MV & HV TOV test system

MODEL STOV1200

Application

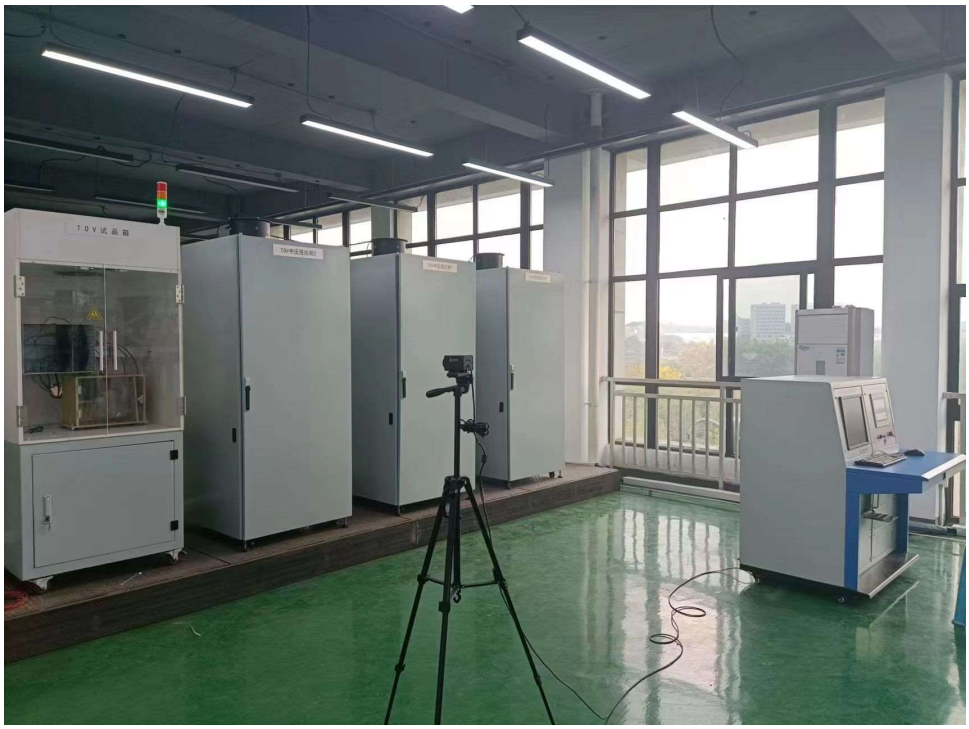
The TOV test system is mainly used for SPD TOV test caused by the faults in the medium and high voltage system.

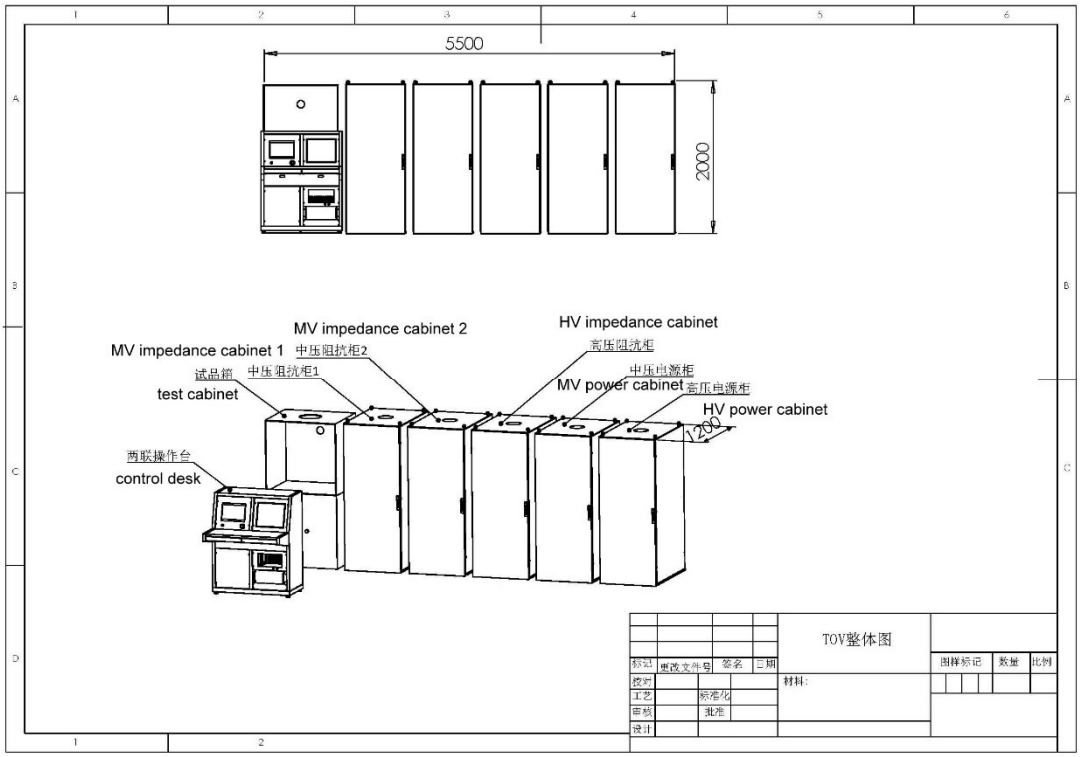
Standard

IEC61643-11 surge protective devices-Part 11: surge protective devices connected to low-voltage power systems-requirements and test methods

Dimension and weight

	Part name	Dimension (mm)	Weight (kgs)
1	HV single phase transformer (inside the cabinet)	730*500*940	450
2	3 phase test transformer (inside the cabinet)	730*500*940	750
3	Control desk	1060*950*1450	300
4	HV power cabinet	820*1210*1940	300
5	MV power cabinet	820*1210*1940	320
6	HV impedance cabinet	820*1210*1940	400
7	MV impedance cabinet 1	820*1210*1940	600
8	MV impedance cabinet 2	820*1210*1940	460
9	Test cabinet	830*830*1940	300

