

Portable Machine Analyzer for Equipment Diagnosis, "Model MK-310"*

Katsuhiko Teramae**

1 Introduction

Equipment diagnosis comprises periodic spot checking methods using a portable machine, and continuous monitoring methods using a constant supervising system. The former includes simplified diagnostic devices to detect the trend of the magnitude of vibration, and precision diagnostic devices to analyze the vibration factors. The latter on-line monitoring type has a variety of optional systems depending upon the number of vibration sensor units. These systems are shown in Fig. 1, and are used in optimum combinations by taking into consideration the importance of the facility, maintenance costs, and manpower.

In this report, the features of "MK-310" portable device are outlined. MK-310 is supplied not only domestically, but is also exported as "OEM supply" to equipment manufacturers in the U.S. and West Germany. Its sales activities have been widely expanded with favorable acceptance of users.

2 Outline and Features

The FFT analyzer which has been widely used at the laboratory level is now used for equipment diagnosis in

the field. MK-310 has been developed and marketed for diagnosing varied types of equipment in the field by consolidating all the precision diagnostic know-how accumulated in the past. It is shown in Photo 1. Its major features include:

(1) Built-in Automatic Diagnostic Software

MK-310 incorporates a vibration amplifier. By simply connecting a vibration sensor to it, MK-310 can perform vibration measurements in four modes, namely, displacement, velocity, acceleration and envelope. It also can perform frequency analysis by the FFT method. In addition, through its unique diagnostic method, it can perform an automatic detection, from the analysis data of mechanical abnormalities such as faulty balance and misalignment of rotating machines, as well as bearings and gears. Furthermore, MK-310 carries out diagnoses by inferring the causes of abnormalities.

(2) Portable Function

Since MK-310 is battery-driven and weighs only 6.5 kg, it can easily be used in the field. Results are printed out on the spot, and, even when its power supply is shut off, up to 128 pictures can be stored, thereby widening its application to dispatched field work far away.

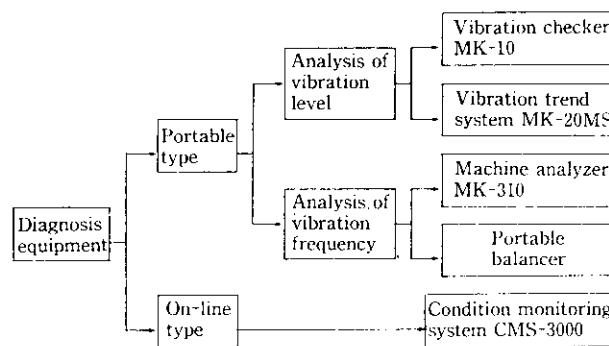


Fig. 1 Types of machine diagnosis system

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** Staff Assistant Manager, Technology Dept., Kawatetsu Advantech Co., Ltd.

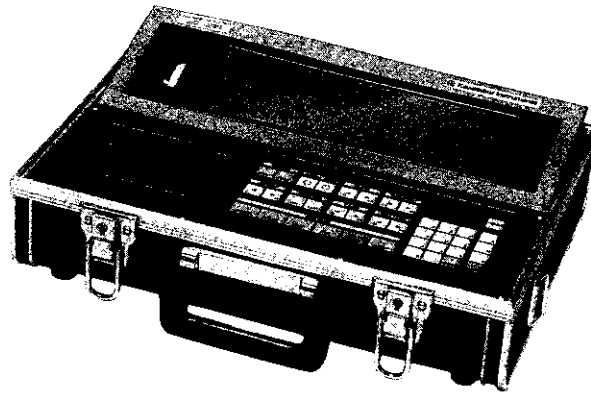


Photo 1 Appearance of MK-310,

(3) Ample Functions

- (a) MK-310 can process all kinds of voltage signals, through its vibration-sensor input terminal and input terminals for sound and voltages. It also has RS-232C output, thereby permitting it to transmit data to outside memory storage and high hierarchical CPUs.
- (b) Since it has a 4K-word-capacity transient memory function, it can store and reproduce waveforms of transient phenomena such as impact vibration.
- (c) Since it has a function for three-dimensional display of changes in time of spectrum, it facilitates observation of natural frequency of rotating machines.
- (d) It incorporates software of the field balance which functions as a balancer.

(4) Simple Operation

As an FFT analyzer, the number of operation keys is set at a minimum, and its operation can be easily carried out on an LCD screen in the interactive mode.

