HIOKI

PARTIAL DISCHARGE DETECTOR ST4200
HIGH VOLTAGE MULTIPLEXER SW2001

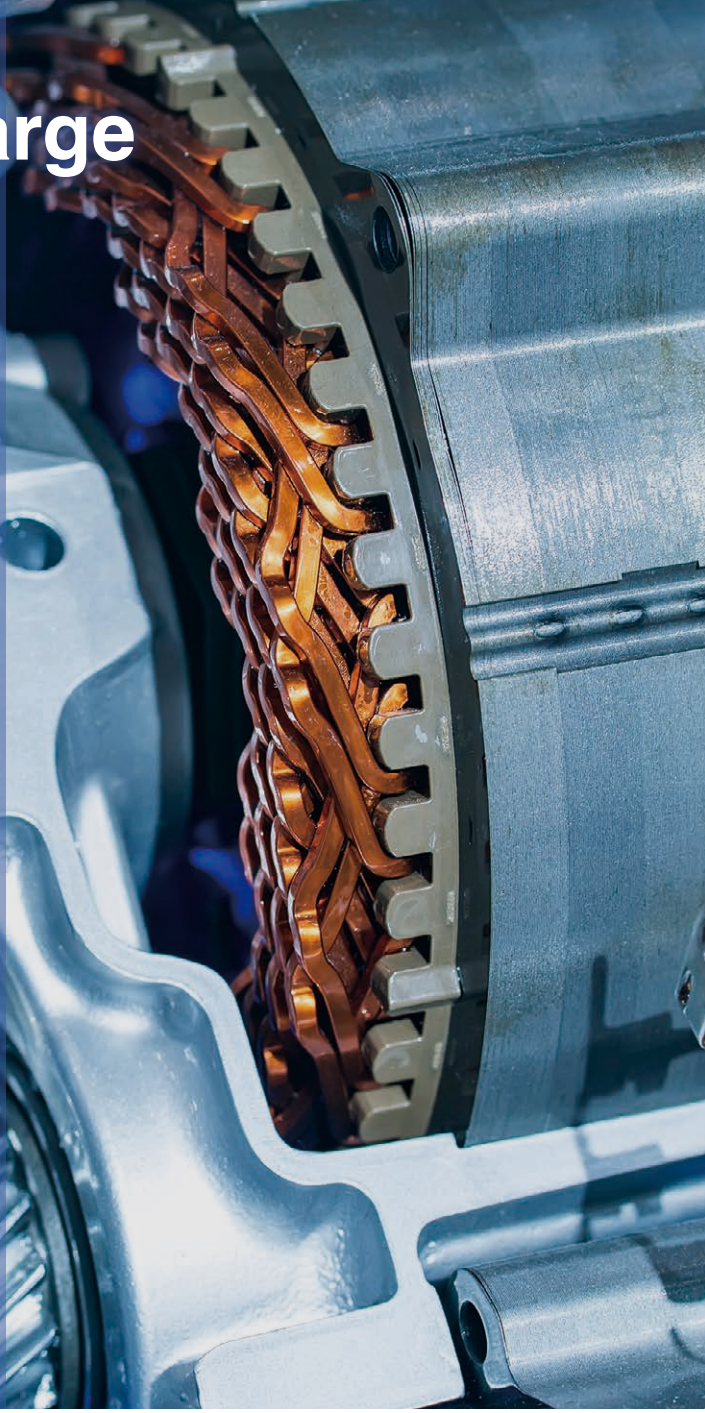
NEW

Enhance PD detection,
Elevate your motor inspection

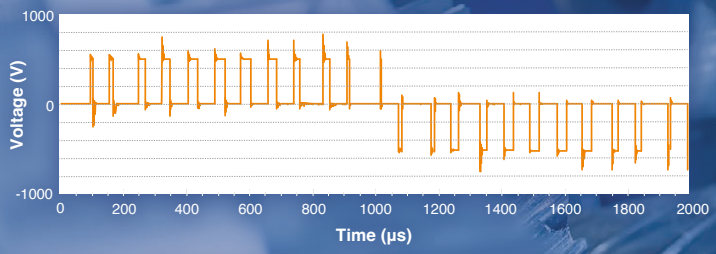
CE 3 year Warranty

Why is partial discharge testing necessary?

In today's motor market, it's no longer enough for R&D and QA teams to simply identify defective motors; they must also detect latent defects. What was once considered "good enough" can now lead to severe consequences. Partial discharge is a key indicator of these latent defects. Traditional motor testing methods, such as hipot, surge, and insulation resistance tests, fail to identify such miniscule defects. As insulation standards advance, previously tolerable weaknesses can now result in partial discharges, leading to short-circuits, insulation failures, and even fires.
Fortunately, incorporating a partial discharge testing regimen can be both quick and effective. Hioki provides a range of flexible solutions, from a straightforward, budget-friendly choice to a comprehensive integrated testing station. These solutions not only safeguard against the costly and hazardous effects of undetected partial discharges but also represent a crucial step forward in the evolution of motor manufacturing.



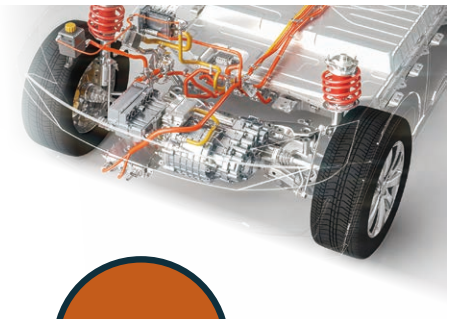
Voltage waveform of the inverter

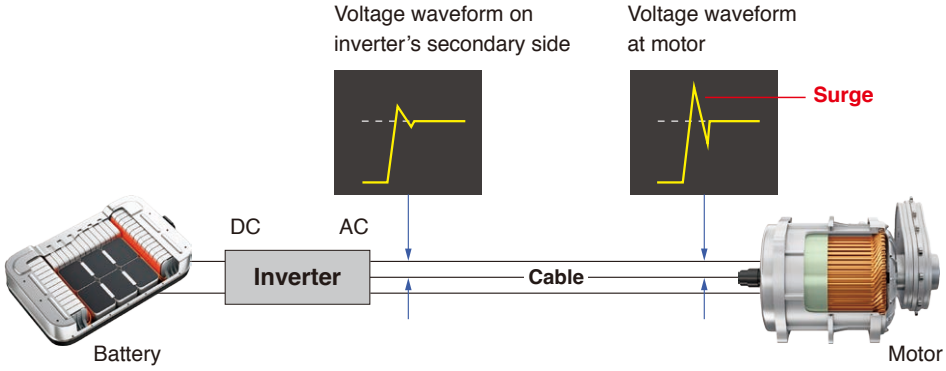


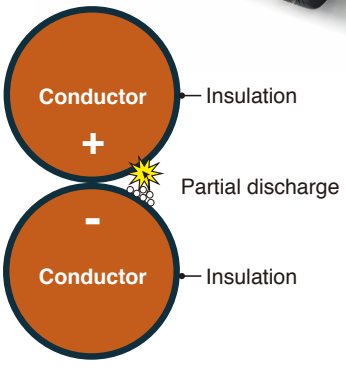
The voltage of the inverter that drives the motor has a waveform that switches rapidly.
Each switching operation is accompanied by a surge voltage of approximately twice or more of the switching voltage, causing a momentary high voltage to be applied between the windings inside the motor. Repeated exposure to this inverter surge voltage accelerates the degradation of insulation.

Latent defects that can lead to serious accidents

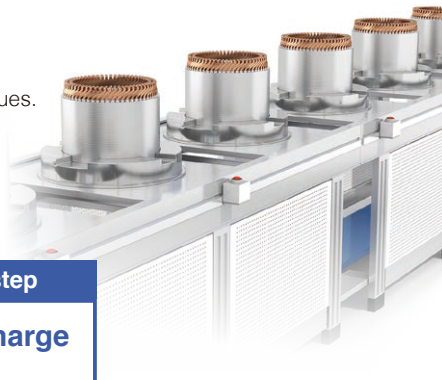
Partial discharges are thought to happen when a voltage above approximately 350 V is applied to a winding that lacks adequate insulation. These discharges can take place in areas of the winding with insufficient insulation. Over time, they repeatedly occur in the same spot, further deteriorating the insulation, leading to short circuits or insulation breakdowns. Such issues can result in severe incidents, including fires.





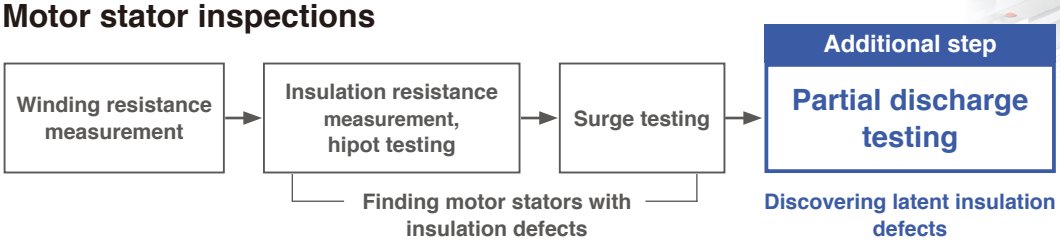


Identifying latent defects before they lead to insulation breakdown



The goal of insulation resistance and hipot testing is to identify motors with already present insulation issues. However, these tests cannot detect latent defects.
By identifying partial discharges, latent defects can be uncovered before they result in failures.

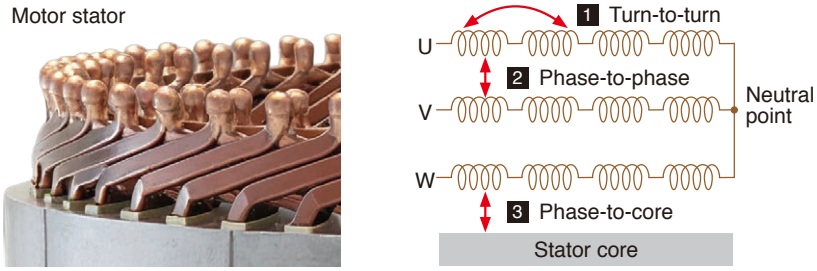
Motor stator inspections



Partial discharge testing in motor stators

In partial discharge testing, partial discharges are detected while applying a high voltage between each phase's windings (turn-to-turn), between phases (phase-to-phase), and between each phase and the stator core (phase-to-core).

