



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS C 6790 : 2010

(USMAJ/JSA)

**Load test of a bolt-clamped Langevin
vibrator using wattmeter method**

ICS 31.080.99

Reference number : JIS C 6790 : 2010 (E)

PROTECTED BY COPYRIGHT

 **Documents**
Document Sharing Hub

11 S

Date of Establishment: 2010-05-20

Date of Public Notice in Official Gazette: 2010-05-20

Investigated by: Japanese Industrial Standards Committee
Standards Board

Technical Committee on Electronics Technology

JIS C 6790 : 2010, First English edition published in 2011-10

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2011

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

PROTECTED BY COPYRIGHT

Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Equipment and apparatus for measurement	3
5 Measuring method	3
5.1 Measurement items	3
5.2 Temperature and humidity of measurement location	4
5.3 Precautions on measurement	4
5.4 Measurement of vibrator input power at no load	4
5.5 Measurement of vibrator input power at load	4
6 Calculation of various characteristics	5
6.1 Calculation items	5
6.2 Braking loss	6
6.3 Internal mechanical vibration loss	6
6.4 Acoustic output	6
6.5 Mechanical load resistance	6
6.6 Electroacoustic conversion efficiency	7
7 Record	7
Annex A (informative) Reverberation tank	8
Annex B (informative) Ultrasonic emitter	9
Annex C (normative) Motional admittance method	11
Annex D (informative) Mechanical load resistance characteristic diagram	14

Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Ultrasonic Manufacturers Association of Japan (USMAJ) /Japanese Standards Association (JSA) with the draft prepared from the association standard (AE-4006A : 2001) [standard of Japan Electronics and Information Technology Industries Association (JEITA)] being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

This **JIS** document is protected by the Copyright Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Load test of a bolt-clamped Langevin vibrator using wattmeter method

Introduction

The bolt-clamped Langevin vibrator is widely used for apparatuses for strong ultrasonic wave applications such as ultrasonic cleaning, ultrasonic welding, ultrasonic machining and ultrasonic dispersion. However, since the test method for calculating various characteristics of a vibrator when it operates at a practical level (hereafter referred to as “at load”) is not yet standardized, the motional admittance method (see Annex C) in which measurement is performed at a low level is substituted.

This Standard is a Japanese Industrial Standard that specifies the test method for calculating various characteristics of a vibrator at a practical level by measuring the input power of a vibrator at load.

1 Scope

This Standard specifies the method for measuring the characteristics at load (internal mechanical vibration loss, electroacoustic conversion efficiency, etc.) of a bolt-clamped Langevin vibrator of which the resonance frequency is 10 kHz to 100 kHz (hereafter referred to as “vibrator”) by the wattmeter method and calculating them.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS C 1102-2 *Direct acting indicating analogue electrical measuring instruments and their accessories Part 2 : Special requirements for ammeters and voltmeters*

JIS Z 8106 *International electrotechnical vocabulary Chapter 801 : Acoustics and electroacoustics*

JIS Z 8703 *Standard atmospheric conditions for testing*

3 Terms and definitions

For the purpose of this Standard, terms and definitions given in **JIS Z 8106** and the following definitions apply.

3.1 wattmeter method

measuring method for obtaining an electroacoustic conversion efficiency, etc. by measuring the input at no load and at load of a vibrator using a wattmeter

3.2 bolt-clamped Langevin vibrator

a vibrator having a construction in which piezoelectric elements sandwiched between metal blocks are fastened with bolts

3.3 reverberation tank

a tank having an irregular structure, of which no surfaces, including the tank wall and water surface, are parallel with another surface

3.4 variable acoustic load

load that can alter the change of radiation impedance into the change of mechanical load impedance by immersing a prolate spheroidal or disciform ultrasonic emitter in a liquid

3.5 vibration transmitting body

vibrating elastic body for transmitting the ultrasonic vibration of a vibrator to an ultrasonic emitter

3.6 vibration displacement amplitude

vibration displacement in the emitting surface of a vibrator (half amplitude)

3.7 vibration velocity

displacement rate in the emitting surface of a vibrator, which is expressed by the product of vibration displacement amplitude and resonance angular frequency

3.8 braking loss

dielectric loss of a piezoelectric element when it is restrained so that the mechanical vibration of a vibrator cannot be performed

3.9 input power

electric power that flows into a vibrator

3.10 internal mechanical vibration loss

vibration loss due to the mechanical resistance inside a vibrator

3.11 power factor correction coil

resonant-circuit coil placed in series or in parallel between a high-frequency power source and a vibrator

3.12 power factor correction capacitor

resonant-circuit capacitor placed in parallel between a high-frequency power source and a vibrator

3.13 acoustic output

mechanical output emitted from the emitting surface of a vibrator into a medium

3.14 resonance frequency

frequency in which the vibration velocity of the emitting surface of a vibrator becomes maximum when the constant voltage driving of the vibrator is performed

3.15 mechanical load impedance

value obtained by dividing the force acting on the emitting surface of a vibrator by the vibration velocity of the emitting surface, which is expressed by a complex number

3.16 mechanical load resistance

real part of mechanical load impedance

3.17 electroacoustic conversion efficiency

ratio of acoustic output to input power, which is expressed by percentage (%)

4 Equipment and apparatus for measurement

4.1 Meter and measuring instrument

Unless otherwise specified in the individual standard, the meter of Class 0.5 specified in **JIS C 1102-2** shall be used, and the measuring instrument with the accuracy equivalent or superior to this shall be used. The input impedance of the meter and measuring instrument shall be a value the effect of which on the measurement system is negligible.

4.2 High-frequency power meter

The high-frequency power meter shall have a sufficient measurement frequency range and measurement power range in the frequency to measure.

4.3 Vibration displacement meter

The vibration displacement meter shall have a sufficient resolution and measurement range in the frequency to measure.

4.4 High-frequency power source

The high-frequency power source shall have small harmonic components in the frequency to measure and a sufficient output for the measurement at load, and shall consist of an ultrasonic wave vibrator or a signal generator, and a power amplifier.

4.5 Tank

The structure of the tank shall be such that it has sufficient capacity and the generation of standing waves of a reverberation tank, an anechoic tank, etc. is minimum. However, when a prolate spheroidal ultrasonic emitter is used, the shape of the tank may be an ordinary cube.

An example of shape and dimensions of the reverberation tank is shown in Annex A.

4.6 Ultrasonic emitter

The ultrasonic emitter shall be a prolate spheroidal emitter or a disciform emitter which serves as sufficient acoustic load in the frequency to measure. An example of shape and dimensions of the prolate spheroidal emitter and disciform emitter is shown in Annex B.

5 Measuring method

5.1 Measurement items

The measurement items shall be as follows.

- a) Vibrator input power at no load (W_{en})
- b) Vibrator input power at load (W_{el})