 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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ACCESS DIGITAL SECTION FOR ISDN PRIMARY RATE AT 1544 kbit/s

(Helsinki, 1993)

1 General

1.1 Scope

This Recommendation describes the characteristics of the primary rate access digital section at 1544 kbit/s between the user network interface (at the T reference point, defined in Recommendation I.411) and the local exchange (at the V3 reference point, defined in Recommendation Q.512) supporting the 1544 kbit/s primary rate interface structures defined in Recommendation I.412 and the required additional functions.

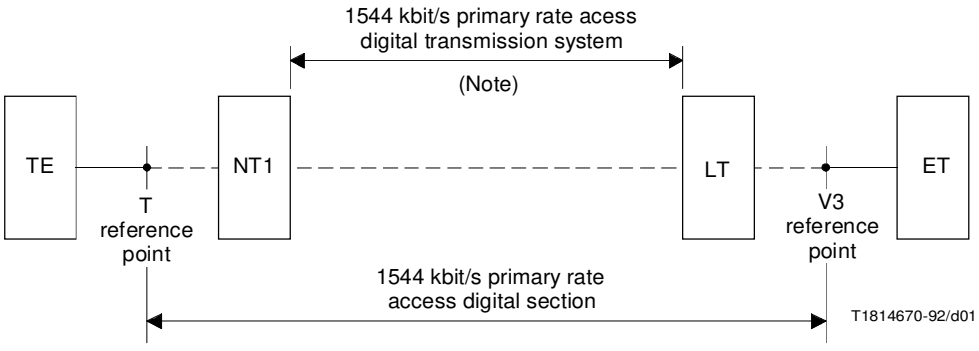
In this Recommendation and unless otherwise indicated, the term TE is used to indicate terminating layer 1 aspects of TE1, TA and NT2 functional groups.

When the term TE indicates terminating layer 1 aspects of TE1, then according to Figure 2/I.411, the S and T reference points coincide.

The terminology used in this Recommendation is contained in Recommendations I.112 and G.701.

1.2 Configuration

Figure 1 shows the boundaries of the access digital section in relation to the digital transmission system.



NOTE – The 1544 kbit/s primary rate access digital transmission system refers to either a line system using metallic media or optical fibres, or radio systems.

FIGURE 1/G.963

The 1544 kbit/s primary rate access digital section and digital transmission system boundaries

The concept of an access digital section is used in order to allow a functional and procedural description and a definition of network requirements.

NOTE – From a functional point of view, the information transferred acrosss reference points T and V3 is different and therefore the 1544 kbit/s primary rate access digital section may not be symetrical.

The concept of a digital transmission system is used in order to describe the characteristics of an implementation using a specific medium in support of the access digital section.

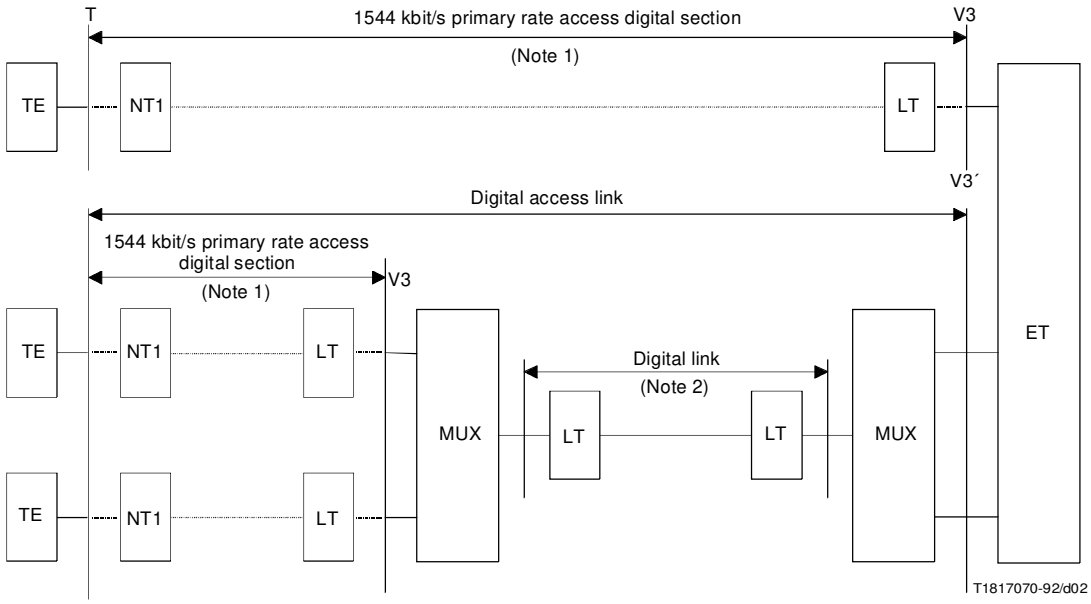
NOTE – The T and V3 reference points are defined in Recommendations I.411 and Q.512, respectively.

1.3 Application

The 1544 kbit/s primary rate access digital section may be applied as given in Figure 2 for:

– direct access to the local exchange (V3 reference point);

– access via higher order multiplex equipment to the local exchange.



NOTES

1 1544 kbit/s primary rate access digital sections may include one or more regenerators.

2 Multiple applications of digital links and multiplexors are possible.

FIGURE 2/G.963

Examples of equipment configurations in the ISDN subscriber primary rate access at 1544 kbit/s

1.4 Abbreviations

A number of abbreviations are used in this Recommendation, some of which are commonly used in the ISDN reference configuration while others have been created only for this Recommendation, as follows:

DS (1544 kbit/s Primary Rate) access Digital Section

FE Function Element used between ET and LT

SIG SIGnal between LT and NT1

DL 4 kbit/s Data Link (m-bits)

PRM Performance Report Message

HDLC High level Data Link Control procedures

2 Modelling and relationship between the digital section and the ET

The general model shown in Figure 3 depicts the whole ISDN customer access layer 1 and adjacent entities and provides the basis to describe the functions performed by the DS and those performed by TE, ET and system management and how various functions are grouped. In particular, according to this model the maintenance functions specified in this Recommendation are not confined to functions performed by the DS but include functions associated with ET layer 1.

This model includes primitive procedures between ET layer 1 and ET layer 2 and between ET layer 1 and system management:

– I.431 to Q.920/Q.921 interactions between ET layer 1 and ET layer 2 and between ET layer 1 and system management based on PH and MPH primitives, respectively, as defined in Recommendation I.431. These interactions are for the support of functions specified in Recommendations Q.920 and Q.921;

– interactions between ET layer 1 and system management for the support of functions associated with the DS, based on MPH primitives.

The primitive procedures within TE comply with the specification according to Recommendation I.431.

This model does not constrain layer 1 arrangements between LT and NT1, or the primary rate access digital transmission system technology.

3 Functions

For each direction of transmission of the DS the following shall be provided:

– 24 time-slots at 64 kbit/s for the transport of any appropriate allocation of the following: B-, H0-, and H11-channels;

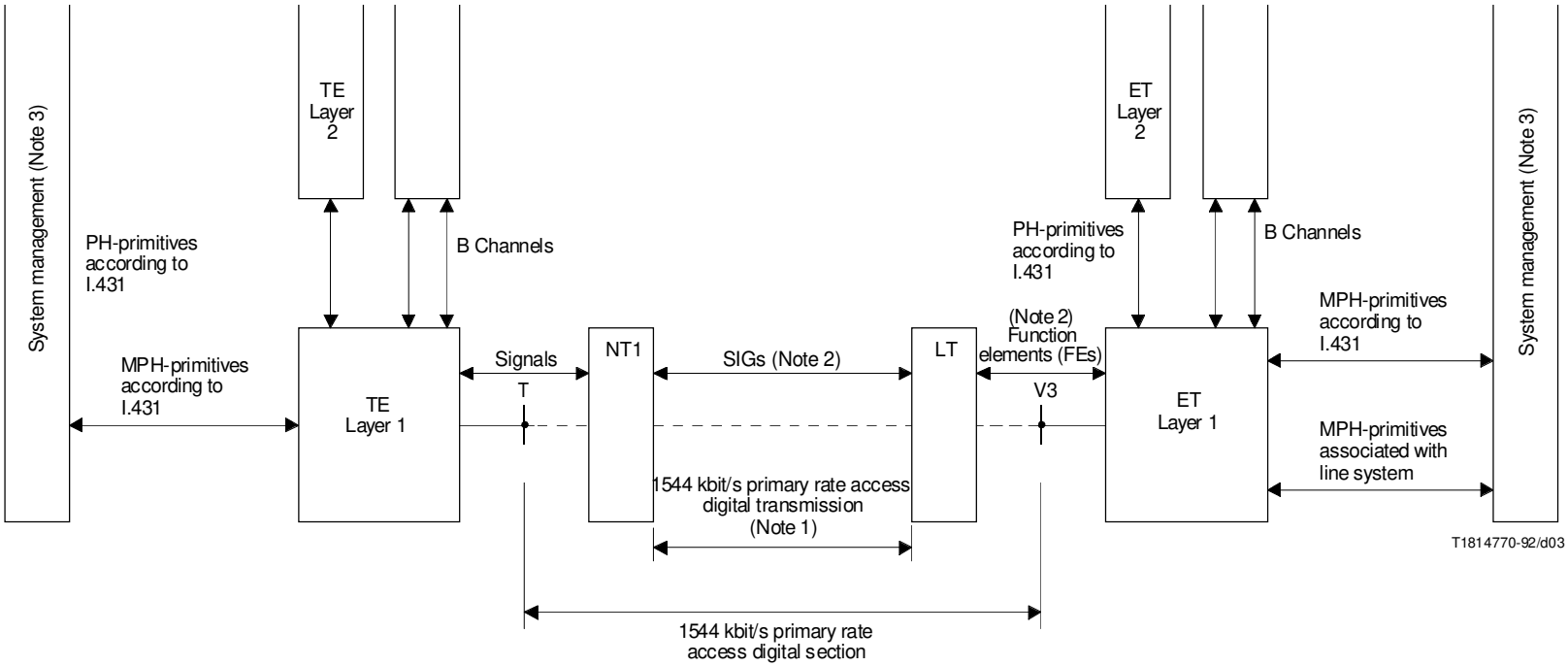
– 1 time-slot at 64 kbit/s within 24 time-slots for the transport of a D-channel when this channel is present;

