Dear Client

Thank you for Purchasing our **HT-TC Cable Fault Locator**. Please read the manual in detail prior to first use, which will help you use the equipment skillfully.

Our aim is to improve and perfect the company's products continually, so there may be slight differences between your purchase equipment and its instruction manual. You can find the changes in the appendix. Sorry for the inconvenience. If you have further questions, welcome to contact with our service department.

The input/output terminals and the test column may bring voltage, when you plug/draw the test wire or power outlet, they will cause electric spark. PLEASE CAUTION RISK OF ELECTRICAL SHOCK!

Company Address:

- T4，No. 41, High-tech 2 Road，East Lake High-tech Development Zone，Wuhan
- Sales Hotline: 86-27- 87457960
- After Service Hotline**:** 86-27- 87459656
- Fax: 86-27- 87803129
- E-mail: qiao@hvtest.cc
- Website: www.hvtest.cc

◆ SERIOUS COMMITMENT

All products of our company carry one year limited warranty from the date of shipment. If any such product proves defective during this warranty period we will maintain it for free. Meanwhile we implement lifetime service. Except otherwise agreed by contract.

◆ SAFETY REQUIREMENTS

Please read the following safety precautions carefully to avoid body injury and prevent the product or other relevant subassembly to damage. In order to avoid possible danger, this product can only be used within the prescribed scope.

Only qualified technician can carry out maintenance or repair work.

--To avoid fire and personal injury:

Use Proper Power Cord

Only use the power wire supplied by the product or meet the specification of this produce.

Connect and Disconnect Correctly

When the test wire is connected to the live terminal, please do not connect or disconnect the test wire.

Grounding

The product is grounded through the power wire; besides, the ground pole of the shell must be grounded. To prevent electric

shock, the grounding conductor must be connected to the ground.

Make sure the product has been grounded correctly before connecting with the input/output port.

Pay Attention to the Ratings of All Terminals

To prevent the fire hazard or electric shock, please be care of all ratings and labels/marks of this product. Before connecting, please read the instruction manual to acquire information about the ratings.

Do Not Operate without Covers

Do not operate this product when covers or panels removed.

Use Proper Fuse

Only use the fuse with type and rating specified for the product.

Avoid Touching Bare Circuit and Charged Metal

Do not touch the bare connection points and parts of energized equipment.

Do Not Operate with Suspicious Failures

If you encounter operating failure, do not continue. Please contact with our maintenance staff.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in Explosive Atmospheres.

Ensure Product Surfaces Clean and Dry.

—Security Terms

Warning: indicates that death or severe personal injury may result if proper precautions are not taken

Caution: indicates that property damage may result if proper precautions are not taken.

CONTENTS

Ⅰ. Product introduction

The normal operation of cable-communication and electric transport completely rely on the good condition of the cable-circuit. Once the circuit breaks down and without punctually examination and repairing, it will no doubt trigger the mass economic loss and bad social influence. So the electric fault measuring testing instrument is a very important tool. The intellectual testing instrument uses multiple testing methods and adopts the most advanced electronic devices and with computer and special electronic technology, combining our company's successful experience of long-time exploitation on cable-fault measuring testing instruments, and it is absolutely of high tech, intelligence and abundant functions.

Our cable-fault detector is a testing device of good integrity. It can test on the High Resistance Flashover Fault, Grounding High and Low Resistance Fault, Short & Off Circuit on the Cable Fault and Poor contact and etc. If being equipped with sounding method and locating instrument, it can exactly detect the fault point. Furthermore, it especially applies to test for various power cable and communication cable.

Ⅱ. Product features and technique parameters

1. Functions

1.1 Multiple functions

Safe, quick and accurate test. The instrument applies the methods of Low Voltage Pulse and HV Flashover. It can test all kinds of faults, especially on the Flashover and High Resistance fault testing and without burning through. If it is equipped with locating instrument, it can exactly point out the location of the fault.

1.2 High Precision

Our instrument uses the tech of high speed data sampling, the speed of A/D is 100MHz, and makes resolution ratio of 1m and testing dead zone of 1m.

