



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.117

(02/96)

TRANSMISSION SYSTEMS AND MEDIA

GENERAL CHARACTERISTICS OF INTERNATIONAL TELEPHONE CONNECTIONS AND INTERNATIONAL TELEPHONE CIRCUITS

TRANSMISSION ASPECTS OF UNBALANCE ABOUT EARTH

ITU-T Recommendation G.117

(Previously "CCITT Recommendation")

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.117 was revised by ITU-T Study Group 12 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 6th of February 1996.

NOTE

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

© ITU 1996

All rights reserved. No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the ITU.

CONTENTS

		<i>Page</i>
1	Objective	1
2	Principles of the scheme of nomenclature.....	1
3	Summary of the descriptive terms used	2
3.1	One-port networks	2
3.2	Two-port networks	2
3.3	Signal generating devices	2
3.4	Signal receiving devices	2
4	Definitions and measuring techniques based on idealized measuring arrangements	3
4.1	One-port networks	4
4.2	Two-port networks	7
4.3	Signal generating devices	10
4.4	Signal receiving devices	11
5	Other measurement definitions	12
5.1	Common-mode rejection ratio	13
	Annex A – Aspects of conversion from longitudinal to transversal signals at analogue ports in some practical cases	14
A.1	Introduction	14
A.2	Calculation of the longitudinal conversion loss.....	14
A.3	The difference between LCL_c and LCL_m in a practical case – two examples.....	16
A.4	Additional Insight into Longitudinal Conversion Loss	16
	References	18

SUMMARY

In many applications, the balance performance of equipment is crucial in order to ensure a satisfactory suppression of unwanted signals from the normal transmission path. This Recommendation gives guidance of suitable measurement methods for evaluating different effects of unbalance.

Recommendation G.117

TRANSMISSION ASPECTS OF UNBALANCE ABOUT EARTH

(Geneva, 1980; amended at Malaga-Torremolinos, 1984 and Melbourne, 1988;
revised in 1996)

1 Objective

This Recommendation gives a comprehensive set of prescriptive measurements of various balance parameters for one-port and two-port networks. These are intended for use either in the field or in the factory with relatively simple test apparatus (e.g. standard transmission oscillators, level measuring sets), and a special test bridge. Measuring arrangements for assessing the degree of unbalance are covered in Recommendation O.9 [1], which are consistent with this Recommendation.

The definitions and methods are so devised that the results obtained from separately-measured (or specified) items of equipment (e.g. feeding-bridges, cable pairs, audio inputs to channel translating equipment, etc.) can be meaningfully combined though not necessarily by simple decibel addition. This allows the performance of a tandem connection of such items to be predicted or at least, bounds determined for that performance. Performance in this sense means those features affected by unbalanced conditions, e.g. level of impulsive noise, sensitivity to longitudinal exposure, crosstalk ratios, etc.

2 Principles of the scheme of nomenclature

Many different terms have been used throughout the literature concerning unbalance about earth, some conflicting, or in other respects inadequate. The descriptive titles of the quantities given in this Recommendation are based on the following principles which have been adopted:

- a) Mode *conversion*, e.g. a poor (unbalanced) termination will develop an unwanted transverse signal when excited by a longitudinal signal. The measure of this effect is here termed *longitudinal conversion ratio*, and when expressed in transmission units *Longitudinal Conversion Loss*, or LCL.
- b) When a two-port is involved where for example an excitation at one port produces a signal at the other port, then the designation will include the word *transfer*, for example *longitudinal conversion transfer ratio* and the corresponding *loss*, LCTL.
- c) The impedance of the longitudinal path presented by a test object is a key parameter. The term *longitudinal impedance ratio* and the corresponding decibel expression, *longitudinal impedance loss*, are used to characterize the particular measurement defined.
- d) Active devices which are sources of signals (e.g. an oscillator, the output port of an amplifier) are additionally characterized by the amount of unwanted longitudinal signal that is present in the output. The key word *output* is now included, to give *longitudinal output voltage*, and the corresponding *longitudinal output level*. When such unwanted signals are expressed as a proportion of the wanted (transverse) signal the key phrase is *output signal balance ratio*, the decibel expression of which is *output signal balance*.
- e) Devices which continuously respond to signals (e.g. level-measuring sets, the input port of an amplifier) and which can in principle respond to unwanted longitudinal signals by reason of internal mechanisms (i.e. even if their input impedances were perfectly balanced) are characterized by measures containing the words *input interference*. These measures are *input longitudinal interference ratio* and the corresponding decibel expression *input longitudinal interference loss*. The long-established and well-defined *common-mode rejection ratio* is maintained. The term *sensitivity coefficient* is avoided, since this is widely used in the Directives [2] and the work of Study Group 5 with a rather specialized meaning.



