

Various Maintenance Tools

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Abstract

The maintenance tools used for our maintenance services are testing instruments used to improve efficiencies of on-site inspection or diagnostic services, and to assist and support more advanced services.

Thanks to these tools, we were able to increase the added values to our service offerings and provide quality services to more customers. Merits included securing work safety and obtaining stable measurement results without irregular performance. We got reliable diagnosis results.

The introduction of these dedicated tools enabled us to make the best use of limited facility shutdown time for maintenance. These tools are not for sale. Our maintenance and diagnostic services are backed by these various tools as we strive to advance our services.

1 Preface

Our field service engineers can accomplish the designated work in a limited time by drawing on many years of experiences and accumulated technical expertise. The quality of their servicing is sufficiently high in terms of safety, quality, and skills.

Various kinds of maintenance tools are used to assist and support daily facility inspection routines and diagnostic services more efficiently by maintenance personnel.

This paper introduces outlines of these maintenance tools we developed and introduces part of their specifications.

2 Various Maintenance Tools

2.1 Contact Resistance Meter for Auxiliary Relays

Fig. 1 shows an external appearance of the contact resistance meter for auxiliary relays. This tool is used to confirm the soundness of contacts or their deterioration evaluation for the plug-in type auxiliary relays.

The auxiliary relays are mostly used in control panels and related equipment. Many auxiliary relays are used in sequence circuits. Since failures in auxiliary relays that support the control of equipment can immediately result in system shutdown, it is

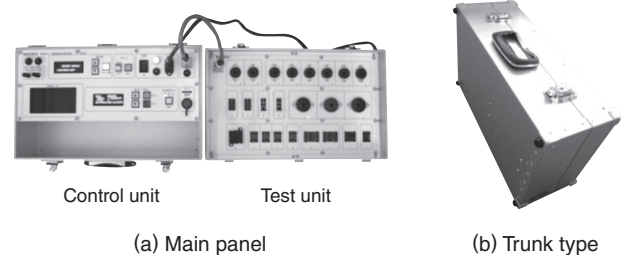


Fig. 1 Contact Resistance Meter for Auxiliary Relays

The main panel (control unit), top panel (test unit), and trunk case in a portable state are shown.

essential to grasp the condition of deterioration at all times. This tool is useful to maintain the reliability of facilities and provides assistance in determining the replacement time for auxiliary relays and reviewing the replacement intervals.

2.1.1 Features

The contact resistance meter for auxiliary relays is provided with a contact checking function necessary for testing (simultaneous measurement of contact resistance for all relay contacts to identify pass or fail and deterioration), various testing power supplies, and auto-changeover mechanism for socket pin arrays. This tool is applicable to a variety of plug-in type auxiliary relays.

By using microcomputer-based easy operation menus and advanced auto-testing functions, we

can test efficiently in a short time. In addition to the capability of measured data recording and saving (100 items), it is possible to save data in an SD card and transfer these data to a Personal Computer (PC). Fig. 2 shows the result of contact resistance measurement and evaluation judgment. Table 1 shows an example of measured data recording and saving.

This tool is accommodated in a trunk case and can be carried with one hand. Since all functions needed for testing are assembled in this tool, we can conduct fast and accurate testing in any test site.

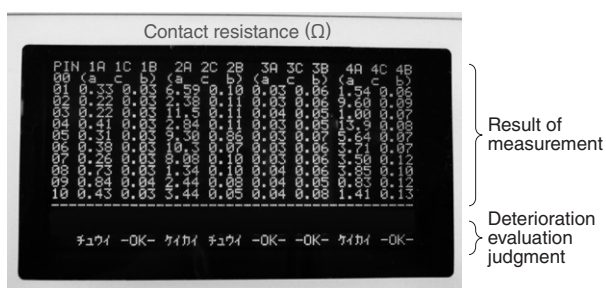


Fig. 2 Result of Contact Resistance Measurement and Evaluation Judgment

The result of contact resistance measurement (10 times in test mode) and evaluation judgment is shown.

