Various Maintenance Tools

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Keyword Timer test, Auxiliary relay test, CB test, Megger test, Generator test, Maintenance, Tool

Abstract

Field inspection, testing, and measurement tend to be complicated and challenging. In order to support fieldwork efficiently, we have developed and applied a variety of maintenance tools. For conventional inspection and diagnostic service menus, application of maintenance tools was difficult in terms of working time and other factors. The opportunities for application can be increased by utilizing the maintenance tools. As a result, we can offer quality services to more customers.

Some customers want to reduce their facility shutdown time during maintenance services. In order to respond to such requests, we have developed dedicated maintenance tools. These tools are effectively increasing the assurance of safety and improvement of servicing.

1 Preface

Meiden maintenance service personnel are always making efforts to maximize safety, quality, and technologies during limited maintenance time on-site.

Since the customers' goal is to reduce maintenance time, we have developed various maintenance tools to realize efficient inspection, testing, and often complicated and challenging measuring work.

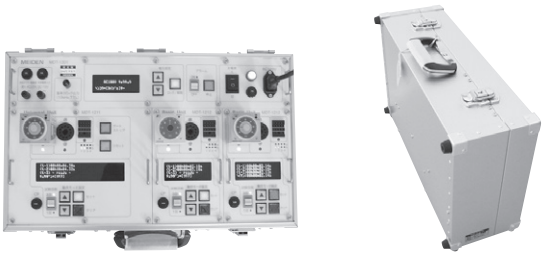
This paper introduces part of the specifications and outline regarding maintenance tools that we have developed and applied.

2 Various Maintenance Tools

2.1 Timer Auto-Tester (see Fig. 1)

This type of tester is used for the measurement of setup time for the plug-in type of analog timer. It is used to examine the soundness of timers utilized in various electrical facilities and also for acceptance tests when timers are to be newly applied.

The analog timer is used in many control panels and machines as a device to set up a time constant in various sequence circuits. Recently, analog timers have been replaced by sequencers; however, since many old equipment and facilities are still used in the field, there are many occasions that call for maintenance. In particular, they are playing important roles in maintaining reliability of facilities because adequate maintenance can be performed by checking the changes in setting time and contact deterioration due to aging deterioration.



(a) Main-unit panel (b) Carrier case

Fig. 1 Timer Auto-Tester

An external appearance of a portable carrier case is shown, where the main-unit panel and the main body are provided with lids.

2.1.1 Features

This tester is provided with the respective functions of time measurement needed to test analog timers, contact testing, and automatic changeover for various test power sources and socket pin allocations. It is applicable to many types of plug-in type analog timers and capable of testing in many operation modes.

No operational training is needed because of its simple operation menus are helped by a microcomputer and advanced auto-testing functions. All necessary testing functions are compactly accom-

Table 1 List of Test Operation Modes for Timer Auto-Tester

Timer operation modes are shown, with which testing can be performed by the aid of a timer auto-tester. Descriptions of ON delay, one shot, etc., are intended for the discrimination of timer operation.

No.	Description (by OMRON Corporation)
01	Power start, ON delay
02	Power start, flicker OFF start
03	Power start, flicker ON start
04	Power start, OFF delay
05	Power start, interval
06	Power start, one shot
07	Signal start, ON delay
08	Signal start, flicker OFF start
09	Signal start, flicker ON start
10	Signal start, ON-OFF delay (ON start)
11	Signal start, OFF delay
12	Signal start, interval
13	Signal start, ON-OFF delay (OFF start)
14	Signal start, one shot
15	Star-delta
16	Twin (OFF start)
17	Twin (ON start)

modated in a carrier case that can be carried with a single hand; Therefore, fast and accurate testing can be conducted in any servicing site.

2.1.2 Outline of Specifications

(1) Application and purpose

Acceptance test for timers and inspection of aging deterioration

(2) Applicable timers

46 types made by OMRON Corporation, 25 types made by Panasonic Corporation, and 12 types made by FUJI ELECTRIC CO., LTD.

