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**PUBLIC DATA NETWORKS
MAINTENANCE**

**PRINCIPLES OF MAINTENANCE TESTING
FOR PUBLIC DATA NETWORKS USING DATA
TERMINAL EQUIPMENT (DTE) AND DATA
CIRCUIT - TERMINATING EQUIPMENT (DCE)
TEST LOOPS**

ITU-T Recommendation X.150

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation X.150 was published in Fascicle VIII.3 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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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Recommendation X.150

PRINCIPLES OF MAINTENANCE TESTING FOR PUBLIC DATA NETWORKS USING DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) TEST LOOPS

(Geneva, 1980; amended at Malaga-Torremolinos, 1984)

1 Introduction

The CCITT,

considering

- (a) the increasing use being made of data transmission systems;
- (b) the volume of the information circulating on data transmission networks;
- (c) the savings to be made by reducing interruption time on such data circuits;
- (d) the importance of being able to determine responsibilities (of necessity involving several parties) in maintenance questions for networks; and
- (e) the advantages of standardization in this field,

unanimously declares

that the locating of faults can be facilitated in many cases by data circuit loop testing procedures in DTEs and DCEs.

2 Scope

This Recommendation specifies the principles of maintenance testing for public data networks using the DTE/DCE test loops. The definition of the loops, the principles for the control of the loops and the principles for the indications to be presented when the loops are activated are described herein for general application with all DTE/DCE interfaces. Specific details concerning the implementation of these principles are contained in the individual DTE/DCE interface Recommendations. The maintenance philosophy, definitions and general principles are applicable to interface Recommendations, such as X.20, X.20 *bis*, X.21, X.21 *bis*, and X.22.

2.1 Maintenance philosophy

The provision of DTE and DCE test loops in public data networks is based upon the following maintenance philosophy:

- a) test loops may be used by an Administration's test centre(s) to test the operation of either leased lines or circuit-switched network subscriber lines, including either all or part of the DCE, without necessarily requiring the dispatch of network maintenance personnel to the subscriber's premises;
- b) where, allowed by national testing principles, DCE test loops may also be used by a DTE to test the operation of network connection or leased lines. Where provided, the intent is for the DTE to make initial tests to isolate a trouble condition either in the DTEs or in the data circuit.

2.2 Loop testing principles

The provision of loop testing capabilities should be based on the following principles:

- a) the loops should be transparent, e.g. they should be bit sequence independent;
- b) loop testing is a disruptive type of testing, e.g. when a loop has been established transmission of data is not possible;
- c) test loops may be established from any state; however, when loop testing is commenced from the *data transfer* state, the same test procedures may be used for both leased lines and circuit-switched connections;

- d) when allowed, the preferred DTE test sequence is: loop 1 - loop 2 - loop 3, sequentially from both ends of the circuit.

3 Definition of the loops

Nine loops are defined as shown in Figure 1/X.150. For clarity these nine loops have been grouped as follows:

- a) DTE test loop - type 1 loop (§ 3.1)
 - Loop 1 (§ 3.1.1)
 - b) Local test loops - type 3 loops (§ 3.2)
 - Loop 3d (§ 3.2.1)
 - Loop 3c (§ 3.2.2)
 - Loop 3b (§ 3.2.3)
 - Loop 3a (§ 3.2.4)
 - c) Subscriber-line test loops - type 4 loops (§ 3.3)
 - Loop 4a (§ 3.3.1)
 - Loop 4b (§ 3.3.2)
 - d) Network test loops - type 2 loops (§ 3.4)
 - Loop 2b (§ 3.4.1)
 - Loop 2a (§ 3.4.2)