2.1.2 Outline of Specifications

- (1) Use and purpose
 - Soundness checks and inspections of deterioration over time for auxiliary relays
- (2) Target relay types
 - Target 185 relay types manufactured by 5 makers: OMRON Corporation, FUJI ELECTRIC CO., LTD., FUJITSU COMPONENT LIMITED, Panasonic Corporation, and IDEC CORPORATION
- (3) Test operation mode
 - Automatic testing (10 times, 20 times, 50 times continuously), forced operation
- (4) Testing power supply
 - 7 types built-in (DC12/24/48/100V, AC24/100/200V), external power supply acceptable
- (5) Contents of testing
 - (a) Contact resistance measurement and evaluation judgment: DC 4-terminal method, and evaluation of absolute values and dispersion
 - (b) Applicable contact points: a-contact, b-contact (single stable operation, latch operation)
 - (c) Contact current and voltage: 1/10/100mA (changeover selection), DC5V (Fixed)

2.2 Artificial Grounding Relay Tester

Fig. 3 shows an external appearance of the artificial grounding relay tester. In order to prevent relay malfunction at the time of a ground fault, an

Table 1 Example of Measured Data Recording and Saving

An example of measured data recording and saving is shown. Since the measured data is saved in a CSV format, it can be edited by using Excel.

Test No.	Maker	Type	Testing frequency	Control voltage	Contact current	Alert setting	Caution setting
A00150	OMRON	MM3XKP	T-10	DC100V	0.1A	5.0Ω	0.5Ω

Pin No.	15		14		12		**		
	5	6	7	8	3	4	**	**	
Measured value (Ω) n=10	1	5.41	0.03	0.65	0.22	2.10	0.02	9999	9999
	2	2.65	0.04	0.59	0.20	4.36	0.02	9999	9999
	3	6.37	0.05	0.22	0.10	8.68	0.02	9999	9999
	4	2.13	0.05	0.98	0.08	2.34	0.02	9999	9999
	5	3.85	0.07	2.45	0.08	3.12	0.02	9999	9999
	6	1.26	0.07	1.72	0.08	1.68	0.02	9999	9999
	7	12.70	0.06	0.90	0.10	2.47	0.02	9999	9999
	8	2.55	0.07	0.78	0.08	1.36	0.02	9999	9999
	9	4.23	0.08	1.32	0.10	4.89	0.02	9999	9999
	10	2.03	0.07	0.98	0.10	3.66	0.02	9999	9999
Deterioration judgment	Alert	-OK-	Caution	-OK-	Alert	-OK-	Nil	Nil	

Note: Notation for "no contact" in the table is as follows:
 Pin No.: Asterisk *
 Measured value: 9999

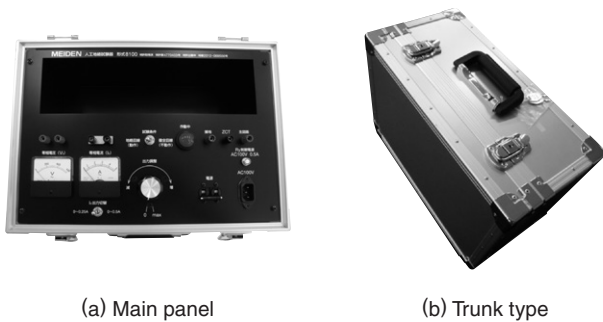


Fig. 3 Artificial Grounding Relay Tester

An external appearance of the main panel and its trunk case in portable state are shown.

artificial grounding test is carried out to confirm the correct function of a directional ground fault relay: selecting and disconnecting the ground-fault line only.

This test is indispensable for the confirmation of overall system protection. Normally, it is necessary to prepare for heavy and large testing equipment to apply a high voltage to the test circuit. Since a high voltage is applied at the time of testing, creating a sufficient safety zone and safety arrangements are needed for security around the test performance area. For this reason, it ended up formally as a large-scaled testing.

