ZX-702 Three Phase
Microcomputer Relay Protection Tester

Chapter 1 Device Characteristics and Technical Parameters

Section I Main Features

- **The standard output of 4 phases of voltage and 3 phases of current** It could combine various type of current or voltage conveniently and has diversity type of protective experiment. Every phase of voltage output is 120V, and the total of the parallel current is 120A. The fourth phase voltage Ux has many functions and it can be set to be 4 type of every three voltages or synchronism checking voltage, or output any value of voltage.

The stand-alone operation is convenient A Singer Relay is operated by the convenient and flexible rotation mouse through the large LCD screen and all English display. It can complete the most testing work, including all sorts of relay and microcomputer protection test, and can simulate all kinds of complicated instantaneity, permanent, transform failure for the test. It can be used right after the starting up and operated conveniently.

Dual operation model, connect computer for work

By using the English setting operation software on the Windows platform, it can work for all kinds of large, complex and higher degree automation check work and it is convenient to test and scanning all kinds of protection fixed value, as well as storage real-time test data, display vector chart, draw fault waveform, online print statements, and so on.

- **Strong function of software** It can complete all kinds of large complex check work requiring for high degree automation, such as three phase differential test, auxiliary power supply for fast cutting and automatic input test, line protection by synchronism checking voltage reclosing and so on. and it can easily test and scanning all kinds of protection setting for fault playback, storage real-time test data, display vector chart, online print reports, etc.
- **The amount of switch quantity contacts is rich** 7 road contact input and 2 couples of empty output contact. The input contact is compatible for both empty contact and 0 ~ 250 v contact, and it has intelligent automatic recognition. Input and output contact can be expanded based on the user's need.
- **Large LCD screen** The device adopts large and high resolution radio graphics LCD screen with 320 x 240 lattices, and the whole operation process are set on the screen, whose operation interface and test results are both show in English, intuitional and clear.
- **Self-protection** Use reasonable design of the heat dissipation structure, has various reliable and perfect protection and power soft start, along with fault self-diagnosis and locking

function.

- **Independent DC power output** The device is equipped with a way of 110v DC and 220v DC special adjustable power output.
- **Cost-effective** It is an interdisciplinary design production, integrating many advanced scientific and technological achievements of many areas. More important, its large tester performance, and small tester price, distinguishes it as a very cost-effective machine.

Section II Rated Parameter

Alternating current output

Output accuracy: **0.5magnitude**
Phase current output (effective value): **0~40A**
Three parallel phase current output (effective value): **0~120A**
Phase current value with long time under permission (effective value): **10A**
Phase current maximum power output: **400VA**
Three parallel phase current maximum power output: **1000VA**
Three parallel phase current maximum work time: **10s**
Frequency range (base wave): **20~1000Hz**
Harmonic frequency number: **1~20 time**

Direct current output

Output accuracy: **0.5magnitude**
Current output: **0 ~ ± 10 A/each phase, 0 ~ ± 30 A/every three parallel**
Maximum output of load voltage: **20v**

Alternating current output

Output accuracy: **0.5magnitude**
Phase voltage output (RMS): **0 ~ 120v**
Line voltage output (RMS): **0 ~ 240v**
Phase voltage/line voltage power output: **80VA/100VA**
Frequency range (base wave): **20 ~ 1000Hz**
Harmonic frequency number: **1 ~ 20 times**

Direct voltage output

Output accuracy: **0.5magnitude**
Phase voltage output amplitude: **0 ~ +160v**
Line voltage output amplitude: **0 ~ + 320v**
Phase voltage/line voltage power output: **70VA/140VA**

◆ The switch quantity and time measurement

		note
Switch parameters input	7 ways	Empty contact: 1~20mA, 24v Power contact access： “0”： 0～ +6V； “1”： +11 V～ +250V
Switch parameters output	2 couples	DC：220V / 0.2A；AC：220V / 0.5A
Time measurement	Measuring range: 0.1ms ～ 9999s measuring accuracy: 0.1ms	

◆ Volume and weight

Appearance and size	365×300×165mm³
Weight of a single machine	15kg
Supply power	AC 220V±10%，50 / 60Hz
Environmental temperature	-10℃ ～ +50℃

Chapter 2 Hardware Structure

Section Ⅰ Hardware Devices

◆ Digital signal processing microcomputer

The device adopts high speed, high performance digital control processor as control computer, the software uses double precision algorithm to produces any precision waveform each phase. Since using one structure, each part combines closely, so data transmission distance is short, and its structure is compacted. In addition, it has overcome the notebook computer's problems about little output points resulted from the long line and the narrow band of direct control type measurement instrument for data communication.

◆ D/A conversion and low frequency pass filter

Adopting high speed and high D/A converter, ensure the full range current, voltage precision and linearity.

Due to the D/A high resolution and high fitting density, waveform distortion is small, the harmonic component is small, the demand of low pass filter's is very low, which has the very good transient characteristics and phase frequency characteristics, the amplitude frequency characteristics, easy to achieve accurate phase shift, harmonic superposition, and the high frequency can also guarantee the high accuracy.

◆ Voltage and current amplifier

The phase current or voltage does not use the riser, booster, but uses direct output method. the current, voltage source can be directly output from dc to contain various frequency component of the waveform, such as square, every harmonic superposition combination waveform, fault transient waveform, etc., and can simulate all kinds of fault current and voltage characteristics when short circuit happens.

Power amplifier circuit adopts imported high power high fidelity modular power device for power output stage, combined with elaborate, reasonable design of the heat dissipation structure, has the enough power redundancy and heat capacity. Power amplifier circuit has complete protection for overheat, over current, over voltage and short circuit. When the over current appears in the current loop, voltage loop appear overload or short circuit, it can automatic limit output power, turn off the amplifier circuit, and give alarm signal. To prevent large electrical flow caused by long-term power amplifier work circuit overheating, the device sets up bigger electric shed software time limit. The device can work for a long time under the current of 10A or less than 10A, when the current is more than 10 A, software start according to time limit, the software automatically shut off power output and

give alarm indication. Output current is larger, the shorter the time limit.

◆ Switch-in and switch-out

Switch input circuit can be compatible with empty contact and 0~250 v potential contact. In potential model, 0~6v for connected, 11~250v for disconnected. The switch quantity can measure each phase switch contact action time and action time difference conveniently.

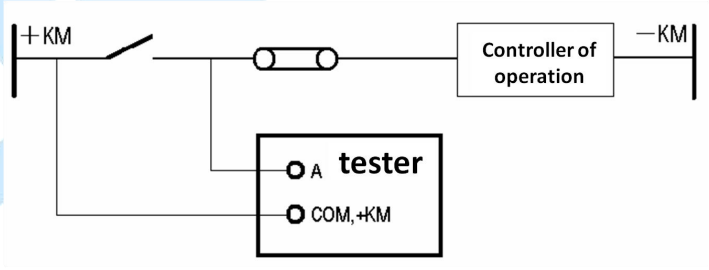
Switch into part and host working power supply, power amplifier power are all isolated. The switch into part is floating-ground, so open switch into part's some end and current, voltage part public end UN, IN are not mutually.

The potential of switch input has directivity, the positive potential port should be connected with public potential port and the negative potential port should be connected with the switch input port, ensuring public potential port is higher than that of switch into port. When in the field wiring, public potential port should be connected with + KM, negative potential port should be connected with switch into port. If connecting is contrary, it will not be able to detect correctly.

