

An American National Standard

IEEE Standard for the Measurement of Impulse Strength and Impulse Bandwidth

Sponsor
**Standards Committee
of the
IEEE Electromagnetic Compatibility Group**

Approved May 30, 1974
Reaffirmed March 5, 1981
Reaffirmed September 18, 1986
Reaffirmed March 18, 1993

IEEE Standards Board

Approved December 30, 1977
Reaffirmed February 9, 1987
Reaffirmed August 30, 1993

American National Standards Institute

Corrected Edition June 1992

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**The Institute of Electrical and Electronics Engineers, Inc
345 East 47th Street, New York, NY 10017, USA**

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Foreword

(This foreword is not a part of IEEE Std 376-1975, IEEE Standard for the Measurement of Impulse Strength and Impulse Bandwidth.)

For many purposes in radio interference and electromagnetic compatibility work, it has become convenient to measure broadband emission in terms of peak voltage or field strength, especially with the use of automatic spectrum scanning instrumentation. Because of the simplicity of the impulse generator, it is used frequently for calibration purposes. This standard provides basic information relating to the use of this device and interpretation of measurements made using instruments based on it.

The measurement of impulse strength and impulse bandwidth, while conceptually relatively simple, in practice have been found difficult to perform with high accuracy and reproducibility. Various methods have been evaluated in various laboratories, and are mentioned in this standard. After much consideration, two techniques are recommended for general use.

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IEEE Standard for the Measurement of Impulse Strength and Impulse Bandwidth

1. Introduction

The importance of the impulse as a concept in engineering work has come about not only because of the extensive use of pulses in many types of communication systems, but also because many sources of interference or radio noise are “impulsive” in nature. By an impulsive source one generally means a source of electromagnetic energy which can be represented by a series of discrete disturbances of low duty cycle. Usually, it will have a relatively broad frequency spectrum. The importance of the impulse is related to the fact that where the duration of the pulse generated by a given source is sufficiently short¹ in comparison with the reciprocal of the center or tuned frequency of a “narrow-band” network responding to it, the waveform at the output of the network is of a very definite shape practically independent of the input waveform, and has a peak value proportional to its “impulse strength.” Because of these relations, an impulse generator is useful for calibrating the network response, and the networks themselves may be characterized in terms of their equivalent “impulse bandwidth.”

Because the impulse has a broad spectrum, a quantitative measure of the “spectrum amplitude” is also a useful quantity.

2. Definitions

impulse strength: The area under the amplitude-time relation for the impulse.

NOTE — This definition can be clarified with the aid of Fig 1. Let $A(t)$ be some function of time having a value other than zero only between the times t_1 and $t_1 + \delta$. Then let the area under the curve $A(t)$ be designated by σ :

$$\sigma = \int_{-\infty}^{\infty} A(t) dt = \int_{t_1}^{t_1 + \delta} A(t) dt$$

¹For a rectangular pulse, the spectrum is flat within about 1 dB up to a frequency for which the pulse duration is equal to 1/4 cycle. See Fig A.2.

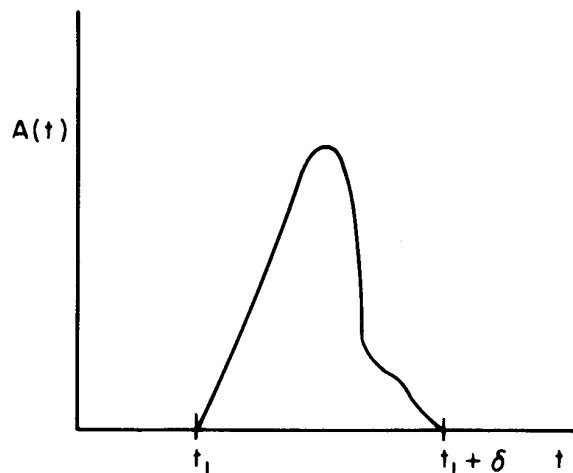


Figure 1— A Pulse of Arbitrary Shape

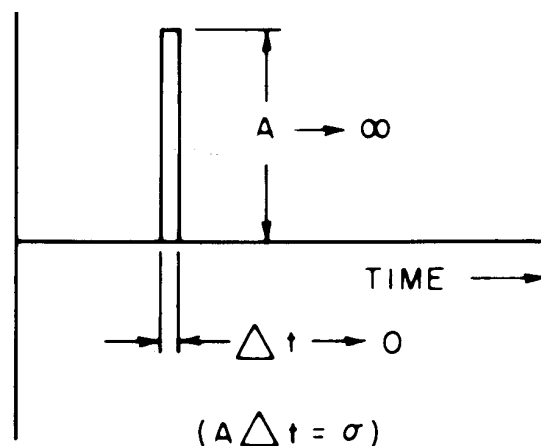


Figure 2— A Rectangular Pulse

To define the theoretical or ideal impulse, let $A(t)$ vary in a reciprocal manner with δ such that the value σ remains constant, so that

$$\sigma = \lim_{\delta \rightarrow 0} \int_{t_1}^{t_1 + \delta} A(t) dt$$

In the limit the function $A(t)$ becomes an ideal “impulse” of “strength” σ . As an example, consider the function shown in Fig 2. Here a rectangular pulse of finite duration Δt and height A is shown. Now let $A = \sigma/\Delta t$ where σ is (for the present argument) an arbitrary constant, and let $\Delta t \rightarrow 0$. In the limit we have an impulse of strength σ . When $\sigma = 1$, one has a “unit impulse.”

In many conventional applications the amplitude $A(t)$ has the dimension volts and σ then has the dimension volt-seconds.

spectrum intensity: (For spectra which have a continuous distribution of components (components are not discrete) over the frequency range of interest). The spectrum intensity is the ratio of the power contained in a given frequency range to the frequency range as the frequency range approaches zero. It has the dimensions watt-seconds or joules and is usually stated quantitatively in terms of watts per hertz.

spectrum amplitude: The voltage spectrum of a pulse can be expressed as²

²See IEEE Std 263-1965, Measurement of Radio Noise Generated by Motor Vehicles and Affecting Mobile Communications Receivers in the Frequency Range 25 to 1000 MHz.