

Implementor's Guide for Recommendation G.168

1 Introduction

This document contains technical corrections and clarification for the implementation of Test No. 2C, Test No 3C, Test No. 5, Test No 7, Test No. 8, Test No 10A, Test No 14 and Figures 7, 9, 15 and 22 in Recommendation G.168 (04/00).

1.1 References

- [1] ITU-T Recommendation G.168 (04/00) - Digital Network Echo Cancellers
- [2] ITU-T Recommendation Q.143 (Blue Book 1993) - Specifications of Signalling System No. 5 - Line Signal Sender
- [3] ITU-T Recommendation Q.144 (03/93) - Specifications of Signalling System No. 5 - Line Signal Receiver
- [4] ITU-T Recommendation Q.271 (Blue Book 1993) - Specifications of Signalling System No. 6 - Continuity Check of the Speech Path - General
- [5] ITU-T Recommendation Q.724 (11/88) - Specifications of Signalling System No. 7 - Telephone User Part - Signalling Procedures

1.2 Background

This guide is a compilation of reported defects, their resolutions and minor upgrades to the April 2000 edition of ITU-T Recommendation G.168 [1]. It includes all approved corrigenda and is intended to be an additional authoritative source of information for implementors to be read in conjunction with the Recommendation itself.

1.3 Scope of the guide

This guide records the resolutions of defects in the following categories:

- technical errors, such as omissions, inconsistencies, etc.
- ambiguities;

1.4 Document history

Version	Summary
Draft A	New Implementors' Guide
Draft B	Minor change to align with Recs. Q.143 and Q.144
Draft C	Rec. Q.724 added to cover System 7 requirements. Change to note in System 5.
Draft D	Table 3 amended to give receiver specifications. 1780Hz requirement deleted.
Draft E	Minor changes to Test 8. Test 7 and Figure 7 corrections added.

Draft F	Sections 2.4 to 2.8 added.
Draft G	Section 2.9 added.

2 Technical errors and ambiguities

2.1 Test No. 8 - Non-Convergence of echo cancellers on specific ITU-T No. 5, 6, and 7 in-band signalling and continuity check tones (optional)

The wording that specifies the signal levels to be used in this test, has been changed to remove any ambiguities, and to align the requirements with the appropriate signalling Recommendations.

In this test, the signal level of the tones applied is given in paragraph 2 as:

"The peak level of each frequency applied is equivalent to the peak level of a sinusoid with a rms level, M , of $-18 \leq M \leq +3$ dBm0."

This sentence should be deleted and the following new wording should be added after the existing second paragraph:

"The power level M , of each signal applied should be within the following limits:

System 5: $-16 \leq M \leq -2$ dBm0

Note: This range applies to the single frequency signals f_1 and f_2 . The level of the individual signals in the compound signal may differ from each other by not more than 5dB. Note that when the levels of the individual signals approach -2dBm0, the compound signal may be clipped. The nominal transmit level is specified as -9 ± 1 dBm0.

See Recommendations Q.143 [2] and Q.144 [3].

System 6: $-18 \leq M \leq -6$ dBm0

Note: The nominal transmit level is -12 ± 1 dBm0

See Recommendation Q.271 [4].

System 7: $-18 \leq M \leq -6$ dBm0

Note: The nominal transmit level is -12 ± 1 dBm0

See Recommendation Q.724 Section 7 [5].

The above levels are designed to ensure that the echo canceller will operate with signals that occupy the entire range of levels given in the appropriate signalling Recommendations."

The signalling frequencies to be used in Test 8 and their associated tolerances given in Table 3 are based on the respective 'sender' specifications. An echo canceller should be based on 'receiver'

specifications, and Table 3 should therefore be amended to include the 'receiver' tolerances for Systems 5, 6 and 7 as stated in Recommendations Q.144 [3], Q.271 [4], and Q.724 [5] respectively. In addition, the 1780Hz requirement for System 7 has been removed from Table 3, since this frequency is only applicable for 2-wire systems which are not covered by Recommendation G.168.