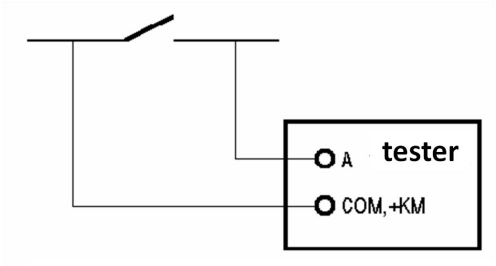
Switch output part is the relay empty output. Output capacity of DC: 220 v / 0.2 A, AC: 220 v / 0.5 A. Switch output and the voltage, current, switch into and so on are in the complete isolation. Each open amount of movement process in each test module is different from each other, and for detailed information, please see each module software operating instructions

The following are two common wiring diagrams for switch output:

Potential contact



Empty contact



◆ Liquid crystal display and rotating mouse operation

The device adopts blue backlit LCD screen of high resolution radio with 320 x 240 lattice for

display, and the whole operation process are set on the screen, whose operation interface and test results are both show in Chinese, intuitional and clear. Operating is controlled by rotating mouse and two buttons, and all data and test process are set by rotating mouse on the screen. Easy to operate and master

◆ Special dc power output

The device set a special adjustable dc power output in the chassis base coat, there are 110 v and 220 v two gears, and can be used for field test auxiliary power supply. This power also set a potentiometer, can be adjusted in 80%-110% range. The power supply working current is 1.5 A, and it not only can be used as protection of dc working power supply, but also as jump switching circuit power. If this power source overloads or becomes short circuit, it will burn out corresponding insurance (2 a / 250 v), and to repair, changing its insurance tube is enough.

◆ independent adjustable dc power supply

The device set a special adjustable dc power output in the case base plate, there are 110 v and 220 v two gears, and can be used for field test auxiliary power supply. This power also set a potentiometer, can be adjusted in 80% - 110% range. The maximum current this power can supply is 1.5 A. there is a cooling fan, power cord, earth terminal and three insurance in the bottom. One of the Three insurance is general power insurance (10 a / 250 v), and the others are voltage loop insurance (2 a / 250 v).

Chapter 3 Stand-alone Operation Module Function Instruction

■ Please read this before stand-alone operation

- **Rotating mouse usage**

Rotating mouse function is similar to the computer-use mouse, and it has three kinds of operations: "turn lefted," "right hand", "press selected". The three operation of the mouse can be used to move cursor and modify data.

Move the cursor: when the screen displays for operation, move the cursor. When the cursor moves to one option to select, press the knob is opening or switching this option. If the option selected to be open is a data item, it means it runs into the data modification process, the use "turn left", "turn right" to modify data by increase or decrease it; If the open is a select box (such as "manual test/automatic test"), press the knob is switching to another state.

Rotating mouse data input method: each data generally is divided into two parts to modified, for current, voltage, frequency are divided into integer part and decimal part, equal to phase Angle points in one hundred part, ten part and the part. To modify data, move cursor to the data, press down knob to open the data item, the cursor will narrowly focus to integer part (the first part). the first step is to modify this part, using "turn left", "turn right" to increase or decrease this part (every spin of a lattice adds or subtracts 1, for increase or decrease rapidly, please use “▲”、“▼” each press will add or subtract 10); After modifying this part, press the knob to let cursor focus on the decimal part (the second part), and it will go into the second part of modification, the modification way is the same as the first part; After the modification, press knob again and the cursor would recovery for big shape, it indicates that the completion of the data modification. The cursor can be moved then.

- **Symbol description of Screen display function**

 "Change" mark. In the Test, if a quantity needs to increase or decrease by a set step length, open this mark.

 Instructions of switch input contact, state: "disconnected".

 Instructions of switch input contact, state: “connected”.

- **Tester software returns from the PC communication to single operating status**

If the software screen is in the PC communication state, press the knob for 3 seconds and the software will automatic return to single operation screen.

- **The main menu**

Connect the device's power cord and input/output line, open the power switch, the power indicator light (green) bright, the screen's blue setting bright, the device self-checking is finished and it would enter into the relay protection tester main menu in Chinese situation.

The main menu has ten optional. Swirl rotating mouse to move cursor to a option, press the rotating mouse to go into this experiment.

Section Ⅰ AC test

■ Interface Description

When in Ac test, every phase voltage and current output are AC quantity, each voltage and current amplitude, phase and frequency can be adjusted at any value, and to meet all kinds of tests' need to all sorts of quantity carrying on the adjustment and the requirements of the combination. When Test's relay and protection of the contact work, it can record action time, return time and action value, return value, etc.

This test menu can test various relay, phase, frequency relay, microcomputer protection and so on, and it also can simulate the whole test.

The changeable parameters in the tes： Ua: value, phase. Ia: value, phase
Ub: value, phase. Ib: value, phase
Uc: value, phase. Ic: value, phase
The AC frequency

Values to input： Initial value and Step length value of each variable quantity (positive or negative). The sign " " of the values which need to be changed are displayed.

Manual test/automatic test：After the beginning of the experiment, whether it is manual controlling or automatic controlling of parameters to increase or decrease can be set

After input all data and setting parameters, move the cursor and press the "confirm", check amount Settings right now and if it is correct, select "start" to begin testing. Device begins to output, and the lower part of screen will pop up the testing relay contact state diagram.

Manual test： use "▲", "▼" key or rotating knob to control the parameters to add or subtract in each step length, observe the measured element movement situation on the screen. When the contacts close or open, the screen will show its action time and return time, and the corresponding

output (Ua, Ub, Uc, Ia and Ib, Ic) value and phase Angle (which is the measured element action value and return value).

Automatic test: The quantity automatically increases. when relay contacts work, the output of the various parameters of the device maintain in the action point position, waiting for the next step operation, at this time, click the "▲" or "▼" key or "positive" or" reverse" rotating knob a case, the test will automatic increase or decrease again according to the given direction until the next shift to maintain in the position waiting. And it can be repeated over and over again in any directions for automatic test, testing the action value, return value and so on.

- **Switch-in signal:** the testing contacts can be connected to any DI.
- **Switch-out signal:** two output nodes, one output tracks the process of test, it closes when "start" is pressed, it disconnects when "Stop" is pressed; the other tracks the changes of the test data, that is, it closes at the first time the button "▲" or "▼" is pressed after the start of the test, it disconnects when the test stops.
- **The data recording area:** when the protection act or return, in addition to the recording of operating time and return time, the lower two rows are the voltage, the current and the phase angle when it acts or returns.
- **Combination output:** The voltage and current can be combined to output different quantities: ac voltage can output 120v each phase. When needs higher output voltage, it can use two channel series, such as Ua outputs 120v, 0°, Ub outputs 120v, 180°, so the Uab outputs for 240v. Ac current can output. 40A each phase. When need bigger output current, it can use two or three channel parallel, and the maximum parallewl current is 80A or 120A, and be sure that parallel current should have the same phase.

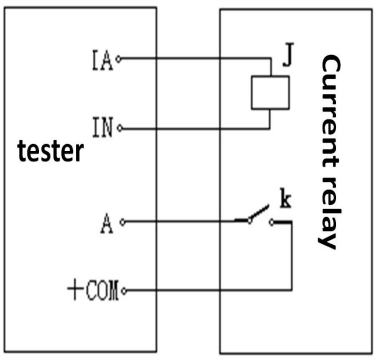
Note:

1. **Please use shorter and thicker conductors to reduce the resistance of the circuit.**
2. **Please don't keep big current for a long time, because it is easy to damage the tester and the devices under test.**
3. **The automatically changing time interval of the automatic test is about 0.3s, for the test time relay or other long-time action relay, the measure of the time will be incorrect, please use manual change mode test.**

■ Test Guidance

Test ac current relay action current, return current and action time, return time.

