RW ENERGY

PRODUCT MANUAL

http://www.rw-relay.com

RWK-35

6kV,…40.5kV Automatic Recloser controller

Integrate multiple functions

Quickly break the fault current

It has multiple automatic overlaps

Comply with IEC / CEI /GB/JB/DL standards
Provided customized manufacture
Whole solutions for design, assembly, test...
Accountable solution for safety and reliability
Wide range offering, easy business and convenient installation

Foreword

Please read this chapter carefully before using this product!

This chapter introduces the safety precautions before using this product. Please make sure the content of this chapter is fully read and understood before installation and usage. Our company will not undertake any responsibilities for any damage or injury caused by improper operations due to ignoring relevant warning in this operation instruction.

Before operating this device, relevant professional personnel shall read this instruction carefully and well understand the content.

Operation instructions and warnings:

The following standard definitions will be adopted in this operation instruction.

Danger! Ignoring the safety precautions may cause personal death, serious personal injury or serious equipment damage.

Warning! Ignoring the safety precautions may cause personal death, serious personal injury or serious equipment damage.

Caution! Ignoring the safety precautions may cause a slight personal injury or equipment damage, especially the damage of device or the equipment protected by the device.

- **Danger!**

When the Primary circuit is live, it is forbidden to open the secondary side of the Current Transformer as this may cause extremely high Voltages.

Warning!

Some parts of the device may have high Voltage when the electrical device is running. Improper operation may cause serious personal injury or equipment damage.

Only qualified professional personnel are allowed to operate the device or work nearby the device. The professional operator shall fully understand the precautions, working flows and safety regulations mentioned in this instruction.

- **Caution!**

Grounding terminals of the device shall be firmly grounded.

The device is only permitted to run in atmospheric environment that is specified in the technical specifications, and abnormal vibrations shall be avoided in its running environment.

When connecting the AC Voltage current circuit or power circuit, please make sure they conform to the rated parameters of the device.

When the output terminals of the device are connected to external circuit, please check the Voltage of external power carefully to prevent overheating of the circuit.

Carefully check the cable connected to the device, be careful not to apply too much external force on it.

Note!

Every care has been taken in preparation of this manual. However, please note that not all the details or variations in the equipment or process being described can be covered. Neither is it expected to address all contingencies associated with the installation and operation of this equipment. If you need more information, please contact the manufacturer.

The fixed value in the picture is only for demonstration, not for actual configuration.

Contents

Chapter 1: Overview

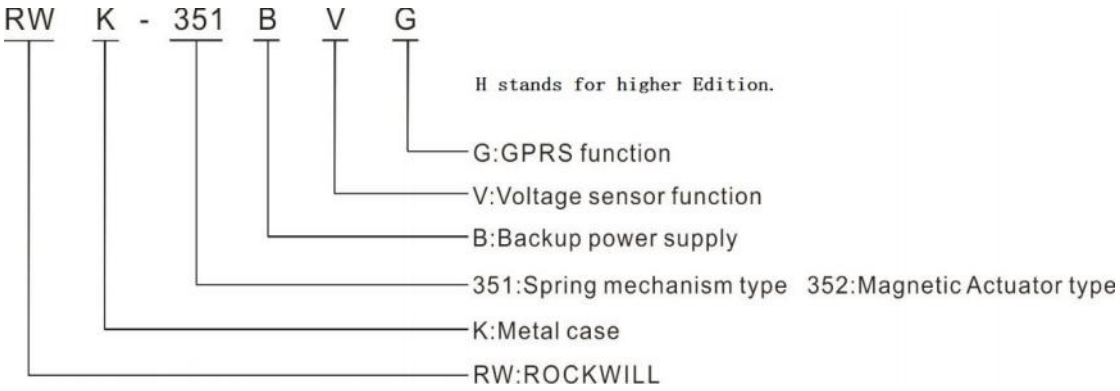
1.1 Description

RWK-35 is an intelligent medium Voltage controller used in overhead line grid monitoring for the purpose of overhead line protection. It can be equipped with RCW(RVB) type vacuum circuit breaker to achieve automatic monitoring, fault analysis and store event records.

This unit offers safe line switching of faults on the power grid and provides automatic power recovery.
RWK-35 series is suitable for up to 35kV outdoor switchgear include: vacuum circuit breakers, oil circuit breakers and gas circuit breakers.
RWK-35 intelligent controller is equipped with line protection, control, measurement and monitoring of Voltage and current signals integrated automation and control devices outdoors.

RWK is a automatic management unit for single way/multi ways/ring network/two power sourcing, provided with all Voltage and current signals and all functions.
RWK-35 column switch intelligent controller supports:
Wireless (GSM/GPRS/CDMA), Ethernet mode, WIFI, optical fiber, power line carrier, RS232/485, RJ45 and other forms of communication, and can access other station premises equipment (such as TTU, FTU, DTU, etc.).

1.2 Product mode definition



1.3 Protection

79	Auto Reclose (Reclose)
50P	Instantaneous/Definite-Time Overcurrent (P.OC)
51P	Phase Time-Overcurrent (P.Fast curve/P.Delay curve)
50/67P	Directional Phase Overcurrent (P.OC-Direction mode(2-Forward/3-Reverse))
51/67P	Directional Phase Time-Overcurrent (P.Fast curve/P.Delay curve-Direction mode (2-Forward/3-Reverse))
50G/N	Ground Instantaneous/Definite-Time Overcurrent (G.OC)
51G/N	Ground Time-Overcurrent (G.Fast curve/G.Delay curve)

50/67G/N	Directional Ground Overcurrent (G.OC- Direction mode (2-Forward/3-Reverse))
51/67G/N	Directional Ground Time-Overcurrent (G.Fast curve/G.Delay curve-Direction mode(2-Forward/3-Reverse))
50SEF	Sensitive Earth Fault (SEF)
50/67SEF	Directional Sensitive Earth Fault (SEF-Direction mode(2-Forward/3-Reverse))
59/27TN	Earth Fault Protection With 3RD Harmonics (SEF-Harmonic inhibit enabled)
51c	Cold Load (Cold load)
TRSOTF	Switch-Onto-Fault (SOTF)
81	Frequency protection (Frequency)
46	Negative- Sequence Overcurrent (Nega.Seq.OC)
27	Under Voltage (L.Under volt)
59	Over Voltage (L.Over volt)
59N	Zero-Sequence Over Voltage (N.Over volt)
25	Synchronism - Check
25/79	Synchronism - Check/Auto Reclose
60	Voltage unbalance
32	Power direction

Inrush

Loss of phase

Live load block

High gas

High temperature

Hot line P.OC

Hot line G.OC

1.4 Supervision

74T/CCS	Trip & Close Circuit Supervision
60VTS	VT Supervision

1.5 Control

86	Lockout

CB Control

1.6 Features

Password Protection – 2 levels.

50Hz/60Hz systems and two phase/three phase wiring methods are available.

Protection configuration is complete, and all protection functions can be switched on and off.

9 binary inputs.

Large capacity flash memory that can record at least 100 historical events, and no data will be lost, even when the power is off.

Circuit operating loop can be used either with direct or alternating current, self-adaptation open/close brake function, which can co-work with a variety of breakers, and the operation is simple and reliable.

The device has complete self-monitoring function to check the conditions of various parts of the device, ensuring the reliability of the device.

1.7 Monitoring Functions

Primary/Secondary Phases and Earth Currents

Phases Current with 2nd Harmonics and Earth Current With 3RD Harmonics

Direction

Primary/Secondary Line and Phase Voltages

Apparent Power and Power Factor

Real and Reactive Power

Energy and History Energy

Max Demand and Month Max Demand

Positive Phase Sequence Voltage

Negative Phase Sequence Voltage & Current

Zero Phase Sequence Voltage

Frequency

Binary Input/Output status

Trip circuit healthy/failure

Time and date

Trip, alarm, signal records

Counters

Wear

Outage

1.8 Hardware

4 CT 1 VT 6 Voltage sensor 9 Binary Inputs 2 Binary Outputs

1.9 Data Storage and Communication

RS485/USB or RS485/RS232 port and Ethernet/RJ45

Protocols –IEC60870-5-101, IEC60870-5-104, DNP3.0 or Modbus RTU

Event Records

Fault Records

Measurands

Commands

Time Synchronism

Viewing and Changing Settings

Chapter 2: Technical Performance Index

2.1 Inputs and Outputs

Phase Current Inputs

Quantity	3
Rated Current In	1A
Measuring Range	20 x In
Instrumentation≥ 0.1xIn	±1% In
Frequency	50/60Hz
Thermal Withstand: Continuous 10 Second 1 Second	 5 x In 10 x In 40 x In
Burden @ In	≤0.2VA (5A Phase element)

Sensitive Earth Current Inputs

Quantity	1
Rated Current In	1A
Measuring Range	2 x In
Instrumentation≥ 0.1xIn	±1% In
Frequency	50/60Hz
Thermal Withstand: Continuous 10 Second 1 Second	 5 x In 10 x In 40 x In
Burden @ In	≤0.02VA (1A Earth element)

Voltage Inputs

Quantity	1 PT Voltage
Nominal	40…120 Vrms
Operating Range	0...200 Vrms

Instrumentation≥0.8xVn	±1% Vn
Burden @ 110V	0.06 VA
Over Voltage Withstand	240 Vrms

Voltage sensor Inputs

Quantity	6 x Voltage sensor
Nominal	0…60 Vrms

Auxiliary Supply

DC Voltage	220V Range 200 to 320V
AC Voltage	220 V AC 50/60Hz Range 175 to 285Vrms AC 50/60Hz ±5%
Power consumption	≤100W/300W

Binary Inputs

Number	9
Operating Voltage	24V DC
Maximum dc current for operation	2mA

Binary Outputs

Number	5
Operating Voltage	220V DC (2) Passive (3)
Operating Mode	User selectable - Self or Hand/Electrical Reset or pulsed
Operating Time from Energizing Binary Input	<20ms

2.2 Unit Design

Indication	16 Character 4 lines Display 41 LEDs
User Interface	21 Navigation Keys
Weight	32kg

2.3 Serial Interface

Communication Port	RS485/RS232/RJ45
Protocols	IEC60870-5-101 IEC60870-5-104 DNP3.0 MODBUS RTU

2.4 Data Storage

Events	6500 (Totally)

2.5 Mechanical Tests

Vibration (Sinusoidal) --- IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5gn	≤5%
Vibration withstand	1.0gn	≤5%

Shock and Bump --- IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	0.5gn, 11ms	≤5%
Shock withstand	15gn, 11ms	≤5%
Bump test	10gn,16ms	≤5%

Shock and Bump --- IEC 60255-21- 3 Class I

Type	Level	Variation
Seismic response	X-plane-3.5mm Displacement below crossover freq (8-9Hz) 1gn and above Y-plane-1.5mm Displacement below crossover freq (8-9Hz)	≤5%

	0.5gn above	

Mechanical Classification

Durability	>106 operations

2.6 Electrical Tests

Insulation --- IEC 60255-5

Type	Level
Between any terminal and earth	2.0 kV AC RMS for 1 min
Between independent circuits	2.0 kV AC RMS for 1 min
Across normally open contacts	kV AC RMS for 1 min

High Frequency Disturbance --- IEC 60255-22-1 Class Ⅲ

Type	Level	Variation
Common (longitudinal) mode	2.5 kV	≤5%
Series (transverse) mode	1.0 kV	≤5%

High Frequency Disturbance --- IEC 60255-22-2 Class Ⅳ

Type	Level	Variation
Contact discharge	8.0 kV	≤5%

Fast Transients --- IEC 60255-22-4 Class A (2002)

Type	Level	Variation
5/50 ns 2.5 kHz repetitive	4 kV	≤5%

Surge Immunity --- IEC 60255-22-5

Type	Level	Variation
Analog Inputs: Line to Earth	4.0 kV	≤10%
Case, Aux Power & I/O: Line to Earth	2.0 kV	≤10%
RS485 Comms port: Line to Earth	1.0 kV	No Data Loss
Analog Inputs: Line to Line	1.0 kV	≤10%
Case, Aux Power & I/O: Line to Line	1.0 kV*	≤10%

* Note 45ms DTL pick-up delay applied to binary inputs

Conducted Radio Frequency Interference --- IEC 60255-22-6

Type	Level	Variation
0.15 to 80 MHz	10 V	≤5%

Radiated Radio Frequency --- IEC 60255-25

Type	Limits at 10 m, Quasi-peak
30 to 230 MHz	40 dB(μV)
230 to 10000 MHz	47 dB(μV)

Conducted Radio Frequency

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5 MHZ	79 dB(μV)	66 dB(μV)
0.5 to 30 MHZ	73 dB(μV)	60 dB(μV)

Radiated Immunity --- IEC 60255-22-3 Class Ⅲ

Type	Level
80 MHz to 1000 MHz Sweep	10 V/m
1.4GHz to 2.7GHz Sweep	10 V/m
80,160,380,450,900,1850,2150 MHz Spot	10 V/m

2.7 Climatic Tests

Temperature --- IEC 60068-2-1/2

Operating Range	-10°C to +55°
Storage range	-25°C to +70°

Humidity --- IEC 60068-2-78

Operational test	56 days at 40°C and 93% relative humidity

Chapter 3: Protection Functionality

3.1 Function Description

79 Auto Reclose (Reclose)

The Relay bits SH0 through during different periods of a reclose cycle as shot(reclose) counter increments. The shot counter increments just before each reclose.

Relay Word Bit	Asserted to Logical 1 From:
SH0	reset state to just before 1st reclose
SH1	just before 1st reclose to just before 2nd reclose
SH2	just before 2nd reclose to just before 3rd reclose
SH3	just before 3rd reclose to just before 4th reclose
SH4	just before 4th reclose, and following(through lock out state)

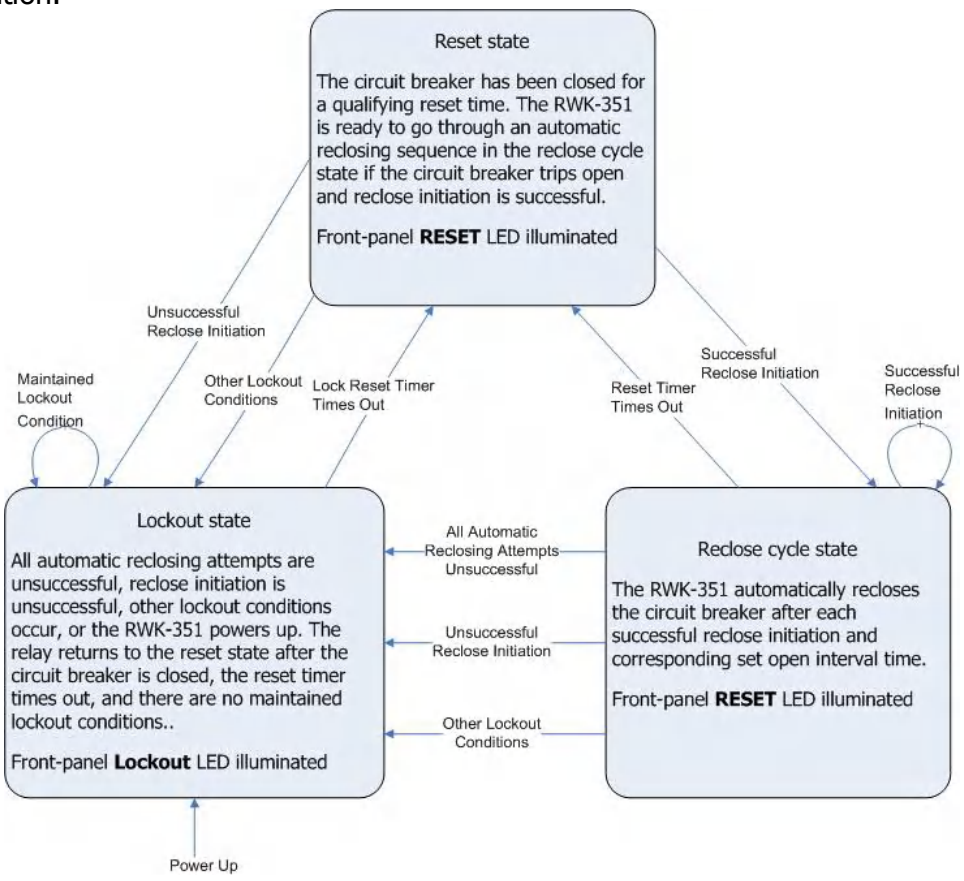
An example reclose cycle (from reset to lockout) appears as:

(reset) 1st trip—1st reclose-2nd trip—2nd reclose—3rd trip—

3rd reclose—4th trip (lockout)

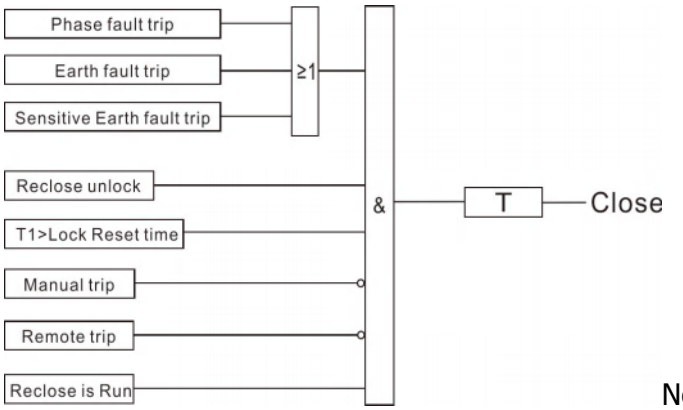
SH0=logical enable during the first trip, SH1=logical enable during the second trip, and so forth.

The figure below explains in general the different states of the reclosing relay and its operation.



A high proportion of faults on an overhead line network are transient and can be cleared quickly by high speed tripping followed by an automated circuit breaker reclose sequence.

Action Logic diagram:



Note: Run is "√", Stop is "×".

T1—The time after 1st protection trip T—Delay time

The function provides phase fault and earth fault/sensitive earth fault sequences of up to 5 trip i.e.4 reclose attempts before lockout, after the Lock Reset time the reclose charging complete.

Note: P.OC1 and G.OC1 trip will make the recloser lockout.

Sequence Coordination Setting of recloser:

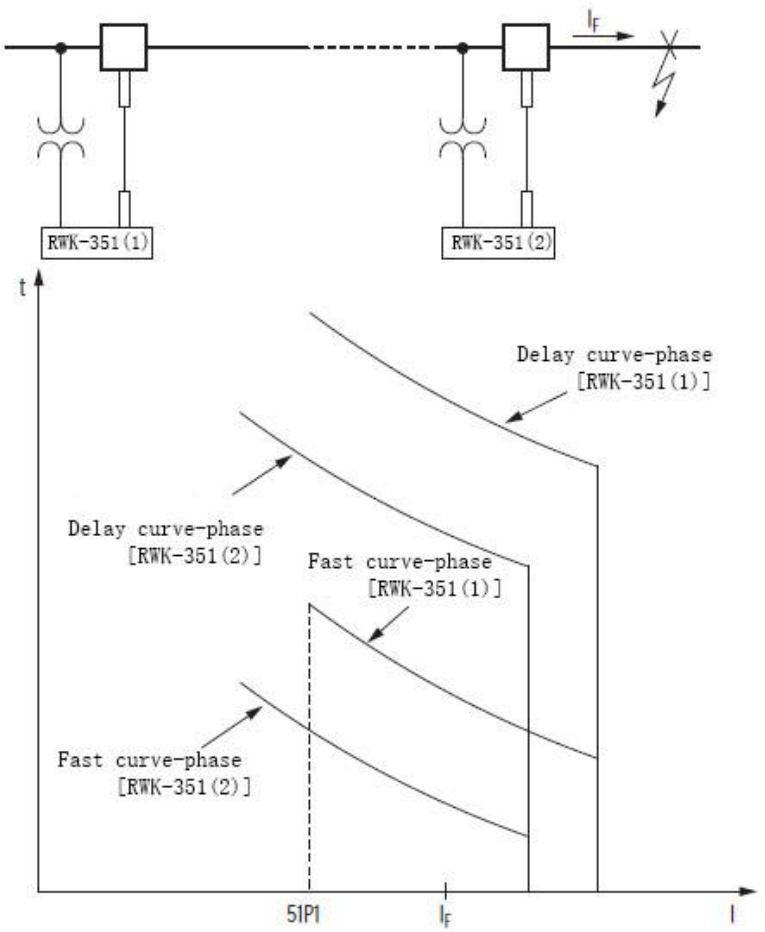
Sequence coordination keeps the RWK-35 in step with a downstream recloser control (another RWK-35 or otherwise; see in the Figure below). Sequence coordination prevents overreaching RWK-35 fast curves from tripping for faults beyond the downstream recloser control. This is accomplished by incrementing the shot counter and controlling fast curves with resultant shot counter elements.

In order for the sequence coordination logic in RWK-35 (1) to increment the shot counter by one count to keep in step with the operation of downstream RWK-35 (2), all the following have to occur in RWK-35 (1):

- ➢ No trip present
- ➢ Recloser closed
- ➢ Sequence coordination setting to 1 in the reclose protection parameter.

Every time the sequence coordination logic increments the shot counter (e.g., from 0 to 1), the reset timer is loaded up with reset time. The reset timer starts timing—when it times out, the shot counter returns back to shot = 0. But if during this reset timer timing, the sequence coordination logic causes the shot counter to increment again (e.g., from 1 to 2), the reset timer is fully loaded up again with reset time.

Sequence coordination can increment the shot counter beyond last shot, but no further than shot = 4. The reset timer timing is subject to cycle reset time and lock reset time.



Enable end shot of reclose:

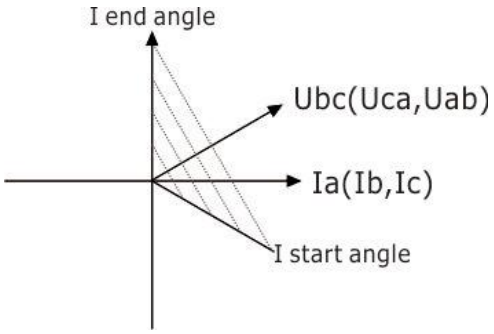
Enable end shot keeps the RWK-35 to trip the circuit breaker reasonably in the cycle of reclose. For example, set the value to 2, the fast curve protection is available just in the 1st, 2nd trip in reclose cycle, the delay curve is available just in 3rd-5th trip in reclose cycle.

The element is blocked when the following communication signal is activated:
· Reclose Disable

50P Instantaneous/Definite-Time Overcurrent (P.OC)

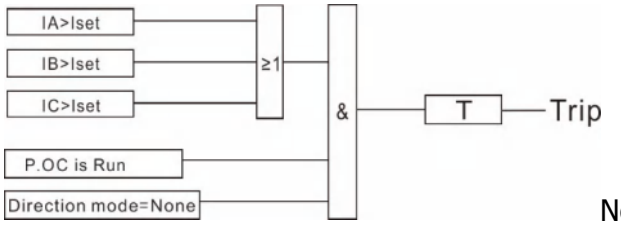
Three modes are available for the phase instantaneous/timing overcurrent element. All of which are definite time actuate features, forward direction component block, and reverse direction component block is available for each section. 90° wiring method is adopted for direction component, that is Uab corresponds to Ic, Ubc corresponds to Ia and Uca corresponds to Ib, and follow the principle of start according to phase. The angle of the direction component is between the **I start angle** and the **I end angle** which set in the **common value**, and it is the angle of Voltage leading current. In addition, the directional elements are affected by the **Loss Of Phase** protection. When the PT is broken, if the **Loss Of Phase** block mode is lockout, the directional elements are locked, and the protection in the relevant direction does not act; If the **Loss Of Phase** block mode is unlock, direction judgment will not be performed.

When you use the reclose function, you can set the value ("Activate shot") in the P.OC1, P.OC2 to decide in which time the protection is available. For example, you set the value ("Activate shot") of P.OC1 to "3". It means P.OC1 is available just in SH2, SH3 and SH4. P.OC1 is invalid (even if the current is over the set value) in SH0 and SH1.



Mode 1: Normal overcurrent

Action Logic diagram:



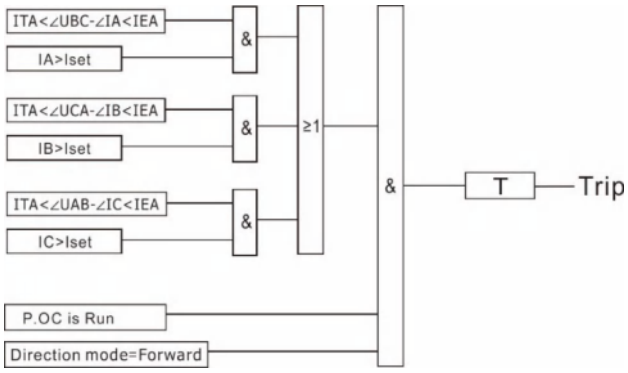
Note: Run is "√", Stop is "×".

IA IB IC—Measured current Iset—Pickup current T—Delay time

Direction

The element includes an algorithm, which provides correct operation for various transient conditions including motor start/stop when connected to the line. It responds correctly even during fault conditions where the motor acts as generator feeding power into the network. The controller shall be able to detect and operate for faults in both the forward and the reverse directions. Direction mode 2 is forward and Direction mode 3 is reverse. G. OC, SEF and Direct.Power also has this function.

Mode 2: Forward directional overcurrent



Note: Run is "√", Stop is "×".

IA IB IC—Measured current Iset—Pickup current T—Delay time IEA—I end angle ∠UBC-∠IA—Angle of UBC exceeding IA ∠UCA-∠IB—Angle of UCA exceeding IB ITA<∠UAB-∠IC<IEA—Angle of UAB exceeding IC ITA—I start angle

Mode 3: Reverse directional overcurrent

Direction mode is selected as reverse. The logic is the same as the forward direction, but the reverse direction angle is outside the forward direction angle.

The element is blocked when the following communication signal is activated:

· Protection Disable

· Inrush Feature

· **Loss Of Phase**-**Block mode**=**Lockout** (P.OC–**Direction mode**=**Forward**)

50G/50N/SEF

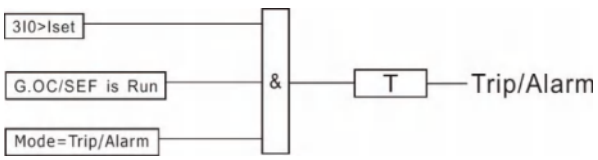
Ground Instantaneous/Definite_Time Overcurrent(G.OC)/SEF

Two earth fault measurement modes are available. One mode directly measures the earth current from an independent CT, this input can be ordered as sensitive earth fault. The second mode derives the earth current internally from the 3 phase CT inputs to give earth fault.

