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Australian Standard®

# SPEED FLUCTUATIONS IN ANALOGUE SOUND RECORDING AND REPRODUCING EQUIPMENT—METHOD OF MEASUREMENT

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Australian Broadcasting Corporation

Australian Electrical and Electronic Manufacturers Association

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# PREFACE

This Standard was prepared by the Association's Committee on Audio and Video Engineering and Recording. It is technically identical with IEC 386, *Method of measurement of speed fluctuations in sound recording and reproducing equipment,* as amended by Amendment No 1, March 1988. The major departure from the IEC Publication concerns the explanation given in Clause 3(d) of the $2\sigma$ (sigma) method of measuring wow and flutter which has been expanded in clarification without introducing technical changes.

The purpose of the Standard is to specify a method of measurement for short-term variations in the speed of the sound recording medium, whether it be tape or disc, which is generally known as 'wow' or 'flutter' and which occurs through lack of precision in the mechanical drive of the equipment. A method of measuring drift (i.e. longer term variations), is also described. The characteristics of the required instrumentation are also specified.

The Standard was prepared for reference purposes as part of the necessary background to the preparation of a Standard on high fidelity audio recording and reproducing equipment.

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# Australian Standard

# SPEED FLUCTUATIONS IN ANALOGUE SOUND RECORDING AND REPRODUCING EQUIPMENT—METHODS OF MEASUREMENT

**1 SCOPE.** This Standard uses a method of measurement applying the weighted peak technique.

Explanatory notes concerning flutter and wow measurement are given in Appendix A. Details of suitable measuring equipment are given in Appendix B.

**2 DEFINITIONS.** For the purposes of this Standard, the following definitions shall apply.

**2.1 Flutter**—undesired form of frequency modulation introduced into the signal by an irregular motion of the recording medium during the recording/reproducing process, at frequencies above 10 Hz.

**2.2 Wow**—undesired form of frequency modulation introduced into the signal by an irregular motion of the recording medium during the recording/ reproducing process, at frequencies from 0.1 Hz to 10 Hz.

**2.3 Drift**—slow variation of the velocity of the recording medium during recording and reproducing.

**3 MEASUREMENT OF FLUTTER OR WOW.** In analogue sound recording, it is virtually impossible to obtain completely constant speed of the recording medium because of variations in the mechanical drive. (See Appendix A.)

A method giving the peak value shall be used for the measurement of both flutter and wow for analogue sound recording and reproduction equipment with the following specific requirements:

(a) The measurements shall be made at a nominal frequency of 3150 Hz.

(b) Ideally the measurement should be made on one element only of the system (either the recorder or the reproducer, but not on both) under such conditions that the flutter and wow in the remaining parts of the system is negligible. In testing record players or tape replay units, it must be assumed that test disc or test tape contains negligible wow and flutter. When testing a tape recorder, the test signal at 3150 Hz shall be recorded on a blank test tape which shall then be replayed on a tape deck contributing negligible wow and flutter. The output of this unit is then fed into the wow and flutter meter, the indication on the meter being the wow and flutter of the recorder under test.

Where this condition cannot be fulfilled, a complete recorder/reproducer system may be measured by recording a 3150 Hz test frequency and reproducing this recording several times, measuring in each case the total flutter and wow and forming the arithmetic average value of these measurements. Since this method would seem to be the most suitable manner in which to measure tape recorders, the importance of Clause 3(c) cannot be over emphasized.

Flutter and wow shall not be measured while simultaneously recording and reproducing.

(c) The measuring conditions shall always be stated, namely: reproducer only, recorder only or complete recording/reproducing system.

(d) In order to obtain a stable and reproducible rating of the value for wow and flutter, the use of the $2\sigma$ (sigma) method is recommended, thereby eliminating random peaks.

The $2\sigma$ method is based on the property of a random (Gaussian) distribution that its excursions exceed $2\sigma$, i.e. twice the standard deviation, sigma (the r.m.s. value), for 5% of the time.

The probability, $p$, of exceeding a limit $\pm r$ times the r.m.s. value (1) is:

$$p = 1 - \text{erf}(r/\sqrt{2})$$

When $r = 2$, then $p = 0.0455$.

NOTE: See Ref. 2, where erf($x$) is described as the error integral, $E_2(x) = \phi(x) = \text{erf}(x)$.

Thus on the assumption that the speed deviation follows a Gaussian distribution, the measurement is implemented as follows:

During a time interval $T$, see Figure 3, of at least 5 s, the instantaneous speed deviations are first stored in a memory. These deviation values are then compared with a threshold $\Delta\nu_0$, which initially is chosen arbitrarily.

The cumulative time $\Sigma t_i$, within the given time interval $T$, during which the instantaneous speed deviations exceed the threshold $\Delta\nu_0$ in a positive or negative direction, is calculated. A new threshold value $\Delta\nu_0$ is then estimated, to produce a value of $\Sigma t_i$ nearer to $0.05T$, and the calculation of $\Sigma t_i$ repeated.

The measuring equipment thus searches for that threshold $\Delta\nu_0$ for which the cumulative time $\Sigma t_i$ is equal to 5% of the time interval $T$.

The measured value $\Delta\nu_0$ shall be expressed as a percentage of the average speed.

**4 MEASURING EQUIPMENT.**

**4.1 General requirements.** In addition to the characteristics desirable in the measuring equipment given in Appendix B, it shall have the following characteristics.

**4.2 Response curve.** As specified in Table 1 and Figure 1.

NOTE: An unweighted response curve, flat at least between 0.1 Hz and 200 Hz would provide useful additional information about the source of flutter and wow. Tolerances and dynamic characteristics are not specified for the unweighted response curve.

(1) Fink, D.O., *Television Engineering Handbook*, McGraw-Hill, New York, 1953, p.16-9 and Fig. 16-6, Probability of occurrence of any value of noise voltage.

(2) Jahnke, E. and Emde, F., *Tables of Functions*, 4th Ed., Dover, New York, 1945, p.24.

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