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JYC Tan Delta Tester 10KV/12kV



Operation Manual





Please read this Manual carefully for safety and correctness operation;
This Company shall not be liable for any damage or losses other than the instrument itself;
The patent right and software copyright of this Instrument shall only belong to the Company, and any infringement act will be investigated

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1. Characteristics and Performance

JYC Automatic High-Precision Tan Delta Tester is designed for high-interference field testing and precision laboratory measurements of dissipation factor. This all-in-one instrument integrates a capacitance bridge, a variable-frequency power source, a step-up transformer, and a reference capacitor. By utilizing frequency-domain anti-interference technology and Digital Fourier Transform (DFT) filtering, the system provides fully automated and intelligent measurements with exceptional data stability, even in environments with severe electromagnetic interference. Test results are presented on a large LCD screen and can be exported via the integrated micro-printer.

1.1 Main Technical Indicators

Item	Specification
Accuracy	Cx: $\pm(1\% \text{ regarding } + 2\text{pF})$ Tg δ : $\pm(1\% \text{ regarding } + 0.00040)$
Interference Rejection	Frequency conversion technology; maintains rated accuracy under up to 200% power frequency interference.
Capacitance Range	Internal high voltage: 3pF–60,000pF/10kV; 60pF–1 μ F/0.5kV External high voltage: 3pF–1.5 μ F/10kV; 60pF–30 μ F/0.5kV
Maximum Resolution	0.001pF, 4 significant digits
tan δ Range	Unlimited; resolution 0.001%; Automatic identification of capacitive, inductive, and resistive specimens.
Test Current Range	5 μ A – 5A
Internal High Voltage Output	Voltage range: 0.5~10kV; Max output current: 200mA
Voltage Regulation	Continuous smooth adjustment
Voltage Accuracy	$\pm(1.5\% \text{ reading} + 10\text{V})$
Voltage Resolution	1V
Test Frequency	Single frequency 45/50/55/60/65 Hz; Dual frequency: 45/55Hz, 55/65Hz, 47.5/52.5 Hz
Frequency Accuracy	$\pm 0.01\text{Hz}$
External High Voltage Support	UST Mode: Max. 5A, 40–70 Hz; GST Mode: Max. 10kV/5A, 40–70 Hz
CVT Excitation Source (LV Output)	Output voltage: 3–50V; Output current: 3–30A
Measurement Duration	Approx. 15s (mode dependent)
Input Power Supply	180V–270VAC, 50Hz/60 Hz $\pm 1\%$ (Grid or Generator compatible)
Communication Interface	Standard RS232 port
Data Storage	100 internal memory groups
Printer	Built-in micro thermal printer
Operation Temperature	-10 $^{\circ}$ C–50 $^{\circ}$ C
Relative Humidity	<90% (non-condensing)



1.2 Main Function Characteristics

1.2.1 Frequency Conversion Anti-interference

Utilizing advanced frequency conversion technology, the instrument maintains high measurement accuracy and exceptional data stability even in environments with 200% power frequency interference. It is ideally suited for on-site Tan Delta testing in high-voltage substations with severe electromagnetic interference.

1.2.2 High-precision Measurement

Utilizing digital waveform analysis and automated bridge self-calibration, the instrument works in conjunction with a high-precision three-terminal reference capacitor to achieve superior measurement accuracy. The input impedance for all measurement ranges is maintained below 2Ω , effectively eliminating the errors caused by stray capacitance of the test cables.

1.2.3 Multi-level Safety Protection for Personnel and Equipment

High Voltage Protection: In the event of a short circuit, breakdown, or HV current fluctuations, the instrument will immediately terminate the output via a high-speed short-circuiting mechanism.

Low Voltage Protection: Protection is automatically triggered in cases of incorrect 380V connection, power supply fluctuations, or sudden power loss, preventing any overvoltage conditions.

Grounding Protection: The instrument monitors grounding integrity. If improper grounding causes the chassis to carry hazardous voltage, the system will initiate a safety lockout.

CVT Protection: Four programmable limits for HV/LV voltage and current prevent equipment damage. The excitation voltage is interlocked with menu selection to prevent accidental output. No 10kV high voltage is generated during CVT excitation mode.

Operational Safety Features: Dual-stage power switches, real-time voltage/current monitoring, and multi-step key confirmation. Terminals are clearly labeled for HV/LV. Features include soft-start voltage ramping, emergency quick-discharge, and audible/visual alarms.

Anti-Capacitance Rise: To counter the voltage rise effect when testing large capacitance loads, the instrument automatically tracks and stabilizes the output to maintain a constant test voltage.

Shock Resistance: The instrument features a ruggedized design capable of withstanding severe vibration and mechanical shocks during long-distance transportation.

Heavy-Duty HV Cable: Uses high-voltage insulated leads designed for rugged field use, suitable for dragging across rough terrain without insulation compromise.

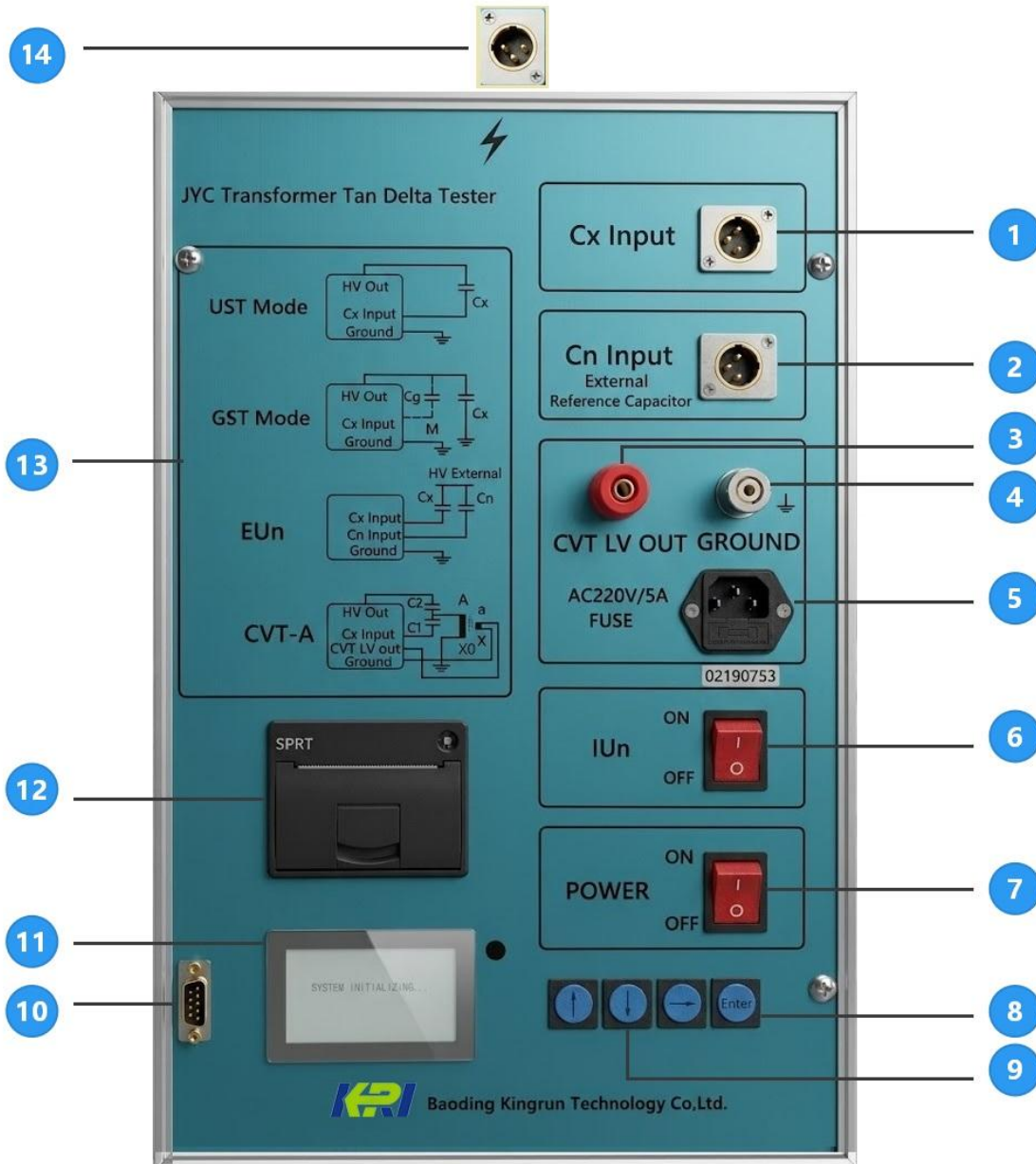
1.2.4 Powerful Functions

(1) **Integrated All-in-One Design:** Supports multiple operating modes including UST/GST, Internal/External Standard Capacitor, and Internal/External HV Source. This integrated structure allows for all conventional Tan Delta tests without the need for any external auxiliary equipment.

- (2) **Intelligent Measurement & Display:** Features a backlit LCD with menu-driven operation. The system automatically identifies capacitive, inductive, or resistive test objects. An integrated micro-printer is included for immediate data output.
- (3) **Extended Measurement Capabilities:** Equipped with an external standard capacitor interface. It can be connected to an oil cell for precision insulating oil testing, solid material electrodes for insulation material testing, or an external HV standard capacitor for high-voltage Tan Delta measurements.
- (4) **Power Supply Adaptability:** Automatically identifies 50Hz/60Hz systems and supports generator power. Accurate measurements are maintained even with significant frequency fluctuations.
- (5) **Built-in Circuit Models:** Supports both Series and Parallel equivalent circuit models to facilitate instrument calibration and verification.
- (6) **Advanced CVT Self-Excitation:** Single-connection measurement for C1 and C2 simultaneously. The system automatically compensates for busbar grounding and potential divider effects. No additional accessories or cable changes are required. The HV excitation lead is designed for rugged field use.
- (7) **GST Low-Voltage Guarding:** Features a Guard (shielding) function for GST mode. This allows for non-disconnecting 10kV Tan Delta measurement of C11 even when the 220kV CVT busbar is grounded.
- (8) **External Source Identification:** Automatically recognizes external HV source frequencies from 40Hz to 70Hz. Supports power frequency, variable frequency, and series resonant power sources for high-capacity, high-voltage testing.
- (9) **Intuitive User Interface:** Features a graphical menu on a large backlit LCD for clear visibility, with real-time monitoring of test current and voltage.
- (10) **Data Management:** Includes a real-time calendar/clock and internal memory for up to **100 test records**.
- (11) Equipped with a standard computer interface for data export and analysis.



1.2 Front Panel Function



1	Cx: Test Object Input (10 μ A~5A)	8	Function Key
2	Cn: Reference Capacitor Input (10 μ A~5A)	9	Enter Key
3	External self-excitation output (3~50V, 3~30A)	10	RS232 interface
4	Ground Terminal	11	LCD Screen
5	Power Input (180V~270V 50Hz/60Hz)	12	Built-in Printer
6	Internal Excitation Power Switch (IUn)	13	UST/GST/Eun/CVT-A Diagram
7	Main Power Switch	14	HV Output (0.5-12kV)

Standard Accessories



2. Instructions for Panel

2.1 High Voltage Output Socket - on the side of tester (0.5-12kV, 200mA at the Maximum)

Mounted on the front panel, equipped with a protective sliding cover.

