

## Recommendation T/CS 54-07 (Vienna 1982)

### ANALOGUE SUBSCRIBER LINE TESTS AND MEASUREMENTS

Recommendation proposed by Working Group T/No. 11 "Switching and Signalling" (CS)

*Text of the Recommendation adopted by the "Telecommunications" Commission:*

"The European Conference of Postal and Telecommunications Administrations,

*considering*

- that analogue subscriber lines are currently generally used and will continue to be used to a great extent in the foreseeable future;
- that on the basis of the defined maintenance philosophy, procedures for testing, measuring and monitoring, together with the field of application for subscriber line maintenance, all need to be specified;
- that existing practice for analogue subscriber line maintenance shows a considerable variance in solutions;
- that system independent equipment, as well as the integration of some or all of these functions into digital local exchanges may be used,

*recommends*

that the members of the CEPT use for new exchanges, and/or system independent test and/or measurement equipment, the procedures for analogue subscriber line tests and measurements set-out below."

#### GENERAL INTRODUCTION – FIELD OF APPLICATION

This Recommendation covers the maintenance of an analogue subscriber connection. Referring to the Figure 1 (T/CS 54-07), three parts can be recognized in this connection:

- the subscriber set or STE (subscriber terminal equipment);
- the transmission part of the subscriber connection;
- the exchange terminal (ET).

The ET can be situated in a local digital exchange or in a remote multiplexer or concentrator.

Special categories of lines (e.g. party lines, analogue subscriber carrier systems, concentrators, service restrictions indicated by the presence of ground on one of the wires, etc.) are not covered in the present Recommendation. The test and/or measurement procedures to be used in such lines is for further study.

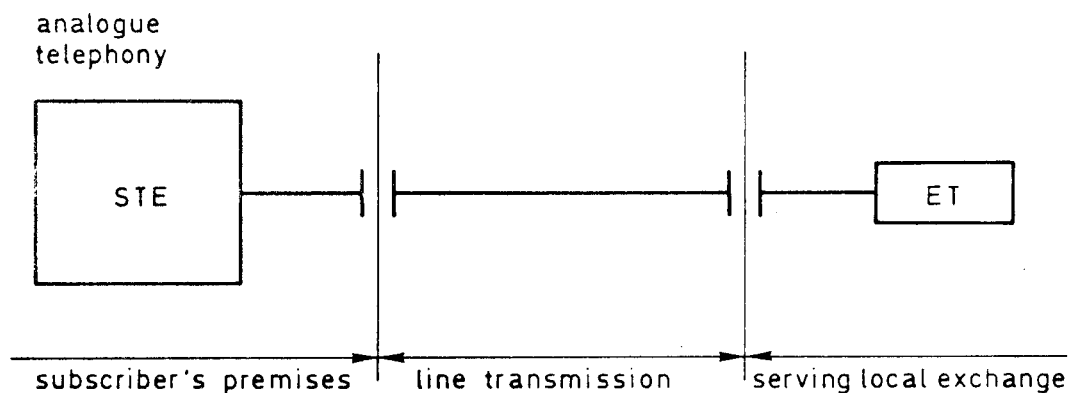


Figure 1 (T/CS 54-07). Parts of an analogue subscriber's connection.

#### PART 1: OUTWARD TESTS AND MEASUREMENTS

This part of the Recommendation considers only the outward tests and measurements of the subscriber set and the subscriber line.

## 1. GENERAL REQUIREMENTS

- 1.1. In order to adequately perform the tests of the subscriber set and subscriber line, the exchange must be capable of preventing disturbing influences from the exchange terminal to the line, e.g. by complete disconnection.
- 1.2. It must be possible to connect any subscriber line via an appropriate access to the test equipment, e.g. a metallic path.
- 1.3. It should be possible to initiate the tests and/or measurements and to receive the results locally or at a remote work position. For some tests and/or measurements, initiation will take place from the subscriber's premises.
- 1.4. With respect to the line tests and/or measurements, each subscriber's line will be in one of the following states:
  - fault free line;
  - line not tested;
  - faulty line.

A faulty line may be *blocked* or *marked*. The term *blocked* means that the line is blocked to calls due to a detected fault. The term *marked* means that the line has been indicated as faulty because of failure but is not blocked to calls.