1.3 High intelligent

The testing results automatically show by wave form and data on the large LED. It is easy for viewing. It does not need especial training for operators.

1.4 Function of Wave Form and Parameter Saving & Reading

It uses non-volatile devices and after turning off, it still saves the wave form and data.

1.5 Function of Double-trace Showing

It can compare the wave forms of fault-manner cables and those of the regular ones. It is benefit for the further testing of the fault.

1.6 Function of Magnifying on the Scale of Wave Form

Through magnifying the scale of the wave form, it can make further exact testing.

1.7 It can wantonly change the position of the cursor, showing the direct or indirect distance of fault point and testing point.

1.8 It has the function of changing the speed of communication depending on the tested cable.

1.9 The instrument is portable and with a chargeable battery to provide power. It is convenient to take and use.

2 Main technique parameters

2.1 Scope of application and using purpose

The instrument can test all kinds of electric cable(voltage of 1KV-35KV) and the Short Circuit, Grounding, Leakage of High Resistance. High Resistance Flashover, Out Line and Bad Contact fault on the local cables, frequency modulation communication cables, coaxial cable and metal aerial cables. It also can test the length of cable and the spread velocity on the cable.

2.2 The longest testing distance is 15KM (100KM for the open-wire line)

2.3 Testing .dead zone is 1M.

2.4 Resolution of reading is 1M

2.5 Power dissipation is 5VA

2.6 Service condition :

environment temperature 0℃~＋40℃

terminal temperature　－10℃~＋50℃

relative humility　20-90%RH

2.7　Dimension: 275×220×160mm^3

2.8　Weigh: 1.8kg

Ⅲ. Low Voltage Impulse Testing Method

1. Principle of Testing

The principle of cable fault testing is based on the asymmetrical resistance's reverse on the communication of the electric wave in the cable.

Based on the theory of Transportation Line, every line has a unique resistance Z_c, which is depending on the structure of the circuit but not the length of the line. In the symmetrical transportation line, the resistance input equals the unique resistance at any point. If the load of terminal equals the unique resistance, the current wave and voltage wave on the transportation reverse none but absorbed totally by the terminal. When the resistance at any point is unequal to Z_c, the electric wave reverse all or partly. The scale of reverse polarity can be expressed by parameter P, the relation is on the below:

$$P=\frac{U_r\text{（reflection wave）}}{U_i\text{（incident wave）}}=\frac{Z_o-Z_c}{Z_o+Z_c}\qquad(1)$$

Z_c is the resistance of the transportation line

Z_o is the resistance of the reverse transportation line

(1) When it works without fault, $Z_o = Z_c$, $P = 0$, no reverse.

(2) when the circuit is off line, $Z_o = \infty$, $P = 1$, it reverse totally and the polarity of the incoming wave and its reflex are the same.

(3) when the circuit is short circuit, $Zo = 1$, $P = -1$, it minus totally reverse and the polarity of the incoming wave and its reflex are the opposite .

When there is an impulse electric wave, the impulse conveys on the line by the speed of V, and reflex to the input terminal when the row distance L_x meets the fault point. The time of the reverse is T, so the relation is on the below:

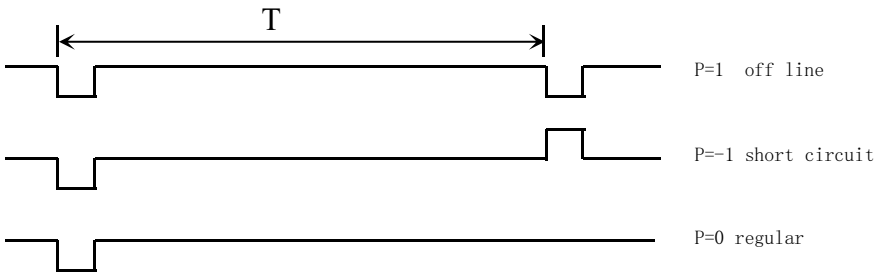
$$2L_x = VT$$

$$\therefore L_x = \frac{1}{2}VT \qquad (2)$$

V is the speed of the electric wave of the line, and is related to the linear circuit parameter and constant to an case which can be detected by the instrument and calculated by computer. When the displayer show the the impulse and the reverse wave from the fault point in real time, we can get the time T by providing the instrument's time signal. So we can get the location of the fault point from (2). Different kinds of faults has wave charts as below:

Method of impulse can easily detect the fault in the off line, short circuit and cable's low voltage grounding. In the situation of high resistance fault, for it still shows high resistance in the condition of low voltage impulse and makes no or few reverse wave. In this

situation, we need add amount of current or high voltage impulse to discharge it and get the reverse wave by the short circuit in a wink by flashover electric arch.



IV. High Voltage DC Flashover Method

When the resistance of fault is really high, before it forms a constant current tunnnel, it can grandually rise the voltage on the cable. Reaching some voltage, the fault point is first been sparked over forming the flashover, and we can use the electric arch added to the voltage to form a short circuit reverse. The reverse wave at the input terminal forms the open reverse by the high resistance resourse. So the voltage reverse many times between the input terminal and output terminal until it runs out of energy. The grahp of testing principlewave form of reverse wave are as below:

The distance of the fault point: $L_x = \frac{1}{2} V \cdot T$

Among: $T = t_2 - t_1 = t_2 - t_1 = t_2 - t_1 = \cdots\cdots$

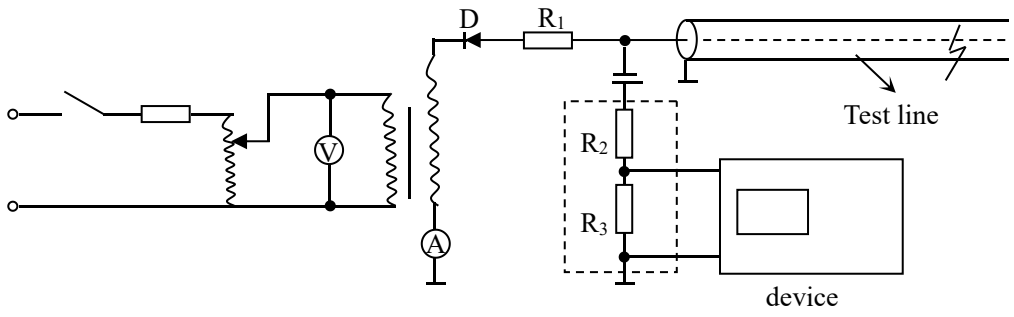


Figure 2

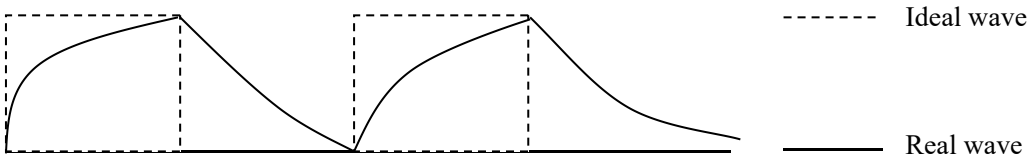


Figure 3

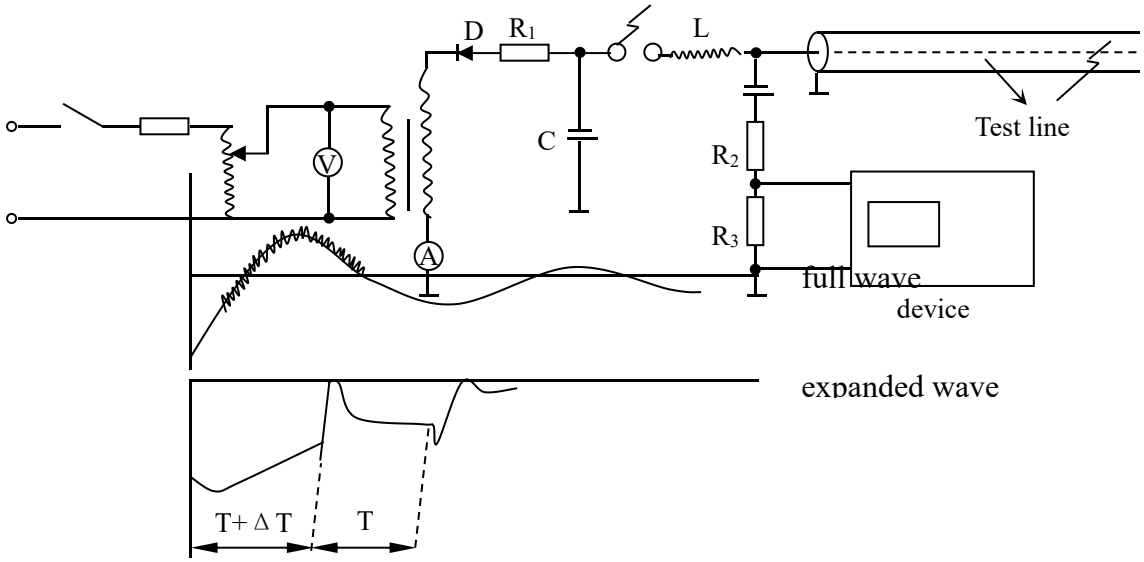
Theoritically the wave form should be steep square wave, but refer to the incomplete reverse and circuit comsuption the real wave becomes smaller and smoother.

V. High Voltage Impulse Flashover Method

When fault point reduces the resistance and forms constant resistance tunnal, we have to choose the voltage impulse method for we can not add more high voltage current by the limit of instrument capacity. High voltage current through sphere gap can charge the cable until spark-over, and we still use the reverse wave produced by the flashover electirc