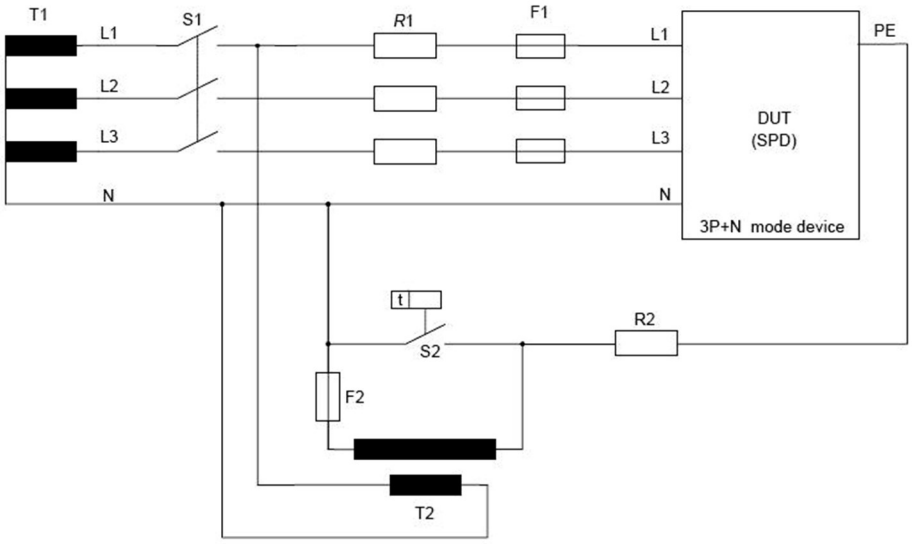




Technical Parameters

1) Input power supply:3 phase, 4 line, larger than 650kVA;
2) With a separate earthing point, the earthing resistance is less than 3 Ohm;
3) The TOV test system must be installed in the first floor;
4) Maximum open circuit voltage:1200V(Tolerance:-5% ~0%);
5) Maximum short circuit current:300A (Tolerance:0% ~10%);

Below is the example of circuit for testing SPDs for use in TT systems under TOVs caused by faults in high (medium) voltage systems.



S1: Main switch

S2: Timer switch-closing 200ms after main switch

F1: Maximum recommended over current protection according to manufacturer's instructions

F2: TOV transformer protection fuse (withstand 300A for 200ms)

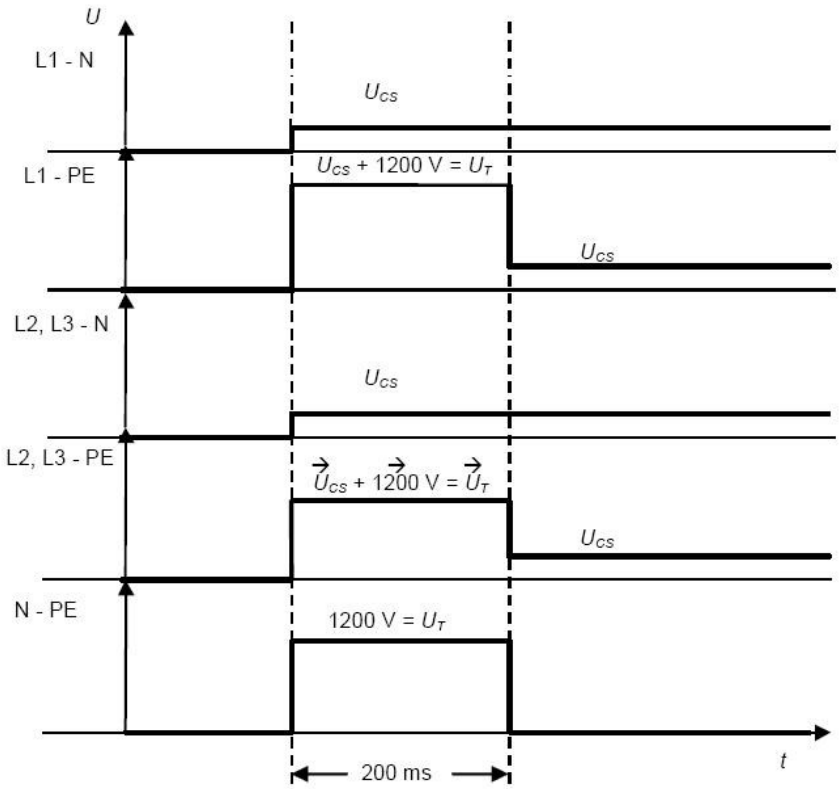
T1: Power supply transformer with a secondary voltage at U_{REF}

T2: TOV transformer with primary voltage at U_{REF} and secondary voltage of 1200V

R1: Current-limiting resistor to adjust the prospective short-circuit current of the power supply at U_{REF}

R2: Current-limiting resistor to adjust the prospective short-circuit current of the TOV circuit to 300A

DUT: Device under test



8.3.5.3.2 Additional test for SPD's failure mode simulation

Sample preparation

For this test any electronic indicator circuitry may be disconnected.

New samples shall be used and fitted as in normal use, according to the manufacturer's instructions and connected with conductors of the maximum cross section according to 8.4.2. The maximum length of the cables connecting the sample shall be of 0,5 m each.

External disconnectors, if recommended by the manufacturer, shall be used.

Test procedure

The test sample shall be connected to a power frequency voltage source at the following conditioning voltages:

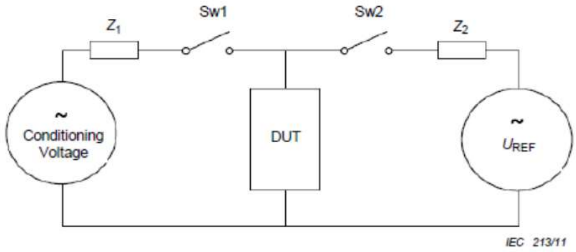
- for SPDs rated U_C up to 440 V, apply a voltage equal to 1 200 V_{rms} $^{+5}_{0}$ %,
- for SPDs with U_C rated above 440 V, apply a voltage equal to 3 times U_C $^{+5}_{0}$ %.

The conditioning voltage is applied for a duration of 5 s $^{+5}_{0}$ %. The prospective short-circuit current of this power source for conditioning shall be adjusted to a value between 1A and 20 A_{rms} $^{+5}_{0}$ %, as provided by the manufacturer according to 7.1.1 d5).

