



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.131

(08/96)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA

International telephone connections and circuits – General characteristics of the 4-wire chain formed by the international circuits and national extension circuits

Control of talker echo

ITU-T Recommendation G.131

(Previously “CCITT Recommendation”)

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FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

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

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation G.131 was revised by ITU-T Study Group 12 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 30th of August 1996.

NOTE

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

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SUMMARY

This Recommendation provides specifications for talker echo control. The intention of this Recommendation is to ensure the acceptable echo performance on international (and national) connections. The specifications include a maximum transmission time (delay) limit beyond which an active echo control device has to be deployed. In addition, application and engineering rules related to connections with echo control devices as well as connections not requiring active echo control are given. Recognizing that some network operators may want to deploy echo control devices in connections with less transmission time than the limit specified in this Recommendation (e.g. if better echo performance is desired), talker echo tolerance curves are also included in this Recommendation and examples on how they can be used to evaluate effects of echo in specific network scenarios are given in Appendix I.

CONTROL OF TALKER ECHO

*(Geneva, 1964; amended at Mar del Plata, 1968, and Geneva, 1972, 1976, and 1980;
Malaga-Torremolinos, 1984; Melbourne, 1988; revised in 1996)*

1 Introduction

NOTE – Previous versions of Recommendation G.131 included a clause on stability that has been deleted because modern networks are largely all four-wire.

In a two-way telephone conversation a talker sometimes can hear his own voice as a delayed echo, a phenomenon called talker echo. This echo is caused by signal reflections in the transmission path. Most often these occur at 2-wire/4-wire hybrids, sometimes at the listener side as an acoustic feedback from earphone (or loudspeaker) to microphone and possibly also via crosstalk in the handset cord. (Note that if the reflected voice signal has no delay it is called sidetone, see clause 5/G.121 [5].)

Echo control devices such as echo cancellers (echo suppressors may still be used in some networks) might not be used normally, except on connections involving very long delays, where other means of controlling echo, such as network loss, are not appropriate. There is often no general need for echo control devices in national networks but they may be required for inland service in large countries, on long international calls and in connections including satellites. Additionally, echo control devices may also be needed when large delays are introduced into connections due to signal processing systems (e.g. PLMN, ATM, etc.) or on loaded-cable circuits (low-velocity circuits) used for international calls.

2 References

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

- [1] ITU-T Recommendation P.310 (1996), *Transmission characteristics for telephone-band (300-3400 Hz) digital telephones.*
- [2] ITU-T Recommendation G.165 (1993), *Echo cancellers.*
- [3] CCITT Recommendation G.164 (1988), *Echo suppressors.*
- [4] ITU-T Recommendation Q.115 (1993), *Control of echo suppressors – Control of echo suppressors and echo cancellers.*
- [5] ITU-T Recommendation G.121 (1993), *Loudness Ratings (LRs) of national systems.*
- [6] ITU-T Recommendation G.111 (1993), *Loudness Ratings (LRs) in an international connection.*
- [7] ITU-T Recommendation G.122 (1993), *Influence of national systems on stability and talker echo in international connections.*
- [8] ITU-T Recommendation G.114 (1996), *One-way transmission time.*

4 Active echo control devices

Specific guidelines for deployment of active echo control devices (such as echo cancellers) may vary between national networks and even between networks within the same country. They are usually established in consideration of performance and customer expectations, competitive pressures, specific business goals, economical and technological constraints, etc. They need to take into account distances, routing and estimated processing time of the equipment in the connection. As a practical matter, however, echo control rules are often based on broad assumptions, simplified to the delay limits (with the corresponding trunk length limits) beyond which echo controlling devices have to be applied; or on specific bilateral agreements between Administrations.

4.1 Application guidelines

In general, it is recommended that the active echo control devices shall be deployed on all connections which exceed the total one-way talker echo transmission path time of 25 ms.

This guideline is intended to ensure the acceptable echo performance on international (or national) connections terminated by analogue subscriber lines. It is understood, however, that echo control devices may be deployed in connections with less transmission time for reasons such that improvement in the echo performance is desired, that additional routing flexibility is needed or low values of TELR are to be expected in the network. In such cases a lower limit of one-way delay in the talker echo path should be considered. Curves in Figure 1 can be used as the guidance for the desirable performance (see Appendix I).

The echo control device application guideline provided here can be significantly relaxed if only digital telephone sets, meeting specifications provided in Recommendation P.310 [1], are deployed with networks that are fully digital.

In exceptional cases, such as in networks with low end-to-end losses, the introduction of a small amount of additional loss (at the appropriate place) may allow the 25 ms limit to be somewhat exceeded without detrimental effects, neither with regard to the talker echo nor to the Overall Loudness Rating (OLR).

In some specific cases, such as interconnections between public and other networks (e.g. private networks), the public network may not provide sufficient echo control. In such cases the need of providing echo control in the connection segment attached to the public network has to be considered by the private network provider.

Echo cancellers should at a minimum meet the requirements of Recommendation G.165 [2]. Echo suppressors, if used, should have characteristics specified in Recommendation G.164 [3].