Function:

1. Internal HV output source;
2. Measurement of test current in **GST (Grounded System Test)** mode;
3. Connection point for the HV terminal of the internal reference capacitor.



Pin Assignment: Pin 1 of the socket connects to the HV core wire (Red Clamp); Pins 2 & 3 connect to the HV shield (Black Clamp). UST Mode: Both the core wire (Red) and the shield (Black) can function as the energizing leads. GST Mode: Only the core wire must be used to energize the high-voltage terminal of the specimen. Guarding: If the specimen's HV end features a guard electrode (e.g., a grading ring), connect it to the HV shield; otherwise, leave the HV shield floating.

Precautions:

- (1) The instrument uses universal measurement cables; it is highly recommended to use the dedicated HV lead for this socket. **DANGER:** The HV socket and leads carry **lethal voltages**. It is strictly forbidden to touch the socket, cables, clamps, or any energized parts of the specimen! Connect leads only after verifying the power is OFF, and maintain a safe distance during measurement.
- (2) When verifying **GST accuracy** using a standard Tan Delta calibrator (or reference capacitor), a **fully shielded plug** must be used to connect the specimen. Exposed core wires will introduce measurement errors.
- (3) Ensure a **solid, low-resistance connection** between the HV lead and the specimen's HV terminal. Poor contact may lead to measurement errors, data instability, or trigger instrument protection.

- (4) When **disconnecting leads** in high-interference environments, ensure the cable remains **grounded** during the process to prevent **inductive electric shock**.

2.2 Cx Input (10 μ A-5A)



Function: Inputs the specimen current during UST (Ungrounded System Test) mode.

Wiring method: Pin Assignment: Pin 1 connects to the measurement core wire (Red Clamp); Pins 2 & 3 connect to the shield (Black Clamp). UST Mode: Connect the core wire (Red) to the Low-Voltage (LV) signal terminal of the specimen. If the specimen has a guard electrode at the LV end, connect it to the shield; otherwise, leave the shield floating.

Precautions:

- (1) **DO NOT** unplug any connectors during measurement. This prevents the specimen current from flowing through the operator to the ground, which poses a **lethal shock hazard**.
- (2) When verifying UST accuracy using a standard Tan Delta calibrator (or reference capacitor), ensure the specimen is connected via a **fully shielded plug**. Any exposed core wire will introduce measurement errors.
- (3) Ensure a **solid, low-resistance connection** between the test lead and the specimen's LV terminal. Poor contact may lead to measurement errors, data instability, or trigger instrument protection.
- (4) When **disconnecting leads** in high-interference environments, maintain the cable's ground connection until it is fully detached to prevent **inductive electric shock**.

2.3 Cn Input (10 μ A-5A)



Function: Inputs the current from an external reference capacitor.

Wiring method: Similar to the Cx socket, with the following distinctions:

- (1) When using an external reference capacitor, a **fully shielded plug** must be used. This configuration is typically employed with **High-Voltage (HV) grade reference capacitors** for high-voltage Tan Delta measurements.
- (2) Select "**Ext. Standard**" (or **External Cn**) mode from the operation menu.
- (3) **Input the C and tan δ parameters** of the external reference capacitor into the instrument to achieve absolute Tan Delta measurements of the specimen (Cx). Theoretically, any capacitor with known parameters can serve as a reference; however, a certified **Standard Capacitor** provides superior long-term stability and precision.
- (4) Regardless of whether the specimen is measured in **UST or GST mode**, the reference capacitor (Cn) must **always** be connected in **UST mode**.

2.4 CVT Excitation Output (3-50V, 3-30A)



Function: Outputs the **variable-frequency excitation power** required for CVT measurements via this socket and the grounding terminal.

CVT Precautions:

- (1) Due to the high output current, the **CVT secondary windings** must be connected using the instrument's dedicated **low-resistance leads**. Poor contact or high contact resistance will compromise measurement accuracy.

- (2) Select the appropriate **voltage and current protection limits** from the menu based on the CVT's rated capacity.
- (3) When the CVT measurement starts, a **2–5V probing voltage** is initially outputted. If an external wiring error is detected, the instrument will automatically shut down. To verify instrument functionality, you can measure this probing voltage as a diagnostic step.
- (4) This output is **disabled** when UST or GST modes are selected.

2.5 Grounding Terminal



This terminal is internally bonded to the chassis and the power socket's ground. If the instrument's HV cables feature a shielded ground, the ground plug should be inserted into this jack.

Precautions:

- (1) Despite the built-in grounding protection, the instrument **must be reliably and independently grounded** for all measurement types to ensure operator safety.
- (2) Ensure a **solid, low-resistance ground connection**. Inspect the grounding conductor for paint or corrosion, and scrape to bare metal if necessary. Poor grounding can lead to measurement errors, data instability, or **hazardous conditions**.

2.6 Power Supply (180V-270V 50Hz/60Hz)



Precautions:

- (1) The instrument features a **rapid power-loss protection** system. In the event of a sudden low-voltage power failure, the HV output is immediately short-circuited and terminated. Ensure that all power connections (sockets, switches, etc.) are secure; any power interruption exceeding **a few milliseconds** will trigger this protection.
- (2) If the input voltage exceeds 270V (e.g., accidental 380V connection), the overvoltage protection will trigger and cut off internal power. In this state, only the main power indicator will remain lit, while the screen remains blank. If this occurs, verify the power source before restarting.
- (3) If the input voltage is too low to reach the set test voltage, an external **voltage regulator** may be used.
- (4) The instrument automatically adapts to both **50Hz and 60Hz** power supply frequencies.
- (5) When using a generator, frequency fluctuations can be significant. Since interference is typically absent in such environments, the **"Fixed Frequency"** mode can be selected to eliminate the effects of unstable supply frequency.

2.7 Fuse Base

The fuse base is integrated with the low voltage power socket. The specification of the fuse is 5A/250V and the dimension is $\phi 5 \times 20$ mm.


Precautions:

Always replace with a fuse of the **same specification**. If the replacement fuse blows immediately, the instrument may have an internal fault. Please contact the manufacturer for technical support.

2.8 IUn (Internal HV Enable Switch)



Function: This acts as the **master safety switch** for the built-in high-voltage system and the CVT excitation system. When this switch is **OFF**, the instrument automatically defaults to **External HV Measurement mode**. This switch is interlocked with the main power supply.

Precautions: 

- (1) Enable this switch only when using the internal HV source. Once measurement starts, the instrument will **automatically ramp the voltage** up or down, accompanied by **audible and visual alarms**. **DANGER:** High voltage is present while the alarm is active!
- (2) In an emergency, immediately turn this switch **OFF** or shut down the main power switch.
- (3) If a protection error occurs, troubleshoot the issue before restarting the instrument.

2.9 Power Switch



Upon toggling the **Main Power Switch**, the instrument name and serial number will be displayed, followed by the measurement menu after a few seconds. Turning off this switch simultaneously de-energizes the internal high-voltage system. In case of emergency, shut off this switch immediately.

2.10 Keypad Controls




- (1) Use the "→" key to move the cursor, and the "↑" and "↓" keys to modify the selected value. The "**Enter**" key is used to confirm settings or terminate a test. Please refer to the specific model's manual for detailed key functions.
- (2) During the measurement process, pressing **any key** will immediately terminate the test.

2.11 LCD Display

The screen displays menus, measurement results, and troubleshooting messages. **Caution:** Avoid prolonged exposure to direct sunlight and prevent heavy pressure on the screen surface.

2.12 Printer

Automatic Printing: When enabled in the menu, the instrument automatically prints results upon test completion. This allows the operator to de-energize the system from a safe distance, enhancing operational safety.

Manual printing: in the result interface, select the print icon , press On button for manual printing.

Paper Replacement: This is a thermal printer using 58mm wide thermal paper. Note: Thermal printers do not require a color ribbon. To change paper: open the paper compartment cover, insert the paper roll (ensuring a small leader strip remains outside), and snap the cover closed.

2.13 Communication Interface

Function: Standard RS232 interface for connection to a PC or laptop serial port. Ensure that both the instrument and the PC are configured with the same Baud rate and communication address.

Communication Protocol: The instrument communicates with the PC via a dedicated protocol, enabling real-time control, configuration, measurement, and data management. Notice: Remote operation should only be performed within line-of-sight. Ensure all personnel are at a safe distance before initiating a measurement.

3. Operation Instructions

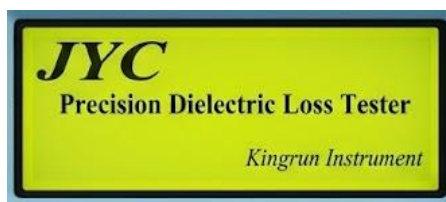
3.1 Contrast Adjustment

The LCD contrast is factory-calibrated. If adjustment is required, use the following procedure:

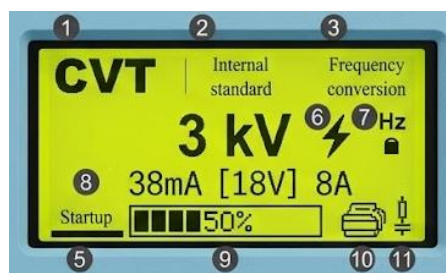
Press and hold the \uparrow or \downarrow key while toggling the Main Power Switch to ON. Use the \uparrow or \downarrow keys to adjust the contrast to the desired level, then press the "Enter" key to save and exit.


3.2 Enter Menu

After toggling the Main Power Switch, the startup screen appears followed by the production date. The system then automatically enters the **Main Measurement Menu**.



To use the internal HV source, ensure the **Internal HV Enable Switch** is turned ON.



Once enabled, a **high-voltage ready icon**  (marked at ⑥) will appear after a few seconds. In this state, the cursor can navigate through positions ① to ⑤.

If the Internal HV Enable switch is OFF, position ③ will display "EXT. HV" (External High Voltage), and the cursor will only be accessible at ①, ②, and ⑤.

3.3 Selection of Wiring Mode

With the cursor at ①, use the \uparrow/\downarrow keys to select the test mode: UST (Ungrounded), GST (Grounded), CVT Self-Excitation, or Ratio (Transformation Ratio).

3.4 Select Reference Capacitor

When using the External Standard mode (typically for high-voltage dielectric loss tests), you must input the external capacitor's parameters. Press and hold the "Enter" key at this position until the parameter screen appears.



External standard capacitor and dielectric loss can be set. Cn adopts scientific counting method, such as $5.000e1=5.000 \times 10^1=50.00$ and $1.000e2=1.000 \times 10^2=100.0$, and the range is $0.000e0-9.999e5$ (namely 0-999900pF).

The setting range of tgδ is 0 to $\pm 9.999\%$.

A "*" symbol in the corner indicates factory-locked parameters. **DO NOT** modify these settings, as they are critical factory calibration data; unauthorized changes will severely compromise accuracy.

3.5 Selection of Test Frequency

3.5.1 Default Frequency of Startup

The cursor is at ③ and "Frequency Conversion" is displayed, representing 45/55Hz automatic frequency conversion. The instrument automatically uses 45Hz and 55Hz to measure once respectively, and then the data at 50Hz without interference is calculated. Automatic default mode for startup is this mode, which is recommended to use.

