CONTENTS

1 Overview

As the central part of air circuit breaker, controller is primarily used for power distribution, feed and generation protection, thus to protect lines and power equipment from overload, short circuit, grounding and harm of other faults. Through the microprocessor with the button setting mode, the controller has the function of the numerical display, LED indication, fault record, various alarm contact outputs, ground protection, load monitoring and other functions besides the realization of precisely selective-matched overcurrent characteristic protection.

2 Product Classification

2.1. Rated current classification

The controller is divided into the following categories as per the rated current: 200A, 400A, 630A, 800A, 1000A, 1250A, 1600A, 2000A, 2500A, 2900A, 3200A, 4000A, 4500A ,5000A, 6300A,7500A.

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2.2 Controller function classification

Function classification	Function description
Basic functions	1. Multi-curve long-time delay protection 2. Current unbalance (open phase) protection 3. Graphic LCD display in Chinese 4. Multi-curve short-time delay inverse time limit protection 5. MCR 6. LED fault status indication 7. Short-time delay fixed time-limit protection 8. Load monitoring 9. Fault record and query 10. Short circuit instantaneous protection 11. Self-diagnosis 12. Contact equivalent 13. Ground protection 14. Thermal memory 15. Operation times query 16. Grounding alarm 17. Four-phase and ground current display 18. Clock function 19. Current leakage alarm 20. Current leakage protection 21. HSISC 22. Peak factor measurement 23. Power Quality 24. Parameter backup 25. Overload recloser 26. Abnormal condition inquiry
V function	1. Voltage measurement 2. Frequency measurement 3. Voltage unbalance rate measurement 4. Phase sequence detection 5. Current required value measurement 6. Overvoltage protection 7. Undervoltage protection 8. Overfrequency protection 9. Voltage unbalance protection 10. Underfrequency protection 11. Phase sequence protection 12. Required value protection 13. Voltage phase failure 14. Frequency change rate protection
P function	1. Voltage measurement 2. Frequency measurement 3. Voltage unbalance rate measurement 4. Phase sequence detection 5. Power measurement 6. Power factor measurement 7. Electric energy measurement 8. Required value measurement 9. Harmonics measurement 10. Overvoltage protection 11. Undervoltage protection 12. Voltage unbalance protection 13. Overfrequency protection 14. Underfrequency protection 15. Phase sequence protection 16. Reverse power protection 17. Required value protection 18. Overpower (active) 19. Overpower (reactive) 20. Underpower (active) 21. Directional overcurrent protection 22. Electric energy pulse
Optional	1. Signal unit 2. Communication function (fault recording/Waveform capture/broadcast calibration time)

function	3. High precision measurement 4. Temperature protection and measurement 5. Dual protection 6. Historical recording (current/voltage/frequency/power/temperature/humidity values, electrical energy curves, temperature curves, protection value changes,/log records) 7. Health/life prediction
Customized function	1. Current leakage fixed time limit 2. Instantaneous action protection function customization (to be selected in the ordering specification) 3. Dedicated functions

3. Operation modes

3.1 Operation modes of the controller power supply

The working power supply of controller is provided by the transformer and auxiliary power supply. To ensure reliable operation and breaking of small current in case of failure, please adopt the dual-power supply mode.

3.1.1 To be powered by the CT power supply

Normal operating conditions of the controller: the primary current single-phase and three-phase are no less than 0.4In and 0.2In respectively. When the rated current is ≤400A, the primary current single-phase and three-phase of the main circuit are no less than 1.0In and 0.6In respectively. Otherwise, it must be powered by the auxiliary power supply.

3.1.2 To be powered by the auxiliary power supply

Normal operating conditions of the controller: (85%~110%) Us.

AC power voltage (50/60Hz): AC230V, AC400V; the allowable error is ±15%

DC power voltage: DC220V, DC110V, DC24V. The allowable error is ±5%

For the DC power voltage, 1/2-pin input of the controller is only DC24V. When DC110V/DC220V is required by users, an external DC power supply module with the voltage converted to DC24V must be provided.

3.1.3 To be powered by the test port

Rated voltage: DC24V, with an allowable error of ±5%

3.2 Rated power consumption of controller

Rated power consumption: ＜7W.

3.3 Contact capacity of the switch contact output

DO signal alarm output, contact capacity: AC250V/3A;

Fault tripping contact output, contact capacity: AC250V/10A;

Auxiliary contact output of the circuit breaker status, contact capacity: AC250V/10A.

3.4 Anti-interference performance

Meet the requirements of Appendix F of GB14048.2.

3.5 Conforming standards

IEC60947-1 GB/T 14048.1 Low-voltage Switchgear and Control Equipment - General Rules

IEC60947-2 GB/T 14048.2 Low-voltage Switchgear and Control Equipment - Low-voltage Circuit Breaker

3.6 Normal operation and installation conditions

Working temperature: -40℃～+70℃;

Storage temperature: -45℃~~＋85℃;

The monthly average maximum relative humidity of the installation site for the maximum humidity is no more than 90% at an average minimum temperature no more than +25℃ in the month. Thus, the condensation occurred on the product surface due to temperature change is allowed;

Pollution level of 3. (In case of assembled with the circuit breaker);

Installation category of III. (In case of assembled with the circuit breaker).

4 Description of Function

4.1 Protection characteristic

Any protection action will be recorded. The detailed parameters and the time of disconnection when disconnection occurs can be obtained by information search. At the same time, the on-off output can be set.

4.1.1 Overload long-time delay protection

The overload long time-delay protection function is used for protecting the cable overload and current-based root mean square value (RMS).

4.1.1.1 Setting parameters related to overload protection

Setting parameters of overload long time delay protection are shown in Table 1.

For the characteristic curve, see Appendix A.

Table 1 Setting parameters of overload long time delay protection

Parameter name	Setting range	Setting step length	Remarks
Current setting value: Ir	OFF+(0.4~1.0) In	1A (In=2000A and below) 2A (In=2500A and above)	Power distribution protection: 1.0In; Generator protection: 1.25In.

Protection curve type selection	1） Standard power distribution protection I^2t: $t = 2.25T_R / N^2$ (factory default) Standard generator protection I^2t (F): $t = 2.25T_R / N^2$ 2) Express inverse time limit (power distribution protection) EI(G): $t = 1.25T_R /(N^2-1)$ 3) Express inverse time limit (motor protection) EI(M): $t = 1.3974T_R \times \ln[N^2/(N^2-1.15)]$ 4) High-voltage fuse compatible HV: $t = 4.0625T_R/(N^4-1)$ N= I/Ir I—Fault current Ir—Long time-delay setting current t—Long time-delay action time TR—Long time-delay setting time
Protection curve setting	C01～C16 (delay time setting)
Thermal memory time setting	Instantaneous, 10min, 20min, 30min, 45min, 1h, 2h, 3h

Note: Overload long-time delay protection has inverse time limit. One of its four types of characteristic curves may be selected.

4.1.1.2 Overload long-time delay protection action features

For the overload long-time delay protection action features, see Table 2

Table 2 Overload Long Time-delay Action Features

Features	Multiple of current (I/Ir)	Appointed tripping time	Accuracy of delay time
Inaction features	1.0	2 h inaction	-
Action features	1.3	2 h action	-
Action delay	≥ 1.3	See Table 3 and the feature curve	±10% (inherent absolute error (±40 ms)

Remarks: Generator protection In case the overload current is more than 1.2*Ir, it operates within 2 hours

Table 3 Overload Long-time Delay Protection Action Delay Time

Curve type	Fault current	Delay time(s)															
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
I^2t	1.5×Ir	15.00	30.00	60.00	120.00	240.00	360.00	480.00	600.00	720.00	840.00	960.00					
	2×Ir	8.44	16.88	33.75	67.50	135.00	202.50	270.00	337.50	405.00	472.50	540.00					
	6×Ir	0.94	1.88	3.75	7.50	15.00	22.50	30.00	37.50	45.00	52.50	60.00					
	7.2×Ir	0.65	1.30	2.60	5.21	10.42	15.63	20.83	26.04	31.25	36.46	41.67					
EI(G)	1.5×Ir	8.00	12.80	19.20	32.00	48.00	64.00	80.00	108.00	144.00	224.00	320.00	480.00	640.00	800.00	960.00	1120.00
	2×Ir	3.33	5.33	8.00	13.33	20.00	26.67	33.33	45.00	60.00	93.33	133.33	200.00	266.67	333.33	400.00	466.67
	6×Ir	0.29	0.46	0.69	1.14	1.71	2.29	2.86	3.86	5.14	8.00	11.43	17.14	22.86	28.57	34.29	40.00
	7.2×Ir	0.20	0.31	0.47	0.79	1.18	1.57	1.97	2.66	3.54	5.51	7.87	11.80	15.74	19.67	23.60	27.54
EI(M)	1.5×Ir	6.22	9.96	14.90	24.90	37.30	49.80	62.20	84.00	112.00	174.00	249.00	373.00	498.00	622.00	747.00	871.00
	2×Ir	2.95	4.72	7.06	11.79	17.67	23.59	29.46	39.79	53.05	82.42	117.95	176.68	235.89	294.63	353.84	412.58
	6×Ir	0.28	0.45	0.68	1.13	1.69	2.26	2.82	3.81	5.08	7.89	11.30	16.92	22.59	28.22	33.89	39.52
	7.2×Ir	0.19	0.31	0.47	0.78	1.17	1.56	1.95	2.63	3.51	5.45	7.81	11.69	15.61	19.50	23.42	27.30
HV	1.5×Ir	2.46	3.94	5.90	9.85	14.80	19.70	24.60	33.20	44.30	68.90	98.50	147.00	197.00	246.00	295.00	344.00
	2×Ir	0.67	1.07	1.60	2.67	4.01	5.34	6.66	8.99	12.00	18.66	26.68	39.81	53.35	66.63	79.90	93.17
	6×Ir	0.01	0.01	0.02	0.03	0.05	0.06	0.08	0.10	0.14	0.22	0.31	0.46	0.62	0.77	0.93	1.08
	7.2×Ir	0.00	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.10	0.15	0.22	0.30	0.37	0.45	0.52

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4.1.2 Thermal memory

4.1.2.1 Heat capacity

In order to prevent the unacceptable repeated or periodic overload, the controller tracks and records the heating effect of the load current; when the heating effect accumulated by overload reaches to the expected level, it will trip the switch. The changing method of heat capacity is determined by the curve selected.

4.1.2.2 Cooling time

Apart from EI (M) express inverse time (motor protection), for all other curves, the heat capacity increases only when the current measured value is greater than 1.1Ir; after the circuit breaker trips due to overload or inverse time short circuit fault or returns from overload state to the non-overload state, the heat capacity decays according to the index rules. The heat capacity cooling time which can be set by the user is: instant, 10 min, 20 min, 30 min, 45 min, 1 h, 2 h, 3 h.

4.1.2.3 Express inverse time motor protection

For generator protection with express inverse time, the cooling time cannot be set. The heat capacity varies with current.

4.1.2.4 Thermal memory characteristics without auxiliary working power supply

When the controller isn't connected to the auxiliary power supply, and if it is closed immediately after the switch action, the heat capacity produced by the previous current will be ignored. Reclose to make the controller back on electricity and reset, and then the heat capacity restores to zero. As shown in Figure 1 below:

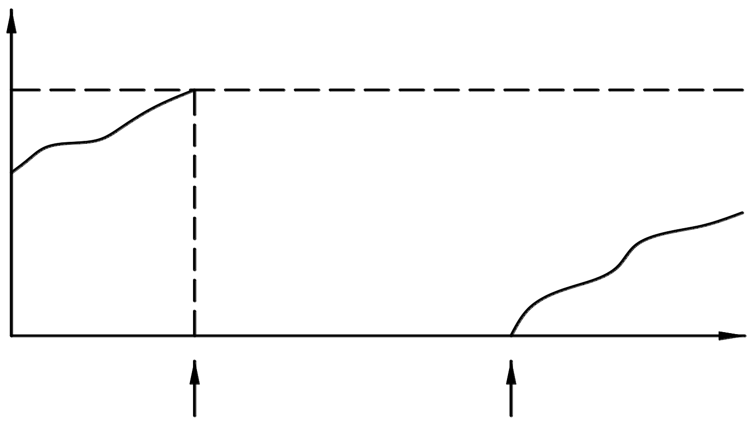


Figure 1 Thermal Memory Characteristics without the Auxiliary Power Supply

4.1.2.5 When the controller is connected to the auxiliary power supply, the heat capacity reduces after the action of the circuit breaker, and the heat capacity produced by the previous current after closing of the circuit breaker will be memorized. The heat capacity reduces after disconnecting of the action, and the heat capacity after reclosing will continue to change according to the present current. As shown in Figure 2:

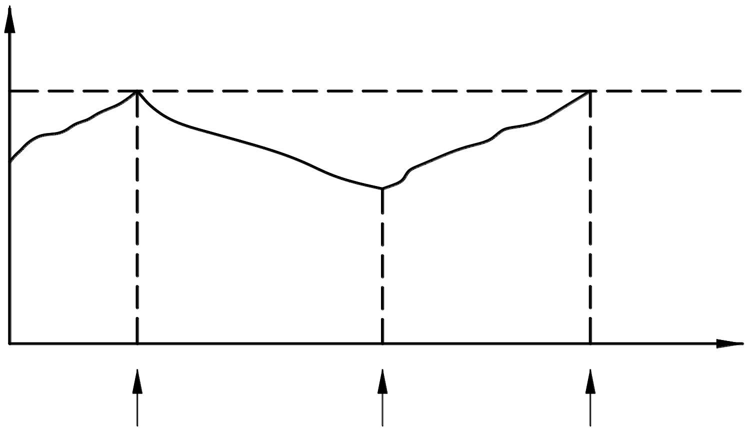


Figure 2 Thermal Memory Characteristics with the Auxiliary Power Supply

4.1.3 Short circuit short-time delay protection

Short time delay protection is to prevent the resistant short circuit of the power distribution system. This kind of short circuit is generally due to short circuit fault of local wires. Generally, the electric current would be beyond the scope of overload, but the short circuit current is not very large.

Tripping time delay of the short-circuit short time delay is aimed to realize the selective protection.

Short circuit time-delay protection is based on the protection of the root mean square value (RMS), which is divided into two segments: reverse time limit and fixed time limit, thus further strengthening the cooperation with the lower protection device.

Short time delay protection can be equipped with regional interlocking function.

When the short circuit fault occurs in the inlet wire side of the circuit breaker at the corresponding level, the short-circuit short time delay will instantaneously disconnect the circuit breaker; when the short circuit fault occurs in the outlet wire side of the lower circuit breaker, the circuit breaker at the same level will be disconnected after the set delay time of the short-circuit short time delay. The realization of this function needs to use switch input (DI) and switch output (DO). DI is used to detect the regional interlocking signal of the lower circuit breaker, while DO is used to send interlocking signal to the upper circuit breaker.

4.1.3.1 Related setting parameters of the short-time delay protection

Short-time protection parameter settings are shown in Table 4.

Table 4 Short-time protection parameter settings

Parameter name	Setting range	Setting step length	Remarks
Reverse time limit action current setting value I_{sd1}	OFF+(1.5~15)Ir	1A (In=2000A and below) 2A (In=2500A and above)	Ir is the overload long time delay setting value. When Ir=OFF, Ir
Setting value of action	OFF+(1.5~15)Ir		

current with fixed time limit Isd2			in the formula will be replaced with the rated current In.
Setting value of delay time with fixed time limit Tsd	0.1~1.0s	0.1s	
Short circuit interlocking (ZSI)	1. At least one switch output (DO) is set to be “Regional interlocking” or “Short circuit interlocking” 2. At least one switch input (DI) is set to be “Regional interlocking” or “Short circuit interlocking”		1. The options of signal unit include S1, S2 and S3; 2. When DI/DO is set as "regional interlocking", it works for both "grounding regional interlocking" and "short-circuit regional interlocking"; when "short-circuit interlocking" is set, it only works for "short-circuit regional interlocking". 3. If function is not set, then the regional interlocking/short-circuit interlocking function will not apply.

