T-305E High Voltage Surge Generator

User Manual

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Legal Notices

This product complies with the design requirements for environmental protection and personal safety.

This product is a professional instrument specially designed for power cable faults. Please do not use it for any other purpose. The company assumes no responsibility or loss if it is used for other purposes.

The safety regulations in this user manual should be strictly adhered to.

The storage, use and disposal of the product should be in accordance with the product manual, relevant contracts or relevant laws and regulations.

As part of Kehui's continual product development this product is subject to design or technical changes without prior notice. When product improvement or technical changes occur, you can check the information through Kehui International Ltd. website http://www.kehui.com.

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Revision history:

Data version	Revision date	Revision reason	Person
3.0	2019.05.01	New block diagram and front panel added, final edit	TonYip/DiaKib
3.1	2019.05.01	New block diagram P8	DiaKib
3.2	2020.02.10	Clarified grounding and T-H200 operation	BilKib
3.3	2021.03.17	Updated technical data, more detail on 2048J version	BilKib
3.4	2021.04.10	Replacement of diagrams with photographs. Page numbering & Order codes	BilKib/DiaKib
3.5	2021.07.16	Layout change and additional instructions following customer feedback	BilKib

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Foreword

Thank you for purchasing the new product of Kehui - T-305E, the high voltage surge generator (hereinafter referred to as T-305E)

The T-305E is a high-performance high voltage surge generator with a maximum output voltage of 32kV and with versions providing a maximum surge energy of 1024J or 2048J. It is used for pre-location and pinpointing of high impedance and intermittent flashing faults of underground power cables.

The T-305E provides either DC or single-shot high voltage surge voltage signals to the faulty cable to break down the fault for pre-location purpose. It works in conjunction with Kehui's T-906, cable fault locator, to pre-locate cable faults. T-305E supports the Secondary/ Multiple Impulse Methods (SIM/MIM) and the Impulse Current Method (ICM) for fault pre-location.

T-305E works in conjunction with the T-506 for cable fault pinpointing. It provides cyclic impulses to the faulty cable to periodically break down high impedance and flashing faults. A magnetic field and an acoustic signal are produced during this process. The signals are used by the T-506 to trace and to pinpoint the fault by the magnetic field and sound coincidence method. The unit can also be used as a DC power source for the T-H200 sheath fault locator.

Kehui constantly improves its products, and the individual instruments provided may differ from the instructions in this manual without prior notice. We are always at your service if you have any queries or should you require further information.

Table of Contents

1. Safety Instructions

Safety Note: This user manual is the basic commissioning and on-site operation guide for the T-305E. All operators who will use the T-305E should read the entire contents of this manual in advance. The manufacturer of this product is not responsible for any loss caused by the operator's failure to comply with the operating procedures of this manual or for violation of the safe working procedures of the operator.

Meaning of the manual symbols Important instructions concerning personal safety, operating procedures, technical safety, etc., are marked with the following symbols:

Symbol	Meaning
	Indicates a potential hazard that could result in fatal or serious injury
	Indicates a potential hazard which, if not avoided, may result in minor personal injury or property damage.
	Indicates that it contains important information and useful guidance for using this product. Failure to heed this information will result in the test not functioning properly.
	Indicates that this is a useful guideline based on field practice.

Use of accessories: Please be sure to use Kehui's spare parts to ensure the safe and reliable use of this instrument. Using accessories made by other companies will make any warranty null and void.

Repair and maintenance: This instrument must be repaired and maintained by Kehui or an agent authorised by Kehui. If you have any questions such as maintenance, cable fault detection, on-site test consultation, etc., please contact info@kehui.com

2. Product Overview

2.1 Product features

The product has the following characteristics:

1. Three modes of operation: DC, pulse or periodic.
2. Different capacitor bank connection to provide different capacitance by a switch operation. The energy of the surge is directly proportional to the capacitance value.
3. Interlocking features prevent the equipment from HV operation if the ground is not securely connected.
4. Automatic discharge facility to remove the charges for the equipment and the cable's capacitance after test.

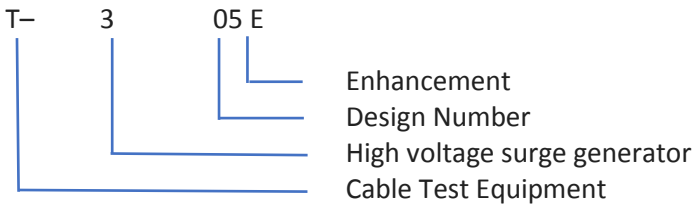
2.2 Main use and scope of application

T-305E is used together with Kehui's power cable fault locator T-906 and pinpointer T-506, to pre-locate and to pinpoint underground power cable faults

The equipment consists of voltage conversion and rectification to produce high DC voltage for the test. Interlocking and safety features ensure safe and reliable operation of the equipment during test.

2.3 Product nomenclature

Product model naming method:



2.4 Environmental conditions

1. Working environment temperature: -10°C to 40°C
2. Working environment humidity: 20-90% RH at 25 °C
3. Storage environment temperature: -10°C to 60°C
4. Atmospheric pressure: 86 to 016kPa

2.5 Standard Configuration

1. T-305E instrument
2. Cable for triggering and signalling
3. Earthing cables
4. A user manual

2.6 Technical Data Sheet

Technical Parameters	Parameter Value
Output Voltage	0-32kV, 0-16kV, 0-8kV, Adjustable negative DC
DC Voltage	0-32kV/25mA negative polarity
Rated capacitance for 1024J version	2µf (when output voltage is from 0 to 32kV) 8µf (when output voltage is from 0 to 16kV) 32µf (when output voltage is from 0 to 8kV)
Rated capacitance for 2048J version	4µf (when output voltage is from 0 to 32kV) 16µf (when output voltage is from 0 to 16kV) 64µf (when output voltage is from 0 to 8kV)
Impulse energy	1024J: (32kV/2µF, 16kV/8µF, 8kV/32µF) 2048J: (32kV/4µF, 16kV/16µF, 8kV/64µF)
Operating mode	DC / Pulse / Cyclic
Testing method	SIM(MIM) / ICM
Discharge period	4 - 15s adjustable continuously when in Cyclic mode
Discharge device	Built-in
Working voltage	220/240Vac±10% (110V through step-up transformer)
Mains Frequency	50/60Hz±20%
Maximum Power consumption	1500W
Dimensions	1024J Version: 500x400x960mm 2048J Version: 500x400x1100mm
Weight	75kg for standard (1024J) version 120kg for 2048J version
HV Cable length	3.6m
Ground cable length	4m
Working ground cable	1.1m
Discharge rod cable	2m
Power cable	1.8m
Operating temperature	-10°C to +50°C
Storage temperature	-40°C to +60°C
Ingress Protection	IP21

