

IEEE Guide on Conductor Self-Damping Measurements

IEEE Standards Board

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Foreword

(This Foreword is not a part of IEEE Std 563–1978, Guide on Conductor Self-Damping Measurements.)

This Guide has been prepared jointly by the IEEE Task Force on Conductor Vibration and the CIGRE (*Conference Internationale des Grandes Reseaux Electriques a Haute Tension*, International Conference on Large High Voltage Electric Systems) study committee 22 — Overhead Lines — Working Group 01 on Mechanical Oscillations. It is the first in a series of guides planned for standardizing the measurement of the inherent energy dissipation characteristics of overhead conductors, the performance of aeolian vibration damper and ultimately the prediction of the vibration amplitudes and the dynamic mechanical strain in conductors resulting from wind induced vibration. An objective of these guides is to establish universally accepted procedures and parameters for developing methods for controlling aeolian vibration.

This Guide was prepared by the Subcommittee on Conductor Vibration of the Towers, Poles, and Conductors of the Transmission and Distribution Committee of the IEEE Power Engineering Society. The membership of this subcommittee was:

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IEEE Guide on Conductor Self-Damping Measurements

1. Scope

With the increasing interest and concern regarding the vibration of overhead conductors, and the emphasis on the improvement of existing methods and the development of new techniques for controlling the problem, there is a growing requirement for reliable information on the self-damping characteristics of conductors. This parameter is a principal factor in determining the response of conductors to alternating forces, such as arise from wind flow over conductors. This guideline has been prepared for the purpose of encouraging investigators contemplating making measurements of the inherent damping characteristics of conductors, to adopt the methods outlined herein. It is anticipated that the resulting information, being in a compatible and consistent form, will provide a reliable basis for studying the vibration and damping of conductors in the future and for the comparison of data of various investigators. The methods and procedures recommended are not intended for quality control test purposes. SI units are used throughout this document with the commonly employed English units shown in parentheses.

There are several methods available for measuring the energy dissipated by a cable vibrating in a principal mode. These can be divided into two main groups which are usually referred to as the “free vibration” and “forced vibration” methods. The vibration of a cable in a principal mode can be observed only in the absence of any exciting force, that is, after the force has been disconnected and the other modes have decayed to insignificant values. The energy dissipated can then be derived from the rate of decay of the vibration. This method can be greatly affected by the method used to disconnect the driving force as the slightest additional disturbance of the conductor causes other vibration modes to be generated and this must be avoided.

With the relatively low rates of decay which are usually associated with stranded conductors, the “forced vibration” method is satisfactory as the contribution of the modes, other than the one which is being excited, is not significant if the frequency of the exciting forces corresponds closely to the resonant frequency of the mode under test and if the exciting force is substantially sinusoidal and of sufficiently low magnitude. Two forced vibration methods are therefore suggested:

1.1

The “power method” [1]¹ in which the conductor is forced into resonant vibration by an electrodynamic shaker and the power input into the system is determined directly from the product of the excitation force and the resulting velocity at the point of application of the load. This represents the power dissipated by the conductor provided the two quantities are sinusoidal and are in phase with each other. It assumes also that the losses of the terminations are small compared with the dissipation within the conductor. The “power method” also permits the mechanical resistance per unit length of the conductor to be determined directly from the ratio of the force to the velocity.

¹The numbers in brackets correspond to the references listed in Section 9 of this guide.

1.2

The “standing wave” method [2], [3] in which the power transfer P_1 from the vibration generator towards the ends of the span at any particular node 1, is derived from the inverse or the reciprocal of the standing wave ratio, that is, the ratio of the nodal and antinodal amplitudes and is given as follows:

$$P_1 = \sqrt{Tm} \frac{V^2}{2} \left(\frac{a_1}{Y} \right)$$

where

$\sqrt{Tm}$	the wave or characteristic impedance (At very high frequencies this may be modified due to the effect of the stiffness of the conductor.)
$\frac{Y}{V}$	standing wave ratio
V_1	single amplitude velocity at antinode
T	conductor tension
m	conductor mass per unit length.

Then the power dissipated between two nodes 1 and 2 is simply

$$P = P_1 - P_2$$

The first method is simpler, faster, and requires somewhat less sophisticated instrumentation and is satisfactory for most measurements provided the termination losses are small. These can be determined by comparing the power inputs for two spans of different lengths identically terminated. (See discussion on Termination (Section C1) on methods for reducing losses to a satisfactory level.) Where it is not convenient to change the span length, it is necessary to employ the “standing wave” method to determine the losses due to the termination of the conductor. This method although more time-consuming, is preferred by some investigators. It does require special care in measuring the conductor amplitudes particularly at nodes where they are usually very small and in ensuring that only the component at the excitation frequency is measured.

The guideline provides information on the requirements for the test span and on the testing conditions, and suggests the form in which the results be presented.