5 Additional echo control rules

The rules given below are subdivided into ideal and practical rules. It is recognized that in some practical situations ideal rules may not provide solutions that are flexible enough. Practical rules are suggested in the hope that they will ease possible problems in such circumstances. They should not be invoked unless the ideal rules cannot reasonably be complied with.

5.1 Rules for connections with echo control devices

5.1.1 Ideal rules

5.1.1.1 Rule 1

- 1) Circuits equipped with echo cancellers can be connected together in tandem without significant echo performance degradation.
- 2) Not more than the equivalent of one full echo suppressor (i.e. two half-echo suppressors) should be included in any connection needing an echo control. When there is more than one full echo suppressor the conversation is liable to be clipped; lockout can also occur.
- 3) A circuit equipped with echo suppressors (Recommendation G.164 [3]) can be connected with another circuit equipped with echo cancellers (Recommendation G.165 [2]) without additional performance degradation.

NOTE – The overall performance will not be better than that provided by the poorer performing device.

5.1.1.2 Rule 2

The half-echo suppressors should be associated with the terminating sets of the 4-wire chain of the complete connection. This:

- reduces the chance of speech being mutilated by the echo suppressors because the hangover times can be very short;
- reduces the chance of ineffective echo suppressor operation as end delays are short and minimum required echo losses can be assured.

5.1.2 Practical rules

5.1.2.1 Rule 3

- 1) The echo control device may be fitted at the international exchange or at an appropriate national transit centre. However, each echo control device should be located sufficiently near to the respective hybrid points for the end delays not to exceed the maximum echo capacity of the echo control device. For countries of average size, this will normally mean that the originating and terminating control devices will be in the countries of origin and destination of the call.
- 2) If an echo canceller has a sufficiently long echo capacity, it may be placed in the originating exchange in order to control echo returned by the terminating exchange.
- 3) Circuits equipped with echo cancellers can, under most network conditions, be connected in tandem without significant echo performance degradation. (Recommendation Q.115 [4] provides a description of the control logic that may be used in the deployment of echo cancellers).

5.1.2.2 Rule 4

In isolated cases a full short-delay echo suppressor may be fitted at the outgoing end of a transit circuit (instead of two half-echo suppressors at the terminal centres) provided that neither of the two hangover times exceeds 70 ms. This relaxation may reduce the number of echo suppressors required and may also simplify the signalling and switching arrangements. It is emphasized that full echo suppressors must not be used indiscriminately; the preferred arrangement is two half-echo suppressors as near the terminating sets as possible. A full echo suppressor should be as near to the “time-centre” of the connection as possible, because this will require lower hangover times.

Whether a full long-delay echo suppressor or canceller can be used in this circumstance is under study.

5.1.2.3 Rule 5

On a connection that requires echo control, up to the equivalent of two full echo suppressors (e.g. three half-echo suppressors or two half-echo suppressors and a full one) may be permitted. Every effort should be made to avoid appealing to this relaxation because the equivalent of two or more full echo suppressors, with long hangover times, on a connection can cause severe clipping of the conversation and considerably increases the risk of lockout. This rule does not apply to echo cancellers (see Rule 1).

5.1.2.4 Rule 6

In general it will not be desirable to switch out (or disable) the intermediate echo suppressors when a circuit equipped with long-delay echo control devices is connected to one with short-delay echo suppressors. However, it would be desirable to switch out (or disable) the intermediate echo suppressors if the mean one-way propagation time of that portion of the connection which would now fall between the terminal half-echo suppressors is not greater than 50 ms, since the different types are likely to be compatible. An intermediate echo canceller need not be switched out.

5.2 General rules (for connections with or without echo control devices)

5.2.1 Ideal rule

5.2.1.1 Rule 7

Connections that do not require echo control devices should not be fitted with them because they increase the fault rate and are an additional maintenance burden.

5.2.2 Practical rules

5.2.2.1 Rule 8

In exceptional circumstances, such as breakdown, an emergency route may be provided. The circuits of this route need not be fitted with echo control devices if they are usable without them for a short period. However, if the emergency routing is to last more than a few hours, echo control devices must be fitted according to the rule in 4.1 above.

5.2.2.2 Rule 9

It is accepted that a connection that does not require echo control devices may in fact be unnecessarily equipped with one or two half-echo suppressors, or a full echo suppressor or echo cancellers. (The presence of an echo suppressor in good adjustment on a circuit with modest delay times can hardly be detected and in the case of echo cancellers it may improve the overall performance of the connection.)

Where a terminating international exchange is accessible from an originating international exchange by more than one route, and:

- 1) at least one route requires echo control, and at least one route does not; and
- 2) the originating exchange is unable to determine which route is to be used; echo control devices should be connected in all cases.