4.1.3.2 Short-time delay inverse time action features

Short time delay inverse time action features are shown in Table 5

For the characteristic curve, see Appendix B.

Table 5 Short time delay inverse time action features

Features	Multiple of current (I/Isd1)	Appointed tripping time	Accuracy of delay time
Inaction features	≤0.9	Inaction	
Action features	≥ 1.1	Action[Note 1, Note 2]	±10% (inherent absolute error (±40 ms)

Note 1: The delay features of the short time delay inverse time limit are the same with those of the overload long time delay, but the action delay time is one-tenth of the long time-delay action time.

For example: setting value of the long time delay: Ir

Setting value of the short time delay inverse time limit: Isd1=4Ir

Fault current: I=3Ir

At this movement, the action type is the overload long time delay, and the fault delay time is T_R.

Change the setting value to: long time delay setting value: Ir

Setting value of the short time delay inverse time limit: Isd1=2Ir

Fault current: I=3Ir

At this moment, the fault delay time is $T_R/10$, and the action type is the short circuit short time delay inverse time limit.

Thus, for the same fault current, the time difference between the overload inverse time action and the short circuit short time delay inverse time limit action is nine times.

Note 2: Either long time delay action or short time delay inverse time limit action, when the fault occurs, if the protection is in the cold state, i.e., the heat capacity = 0, the action delay time is not less than the setting value of the short time delay definite time. Namely, if the theory time found out in the feature curve is less than the time of the short time delay definite time, the action delay time shall be the delay time set by the short time delay definite time. If the fault occurs in heat state, i.e., the heat capacity≠0, the action delay time is not limited by the delay time set by the short time definite time.

4.1.3.5 Short time delay fixed time action features

Short time delay definite time action features are shown in Table 6

Table 6 Short time delay definite time action features

Features	Multiple of current (I/Isd2)	Appointed tripping time	Accuracy of delay time
Inaction features	≤0.9	Inaction	-
Action features	≥ 1.1	Definite time set delay time Tsd	±10% (inherent absolute error ±40 ms)

4.1.4 Short circuit instantaneous protection features

Short circuit instantaneous protection is used to prevent the short circuit of the power distribution system. This kind of failure is commonly interphase short circuit fault. The short-circuit current is larger, so it needs a quick disconnection. The protection is based on the root mean square value (RMS).

4.1.4.1 Related setting parameters of short-circuit instantaneous protection

Short-circuit instantaneous protection parameter settings are shown in Table 7.

Table 7 Short-circuit instantaneous protection settings

Parameter name	Setting range	Setting step length
Action current setting value Ii	OFF+(1.0~20) In	1A (In=2000A and below) 2A (In=2500A and above)

4.1.4.2 Short-circuit Instantaneous Protection Action Features

For the short-circuit instantaneous protection action features, see Table 8

Table 8 Short-circuit instantaneous protection action features

Features	Multiple of current (I/Ii)	Appointed tripping time
Inaction features	≤0.85	Inaction
Action features	≥ 1.15	＜40ms Action
Action features	I>MCR settng value	＜30ms Action

4.1.5 MCR protection

MCR protection can protect the making capacity of the circuit breaker by preventing from making current which exceeds the ultimate capacity of the circuit breaker and causing the switch damaged. The protection works instantaneously (within 100ms) when the brake is separated and closed.

4.1.5.1 MCR protection related setting parameters

MCR protection parameter settings are shown in Table 9.

Table 9 MCR protection parameter settings

Parameter name	Setting range	Setting step length
MCR action current setting value	(1～20)In (factory setting value 10In)	1*In

Note: This group of setting value is generally determined based on the breaking capacity of the circuit breaker when it leaves the factory. Cannot be resettled by users.

4.1.5.2 MCR protection features

MCR protection features are shown in Table 10.

Table 10 MCR protection features

Feature	Multiple of current (I/I_{MCR})	Appointed tripping time
Inaction features	≤0.80	Inaction
Action features	≥ 1.1	＜100ms Action

4.1.6 Ground protection

For the single-phase metallic ground fault protection, adopt the differential type (T) protection mode; namely take the vector sum of the four-phase (3-phase 4-wire system) or three-phase (3-phase 3-wire system) current for protection. For the differential type ground fault, regional interlocking can be realized.

4.1.6.1 Related setting parameters of ground protection

Table 11 Ground Protection Parameter Settings

Parameter name	Setting range	Setting step length	Remarks
Action current setting value Ig	OFF+(0.2~1.0)×In	1A (In=2000A and below) 2A (In=2500A and above)	

Inverse time limit shear coefficient K	(1.5~6)+OFF	0.5	
Delay time Tg	0.1~1s	0.1s	
Grounding interlocking (applicable to T-type ground fault) (ZSI)	1. At least one switch output (DO) is set to be “Regional interlocking” or “Ground interlocking” 2. At least one switch input (DI) is set to be “Regional” or “Ground interlocking”		1. The signal unit options must be S1, S2 or S3; 2. When DI/DO is set as “Regional interlocking”, it works for both “Ground regional interlocking” and “Short-circuit regional interlocking”; when “Ground interlocking” is set, it only works for “Ground regional interlocking”. 3. If function is not set, then the interlocking function will not apply.

4.1.6.2 Ground fault protection features

Ground protection action features are shown in Table 12 See Appendix D for the characteristic curve

Table 12 Ground Protection Action Features

Features	*Multiple of current (I/Ig)*	Appointed tripping time	Accuracy of delay time
Inaction features	≤0.8	Inaction	
Action features	≥ 1.0	Action fixed time limit setting, see the remarked delay time Tg	±10% (inherent absolute error ±40 ms)

Note: Time delay of the ground fault is divided into two segments: reverse time limit and fixed time limit, when the multiple of fault current (I/Ig) is less than K, the action features belong to the inverse time limit characteristics, with the action delay time calculated using the following formula.

$$t = Tg \times K \times Ig / I$$

Wherein: t——Action time. Tg——Set delay time.

K——Shear coefficient. Ig——Set action current.

I——Ground measurement current.

When the multiple of fault current is no less than K or K is set to be OFF, the action delay features belong to the fixed time limit characteristics, with the delay time equaling to the set delay time.

4.1.6.3 Testing principle diagram

1. Differential type (T)

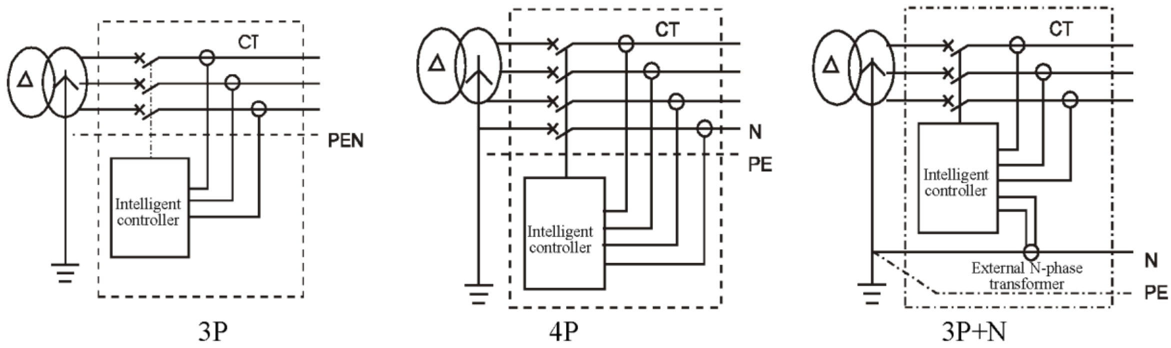


Figure 3 Testing Principle of Differential Type Ground Protection

2. Ground current type (W)

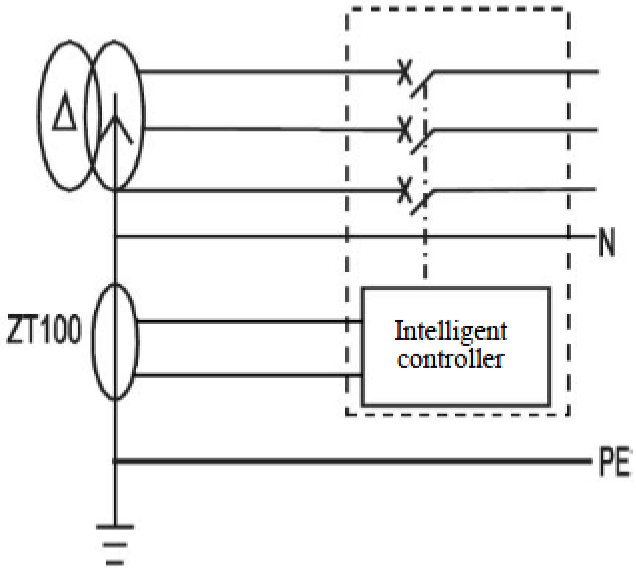


Figure 4 Testing Principle of Ground Current Type Ground Protection

This transformer is an extra special transformer corresponding to the rated current of the circuit breaker, and each type of rated current corresponds to one type of transformer.

4.1.7 Current leakage protection (residual current protection) (4000A and below)

Suitable for the current leakage fault caused by damage of equipment insulation or exposed conductive parts in contact with human body. The current leakage tripping value I△n is directly represented in amperes, which is irrelevant with the rated current of the circuit breaker. The zero-sequence sampling method is adopted for the signal acquisition, with an extra ZT100 rectangle transformer required; this sampling method provides the higher accuracy and sensitivity, suitable for the smaller current protection. The testing principle diagram is shown as below:

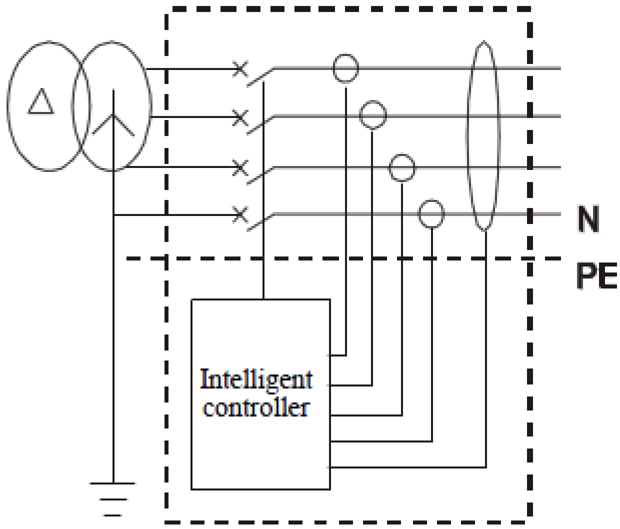


Figure 5 Testing Principle of Current Leakage

4.1.7.1 Related setting parameters of current leakage protection (residual current protection)

Parameter name	Setting range	Setting step length
Action current setting value I△n	0.5~30.0A	0.1A
Delay time T△n (s)	Conventional：Instantaneous, 0.06, 0.08, 0.17, 0.25, 0.33, 0.42, 0.5, 0.58, 0.67, 0.75, 0.83 Customization: Instantaneous, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0	
Execution mode	Tripping/close	

4.1.7.2 Current leakage protection (residual current protection) features

Features	Multiple of current (I/I△n)	Appointed tripping time	Delay allowable error
Inaction features	＜0.8	Inaction	
Action features	＞1.0	Action	
Action delay	≥ 1.0	See the table below	±10% (inherent absolute error (±40 ms)
Action delay (when customized)	≥ 1.0	Perform action according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.7.3 Current leakage protection (residual current protection) action delay

Setting time s	Instantaneous	0.06	0.08	0.17	0.25	0.33	0.42	0.5	0.58	0.67	0.75	0.83
Fault current (A)	Maximum off time											
I△n	0.04	0.36	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
2I△n	0.04	0.18	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5
5I△n 10I△n	0.04	0.072	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1

4.1.8 Neutral wire protection

In actual applications, the cable and current characteristic applied by the neutral phase are always very different from other three phases. The controller carries out different protection to the neutral phase according to different applications. When the neutral wire is too thin, the half fixed value can be adopted for protection; when the neutral wire is the same with other wires, the full fixed value can be adopted for protection; when the harmonics of the power grid are heavier, the double fixed value or 1.6 times of fixed value can be adopted for protection.

● Related setting parameters of neutral wire protection

Neutral wire protection parameter settings are shown in Table 16

Table 16 Neutral wire protection parameter settings

Neutral wire protection type	Description
50%	Half neutral wire protection ● In case of neutral wire overload fault, protection action point is equal to half of the setting value. ● In case of short circuit short time delay fault of the neutral wire, protection action point is equal to half of the setting value ● In case of short circuit transient fault of the neutral wire, protection action point is equal to the setting value ● In case of ground fault of the neutral wire, protection action point is equal to the setting value
100%	Full neutral wire protection ● In case of overload fault of the neutral wire, protection action point is equal to the setting value ● In case of short-circuit short time delay fault of the neutral wire, protection action point is equal to the setting value ● In case of short circuit transient fault of the neutral wire, protection action point is equal to the setting value. ● In case of ground fault of the neutral wire, protection action point is equal to the setting value.
160%	1.6 times of neutral wire protection ● In case of overload fault of the neutral wire, protection action point is equal to 1.6 times of the setting value. ● In case of short-circuit short time delay fault of the neutral wire, protection action point is equal to 1.6 times of the setting value ● In case of short circuit transient fault of the neutral wire, protection action point is equal to the setting value. ● In case of ground fault of the neutral wire, protection action point is equal to the setting value.

200%	Double neutral wire protection ● In case of overload fault of the neutral wire, protection action point is equal to 2 times of the setting value. ● In case of short-circuit short time delay fault of the neutral wire, protection action point is equal to 2 times of the setting value ● In case of short circuit transient fault of the neutral wire, protection action point is equal to the setting value. ● Ground fault of the neutral wire, protection action point is equal to the setting value.
OFF	Without neutral wire protection function

4.1.9 Grounding alarm

Grounding alarm function and ground protection function are independent of each other and exist at the same time, and have separate setting parameters.

4.1.9.1 Action principle

The alarm action principle is shown in Figure 6

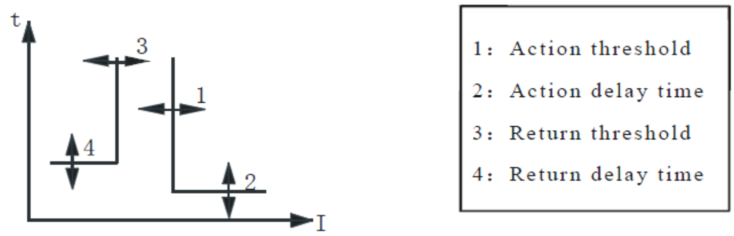


Figure 6 Alarm Action Principle

As shown in the above figure: Start alarm based on the true effective value of grounding current. When the grounding current is greater than the action threshold (1), it will start alarm delay. When the action delay time reaches (2), it will give alarm, and the grounding alarm DO acts. When the grounding current is less than the return threshold (3), it will start return delay. When the return delay time reaches (4), then it will remove alarm, and the grounding alarm DO returns; the return threshold value must be less than or equal to the action threshold.