– 8 kbit/s for frame alignment, and to follow the procedure for multiframe alignment, CRC, and the utilization of the m-bits, as described in Recommendations G.704 and G.706.

Figure 4 shows the functions which must be supported by the DS.

3.1 B-channel

This function provides for the bidirectional transmission of independent B-channel signals each having a bit rate of 64 kbit/s as defined in Recommendation I.412.



NOTES

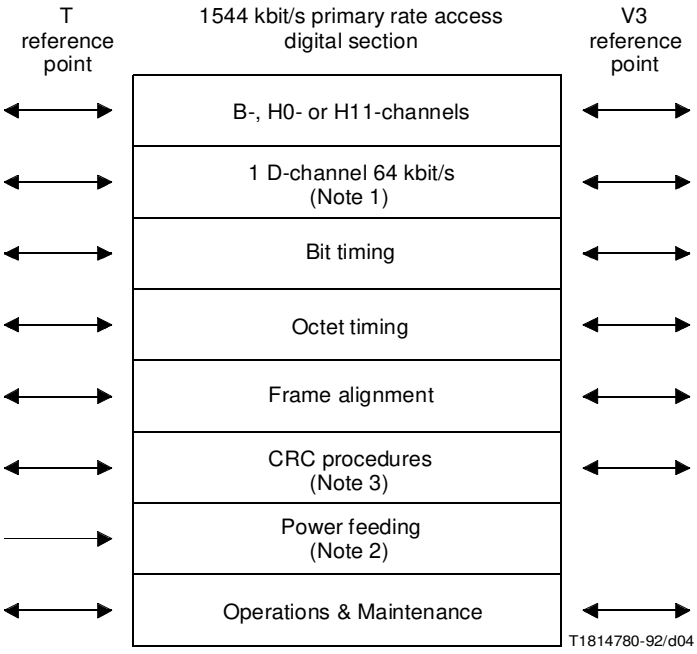
1 The digital transmission system refers to either a digital line transmission system using metallic media or optical fibres, or radio systems.

2 SIGs, FEs and primitives refer to an exchange of information. They do not imply any specific implementation. Some of these functions may be terminated in the LT and then would not pass the digital transmission system.

3 The term "system management" corresponds to both system and layer management as defined in Recommendation Q.940.

FIGURE 3/G.963

General model of ISDN customer access layer 1 and adjacent entitles



NOTES

1 Provided when this channel is present.

2 This power feeding function is optional. Only NT1 may be powered from the interface at the T reference point (see Recommendation I.431).

3 The generation, monitoring, or termination of the CRC bits is optional.

FIGURE 4/G.963

Functions

3.2 H0-channel

This function provides for the bidirectional transmission of independent H0-channel signals each having a bit rate of 384 kbit/s as defined in Recommendation I.412.

3.3 H11-channel

This function provides for the bidirectional transmission of an H11-channel signal having a bit rate of 1536 kbit/s as defined in Recommendation I.412.

3.4 D-channel

This function provides for the bidirectional transmission of a D-channel signal having a bit rate of 64 kbit/s as defined in Recommendation I.412.

3.5 Bit timing

This function provides bit (signal element) timing to enable the TE or NT and LT or ET to recover information from the aggregate bit stream.

3.6 Octet timing

This function provides 8 kHz timing for TE or NT and LT or ET to enable an octet structure for voice coders and for other timing purposes as required.

3.7 Frame alignment

This function provides information to enable the TE or NT and LT or ET to recover the time-division multiplexed channels.

3.8 CRC procedure

This function protects against false framing and may provide for error performance monitoring of the access digital section. This includes the multiframe procedure defined in Recommendation G.704.

3.9 Power feeding

This optional function feeds power to NT1 via the user network interface in accordance with Recommendation I.431.

3.10 Operations and maintenance

This optional function supports required actions and information for operating and maintaining the DS controlled by the ET as defined in Recommendation I.604. The function is conveyed by a bidirectional 4 kbit/s data link transported in the m-bits.

Four categories of functions have been identified:

- commands regarding LT, regenerator, or NT1;
- information from LT, regenerator, or NT1;
- indications of defect conditions;
- indications of access digital section power feeding status.

4 Network performance

4.1 Availability

The definition of availability is given in Annex A/G.821. The availability objective of the DS should be consistent with the availability requirement for the hypothetical reference digital section as given in Recommendations G.801 and I.350.

4.2 Signal transfer delay

Signal transfer delay is specified for B-channels and is defined as absolute signal delay between T and V3 reference points for each direction of transmission. The value shall be less than 2 ms when systems are implemented using metallic media, optical fibres, or a radio relay system. The application of a satellite system in the DS is also possible; however, for speech services, Recommendation G.114 may limit such an application until appropriate methods to control double satellite hops and switching of echo control devices are available. These methods are outside the scope of this Recommendation.

In case of remote application of the DS (see Figure 2 with a digital link between the DS and the ET) the signal transfer delay is defined for the DS between the T and V3 reference points.

4.3 Error performance

Error performance must be consistent with the requirements given in Recommendation G.821, local grade.

4.4 Jitter

4.4.1 Output/input jitter at the T reference point

The requirements are defined in 4.5/I.431.

4.4.2 Jitter at the V3 reference point

The input jitter limits are described in Recommendation G.824.

NOTE – If models described in Figure 2 are used to connect a customer to the ET, jitter reduction is not required at V3.

5 Operations and maintenance

5.1 General

This subclause describes the operations and maintenance functions for the DS.

Further assumptions regarding system management are given in Annex A. The maintenance functions defined in Recommendation I.604 provide the capability to maintain the DS to the level of network performance given in 4.

lt must be possible to test and maintain the DS in accordance with Recommendation I.604 regardless of the subscriber installation.

The main features are:

a) control of maintenance and test support facilities;

b) monitoring of the function elements to provide operating and performance information and fault condition indications;

c) maintenance communication facility.

5.2 Control facilities

5.2.1 Loopbacks

Loopbacks are maintenance tools used to assist in locating faults in the network. This specification covers loopback 1, 1A and 2 (see Recommendation I.604), all of which are complete loopbacks. Loopbacks are controlled by the codewords specified in Table 2.

5.2.1.1 Loopback implementation

The various loopbacks are summarized below, and illustrated in Figure 5.

1) Loopback 1 is located within the LT. It loops the 1544 kbit/s signal back to the ET.

2) Loopback 1A is located within the regenerator. It loops the 1544 kbit/s signal back to the ET.

3) Loopback 2 is located within the NT1 and loops the 1544 kbit/s signal (line loopback) or 1536 kbit/s signal (payload loopback) back to the ET. Loopback 2 may be implemented as a line loopback or as a payload loopback depending on whether the NT1 terminates framing.

NOTE – Line loopback shall result in a full 1544 kbit/s loopback back to the interface of the received bit stream. Bit sequence integrity shall be maintained.

A payload loopback is implemented only in equipment that terminates framing of the primary rate access line. The signal looped back to the received signal is 1536 kbit/s. The framing bits are originated at the loopback point. The payload loopback shall maintain bit sequence integrity for the information bits; however, the payload loopback need not maintain the integrity of eight-bit time slots, frames, or multi-frames.