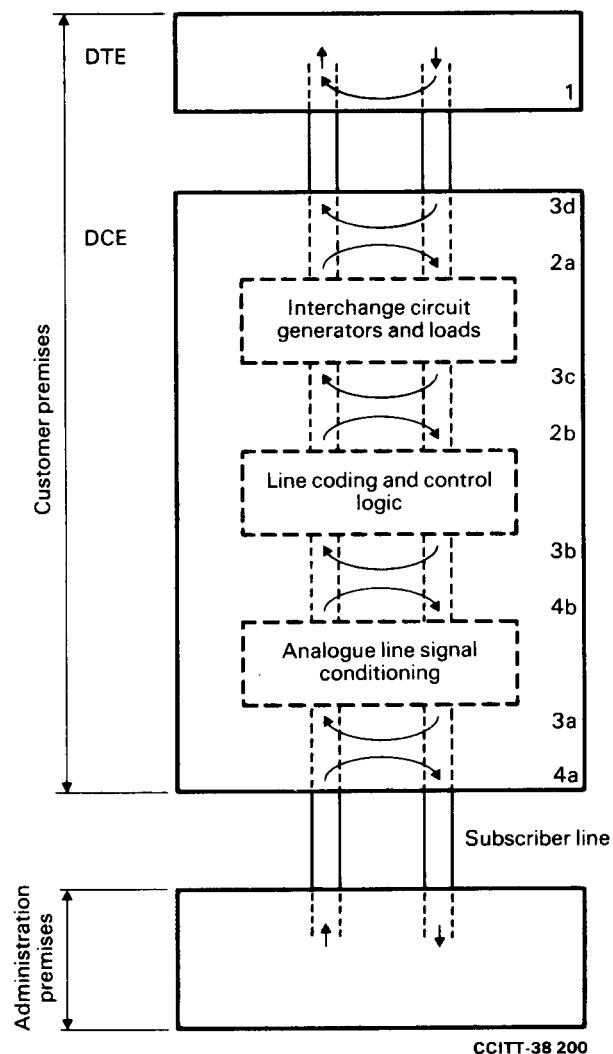
3.1 *DTE test loop - type 1 loop*

3.1.1 *Loop 1*

This loop is used as a basic test of the operation of the DTE, by looping back the transmitted signals inside the DTE for checking. The loop should be set up inside the DTE as close as possible to the DTE/DCE interface.

Loop 1 may be established from either the *data transfer* or *ready* state.

In some networks, for short routine tests during the *data transfer* state, the DTE should either maintain the same status on the interchange circuits as before the test or where possible send the *DTE controlled not ready* signal.



Note – The back-to-back loopbacks (e.g. 3d/2a, 3c/2b, 3b/4b and 3a/4a) that are provided should be configured in such a manner that there is no active equipment between the loopbacks. For example: an Administration may operate the back-to-back loopbacks simultaneously in the same relay or switch.

FIGURE I/X.150

If the loop is established from the *data transfer* state, the DCE may continue to deliver data to the DTE during the test as though the DTE were in normal operation. It will be the responsibility of the DTEs to recover from any errors that might occur while the test loop is activated.

If the loop is established from the *ready* state, the DTE should continue to monitor so that an incoming call may be given priority over a routine test. Alternatively, in cases where the DTE cannot accept incoming calls, DTEs shall signal one of the *not ready* states.

The DCE continues to present signal element timing and, if implemented, byte timing. The DTE need not make use of the timing information during a loop test.

3.2 Local test loops - type 3 loops

Local test loops (type 3 loops) are used to test the operation of the DTE, the interconnecting cable and either all or parts of the local DCE, as discussed below.

Where allowed by national testing principles, loop 3 may be established from any state.

For testing on leased circuits and for short duration testing on circuit-switched connections, the DCE should either continue to present toward the line the conditions that existed before the test (e.g. either *data transfer* or *ready* state) or send the *controlled not ready* state to the remote DTE. Where this is not practical (e.g. in some cases for loop 3a) or desirable (e.g. for long duration testing in circuit-switched applications), the DCE should terminate an existing call and, if possible, signal toward the subscriber-line one of the *not ready* states.

The DCE continues to present signal element timing, and, if implemented, byte timing. The DTE must make use of the timing information.

3.2.1 *Loop 3d*

This loop is used to test the operation of the DTE, including the inter-connecting cable, by returning transmitted signals to the DTE for checking. The loop is set up inside the local DCE and does not include interchange circuit generators and loads. The DCE may make either type 2 or type 4 loop tests during the loop 3d test condition.

Note - While test loop 3d is operated, the effective length of the interface cable is doubled. Therefore, to insure proper operation of loop 3d, the maximum DTE/DCE interface cable length should be one-half the length normally appropriate for the data signalling rate in use.