Following the application of the conditioning voltage a voltage equal to U_{REF} $^{0}_{-5}$ % with a short-circuit current capability as given below, shall be applied to the sample for a period of 5 min $^{+5}_{0}$ % or for at least 0,5s after interruption of the current by an internal or external disconnector.

The transition from conditioning voltage application to U_{REF} application shall be performed without interruption. The current flow through the SPD shall be monitored. An appropriate test circuit and timing diagram is shown in Figure 12 and Figure 13.

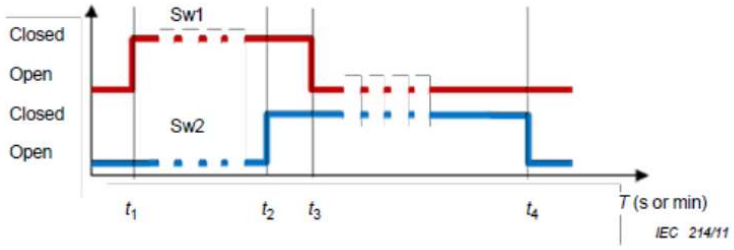
The prospective short-circuit current of the power source at U_{REF} shall have a tolerance of $^{+5}_{0}$ % at the location where the SPD is connected. The power factor of the power source shall comply with Table 8.



Key

Z_1: Impedance to adjust the prospective short-circuit current of preconditioning generator
Z_2: Impedance to adjust the prospective short-circuit current of U_{REF}
Sw1: Mechanical or static switch to apply the preconditioning stress to the SPD
Sw2: Mechanical or static switch witch to apply the reference test voltage to the preconditioned DUT
Sw1 and Sw2 can be mechanical or static
DUT: Device under test (SPD + Disconnector, if applicable)

Figure 12 – Test circuit for SPD's failure mode simulation



Key

t_1 = 0
$t_3 \geq t_2 \geq$ 5s -0%
$t_2 \leq t_3 <$ 5 s +5%

t_4 =5 min $^{+5}_{0}$ % or. ≥ 0,5 s after current interruption

Figure 13 – Timing diagram for SPD's failure mode simulation

Each of the following tests shall be performed on a new set of three preconditioned samples as above at U_{REF} with a short-circuit current of 100 A, 500 A and 1 000 A, respectively, unless these values exceed the declared short-circuit rating of the SPD.

A further test shall be performed on three preconditioned samples as above and at U_{REF} with a prospective short-circuit current equal to the manufacturer's declared short-circuit current rating. For this test, the time interval between the completion of the conditioning test and the application of U_{REF} shall be as short as possible and shall not exceed 100 ms.

If all oscillograms of the tests on the first set of samples (100 A test set up) show a disconnection within 5 s during the application of the conditioning voltage, no further test is performed.

Pass criteria

The pass criteria **C**, **I**, **M** and **N** according to Table 4 shall apply. In general pass criteria **H** and **J** according to Table 4 shall apply in addition, except for

- short circuiting type SPDs
- SPDs where the current is interrupted during the application of U_{REF}

where no disconnection occurs.

For this test any damage to electronic indicator circuitry during the conditioning test is not regarded as a failure.

8.3.8.2 TOVs caused by faults in the high (medium) voltage system

SPDs connected to PE and for use on power distribution systems shall be tested using either the TOV voltages U_T given in Annex B, or the TOV voltages stated by the manufacturer according to 7.1.1 c1), whichever values are higher.

Table B.1 shall be applied to all SPDs and, depending on the information given by the manufacturer on 7.1.1 c1), the additional tables according to clause B.1 of Annex B shall also be applied.

New samples shall be used and fitted as in normal use, according to the manufacturer's instructions, and connected to a test circuit according to Figure 16 or equivalent.

Test procedure

The test voltage U_T $^{0}_{-5}$ % is applied to the test sample at 90 electrical degrees of phase L1 by closing switch S1.

After the TOV application time t_T $^{0}_{-5}$ % switch S2 is closed automatically.

This connects the SPD´s PE-terminal to the neutral (via the current limiting resistor R2) by short-circuiting the TOV-transformer's (T2) secondary winding. This results in the operation of fuse F2 protecting the TOV transformer.

An example of a test circuit and a corresponding timing diagram to perform this test is given in Figure 16 and Figure 17.

Additional examples of alternative test circuits are given in Annex E.

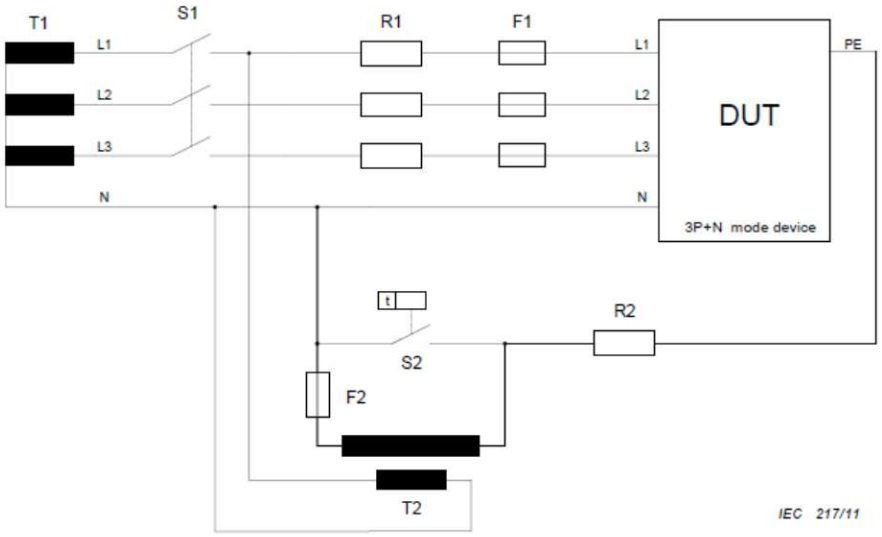
Other test circuits are permitted as long as they ensure the same stress to the SPD.

The prospective short-circuit current of the power source for U_{REF} shall be equal to five times the rated current of the maximum overcurrent protection declared by the manufacturer, or 300 A if no maximum overcurrent protection is declared. The tolerance for the current is $^{+10}_{0}$ %.