Only free lines will be able to be tested and/or measured by *all* the methods described in this Recommendation.

When the line is not tested, the reason why it is not tested will be presented, except if the line is not installed.
- 1.5. When the subscriber line is tested or measured without the knowledge of the actual subscriber, the subscriber should be kept as unaware of these actions as possible (e.g. bell-ringing, clicks, etc.).

## 2. TEST AND/OR MEASUREMENT METHODS

Three test and/or measurement methods can be distinguished:

- A. tests initiated from subscriber's premises (on demand, by dialling a special code);
- B. tests and/or measurements initiated from administration's premises (on demand, usually via a man-machine interface, e.g. control desk);
- C. automatic tests (automatic routine tests and/or measurements, automatic tests on a call-by-call basis).

The choice of the applied procedure(s) (e.g. omitting the automatic tests on a call-by-call basis) depends on technical and economical considerations that can be different for each Administration according to the structure of the network and the organization of maintenance. It should be in accordance with a general maintenance philosophy.

## 3. TESTS INITIATED FROM THE SUBSCRIBER'S PREMISES

- 3.1. These tests provide maintenance staff with the ability to access a ringback service from the subscriber's premises, in order to initiate some tests on the line and the terminal equipment. These tests should also be possible from any point in the local network, by means of a portable telephone set.

The following call procedure could be adopted (needs further study):

  - maintenance staff member dials a particular access code on the set to be tested;
  - the exchange sends back a tone indicating whether the test equipment is available or not;
  - the successive actions to off-hook and on-hook enable the different tests to be made.

*Note:* The different test to be made could also be selected by differing access codes, determining individual test or groups of tests.
- 3.2. From the subscriber's premises, the following tests are implicit in the call procedure:
  1. dial performance;
  2. multifrequency keying performance;
  3. test of bell functions.

3.3. The following tests can also be provided optionally:

1. foreign DC and AC voltages;
2. insulation resistance;
3. power supply, current or loop resistance;
4. meter at subscriber's premises;
5. loop capacitance;
6. quality of speech transmission (telephony);
7. extensive MFPB or dial performance tests.

#### 4. TESTS AND/OR MEASUREMENTS FROM ADMINISTRATION'S PREMISES

These detailed tests and/or measurements are initiated from local or remote man-machine terminals. They can be initiated after the examination of the fault reports resulting from previous automatic routine tests, previous automatic call-by-call tests or on the basis of subscriber complaints. They have priority over automatic routine tests. Lines with a permanent busy condition should be able to be tested and/or measured from Administration's premises. Where subscriber co-operation exists, a speech connection is assumed. When tests are being done without subscriber co-operation and the subscriber is making a call attempt, the tests or measurements should be aborted. They should also be aborted, if possible, when an incoming call is made to the subscriber line being tested.

In the following, tests and/or measurements from the Administration's premises are identified. The actual tests to be performed, fault limits, the lines to be tested and the test moment(s) may be controlled by man-machine-communication.

##### 4.1. Without co-operation at subscriber's premises:

1. foreign DC voltage:
  - between a and b
  - a to ground
  - b to ground;
2. foreign AC voltage:
  - between a and b
  - a to ground
  - b to ground;
3. insulation resistance:
  - between a and b
  - a to ground or to exchange battery
  - b to ground or to exchange battery;the last two tests of point 3. above may be replaced by a to ground or to exchange battery, with b connected to a;
4. loop continuity: measurement of the capacitance a to b;
5. data for the localization of line faults;
6. test of the test access and the connection between the line and the ET.

##### 4.2. With co-operation at the subscriber's premises:

1. dial performance:
  - number of pulses received
  - dial speed
  - pulse ratio;
2. MFPB performance:
  - digits received (A, B, C, D included): go/no-go test only;in the case of a no-go result, the frequency, level and pulse length measurements can be optionally provided;
3. test of the meter at subscriber's premises;
4. payphone signals need further study;
5. call test, a functional test of the subscriber set: ringing, talking, listening;
6. test of the register-recall signal;
7. test of special conditions on the line, e.g. subscriber controlled service restrictions;
8. measurement of the loop resistance and/or feeding current.

It should be possible to define a basic subset of the tests under Section 4.1. which could be initiated by a single command.