3 Specifications

(1) Contents of Processing

- (a) Display of time waveform
- (b) Transient recording (Memory capacity: 4k word)
- (c) Linear spectrum
- (d) Three-dimensional display of spectrum
- (e) Extraction and display of ten large spectra.
- (f) Automatic diagnosis: Faulty balance, misalignment, faulty bearing, and gear tooth damage
- (g) Field balancing
- (h) Differentiation and integration of spectrum

(2) Inputting Portion

Input channel: 1 channel
 Input coupling:
 Vibration ... AC (10 Hz; -1 dB)
 Voltage ... AC (1 Hz; -3 dB)

Attenuator range:

Vibration displacement
 ... 5 to 1,500 μ (both amplitudes)

Vibration velocity ... 0.05 to 15 cm/s

Vibration acceleration
 ... 0.05 to 15 G

Vibration ENV ... 0.05 to 15 G

Voltage AC/DC ... ± 0.1 to 50 V

Input level display: Analog meter indication

(3) Analyzer

Frequency range: 10 Hz to 20 KHz, 11 steps

Number of sampling points: 1 024 points

Frequency resolving power: 1/400 of analysis range

Dynamic range: 60 dB or above

A/D resolving power: 12 bit/W

Sampling frequency: 2.56 times the analysis range

Window function: Hanning, humming and flat

Averaging function: 2 to 32, 5-step linear average

(4) Displayer

Display method: LCD graphic (128 \times 480 dots)

Display size: 62 mm \times 230 mm

X-axis scale: Frequency or time (linear)

Y-axis scale: Level (linear and logarithmic)

(5) Output Portion

Printer: Small-sized graphic printer

External output: Analog output and digital output (RS-232C)

(6) Storage Portion

(a) Capable of storing 128 pictures of analysis data and capable of data memory storage by battery backup

(b) Panel condition memory function, and automatic restoration to the set condition at the time of power OFF by OFF-ON power turning

(7) Alarm and Protective Portion

Result of automatic diagnosis: Alarm buzzer is sounded at the time of abnormality.

Low-battery indication: When battery drops to 11.5 V or below, the mark on LCD flickers and alarm buzzer is sounded.

Measuring condition

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**** BEARING DAMAGES ****
*89-10-21 10:50
SIGNAL [VIBRATION]
MODE [ENU]
RANGE [0.5G]
FREQUENCY [200Hz]
DATA No. [12.01H]
METHOD [Auto]
ROTOR SPEED [660] RPM
PITCH DIAMETER [36.0] mm
BALL/ROLLER DIAMETER [6.3] mm
NUMBER OF BALLS [10]
ANGLE OF CONTACT [9.6] deg
-----
INPUT: 891021
  
```

Results of diagnosis

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DATA No. 12.01H DATE 89-10-21 10:50
MODE ENU RANGE 0.5G
No. 1 FREQUENCY [SPECTRUM]
45.0Hz 0.02486
135.0 0.00800
177.0 0.00527
198.0 0.00750
12.0 0.00223
73.0 0.00177
88.0 0.00177
163.0 0.00177
10
REPLAY: 891021
ROTOR SPEED : 660RPM
P1 : 11.0Hz
P2 : 33.0Hz
P3 : 45.0Hz
P4 : 66.0Hz
P5 : 99.0Hz
RESULT OF ANALYSIS : DAMAGED OUTER RING
-----
FFT DISPLAY: 891021
  
```

FFT wave form

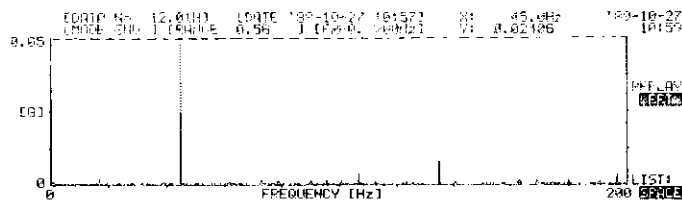


Fig. 2 Diagnosis data of MK-310

(8) General Specifications

Power source: Built-in battery and AC 100 V (using an adapter)

Power consumption: About 5 VA

Continuous operation time: 3 h or over

Operating temperature range: 0 to 40°C

External dimensions: 375 W × 280 D × 130 H mm

Weight: About 6.5 kg

(9) Standard Configuration

MK-310 proper	1 unit
Pickup, PU-101	1 unit (cable: 5 m)
Input cable	1 unit (cable: 1 m)
AC adapter	1 unit
Recording paper	5 rolls
Instruction Manual	1 copy

4 Examples of Diagnosis

An example of vibration diagnosis of bearing damage is shown in Fig. 2. Automatic diagnosis is performed by the built-in software. Diagnosis is performed in such a

way that an automatic diagnostic software incorporated calculates repetitive frequencies obtainable at the time of damage by using rotor speed and bearing specifications given in advance, and by comparing these frequencies with a frequency spectrum actually measured, whether abnormality exists or not is determined.

In this example, the conditions of the vibration frequency spectra, which occur when the outer ring of the bearing is damaged, are comprehensively judged, and an automatic diagnosis of "DAMAGED OUTER RING" is given.

For Further Information, Please Contact to:

Kawatetsu Advantech Co., Ltd.

Head Office: 3-48 Takahatacho, Nishinomiya,

Hyogo Pref. 663 Japan

Phone: 0798-66-1502, Fax: 0798-65-7025

Tokyo Office: 14-4 Nihonbashi-kodemmacho,

Chuōku, Tokyo 103 Japan

Phone: 03-3662-5341, Fax: 03-3662-5346