The prospective short-circuit current delivered by the TOV transformer shall be adjusted to

300 A $^{+10}_{0}$ % by R2.

With the exception of SPDs connected neutral to ground, U_{REF} remains applied to the test sample for 15 min without interruption until switch S1 is reopened.



Key

S1	Main switch
S2	Timer switch – closing 200 ms after main switch
F1	Maximum recommended overcurrent protection according to manufacturer's instructions
F2	TOV transformer protection fuse (needs to withstand 300 A for 200 ms)
T1	Power supply transformer with a secondary voltage at U_{REF}
T2	TOV transformer with primary voltage at U_{REF} and secondary voltage of 1 200 V
R1	Current-limiting resistor to adjust the prospective short-circuit current of the power supply at U_{REF}
R2	Current-limiting resistor to adjust the prospective short-circuit current of the TOV circuit to 300 A (approximately 4 Ω)
DUT	Device under test

Figure 16 – Example of circuit for testing SPDs for use in TT systems under TOVs caused by faults in high (medium) voltage systems

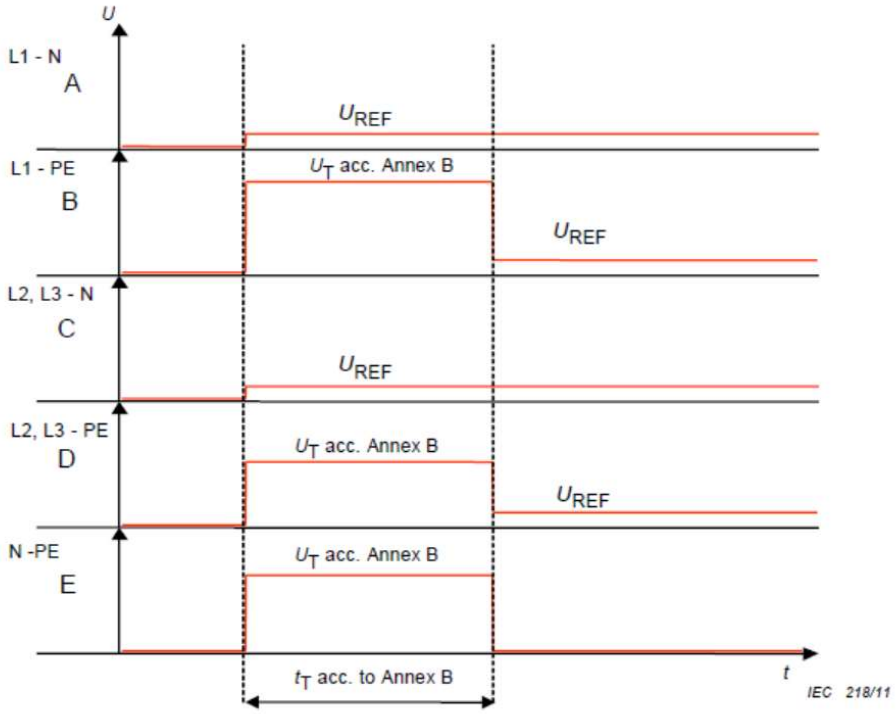


Figure 17 – Timing diagram for use in testing SPDs under TOVs caused by faults in the high (medium) voltage system using circuit of Figure 16

Pass criteria:

a) TOV failure mode:

The pass criteria **C**, **H**, **I**, **J**, **K**, **L** and **M** according to Table 4 shall apply.

b) TOV withstand mode:

The pass criteria **A**, **B**, **C**, **D**, **E**, **G**, **I**, **K**, **L** and **M** according to Table 4 shall apply.

8.3.5.3 Short-circuit current behaviour tests

This test is not applied to SPDs which are either

- classified for outdoor use and for mounting out of reach, or
- for connection N-PE in TN and/or TT systems only.

Table 8 – Prospective short-circuit current and power factor

I_p (kA) $^{+5}_{0}$ %	cos φ ($^{0}_{-0,05}$)
$I_p \leq 1,5$	0,95
$1,5 < I_p \leq 3,0$	0,9
$3,0 < I_p \leq 4,5$	0,8

a) Test at the declared short-circuit current rating

The sample is connected to a power frequency source at U_{REF}. The prospective short-circuit current as declared by the manufacturer and with the corresponding power factor as given in Table 8 are adjusted at the SPD terminals.

The test is carried out twice with U_{REF} applied at (45 ± 5) electrical degrees and at (90 ± 5) electrical degrees after the zero crossing of the voltage.

If a replaceable or resettable internal or external disconnector operates, the relevant disconnector shall be replaced or reset each time. If the disconnector cannot be replaced or reset, the test is stopped.

Pass criteria

The pass criteria **C**, **H**, **I**, **J**, **K**, **M** and **N** according to Table 4 shall apply.

b) Test at low short-circuit current

A power frequency source at U_{REF}, having a prospective short-circuit current of five times the rated current of the maximum overcurrent protection (if declared by the manufacturer), and a power factor according to Table 8, shall be applied for 5 s ± 0,5 s. If no external overcurrent protection is required by the manufacturer, a prospective short-circuit current of 300 A is used.

The test is carried out once with U_{REF} applied at (45± 5) electrical degrees after the zero crossing of the voltage.

Pass criteria

The pass criteria **C**, **I**, **M** and **N** according to Table 4 shall apply.

If disconnection occurs during this test, pass criteria **H**, **J**, and **K** according to Table 4 shall apply in addition.