4.1.9.2 Related setting parameters of grounding alarm

Grounding alarm parameter settings are shown in Table 17

Table 17 Grounding Alarm Parameter Settings

Parameter name	Setting range	Setting step length	Remarks
Alarm action current setting value	OFF+(0.2~1.0)×In	1A (In=2000A and below) 2A (In=2500A and above)	
Alarm action delay	0.1~1.0s	0.1s	
Alarm return current setting value	(0.2~1.0)×In	1A	Only when the execution mode is

Alarm return delay	0.1~1.0s	0.1s	"alarm", this setting is available
Alarm DO output	Set one DO of the signal unit as "Grounding alarm". (This is not required. If this item has not been set, the alarm information can only be read from the controller display screen, without contact output)		

4.1.9.3 Grounding alarm action features

Grounding alarm action features are shown in Table 18

Table 18 Grounding Alarm Action Features

Features	Multiple of current (I/setting value)	Appointed tripping time	Accuracy of delay time
Inaction features	≤0.9	Inaction	-
Action features	≥ 1.0	Action, fixed time limit characteristics according to the set delay time	±10% (inherent absolute error ±40 ms)

4.1.9.4 Grounding alarm return features

Grounding alarm return features are shown in Table 19

Table 19 Grounding Alarm Return Features (only when execution mode is "alarm", can this feature be available)

Features	Multiple of current (I/setting value)	Appointed tripping time	Accuracy of delay time
Non-return feature	≥ 1.0	Non-return	-
Return feature	≤0.9	According to the alarm setting delay, fixed time limit characteristics equaling to the set delay time	±10% (inherent absolute error ±40 ms)

4.1.10 Current leakage alarm (4000A and below)

The current leakage alarm function and protection function are independent of each other and exist at the same time with separate setting parameters. The action principle, action features and return features are the same with those of the grounding alarm.

Table 20 Current Leakage Alarm Parameter Settings

Parameter name	Setting range	Setting step length	Remarks
Alarm action current	0.5 ~ 30.0A	0.1A	

setting value			
Alarm action delay	0.0~1.0s	0.1S	
Alarm return current setting value	0.5~30.0A	0.1A	Only when the execution mode is “alarm”, this setting is available
Alarm return delay	0.0~1.0s	0.1S	
Alarm DO output	Set one DO of the signal unit as “Current leakage alarm”. (This is not required. If this item has not been set, the alarm information can only be read from the controller display screen, without contact output)		

4.1.11 Current unbalance protection/current unbalance alarm

Current unbalance protection carries out protection for broken phase and three-phase current unbalance according to the unbalance rate between the three-phase current. When the execution mode is alarm, the action principle is the same with that of the ground protection. Current unbalance is shown in Figure 7.

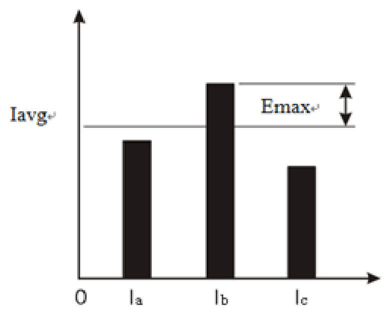


Figure 7 Current imbalance

Unbalance rate calculation method: $Iunbal = \frac{|Ix - Iavg|}{Iavg} \times 100\%$

Wherein, Iavg is the average true effective value (RMS) of the Ia, Ib, Ic three-phase current

$$Iavg = \frac{Ia + Ib + Ic}{3}$$

Ix: Current value of each phase

Emax: Maximum difference value between each phase current and Iavg

4.1.11.1 Related parameter settings of current unbalance protection/current unbalance alarm

Parameter settings of current unbalance protection/current unbalance alarm are shown in Table 21

Table 21 Parameter Settings of Current Unbalance Protection/Current Unbalance Alarm

Parameter name	Setting range	Setting step length	Remarks
Protection/alarm start setting value	5%～60%	1%	
Action delay time setting value	0.1~40.0s	0.1s	

Alarm action return setting value	5%～start value	1%	Only when the execution mode is "alarm", this setting is available
Alarm return delay time	10~200s	1s	
Alarm DO output	Set one DO of the signal unit as "I unbalanced alarm". (This is not required. If this item has not been set, the alarm information can only be read from the controller display screen, without contact output)		
Execution mode	Alarm/tripping/close		

4.1.11.2 Current unbalance action features

Current unbalance action features are shown in Table 22

Table 22 Current Unbalance Action Features

Features	Actual current unbalance rate/setting value	Appointed tripping time	Accuracy of delay time
Inaction features	≤0.9	Inaction	-
Action features	≥ 1.1	Acts according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.11.3 Current unbalance alarm return features

Current unbalance alarm return features are shown in Table 23

Table 23 Current Unbalance Alarm Return Features (only when execution mode is "alarm", can this feature be available)

Features	Actual current unbalance rate/setting value	Appointed tripping time	Accuracy of delay time
Non-return feature	≥ 1.1	Non-return	-
Return feature	≤0.9	Returns according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.12 Required current protection/required current alarm

The required value of the true RMS value of each phase current is calculated within a sliding time window. When the required value exceeds the limit, the protection will act. When the execution mode is alarm, the action principle is the same with that of the grounding alarm. Settings of the sliding time window are shown in the "Gauge Setting" menu item. The required current protection is set separately for each phase:

A-phase maximum required current value

B-phase maximum required current value

C-phase maximum required current value

N-phase maximum required current value (won't be influenced by the neutral wire protection setting)

4.1.12.1 Related setting parameters of required current protection/required current alarm

Setting parameters of required current protection/required current alarm are shown in Table 24

Table 24 Setting parameters of required current protection/required current alarm

Parameter name	Setting range	Setting step length	Remarks
Protection/alarm start setting value	(0.2~1.0) In	1A (In=2000A and below) 2A (In=2500A and above)	
Action delay time setting value	15～1500s	0.1s	
Alarm action return setting value	0.2In ～ start value	1A (2000A and below) 2A (2500A and above)	Only when the execution mode is "alarm", this setting is available.
Alarm return delay time	15～150□s	0.1s	
Alarm DO output	Set one DO of the signal unit as "required value fault" or "each phase required value fault". (This is not required. If this item has not been set, the alarm information can only be read from the controller display screen, without contact output.)		
Execution mode	Alarm/tripping/close		

4.1.12.2 Required current protection/required current alarm action features

For required current protection/required current alarm action features, see Table 25

Table 25 Required current protection/required current alarm action features

Features	Multiple of current (I/setting value)	Appointed tripping time	Accuracy of delay time
Inaction features	≤0.9	Inaction	-
Action features	≥ 1.1	See Note	±10% (inherent absolute error ±40 m)

Note: The current required during the window time shall be satisfied first. After reaching the protection start value, perform the action at the set time.

4.1.12.3 Required current protection return features

Required current protection return features are shown in Table 26.

Table 26 Required current return action features (only when execution mode is "alarm", can this feature be available)

Features	Multiple of current (I/setting value)	Appointed tripping time	Accuracy of delay time
Non-return feature	≥ 1.1	Non-return	-
Return feature	≤0.9	Returns according to	±10% (inherent absolute error (±40

		the set delay time	ms)

4.1.13 Undervoltage protection/undervoltage alarm

The controller measures the real-time voltage value (RMS) of Uan, Ubn and Ucn among the relative neutral wires. When the minimum value of phase voltage is less than the setting value, namely the minimum value of voltage is less than the setting value of undervoltage protection, the undervoltage protection/undervoltage alarm acts; when the minimum value of three-phase voltage is greater than the return value, the alarm action returns.

4.1.13.1 Undervoltage protection/undervoltage alarm action principle

Undervoltage protection/undervoltage alarm action principle is shown in Figure 8

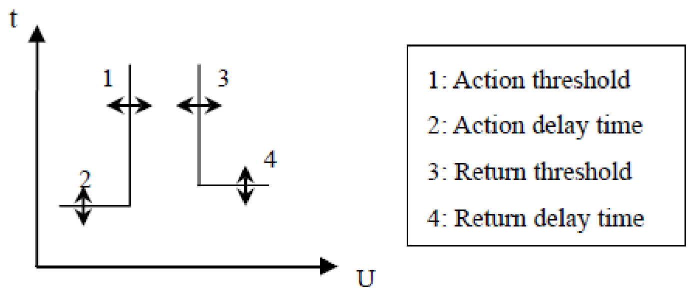


Figure 8 Undervoltage protection action principle

When the minimum value of voltage is less than the action threshold (1), an alarm or tripping delay will be started; when the action delay time reaches (2), the alarm or tripping signal will be sent out, then undervoltage fault DO will act; when the minimum value of voltage is greater than the return threshold (3), the return delay will be started; when the return delay time reaches (4), the alarm will be removed, and undervoltage fault DO will return.

4.1.13.2 Related setting parameters of undervoltage protection

Parameter settings of undervoltage protection are shown in Table 27.

Table 27 Undervoltage protection parameter settings

Parameter name	Setting range	Setting step length	Remarks
Protection/alarm start setting value	100V ～ return value	1V	
Action delay time setting value	0.2～60s	0.1s	
Alarm action return setting value	Start value~600	1V	Only when the execution mode is “alarm”, this setting is available; the return value should be greater than or equal to the start value.
Alarm return delay time	0.2～60s	0.1s	
Alarm DO output	Set one DO of the signal unit as "undervoltage fault". (This is not required. If this item has not been set, the alarm information can only be read from the controller display screen, without contact output.)		

Execution mode	Alarm/tripping/close

4.1.13.3 Undervoltage protection/undervoltage alarm action features

Undervoltage protection/undervoltage alarm action features are shown in Table 28.

Table 28 Undervoltage Protection/Undervoltage Alarm Action Features

Features	Multiple of voltage (Umin/action setting value)	Appointed tripping time	Accuracy of delay time
Inaction features	＞1.1	Inaction	-
Action features	≤0.9	Acts according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.13.4 Undervoltage alarm return features

Undervoltage alarm return features are shown in Table 29

Table 29 Undervoltage alarm return features (when the execution mode is set as "alarm", this feature is available)

Features	Multiple of voltage (Umin/return setting value)	Appointed tripping time	Accuracy of delay time
Non-return feature	＜0.9	Non-return	-
Return feature	≥ 1.1	Returns according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.14 Overvoltage protection/overvoltage alarm

The controller measures the real-time voltage value (rms) of U1, U2 and U3 among the relative neutral wires. When the maximum value of phase voltage is greater than the setting value, namely the maximum value of voltage is greater than the setting value of overvoltage protection, the overvoltage protection/overvoltage alarm acts; when the maximum value of three-phase voltage is less than the return value, the overvoltage alarm action returns.

4.1.14.1 Overvoltage protection/Overvoltage alarm action principle

Overvoltage protection/overvoltage alarm action principle is shown in Figure 9

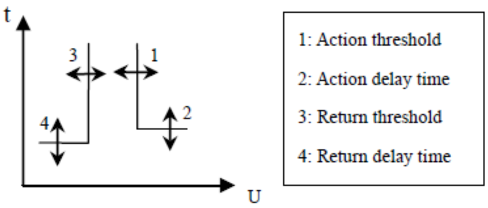


Figure 9 Overvoltage Protection/Overvoltage Alarm Action Principle

When the maximum phase voltage is greater than the action threshold (1), alarm or tripping delay will be started; when action delay time reaches (2), alarm or tripping signal will be sent out, then overvoltage fault DO will act; when the execution mode is alarm, after the alarm action, if the maximum phase voltage is less than the return threshold (3), return delay will be started; when the return delay time reaches (4), the alarm will be removed, and overvoltage fault DO will return

4.1.14.2 Related parameter settings of overvoltage protection/overvoltage alarm

Parameter settings of overvoltage protection/overvoltage alarm are shown in Table 30

Table 30 Overvoltage protection parameter settings (undervoltage setting value must be less than the overvoltage setting value)

Parameter name	Setting range	Setting step length	Remarks
Protection/alarm start setting value	Return value ~ 1200V	V	
Action delay time setting value	0.2~60s	0.1s	
Alarm return setting value	100V ~ start value	1V	Only when the execution mode is "alarm", this setting is available; the start value should be greater than or equal to the return value.
Alarm return delay time	0.2~60s	0.1s	
Alarm DO output	Set one DO of the signal unit as "overvoltage fault" output. (This is not required. If this item has not been set, the alarm information can be read from the controller display screen, without contact output.)		
Execution mode	Alarm/tripping/close		

4.1.14.3 Overvoltage protection/overvoltage alarm action features

Overvoltage protection/overvoltage alarm action features are shown in Table 31

Table 31 Overvoltage Protection/Overvoltage Alarm Action Features

Features	Multiple of voltage (Umax/action setting value)	Appointed tripping time	Accuracy of delay time
Inaction features	≤0.9	Inaction	-
Action features	≥ 1.1	Acts according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.14.4 Overvoltage alarm return features

Overvoltage alarm return features are shown in Table 32

Table 32 Overvoltage alarm return features (when the execution mode is set as “alarm”, this feature is available)

Features	Multiple of voltage	Appointed tripping	Accuracy of delay time

	(Umax/return setting value)	time	
Non-return feature	≥ 1.1	Non-return	
Return feature	≤0.9	Returns according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.15 Voltage unbalance protection/voltage unbalance alarm

Voltage unbalance protection/alarm carries out protection/alarm action according to the unbalance rate among the three-circuit voltage.

Its action principle is the same with that of overvoltage protection/overvoltage alarm. Voltage unbalance is shown in Figure 10.

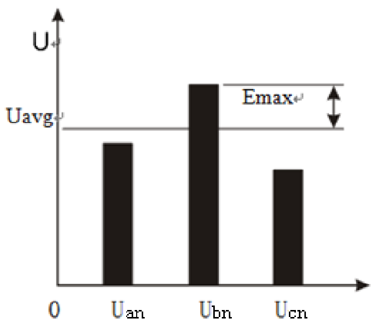


Figure 10 Voltage imbalance

Unbalance rate calculation method: $Uunbal = \frac{|Ux - Uavg|}{Uavg} \times 100\%$

Wherein, Uavg is the average true root mean square value (RMS) of the three-phase circuit voltage

$$Uavg = \frac{Uan + Ubn + Ucn}{3}$$

Emax: Maximum difference value between each phase voltage and average value

4.1.15.1 Related parameter settings of voltage unbalance protection/alarm

Parameter settings of voltage unbalance protection/alarm are shown in Table 33

Table 33 Parameter Settings of Voltage Unbalance Protection/Alarm

Parameter name	Setting range	Setting step length	Remarks
Protection/alarm start setting value	2%～30%	1%	
Protection action delay	0.2～60s	0.1s	

time setting value			
Alarm action return setting value	2%～start value	1%	When the execution mode is "alarm", thi setting value is available Value (the return value must be greate than or equal to the start value)
Alarm return delay time	0.2～60s	0.1s	
Alarm DO output	Set one DO of the signal unit as "U unbalanced alarm" output. (This is not required. If this item has not been set, the alarm information can be read from the controller display screen, without contact output.)		
Execution mode	Alarm/tripping/close		

4.1.15.2 Voltage unbalance protection/voltage unbalance protection alarm action features

Voltage unbalance protection/voltage unbalance protection alarm action features are shown in Table 34

Table 34 Voltage Unbalance Protection/Voltage Unbalance Protection Alarm Action Features

Features	Actual voltage unbalance rate/setting value	Appointed tripping time	Accuracy of delay time
Inaction features	≤0.9	Inaction	-
Action features	≥ 1.1	Acts according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.15.3 Voltage unbalance alarm return features

Table 35 Voltage protection alarm return features (when the execution mode is set as "alarm", this feature is available)

Feature	Actual voltage unbalance rate/setting value	Appointed tripping time	Accuracy of delay time
Non-return feature	≥ 1.1	Non-return	
Return feature	≤0.9	Returns according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.16 Underfrequency, overfrequency protection/alarm

The controller tests the system voltage frequency, and can carry out protection/alarm action no matter the frequency is too large or too small. The action principle and action features of overfrequency and underfrequency protection/alarm are the same with those of the overvoltage and undervoltage protection/alarm. Please refer to 3.1.12 and 3.1.13.