arch. At the input terminal of cable we detect the inductance L to read the reverse wave. The circuit principle graph is as below. Electric wave reverse at the fault point and reverse by L at the input terminal, so it forms multiple reverse. Because of the self-inductance phenomenon, it shows as open reverse at frist for the resistant effort of L, and shows as short circuit reverse by the acumulation of current. And the whole circuit is made of process of discharge by electric capacity C and inductance L. So at the output terminal the curve shows as a reducing cosine wave added by several quick impulse reverse waves. As the graph below. We can get distance of fault from the internal of reverse wave.

Fault distance: $L_x = \frac{1}{2} V \cdot T$

T+ΔT≥T , ΔT is time of discharge decay.



VI. Fundamantal Principle and Composition

1. Fundamantal Principle of Instrument

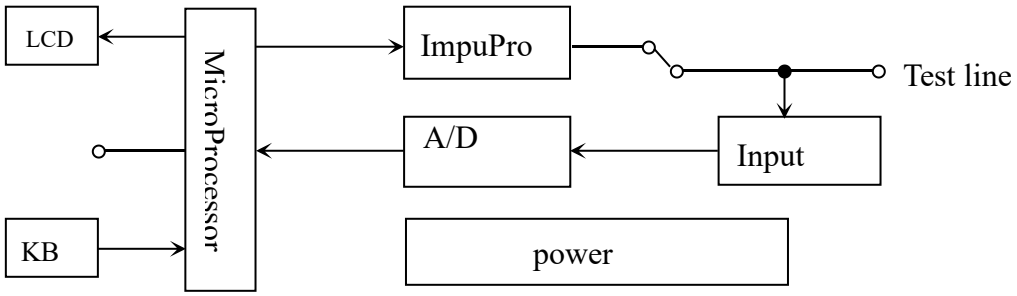
Based on the fault testing principle, when the device is in the trig mode of flashover, the flashover wave formed by electric arch on the fault point is random einmal transient wave, so the instrument should have the function of saving, capture and displaying the einmal transient wave. The instrument applies the technology of digital storing using the high speed A/D converter to get sample, and converts the transient analog signal to digital signal in real time and saves it in the cache. Then sent the signal to LCD displayer control circuit after processing in the CPU as time series dot matrix signal and then shows the sampling parameter on the LED displayer.

When the instrument in the mode of impulse trigging, it sent

detective impulse to the tested cable and input circuit in certain cycle. At the same time the A/D works and has the same process of sampling, storing, processing and displaying as stated before. LED displayer should have reverse wave form.