3. Working principle

3.1 Basic Operation

At its simplest level the surge generator can be considered to be a capacitor C which is charged to a selectable voltage (via the transformer) and discharged into the cable through a contactor S1. The value of the capacitor and the voltage can be changed to optimise the surge to break down the fault.

The equipment has an internal safety discharge feature. When the equipment is powered off, the selected capacitors and the cables will be connected to earth/ground through the safety facility. This works by closing the switch S2 which allows the charge stored in the cable capacitance and the surge generator capacitor to be safely “dumped” through a resister. A simplified scheme is shown in figure 3.1. The switch S1 can be controlled by a timer to give periodic surges required for pinpointing.

Note: References to earth/earthing and ground/grounding are used throughout and are interchangeable.

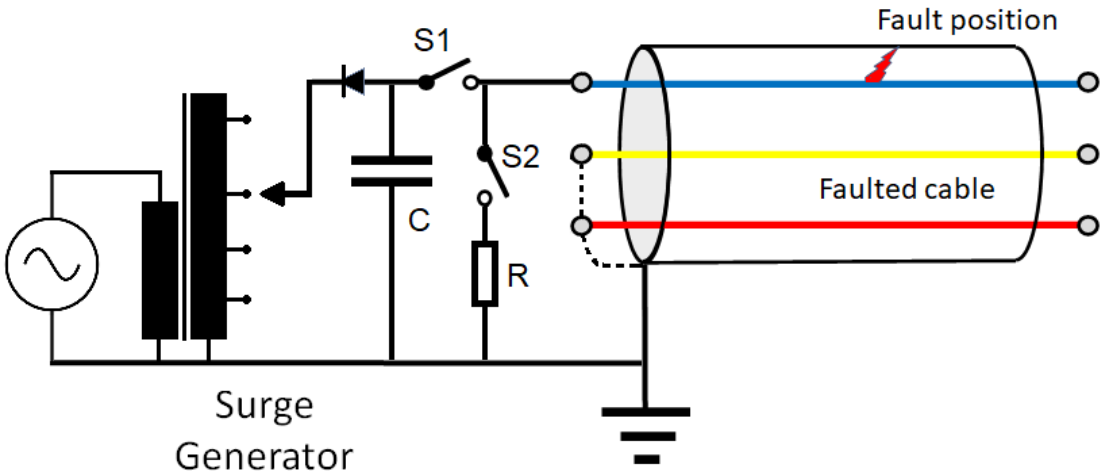


Figure 3.1 Surge Generator schematic diagram

The design of a practical surge generator is more complicated as can be seen in the block diagram Figure 3.2 for the T-305E.

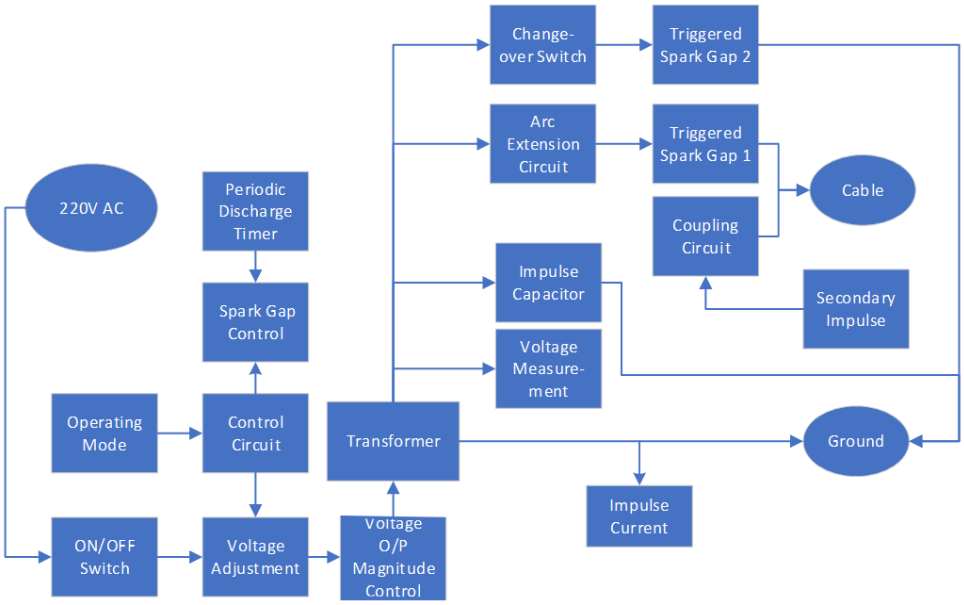


Figure 3.2 T-305 Block diagram

3.2 DC operation

The surge generator can be used as a DC source by closing switch S1 and applying the rectified voltage signal directly to the cable. In this way the device may be used to check the voltage withstand of the cable.

If a fault on the cable breaks down under this voltage, it sets up a travelling wave which reflects between the fault and the surge generator which can be measured on a suitable instrument (e.g., The Kehui T-906) through an inductive coupler on the earth lead. The distance to the fault can be calculated from the time between the voltage peaks on the resultant waveform and knowledge of the velocity of propagation of the surge.

DC mode can also be used to power a sheath fault locator, such as the Kehui T-H200. Using the surge generator for this application makes it unnecessary to use a separate power source such as the Kehui T-100C. Further details can be found in Section 5.