(3) Test operation modes (see **Table 1**)

17 modes

(4) Test power source

7 types of DC12/24/48/100V, AC24/100/200V incorporated; external power supplies enabled

(5) Contents of testing

(a) Setup time measurement: 0.02s ~ 99h59min 59.99s

(b) Contact operation check of followings:

Contact a (normally open contact)

Contact b (normally closed contact)

(a) Main-unit panel (b) Carrier case

Fig. 2 Auxiliary Relay Tester

An external appearance of a portable carrier case is shown, with the main-unit panel and the upper lid panel.

(6) Dimensions and mass

(a) Dimensions: W500×H300×D160mm

(b) Mass: Approx. 8.4kg

2.2 Auxiliary Relay Tester (see Fig. 2)

This type of tester is a device to check the adequacy of contact performance for plug-in type relays. Like the above-mentioned timer auto-tester, this tester is used for the inspection of soundness of auxiliary relays to be used in various electrical facilities and for the acceptance test to be performed at the time of new installations.

Auxiliary relays are used in many control panels so many auxiliary relays are used in sequence circuits. Maintenance services are often conducted and the volume of relays tested at a time is high. In particular, it is important to understand the presence of contact deterioration caused by aging deterioration (frequency of use) and circumstances (corrosive gases). Periodic inspection is helpful to maintain reliability of facilities.

2.2.1 Features

This tester is provided with the contact testing function needed for the testing of auxiliary relays, various test power sources, and auto-changeover mechanism to control socket pin allocations. It is applicable to a variety of plug-in type auxiliary relays.

No operational training is needed because of simple operation menus helped by a microcomputer and advanced auto-testing functions. Thanks to the auto-sensing function that senses insertion and withdrawal of test pieces, many of the same relays with frequent insertions and withdrawals can be efficiently tested in a very short time. All necessary testing functions are compactly put together in a carrier case that can be carried with a single hand. Therefore, fast and accurate testing can be implemented in any servicing site.

2.2.2 Outline of Specifications

(1) Application and purpose

Acceptance test for auxiliary relays and inspection of aging deterioration

Table 2 List of Test Operation Modes for Auxiliary Relay Tester

This table shows various test operations of auxiliary relays that can be tested with the auxiliary relay tester.

No.	Display	Contents	Remarks
1	M-1	Manual mode, executed once	Required time: 1s
2	M-3	Manual mode, executed 3 times	Required time: 3s
3	M-5	Manual mode, executed 5 times	Required time: 5s
4	M-10	Manual mode, executed 10 times	Required time: 10s
5	M-100	Manual mode, executed 100 times	Required time: 1min40s
6	M-1000	Manual mode, executed 1000 times	Required time: Approx. 17min
7	M-2000	Manual mode, executed 2000 times	Required time: Approx. 34min
8	M-5000	Manual mode, executed 5000 times	Required time: Approx. 1h30min
9	M-10000	Manual mode, executed 10,000 times	Required time: Approx. 2h50min
10	M-20000	Manual mode, executed 20,000 times	Required time: Approx. 5h40min
11	M-continuous	Operation in manual mode till stoppage	—
12	A-1	Auto-mode※1, executed once	Required time: 1s
13	A-3	Auto-mode, executed 3 times	Required time: 3s
14	A-5	Auto-mode, executed 5 times	Required time: 5s
15	A-10	Auto-mode, executed 10 times	Required time: 10s
16	A-20	Auto-mode, executed 20 times	Required time: 20s
17	A-30	Auto-mode, executed 30 times	Required time: 30s
18	A-50	Auto-mode, executed 50 times	Required time: 50s
19	A-100	Auto-mode, executed 100 times	Required time: 100s
20	Keep set	Forced setting of latch system of keep relay※2	Displayed only if class is keep relay.
21	Keep reset	Forced resetting of latch system of keep relay	Displayed only if class is keep relay.
22	Forced operation	General relay forced/open	Displayed only if class is other than keep relay.

Notes. ※1. Auto-mode: Automatic execution mode of specified test times by automatically sensing insertion and withdrawal of objective relay socket.
※2. Keep relay: It is also called “Latching relay.”