8.3.5.3.1 Additional test for SPDs with I_{fi} lower than the declared short-circuit

Description of main parts

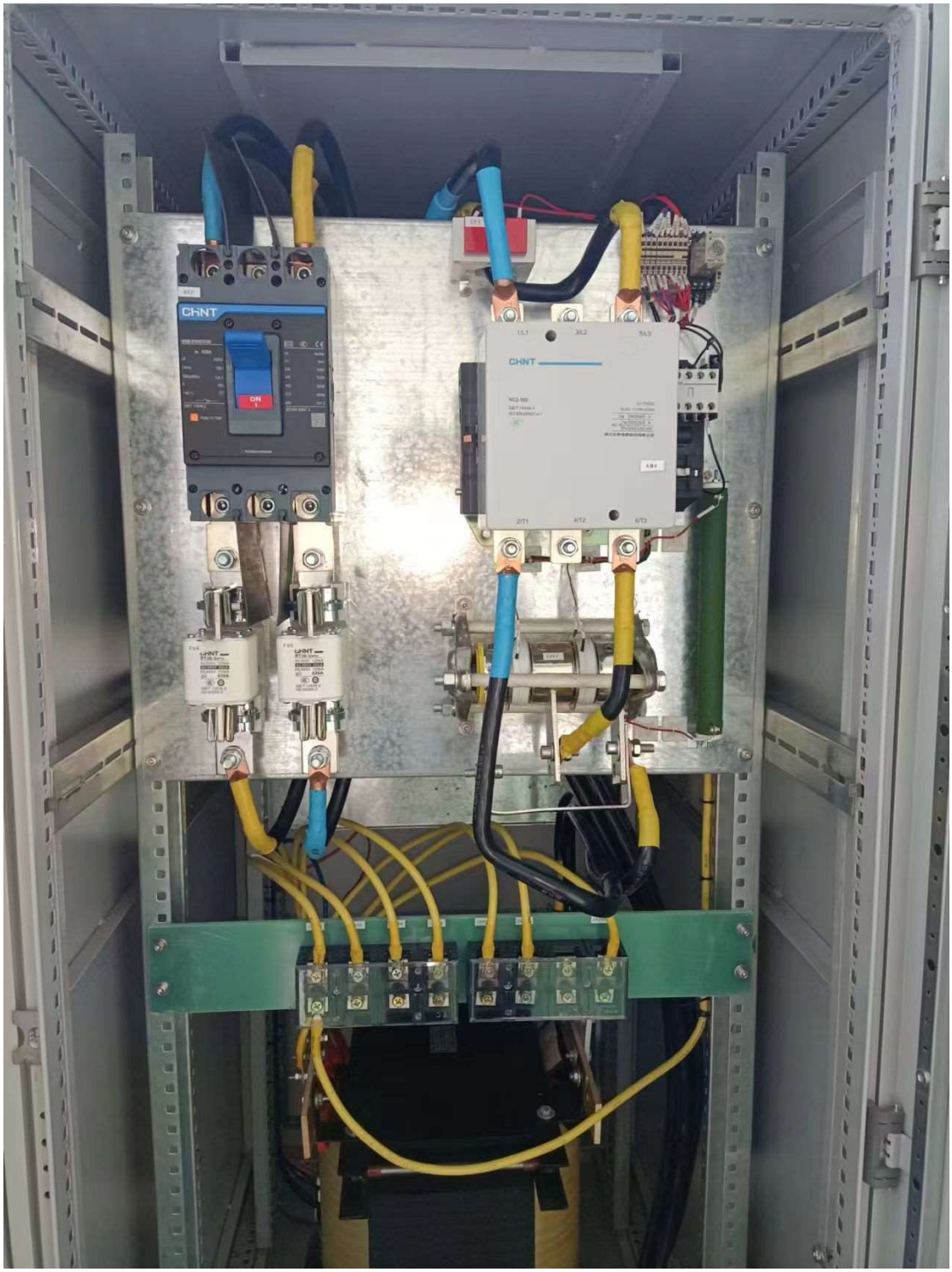
1. T1: Power supply transformer

The output voltage of transformer T1 is U_{REF} and T1 is acted as the power supply for SPD in the fault of the high voltage system.
Input: AC, L-L, 380V/ L-N 220V/ 3 phase 4 lines, with +5% voltage tap and +10% voltage tap;
Output: phase voltage is 255V/336V/440V;
Capacity: 250 kVA;
Load capacity: withstand @ 500A for 5 second.

2. T2: TOV transformer (Single-phase test transformer)

The output voltage of transformer T2 is of U_T.
Input: AC220V, single phase, +5% and +10% voltage taps
Output: multiple taps with 1200V,1250V,1380V,1530V,1800V, 2070V, 2400V;
Capacity: 150kVA; When the output voltage is 1200V, the expectable short circuit current is 300A+10%; The rated current is 20A when the output voltage is not 1200V.
Output TOV duration: According to the specified value in IEC61643-11;
Time of Duration: 200ms (Tolerance:0~10%)

Test current: 300A (RMS)+10%



3. Impedance cabinet (1pc)

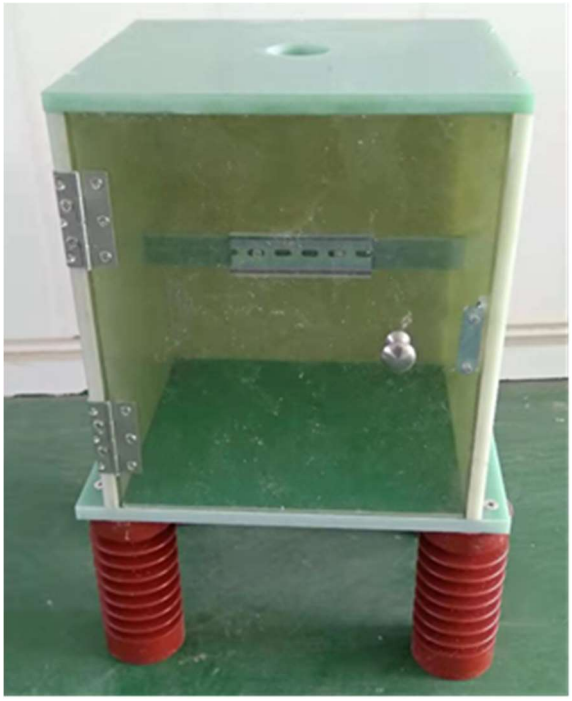
The impedance cabinet includes the manually adjustable resistance with high power, which can be used to adjust the TOV current. The resistance can be adjusted manually In order to reach 300A~500A current.
It can be used to failure mode (1~20A adjustable).