3.3 Surge operation

If the fault cannot be broken down by simply raising the voltage, it will be necessary to send a surge of energy in to the cable. This is achieved by charging capacitor C to the required voltage and discharging it into the suspected cable core through switch S1.

The surge of energy in the cable will be reflected from the far end of the cable, such that the fault is subjected to a voltage approaching twice the value injected (e.g., a surge at 32kV setting will subject the fault up to 64kV).

The ability to break down the fault is not just a function of the voltage; it is also dependent on the available energy which is a function of capacitance where the energy in Joules is equal to ½ CV^2 where C is in µF and V in kV.

The stored energy is discharged into the cable with a steep-fronted, high energy surge. Examples of these waveforms are shown in Figure 3.3.

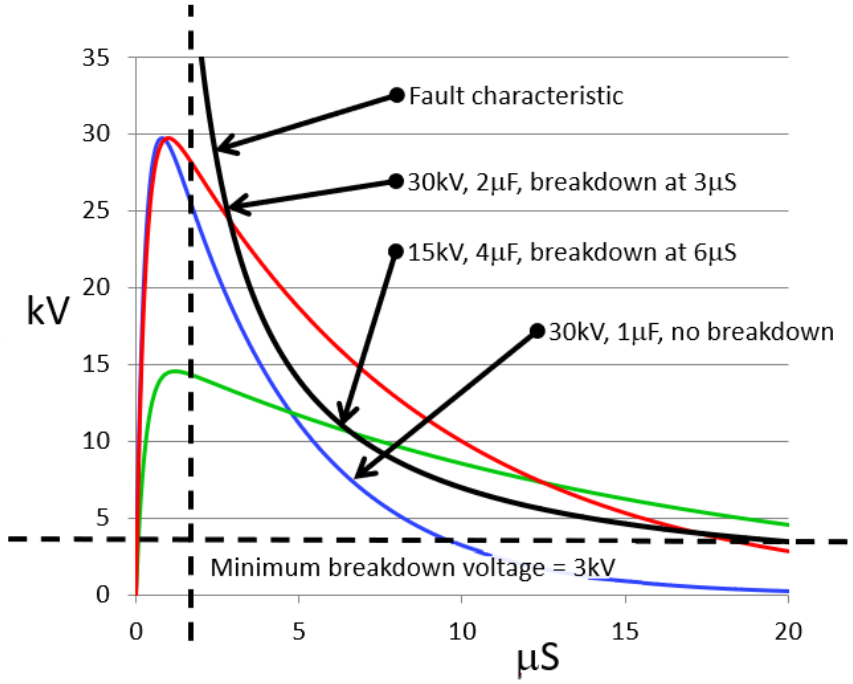


Figure 3.3. Surge characteristics

This is a series of curves with axes; V (kV) and t (µs). The black line represents a typical fault characteristic showing that it will not break down instantaneously.

It is a common misconception that the ability of a surge to break down the fault is solely dependent on the magnitude of its voltage. Figure 3.3 shows that this is not always the case. If the green 15kV (4µF) curve is considered, it only cuts the fault characteristic after 6 µs, when it is past its peak. Meanwhile with twice the voltage but a much lower capacitance, the blue 30kV curve fails to cut the fault characteristic at all and does not result in a breakdown. Increasing the capacitance by a factor of two, as shown in the red curve causes a breakdown after around 4µs. The increase in capacitance serves to increase the energy delivered in the surge, allowing the breakdown to be achieved at a lower voltage, which may be the difference between a successful and unsuccessful test.

A further benefit of increasing the capacitance is that the extra energy should result in a louder sound and more vibration at the fault point which will enhance the pinpointing process.

The T-305E is available in versions with either 1024J output or 2048J, the disadvantage of the higher value being an increase in the surge generator's size and weight.

3.4 Low-voltage cable break-down

The term "low voltage cable" refers to cables rated below 400V and hence, the insulation rating is also low. In order to protect the healthy sections of the cable, the operator should be careful to ensure the discharge voltage does not exceed 5kV. If it is difficult to break-down the fault point at this level, it is better to increase the capacitor value. Typically, 5kV with 10µF should be sufficient to break-down the fault.

4. Equipment Construction

The surge generator is housed in a rectangular case, mounted on a pair of wheels to provide mobility, facilitated by the rear mounted handles. At the front, castors, fitted with brakes, ensure the equipment in immobile whilst in use. The difference between the 1024J and 2048J versions of the equipment, is the size of the internal capacitors. This makes the 2048J device heavier and slightly taller (see section 2.6 Technical data).

The T-305E is fitted with a collapsible shelf, which provides a convenient space to position the Kehui T-906 TDR fault locator. The cables are contained in a bag at the front of the unit.

Figure 4.1 T-305E in use, showing wheels, castors, cable bag and shelf

4.1 User interface Description

The user interface is situated on top of the unit. The layout of the 1024J and 2048J versions is identical except for the values on the capacitor bank switch. The details of the user controls are shown in figure 4.3.

Figure 4.2 Top panel (user interface) on the 2048J version

Figure 4.3 1024J T-305E Front panel

1. HV Voltmeter: Shows the magnitude of the high voltage output. The analogue meter allows the voltage fluctuations to be observed during discharge.
2. Ammeter: Indicates the leakage current during insulation testing.
3. Grounding alarm: Provides a red indication when the protective ground is not properly connected. When the alarm is activated, the HV circuit will also be disabled.
4. Stop: Pressing this button will open the HV circuit. The red “start” indication will be switch off and the green “stop” indication will turn on.
5. Power switch: The key prevents the unit being turned on when the by unauthorised personnel.
6. Timer: The timer sets the cyclic discharge from 4 – 15.
7. Start: Pressing this button will close the HV circuit. The internal discharge switch will operate. The red “start” indication will be on and the green “stop” indication will be off.
8. Mode – Allows the selection of DC, pulse or cyclic modes of operation.
9. Surge – When the pulse mode is selected, pressing this button will produce a single surge pulse in to the cable under test.
10. Capacitor bank switch – Consists of three capacitor bank settings, selectable for different cable types and different fault types (note the capacitance values vary between the 1024J and 2048J versions).
11. Test Voltage Control – Has a zero voltage interlocking during power-up. Before power-up, the voltage must be adjusted to zero, otherwise the HV circuit cannot start.
12. Test method switch: To switch between two test methods: Impulse current method (ICM) and Secondary/Multiple impulse method (SIM/MIM).
13. Emergency Stop: In an emergency situation, pressing this button will cut off the power supply and automatically discharge any residual charge.