2. Composition of the Instrument

Instrument is designed as the core of micro processor and controlling the signal's sending, receving and digitalizing processing. The principle of the operation is as below:



The word done by microprocessor concludes: data sampling, data storing, data filtration, cursor moving, distance computing, graph comparing, graph size changing and displaying on the LED. And it also can depend on need to communicate by the tranportion port and PC.

Impulse producer forms the a logic impulse of a certain width by the coding signal from the micro processor. The impulse will be converted by transmitting circuit to high range and eventually to the tested cable.

High speed A/D producer is to convert reverse signal on the tested cable through input circuit sending A/D sampling and finally sent ot

the micro processor.

Keyboard it the window for communication between human and computer. Opertators can type the command by keyboard to computer by the testing and then the computer controller complete some kind of testing.

VII. Panel Controlling and Keymanual's Function

1. On/ off: control the power of the device on or off. Press the button, the device has the power and displayer will show the window of operations.
2. Mode : press is flash over mode, otherwise it is impulse mode.
3. Waveform control: control the wavefrom size.
4. Output: the output line of device connected to the tested terminal of cable.
5. Transmission speed: The preset speed of the instrument is

200m / μs. The corresponding value should be entered according to the actual type of cable. Otherwise, the result will be incorrect.

6. Transmit: Each time pressed, the instrument emits a pulse and samples.

7. Display scale: Different measurement range corresponds to a different display scale, that is, the sampling point, according to different intervals displayed on the screen, the larger of range, the larger interval, the greater the proportion of display, change the display scale the waveform can be extended. Adjust the display scale by pressing the decrease/increase key.

VIII. Instrument use fault test method

1. Fault type detect

Before the test cable fault, first determine the type of fault in order to determine which test method to use. With the help of a multi-meter or megger or other tools and on-site experience, you can prejudge the type of failure.

If the fault type is open, short circuit, poorly contacted, or low impedance grounded, use low voltage impulse method for measurement. If it is high resistance fault, you should use high voltage impulse method. If the fault type is not certain, you can use the waveform comparison method.

2. Wave velocity calibration

When the measured cable velocity cannot be determined, it must

be calibrated to ensure the accuracy of fault measurement. The calibration method is as follows:

1) Prepare a standard cable same type as the cable under test;

2) Connect the standard cable to the output port of the tester;

3) Turn on the instrument power switch;

4) Choose the impulse mode, the upper right corner of the screen shows "impulse";

5) Adjust the measurement range more than or equal to the length of the standard cable;

6) Press the "impulse" button to send the test pulse, the screen to get reflected waves;

7) Press the ▸ button to move the cursor to the start of the reflected wave. If the reflected wave is not well discriminated, adjust the “waveform control” knob to change the amplitude of the waveform and then retransmit the pulse;

8) Modify the wave speed until the measured distance is equal to the length of the standard cable, and then note the value for use.

3. fault test

1) Low voltage impulse method

A. Disconnect all equipment from the cable under test

B. Connect the cable under test to the output port of the tester.

C. Turn on the power.

D. Choose the impulse mode.

E. Enter the wave speed value corresponding to the cable under test.

F. Adjust the “waveform control” to maximum, press “transmit”, there is wave on the screen.

G. If there is no reflected wave, adjust the measurement range and then repeat the pulse, so try several times, until wave reflects.

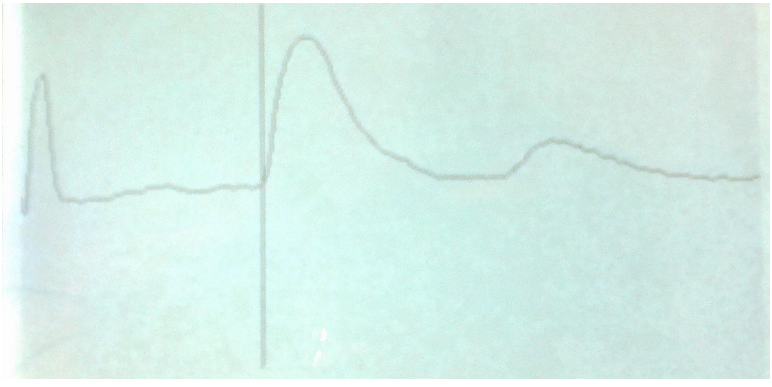
H. Adjust the gain and retransmit the pulse, make the front of the most steep reflection wave;