This tool was designed to carry out artificial ground fault testing safely and easily. We developed the tool in compact and light weight design to realize testing in any test site. It realized improved safety and reduced testing time, etc.

2.2.1 Features

Compared with past heavy and large-scaled test equipment, the artificial grounding relay tester comes in a compact and light design. We can, therefore, easily carry in and out of the test site. In addition, preparations for testing became very easy.

The power supply for testing is regular single-phase 100V AC. Since the applied voltage for testing is also low, testing can be done safely. Selection of “ground fault line” and “sound line” can be made by a simple switchover action, and it is unnecessary to change the test circuit connections for every testing. This means decreased testing time. **Fig. 4** shows an example of artificial ground fault testing.

2.2.2 Outline of Specifications

(1) Use and purpose

Checking test after partial updating of 67Ry and transformers and checking of ground fault direction



(a) Testing by an existing method



(b) Testing by using the artificial ground fault tester

Fig. 4 Example of Artificial Ground Fault Testing

An external appearance of ground fault testing by an existing method and the same testing by using this tester is shown.

(2) Test operation mode

Ground fault line (operation) and sound line (non-operation)

(3) Test voltage and current

Zero-phase-sequence voltage (V_0): 0 ~ approx. 440V

Zero-phase-sequence current (I_0): 0 ~ approx. 0.5A, 0 ~ approx. 0.25A

(4) Contents of testing

(a) Check wiring connections and polarities among Earthed-type Voltage Transformers (EVT), Zero-phase-sequence Current Transformers (ZCT), and directional ground fault relays (67Ry)

(b) 67Ry operation checks under the condition of a circuit in a ground fault

2.3 Pulse Current Generator

Fig. 5 shows an external appearance of the pulse current generator. This tool is used to examine the soundness of the current detector (hall CT) generally used in inverter and converter units.

It can handle not only individual unit testing

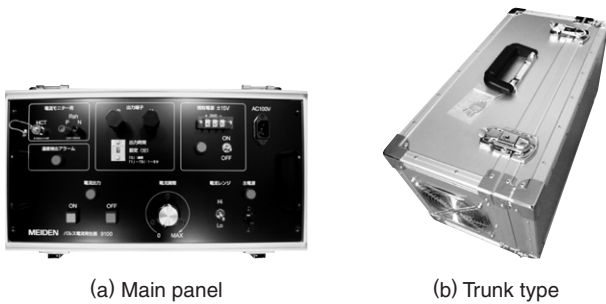


Fig. 5 Pulse Current Generator

An external appearance of the main panel and its carrying trunk case are shown.

on current detectors but also the integrate test combining a current detector and equipment unit: function and performance test.

2.3.1 Features

A recorder (memory high coder or oscilloscope) is connected to a memory terminal of this tester to check the output signals and their behavior while the magnitude of pulse currents is adjusted so that the soundness of the parts or equipment under test can be inspected. The pulse current can be generated from tens of amperes DC and up to as high as 500A (Rated at 400A).

Formerly, operation test was carried out on the test site by inputting a simulation signal from the secondary circuit of the current detector. When this tool was adopted, it became unnecessary to separate the current detector from the equipment unit. This means the operation test became simplified. It is also possible to eliminate concerns such as insufficient contact pressure caused by connector pin removing-inserting or wrong connections at the time of system restoration. As a result, we can proceed with testing in safe and efficient manner.

This tool is accommodated in a trunk case that can be carried with one hand. Since all functions needed for testing are assembled in this tool, we can conduct fast and accurate test at the test site.

Fig. 6 shows an example of actual test using a current detector (component under test) with this tester.