Where is partial discharge most likely to occur?



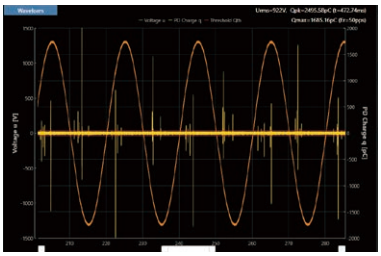
1 Turn-to-turn PD: Discharges caused by voltage differences between wires in the same phase. Surge generator is used for the test.

2 Phase-to-phase PD: Discharges caused by contact between wires in different phases or by misalignment/tearing of insulating paper. Ideally, the test should be performed with the neutral point open and using a high-voltage AC power source for the test.

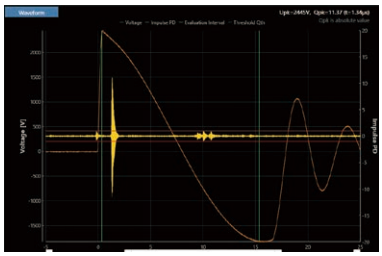
3 Phase-to-core PD: Discharges caused by contact between wires and the stator core, or by misalignment/tearing of insulating paper. A high-voltage AC power source is used for the test.

Choose the optimal PD testing methods for reliable detection

Since the turn-to-turn PD test checks the ability to resist inverter surges, a surge PD test is performed using an impulse or surge waveform. Ideally, testing between phases and between each phase and the stator core should be done by AC PD testing because the longer voltage application time would increase the likelihood of partial discharge to occur. However, since AC PD testing cannot be performed for phase-to-phase PD tests with a closed neutral point, an impulse waveform is used.



AC PD testing



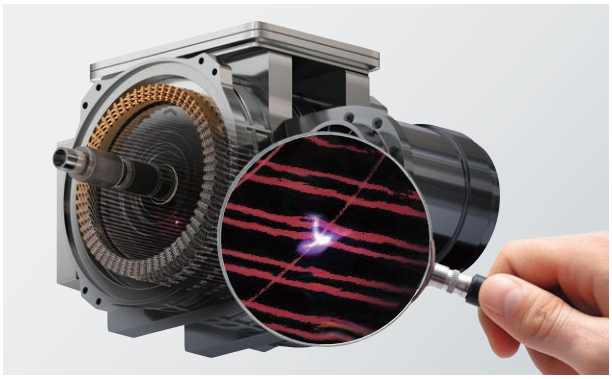
Surge PD testing

Hioki recommends using both AC PD testing and surge PD testing for stator partial discharge testing.
The ST4200-50 Partial Discharge Detector can perform both types of partial discharge detection in a single unit.

Partial Discharge Detector

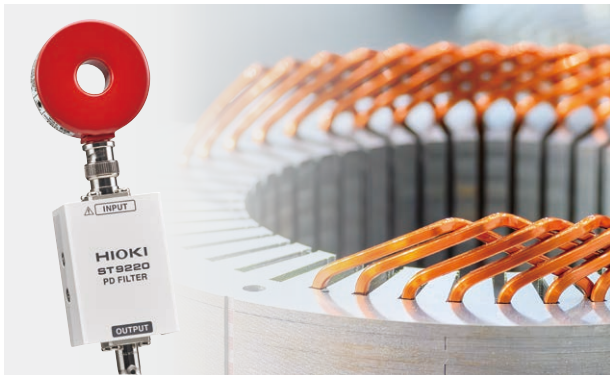
ST4200

Enhanced reliability, Upgraded quality



Maximize PD detection to find a variety of latent defects

- Dual-mode PD detection provides reliable inspection with both AC PD and Surge PD testing.

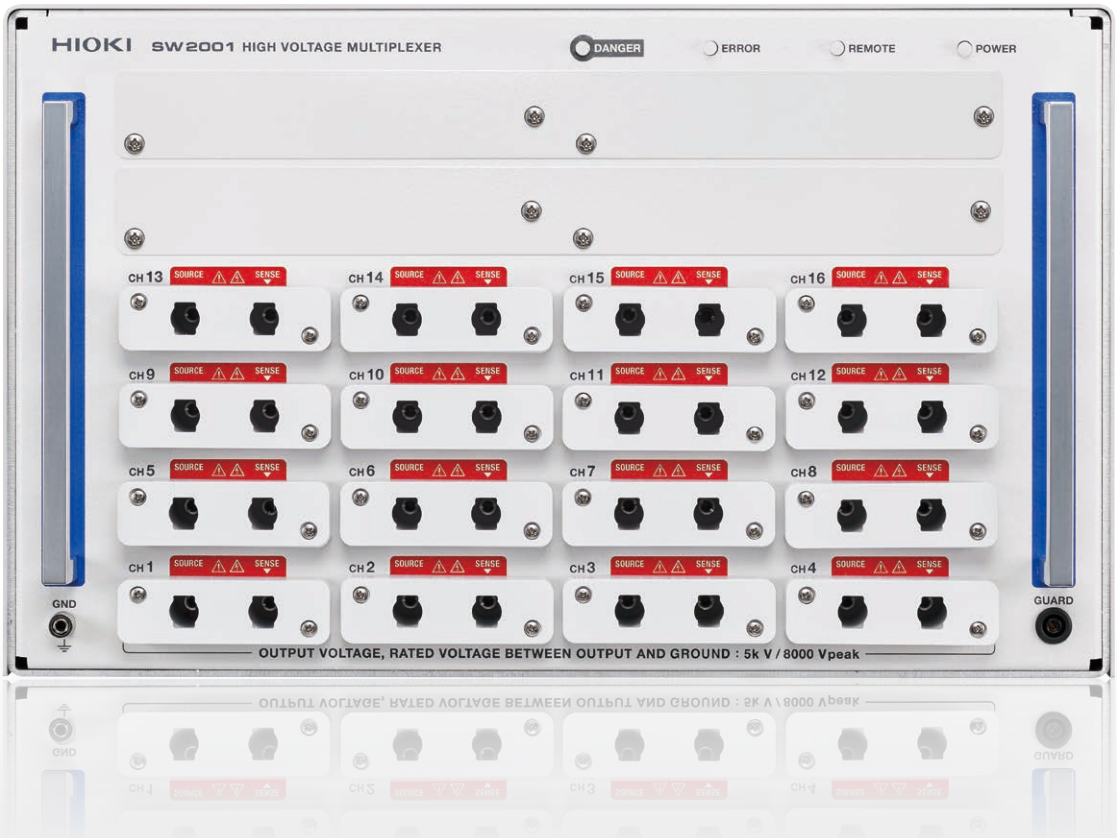


Reliable PD testing even on production lines

- Noise-resistant PD detection with a high-frequency CT.
- Stable partial discharge detection even in complex inspection systems when used in conjunction with SW2001.

High Voltage Multiplexer

SW2001



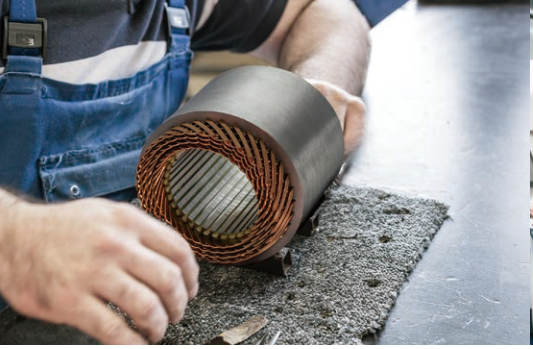
Boosted productivity, Enhanced reliability

Boost productivity with one multiplexer handling six tests

- Selectable number of channels for your test needs: 4, 8, or 16 channels.

Enhance reliability with reduced production line stops, test accuracy, and reproduceable results

- Highly reliable multiplexing design with extended operational lifespan.



Benefit

01 **Maximize PD detection to find a variety of latent defects**
02 **Streamline your data analysis and accelerate research with diverse analytical functions**
03 **Reliable PD testing even on production lines**
04 **Simplified system design for improved noise resistance**
05 **Boost productivity with one multiplexer handling six tests**
06 **Enhance reliability with reduced production line stops, test accuracy, and reproduceable results**

Challenge & Solution

Partial discharge testing on production lines faces challenges with reproducibility due to noise interference. This issue arises from the choice of partial discharge detection methods and the design of the motor inspection systems. While the use of multiplexers is increasing to enhance the efficiency of motor production testing, designing a system that can safely and reliably switch between high-voltage and low-voltage measurements is challenging. It is also challenging to minimize the impact of multiplexers on measurement performance while also improving the system's robustness to minimize maintenance downtime. Balancing these design requirements is a complex task. It is also a strenuous effort to reduce the impact of multiplexers on measurement performance while also enhancing the system's robustness to minimize maintenance downtime.

Benefit 01

Maximize PD detection to find a variety of latent defects

Challenges

Surge PD testing can be used to detect partial discharges at all three points of the stator (turn-to-turn, phase-to-phase, and phase-to-core) regardless of the neutral point connection. Although performing only surge PD testing would be easy, it is not very effective at detecting partial discharges in the following ways.

- ⃠ The test surge often does not give enough time for partial discharge to occur.
- ⃠ The test surge gets attenuated inside the stator.