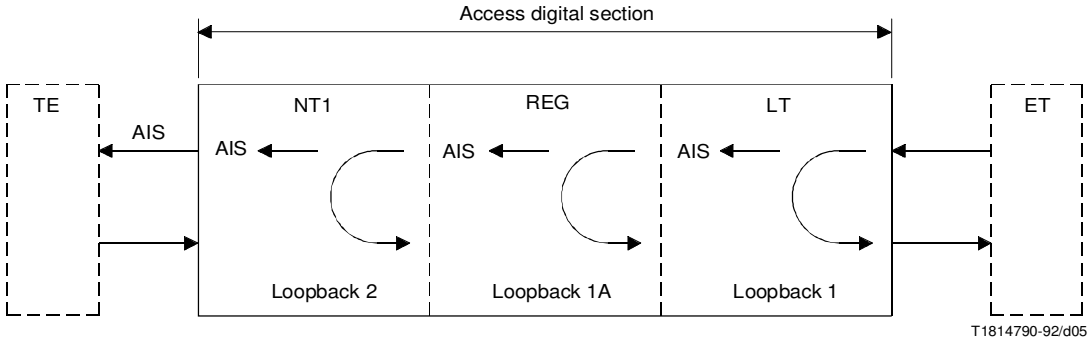


FIGURE 5/G.963

Loopbacks associated with the 1544 kbit/s access digital section

5.2.1.2 Loopback procedure

The loopback control conforms with Recommendation I.604.

A normal call set-up request cannot override a request for loopback 1, 1A or 2.

A sequence for the loopback procedure when controlled by the ET system management is:

a) ET generates an operation command for the required loopback;

b) ET receives loopback operation acknowledgement;

c) ET performs the test;

d) ET generates a release command;

e) ET receives a loopback release indication.

Activation of loopback shall be a two step process, as follows:

1) ET issues **a** loopback activate code 10 times in 160 consecutive m-bit positions;

2) the requested loopback is activated when the loopback activate code is detected at least 5 times and is no longer detected.

This procedure is applicable to options 1, 2 and 4 defined in Recommendation I.604. Refer to Figures 6, 7 and 8 for description to the options 1, 4 and 2, respectively.

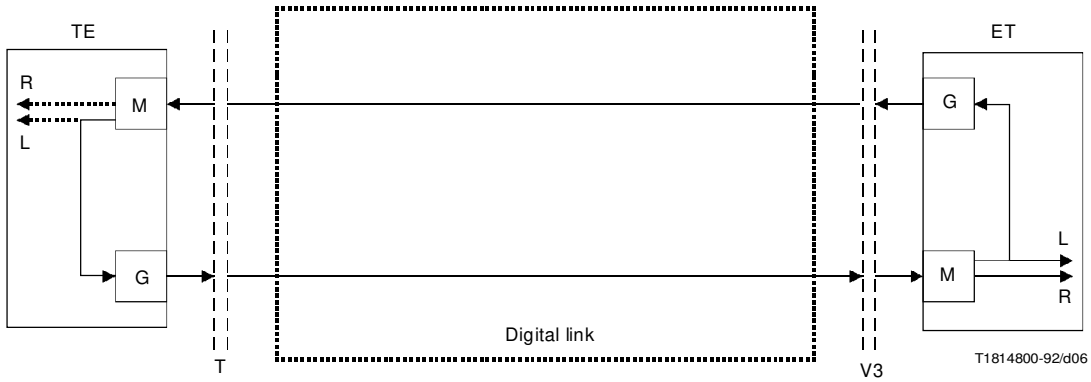
Whenever a loopback is activated, AIS shall be sent forward as a replacement for the looped signal.

Loopbacks shall be deactivated upon receipt of any one (or combination) of the following:

1) The loopback deactivate codeword;

2) AIS;

3) a data link message consisting of two occurrences of the one-per-second PRM separated by uninterrupted idle code.



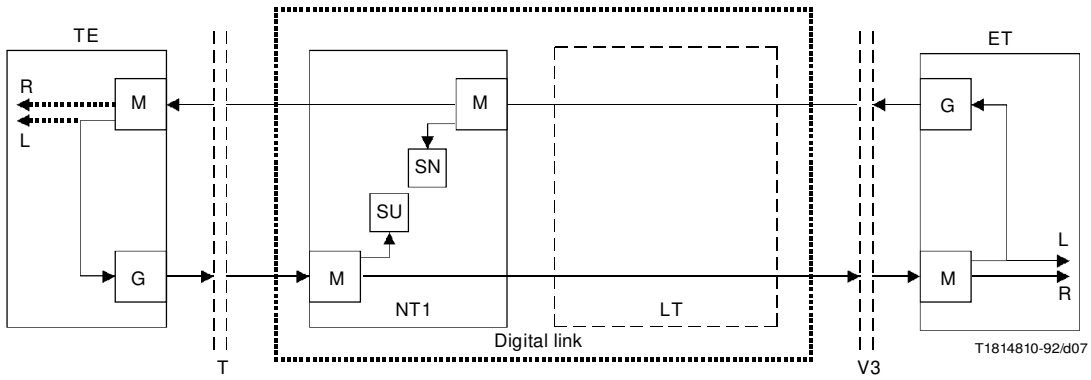
Mandatory

Optional

L Local CRC error information
R Remote CRC error information
M CRC monitor
G CRC generator

FIGURE 6/G.963

Access digital section using Option 1 NT1
(No CRC processing)



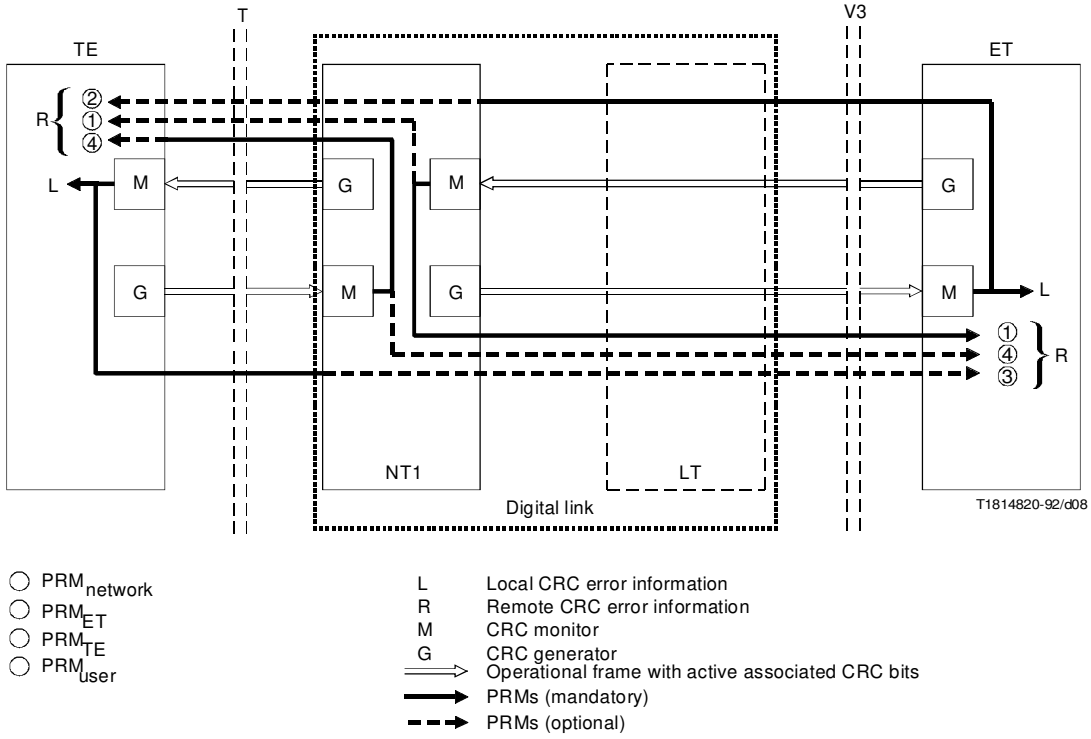
Mandatory

Optional

L Local CRC error information
R Remote CRC error information
M CRC monitor
G CRC generator
SN Storage for network side monitor
SU Storage for user side monitor

FIGURE 7/G.963

Access digital section using Option 4 NT1
(CRC monitoring in the NT1)



NOTE – See Table 4.

FIGURE 8/G.963

Access digital section using Option 2 NT1 (CRC processing in the NT1)

5.3 Monitoring

5.3.1 Functions

The following operational conditions are monitored throughout the section:

a) the defect conditions;

b) the transmission performance;

c) the power feed status (optional).

5.3.2 Anomaly and defect conditions and consequent actions

5.3.2.1 Anomaly and defect conditions

The DS shall detect the following anomalies or defects:

From the user side and the exchange side of the DS:

– loss of power at NT1 (optional);

– loss of incoming signal;

– loss of frame alignment (see Recommendations G.706 and I.431);

– CRC error (optional).

NOTE – DS equipment (NT1, LT ...) must detect loss of incoming signal or loss of frame alignment (option 2 only) and must generate downstream (to reference point V3) the fault indication signal AIS.