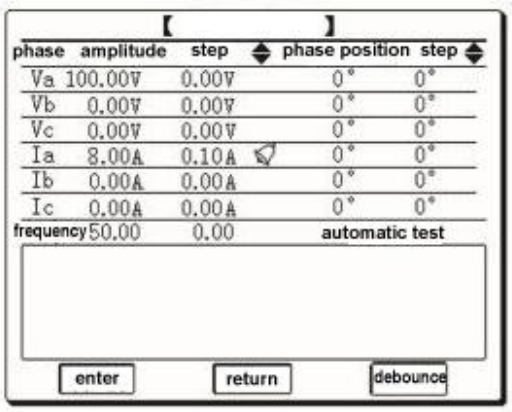
First connected panel IN and IA to the test relay action coil ends, relay action contact connected to the switch A and + COM. Set A phase current to begin to increase since 8A, increasing step length is 0.1 A. set test to automatic mode, move the cursor to the "Determine" and press, then check the setting parameters and connection, if it is correct, move your mouse to "start" and press,



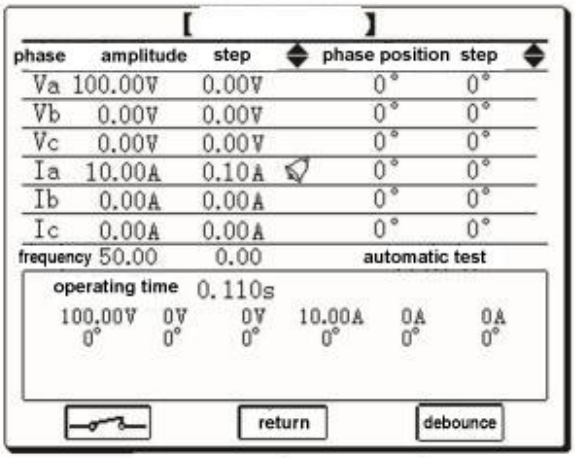
Connecting diagram

and A phase output current to relay is 8 A, and increase at 0.1 A / 0.3 seconds speed. From the screen, the current effective value and relay contact state can be seen. After contact movement, tester output is kept as the value of action time, showing action time and the output of action about effective value and phase, and from left to right, in order for UA, UB, UC, IA and IB, IC, the first line is value, the second line is phase; Now make the mouse turn left (or click the "▼"), the output value is automatically reduce until contact returns, after contact returning, device output remain unchanged, and shows the return time and return value (the third line is value, the fourth line is phase), test waiting for specified change direction or stop test. As the chart:

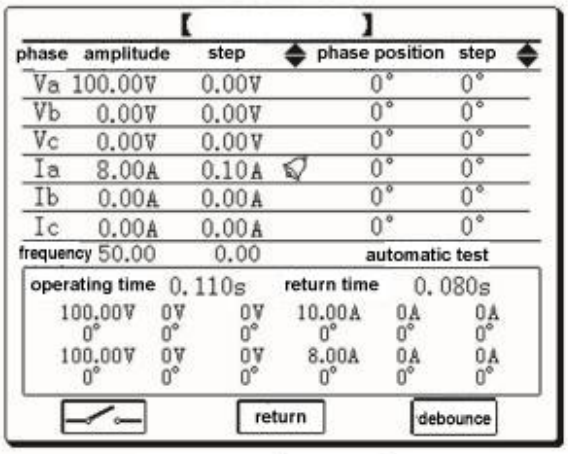
Action value is 10A, the return value is 8A, action time is 110 ms and the return time is 80 ms.



AC test （setting）



AC test （operating）



AC test （return）

Section II　DC test

■ Interface Description

When in DC test, every phase voltage and current output are DC quantity, each voltage and current amplitude, and polarity can be adjusted to meet all kinds of tests' need to all sorts of quantity carrying on the adjustment and the requirements of the combination. When Test's relay and protection of the contact work, it can record action time, return time and action value, return value, etc. the experiment method is similar to the AC current experiment.

This test menu can test various relay, such as DC relay, time relay, sign relay, reclosing relay, etc.

The changeable parameters of the experiment： Ua: value, Ia: value,
Ub: value, Ib: value,
Uc: value, Ic: value,

Values to input: Initial value of each variable quantity, Step length value of each variable quantity (positive or negativee). The signs " " of the values which need to be changed are displayed.

Manual test/automatic test： After the beginning of the experiment, whether it is manual control or automatic increase or decrease can be set.

After input all data and setting parameters, move the cursor and press the "confirm", check amount Settings right now and if it is correct, select "start" to begin testing. Device begins to output, and the lower part of screen will pop up the testing relay contact state diagram.。

- **Manual test：** use "▲", "▼" key or rotating knob to control the parameters to add or subtract in each step length, observe the measured element movement situation on the screen. When the contacts close or open, the screen will show its action time and return time, and the corresponding output (Ua, Ub, Uc, Ia and Ib, Ic) value and phase Angle (which is the measured element action value and return value).
- **Automatic test:** The quantity automatically increases. when relay contacts work, the output of the various parameters of the device maintain in the action point position, waiting for the next step operation, at this time, click the "▲" or "▼" key or "positive" or" reverse" rotating knob a case, the test will automatic increase or decrease again according to the given direction until the next shift to maintain in the position waiting. And it can be repeated over and over again in any directions for automatic test, testing the action value, return value, etc.
- **Switch-in signal:** the testing contacts can be connected to any DI.
- **Switch-out signal:** two output nodes, one output tracks the process of test, it closes when "start" is pressed, it disconnects when "Stop" is pressed; The other tracks the changes of the test data, that is, it closes at the first time the button "▲" or "▼" is pressed after the start of the test, it disconnects when the test stops.

- **The data recording area:** when protection move and return, in addition to record action time and return time, lower part of the screen displays action and return's Ua, Ub, Uc, Ia, Ib, Ic amplitude, the first line is the quantity action value, the second line is return value.
- **Combination output:** dc voltage can output ±160v each phase. When needs higher output voltage, it can use two channel series, such as Ua outputs +160v, Ub outputs -160v, so the Uab outputs for 320v.

Note:

1. **The automatically changing time interval of the automatic test is about 0.3s, for the test time relay or other long-time action relay, the measure of the time will be incorrect, please use manual change mode test.**
2. **when test signal relay, polarization relay, which has very small current (less than 20 ma) relay, due to relay coil resistance is too large (hundreds to thousands of Europe), generally we cannot use current output to test directly, use voltage output, and the let measured action voltage divided by the coil resistance which is tested by a multi meter, then we can get the action current.**

Section III Synchronism and low-frequency test

■ Interface Description

synchronism and low-frequency test are changeable frequency tests， and they are use in the frequency difference experiment of the synchronism and low-frequency test.

In the interface divide Ua, Ub into the first group, the program of this group is fixed for variable frequency; divide Uc and Ia and Ib, Ic for the second group, and this group can be set for variable frequency or constant frequency. Ua, Ub, Uc output can be 0-120v

synchronism test：In the frequency difference test of synchronism test set the first group at variable frequency, the second group at constant frequency, so Ua, Ub's frequencis will change, Uc's frequency remains the same, so between the two groups there appears frequency difference. Use Ua and Uc or Ub and Uc as the parallel side in the synchronism test and system's voltage for frequency difference experiment of the synchronism test.

low-frequency test：Set both the two groups at frequency changeable, so Ua, Ub, Uc, Ia and Ib, Ic change frequency at the same time for low-frequency test.

The changeable parameters of the experiment： frequency.

Values to input： Initial value and phase of each phase voltage;
Initial value of frequency;
Frequency step of manual test/the frequency change value in every second of automatic test: $\Delta f/\Delta t$

In Manual frequency change test, manually control to increase or decrease frequency, every time we turn the knob a lattice or click the "▲" or "▼", frequency varies a step length.

In Automatic frequency test, frequency step when will automatically become the value of

changeable frequency: Δf/Δt, that is how many Hz frequency change per second, the frequency change at this constant rate, and it is use for low cycle slip blocking test.

After input all data, move the cursor and press the "confirm", “start”to start test. In the manual frequency change model, turn the knob or use "▲", "▼" to add or subtract frequency, when the rely contact works or returns, the screen will show its action time and return time, action frequency and return frequency, and the difference of phases between Ua and Ub. (Which is used for the test about phase difference in synchronization).

Automatic frequency changing is mainly used to do low cycle slip. after the test starting, current and voltage, frequency begin to output in initial value, don't immediately change frequency, the frequency will automatic reduce after press the "▼", when relay contacts work, the frequency will stay in action point position, waiting for the next operation, now click "▲" or "▼" button, the frequency will increase or decrease according to the given direction automatically, until the next action.

- **Switch-in signal:** the testing contacts can be connected to any DI.
- **Switch-out signal:** two output nodes, one output tracks the process of test, it closes when "start" is pressed, it disconnects when "Stop" is pressed; the other tracks the changes of the test data, that is, it closes at the first time the button "▲" or "▼" is pressed after the start of the test, it disconnects when the test stops.
- **The data recording area:** when protection move and return, record action time and return time, action frequency and return frequency and the difference of phases between Ua and Ub. (Itis used for the test about phase difference in synchronism voltage).

