



Designation: F 2137 – 04

Standard Practice for Measuring the Dynamic Characteristics of Amusement Rides and Devices¹

This standard is issued under the fixed designation F 2137; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers acquisition of data related to the dynamic characteristics of amusement rides and devices.

1.2 This practice also defines the specific requirements of a Standardized Amusement Ride Characterization Test (SARC Test) for use in characterizing the dynamic motion of an amusement ride or device.

2. Referenced Documents

2.1 SAE Standard:

SAE J211 Instrumentation for Impact Tests²

3. Terminology

3.1 Definitions:

3.1.1 *aliasing*—a phenomenon associated with sampled data systems, wherein a signal containing significant energy at frequencies greater than one half of the system sample frequency manifests itself in the sampled data as a lower frequency (aliased) signal. Aliasing can be avoided only by limiting the frequency content of the signal prior to the sampling process. Once a signal has been aliased, it is not possible to reconstruct the original signal from the sampled data.

3.1.2 *calibration constant*—the arithmetic mean of the sensitivity coefficients, evaluated at frequencies that are evenly spaced on a logarithmic scale between F_L and F_H .

3.1.3 *calibration value*—the ratio of the reference calibration system output, in engineering units relevant to the transducer, to the data channel output, in volts, as measured at constant excitation frequency and amplitude.

3.1.4 *channel frequency class (CFC)*—a frequency response envelope that conforms to Fig. 1 and is referred to by the value F_H in hertz. The CFC frequency response envelope is defined by the boundaries shown in Fig. 1 and the following characteristic frequencies:

F_L —Pass band lower limit (hertz). Always equal to zero (0.0) hertz.

F_H —Pass band upper limit (hertz). The CFC designator.

F_N —The corner or knee of the frequency response envelope. Always equal to or greater than $1.667 \times F_H$.

F_S —The minimum sample frequency for a sampled data system that corresponds to the designated CFC. Always equal to or greater than $12 \times F_H$.

3.1.4.1 *Discussion*— F_L , F_H , F_N , and F_S are always specified in hertz. While the characteristics of the CFC may be applied to individual components of a data channel, the CFC is, by definition, the frequency response envelope of the entire data channel from the mounted transducer to the final representation of the acquired data.

3.1.5 *coordinate system*—three orthogonal axes that intersect at an origin whose positive directions correspond to the right-hand rule.

3.1.5.1 *measurement coordinate system*—a coordinate system that provides the reference axes and sign convention for the test data record(s).

3.1.5.2 *patron coordinate system*—a coordinate system that is fixed with respect to the human upper torso and oriented as in Fig. 2.

3.1.5.3 *vehicle coordinate system*—a coordinate system that is fixed with respect to the ride or device being tested.

3.1.6 *data channel*—the entire instrumentation system for a single channel of data acquisition; from the transducer to the final representation of the data, including all post-acquisition data processing that may alter the amplitude or frequency content of the data.

3.1.7 *data channel full scale*—the maximum usable value, in units of the physical phenomenon being measured, that may be represented by a data channel. This value is determined by the data channel component with the lowest full-scale range.

3.1.8 *free-run time*—a period of time during the ride cycle when no energy is added to the ride vehicle.

3.1.9 *full-scale*—the maximum usable value, in units of the physical phenomenon being measured, which may be represented by a data channel or some component thereof.

3.1.10 “*g*”—the standard acceleration due to gravity at the surface of the earth. Defined as 32.2 ft/s/s or 9.81 m/s/s.

3.1.11 *nonlinearity*—the ratio, in percent, of the maximum difference between a calibration value and the corresponding

¹ This practice is under the jurisdiction of ASTM Committee F24 on Amusement Rides and Devices and is the direct responsibility of Subcommittee F24.10 on Test Methods.

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² Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