I. Press ◄ or ► to move the measuring cursor to the leading edge of the reflected wave, and the upper left corner of the screen shows the fault distance;

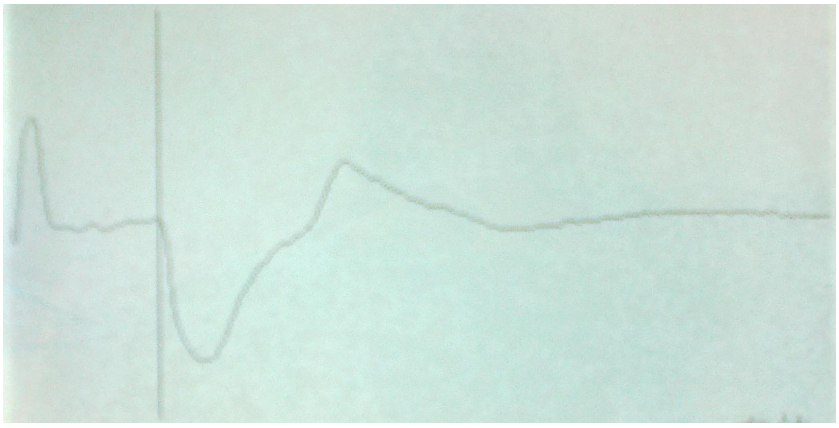
J. In order to improve the accuracy, change the waveform proportion, the waveform is expanded, according to the above method for precise positioning;

K. The fault type can be judged by the polarity of the reflected wave.

Short circuit waveform:



Short circuit waveform:

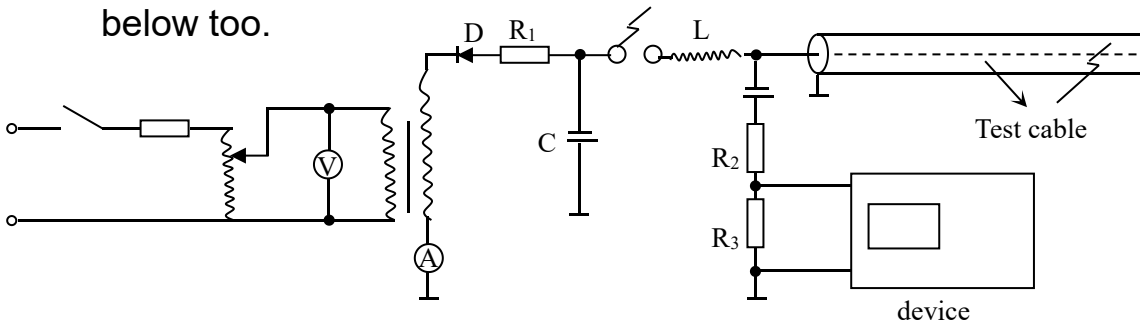


A. First working mode at flash over, the transmission speed should be the wave speed of the cable under test.

B. Application: the resistance of the fault is very high and not forming a fixed tunnel, under a certain voltage it can create a flashover discharging fault of the electric cable. Preventative spark-over testing usually applies this method.

C. The time of the high voltage current flashover method varies, and the short one can exist for some times. The wave form is simple, can be easily recognized and with a high accuracy and value it.

D. The principle graph of the current flashover method is as below. In the real testing, apply the high voltage equipment and our high voltage testing production. The connecting graph is as below too.



T1 voltage adaptor……2KVA

T2 high voltage transformer……0～50KV，2KVA

D high voltage silicon stack……ReV: 100KV，FoV: 100mA

C high voltage capacity……...0.1μF，10KV

The AC/DC meter: 0-300V; The current meter: 100mA;

In the high pressed testing equipment,

Resistance: 30±20/5kΩ;

Output resistance: 500Ω±10%.