4.1.16.1 Frequency protection parameter settings

Parameter settings of underfrequency protection are shown in Table 36, while parameter settings of overfrequency protection are shown in Table 37

Table 36 Underfrequency protection parameter settings

Parameter name	Setting range	Setting step length	Remarks
Protection/alarm start setting value	45.0Hz~return value	0.1Hz	
Action delay time setting value	0.2～5.0s	0.1s	
Alarm action return setting value	Start value~65.0Hz	0.1Hz	When the execution mode is “alarm”, this setting value is available (the return value must be greater than or equal to the start value)
Alarm return delay time	0.2～36.0s	0.1s	
Alarm DO output	Set one DO of the signal unit as "underfrequency fault" output. (If this item has not been set, the alarm information can be read from the controller display screen, without contact output.)		
Execution mode	Alarm/tripping/close		

Table 37 Overfrequency protection parameter settings (underfrequency setting value must be less than the overfrequency setting value)

Parameter name	Setting range	Setting step length	Remarks
Protection/alarm start setting value	Return value~65.0Hz	0.1Hz	
Action delay time setting value	0.2～5.0s	0.1s	
Alarm action return setting value	45.0Hz~start value	0.1Hz	When the execution mode is “alarm”, this setting value is available (the return value must be greater than or equal to the start value)
Alarm return delay time	0.2～36.0s	0.1s	
Alarm DO output	Set one DO of the signal unit as "overfrequency fault" output. (If this item has not been set, the alarm information can be read from the controller display screen, without contact output.)		
Execution mode	Alarm/tripping/close		

4.1.17 Reverse power protection/alarm

Reverse power protection/alarm takes the sum of the power of three-phase active power. When the power flow direction is opposite to the power direction set by users, and greater than the setting value, protection/alarm will start. Power direction and power supply inlet wire direction are set in the “Gauge setting” menu item, and they must be consistent with the actual application situation. Its action principle is the same with that of overvoltage protection/alarm.

4.1.17.1 Related setting parameters of reverse power protection/alarm

Setting parameters of reverse power protection/alarm are shown in Table 38

Table 38 Setting Parameters of Reverse Power Protection/Alarm

Parameter name	Setting range	Setting step length	Remarks
Protection/alarm start setting value	5～500kW	1kW	
Action delay time setting value	0.2～20s	0.1s	
Alarm action return setting value	5kW～start value	1kW	When the execution mode is “alarm”, this setting value is available (the return value must be greater than or equal to the start value)
Alarm return delay time	1.0～360s	0.1s	
Alarm DO output	Set one DO of the signal unit as “reverse power fault” output. (If this item has not been set, the alarm information can be read from the controller display screen, without contact output.)		
Execution mode	Alarm/tripping/close		

4.1.17.2 Reverse power protection/alarm action features

Reverse power protection/alarm action features are shown in Table 39

Table 39 Reverse Power Protection/Alarm Action Features

Features	Reverse power value/Setting value	Appointed tripping time	Accuracy of delay time
Inaction features	≤0.9	Inaction	-
Action features	≥ 1.1	Acts according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.17.3 Reverse power protection/alarm return features

Reverse power protection/alarm return features are shown in Table 40

Table 40 Reverse Power Protection/Alarm Return Features (when the execution mode is set as “alarm”, this feature is available)

Features	Reverse power value/Setting value	Appointed tripping time	Accuracy of delay time
Non-return feature	≥ 1.1	Non-return	-
Return feature	≤0.9	Returns according to the set delay time	±10% (inherent absolute error (±40 ms)

4.1.18 Phase sequence protection/alarm

Phase sequence detection is taken from the primary voltage. When the set direction of the phase sequence is detected to be the same with that of the start value, the protection/alarm will act. When the protection/alarm action feature is instantaneous, or one phase or multiphase voltage does not exist, this function will automatically exit.

Table 41 Phase sequence protection/alarm parameter settings

Parameter name	Setting range	Remarks
Action phase sequence	Δφ: A, B, C / Δφ: A, C, B	
Alarm DO output	Set one DO of the signal unit as the "phase sequence fault". (This is not required. If this item has not been set, the alarm information can be read from the controller display screen, without contact output;)	
Execution mode	Alarm/tripping/close	

4.1.19 Load monitoring protection features

Load monitoring can be used for pre-alarm or controlling the load of subcircuit. Action is triggered according to the power or current. There are two optional ways:

Way 1, it can independently control load of two branches. When the running parameters exceed the setting value, the corresponding load monitoring DO delays action (corresponding DO function needs to be set), controls and breaks load of two branches, and ensures the power supply of the main system.

Way 2, it is commonly used to control the load of the same branch. When the operation parameters exceed the start value, "load monitoring 1" DO delays action (action types include the pulse mode or level mode) to break the branch load; if the operation parameter value is lower than the return value after breaking, and after the delay setting time, "load monitoring 1" DO returns, and "load monitoring 2" DO acts (level mode or pulse mode), then the breaking load will be switched on, and the power supply of the system will be returned.

4.1.19.1 Action principle of the load monitoring based on current

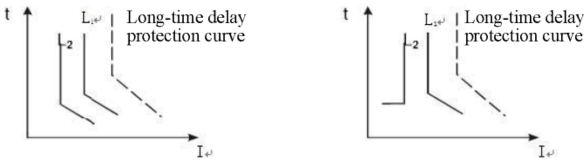
The load monitoring current way and action features are shown in Figure 11

With current as the operation parameter. Action inverse time limit feature is the same with that of the overload. Curve rate and action value are set independently. In case of Way 2, load recovery delay time is definite time.

Note: In case of Way 2, the start value L_1 must be greater than or equal to the return value L_2

4.1.19.2 Action principle of the load monitoring based on active power

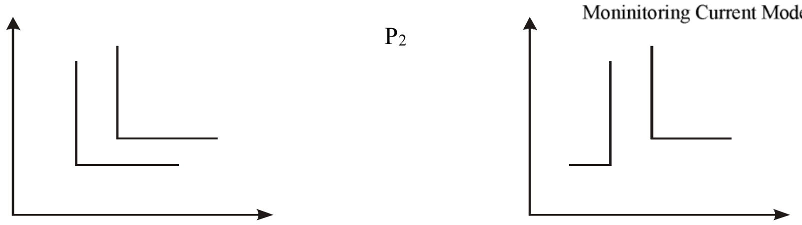
The load monitoring power way and action features are shown in Figure 12.



Way 1 Way 2 Note)

Figure 11 Action Features of Load Moninitoring Current Mode

t P2



Way 1 Way 2 Note)

Figure 12 Load monitoring power way and action features

With the system active power as the operation parameter. Unload and return delay time are definite time.

Note: In case of Way 2, the start value P1 must be greater than or equal to the return value P2.

4.1.19.3 Settings of load monitoring related parameters

Load monitoring parameter settings are shown in Table 42.

Table 42 Load monitoring parameter settings

Parameter name		Setting range	Setting step length	Remarks
Load monitoring method		1. Current mode 1 2. Current mode 2 3. Power mode 1 4. Power mode 2 5. Close		T_R: overload long time-delay action time; Ir: setting value of the overload long time-delay action.
Unloading I action setting value	Current mode 1 Current mode 2	0.2~1.0Ir	1A	
	Power mode 1 Power mode 2	200～10000kW	1kW	
Unloading I action delay	Current mode 1 Current mode 2	20~80%T_R	1%	
	Power mode 1 Power mode 2	10～3600s	0.1s	
Unloading II action setting value	Current mode 1	0.2~1.0Ir	1A	
	Current mode 2	0.2Ir~unload I		
	Power mode 1	200～10000kW	1kW	
	Power mode 2	100kW～unloading I	1kW	
Unloading II action delay	Current mode 1	20~80%T_R	1%	
	Current mode 2	10～600s	0.1s	

	Power mode 1 Power mode 2	10～3600s	0.1s	
Alarm DO output	Set one DO of the signal unit as "load monitoring 1" and another as "load monitoring 2".			

4.1.20 Underpower protection/alarm

Underpower protection/alarm trips when the provided power falls below the set threshold. If the power falls below the activation threshold, the protection will trip within a fixed time set by the user.

4.1.20.1 Underpower protection/alarm related setting parameters

Underpower protection/alarm setting parameters are shown in Table 43.

Table 43 Underpower Protection/Alarm Setting Parameters

Parameter name	Setting range	Setting step	Remarks
Protection start setting	5～500kW	1kW	
Setting value of protection action delay time	0.2～20s	0.1s	
Alarm action returns to set value	5kW～Opening value	1kW	This setting value is available only when the execution mode is "alarm" (the return value must be greater than or equal to the start value)
Alarm return delay time	1.0～360s	0.1s	
Alarm DO output	Set a DO of the signal unit to the "power failure" output. (if this item is not set, the alarm information can be read from the controller display screen without contact output.)		
Implementation modalities	Alarm/trip/off		

4. 1. 21 Power factor alarm

Power factor alarm alarms when the absolute value of the power factor provided is lower than the set threshold, and clears the alarm information if the power factor is higher than the return value.

4. 1. 22 Over active power protection/alarm

The over active power protection will trip when the active power is higher than the set threshold.

Table 44 Over active power protection

Parameter name	Setting range	Remarks
Over active power protection		
Protection alarm DO output	Set a DO of the signal unit as "overplayed power failure". (It is not necessary. If this item is not set, the alarm information can be read from the controller display without an contact output;)	
Implementation modalities	Alarm/trip/off	

4. 1. 23 Over reactive power protection/alarm

The over reactive power protection will trip when the active power is higher than the set threshold.

Table 45 Over reactive power protection

Parameter name	Setting range	Remarks
Over reactive power protection		
Protection alarm DO output	Set a DO of the signal unit as "over -effective power failure". (It is not necessary. If this item is not set, the alarm information can be read from the controller display without an contact output;)	
Implementation modalities	Alarm/trip/off	

4. 1. 24 Internal temperature protection/alarm

The internal temperature protection will trip when the temperature measured by the controller board reaches the set threshold.

Table 46 Controller temperature protection

Parameter name	Setting range	Remarks
Controller temperature protection	50℃~85℃	
Protection alarm DO output	Set a DO of the signal unit as "controller temperature failure". (It is not necessary. If this item is not set, the alarm information can be read from the controller display without an contact output;)	
Implementation modalities	Alarm/trip/off	

4. 1. 25 Contact temperature protection/alarm

The contact temperature protection will trip when the measured contact temperature reaches the set threshold.

Table 47 Contact temperature protection

Parameter name	Setting range	Remarks
Contact temperature protection	70℃~130℃	
Protection alarm DO output	Set a DO of the signal unit as "contact temperature failure". (It is not necessary. If this item is not set, the alarm information can be read from the controller display without an contact output;)	
Implementation modalities	Alarm/trip/off	

4. 1. 26 Directional over current protection

Directional over current protection prevents selective directional short circuits. Depending on the direction of the measured current, the tripping time can be different. When the protection start setting is exceeded, the protection will trip for a fixed time determined by the direction of the fault.

4. 1. 26. 1 Action principle of directional over current protection

See Figure 13 for the action principle of directional over current protection.

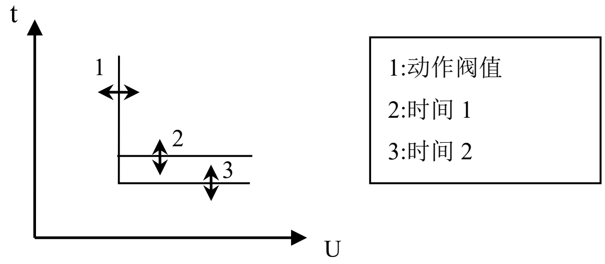


Figure 13 Action principle of directional over current protection

4. 1. 26. 2 Setting parameters of directional over current protection

See table 48 for the setting of directional over current protection parameters.

Table 48 Setting of directional over current protection parameters

Parameter name	Setting range	Setting step	Remarks
Protection start setting	0.6～10In	1A	
Time setting	0.2～0.8S	0.01S	
Direction selection	Forward/reverse/off		
Implementation modalities	Alarm/trip/off		

4. 1. 26. 3 Action characteristics of directional over current protection

See table 49 for the characteristics of D protection action.

Table 49 D Protection Action Features

characteristic	Voltage multiple (Umax/action setting)	Agreed trip time	Delay time accuracy
Action properties	＞1.1	Inaction	—
Inaction properties.	≤0.9	Set the delay time for the action	±10%（Inherent absolute error ±40ms）

4.2 Measuring function

4.2.1 Real-time value measurement

4.2.1.1 Current

a) Measurement mode

Measurement of the instantaneous current value (RMS) includes: I_a, I_b, $I_c$and I_N, ground fault current Ig, residual current $I_{\triangle}$n, applicable to the 50Hz, 60Hz power grid.

b) Measurement range

I_a, I_b, I_c and I_N are not less than 25 In (rated current of the circuit breaker).

Given the high current application environment of frame circuit breakers, the controller is designed to prevent interference by not displaying readings for lower current levels.

rated current（A）	Minimum Display Current(A)

200A	30A
400~800	60A
1000~2000	100A
2500~4000	150A
5000~8500	200A

c) Measurement accuracy

Within the scope of 2In, error is ±1.5%; while above 2In, error is ±5%. When the high -precision measurement is enable, 0.1in ~ 1in, the error is ± 0.5%.

d) Display with histogram

Controller displays the current value of A, B, C and neutral wires (depending on the system type selection) with histogram, and indicates the set value percentage of the current relative to the overload (the relative and rated current in case of closing of overload).

4.2.1.2 Current unbalance rate Iunbal

Current unbalance is shown in Figure 14

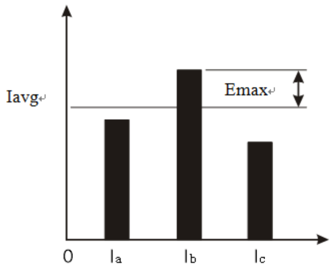


Figure 14 Current imbalance

This function calculates the unbalance percentage among the three-phase current

$$Iavg = \frac{Ia + Ib + Ic}{3}$$

$$Iunbal = \frac{|Ix - Iavg|}{Iavg} \times 100\%$$

Ix: Indicates the current value of each phase

Iavg: The average value of three-phase current RMS

Emax: Maximum difference value between each phase current and Iavg

4.2.1.3 Voltage

a) Measurement mode

True RMS measurement, applicable to the 50Hz,60Hz power grid.

b) Measurement range

Circuit voltage (the phase-phase voltage): 0V~1200V;

Phase voltage (measuring phase- neutral wire voltage): 0~600V.

c) Measurement accuracy: ±0.5%

4.2.1.4 Phase sequence

Display of the order of phase. If there's no voltage function, there's no phase order detection too.

4.2.1.5 Frequency[Note)]

a) Measurement range is 40Hz～65Hz

b) Error is ±0.1Hz

4.2.1.6 Voltage unbalance rate Uunbal

Voltage unbalance rate is shown in Figure 15

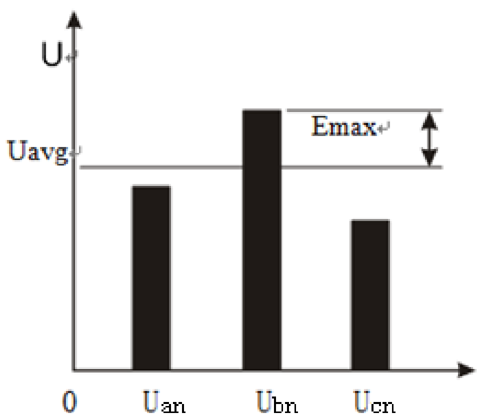


Figure 15 Voltage imbalance

This function calculates unbalance percentage among the three-phase voltage

$$Uavg = \frac{Uan + Ubn + Ucn}{3}$$

$$Uunbal = \frac{|Ux - Uavg|}{Uavg} \times 100\%$$

Ux: Indicates the voltage value of each phase

Uavg: The average value of three-phase voltage RMS value

Emax: The maximum difference value between each phase voltage and Uavg

4.2.1.7 Power

a) Measurement mode

True active, true reactive mode.

b) Measuring content

System active power, reactive power, apparent power

Split-phase active power, reactive power, apparent power (not appl -wire system)

c) Measurement range

Active: -32768kW~+32767kW

Inactive: -32768kar~+32767kar

Apparent: 0kVA~65535kVA

Error: ±2.5%, When the high -precision measurement is enable, the error is ± 1%

4.2.1.8 Power factor

a) Measuring content

System power factor

Power factor of each phase (not applicable to the three-phase three-wire system)

b) Measurement range

Range: -1.00~+1.00, error: ±0.02

4.2.1.9 Electric energy

a) Measuring content

Input active power (EPin), input reactive power (EQin)

Output active power (EPout), output reactive power (EQout)

Total active power (EP), total reactive power (EQ), total apparent power (ES)

b) Active: 0~4294967295kWh

Inactive: 0~4294967295kvarh

Apparent: 0~4294967295 kVAh

c) Measurement accuracy

Electric energy display error is 2.5%

Note: The symbols of active power, reactive power and power input/output should be set as the "Upper inlet wire" or "Lower inlet wire" in the "Mode of inlet wire" under the "Gauge setting" menu item according to the actual usage situation.