3.2.2 *Loop 3c*

This loop is used to test the operation of the DTE, including the inter-connecting cable and DCE interchange circuit generators and loads. In this case, the Note in § 3.2.1 concerning restrictions of interconnecting cable length does not apply.

3.2.3 *Loop 3b*

This loop is used as a test of the operation of the DTE and the line coding and control logic and circuitry of the DCE. It includes all the circuitry of the DCE, with the exclusion of the line signal conditioning circuitry (e.g. impedance matching transformers, amplifiers, equalizers, etc.). The delay between transmitted and received test data is a few octets.

Note - In some DCEs, the setting of loop 3b will result in momentary loss of envelope alignment causing spurious signals to appear on receiving interchange circuits for a period of time. This may impact upon the DTE test procedure. Refer to the DTE/DCE Recommendations for information regarding the signal element timing. In some networks, the setting of loop 3b will cause clearing of existing connections.

3.2.4 *Loop 3a*

This loop is used to test the operation of the DTE and the DCE. The loop should include the maximum amount of circuitry used in DCE working including, in particular, the line signal conditioning circuitry. It is recognized that, in some cases, the inclusion of devices (e.g. attenuators, equalizers or test loop translators) may be necessary in the loopback path. The subscriber line is suitably terminated during a loop 3a test condition. The delay between transmitted and received test data is a few octets.

Note - In some DCEs, the setting of loop 3a will result in momentary loss of envelope alignment causing spurious signals to appear on the receiving interchange circuits for a period of time. This may impact upon the DTE test procedure. Refer to the DTE/DCE interface Recommendations for information regarding the signal element timing. In some networks, the setting of loop 3a will cause clearing of existing connections.

3.3 *Subscriber line test loops - type 4 loops*

Subscriber line test loops (type 4 loops) are provided for the maintenance of lines by the Administrations. The DCE signals to the local DTE a *not ready* or *test mode* state, as appropriate for the specific DTE/DCE interface. The DCE continues to present signal element timing and, if implemented, byte timing.

Note - In the case of loops 4 and 2 (see below) the DCE may signal the local DTE in such a manner that the DTE can distinguish a test mode from a network failure.

3.3.1 *Loop 4a*

This loop is only provided in the case of 4-wire subscriber lines. Loop 4a is for the maintenance of lines by Administrations. When receiving and transmitting pairs are connected together, the circuit under test may not be measured as a data circuit. Loop 4a may be established inside the DCE or in a separate device.

3.3.2 Loop 4b

This loop is used by Administrations to test the operation of the subscriber line including the line signal conditioning circuitry in the DCE. When the receiving and transmitting circuits are connected at this point, loop 4b provides a connection that can be considered as a data circuit.

Note - The implementation may be such that some impairment of the performance is expected since the DCE, in this case, does not perform a complete signal regeneration/conversion.

3.4 Network test loops - type 2 loops

Network test loops (type 2 loops) are used by the Administration's test centre(s) to test the operation of the leased line or subscriber line and either all or part of the DCE as discussed below.

Where allowed by national testing principles, loop 2 may also be used by a DTE, as follows:

- in case of switched circuit networks when the DTEs are in the *data transfer* state, to test the operation of the network connection including the remote DCE;
- in case of leased lines in the *ready* state, to test the operation of the line including the remote DCE.

The DCE signals the local DTE a *not ready* or *test mode* state as appropriate for the specific DTE/DCE interface (see Note to § 3.3). The DCE continues to present signal element timing and, if implemented, byte timing.

3.4.1 Loop 2b

This loop is used by either the Administration's test centre(s) and/or the remote DTE to test the operation of the subscriber line and all the circuitry of the DCE, with the exception of interchange circuit generators and loads.

3.4.2 Loop 2a

This loop is used by either the Administration's test centre(s) or the remote DTE to test the operation of the subscriber line and the entire DCE.

Note - While in the loop 2a condition, the DCE may present an *open circuit* condition to the DTE on certain interchange circuits. It is assumed that the DCE detects electrical signal faults condition as *not ready* as appropriate for the specific electrical characteristics.