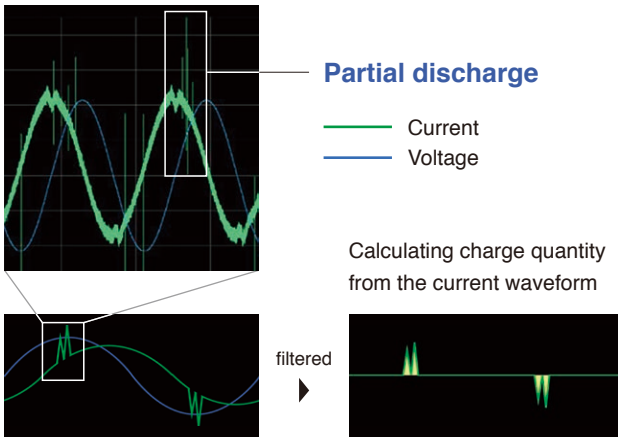
Solution

Dual-mode partial discharge detection

Find the maximum number of latent defects by utilizing both AC PD and surge PD testing.
You can select the optimal PD testing method based on whether or not the neutral point is connected and the test location.

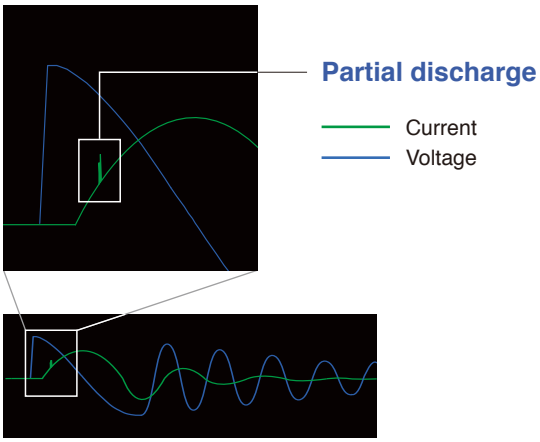
AC PD testing

A high AC voltage is repeatedly applied while the charge quantity (pC) of the discharge is measured based on the current waveform. Compliance with IEC 60270 and IEC 60034-27-1.

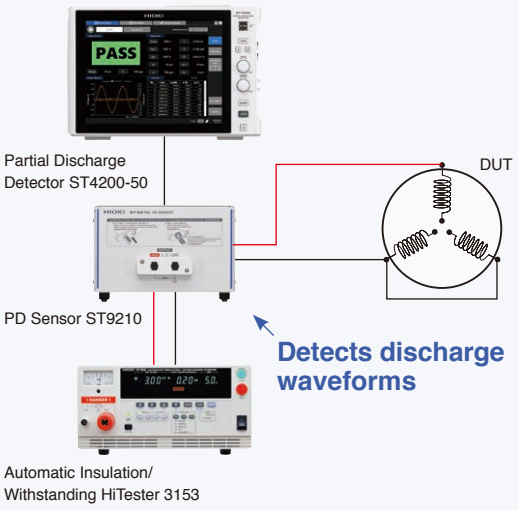


Surge PD testing

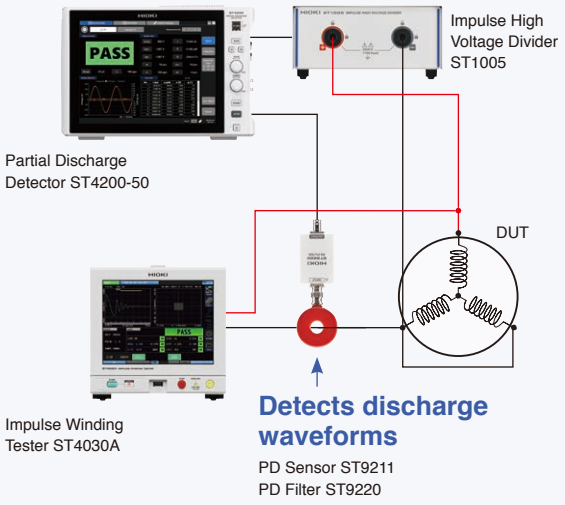
An instrument applies a surge while the discharge waveforms appearing in the current waveform are detected. This tests how well the stator can withstand a surge voltage.
Compliance with IEC 61934 Edition 2.0 and IEC 60034-27-5.



Before neutral-point connection



After neutral-point connection



Benefit 02

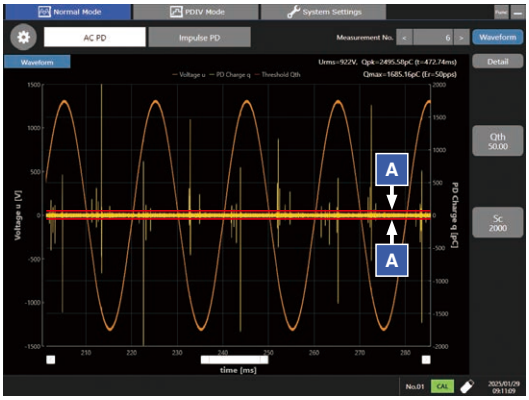
Streamline your data analysis and accelerate research with diverse analytical functions

AC PD testing (Normal Mode)

In Normal Mode, PD testing is conducted at a constant test voltage. The red line labeled *A* in the figure to the right indicates the PD threshold (Qth). Any pulses that surpass this threshold are registered as partial discharges.

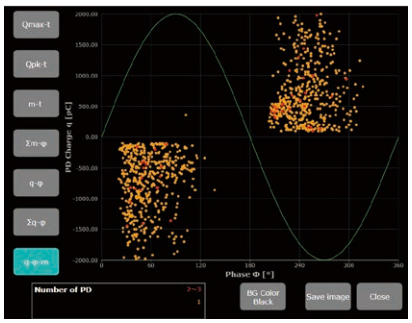
The pass/fail criteria for the PD test can be configured based on parameters such as Qmax (maximum PD charge) and n (the number of partial discharge pulses occurring per second).

Besides Phase-Resolved Partial Discharge (PRPD) analysis, the system offers a range of analytical functions, including Qmax-t, Qpk-t, m-t, Σm-Φ, q-Φ, and Σq-Φ.

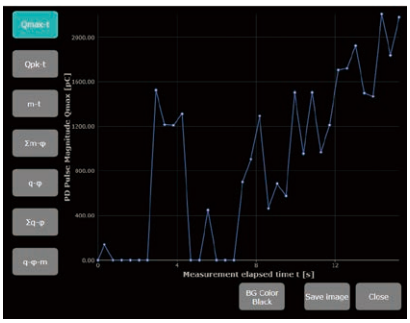


Setting of PD threshold

AC PD Normal Mode measurement



q-Φ-m analysis graph



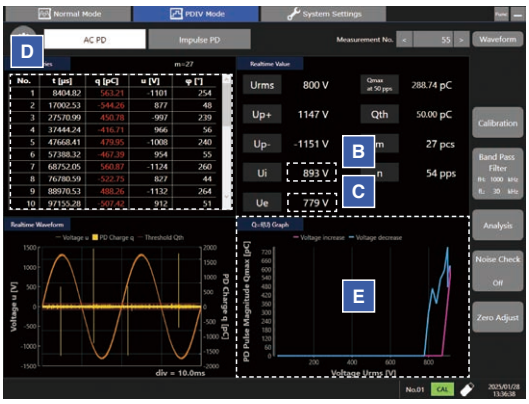
Qmax-t analysis graph

AC PD testing (PDIV Mode)

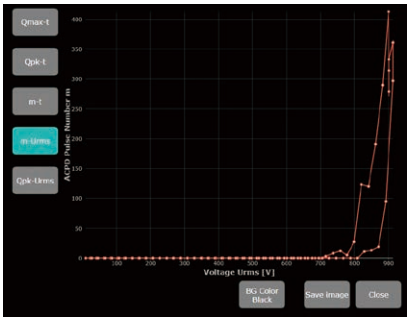
In PDIV mode, the test voltage is ramped up and down to measure the Partial Discharge Inception Voltage (PDIV) and Partial Discharge Extinction Voltage (PDEV). (*B* in the right figure indicates the PDIV value, and *C* indicates the PDEV value.)

For each measurement cycle, recorded PD data, including time of occurrence, charge magnitude, instantaneous voltage, and voltage phase, can be displayed and recorded. (*D* in the right figure shows the measurement display.)

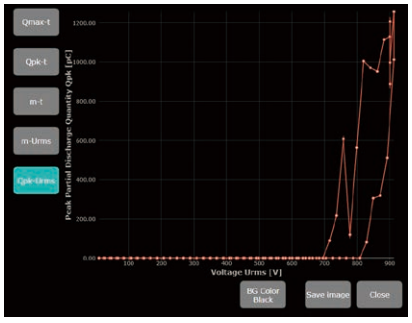
A graph of voltage versus maximum charge (Qmax) is plotted in real time (*E* in the right figure). The system also offers various other analysis functions, such as pulse-count versus voltage graphs.



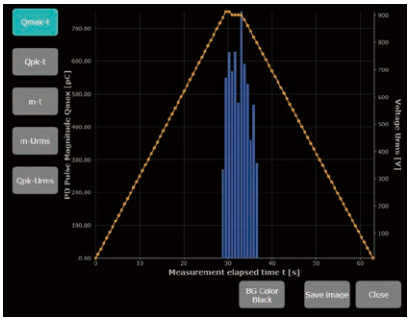
AC PD PDIV Mode measurement



m-Urms analysis graph



Qpk Urms analysis graph



Qmax-t analysis graph

Surge PD testing (Normal Mode)

In normal mode, PD testing is conducted at a fixed test voltage. The red line (*F*) in the accompanying figure represents the PD threshold (Qth).

Only pulses exceeding this Qth value are considered and recorded as partial discharges. Furthermore, a gating period (*G*) can be defined to mitigate the effects of non-PD pulses that may occur during the rising edge of the impulse waveform.

Furthermore, in normal mode, the number of test repetitions can be set arbitrarily. Table *H* on the right presents data acquired from a series of 10 tests. This table displays and records key parameters for each test, including the peak partial discharge magnitude (Qpk), the peak test voltage (Upk), and the time from the trigger point to when a peak partial discharge is detected (tpk).