5.3.2.2 Detection of anomaly and defect indication signals

Unless otherwise noted, the following anomaly and defect indications shall be detected under options 2 and 4 only:

a) Within the access digital section:
   - loss of incoming signal or loss of frame alignment (options 1, 2 and 4 apply);
   - CRC error;
   - excessive CRC errors;
   - CRC error information (optional in option 4);
   - loss of power at NT1 (optional);
   - AIS at line side of NT1.

b) At the interface at the T reference point:
   - loss of incoming signal or loss of frame alignment (options 1, 2 and 4 apply):
   - CRC error;
   - excessive CRC errors;
   - CRC error information (optional in option 4);
   - loss of power feeding (optional).

c) At the interface at the V3 reference point:
   - loss of incoming signal (options 1, 2 and 4 apply).

5.3.2.3 Consequent actions

The actions that the DS must take after defect detection or defect indication detection are given in Table 5 (see 6.7.2).

Failure indication information (RAI and AIS) is automatically transmitted from the DS to the ET.

When the defect conditions have disappeared or the defect indication signals are not received anymore, the defect indication signals AIS and RAI should disappear as soon as possible.

5.3.3 Error performance monitoring

5.3.3.1 General

Monitoring error performance of the DS and reporting on such performance is optional.

NOTE – For CRC processing functions within the DS, refer to the options as given in Recommendation I.604.

5.3.3.2 Error performance parameters

The ET will receive the following transmission-error information to allow it to evaluate the error performance parameters defined in Recommendation G.821.

Occurrences of transmission-error events indicate the quality of transmission. The occurrences that shall be detected and reported are:

- no events;
- CRC error;
- severely-errored framing.

The occurrences that should be detected and reported are:

- frame synchronization bit error;
- line code violation;
- controlled slip.

These are defined in the following subclauses.

5.3.3.2.1 CRC error event: A CRC error event is the occurrence of a received CRC code that is not identical to the corresponding locally-calculated code.

5.3.3.2.2 Severely-errored framing event: A severely-errored framing event is the occurrence of two or more framing-bit errors within a 3 ms period. Contiguous 3 ms intervals shall be examined. The 3 ms period may coincide with the multi-frame defined in Recommendation G.704.

NOTE – The use of existing 2 of 4, 2 of 5, 3 of 5, etc. framing error detection criteria may be substituted for this criterion.

5.3.3.2.3 Frame synchronization bit error event: A frame synchronization bit error event is the occurrence of a received framing-bit error.

5.3.3.2.4 Line code violation event: A line code violation event is the occurrence of a received violation that is not part of a line code substitution rule.

5.3.3.2.5 Controlled slip event: A controlled slip event is the occurrence of a replication, or deletion, of a frame by the receiving terminal. A controlled slip may occur when there is a difference between the timing of a synchronous receiving terminal and the carrier signal. A controlled slip event is normally associated with the ET and TE layer 1.

5.3.4 Status report functions: Status report functions cover information which relates to the overall operation and performance of the DS.

Listed below are descriptions of the status report functions:

i) Transmission errors

This information, derived in the DS, allows the ET to evaluate transmission error performance.

ii) Loopback 1 status

This information gives the status of loopback 1.

iii) Loopback 1A status

This information gives the status of loopback 1A.

iv) Loopback 2 status

This information gives the status of loopback 2.

v) User network interface power feed status (optional)

This information indicates the status of the power feed at the user network interface at T reference point.

vi) User network interface power feed fault (optional)

This information indicates a failure of the normal power source.

vii) Defect indication information

This information is transmitted automatically under conditions specified in 5.3.2.1.

6 Operation and maintenance procedures

6.1 General

This subclause describes the operational and procedural functions associated with access digital sections implementing the CRC processing capabilities described in Annex A/I.604.

This CRC processing is part of the overall operation and maintenance functionality prescribed for the DS under NT1 options 1, 4 and 2. CRC generation and results reporting occur in the functional groupings ET, NT1 (option 2 only) and TE.

The following subset of the DS maintenance functions may be assigned to the NT1.

– Recognition of loss of incoming signal (6.5).

– Recognition of loss of frame alignment (only option 2).

– Generation of AIS (6.5).

– Generation of CRC (option 2 only, see Note 1).

– Monitoring of DL: The NT1 must monitor the received DL (at each of its two interfaces) for messages that require some NT1 action (e.g. loopback) and these messages are not usually passed to the opposite interface. DS passes the DL messages transparently or non-transparently depending on options according to Recommendation I.604.

– Monitoring of CRC: Figures 6, 7 and 8 illustrate this functionality which is consistent with Annex A/I.604, NT1 options 1, 2 and 4, respectively. In NT1 using option 2 or option 4, as an option, the NT1 may monitor the received CRC block from each interface.

– Calculation, storage and thresholding of performance monitoring (PM) data: As an option, the NT1 may calculate layer 1 performance parameters (i.e. CRC check sums and their interpretation) or provide storage for PM-data history, or provide threshold reporting for PM data, or any logical combination of these functions (Note 2).

– Provision of loopback 2 functionality: The NT1 must provide loopback 2 functionality; i.e. activate and release a loopback 2 in response to priority message received via the DL of either interface.

NOTES

1 The NT1 using option 4 must not generate new CRCs and the NT1 using option 2 must generate new CRCs.

2 In the NT1 using option 2, layer 1 performance parameters calculated at both sides of NT should be transmitted to both the ET an the TE using LAPD frames (see Figure 8).

6.2 4 kbit/s data link

The 4 kbit/s data link (DL) is derived from the m-bits of 1544 kbit/s frame overhead. The DL carries two types of information: control signals and performance data. Unless otherwise indicated, the specification of these signals is the same for both directions of transmission.

The control signals are pre-emptive, i.e. when sent, they overwrite other signals on the DL. The two categories of control signals (priority and command messages) are defined in 6.2.1.1 and 6.2.1.2.

The performance data is transmitted in a simplified format similar to the Q.921/LAPD protocol and is described in 6.2.2.

6.2.1 Control signals

Control signals are repetitive bit-oriented codewords used to convey alarm and command information. Control signals preempt all other uses of the DL.

Control signals consist of multiple repetitions of bit-oriented codewords conforming to the format:

11111111 0xxxxxx0 (where the leftmost bit is transmitted first.)

Table 1 defines the specific codewords used for priority messages, e.g. alarms, and for commands, appropriate to the DS. Other bit-oriented codewords may be used on the DL to support operation and maintenance of digital links and of TEs. NT1s and regenerators shall not act upon any bit-oriented codewords other than those listed in Table 1. NT1s/regenerators shall not source any messages other than AIS and priority messages listed in Table 1 and then only under conditions prescribed for their use.

TABLE 1/G.963

Assigned bit-oriented data link messages

Function	Codeword (Note 1)
Priority messages	
RAI	11111111 00000000
Loopback retention	11111111 01010100 (Note 3)
NT1 power off (option 2 only)	11111111 00111000
Command messages (Note 2)	
Loopback 1A activate	11111111 01001000
Loopback 2 activate	11111111 01110000
Loopback 2 deactivate	11111111 00011100
Universal loopback deactivate	11111111 00100100

NOTES

1 The leftmost bit is transmitted first.

2 The loopbacks are defined in 5.2.1.

3 The codeword "Loopback Operate Acknowledge" (LOA) is the same codeword as "Loopback Retention".

6.2.1.1 Priority messages

Priority messages indicate a service-affecting condition. They shall be transmitted until the condition no longer exists, but not for less than one second. These messages may be interrupted for a maximum of 100 ms per interruption with a minimum interval of one second between the start of interruptions.

NOTE – The ET is aware that the state "NT1 power off" may appear to the access digital section as a fault state. In NT1 option 2, to distinguish between NT1 power off and the fault state, the DS must transmit NPO to the ET in the "Loss of NT1 power" state (dying gasp).

6.2.1.2 Command messages

Command messages are transmitted to perform loopback functions for the DS. They may also be used to support the DS and TE maintenance functions. Only those messages listed in Table 1 shall be acted on by NT1s/regenerators. Command codewords will be repeated at least 10 times. NT1s/regenerators shall act upon commands (see Recommendation I.604) when the appropriate codewords are detected at least 5 times in 10 intervals.

6.2.2 Performance report message (PRM)

Performance verification of the DS is based on facility monitoring and calculation and comparison of check sums generated by framing sources. Framers insert a six-bit check sum into the C_1 through C_6 bit positions of the 1544 kbit/s frame F-bits overhead. This CRC-6 polynomial is the check sum associated with the preceding multi-frame.

Partial verification of the performance is possible at any point in the section by securing a 1544 kbit/s frame reference, calculating CRC-6 check sums, and comparing them to those (received in the bit positions reserved for C_1 through C_6) calculated and inserted by the framer. Upstream performance can thus be verified from the monitoring point for both ET and NT/TE generated information. The downstream performance can be inferred from the performance report described below.