3.5.2 Selection of More Frequencies

The cursor is at ③ and press "Enter" button for more than 1s to switch to the full frequency selection and then press \uparrow/\downarrow button to display "45Hz / 50Hz / 55Hz / 60Hz / 65Hz / 50 ± 5 Hz / 60 ± 5 Hz / 50 ± 2.5 Hz" in cycle:

"50Hz" : it is power frequency measurement; this setting cannot resist interference, which shall be adopted during measurement in the lab or calibration.

"45/55/60/65Hz" : it is single frequency measurement, which is adopted during the research into the change of dielectric loss under different frequencies.

" 50 ± 5 Hz" : it is 45/55Hz automatic frequency conversion, which is suitable for measurement under power frequency interference in 50Hz power grid.

" 60 ± 5 Hz" : it is 55/65Hz automatic frequency conversion, which is suitable for measurement under power frequency interference in 60Hz power grid.

" 50 ± 2.5 " : it is 47.5/52.5Hz automatic frequency conversion, which is suitable for measurement under power frequency interference in 50Hz power grid.

Press “Enter” button, is displayed or cancelled at ⑦. This symbol indicates that the power is supplied by a generator and the frequency strictly selected can be output. This method cannot track the interference frequency and cannot be used for anti-interference. The fixed frequency of 50Hz is recommended for generator power supply.

Press “Enter” button for more than 1s to cancel full frequency selection.

3.6 Selection of Test High Voltage

3.6.1 Selection of High Voltage under UST/GST Mode

When the cursor is at ④, press $\uparrow\downarrow$ key to display test high voltage in cycle “0.5 /0.6 /0.8 /1 /1.5 /2 /2.5 /3/3.5 /4 /4.5 /5 /5.5 /6 /6.5 /7 /7.5 /8 /8.5 /9 /9.5 /10kV”; Select test high voltage according to high voltage test procedures.

After starting the measurement, it shows measurement high voltage and high voltage current (mA) will appear at ⑧.

3.6.2 Selecting High Voltage and Protection Limits in CVT Self-Excitation Mode

For CVT self-excitation measurements, the **Internal HV Enable Switch** must be turned **ON**. The instrument provides the excitation voltage internally, which is output through the "**Low Voltage Output**" and "**Measurement Ground**" terminals. To ensure operational safety, the following protection limits must be configured for the CVT self-excitation method:

When the cursor at ④, press “Enter” button to cycle through xxkV / xxmA / xxV / xxA in cycle, and press $\uparrow\downarrow$ to select desired values:

xxkV: 0.5/0.6/0.8/1/1.5/2/2.5/3/3.5/4kV This represents the **High-Voltage (HV) upper limit**. In this mode, the voltage is restricted to 4kV or below.

xxmA: 10/15/20/25/30/35/40/45/50/60/70/80/100/120/140/200mA. This represents the **upper limit for high-voltage current** of the test object.

xxV: 3/4/5/6/7/8/9/10/12/15/20/25/30/35/40/50V. This represents the **upper limit for low-voltage excitation voltage**.

xxA: 3/4/5/6/7/8/9/10/11/12/13/14/15/16/20/30A. This represents the **upper limit for low-voltage excitation current**.

Precautions:



- (1) All four protection limits are active simultaneously during measurement; therefore, the actual test high voltage may not reach the preset value. If the high voltage fails to reach the target due to a limit being triggered, appropriately adjust the specific protection limit that is causing the restriction.
- (2) Typically, during C1 measurement, the low-voltage excitation voltage can reach 20V, while during C2 measurement, the low-voltage excitation current can reach 15A. Generally, the high voltage can be set between 2–3kV. High-voltage current limiting is rarely required and can be set to the maximum of 200mA.

After initiating the CVT measurement, the excitation high voltage will be displayed at position ④. Position ⑧ will display the high-voltage current (mA), low-voltage (V), and low-voltage current (A). A displayed value enclosed in brackets, such as [18V], indicates that this specific parameter has reached its protection limit. If no brackets are shown, it indicates that the excitation high voltage itself has reached the set protection limit.

3.7 Automatic Printing

The cursor is at ⑤, press ↑ button to display or cancel the printer icon at ⑩, which indicates the end of measurement and the start of automatic printing.

3.8 Series Connection Mode

With the cursor at position ⑤, rapidly press the "Enter" key 10 times to display or hide the RC series connection symbol  at (11). The presence of this symbol indicates that the instrument is simulating a Schering Bridge model. The absence of this symbol indicates it is simulating a Current Comparator Bridge model. This symbol should be displayed when calibrating the instrument with a standard Tan Delta calibrator in a laboratory environment, but  should be disabled for all on-site measurements.

3.9 Start Measurement

With the cursor at position ⑤, press and hold the "Enter" key for more than 1 second to initiate the measurement.

An audible and visual alarm will be triggered upon starting the measurement; the progress indicator at ⑨ will show 0% to 99% to represent the measurement status.

During testing, press any key to terminate the measurement. In case of an emergency, immediately shut off the Main Power Switch.

3.10 View Data

Once results are displayed, use the ↑/↓ keys to browse the data and press the "Print" key to output the results. Press and hold the "Enter" key for 1 second to exit.

The instrument automatically identifies whether the test object is capacitive, inductive, or resistive:

1. For capacitive objects, **Cx** and **tgδ (tan δ)** are displayed.
2. For inductive objects, **Lx** and **Q (Quality Factor)** are displayed.
3. For resistive objects, **Rx** is displayed along with any parasitic **Cx** or **Lx**. The display units are selected automatically for optimal readability.

Test Object	Displayed Parameters	Technical Remarks
Capacitive	Cx / tanδ / U/ I /θ/ P / f / T	If tan δ > 1.0, display as Cx with series/parallel resistance (R_x).
Inductive	Lx / Q / U/ I /θ/ P / f / T	
Resistive	Rx / Cx (Lx)/ U/ I /θ/ P / f / T	If Q < 1.0, display as Lx with series resistance (Rs).

Cx- Capacitance of test object [1μF=1000nF / 1nF=1000pF], For example, a display of 10.00nF equals 10000pF.;

tgδ- Dielectric Loss Factor [1%=0.01];

Lx- Inductance of test object [1MH Megahenry =1000kH / 1kH=1000H];

Q- Quality Factor [Dimensionless]

Rx- Resistance value of test object [1MΩ=1000kΩ / 1kΩ=1000Ω];

U- Test Voltage [1kV=1000V / 1V=1000mV];

I- Current of test object [1A=1000mA / 1mA=1000μA];

Φ- The angle of the current of test product exceeding the previous test voltage [°degree] or the angle of primary voltage exceeding previous secondary voltage during the measurement of ratio of transformation.

Φ: Phase angle [°] by which the test current leads the test voltage, or the phase angle by which the primary voltage leads the secondary voltage during Transformation Ratio measurement.

K: Transformation Ratio (Primary Voltage / Secondary Voltage) during CVT Ratio measurement.

P- Loss power of test object [1kW=1000W / 1W=1000mW];

F- Frequency [Hz]. Displays the actual frequency in fixed mode, or the center frequency in automatic frequency conversion mode.

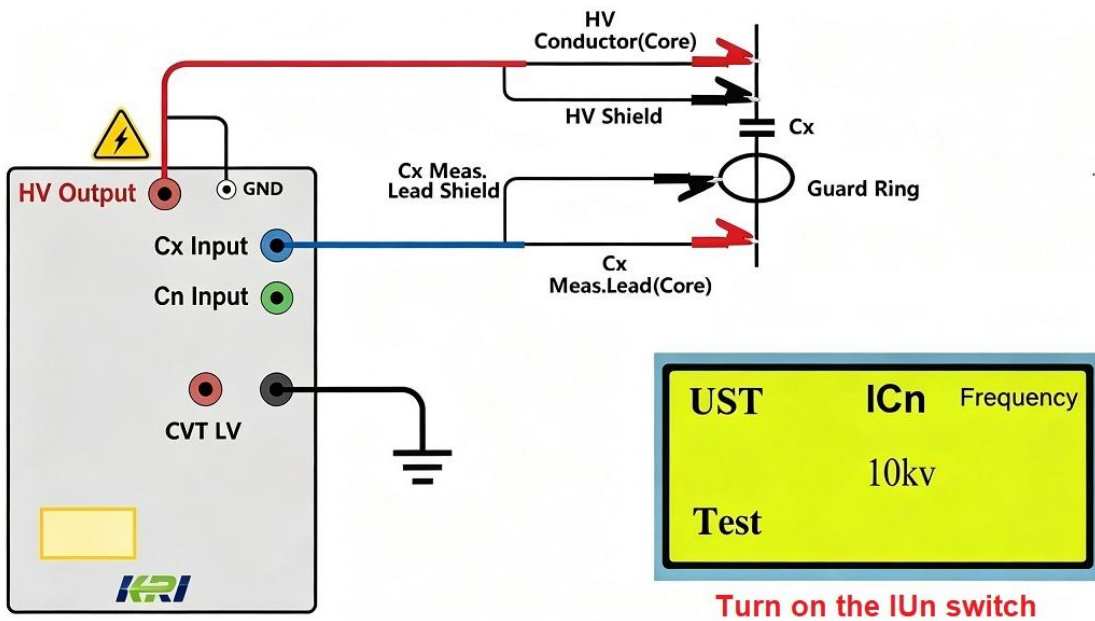
t-Temperature [°C]. Measured by the internal sensor. Please note that accuracy may be affected by the instrument's internal heat. Displayed measurement data is not automatically temperature-compensated.

For CVT Self-Excitation measurements, the displayed data includes: C1, tgδ, C2, tgδ, U1, U2, F, and t. Based on the wiring: C1 is defined as the component connected to the "Cx" input socket; C2 is defined as the component connected to the High-Voltage lead. U1 represents the high voltage during C1 measurement, and U2 represents the high voltage during C2 measurement.

