Instruction Manual & User's Guide

10kV~38kV Pole mounted SF_6-insulated Automatic Vacuum Recloser with Microprocessor based controller integrated with Remote Terminal Unit(RTU)

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SF6 AUTOMATIC VACUUM RECLOSER BODY

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MICROPROCESSOR BASED CONTROLLER INTEGRATED WITH RTU

1. SAFETY INFORMATION

1.1 Safety for Life

Jinkwang's products meet or exceed all applicable industry standards relating to product safety. We actively promote safe practices in the use and maintenance of our products through our technical information, instructional training programs, and the continuous efforts of all Jinkwang employees involved in product design, manufacture, marketing and service

1.2 Safety Information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the recloser described.
Only authorized technicians who are familiar with this recloser should install, operate and service it.

Following is important safety information. For safe installation and operation of the recloser, be sure to read carefully and understand fully followings. Additional statements, related to specific matters and procedures, can be observed throughout this manual.

This manual may contain four types of hazard statements:

Danger : Indicates an imminently hazardous situation which, if not avoided, will result in serious injury.

Warning : Indicates a potentially hazardous situation which, if not avoided, could result in serious injury.

Caution : Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or equipment damage.

1.3 Safety Instruction

Following are general cautions and warning statements that apply to this recloser.

Danger :

1. Follow all locally approved safety procedures when working around high voltage lines and equipment. Contact with hazardous voltage will cause severe personal injury.

Warning :

1. This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in severe personal injury and equipment damage.

2. The recloser must be selected for the intended application. It must be installed and serviced by proper personal who have been trained and understand proper safety procedures. This instructions are written for such personal and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install, or maintain this recloser can result in severe personal injury.

3. Before installing, operating, maintaining or testing this recloser, carefully read and understand the contents of this manual. Improper operation, handling or maintenance may result in severe personal injury, and damage to the recloser.

2. GENERAL INFORMATION

2.1 Instruction

This manual provides installation, operation and maintenance instructions for the JK-REC Type electronically controlled recloser.
Before installing and operating this recloser, carefully read and understand the contents of this manual.

2.2 Read this Manual First

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing and operating this recloser.

2.3 Additional Information

This manual cannot cover all details or variations in the recloser, procedures or process described, nor provides directions for meeting every possible contingency during installation, operation or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your Jin Kwang sales representative.

2.4 Applied Standards

The recloser is designed, manufactured and tested in accordance with ANSI C37.60, ANSI C37.71, ANSI C37.73, ANSI C37.85, IEC 60255-5, IEEE C62.41(1991), ANSI/IEEE C37.90.1(1989), IEEE C37.90.2(1995).

2.5 Quality Standards

The recloser shall be manufactured according to ISO9001(1994) quality control system.

2.6 Acceptance and Initial Inspection

The recloser is completely assembled, tested, and inspected at the factory. It is good condition when accepted by the carrier for shipment. Upon receipt, inspect the shipping container for signs for damage. Unpack the recloser and inspect it thoroughly for damage incurred during shipment. If damage is discovered, file a claim with carrier immediately.

2.7 Handling and Storage

Be careful during handling and storage of the recloser to minimize the possibility of damage. In particular, protect the porcelain bushing in handling.

Only use the lifting lug when lifting the recloser. If the recloser is to be stored for any length of time prior to installation, provide a clean, dry storage area.

2.8 Description

New demands for managing distribution systems call for control devices inherently reliable and intelligent. Customers require a built-in capability for data gathering and communication, along with an extremely low maintenance product.

The Jinkwang electronically controlled, three phase automatic recloser (hereinafter referred to as "the recloser") provides reliable and economical over-current protection for distribution circuit, ranging from 15 through 38kV.

The recloser senses line current and automatically interrupts the phase of the distribution circuit to which it is

connected when line current exceeds the minimum trip level. Next, it automatically recloses to restore ser-vice

and monitors the line to determine if the fault has been cleared. If the fault is permanent, the recloser sequences to lockout after one, two, three, or four preset trip operations

Once the recloser sequences to lockout, the recloser must be manually reset to restore service.
Should the fault clear before lockout, the recloser will reset automatically for another sequence of operations. The recloser can also be set for non-reclosing operation (lock out after the first trip operation) The recloser can be remotely set for non-reclosing operation via the remote non-reclosing feature. The trip operations of the recloser can be all fast, all delayed, or any combination of fast operations and delayed operations up to a maximum total of four. Fast operations clear temporary faults before branch line fuses are weakened. Delayed operations allow time for fuses or other downline protective devices to clear to limit permanent faults to the smallest section of line.

The Jinkwang type JK-REC recloser has a characteristic as followings.

1) The recloser meets actively in distribution line protection coordination that change variously by control technology that use microprocessor, and are being operated locally or remotely.

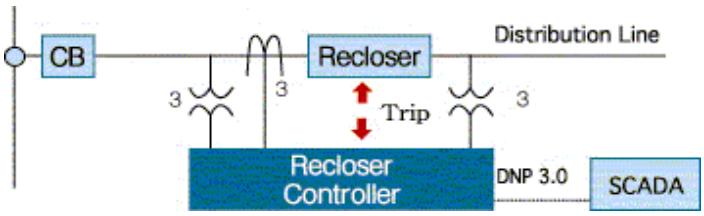
2) Communication protocols to DAS make the automated protection coordination possible.

3) The control has a total of 48 built-in T-C curves, and a T-C curve, which has a time multiplier and a minimum response time applied to the fundamental curve and a high current lockout characteristic, allows programming via keypad or RS232 communication port on the front of control panel.

4) Fault recording for analysis can be backed up using LCD display or handheld controller applying gradually fault recording that need in the maintenance on the distribution lines.

5) All operating parameters and settings are easily programmable via handheld controller or PC using RS-232 port on the front panel.

6) The control is equipped with the function of sequence coordination to prevent unnecessary operation of the upstream reclosers when two or more reclosers are being operated in series.