All computed electric energy value is the "total absolute value". Represents the sum of the power input and output values:

$EP = \sum EPin + \sum EPout$ $EQ = \sum EQin + \sum EQout$

4. 2.1.10 internal temperature

a) Measurement content: internal temperature of control panel

b) Measurement range: 0-85 ℃; Error+5 ℃

4. 2. 1. 11 internal humidity

a) Measurement content: humidity inside the control board

b) Measurement range: 0.00 degrees to 100.00 degrees; Error: ± 20%

4. 2.1.12 contact temperature

a) Measurement content: temperature at the contact inside the control board frame

b) Measurement range: 0-165 ℃; Error+5 ℃

4.2.2 Demand measurement

4.2.2.1 Current demand measurement

a) Measuring content

Measure the current required value I_a, I_b, I_c, I_N (depending on the system type selection) and set the time parameters of measuring the required current.

b) Measurement mode

Sliding type: sliding window time range: 5~60 min.

c) Measurement range

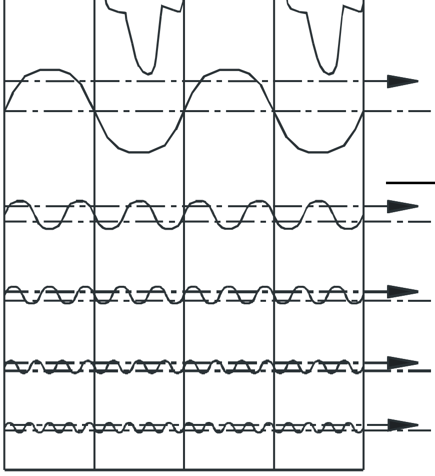
The same with the real value

measurement of current.

d) Measurement accuracy

Within the scope of 2In, error is ±1.5%;

while above 2In, error is ±5%.



4.2.2.2 Power demand measurement

a) Measuring content

Required value of system active power P, inactive power Q and apparent power S.

b) Measurement mode

Sliding type: sliding window time range: 5~60 min.

c) Measurement range

The same with the real value measurement of power.

d) Measurement accuracy: ±2.5%

4.2.3 Harmonics measurement

4.2.3.1 About harmonics

Harmonic is the most commonly encountered problem in the modern electrical facilities. When the harmonic occurs, the waveform of the current or voltage will distort, and will no longer the absolute sine curve. Distorted current or voltage waveform affects the distribution of the electric power, thus the power supply quality won't reach the optimum.

Harmonic is caused by the nonlinear load. When current waveform flowing in the load is inconsistent with the voltage waveform, it is called a nonlinear load. Typical nonlinear load is usually used for power electronics. Its proportion in the consumer market of electronics is growing. Common nonlinear loads, such as: electric welding machine, electric arc furnaces, rectifier, speed regulation device of asynchronous or DC motor, computer, copier, fax machine, TV, microwave oven, neon light, UPS, etc. Nonlinear phenomena may also be caused by converter or other equipment.

a) Definition of harmonic

1) One signal is composed of the following factors:

Original sine curve signal under the fundamental wave frequency

Other sine curve signal (harmonic), with the frequency integral multiples of the fundamental wave frequency

DC component (in some cases)

2) Any signal can be expressed in the following formula:

$$y(t)=Y_0+\sum_{n=1}^{\infty} Yn \times \sin(n\omega t - \varphi n)$$

Wherein:

Y_O is the DC component (usually regarded as 0)

Yn is the RMS value of the nth harmonic

ωis the angular frequency of the fundamental wave

φn is the phase displacement of harmonic when t＝0

Harmonic number n refers to the Nth harmonic. It is a sine curve signal with frequency of n times of the fundamental wave frequency.

For example, current and voltage waveforms usually have the following features:

The fundamental wave frequency is 50 Hz

The second harmonic frequency is 100 Hz

The third harmonic frequency is 150Hz

……

Distorted waveform is the result of the superposition multiple harmonic on the fundamental wave form.

b) Influence of harmonics

Increase the current of the system, resulting in overload

Too much equipment wear and tear, and aging in advance

Voltage harmonic impacts the normal work of load

Communication network is affected

c) Acceptable level of harmonics

1) Standard and regulation OF the harmonic interference:

Compatibility standards of public facilities: low pressure: IEC6000-2-2

Medium voltage: IEC6000-2-4

Electromagnetic compatibility (EMC) standard: Load lower than 16 A: IEC6000-3-2

Load higher than 16 A: IEC6000-3-4

2) Voltage harmonic arranged according to even order and odd order and acceptable harmonic levels are shown in Table 43.

Low voltage (LV) system

Medium voltage (MV) system

Extra high voltage (EHV) system

Table 50 Acceptable harmonic level

Odd harmonics (not a multiple of 3)		Odd harmonics (a multiple of 3)		Even harmonic	
Order n	LV	Order n	LV	Order n	LV
5	6	3	5	2	2
7	5	9	1.5	4	1
11	3.5	15	0.3	6	0.5
13	3	21	0.2	8	0.5
17	2	>21	0.2	10	0.5
19	1.5			12	0.2
23	1.5			>12	0.2
25	1.5				

Note: The harmonic content of the nth harmonic is the percentage ratio of the nth harmonic to the fundamental RMS value. This value is displayed in the screen of the controller.

d) Low frequency odd harmonics

Mainly 3rd, 5th, 7th, 11th and 13th harmonics

4.2.3.2 Harmonics measurement content

a) Purpose of the harmonic measurement

As a precaution, obtaining system information and detecting drift

As corrective action, diagnose disturbance, or detect the effectiveness of the scheme

b) Fundamental wave measurement

Including:

Current - I_a, I_b, I_c and I_N.

Voltage - Uab, Ubc, Uca and Uan, Ubn, Ucn

c) Total harmonic distortion THD and thd

1) Current:

The total distortion rate of THD harmonic relative to the fundamental wave is the ratio of the square root of the quadratic sum of all the harmonic currents above the second harmonic to the fundamental wave current. The total distortion rate of thd harmonic relative to the current effective value is the ratio of the square root of the quadratic sum of all the harmonic currents above the second harmonic to the current effective value.

When this value is less than 10%, it will be regarded as normal, without abnormal work risk; when this value is 10~50%, it indicates that there is a clear harmonic interference, which may cause temperature rise, thus the cable needs to be increased. When this value is more than 50%, it indicates that there's a major harmonic interference. It may affect the normal work, and needs to carry out in-depth analysis on equipment.

2) Voltage:

The total distortion rate of THD harmonic relative to the fundamental wave is the ratio of the square root of the quadratic sum of all the harmonic voltages above the second harmonic to the fundamental wave voltage. The total distortion rate of thd harmonic relative to the voltage effective value is the ratio of the square root of the quadratic sum of all the harmonic voltages above the second harmonic to the voltage effective value.

When this value is less than 5%, it will be regarded as normal, without abnormal work risk; when this value is 5~8%, it indicates that there is a clear harmonic interference, which may cause temperature rise, thus the cable needs to be increased. When this value is more than 8%, it indicates that there's a major harmonic interference. It may affect the normal work, and needs to carry out in-depth analysis on equipment.

d) Amplitude spectrum of the first 31th harmonics

Controller can display FFT amplitude of the 3rd~31th harmonic, and display the harmonic amplitude of different frequency in the form of rectangular figure, and form wave spectrum analysis of harmonic.

4.2.3.3 Waveform and waveform capture

Controller can capture current and voltage waveforms by digital sampling technology similar to the applied oscilloscope technology. Waveform capture is the method of detecting the weak link in system and equipment. By capturing information of waveform display, the harmonic level and the direction and amplitude of harmonic can be determined.

Users can manually browse the following waveform:

a) 4 currents I_a, I_b, I_c and I_N;

b) 3 phase voltages Uan, Ubn, Ucn;

c) Recorded in one cyclic wave.

d) The wave data can be read through communication.

4. 2.3.4 power quality and strategy

The controller can obtain power quality record data through communication. There are short-term voltage interruption count, short-term voltage drop count, short-term voltage rise count, slow voltage level 1 dip alarm count, slow voltage level 2 dip alarm count, slow voltage level 3 dip alarm count, slow voltage level 1 rise alarm count and slow voltage level 2 Rise alarm count recorded in 24 hours, 7 days and 1 year respectively.

4. 2.3.5 temperature measurement

It can measure the temperature, humidity and contact temperature inside the controller;

Internal temperature and humidity accuracy is ± 2%; The measurement range is 0-85 ℃;

The temperature accuracy of the contact is ± 5%, and the measurement range is 0-150 ℃.

4.2.4 Gauge setting

4.2.4.1 System type

a) 3ф3W3CT:

System type: three-phase three-wire

Pole number of the circuit breaker: three poles (3P)

b) 3ф4W3CT:

System type: three-phase four-wire

Pole number of the circuit breaker: three poles (3P)

c) 3ф4W4CT:

System type: three-phase four-wire

Pole number of the circuit breaker: four poles (4P) or three poles plus N-phase (3P+N)

4.2.4.2 Mode of inlet wire

Upper incoming line: The incoming line of the power source is located at the upper side of the circuit breaker.

Lower incoming line: The incoming line of the power source is located at the lower side of the circuit breaker.

4.2.4.3 Power direction

P+: Receiving electricity, power consumption

P-: Electric power generation, output power

4.3 Maintenance function

4.3.1 Historical peak value

4.3.1.1 Historical peak value of current

Content recorded:

I_a, I_b, I_c and I_n, ground fault current Ig and the maximum value of residual current IΔn appeared since the running. This value can be reset manually.

4.3.1.2 Historical peak value of demand

Content recorded:

$\overline{Ia}$、$\overline{Ib}$、$\overline{Ic}$、$\overline{In}$、$\overline{P}$、$\overline{Q}$、$\overline{S}$ The maximum value appeared since running. This value can be reset manually.

4.3.2 Contact equivalent

Controller calculates and displays wear and tear of contact, i.e., the contact life, according to the contact mechanical life, breaking current and other parameters. When delivery, contact life of controller is 0, meaning that there's no wear and tear. When the display value reaches to 80%, a signal alarm will be sent out to remind users to timely take maintenance measures. After the contact is replaced, contact life can be resumed to the initial value through the button operation, but the total life still remains as the total consumed life of the contact of circuit breaker.

4.3.3 Number of operations

Record the sum of number of operations of the circuit breaker. This value can be cleared manually.

4.3.4 Fault record function

4.3.4.1 Tripping history can display the parameters measured in the last 8 times of tripping at any time.

4.3.4.2 For each tripping, the specifically recorded parameters are as follows:

Tripping cause

Tripping threshold

delay time

Current or voltage value (some fault types don't have such item, e.g. MCR tripping, undervoltage tripping).

Fault time (year, month, day, hour, minute, second)

4.3.5 Alarm history record

4.3.5.1 Alarm history can display the parameters measured in the last eight times of alarm at any time.

4.3.5.2 For each alarm, the specifically recorded parameters are as follows:

Alarm cause

Alarm threshold

Fault time (year, month, day, hour, minute, second)

4.3.6 Dislocation history

4.3.6.1 The dislocation history can display the parameters measured in the last eight times of alarm at any time.

4.3.6.2 For each dislocation, the specifically recorded parameters are as follows:

Dislocation type (switch on, off or tripping)

Dislocation cause (local/remote operation, fault/test tripping)

Dislocation time (year, month, day, hour, minute, second)

4.3.7 Self-inspection function

The controller can display error information and send alarm signals when EEPROM fails, AD sampling error, controller battery power is insufficient and other errors.

The controller can perform self-test on NFC, Bluetooth and Wi-Fi modules.

4. 3. 8 logging

4.3.8.1 average voltage per hour

Cycle through 256 records.

4.3.8.2 maximum and minimum current

Cycle through 256 records.

4.3.8.3 maximum and minimum voltage

Cycle through 256 records.

4.3.8.4 maximum and minimum frequency

Cycle through 256 records.

4.3.8.5 maximum and minimum power

Cycle through 256 records.

4. 3.8.6 record of protection value change

Cycle through 256 records.

4. 3.8.7 maximum and minimum contact temperatures

Cycle through 256 records.

4.3.8.8 maximum and minimum onboard temperatures

Cycle through 256 records.

4. 3.8.9 maximum and minimum onboard humidity

Cycle through 256 records.

4. 3.8.10 parameter change

Cycle through 256 records.

4.3.9 electric energy pulse constant

There is a certain correlation between the electric energy pulse constant and the rated current. See table 51.

Table 51 Electric energy pulse constant

Rated current	Constant value of electric energy pulse
200	100
400,630	50
800,1000,1250,	20

1600,2000,2500,2900	10
3200,4000,4500,5000	5
5500 and above	2

4.3.10 Parameter backup

The parameter backup function requires basic support from the communication function. The protection parameters can be backed up and restored to the default data of the manufacturer.

4.4 Communication functions

4.4.1 Communications

The controller with communication functions can realize "four remotes" data transmission function, i.e., remote metering, remote control, remote adjustment and remote communication, through the communication port according to the stipulated agreement requirements. Communication port output uses photoelectric isolation, and is suitable for strong electrical interference environment. The Modbus-RTU protocols are built-in, and do not need additional conversion module. Communication parameter settings are shown in Table 52.

Table 52 Communication parameter settings

Communication protocol	Modbus-RTU
Communication address	2~247
Baud rate (bit/s)	9.6k, 19.2k, 38.4k, 115.2k

4.4.2 Log full-read

The log full-read function is added in the controller. According to the agreed method in the defined communication protocol, a variety of data records in the controller can be read at one time, including tripping record, alarm record and displacement record. This feature is especially convenient for the platform system to obtain log information.。

4.4.3 Health

The health indicators are added in the controller, including general health, operation times health, contact wear health, life health and temperature health. The general health means the comprehensive sum of the operation times health, contact wear health, life health and temperature health. It takes the minimum value from four health values as the health indicator of the entire circuit breaker, thus reading the related health data according to stipulations of the communication.

4.4.4 Life prediction

It is possible to the related data to the life predication in the controller according to the address in the communication protocol via communication after the communication function is optional.

4.4.5 Fault recording

After the communication function is optional, the controller features the fault recording function. It is mainly used for the real-time sampling of 5 period-wave current fault data in case of fault tripping for current fault; then collects the waveform data for the current fault phase. In case of the current fault for several phases, take the channel with the maximum current phase as the collection object. It is possible to the related data to the fault waveform in the controller according to the address in the communication protocol via communication.

4.4.6 address mapping

The software has up to 128 mappable addresses, which users can modify. The modified mapping address shall be within the scope of this agreement. The mapping address is read only and not writable. The address mapping address of 0.e000-0.e07b can be modified by the function code of 0.x1a.

4. 4. 7 abnormal conditions

Users can obtain the current abnormal information of the controller through abnormal condition query.