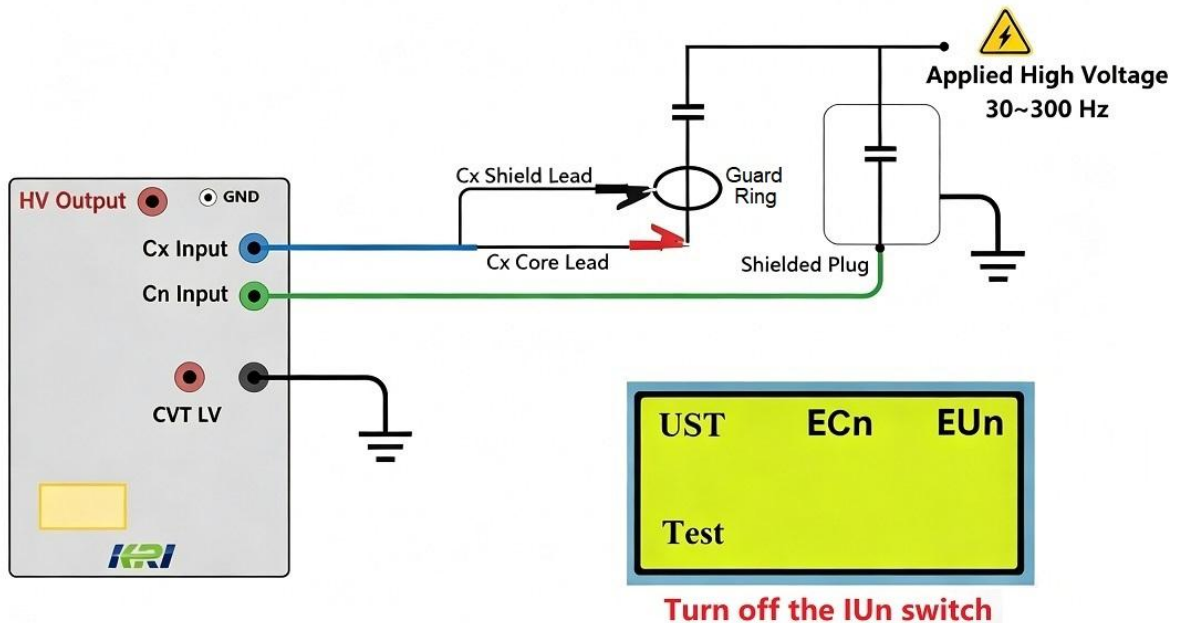
A display of "OVER" indicates that the measurement data exceeds the instrument's range.

3.11 Reference Wiring Diagrams

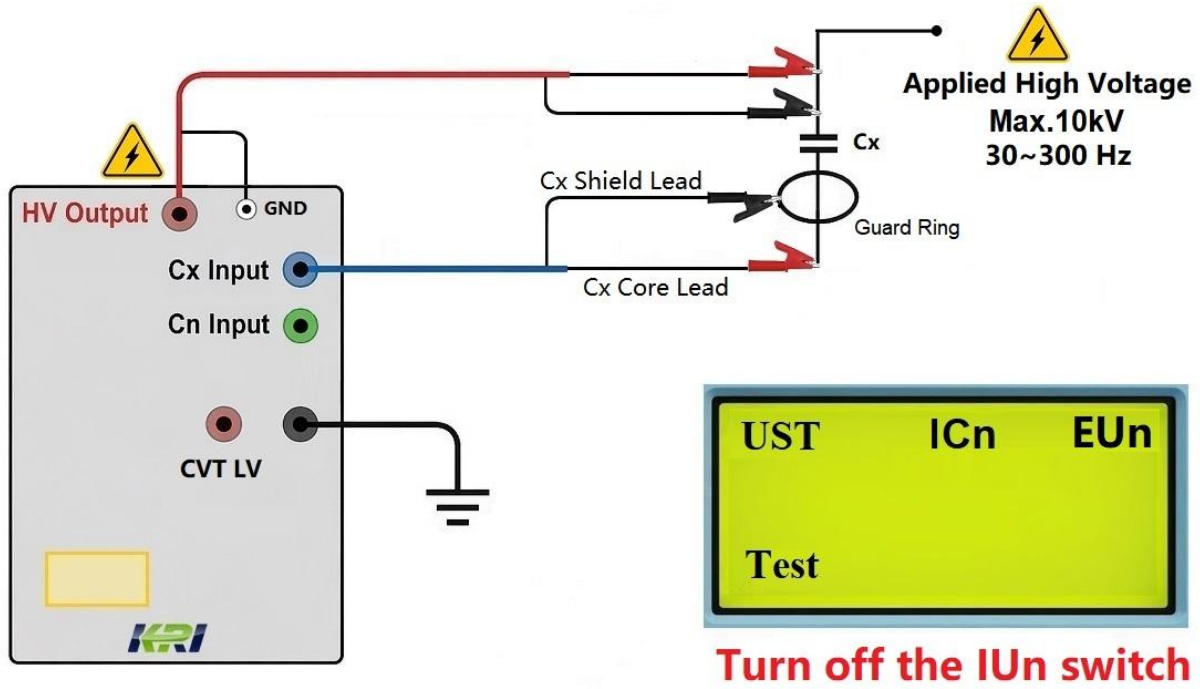
3.11.1 Standard UST, Internal Reference Capacitor, and Internal HV:



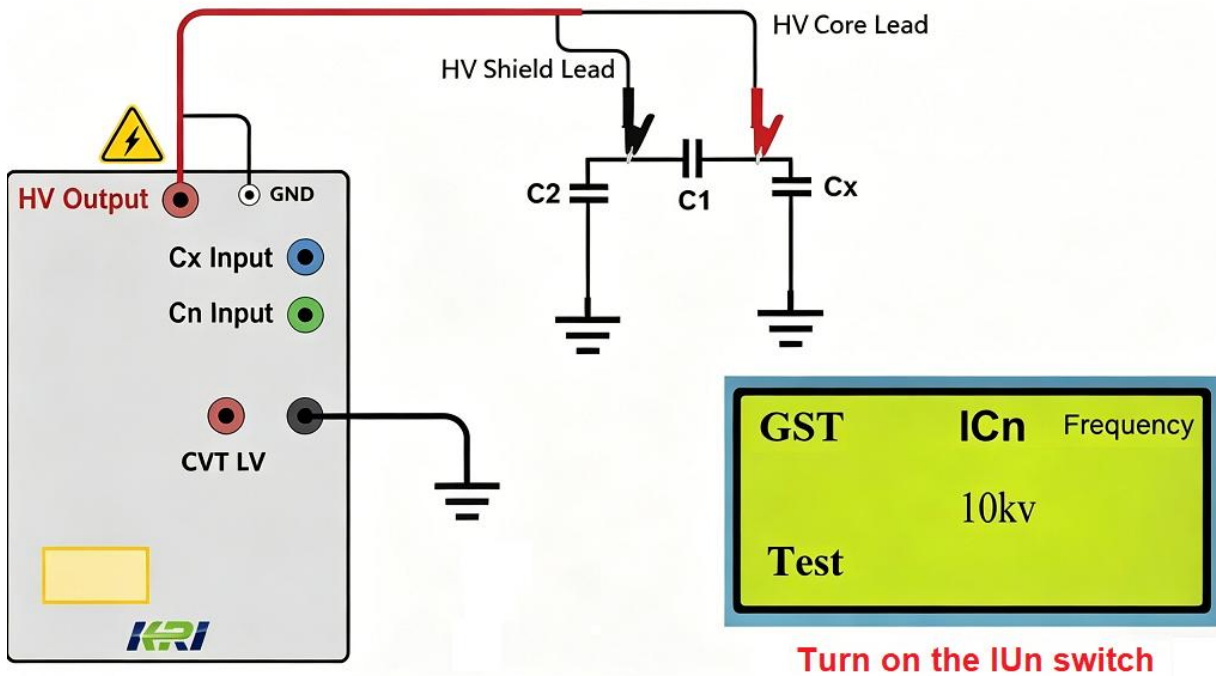
3.11.2 External Standard Capacitor (ECn) and External High Voltage (EUn) for HV Dielectric Loss:



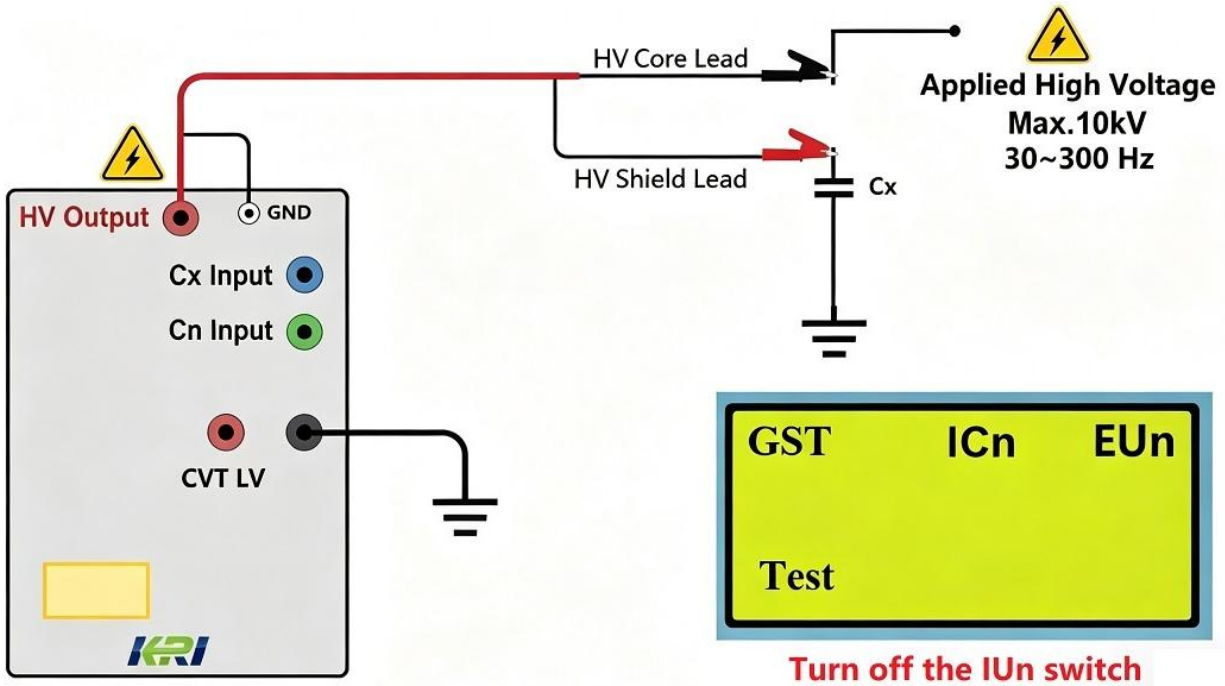
3.11.3 Internal Standard Capacitor (ECn) and External High Voltage (EUn) for Large Cap. Test Object:



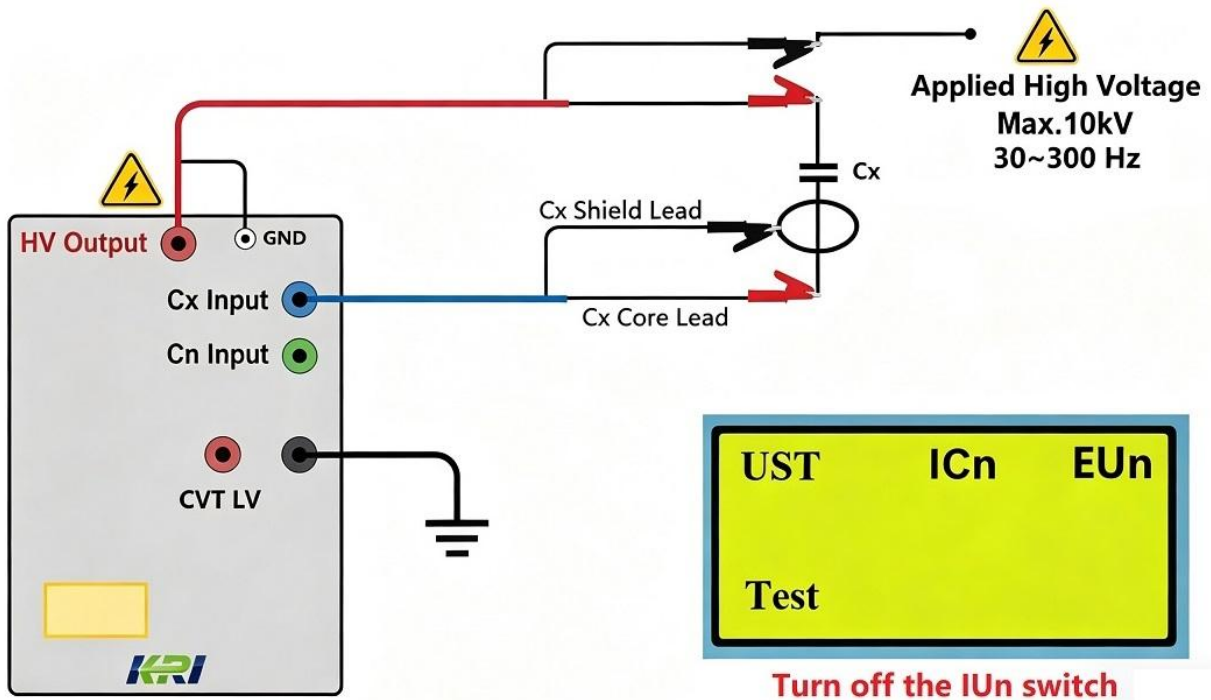
3.11.4 Standard GST, Internal Reference Capacitor(ICn), and Internal HV(IUn):