6.2.2.1 Method of operation

This subclause illustrates the use of the m-bits for conveying performance information specified in 5.3.3.2. Performance information appearing in one direction of transmission is a quantification of the quality of transmission in the opposite direction.

A simplified version of the LAPD protocol, utilizing only unnumbered frames, is used for this purpose. Reports are transmitted at one second intervals, and that data for each second is repeated in four messages in subsequent reporting periods. The repetitions provide robustness to the method. The specification of these signals is the same for both directions of transmission.

NOTE – As mentioned in 6.2, the m-bits are also used for the transmission of priority messages, e.g. alarms and command and response messages. In the DS supporting options 1 and 4 (see Recommendation I.604), such messages have a priority over performance report. In system supporting option 2 of Recommendation I.604, the performance report message including CRC error information can be sent at a maximum of 100 ms per interruption while transmitting RAI.

Both the received and the transmitted signals include PRMs sent each second. The one-second timing (which defines the measurement interval) may be derived from the transmitted or received signal, as applicable, or from any source with an accuracy of ±32 ppm, or better. The phase of the one-second periods with respect to the occurrence of error events is arbitrary, i.e. the one-second timing does not depend on the time of occurrence of any error event.

The message structure is shown in Figure 9 and an example in Figure 10. PRMs are summarized in Tables 3 and 4.

Counts of events are accumulated in each contiguous one-second interval. At the end of each one-second interval, a modulo 4 counter is incremented, and the appropriate performance bits are set in the t_0 octets (octets 5 and 6 in Figure 9). These octets, along with octets that carry the performance bits of the preceding three one-second intervals, form the performance report.

Complete specifications for generation and application of the performance report message are found in Recommendation I.431.

NOTES

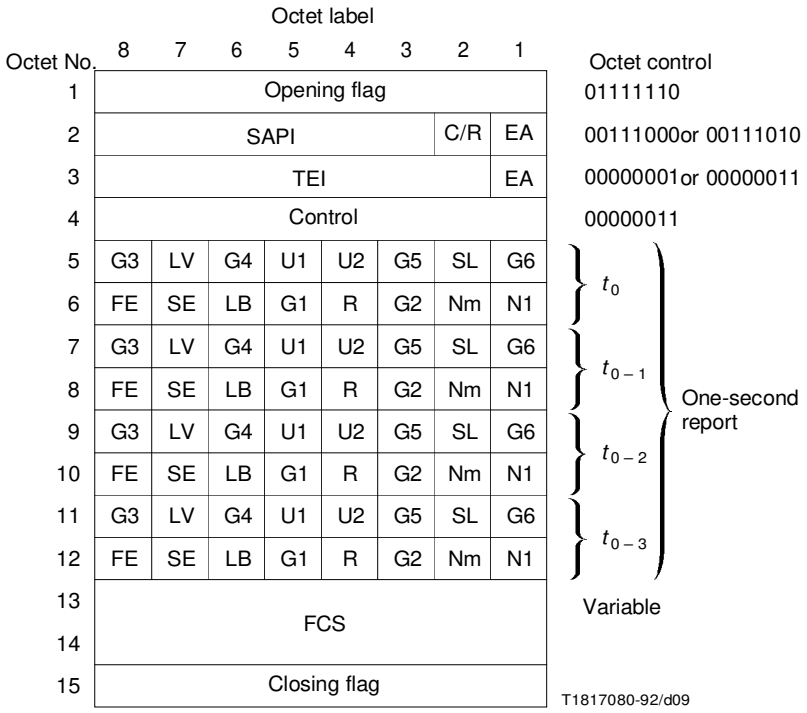
1 A single PRM occupies 15 bytes. This is transmitted once per second. A PRM with one address should not be blocked or overwritten by one with another address. When the NT1 with CRC processing (option 2 according to Recommendation I.604) transmits three kinds of 15-byte PRMs. The three PRMs occupy 45 bytes per second (see Figure 8). The transmission algorithm for PRMs is given in Appendix I.

2 In the DS based on option 2, the bits “TEI” and “C/R” of the LAPD frame are used as addresses to indicate the monitored locations (ET to NT1 networkside)/(NT1 networkside to ET)/(NT1 userside to TE)/(TE to NT1 userside) of performance information contained in a message. The C/R bit indicates whether the PRMs source is NT1-networkside source/TE source (C/R = 0) or ET source/NT1-userside source (C/R = 1). The TEI bit indicates whether the monitored section is the link between ET and NT1 (TEI = 0) or the link between NT1 and TE (TEI = 1).

6.3 Partitioning of functions

Recommendation I.431 defines the network side of the user-network interface at reference point T as one functional block which supports the operation and maintenance procedures across the T reference point and the primitive procedures at the ET layer 1/ET layer 2 boundary and at the ET layer 1/system management boundary. This block includes the functional groupings NTI, LT and ET layer 1.

This concept is described in terms of a state machine, called the G state machine in Recommendation I.431.



Address	**Interpretation**
00111000	SAPI = 14, C/R = 0 (NT1 – networkside/TE), EA = 0
00111010	SAPI = 14, C/R = 1 (ET/NT1 – userside), EA = 0
00000001	TEI = 0, EA = 1(Performance report related to the access digital section) (Note 2)
00000011	TEI = 1, EA = 1 (Performance report related to the link between NT1 and TE) (Note 3)

Control	**Interpretation**
00000011	Unacknowledged information transfer

One-second report	**Interpretation**
G1 = 1	CRC error event = 1
G2 = 1	1 < CRC error event ≤ 5
G3 = 1	5 < CRC error event ≤ 10
G4 = 1	10 < CRC error event ≤ 100
G5 = 1	100 < CRC error event ≤ 319
G6 = 1	CRC error event ≥ 320
SE = 1	Severely-errored framing bit ≥ 1 (FE shall be = 0)
FE = 1	Framing synchronization bit error event ≥ 1 (SE shall be = 0)
LV = 1	Line code violation event ≥ 1
SL = 1	Slip event ≥ 1
LB = 1	Loopback 3 activated indication
U1, U2, R	Reserved for national option (Default value is all “0”)
NmN1 = 00, 01, 10, 11	One-second report modulo 4 counter

FCS	**Interpretation**
Variable	CRC16 Frame Check Sequence

NOTES

1 The rightmost bit is transmitted first.

2 In options 1 and 4 of Recommendation I.604, this report is between the ET and TE. In option 2 of Recommendation I.604, this report is between the ET and NT1.

3 This applies only to implementations following option 2 of Recommendation I.604.

FIGURE 9/G.963

Performance report message structure

	$t = t_0$	$t = t_{0+1}$	$t = t_{0+2}$	$t = t_{0+3}$
FLAG	01111110	01111110	01111110	01111110
ADDRESS OCTET 1	00111000	00111000	00111000	00111000
ADDRESS OCTET 2	00000001	00000001	00000001	00000001
CONTROL	00000011	00000011	00000011	00000011
MESSAGE OCTET 1	00000001	00000000	10000000	00100000
MESSAGE OCTET 2	00000000	00000001	00000010	00000011
MESSAGE OCTET 3	00000000	00000001	00000000	10000000
MESSAGE OCTET 4	00010011	00000000	00000001	00000010
MESSAGE OCTET 5	00000000	00000000	00000001	00000000
MESSAGE OCTET 6	01000010	00010011	00000000	00000001
MESSAGE OCTET 7	00000010	00000000	00000000	00000001
MESSAGE OCTET 8	00000001	01000010	00010011	00000000
FCS OCTET 1	xxxxxxxx	xxxxxxxx	xxxxxxxx	xxxxxxxx
FCS OCTET 2	xxxxxxxx	xxxxxxxx	xxxxxxxx	xxxxxxxx

$t = t_{0-3}$, Slip = l, all other parameters = 0, $N(t)$ = l

$t = t_{0-2}$, Severely errored framing event = l, all other parameters = 0, $N(t)$ = 2

$t = t_{0-1}$, CRC error events = l, all other parameters = 0, $N(t)$ = 3

$t = t_0$, CRC error events = 320, all other parameters = 0, $N(t)$ = 0

$t = t_{0+1}$, CRC error events = 0, all other parameters = 0, $N(t)$ = l

$t = t_{0+2}$, CRC error events = 6, all other parameters = 0, $N(t)$ = 2

$t = t_{0+3}$, CRC error events = 40, all other parameters = 0, $N(t)$ = 3

NOTE – This example describes the C/R = 0/TEI = 0 case only.

FIGURE 10/G.963

Performance report messages – Example

Two state machines are defined to describe the relationship between signals across reference point T (which are indicated as signals (SIGs) in Figure 3 and defined in Recommendation I.431) and signals across reference point V3 (which are indicated as function elements (FEs) in Figure 3 and defined in 6.5) and the relationship between FEs and primitives. One of these state machines is in the DS (DS virtual state machine), and the other is at the network side of the V3 reference point (ET layer 1 virtual state machine). Figure 11 illustrates this approach.