4 Minimum implementation of test loops

4.1 DCE test loops

Sufficient test loops should be provided in the DCE to allow the customer and/or the Administration's maintenance personnel to positively distinguish between DTE and DCE/line faults.

The DCE will implement at least one of the four local test loops (type 3). The DCE will also implement at least one of the two network test loops (type 2). The implementation of the loops within the DCE is a national matter. Implementation of test loops beyond the minimum set specified above may be provided by some Administrations.

4.2 DTE test loops

It is suggested that all new DTEs provide loop 1.

5 Loop control

5.1 General

Where available, the means for remotely controlling a loop in one country from a location in another country are described in appropriate DTE/DCE interface Recommendations.

In leased circuit services, subscriber-line and network test loops should not be activated before the customer has been informed. However, some Administrations may activate these loops when abnormal conditions are detected in the network without first informing the customer.

In circuit-switched services, subscriber-line and network test loops should not be activated when the DTE is engaged in a call. In case of a collision between call request and the activation of these loops, the loop activation command will have priority and the call request will be cancelled. These loops may be activated without the prior knowledge and agreement of the customer for periods which normally do not exceed one second.

5.2 Control of the local test loops

To facilitate the testing of the DTE by the customer, manual activation (by means of a switch of the DCE) will be provided for at least one of the four local test loops (type 3). The precise implementation is a national matter. However, customer-controlled automatic activation of the local test loops via the DTE/DCE interface should be considered.

Where available, the means for DTE control of these loops via signals in the DTE/DCE interface are described in the appropriate DTE/DCE interface Recommendations.

Note - With the introduction of the electrical interchange circuits as defined in Recommendations X.26/X.27, some Administrations may locate the DCE in a location that is remote (up to 1000 metres) from the DTE. Therefore, manual loop activation by the customer may be either difficult or impossible. Thus, some form of an automatic activation of these loops should be considered. Also the limitations in the Note of § 3.2.1, loop 3d, should be considered.

5.3 Control of the network test loops

5.3.1 General

Each network test loop implemented in the DCE will be activated either by a manual switch on the DCE or remotely from the Administration's test centre(s) or both. The means for loop activation, the method for achieving remote control and the method for notifying the network of manual activation are national matters. Random signals may be delivered to the DTE prior to closing of loops.

Where loop 2a or 2b is provided for customer use, the procedure for its use is subject to the relevant interface Recommendations.

5.3.2 Leased circuits

5.3.2.1 Point-to-point leased lines

In case of point-to-point line circuits, the Administrations will provide one or more of the following:

- a) customer control of the network test loop in the local DCE via a manually operated switch on the DCE;
- b) customer control of the network test loop via the remote DTE/DCE interface.

Note - The provision for the remote control of a loop in one country from a location in another country is subject to bilateral agreement between the affected Administrations.

- c) remote control from the Administration's data test centre.

When available, the method for activation of the network test loop in a DCE by a command signal from a remote DTE/DCE interface will be as described in the appropriate DTE/DCE interface Recommendation.

5.3.2.2 Centralized multipoint leased circuits

The principle of maintenance testing for centralized multipoint circuits are for further study. In this regard, the specific details concerning the implementation of these principles are contained in the individual DTE/DCE interface Recommendations.

5.3.3 Switched networks

In a similar manner to the technique described in § 5.3.2.1 above, Administrations may provide a means for remotely controlling the network test loop from their test centre(s). This is recognized to be a national matter; however, if provided, the procedure to be used is described in the appropriate interface and signalling Recommendations. The remote control of network test loops in a DCE via the remote DTE/DCE interface is subject to bilateral agreement between the affected Administrations.

Note - Where allowed by national testing principles, the DTE may establish a network test loop in the remote DCE when in the *data transfer* state by means of a signal across the DTE/DCE interface. In this case, it should be possible for the DTEs to re-enter the data transfer state after deactivation of the network test loop. It will be the responsibility of the DTEs to recover from any errors that might occur while the test loop is activated.

5.4 Control of subscriber-line test loops

The provision of and use of subscriber-line test loops is a national matter. They are designed for the maintenance of lines by Administrations in case of 4-wire subscriber lines.