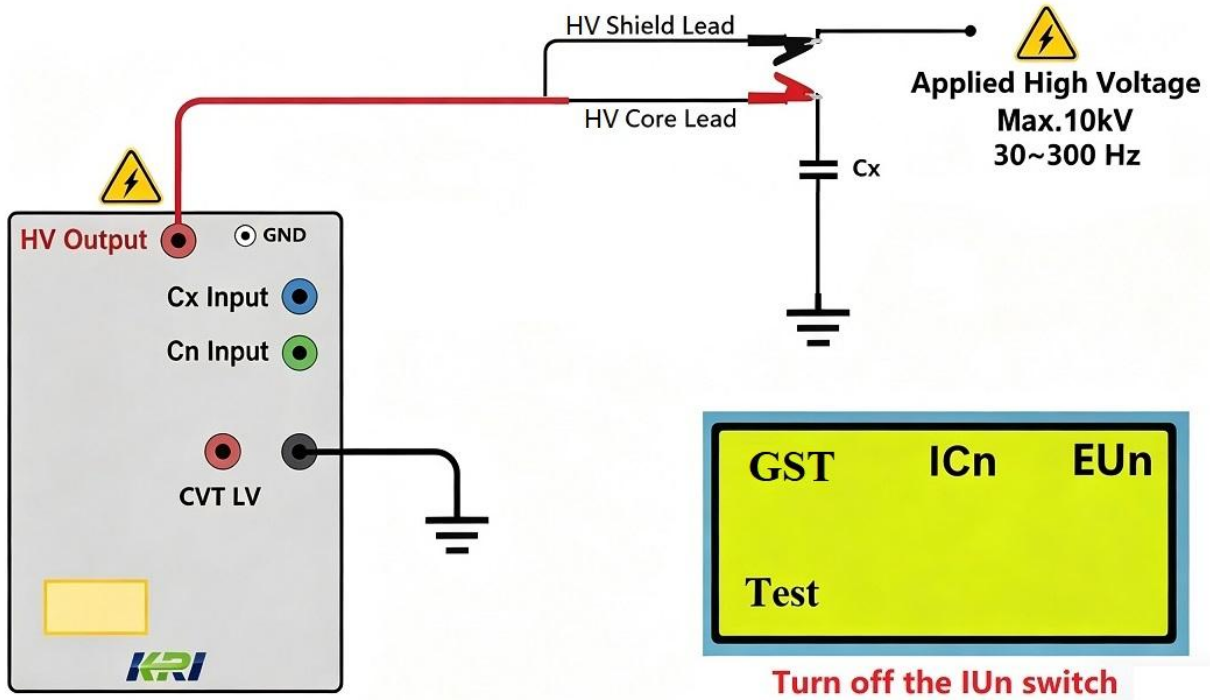
3.11.5 GST Internal Standard Capacitor (ECn) and External High Voltage (EUn) for Large Cap. Test Object:



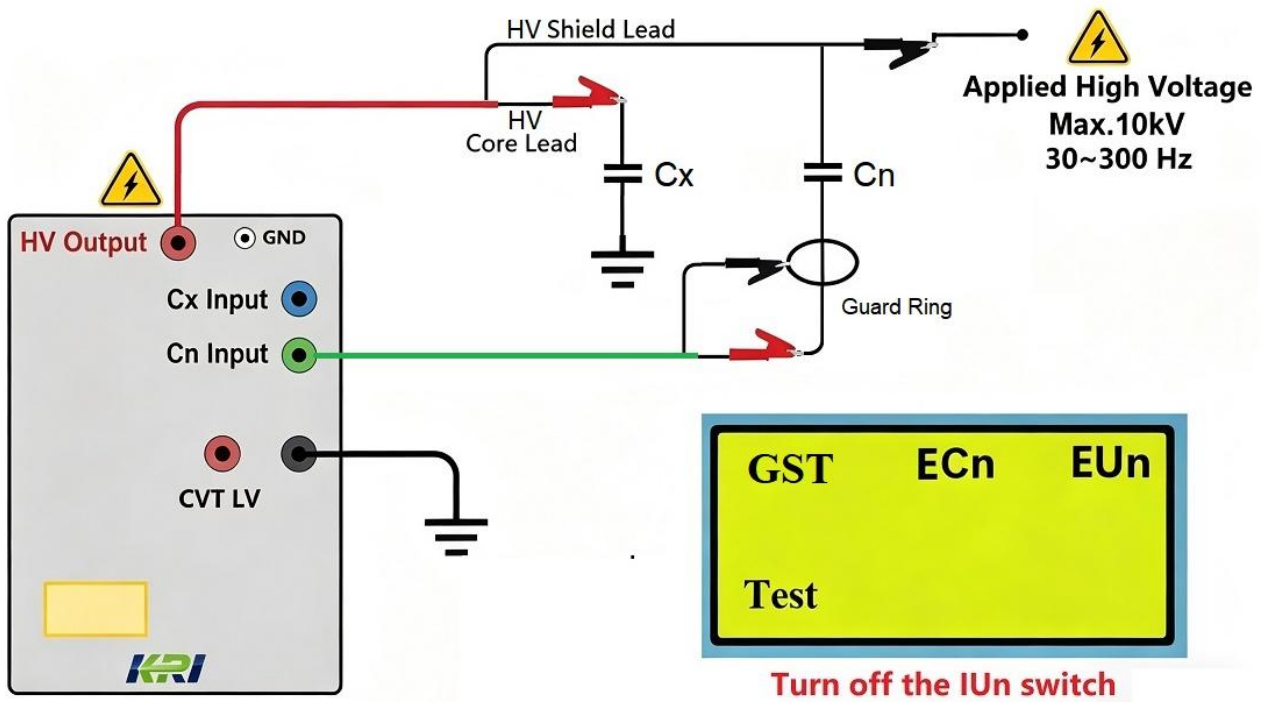
3.11.5 UST, Internal Reference Capacitor, and External HV Source:



3.11.6 GST, Internal Reference Capacitor, and External HV Source:

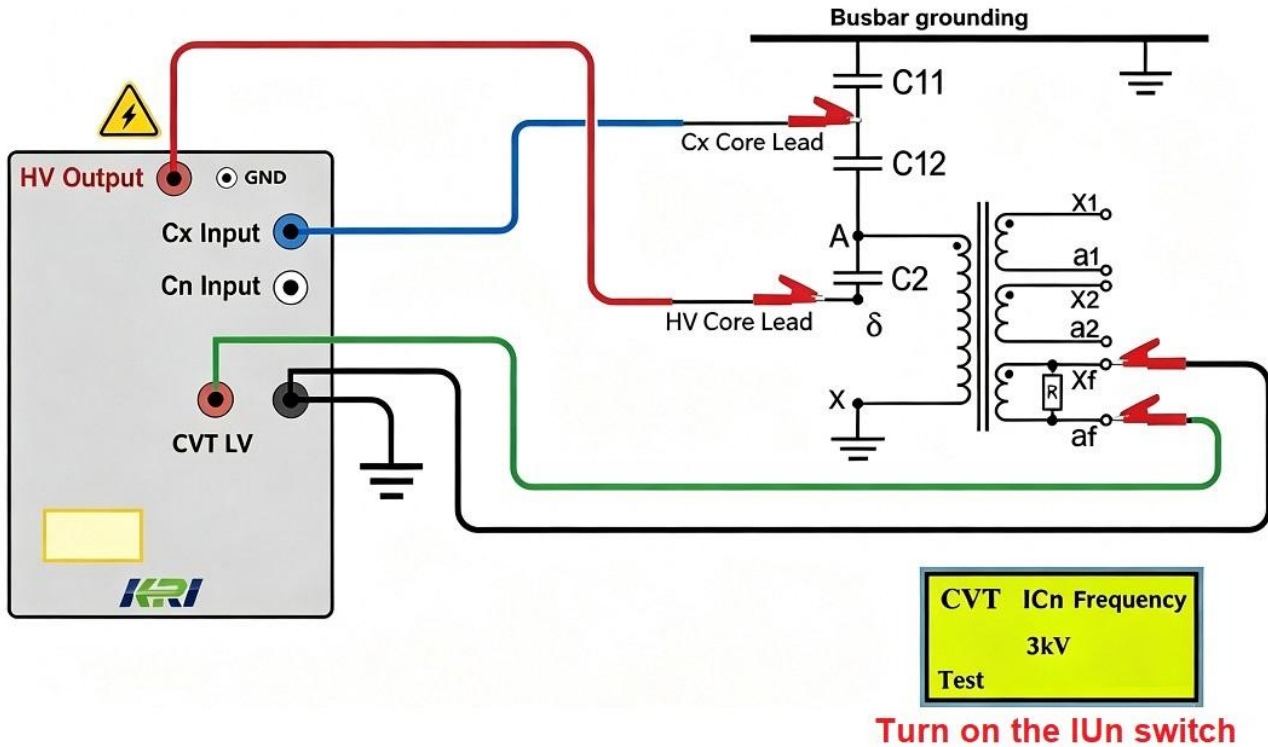


3.11.8 GST, External Reference Capacitor, and External HV Source:



3.11.12 Ground-Trailing High Voltage Lead in CVT Mode

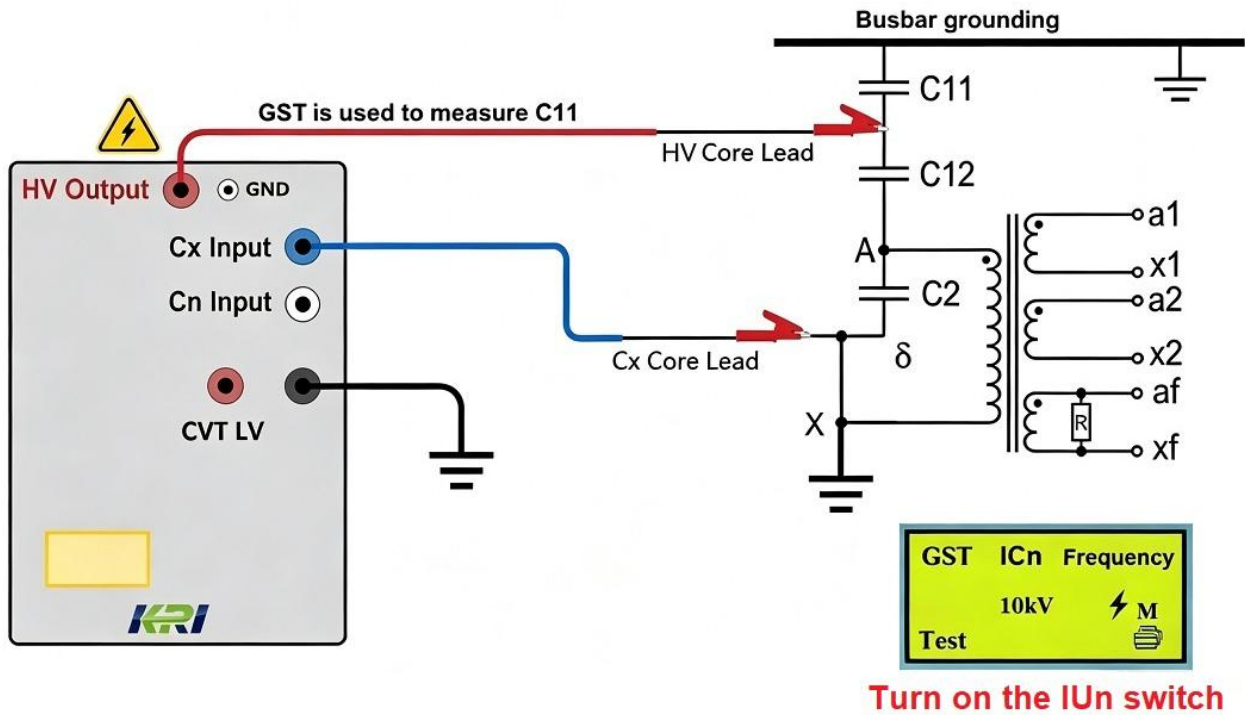
When using the CVT self-excitation method, connect the high-voltage (HV) core wire to the lower terminal of C_2 and the C_x core wire to the upper terminal of C_{12} . In this configuration, the HV lead can be trailed on the ground without the need for suspension, as the instrument provides automatic internal compensation for any resulting stray effects.



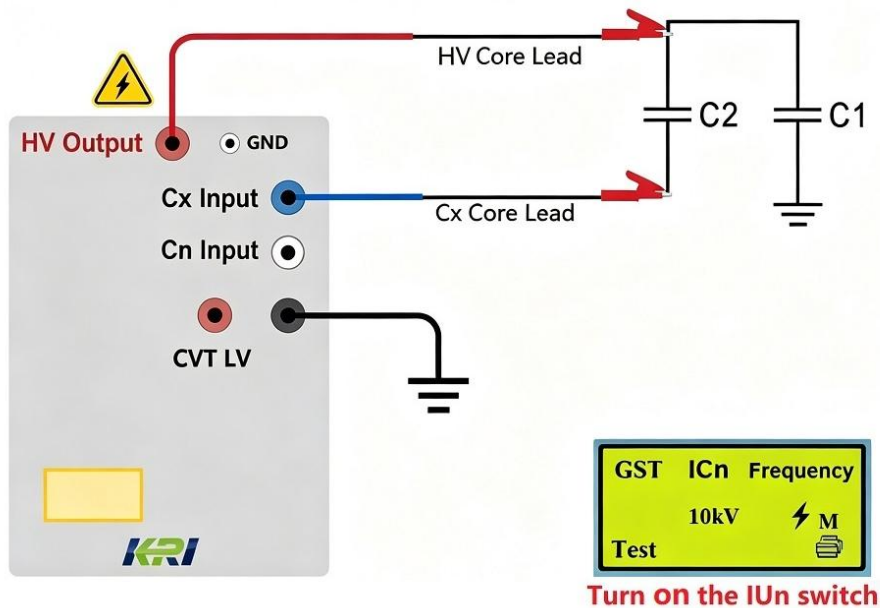
3.11.13 Low Voltage Shielding of GST

In GST mode with internal reference and internal HV, move the cursor to the "Start" position and press the " \downarrow " key. An "M" will be displayed in the lower-right corner, indicating that the GST Low-Voltage Guarding (M-mode) function is activated.

This function enables a 10kV GST tan delta measurement of C_{11} without detaching its primary leads, even when the 220kV CVT busbar is grounded. As shown in the diagram below: with the busbar grounded and the upper terminal of C_{11} remaining connected, connect the lower terminal of C_{11} to the HV core wire, and connect the δ and X terminals at the end of C_2 to the C_x core wire. In this setup, C_{12} and C_2 are effectively guarded at low voltage. The instrument utilizes the "GST / 10kV / M" mode to accurately measure C_{11} .



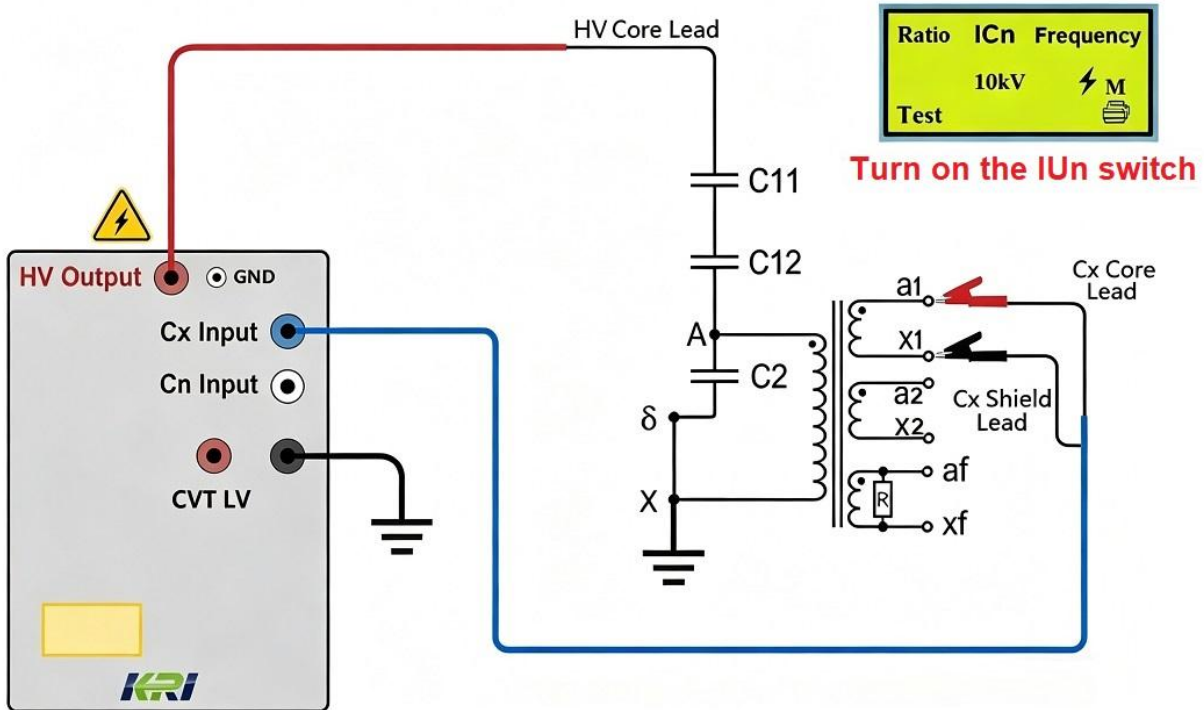
3.11.14 In GST mode with internal reference and internal HV, move the cursor to the "Start" position and press the "↓" key. An "M" will be displayed in the lower-right corner.



By enabling the GST Low-Voltage Guarding (M-mode), you can perform a 10kV GST tan delta measurement on the upper capacitor C_1 without detaching the busbar. As shown in the figure below: with the busbar grounded and the upper terminal of C_1 remaining connected, connect the lower terminal of C_1 to the HV core wire and the C_2 terminal to the C_x core wire. Using the "GST / 10kV / M" measurement mode, the instrument can simultaneously determine the capacitance and dielectric loss ($\tan \delta$) for both C_1 and the guarded lower section.

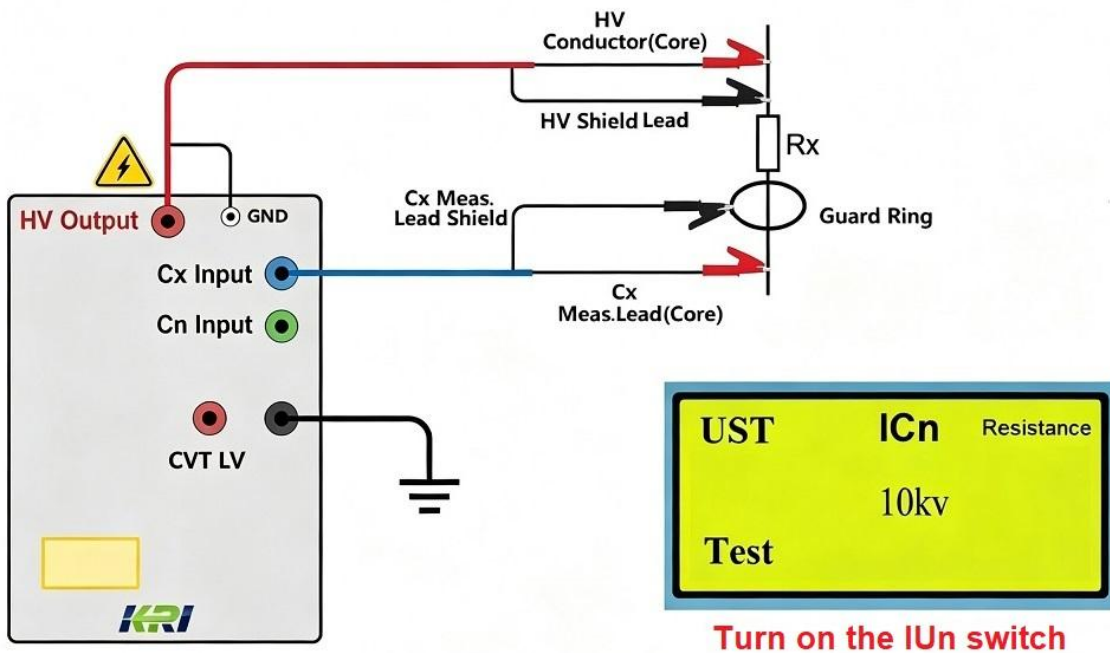
3.11.15 Test on Ratio of PT or CVT

Connect the red clamp of the High-Voltage (HV) core wire to the upper terminal of the CVT, ensuring the busbar is disconnected from the ground. The lower terminal of the CVT must be grounded. Connect the red and black clamps of the low-voltage lead to the secondary winding. Note: If the measured phase angle is near 180°, reverse the connection of the red and black clamps.

