ICS 17.160
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NATIONAL STANDARD OF THE

PEOPLE'S REPUBLIC OF CHINA

GB/T 29716.2-2018

Mechanical vibration and shock -- Signal processing -- Part 2: Time domain windows for Fourier Transform analysis

Issued on: March 15, 2018 **Implemented on: October 1, 2018**

Issued by: State Administration for Market Regulation, China National Standardization Administration

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Foreword

GB/T 29716 "Mechanical Vibration and Shock Signal Processing" consists of the following parts.

--- Part 1. Introduction;

--- Part 2. Time domain window of Fourier transform analysis;

--- Part 3. Time-frequency analysis method;

--- Part 4. Impact response spectrum analysis;

--- Part 5. Time scale analysis method.

This part is the second part of GB/T 29716.

This part is drafted in accordance with the rules given in GB/T 1.1-2009.

This section uses the translation method equivalent to ISO 18431-2.2004 "Mechanical Vibration and Shock Signal Analysis Part 2. Fourier Transform

Change the time domain window of the analysis (English version) and incorporate the contents of its amendment ISO 18431-2.2004/Cor.1.2008.

The documents of our country that have a consistent correspondence with the international documents cited in this part of the norm are as follows.

---GB/T 2298-2010 Mechanical vibration, shock and condition monitoring vocabulary (ISO 2041.2009, IDT)

This part is proposed and managed by the National Technical Committee for Standardization of Mechanical Vibration, Shock and Condition Monitoring (SAC/TC53).

This section drafted by. Zhengzhou University, Zhengzhou Machinery Research Institute, Guangdong Electric Power Grid Co., Ltd. Electric Power Research Institute, State Grid Henan Electric

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Introduction

Measurement data for vibration and shock can include displacement, velocity, and acceleration, which can be characterized as smooth or non-stationary in time history. base

The spectral analysis method of the Fourier transform is one of the tools for analyzing these two types of signals. In the process of digital signal processing, the observed signal is

There are N samples with uniform time intervals in the time domain. Using a discrete Fourier transform on these N samples can obtain a series of simple cycles

The sine and cosine functions whose amplitude and harmonic balance are determined by the time domain window for these N samples.

This section of GB/T 29716 specifies the three most common use of windows.

Mechanical vibration and shock signal processing

Part 2. Time domain window of Fourier transform analysis

1 Scope

This part of GB/T 29716 specifies a set of algebraic functions that are used to describe the pre-processing of vibration and shock digital sample data.

A set of time domain windows is chosen as a precursor to the spectral analysis of discrete Fourier transforms. Selected windows include Hanning windows, flat roof windows and moments

Shaped window.

This section is one of a series of documents detailing the signal processing tools available for the time domain, frequency domain, and time-frequency combination domain.

2 Normative references

The following documents are indispensable for the application of this document. For dated references, only dated versions apply to this article.

Pieces. For undated references, the latest edition (including all amendments) applies to this document.

ISO 2041.1990 Vibration and Shock Vocabulary (Vibrationandshock-Vocabulary)

3 Terms and definitions

The following terms and definitions as defined by ISO 2041 apply to this document.

3.1

Discrete Fourier Transform DiscreteFourierTransform

DFT

Based on the Fourier integral transform, N uniforms observed over a finite continuous time can be obtained by discrete transformations in the time domain and the frequency domain.

Sample spectrum estimates for uniform time difference.

X(m)=

fSsum

N-1

n=0

x(n)e-i2pinm/N

The definition of the symbol in the formula is given in Chapter 4.

3.2

Fast Fourier Transform FastFourierTransform

FFT

A discrete Fourier transform calculation algorithm that optimizes computational efficiency.

Note. This algorithm is the classic Cooley-Tukey algorithm (see [1]) or the Sande-Tukey algorithm.

3.3

Time window timewindows

In a limited time observation record, the aperiodicity of the acquired signal causes energy to flow into the adjacent frequency domain (spectral leakage), and the time window is

A weighting function is used throughout the collected data system to reduce the amount of energy loss, ie, has been truncated to a sinusoidal component.

4 symbol

a(i) flat top window constant

Be equivalent noise bandwidth

fS sampling frequency

i flat top window constant index

m frequency sample

n time sample

N sample data block size; number of transformed sample points

w(n) window function in time domain

W(m) window function in the frequency domain

x(n) sample physical quantity in the time domain

Digital Fourier Transform of X(n) x(n, deltat)

5.1 Overview

There are three commonly used time domain windows in Fourier analysis. Hanning windows, flat top windows, and rectangular windows.

Note. Rectangular windows are not really used for algebraic operations of windows, but are included in this section for completeness.

Table 1 window characteristics

Window type

Highest side lobes

dB

Sidelobe attenuation

dB/10oct

Noise bandwidth

Number of lines*

Maximum error