Setting of the PD threshold and the Judgments window

Surge PD Normal Mode measurement

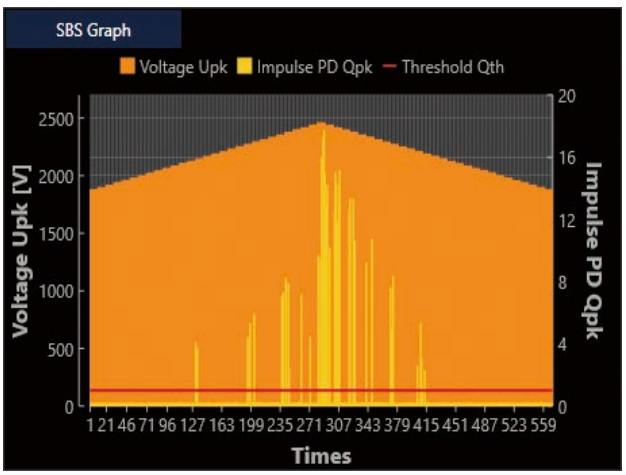
Surge PD testing (PDIV Mode)

PDIV Mode allows users to define the starting voltage, maximum voltage, and voltage step. This mode then displays and records key partial discharge parameters: see Figure *I*.

PDIV ..... Partial Discharge Inception Voltage
RPDIV ..... Repetitive Partial Discharge Inception Voltage
RPDEV .... Repetitive Partial Discharge Extinction Voltage
PDEV ..... Partial Discharge Extinction Voltage

Furthermore, the SBS graph (Graph *J*) provides real-time monitoring of the applied voltage and the corresponding PD pulse magnitude throughout the test.

Surge PD PDIV Mode measurement



SBS analysis graph

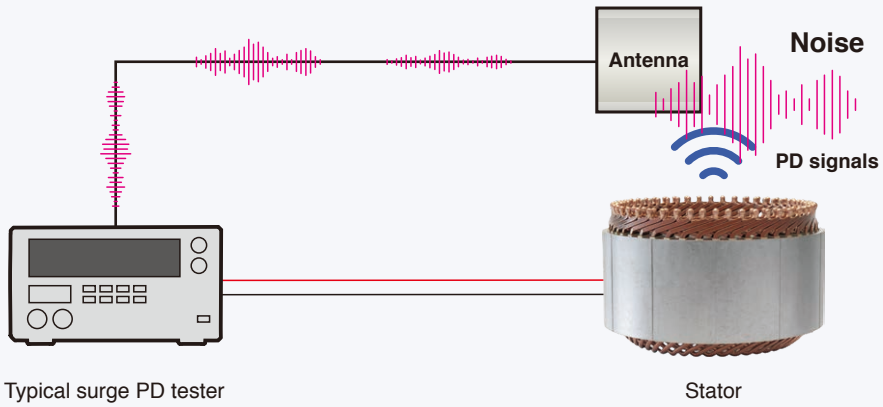
Benefit 03

Reliable partial discharge testing even on production lines

Challenges

Using microwave antennae to detect partial discharge causes the following challenges

- It picks up noise from plant equipment and power lines, affecting measured values.
- Slight antenna directivity errors result in false PASS/FAIL judgments.

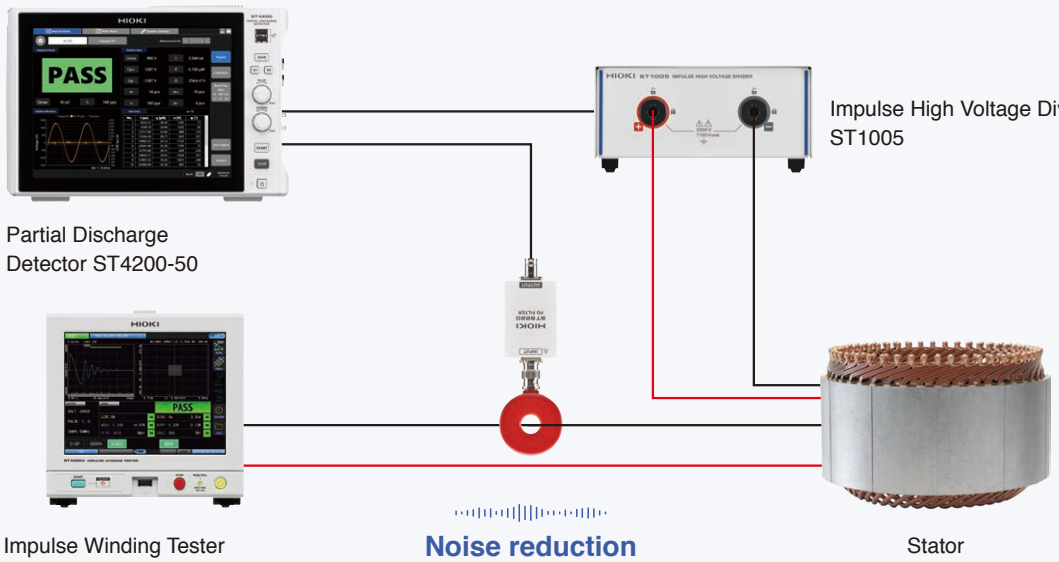


Highly succesptible to noise

Solution

Noise-resistant partial discharge detection with a high-frequency CT

Partial discharge testing using a high-frequency CT simplifies installation by reducing the need for precise positioning and minimizes noise. Both of these benefits reduce measurement errors when compared to the antenna method.



Benefit 04

Simplified system design for improved noise resistance

Challenge

⃠ Noise from complex wiring inside the test system makes PD detection unstable.

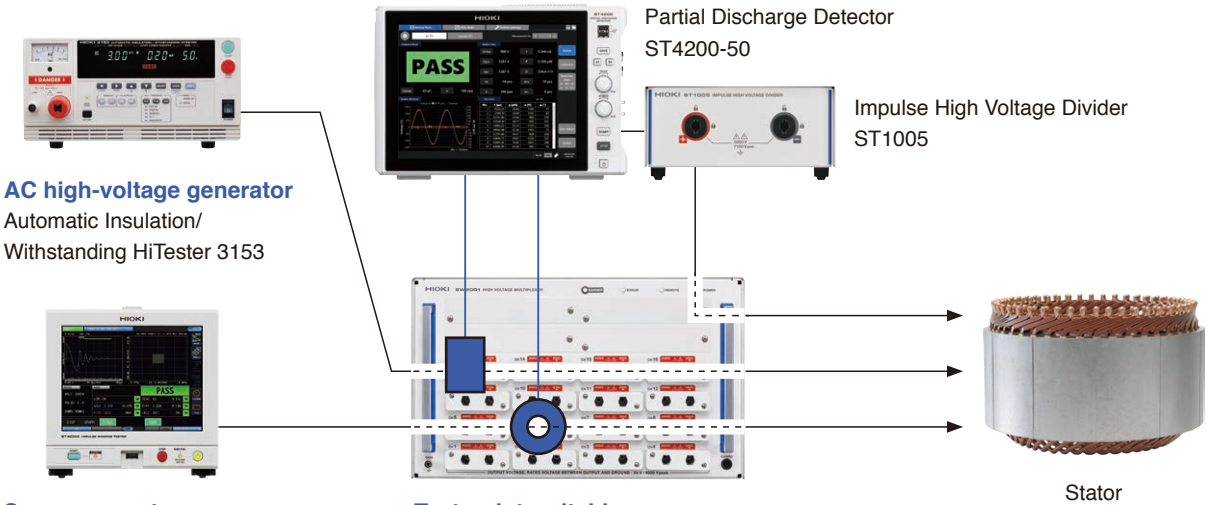
Complex wiring

Noise makes detection unstable

Solution

Integration with the SW2001 High Voltage Multiplexer

To minimize the impact of noise in complex testing environments, a partial discharge testing system with the ST4200-50 can utilize a multiplexer-based architecture, incorporating the SW2001. This design significantly reduces wiring complexity by consolidating multiple input signals, minimizing cable runs and interconnections. This approach effectively reduces potential noise sources such as electromagnetic interference (EMI), ground loops, and capacitive coupling, resulting in more accurate and reliable measurements.



Factory option accessories

Please specify at the time of order as the unit is embedded during the manufacturing process.

AC partial discharge detection
PD Sensor ST9200

Surge partial discharge detection
PD Sensor ST9201-50

Benefit 05

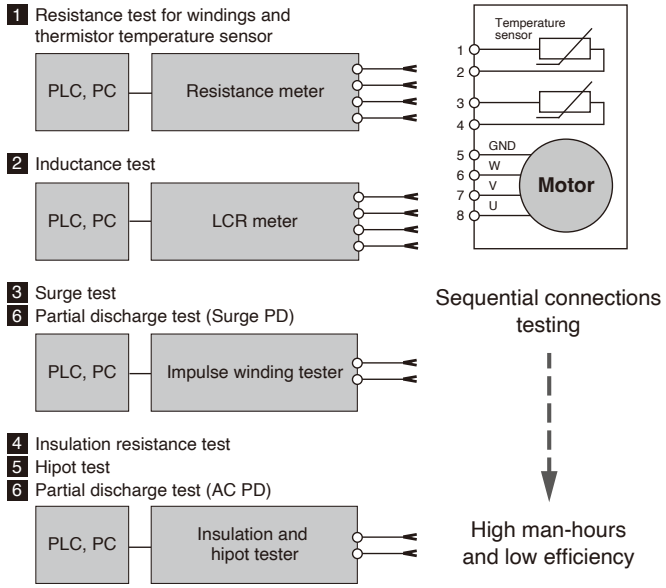
Boost productivity with one multiplexer handling six tests

Conventional motor test lines often require moving motors from one testing station to another between tests.
To enhance efficiency and optimize space utilization, modern lines consolidate multiple tests into a single location.

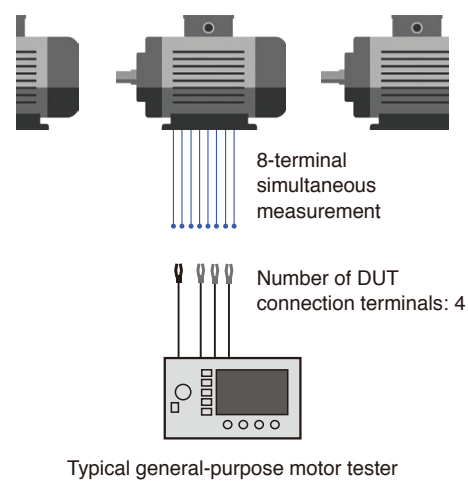
Challenges

- Traditional motor test systems often limit testing to one motor at a time, requiring frequent and time-consuming reconnections of test leads for multi-motor inspections.
- During finished motor testing, connections are required not only to four terminals (U, V, W, and ground), but also to the thermistor temperature sensor terminals.

