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Standard Guide for Evaluating Data Acquisition Systems Used in Cyclic Fatigue and Fracture Mechanics Testing¹

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^{ε1} NOTE—Equation A4.1 was editorially revised in April 2000.

1. Scope

1.1 The purpose of this guide is to understand and minimize the errors associated with data acquisition in fatigue and fracture mechanics testing equipment. This guide is not intended to be used instead of certified traceable calibration or verification of data acquisition systems when such certification is required. It does not cover static load verification, for which the user is referred to the current revision of Practices E 4, or static extensometer verification, for which the user is referred to the current revision of Practice E 83. The user is also referred to Practice E 467.

1.2 The output of the fatigue and fracture mechanics data acquisition systems described in this guide is essentially a stream of digital data. Such digital data may be considered to be divided into two types—Basic Data, which are a sequence of digital samples of an equivalent analog waveform representing the output of transducers connected to the specimen under test, and Derived Data, which are digital values obtained from the Basic Data by application of appropriate computational algorithms. The purpose of this guide is to provide methods which give confidence that such Basic and Derived Data describe the properties of the material adequately. It does this by setting minimum or maximum targets for key system parameters, suggesting how to measure these parameters if their actual values are not known.

2. Referenced Documents

2.1 ASTM Standards:

- E 4 Practices for Force Verification of Testing Machines²
- E 83 Practice for Verification and Classification of Extensometers²
- E 467 Practice for Verification of Constant Amplitude Dynamic Loads in an Axial Load Fatigue Testing System²
- E 1823 Terminology Relating to Fatigue and Fracture Testing²

¹ This guide is under the jurisdiction of ASTM Committee E-8 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.03 on Advanced Apparatus and Techniques.

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² Annual Book of ASTM Standards, Vol 03.01.

3. Terminology

3.1 Definitions:

3.1.1 *bandwidth* [T^1]—the frequency at which the amplitude response of the channel has fallen to $1/\sqrt{2}$ of its value at low frequency.

3.1.1.1 *Discussion*—This definition assumes the sensor channel response is low-pass, as in most materials testing. An illustration of bandwidth is shown in Fig. 1.

3.1.2 *Basic Data sample*—the sampled value of a sensor waveform taken at fixed time intervals. Each sample represents the actual sensor value at that instant of time.

3.1.2.1 *Discussion*—Fig. 2 shows examples of Basic Data samples.

3.1.3 *data rate* [T^1]—the data rate is $1/t_d$ Hertz where the time intervals between samples is t_d in seconds.

3.1.3.1 *Discussion*—The data rate is the number of data samples per second made available to the user, assuming the rate is constant.

3.1.4 *Derived Data*—any waveform parameter which is derived from one or several of the Basic Data samples.

3.1.4.1 *Discussion*—Fig. 2 illustrates examples of Derived Data.

3.1.5 *noise level*—the standard deviation of the data samples of noise in the transducer channel, expressed in the units appropriate to that channel.

3.1.6 *peak*—the point of maximum load in constant amplitude loading (see Terminology E 1823).

3.1.7 *phase difference* [$^\circ$]—the angle in degrees separating corresponding parts of two waveforms (such as peaks), where one complete cycle represents 360° .

3.1.7.1 *Discussion*—The phase difference of a cyclic waveform only has meaning in reference to a second cyclic waveform of the same frequency.

3.1.8 *sampling rate* [T^1]—the rate at which the analog-to-digital converter samples a waveform. This rate may not be visible to the user of the data acquisition system.

3.1.8.1 *Discussion*—A distinction is made here between *sampling rate* and *data rate*, because in some data acquisition systems, the analog waveform may be sampled at a much