When you used the reclose function, you can set the value ("Activate shot") in the G.OC1, G.OC2 to decide in which time the protection is available. For example, you set the value ("Activate shot") of G.OC1 to "3". It means G.OC1 is available just in SH2, SH3 and SH4. G.OC1 is invalid (even if the current is over the set value) in SH0 and SH1.

Earth fault/Sensitive Earth Fault Alarm/Trip

Action Logic diagram:

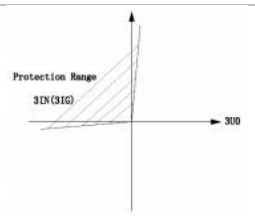
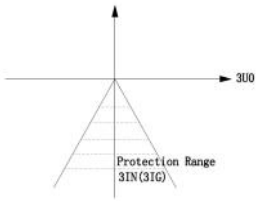


Note: Run is "√", Stop is "×".

3IN/3IG—Earth current Iset—Pickup current T—Delay time

Forward Directional Earth fault/Sensitive Earth Fault Alarm/Trip

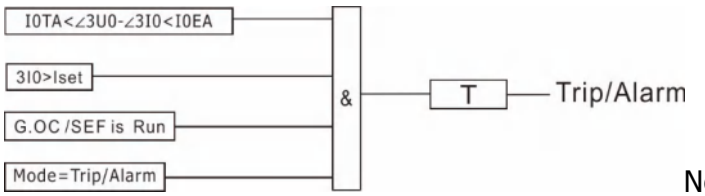
The angle of zero-sequence Voltage exceeding zero-sequence current is 175° to 275° when the neutral point is grounded, the angle of zero-sequence Voltage exceeding zero-sequence current is 60° to 120° when the neutral point is not grounded. Action area shown below:

	
175°<3IN/3IG∠3U0<275°	60°<3IN/3IG∠3U0<120°

The direction is the same as the three-phase direction overcurrent. The angle of the direction component is between the **I0 start angle** and the **I0 end angle** which set in the **common value**, and it is the angle of Voltage leading current. In addition, the directional elements are affected by the **Loss Of Phase** protection. When the PT is broken, if the **Loss Of Phase** block mode is lockout, the directional elements are locked, and the protection in the relevant direction does not act; If the **Loss Of Phase** block mode is unlock, direction judgment will not be performed.

The SEF function equipped with harmonic filtering to prevent operation when harmonics are present in the primary residual earth currents. A low pass filter with 3rdharmonic rejection. It is necessary to enable **Harmonic inhibit** in SEF protection.

Action Logic diagram:



Note: Run is "√", Stop is "×".

3I0—Earth current Iset—Pickup current T—Delay time I0TA—I0 start angle I0EA—I0 end angle ∠3U0-∠3I0—Angle of 3U0 exceeding 3IN/3IG

The element is blocked when the following communication signal is activated:

· Protection Disable

· Ground Disable

· Inrush Feature

· SEF Disable (Only SEF protection is affected)

· Harmonic inhibit (Only SEF protection is affected)

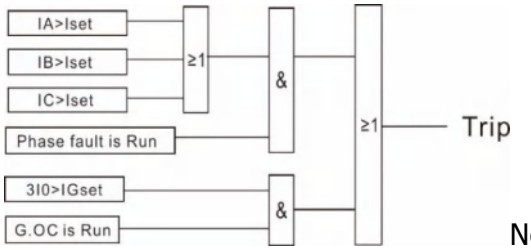
· **Loss Of Phase**-**Block mode**=**Lockout** (G.OC/SEF-**Direction mode**=**Forward**)

51c Cold Load Pickup (Cold load)

If a circuit breaker is closed onto a "cold" load, i.e.one that has not been powered for a prolonged period, this can impose a higher than normal load-current demand on the system which could exceed normal settings. These conditions can exist for an extended period and must not be interpreted as a fault. To allow optimum setting levels to be applied for normal operation, the cold load pickup feature will apply alternative current settings for a limited period. The feature resets when either the circuit breaker has been closed for a settable period, or if the current has reduced beneath a set level for a user set period.

When the time of the line lost current is longer than the "Loss-load time", the load of the line is cold. Next time the line has current, "Cold load" protection will start, the protection you set (phase fault/earth fault/sensitive earth fault) is invalid, the recloser will only when the current satisfies the logic diagram below. After the "Restore time", "Cold load" protection ends, the protection you set becomes.

Action Logic diagram:



Note: Run is "√", Stop is "×".

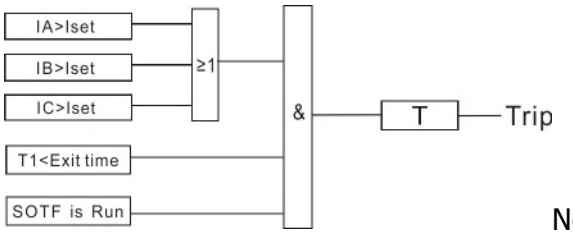
IA IB IC—Measure current 3I0—Measure Ground current
Iset—Pickup-Phase current IGset—Pickup-Ground current

This protection cannot be used alone, but must be used together with P.OC1, P.OC2, P.OC3, G.OC1, G.OC2, and G.OC3.

TRSOTF Switch-Onto-Fault (SOTF)

When switching on manual closing acceleration, if you close the recloser on to a fault during the "exit time", the phase over current protection will accelerate the operation. The exit time of acceleration can be adjusted.

Action Logic diagram:



Note: Run is "√", Stop is "×".

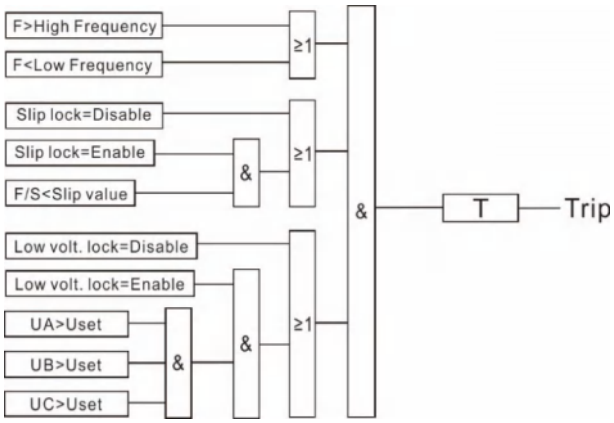
IA IB IC—Measured current Iset—Pickup current T—Delay time
T1— The time after manual close

The element is blocked when the following communication signal is activated:
· Protection Disable

81 Frequency Protection (Frequency)

When the frequency of the power PT is to high or to low, the Recloser will trip to protect the line.

Action Logic diagram:



Note: Run is "√", Stop is "×".

F—Frequency of power PT F/S—The rate of frequency (HZ) and seconds (S)
UA UB UC—Measured Voltage T—Delay time

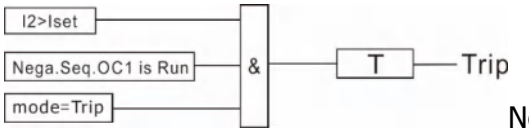
The element is blocked when the following communication signal is activated:
· Protection Disable

46 Negative- Sequence Overcurrent (Nega.Seq.OC)

Negative sequence phase current is calculated by the three phases. There are two sections of negative sequence overcurrent protection for definite time limit.

Section I is used to for open-phase protection.

Action Logic diagram:

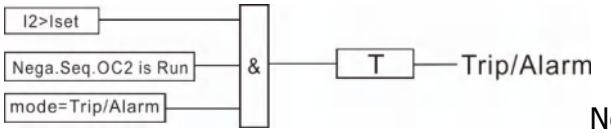


Note: Run is "√", Stop is "×".

I2—Measured negative sequence current Iset—Pickup current T—Delay time

Section II is used to for unbalanced protection.

Action Logic diagram:



Note: Run is "√", Stop is "×".

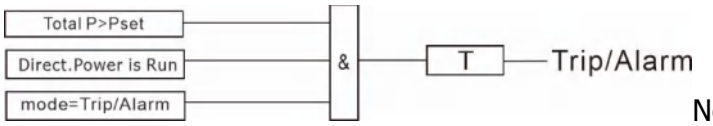
I2—Measured negative sequence current Iset—Pickup current T—Delay time

The element is blocked when the following communication signal is activated:
· Protection Disable

Direct.Power

When the total three-phase power exceeds the set power, it will act after a delay time. This protection has directional options. When set to forward, if the active power exceeds the setting power value and is positive, it will trip; When set to reverse, if the active power exceeds the setting power value and is negative, it will trip.

Action Logic diagram:



Note: Run is "√", Stop is "×".

Total P—Three phase active power Pset—Pickup power T—Delay time

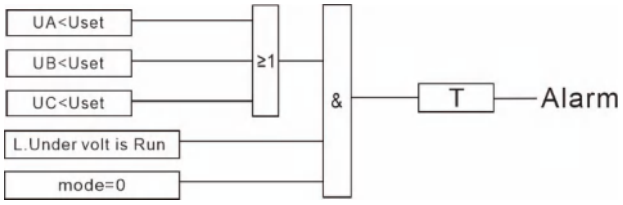
The element is blocked when the following communication signal is activated:
· Protection Disable

27 Under Voltage (L.Under volt)

The device uses the line Voltage as the criteria for under Voltage protection. Under Voltage protection includes mode I (No Voltage +Low Voltage protection), mode II (Via current locking low Voltage protection) and mode III (Pure low-Voltage protection).

Action Logic diagram:

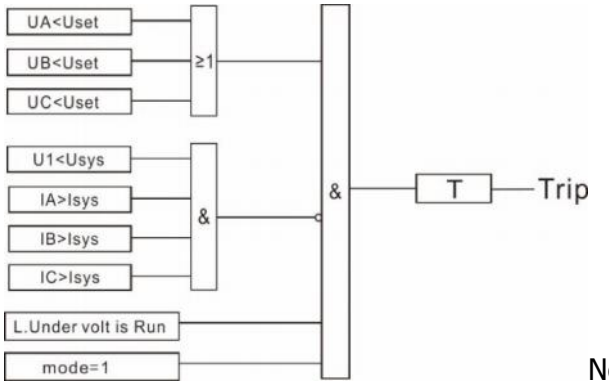
Mode 0: Low Voltage alarm



Note: Run is "√", Stop is "×".

UA UB UC—Measured Voltage Uset—Pickup Voltage T—Delay time

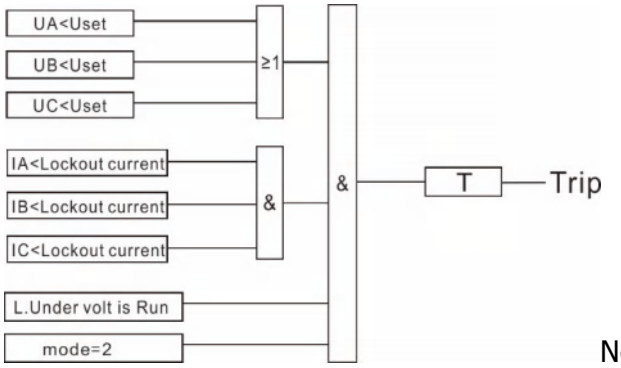
Mode 1: No Voltage +Low Voltage protection



Note: Run is "√", Stop is "×".

UA UB UC—Measured Voltage Uset—Pickup Voltage T—Delay time
U1—positive sequence Voltage Usys—System value (secondary value 5V)
IA IB IC—Measured current Isys—System value (secondary value 0.01A)

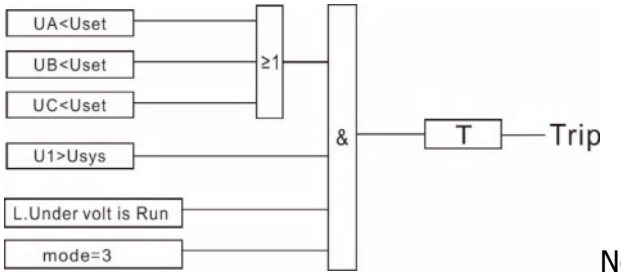
Mode2: Via current locking low Voltage protection



Note: Run is "√", Stop is "×".

UA UB UC—Measured Voltage Uset—Pickup Voltage T—Delay time
IA IB IC—Measured current

Mode3: Pure low-Voltage protection



Note: Run is "√", Stop is "×".

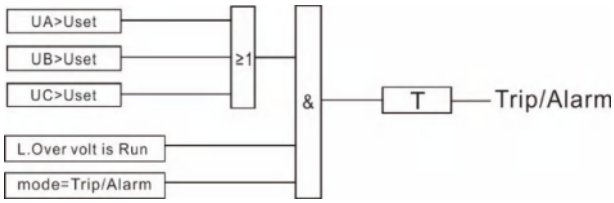
UA UB UC—Measured Voltage Uset—Pickup Voltage T—Delay time
U1—positive sequence Voltage Usys—System value (secondary value 5V)

The element is blocked when the following communication signal is activated:
· Protection Disable

59 Over Voltage (L.Over volt)

The device uses the line Voltage as the criteria for over Voltage protection.

Action Logic diagram:



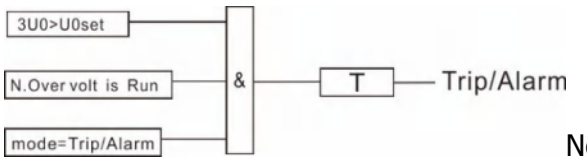
Note: Run is "√", Stop is "×".

UA UB UC—Measured Voltage Uset—Pickup Voltage T—Delay time

The element is blocked when the following communication signal is activated:
· Protection Disable

59N Zero-Sequence Over Voltage (N.Over volt)

Action Logic diagram:



Note: Run is "√", Stop is "×".

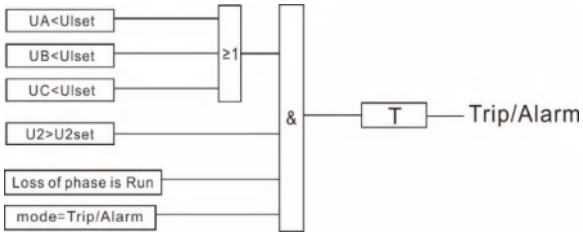
3U0—Measured zero-sequence Voltage U0set—Pickup Voltage T—Delay time

The element is blocked when the following communication signal is activated:
· Protection Disable

Loss Of Phase

The device judges the Voltage circuit breaking through collecting Voltage. There are two block modes, mode I: lockout Voltage related components, that is the protection related to the direction disable; mode II: unlock Voltage related components, that is no direction judgment.

Action Logic diagram:



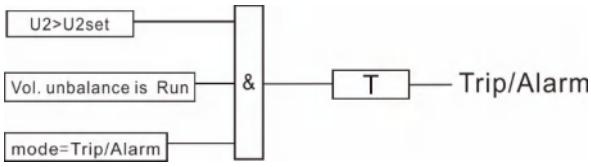
Note: Run is "√", Stop is "×".

UA UB UC—Measured Voltage Ulset—Pickup low Voltage(common) T—Delay time
U2—Negative sequence Voltage U2set—Pickup negative sequence Voltage

The element is blocked when the following communication signal is activated:
· Protection Disable

Voltage unbalance (Vol. unbalance)
Use negative sequence Voltage to detect whether the line Voltage is balanced.

Action Logic diagram:



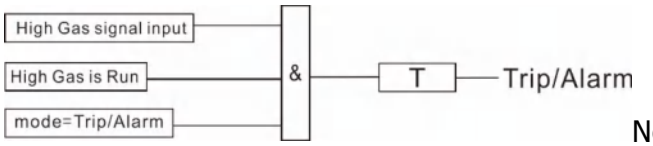
Note: Run is "√", Stop is "×".

U2—Negative sequence Voltage U2set—Pickup negative sequence Voltage
T—Delay time

The element is blocked when the following communication signal is activated:
· Protection Disable

Heavy gas protection (High Gas)

Action Logic diagram:

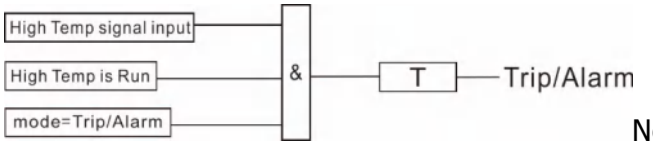


Note: Run is "√", Stop is "×".

The element is blocked when the following communication signal is activated:
· Protection Disable

High temperature protection (High Temp)

Action Logic diagram:



Note: Run is "√", Stop is "×".

The element is blocked when the following communication signal is activated:
· Protection Disable

Control circuit broken alarm

Under normal conditions, the switch on and switch off signals are in different status, and when these two signals are in the same status for 10s, the device will send a control circuit broken alarm signal.

Hotline

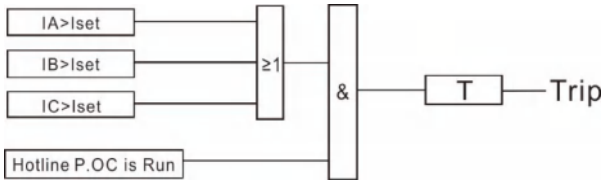
When the line is under repair, you can turn on the feature of hotline, this will inhibit any close functions for safety. Press the "Hotline" pushbutton and the feature of hotline is turned on. Press the "Hotline" pushbutton again, and the feature of hotline will be turn off.

There are two protections:

Hotline P.OC

The phase current is greater than the pickup value and trips after delay.

Action Logic diagram:



Note: Run is "√", Stop is "×".

IA IB IC—Measured current Iset—Pickup current T—Delay time

The element is blocked when the following communication signal is activated:

· Protection Disable

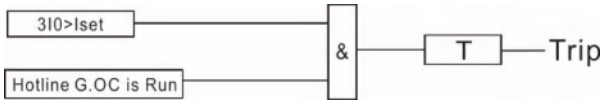
· Hotline Disable

· Inrush Feature

Hotline G.OC

The earth current is greater than the pickup value and trips after delay.

Action Logic diagram:



Note: Run is "√", Stop is "×".

3I0—Earth current Iset—Pickup current T—Delay time

The element is blocked when the following communication signal is activated:

· Protection Disable

· Hotline Disable

· Ground Disable

· Inrush Feature

Live Load Block

Live Load Block function prevents close operation when the Voltage on the load side. In the network where it is planned to install reclosers, there are sources of electric (solar) energy generation. The recloser must monitor the absence of Voltage from the load side. In case if Voltage available from the load side, recloser should not close.

Blocking of swiching on and reclosing if available Voltage on load side. After protection tripping controller should analyze if available Voltage on load side. If available Voltage on load side then function close and reclose should be deactivated. At the same time if the Voltage on the source side is greater than the **High Voltage** value, the reclosing and closing operation can't be carried out.

And the Voltage must be greater than the **Low Voltage** value to be considered as Voltage.

High Voltage value, **Low Voltage** value and **Live Load Block** enable are set in the **Common** value menu.

Inrush Feature

An Inrush feature shall be provided to prevent feeder trip during energization and during auto-recloser operation due to inrush currents associated with transformers, motor start currents and others.

Second harmonic inhibit. When the **Inhibit mode** is selected as **Single**, the suppression will be carried out when the harmonic ratio of the overcurrent phase is greater than the **Inhibit ratio** value. When the **Inhibit mode** is selected as **Cross**, suppression will be executed when the harmonic ratio of one phase is greater than the **Inhibit ratio** value. For zero sequence suppression, as long as the harmonic ratio of one phase is greater than the **Inhibit ratio** value, it will be suppressed.

The element is blocked when the following communication signal is activated:
· Protection Disable

Synchronising Check Element

The two synchronising check elements are single-phase elements, with single phase Voltage inputs VP and VS used for both elements:
VP is the source side phase input Voltage (UA, UB, or UC), designated by setting **Phase** (if **Phase**=1, then VP=UA; if **Phase**=2, then VP=UB; if **Phase**=3, then VP=UC).
VS is the load side phase input Voltage(UR, US, or UT), designated by setting **Phase** (if **Phase**=1, then VS=UR; if **Phase**=2, then VS=US; if **Phase**=3, then VS=UT).\

Synchronising check is only needed when the circuit breaker is open. System frequencies are determined from Voltages VP and VS. Single-phase Voltage inputs VP and VS are compared to a Voltage window, to verify that the Voltages are "healthy" and lay within settable Voltage limits **Low Voltage** and **High Voltage**. The two synchronising check elements use the same Voltage window (to ensure healthy Voltage), slip frequency settings and max angle settings.

Synchronising check elements settings as shown in the following table:

Setting	Definition
Low Voltage	low Voltage threshold for "healthy Voltage" window
High Voltage	high Voltage threshold for "healthy Voltage" window
Phase	synchronising phase
Max angle	synchronising check element maximum angle
Slip frequency	maximum slip frequency
Close time	breaker close time for angle compensation
Max time	maximum synchronization time

Slip Frequency Calculator:

Slip Frequency = fP – fS (in units of Hz = slip cycles/second)

fP = frequency of Voltage VP (in units of Hz = cycles/second)

fS = frequency of Voltage VS (in units of Hz = cycles/second)

A complete slip cycle is one single 360-degree revolution of one Voltage (e.g., VS) by another Voltage (e.g., VP). Both Voltages are thought of as revolving phasor-wise, so the "slipping" of VS past VP is the *relative* revolving of VS past VP. For example, if Voltage VP has a frequency of 59.95 Hz and Voltage VS has a frequency of 60.05 Hz, the difference between them is the slip frequency:

Slip Frequency = 59.95 Hz – 60.05 Hz = –0.10 Hz = –0.10 slip cycles/second

The slip frequency in this example is negative, indicating that Voltage VS is not "slipping" *behind* Voltage VP, but in fact "slipping" *ahead* of Voltage VP. In a time period of one second, the angular distance between Voltage VP and Voltage VS changes by 0.10 slip cycles, which translates into:

0.10 slip cycles/second • (360°/slip cycle) • 1 second = 36°

Thus, in a time period of one second, the angular distance between Voltage VP and Voltage VS changes by 36 degrees.

Angle Difference Calculator

The synchronising check element Angle Difference Calculator runs if the slip frequency is less than the maximum **Slip frequency** setting.

If the slip frequency is less than or equal to 0.005 Hz, the Angle Difference Calculator does not take into account breaker close time—it presumes Voltages VP and VS are "static" (not "slipping" with respect to one another). This would usually be the case for an open breaker with Voltages VP and VS that are paralleled via some other electric path in the power system. The Angle Difference Calculator calculates the angle difference between Voltages VP and VS:

Angle Difference = |(∠VP –∠VS)|

Also, if breaker **Close time** setting = 0.000S, the Angle Difference Calculator does not take into account breaker close time, even if the Voltages VP and VS are "slipping" with respect to one another.

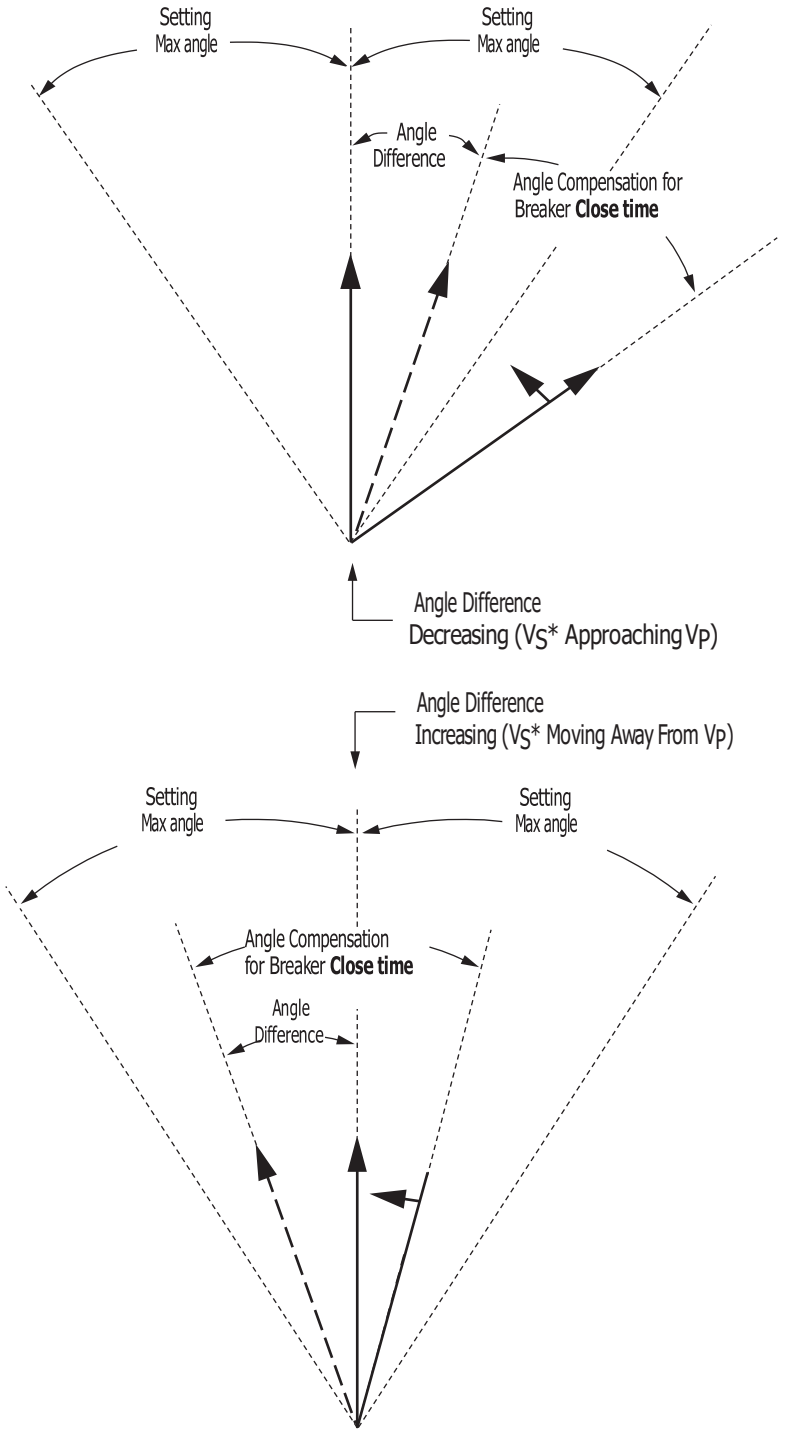


Figure 1 Angle Difference Between VP and VS Compensated by Breaker Close Time (fP < fS; VP Shown as Reference in This Example)

If the slip frequency is greater than 0.005 Hz and breaker **Close time** $\neq 0$, the Angle Difference Calculator takes the breaker close time into account with breaker close time setting. The Angle Difference Calculator calculates the Angle Difference between Voltages VP and VS, compensated with the breaker close time:

Angle Difference = $|(\angle VP - \angle VS) + [(fP - fS) \bullet$ **Close time** $\bullet \ 360°]|$

Angle Difference Example (Voltages Vp and Vs Are "Slipping"). For example, if the breaker **Close time** is 0.167s. Presume the slip frequency is the example slip frequency calculated previously. The Angle Difference Calculator calculates the angle

difference between Voltages VP and VS, compensated with the breaker close time:

Angle Difference = |(∠VP – ∠VS) + [(fP – fS) • **Close time** • 360°]|

Intermediate calculations:

(fP – fS) = (59.95 Hz – 60.05 Hz) = –0.10 Hz = –0.10 slip cycles/second

Close time = 0.167second

Resulting in:

Angle Difference = |(∠VP – ∠VS) + [(fP – fS) • **Close time** • 360°]|
= |(∠VP – ∠VS) + [–0.10 • 0.167 • 360°]|
= |(∠VP – ∠VS) – 6°|

During the breaker **Close time**, the Voltage angle difference between Voltages VP and VS changes by 6 degrees. This 6-degree angle compensation is applied to Voltage VS, resulting in derived Voltage VS*, as shown in *Figure 1.*

The top of *Figure 1* shows the Angle Difference *decreasing*—VS* is approaching VP. Ideally, circuit breaker closing is initiated when VS* is in-phase with VP (Angle Difference = 0°). Then when the circuit breaker main contacts finally close, VS is in-phase with VP, minimizing system shock.