4.2 Rear Panel Description

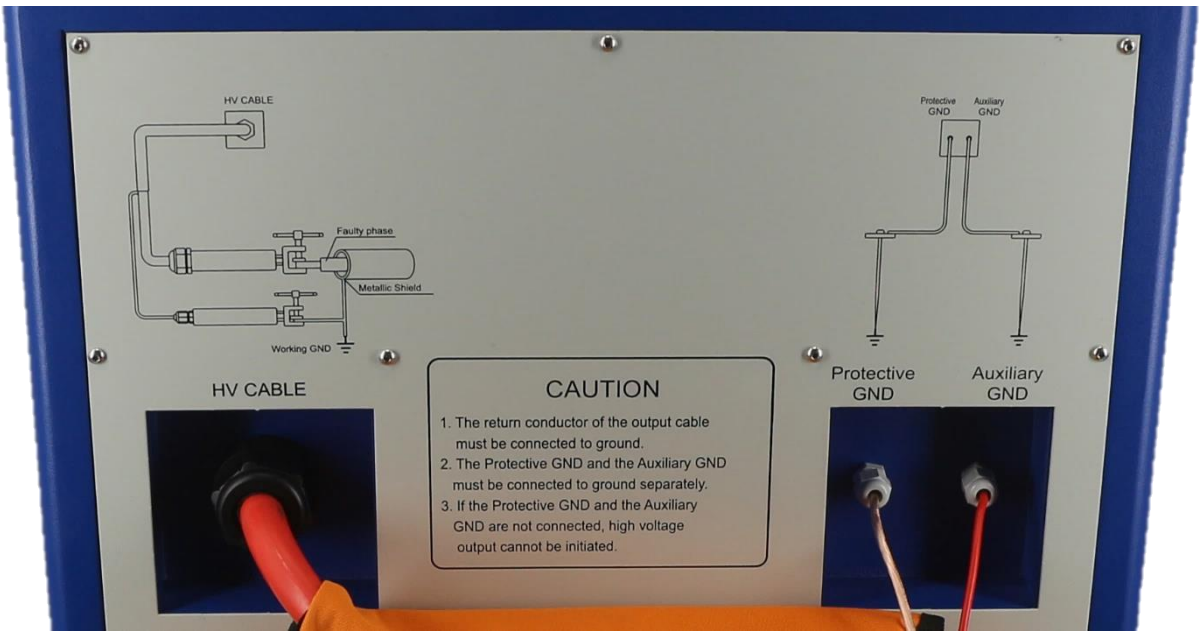


Figure 4.4 T-305E Back panel

The back panel of the instrument consists of the high voltage output cable, the protection grounding cable and auxiliary grounding cable.

i. High-voltage output cable: The core of the high-voltage cable is connected to the faulty cable, the transparent grounding wire is connected to the metallic protective sheath of the faulty cable. The metallic protective sheath must be grounded, which is called the working ground (**Working GND)**.

ii. Protection grounding cable: The protection grounding cable is connected to the ground using the grounding clamp. The protection ground (**Protection GND**) must be separated from the working ground. If separate grounding points are not available, the protection ground can also be connected to the substation earth bar but it must be as far away as possible from the point where the 'working ground' is connected.

iii. Auxiliary grounding cable: The auxiliary grounding cable is connected to the ground using the grounding clamp. The auxiliary ground (**Auxiliary GND**) must be separate from the protection ground. If separate grounding points are not available, the auxiliary ground can also be connected to the substation earth bar but it must be as far away as possible from the point where the 'working ground' is connected. Additionally, it must not be clamped together with the auxiliary ground, but connected at a separate point on the substation earth bar.

Note: The protection ground and the auxiliary ground must be grounded separately, otherwise the high voltage output cannot start.

4.3 Side Panel Description

Figure 4.5 T-305E Side panel connections

Trigger connection to T-906 fault locator to implement the SIM/MIM or ICM method, depending on the mode selected.

The side panel consists of the power socket and the interface to T-906, the cable fault locator.

i. Power socket: Connect 220/240V AC input to provide power for the normal operation of the device.

ii. Trigger/Signal port: For connection to the trigger/signal port of T-906. For the impulse current method, the output signal is the impulse current. For the secondary/multiple impulse method, the output signal is the secondary impulse, the input trigger is the Time Domain Reflectometry (TDR) pulse.

5. Getting started

Before operating the instrument, ensure that the cable under test is without power, fully discharged (see below) and totally isolated.

5.1 Using the discharge rod

The discharge rod supplied with T-305E is multi-sectional and retractable, and in the first section a discharge resistor is embedded. The discharge procedure consists of three stages: air ionisation discharge, resistance discharge and direct grounding discharge.

i. Connect the discharge rod cable to the rod and attach it securely to a suitable grounding point using the crocodile clip.

ii. Holding the handle of the rod, slowly let its metallic point approach the HV test item. During this process, a crackling discharge sound can be heard. This is air ionization discharge.

iii. After the air ionisation discharge becomes weak, the point of the rod can make contact with the HV test item directly. At this time, the item will be discharged through the discharge resistor inside the rod. The reading of the KV voltmeter will drop down.

iv. When the reading of the KV voltmeter drops to less than 5kV, use the earth contact tip of the discharge rod to directly ground the item.