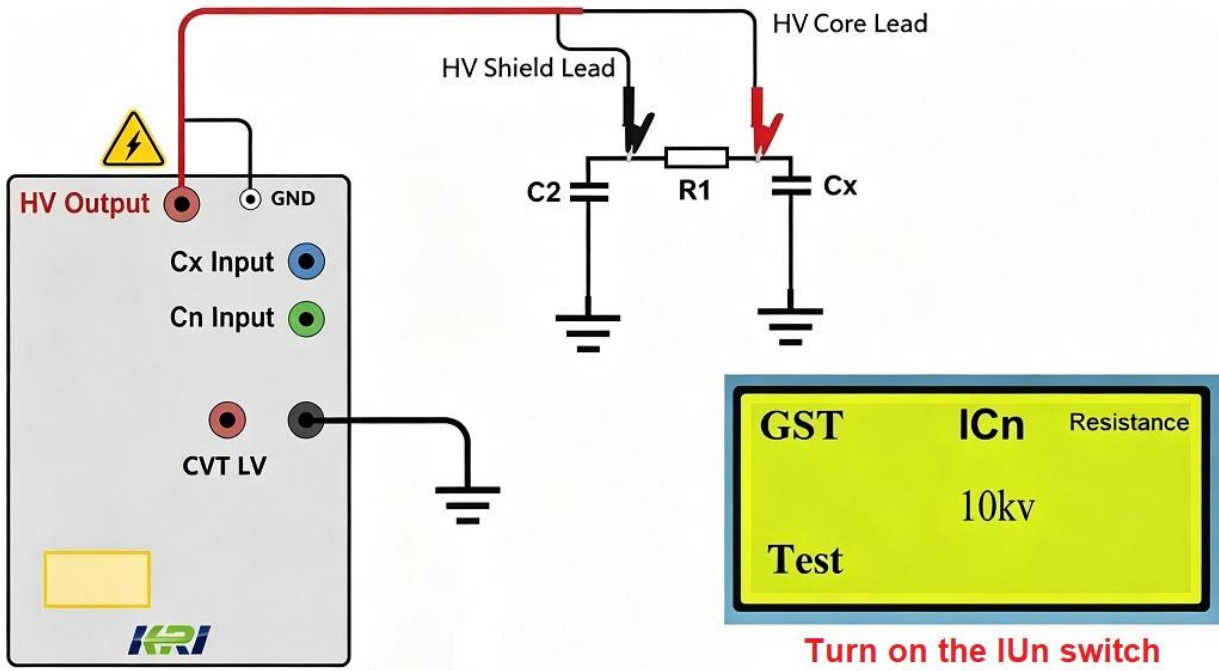


3.11.16 Insulation Resistance Test Wiring Methods (Optional Features):

UST: The wiring configuration for the insulation resistance test is identical to that of the dielectric loss test. In the diagram, simply replace the capacitive test object with a resistive one.



GST:

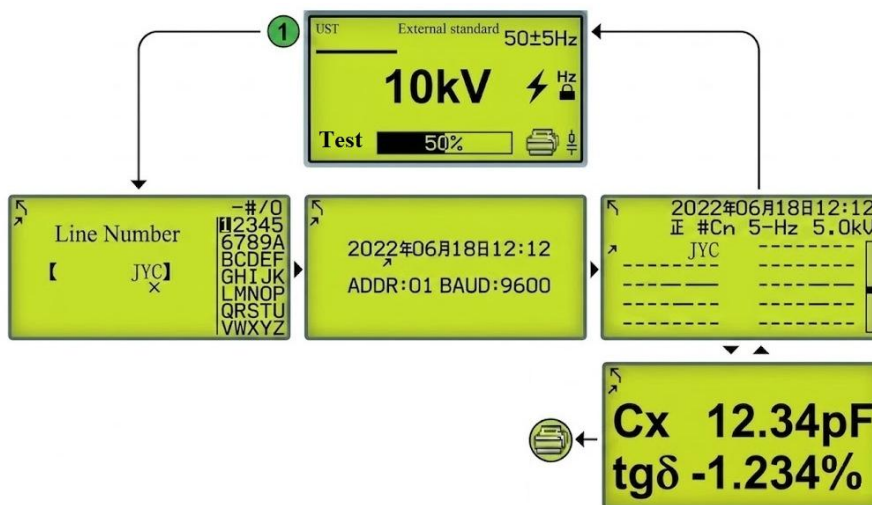


3.12 Connection to Computer



Once connected to a PC, the instrument can be remotely controlled via the host software. For detailed operating instructions, please refer to the Software User Manual.

3.13 Extras Menu

3.13.1 Enter/Exit Extras Menu



With the cursor at position ① in the Main Menu, short-press the "Enter" key to cycle through the "Line ID / Clock / Storage" menus or to exit. At any time, pressing and holding the "Enter" key for more than 1 second will return you directly to the Main Measurement Menu.

The arrow  in the upper-left corner of the screen represents the "Exit" command. When the cursor highlights this arrow , short-press the "Enter" key to exit.

3.13.2 Setting the Line ID

Configure the Line ID for data printing and storage records. If not required, this field can be left blank (set as spaces).

The interface provides three cursor options: Exit, Delete, and Set.

Select "Exit" and short-press "Enter" to save and proceed to the Clock Menu.

Selecting the "Delete" (cross icon) and short-pressing "Enter" will remove the last character entered.

In the "Set" area, a blinking cursor will appear. Navigate to the desired character and short-press "Enter" to input it.

3.13.3 Clock, Address, and Baud Rate Setup

Navigate to the target field, use the \uparrow/\downarrow keys to modify values, and short-press "Enter" to confirm and save.

The first line displays the System Clock (Date/Time).

ADDR: The communication address code, adjustable from 01 to 32. A single PC can manage up to 32 units simultaneously.


BAUD: The serial communication speed, selectable from 2400, 3600, 4800, or 9600 bps.

Note: For successful PC connectivity, the instrument's address and baud rate must match the settings in the host software.

3.13.4 Data Storage Operations

Saving Data: It is recommended to set the "Line ID" before testing. Upon completion of a measurement, the following data screen will be displayed:



Move the arrow cursor to the black block representing "Store"  and short-press the "Enter" key to save.

Note: Stored data is sorted chronologically; if the storage limit of 100 records is reached, the oldest record will be automatically overwritten.

Viewing Data: Move the arrow cursor to the front of the record name (Line ID); the measurement date and settings will be displayed in the upper-right corner. Short-press "Enter" to view the detailed data or print it. On the printed report, the symbol "MD" (Memory Data) indicates the record is retrieved from storage. Short-press "Enter" again to exit the view.

Deleting Data: Move the arrow cursor to the front of the record name and rapidly press the "Enter" key three times to delete the entry.

"....." indicates an empty storage slot.

Align the arrow with the exit icon and short-press "Enter" to return to the Main Measurement Menu.

4. Precautions for On-site Test

If the measurement results appear clearly irrational during use, please investigate the potential causes from the following aspects:

3.1 Poor Hook Contact

When using connection hooks on-site, ensure they maintain firm contact with the test object. Poor contact may cause discharge at the connection point, leading to severe data fluctuations. Be particularly mindful of thick oxide layers on conductors or wire movement caused by wind, both of which can compromise contact quality.

4.2 Poor Grounding Contact

Inadequate grounding may trigger instrument protection or cause significant data instability. Paint and corrosion at the grounding point should be scraped away to ensure a zero-resistance ground connection.

4.3 Direct Measurement of CVT or Measurement of Electromagnetic PT with End Shielding Method

Direct measurement of the lower coupling capacitor of a CVT may result in negative dielectric loss; the self-excitation method should be used instead.

When measuring electromagnetic PTs using the end-shielding method, "T-network interference" caused by moisture may lead to negative dielectric loss. To resolve this, dry the three-skirt porcelain bushings and the terminal block. Alternatively, use the conventional method or the end-excitation method.

4.4 Excessive Air Humidity

High humidity can cause dielectric loss values to increase abnormally (or decrease/become negative) and become unstable. If necessary, a guard ring may be applied. Note that the use of guard rings is controversial as it alters the electric field distribution of the test object; refer to relevant industry standards for guidance.

4.5 Generator Power

If the frequency of the generator power supply is unstable, it is recommended to operate the instrument in the fixed 50Hz frequency mode.

4.6 Test Line

Prolonged use may lead to hidden open circuits within the test leads, short circuits between the core and shield, or poor plug contact. Users should perform regular maintenance on all test leads.

When testing standard reference capacitors, fully shielded plugs must be used to eliminate the effects of additional stray capacitance; otherwise, the true accuracy of the instrument cannot be verified.

When measuring a CVT using the self-excitation method, non-dedicated high-voltage leads must be suspended; otherwise, additional stray capacitance and dielectric loss to the ground will introduce measurement errors.

4.7 Selection of Working Mode

After completing the wiring, ensure the correct measurement mode (UST, GST, or CVT) is selected. Selecting the wrong mode will lead to incorrect results. In high-interference environments, the frequency conversion (anti-interference) mode must be utilized.

4.8 Influence of Test Method

Since dielectric loss measurements are highly sensitive to the test methodology, it is important to distinguish between errors caused by the test setup and actual instrument malfunctions. If issues arise, verify the wiring configuration before troubleshooting the instrument itself.

4.9 Instrument Fault

Use a multimeter to check the test leads for open circuits or short circuits between the core and the shield. Verify that the 220V input power is within the acceptable range and that the instrument is properly grounded.

Perform a UST and GST test on a standard reference capacitor or a test object with known values. If the results are accurate, the instrument is functioning correctly.

Unplug all test leads and perform an open-circuit (air) voltage ramp test. If the instrument fails to operate under these conditions, it may have an internal fault.

After initiating a CVT measurement, verify the low-voltage output; a voltage of 2–5V should be present. Absence of this voltage indicates an instrument fault.

5. Instrument Calibration

5.1 Calibration with Standard Losser

Connect the standard calibrator using a shielded cable with matching plugs. If the accuracy of the calibrator cannot be verified, use the comparison method with a 2801 bridge or another high-precision bridge as the reference standard.

The instrument should be set to "Internal Standard" and "RC Series Mode." Select either the Power Frequency (50Hz) or Fixed Frequency (50Hz) mode.

5.2 Calibration with QSJ3

Connect the QSJ3 using a shielded cable. Select the "UST / External C_n / External U" measurement mode. The current ratio is $C_x:C_n$; ensure an appropriate value is entered for C_n .

5.3 Anti-interference Verification

Set up a circuit to inject a quantified interference current into the instrument.

Precautions:

- 1) Consider that this verification circuit may become an electrical part of the test object.
- 2) Once started, the instrument may introduce measurement frequency components into the 220V supply line. If these components re-enter the instrument via the interference current, the anti-interference test will be invalid.
- 3) Avoid using nearby high-voltage conductors to create interference, as this can trigger corona or tip discharges. Such non-linear discharge resistance often produces same-frequency interference, which is difficult to filter.