Note:

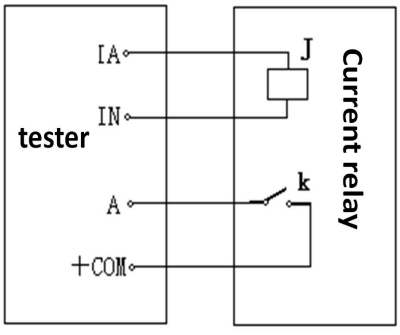
1. **When do low- frequency slip blocking experiment, we should adopt the automatically frequency changing mode, at that time, the frequency constantly change at Δ f / Δ t per second rate, and it is easily to do slip blocking test.**
2. **when Do low frequency action value and action time, we should adopt manual frequency change way and to decrease frequency slowly, due to the fast frequency change of automatic frequency changing model, the measurement of time value will not be accurate.**

■ Test Guidance

◆ The test of low-frequency relay’s movement frequency, action time and slip blocking value

The test interface setting is as blow.

When test the action value and action time, it should adopt manual changing frequency model. after input every phase voltage, current, initial value of frequency, changing step length,



Connecting diagram

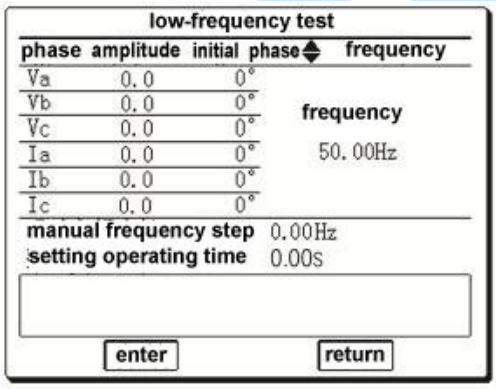
press "confirm", ”start” to begin output, then turn left the knob slowly in manual way to decrease frequency slowly, until the relay working. Now, record the action value and action time.

When doing the slip blocking experiment, it should adopt automatic changing model. So change the “手动变频步长（manual changing step length model）” into “自动变频步长（automatic changing step length model）” That is Δf/Δt, the step length value then will change into nn.nn Hz/S immediately. After pressing "confirm", “start” to begin to output, the frequency will be constantly. but After press the “▼”, the frequency becomes to decrease. If the setting value is more than the slip blocking value, the protection would not work, but if the setting value is less than the slip blocking value, the protection will work.

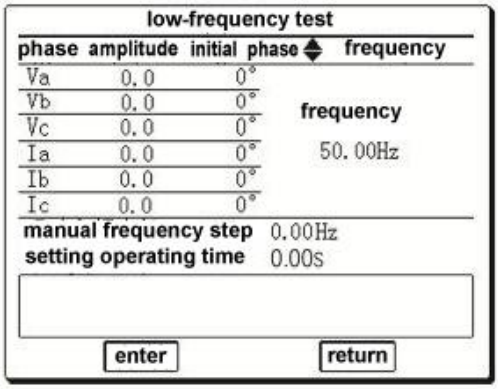
◆ **Use variable frequency test of synchronism checking relay to test action frequency difference and action Angle difference**

The test interface setting is as blow.

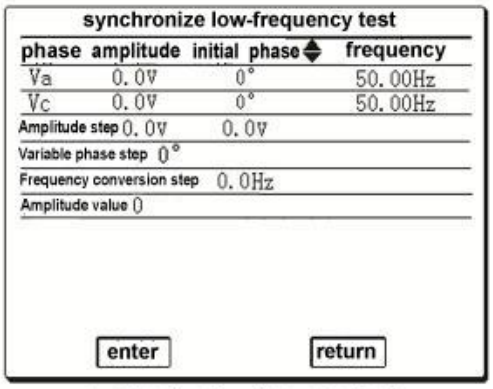
In the test, the frequency of Ua is changeable, the frequency of Uc remains 50 HZ, there is difference between the two frequencis. Adjust the frequency of Ua (slow in manual model) until the angle difference of relay’s contacts action frequency and the Ua and Ub’s frequency is the same of the action frequency and action angle difference.



low-frequency test



low-frequency test

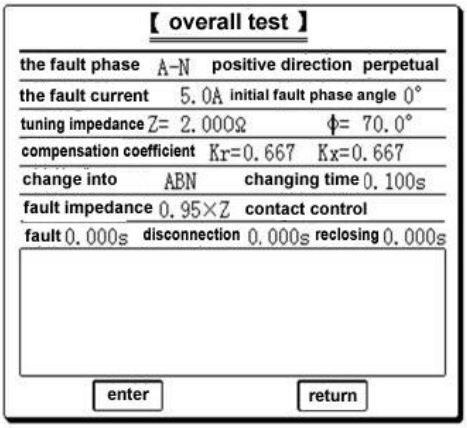


synchronize low-frequency test

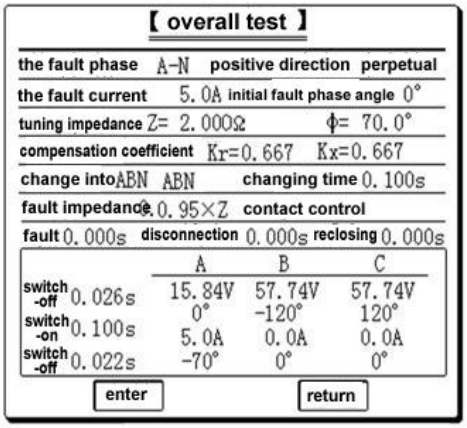
Section IV The overall test 1

■ Interface Description

The test is equivalent to static model test of relay protection device. through setting each test parameters, simulate various instantaneous, permanent single-phase grounding, alternate with short circuit or conversion failure, in order to achieve proceed the combination test or fixed value check of distance protection, zero sequence pilot protection or reclosing action device.



setting



record

Values to input:

Fault phases: A-N / B-N / C-N / A-B / B-C / C-A / ABN / BCN / CAN / ABC;

Positive direction/reverse direction fault: Permanent/instantaneity fault

Fault current; Fault initial Angle;

Setting impedance Z, Φ or R, X; Zero sequence compensating coefficient Kr, Kx.

Conversion /non conversion failure; Switching time;

Convert: A - N/B - N/C - N/A - B/B - C/C - A/ABN/BCN/CAN/ABC;

Fault impedance ratio;

Time control/contact control mode;

Fault time, break time, coincidence time (the three time quantities are only used in "time control").

◆ **Fault phase** can be set as AN, BN, CN, AB, BC, CA, ABN, BCN, CAN and ABC.

◆ **Setting impedance** fault impedance can be input in Z, Φ mode or R, X mode, input in one mode, and the value of another way can be automatically calculated by computer. Z, Φ or R, X input mode is switched by cursor in the "Z =" position in the knob switch.

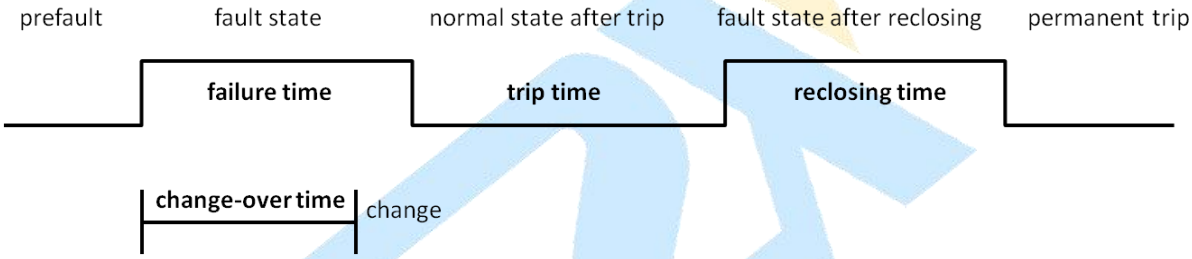
◆ **Fault impedance multiples** is n × "setting impedance", take this value as the short-circuit point impedance to proceed simulate.

◆ **Time control/contact control**

In contact control, the protection's jump, reclosing, and jump contact control current voltage to transit. Such as jump contact will make tester output from the fault quantity into normal quantity (jump after stating).

In time control, according to the time interval that has been set, output every quantity in order, before failure, failure, after jumping, after reclosing, after permanent jumping all kinds of quantity. When protection operates, only record operating time, without changing the various output state duration.

