

TECHNICAL REPORT



**Dynamic modules –
Part 6-5: Investigation of operating mechanical shock and vibration tests for
dynamic modules**

IEC TR 62343-6-5:2011

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

DYNAMIC MODULES –

Part 6-5: Investigation of operating mechanical shock and vibration tests for dynamic modules

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IEC 62343-6-5, which is a technical report, has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
86C/943/DTR	86C/958/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 62343 series, published under the general title *Dynamic modules*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- replaced by a revised edition, or
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DYNAMIC MODULES –

Part 6-5: Investigation of operating mechanical shock and vibration tests for dynamic modules

1 Scope

This part of IEC 62343, which is a technical report, explains an investigation of operating mechanical shock and a vibration test for dynamic modules. It also describes the results of a survey, evaluation and mechanical simulation of mechanical shock and vibration testing. This report covers a study of standardization for operating mechanical shock and vibration test methods.

2 Background

The recent deployment of advanced, highly flexible optical communication networks using ROADMs (reconfigurable optical add drop multiplexing) systems has been accompanied by putting dynamic wavelength dispersion compensators, wavelength blockers and wavelength selective switches to practical use as “dynamic modules.” Since these dynamic modules incorporate such brand-new technology as MEMS (micro electromechanical systems), there are concerns about the vulnerability of MEMS to operational shock and vibration conditions, which urgently require establishing evaluation methods and conditions for operational shock and vibration. Standards for shock and vibration test conditions as pertaining to storage and transport are already established, but methods and conditions for evaluating operational shock and vibration are not yet established.

The JIS (Japanese Industrial Standards) committee consequently conducted a questionnaire survey on the shock and vibration testing of passive optical components and dynamic modules in commercial use. The survey revealed that many respondents confirmed a need to standardize evaluation conditions for operational shock and vibration, and some suggested earthquakes, hammers impact testing and inserting an adjacent board as cases of shock and vibration during dynamic module operation. Based on the survey results, the JIS committee evaluated such operational shock and vibration by conducting hammer impact tests using several dynamic modules, compared the results through simulation, and then recommended specific evaluation conditions.

This technical report is based on OITDA (Optoelectronic Industry and Technology Development Association) – TP (Technical Paper), TP05/SP_DM-2008, “Investigation on operational vibration and mechanical impact test conditions for optical modules for telecom use.”

3 Questionnaire results in Japan

The JIS committee conducted a questionnaire on operational shock and vibration testing. The questionnaire allowed the respondents to specify the optical components to be tested. This questionnaire included optical switches, VOAs (variable optical attenuators) and tunable filters among the mechanical components used in all possible situations. The survey covered 18 organizations: eight Japanese manufacturers of mechanical optical components, eight device makers as users of such components, and two research institutes. Responses were received from 14 of these organizations (for a response rate of 78 %), among which 12 respondents specified optical switches, seven specified VOAs and three chose tunable filters. In tabulating the data, the survey asked questions regarding these three types of components and described occurrences not dependent on the type of component, the manufacturer and the user, and evaluation conditions.

The results revealed a strong need for the standardization of operational shock and vibration evaluation methods and conditions for such dynamic modules as optical switches and VOAs. A majority of respondents also requested that hammer impact testing and the insertion of an adjacent board be included as cases of operational shock and vibration.

4 Evaluation plan

Based on the survey results described in Clause 3, the appropriate conditions for shock and vibration testing were determined based on an evaluation. The evaluation method consisted of the following three steps.

Step 1: Measure the shock and vibration characteristics of a board with a shock sensor inserted into a standard rack by striking the front face of the board with a hammer or by inserting an adjacent board.

Step 2: Test an optical module installed in a standard rack by repeating the procedure in Step 1. Measure any changes in the optical characteristics of the optical module.

Step 3: Use standard shock and vibration test equipment to reproduce the shock and vibration characteristics obtained in Step 1 and the optical characteristics of the optical module obtained in Step 2.