6. Brief Introduction to Working Principle of Instrument

6.1 Instrument Structure

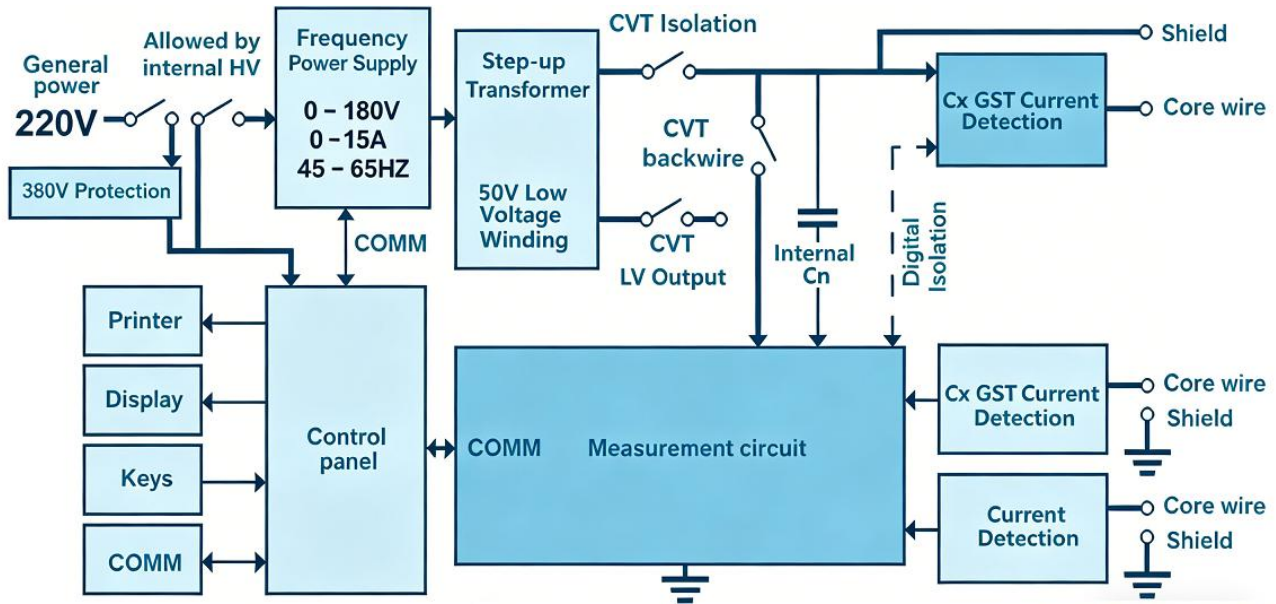


Diagram of Instrument Structure

Measurement Circuit: Responsible for all computations, including Fourier Transforms and complex number operations, as well as range switching and frequency conversion power control.

Control Panel: Integrates the printer, keypad, display interface, and communication relay.

Variable Frequency Power Supply: Utilizes an SPWM (Sinusoidal Pulse Width Modulation) switching circuit to generate a high-power, stable sine wave output.

Step-up Transformer: Elevates the output from the variable frequency supply to the required test voltage; features a maximum reactive power capacity of **2kVA for 1 minute**.

Reference Capacitor: Internal C_n , serves as the measurement baseline.

C_n Current Detection: Detects current flowing through either the internal or external reference capacitors.

Cx UST Current Detection: Dedicated exclusively to UST (Ungrounded System Test) measurements.

Cx GST current detection: only used for GST measurement of inverse wire.

GST Digital Isolation Communication: Employs high-speed digital isolation circuitry to safely transmit current signals from the high-potential (GST) side to the low-voltage processing side.

6.2 Working Principle

Upon initiation, the high-voltage setpoint is transmitted to the variable frequency power supply. The supply utilizes a **PID algorithm** to gradually ramp the output to the target value. The measurement circuit feeds the actual high-voltage data back to the power supply for real-time fine-tuning of the low-voltage stage, ensuring a precise high-voltage output.

Based on the selected configuration (UST/GST and Internal/External C_n), the circuit automatically selects the appropriate input and switches ranges according to the test current. The system employs **Fourier Transform (FFT)** algorithms to filter out interference and isolate the fundamental signal wave. It then performs **vector operations** on the reference and specimen currents: capacitance is derived from the amplitude, while the dielectric loss (**$\tan\delta$**) is determined by the phase angle difference.

The instrument performs multiple measurement cycles and selects the median result through a sorting algorithm to ensure stability. Upon completion, the measurement circuit issues a ramp-down command, and the power supply gradually reduces the voltage to zero.

CVT Measurement: The CVT isolation switch is opened while the low-voltage isolation switch is closed to output the excitation voltage. During C_2 measurement, the CVT internal switching relay is activated to route C_2 into the measurement channel, utilizing C_1 as the reference capacitor for the measurement of C_2 .

7. Discussion on Frequency Conversion Measurement

7.1 Frequency Conversion Measurement

In environments with severe interference, frequency conversion measurement provides accurate and reliable results. For instance, during a 55Hz measurement, the system selectively allows only the 55Hz signal to pass, effectively suppressing 50Hz interference. This is because the measurement system can easily distinguish between different frequencies. The following calculation demonstrates the efficacy of frequency-selective measurement:

Consider two sinusoidal waves where one frequency is double the other. Let the higher frequency be the interference, with an amplitude 10 times that of the signal:

$$Y=1.234\sin(x+5.678^\circ)+12.34\sin(2x+87.65^\circ)$$

4 measurement values are obtained if $x=0/90/180/270^\circ$;

$$Y_0=12.4517, Y_1=-11.1017, Y_2=12.2075, Y_3=-13.5576,$$

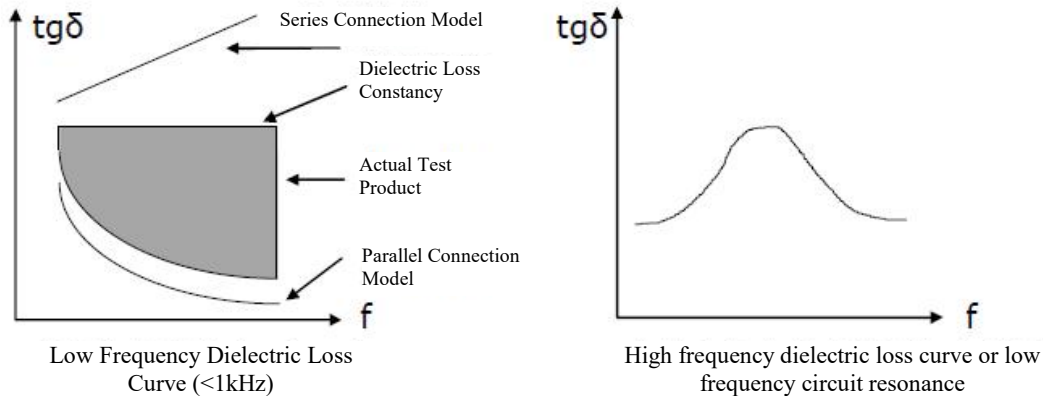
Calculate $A=Y_1 - Y_3=2.4559$, $B=Y_0 - Y_2=0.2442$, then,

$$\varphi=\text{tg}^{-1}(B/A)=5.678^\circ \quad V=\frac{A^2+B^2}{2}=1.234$$

These results correspond exactly to the phase and amplitude of the low-frequency signal, demonstrating that the interference has been successfully suppressed. In actual practice, the instrument samples tens of thousands of points, requiring significant computation to ensure the results reflect the overall characteristics of the waveform.

7.2 Relationship between Frequency and Dielectric Loss

Dielectric loss has two ideal models of RC series connection and parallel connection: serial connection model is $\text{tg}\delta=2\pi fRC$, parallel connection model is $\text{tg}\delta=1/(2\pi fRC)$, and $\text{tg}\delta$ is positively and negatively correlated to the frequency f respectively. As is shown in the Figure, f has a great influence on the two models of full direct proportion and full inverse proportion. However, the actual capacitor is a mixed model with multiple models interwoven, and the influence of f is small at this time.



7.3 Automatic Frequency Conversion is Equivalent to 50Hz.

The instrument utilizes automatic frequency conversion to sample data at two points (45Hz and 55Hz) flanking the 50Hz interference frequency, then extrapolates the equivalent data for 50Hz. Aside from low-frequency resonance occurring in complex multi-component circuits, the dielectric material in a single test object cannot produce an energy absorption peak at such low frequencies. Near the power frequency, dielectric loss consistently exhibits a monotonic relationship with frequency. Consequently, this interpolation method does not introduce significant error.

In practice, the two dielectric loss values obtained prior to averaging are typically very close, providing high reference value even individually. Currently, frequency conversion Tan Delta testers have become standard equipment for dielectric loss measurement, with their superior anti-interference capabilities and high precision widely recognized across the industry.

8. Error Message and Processing

Error messages 1 through 4 are displayed in full-screen mode. Error messages 5 through 21 are displayed at position ⑧ (lower-right corner) for Type A, B, and C instruments, or at position ⑨ (bottom-center) for Type D, E, and F instruments.

S/N	Screen Display	Instructions	Cause and Processing
1	HV-CT Error! Or GST of the instrument has errors!	GST signal fault	Restart the instrument; if the error persists, contact the manufacturer's technicians
2	Save-Data Error!	Internal parameter error; possible hardware failure	Reset according to the original parameters on the factory certificate or contact the manufacturer.
3	RANGE ERROR! Or input circuit!	Range switching failure	test object may be short-circuited; please check the object and its wiring.
4	GROUND ERROR! Or poor grounding!	Instrument not grounded or poor grounding	Check for loose grounding leads or rust/paint at the grounding point
5	Er-Ps	Inverter power software protection	Check power socket contact, voltage stability, and lead connections.
6	Er-Ii	Excessive inverter input current	Contact the manufacturer's technical support.
7	Er-Io	Excessive inverter output current	Load is too heavy or shorted; check the specimen or try at a lower voltage.
8	Er-Vi	Inverter input voltage too high	Verify the power source; it must be below 270V.
9	Er-Vo	Inverter output voltage too hig	Contact the manufacturer's technical support
10	Er-Pi	Inverter hardware protection	Retry the test; if the error persists, contact the manufacturer.
11	Er-HL	Unbalanced positive/negative power supply	Retry the test; if the error persists, contact the manufacturer.
12	Er-Hz or Er-Lz	Positive/Negative power supply too low	Contact the manufacturer's technical support
13	Er-HT or Er-LT	Positive/Negative power supply too high	Check the input voltage; it must be below 270V.
14	Er-TT	Inverter overheating	Shut down the instrument and allow it to cool.
15	Er-Zx	Output voltage/current fluctuation	Check all lead connections and verify measurement settings
16	ER-cw	CVT wiring error	Check and reset the high-voltage limit.
17	ER-cV	HV setting exceeds limit	Check and reset the high-voltage limit.
18	ER-cv	LV setting exceeds limit	Check and reset the low-voltage limit.
19	ER-cI	HV current setting exceeds limit	Check and reset the HV current limit.
20	ER-ci	LV current setting exceeds limit	Check and reset the LV current limit.
21	ER-Bd	Measurement signal instability	Check all connections throughout the entire measurement loop.



9. After-sales Service

Products exhibiting defects in materials or workmanship will be repaired or replaced free of charge for a period of 24 months from the date of purchase. Beyond the warranty period, the company remains committed to providing lifelong maintenance and technical support. Should you encounter any operational abnormalities or instrument failures, please contact us promptly so that we may arrange the most efficient solution for you.