2.3.2 Outline of the Specifications

(1) Use and purpose

Acceptance test, confirmation of soundness, and test of deterioration over time for current detector (hall CT) and equipment unit with current detector

(2) Specifications of measurement

- (a) Impulse current: Rated 400A (500A Max.)
- (b) Impulse period: 200/300/400/500ms (changeable with a built-in dip switches)

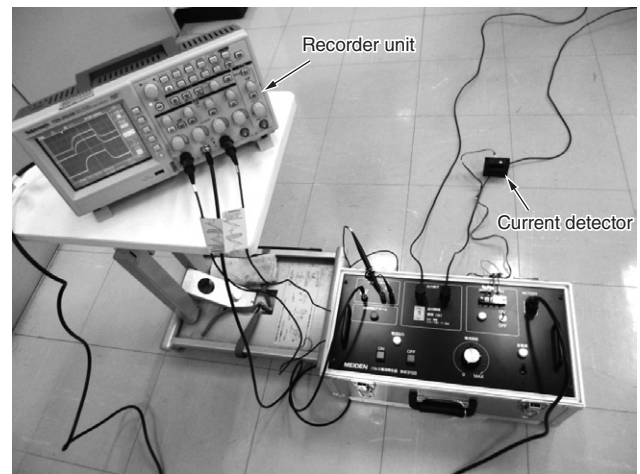


Fig. 6 Example of Actual Test Using a Current Detector (Component under Test)

An example of a test is shown.

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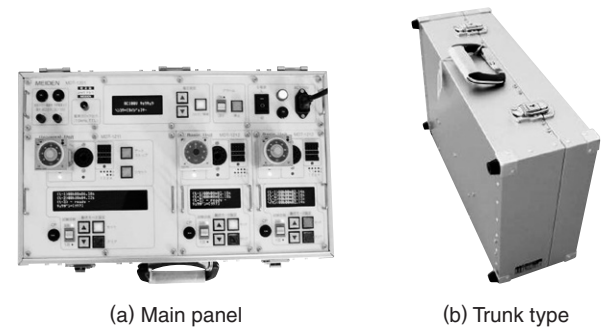


Fig. 7 Automatic Timer Tester 1201

An external appearance of the main panel and its carrying trunk case are shown.

- (c) Impulse width: 0.2/0.3/0.4/0.5ms (changeable with a built-in dip switches)
- (d) Operation time: Continuous mode or timer mode (1 ~ 9 minutes)
- (e) Rsh terminal for current monitor: Shunt resistor (20A/100mV, Accuracy 1.0 class)
- (f) HCT terminal for current monitor: Hall CT (1000A/4V)

2.4 Other Maintenance Tools (Various Lineups)

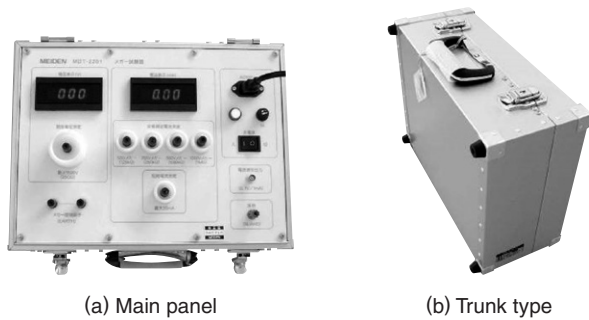
In addition to the aforementioned tools, various maintenance tools we developed and applied are introduced below.

2.4.1 Automatic Timer Tester 1201

Fig. 7 shows an external appearance of the automatic timer tester 1201.

(1) Use and purpose

Acceptance test and inspection of deteriora-



(a) Main panel

(b) Trunk type



(c) Standard resistor (Option)

Fig. 8 Megger Tester 2201

An external appearance of the main panel, its carrying trunk case and standard resistor (available as an option) are shown.

tion over time for timers (time limit relays)

(2) Target timers

46 models manufactured by OMRON Corporation, 25 models by Panasonic Corporation, and 12 models by FUJI ELECTRIC CO., LTD.