Table 3: Applicable Signalling Tones

System 5	System 6	System 7
2400±15 Hz	2000 ± 30Hz	2000±30 Hz
2600±15 Hz		
2400±15 Hz & 2600±15 Hz		

2.2 Test No. 7 - Stability test

The object of this test is to verify that the echo canceller will remain stable for narrowband signals. The current wording states that the measurement should be performed after two minutes, whereas the intention was to measure throughout the 2 minute duration of this test.

The entire text in Test No. 7 should be deleted and should be replaced with the following text:

"The object of this test is to verify that the echo canceller will remain stable for narrow-band signals. The residual echo is measured throughout the application of a mono-frequency sinusoidal wave.

The test method is as follows: with the H register initially set to zero, and the NLP disabled, the echo canceller is converged on the sinusoidal signal for two minutes. The residual echo level is measured continuously throughout the two minutes that the input signal is applied.

Requirement

With the echo canceller H register initially set to zero, apply a mono-frequency signal, except for those identified in Table 3 of Test No. 8, for two minutes at R_{in} . The residual echo level, measured continuously throughout the two minutes that the input signal is applied, should be less than or equal to that shown in Figure 22 after an initial convergence period of 10 s. The level of R_{in} for this test should be in the range $L_{Rin} \geq -30$ dBm0 and $\leq +3$ dBm0, with an echo path consisting of an $ERL \geq 6$ dB, with an echo-path delay $t_d \leq \Delta$ ms.

The residual echo level is measured using a meter conforming to the characteristics of 6.4.1.2.1."

Note that the requirements for Test No. 7 are given in Figure 22. This graph gives L_{RES} plotted against L_{Rin} . The graph is intended to be a straight line between the following two co-ordinates:

(-30, -55)

(+3, -27.5)

The graph in Figure 22 is correct at these two points, but due to unequal spacing, is incorrect everywhere else. Figure 22 should therefore be deleted and replaced with the following:

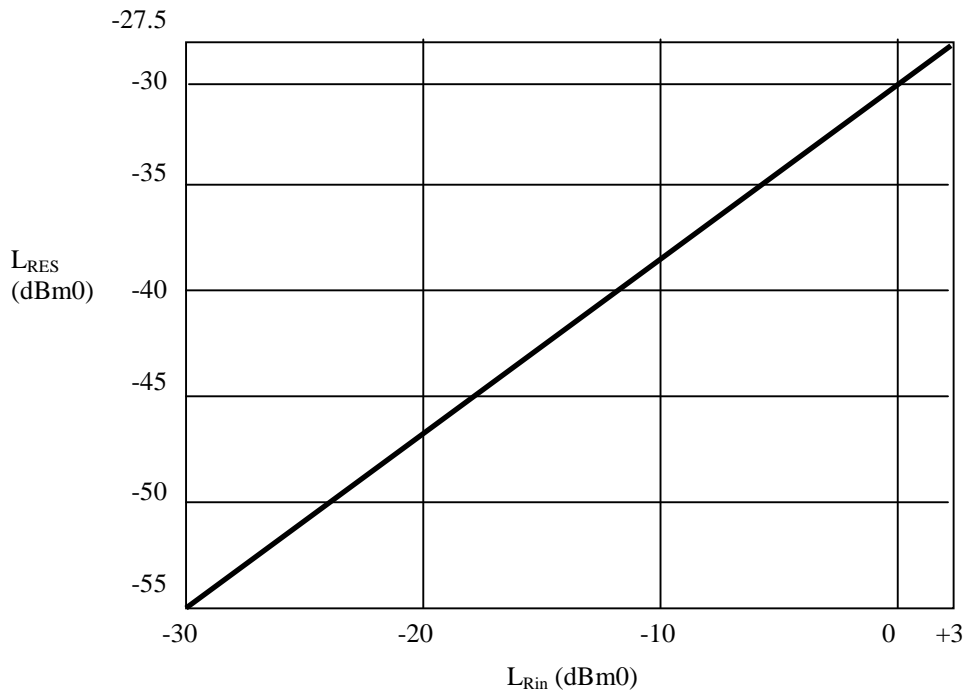


Figure 22: Performance requirements for test 7

Note that the equation for the line in Figure 22 is: $L_{RES} = 0.83L_{RIN} - 30$

2.3 Section 6.4.2 - Echo Canceller Performance

Figure 7 shows an echo path model using $g(k)$. This figure is incorrect, since it does not include any linear (PCM) to A/mu-law conversion. The following changes should be made to the paragraph immediately before Figure 7:

An echo path model which allows more realistic end-paths to be modeled can be realized by replacing the dotted box in Figure 6 with Figure 7. The characteristics of the end-path, which includes the A/mu-law converters, can be modeled as an impulse response $g(k)$.