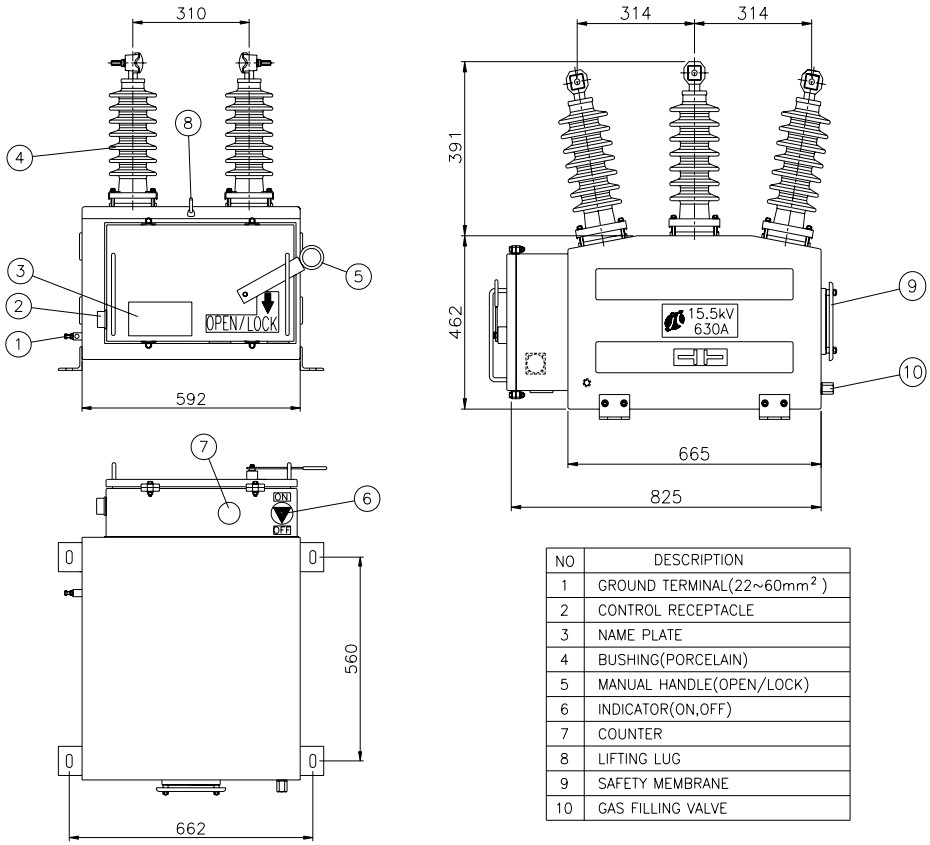


3. RATING & SPECIFICATIONS

No.	Description	Unit	Specifications		
1	Type		JK-REC-11	JK-REC-22	JK-REC-33
2	Insulation		SF6		
3	Ratings				
	Maximum System Voltage	kV	15.5	27	33
	Rated Voltage	kV	15	22	38
	Rated Current	A	630	630	630/800
	Rated Frequency	Hz	50/60	50/60	50/60
	Mechanical Operation(Min.)	C-O	10,000	10,000	10,000
	Rated Gas Pressure at 20°C	kg/cm^2.G	0.5	0.5	0.5
4	Breaking Capacity				
	Rated symmetrical interrupting current	A	12.5/16	12.5/16	12.5/16
	Short Time Withstand Current(1sec)	kA	12.5/16	12.5/16	12.5/16
	Making Current(peak)	kA	32.5/40	32.5/40	32.5/40
	Cable Charging	A	5	5	5
	Transformer Magnetizing	A	22	22	40
5	Impulse Insulation Level(1.2 × 50μs)				
	Phase to Earth	kV	110	150	170
	Across Interrupter	kV	110	150	170
6	Power Frequency Insulation Level, dry				
	Phase to Earth	kV	50	60	70
	Across Interrupter	kV			
7	Power Supply				
	Operation	V	AC120(AC127V or AC220)		
	Control Circuit	V	DC12(13.8) or DC 24		
8	Environmental				
	Ambient Temperature	˚C	-30 ~ +50		
	Humidity	%	0 ~ 100		
9	Net Weight(Switch Body/ Control Cabinet)	kg	195/60		300/60

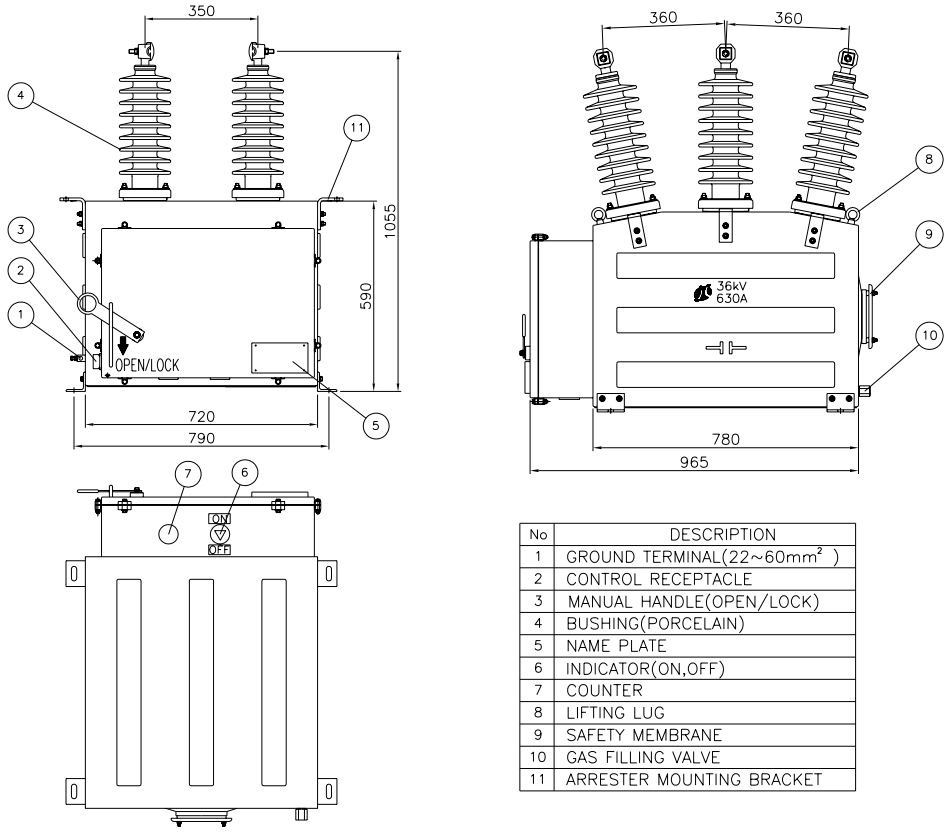
4. CONSTRUCTION

The recloser shall consist of a mechanism housing including magnetic actuator and vacuum interrupter, and controller. The vacuum interrupter provides greatly enhanced long contact life.
The vacuum interrupters are installed into tank that is made of stainless steel. The lightweight and portable gas insulation effectively reduces installation costs.