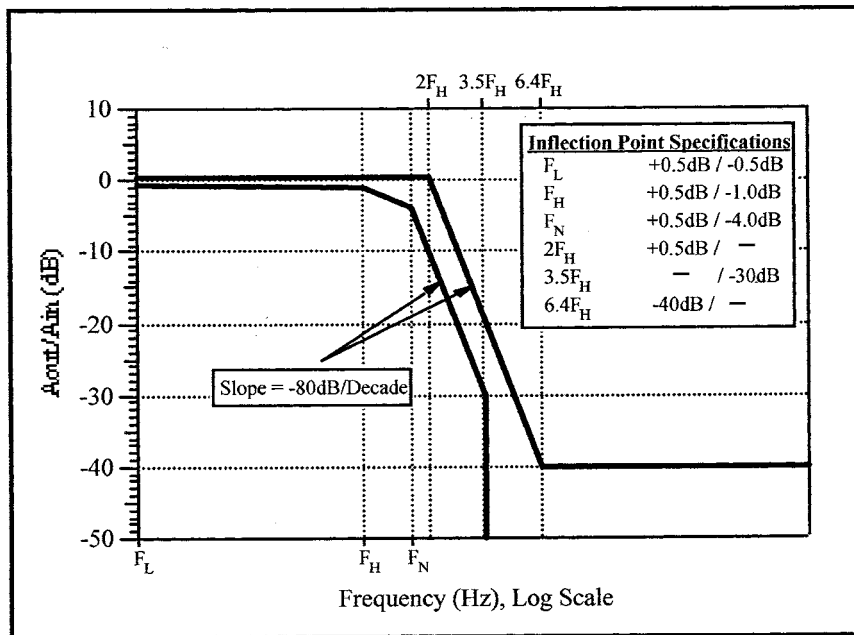


FIG. 1 Frequency Response Envelope

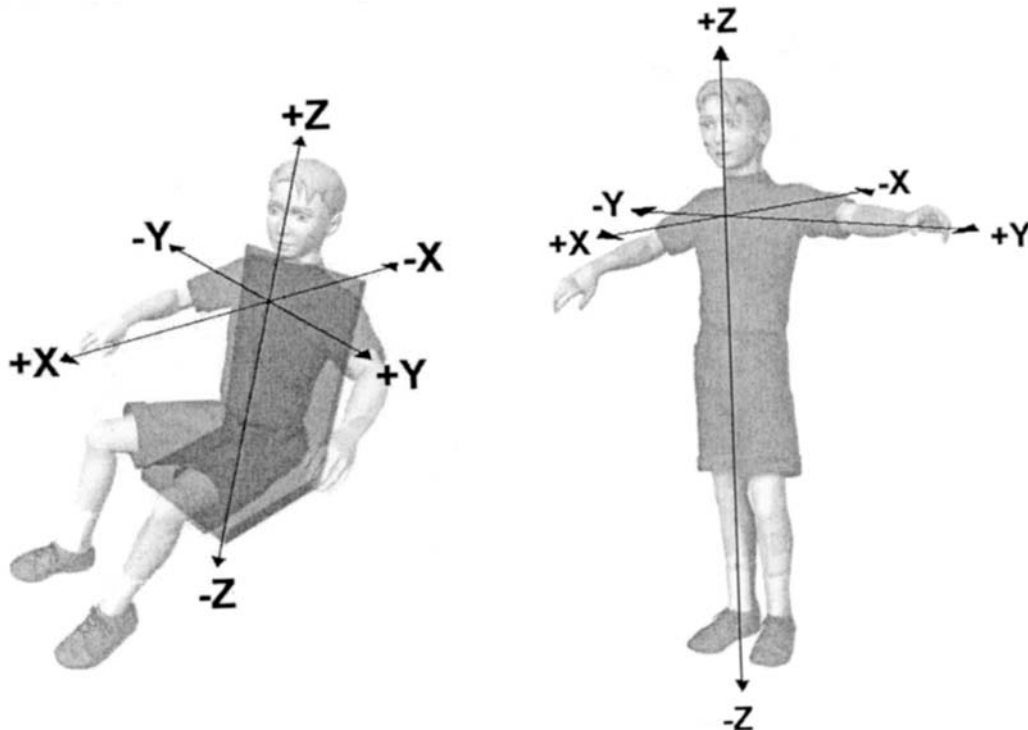


FIG. 2 Patron Coordinate System

value determined from the straight line defined by the sensitivity coefficient and zero bias.

3.1.12 *reference calibration system*—the entire calibration instrumentation system from the reference transducer to the output device that provides the calibration excitation value in engineering units appropriate to the physical phenomenon being measured.

3.1.13 *resolution*—the lowest magnitude data channel output value that can be identified as non-zero.

3.1.14 *sensitivity coefficient*—the slope of the straight line representing the best fit, as determined by the method of least squares, to calibration values generated at a single frequency and at various amplitudes within the data channel full scale range. In the special case where only a single calibration value is considered, the sensitivity coefficient and the calibration value will be equal.

3.1.15 *standardized amusement ride characterization test (SARC Test)*—an instrumented test of amusement ride