In addition, Figure 7 should be deleted and replaced with the following:

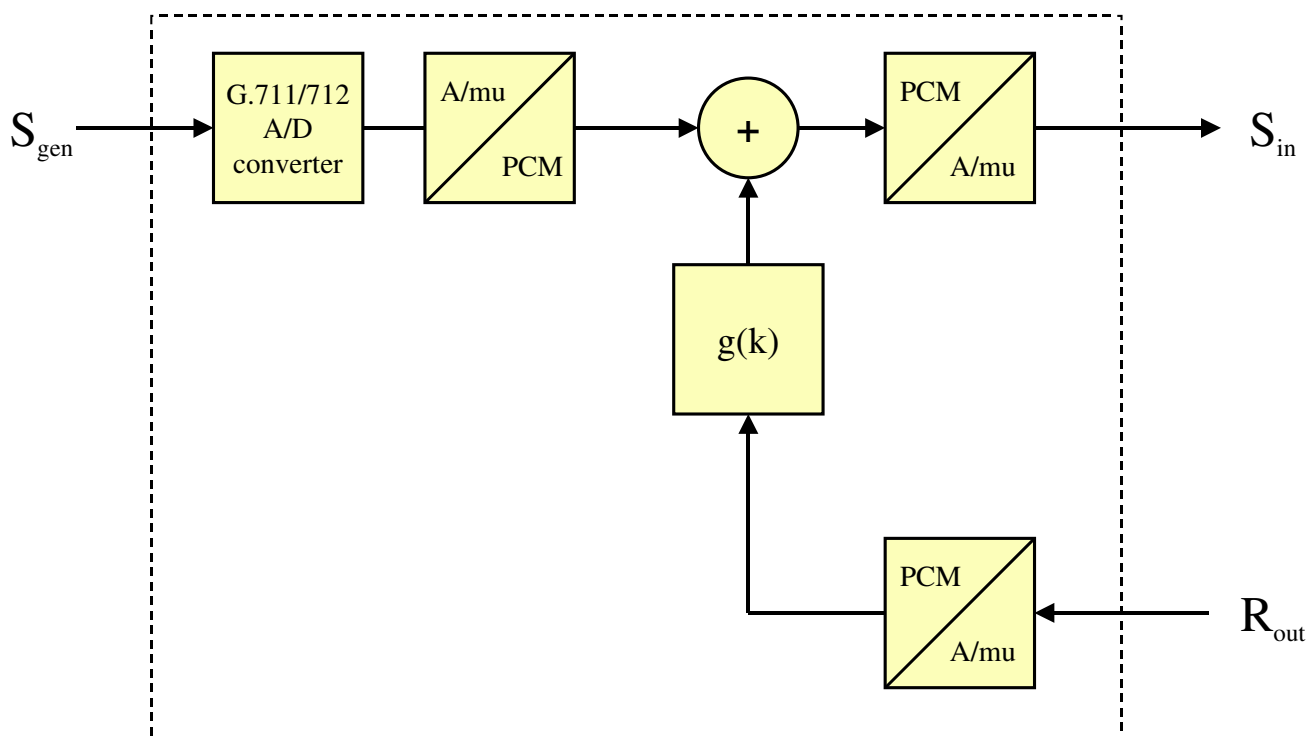


Figure 7: Echo Path Model using $g(k)$

In addition, the following sentence should be added to the end of Section 6.4.2:

"In all tests dependent upon precise timing, appropriate provision for the delay inserted by the filter or filters in the measurement system used, as described in section 6.4.1.2, needs to be taken into account."

2.4 Section 6.4.2.6 Test No. 5 - Infinite return loss convergence test

The requirement of this test states that: "...the combined loss $L_{Rin} - L_{RES}$ should meet the requirements of Figure 12, as measured using the method of 6.4.1.2.1."