NO	DESCRIPTION
1	GROUND TERMINAL(22~60mm^2)
2	CONTROL RECEPTACLE
3	NAME PLATE
4	BUSHING(PORCELAIN)
5	MANUAL HANDLE(OPEN/LOCK)
6	INDICATOR(ON,OFF)
7	COUNTER
8	LIFTING LUG
9	SAFETY MEMBRANE
10	GAS FILLING VALVE

(15/24 kV Recloser schematic diagram)



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10	GAS FILLING VALVE
11	ARRESTER MOUNTING BRACKET

(33 kV Recloser schematic diagram)

4.1 Tank

The tank of the recloser is fabricated from cold rolled steel and plate. The material used is 304L stainless steel (SF6 Gas insulated type only)and the design thickness is a minimum 3㎜.

4.2 Switching module

In contrast to the majority of conventional circuit breakers, this patented design incorporates three independent magnetic actuators: one per pole. This minimizes the number of moving parts, all of which are symmetrical about the central synchronization of the poles operation.

The vacuum interrupter and the magnetic actuator are located at opposite ends of a hollow support insulator. The actuator armature is rigidly coupled to the vacuum interrupter moving contact by a linear drive insulator within the support insulator. This provides direct linear movement in both directions and avoids the use of rotating shafts, bearings and bell cranks.
The result is a maintenance free switch module with a long trouble free mechanical life.

The actuators are situated inside the frame. A synchronizing shaft connects the three poles and performs three functions:

- synchronization of the poles operation
- control of the auxiliary switches
- link-motion drive of mechanical interlocks.

4.2.1 Magnetic actuator

The actuator is held in its two end positions without the use of mechanical latches.

- in the OPEN position the armature is held by the opening spring.
- in the CLOSED position the armature is held by magnetic flux produced by a ring permanent magnet.

This actuator has only one coil. To close and trip the actuator it is necessary to inject current into the coil in different directions.

4.2.2 Vacuum interrupters

As soon as the vacuum interrupter contacts open, the interrupting current initiates a so-called “vacuum arc” that burns essentially in plasma originating from evaporated contact material.
The current continues to flow through this plasma until a current zero. At this moment the arc is extinguished and transient recovery voltage appears across the open gap.
If the contact surface is locally overheated it produces a lot of vapor, resulting in the deterioration of the vacuum followed by electrical breakdown. To avoid this, effective control of the vacuum arc is necessary.

The most effective way to achieve this goal is to apply an axial magnetic field produced by the interrupting current itself. This method is implemented in vacuum interrupters developed.

Several major benefits result from this design:

- High interrupting capacity
- Very compact dimensions
- Low chopping current (45 amps) This limits inductive switching overvoltage to safe values.
- Axial magnetic field minimizes contact erosion and ensures a very long and reliable life.

4.2.3 Operation of switching modules

Closing

- In the OPEN position the vacuum interrupter contacts are held open by the force of the opening spring in the actuator acting through the drive insulator.
- To close the vacuum interrupter contacts a current pulse, derived from the closing capacitor in the control module, is injected into the actuator coil.
- The current in the coil produces a magnetic flux in the gap between the upper yoke and the actuator armature.
- Rising coil current increases the magnetic flux and the electromagnetic attraction between yoke and armature increases to overcome the restraining force of the opening spring. (Line1)
- The armature, drive insulator and moving contact start to move.
- As the armature moves towards the upper yoke the magnetic air gap decreases and consequently the magnetic attraction force increases. This increasing force accelerates the armature, drive insulator and moving contact to a closing speed of 1 m/s. This optimum speed ensures a complete absence of contact bounce and reduces the probability of pre-strikes of the vacuum gap before the contacts close. (Line 2)
- The accelerating armature also generates a back emf in the coil and reduces the coil current (Line 1-2)

- At contact close (Line 2) the moving contact stops but the armature travel continues for 2mm under rapid deceleration caused by compressing the contact pressure spring.

- At the limit of its travel the armature latches magnetically to the upper yoke. (Line 2a) The moving armature induced back emf collapses and the coil current again increases (Line 2a-3) saturating the ring magnet.

  This saturation increases the power of the ring permanent magnet to a level that generates flux to hold the armature in the CLOSED position after the coil current has been cut off by an auxiliary switch. (Line 3) Testing has proved that this flux is sufficient to hold the actuator CLOSED even under vibration and impact conditions.

- The travel of the armature also compresses the opening spring in preparation for the next opening operation.

- The synchronizing shaft is also driven through 44°of rotation during the closing operation and provides position indication, auxiliary switch operation and mechanical interlocking actions.

Opening

- To open the interrupter a current of opposite polarity, derived from the opening capacitor in the control module, is passed through the coil for 1520 milliseconds. (Line 4-5)

- This current partially demagnetizes the ring magnet and reduces the magnetic holding force on the armature.

- Opposing forces from the charged opening spring and the contact pressure spring cause the armature to release and accelerate rapidly. After 2 mm of free travel it engages with the drive insulator and thus the moving contact.

- The peak force produced by the armature at this point exceeds 2000 N which ensures easy breaking of any micro-welds at the contact surfaces which can appear due to short circuit current action.

- The moving contact accelerates rapidly ensuring a high interrupting capacity. (Line 5)

- At full travel (Line 6) the armature, drive insulator, moving contact assembly is again held open by the opening spring force.

- The synchronizing shaft is also driven through 44° of rotation during the opening operation and provides position indication, auxiliary switch operation and mechanical interlocking actions.

Manual closing

Closing can only be carried out through the control module. If the normal substation supply to the control module is de-energized it may be operated using a portable low voltage source through a special emergency power supply input.

Manual opening

The module may be manually opened.
By rotating the synchronizing shaft a force exceeding the magnetic attraction forces of the ring magnet is applied to the armature, which then starts to move.
As the air-gap increases the opening spring and contact pressure spring over come any magnetic holding force and the interrupter opens.

Auxiliary switches

All switching modules are equipped with thirteen auxiliary switches, six normally open (NO) and seven normally closed (NC). Auxiliary switches are operated by cam that is fitted on the synchronizing shaft. One NC auxiliary switch is used for interconnection with the control module. All others are available for external use.

Auxiliary switches ratings are shown in the table below.

Parameters	Value
Type	VANCT8AC1
Rated Current	
at 250 V AC	
Active load	5 A
Inductive load	2 A
at 30 V DC	
Active load	5 A
Inductive load	3 A
at 125 V DC	
Active load	0.5 A
Inductive load	0.03 A

4.3 Current transformers

The reclosers have a 1000:1 ratio current-sensing transformer. Current transformers shall be mounted inside the recloser with secondary pre-wired to the controller prior to shipment. The recloser shall include 3 CT's, 1 per phase, with sufficient accuracy to operate the controls and designed functions within tolerances ±1% at rated current. A solid-state CT protector circuit, inside the recloser tank, ahead of the cable disconnect, is connected to the current transformer

4.4 Bushings

The bushings are constructed of high quality white porcelain and resistant to moisture, external shock, and thermo-cycling. The bushings also provide leakage resistance and the high dielectric strength required for operation of the recloser in pollution contaminated environments.