5 Evaluation results

5.1 Step 1

5.1.1 Evaluation of hammer impact

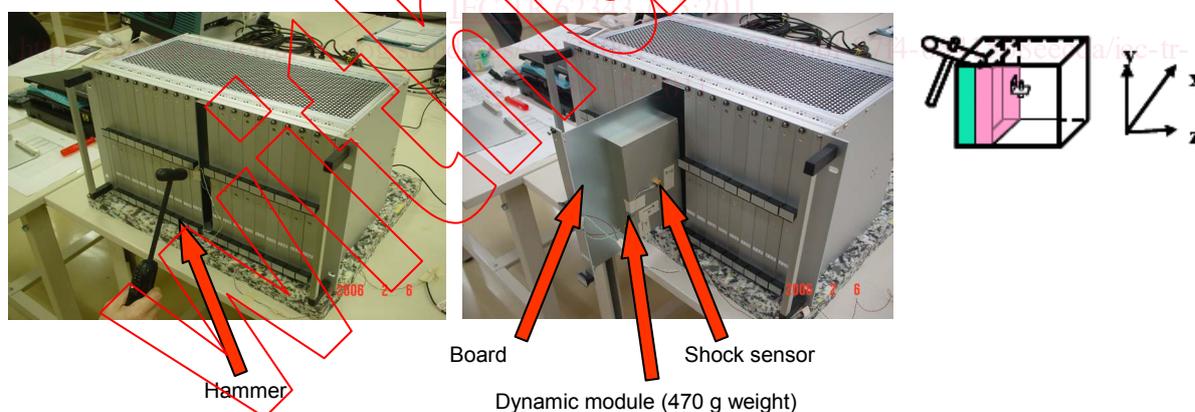


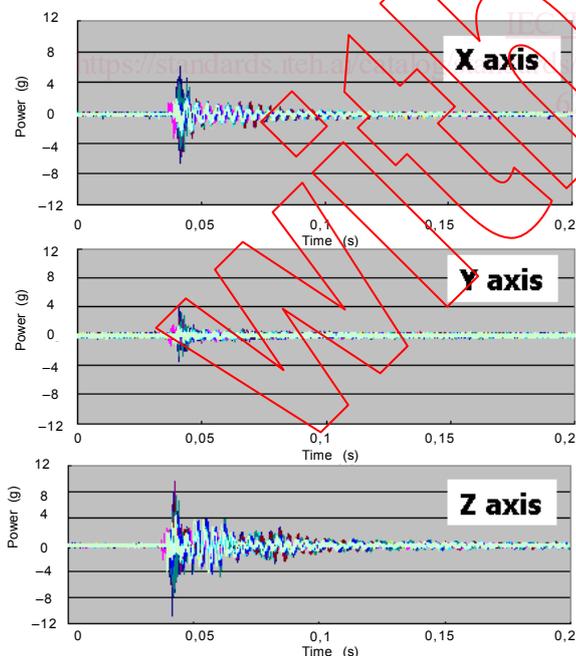
Figure 1 – Photos of evaluating hammer impact, rack and boards

A board with a shock sensor attached is inserted into the rack. The front of the board is then struck repeatedly by a hammer, along with an adjacent board being forcibly inserted, in order to measure the impact and frequency detected by the shock sensor. The handles attached to the front edge of the rack are also forcibly struck by hand, with the impact being measured as well. Figure 1 shows photos of evaluating hammer impact, as well as the rack and boards. Table 1 summarizes the specifications of the rack and boards and the conditions of evaluating hammer impact and acquiring data.

Table 1 – Rack and board specifications, conditions of evaluating hammer impact and acquiring data

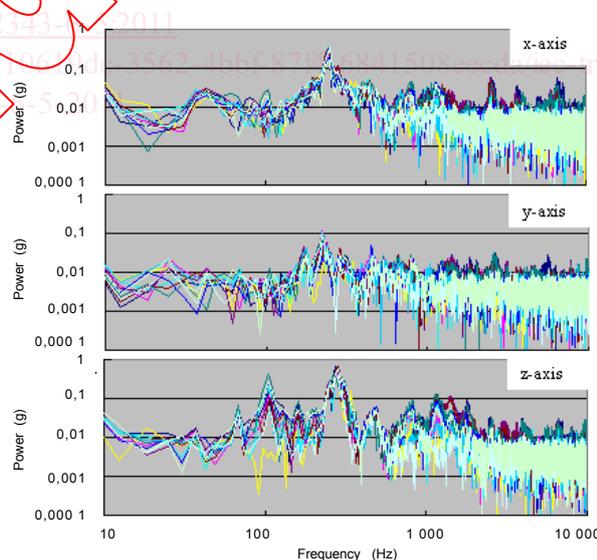
Item	Specifications / Conditions
Rack size	432 mm (W) × 240 mm (D) × 262 mm (H)
Back connectors	2 pins - 96 pins
Number of boards	20
Striking force (acceleration intensity)	H (1 800 m/s ² to 2 400 m/s ²) ~ 210 G M (1 200 m/s ² to 1 600 m/s ²) ~ 140 G L (300 m/s ² to 400 m/s ²) ~ 35 G
Places to strike	Top, middle of front panel of board
Board thickness	1,6 mm, 1,5 mm, 1,2 mm
Location of board	Centre, side
Number of board	One, full size
Directions	x, y, z
Data acquisition	40 μs × 5 000 points (200 ms)
Sensing frequency band	10 Hz - 10 kHz