For each on-demand test, the exact values of the measurements of the specified parameters should be presented, as well as the fault limits and a *pass/fail* indication.

Before an on-demand test is made, a check to determine the presence of a call on the line should be performed.

## 5. AUTOMATIC ROUTINE TESTS AND MEASUREMENTS

Automatic routine tests are performed on some or all subscriber lines at predetermined times, usually at night, e.g. once a week. Some specific automatic routine measurements which give more detailed and statistical information about the subscriber lines and associated local cable network may also be done. In this case, the measured value of all measured lines is presented and the frequency of these measurements may be lower.

When the automatic routine test is applied on a call-by-call basis, it can be used for lines not previously tested and on lines found faulty during the call-by-call tests. Faulty lines should be tested periodically with an interval that can be changed by commands. A line which is found correct should no longer be stated faulty.

The testing equipment should be able to recognize the state of the lines in use (see Section 1.4.). Spare (unused) lines need not be tested.

During a test cycle covering all the lines, free lines are tested and busy lines are identified. After this test cycle, the lines previously identified as busy may be tested in a second test cycle. Each line can then be classified as correct, faulty or busy. At the end of the automatic routine test, a list is presented giving the directory and/or equipment number of the lines that are faulty or busy, and of the lines no longer stated faulty. The test limits and periods will also be indicated.

When a subscriber initiates a call during a measurement testing on his line, the test or measurement should be aborted as soon as possible and in a way that causes minimum effect on the service offered to the subscriber, e.g. delay to dial tone, clicks on line, etc. When an incoming call is made to a subscriber line which is being tested or measured, the test or measurement should, if possible, be aborted too.

The results of the automatic routine test are of the type *go/no-go*. However, the equipment should, in the case of automatic routine measurements, also be able to present the real measured value of the specified parameters. Further processing of such type of data, e.g. for more detailed or statistical information, need not necessarily be done by the line testing and/or measuring equipment itself.

A faulty line should only be blocked in case of excessive AC or DC voltage detected on the line.

The line testing equipment should automatically check itself, either periodically, or after a predetermined number of consecutive tests with results out-of-limit.

Man-machine-communication facilities which may be local or remote must be provided in order to specify:

- the lines to be tested and/or measured;
- the start time and the frequency of tests and/or measurements;
- the subset of tests and/or measurements to be performed;
- the fault limits;
- the destination and presentation of the output.

The following automatic routine tests and/or measurements are identified; however, the actual tests to be performed, fault limits, the lines to be tested and the test start time and frequency may be controlled by man-machine-communication.

1. foreign AC voltage:
  - between a and b
  - a to ground
  - b to ground;
2. foreign DC voltage:
  - between a and b
  - a to ground
  - b to ground;
3. insulation resistance:
  - between a and b
  - a to ground or to exchange battery
  - b to ground or to exchange battery;
  - the last two tests may be replaced by a to ground or to exchange battery, with b connected to a;
4. loop continuity:
  - measurement of the capacitance a to b.

The initial voltage tests should be compulsory, no further tests should be applied to lines failing the voltage tests. All measurements to ground refer to exchange ground.

## 6. AUTOMATIC TEST ON A CALL-BY-CALL BASIS

At every call set-up, a subscriber line test is performed, both on the calling (A-) and the called (B-) subscriber line. The test is performed after the seizure for the A-subscriber, before the dial tone for the B-subscriber, and before the ringing current is sent, or after clear-down for either A- or B-subscriber.

The call-by-call test must be such that the network service performance and network technical performance parameters are met, e.g. dial tone delay.

Lines which are found faulty should be either marked or blocked, depending upon the severity of the fault (see Section 1.4.).

The following tests, on a call-by-call basis, should be provided. However, the tests to be performed, fault marking limits and fault blocking limits may be controlled by man-machine-communication.

### 6.1. Foreign voltage

1. foreign DC voltage:
  - between a and b
  - a to ground
  - b to ground;
2. foreign AC voltage:
  - between a and b
  - a to ground
  - b to ground.

### 6.2. Insulation resistance

1. A-subscriber:
  - a to ground, with b wire connected via the telephone set;
2. B-subscriber:
  - a to ground, b to ground (this may be replaced by:
    - a to ground, with b connected to a);
  - between a and b.