The bottom of *Figure 1* shows the Angle Difference *increasing*—VS* is moving away from VP. Ideally, circuit breaker closing is initiated when VS* is in-phase with VP (Angle Difference = 0°). Then when the circuit breaker main contacts finally close, VS is in-phase with VP. But in this case, VS* has already moved past VP, it will be switched on immediately.

Synchronising Check Element Outputs. Synchronising check element outputs assert to logical 1 for the conditions explained in the following text.

Voltages VP and VS are "Static" or setting **Close time** = 0.000S. If VP and VS are "static" (not "slipping" with respect to one another), the Angle Difference between them remains constant—it is not possible to close the circuit breaker at an ideal zero degree phase angle difference. Thus, synchronising check elements assert to logical 1 if the Angle Difference is less than corresponding maximum angle setting **Max angle**. Also, if breaker **Close time** setting = 0.000S, the Angle Difference Calculator does not take into account breaker close time, even if the Voltages VP and VS are "slipping" with respect to one another. Thus, synchronising check elements assert to logical 1 if the Angle Difference is less than corresponding maximum angle setting **Max angle**.

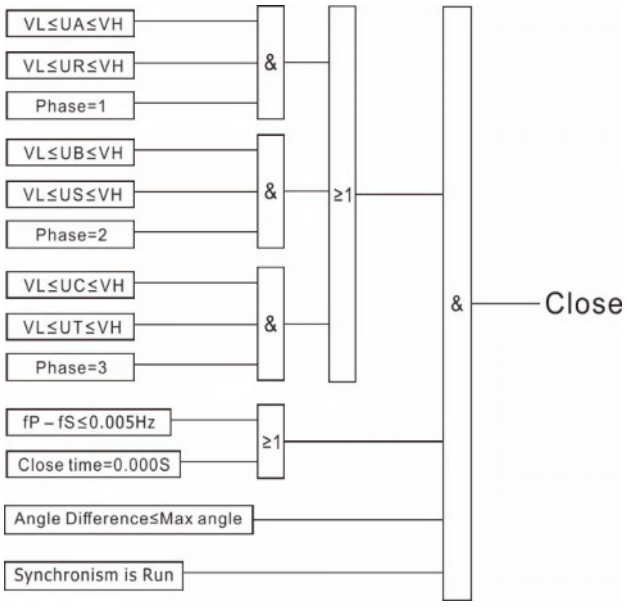
Voltages VP and VS are "Slipping" and setting **Close time** ≠ 0.000S. If VP and VS are "slipping" with respect to one another and breaker close time setting **Close time** ≠ 0.000S, the Angle Difference (compensated by breaker **Close time**) changes through time. Synchronising check element asserts to logical 1 for any one of the following two scenarios.

1. The top of *Figure 1* shows the Angle Difference *decreasing*—VS* is approaching VP. When VS* is in-phase with VP (Angle Difference = 0°), synchronising check elements assert to logical 1.
2. The bottom of *Figure 1* shows the Angle Difference *increasing*—VS* is moving away from VP. VS* was in-phase with VP (Angle Difference = 0°), but has now moved past VP. If the Angle Difference is *increasing*, but the Angle Difference is still less than maximum angle settings **Max angle**, then corresponding synchronising check elements assert to logical 1.

In this scenario of the Angle Difference increasing, but still being less than maximum angle settings **Max angle**, the operation of corresponding synchronising check elements becomes *less restrictive*. Synchronising check breaker closing does not have to wait for Voltage VS* to slip around again in-

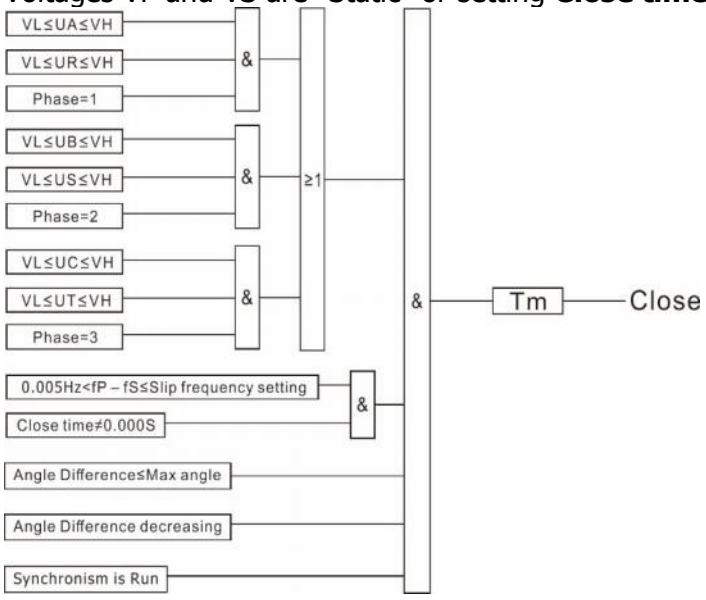
phase with VP (Angle Difference = 0°). There might not be enough time to wait for this to happen. Thus, the "Angle Difference = 0°" restriction is eased for this scenario.

Action Logic diagram:



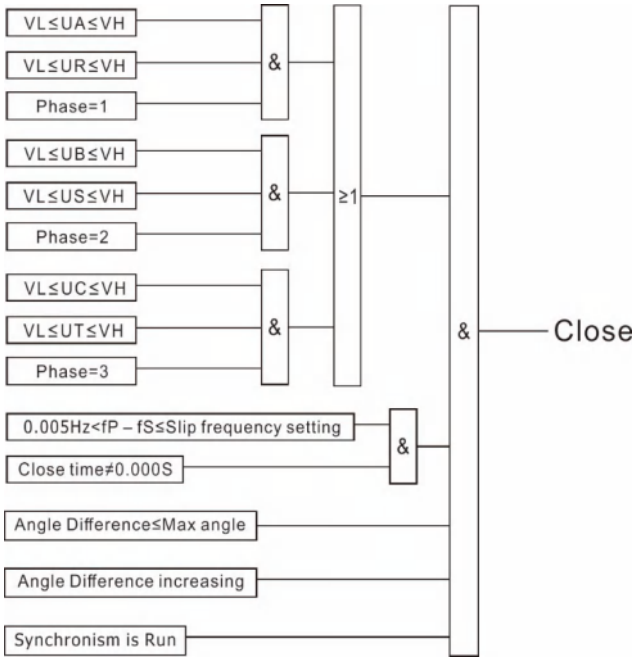
Note: Run is "√", Stop is "×".

Voltages VP and VS are "Static" or setting **Close time** = 0.000S.



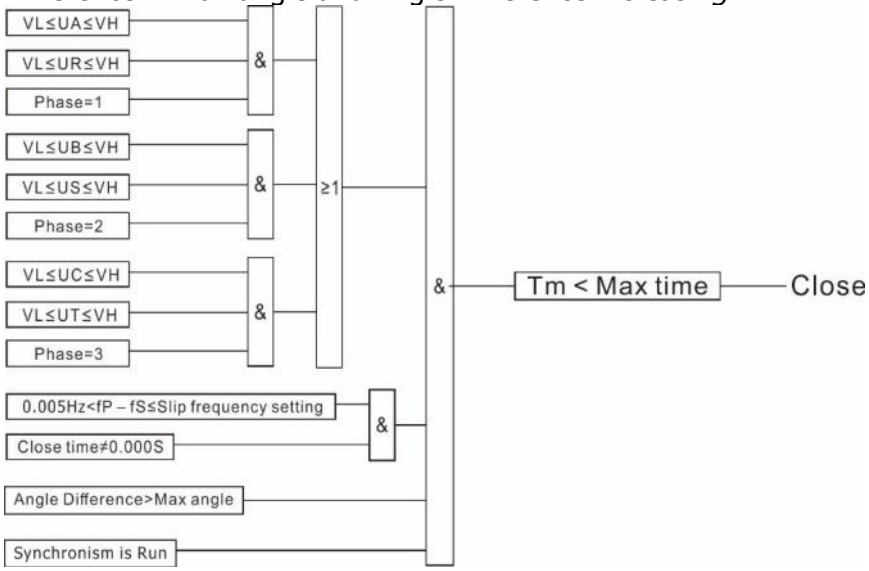
Note: Run is "√", Stop is "×".

Voltages VP and VS are "Slipping" and setting **Close time** ≠ 0.000S. The Angle Difference ≤ Max angle and Angle Difference *decreasing.*



Note: Run is "√", Stop is "×".

Voltages VP and VS are "Slipping" and setting **Close time** ≠ 0.000S. The Angle Difference ≤ Max angle and Angle Difference *increasing.*



Note: Run is "√", Stop is "×".

Voltages VP and VS are "Slipping" and setting **Close time** ≠ 0.000S. The Angle Difference > Max angle.

VL—Low Voltage VH—High Voltage Tm—Time from VS * approaching VP to VS* is in-phase with VP (Angle Difference = 0°) fP – fS—Slip frequency

UA, UB, UC—The source side phase Voltage

UR, US, UT—The load side phase Voltage

Note: In the check synchronization logic, the auto reclosing is the same as the closing.

The element is blocked when the following communication signal is activated:

· Protection Disable

3.2 Time-Overcurrent Curves

The following information describes the curve timing for the curve and time dial settings made for the time-overcurrent elements. The time-overcurrent relay curves conform to IEEE C37.112-1996 IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays.

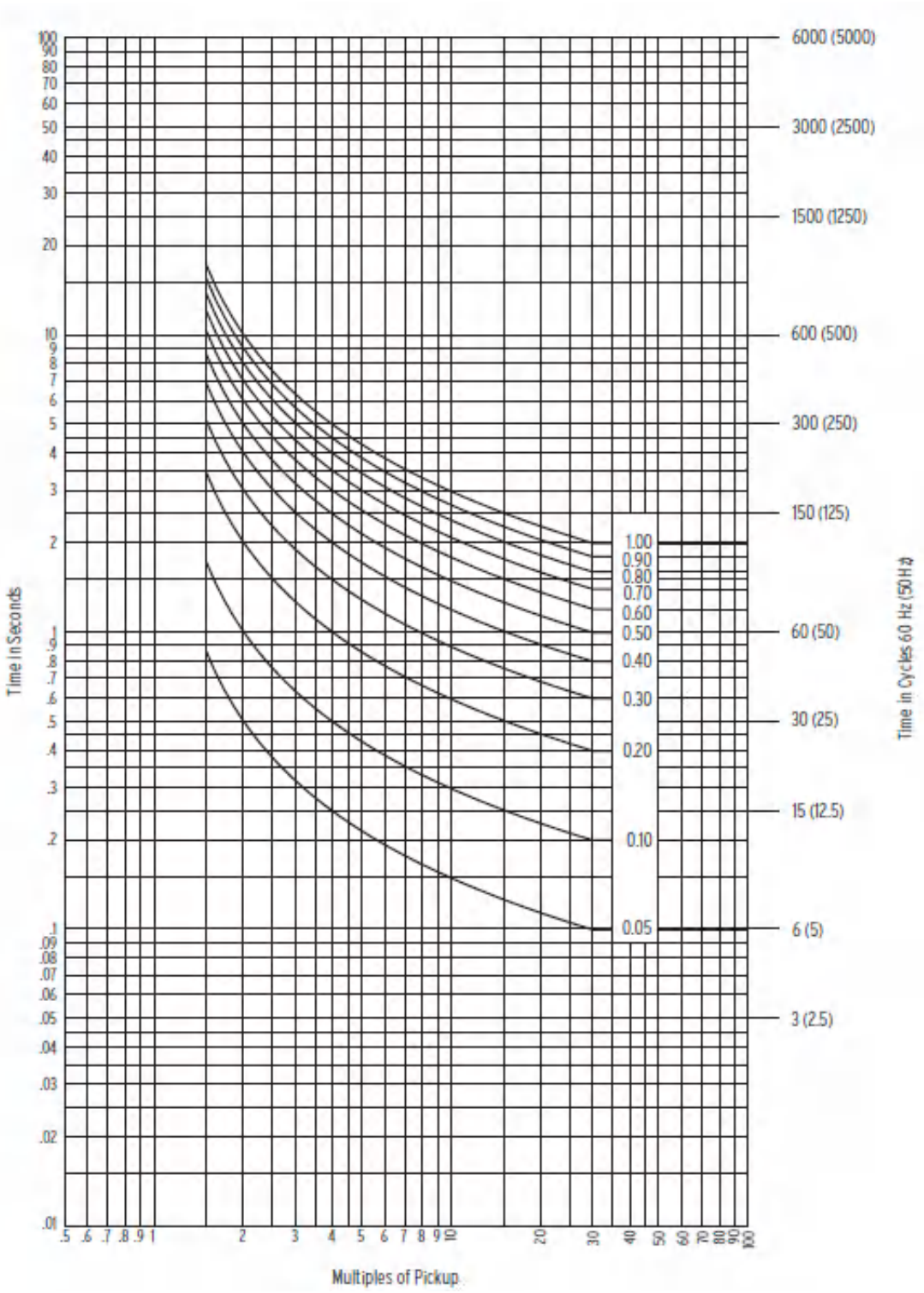
T_p = Operating time in seconds
TD = Time-dial setting
M = Applied multiples of pickup current

Equations Associated With IEC Curves

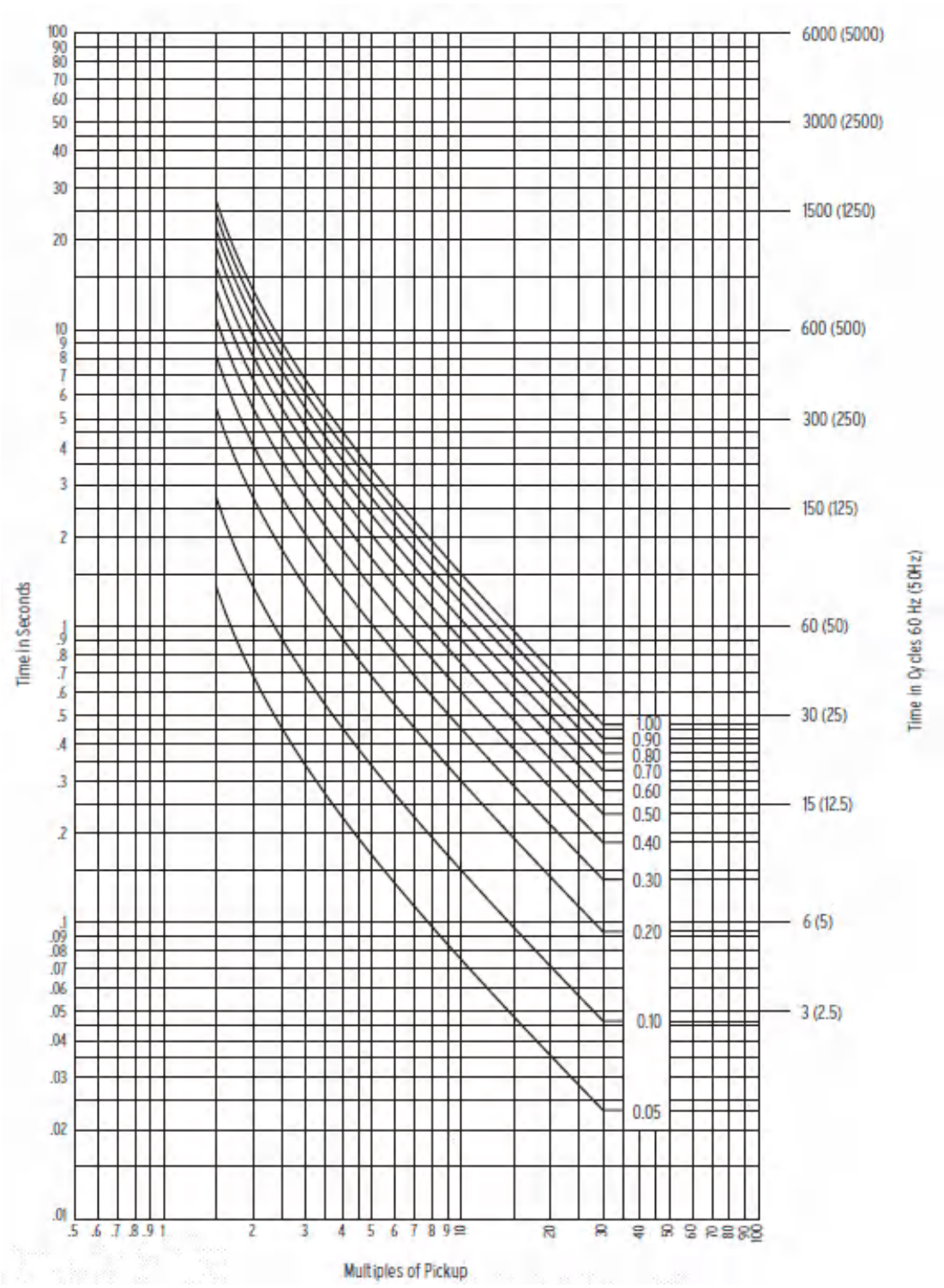
No	Curve Type	Operating time
1	C1 (Standard Inverse)	$T_p = TD \bullet \left(\frac{0.14}{(M^{0.02} - 1)} \right)$
2	C2 (Very Inverse)	$T_p = TD \bullet \left(\frac{13.5}{(M - 1)} \right)$
3	C3 (Extremely Inverse)	$T_p = TD \bullet \left(\frac{80}{(M^2 - 1)} \right)$
4	C4 (Long-Time Inverse)	$T_p = TD \bullet \left(\frac{120}{(M - 1)} \right)$
5	C5 (Short-Time Inverse)	$T_p = TD \bullet \left(\frac{0.05}{(M^{0.04} - 1)} \right)$

Equations Associated With U.S. Curves

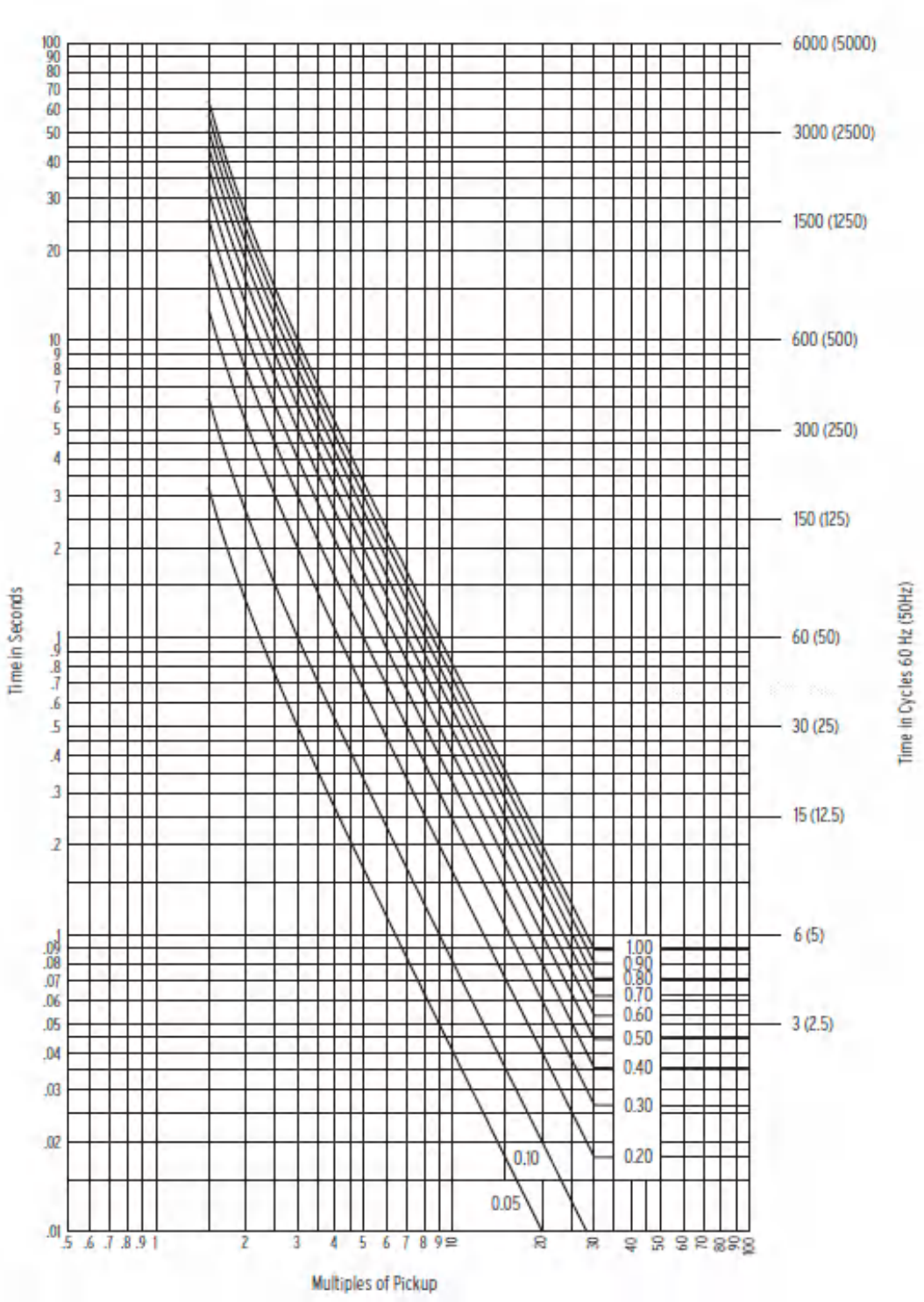
No	Curve Type	Operating time
6	U1 (Moderately Inverse)	$T_p = TD \bullet \left(0.0226 + \frac{0.0104}{(M^{0.02} - 1)} \right)$
7	U2 (Inverse)	$T_p = TD \bullet \left(0.180 + \frac{5.95}{(M^2 - 1)} \right)$
8	U3 (Very Inverse)	$T_p = TD \bullet \left(0.0963 + \frac{3.88}{(M^2 - 1)} \right)$
9	U4 (Extremely Inverse)	$T_p = TD \bullet \left(0.0352 + \frac{5.67}{(M^2 - 1)} \right)$
10	U5 (Short-Time Inverse)	$T_p = TD \bullet \left(0.00262 + \frac{0.00342}{(M^{0.02} - 1)} \right)$



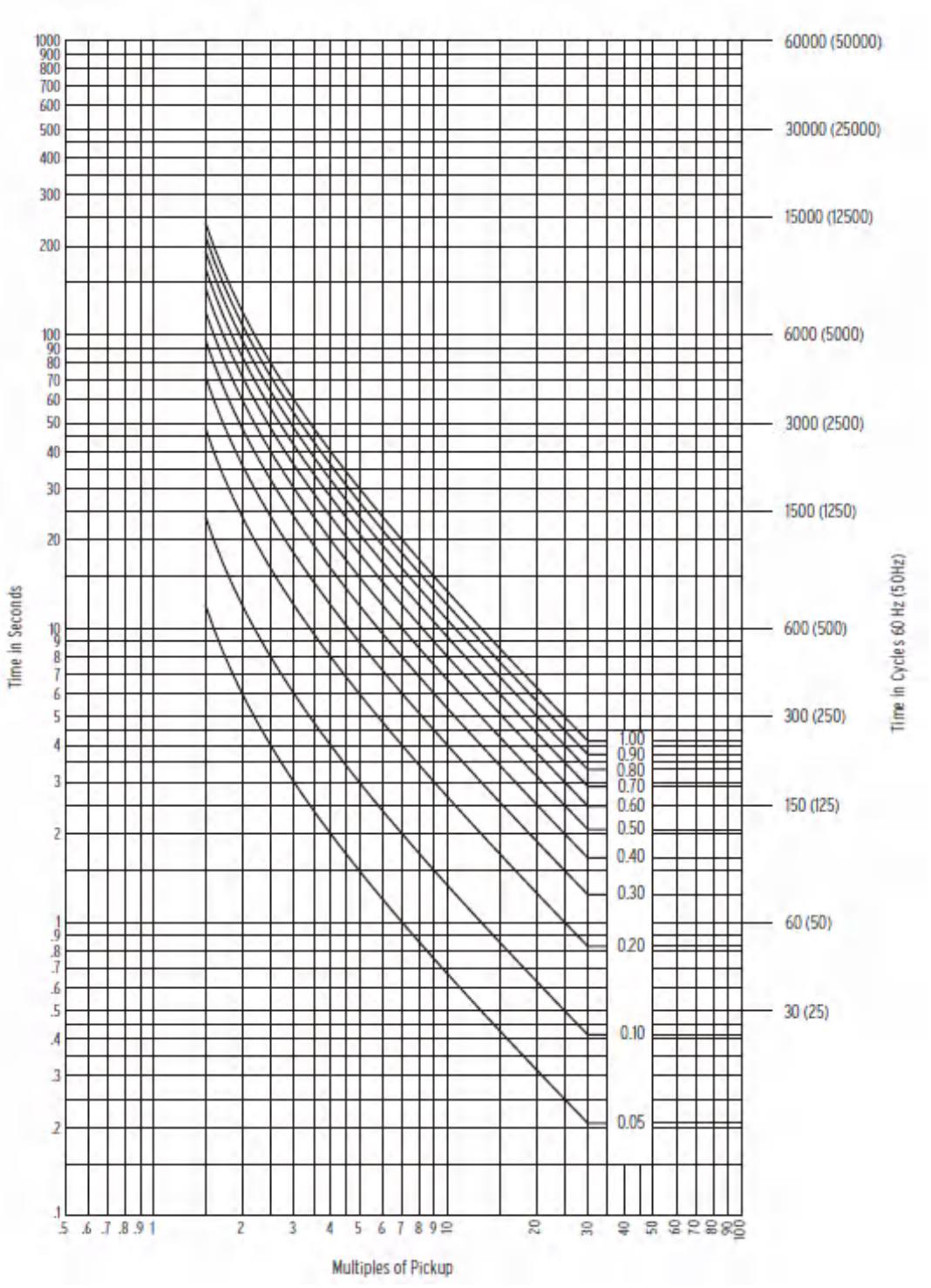
IEC Class A Curve (Standard Inverse): C1