4. 4.8 broadcast timing

The broadcast timing mode can be applied to broadcast timing for controllers in the network.

4.5 DI/DO functions

DI input function: When the signal unit is S2, S3, controller can provide 1-2 programmable passive switch input. DO output function: Configuring normally open/closed/pulse mode output with software, the selected relay contact load is 250VAC/30VDC 3A (resistive) within the air circuit breaker product. In case the larger load needs to be controlled, please optionally select the external relay module or contactor control. Function Selection Table 53 of Air Circuit Breaker Product Signal Unit

Table 53 DI/DO Functions

Type of signal unit	Rated current	Field of Application
S1	4DO (4 output contacts)	To be used as the end segment of regional interlocking
S2	3DO (3 output contacts) 1DI (1 input contact)	Regional interlocking between air circuit breakers
S3	2DO (2 output contacts) 2DI (2 input contacts)	Regional interlocking between air circuit breakers

Table 54 DI function setting table

Function setting	Alarm, tripping, regional interlocking, general, grounding interlocking, short circuit interlocking	
DI input form	Normally opened	Normally closed

DO output function: Controller can provide 2~4 sets of independent signal contact output. DO: DC110V, 0.3A or AC250V, 3A.

Table 55 DO Function Setting Table

Function setting	See Table 44			
Execution mode	Normally opened level	Normally closed level	Normally opened impulse	Normally closed impulse
Impulse time	None		1～360s step length 1s	

Table 56 Parameter Settings of Switch Output (DO)

General	Alarm	Fault tripping	Self-diagnosis alarm	Load monitoring 1
Load monitoring 2	Overload pre-alarm	Overload fault	Short time delay fault	Transient fault
Grounding/current leakage fault	Grounding/current leakage alarm	Current unbalance fault	Middle-phase fault	Undervoltage fault
Overvoltage fault	Voltage unbalance fault	Underfrequency fault	Overfrequency fault	Required value fault
Reverse power fault	Regional interlocking	Remote closing	Remote opening	Phase sequence fault
MCR fault	Grounding interlocking	Short circuit interlocking	A-phase required value fault	B-phase required value fault
C-phase required value fault	N-phase required value fault	Required value out-of-limit	Alarm of operation times	Contact wear alarm
Remote reset	Internal overtemperature	Contact overtemperature	Power factor alarm	Frequency change
Phase failure	Underpower alarm	Over active power	Over reactive power	Power direction

Note: General refers to that the input and output are not used in the controller, and can be operated by the upper computer in communication network.

I/O state: Check the current state of I/O.

DO: "1" means that the output relay is closed; "0" means that the output relay is disconnected.

DI: "1" means the action; "0" means reset. (Relative to the setting of DI execution mode).

4. 5. 1 overload closing

Overload reclosure must be supported by signal unit. If it is necessary to change the reset time and action time of overload reclosure, the controller needs to have communication function.

The overload reclosure function is enabled only when do1 is set to remote reset and DO2 is set to remote closing. When the overload reclosure function is enabled, in case of overload long-time delay protection, after the controller delays the load closing reset time, do1 outputs the remote reset command, and then delays the load closing action time, DO2 outputs the remote closing command.

4.6 Regional selective interlocking (ZSI)

The regional interlocking diagram is as shown in Figure 16

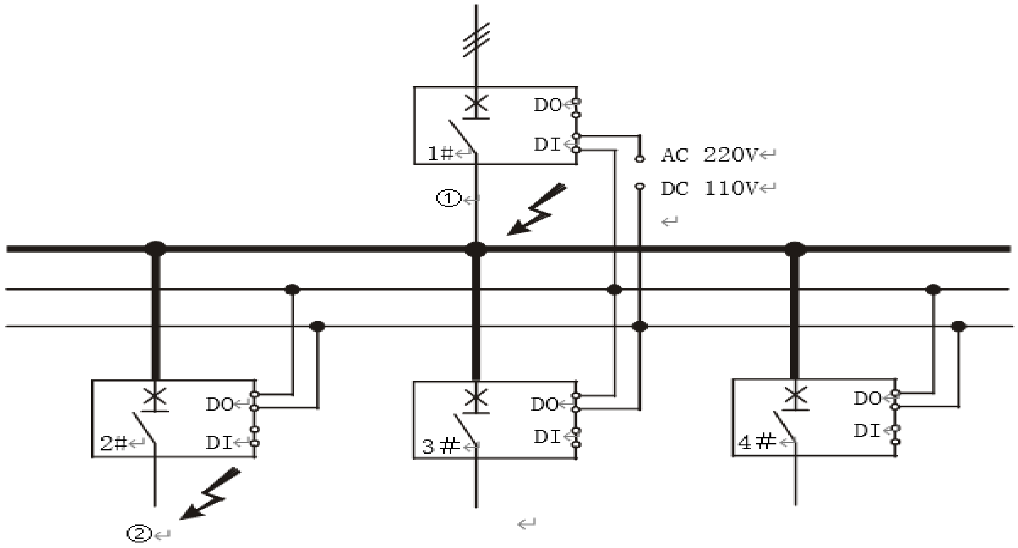


Figure 16 Regional Interlocking Diagram

Regional selective interlocking includes short circuit interlocking and grounding interlocking. In the same power circuit of two or more circuit breakers with superior and subordinate correlation:

1) When the short circuit or ground fault occurs on the outlet side (such as position ②) of the lower circuit breaker (2#~4# circuit breakers), the circuit breaker at a lower level will trip (tripping type may be set based on the demand of the user), and send a regional interlocking tripping signal to the upper circuit breaker; the superior circuit breaker (1# circuit breaker) will delay according to the short circuit or ground protection setting after receiving the regional interlocking tripping signal. If the fault current is eliminated during the process of time delay of the superior circuit breaker, the protection will return, and the superior circuit breaker won't act; if the fault current has not been eliminated after tripping of the subordinate circuit breaker, the superior circuit breaker will act according to the short circuit or ground protection setting, and remove the fault wire.

2) When the short circuit or ground fault occurs between the upper circuit breaker (1# circuit breaker) and the lower circuit breaker (2#~4# circuit breakers) (such as position ①), the upper circuit breaker hasn't yet received the regional interlocking signal, thus tripping immediately and rapidly removing the fault wire.

Parameter setting:

The upper circuit breaker shall set at least one DI as the regional interlocking test;

The lower circuit breaker shall set at least one DO as the regional interlocking signal output.

4.7 Test and lock

4.7 .1 Test tripping

Test tripping has three test modes, i.e., three-section protection, grounding and mechanism action time.

Three-section protection test: Input simulated fault current to simulate the protection situation of controller when overload, short circuit and transient fault occurs.

Grounding fault test: Input the simulated grounding fault current to simulate the protection situation of controller when a grounding fault occurs. Thus, check the setting value of action features.

Mechanism action time test: Force the magnetic flux transducer to act, so as to test the intrinsic mechanical time of the controller tripping.

Test parameter settings are shown in Table 57.

Table 57 Test Parameter Setting

Test type	Three-section protection	Ground fault	Action time
Test parameter	0A～131.0kA (Note 1)	0A～131.0kA (Note 2)	N/A
Test control	Start + stop		

Note: 1. When In≤2000A, 0～65.5kA, the step size 1A (when it is greater than 10kA, the step size is 0.1kA).

When In>2000A, 0～131kA, the step size 2A (when it is greater than 10kA, the step size is 0.2kA).

2. In case of the ground fault test, same as Note 1:

4.7.2 Remote lock

Locking: Under the "lock" status, the controller will not respond to the remote command of the upper computer.

Unlocking: Under the "unlocking" status, the controller will respond to the remote switch on, off and reset command from the upper computer.

4.7.3 Parameter locking

Locking: Under the "lock" status, the user may not modify the parameter.

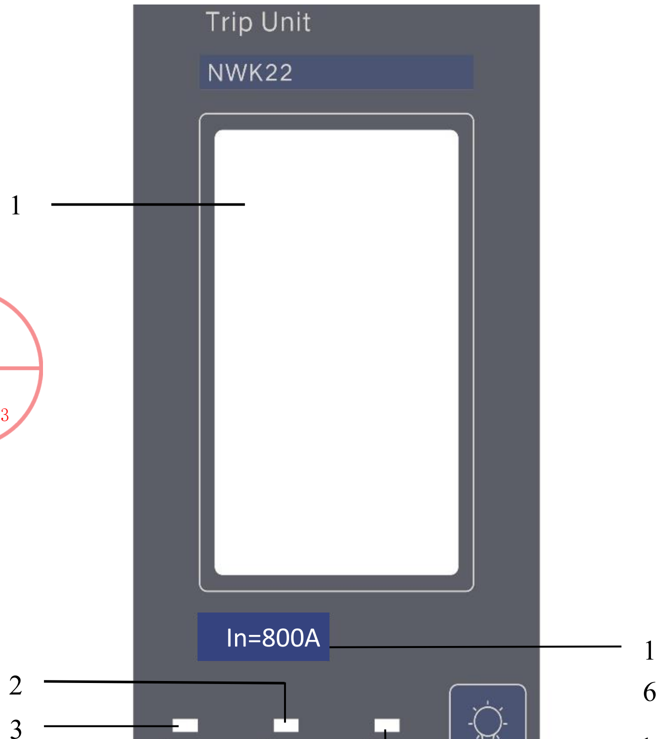
Unlocking: Under the "unlocking" status, the user may modify the parameter.

4. 8 dual protection

When the controller has dual protection function, it can set dual undervoltage, overpressure, Underfrequency, overfrequency and reverse power protection. The first protection and the second protection have the same switch and different starting value, starting time, return value and return time.

5 Operating Instructions of Controller Menu

5.1 Display operation panel



1. LCD interface display

2. “Normal” indicator (LED): the green LED always flashes as long as the controller is turned on and works properly.

3. “Communication” indicator (LED): LED flashes during communication.

4 “Fault/Alarm” indicator (LED): During normal operation, LED is not on; in case of fault tripping, the red LED flashes quickly; in case of an alarm, the red LED is always on.

5. Protection curve LED. The corresponding LED flashes respectively from left to right to indicate the fault type in case of disconnection; for the protection parameter settings, the LED is always on to indicate the currently selected items.

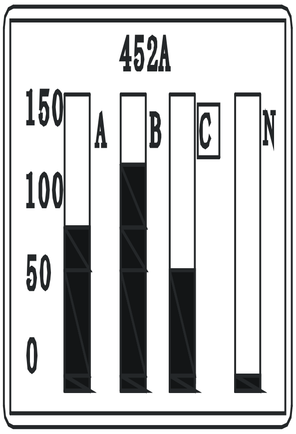
6. “Setting” button: Switch to the topic menu of parameter settings (“Right” button is located underneath the password entry interface).
7. “Measurement” button: Switch to the default topic menu of measurement (“Left” button is located underneath the password entry interface).
8. “Up” button: Move the menu content up on the current option, or incrementally change the parameters.
9. “Down” button: Move the menu content down on the current option, or decrementally change the parameters.
10. “Exit” button: Exit the current option to the previous menu, or cancel the current parameter settings.
11. “Test Port”: Plugged into the portable power box or test unit.
12. “Select” button: Go to the next menu pointed by the specified item, or select and store parameters.
13. “Information” function button: Switch to the topic menu of history and maintenance.
14. “Protection” function button: Switch to the topic menu of protection parameter settings
15. “Reset” button: Clock and fault reset
16. Rated current display.

5.2 Topic menu of controller

5.2.1 Topic menu of controller

5.2.1.1 Default interface

Display the histogram of each phase current without other function actions.



- The default interface is displayed when the controller is powered on;
- Under each topic menu, press  or the corresponding topic buttons to return to the default interface;
- If there is no any button operation within 5min, then the box cursor automatically indicates the current maximum phase;
- On the non-fault pop-up interface, if there’s no key operation in 30 min, it will return to the default interface automatically.

5.2.1.2 “Measurement” menu

```
I        (A)
U        (V)
F        (Hz)
E        (kwh)
P        (kw)
H        (h)
```

- Press to enter the main menu of measurement
- Press or button to return to the default interface;
- Press on other non-fault interface to skip to the measurement menu.

5.2.1.3 "System parameter menu"

```
Set Time
Set Meter
Test&Lock&F
System Parm
Com.  Set
```

- Press to enter the system parameter menu
- Press or button to return to the default interface;
- Press on other non-fault interface to skip to the system parameter menu;
- If there's no other operation, the system will return to the default interface in several minutes.

5.2.1.4 "Protection parameter menu"

```
I Protest
Load Monitor
U Protect
Misc Protect
```

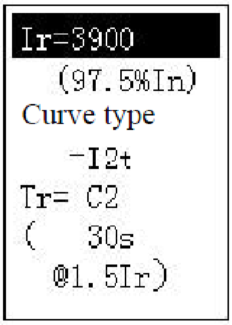
- Press to enter the system parameter menu
- Press or button to return to the default interface;
- Press on other non-fault interface to skip to the protection parameter setting menu.

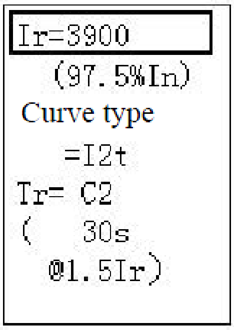
5.2.1.5 "Historical record and maintenance" menu

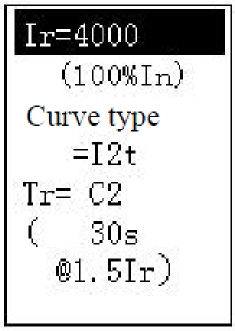
```
Ops Count
Contact Wear
Ops Record
Trip Record
Alarm Record
```

- Press to enter the main menu of "historical record and maintenance”
- Press or button to return to the default interface;
- Press on other non-fault interface to skip to the historical record and maintenance menu.

5.2.1.6 Example of submenu operation: setting of overload long time delay protection





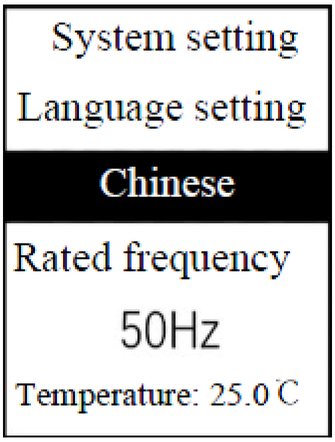


Then

adjust the setting value.

save the setting value.