Figure 2a) shows the measurement results. Here, H denotes a high level of hammer impact (at 210 G). The location of impact is at the centre on the front face of a board 1,6 mm thick, located at the centre of the 20 boards installed, with data being acquired on tests repeated 11 times. Figure 2b) shows the Fourier transform results of data based on the frequency component.



2a) Measurement results

IEC 127/11



2b) Fourier transformation data

IEC 128/11

Figure 2 – Evaluation results of hammer impact H

The results show vibration time in the range of 100 ms to 200 ms, with vibration amplitude descending in order of z axis > x axis > y axis. The peak shock (initial pulse) was 5 G to 10 G (in 2 ms to 5 ms). In contrast, Fourier transform results show a number of vibration

peaks (at 100 Hz, 250 Hz and more than 1 kHz). The largest peak was at 220 Hz to 280 Hz. For the z axis, the peak pulse intensity was roughly 0,5 G. Here, the strongest impact was in the z axis, despite the fact that shock had been applied to the x axis. This is believed to be the result of drum vibrations on the board. The results of hammer impacts M and L (at 2,6 G to 4 G and 0,9 G to 1,5 G, respectively) show the almost same frequency spectra and peak amplitude for the z axis.

Next, the dependence on each evaluation condition (e.g., board thickness, board installation location, number of boards installed) was examined. The evaluation showed no significant difference in any of the evaluation conditions. Regarding the dependence on hammer impact strength, the peak shock roughly correlated to impact strength. A small peak of 70 Hz was seen in the y axis for hammer impact L. For the dependence on board thickness, there were two peaks in the x axis at thickness of 1,2 mm. The peak also moved slightly to the lower frequency in the z axis. No difference could be detected in terms of location of board installation and board impact.

5.1.2 Evaluation of adjacent board insertion and rack handle impact

In addition to evaluating hammer impact, tests were also conducted to evaluate the insertion of an adjacent board and impact on the handle on the front side of the rack. Figure 3 shows photos of the evaluation tests.

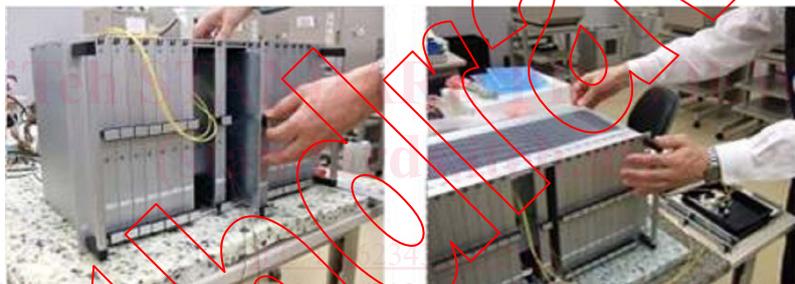


Figure 3 – Photos of evaluating adjacent board insertion and rack handle impact

An analysis of data compared the peak amplitudes in the z axis on the graph showing vibration attenuation before Fourier transformation. This analysis revealed that peak shock for the z axis was 5,2 G to 6 G for the adjacent board insertion test (similar to the result for hammer impact H) and 1 G to 1,4 G for the rack handle impact test (similar to the result for hammer impact L).

An examination of some data on the frequency characteristics after Fourier transformation did not reveal significant differences from the evaluation of hammer impact.

5.2 Step 2

In Step 2, a dynamic module was attached to a board for which the shock sensor monitors shock and vibration, identical to the approach in Step 1. At the same time, any changes in optical characteristics (loss) were monitored. Figure 4 shows photos of the board with the VOA and the rack with WSS (wavelength-selective switch) attached on the boards.