Documents

Document Sharing Hub

Recommendation G.117 (02/96)

1

- f) When a two-port network is involved, the input and output signals may not be the same, for example, they may have different levels, frequencies (FDM modems) or structure (PCM multiplex equipments). These aspects should be taken into account when formulating proposals for the item under test.
- g) In the case of receiving devices in which the operation is not a linear continuous function of the level of the input signal (e.g. a group-delay measuring set or a data modem) the key principle is the *threshold* level of the interference; this is the level at or above which an unacceptable amount of degradation of performance or misoperation occurs. Thus *longitudinal interference threshold voltage* and the corresponding *levels* are obtained.

3 Summary of the descriptive terms used

3.1 One-port networks

- a) transverse reflexion factor (transverse return loss: TRL);
- b) transverse conversion ratio (loss: TCL);
- c) longitudinal conversion ratio (loss: LCL);
- d) longitudinal impedance ratio (loss: LIL);
- e) transverse output voltage (level: TOL);
- f) longitudinal output voltage (level: LOL).

Voltages e) and f) are unwanted signals uncorrelated to the wanted signals.

3.2 Two-port networks

3.2.1 Separate measurement

For each port taken separately the one-port measures:

- a) transverse reflexion factors (transverse return losses: TRL);
- b) transverse conversion ratio (loss: TCL);
- c) longitudinal conversion ratios (losses: LCL);
- d) longitudinal impedance ratios (losses: LIL);
- e) transverse output voltage (levels: TOL);
- f) longitudinal output voltage (levels: LOL).

3.2.2 Measurement combined

In addition, the following transfer parameters are for each of the two directions of transmission:

- a) transverse transfer ratios (losses: TTL);
- b) transverse conversion transfer ratios (losses: TCTL);
- c) longitudinal transfer ratios (losses: LTL);
- d) longitudinal conversion transfer ratios (losses: LCTL).

3.3 Signal generating devices

- Output signal balance ratio (losses: OSB).

This is in addition to the six one-port measures listed in 3.1.

3.4 Signal receiving devices

- a) Input longitudinal interference ratio (loss: ILIL).
- b) Longitudinal interference threshold voltage (level).

These are in addition to the six one-port measures listed in 3.1. If the wanted signal is longitudinal (e.g. as in a signalling system) and the interfering voltage transverse, replace the word *longitudinal* with *transverse* in the descriptive terms.

4 Definitions and measuring techniques based on idealized measuring arrangements

The illustrated definitions in this clause assume ideal test bridges (with lossless infinite-inductance centre-tapped coils), zero impedance voltage generators and infinite-impedance voltmeters.

An important aspect of this set of mutually consistent measurements is that the test bridge provides simultaneously defined reference terminations of Z ohms for the transverse paths, and $Z/4$ ohms for the longitudinal paths. From this starting point, the performance of cascaded items, each measured in the prescribed fashion, can be calculated. This takes account of the fact that the cascaded items do not, in general, exhibit the reference impedances provided by the test conditions.

It simplifies the mathematical treatment if the reference impedance is non-reactive and this also accords with the important objective of being able to use readily-available transmission test-apparatus to obtain field and factory measurement results.

The ideal test bridge configuration used in the following pages is shown in Figure 1.

Note, however, that this test bridge configuration, with transversal impedance Z and longitudinal impedance $Z/4$, in general does not represent conditions met in practice. Thus, some care is needed when translating measured unbalance parameters into useful unbalance information for practical cases. This applies in particular for the commonly used parameter LCL, Longitudinal Conversion Loss. This is discussed in more detail in Annex A.

The transverse and longitudinal sources E_T and E_L are activated as required by the particular measurement being made. In Figure 6, neither source is active, and the bridge then provides only passive terminations of Z and $Z/4$.

NOTE – It would have been in keeping with traditional transmission theory for the parameters to be defined in terms of half the open-circuit e.m.f. However, to harmonize with Recommendation O.9, this Recommendation defines some parameters in terms of V_T . If the input impedance of the device under test is nominally equal to the driving device, then the two methods are equivalent.

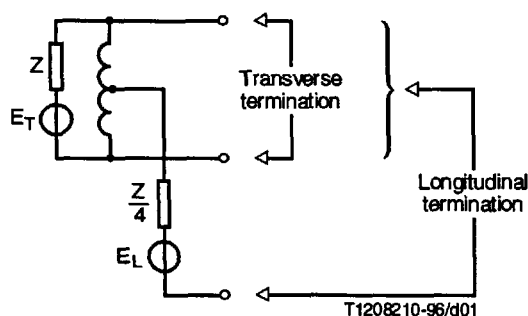


FIGURE 1/G.117