5.2.1.7 Example of submenu operation: Switching functions in Chinese and English



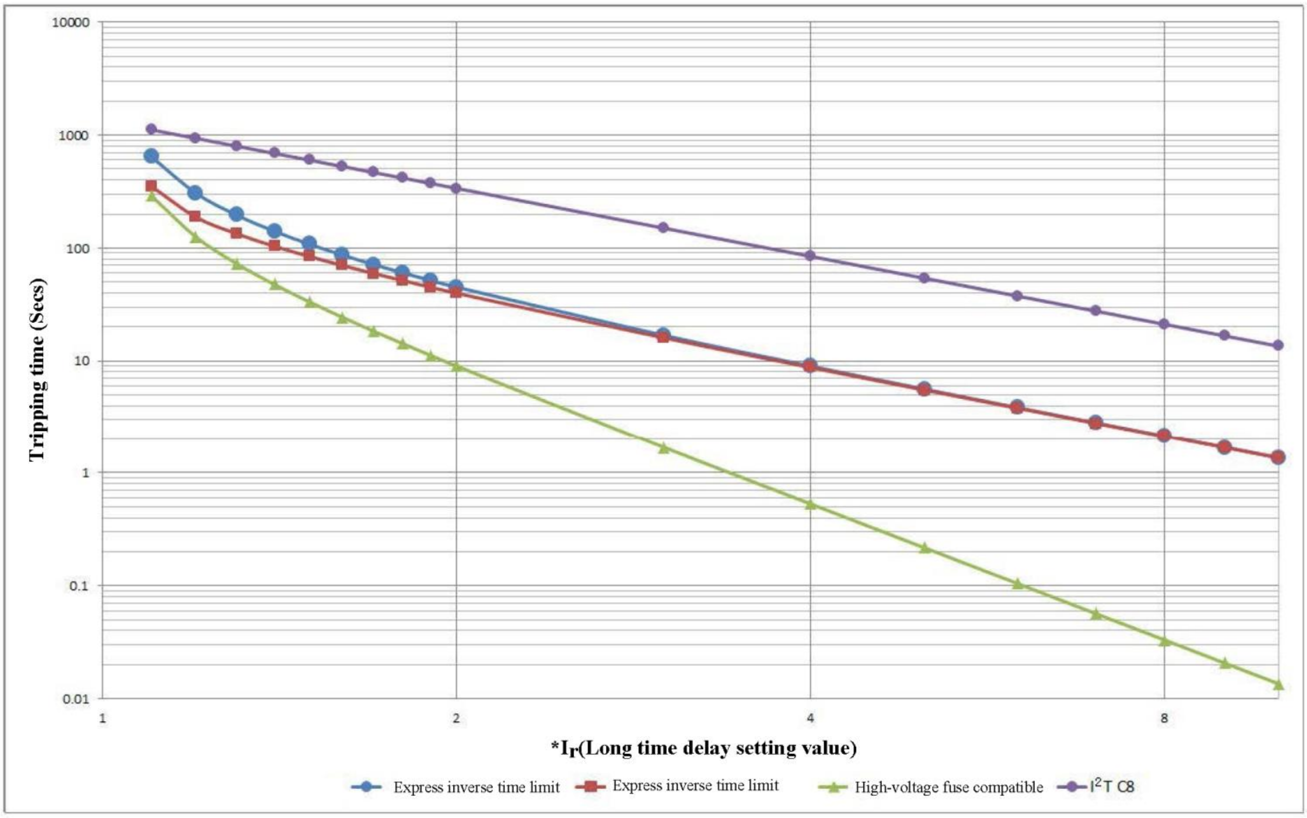
- Press to enter the system parameter menu and rated parameters
- Press to select the rated parameters, and press to enter the rated parameters
- Press to select the language, press to adjust to English
- Press to confirm selection of the language

5.2.1.8 Annotation

Number	Abbreviation	Annotation
1	Inst.	Instantaneous
2	IDTL	Inversive Definite Time Limit
3	DTL	Definite Time Limit
4	RC	Residual Current
5	Rev	Revert
6	com. set	Communication Set

7	GF	Ground Fault
8	Phase Seq	Phase Sequence

Appendix A Overload Protection Characteristic Curve



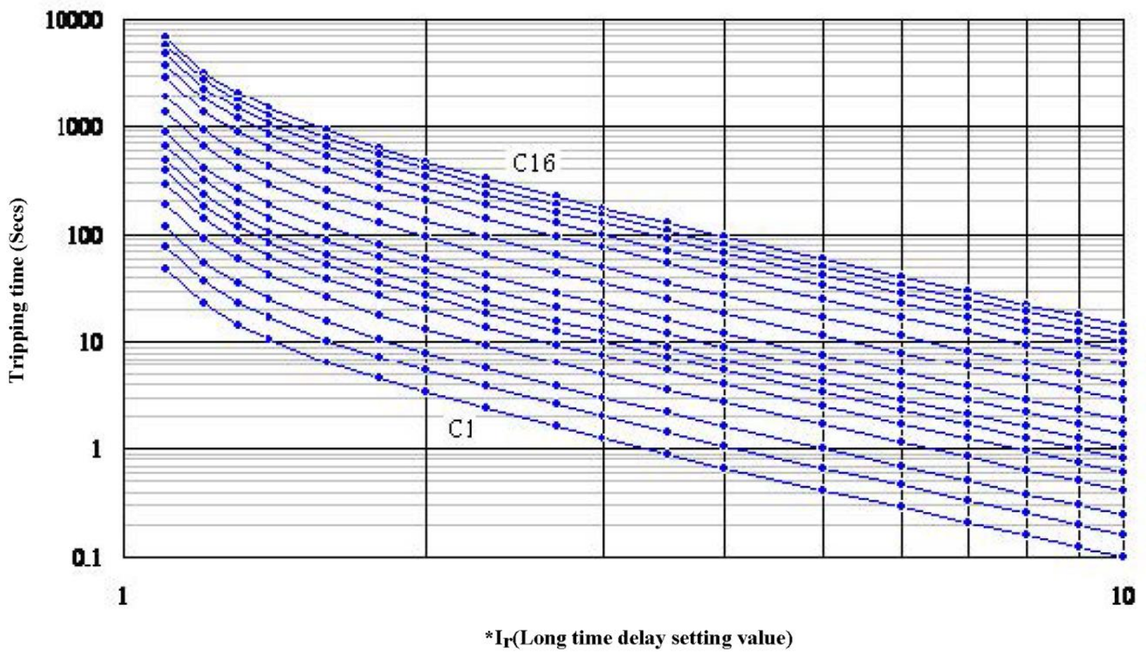


Figure A2 - Express Inverse Time Limit
(Power Distribution Protection)

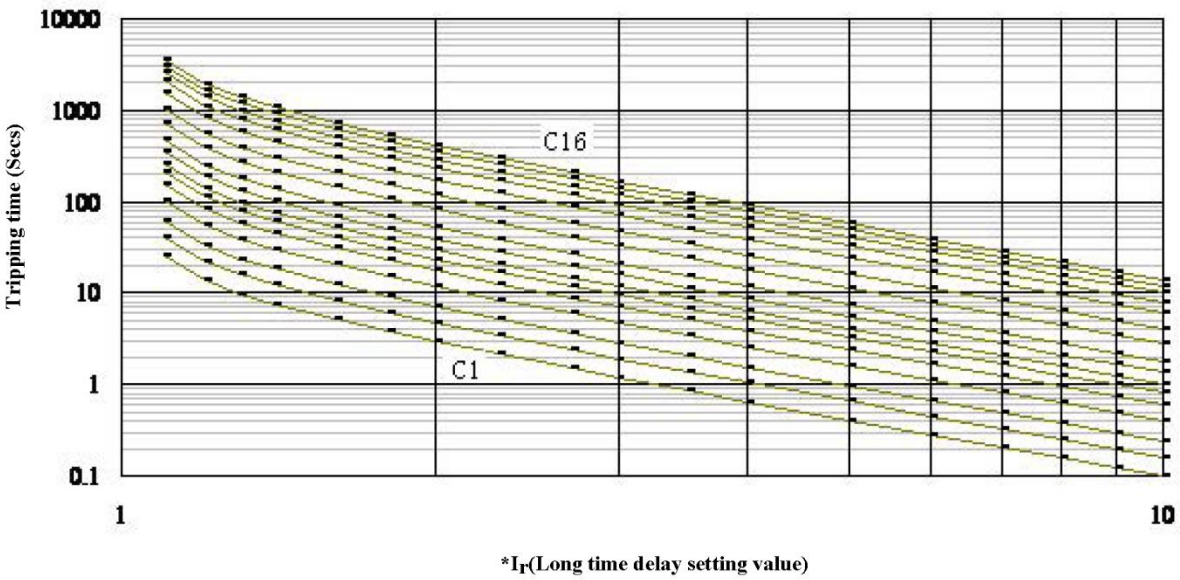


Figure A3 - Express Inverse Time Limit
(Motor Protection)

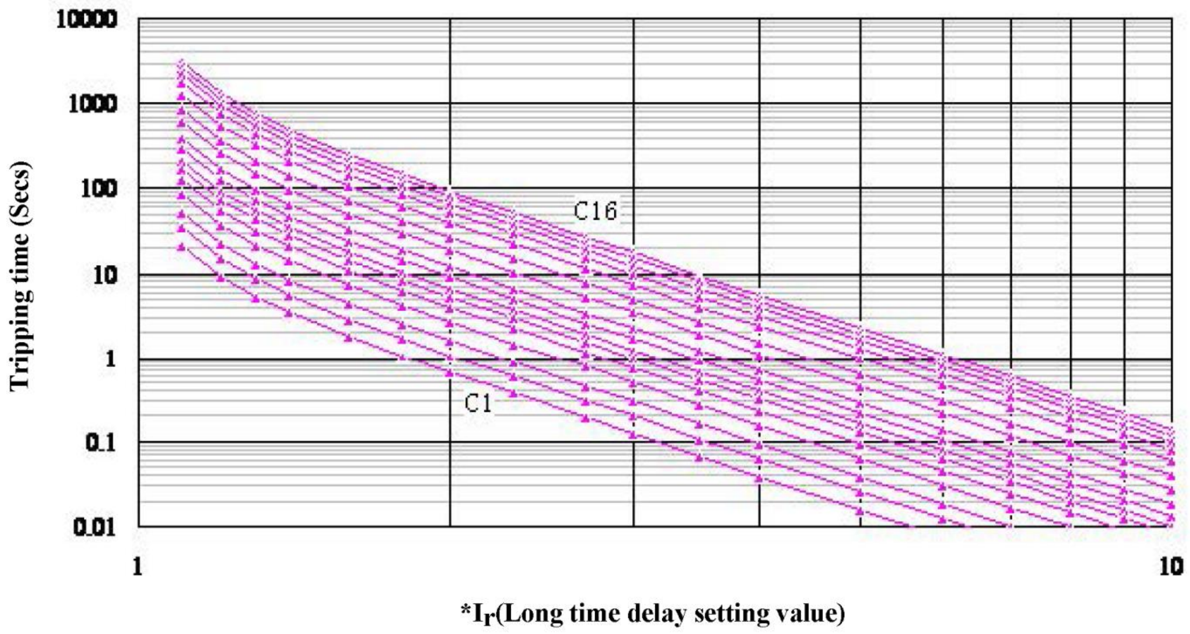


Figure A4 - High-voltage Fuse Compatible

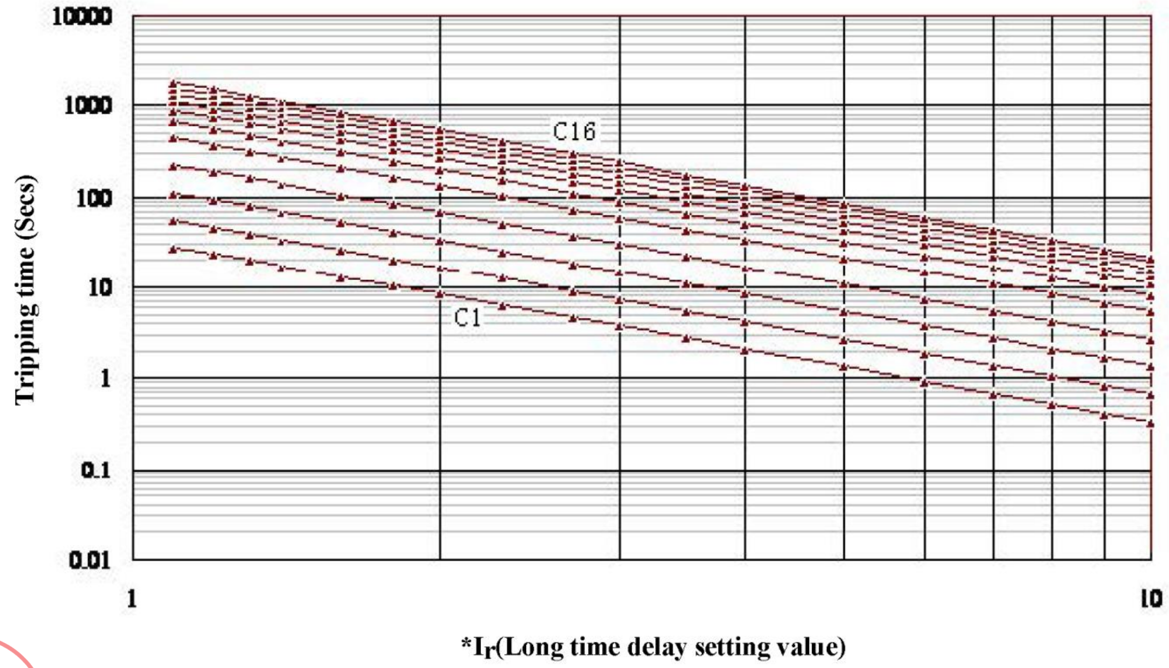
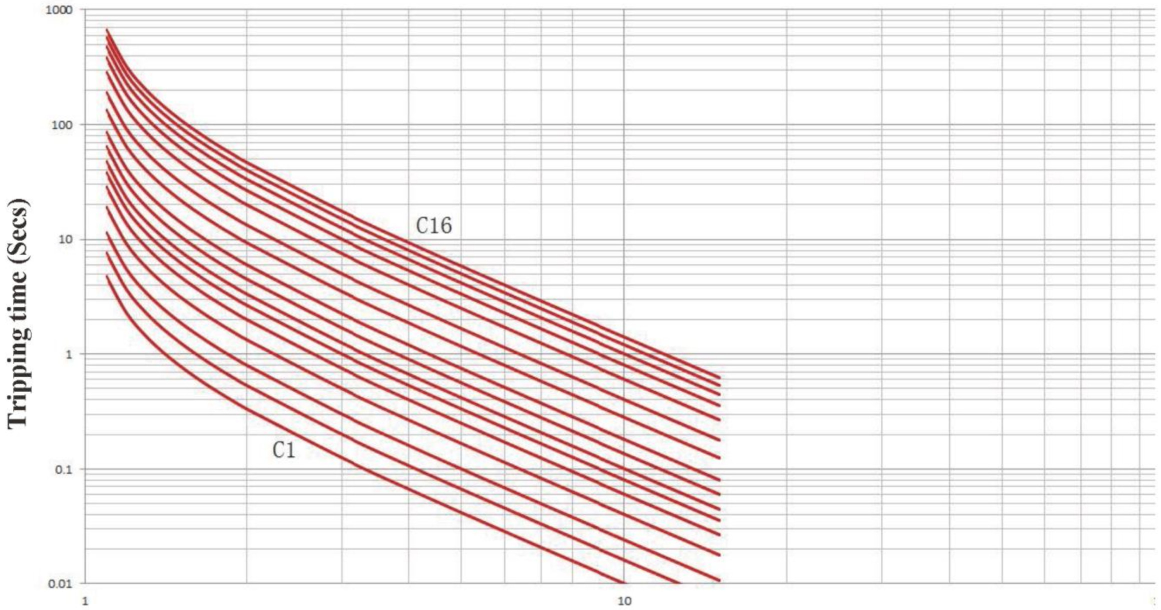


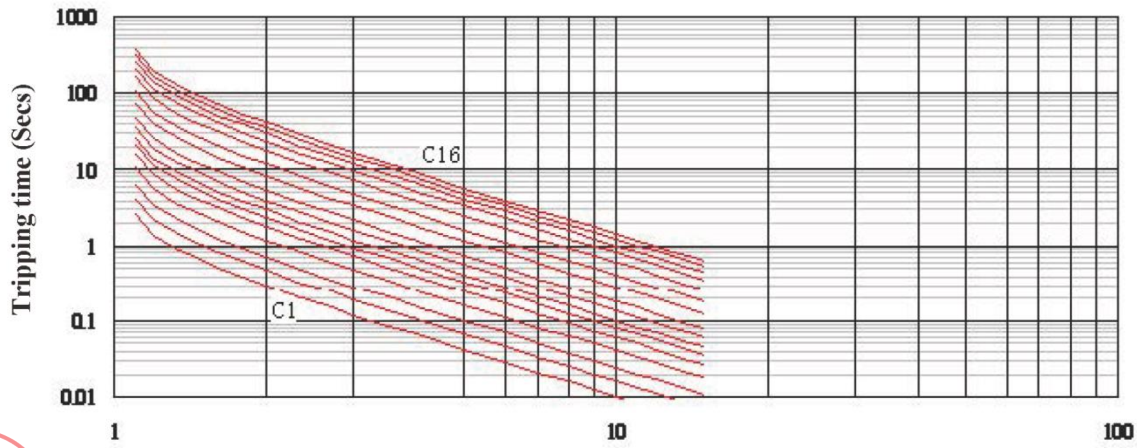
Figure A5 - Standard Power Distribution Protection I^2T