Conventional motor test line



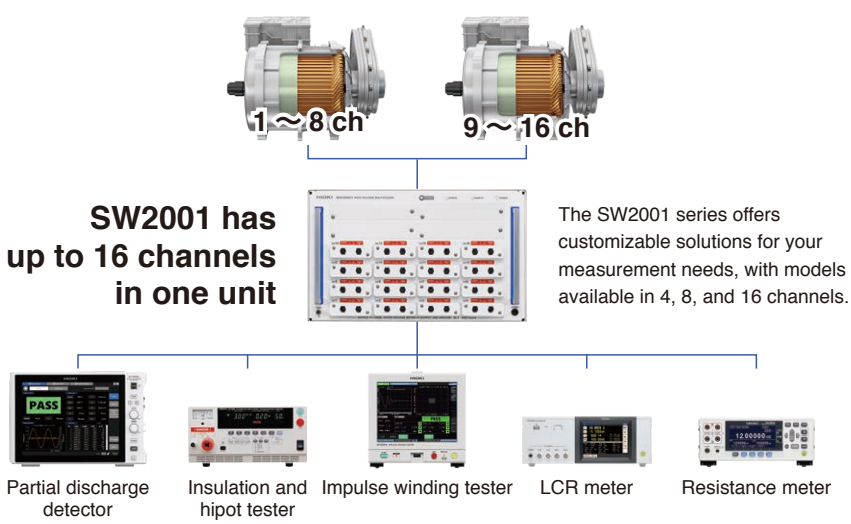
Modern motor test line



Solution

Select the number of channels based on your testing needs

Streamline your motor inspections by connecting multiple instruments for six different tests: resistance, inductance, surge, hipot, insulation resistance, and partial discharge (ACPD and surge PD). The multiplexer eliminates the need for frequent reconnections, in both serial motor test lines (conventional test lines) and parallel motor test lines. The SW2001 supports simultaneous testing of up to 3 three-phase motors with two built-in thermistor temperature sensors. *Partial discharge testing is only available for the stator.



Benefit 06

Enhance reliability with reduced production line stops, test accuracy, and reproduceable results

Combined motor/stator testing systems typically involve high-voltage testing such as the hipot test (applying several kV between coil and core) and low-voltage testing such as the winding resistance test. This necessitates switching measurement circuits between the test instrument and the device under test (DUT).

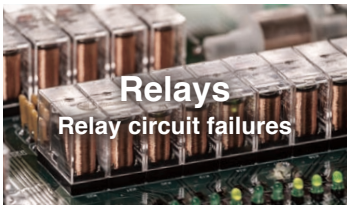
Challenges

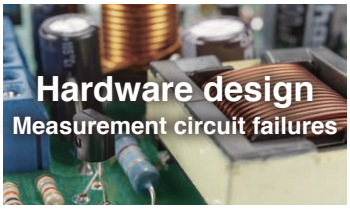
1. Impact of multiplexer design on measurement

- Poor insulation performance
  Designs that fail to meet the necessary insulation performance can cause measurement error in insulation resistance and hipot tests (occurring from humidity changes causing leakage current).
- Increase in relay contact resistance
  Typical relays experience an increase in contact resistance due to repeated use, leading to variations in measurement values.
- Hardware design issues
  Suboptimal design causes noise interference and internal discharge, reducing reliability in partial discharge detection and other motor inspections.

2. Sudden failure of measuring instruments

- Failure due to residual energy
  If a low-voltage measuring instrument, such as a resistance meter, is connected to the test object without sufficiently discharging the energy accumulated in the winding during high-voltage testing, the high voltage generated between windings may cause the low-voltage measuring instrument to fail.
- Frequent high-voltage relay replacement
  If the high-voltage relays used in the multiplexer do not fully meet the required voltage specifications, they rapidly deteriorate, leading to frequent relay replacements. This results in production line downtime and reduced productivity.

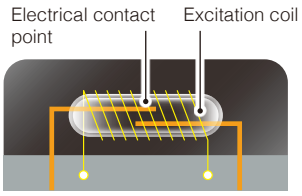




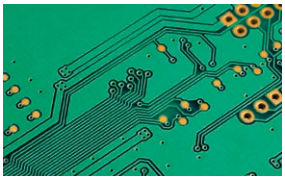
Solution

Highly reliable multiplexing design with extended operational lifespan: SW2001

The SW2001 employs highly durable high-voltage reed relays to reduce maintenance frequency. These relays operate by generating a magnetic field through current flow in an adjacent excitation coil, which switches the contacts inside a glass tube. The multiplexer's high-voltage reed relays with this operating mechanism enable safe switching in high-voltage circuits (with a maximum peak voltage of 8 kV) and help reduce the impact of leakage current on measurements.
In addition to adopting such reed relays, the SW2001 multiplexer utilizes advanced insulation design to ensure more accurate measurements. This includes optimizing the spatial insulation distance between relays, selecting appropriate insulation materials, and using high-voltage printed circuit boards to enhance insulation between relays and grounding. Furthermore, to minimize the risk of damage to the measuring instrument caused by energy accumulated in the measured winding, a protective discharge function is incorporated.



High-voltage reed relays


Optimization of insulation design

Guaranteed measurement performance and high durability

Effect on accuracy
- Insulation resistance measurement accuracy: 2% (1 M to 1 G)
- Magnitude of effect on AC PD measurement: 40 pC or less (during 3 kV application)

Durability
- Maximum allowable impulse current: 100 A peak
- Main circuit relay service life: 5 million or more cycles (reference value, not guaranteed)


SW2001

Reliable switching

The SW2001 facilitates safe and precise measurement for the diverse set of motor tests that demand a wide range of specs from high sensitivity for low voltages (motor winding resistance tests and inductance tests) to high-voltage resistance (max. 5 kV RMS for AC/DC hipot tests and max. 8 kV peak for surge tests).

Protective discharge function

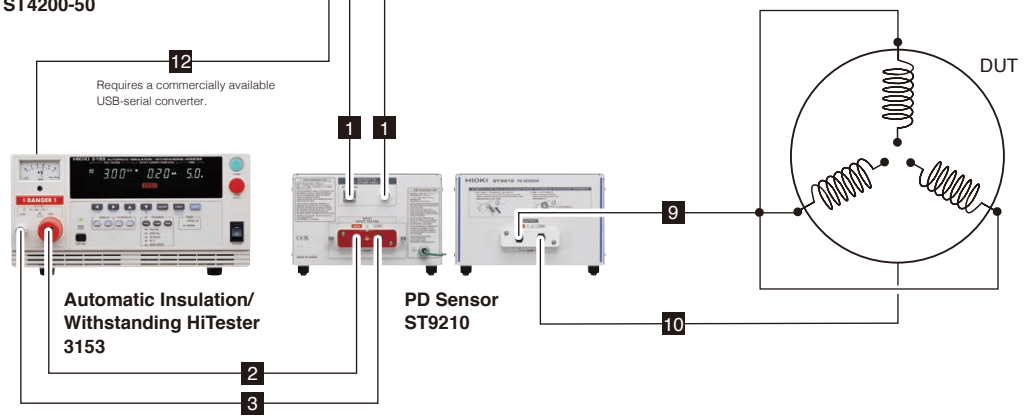
The protective discharge function can ground the output-side's main circuit so that it can discharge residual energy prior to closing the I/O relay's main circuit. This prevents damage to low-voltage meters from stored energy.

System configuration

AC PD testing

Partial Discharge Detector
ST4200-50

The ST4200-50 controls the 3153 to apply a test voltage ranging from 0.2 kV rms to 5 kV rms to the DUT. Partial discharge signals generated under the applied voltage are detected via the ST9210 and measured by the ST4200-50, with discharge magnitude evaluated in picocoulombs (pC). This configuration enables a standalone test system that performs the entire sequence—from voltage application through partial discharge measurement to pass/fail judgment—in a single setup.



Devices and accessories used

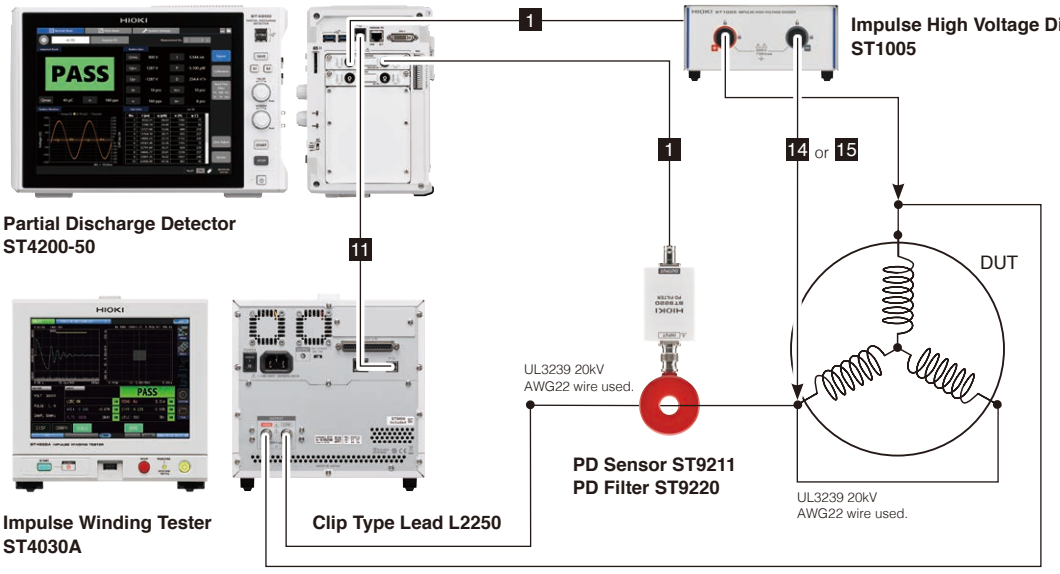
ST4200-50 (×1), **3153** (×1), **ST9210** (×1), **1 L9218** (×2), **2 L2270** (×1), **3 L2271** (×1), **9 Clip Type Lead (Red)** (×1), **10 Clip Type Lead (Black)** (×1), **12 L9637** (×1)

Note: PD calibrator required for PD test system calibration. Please purchase one separately.