4.5 Solderless Grounding Terminal

The solderless clamp type ground terminal connector terminal connector can be specified with eye bolt terminal for connecting a 38mm^2 ~200mm^2 connector.

4.6 Grounding connector

The ground connector is provided complete with stainless steel bolt, nut and spring washer for connecting a 22mm^2 ~ 60mm^2 steel ground connector.

4.7 Manual Operating and Lock Handle

The manual operating and lock handle is mounted on the side of main body and is operated by hot stick to enable to be manually opened and lockout.
If you operate the recloser with electric control, the lock handle should be manually returned by hot stick and placed at normal position.

4.8 Safety locking device

The recloser utilizes gas as the insulation medium. Normal gas pressure at the time of manufacture is 0.5㎏.f/㎠.G. The safety locking device prevents operation of the recloser, electrically from the local control panel and remote position during low gas pressure condition(i.e. when internal gas pressure drops to 0.1～0.2㎏.f/㎠.G), by locking the recloser in its current state.

4.9 Pressure release device

The recloser has a pressure release device (or safety membrane) to release the pressure inside of the recloser when internal pressure rise to 1.0～2.0㎏f/㎠.G due to an abnormal condition.

The pressure release device is located on the opposite side to the manual operating and lock handle. Discharge is vented away from the direction of the operator.

4.10 Counter

The five-digit mechanical operations counter, which records all trip operations, is located at the bottom of the mechanism box.

4.11 Position Indicator(ON / OFF)

Position indicator flag is coupled to the recloser mechanism to show the position of the main contacts. When the flag displays Green color , the main contacts are open; When the flag displays Red color, the main contacts are closed.

4.12 Gas Filling Valve

This Valve is mounted on the side of the recloser tank and “CARE” must be paid not to be opened with protection cap for preventing the gas leakage on the filling valve.

5. INSTALLATION PROCEDURE

Warning

1. Always use a hot-stick when working with this recloser . Failure to do so could result in contact with high voltage, which will cause severe personal injury.

2. Solidly ground all equipment. Failure to comply could result in severe personal injury or equipment damage.

Caution

1. Follow all locally approved safety practices when lifting and mounting the recloser. Use the lifting lugs provided. Lift the recloser unit smoothly and do not allow it to shift. Improper lifting can result in it's damage.

2. Do not connect this control to an energized recloser until all control settings have been properly programmed and verified. Refer to the programming information for this control. Failure to comply can result in control and recloser misoperation, equipment damage, and personal injury.

3. Bushings have sharp edges. Wear protective gloves when handling the unit. Failure to do so can results in cuts and abrasions.

4. Do not adjust or rotate bushing terminals. The bushing terminals are factory-calibrated to meet the continuous current requirement of the recloser. Adjusting or rotating the bushing terminals can damage the encapsulated interrupter resulting in equipment damage or personal injury.

5.1 General

All reclosers are carefully tested and adjusted at the factory to operate according to published data. Well-equipped test facilities, detailed testing procedures, and thoroughly trained personnel assure accurately calibrated equipment. Each recloser leaves the factory ready for installation.

5.2 Checking items prior to installation

1) Check bushing's crack and high voltage line connection(bushing terminal).,

2) Check ratings on the nameplate.
Making sure the ratings and settings on the recloser nameplate are correct for the planned installation.

3) Check operation of the switch.
Connect control and recloser using the control cable. Connect the control battery Perform several closing/opening pushing close/open buttons and confirm recloser operation via position indicator. The five-digit operations counter should count one operation.

4) Check it thoroughly for damage incurred during storage.
Perform high-potential withstand tests. Prior to installing the recloser, perform high potential withstand tests. This test will help discover any shipping damage affecting the dielectric condition of the recloser or the vacuum integrity of the interrupter.

5) Low Gas Pressure(SF6 Gas insulated type only)
This recloser is filled with 0.5㎏.f/㎠.G. A low pressure LED on the control panel is illuminates when internal gas pressure drops to 0.1～0.2㎏.f/㎠.G. Make sure a low pressure LED to the connection condition of the main body and control cabinet

6) Make sure a flash of all lamp status indicators to perform a front-panel lamp test in the control cabinet.

7) Make sure a mounting condition of the control cabinet's components such as a batteries, power transformer for power supply, etc.

8) Program the control.
FTU-R100 controls are carefully tested at the factory, shipped and ready for operation. Inspect the control and make sure that all TCC program settings are correct for the planned installation.
Connect control battery to the battery plug.

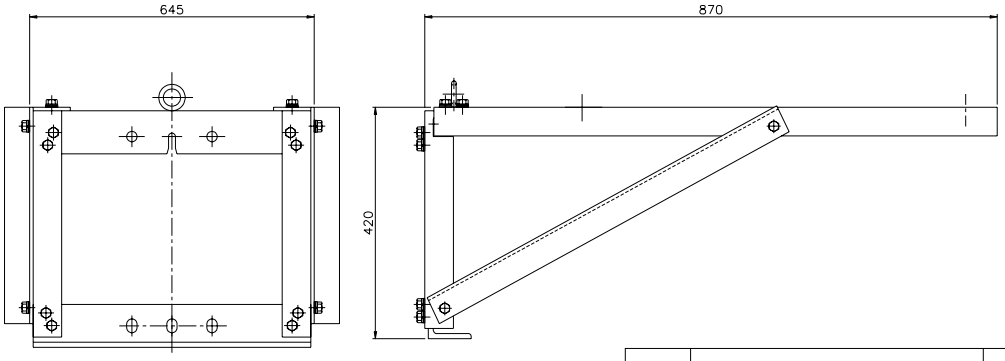
Note: The unit should not be stored or shipped with the batteries connected. Even if the recloser is not in service, connected batteries will still expend energy. Disconnect the batteries when the recloser is not in service. Make sure that the control cable is connected between the recloser and control.