6 Insertion of echo control devices in a connection

Ways of inserting echo control devices in a connection which have been considered are the following:

- 1) arrange for the circuits to be permanently equipped with echo control devices that can be disabled if not required;
- 2) provide a pool of echo control devices common to several groups of circuits, and arrange for an echo control device to be associated with any circuit that requires one (see Recommendation Q.115 [4]);
- 3) divide the circuits of an international route into two groups, one with and one without echo control devices and route the connection over a circuit selected from the appropriate group according to whether the connection merits an echo control device. However, it is recognized that circuits may not be used efficiently when they are divided into separate groups. This must be borne in mind;
- 4) conceive schemes in which the originating country and the terminal country are divided into zones at increasing mean radial distances from the international centre and determine the nominal lengths of the national extension by examining routing digits and circuits-of-origin.

It should be appreciated that different carriers need not use the same method although the methods must be compatible to permit satisfactory intercontinental connections. There appears to be no great difficulty in arranging this.

7 Speech processing devices

Some speech processing devices, such as speech interpolation devices, have an inherent echo-suppressor function. However, such devices may only suppress echo during the single talk mode and not during double talking conditions (see 1.7/G.164 [3]) unless they are equipped to perform full echo-suppressor functions. When devices without full echo control are connected in tandem with echo cancellers, performance degradation due to echo may occur during double talking conditions as the intermediate echo canceller will not be effective during double talk.

Appendix I

Assessment of talker echo effects

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

Figure I.1 illustrates the typical talker echo caused by a reflection at the 2-wire/4-wire hybrid at the far end of a connection.

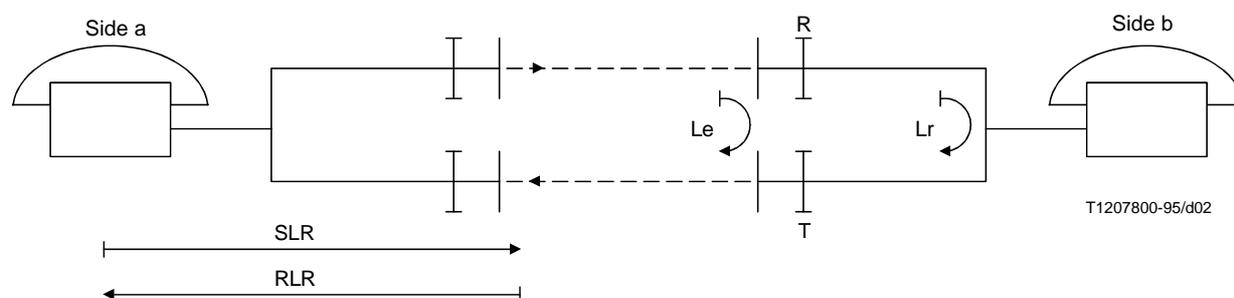


FIGURE I.1/G.131

Talker echo at side a, caused by reflections at side b

With the designations of the figure:

$$\text{TELR} = \text{SLR} + \text{RLR} + \text{Le}$$

and:

$$\text{Le} = \text{R} + \text{T} + \text{Lr}$$

where L_r is the weighted average of the return loss at the hybrid, weighting according to Recommendation G.122 [7].

This Recommendation specifies that no special echo control devices are needed if $T < 25$ ms. According to Figure 1, this corresponds to $\text{TELR} = 33$ dB at the limit $T = 25$ ms. In many networks, $(T+R) = 6$ dB and $\text{SLR}_{\text{nom}} = 7$, $\text{RLR}_{\text{nom}} = 3$. Thus one should have $L_r > 17$ dB which is not unreasonable for an average length of subscriber cable and if the impedance of the terminals can be specified with fairly tight tolerances. However, this may not be the case for all networks as described in the examples below.

In some networks, the average return loss of the terminating impedances against a nominal balance impedance is 14 dB, with a standard deviation of 3 dB. Very short subscriber lines are also common. According to Recommendation G.121, the loudness ratings of the telephone sets are:

$$\text{SLR}_{\text{nom}} = 7, \text{SLR}_{\text{min}} = 2; \text{RLR}_{\text{nom}} = 3, \text{RLR}_{\text{min}} = 1$$

Example 1

Nominal loudness ratings, nominal return loss $L_r=14$, zero length line.

$$\text{TELR} = 7 + 3 + 6 + 14 = 30$$

This corresponds to an “acceptable” limit $T < 18$ ms, “limiting case” $T < 33$ ms.

Example 2

Nominal loudness ratings, lowest “2-sigma” return loss $L_r=8$ dB, zero line.

$$\text{TEL}R = 7 + 3 + 6 + 8 = 24$$

This corresponds to an “acceptable” limit $T < 9$ ms, “limiting case” $T < 19$ ms.

Example 3

Loud telephone set, lowest “2-sigma” return loss $L_r=8$ dB, zero line length.

$$\text{TEL}R = 2 + 1 + 6 + 8 = 17$$

This corresponds to a “limiting case” of 7 ms.

For digital handsets of nominal performance the so-called “Terminal Coupling Loss” (TCL) should be in the order of 40 to 46 dB. If the talker at the other end has a set of normal sensitivity ($\text{SL}R + \text{RL}R = 10$ referred to the 0 dBr point), his TELR will be in the order of 50 to 56 dB.

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