(2) Applicable relays

68 types made by OMRON Corporation, 56 types made by IDEC CORPORATION, 44 types made by FUJI ELECTRIC CO., LTD., 14 types made by Panasonic Corporation, and 3 types made by FUJITSU COMPONENT LIMITED

(3) Test operation modes (see Table 2)

21 modes

(4) Test power source (external power supplies enabled)

7 types of DC12/24/48/100V, AC24/100/200V incorporated; external power supplies enabled

(5) Contents of testing

(a) Contact operation check of following:
Contact a (normally open contact)
Contact b (normally closed contact) (single stable operation, latch operation)

(b) Contact current: 1/10/100mA (changeover for selection)

(6) Dimensions and mass

(a) Dimensions: W500×H300×D180mm

(b) Mass: Approx. 12kg

2.3 Circuit-Breaker (CB) Operation Tester (see Fig. 3) and Contact Resistance Checker (see Fig. 4)

This tester is intended to check Meiden CBs

(a) Main-unit panel (b) Upper lid and printer installations (c) Carrier case

Fig. 3 CB Operation Tester

An external appearance of a portable carrier case is shown, with the main-unit panel and the upper lid panel.

(a) Main-unit panel (b) Carrier case

Fig. 4 Contact Resistance Checker

An external appearance of a portable carrier case is shown, where the main-unit panel and the main body are provided with lids.

Table 3 CB Operation Tester Objective CB & Magnetic Contactors

A list of Meiden equipment units is shown, capable of being tested with a CB operation tester.

Equipment name	Model name	Operation, control and ratings							
		Closure control, operation voltage (V)	Opening control voltage (V)	Closure operation system	Closure operation motor voltage (V)	Closure operation motor current DC100V (A)	Closure control, operation current DC100V (A)	Opening control system	Opening control, operation current DC100V (A)
Large-capacity Vacuum Circuit-Breaker (VCB) 12/24kV	VE-14A	DC100, etc.	DC100, etc.	Motor-charged spring	AC/DC100, etc.	5	3	Voltage tripping	6
	VE-24	DC100, etc.	DC100, etc.	Motor-charged spring	AC/DC100, etc.	5	3	Voltage tripping	6
	VE-27	DC100, etc.	DC100, etc.	Motor-charged spring	AC/DC100, etc.	5	3	Voltage tripping	6
VCB 7.2/3.6kV electromagnetic operation type	VE-1	DC100, etc.	DC100, etc.	Electromagnetic operation	Nil	Nil	※26	Electromagnetic operation	2.9
	VE-1L	DC100, etc.	DC100, etc.	Electromagnetic operation	Nil	Nil	※26	Electromagnetic operation	2.9
	VE-2	DC100, etc.	DC100, etc.	Electromagnetic operation	Nil	Nil	※56	Electromagnetic operation	2.9
	VE-2L	DC100, etc.	DC100, etc.	Electromagnetic operation	Nil	Nil	※56	Electromagnetic operation	2.9
	VE-2S	DC100, etc.	DC100, etc.	Electromagnetic operation	Nil	Nil	※38	Electromagnetic operation	2.9
	VE-4	DC100, etc.	DC100, etc.	Electromagnetic operation	Nil	Nil	※65	Electromagnetic operation	2.9
12kV VCB	VE-12	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	0.8	3.5	Voltage tripping	4
	VE-14A	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	3.5	4	Voltage tripping	6
24/36kV VCB	VE-22N	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	3.8	3.7	Voltage tripping	6
	VE-32	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	5	3.5	Voltage tripping	4
VCB 7.2kV motor charged spring operation type	VJ-1L	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	1	1.5	—	3
	VJ-1	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	1	1.5	—	3
	VJ-2L	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	1.5	1.5	—	3
	VJ-2S (600A)	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	1.5	1.5	—	3
	VJ-2S (1200A)	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	1.5	1.5	—	3
	VJ-2S (2000A)	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	2	2	—	6
	VJ-2S (3000A)	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	2	2	—	3
	VJ-3	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	2	2	—	3
	VJ-4	DC100, etc.	DC100, etc.	Motor-charged spring	DC100, etc.	2	2	—	5.5

Note: A supply of external power is needed for closure.

Equipment name	Model name	Operation and ratings					
		Closing coil voltage of operation circuit (V)	Tripping coil voltage of operation circuit (V)	Closing current of regular excitation system (A)	Holding current of regular excitation system (A)	Closing current of latch system (A)	Holding current of latch system (A)
High-voltage vacuum magnetic contactor	V-tactor	AC/DC100	AC/DC100	1.4	0.27	3.1	1.1
		AC/DC200	AC/DC200	0.7	0.14	1.6	1

and magnetic contactors, mostly used at the time of periodic inspection.