5.3 Installation procedure

5.3.1 Mount the recloser

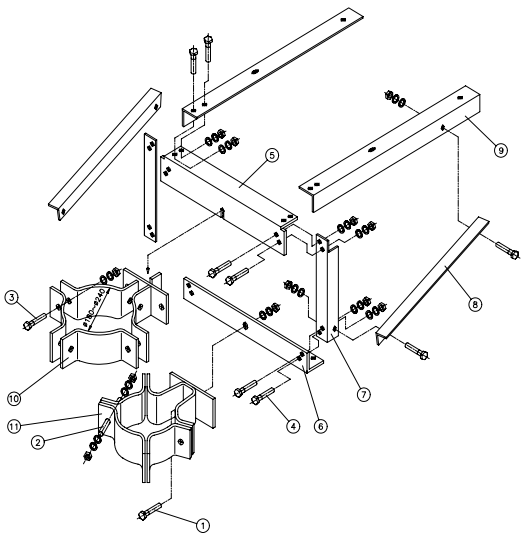
Assembly the mounting frames and then assembly the mounting frames and the recloser
Lift the recloser to the pole with suitable lifting ropes and fix the recloser to the pole with hanger bands.
When lifting the recloser, use the lifting lugs located on the top of the tank and follow approved procedure. At this point, the contacts are opens. Never use its porcelain bushing, bushing terminals nor manual trip handle. These handling will cause the damage to the recloser.

- The following figure shows Jinkwang's mounting frames.



Mounting frames

- The assembly method of mounting frames as follows



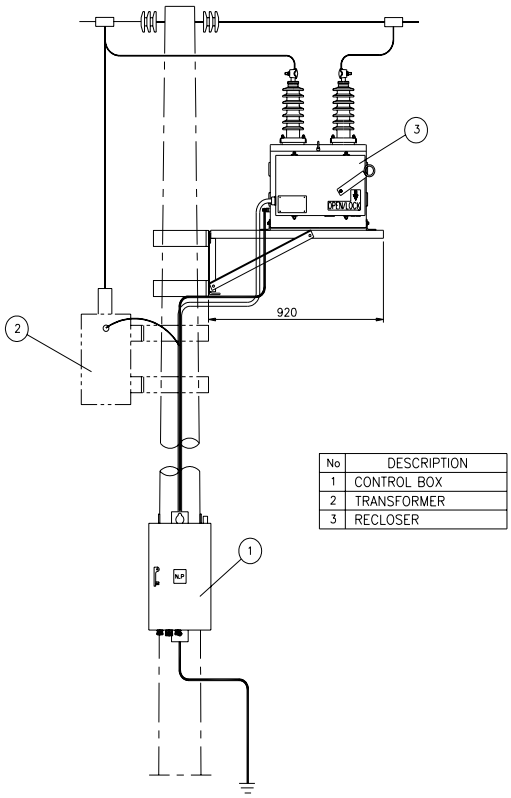
No	Description	Q'ty
1	Hex bolt, nut, Spring washer, Plate washer	4
2	Stud washer	4
3	Hex bolt, nut, Spring washer, Plate washer	4
4	Hex bolt, nut, Spring washer, Plate washer	20
5	Upper band	1
6	Lower band	1
7	Vertical bracket	2
8	Bracket support	2
9	Vertical bracket	2
10	Hanger band "A"	1
11	Hanger band "B"	1

Lifting the recloser

5.3.2 Ground the recloser

Refer to our typical mounting arrangement as shown in figure.
Make ground connections to the recloser ground connector located on the side of the recloser. It will accommodate 22mm2 to 60mm2 steel ground connector. Make ground connections in accordance with approved utility standards.

The following figure shows typical pole type mounting arrangement of the recloser.



Typical pole type mounting arrangement

5.3.3 Install the control

Refer to FTU-R100 microprocessor-based recloser control instruction manual and user's guide for complete recommended grounding instruction. Connect the control cable between the control and main body of the recloser.

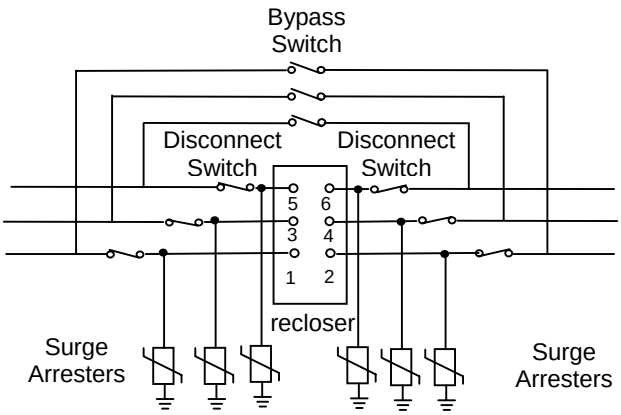
5.3.4 Ground the control

Ground the control using the ground connector provided at the upper of the control cabinet for connecting 22mm^2 to 60mm^2 stranded grounding cable to a suitable ground. Make ground connections in accordance with approved utility standards. Make sure the control is grounded and properly programmed for the planned installing.

5.3.5 Make the high-voltage line connections.

- Provide surge protection to both sides of each recloser.
- Connect high-voltage lines to the recloser bushing terminals.
- Connect the high-voltage lines to the bushing terminals with source leads connected to bushings 1, 3 and 5. of the recloser. The high-voltage bare conductors should be placed in the hole of the clamp type terminals fastened with nut up to tensile torque of 400 ㎏.f/㎠.
  The bare conductor size ranging from 38mm^2 to 240mm^2 is adequate for the connection with the clamp type terminal.

Note: Disconnect switches and bypass switches are recommended to facilitate switching and isolation.



Connection diagram with switches to facilitate

- Block ground sensing via the control.
- Close source and load disconnect switches.
- Close reclosers via control signal.
- Open bypass switches.
- Enable ground sensing, if applicable.

5.4 After installation, checking items

1) High voltage wire insulation distance that is connected to bushing terminal should be checked by each phase.(Phase to phase spacing of high voltage wire must keep more than smallest 250mm).

2) Check installation condition of insulation cover that is mounted to the top end of bushing.

3) Check the Work tool remaining and cleanliness condition on the top of main body and mounting hardware.

4) Check cleanliness condition of bushing.

5) Make sure a position of manual operating and Lock handle (If the lock handle is placed at locking position, it should be manually returned by hot stick and placed at normal position).

6) Make sure a mounting condition of the control cabinet's components such as a batteries, power transformer for power supply, etc.

7) Check a charging condition and capacity of batteries using the battery test button in the control.

8) Check a grounding connection of main body and control cabinet.

9) Check a connection condition of the control cable and power cable.

5.5 Place the recloser in Service

Always follow locally approved procedures and safety practices when placing the recloser in service.
Be sure that 24-volt control back-up battery is properly connected. When the control is connected, the recloser can be placed in service.

1) Move the manual operating and Lock handle (yellow color) to the OPEN (down) position.