◆ **Fault time, break time, reclosing time** in time control mode, are used to control the output quantity's failure duration, normal quantity's duration time after fault break and output failure quantity's duration after reclosing again. In the contact control, it doesn't work.

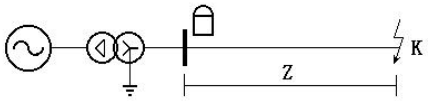


◆ **Conversion failure/non conversion failure** use to set convert failure. From moment of fault beginning, when switching time comes, no matter whether the protection works to jump circuit breaker, they are all into the converted fault condition. But jump phase voltage and current are not influenced by fault condition, voltage V=57.7V or 0V, current I=0A. Fault switching time is counted from the first failure start.

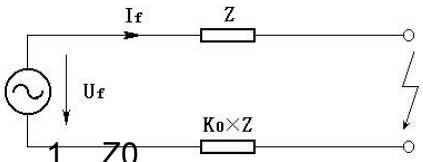
◆ **Fault types after converting** can be set as AN, BN, CN, AB, BC, CA, ABN, BCN, CAN, ABC.

◆ **Fault starting Angle:** voltage initial phase Angle when failure happens. Because three-phase voltage current phase is not consistent, reclosing Angle and fault type are concerned, general use the type fault reference phase to calculate: single-phase fault use fault phase, two phase short circuit or two phase connecting ground fault use two phase with non fault phase, three phase short circuit use A phase to calculate.

◆ **Short-circuit calculating model：**



◆ **Zero sequence compensating coefficient：**



$$K0 = \frac{1}{3}\left(\frac{Z0}{Z1} - 1\right)$$

If positive sequence group anti Angle Φ (Z1) and zero sequence impedance Angle Φ (Z0) are different, K0 at this time is complex number, use Kr, Kx to calculate.

$$Kr = \frac{1}{3}\left(\frac{R0}{R1} - 1\right) \qquad Kx = \frac{1}{3}\left(\frac{X0}{X1} - 1\right)$$

If $\Phi(Z1) = \Phi(Z0)$, then K0 is a actual number，now Kr＝Kx ，set they as Kr=Kx=K0。

Note：

1. **In the combination test, all failure data completed by computer. Computer calculated short-circuit voltage according to a set of fault current and fault impedance, each phase should not be greater than rated voltage of 57.7 V, if it is too large, the current is decreased automatically to meet with the requirement of Vf <=57.7V.**
2. **If the fault impedance is too little, general a larger fault current should be set. If fault impedance is a bigger one, set a smaller fault current, in order to make fault voltage appropriate. It also meets with the actual operation. Otherwise it would be able to affect the measurement result.**

■ Test Guidance

When all dates are setted, press “Determine”, then the computer will compute the flaut currents and voltages of each phase for the operator to check. Press ”Before failure”, the device will output the normal symmetrical voltage of each phase, and the voltages of each phase are 57.7V, the currents are 0A. Press”fault” or connect the switch-in C, the device will get in flaut-output modal, it will output the flaut current and voltage to the protection that is under test. After the protection triped, the device will output the normal signals. After the protection reclosed, the device will output the normal signals if the flaut is momentary, if the flaut is permanent, the device will output the flaut signals again, and the protection will trip again, then the device output the normal signals.

At any time during the test, the device will break out of the test process if the “Stop” button is pressed.

- Switch-in: the switch-in A, B, C are used as the inputs of triping contacts of the protection; the switch-in R is used as the input of reclosing contact; the switch-in C is used as the input of flaut starting contact.
- Switch-out: when the protection outputs flaut signals, switch-out 1 is connected; when the protection trips, switch-out 2 is connected.

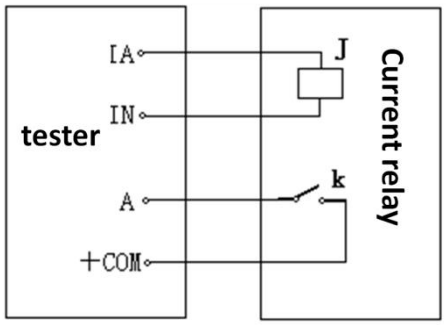
Section V The overall test 2

■ Interface Description

The overall test 2 test is basically the same function with the overall test 1. In the overall test 1 ,we set all kinds of fault according to the impedance mode to test the protection, but for some protection, we can’ t find out the fault impedance, but only the fault voltage and current, such as zero-sequence protection or the protection of 35KV line, then we can use this module to do test.

◆ **The failure phase** can be set as AN, BN, CN, AB, BC, CA, ABC-type failure.

◆ **Fault voltage U** for a single-phase fault, and three-phase fault, the fault voltage U is the fault phase voltage, for phase tc phase fault, the fault voltage U is the line voltage of the two fault phases.



Connecting diagram

◆ **Tuning current I** is the setting current value of a section of the protection, or slightly larger.

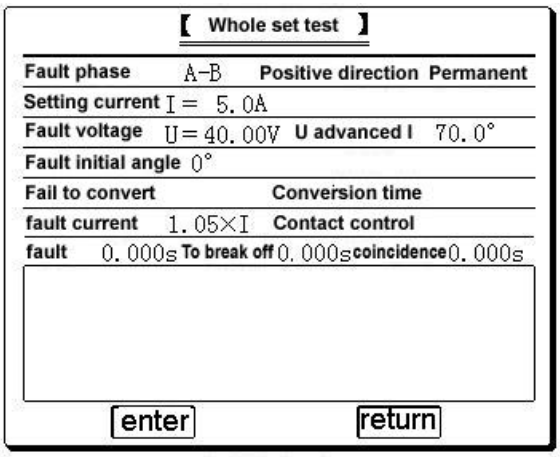
◆ **Fault current** is n × "setting current", we set this value as the phase short-circuit current of the fault simulation test.

Other options and the testing process are exactly the same as the overall test 1. Please refer to that section.

■ Test Guidance

The 35kv line low voltage blocking test

The 35kv line low voltage blocking test: parameters are set as the right, value of the rated current is 5A, the blocking voltage (line voltage) is 40V, check the operating time of protection and reclosure. Connect the ABC three-phase voltage and the A, C phase current to the protection unit, connect the trip contacts to the switch-in signal A，connect reclosure contacts to the R，connect contact loops to the + COM, then the test can be carried out.



Parameter setting

Section VI Time test (the operating time measurement of the multi-contact breaker)

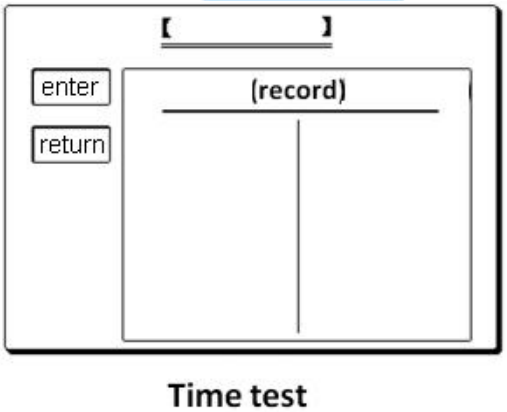
■ Interface Description

The device monitors the changes of 7-channel switch-in in the test, and records the time sequence of successive operations of each switch. The way it works likes a 7-channel digital milliseconds or DI time sequence recorder. This can be used to measure the operation process of a plurality of contacts of the circuit breaker, or the operating time and the synchronism of the six contacts in the three-phase switch. The wiring methods are as follows:

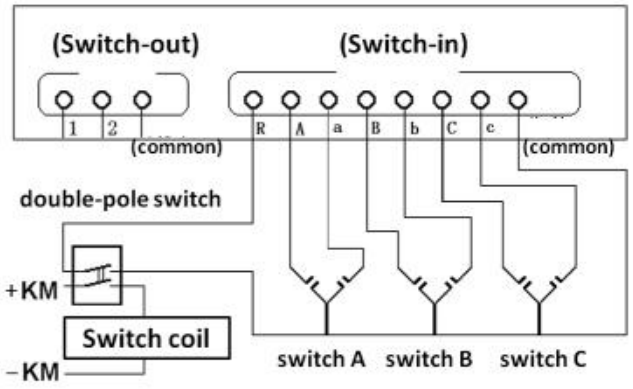
A double-pole double-throw switch is required in the test, one pole is used for the on-off of the switching or tripping current, the other pole is connected into the switch with the 6 auxiliary contacts of the switch contacts to measure the time.