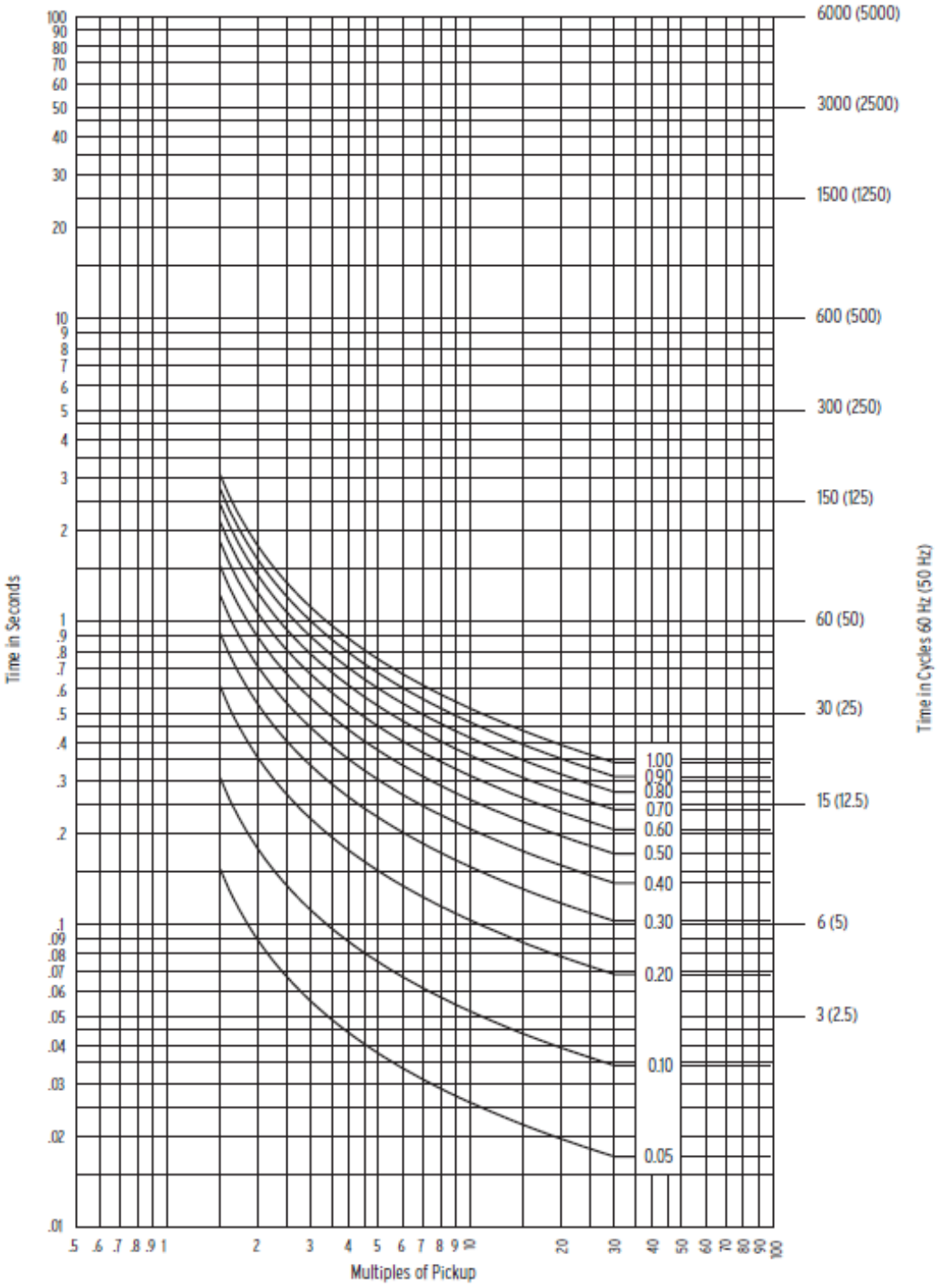
IEC Class B Curve (Very Inverse): C2



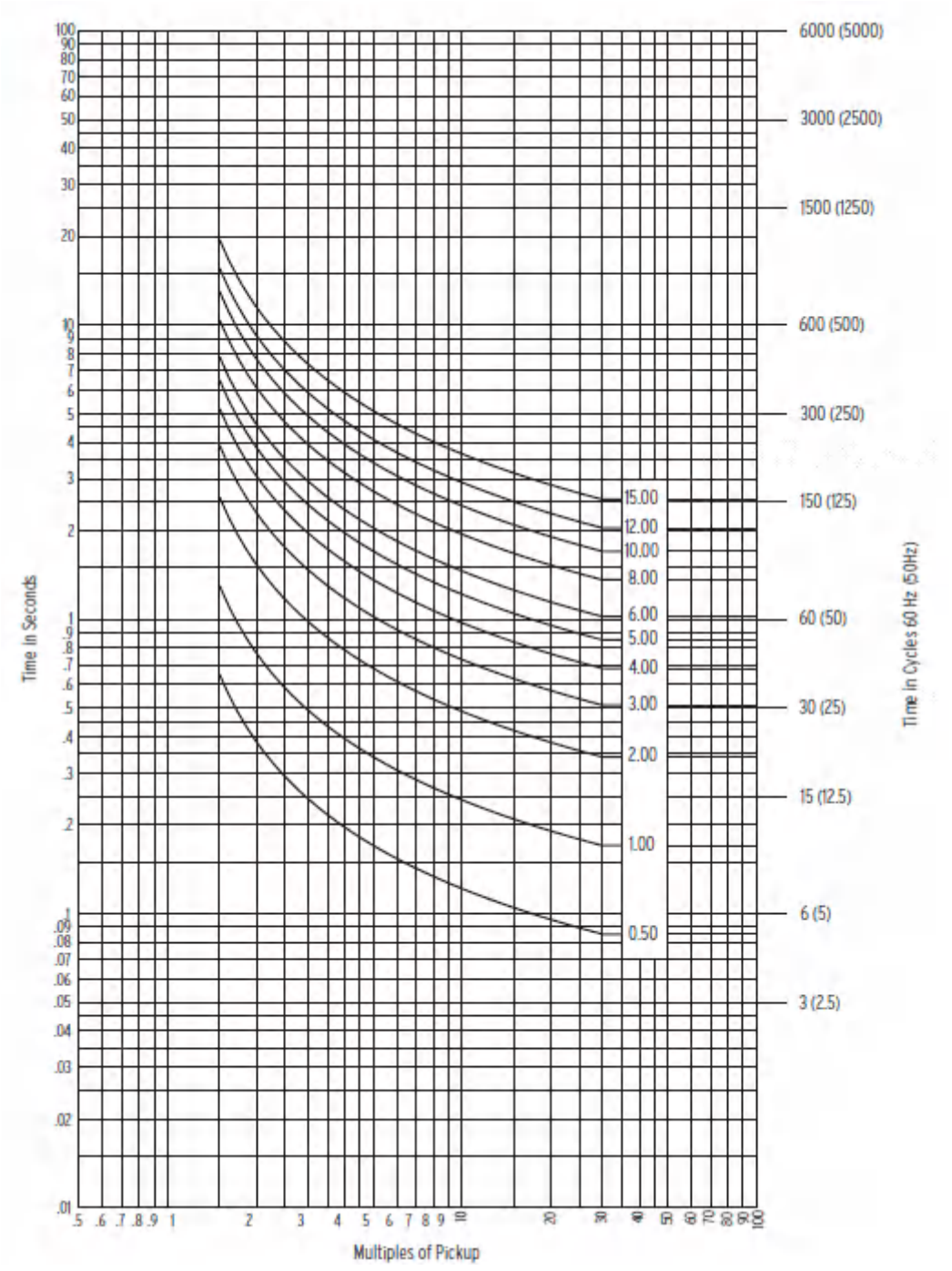
IEC Class C Curve (Extremely Inverse): C3