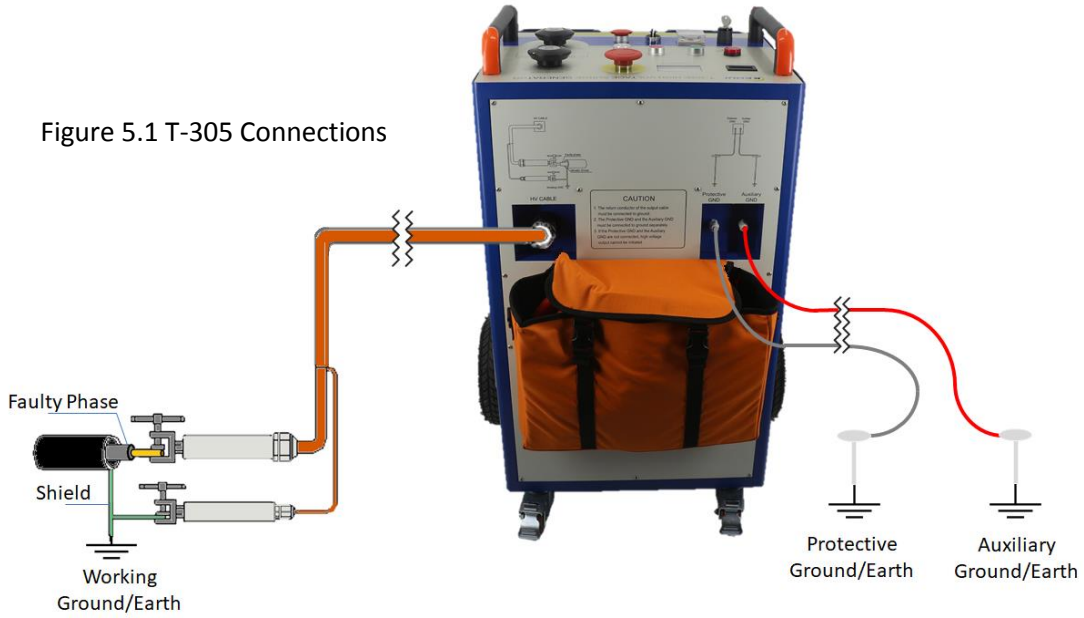
5.2 Wiring connection

i. Preliminary work: disconnect the faulty cable with other devices and ground the metal sheath. This is the Working Ground, the zero-volt reference point during the discharge process.

ii. Position the T-305E at about 2m away from the faulty cable, and put the cable fault locator on the tray at the side panel for easy operation.

iii. Connect the testing cables according to the figure shown below:

Figure 5.1 T-305 Connections



Note: The protection ground and the auxiliary ground must be grounded separately, otherwise the system is not safe.

There are five cables that are connected to the device, these are:

1. High Voltage Test Cable - The red high voltage cable should be connected to the faulty core of the cable under test, the transparent cable should be connected to the metal sheath, and the metal sheath should be grounded (the Working GND).
2. Protective GND Cable - This cable should be connected to a separate grounding point from the Working GND for safety reasons.
3. Auxiliary GND Cable - Use a metal drill rod for grounding. Again, for safe working, this needs to be separated from the Protective GND.
4. Power Cable - This is to connect to the 220/240V AC supply.
5. TRIGGER/SIGNAL Cable – This is to connect to the TRIGGER/SIGNAL port of the cable fault locator T-906.

Note: The Protective GND should be electrically separated from the Working GND (GND). This is to protect the shell of the instrument from the inducing voltage during high voltage discharge. This is also to protect the user from being injured in case of any T-305E current leakage.

Warning: Separate the Working GND with the Protective GND, they cannot be connected to one point. *When it is discharging, the voltage of the working GND point will be raised to thousands of volts in a second. If the Protective GND is not separated from the Working GND, the high voltage may transmit through the protective earth lead onto the shell of the T-305E, causing damages to the instrument and injury to the user.*

iv. Ensure that the retractable discharging rod is securely attached then clip the other end on the Working GND point. The discharge rod should be readily accessible beside theT-305E.

v. After examining all the cables to ensure the connections are correct, the T-305E can then be powered-on.

5.3 Modes of operation

The T-305E has three modes of operation selectable from the mode switch (figure 4.3 item 8), these are DC mode, Pulse mode and Cyclic mode.

5.3.1 DC mode

The DC mode is used for the DC Flashover method (section 6.1), the DC Voltage Withstand Test (section 7) and it can also be used as a power source for sheath fault testing with the Kehui T-H200 (section 9).

5.3.2 Pulse mode

The Pulse mode is used for the other pre-location methods; the Impulse flashover method (section 6.2), the Impulse current method, or ICM (section 6.3) and the Secondary/Multiple impulse method or SIM/MIM (section 6.4).

5.3.3 Cyclic mode

The Cyclic mode is used for pinpointing using a separate acoustic/electromagnetic detector such as the Kehui T-506 (section 8).

6. Fault pre-location

Warning:

- ***Cable fault location must be performed by properly trained personnel. A minimum of two people should be present during the test, to ensure safety.***
- ***The operators must be at least 0.5 meters away from the HV connections during testing.***
- **Before switching between different modes of operation, the user must completely discharge the T-305E and switch it off.**
- **When the test is complete, discharge the cable and surge generator manually using the discharge rod.**

T-305E allows several different methods of fault location. Where a triggered TDR unit is required, the instructions assume the use of the Kehui T-906 which can be connected directly to the TRIGGER/SIGNAL output port of the T-305E.

6.1 DC flashover method

The DC Flashover method requires a DC output from the T-305E which is increased until the fault breaks down, the resulting current flow will trigger the T-906 fault locator.

This method can only be used when the fault resistance is very high, as otherwise, most of the voltage drop is across T-305E's internal resistance and the voltage at the fault point will be too low to cause a break-down. In this case, the reading on the kV voltmeter will not increase and there is a significant buzzing sound from the instrument.

Approximately 20% of cable faults can be located using the DC Flashover methods and most faults that occur during preventive maintenance tests belong to this category.