To star the test, press the "start" button, and two contacts closed, the device is waiting for discrete inputs. Switch-on the double-pole double-throw switch to start the jumping / closing, start switch-in signal R at the same time to start timing, then each switch contacts of each phase acts successively. The time between the operation of R and the operation of A to C is the switching time, the time between the operation of A and the operation of C is the time difference between operations.

Note: Starting time for timing is the time of the first switch (any one) operation, and then each switch operation (closed or open) has a time to record, the time are from the starting time as the time origin.



Time test



Section VII Power direction and impedance relay test

■ Interface Description

This test is mainly used for power direction, impedance relay checksum. In the power direction relay a route voltage and a phase current are commonly used for 90° connection. And in the impedance relay, we commonly use the connection mode of a phase voltage or line voltage and a current of one phase or two-phase, and the 3-phase voltage (normally 57.7V, 90° Ahead of line voltage) is needed to be leaded in.

In the test, one phase voltage or line voltage and one phase current can be optionally specified, to do tests of power direction or impedance relay as the operating return angle, the operating power and operating impedance. Other phase voltages that are not involved in the adjustment of this test are set as 57.7V.

Values to input: Phase of Voltage (Ua / Ub / Uc / Uab / Ubc / Uca);

Initial value, step, flag of voltage;

Phase, step and flag of voltage;

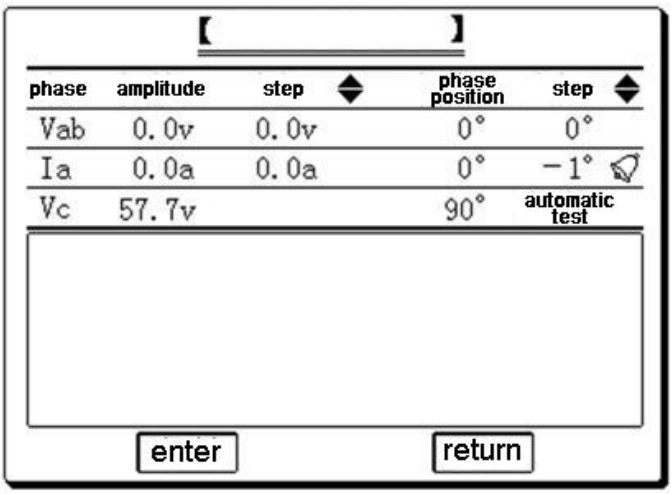
Phases of current (Ia / Ib / Ic / Iab / Ibc / Ica);

Initial value, step, flag of current;

Phase, step and flag of current;

Automatic test / manual test

The changeable parameters of the experiment: the amplitude and phase of the voltage and current.



power and impedance test

- Switch-in signal: the testing contacts can be connected to any DI.
- Switch-out signal: two output nodes, one output tracks the process of test, it closes when "start" is pressed, it disconnects when "Stop" is pressed; the other tracks the changes of the test data, that is, it closes at the first time the button "▲" or "▼" is pressed after the start of the test, it disconnects when the test stops.
- The data recording area: when the protection act or return, in addition to the recording of operating time and return time, the lower two rows are the voltage, the current and the phase angle when it acts or returns.

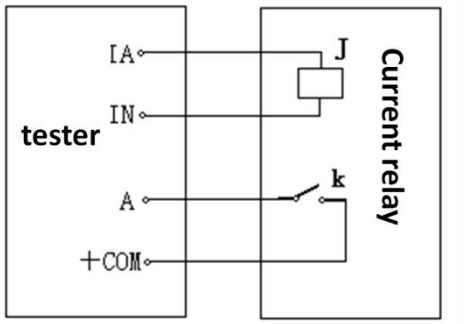
After the data set, press "confirm", the screen will show the state diagram of the relay contact, press "start" to start output test, the variable quantities can change automatically or manually, the test method is similar to the exchange tests. When the relay contacts act or return the data recording area on the screen will display operating time, return time, voltage, current and phase angle of the relay under test.

Note: **If line current such as Ia or Ib is used in power direction relay or the impedance relay test, In should be connected to guarantee the accuracy of the current.**

■ Test Guidance

Scaning sensitivity angle of directional power relay test

Scanning sensitivity test: connect UA, UB, UC, UN and IC, IN to the protection unit set UAB 100V, IC 5A (equal to the current setting), IC initial phase value is set to 180°,the step is set to -1° and +1°. After two automatic tests, you can find out the left and right margins to operation, then you can calculate sensitivity angle.



Connecting diagram

Section VIII Differential test

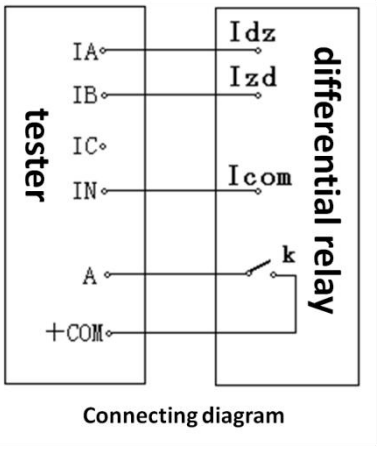
■ Interface Description

In the differential test, the device output two current from terminals Ia, Ib , mainly for testing differential relays. The Ia-phase is the operating current Idz, fixed at fundamental, but the amplitude is variable. The Ib-phase is the brake current Izd, can be set as amplitude variably DC, fundamental or secondary current.

When drawing the ratio braking characteristics of the differential relay, set the brake current value at the fundamental values of Izd. When drawing the DC magnetic assist characteristics, set the

current value at the DC value. When drawing the second harmonic restraint characteristics, set current value at the secondary current.

When Izd, Idz output AC, the maximum current is 30A; when Izd output DC, the maximum current is 10A.



Connecting diagram

Values to input: Initial value, step, flag of Idz;

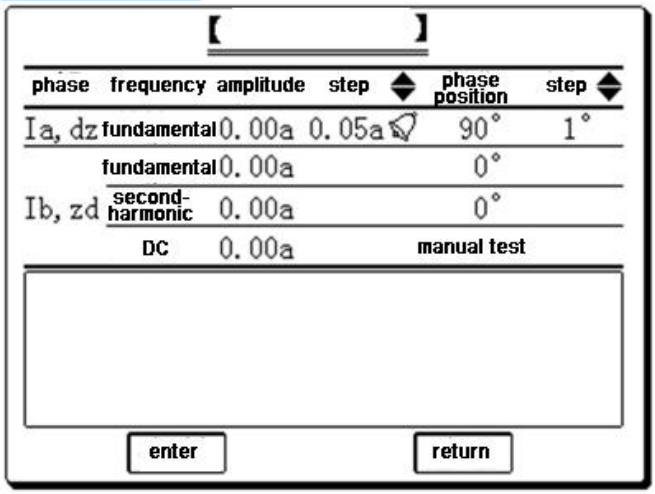
Phase and amplitude of each Izd;.

Automatic test / manual test

The changeable parameters of the experiment: the amplitude and phase of the Idz.

- Switch-in signal: the testing contacts can be connected to any DI.
- Switch-out signal: two output nodes, one output tracks the process of test, it closes when "start" is pressed, it disconnects when "Stop" is pressed; the other tracks the changes of the test data, that is, it closes at the first time the button "▲" or "▼" is pressed after the start of the test, it disconnects when the test stops.
- The data recording area: when the protection act or return, in addition to the recording of operating time and return time, the side two rows are the current of Idz and Izd when it acts or returns.

After the datas setted, press "confirm", the screen will show the state diagram of the relay contact, press "start" to start output test, the variable quantities can change automatically or manually, the test method is similar to the exchange tests. When the relay contacts act or return the data recording area on the screen will display operating time, return time, the current value of Idz and Izd of the relay under test.



differential test

Section IX Differential harmonic test

■ Interface Description

The differential harmonic test is similar to differential test. Device output two current from terminals Ia, Ib, one is the operating current Idz and the other is the brake current Izd. Mainly used for testing differential relay’s harmonic brake characteristics.