2) Close the source and load disconnect switches.

3) Move the manual operating and Lock handle (yellow color) to up position and then close using a close button on the control panel necessarily. This resets the control and synchronizes the control to the recloser. The recloser should immediately close.

4) Open the bypass switch. The recloser is now in service.

5.6 Remove the recloser from Service

1) Follow standard utility procedures for removal of recloser from service.

2) Close the bypass switch.

3) Pull down the manual operating and Lock handle (yellow color) with a hotstick.

4) The manual operating and Lock handle (yellow color) is located on the side of the recloser.

5) Open the source and load disconnect switches.

6) Disconnect the batteries in the control box.

Note: The unit should not be stored or shipped with the batteries connected. Even if the recloser is not in service, connected batteries will still expend energy. Disconnect the batteries when the recloser is not in service.

6. RECLOER OPERATION

Warning

1. Do not reply on the open position of the open/lock handle(yellow color) or the contact position indicator; it does not ensure that the line has been de-energized. Always establish a visible disconnect. Failure to follow proper safety practices can result in contact with high voltage, which will cause severe personal injury.

Caution

1. Pushing the yellow manual operating and Lock handle to the closed position will not close the recloser. All close operations are initiated by the FTU-R100 microprocessor-based recloser control.

6.1 Closing Operation

Closing operation should be performed with a close button on the control panel necessarily. But, before operating the recloser on the control panel, make sure a position of manual open& lock handle. Check whether the manual open&lock handle indicate lock position or not.

Note: When the recloser is closed, the manual operating and Lock handle should be positioned in free condition(upward).

6.2 Opening Operation

The manual operating and Lock handle(yellow color) in the recloser is used to open and lock out the recloser. If the recloser is opened with a manual operating & lock handle, it automatically operates to lockout. So, it disable in the electrical and supervisory closing.

The manual operating and Lock handle is designed to be operated with a hot stick. Pulling down the manual operating and Lock handle open the main contacts of the recloser. Contact position is indicated by the open flag of the contact open indicator. The handle will remain down in the open position and not return upward in the close position.
Therefore, when the recloser is closed, the manual operating and Lock handle should be positioned in free condition.

Note: When the recloser electrically operates to lockout, the open/ lock operating handle will not drop by the open position. The handle remains in the open position only after manual operations are performed.

6.3 Lock Operation

When the manual operating and Lock handle has been manually pulled down into the lock position, any current over the minimum trip rating will cause the control to automatically lock the recloser. The manual operating and Lock handle does not interfere with manual recloser operation or operation via a SCADA trip or close signal. The recloser can be opened or closed manually regardless of the position of the lock handle.

7. MAINTENANCE

Warning

1. Always use a hotstick when working with the recloser. Failure to do so could result in contact with high voltage, which will cause severe personal injury.

Caution

2. The equipment requires routine inspection and maintenance to ensure proper operation. If it is not maintained it may fail to operate properly. Improper operation may cause equipment damage and possible personal injury.

7.1 General

Jin Kwang's reclosers require inspection and maintenance to ensure proper operation.
If the recloser is not adequately maintained, it may fail to operate properly. Even though the recloser has been designed as a low maintenance unit, maintenance interval depends on the local climatic condition. Jin Kwang recommends that the recloser be inspected and maintained for long life.

7.2 Frequency of maintenance

To assure proper and trouble-free operation, reclosers must be maintained when they have operated the equivalent of a rated duty cycle.

Note: ANSI C 37.61, "Guide fot the application, Operation and Maintenance of Automatic Circuit reclosers", gives a procedure for converting the rated standard duty cycle into an equivalent duty cycle based on the actual operating duty of the recloser

7.3 Check the operation of low pressure indicator

The recloser is filled with 0.5kgf/cm^2 of SF_6 gas in normal service, however, if gas pressure drops to **0.1 ~ 0.2kgf/cm^2** or less by means of any cause, a low pressure locking device works to prevent the operation of the switch manually and electrically (from local control panel and from remote location).

At the same time, a low gas pressure indicator located at the side of switch will be shown and a low pressure indicator lamp on the control panel will illuminate to indicate that switch operation has been blocked.

7.4 Check the recloser visually

Inspect each of the bushing for breaks, cracks, burn or heavy pollution and other part of the recloser.

1) If polluted, clean the bushing.

2) If damaged, replace whole of the recloser with new one.

1. OVERVIEW

1.1 Protection of Distribution Lines

Distribution lines have their own equipment outdoors, the types of loads are various, and the configurations of the

networks are flexible and complicated. There are many kinds of fault causes such as direct contact of trees or birds, natural phenomenon of lightning or heavy snow, and fault spread-out due to customer's facilities. Among these faults, most of faults are temporary and the dominant fault type is ground-fault.

For rapid fault detection and fault section isolation, blackout area minimization, many protection devices such as Recloser, Sectionalizer, and Line Fuse are adopted. Among these devices, Automatic Circuit Recloser is the most important protection device, whose main functions are fault current trip and auto-reclosing.

One distribution line has over 2 Reclosers of serial connections or Recloser – Sectionalizer - Line Fuse of serial connections. This configuration is the concept of Primary Protection and Back-up Protection. In other words, protection coordination is required in the way that a protection device nearer to fault point operates first to eliminate the fault and other devices farther from fault point are configured to operate later with time delays.

1.2 Functions of Automatic Circuit Recloser

When a fault occurs on the load side of Recloser installed location, Recloser detects fault current, trips fault current at high speed, and does reclosing actions after the set time to re-activate the faulted section. In case of temporary fault, the fault can be removed by itself according to high-speed trip and dead time before reclosing actions. But, in case of permanent fault, because fault current is still detected after trip and reclosing actions of pre-set counts, Recloser is locked out finally as opened.

Recloser has the time delay element in protection function of its controller and can be freely configured for protection coordination with other protection devices.

1.3 Main Features of FTU-R100

Recloser body is connected serially to distribution line to operate open / close of the line, and Recloser Controller is in charge of measurements of currents, voltages, and other electric values, protection, control, status monitoring, recording, and communication.

FTU-R100 is a kind of IED's (Intelligent Electronic Device) for power system automation, which is a fully digitalized and microprocessor-based control device, and through connecting with this control device, Recloser can play a role of automated protection device.