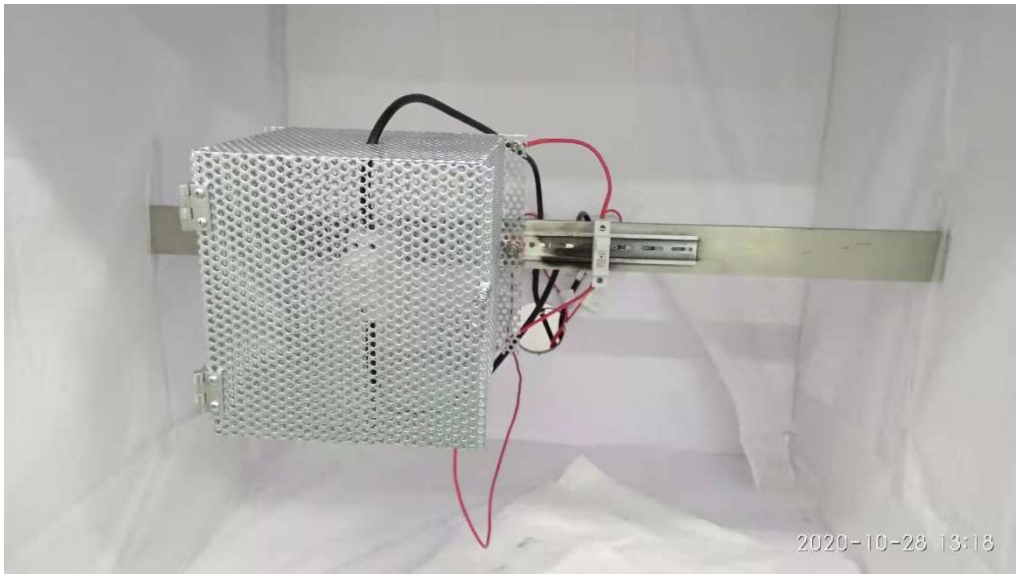
4. Inductance cabinet (1pc)

3 phase inductance cabinet, the inductance can be adjusted manually as per IEC61643-11.

5. Test cabinet (1pc)

The test object is placed on a guide rail in square wooden box;
The side surface of wooden box is 500mm±50mm away from SPD's outer surface;
Tissue paper or gauze should be covered inside the box surface.
The front of the box remains open in order to connect the power cable according to the requirements of the manufacturer.
Dimension of the test cabinet:240 or 340 mm wide, 240mm long, 260mm high.

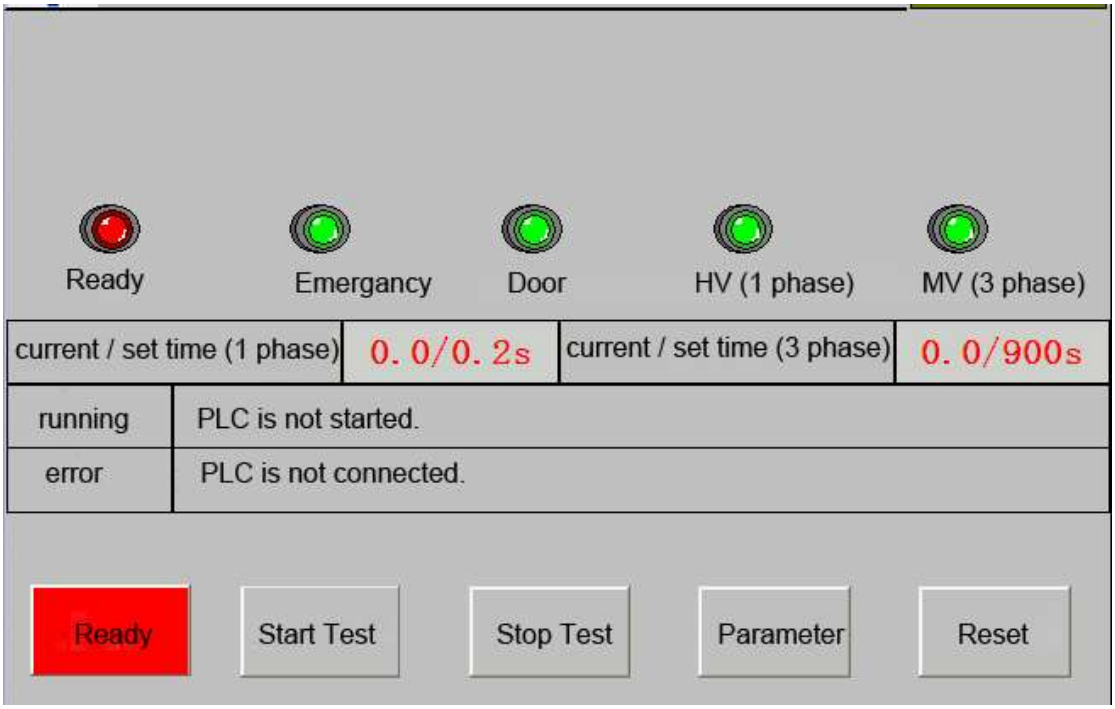




6. Control system

- Set the voltage and time parameters through human-computer interface
- Scalability and reliability of PLC control system, easy to maintain
- The optical fiber transmits and controls signals which can not only guarantee the system reliability, but also provide security isolation for the system
- The duration time of TOV voltage and current can be set with the range of 10ms~10s
- Various test modes for selection, more than ten groups of test parameters can be saved.

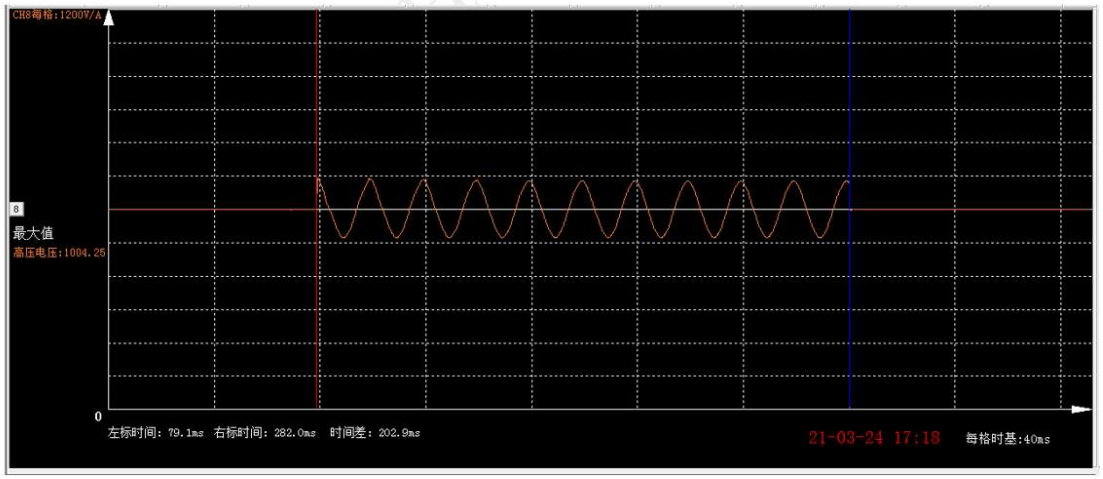
- Emergency stop button
- Automatically cut off the power supply in case of over current
- Over current relay with double protection
- Alarm function of power supply failure
- 90° triggering mode, use thyristor to control the output.
- RS232 connection