Idz and Izd can be superimposed by DC until the sixth harmonic, for testing harmonic characteristics of differential relays. The initial current amplitude and phase of Izd and Idz can be set, and set one current and its phase changes of Idz or Izd, then set the step, then change the current amplitude and phase to do the harmonic operation characteristics of the differential relay test.

Values to input:

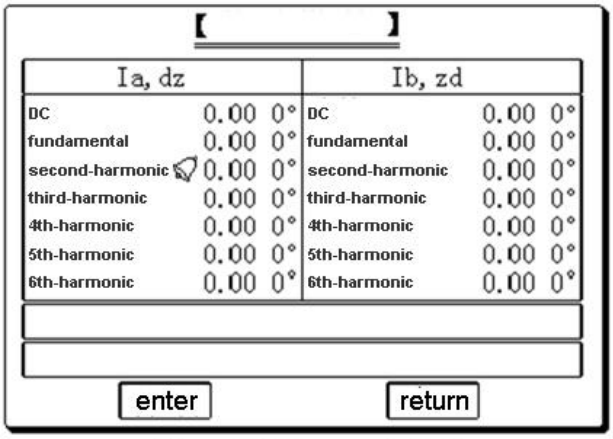
The current amplitude and phase of Idz and Izd from DC to the sixth harmonic;

Choose a harmonic current of Idz or Izd to change, by putting “ “at the back of the chosen one;

Current amplitude step size and current phase step size.

- Switch-in signal: the testing contacts can be connected to any DI.
- Switch-out signal: two output nodes, one output tracks the process of test, it closes when "start" is pressed, it disconnects when "Stop" is pressed; the other tracks the changes of the test data, that means, it closes at the first time the button "▲" or "▼" is pressed after the start of the test, it disconnects when the test stops.

After the data set, press "confirm", the screen will show the state diagram of the relay contact, press "start" to start output test, during the test, change the chosen harmonic gradually, until the relay contacts acts or returns. The wiring method is the same as the differential test.

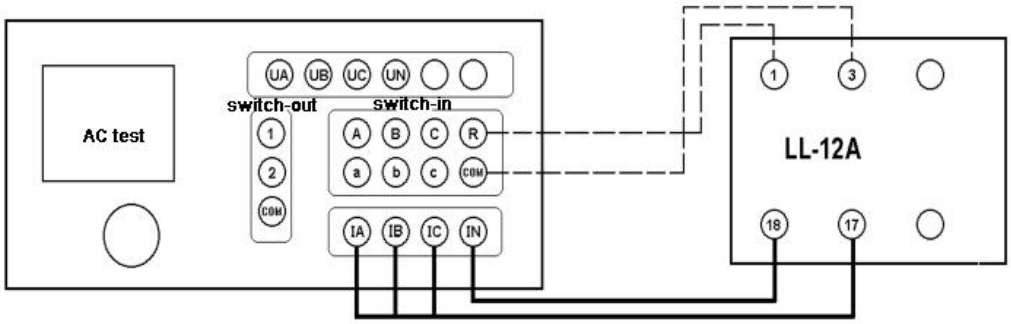


differential harmonic test

Appendix: Relay Test Methods

1, Calibration of AC voltage/current/inverse time current relay

In the AC test, Ua (Uab) or Ia is set to a certain initial value, then set step, press "▲", "▼" key or rotate the knob (can also use the automatic test mode) to plus or minus the voltage / current, and then measure the operation value and the return value、 the operating time and return time of AC voltage/current/inverse time current relay， then you can calculate the return coefficient.



2, Calibration of DC voltage / current relay

In the AC test, Ua (Uab) or Ia is set to a certain initial value, then set step, press "▲", "▼" key or rotate the knob (can also use the automatic test mode) to plus or minus the voltage / current, and then measure the operation value and the return value、 the operating time and return time of DC voltage/current relay， then you can calculate the return coefficient.

3, Calibration of the time relay

Make the test manually, measure the operation value, the return value and the operating time, the return time in the methods of AC or DC voltage relay test.

4, Calibration of the power relay

(1) The operation and sensitive angle measurement of power direction relay

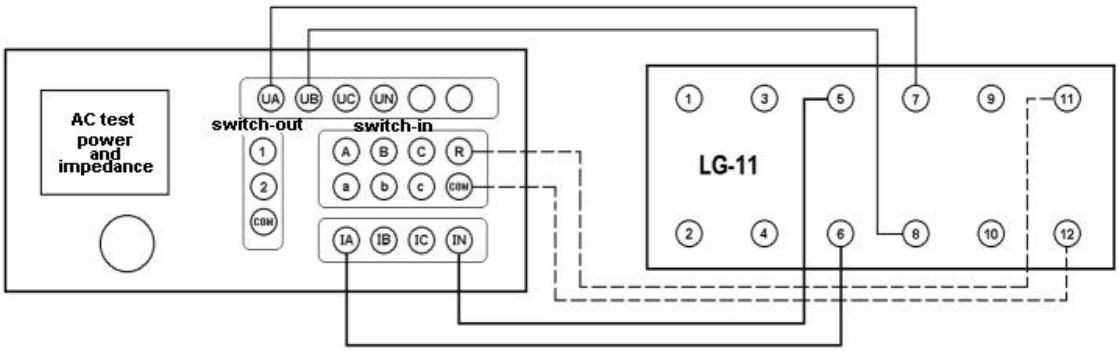
In power and impedance relay test, set Uab and Ia as rating value, and then set the phase angle step of Uab, adjust the voltage phase angle (automatic test mode can be used here), measure the

boundary angle φ1、φ2 of operating zone on both sides, then the sensitivity angle is φLM = ½ (φ1 + φ2).

(2) The measurement of the minimum operating power

Set the angle as sensitive angle φLM, set Uab or Ia as rating value, set Uab (Ia) as zero.

Set the step of Uab (or Ia), and turn up the voltage (or current). Measure out the minimum operating power.



(3) The creep test

Turn-off current circuit, set the initial value of Uab as zero, the step as rated voltage suddenly put or takeaway the voltage , the relay contacts should not presently switched.

Short the voltage loops through a 20 ohm resistor, set the initial value of Ia as zero, the step as a multiple of the rated current, suddenly put or takeaway the voltage , the relay contacts should not presently switched.

(4) Inspection of memory effect

Set the angle as the sensitive angle φLM, and set Ia as 0.5 times and several times the rated current. When Uab Suddenly reduces to zero from 100V, if the relay switchs reliable, the memory effects.

5, Calibration of the impedance relay

(1) The sensitive angle and tuning impedance measurement of impedance relay

In power and impedance relay test, set Ia as 5A (or 1A), Uab as 0.7 times the voltage corresponding to the tuning impedance, adjust the voltage phase angle (automatic test mode can be used here), measure the boundary angle φ1、φ2 of operating zone on both sides, then the sensitivity angle is φLM = ½ (φ1 + φ2).

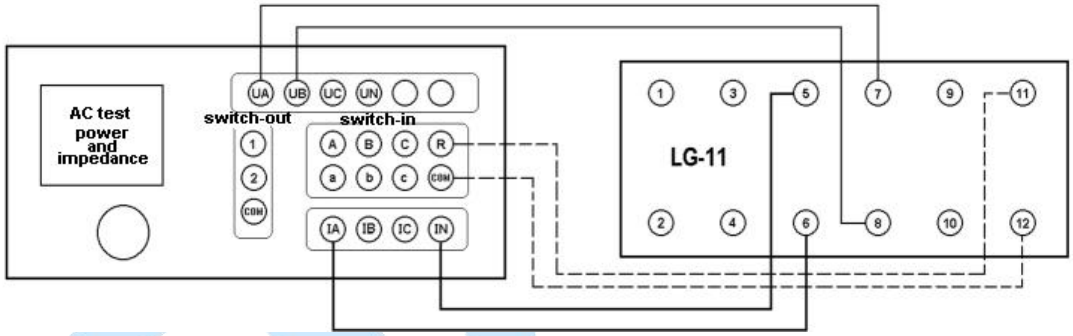
Set the phase angle as φLM. change the voltage from high to low until the relay operate, draw the operating voltage U_{DZ}, calculate the tuning impedance Z_{SET} according to $Z_{SET} = U_{DZ}/I$.