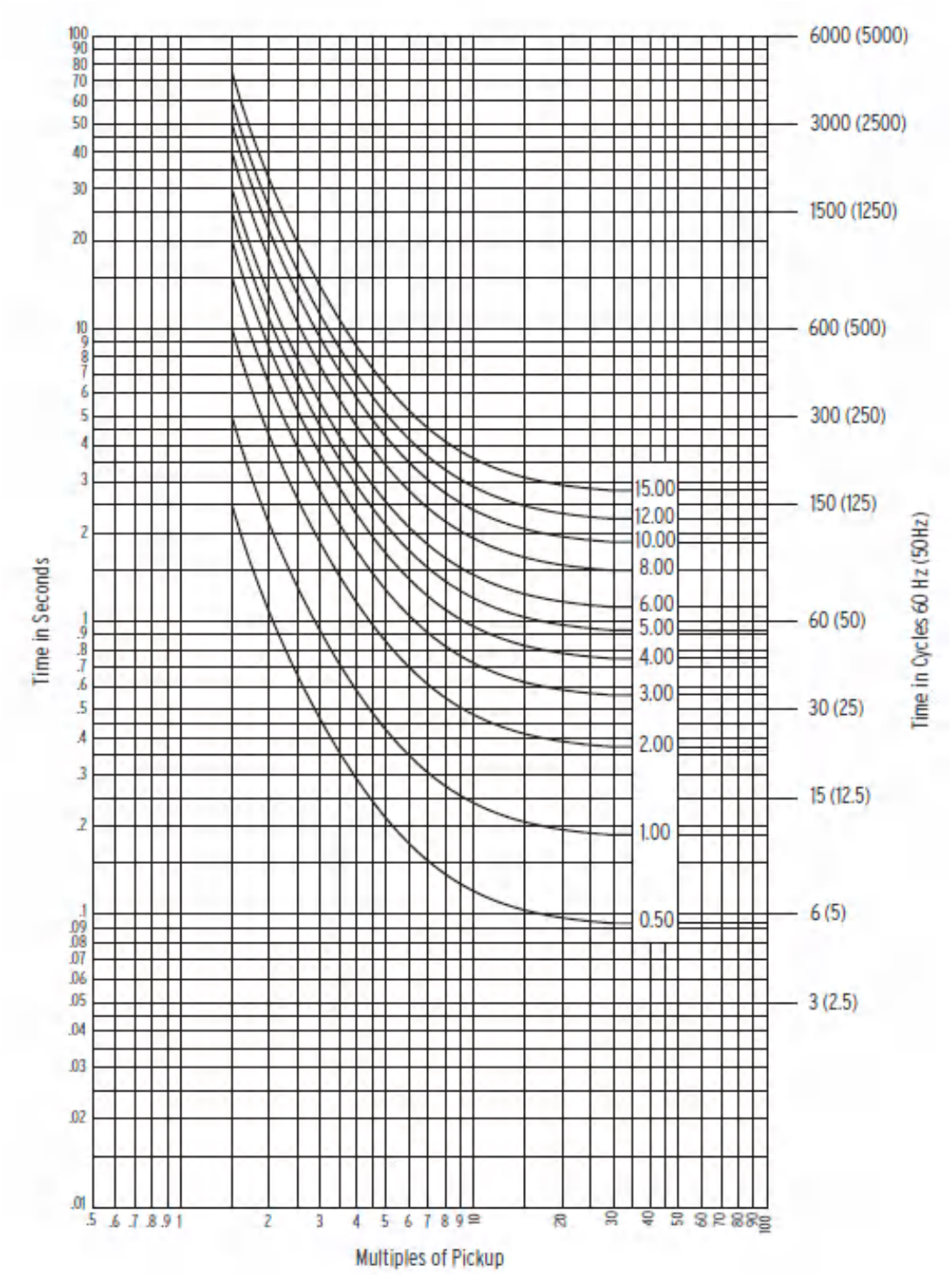
IEC Long-Time Inverse Curve: C4



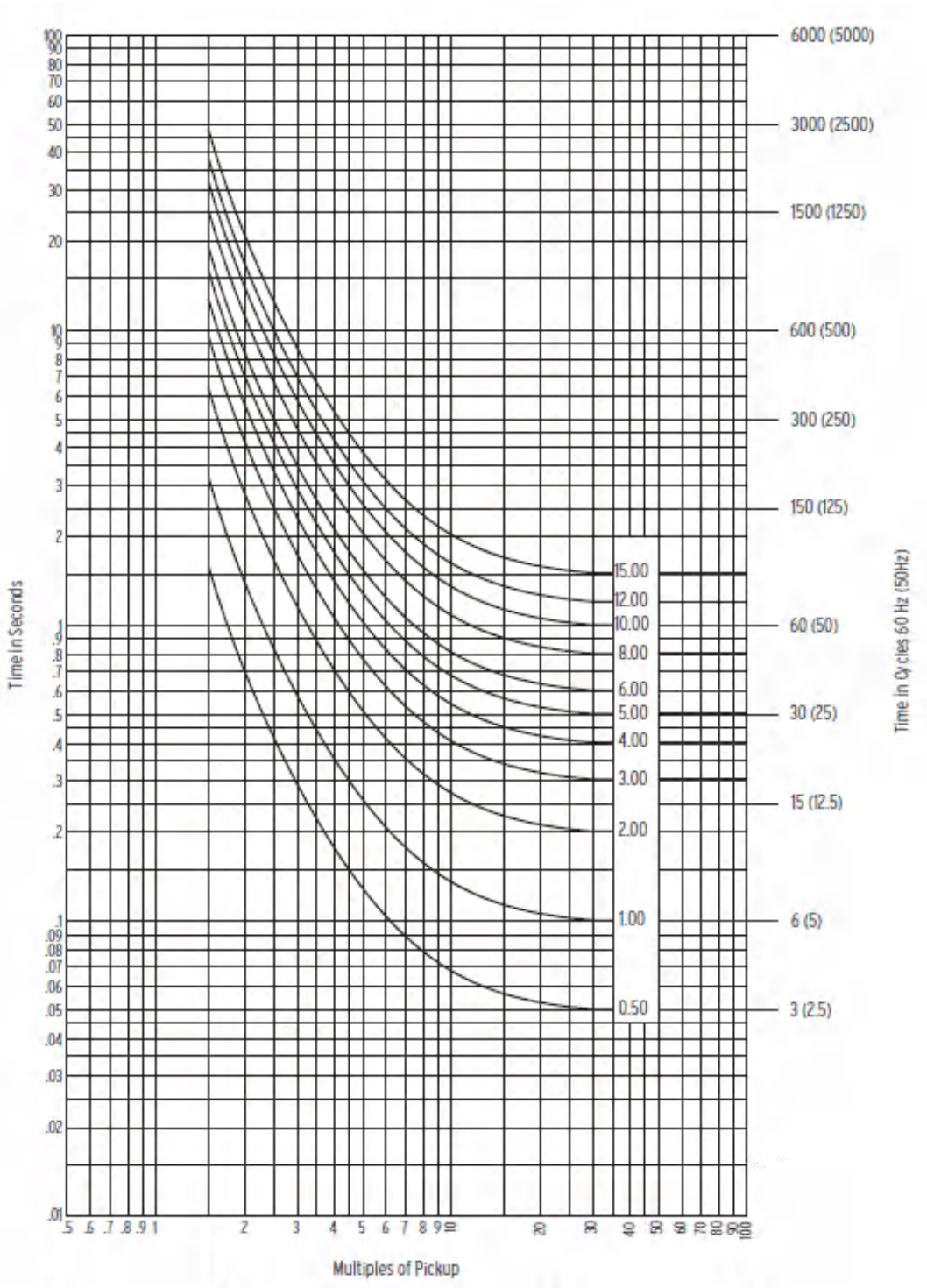
IEC Short-Time Inverse Curve: C5



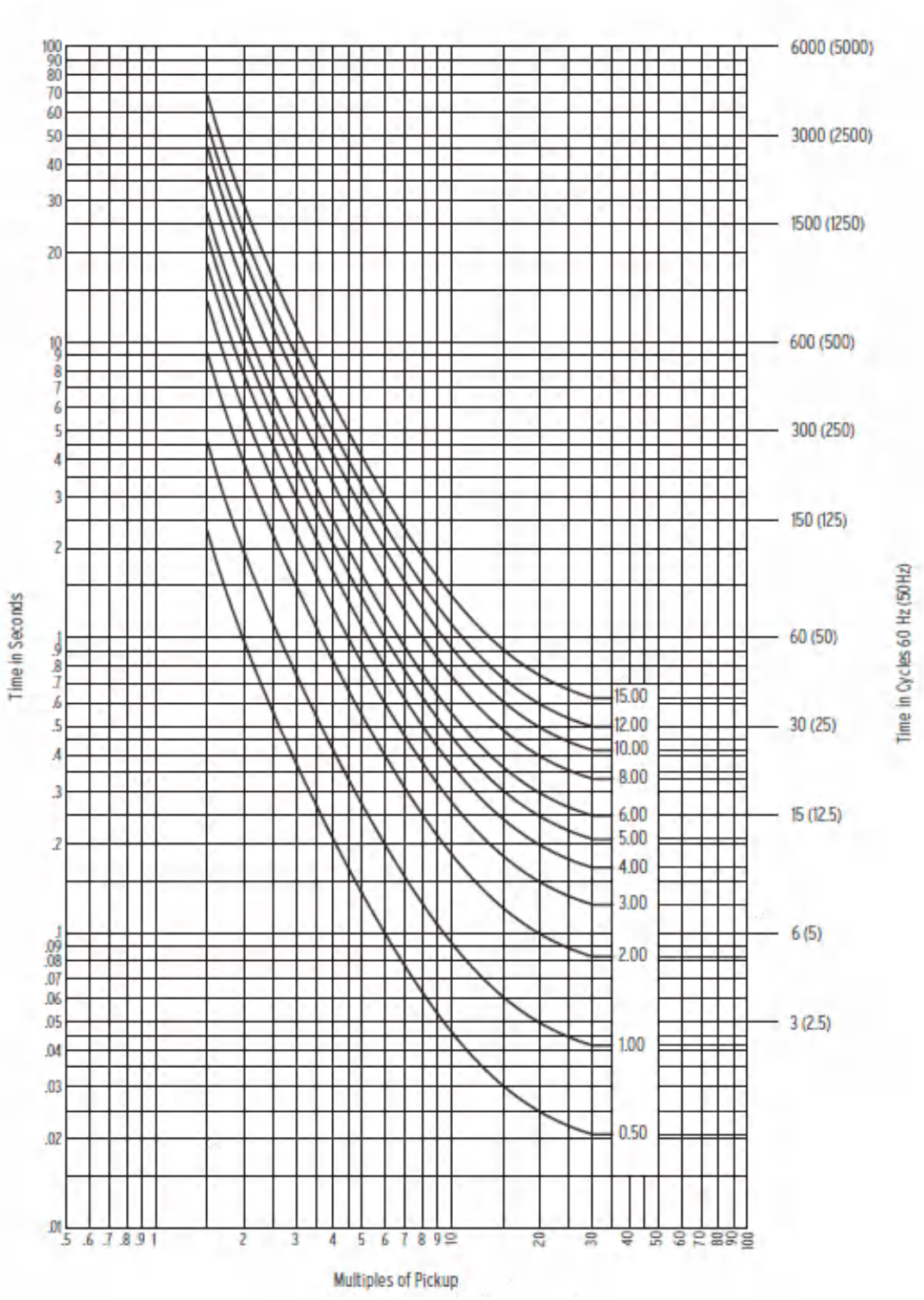
U.S. Moderately Inverse Curve: U1



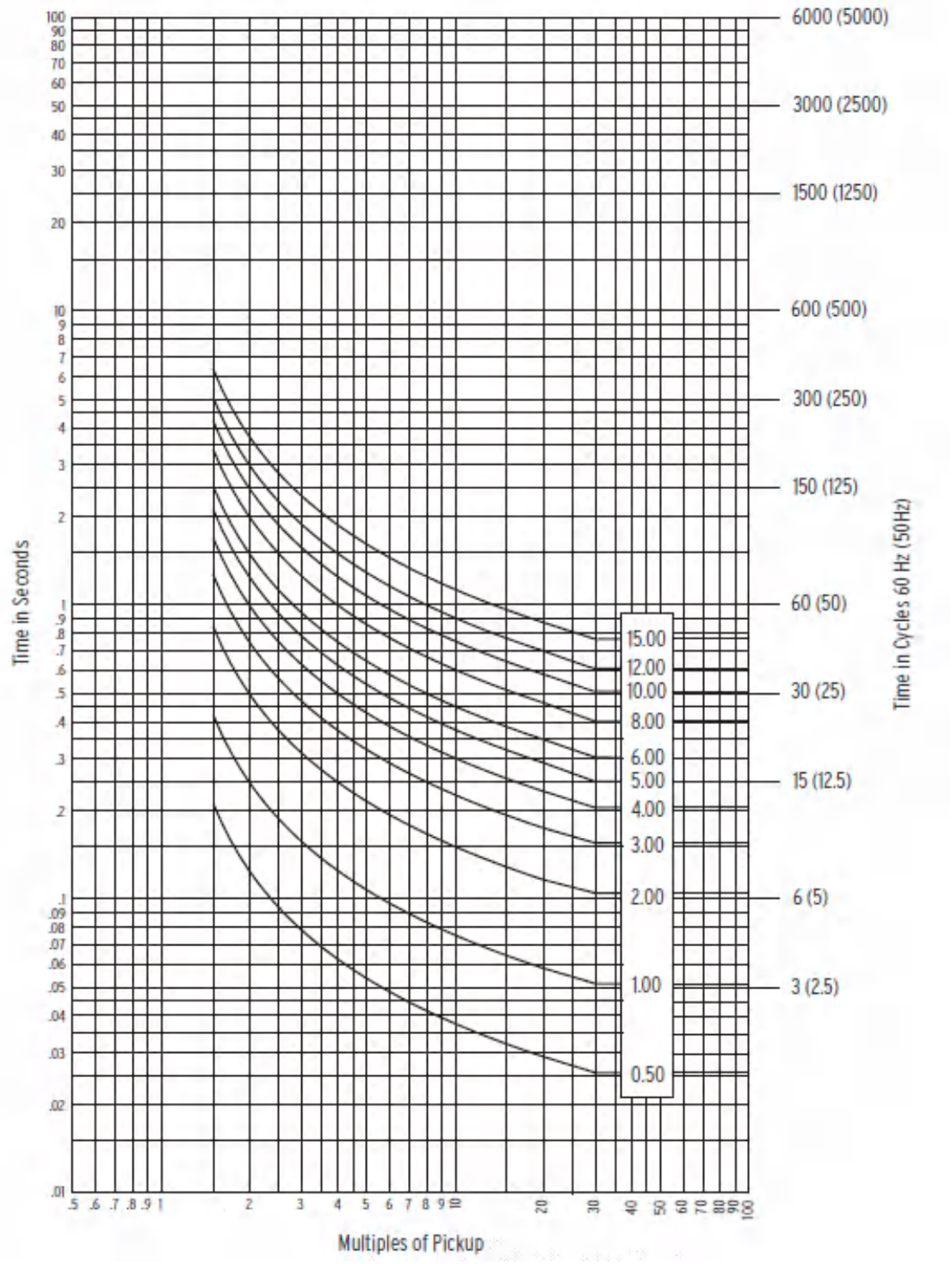
U.S. Inverse Curve: U2



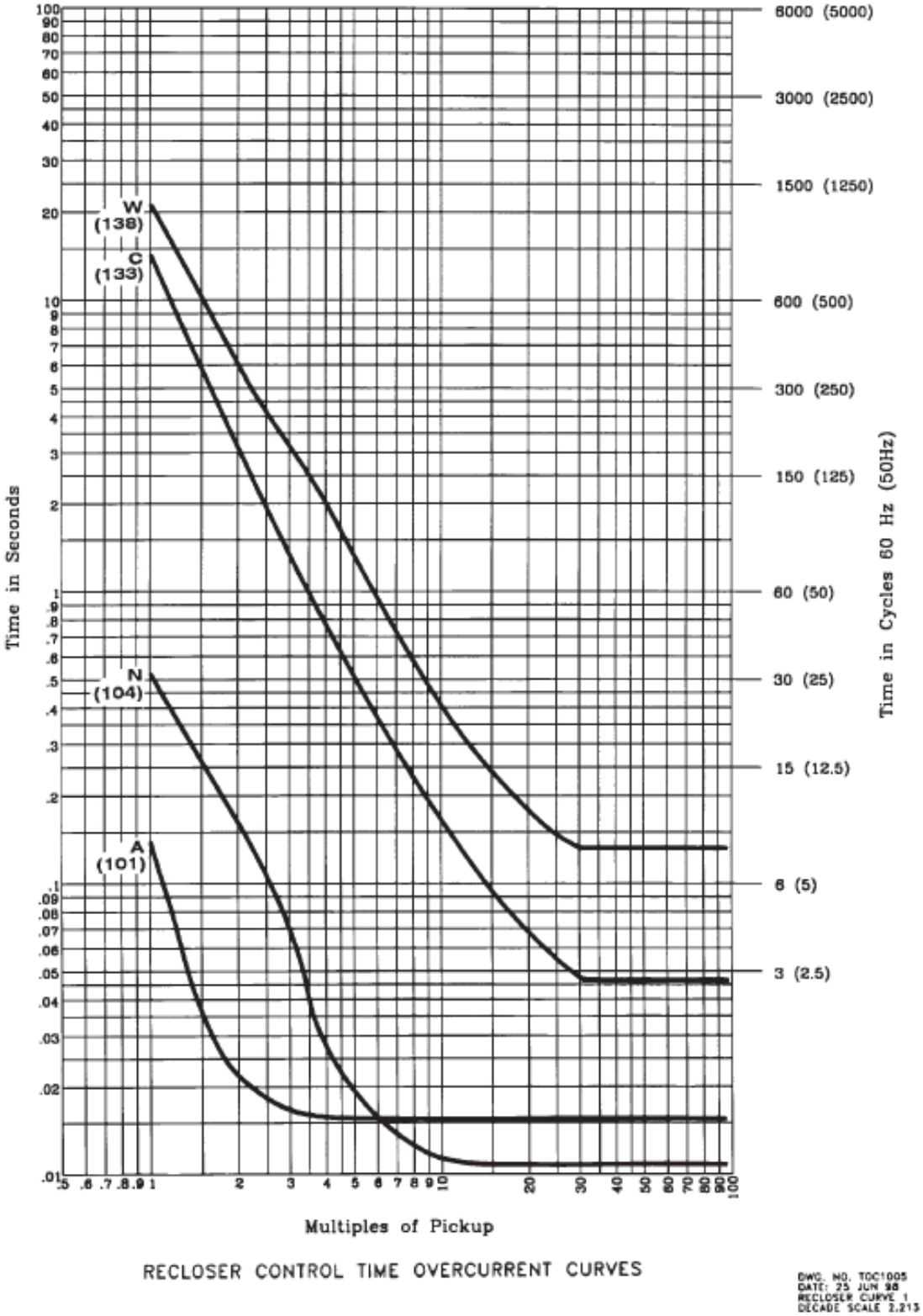
U.S. Very Inverse Curve: U3



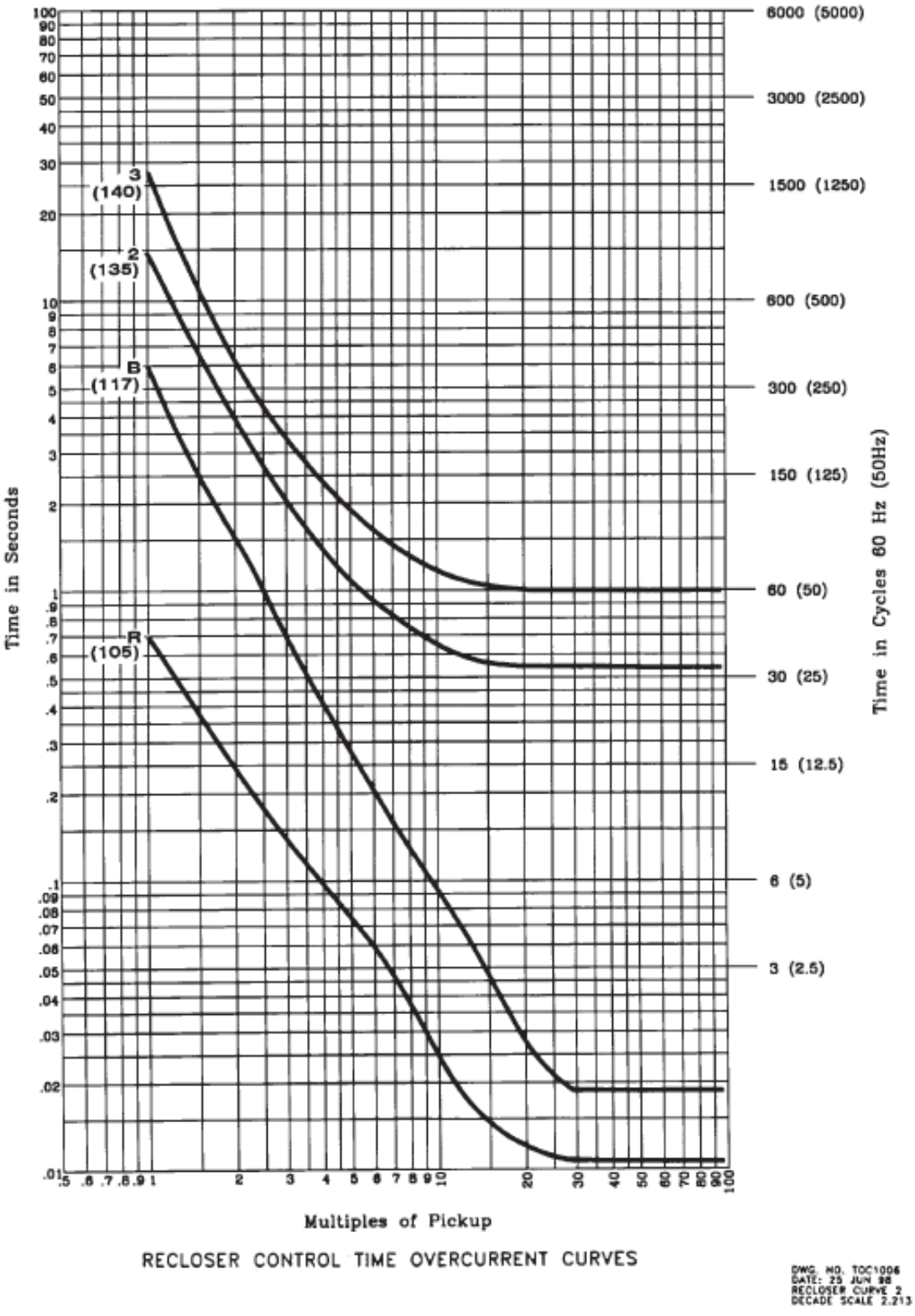
U.S. Extremely Inverse Curve: U4



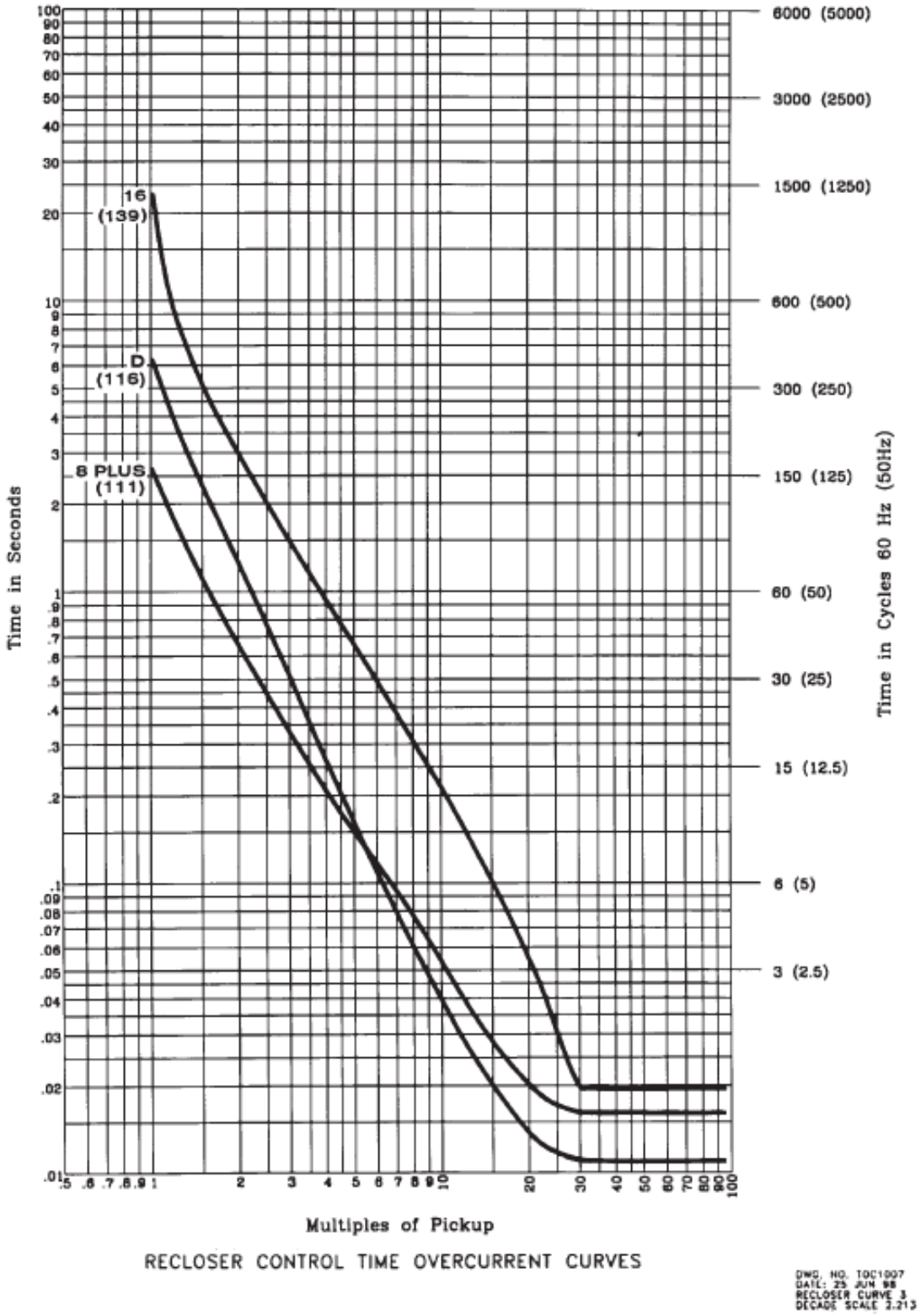
U.S. Short-Time Inverse Curve: U5



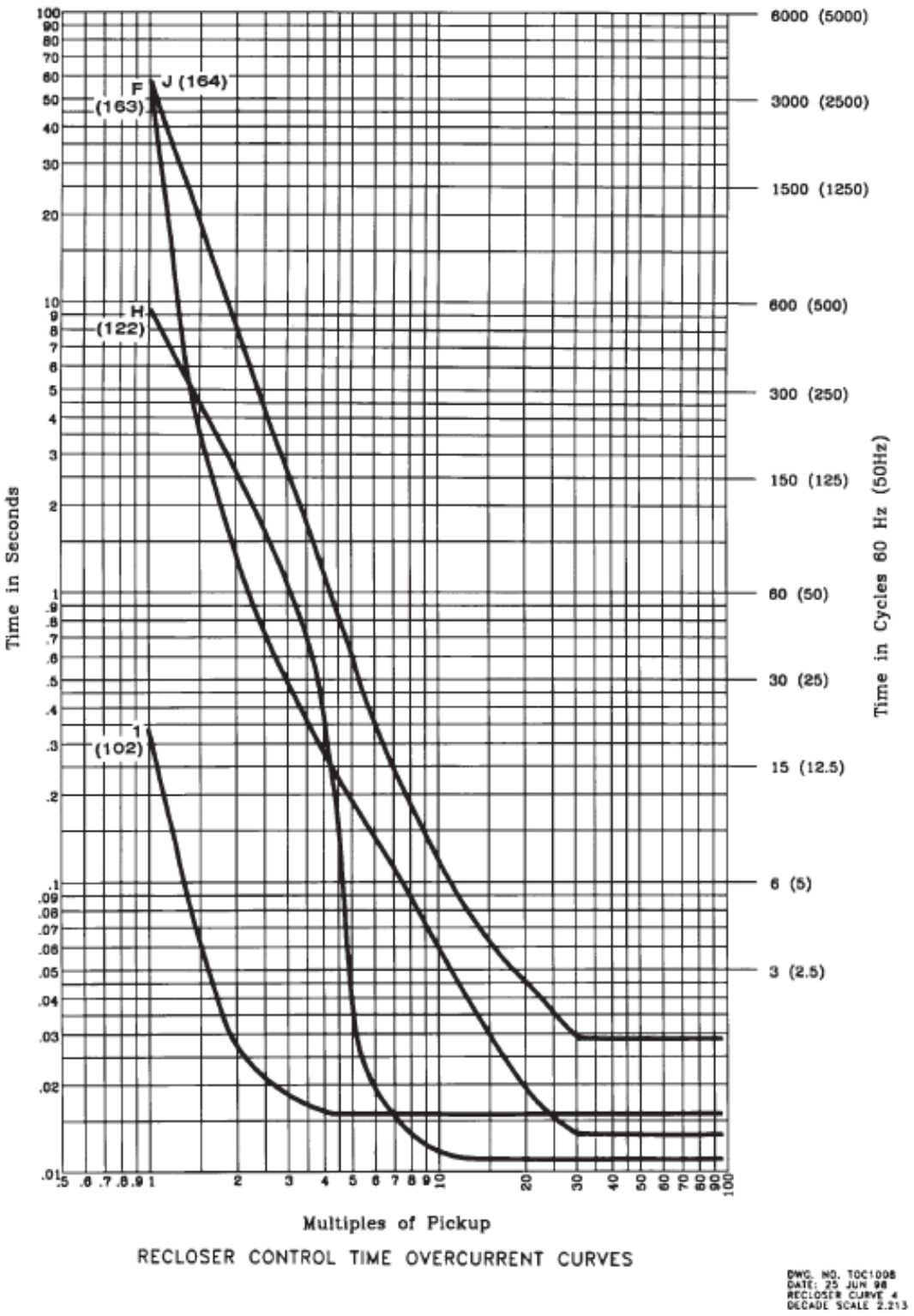
Recloser Control Response Curves A, C, N, and W



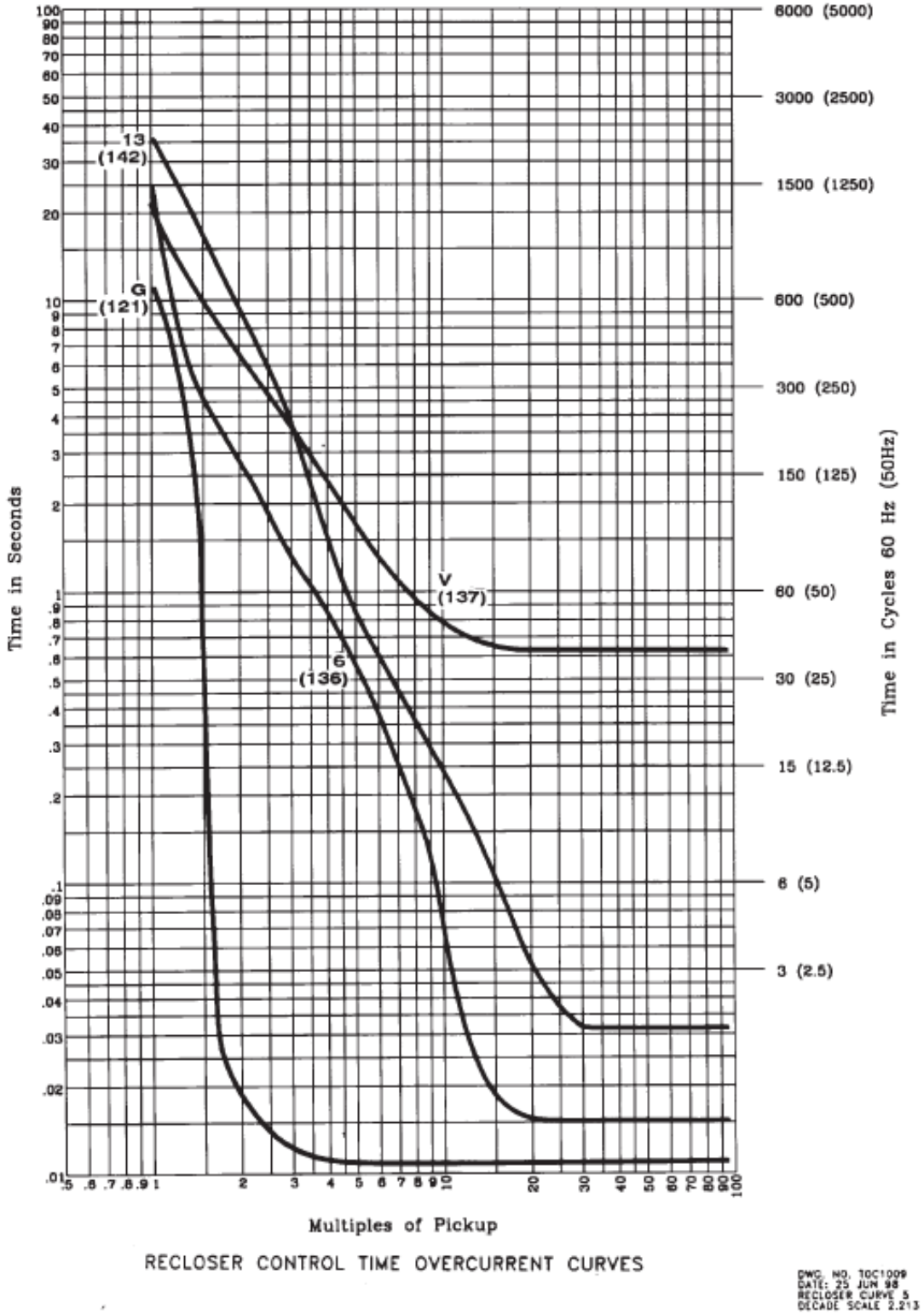
Recloser Control Response Curves B, R, 2, and 3



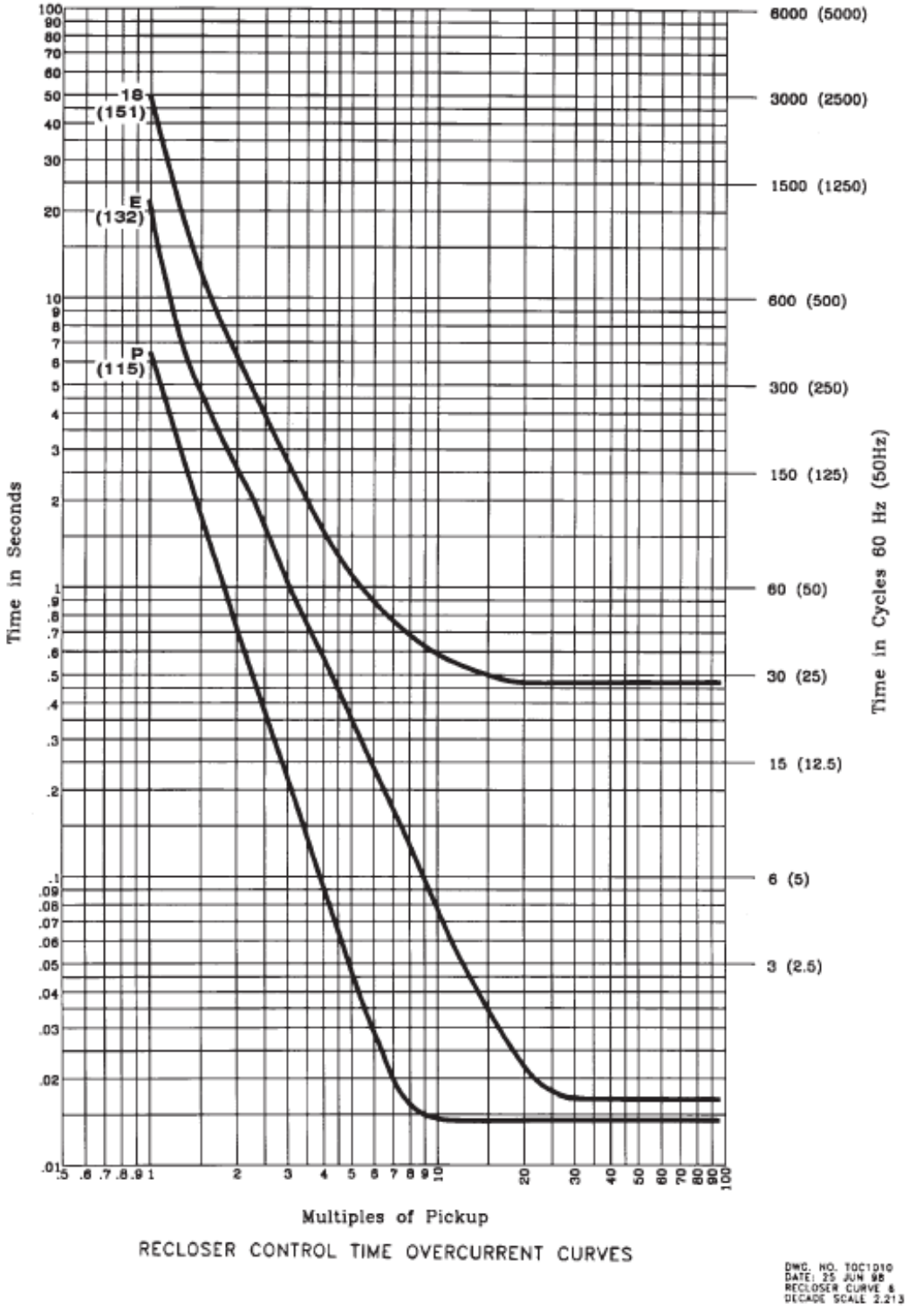
Recloser Control Response Curves D, 8PLUS, and 16



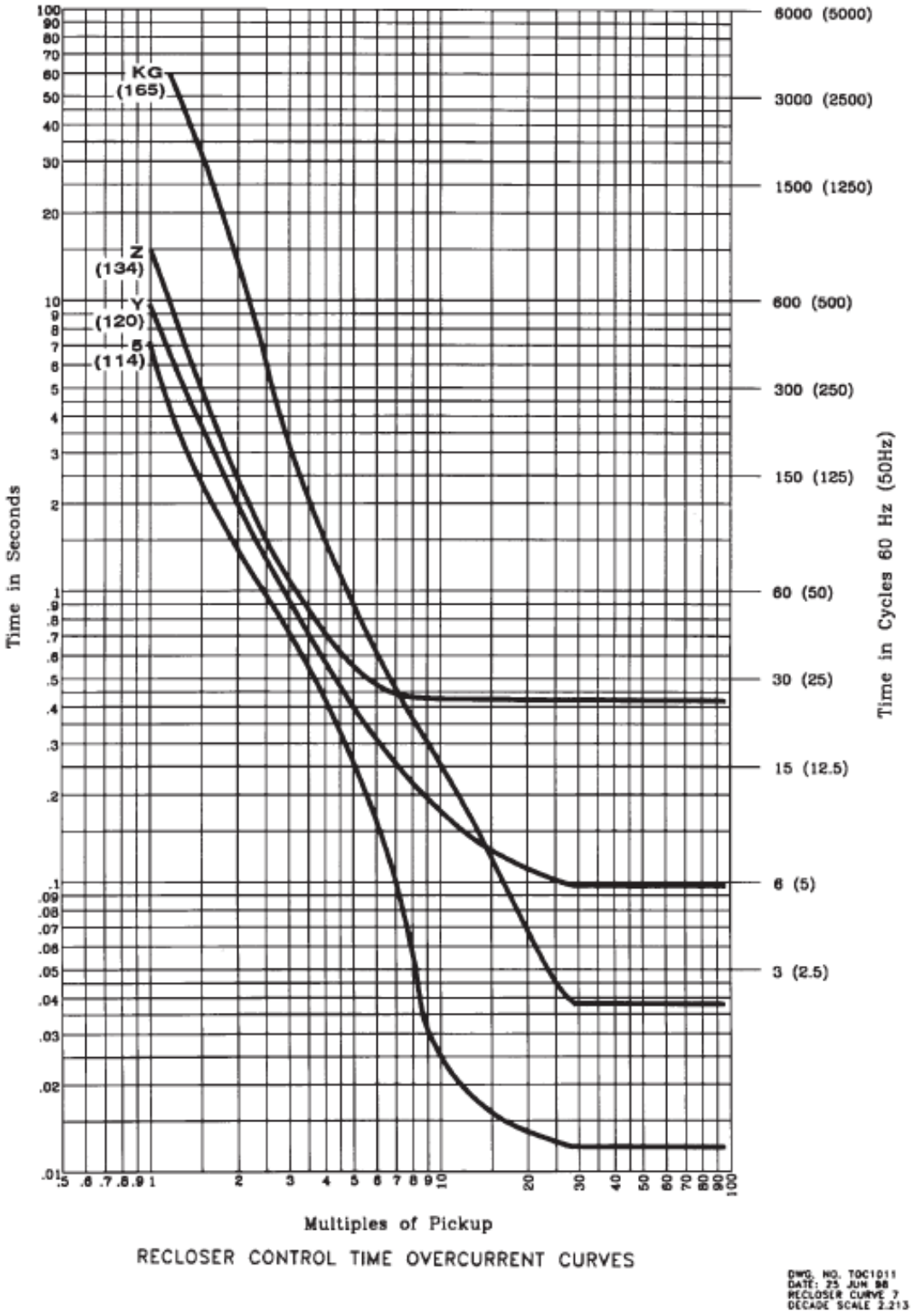
Recloser Control Response Curves F, H, J, and 1



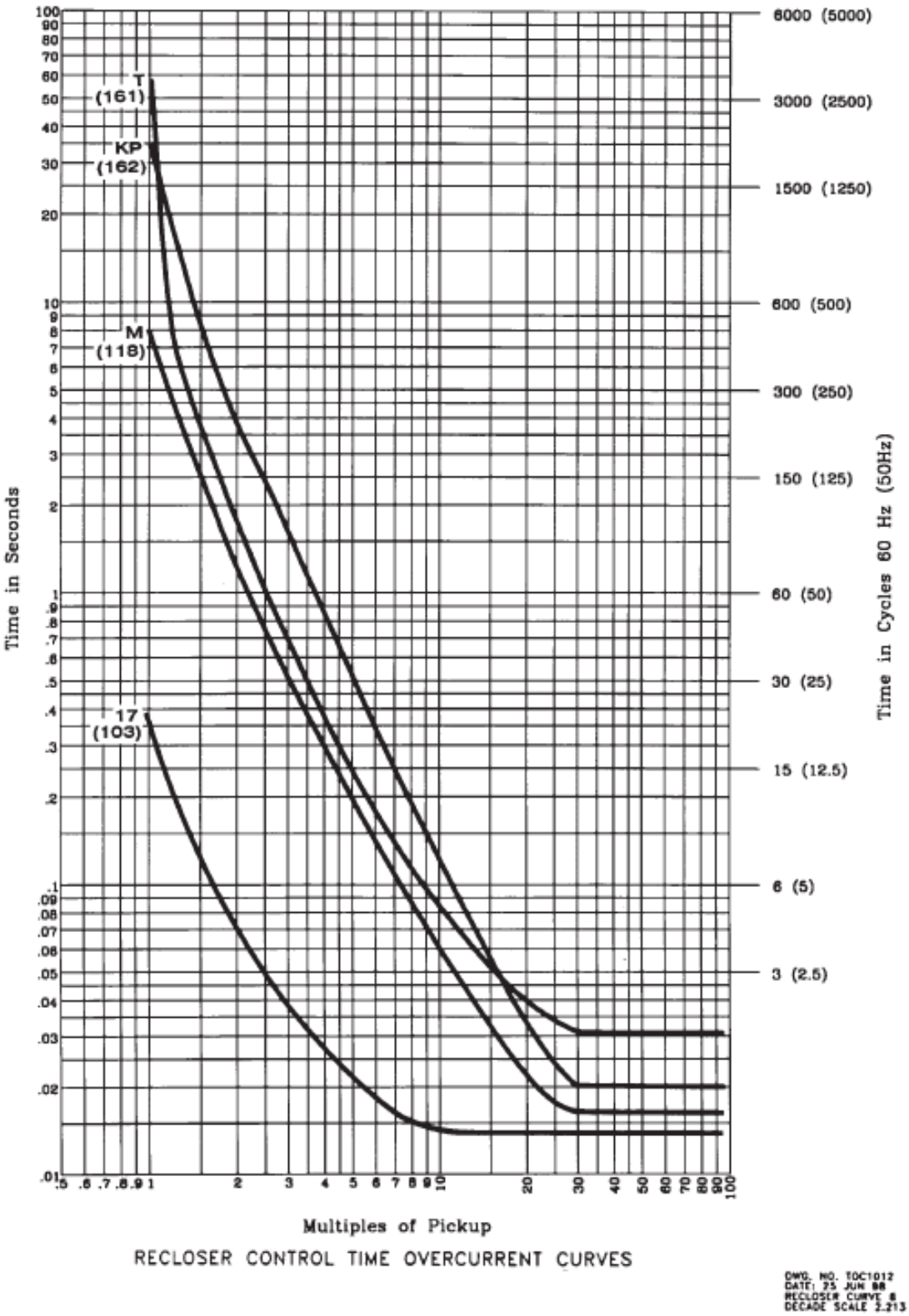
Recloser Control Response Curves G, V, 6, and 13