In addition to primitives defined in Recommendations I.431 and Q.920 related to call control, Figure 11 also introduces a new set of primitives related to configuration control and the control of loopbacks. Partitioning of operation and maintenance procedures between two state machines is used for the convenience of easy and accurate description. The ET layer 1 state machine is to be viewed as virtual and is not intended to imply any particular implementation; however, the functional behaviour shall be as defined in the ET state tables (see Table A.1). This is required to interwork with the DS state machine defined in this Recommendation and to satisfy the requirements specified in the G state table in Recommendation I.431.

However**,** in order to implement a customer access, the virtual DS state machine has to be partitioned further. Figure 12 shows the partitioning of the DS state machine into NT1 state machine (NT-states) and LT state machine (LT-states).

The NT1 state machine supports user-network interface procedures in accordance with Recommendation I.431 based on signals, and interacts with the LT state machine by means of a signal repertoire (SIGs) which must be supported by the line transmission system. The LT state machine interacts with the ET layer 1 state machine by means of a set of function elements (FEs). The ET layer 1 state machine contains those states which represent the local exchange view of the status of the interface at reference point T and of DS. It supports the already specified primitive procedures to provide services to ET layer 2 and system management in accordance with Recommendation I.431, and additional primitive procedures for the support of functions associated with DS.

Figure 12 provides information for the description of the 1544 kbit/s primary rate access digital transmission system defined in Figure 1.

6.4 Definitions of signals at the T reference point

Signals exchanged between the DS and TE via the interface at reference point T under normal and defect conditions are defined in Recommendation I.431.

6.5 Definition of FEs at the V3 reference point

The function elements represent input signals which are consumed if a state transition occurs, even if it is a null transition (remains in the same state), and are no longer available to initiate one more state transition.

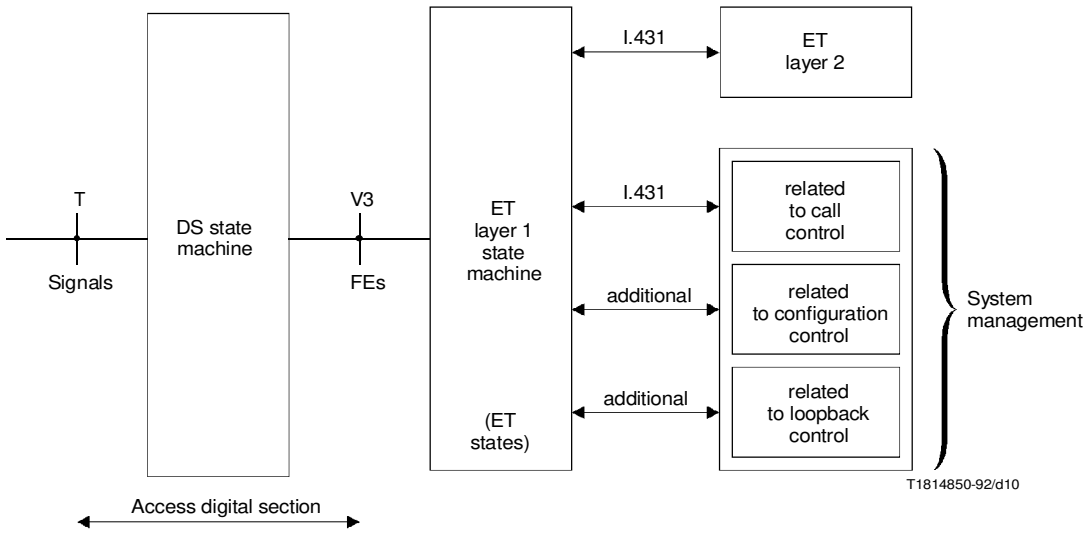


FIGURE 11/G.963

State machines

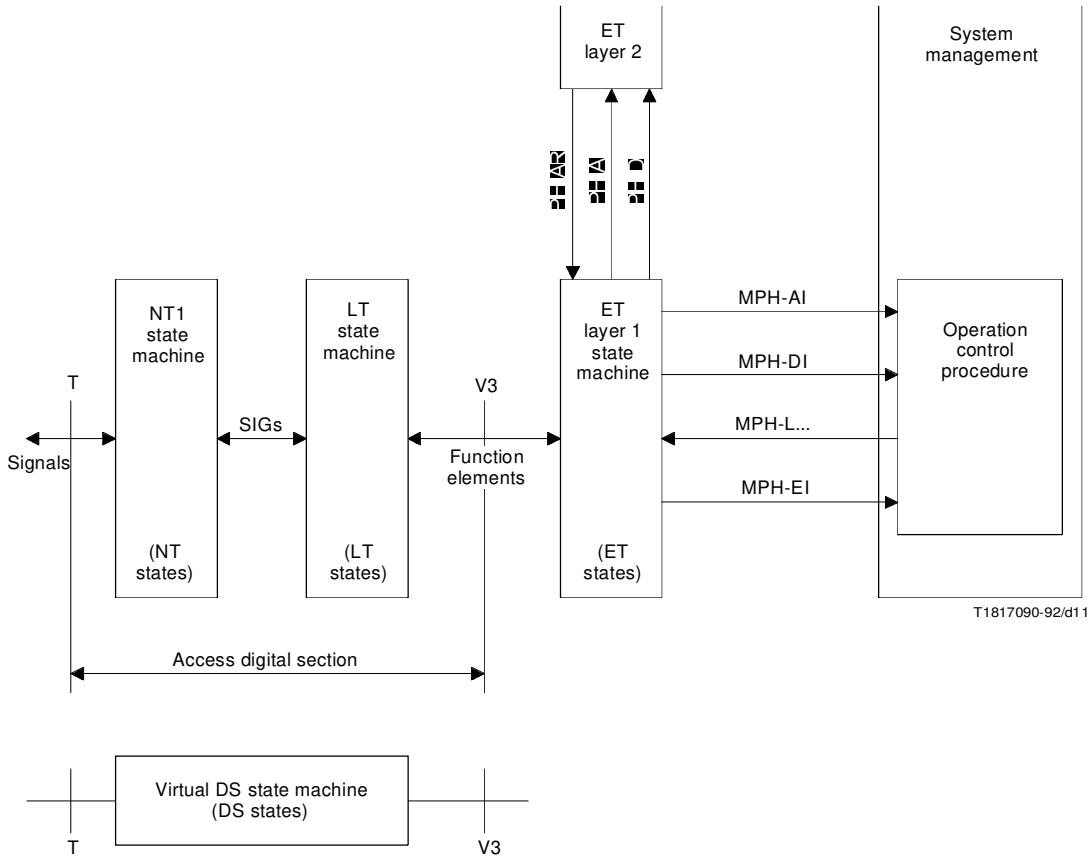


FIGURE 12/G.963

Partitioning of the DS state machine

The following repertoire of function elements associated with the operation and maintenance procedures is defined by the coding given in Table 2:

- FE A (LT <-- ET) indication of operational frames to DS
- FE B (LT --> ET) indication of operational frames from DS
- FE C (LT --> ET) indication of RAI from DS
- FE D (LT <-- ET) indication of RAI to DS
- FE E (LT --> ET) indication of LOS from DS
- FE F (LT <-- ET) indication of LOS to DS
- FE G (LT -->ET) indication of AIS from DS
- FE H (LT -->ET) indication of CRC error information from TE/NT2
- FE I (LT <-- ET) indication of CRC error information to DS
- FE J (LT <-- ET) request for loopback 2 activate
- FE K (LT <-- ET) request for loopback 1 activate

– FE L(LT <-- ET) request for loopback 1A activate

– FE N (LT --> ET) loopback operate acknowledge

– FE O (LT <-- ET) request for loopback deactivate

– FE R (LT <-- ET) request for loopback 2 deactivate

– FE S (LT -->ET) indication of NT1 power off (optional)

– FE T (LT -->ET) indication of CRC error information from NT1-networkside (option 2 only)

– FE U (LT --> ET) indication of CRC error information from NT1-userside (option 2 only)

– FE X (LT <-- ET) indication of AIS to DS

Tables 3 and 4 illustrate PRMs associated with the ET, NT1 or TE and transmitted through the DS.