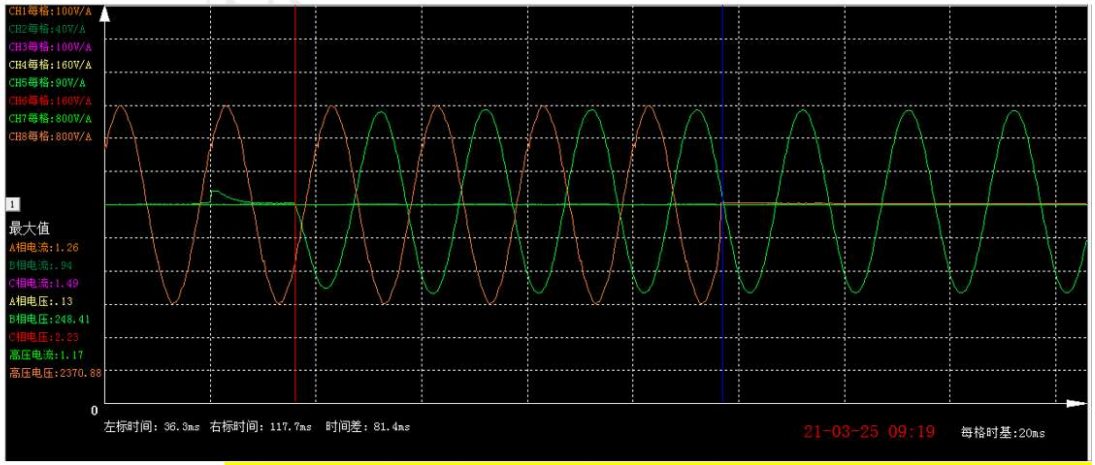
7. The measurement system

- Display real-time test voltage and current value
- Display peak voltage and current
- With up-down, left-right cursor, the equipment can test the voltage value and duration time manually.
- Draw current and voltage waveform automatically, save the waveform as BMP or JPG format, edit the lab report conveniently.
- Record test time, test current, test voltage automatically and the data can be saved.

2.4 高压 TOV 触发角度及 200ms 时间确认

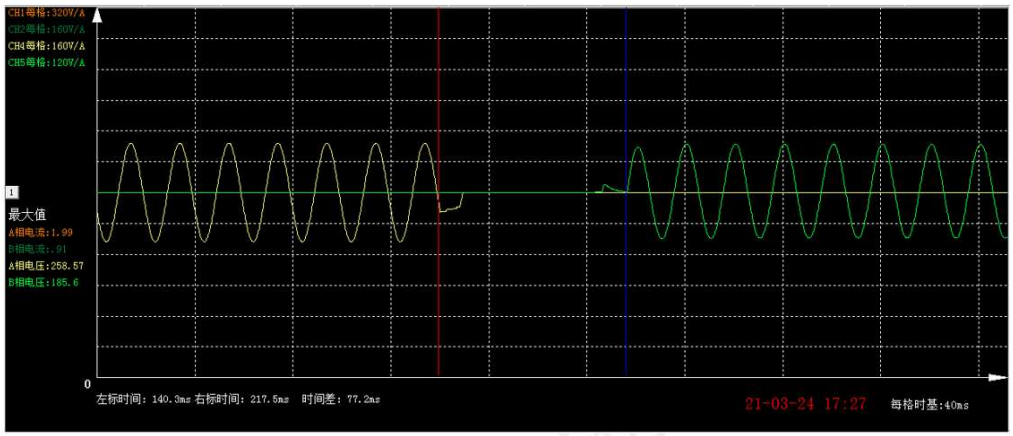


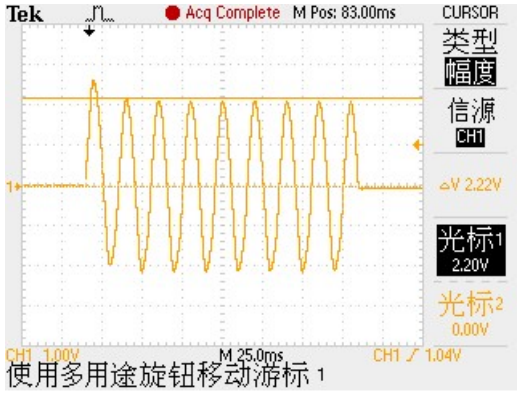
2.2 失效模式电压及流程、Ut 及 Uref 电压重叠时间确认
增加阻抗电流调整