(3) Test operation mode

17 modes (ON-delay, OFF-delay, star-delta, one-shot, etc.)

(4) Built-in testing power supplies (DC12/24/48/100V, AC24/100/200V) and external supply enabled

(5) Contents of testing

- (a) Setting time measurement: (0 ~ 99h 59.99s)
- (b) Operation checks for coils and all contacts

2.4.2 Megger Tester 2201

Fig. 8 shows an external appearance of the megger tester 2201.

(1) Use and purpose

Megger calibration (periodic inspection, pre-use inspection)

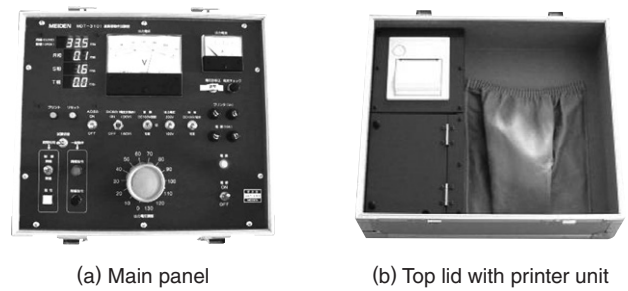
(2) Target meggers

Meggers rated 125/250/500/1000V

(3) Contents of testing

Tests itemized below are carried out in accordance with JIS C1302-2002

- (a) Open-circuit voltage
- (b) Rated measuring current
- (c) Short-circuit current Operation checks for all contacts
- (d) Tolerance for resistance measurement (added



(a) Main panel

(b) Top lid with printer unit



(c) Trunk type

Fig. 9 Circuit-Breaker Operation Tester 3101

An external appearance of the main panel, the top panel with a printer, and the trunk case are shown.

by an option)

2.4.3 Circuit-Breaker Operation Tester 3101

Fig. 9 shows an external appearance of the circuit-breaker operation tester 3101.

(1) Use and purpose

Soundness check and inspection of deterioration over time for circuit-breakers

(2) Target circuit-breakers

We manufactured 22 models. Applicable to almost all our circuit-breakers such as vacuum circuit-breakers (VJ, VE series) and magnetic contactors (V-tactors series) provided that external closure power and pneumatic air are available.

(3) Contents of testing

- (a) Operation test for circuit-breaker closure, tripping, and spring charging
- (b) Minimum voltage measurement for closure, tripping, and spring charging
- (c) Trip-free test
- (d) Operating time measurement for main circuit contacts (0 ~ 999.9ms)

2.4.4 Contact Resistance Meter 3201 (Sister Product of Circuit-Breaker Operation Tester 3101)

Fig. 10 shows an external appearance of the contact resistance meter 3201.

(1) Use and purpose

Soundness check and inspection of deterioration over time for circuit-breakers

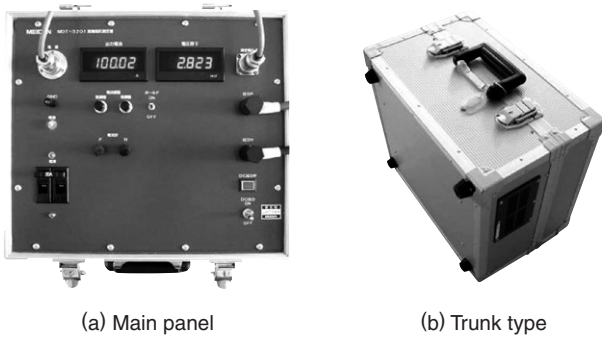


Fig. 10 Contact Resistance Meter 3201

An external appearance of the main panel and its carrying trunk case in portable state are shown.

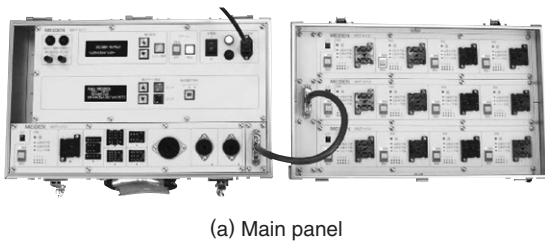


Fig. 11 Auxiliary Relay Tester 4101

An external appearance of the main panel and its carrying trunk case are shown.