Main features of FTU-R100 are as follows,

Measurements :

Magnitude and phase angle of voltages & currents (Fundamental frequency)
Sequence components of 3-phase voltages & currents
True RMS, Harmonics and THD of voltages and currents
Active, reactive and apparent power for each phase and 3-phase
Energy (4-quadrant metering)
Displacement Power Factor
Frequency
Phase difference between source and load-side voltage,

Control :

Manual Recloser Open / Close at local or remote (SBO operation)
Interlocking (Gas low, Handle lock, Operator place, Sync. Fail, Live Load)
Battery test

External Trip and Close by contact input (Option)
Enable or disable reclosing & protection function

Protection :

3-stage over current protection
- Fast and Delayed TC trip elements for phase and earth fault : 54-types of Built-in TC Curves & 4 Customized TC Curves
- Definite time over-current element

- Definite time HCT (High Current Trip)

SEF (Sensitive Earth Fault) Detection
Auto-Reclosing (up to 4 shots)
Cold Load protection (pickup adjustment)
Magnetizing Inrush Restraints
Sequence Coordination
Open Line Detection
Phase Sync. Fail Detection
Under Voltage Protection(UVR)
Under Frequency Protection(UFR)

Status Monitoring :

10 Contacts inputs
- Recloser Open / Closed,
- Locked
- Gas Pressure Low
- External AC Power Loss
- Battery over-discharged,
- Enclosure Door Open
- Spare (3 points : Optionally external trip and close command)

Recording :

Event recording with time-stamp
- I/O, Functional, System, Fault, Demand Current & Demand Power

Fault Waveforms
- 8 faults, 32 samples/cycle, 10 cycles

FTU Restart Count
Switch Open Count
Fault Detection Count

Communication Protocols :

SCADA Port : DNP3.0, IEC60870-5-101 (optional) with modem control
Maintenance Port : MODBUS-RTU

2. TECHNICAL DATA

2.1 Environmental Conditions

Altitude	< 2,000m
Wind speed	< 40m/s
Ambient Temperature	- 25 ~ +70°C, KSC 0220/1
Storage Temperature	- 40 ~ +85°C
Humidity	< 95%RH
Dielectric withstand	IEC 60255-5, 2kV
Impulse voltage	IEC 60255-5, 6kV for current input circuit IEC 60255-5, 4kV for voltage, power input & Contacts I/O
Insulation resistance	IEC 60255-5, >500MΩ (DC500V)
High frequency disturbance	IEC 61000-4-12 class 3 (2.5kV)
Fast transient noise	IEC61000-4-4 class 4 (4kV)
Radio frequency noise	IEC 61000-4-3 10V/m
Vibrations	IEC 60255-21-1 class 2
Mechanical Shock	IEC 60255-21-2 class 2
Enclosure protection	IP54

2.2 Inputs / Outputs

Binary Contacts Input : 10 points

DC 24V biased in the control box
Opto-isolation (Viso) : 2,000Vrms
Delay time setting (10~500ms, 5ms step) for each contact input to suppress bouncing
Signals

- Recloser Open
- Recloser Closed
- Recloser Locked
- Gas pressure low
- External AC power fail
- Battery discharged
- Control box door open
- External Trip command (Option)
- External Close command (Option)
- Spare

Binary Contacts Output : 4 points

DC 24V Aux. Relay Contact Pulse Output
Opto-isolation between aux. relay and logic (Viso) : 2,000Vrms
Pulse width of output is variable
Signals & contact rating

- Switch Open or Trip, Close

Rated current	16 A
Rated voltage/max. breaking voltage AC	250Vac/440Vac
Maximum breaking capacity AC	4,000 VA
Make current (max. 4s at duty cycle 10%)	30 A
Dielectric strength	
coil-contacts	5,000 Vrms
open contact circuit	1,000 Vrms
Mechanical Life	> 30 x 10^6 operations
Operate Time	typical 7ms

- Battery Test / Spare

Rated current	10 A at 250VAC/30VDC (PF=1)

	5 A at 250VAC/30VDC (PF=0.4 L/R=7ms)
Make current	10 A
Max. Operating voltage	380 VAC, 125 VDC
Max. switching capacity	2,500VA, 300W (PF=1)
	1,250VA, 220W (PF=0.4 L/R=7ms)
Dielectric strength	
coil-contacts	2,000 Vrms
open contact circuit	1,000 Vrms
Mechanical Life	typical 50 x 10^6 operations
Operate Time	10ms max. (typical 5ms)

Current Input : 4 channel

12.5A maximum (external CT Ratio is 1,000:1 normally)
Burden : below than 1VA
3-phase currents and neutral currents
Isolation by auxiliary CT of RTU (Viso) : 2,000Vrms
Surge withstand voltage : 6kV
Signals
- Ia : A-phase current
- Ib : B-phase current
- Ic : C-Phase current
- In : Neutral current

Voltage Input : 6 channel

4Vrms at rated phase voltages
Burden : below than 0.01VA
Maximum input range : ~ 200%
Isolation by auxiliary PT of RTU (Viso) : 2,000Vrms
Surge withstand voltage : 4kV
Signals
- Va : A-phase voltage
- Vb : B-phase voltage
- Vc : C-Phase voltage
- Vr : R-phase voltage
- Vs : S-phase voltage
- Vt : T-Phase voltage

Power Supply Input

DC 24V (DC20 ~ 29V)
Power consumption : Max. 15W

2.3 Measurements

Current

RMS (A) & Phase angle (^{0})	Ia, Ib, Ic, In	
Sequence Component	I_1 ,I_2 , I_0	
True RMS	Ia, Ib, Ic	
Reading range	2 ~ 12,500A (External CT ratio 1000:1)	
Accuracy	2 ~ 600A	: ±0.5% or ±1A
	600~12,000A	: ±3%

Voltage

RMS (A) & Phase angle (^{0})	Va, Vb, Vc, Vr, Vs, Vt
Sequence Component	V_{1S} (positive seq.), V_{2S} (negative seq.),V_{0S} (zero seq.)