TABLE 2/G.963

Signals between ET and DS at reference point V3 under normal and abnormal conditions

Name	Conditions	FE
NOF (Normal operational frame)	Operational frame with: – active associated CRC bits; – no defect indication; – PRMs transmitted and other m-bits available (tables 3 and 4).	FE A, FE B
RAI	Operational frame with: – active associated CRC bits; – 16-bit sequence of eight binary ONEs and eight binary ZEROs (11111111 00000000) in the m-bits; – PRMs transmitted during the maximum of 100 ms interval (option 2 only).	FE C, FE D
LOS	No received incoming signal (Loss of signal).	FE E, FE F
AIS	Continuous stream of binary ONEs (Recommendation M.20).	FE G, FE X
RLlA	Operational frame with: – active associated CRC bits; – 16-bit sequence of 11111111 01001000 in the m-bits for request for loopback 1A activate.	FE L
RL2	Operational frame with: – active associated CRC bits; – 16-bit sequence of 11111111 01110000 in the m-bits for request for loopback 2 activate.	FE J
L2D	Operational frame with: – active associated CRC bits; – 16-bit sequence of 11111111 00011100 in the m-bits for request for loopback 2 deactivate.	FE R
LD	Operational frame with: – active associated CRC bits; – 16-bit sequence of 11111111 00l00l00 in the m-bits for request for loopback deactivate.	FE O
LOA	Operational frame with: – active associated CRC bits; – 16-bit sequence of 11111111 01010100 in the m-bits for loopback operate acknowledge.	FE N
NPO (Optional)	Operational frame with: – active associated CRC bits; – 16-bit sequence of 11111111 00111000 in the m-bits for indication of NT1 power off.	FE S

TABLE 3/G.963

Definition of performance report messages (Options 1 and 4 NT1)

Name	Information	TEI	C/R	FEs
PRM_{ET}	Includes performance information detected at ET	0	1	FE I
PRM_{TE}	Includes performance information detected at TE	0	0	FE H

TABLE 4/G.963

Definition of performance report messages (Option 2 NT1)

Name	Information	TEI	C/R	FEs
$PRM_{network}$	Includes performance information detected at the networkside of NT1	0	0	FE T
PRM_{ET}	Includes performance information detected at ET	0	1	FE I
PRM_{TE}	Includes performance information detected at TE	1	0	FE H
PRM_{user}	Includes performance information detected at the userside of NT1	1	1	FE U

6.6 PH and MPH primitives

6.6.1 The repertoire of PH and MPH primitives within ET for the support of functions specified in Recommendations Q.920 and Q.921 for call control

The repertoire of these primitives is defined in Recommendations I.431 and Q.921.

6.6.2 Repertoire of MPH primitives within ET for the support of functions associated with the digital section

The following primitives should be used between layers 1 and 2 (primitives PH) or between layer 1 and the management entity (primitives MPH).

PH-AI PH Activate indication

PH-DI PH Deactivate indication

MPH-AI MPH Activate indication (used as error recovery and initialization information)

MPH-EIn MPH Error indication with parameter “n”

n Parameter which defines the failure condition relevant to the reported error

6.7 Digital section (DS) state machine

The DS state machine specifies the relationship between signals at reference point T and FEs at reference point V3 under failure conditions and during loopback procedures.

The state transition table specifies the procedures. It includes the actions to be taken on various events while in a specific state.

6.7.1 DS state definitions

Hereafter are defined the states that the DS may enter as a result of: signals received across the interface at the T reference point; FEs received across the interface at reference point V3; or internal events.

The DS states are classified into the following six groups:

STATE DS 0.x	NT1 power on/off. In these states LT power is on;
STATE DS 1.x	LT power on/off. In these states NT1 power is on;
STATE DS 2.x	DS is operational and detects failure conditions at reference point T;
STATE DS 3.x	internal DS failure exists;
STATE DS 4.x	DS is operational and detects failure conditions at reference point V3;
STATE DS 5.x	loopback procedures.

DS 0.1 state: NT1 power off

– In general, the DS can neither transmit nor receive signals at reference point T.

DS 0.2 state: NT1 power on

– This is a transient state, and the DS may change state after detection of the signal received.

DS 1.1 state: LT power off

– In general, the DS can neither transmit nor receive signals at reference point V3.

DS 1.2 state: LT power on

– This is a transient state and DS may change state after detection of the signal received.

DS 2.1 state: Operational condition

– Network timing and layer 1 link are available.

– The DS transmits and receives normal operational frames.

DS 2.2 state: Fault condition No. 2 (FC2)

– Network timing is not available at reference point T.

– The DS receives RAI (see Recommendation I.431) from reference point T and normal operational frames (NOF) (see Table 2) from reference point V3.

– The DS transmits normal operational frames (see Recommendation I.431) to reference point T and RAI (see Table 2) to reference point V3.

DS 2.3 state: Fault condition No. 4 (FC4)

– Network timing is available at reference point T.

– The DS recognizes “Loss of signal (LOS)” or “Loss of frame alignment (LFA)” at reference point T and receives RAI from reference point V3 (Recommendation I.431).

– The DS transmits RAI to reference point T and AIS (see Table 2) to reference point V3.

DS 3.1 state: Fault condition No. 1 (FC1)

– Network timing is available at reference point T.

– The DS receives normal operational frames from reference point T and RAI from reference point V3.

– The DS transmits RAI to reference point T and no signal to reference point V3.

DS 3.2 state: Fault condition No. 3 (FC3)

– Network timing is not available at reference point T.

– The DS receives RAI from reference point T and NOF from reference point V3.

– The DS transmits AIS (see Recommendation I.431) to reference point T and RAI to reference point V3.

DS 3.3 state: Fault condition No. 1 and fault condition No. 3 (FC1 and FC3)

– Network timing is not available at reference point T.

– The DS transmits AIS to reference point T and no signal to reference point V3.

DS 4.1 state: AIS from ET

– The DS transmits AIS to reference point T and RAI to reference point V3.

DS 4.2 state: RAI from ET

– The DS transmits RAI to reference point T and NOF to reference point V3.

DS 5.1 state: Loopback 1A activated

– The DS receives at least 10 repetitions of RL1A (see Table 2) followed by loopback retention from the ET.

– The DS operates loopback 1A.

– The DS transmits AIS to reference point T, and LOA (see Table 2) to reference point V3.

DS 5.2 state: Loopback 2 activated

– The DS receives at least 10 repetitions of RL2 (see Table 2) followed by loopback retention from the ET (see Note).

– The DS operates loopback 2.

– The DS transmits AIS to reference point T, and LOA to reference point V3.

NOTE – In another procedure, NT1 may receive continous RL2 from the ET.

6.7.2 DS state transition matrix

Table 5 provides the DS state transition matrix for 1544 kbit/s primary rate. The indication of DS failure to the ET should have priority over the indication of user-network interface failure to the ET, and the indication of an upstream failure to the ET should have priority over the indication of a downstream failure to the ET.

The signal specifications and state tables for the user and network sides of reference point T are contained in Recommendation I.431.

6.8 Definition of ET layer 1 state machine

The definition of the ET layer 1 state machine is outside the scope of this Recommendation, but because it is important for the understanding of the behaviour of the DS, information on this issue is given in A.2.6.

TABLE 5/G.963

DS state transition matrix

State		DS0.1	DS0.2	DS1.1	DS1.2	DS2.1	DS2.2	DS2.3	DS3.1	DS3.2	DS3.3	DS4.1	DS4.2	DS5.1	DS5.2
Operational condition or Failure condition		NT1 power off	NT1 power on	LT power off	LT power on	Opera-tional	FC2	FC4	FC1	FC3 without FC1	FC3 with FC1	AIS at V3	RAI at V3	Loopback 1A activated	Loopback 2 activated
Signal transmitted toward V3 (FEs)		FE E (Note 3)	FE E	FE E	FE E	FE B	FE C (Note 2)	FE G	FE E (Note 1)	FE C (Note 2)	FE E (Note 1)	FE C (Note 2)	FE B	FE N	FE N
Signal transmitted toward T (signals)		No signal	No signal	AIS	AIS	NOF	NOF	RAI	RAI	AIS	AIS	AIS	RAI	AIS	AIS
At T	Reception of NOF from TE	/	/	/	/	–	DS2.1	DS2.1	–	/	/	/	–	/	/
	Reception of RAI from TE	/	FE C (Note 2)	–	FE C (Note 2)	FE C (Note 2)	–	/	–	–	–	–	FE C (Note 2)	–	–
	Loss of incoming signal (LOS)/ Loss of frame alignment (LAF) at T	/	DS2.3	–	DS2.3	DS2.3	DS2.3	–	–	DS2.3	–	–	DS2.3	–	–
I N T E R N A L	No internal network failure	/	–	/	–	–	–	–	DS2.1	DS2.1	DS2.1	–	–	/	/
	FC1	/	DS3.1	/	DS3.1	DS3.1	DS3.1	DS3.1	–	DS3.3	–	DS3.1	DS3.1	DS3.1	DS3.1
	FC3	/	DS3.2	/	DS3.2	DS3.2	DS3.2	DS3.2	DS3.3	–	–	DS3.2	DS3.2	DS3.2	DS3.2
	Loss of NT1 power	/	DS0.1	/	DS0.1	DS0.1	DS0.1	DS0.1	–	DS0.1	–	DS0.1	DS0.1	–	DS0.1
	Return of NT1 power	DS0.2	/	/	/	/	/	/	/	/	/	/	/	–	/
	Loss of LT power	–	DS1.1	/	DS1.1	DS1.1	DS1.1	DS1.1	DS1.1	DS1.1	DS1.1	DS1.1	DS1.1	DS1.1	DS1.1
	Return of LT power	–	DS1.2	DS1.2	/	/	/	/	/	/	/	/	/	/	/
At V3	FE A	/	/	/	/	–	–	/	/	–	/	DS2.1	DS2.1	DS2.1	DS2.1
	FE X	/	DS4.1	–	DS4.1	DS4.1	DS4.1	DS4.1	DS4.1	–	–	–	DS4.1	DS4.1	DS4.1
	FE D	/	DS4.2	/	DS4.2	DS4.2	–	–	–	–	–	DS4.2	–	–	–
	FE L	/	DS5.1	/	DS5.1	DS5.1	DS5.1	DS5.1	DS5.1	–	–	/	DS5.1	/	/
	FE J	/	DS5.2	/	DS5.2	DS5.2	DS5.2	DS5.2	DS5.2	–	–	/	/	/	/
	FE R	/	/	/	/	/	/	/	/	/	/	/	/	/	DS2.1
	FE O	/	/	/	/	/	/	/	/	/	/	/	/	DS2.1	/