(2) Application

Measurement of contact resistance in the main circuit (DC 4-terminal method). Applicable to general measurement of contact resistance

(3) Contents of measurement

- (a) Standard output current: 10 ~ 100A (Freely changeable)
- (b) Voltage drop measurement: 0 ~ 19.999mV (At 100A: Equivalent to 0 ~ 199.99 $\mu\Omega$)
- (c) Capability test of continuous operation for 10 min (in the case of intermittent use)

2.4.5 Auxiliary Relay Tester 4101

Fig. 11 shows an external appearance of the auxiliary relay tester 4101.

(1) Use and purpose

Acceptance test and inspection of deteriora-

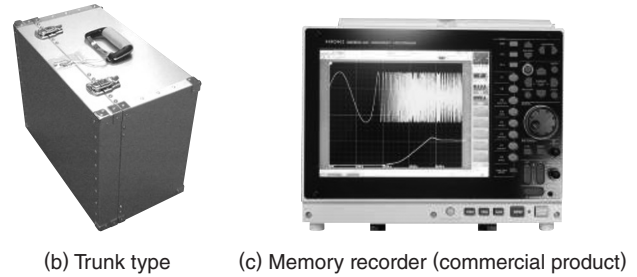
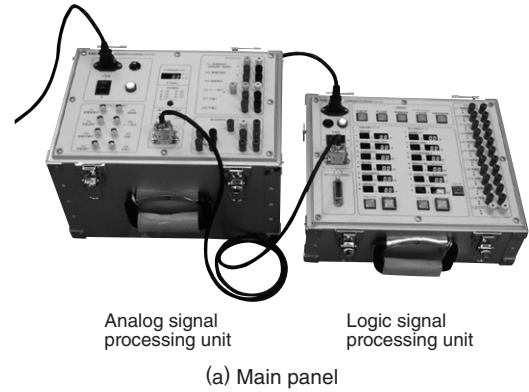


Fig. 12 Generator Dynamic Characteristic Tester 5101

An external appearance of the main panel and its carrying trunk case are shown. The memory recorder used here is a commercial product.

tion over time for auxiliary relays

(2) Target relays

Total 185 models manufactured by 5 makers: OMRON Corporation, FUJI ELECTRIC CO., LTD., FUJITSU COMPONENT LIMITED, Panasonic Corporation, and IDEC CORPORATION

(3) Test operation mode (Setting for No. of tests)

17 modes (manual mode: 1 ~ infinity, auto-mode: 1 ~ 10 times)

(4) Built-in testing power supplies (DC12/24/48/100V, AC24/100/200V) and external power supply enabled

(5) Contents of testing

Operation checks for coils and all contacts (Contact current: 1/10/100mA)

2.4.6 Generator Dynamic Characteristic Tester 5101

Fig. 12 shows an external appearance of the generator dynamic characteristic tester 5101.

(1) Use and purpose

Soundness check and inspection of deterioration over time for generators

(2) Application

Regular-use and emergency-purpose generators (Diesel, gas turbine, etc.). Applicable to generators with 2, 4, 6, 8, 10, and 12 poles

- (3) Contents of testing
 - (a) Start-stop test
 - (b) Load shutdown test
 - (c) Indicial response test (Sudden load change test)
 - (d) Auto-synchronization test

3 Postscript

This paper introduced the outline of our maintenance tools used for our maintenance service sites.

Going forward, we aim to realize more advanced maintenance tools that excel in terms of portability and convenience, advancement of measured data saving and checks plus diagnostic accuracy, better network capability, and acquisition of data relating to diagnostic factors (signs of equipment deterioration and malfunction).

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