CBs play important roles for protection and security preservation in various power generation facilities as well as power incoming and distribution substations. Since many CBs are generally installed in large-scale machine sites, it is necessary to implement the inspection program efficiently and promptly.

2.3.1 Features

The CB operation tester is used to examine the respective CB functions of current interruptions, closures, and spring charges; it also measures the operating time of main circuit contact motion. Since a microcomputer is used to control the command phase of each operating power source, values from stabilized measurement can be obtained continuously and this can shorten the overall testing time.

The contact resistance checker is used to measure the contact resistance of main-circuit contact points with a large current. Since a stabilized current can be fed for a long time, continuous testing can be carried out and the testing time can be curtailed.

For both testers, all necessary testing functions are accommodated in a portable carrier case; therefore, fast and accurate testing can be performed in any site.

2.3.2 CB Operation Tester and Outline of Specifications

(1) Application and purpose

Examination of CB soundness and inspection of aging deterioration

(2) Applicable equipment (see **Table 3**)

We made 22 models (VJ & VE Series) of CBs and medium-voltage vacuum magnetic contactors V-tactor (applicable to almost all CBs with external closing power sources and pneumatic systems).

(3) Contents of testing

(a) Operation test for closure, tripping, and spring charge

(b) Measurement of minimum voltage for closure, tripping, and spring charge

(c) Trip-free test

(d) Measurement of main-circuit contact operation time (0 ~ 999.9ms)

(4) Dimensions and mass

(a) Dimensions: W400×H400×D350mm

(b) Mass: Approx. 22kg

2.3.3 Contact Resistance Checker and Outline of Specifications

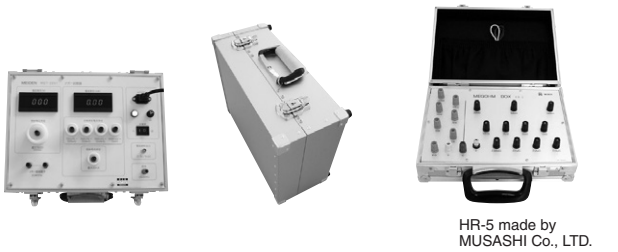
(1) Application and purpose

Examination of CB soundness and inspection of secular deterioration

(2) Contents of testing

Measurement of main-circuit contact resistance (DC 4-terminal method) and other general applications to the measurement of contact resistance

(3) Specifications for measurement



HR-5 made by MUSASHI Co., LTD.

(a) Main unit panel (b) Carrier case (c) Standard resistance box (optional goods available on general market)

Fig. 5 Megger Tester

An external appearance of a portable carrier case is shown, where the main-unit panel and the main body are provided with lids plus an external appearance of optional standard resistance box.

(a) Standard output current: 10 ~ 100A (arbitrarily variable)

(b) Voltage drop measurement: 0 ~ 19.999mV (at 100A: equivalent to 0 ~ 199.99$\mu\Omega$)

(c) Continuous operation possible for 10 minutes (for intermittent use)

(4) Dimensions and mass

(a) Dimensions: W400×H250×D350mm

(b) Mass: Approx. 10kg

2.4 Megger Tester (see Fig. 5)

This tester is a device used for the soundness check and calibration for meggers.

Measurement of insulation is an important item directly related to the evaluation of soundness and safety for shutdowned facilities and equipment. Therefore, meggers are frequently used in maintenance services for electrical facilities. Since a megger is a device that generates a high voltage to measure high resistance using a current flowing through the object under test, the improper use of this device can cause an adverse influence on equipment due to high voltage and current. Accordingly, a megger is an instrument that requires careful handling.

For this reason, a high voltage (voltage of open circuiting), measuring current, and short-circuit current to be generated by a megger are controlled in order not to deviate from the range of JIS Standard specifications. In addition to the capability of making accuracy calibration for the indicated values, confirmation of soundness in voltage and current control functions is a significant factor of safety.

2.4.1 Features

This tester is applicable to meggers of classes up to 1000V. It is a device used to perform calibration and pre-use inspection. All necessary functions

needed for the measurement of an open-circuit voltage, rated measuring current, short-circuit current, and tolerance of resistance measurement conforming to the standard specifications of JIS C1302 are compactly assembled in a portable carrier case. At the time of pre-use inspection and calibration of meggers at our workshop, it can be used as a secondary standard instrument.