Surge PD testing

The ST4200-50 controls the ST4030A to apply impulse voltages from 100 V to 4200 V to the DUT (10 µH to 100 mH).*1 The ST1005 monitors the voltage at the DUT terminals to capture discharge phenomena. Under the applied voltage, partial discharge signals are detected via the ST9211 and measured by the ST4200-50, with discharge magnitude evaluated as a dimensionless quantity. This configuration enables a standalone test system that performs the entire sequence—from voltage application through partial discharge measurement and pass/fail judgment—in a single setup.

*1: The actual voltage applied to the DUT terminals may differ from the voltage on the ST4030A.



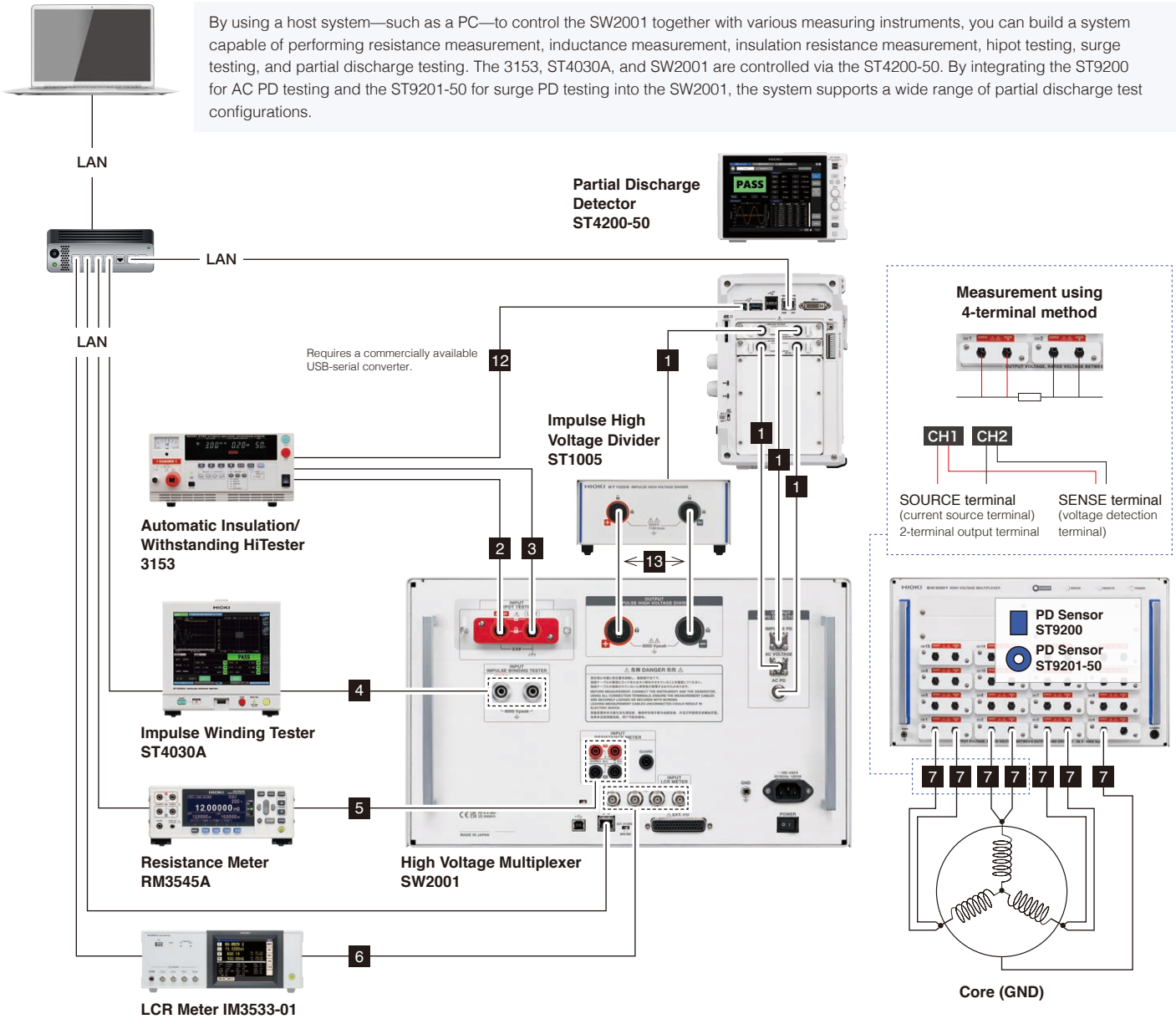
Devices and accessories used

ST4200-50 (×1), **ST4030A** (×1), **ST9211** (×1), **ST9220** (×1), **ST1005** (×1), **14 L1050-11** (×1), **L2250** (×1), **1 L9218** (×2*), **11 L1002** (×1)

*One unit included with ST1005.

Motor testing system with the SW2001 High Voltage Multiplexer

By using a host system—such as a PC—to control the SW2001 together with various measuring instruments, you can build a system capable of performing resistance measurement, inductance measurement, insulation resistance measurement, hipot testing, surge testing, and partial discharge testing. The 3153, ST4030A, and SW2001 are controlled via the ST4200-50. By integrating the ST9200 for AC PD testing and the ST9201-50 for surge PD testing into the SW2001, the system supports a wide range of partial discharge test configurations.



Connection cables & lead cables

CONNECTION CABLE L9218
For connecting the ST4200-50 and SW2001, ST9210, ST1005

CONNECTION CABLE L2270
Red (high): for connecting the 3153

CONNECTION CABLE L2271
Black (low): for connecting the 3153

CONNECTION CABLE L2255
Red and black set: for connecting the ST4030A

CONNECTION CABLE L2111
4-terminal: for connecting the RM3545A

CONNECTION CABLE L2005
4-terminal: for connecting the IM3533-01

UNTERMINATED LEAD CABLE L2265
Red, high-voltage connector to bare wire

UNTERMINATED LEAD CABLE L2266
Black, high-voltage connector to bare wire

9 Make your own using L2265

10 Make your own using L2266

USB CABLE (A-B) L1002

RS-232C CABLE L9637
Please use a commercially available USB-serial converter to connect the ST4200-50 to secondary instruments.

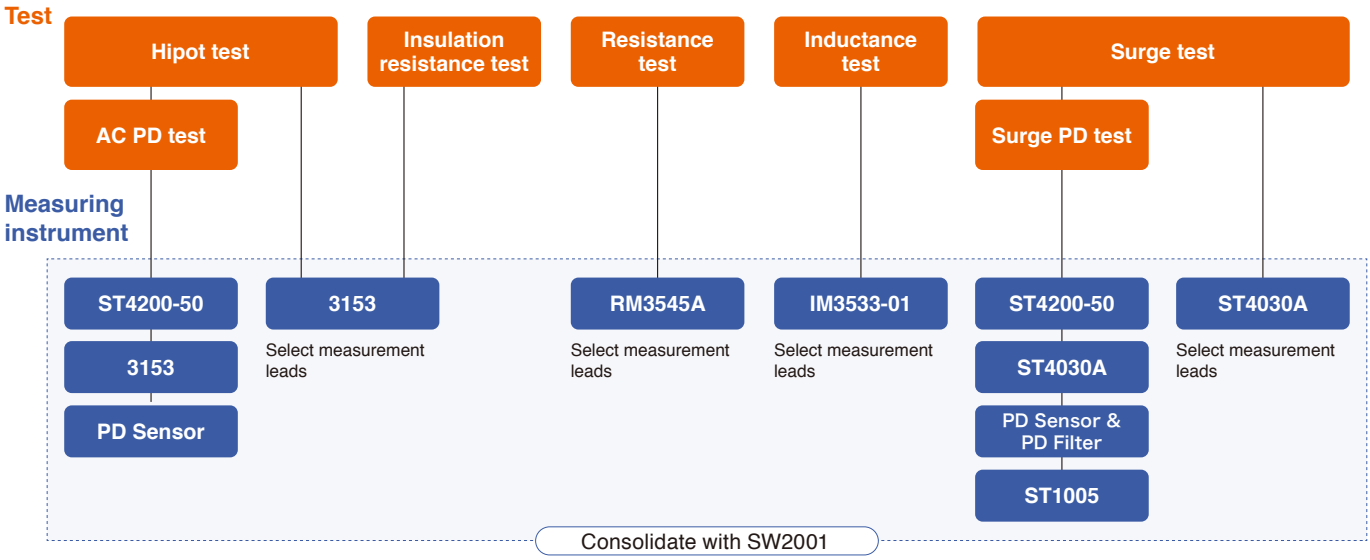
CONNECTION CABLE L1050-10
Red and black cable set: for connecting the ST1005 to SW2001

VOLTAGE CORD L1050-11
Red and black cable set: for ST1005

VOLTAGE CORD L1050-13
Red and black cable set: for ST1005

System configuration

Selection guide



Products required for AC PD testing and surge PD testing in standalone systems

AC PD testing	Surge PD testing	AC PD testing & Surge PD testing
		
Required products*1 **ST4200-50, 3153, ST9210, L2270, L2271, L2265*2, L2266*2, L9218 (×2), L9637*3**	**Required products*4** **ST4200-50, ST4030A, ST9211, ST9220, ST1005, L1050-11, L2250, L9218 (×1), L1002**	**Required products*1 *4** **ST4200-50, 3153, ST4030A, ST9210, ST9211, ST9220, ST1005, L2270, L2271, L1050-11, L2250, L2265*2, L2266*2, L9218 (×3), L9637*3, L1002**

*1: PD calibrator required for AC PD test system calibration. *2: Tip processing may be required for DUT connection.
*3: Please use a commercially available USB-serial converter to connect the ST4200-50 to 3153. *4: UL3239 20kV AWG22 wire is required for measurement.