All measurements to ground refer to exchange ground.

## 7. PARAMETER VALUES

In Tables 1 (T/CS 54-07) and 2 (T/CS 54-07), an overview of all tests and measurements is given. The ranges and accuracies for measurements are minimum requirements. When the value of the parameter is outside the provided range, an indication should be given. This indication should be an out-of-range indicator and/or the maximum or minimum value of this range.

*Note:* The ranges mentioned, as compared to accuracy, are to specify the accuracy only and are not intended to specify the measuring sub-ranges of the actual equipment.

Function	Test and/or measurement methods	Measuring range R and accuracy A	Applicable test procedures	State of STE
1a: to detect and measure foreign AC voltage	Foreign AC voltage: – between a and b – a to ground – b to ground	R: 0-300 V r.m.s. A: 2 ranges a) 0-20 V: $\pm 2V$ b) 20-300 V: $\pm 10\%$ of the real value	See Paragraphs 3., 4., 5. and 6.	On-, off-hook or disconnected
1b: to measure the transmission quality of a subscr. line	Attenuation and (psophometric) noise measurements	No value recommended	See Paragraphs 3., 4. and 5.	On-, off-hook or disconnected
2a: to measure loop capacitance (loop continuity test)	Loop capacity between a and b	R: 0-10 $\mu F$ A: 2 ranges a) 0-0.5 $\mu F$ : $\pm 50$ nF b) 0.5-10 $\mu F$ : $\pm 10\%$ of the real value	See Paragraphs 3., 4.2., 5. and 6.	On-hook
2b: to determine the geographical location of a loop interruption	Loop capacity between a and b	R: 0-1 $\mu F$ A: 2 ranges a) 0-0.05 $\mu F$ : $\pm 5$ nF b) 0.05-1 $\mu F$ : $\pm 10\%$ of the real value	See Paragraph 4.2.	
3: to detect and measure foreign DC voltage	Foreign DC voltage: – between a and b – a to ground – b to ground	R: –100 to +100 V A: 2 ranges a) –1 to +1 V: 0.1 V b) between –100 to –1 V and +1 to +100 V: $\pm 10\%$ of real value	See Paragraphs 3., 4., 5. and 6.	On-, off-hook or disconnected
4a: to detect and measure line insulation failure	Insulation resistance between a and b	R: 0.01 M-1 M Ohm A: 2 ranges a) 0.01 M to 0.16 M Ohm: $\pm 8$ k Ohm b) 0.16 M to 1 M Ohm: $\pm 5\%$ of real value	See Paragraphs 3., 4.2., 5. and 6.	On-hook or disconnected
4b: to detect and measure line insulation failure	Insulation resistance – a to ground or to exchange battery, or – a to ground or to exchange battery with b connected to a	R: 100-10 M Ohm A: 2 ranges a) 100 k-160 k Ohm: $\pm 8$ k Ohm b) 160 k-10 M Ohm: $\pm 5\%$ of real value	See Paragraph 4.2.	On-hook or disconnected
4c: to detect and measure loop resistance	Loop resistance between a and b	R: 10 Ohm to 10 k Ohm A: 2 ranges a) 10-100 Ohm $\pm 10$ Ohm b) 100-10 k Ohm: $\pm 10\%$ of the real value	See Paragraphs 3., 4.2. and 6.	Off-hook

Function	Test and/or measurement methods	Measuring range R and accuracy A	Applicable test procedures	State of STE
1: to measure dial performance characteristics	<ul style="list-style-type: none"> <li>- number of pulses received</li> <li>- dial speed</li> <li>- pulse ratio</li> </ul>	<p>R: 1-12</p> <p>R: 8-12 Hz</p> <p>A: 2% relative</p> <p>R: 5-95%</p> <p>A: 2% absolute</p>	Go/no-go See Paragraphs 3. and 4.2.	Off-hook
2: to measure MFPB performance characteristics	<ul style="list-style-type: none"> <li>- digits received (A, B, C and D included)</li> <li>- frequencies</li> <li>- levels</li> <li>- pulse length</li> </ul>	<p>R: according MFPB coding</p> <p>R: 650-1660 Hz</p> <p>A: 0.2% of the real value</p> <p>R: - 5 dBm to - 28 dBm</p> <p>A: 1 dBm</p> <p>Not applied</p>	Go/no-go See Paragraphs 6. and 4.2.	Off-hook
3: to verify the correct operation of the meter at subscriber's	Go/no-go tests of the meter		Go/no-go See Paragraphs 3. and 4.2.	Off-hook
4: to test STE call functions	Functional test of the STE: <ul style="list-style-type: none"> <li>- ringing</li> <li>- talking</li> <li>- listening</li> <li>- register recall</li> </ul>	<p>R: half nominal ringing current</p> <p>R: not measured, just manually tested</p>	See Paragraphs 3. and 4.2. Go/no-go  Go/no-go  Go/no-go	Off-hook
5: to test and measure payphone coin pulsing	Number of pulses received per coin unit	R: system-dependent	Go/no-go See Paragraph 4.2.	