Appendix B Short-time Delay Inverse Time Limit Characteristic Curve



*Ir(Long time delay setting value)

Figure B1 - Short Time Delay Inverse Time Limit - Express Inverse Time Limit (Power Distribution Protection)



*Ir(Long time delay setting value)

Figure B2 - Short Time Delay Inverse Time Limit - Express Inverse Time Limit (Motor Protection)

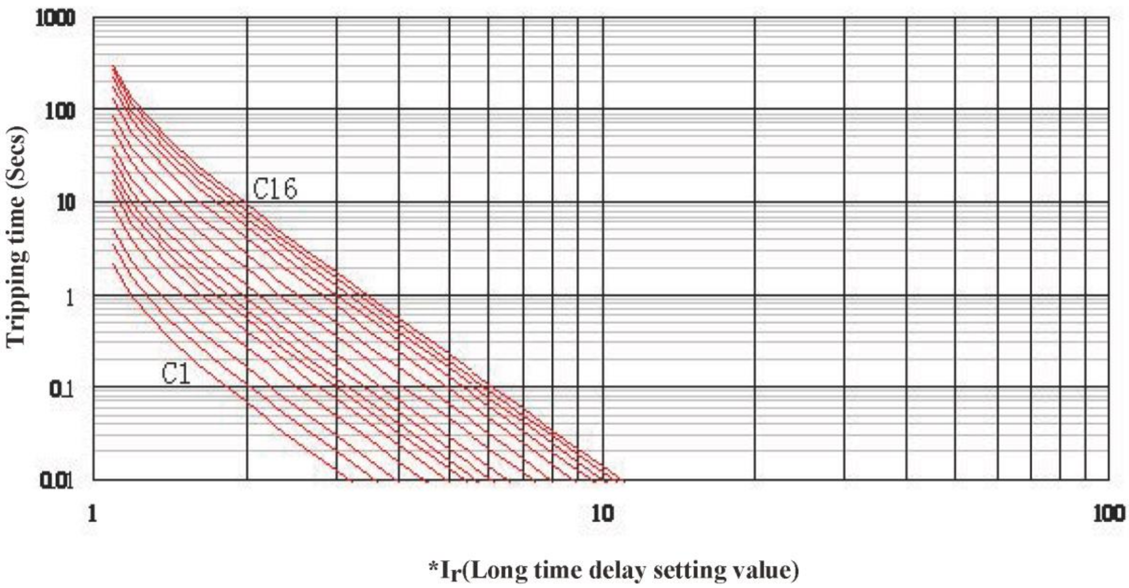


Figure B3 - Short Time Delay Inverse Time Limit - High-voltage Fuse Compatible

Appendix C Curve Example

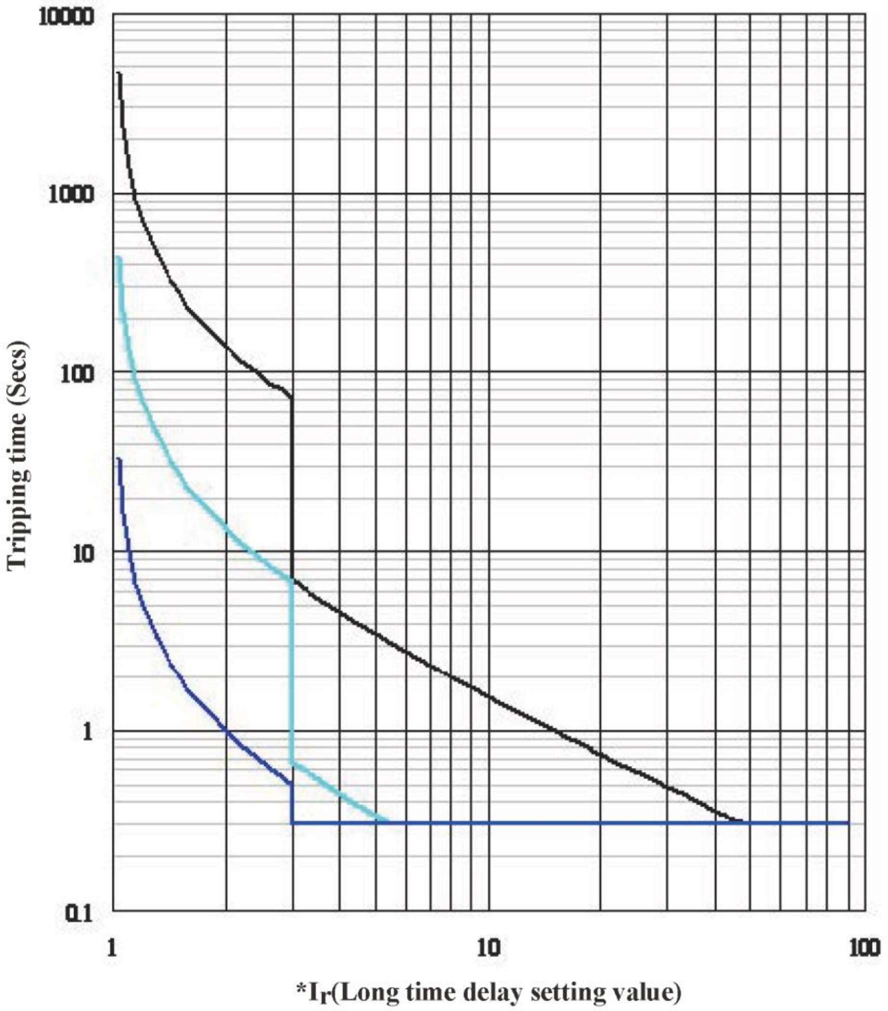


Figure C1 - Inverse Time Limit Protection Example

The above curves are based on the following setting values:
Curve type = fast inverse time limit
Curve rate = C1,C8 and C16 (C1 is the fastest)
Action setting value of the short-time delay inverse time limit = 3 x Isd1
Delay time setting value of the short-time delay definite time limit＝0.3s

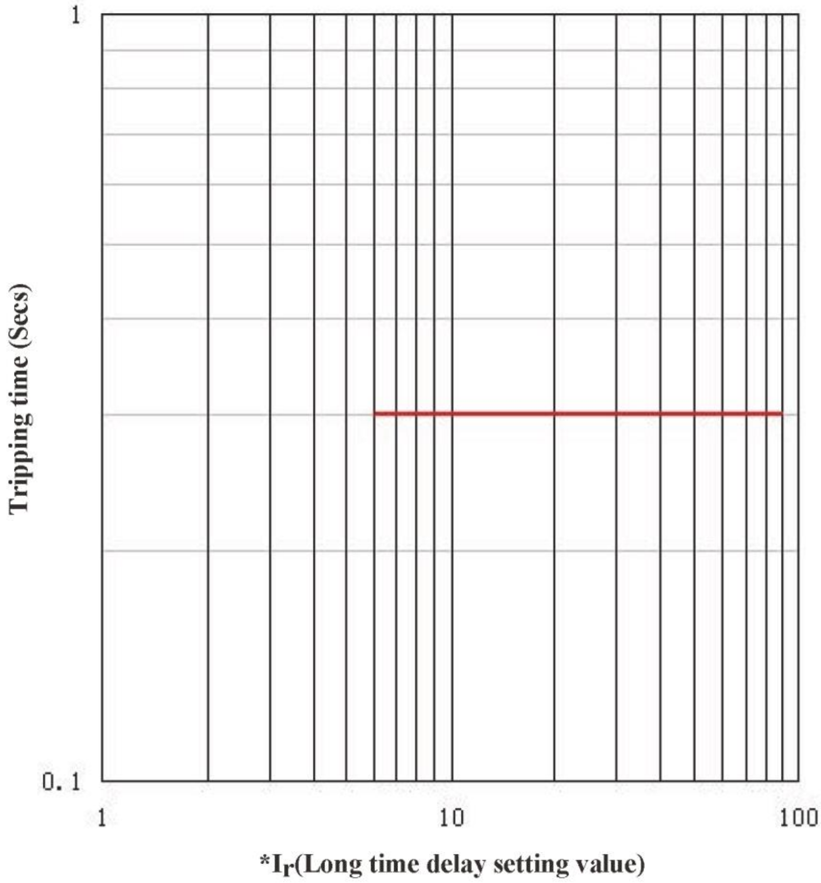


Figure C2 - Definite Time Limit Protection Example

The above curves are based on the following setting values:
Action setting value of the short-time delay definite time limit = 6 x Ir
Delay time setting value of the short-time delay definite time limit＝0.3s

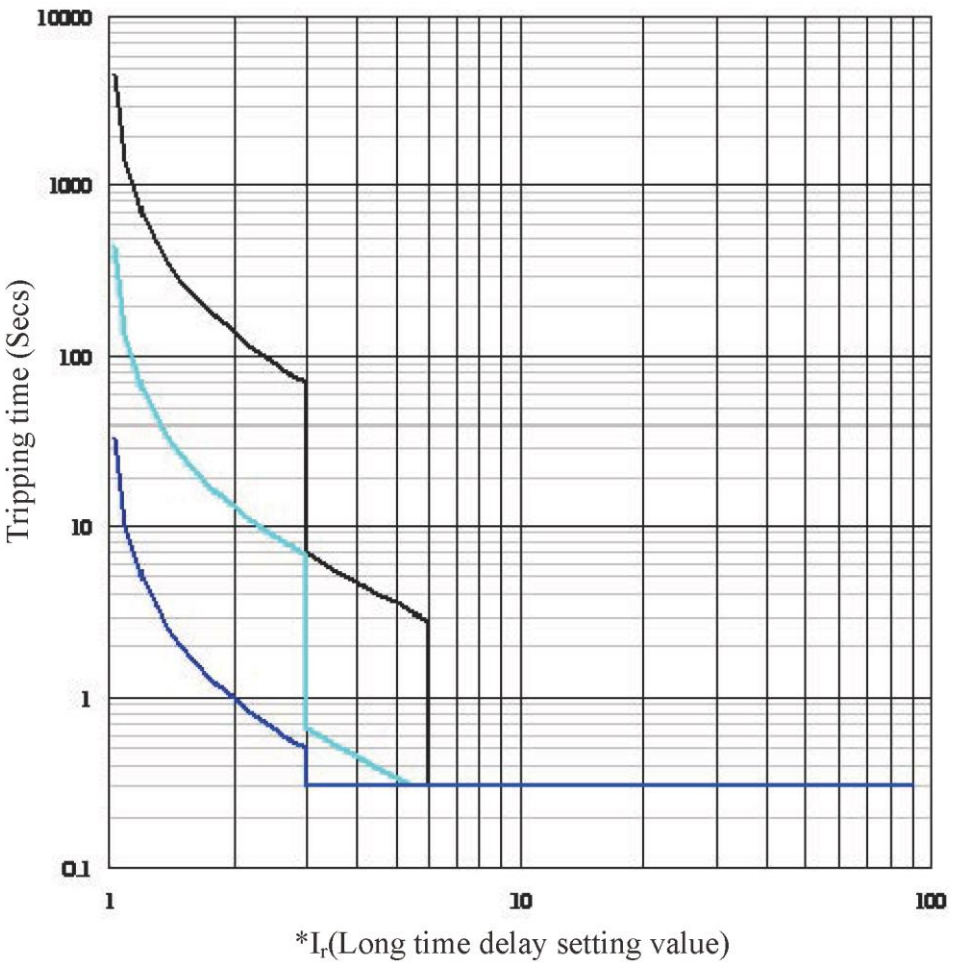


Figure C3 - Inverse Time Limit and Definite Time Limit Example Curve

The above curves are based on the following setting values:
Curve type = fast inverse time limit
Curve rate = C1,C8 and C16 (C1 is the fastest)
Action setting value of the short-time delay inverse time limit = 3 x Isd1
Action setting value of the short-time delay definite time limit = 6 x Ir
Delay time setting value of the short-time delay definite time limit＝0.3s

Appendix D Ground/Current Leakage Protection Features

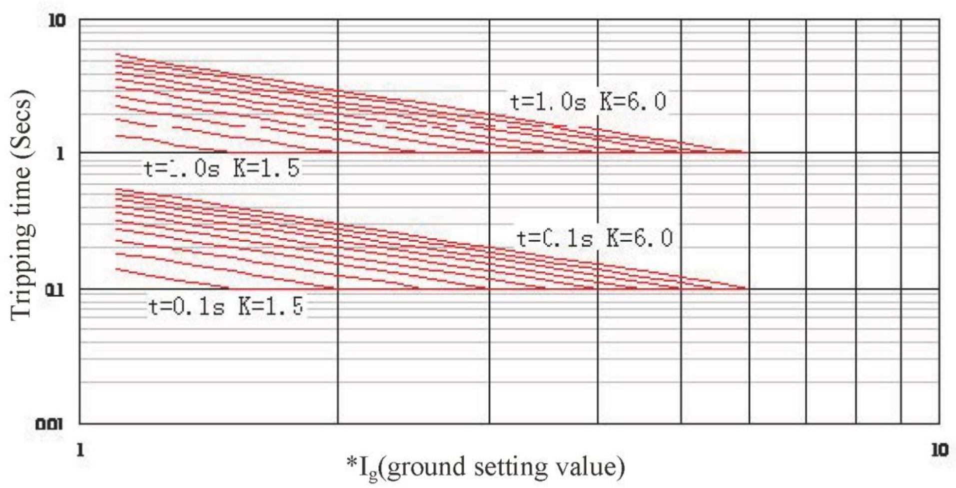


Figure D1 - Ground Protection Curve

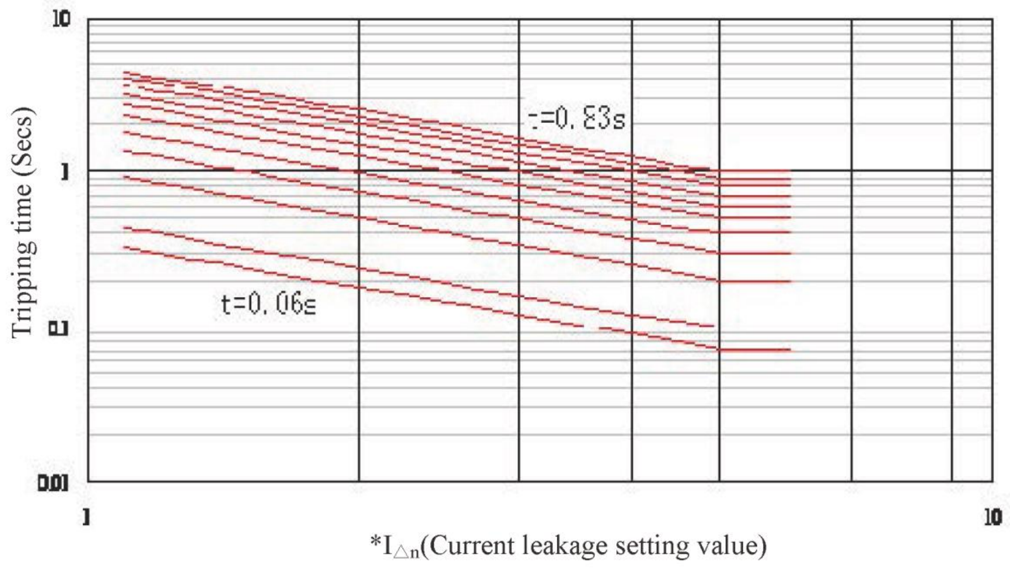


Figure D2 - Current Leakage Protection Curve