Automatic impulse testing of motor stators using high-voltage relays

When the test voltage for impulse testing of motor stators exceeds 1500 V, it becomes difficult to obtain relays for use in switching test circuits.
Consequently, such tests rely on manual measurement or manual switches.
This application proposes an approach for automating impulse testing of stators.

Target

EV motors, inverters, motors in inverter-equipped household appliances, air-conditioner compressors, industrial motors, industrial pumps, and other motors

Market trends

Inverter voltages in motors used in applications such as electric vehicles (EVs) and household appliances are increasing.
As a result, the impulse test voltages used to inspect stators for insulation defects (layer shorts and partial discharges) on production lines are also rising.
Higher impulse voltages make it more difficult to automate testing.

Fig. 1 Testing a stator

Issues

In the case of a 3-phase stator, impulse tests are carried out between each phase combination: U-V, V-W, W-U, V-U, W-V, and U-W.
Consequently, manufacturers work to automate such tests by using relays to switch test circuits.
However, when test voltages exceed 1500 V, it becomes impossible to use standard relays.
As a result, impulse testing between stator phases is carried out by means of manual measurement or manual switches.

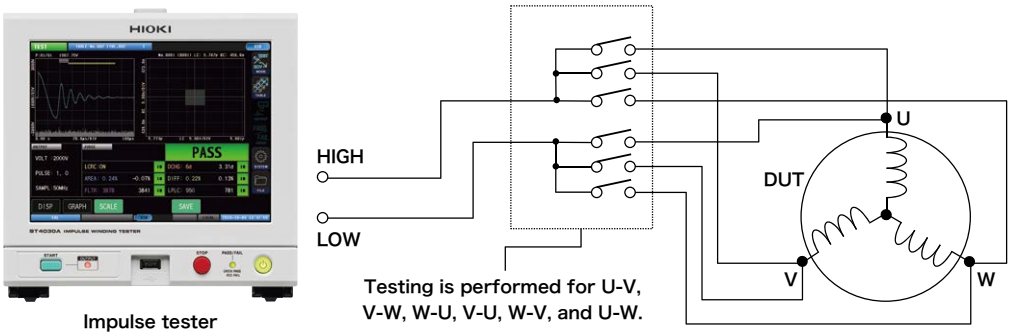

Fig. 2 Impulse testing of a 3-phase stator

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Solution

The High Voltage Scanner 3930 can be used as a measurement circuit switch.
The 3930 incorporates lead relays that can be switched at voltages of up to 5 kV DC or 5 kV AC.
Sequence Maker (an Excel add-in) can be used to create and execute automatic test sequences.
The 3930 can be controlled using I/O from a PLC or similar device.
In this test, Hioki used a PHC-D08 (PATLITE Corporation), which supports contact control from a PC. (See Fig. 3, Fig. 4, and Table. 1)