AUTOMATIC INSULATION / WITHSTANDING HiTESTER 3153

All-in-one Model that Combines Withstand Voltage and Insulation Resistance (AC/DC)

AC hipot test: max. output voltage	5.00 kV AC/100 mA (500 VA)
DC hipot test: max. output voltage	5.00 kV DC/10 mA (50 VA)
Insulation resistance test: measurement range	0.100 MΩ to 9999 MΩ (50 V to 1200 V DC)

IMPULSE WINDING TESTER ST4030A

Diagnose the Insulation Quality and Deterioration of Rotor Windings while in Assembled State via Response Waveform Quantification

Applied voltage*1	100 V to 4200 V (Setting resolution: 10 V steps)
Maximum applied energy	Approx. 88 mJ
Testable inductance range	10 µH to 100 mH

*1: Depending on the inductance or capacitance of the test subject, the actual applied voltage may fall below the set voltage.

RESISTANCE METER RM3545A

New Heights in 100% Inspection. Market leading precision tests for testing every weld or connection on your production line.

Resistance range	1000 µΩ (resolution: 1 nΩ) to 1000 MΩ (resolution: 100 kΩ) , 13 range
Testing current	DC 1 A to 100 nA, when LP ON: 1 mA to 5 µA
Temperature measurement	Temperature Sensor (Z2001 [included accessories]): -10.0°C to 99.9°C Analog input (Ex: Infrared thermometer): DC 0 V to 2.0 V

The temperature compensation function converts the measured resistance value and current temperature into the resistance value at the reference temperature.

LCR METER IM3533

From R&D Applications to Windings, Coil and Transformer Manufacturing

Measurement frequency	1 mHz to 200 kHz
Measurement signal level	V mode, CV mode: 5 mV to 5 Vrms, 1 mV rms steps
	CC mode: 10 µA to 50 mArms, 10 µA rms steps

The cable length setting for measurements can be selected as either 0 m or 1 m. The IM3533-01 allows selection from 0 m, 1 m, 2 m, or 4 m.

Product name: **Partial Discharge Detector ST4200**

Model number (order code) **ST4200-50**

Included accessories: power cord × 1, startup guide × 1

Factory option accessory

SSD UNIT U8332
Internal drive, 256 GB

Please specify at the time of order as the unit is embedded during the manufacturing process.

Options and accessories

PD SENSOR ST9210
Sensor for AC partial discharge test

PD SENSOR ST9211
Sensor for surge partial discharge test

PD FILTER ST9220
Filter for surge partial discharge test

IMPULSE HIGH VOLTAGE DIVIDER ST1005
Divider for surge partial discharge test

USB CABLE (A-B) L1002

RS-232C CABLE L9637
Please use a commercially available USB-serial converter to connect the ST4200-50 to secondary instruments.

USB DRIVE (16 GB) Z4006
Use only storage media sold by Hioki.

SD MEMORY CARD (2GB) Z4001 (8GB) Z4003
Use only storage media sold by Hioki.

Option for ST9210

UNTERMINATED LEAD CABLE L2265	Red, 3 m
UNTERMINATED LEAD CABLE L2266	Black, 3 m
CONNECTION CABLE L2270	Red, 1.5 m
CONNECTION CABLE L2271	Black, 1.5 m
CONNECTION CABLE L9218	1.5 m

Option for ST1005

VOLTAGE CORD L1050-01	Red, black, 1.6 m
VOLTAGE CORD L1050-03	Red, black, 3 m
CONNECTION CABLE L1050-10	Red, black, 1.5 m
VOLTAGE CORD L1050-11	Red, black, 1.6 m
VOLTAGE CORD L1050-13	Red, black, 3 m
CONNECTION CABLE L9218	1.5 m

SW2001-16

Product name: **High Voltage Multiplexer SW2001**

Model number (order code)
4-channel model: **SW2001-04**
8-channel model: **SW2001-08**
16-channel model: **SW2001-16**

Included accessories: power cord × 1, startup guide × 1, support feet for installation × 4, EXT I/O connectors × 2

Factory option accessories

PD SENSOR ST9200
For AC partial discharge detection, embedded into the SW2001

PD SENSOR ST9201-50
For surge partial discharge detection, embedded into the SW2001

Please specify at the time of order, as each of the two sensors is embedded during manufacturing.

Options and accessories

CONNECTION CABLE L9218
For connecting the ST4200-50 and SW2001

CONNECTION CABLE L2270
Red (high): for connecting the 3153

CONNECTION CABLE L2271
Black (low): for connecting the 3153

CONNECTION CABLE L2255
Red and black set: for connecting the ST4030A

CONNECTION CABLE L2111
4-terminal: for connecting the RM3545A

CONNECTION CABLE L2005
4-terminal: for connecting the IM3533-01

UNTERMINATED LEAD CABLE L2265
Red, high-voltage connector to bare wire

USB CABLE (A-B) L1002

CONNECTION CABLE L1050-10
Red and black cable set: for connecting the ST1005 to SW2001

ST4200-50 specifications

Note: the terminology ‘surge’ can be replaced with ‘impulse’.

AC PD measurement

Detection method	Discharge measurement method using detection impedance and band pass filter Conforms to the detection method in IEC 60270.
Sampling rate	100 MS/s
Charge quantity measurement range	Test piece capacitance C: 200 pF ≤ C < 2 nF → Charge quantity measurement range Q: 10 pC ≤ Q ≤ 500 pC Test piece capacitance C: 2 nF ≤ C ≤ 10 nF → Charge quantity measurement range Q: 10 pC ≤ Q ≤ 2500 pC
Sampling time width (Tref)	100 ms to 1000 ms
Test frequency range (applied voltage)	45 Hz to 1.1 kHz
Measurement parameters	**[Normal mode]** Repeatedly occurring maximum PD intensity (Qmax), number of PD pulses generated (m, m+, m-), rate of PD pulse generation (n), voltage RMS value (Urms), voltage peak value (Up+, Up-), voltage peak-to-peak (Upp), average discharge current (I), discharge power (P), quadratic rate (D), PD pulse apparent charge (q), PD pulse phase angle (ϕ) **[PDIV mode]** (normal mode parameters plus the following) PD inception voltage (Ui), PD extinction voltage (Ue)

Impulse PD measurement

Detection method	Discharge current detection using CT and digital filters Conforms to the detection method in IEC 61934 Edition 2.0.
Sampling rate	200 MS/s
Sampling time width (Tref)	10 µs to 800 µs
Measurement parameters	**[Normal mode]** PD peak discharge magnitude (Qpk), pulse sequence PD count (m) **[PDIV mode]** (normal mode parameters plus the following) PD inception voltage (PDIV), repetitive PD inception voltage (RPDIV), repetitive PD extinction voltage (RPDEV), PD extinction voltage (PDEV) , repeating PD peak discharge magnitude (RQpk)

Specifications shared by AC PD and impulse PD measurement

Measurement modes	Normal mode: instrument applies a constant voltage and performs either single or continuous measurement. PDIV mode: instrument performs measurement while varying the applied voltage in compliance with standards.		
Input channels	AC VOLTAGE: voltage monitor signal (BNC terminal) AC PD: AC partial discharge current sensor signal (BNC terminal) IMPULSE PD: impulse partial discharge current sensor signal (BNC terminal)		
Graph display parameters	AC PD	**[Voltage waveform, PD pulse monitor]** X-axis: time; Y-axis: voltage or PD pulse (each with its own scale) **[Voltage and discharge quantity characteristics (Q = f (U) graph)]** X-axis: voltage RMS value; Y-axis: maximum repeating PD strength	
	Impulse PD	**[Current waveform, PD pulse monitor]** X-axis: time; Y-axis: current or PD pulse (each with its own scale) **[Impulse voltage or PD pulse trend with repeated impulse application]** X-axis: count; Y-axis: impulse voltage or PD pulse (each with its own scale)	
Judgment functionality	Judgment description	FAIL if: · Measurement result is greater than or equal to judgment value · Judgment value is negative and the measurement result is less than or equal to the judgment value Otherwise, PASS	
	Measurement parameters for which judgment can be performed	AC PD	**[Normal mode]** Maximum repeating PD strength (Qmax), PD pulse count (m, m+, m-), PD pulse incidence (n), average discharge current (I), discharge power (P), second-order rate (D) **[PDIV mode]** (normal mode parameters plus the following) PD inception voltage (Ui), PD extinction voltage (Ue)
		Impulse PD	**[Normal mode]** PD peak discharge magnitude (Qpk), pulse sequence PD count (m) **[PDIV mode]** (normal mode parameters plus the following) PD inception voltage (PDIV), repetitive PD inception voltage (RPDIV), repetitive PD extinction voltage (RPDEV), PD extinction voltage (PDEV), repeating PD peak discharge magnitude (RQpk)

Accuracy specifications

PD pulse phase angle measurement accuracy (Reference value as this is a specification for AC PD only)	Voltage input frequency: 45 Hz ≤ f ≤ 100 Hz → PD pulse phase angle error (°): ±0.4 Voltage input frequency: 100 Hz < f ≤ 400 Hz → PD pulse phase angle error (°): ±1.0 Voltage input frequency: 400 Hz < f ≤ 1 kHz → PD pulse phase angle error (°): ±2.5
Effects of radiative radio frequency electromagnetic fields	50 pC or less (at 10 V/m)
Effects of conductive radio frequency electromagnetic fields	50 pC or less (at 10 V)
Effects of pulse noise superposed on power supply	50 pC or less (with pulse noise of 1 kV and pulse width of 50 ns)

High-voltage source control

Control description	Cooperative control of withstanding voltage tester and impulse winding tester used as high-voltage generators for partial discharge testing
Compatible instruments (February 2025)	Automatic Insulation/Withstanding HiTester 3153, Impulse Winding Tester ST4030A, etc.