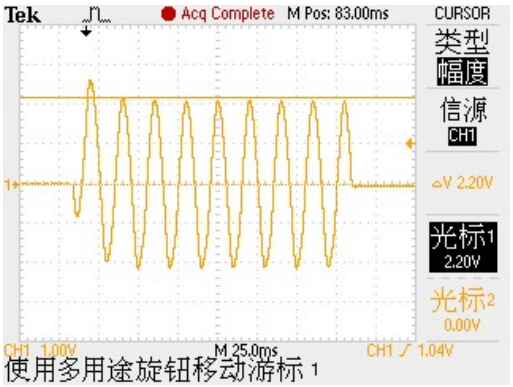


2.3 失零试验、低压电压及流程、Ut及Uref 电压间隔时间确认

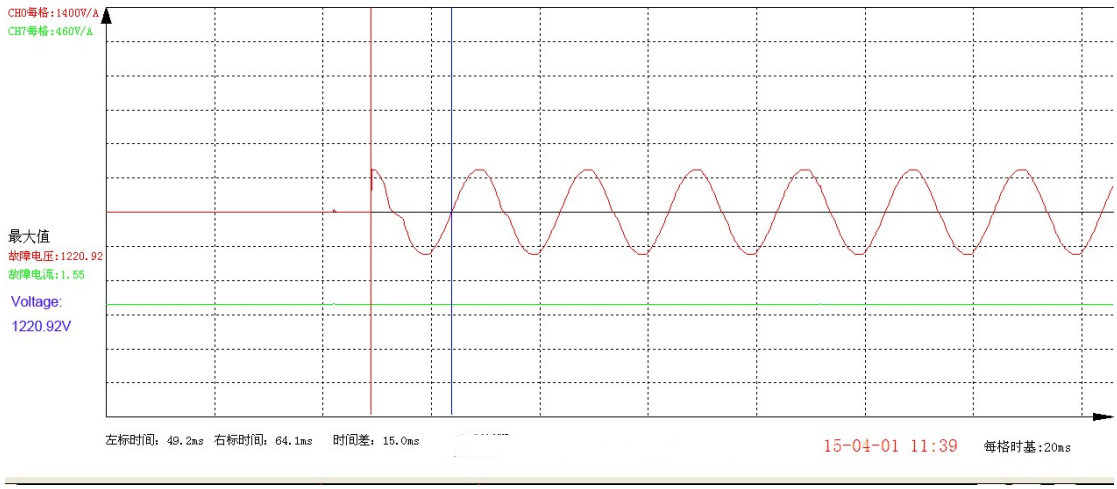
失零试验电流调整测试

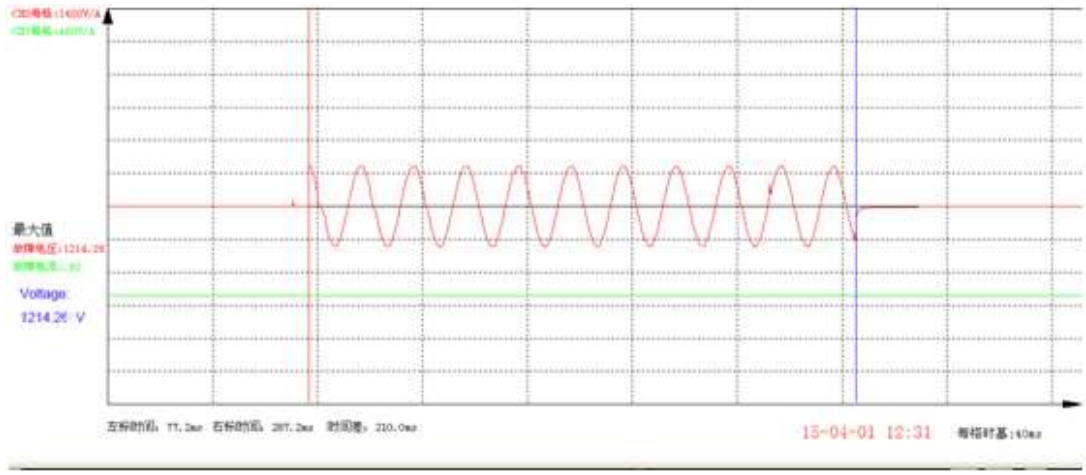


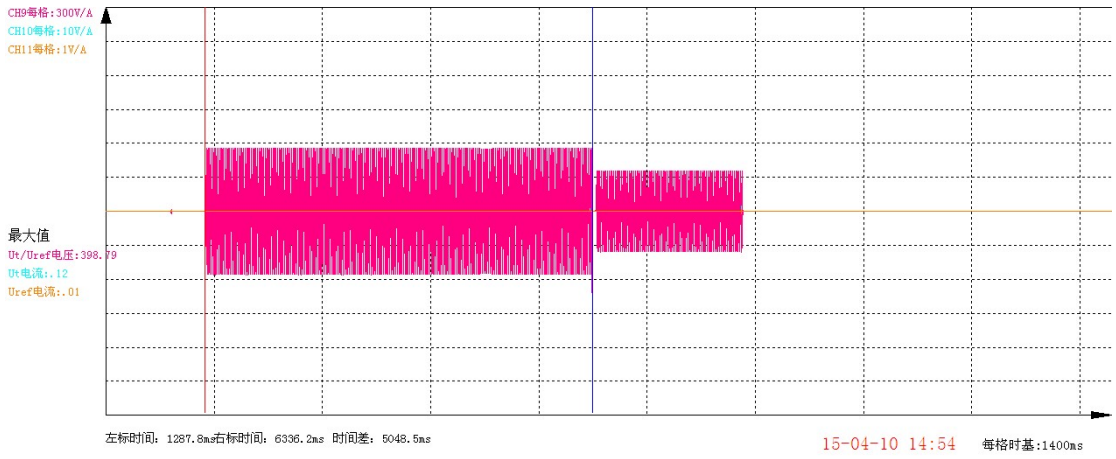




Output Current 300A


CH0每格:1400V/A
CH7每格:460V/A
最大值
故障电压:1220.92
故障电流:1.55
Voltage:
1220.92V
左标时间: 49.2ms 右标时间: 64.1ms 时间差: 15.0ms
15-04-01 11:39
每格时基:20ms


最大值
Voltage:
15-04-01 12:31


CH9每格:300V/A
CH10每格:10V/A
CH11每格:1V/A
最大值
Ut/Uref电压:398.79
Ut电流:.12
Uref电流:.01
左标时间: 1287.8ms右标时间: 6336.2ms 时间差: 5048.5ms
15-04-10 14:54
每格时基:1400ms

Safety Measures

a) the high voltage parts of the device is grounded and isolated;
b) The control cabinet is grounded and the test circuit always grounded at one end;
c) High voltage indicator of red light hints the high voltage is working and green light hints there is no high voltage danger.
d) When the scramming button is pressed, the high voltage device is cut off and terminal grounding of high voltage discharge.
e) When the protection door or scramming switch of test area is opened, high voltage discharges to the ground and the device is not in operation. The interlock light is open.
f) The main loop of the equipment has a fuse for the over current protection to ensure safety.
g) It is equipped with manual grounding rod.