## PART 2: INWARD TESTS

This part of the Recommendation considers only the maintenance of the subscriber line termination (ET, including associated exchange functions).

Depending on the grade of integration in the digital exchange, some of the tests and/or measurements described in this part of the Recommendation can be optional.

### 1. GENERAL REQUIREMENTS

In order to adequately perform the tests and/or measurements of the ET, the exchange must be capable of preventing interferences from the line to influence the testing and/or measuring of the ET.

It must be possible to connect any ET via an appropriate access to the test and/or measurement equipment, e.g. metallic path.

It should be possible to initiate the tests and/or measurements and to receive the results either locally or at a remote work position.

### 2. TEST AND/OR MEASUREMENT PROCEDURES

Two test and/or measurement procedures can be distinguished:

- on-demand tests and/or measurements;
- automatic routine tests.

### 3. ON-DEMAND TESTS AND/OR MEASUREMENTS

These tests and/or measurements are initiated from local or remote measurement man-machine terminals. They can be initiated after the examination of fault reports resulting from the automatic routine tests or on the basis of subscriber complaints. They have priority over automatic routine tests.

It must be possible to specify man-machine-communication:

- the ET to be tested (one or a specific group);
- the subset of tests to be performed (see Section 5).

The simulation of a real call to another subscriber (test-connection) must be possible under man-machine control.

For every on-demand test, the exact measured value will be issued, as well as the fault limits and a *pass/fail* indication. A failing test should not automatically block the ET.

#### 4. AUTOMATIC ROUTINE TEST

Automatic routine tests are performed on some or all ET at predetermined times, normally at night, e.g. once a week.

With respect to the automatic routine test, the ET can be in one of the following states:

- fault free;
- busy (eventually permanent calling condition);
- faulty.

The ET not yet allocated should not be tested. Two test cycles are performed. A first is applied on all free ETs, a second may be performed on the ET found busy during the first cycle. After that, a list of faulty and busy ETs is presented with indication of their directory and/or equipment number. For each faulty ET, the fault report will indicate the failing test (go/no-go indication). A faulty ET cannot be blocked by the test equipment.

Man-machine-communication facilities, either local or remote, must be provided in order to specify:

- the ET to be tested;
- the time and the frequency of testing;
- the subset of tests to be performed (see Section 5.).

It is admitted that an off-hook condition occurring on a line will not be detected by the associated ET on which the testing sequence is being performed.

#### 5. LIST OF ET TESTS

##### 5.1. Power feed

The test equipment measures the feeding voltage.

##### 5.2. Loop detector

The reaction of the ET on the seizure signal (change of the loop from on-hook to off-hook) will be checked. The result of this test is a go/no-go result.

##### 5.3. Ringing and ring trip

The ringing, applied by the ET between a and b wires, is measured by the test equipment. After that, a check will be done to determine whether or not the ring trip function is executed (go/no-go result).

As in Section 5.2., the check of the on-hook and off-hook detection capability is performed under worst case conditions (maximum loop resistance and minimum leakage resistance).

##### 5.4. Metering test

A metering command is given to the ET. A check will be done to determine whether or not a metering pulse appears on the metallic test path. The frequency, level and pulse duration will be measured.

##### 5.5. Transmission test

The purpose of this test is to check performance of the transmission path, including the codec.

##### 5.6. Dial tone test

A command to connect dial tone to the line is given to the ET. A check is performed to determine whether or not the dial tone appears.