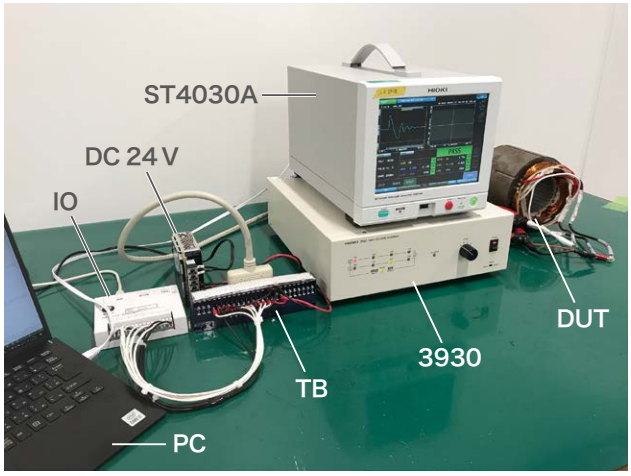


Fig. 3 Photograph of measurement and control equipment

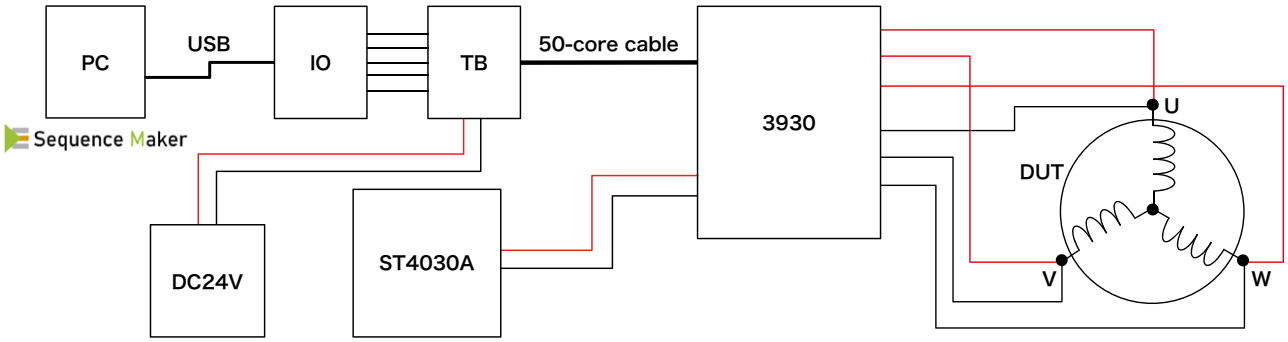


Fig. 4 Schematic diagram

Table.1 Parts list

Symbol	Name	Model	Manufac-turer	Specifications
PC	-	-	-	Windows 10, Sequence Maker
IO	Interface Converter	PHC-D08	PATLITE	-
DC 24 V	Switching Power Supply	S8FS-G03024C	Omron	Output: 24 V DC, 30 W Input: 100 to 240 V AC
50-core cable	Control Input Connection Cable	-	HIOKI	Included with High Voltage Scanner 3930
TB	Terminal Block with Centronics Connector	-	-	Provide a terminal block with a 50-pin Centronics connector (male).
3930	High Voltage Scanner	3930	HIOKI	-
ST4030A	Impulse winding tester	ST4030A	HIOKI	-

Fig. 5 provides a measurement circuit diagram. The 3930 should be used in “Multi” mode.

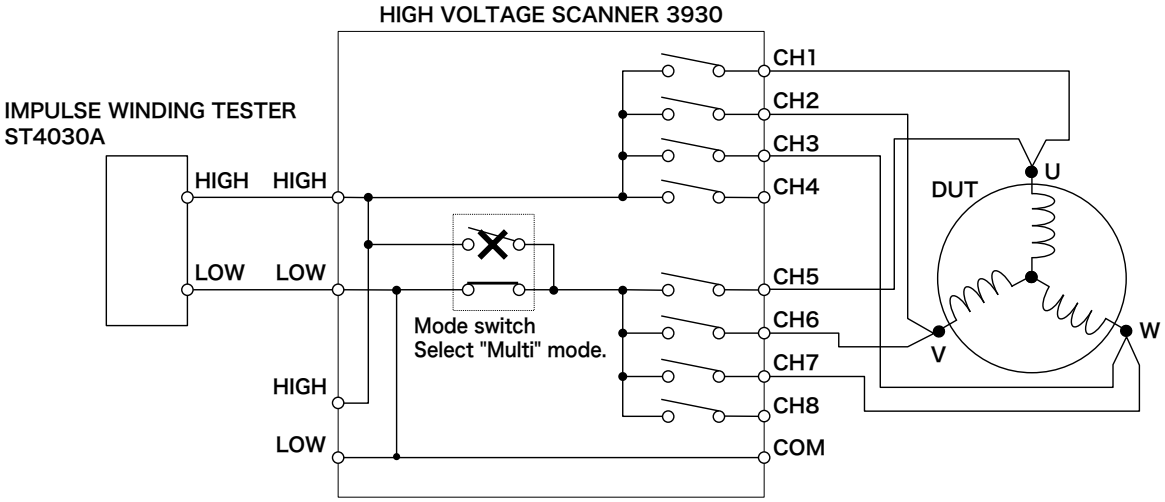
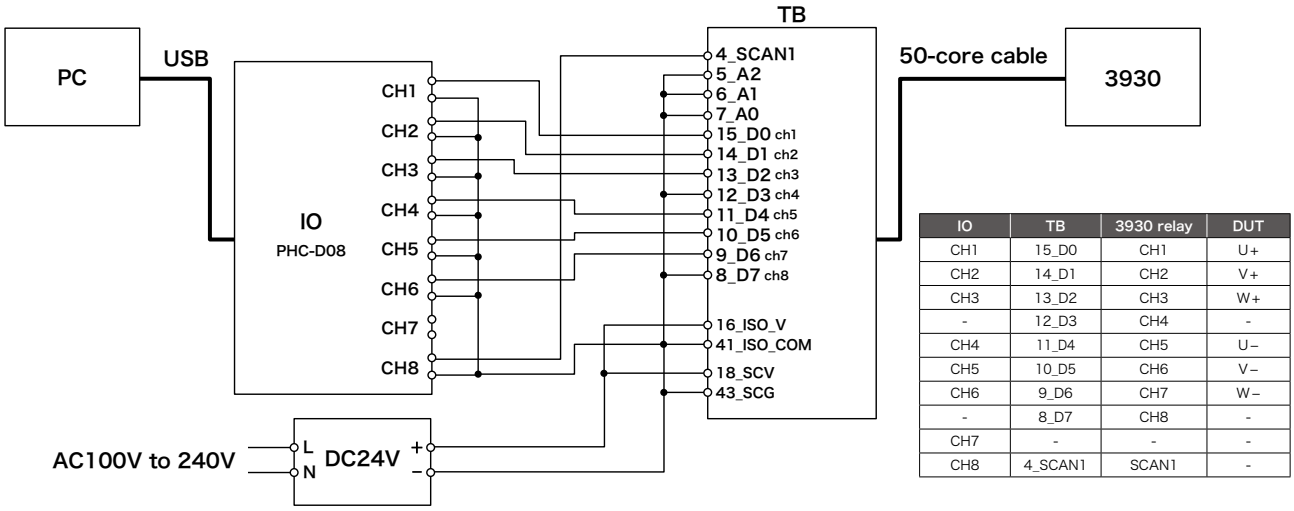


Fig. 5 Measurement circuit diagram

Fig. 6 provides a wiring diagram depicting control of the 3930’s internal relays.
A commercially available power switching power supply is used to power the 3930 and provide the contact voltage.