E. Turn on the power, the screen lights. Then rise the voltage gradually by adaptor, and when the fault point has the phenomenon of flashover, the current in the micro-amp meter rises heavily and the indicator in voltage meter also alters heavily. The wave form as below should be on the screen. From the graph, the interval of t1and t2 should be the distance of the fault points.

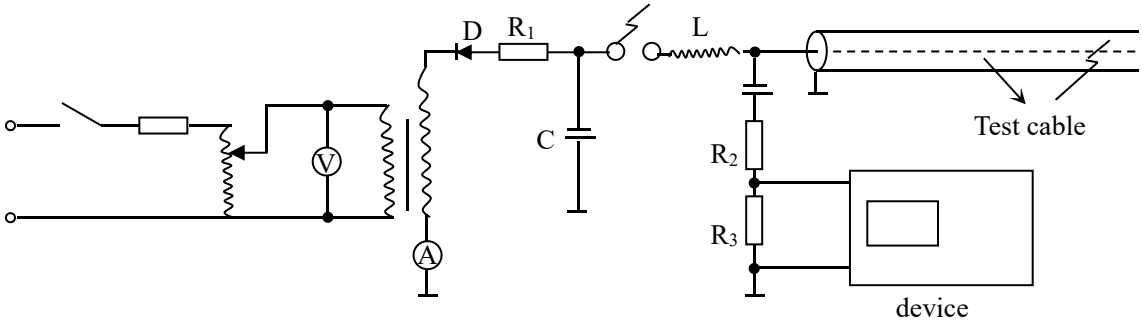
F. The voltage of high voltage flashover testing method could be as high as thousand or ten thousand voltage and operators should obey the operation rules like connecting the equipment to the ground and high voltage equipment's base line and grounding line of the equipment should connect to the cable in lead which is connected to the ground. Connect the lines as 9.3 and check the water resistance and voltage divider resistance in the high voltage testing.

3) Impulse High Voltage Flashover Method

A. Application: the fault point with a high resistance but already forms a fixed a tunnel in cable. The high voltage equipment's capacity is in limit, if the current can not reach the certain level, it should apply flashover method. The fault which can not be tested out by current flashover and impulse method, the method applies it in theory.

B. As the same, it shuold check the switch whether on the position of flashover and the high voltage testing equipment whether has a good water resistance and voltage divider.

C. Connect the devices as below. The ground line works as 8.2.6 and 9.3. The capacity in it is demanded higher than 1μF, the withstand voltage should be in demand. The other demands are as the same of the flashover method. The inductance usually uses as in the device 2 or device 3. Or adjust the wave form according to the length of the tested cable.



D. Testing method: adjust the adaptor to rise the voltage to the burn down of the tested staff. The gap of the spheres should account to the resistance and whether the tested voltaeg could

discharege normally. The impulse flashover fault point whether discharge normally can be detected by the whole wave form.

E. It can detect whether there is a fault of spark-over flashover phenomenon by the sound of the gap sphere dischargin and indicator of the electric meter. If the discharging phenomenon does not clear, it can add the voltage, sphere gap, or the capacity of storage capacitor.