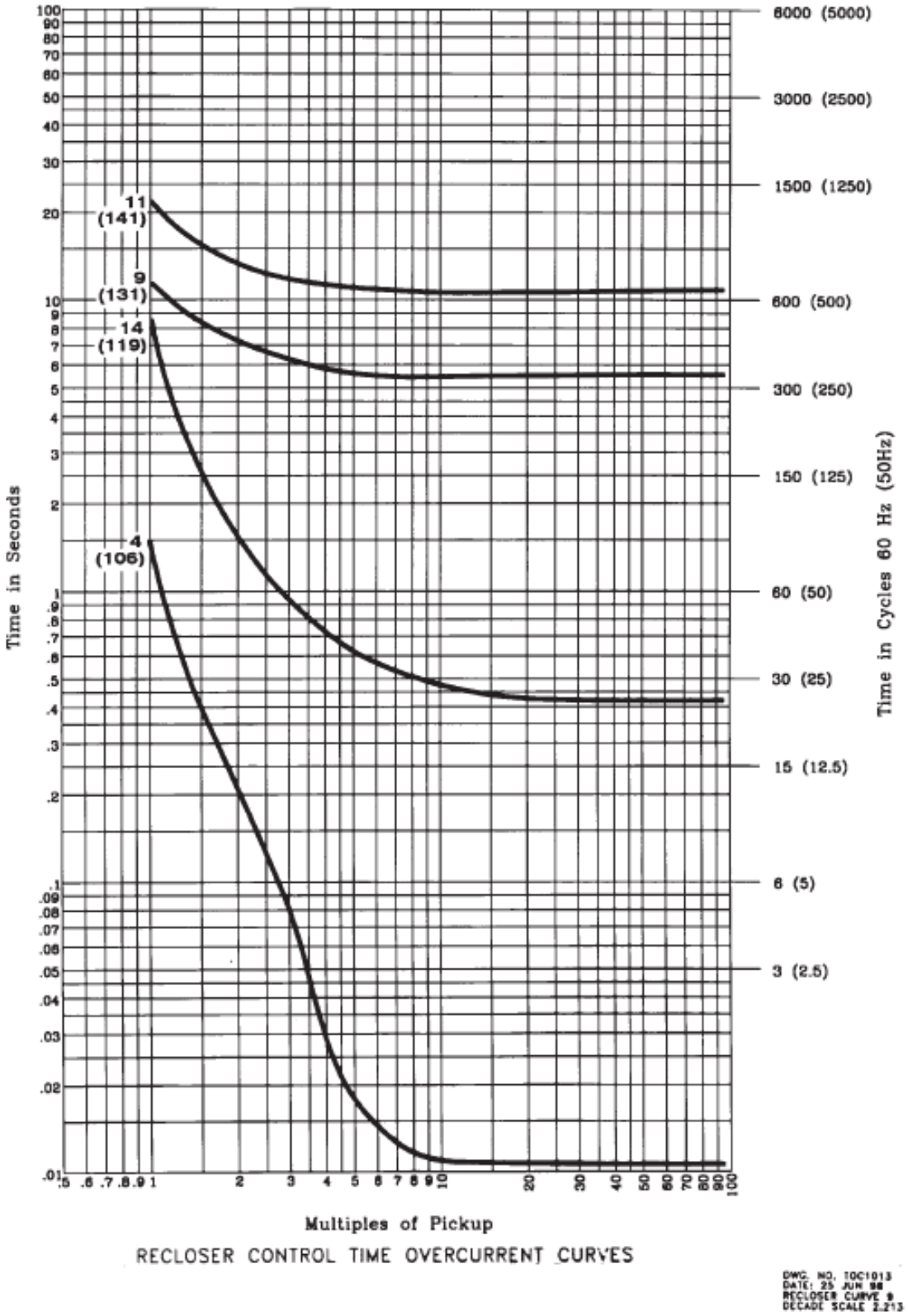
Recloser Control Response Curves E, P, and 18



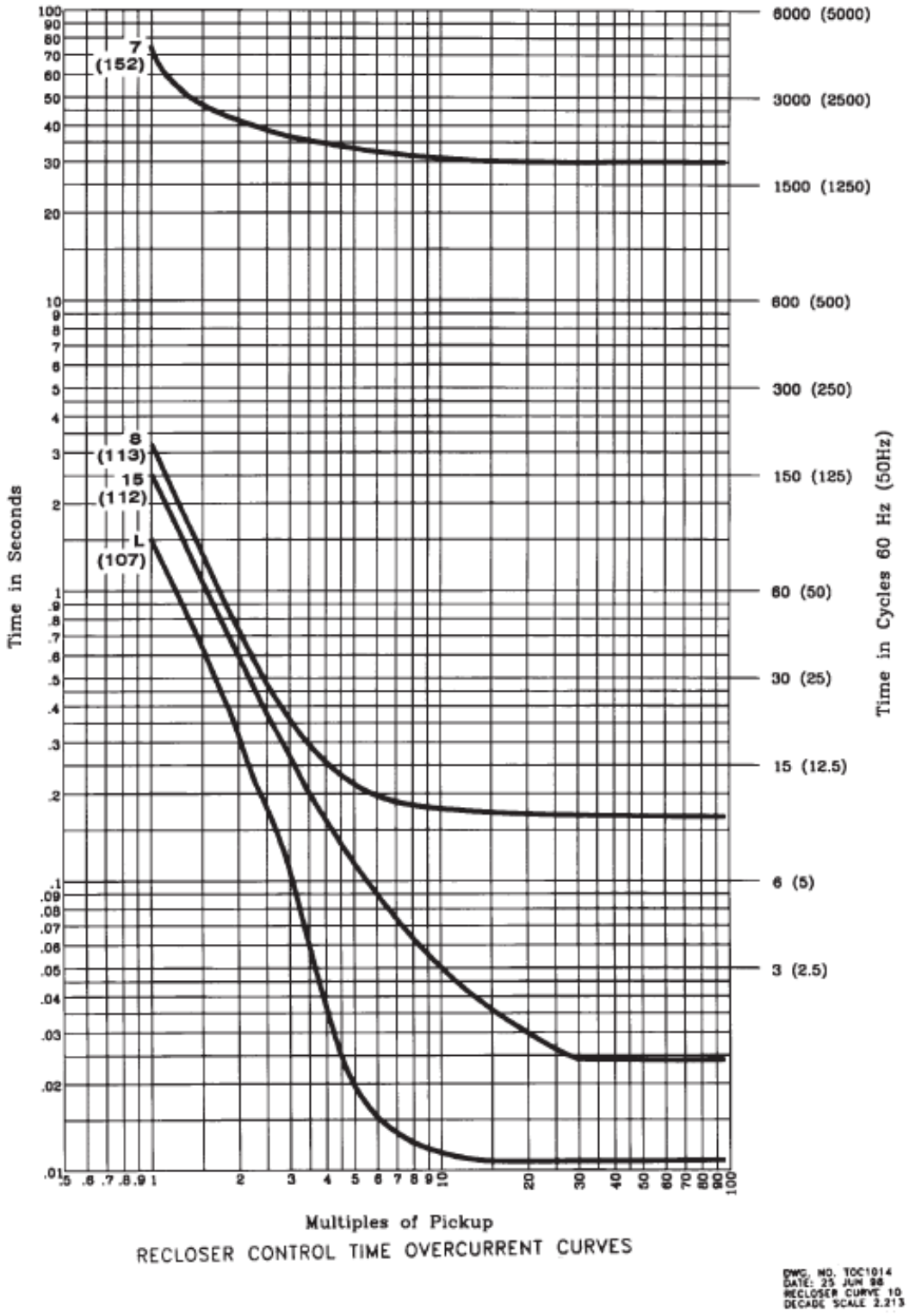
Recloser Control Response Curves KG, Y, Z, and 5



Recloser Control Response Curves KP, M, T, and 17



Recloser Control Response Curves 4, 9, 11, and 14



Recloser Control Response Curves L, 7, 8, and 15

3.3 Constant Value Parameters

All values are given primary side.

79 Auto - Reclose (Reclose)

Description		Setting range	Step length
Reclose	Reclose count	1:One 2:Two 3:Three 4:Four	
	Delay time (1st, 2nd, 3rd & 4th)	0 ~ 60S	0.01S
	Cycle Reset time	1.0 ~ 180S	0.1S
	Lock Reset time	1.0 ~ 180S	0.1S
	Sequence Coord	0 ~ 1	1
	OPLKPH	1 ~ 5	1
	OPLKGR	1 ~ 5	1
	OPLKSF	1 ~ 5	1
	OPLKI2	1 ~ 5	1

50P/51P Phase Fault (P.OC/P.Fast curve/P.Delay curve)

Description		Setting range	Step length
P.OC1	Pickup current	1 ~ 6000A	1A
	Delay time	0 ~ 9.99S	0.01S
	Activate shot	1 ~ 5	1
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	
P.OC2	Pickup current	1 ~ 6000A	1A
	Delay time	0 ~ 9.99S	0.01S
	Activate shot	1 ~ 5	1
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	
P.OC3	Pickup current	1 ~ 6000A	1A
	Delay time	0 ~ 9.99S	0.01S
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	
P.Fast curve	Curve type	1 ~ 16	1
	Pickup current	1 ~ 6000A	1A
	Time dial	0 ~ 99.99S	0.01S
	Time adder	0 ~ 99.99S	0.01S
	Minimum response	0 ~ 99.99S	0.01S

	Enable end shot	1 ~ 5	1
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	
P.Delay curve	Curve type	1 ~ 16	1
	Pickup current	1 ~ 6000A	1A
	Time dial	0 ~ 99.99S	0.01S
	Time adder	0 ~ 99.99S	0.01S
	Minimum response	0 ~ 99.99S	0.01S
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	

50G/51G Earth Fault/Sensitive Earth Fault (G.OC/SEF)

Description		Setting range	Step length
G.OC1	Operating mode	1: Trip 2: Alarm	
	Pickup current	1 ~ 6000A	1A
	Delay time	0 ~ 9.99S	0.01S
	Activate shot	1 ~ 5	1
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	
G.OC2	Operating mode	1: Trip 2: Alarm	
	Pickup current	1 ~ 6000A	1A
	Delay time	0 ~ 9.99S	0.01S
	Activate shot	1 ~ 5	1
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	
G.OC3	Operating mode	1: Trip 2: Alarm	
	Pickup current	1 ~ 6000A	1A
	Delay time	0 ~ 9.99S	0.01S
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	
G.Fast curve	Curve type	1 ~ 10	1
	Pickup current	1 ~ 6000A	1A
	Time dial	0 ~ 99.99S	0.01S
	Time adder	0 ~ 99.99S	0.01S

	Minimum response	0 ~ 99.99S	0.01S
	Enable end shot	1 ~ 5	1
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	
G.Delay curve	Curve type	1 ~ 10	1
	Pickup current	1 ~ 6000A	1A
	Time dial	0 ~ 99.99S	0.01S
	Time adder	0 ~ 99.99S	0.01S
	Minimum response	0 ~ 99.99S	0.01S
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	
SEF	Operating mode	1: Trip 2: Alarm	
	Pickup current	1 ~ 80A	1A
	Delay time	0 ~ 9.99S	0.01S
	Harmonic inhibit	0: Disable 1: Enable	
	Harmonic ratio	1 ~ 20%	0.1%
	Direction mode	1-None: No direction overcurrent 2-Forward: Forward direction component block 3-Reverse: Reverse direction component block	

Hotline P.OC

Description		Setting range	Step length
Hotline P.OC	Pickup current	1 ~ 6000A	1A
	Delay time	0 ~ 9.99S	0.01S

Hotline G.OC

Description		Setting range	Step length
Hotline G.OC	Pickup current	1 ~ 6000A	1A
	Delay time	0 ~ 9.99S	0.01S

51c Cold Load Pickup (Cold load)

Description		Setting range	Step length
Cold load	Pickup-Phase	1 ~ 6000A	1A
	Pickup-Ground	1 ~ 6000A	1A
	Loss-load time	0.1 ~ 99.99S	0.01S
	Restore time	0.1 ~ 99.99S	0.01S

Inrush

Description		Setting range	Step length	
Inrush	Inhibit mode	1: Single 2: Cross		
	Inhibit ratio	1 ~ 20%	0.1%	
	Control word	0000 ~ FFFF	P.OC1	On/Off
			P.OC2	On/Off
			P.OC3	On/Off
			P.Fast	On/Off
			P.Delay	On/Off
			G.OC1	On/Off
			G.OC2	On/Off
			G.OC3	On/Off
			G.Fast	On/Off
			G.Delay	On/Off
			SEF	On/Off
			HL P.OC	On/Off
			HL G.OC	On/Off

TRSOTF Switch-Onto-Fault (SOTF)

Description		Setting range	Step length
SOTF	Exit time	0.1 ~ 9.99S	0.01S
	Pickup current	1 ~ 6000A	1A
	Delay time	0 ~ 9.99S	0.01S

Synchronism

Description		Setting range	Step length
Synchronism	Phase	1 ~ 3	1
	Max angle	0.1 ~ 60°	0.1°
	Slip frequency	0.01 ~ 1 Hz	0.01 Hz
	Close time	0 ~ 9.999 S	0.001 S
	Max time	0 ~ 60 S	0.1 S

81 Frequency Protection (Frequency)

Description		Setting range	Step length
Frequency	Low frequency	40 ~ 60Hz	0.1Hz
	High frequency	50 ~ 65Hz	0.1Hz
	Delay time	0.2 ~ 20S	0.1S
	Slip lock	0: Disable 1: Enable	
	Slip value	0.3 ~ 40	0.1
	Low volt. lock	0: Disable 1: Enable	

	Low volt. value	1～42KV	0.1KV

67 Negative- Sequence Overcurrent (Nega.seq.OC)

Description		Setting range	Step length
Nega.seq.OC1	Operating mode	0: Disable 1: Trip	
	Pickup current	1～6000A	1A
	Delay time	0～99.99S	0.01S
Nega.seq.OC2	Operating mode	0: Disable 1: Trip 2: Alarm	
	Pickup current	1～6000A	1A
	Delay time	0～99.99S	0.01S

Direct.Power

Description		Setting range	Step length
Direct.Power	Operating mode	1: Trip 2: Alarm	
	Pickup power	1～60000KW	1KW
	Delay time	0～60000S	1S
	Direction mode	1-None 2-Forward 3-Reverse	

27 Under Voltage (L.Under volt)

Description		Setting range	Step length
L.Under volt1	Operating mode	0: Alarm 1: No Voltage +Low Voltage protection 2: Via current locking low Voltage protection 3: Pure low-Voltage protection	
	Pickup Voltage	1～42KV	0.1KV
	Delay time	0～99.99S	0.01S
L.Under volt2	Operating mode	0: Alarm 1: No Voltage +Low Voltage protection 2: Via current locking low Voltage protection 3: Pure low-Voltage protection	
	Pickup Voltage	1～42KV	0.1KV
	Delay time	0～99.99S	0.01S

59 Over Voltage (L.Over volt)

Description		Setting range	Step length
L.Over volt1	Operating mode	0: Disable 1: Trip 2: Alarm	
	Pickup Voltage	1～42KV	0.1KV
	Delay time	0～99.99S	0.01S
L.Over volt2	Operating mode	0: Disable 1: Trip 2: Alarm	
	Pickup Voltage	1～42KV	0.1KV
	Delay time	0～99.99S	0.01S

Voltage Unbalance (Vol. Unbalance)

Description		Setting range	Step length
Vol. Unbalance	Operating mode	0: Disable 1: Trip 2: Alarm	
	Pickup Voltage	1～42KV	0.1KV
	Delay time	0～99.99S	0.01S

Loss Of Phase

Description		Setting range	Step length
Loss Of Phase	Operating mode	0: Disable 1: Trip 2: Alarm	
	Delay time	0～99.99S	0.01S
	Pickup Voltage	1～42KV	0.1KV
	Block mode	0-None 1-Lockout: Lock Voltage components 2-Unlock: Unlock Voltage components	

59N Zero-Sequence Over Voltage (N.Overt volt)

Description		Setting range	Step length
N.Overt volt	Operating mode	0: Disable 1: Trip 2: Alarm	
	Pickup Voltage	1～42KV	0.1KV
	Delay time	0～99.99S	0.01S

Heavy gas protection (Hi.Gas)

Description		Setting range	Step length
Hi.Gas	Operating mode	0: Disable 1: Trip 2: Alarm	
	Delay time	0 ~ 99.99S	0.01S

High temperature protection (Hi.Temp)

Description		Setting range	Step length
Hi.Temp	Operating mode	0: Disable 1: Trip 2: Alarm	
	Delay time	0 ~ 99.99S	0.01S

Common value

Description		Setting range	Step length
Common value	I start angle	0 ~ 360°	1°
	I end angle	0 ~ 360°	1°
	I0 start angle	0 ~ 360°	1°
	I0 end angle	0 ~ 360°	1°
	Low Voltage	1 ~ 42KV	0.1KV
	High Voltage	1 ~ 42KV	0.1KV
	Lockout current	1 ~ 6000A	1A
	Live load block	0: Disable 1: Enable	

3.4 Data Storage

Data records are backed up in non-volatile memory and are permanently stored even in the event of loss of auxiliary supply Voltage. Data storage includes functions of energy, demand, trip count, wear, outage and event records. These records can be reset clear.

Energy

This includes total active energy+, total active energy -, total reactive energy+, total reactive energy -, active energy+ per phase, active energy- per phase, reactive energy+ per phase, and reactive energy- per phase.

History Energy

There are 6000 historical energy records, each of which contains total active energy+, total active energy -, total reactive energy+, total reactive energy -, active energy+ per phase, active energy- per phase, reactive energy+ per phase, and reactive energy- per phase.

How often it is recorded is controlled according to the **Max-Demand range** in the **Parameter set.**

Max-Demand range=1: Collect once every 15 minutes.

Max-Demand range=2: Collect once every 30 minutes.

Max-Demand range=3: Collect once every 60 minutes.

Demand

The maximum demand is the average value of power. The value of large interval energy minus small interval energy is divided by time. The maximum demand is also controlled according to the **Max-Demand type** and **Max-Demand range** in the **Parameter set. Max-Demand type** can be set to 1-FIXED or 2-ROLLING. When set to FIXED the demand statistics are calculated over fixed Window duration. At the end of each window the internal statistics are reset and a new window is started. When set to ROLLING the maximum, minimum and mean values demand statistics are calculated over a moving Window duration. The internal statistics are updated when the window advances every Updated Period.

Month Max Demand

The maximum demand of each month can be recorded here, and 240 months in total can be recorded.

Counters

Total Trip Count (ALL): Increments on each trip command issued.
Phase Overcurrent Trip Count (OC): Increments on phase overcurrent trip command issued.
Earth Fault Trip Count (EF): Increments on earth fault trip command issued.
Sensitive Earth Fault Trip Count (SEF): Increments on sensitive earth fault trip command issued.
Current Unbalance Trip Count (CU): Increments on current unbalance trip command issued.

Phase Over Voltage Trip Count (OV): Increments on phase over Voltage trip command issued.
Phase Under Voltage Trip Count (UV): Increments on phase under Voltage trip command issued.
Voltage Unbalance Trip Count (VU): Increments on Voltage unbalance trip command issued.
Zero Sequence Over Voltage Trip Count (OV0): Increments on zero sequence over Voltage trip command issued.
Over Frequency Trip Count (OF): Increments on over frequency trip command issued.
Under Frequency Trip Count (UF): Increments on under frequency trip command issued.
Electric Trip Count (Elec.): Increments on electric trip command issued.
Manual Trip Count (Manu.): Increments on manual trip command issued.
Remote Trip Count (Remote): Increments on remote trip command issued.
Other Trip Count (Oth): Increments on other trip command issued.

Wear

An I2t counter is also included and this can provide an estimation of contact wear and maintenance requirements. The algorithm works on a per phase basis, measuring the arcing current during faults. The I2t value at the time of trip is added to the previously stored value. The t value is the time between circuit breaker contacts separation when an arc is formed. Mechanical wear is the total number of trips divided by **CO Limit**.

Outage

Auto recloser and Control element shall have the facilities to record the cumulative number and duration of outages. The information shall be assessable locally or remotely using a SCADA system. The following parameters shall be recorded:

· Cumulative total number of outages;

· Cumulative total outage duration;

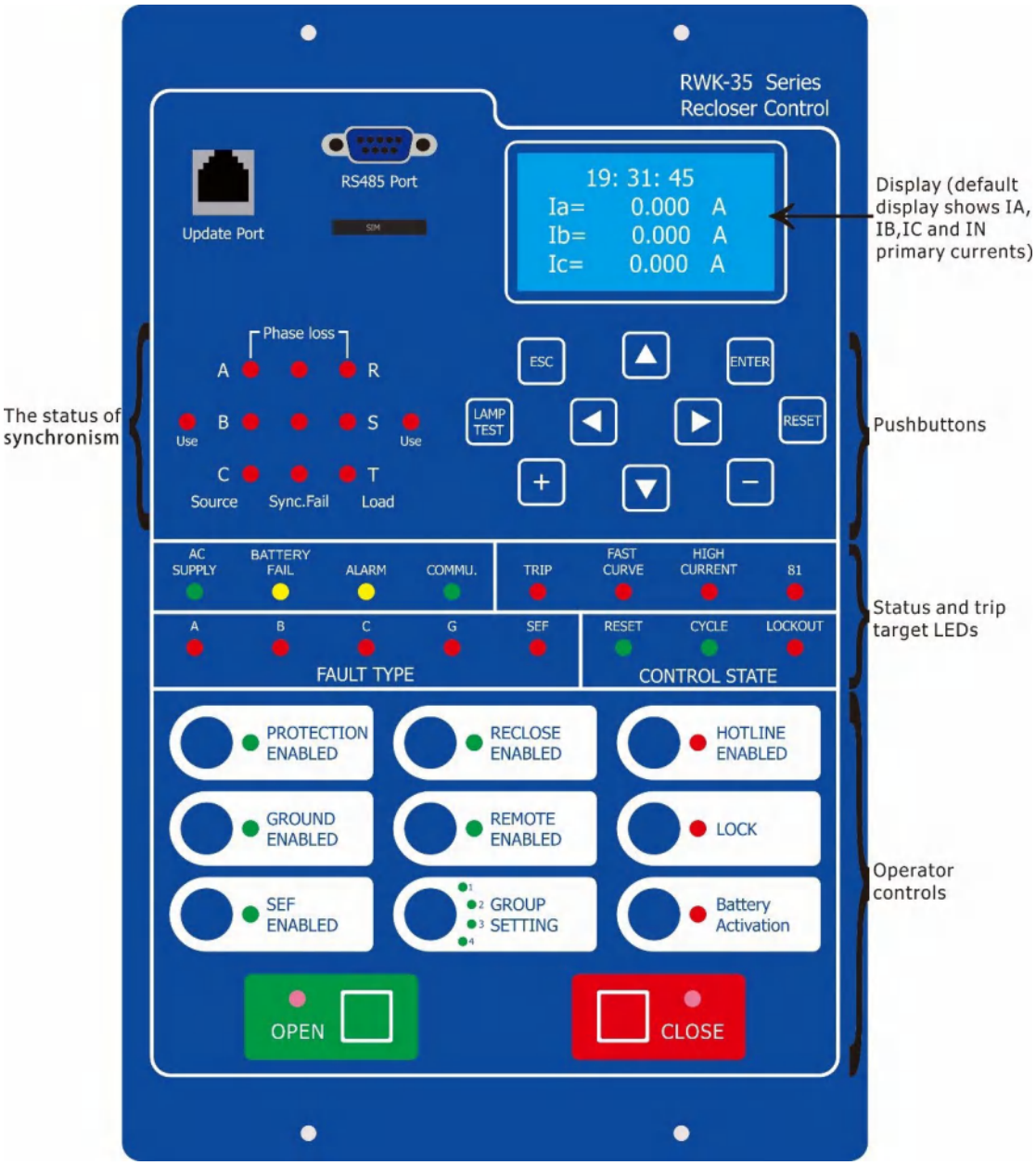
· Time and duration of each outage in the form of an event log.