2.4.2 Outline of Specifications

(1) Application and purpose: Calibration of meggers and soundness check

(2) Applicable meggers: Meggers of classes 125/250/500/1000V

(3) Contents of testing (Conforming to JIS C1302)

(a) Open-circuit voltage

(b) Rated measuring current

(c) Short-circuit current

(d) Tolerance of resistance measurement (optional)

(4) Dimensions and mass

(a) Dimensions: W400×H300×D160 mm

(b) Mass: Approx. 4.5kg

(a) Main unit panel (b) Carrier case (c) Memory recorder (available on general market)

Fig. 6 Generator Dynamic Characteristic Tester

An external appearance of a portable carrier case is shown, where the main-unit panel and the main body are provided with lids.

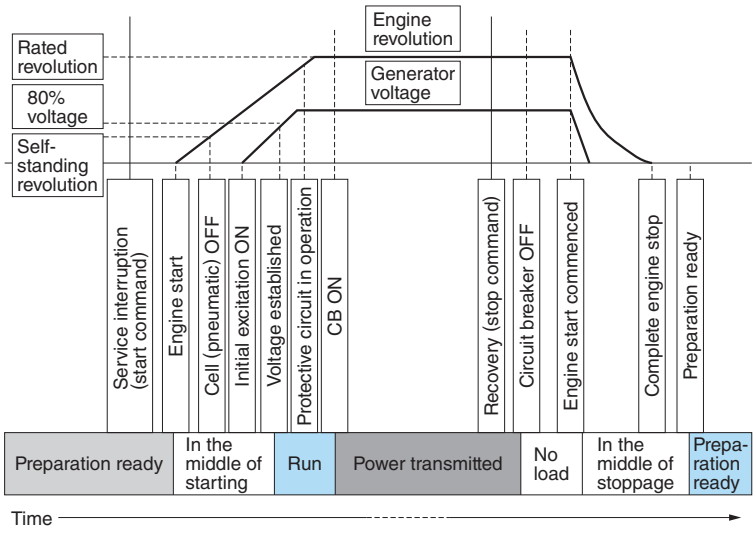


Fig. 7 Generator Start/Stop Sequence

A time chart is shown that explains major performance from the start to stop of a generator.

2.5 Generator Dynamic Characteristic Tester (see Fig. 6)

This tester is used for the detection of any disqualifying symptom in generators and also for the diagnostic services of deterioration conditions. It is used for the recording and evaluation of many analog signals such as generator voltages, engine rpm figures (revolving speed), as well as status signals such as engine start, initial excitation, establishment of voltage, and others.

Electrical signals of generators and also rotation-related information from engines can be picked up to indicate the status of overall generator control system. It is a great tool to support inspection and diagnostic jobs. Fig. 7 shows a generator start/stop sequence.

2.5.1 Features

All necessary functions needed for the testing of generator start-stop performance, loaded tripping, indicial response, and auto-synchronization are compactly assembled in a portable carrier case. Therefore, fast and accurate testing can be conducted at any site.

Since this system is devised to pick up engine revolution figures (revolving speed) in the form of changes in generator voltage (utilizing residual magnetism existing before excitation), it is unnecessary to take out revolution signals. This idea is very simple and useful at the time of preparation for measurements.

2.5.2 Outline of Specifications

(1) Application and purpose

Examination of generator soundness and inspection of aging deterioration

(2) Application

Applicable to regular and emergency generators (diesel, gas turbine, etc.) and generators of 2/4/6/8/10/12 poles

(3) Contents of testing

(a) Start-stop test

(b) Load interruption test

(c) Indicial response test (sudden load change test)

(d) Auto-synchronization test

(4) Dimensions and mass
(a) Dimensions: W350×H250×D450mm
(b) Mass: Approx. 11kg

3 Postscript

This paper introduced the specifications and outline of our maintenance tools actively used in the field of maintenance services. These tools have been useful in lessening the labor in such complicated processes and leveling the techniques.

In the future, we will make efforts to acquire more advanced maintenance tools toward the goals of improving portability and convenience, coordination with measuring data network, and the intake of diagnostic factors (equipment deterioration, symptom of disqualification).