The waveform obtained by the DC Flashover method is relatively easy to interpret. However, the resistance of the fault point will decrease after several discharges, until the method can no longer be applied. Therefore, the DC Flashover method must be used sparingly.

Operational procedure:

i. Turn the **MODE** to the **DC** position.

ii. Power on the T-305E, the green **STOP** button lights up.

iii. Turn the voltage **ADJUST** knob to the zero position, to enable the **START** control.

iv. Press the **START** button, which then lights-up and the green **STOP** light turns off. The sound of the HV protective device inside the instrument can be heard.

v. Turn the **ADJUST** knob slowly, the HV voltmeter will display the voltage applied across the fault point. When the voltage is high enough, the fault will break down, accompanied by the capacitor discharge. Repeat the charge and discharge process, the pointer of the kV meter swings back and forth periodically. Stop the voltage adjustment and check the T-906 unit to confirm that it has triggered. The resulting waveform can be used to measure the distance to the fault.

   When adjusting the voltage, if the HV voltmeter pointer goes up slowly or remains static and there is a loud buzzing sound from the instrument, it indicates that the DC Flashover method is not suitable. The voltage **ADJUST** knob should be immediately returned to the zero position. Under these circumstances a different mode must be used.

vi. Once the process is completed, discharge the cable and surge generator manually using the discharge rod (see section 5.1 Using the discharge rod)

6.2 Impulse flashover method

This mode is used to locate the range of faults with low resistance and high DC leakage current. The corresponding testing method is called the Impulse Flashover method. This works by initially charging the capacitor bank and, when the voltage reaches a certain value, the contactor operates connecting the capacitor to the faulty cable to break-down the fault. The resulting current flow will trigger the Kehui T-906 connected to the internal current coupler via the TRIGGER/SIGNAL port.

The Impulse Flashover method is suitable for most flashover faults. As with the DC method, the waveform obtained by the DC Flashover method is relatively simple and easy to interpret.

Operational procedure:

i. Turn the **MODE** knob to the **PULSE** position.

ii. Power on the T-305E, the green **STOP** button lights up.

iii. Turn the voltage **ADJUST** knob to the zero position, which enables the **START** button.

iv. Press the **START** button, which then lights-up and the green **STOP** light turns off. Inside the instrument, the noise of the HV protective device can be heard.

v. Turn the **ADJUST** knob slowly until the voltage rises to the chosen value, press the **PULSE** button to ascertain whether the voltage is sufficient to break-down the fault. If the fault does not break-down, raise the voltage further and repeat the process until break-down occurs.

vii. The swing of the pointer of the kV meter will indicate the fault status. A small swing indicates the fault has not broken down; if it is large, the operation is successful.

viii. When the break-down voltage value has been found, check whether the T-906 has triggered. If it has but the waveform is not satisfactory, the discharge voltage should be increased and the process repeated until a suitable waveform is obtained.

ix. Once the process is completed, discharge the cable and surge generator manually using the discharge rod (see section 5.1 Using the discharge rod).

6.3 Impulse Current Method (ICM) Testing

In this case other suitable makes of TDR unit can be used, connected using a suitable current sensor attached to the earth wire on the HV output. If the Kehui T-906 is used, an external current sensor is not required, as it can be directly connected to the TRIGGER/SIGNAL port using the Lemo cable supplied.

Operational procedure:

i. Turn the **MODE** knob to the **PULSE** position.

ii. Turn the **TEST METHOD** to **ICM**.

iii. Select a suitable capacitor bank setting.

iv. Power on the T-305E, the green **STOP** button lights up.

v. Turn the voltage **ADJUST** knob to the zero position, which enables the **START** button.

vi. Press the **START** button, which then lights-up and the green **STOP** light turns off. Inside the instrument, the noise of the HV protective device can be heard.

vii. Turn the **ADJUST** knob slowly until the voltage rises to the chosen value, press the **PULSE** button to ascertain whether the voltage is sufficient to break-down the fault. If the fault does not break-down, raise the voltage further and repeat the process until break-down occurs.

viii. When the break-down voltage has been found, press the **PULSE** button again and check the waveform on the T-906, which should allow the fault position to be identified.

ix. Once the process is completed, discharge the cable and surge generator manually using the discharge rod (see section 5.1 Using the discharge rod).

6.4 Secondary/Multiple Impulse Method (SIM/MIM)

The T-906 should be connected to the internal SIM filter of the T-305E through the TRIGGER/SIGNAL port using the Lemo cable supplied.

Operational procedure:

i. Turn the **MODE** knob to the **PULSE** position.

ii. Turn the **TEST METHOD** to **SIM**.

iii. Select a suitable capacitor bank setting.

iv. Power on the T-305E, the green **STOP** button lights up.

v. Turn the voltage **ADJUST** knob to the zero position, which enables the **START** button.

vi. Press the **START** button, which then lights-up and the green **STOP** light turns off. Inside the instrument, the noise of the HV protective device can be heard

vii. Turn the **ADJUST** knob slowly until the voltage rises to the chosen value, press the **PULSE** button to ascertain whether the voltage is sufficient to break-down the fault. If the fault does not break-down, raising the voltage further and repeat the process until break-down occurs.

viii. When the break-down voltage has been found, press the **PULSE** button again and check the waveform on the T-906, which should allow the fault position to be identified.

ix. Once the process is completed, discharge the cable and surge generator manually using the discharge rod (see section 5.1 Using the discharge rod)

7. DC Voltage Withstand Test

For power cables rated at 6kV or below, after the fault has been repaired, the T-305E can be used to perform a DC voltage withstand test.

7.1 Cable Connection

Before commencing the test, disconnect the faulty cable and ground the metal sheath.

Note: This is the Working Ground, the zero-volt reference point during the discharging process.

7.2 Performing the Test

Because the remaining charge on the cable may be significant, it should be thoroughly discharged before the test. As a guide, it usually needs 5 minutes for the discharge process (see section 5.1 Using the discharge rod).