Event Records

Event records include tripping records, alarm records and SOE records. The event recorder feature allows the time tagging of any change of state (Event) in the relay. As an event occurs, the actual event condition is logged as a record along with a time and date stamp to a resolution of 1ms. There is capacity for a maximum of 6400 event records (3000 trip records, 400 alarm records and 3000 SOE records) that can be stored in the relay and when the event buffer is full any new record will over-write the oldest. The following events are logged:

• Change of state of Binary outputs
• Change of state of Binary inputs
• Protection element operation

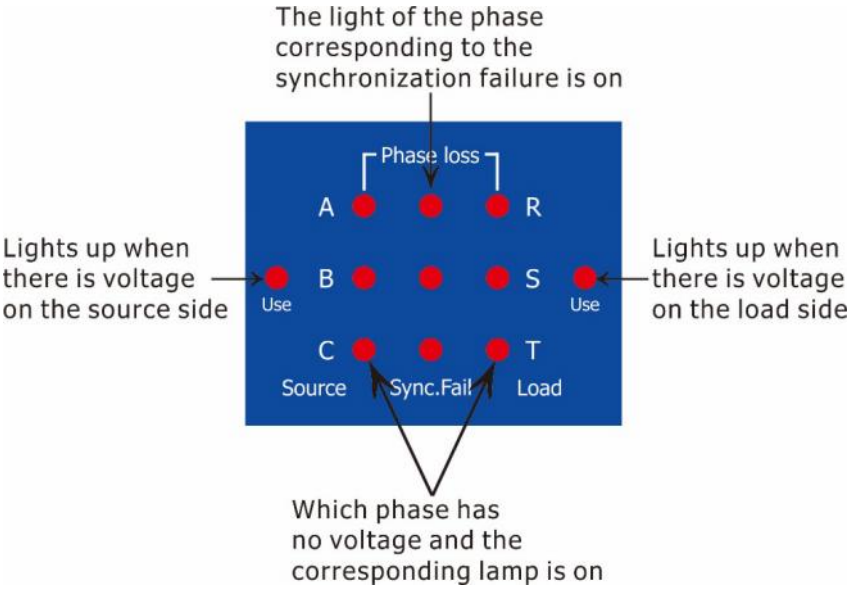
Chapter 4: User Interface

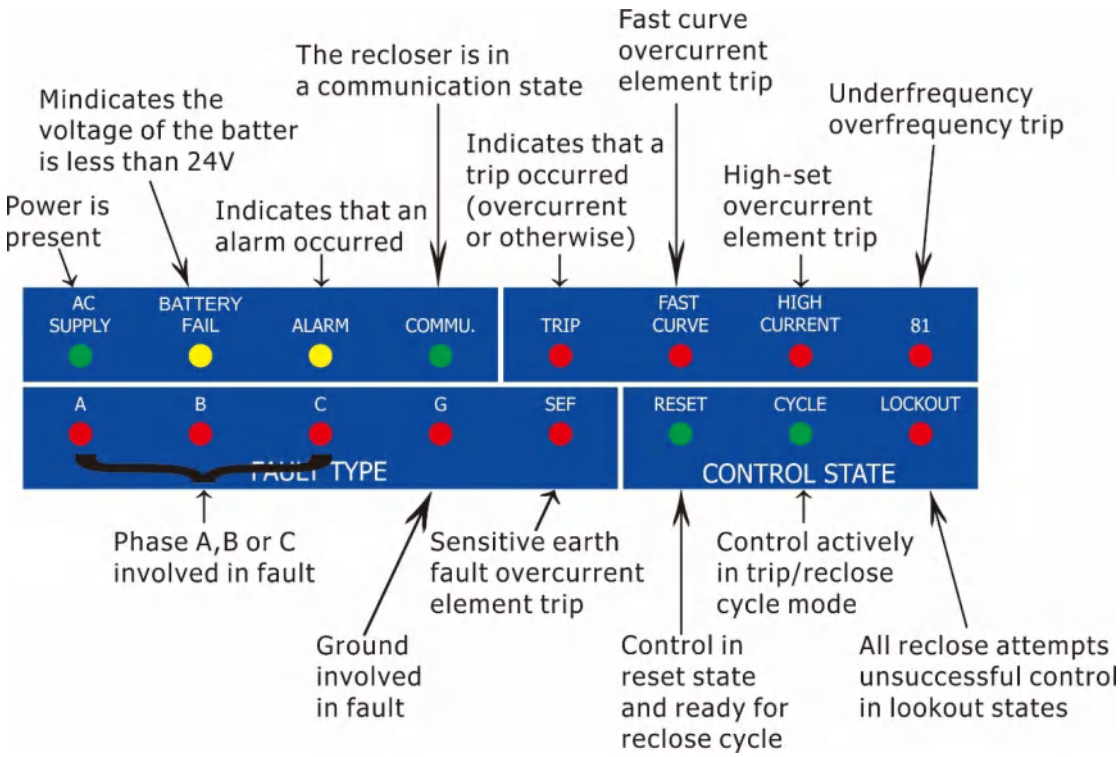


The operator interface is designed to provide a user friendly method of controlling, viewing menus, entering settings and retrieving data from the relay. Eight buttons are provided for navigation around the menu structure.

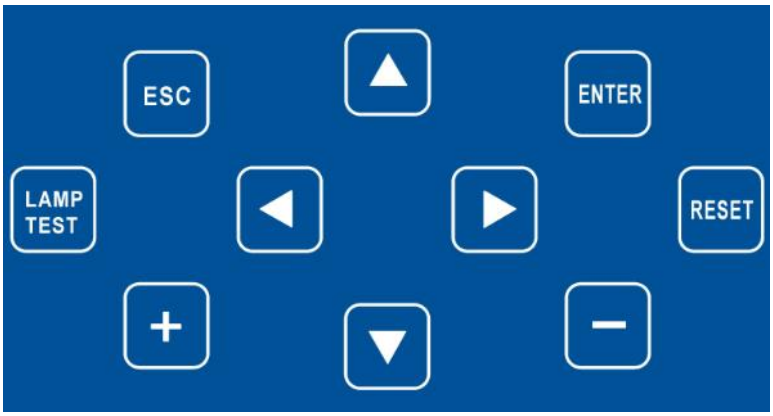
4.1 Status and Trip Target LEDs

Most of the status and Trip Target LEDs and Operator Controls can change function (if desired by the user) by programming at a higher logic level. This subsection discusses each function as shipped from the factory and inscribed on the front panel.





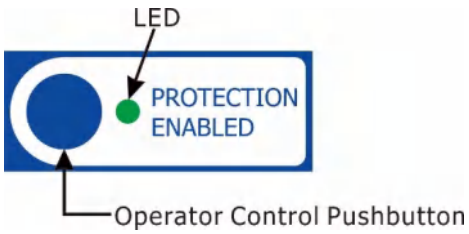
4.2 Pushbuttons

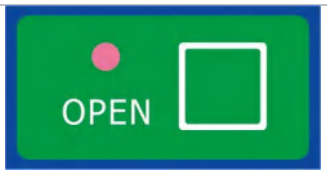


Button	Function
LAMP TEST	Illuminate all front-panel LEDs for 1 second.
RESET	Clear trip-latched targets TRIP, FAST CURVE, HIGH CURRENT, 81, A, B, C, G, and SEF.
ENTER	Select displayed option or setting.
ESC	Cancel command edit or escape to upper command level.
▲	Scroll up on display.
▼	Scroll down on display.
◀	Scroll left on display.
▶	Scroll right on display.
+	increment value.
−	decrement value.

4.3 Operator Controls

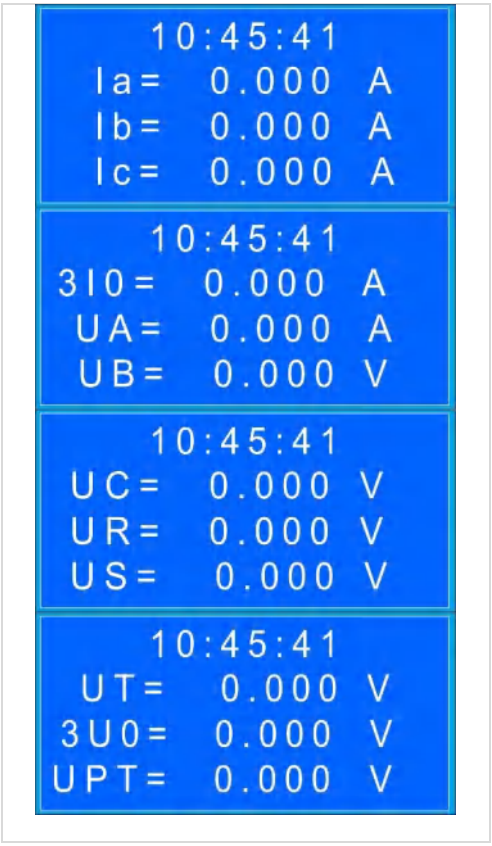
All the following operator control pushbuttons should be pressed momentarily to execute their function.

Press the **PROTECTION ENABLED** to enable/disable the protection tripping. Corresponding LED illuminates to indicate the enabled state.	
Press the **GROUND ENABLED** to enable/disable the ground overcurrent and sensitive earth fault (SEF) element tripping. Corresponding LED illuminates to indicate the enabled state.	
Press the **SEF ENABLED** to enable/disable sensitive earth fault (SEF) element tripping. Corresponding LED illuminates to indicate the enabled state.	
Press the **RECLOSE ENABLED** to enable/disable auto reclosing. Corresponding LED illuminates to indicate the enabled state.	
Press the **REMOTE ENABLED** to enable/disable remote control. Corresponding LED illuminates to indicate the enabled state.	
Press the **GROUP SETTING** to switch setting group. There are four groups in the set value group. Each time you press, add one to the group, and the corresponding light will be on.	
Press the **HOTLINE ENABLED** to enable/disable hotline. Corresponding LED illuminates to indicate the enabled state. **NOTE**: When the reclose is in a status of hotline, the **CLOSE** pushbutton is invalid.	
Press the **LOCK** operator control pushbutton to enable/disable the lock function. Corresponding LED illuminates to indicate the reclose is locked. While the lock function is engaged, the following operator controls are "locked in position": **PROTECTION ENABLED** **GROUND ENABLED** **SEF ENABLED** **RECLOSE ENABLED** **REMOTE ENABLED** **GROUP SETTING** **HOTLINE ENABLED** **CLOSE** While "locked in position," these operator controls cannot change state if pressed—their corresponding LEDs remain in the same state. When the lock function is engaged, the CLOSE operator control can't close the recloser, but the TRIP operator control can still trip the recloser.	

Press the **Battery Activation** to activate the battery activation function. The corresponding LED lights up to indicate that the battery is active.	
Press the **CLOSE** operator control pushbutton to close the recloser. Corresponding LED illuminates to indicate the reclose is closed. The CLOSE operator control pushbutton does not have to be continually pressed to allow for cold load pickup (i.e., disable fast curves, and desensitize delay curves and SEF element). There is automatic allowance for cold load pickup. See the Cold Load Pickup settings in Chapter 3.1: Function Description.	
Press the **Trip** operator control pushbutton to trip the recloser (and take the control to the lockout state). Corresponding LED illuminates to indicate the reclose is Open.	

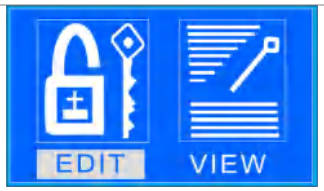
4.4 Default Display

The LCD default display shows IA, IB, IC, 3I0, UA, UB, UC, UR, US, UT, 3U0, UPT.
Note: The light of the LCD will turn off after five minutes, if you do not operate the recloser.



4.5 The Main Menu

Press "Enter" when on the main screen, as shown below, including "EDIT" and "VIEW" menu item. Select the corresponding menu item with the [←] key, [→] and press "ENTER" button to enter the corresponding sub-menu, press the "ESC" key to return to the previous screen.

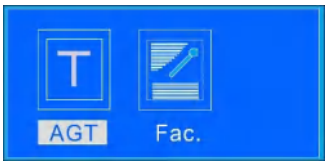


Primacy Menu

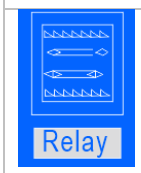
4.6 Submenu

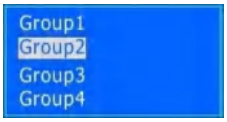
Edit submenu

Choose the edit options, the screen will enter the submenu of the Edit menu, as shown below, the submenu includes "Relay"、"Para"、"Port"、 "Clr"、 "Time"、 "Chnl"、 "AGT" 、"Fac"".



Submenu of edit





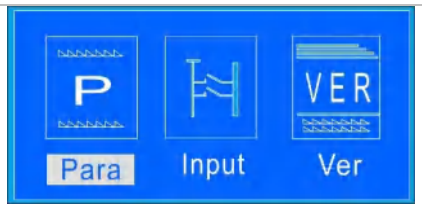
Enter "Relay" submenu, you can select the corresponding group to enter and view each protection feature and set up the parameters.

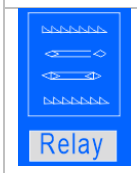
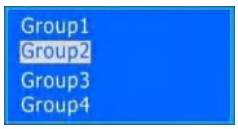
Enter "Para" submenu, you can modify or view other parameters. Like CT rate, PT rate, PTS rate, Source PT, Operator password, CO limit, Wear Limit-MA^2s, Wear Clearance, Max-Demand type, Max-Deman range, Telesignal time, Close pulse time, Trip pulse time, Action interval, Close input type, Enable Mech-Lock, Mech-Lock time.

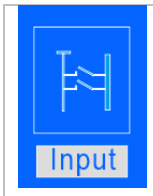
	Enter "Port" submenu, you can modify or view communication channel and parameters.
	Enter "Clr" submenu, you can clear out the events, energy, demand, counters, wear, outage， reset IP.
	Enter the "Time" submenu will modify or check the time.
	Enter "Chnl" submenu, current and Voltage values can be corrected. **Note: Please do not modify this by yourself. Please contact the manufacturer if necessary.**
	Automatic switchover can be set in the group, which can be switched to summer workday group, summer rest day group, winter workday group and winter rest day group. You can also set the start and end time of summer and the start and end time of rest days. Automatic group switching is based on time.
	Enter "Fac." Sub-menu, modify and view the factory settings. **Note: Please do not modify this by yourself. Please contact the manufacturer if necessary.**

View submenu

Choose the view options, the screen will enter the submenu of the View menu, as shown below, the sub-menu includes "Pmete", "Smete", "RPT", "Relay", "Para", "Stat"、"Input", "Ver".



View submenu	
	Enter "Mea." submenu, you can view the primary side measurement data include: phase current, ground current, PT Voltage, phase Voltage, zero sequence Voltage; the secondary side of the measured data include: phase current, ground current, PT Voltage, phase Voltage, line Voltage, zero sequence Voltage, negative-sequence current, negative sequence Voltage, positive sequence Voltage; power; energy; history energy; max demand; month max demand.
	Enter "RPT" submenu, you can view the trip report, alarm report, signal report, counters, wear, outage.
 	Enter "Relay" submenu, you can select the corresponding group to enter and view each protection feature is invested and set up the parameters.
	Enter "Para" submenu, you can view his argument. Like CT rate, PT rate, PTS rate, Source PT, Operator password, CO limit, Wear Limit-MA^2s, Wear Clearance, Max-Demand type, Max-Deman range, Telesignal time, Close pulse time, Trip pulse time, Action interval, Close input type, Enable Mech-Lock, Mech-Lock time.

	Enter the "Input" submenu, you can view the input signal. The input signal includes: Power fault, Active battery, Heavy gas, High temperature, Breaker open, Breaker close, Remote open, Remote close, Door open, Lockout in, Remote enable.
	Enter "Ver" submenu, you can view the device type, version, date of manufacture and device ID.

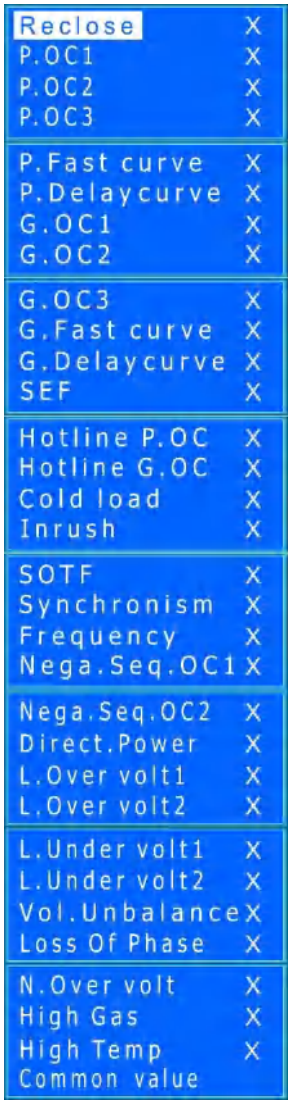
4.7 Entering the password interface

According to the above operation, before entering each item will first enter a password input interface to prevent professional staff misuse. The device original password is "0099", as shown below, press [←] and [→] keys to switch, press the [+] and [-] keys to increase and decrease the number of line with the correct password press "Enter" button to enter.

	Password interface

4.8 Relay setting

Select "Relay" in the edit submenu, press the function key "Enter" to enter, select the corresponding group, press the function key "Enter" to enter the "Relay" submenu, as shown below, each item has a check box and set a value.



1、Reclose: Auto reclosing

2、P.OC1: Instantaneous overcurrent protection

3、P.OC2: Definite time overcurrent protection

4、P.OC3: Overcurrent protection

5、P.Fast curve: Time-Overcurrent fast curves

6、P.Delay curve: Time-Overcurrent delay curves

7、G.OC1: Instantaneous ground overcurrent protection

8、G.OC2: Definite time ground overcurrent protection

9、G.OC3: Ground overcurrent protection

10、G.Fast curve: Ground Time-Overcurrent fast curves

11、G.Delay curve: Ground Time-Overcurrent delay curves

12、SEF: Sensitive earth fault protection

13、Hotline P.OC: Hotline phase overcurrent

14、Hotline G.OC: Hotline ground overcurrent

15、Cold load: Cold Load pickup

16、Inrush: Inrush feature

17、SOTF: Switch-Onto-Fault protection

18、Synchronism: Check synchronization function

19、Frequency: Frequency protection

20、Neag.Seq.OC1: Inter-phase negative sequence over current proteciont,1st

21、Neag.Seq.OC2: Inter-phase negative sequence over current proteciont,2nd

22、Direct.Power: Direct power protection

23、L.Over volt1: Over Voltage protection, 1st

24、L.Over volt2: Over Voltage protection, 2nd

25、L.Under volt1: Under Voltage protection, 1st

26、L.Under volt2: Under Voltage protection, 2nd

27、Vol. Unbalance: Voltage unbalance protection

28、Loss of phase protection

29、N.Over volt: Zero-sequence over Voltage protection

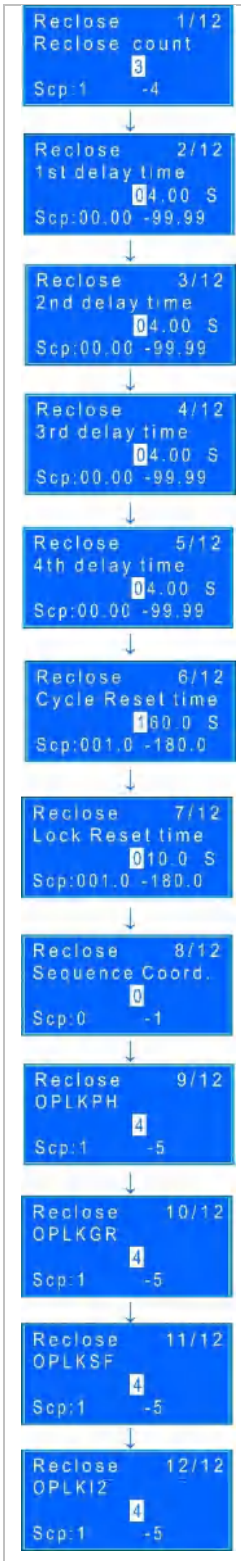
30、High Gas: Heavy gas protection

31、High Temp: High temperature protection

32、Common value: Angle used for phase and ground direction, high Voltage value, low Voltage value, lockout current, live load block.

Automatic reclosing (Reclose)

Select **reclose** in relay menu press "Enter" key to enter, operational processes as shown below:



Reclose count	The highest reclose counts in one cycle, any trip will lockout the recloser after the highest amount of reclosing.
1st delay time	The delay time to reclose after 1st trip in the cycle.
2nd delay time	The delay time to reclose after 2nd trip in the cycle.
3rd delay time	The delay time to reclose after 3rd trip in the cycle.
4th delay time	The delay time to reclose after 4th trip in the cycle.
Cycle Reset time	Reset time from reclose cycle state.
Lock Reset time	Reset time from lockout state.
Sequence Coord	Use for Cooperate with another recloser.
OPLKPH	Operations to lock-phase. For example, you set the value 4, if the phase fault trip appears in SH3 and SH4 of the reclose cycle, the recloser will lockout.
OPLKGR	Operations to lock-ground. For example, you set the value 4, if the Earth fault trip appears in SH3 and SH4 of the reclose cycle, the recloser will lockout.
OPLKSF	Operations to lock-ground. For example, you set the value 4, if the sensitive earth fault trip appears in SH3 and SH4 of the reclose cycle, the recloser will lockout.
OPLKI2	Operations to lock-Negative-Sequence Overcurrent. For example, you set the value 4, if the Negative-Sequence overcurrent trip appears in SH3 and SH4 of the reclose cycle, the recloser will lockout.

Step 1: Choose the reclosing count (1: One, 2: Two, 3: Three, 4: Four).

Step 2: Set the 1st, 2nd, 3rd or 4th delay time, the delay time can be between 0S ~ 60S.

Step 3: Set the cycle reset time, the reset time can be between 1.0S~ 180.0S.

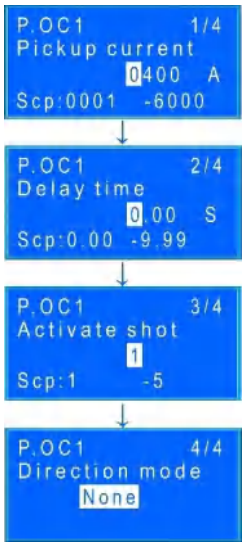
Step 4: Set the lock reset time, the reset time can be between 1.0S~ 180.0S.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode and modified delayed time/reset time.

The operational processes of automatic reclose setting

Three sections phase overcurrent

Select **P.OC** in relay menu, press "Enter" key to enter, operational processes as shown below:



Step 1: Set the overcurrent protection current value, the current value can be between 1A ~ 6000A.

Step 2: Set the overcurrent delay time, the delay time can be between 0S ~ 9.99S.

Step 3: Set the protection Activate shot (If you have selected auto reclosing to be active). P.OC3 does not have this item.

Step 4: Set the direction mode. None: overcurrent without direction; Forward: forward direction overcurrent; Reverse: reverse direction overcurrent.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to modified the value.

The operational processes of simple overcurrent protection setting

Note: There are 3 stages of overcurrent protection settings, the setting up of the other two are the same.

Earth Fault (G.OC)

Select **G.OC** in the relay menu press "Enter" key to enter, operational processes as shown below:

Step 1: Choose the operating mode (1: Earth Fault Trip, 2: Earth Fault Alarm).

Step 2: Set the G.OC protection current value, the G.OC current value can be between 1A ~ 6000A.

Step 3: Set the G.OC delay time, the delay time can be between 0S ~ 9.99S.

Step 4: Set the protection Activate shot (If you have open the reclosing). G.OC3 does not have this item.

Step 5: Set the direction mode. None: overcurrent without direction; Forward: forward direction overcurrent; Reverse: reverse direction overcurrent.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to modified value.

The operational processes of G.OC protection setting

Note: There are 3 stages of ground overcurrent protection settings, the setting up of the other two are the same.

Sensitive Earth Fault (SEF)

Select **SEF** in the relay menu press "Enter" key to enter, operational processes as shown below:

Step 1: Choose the operating mode (1: Sensitive Earth Fault Trip, 2: Sensitive Earth Fault Alarm).

Step 2: Set the SEF protection current value, the SEF current value can be between 1A ~ 80A.

Step 3: Set the SEF delay time, the delay time can be between 0S ~ 9.99S.

Step 4: Set the harmonic inhibit (0: disable, 1: enable). Sensitive Earth Fault protection with 3RD harmonics.

Step 5: Set the harmonic ratio (If harmonic inhibit is enabled).

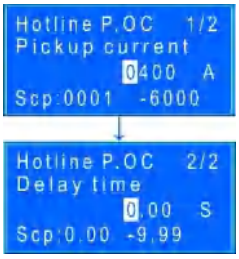
Step 6: Set the direction mode. None: overcurrent without direction; Forward: forward direction overcurrent; Reverse: reverse direction overcurrent.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to modified value.

The operational processes of SEF protection setting

Hotline P.OC/G.OC

Select **Hotline P.OC/G.OC** in the relay menu, press "Enter" key to enter, operational processes as shown below:



Step 1: Set the Hotline P.OC/G.OC protection phase current value, the current value can be between 1A ~ 6000A.

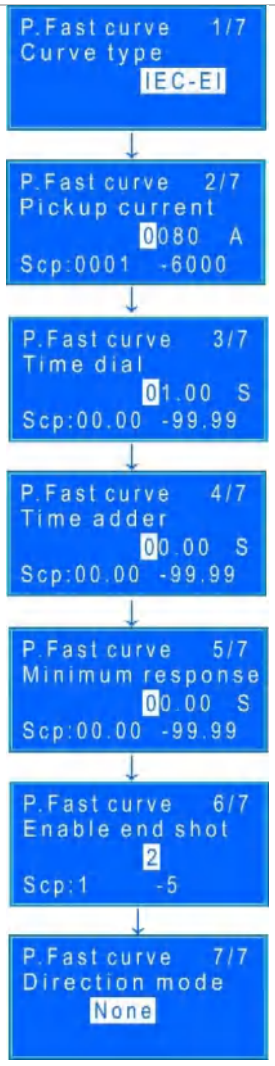
Step 2: Set the Hotline P.OC/G.OC delay time, the delay time can be between 0S ~ 9.99S.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to modified current value and delayed time.

The operational processes of Hotline P.OC/G.OC protection setting

Inverse-time overcurrent

Select **P.Fast curve** press "Enter" key to enter, operational processes as shown below:



Step 1: Choose the Curve type of Inverse-time overcurrent

Step 2: Set the overcurrent protection current value, the current value can be between 1A ~ 6000A.

Step 3: Set the Time dial of time-overcurrent curve.

Step 4: Set the Time adder of time-overcurrent curve (the delay time to trip after "Tp").

Step 5: Set the Minimum response of time-overcurrent curve (If the "Tp" less than it, the recloser will trip after this time).

Step 6: Set the Enable end shot of time-overcurrent curve. For example you set the value to 2,the fast curve protection is available just in the SH0 and SH1 in reclose cycle, the delay curve is available just in SH2,SH3 and SH4 trip in reclose cycle. P.Delay curve does not have this item.

Step 7: Set the direction mode. None: overcurrent without direction; Forward: forward direction overcurrent; Reverse: reverse direction overcurrent.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified current value and constant time.

The operational processes of phase time-overcurrent fast curve setting (The time-overcurrent delay curve is same as it).

Note: This is a phase time-overcurrent protection setting, the use of the time-overcurrent earth fault protection is the same.