(2) The measurement of the precision current curve

Fix the angle between the voltage and current at φLM. Change Iab successively, adjust U_{ab} (automatic test mode can be used here)in each current, get the operation value, draw the precision current curve Z = f (I).

(3) "The birds peck" phenomenon

Disconnect the current circuit, set the initial value of U_{ab} and the step as rated voltage. When the voltage sudden drop to zero, the relay contacts should not have closed. The connection mode is as shown below:



6, Calibration of the synchronism check relay

(1) Inspection of the polarity relationship between two coils

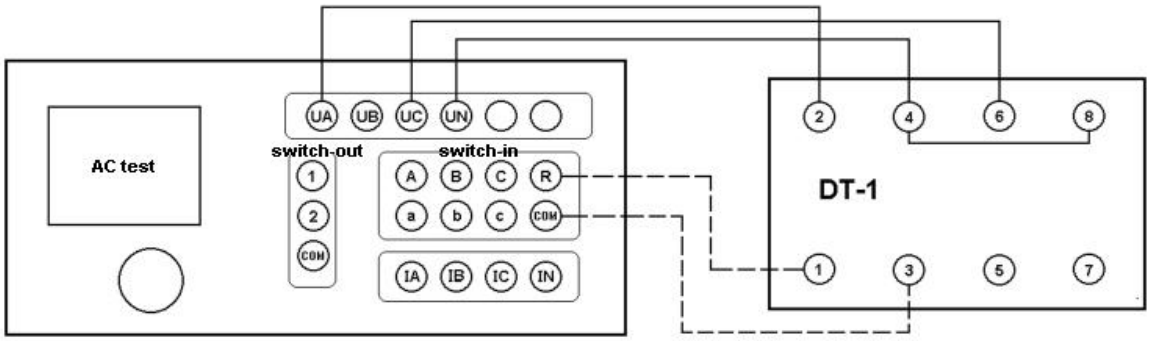
In the AC test, set Ua, Uc as the rated voltage, connected to the coils, if the relay doesn’ t operate, but disconnect any one coil, the relay operate, Note 2 and 6 are the same polarity terminals, otherwise, 2 and 4 are the same polarity terminals.

(2) The measurement of the operation angle

Regulate the polarity terminals, set Ua, Uc as the rated voltage, change the angle between the two voltages, measure the operation and return values.

(3) The measurement of the operation and return voltage

Set a coil voltage as zero, another coil voltage gradually increase from zero (automatic test mode can be used here), measure the operating voltage, and then gradually reduce the voltage, measure the return voltage. Exchange the two coils, and then do the same test.



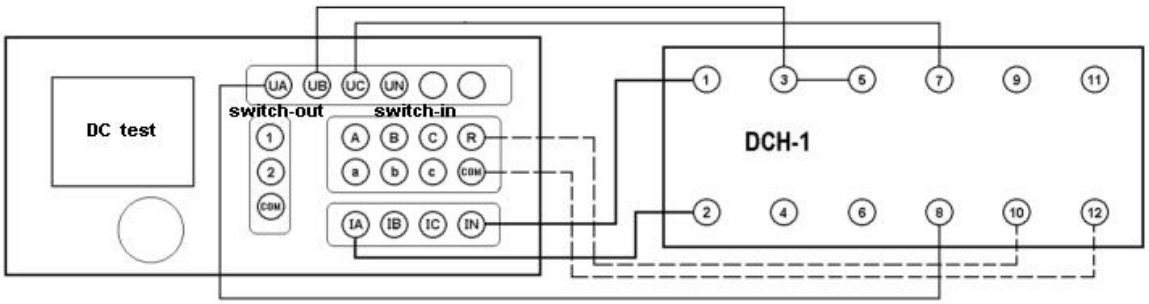
7, Calibration of the low-frequency relay

In the low-frequency test, set voltage and current as rating value, set the initial frequency and the manual conversion step value. Gradually reduce the frequency, measure the frequency and the operating time of the operation of the low-frequency cycle, and then gradually increase the frequency, measure the return frequency and return time.

Changed to automatic frequency inverter type, set the automatic conversion step value $\Delta f/\Delta t$ as setting value, reduce the frequency, the relay should reliable not operate in several consecutive test.

8, Calibration of reclosing relay

(1): Method One (for PC software)



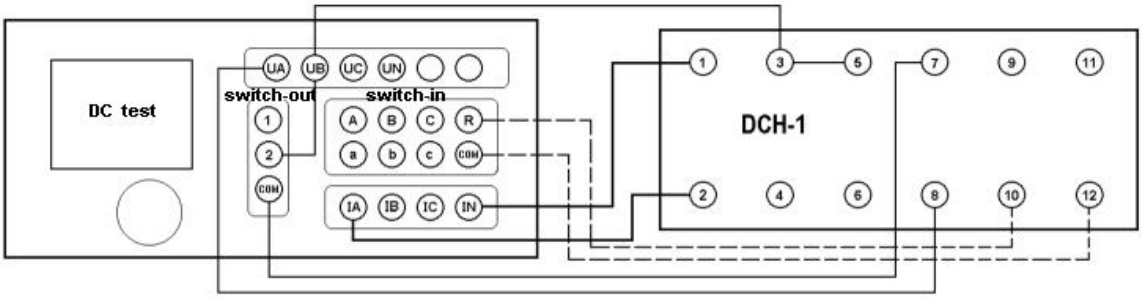
In the manually DC test, set Ia as intermediate relay’ s holding current, Uab as 220V (Ua is +110V, Ub is -110V) to be the charging voltage of capacitor, Uc as +110V. Press "Determine" and “start” to start outputing 220V voltage.

Wait for 15 - 25 seconds, so the reclosing capacitor is full charged and the signal lights, change Uc to -110V (in the output state, click on the Uc value box, key in -110 directly, then press the Enter

key), with the purpose of starting the reclosure by give a start-up voltage to the 7th terminal, after the reclosure started, at the reclosing time when the contacts operate, you can measure the operating time.

Note: If the reclosure can be charged, but can’ t operate, check whether there is a holding current output. During charging, the circuit of current output is disconnected, so the indicator light of the current output is on. When the reclosure operate, the indicator light of the current output should turn off.

(2) Method Two: (for stand-alone operation of)



In the manually DC test, set Ia as intermediate relay’ s holding current, Uab as 220V (Ua is +110V, Ub is -110V) to be the charging voltage of capacitor, turn off all changing signs. Wait for 15 - 25 seconds, so the reclosing capacitor is full charged and the signal lights, then press "▲", "▼" key or rotate the knob. At this point, switch-out 2 closed, UB give -110V voltage to the terminal 7 through the terminal 2, which initiates reclosure. At the reclosing time for contacts to operate, you can measure the operating time.

9、 Differential relay Check

(1) Measurement of the DC magnetic assist characteristics

In the differential test, the braking current Izd is DC current, successive change Izd values, adjust the operating current Idz (automatic test mode can be used here) at each magnetic assist current, measure operating current IdZ, then draw the braking characteristics curve.

(2) Measurement of the ratio braking characteristics

Set the braking current Izd as the fundamental current, successive change the Izd value, adjust the operating current Idz (automatic test mode can be used here) at each magnetic assist current, measure operating current IdZ, then draw the braking characteristics curve.

For DCD-2(A)-type differential relay, test connection as follows: IA – 7; IB – 9; IN – 1; switch-in A – 10; the switch-in common terminal +COM – 12; The relay terminal 3, and 5, 6 and 8 can be shorted respectively.

(3) Measurement of the second harmonic brake characteristics

Set the braking current Izd as the second harmonic current, successive change the value of Izd, adjust the operating current Idz (automatic test mode can be used here) at each magnetic assist current, measure operating current Idz, then draw the braking characteristics curve.

(4) Measurement of the higher harmonic brake characteristics

In differential harmonic test, set the braking current Izd as the superposition of each harmonics, successive change a certain harmonic value of Izd, measure the operating current Idz.