Operational procedure:

i. Turn the **MODE** knob to the **DC** position.

ii. Power on the T-305E, the green **STOP** button lights up.

iii. Turn the voltage **ADJUST** knob to the zero position, which enables the **START** button.

iv. Press the **START** button, which then lights-up and the green **STOP** light turns off. Inside the instrument, the noise of the HV protective device can be heard

v. Increase the voltage by slowly turning the **ADJUST** knob, the voltmeter shows the voltage applied to the cable. When it reaches 75% of the test voltage, the rate of rise should increase to roughly 2% per second avoiding undue stress to the cable.

vi. If the cable fails the test, the voltage will collapse and the current will increase due to the breakdown of the insulation. On a healthy cable, no breakdown will occur.

7.3 Power off the T-305E

After the test is finished, turn the **ADJUST** knob to zero to discharge the cable. The T-305E can then be powered down.

Warning:

The power off procedure for DC Voltage Withstand Test is different from that for break-down test. There is no discharge loop for this test, the energy on the cable can only be discharged by the discharge rod. Therefore, the user MUST follow the correct discharge procedure using the discharge rod as described in section 5.1.

8. Pinpointing faults using the cyclic mode

This mode is used for pinpointing the fault position of the cable using the Kehui T-506 pinpointer or any similar device . In this mode, the T-305E will discharge to the cable at a frequency determined by the TIME dial setting. The flow of current through the fault point as it breaks down, generates periodic magnetic and acoustic signals, which can be picked up by the T-506 pinpointer for precise location of the fault.

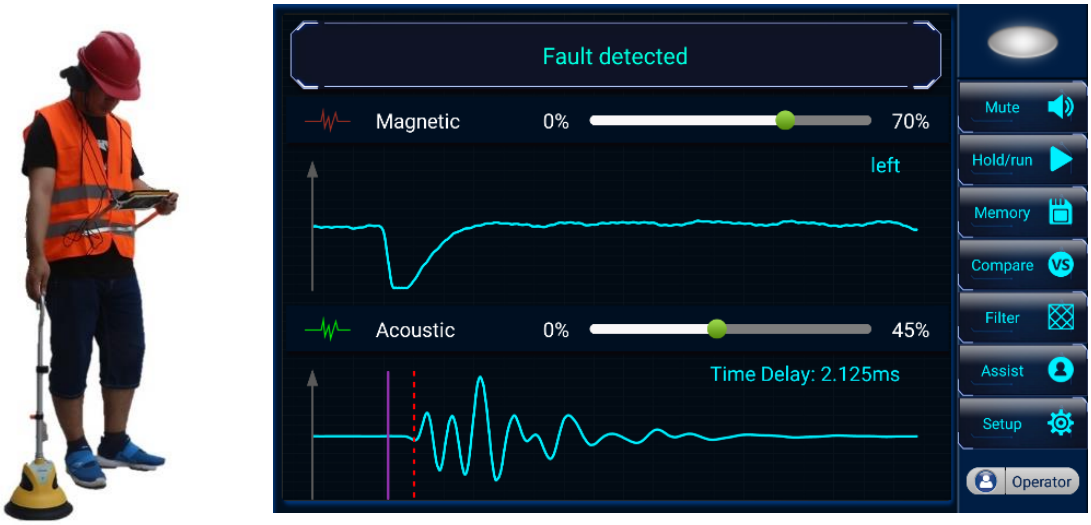


Figure 8.1 Pinpointer in use, with the resultant magnetic and acoustic waveforms

Operational procedure:

vi. Turn the **MODE** knob to the **PULSE** position.

vii. Power on the T-305E, the **POWER** indicator lamp will light-up.

viii. Turn the voltage **ADJUST** knob to the zero position, otherwise the **START** is disabled.

ix. Press the **START** button. The red **START** button will light up, whilst inside the instrument the noise of the HV protective device can be heard.

x. Turn the **ADJUST** knob slowly, and stop it when the voltage rises to the chosen value, press the **PULSE** button to ascertain whether the voltage is high enough to break-down the fault point. If the fault does not break-down, raising the voltage further and repeat the process until the fault breaks down.

x. The swing of the pointer of the kV meter will indicate the fault status. A small swing indicates the fault has not broken down; if it is large, the operation is successful.

xi. Switch the mode switch to CYCLIC and set the required pulse time on the clock by rotating the dial. The allowable time setting is dependent on the voltage set on the unit. The capacitor will require a finite time to charge, which will increase depending on the voltage selected. The minimum times that can be selected for each voltage level are indicated in the table below.

Note, if lower time settings are selected, the unit will not charge to the full voltage and may not break down the fault.

Version	Voltage setting	Minimum Time Setting
1024J	8kV	9s
	16kV	7s
	32kV	6s
2048J	8kV	18
	16kV	12s
	32kV	7s

xii. With the fault being broken down in regular cycles, the user can investigate the cable path around the pre-location point using the pinpointing equipment. When the time difference between the acoustic and electromagnetic signals is at a minimum, the fault has been pinpointed.

xiii. When the process is completed, discharge the cable and surge generator manually using the discharge rod (see section 5.1 Using the discharge rod).

9. Sheath Fault location using the Kehui T-H200

Note that the Kehui T-100C is the preferred power source for the T-H200, however it will also work with other suitable high voltage sources and can be powered from the Kehui T-305 surge generator, used in DC mode as explained above. Connections are shown below:

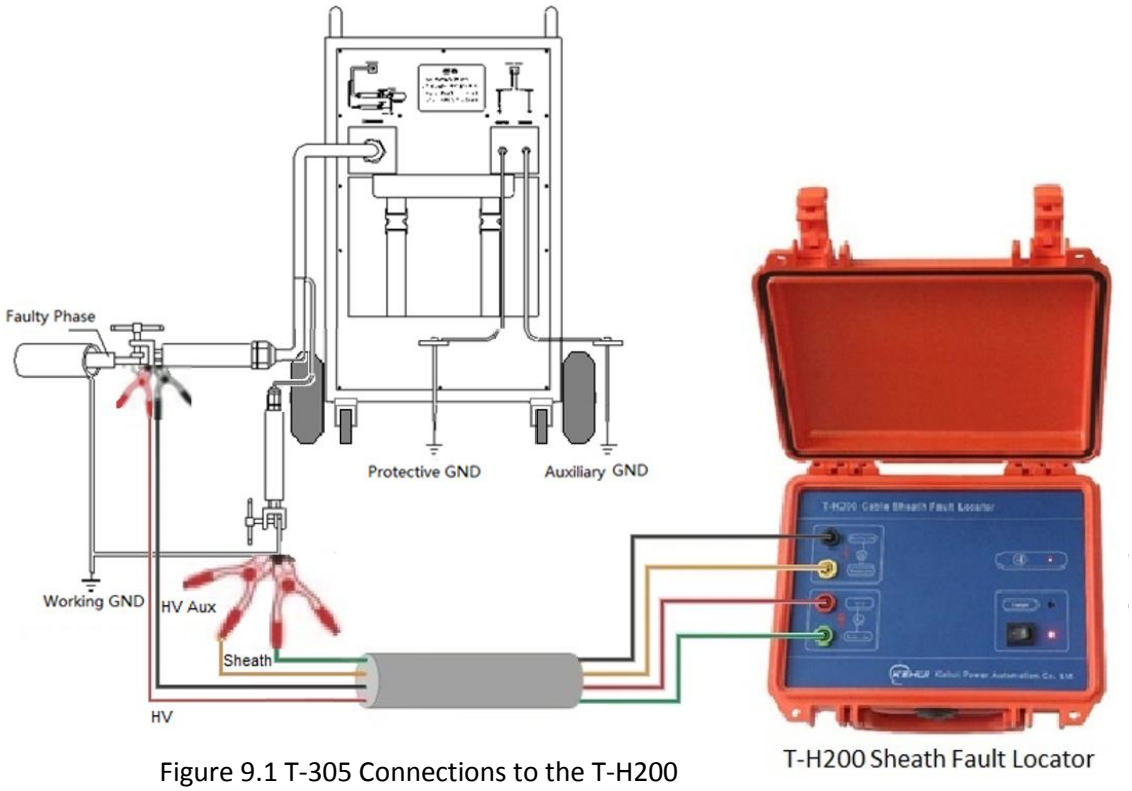


Figure 9.1 T-305 Connections to the T-H200

Operational procedure:

To operate the T-H200 Sheath fault locator, the T-305E provides a continuous constant DC high voltage.

i. Turn the **MODE** to the **DC** position.

ii. Power on, such that the **POWER** indicator lights up.

iii. Turn the voltage **ADJUST** knob to the zero position, otherwise the **START** will not work.

iv. Press the **START** button. The red **START** light comes on and the green **STOP** light turns off. The sound of the HV protective device inside the instrument can be heard.

v. Slowly rotate the **Adjust** knob to increase the output voltage, observing both the voltmeter and the ammeter. When the current reaches 50-100mA, stop increasing the HV voltage.

vi. On the tablet APP, select “cable length” and enter the exact length of the cable, the APP will calculate the “resistivity” automatically, and store the value for the next stage of operation. It is recommended to follow the T-H200 manual instructions to make the measurement

xiv. When the process is completed, discharge the cable and surge generator manually using the discharge rod (see section 5.1 Using the discharge rod)

10. Shut-Down Procedure

The T-305E has an internal high voltage discharge device, which will directly short circuit the cable, capacitor and ground terminals of the instrument when the power is off. If the power is shut off directly, without following the procedure below, the residual electric energy stored in the cable and the capacitor will discharge through this device. This will produce a loud discharge sound and may reduce the lifespan of the T-305E.

Warning: The T-305E MUST be shut down strictly according to the below procedures after the test is finished.

1. Turn the **ADJUST** knob to the zero position.
2. Press down the **PULSE** button to release the power stored in the capacitor.
3. Use the discharge rod in the right way to discharge the faulty cable, until the voltage is lower than 5kV (watch the kV pointer).
4. Press down the **STOP** button, the high voltage input will be cut off.
5. Power off the T-305E.
6. Further discharge the cable completely using the discharge rod.

Note:

Only after all the HV parts have been fully discharged, the lead wires and test wires can be touched and removed. Remove the plug from the power socket first, and then remove the plug on the back panel of the T-305E.

11. Maintenance and troubleshooting

When the following conditions happen, it is mostly likely caused by an incorrect operation. Please perform the following correct procedure.

- The power light is not on when the mains is connected.

  Reason: The power switch needs to be pressed to switch on the power. Check the power cable connection and press the power switch.

- Pressing the START button has no effect.

  Reason: The voltage ADJUST knob is not in zero position. Turn the ADJUST knob to zero position, then press the START button.

- When increasing the voltage ADJUST knob after the instrument has started, the voltmeter does not react.

  Reason: The T-305E is not properly grounded. Ensure that the working GND, the protective GND and the Auxiliary GND are grounded at different positions.

- When increasing the voltage, the voltmeter pointer is always at the lower voltage position, and there is big buzzing noise in the T-305E.

  Reason: The work mode is on DC position, and the fault is a low resistance fault. Adjust the work mode to PULSE position.

This T-305E is a high voltage device, if problems other than the above are identified, contact Kehui for repair or replacement (info@kehui.com). Do not try to fix it yourself, this may cause further damage or injury to the operator.

12. Packing List - T-305E Packing list

No.	Materials	Picture	Quantity	Order Code
1	High Voltage Surge Generator including integral 3.6m HV cables (1024J)		1	15.01.3231
1a	High Voltage Surge Generator including integral 3.6m HV cables (2048J)		Alternative to item 1	15.01.3224
2	Grounding pin		2	05.27.2090
3	Power Cable		1	05.35.2114
4	Discharge Rod		1	05.34.2109
5	Discharge Rod Cable		2	
6	Manual		1	
7	Test certificate		1	
8	QC Pass certificate		1	
9	Adaptor		1	