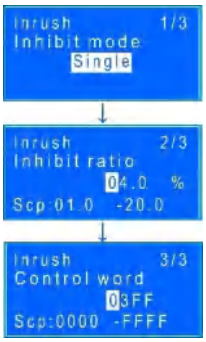
Cold Load (ColdLoad)

Select **ColdLoad** in the relay menu, press "Enter" key to enter, operational processes as shown below:

	Step 1: Set the cold load protection phase current value, the current value can be between 1A ~ 6000A. Step 2: Set the cold load protection ground current value, the current value can be between 1A ~ 6000A. Step 3: Set the loss-load time, the time can be between 0.1S ~ 99.99S. Step 4: Set the restore time, the time can be between 0.1S ~ 99.99S. Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to modified current value and delayed time.
The operational processes of cold load protection setting	

Inrush

Select **Inrush** in the relay menu, press "Enter" key to enter, operational processes as shown below:

	Step 1: Set the Inrush protection inhibit mode. (1: Single, 2: Cross) Step 2: Set the Inrush protection inhibit ratio, the inhibit ratio can be between 1% ~ 20%. Step 3: Set which protections need to be suppressed, press [→] key to enter another interface Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to modified value.
	Press [→] key to move right in the control word to enter this interface, press the [+] and [-] keys at the cursor to modify whether the protection needs to be suppressed. Press [↓] key to switch to next protection.
The operational processes of Inrush protection setting	

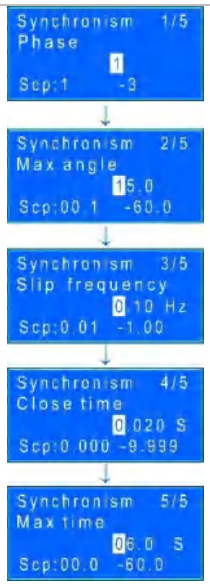
Switch-Onto-Fault (SOTF)

Select **SOTF** in the relay menu, press "Enter" key to enter, operational processes as shown below:

	Step 1: Set the SOTF exit time, the exit time can be between 0.1S~9.99S. Step 2: Set the SOTF protection current value, the current value can be between 1A ~ 6000A. Step 3: Set the delay time, the delay time can be between 0S ~ 9.99S. Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified current value and delayed time.
The operational processes of manual closing acceleration protection setting	

Synchronism

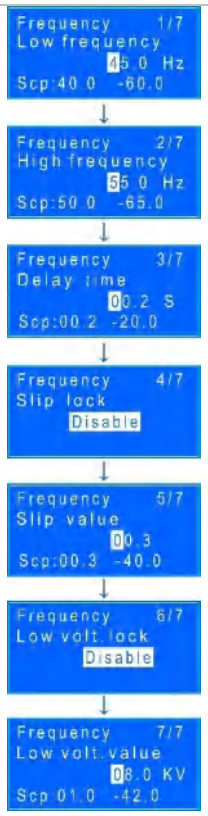
Select **Synchronism** in the relay menu, press "Enter" key to enter, operational processes as shown below:

	Step 1: Set the phase, the phase can be between 1 ~ 3. Step 2: Set the max angle, the max angle can be between 0.1° ~60°. Step 3: Set the slip frequency, the slip frequency can be between 0.01 Hz ~1Hz. Step 4: Set the close time, the close time can be between 0S ~9.999S. Step 5: Set the max time, the max time can be between 0S~60S. Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified current value and delayed time.
The operational processes of synchronism protection setting	

Note: The high Voltage value and low Voltage value used for this protection are in the common value

Frequency protection (Frequency)

Select **Frequency** in the relay menu, press "Enter" key to enter, operational processes as shown below:

<table>
<tr>
<td> 
</td>
<td>Step 1: Set the low frequency, the low frequency can be between 40Hz~60Hz.

Step 2: Set the high frequency, the high frequency can be between 50Hz~65Hz.

Step 3: Set the delay time, the delay time can be between 0.2S ~ 20S.

Step 4: Set the slip lock, the slip lock can be between 0 ~1 (0: disable 1: enable).

Step 5: Set the slip value, the slip value can be between 0.3 ~40.

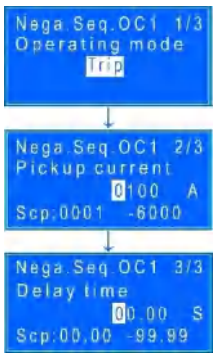
Step 6: Set the low Voltage lock value, low Voltage lock value can be between 0 ~1 (0: disable 1: enable).

Step 7: Set the low Voltage value, low Voltage value can be between 1KV~42KV.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to modified value.</td>
</tr>
<tr>
<td colspan="2">The operational processes of frequency protection setting</td>
</tr>
</table>

Negative Sequence Overcurrent (Nega.Seq.OC)

Select **Nega.Seq.OC** in the relay menu, press "Enter" key to enter, operational processes as shown below:

<table>
<tr>
<td> 
</td>
<td>Step 1: Choose the operating mode (0: Disable, 1: Trip).

Step 2: Set the protection current value, the current value can be between 1A ~ 6000A.

Step 3: Set the delay time, the delay time can be between 0S ~ 99.99S.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified current value and delayed time.</td>
</tr>
<tr>
<td colspan="2">The operational processes of inter-phase negative sequence overcurrent protection setting</td>
</tr>
</table>

Note: This is Nega.Seq.OC1 protection setting, the use of the Nega.Seq.OC2 protection is the same.

Direct.Power

Select **Direct.Power** in the relay menu, press "Enter" key to enter, operational processes as shown below:

<table>
<tr>
<td> 
</td>
<td>Step 1: Choose the operating mode (1: Trip, 2: Alarm).

Step 2: Set the protection power value, the power value can be between 1KW ~ 60000KW.

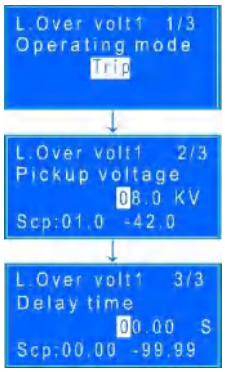
Step 3: Set the delay time, the delay time can be between 0S ~ 60000S.

Step 4: Set the direction mode. None: overpower without direction; Forward: forward direction overpower; Reverse: reverse direction overpower.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified current value and delayed time.</td>
</tr>
<tr>
<td colspan="2">The operational processes of direct power protection setting</td>
</tr>
</table>

Over Voltage (L.Over volt)

Select **L.Over volt** in the relay menu, press "Enter" key to enter, operational processes as shown below:

<table>
<tr>
<td> 
</td>
<td>Step 1: Choose the operating mode (0: Disable,1: Trip, 2: Alarm).

Step 2: Set the overload protection Voltage value, the Voltage value can be between 1KV ~ 42KV.

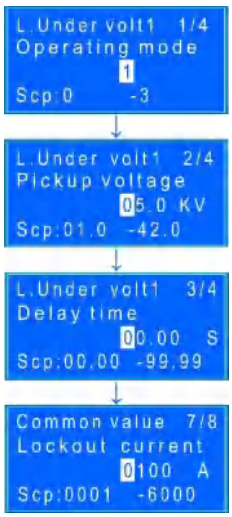
Step 3: Set the delay time, the delay time can be between 0S ~ 99.99S.

Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified current value and delayed time.</td>
</tr>
<tr>
<td colspan="2">The operational processes of over Voltage protection setting</td>
</tr>
</table>

Note: This is L.Over volt1 protection setting, the use of the L.Over volt2 protection is the same.

Under Voltage protection (L.Under volt)

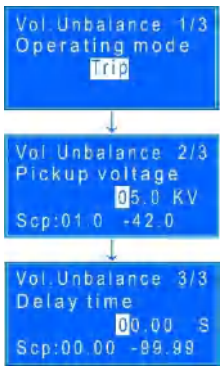
Select **L.Under volt** in the relay menu press "Enter" key to enter, operational processes as shown below:

	Step 1: Choose the operating mode (0: Alarm, 1: No Voltage + low Voltage protection, 2: Via current lock low-Voltage protection, 3: Pure low Voltage protection). Step 2: Set the protection Voltage value, the Voltage value can be between 1KV ~ 42KV. Step 3: Set the delay time, the delay time can be between 0S ~ 99.99S. Step 4: Set the lockout current value, the current value can be between 1A ~6000A. Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified current/Voltage value and delayed time.
The operational processes of Under Voltage protection setting	

Note: This is L.Under volt1 protection setting, the use of the L.Under volt2 protection is the same. The lockout current is in the common value.

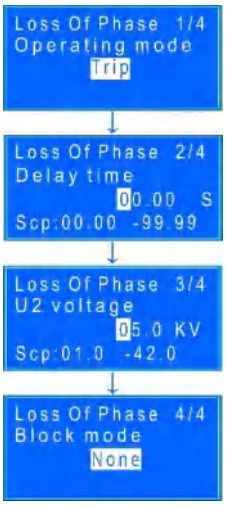
Voltage Unbalance protection (Vol. Unbalance)

Select **Vol. Unbalance** in the relay menu, press "Enter" key to enter, operational processes as shown below:

	Step 1: Choose the operating mode (0: Disable,1: Trip, 2: Alarm). Step 2: Set the protection Voltage value, the Voltage value can be between 1KV ~ 42KV. Step 3: Set the delay time, the delay time can be between 0S ~ 99.99S. Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified Voltage value and delayed time.
The operational processes of Voltage unbalance protection setting	

Loss Of Phase

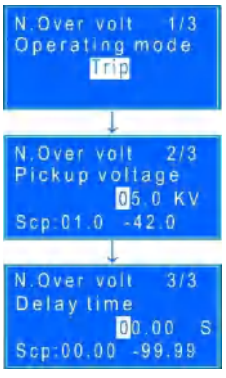
Select **Loss Of Phase** in the relay menu, press "Enter" key to enter, operational processes as shown below:

	Step 1: Choose the operating mode (0: Disable,1: Trip, 2: Alarm). Step 2: Set the delay time, the delay time can be between 0S ~ 99.99S. Step 3: Set the protection negative sequence Voltage value, the Voltage value can be between 1KV ~ 42KV. Step 3: Set the block mode(0-None, 1-Lockout: Lock Voltage components 2-Unlock: Unlock Voltage components). Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified Voltage value and delayed time.
The operational processes of loss of phase protection setting	

Note: The low Voltage value used for this protection are in the common value

Zero-sequence over Voltage protection (N.Over volt)

Select **N.Over volt** in the relay menu, press "Enter" key to enter, operational processes as shown below:

	Step 1: Choose the operating mode (0: Disable,1: Trip, 2: Alarm). Step 2: Set the protection Voltage value, the Voltage value can be between 1KV ~ 42KV. Step 3: Set the delay time, the delay time can be between 0S ~ 99.99S. Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode, modified Voltage value and delayed time.
The operational processes of zero sequence over Voltage protection setting	

Heavy gas protection (High Gas)

Select **High Gas** in the relay menu press "Enter" key to enter, operational processes as shown below:

	Step 1: Choose the operating mode (0: Disable,1: Trip, 2: Alarm). Step 2: Set the delay time, the delay time can be between 0S ~ 99.99S. Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode and modified delayed time.
The operational processes of heavy gas protection setting	

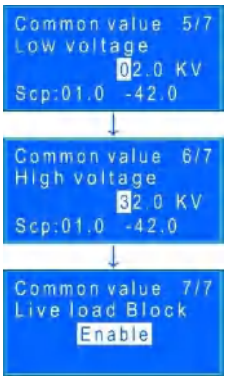
High temperature protection (High Temp)

Optional **High Temp** in the relay menu, press "Enter" key to enter, operational processes as shown below:

	Step 1: Choose the operating mode (0: Disable,1: Trip, 2: Alarm). Step 2: Set the delay time, the delay time can be between 0S ~ 99.99S. Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to switch the mode and modified delayed time.
The operational processes of high temperature protection setting	

Live load block (Common value)

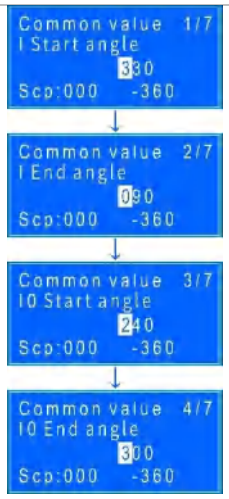
Select **Common value** in the relay menu, press "Enter" key to enter, operational processes as shown below:

	Step 1: Set the low Voltage value, the low Voltage value can be between 1KV ~ 42KV. Step 2: Set the high Voltage value, the high Voltage value can be between 1KV ~ 42KV. Step 3: Set the live load block mode(0: Disable, 1: Enable). Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to modified value.
The operational processes of live load block setting	

Note: The low Voltage value and high Voltage here are also applicable to synchronism and loss of phase protection

Other common values (Common value)

Select **Common value** in the relay menu, press "Enter" key to enter, as shown below:

	The angle for judging the direction is set here. I start angle and I end angle are used for phase currents, I0 start angle and I0 end angle are used for ground current. Note: Press [↓] key to switch to next screen, press the [+] and [-] keys to modified value.
The common value	

4.9 Save parameter

	After setting, press "ESC" key to exit, if modified below figure will show. If you need to save press "Enter" key and input password, otherwise press "ESC" key.
	If you want to save, press the "Enter" key, and you need to enter the correct password to save.
	This interface appears, indicating that the saving is successful.
	If the password is error, this interface will appear.

4.10 Parameter set

Press the **EDIT** → **Para**, enter the "parameter set". **If it is not necessary, all parameters in the para menu cannot be changed.**

CT, PT and PTS rate set

	CT rate is the measurement of three phase current. The value of CT ratio is equal to the primary side current value divided by the secondary side current value. For e.g., 400/5 = 80 or 600/5 = 120.
	VS ratio of the voltage sensor. The value of VS ratio is equal to the primary side resistance value divided by the secondary side resistance value. The default secondary side resistance value is 0.036MΩ. For e.g., 1. the primary side resistance value is 160MΩ, 160/0.036 = 4444; 2. the primary side resistance value is 500MΩ, 500/0.036 = 13888.
	PTS rate is the measurement of power Voltage. The value of PTS ratio is equal to the primary side Voltage value divided by the secondary side Voltage value. For e.g., 11000/110 = 100 or 24000/220 = 109.

Note:
1 Different current transformer, CT ratio becomes different.
2 Different Voltage sensor, PT ratio becomes different.
3 Different PT power Voltage transformer, PTS ratio becomes different.

Choose power side

	Here you can choose which side is the power side. If ABC is selected, ABC is the power side, RST is the load side; and if RST is selected, RST is the power side, ABC is the load side. All Voltage related protection uses the Voltage at the power supply side. Zero sequence Voltage, negative sequence Voltage and positive sequence Voltage are also composed of power side Voltage.

Password set

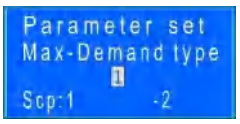
	The device initial password is "0099", the password can be changed anywhere between "0000" ~ "9999", when revised press "Enter" key to confirm, enter the password before the modification.

Wear set

	The rated number of mechanical trips is divided by the total number of trips to obtain the mechanical wear ratio.
	Target value of wear per phase.
	Arcing time of circuit breaker.

Note: Please do not modify these values, if in doubt, please contact supplier.

Relevant parameters of energy and demand records

	Demand recording method. 1: Fixed 2: Rolling
	How often is the accumulated energy and demand collected. 1: Collect once every 15 minutes. 2: Collect once every 30 minutes. 3: Collect once every 60 minutes.

Close and trip pulse time set

	"Close pulse time" is the discharge time for close coil.
	"Trip pulse time" is the discharge time for trip coil.

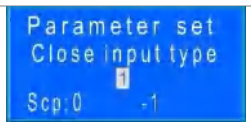
Note: Please do not modify the trip and close pulse time, if in doubt, please contact supplier.

Mechanical locking

	Enabling mechanical locking requires corresponding binary input. The circuit breaker is used for manual interlocking.
	Mechanical locking time, beyond which it will be locked.

Note: Please do not modify these values, if in doubt, please contact supplier.

Other parameters

	Identification time of binary input. Please do not modify this time, if in doubt, please contact supplier.
	The waiting time after pressing the opening or closing button on the panel. When the time is up, the opening or closing will occur.
	This is used when the switch position signal is connected reversely.

4.11 Communication

Press the **EDIT** → **Port**, enter to the communication set menu.

<table>
<tr>
<td> 
</td>
<td>There are 3 communication channels in total here. Enter the corresponding channels and set the corresponding settings. The channel settings are as follows. There is also a common setting.

Note: Press [↓] key to choose the port which you need to set, press the[Enter] to Enter the menu, press [+] and [-] keys to modified communication value.</td>
</tr>
<tr>
<td> 
</td>
<td>Step 1: Enable this channel
0: Close this channel
1: Open this channel

Step 2: Set the baud rate of this channel (Default 9600).

Step 3: Select the communication protocol for this channel
1: IEC60870-5-101
2: IEC60870-5-104
3: DNP3.0
4: MODBUS

Step 4: If it is the IEC60870-5-101 protocol, this parameter is whether it is in balanced mode. If it is MOBUS protocol, this parameter represents whether it is TCP/IP mode.
0: Unbalanced(IEC60870-5-101) / RS485(MOBUS)
1: Balance(IEC60870-5-101) / TCP/IP(MOBUS)

Step 5: Set up device address or source address.

Step 6: Set up destination address (DNP3.0 needs to be set).

Step 7: Enable active upload (For 101 and 104 protocols). What point table is used in MODBUS protocol.
0: Do not upload actively(For 101 and 104 protocols) / Custom point table(MOBUS)
1: Active upload(For 101 and 104 protocols) / Fixed point table cannot be configured by oneself(MOBUS)

Step 8: Enable the active upload of signaling (For 101 and 104 protocols).

Step 9: How often is the signal uploaded.

Step 10: Enable the active upload of meter (For 101 and 104 protocols).

Step 11: How often is the meter uploaded.

Note: The settings of the three channels are the same.</td>
</tr>
</table>

Communication common settings are as follows:

Name	Setting range	Step length	Description
Signal type	1 ~ 2	1	1: Single point 2: Double point
Signal Start Ad.	0 ~ 60000	1	Signal start address
Control type	1 ~ 2	1	1: Single point 2: Double point
Ctrl. Start Ad.	0 ~ 60000	1	Control start address
Meter type	1 ~ 4	1	1: Normalized telemetry 2: Normalized telemetry without quality 3: Standardized telemetry 4: Short floating point telemetry
Meter Start Ad.	0 ~ 60000	1	Meter start address
Address len	1 ~ 2	1	Address length (1: 1 byte 2: 2 byte)
COT len	1 ~ 2	1	COT length (1: 1 byte 2: 2 byte)
I factor	0.01 ~ 100	0.01	Phase current multiplier
I deadband	0.1 ~ 1000	0.1	Phase current dead zone
I0 factor	0.01 ~ 100	0.01	Zero sequence current multiplier
I0 deadband	0.1 ~ 1000	0.1	Zero sequence current dead zone
U factor	0.01 ~ 100	0.01	Line Voltage multiplier
U deadband	0.1 ~ 1000	0.1	Line Voltage dead zone
U0 factor	0.01 ~ 100	0.01	Zero sequence Voltage multiplier
U0 deadband	0.1 ~ 1000	0.1	Zero sequence Voltage dead zone
P factor	0.01 ~ 100	0.01	Power multiplier
P deadband	1 ~ 10000	1	Power dead zone
COS factor	0.01 ~ 100	0.01	COS multiplier
COS deadband	0.01 ~ 1	0.01	COS dead zone
OTH factor	0.01 ~ 100	0.01	Other multiplier
OTH deadband	0.01 ~ 1	0.01	Other dead zone
CLASSA	0 ~ 3	1	Class for analog event data
CLASSB	0 ~ 3	1	Class for digital event data
Select Timeout	0 ~ 30	0.1	Select/operate time-out
Confirm Link	0 ~ 1	1	Enable confirm data link (For 101 and 104 protocols)
Link Retry Times	0 ~ 15	1	Data link retries times
Link Timeout	0 ~ 50	0.1	Seconds to data link time-out
Upload Confirm	0 ~ 1	1	Enable upload confirmation (For DNP3.0 protocols)
Upload Timeout	0 ~ 50	0.1	Seconds to upload time-out
Upload Retry Times	2 ~ 10	1	Upload retries times
Auto Refresh	0 ~ 1	1	Enable automatic reset of events
Refresh time	0 ~ 65535	1	Seconds to automatic reset event

4.12 Clear

Select the **Edit** submenu in "Clr.", press "Enter" key to enter the "Clr." Submenu. The stored data can be cleared here. The contents include event records, energy, demand, counters, wea, outage and reset IP (default IP: 192.168.0.7).

Press "↑" and "↓" keys to switch, select the option to be cleared and press the "Enter" key to enter the correct password.

4.13 Calibration

Select the Edit submenu in "Chnl", press "Enter" key to enter into the password screen, enter the correct password to enter the "Chnl" submenu, press the [+] and [-] keys to correct the value of current and Voltage.

Note: All Voltage and current values in the factory have been corrected before. Please do not change the parameter values which, if in doubt, please contact supplier.

4.14 Auto switch group

Press the **EDIT** → **AGT**, enter to the auto switch group set menu. Automatic switchover can be set in this menu, which can be switched to summer workday group, summer rest day group, winter workday group and winter rest day group. You can also set the start and end time of summer and the start and end time of rest days. Automatic group switching is based on time.

4.15 View measurements

Press the **VIEW** → **Mea.**, view the primary side measurement value, secondary side measurement value, power, electric energy, historical electric energy, demand and monthly maximum demand.

The measured values at the primary side include phase current, zero sequence current, phase Voltage at both sides, zero sequence Voltage, PT Voltage, battery Voltage, line Voltage at both sides, frequency, second harmonic of phase current and third harmonic of zero sequence current.

The measured values at the secondary side include phase current, zero sequence current, phase Voltage at both sides, zero sequence Voltage, PT Voltage, line Voltage at both sides, negative sequence current, negative sequence Voltage, positive sequence Voltage and the angle of these values.

The power interface displays the total active power, reactive power, apparent load power and power factor. And the active power, reactive power, apparent load power and power factor of each phase.

The energy interface displays the active energy+, total active energy -, total reactive energy+, total reactive energy -, active energy+ per phase, active energy- per phase, reactive energy+ per phase, and reactive energy- per phase.

In addition to displaying active energy+, total active energy-, total reactive energy+, total reactive energy-, active energy+ per phase, active energy- per phase, reactive energy+ per phase and reactive energy- per phase, the historical energy interface also displays the recorded time and quantity.

The maximum demand interface displays the time and maximum demand value recorded by the maximum demand.

In addition to displaying the time and maximum demand value of the maximum demand record, the monthly maximum demand interface also displays the number of monthly maximum demand records and the year and year records.

4.16 View report

Enter the main menu select the "VIEW" option press "Enter" key to enter, and then select "RPT" option press "Enter" key to enter the "RPT" submenu, you can view the recording events include: trip signal, alarm signals, SOE signal (circuit breaker status, whether the manual or remote operation, fault trip, time and date, etc.), counters, wear and outage.

4.17 View relay and setting

Enter the main menu select the "VIEW" option press "Enter" key to enter, and then select the "Relay" option to press "Enter" key to enter the "Relay" submenu, you can view all the protection is enabled or disabled, select protection option press "Enter" key to enter the value you can view each protection, press the arrow keys to switch screens.

4.18 View input signal

Enter the main menu select the "VIEW" option press "Enter" key to enter, and then select the "Input" option press "Enter" key to enter the "Input" submenu, you can view the state of input signal.

The input signal includes: Power fault, Active battery, Heavy gas, High temperature, Breaker open, Breaker close, Remote open, Remote close, Door open, Lockout in, Remote enable. 0 to 1 represents binary input.

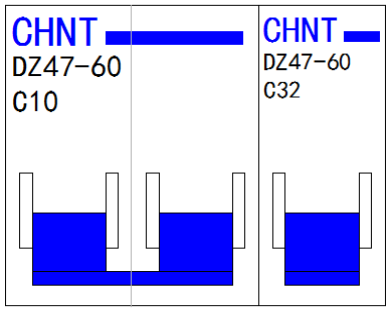
Chapter 5: Peripheral Accessories

5.1 RF remote controller

	Function of each key A:Close B:Trip C:Unlock D:Reset

Note:
1. In order to prevent misuse, press the unlock button for 3 seconds, before execution of the closing operation.
2. The effective distance of RF remote controller is 30 meters.

5.2 Features and the use of external sockets and switches



Note1: Before using the controller, ensure the battery charge for minimum of 24 hours.

Note2: About using these switches

- Turn on the backup switch when using battery power, turn on the PT power switch when using external PT power (PT Voltage depends on the standard at the time of order).

NOTE: If the controller is not used temporarily, be sure to turn off the two switches. When charging is needed, connect the power from the outside and turn on the two switches at the same time.

5.3 The main secondary component parts

	
Cable plug, connect the controller and circuit breakers	Surge protector

Note: For security norms, Surge protector has to be grounded (green line) to the earth.

5.4 Capacitor (Used by permanent recloser)

	1 Temperature range: -25°C~+105°C. 2 Rated Voltage: DC250V. 3 Capacity: Choose according to demand . 4 Rated ripple current: 34.7Arms.

Note: The following operation will cause self-heating of the capacitor that can result in leaking electrolyte outside the seal area. worst of all, perhaps there will be burst or spark that can lead the capacitor to spontaneous combustion.

1. Inverse Voltage.
2. Over Voltage (over rated Voltage).
3. Exceeding the rated ripple current.
4. Violently charge/discharge.

5.5 Battery

- RWK-35 stand-by battery adopts two 9AH lead-acid free of maintenance batteries, the average battery life exceeds 3 years.
- **If the controller is idle, be sure to charge it every two months. Turn on the power switch and battery switch when charging!**

Chapter 6: Installation and Maintenance

Danger: The dangerous Voltage with the device maybe result in the permanent damage of equipment or personnel casualty during installing RWK-35. These Voltages mainly distributes at terminal bar of device and circuits of AC current input, AC Voltage input, digital input, IGBT output and operation power supply., etc. This device's installation, debugging and maintenance can only be operated by technical staff who has been authorized and trained strictly.

6.1 Installation

☆ See the Quick Reference Guide for details!

6.2 Maintenance

- If the device is not used, it should be kept in dry and ventilated places indoors, and charged **once every three months**, the charging time should be more than 24 hours. Before the device is used, the charging time should not be less than 24 hours. Replace the storage battery each three years.

- This device has storage battery management module, which will automatically cut off the storage battery output circuit when the storage battery Voltage is on the low side. You should check the storage battery each year, please replace the storage battery immediately when single storage battery Voltage id lower than DC12V.

- About "para" menu, before leaving the factory, CT / PT / close pulse time / open pulse time have already been set. Under normal circumstances, do not modify them without authorization. PTs is the transformation ratio of Voltage transformer, please modify it according to the actual situation, such as 10kV / 0.22kv Voltage transformer, PTs shall be set to 45.

- Please firstly make sure the first system is power off before the device is maintained, forbid inserting or pulling out aeronautical connector under power, thus avoid CT short circuit happening.

Chapter 7: Others

7.1 Decommission

Shut-down Power Supply

Shut-down Device Power Supply: Turn off external power supply switch of the device.

Disconnect All Power Cables

Disconnect all power cables connected to the device.

Danger: Before disconnecting all power cables connected to the device power module, it must confirm that the external power switch is turned off to avoid danger.

Danger: Disconnecting all power cables connected to the device alternating current module, it must confirm that the equipment corresponding to input alternating component has stopped operation to avoid danger.

Dismantle from Display Cabinet

When the above steps are completed, loosen the fix screws and dismantle the device from the display cabinet.

Danger: When neighboring equipment is in operation, it must strictly confirm the safety distance between the dismantled device and other device in operation and unskilled professional shall take particular caution.

7.2 Disposal

When dispose decommissioned device, please follow relevant regulations of the country where the product is used for the disposal of scrapped electronic products.

Caution: It must strictly adhere to relevant regulations of the country where the product is used for the disposal of scrapped electronic products.

7.3 Parts Attached with the Device

Name	Quantity	Collocation	Usage or Description
User Manual	1	Standard	Please read it carefully before use the device
Software manual	1	Standard	Special introduction to the use of operating software
Quick Reference Guide	1	Standard	For users to quickly understand the product
Hand-held telecontroller	1	Selectable	Telecontrol the close and trip of switch within 30 meters
USB drive	1	Standard	Testing debugging software
Control Cable	According to function	Standard	