General specifications

Location of use	Indoors, Level 2 pollution, maximum elevation of 2000 m
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Standards compliance	Safety: IEC 61010; EMC: EN 61326
Power supply	Rated supply voltage: 100 to 240 V AC; rated power: 300 VA
External dimensions	Approx. 353 mm (13.9 in.) W × 235 mm (9.25 in.) H × 154.8 mm (6.09 in.) D (excluding protruding parts)
Weight	Approx. 7.3 kg (257.5 oz.) (with U8332); approx. 7.1 kg (250.4 oz.) (without U8332)

Data storage functionality

Storage destination	SD memory card	Z4001 (2 GB), Z4003 (8 GB)
	USB drive	Z4006 (16 GB)
	SSD	U8332 SSD Unit (256 GB)
File system	FAT32, NTFS, exFAT	
File name	Alphanumeric, Japanese, and Chinese input	
Treatment of identical file names	Saved after appending serial numbering to end	
Automatic saving	The following are automatically saved after measurements.	
	· Data series (impulse PD and AC PD) · AC PD Q = f (U) graph image · SBS graph image	
Manual saving	The following are saved by pressing the SAVE key. · Data Series (Impulse PD, AC PD) · Q=f(U) graph image of AC PD · AC PD Realtime waveform image · Graph images of AC PD analysis functions · Impulse PD Realtime waveform image · Tables · SBS graph image	
Saving format	Tables	.TBL, .TB1
	Displayed graph image	.BMP, .PNG, .JPEG
	Measurement data	.CSV *Saves in the fixed format for each mode
SAVE key operation	When the SAVE key is pressed, data is saved to the previously set save-destination using the previously set filename in accordance with the save settings.	

Data load functionality

Storage media	SD memory card	Z4001 (2 GB), Z4003 (8 GB)
	USB drive	Z4006 (16 GB)
	SSD	U8332 SSD Unit (256 GB)
Loaded data format	Measurement data (.CSV), Tables (.TBL, .TB1)	

Interfaces

Interfaces	LAN, USB, RS-232C* (please use a commercially available USB-serial conversion cable) EXT. I/O (measurement start, measurement cancel, overall judgment PASS/ FAIL) *Connect to secondary instruments (e.g., Automatic Insulation/Withstanding HiTester 3153)

1 Built-in SSD
specified at time of order

2 USB 2.0 connector × 4

3 USB 3.0 connector × 2

4 LAN connector (100Base-TX)

5 DVI-I terminal

6 SD memory card slot
Be sure to use Hioki's approved storage media accessories. The instrument may not be able to save or load data properly if other media are used.

7 External control terminals

8 Measurement signal input terminal

Test data and waveform images can be saved on the ST4200-50's internal storage or on external media.
This data can be used to validate test results.

ST9210 specifications

Maximum input voltage	AC 5 kV rms, DC 5 kV, 7.07 kV peak
Maximum rated line-to-ground voltage	No measurement category: AC 5 kV rms, DC 5 kV, 7.07 kV peak, Anticipated transient overvoltage 0 V
Internal blocking coil inductance	14 mH ±20%
Internal coupling capacitor capacitance	1.33 nF ±10%
Measurable DUT capacitance range	10 nF or less
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Standards	Safety：EN 61010
Dimensions	Approx. 215W mm × 132H mm × 360D mm (8.46W in. × 5.20H in. × 14.17D in.)
Weight	Approx. 3.57 kg (126 oz.)
Included accessories	Instruction manual, Operating precautions

ST1005 specifications

Maximum rated common-mode voltage	5000 V rms, ±7100 V peak (Within the frequency derating curve)
Maximum rated line-to-ground voltage	No measurement category: AC/DC 5000 V, ±7100 V peak, Anticipated transient overvoltage: 0 V
Measurement accuracy	±0.3%: DC, ±0.3%: 50/60 Hz
Measurement frequency	DC to 10 MHz (-3 dB typ.)
Voltage dividing ratio	1000 : 1
Common-mode voltage rejection ratio (CMRR)	90 dB (typ.): 50/60 Hz
Operating temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Standards	Safety: EN 61010, EMC: EN 61326 Class A
Power supply	Rated supply voltage: AC 100 V to 240 V (50/60 Hz)
Dimensions	Approx. 195.0W mm × 83.2H mm × 346D mm (7.68W in. × 3.28H in. × 13.62D in.)
Weight	Approx. 2.2 kg (77.6 oz.)
Compatible instruments (October 2025)	ST4200-50 Partial Discharge Detector, SW2001 High Voltage Multiplexer
Included accessories	L9218 Connection Cable（1.5 m）, Power cord, Instruction manual, Operating precautions

SW2001 specifications

Basic specifications

Input channels	2 channels of high-voltage 2-terminal input: for insulation and hipot tester, surge tester 2 channels of low-voltage 4-terminal input: for LCR meter, resistance meter
Output channels	CH1 to CH4 (SW2001-04), CH1 to CH8 (SW2001-08), CH1 to CH16 (SW2001-16) SOURCE terminal (or 2-terminal output terminals) and SENSE terminal for each channel
Partial discharge sensor output	AC voltage monitoring, AC partial discharge current, impulse partial discharge current (Current output is available only when equipped with current sensor ST9200 or ST9201-50, which are options that must be specified when ordering.) (Each is output through a BNC terminal.)
Impulse high voltage divider output	Impulse high voltage divider output (banana jacks (special shape))
Maximum input voltage	· High-voltage two-terminal input HIPOT (HIPOT TESTER terminal): 5 kV AC rms, 5 kV DC, 7.07 kV peak · High-voltage two-terminal input IMPULSE (IMPULSE WINDING TESTER terminal): 8 kV peak (impulse) · Low-voltage four-terminal input LCR and RESISTANCE: 30 V AC rms, 60 V DC, 42.4 V peak
Rated output voltage	· Output channel: 5 kV AC rms, 5 kV DC, 8 kV peak (impulse) · Impulse high voltage divider output (IMPULSE HIGH VOLTAGE DIVIDER output terminal): 8 kV peak (impulse)
Maximum rated terminal-to-ground voltage	· High-voltage two-terminal input HIPOT (HIPOT TESTER terminal): 5 kV AC rms, 5 kV DC, 7.07 kV peak · High-voltage two-terminal input IMPULSE (IMPULSE WINDING TESTER terminal): 8 kV peak (impulse) · Low-voltage four-terminal input LCR and RESISTANCE: 30 V AC rms, 60 V DC, 42.4 V peak · Output channel: 5 kV AC rms, 5 kV DC, 8 kV peak (impulse) · Impulse high voltage divider output (IMPULSE HIGH VOLTAGE DIVIDER output terminal): 8 kV peak (impulse)
Maximum allowable impulse current	100 A peak
Primary circuit relay service life	Open/close cycles: 5 million or more (reference value, not guaranteed)
Effects on measurement accuracy (add to measurement accuracy)	· LCR measurement: measurement frequency: DC less than 10 kHz (±3%), 10 kHz to 100 kHz (±5%), measurement impedance 1 MΩ or more is ±5% · DC resistance measurement: ±5% (less than 1 Ω), ±2% (1 Ω or more) · Insulation resistance measurement: 1 MΩ or more to less than 1 GΩ (±2%), 1 GΩ or more to less than 10 GΩ (±5%) · Impulse voltage: No provisions on effect, (internal wiring impedance up to 150 μH), Considering parasitic capacitance of 500 pF · Impulse high voltage divider measured value: ±10% · No-load leakage current: At 1.5 mA or less and 5 kV AC (23°C, 50% RH)
Magnitude of effect on AC PD measurement (reference value, not guaranteed)	Under conditions of ambient temperature at 23°C (73°F), 50% RH and measurement probe open (no capacitive load): With applied voltage of 3 kV, 40 pC or less With applied voltage of 4 kV, 100 pC or less
AC PD frequency characteristics when combined with the ST4200-50 (reference values)	Flat area: 200 kHz to 2 MHz 30 kHz attenuation: 16 dB

Function specifications

Channel switching	Input and output channels are connected to the bus specified by EXT. I/O or communications commands.
Interlock	Opens all relays unconditionally and at top priority based on EXT. I/O
Channel delay	User can set a delay time between completion of all relay switching and outputting of the switched signals. Delay time: 0.000 to 9.999 s (default setting: 0.000 s)
Settings backup	Backs up communications settings to nonvolatile memory
Panel function	Saves channel switching settings to nonvolatile memory (up to 1000)
Communications settings mode switching	Selects the LAN communications settings with a slide switch between the fixed-settings mode (DFLT) and user-configured mode (USER) Selection is applied when the instrument is powered on.
Protective discharge function	Grounds the output-side's main circuit prior to closing the I/O relay's main circuit Discharge time (standby time between grounding the output-side's main circuit and closing the input-side's main circuit) setting: 0.000 to 1.000 s (default value: 0.000 s)
Accelerated discharge function	Reduces the discharge time after performing insulation or hipot testing by using an external discharge resistor to discharge the residual charge held by the circuit under test (Two output channels are used to connect the discharge resistor.)

General specifications

Location of use	Indoors, Level 2 pollution, maximum elevation of 2000 m
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Standard compliance	Safety: IEC 61010; EMC: EN 61326
Interfaces	LAN, USB, EXT. I/O
Power supply	Rated supply voltage: 100 to 240 V AC; rated power: 120 VA
External dimensions	Approx. 439.2 mm (17.29 in.) W × 265.9 mm (10.47 in.) H × 770 mm (30.31 in.) D (excluding protruding parts)
Weight	SW2001-04: approx. 20.5 kg (723.1 oz.); SW2001-08: approx. 22.5 kg (793.7 oz.); SW2001-16: approx. 27.0 kg (952.4 oz.); (All figures do not include weight from the ST9200/ST9201-05 factory options.) With ST9200, add 1.2 kg (42.3 oz.); with ST9201-05, add 324 g (11.4 oz.).

HIOKI

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