IO	TB	3930 relay	DUT
CH1	15_D0	CH1	U+
CH2	14_D1	CH2	V+
CH3	13_D2	CH3	W+
-	12_D3	CH4	-
CH4	11_D4	CH5	U–
CH5	10_D5	CH6	V–
CH6	9_D6	CH7	W–
-	8_D7	CH8	-
CH7	-	-	-
CH8	4_SCAN1	SCAN1	-

Fig. 6 Relay control wiring diagram

Measurement data

ST4030A + 3930

- Sequence Maker switches between the High Voltage Scanner 3930's output channels.
- After switching, Sequence Maker controls the ST4030A to conduct an impulse test.
- Each test consists of three demagnetization pulses, 10 test pulses, and a pass/fail judgment.
- The test results and data are received by Sequence Maker.

Fig. 7 illustrates the effects of wiring length.
The "STANDARD WAVE" shown in the top graph was created by the ST4030A alone.
The "PULSE1 WAVE" depicts the waveform for this test (which adds the 3930 and wiring to increase the wiring length by 3.3 m).
The bottom graph overlays data obtained by testing the same point 10 times in this test.
Although the longer wiring has an effect, it has no impact on the reproducibility of results for that point.

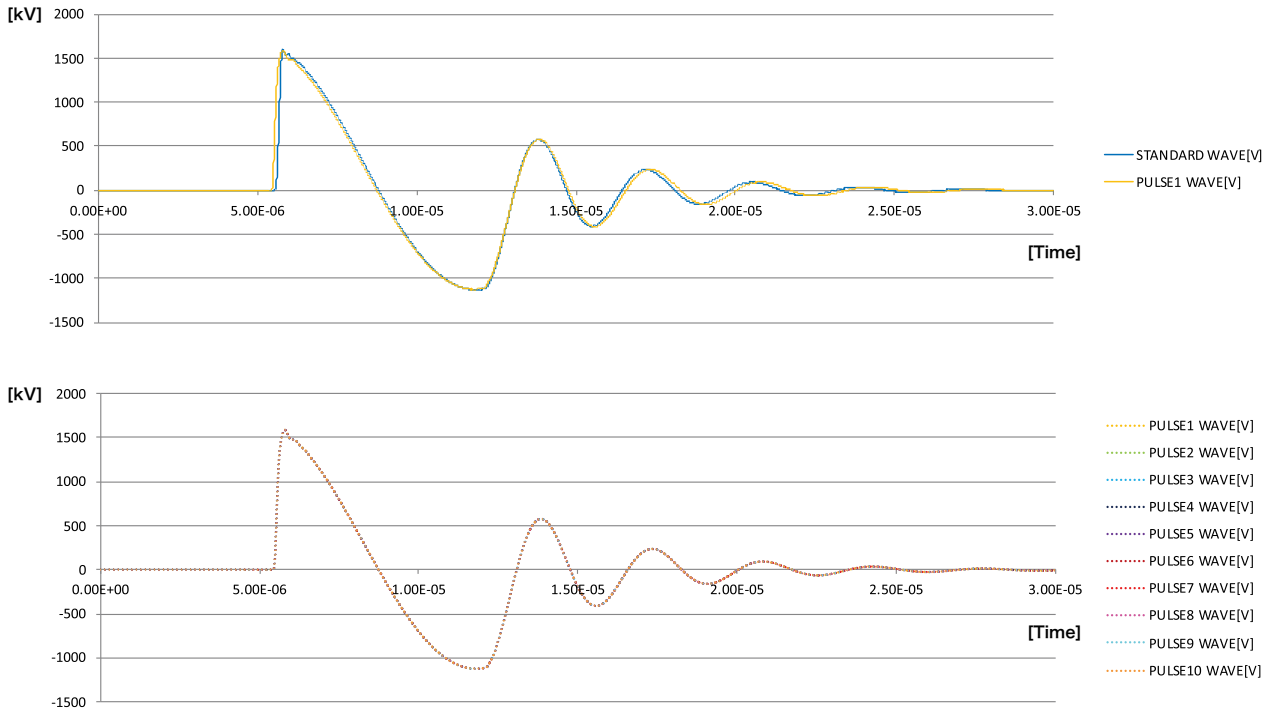


Fig. 7 Effects of wiring length

Summary

·This application describes a method for automatically performing impulse testing between phases (U-V, V-W, W-U, V-U, W-V, and U-W).
·Automatic testing can be performed on production lines by replacing the control and I/O (contact I/O) functionality provided by Sequence Maker with a PLC.

Application precautions:
Sequence Maker can be downloaded free of charge from the following URL: https://www.hioki.com/global/support/download/software/versionup/detail/id_609
Sequence Maker can also be downloaded from the URL provided in the User Manual.
Please contact a Hioki salesperson if you require a sample program.

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