In practical situations, the quantity L_{Rin} and L_{RES} will be measured separately. L_{RES} will be measured using the method of 6.4.1.2.1, but L_{Rin} can be measured using either the 6.4.1.2.1 method, or using the RMS method described in 6.4.1.2. If using the 6.4.1.2.1 method, both input and output signals must be synchronised. If using the RMS method, only the active part of L_{Rin} should be used for the measurement (ie excluding the gaps in the CSS signal).

To make this clear, the following paragraph should be added to the requirement of Test No. 5:

"The level at S_{out} is measured using a meter conforming to the characteristics of 6.4.1.2.1. The level at R_{in} is measured using the RMS method of section 6.4.1.2, but modified to include only those samples of the CSS that are in the active portion of the CSS (i.e. excluding the gaps in the CSS signal). The method of 6.4.1.2.1 may also be used at R_{in} , but the input and output signals must also be synchronized."

2.5 Section 6.4.2.3.3 Test No. 2C - Convergence test in the presence of background noise

The requirements for this test are broken down into three separate sections (a, b and c). The measurement method of section 6.4.1.2.1 should be used to measure the level at S_{out} in all three sections. To make this clear, the following paragraph should be deleted from the end of section 6.4.2.3.3 (c) and added as the third paragraph in section 6.4.2.3.3.

"The level at S_{out} is measured using a meter conforming to the characteristics of 6.4.1.2.1. The level at R_{in} is measured using the RMS method of section 6.4.1.2, but modified to include only those samples of the CSS that are in the active portion of the CSS (i.e. excluding the gaps in the CSS signal). The method of 6.4.1.2.1 may also be used at R_{in} , but the input and output signals must also be synchronized."

In addition, there has been some confusion over the requirements of Test 2C part (b) as given in Figure 15. This figure should therefore be deleted and replaced with the following:

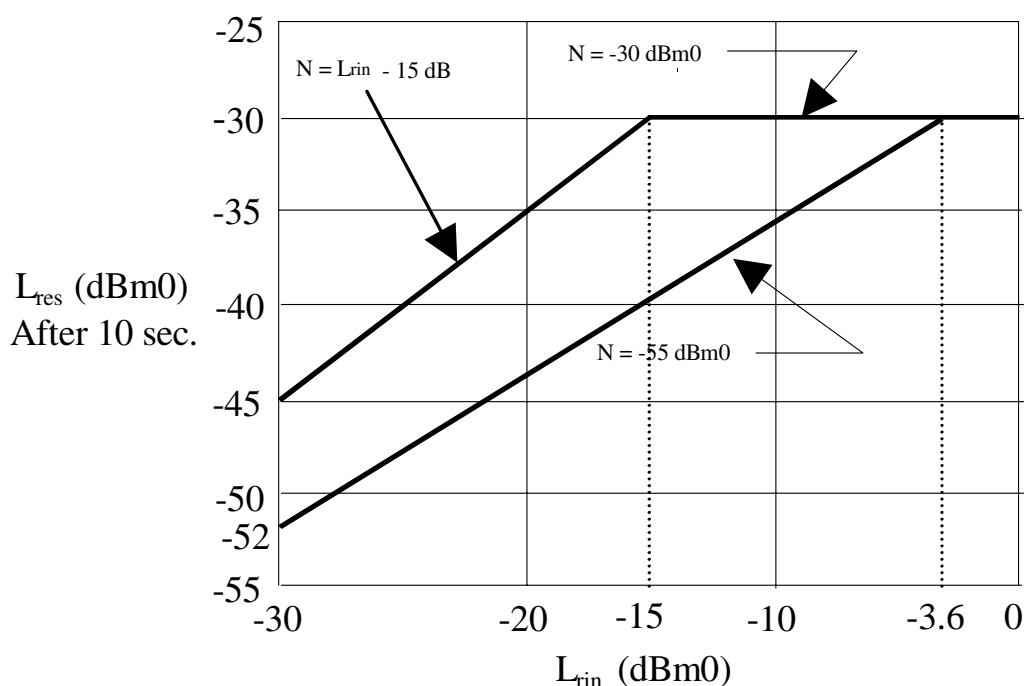


Figure 15: Test No 2C Steady state requirements NLP disabled

2.6 Section 6.4.2.3.1 Test No. 2A - Convergence test with NLP enabled

The requirements for this test are given in Figure 9, in which the horizontal portion of the curve does not show up in the printed document. Figure 9 should therefore be deleted and replaced with the following:

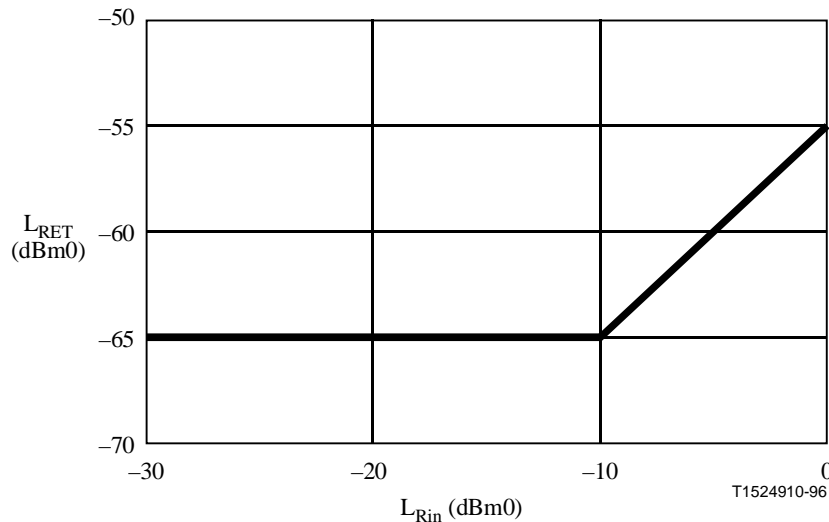


Figure 9: Relationship between receive input level (L_{Rin}) and return echo level (L_{RET}) with NLP enabled

2.7 Section 6.4.2.4.3 Test No. 3C - Double-talk test under simulated conversation

Anecdotal evidence suggests that there may be some confusion between the peaks requirement for this test and that of Test Nos 2A and 2B. The requirement for Test 3C should therefore be clarified as follows:

"With the H-register initially set to zero, for all values of $L_{Rin} \geq -25$ dBm0 and ≤ 0 dBm0, and for all values of $N \geq L_{Rin}$ and for all values of ERL ≥ 6 dB and echo path delay $t_d \leq \Delta$ ms, any peaks (see 6.4.1.2.2) during period t2 should not exceed the level of N during period t1. Unlike test 2A & 2B, where peaks of up to 5 dB are allowed, this is not the case for test 3C. The residual echo level during time period t3 should meet the requirements of Figure 9 with NLP enabled. During t4 and t5, no peaks should exceed the level of $N + 6$ dB."

2.8 Section 6.4.3.1.1 Test No. 10A - Canceller operation on the calling station side

The vast majority of echo cancellers use some form of the least-squares algorithm to model the echo path impulse response. When a sinusoidal input signal is used as the input for the echo canceller, an exact model of the echo path is not possible. This response to a sinusoidal input signal is a well-known and understood consequence of the least-squares algorithm, and is precisely the behavior that can cause a problem with Test 10a.

In Test 10a, Region II starts during the application of the CED signal, and extends to the beginning of Sequence No. 1. Because of the response of least-squares-based algorithms to sinusoidal inputs, during that portion of Region II from the cessation of the CED signal to the beginning of Region III, the echo canceller may produce a residual echo that exceeds the recommendation limits at the end of the CED signal. The user should be aware that this may not be a failure of the echo canceller, but merely a response to the sinusoidal CED input signal. When this response occurs, additional investigation is warranted.

2.9 Section 6.4.3.4 Test No. 14 - Performance with V.series low-speed data modems

The wording of this test should be modified to emphasise that this test should cover the performance of V.18 compatible text telephones. Paragraph 1 of Test 14 should be deleted and replaced with the following text:

"This test is meant to ensure that echo cancellers will not impair the performance of V.Series low-speed (<9.6 kbit/s) modems, including V.22bis modems, and V.18 text telephones, which do not send a 2100 Hz disable tone with phase-reversals. The bit-error rate is measured while the echo cancellers operate in a simulated network with low-speed data modems."