Fault conditions

–	No state change
/	Impossible situation
FE x DS y	Issue function element x Go to state DS y

NOTES

1 When the DS provides AIS rather than LOS, the ET cannot distinguish between FC1 and FC4.

2 In options 1 and 4, the performance report message cannot be sent from the DS while transmitting RAI. FC2 and FC3 faults are indicated identically at reference point V3. Option 2 allows performance report messages including CRC error information to be sent while transmitting RAI, to localize faults FC2 and FC3 at the ET.

3 As an option, the DS may transmit FE S followed by FE E to the ET.

Annex A

(to Recommendation G.963)

System management requirements

(This annex forms an integral part of this Recommendation)

A.1 Introduction

This Recommendation specifies the required functions of the 1544 kbit/s primary rate access digital section and the ET layer 1. In order to ensure correct operation, it is necessary to take into account the assumptions made about the management functions involved. It is assumed that the structure of the management is as given in Recommendation Q.940.

In this Recommendation, distinction is only made between ET layer 1 and system management. Where the term "system management" is used it corresponds to both system management and layer management as defined in Recommendation Q.940.

A.2 System management requirements

A.2.1 General

System management shall not initiate more than one action at a time to ET layer 1. An action is delimited by the primitive which is issued by system management and the corresponding primitive which confirms completion of the task.

A.2.2 Error indications

The management entity takes account of the sequence of primitives before and after the reception of MPH-EI. From the sequence of the primitives, system management may determine the cause of the MPH-EI primitive (e.g loss of synchronization or loss of signal at the interface at reference point T).

Upon the occurrence of an error, ET layer 1 shall notify the event to system management by means of the primitive MPH-EI. System management must decide which appropriate actions should be taken (e.g. hold or abandon call).

A.2.3 Loopback operations

System management should take into account that when ET layer 1 is in loopback operation it does not send any primitives to ET layer 2. If a primitive is sent by ET layer *2* to ET layer 1 during loopback operation, it will be ignored by ET layer 1.

The setting of loopback is initiated by system management by issuing a primitive MPH-LxAR, where x indicates the type of loopback (2, 1 or 1A).

The setting of loopbacks 2, 1 and 1A is confirmed to system management by means of the loopback acknowledge primitive. System management should be able to interpret this loopback acknowledge as a loopback confirmation.

A.2.4 Information to be sent in the D-channel during loopback operation

The information sent in the D-channel should not imitate any HDLC pattern. However, it is the responsibility of system management to decide to send the required pattern for fault localization.

A.2.5 Configuration control

System management shall ensure that any action related to configuration control will be issued only while the access is not active with user traffic.

A.2.6 ET state machine

A.2.6.1 ET state definitions

Hereafter are defined the states that ET layer 1 may enter as a result of: function elements (FEs) received across reference point V3; service primitives received (PH-, MPH-primitive); or internal events.

ET0.1 state: Loss of power state

– In this state the ET can neither transmit nor receive signals.

ET1.1 state: Operational state

– Layer 1 link is available.

– The ET receives normal operational frames (NOF) (see Table 2).

– The ET transmits NOF to reference point V3.

– The ET checks the received frame for CRC and other errors and generates a PRM to reference point V3.

ET2.1 state: Fault condition No. 1 (FC1: see Recommendation I.431)

– The ET detects loss of incoming signal.

– The ET transmits RAI (see Table 2) to reference point V3.

ET2.2 state: Fault condition No. 2 or No. 3 (FC2 or FC3)

– The ET receives RAI (see Note).

– The ET transmits NOF to reference point V3.

– The ET checks the received frame for CRC and other errors and generates a PRM to reference point V3.

ET2.3 state: Fault condition No.4 (FC4)

– The ET detects AIS.

– The ET transmits RAI to reference point V3.

ET2.4 state: Power on state

– This is not a stable state, the ET cannot remain in it.

– No signal is transmitted to reference point V3.

– The ET must change state after identification of a received signal or recognition that no signal is being received (loss of signal, loss of frame alignment event).

NOTE – The DS supporting NT1 option 2 allows transmission of performance report messages including CRC error information to both interfaces while transmitting RAI (see Appendix I). The ET can localize a failure to either:

i) the T reference point (FC2). If frames with performance report messages from TE including continuous CRC error information (defined in Recommendation I.431) are received; or

ii) within the access digital section (FC3), if frames with performance report messages from the NT1 network side including continuous CRC error information are received.

In options 1 and 4, the performance report message cannot be sent while transmitting RAI. FC2 and FC3 faults are indicated identically at reference point V3.

A.2.6.2 ET state matrix

The state transition table specifies the procedures. It includes the action to be taken on various events while in a specific state. It specifies the interactions with ET layer 2 and system management which are required to support the layer interface procedures in accordance with Recommendation I.431 (sequences of PH- and MPH-primitives in compliance with I.431) and the interactions across the layer interface between ET layer 1 and system management for the support of functions within the DS.

The ET state matrix is given in Table A.1.

TABLE A.1/G.963

ET state transmission matrix

	State	ET0.1	ET1.1	ET2.1	ET2.2	ET2.3	ET2.4
Definition of the states	Operational condition of the reference point V3	Power off at ET	Operational	FC1	FC2/FC3	FC4	Power on at ET
	Signal toward the reference point V3	FE F	FE A	FE D	FE A (see Note in A.2.6.1)	FE D	FE F
New received event	Loss of ET power	–	PH-DI MPH-EI0 ET0.1	MPH-EI0 ET0.1	MPH-EI0 ET0.1	MPH-EI0 ET0.1	MPH-EI0 ET0.1
	Return of ET power	ET2.4	/	/	/	/	/
	FE B	/	–	PH-AI MPH-AI ET1.1	PH-AI MPH-AI ET1.1	PH-AI MPH-AI ET1.1	/
	FE C	/	PH-DI MPH-EI1, 2/3 ET2.2	MPH-EI2/3 ET2.2	–	MPH-EI2/3 ET2.2	ET2.2
	FE E	/	PH-DI MPH-EI1 ET2.1	–	MPH-EI1 ET2.1	MPH-EI1 ET2.1	ET2.1
	FE G	/	PH-DI MPH-EI4 ET2.3	MPH-EI4 ET2.3	MPH-EI4 ET2.3	–	ET2.3

Fault conditions

–	No state change
/	Impossible situation
PH-AI	Physical layer activate indication
PH-DI	Physical layer deactivate indication
MPH-AI	Management physical layer activate indication
MPH-EIn	Management physical layer error indication
	n = 0 Power off
	n = 1 FC1 fault indication
	n = 2/3 FC2/FC3 fault indication
	n = 4 FC4 fault indication

NOTE – The PH and MPH primitives are discussed in Recommendations Q.921 and I.431. PH-AR primitive is not shown since the interface is not subject to a deactivation procedure.

Appendix I

(to Recommendation G.963)

Transmission algorithm of performance report messages at NT1 based on option 2

(This appendix does not form an integral part of this Recommendation)

The equipment supporting option 2 (ET, NT1, TE, ...) transmits PRMs to the interfaces at the beginning of any one-second interval (see Figure 8).

Each end of the links between ET and NT1 and between NT1 and TE, determine 1 second intervals counting 8000 frames. An NT1 based on option 2 counts the transmission performance events of the received signals from ET and TE within a one-second interval (T_n). For that interval (T_n), NT1 calculates the performance parameters of each side and inserts them into each LAPD frame.

At the beginning of interval T_{n+1}, $PRM_{network}$ is transmitted first followed by PRM_{user}. $PRM_{network}$ is transmitted from both sides at the same time, and likewise for PRM_{user}.

If NT1 receives PRM_{TE} from TE it transmits PRM_{TE} to ET after transmitting $PRM_{network}$ and PRM_{user} at the beginning of the next interval. Similarly, if NT1 receives PRM_{ET} from ET, it transmits PRM_{ET} to TE after transmitting $PRM_{network}$ and PRM_{user}.