F. The testing of the fault distance is as the same as before.

4) Waveform comparison method

A. Disconnect all equipment from the cable under test;

B. Connect the normal cable to the output port of the tester.

C. Use the low-voltage pulse method to read the measurement waveform of the normal cable and save it.

D. Connect the faulty cable to the output port of the tester and measure its reflected wave;

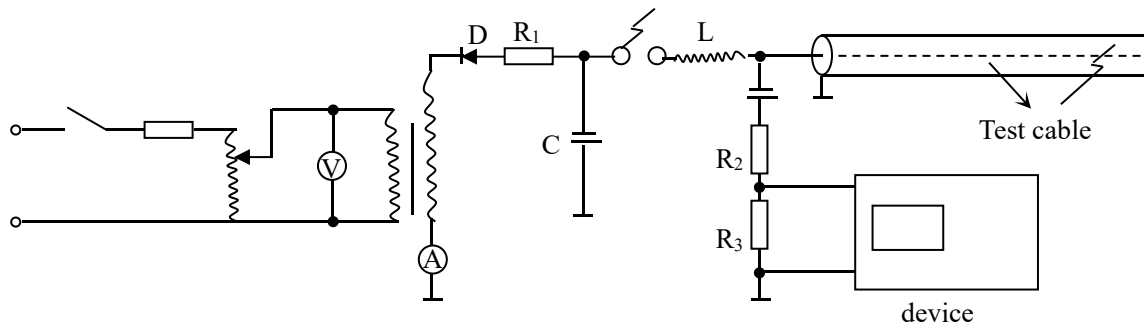
E. Find the saved waveform;

F. Compare the differences between the two waveforms and find the point of failure.

IX. Announcement

1. In the method of impulse testing, it shuold drop off any inside devices and do the testing on the outmost line.
2. In the method of flashover testing, it must turn the switch to the position of flashover.

3. In the method of current flashover or impulse, operators should pay great attention on the safety. Arrange the lines as ordered.
4. After the flashover testing, it should cut off the power, remove the connecting line between the device and high voltage testing equipment. Then discharge the high voltage capacitor and the electric charge stored on the cabel. In discharging, it should first add the current limit resistance R to limit the discharging current and assuage the process of discharging. After the voltage of capacitor is low, it can discharge directly to the ground until the voltage is zero. If discharging in seconds, the instant current can reach hundred amps and it can demage the device or operators.



5. In the testing of current flashover, the whole process must be under carefully monitoring to avoid the sudden rising in current. If the flashover phenomenon does appear, it should reduce the voltage at once and change to the impulse method.
6. Charge: When the battery energy is insufficient, should be charged in time. If the instrument is not used for a long time, it

should be regularly charged, so as not to damage the battery.

X. Packing list

1. Host	1
2. Power cord	1
3. Output cable	1
4. Instruction manual	1
5. Inspection report	1
6. Certificate	1

XI.Common fault repair

Fault phenomenon	Reason	Solution
Power on, power indicator light does not shine	1.indicator broken； 2.battery out power； 3. The circuit board in the host is faulty	1. See if there is an image on the screen； 2.Charge； 3. Contact the supplier.
Power on, power indicator light, but no image	1. Contrast adjustment improperly 2. The circuit board in the host is faulty	1.Adjust contrast knob； 2. Contact the supplier.
Boot, there are images, but no emission waveform	1. Contrast adjustment improperly 2. The circuit board in the host is faulty	1. Adjust contrast knob, press impulse. 2. Contact the supplier.
When measuring, there are emission waveforms, no reflection waveform	1. Measuring range is wrong 2. The output test leads are not connected well to the cable under test 3. The circuit board in the host is faulty	1. Adjust measurement range 2.Check wiring 3. Contact the supplier.

Appendix

Chart of common velocity on the cable(Ref)

unit：m/μs

name	model	Test cable	velocity
Hi-Fre cable	HEQ－2527×4×1.2 ＋6×0.9	Gap of cables	232m/μs
		other	240～244m/μs
	HEQ－2521×4×1.2	Gap of cables	248/μs
	HDYFLE22－156	Gap of cables	224m/μs
		other	230m/μs
Lo-Fre cable	HEQ212×4×12	Gap of cables	240m/μs
		other	248m/μs
Oil immersed communicating insulating cable in lead	ZUQ 6KV3×703×150	Core-core	160m/μs
PVC insulating cable	VLZ 3×120＋1×35 1KV3×50＋1×16	Core-core	178m/μs
PVC insulating cable	VKV20 1KV3×50	Core-core	172m/μs
Mi-coaxial cable	4×2.6/9.4	Core-screen	283m/μs
Sm-coaxial cable	4×1.2/4.4	Core-screen	274m/μs
Local cable	0.5×50	Core-core	196m/μs
	0.4	Core-core	190m/μs
	0.32	Core-core	182m/μs
Opening cable		Core-core	288m/μs