	V_{1L} (positive seq.), V_{2L}(negative seq.),V_{0L} (zero seq.)
True RMS	Va, Vb, Vc, Vr, Vs, Vt
Phase angle difference(^{o})	∠Va - ∠Vr
Reading range	0.1 ~ 26kV
Accuracy	±0.5% or ±0.1kV

Power

Active power (kW)	A phase, B phase, C phase, 3 phase total
Reactive power (kVAR)	A phase, B phase, C phase, 3 phase total
Apparent power (kVA)	A phase, B phase, C phase, 3 phase total
Reading range	0 ~ 32767
Accuracy	±1%

Power factor

A phase, B phase, C phase, 3 phase total
Lead/lag display

Reading range	0 ~ 1.00
Accuracy	±2%

Frequency

Reading range	45 ~ 55Hz (system frequency: 50Hz) 55 ~ 65Hz (system frequency: 60Hz)
Accuracy	±0.02Hz

Energy

Export active energy (kWh)	A phase, B phase, C phase, 3 phase total
Import active energy (kWh)	A phase, B phase, C phase, 3 phase total
Capacitive reactive energy (kVARh)	A phase, B phase, C phase, 3 phase total
Inductive reactive energy (kVARh)	A phase, B phase, C phase, 3 phase total
Reading range	0 ~ 65535 (Rollover)
Accuracy	±2%

Harmonics

Total harmonic distortion (THD, %)

	3-phase currents THD (Ia, Ib, Ic, I3ph) Source side 3-phase voltages THD (Vsa, Vsb, Vsc, Vs3ph) Load side 3-phase voltages THD (Vla, Vlb, Vlc, Vl3ph)
2^{nd} ~ 8^{th} harmonics RMS (A, kV)	Ia,Ib,Ic,Va,Vb,Vc,Vr,Vs,Vt

Demand current and power

Configurable demand interval	5, 10, 15min

Ia, Ib, Ic, Pa, Pb, Pc, P3ph, Qa, Qb, Qc, Q3ph
Daily max. currents and power are stored.

2.4 Communications

Physical Layer

RS232C, 9-pin male connector	DCD(1), RX(2), TX(3), DTR(4), GND(5) DSR(6), RTS(7), CTS(8), NC(9)
Speed (Baud rate)	1200, 2400, 4800, 9600, 19200 BPS
Supports modem control	RTS, CTS, DCD, DTR, DSR CTS, DCD signal timeout configurable RTS off-delay configurable

Optical isolation
ESD, Transient noise protection

DNP 3.0 Protocol

Supports DNP 3.0 Subset level 2
Class of each point is settable
Supports multi-frame transmission (multi-frame interval is configurable)
Enable/Disable unsolicited message class
Supports file transfer function for uploading fault waveform or local event history
Non-transmitted events are stored on non-volatile memory during communication fail
Event buffer size : BI (254), AI(127), Counter(19)
Supports direct operate or select before operate (SBO) for control output
Supports report by exception for analog values
Protocol frame monitor was built in FTU

IEC60870-5-101 Protocol is supported (Optional)

2.5 Display & Operation panel

Setting & Information View

20 characters * 4 lines LCD with LED backlight
Button : Menu, Increase, Decrease, Enter
Function setting (4 setting groups), FTU configuration
Events display
Measurements display

Control Buttons

Operator place select button : Local / Remote
Two step switch control buttons : Select, Open, Close
Battery test button
Annunciator reset button
Reclosing enable button, Protection enable button, Ground protection enable button

LED indicators

Switch status : open, closed
Control status : selected, remote position, battery testing
Function status : A phase fault, B phase fault, C phase fault, ground fault, SEF(selective earth fault), high current trip, sync. fail between load-side and source-side voltages, live line (source-side), live line (load-side)
Reclosing status : ready, progress, lockout
FTU status : CPU run, System error, AC power on, battery low
Communication status : Rx, Tx, RTS

Serial port

RS232C without flow control
PC maintenance tool link
Firmware upgrade

2.6 Digital Processor

Dual Processor architecture

32-bit RISC type micro-controller with on-chip flash program memory
32-bit floating-point digital signal processor

Dual-port memory for communication between two processors
Data memory (SRAM)
Non-volatile memory (128kBytes) for storing events and parameters
Flash Memory for storing fault waveforms
Real-time clock

Analog/Digital conversion

16-bit A/D converter
Sampling rate : 64 samples/cycle
Anti-aliasing analog filter
Two different gain channel for each current input : effective 16-bit resolution for current measurements

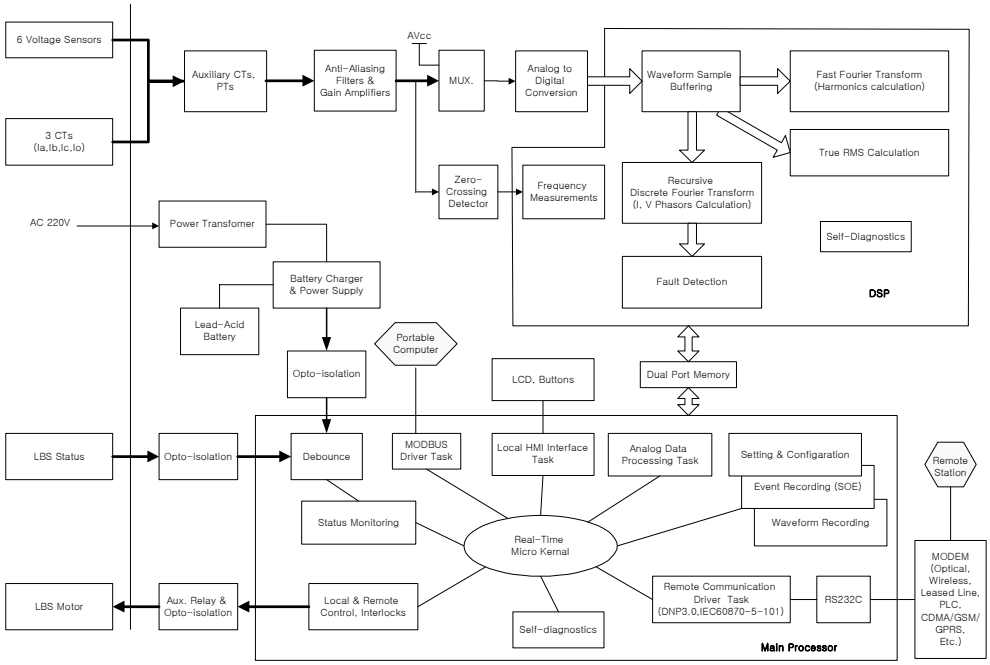
DSP

Correction of analog input error
Discrete Fourier Transform: phasor calculation
Electric quantities calculation & fault decision

CPU

Status monitoring & control
Local Human-Machine Interface
Event & fault recording
Remote communication
Self-diagnosis

Functional Block Diagram



2.7 Settings

2.7.1 Fault Detection

Phase fault detection
FTU detects the phase fault and trip the breaker. The fastest operating time is within 45ms including

auto-recloser operating time. There are 58 trip curves, which can be selected for fast and delayed operation respectively. The curve can be edited by using several parameters, i.e. time multiplier, time adder, minimum response time. And high current trip element can be used for instantaneous trip. It's definite time characteristics. During cold-load condition, pickup multiplied by cold-load multiplier. During this condition, time-delayed curve is applied instead of fast curve. This function can be enabled or disabled by "protection enable" button.

- Pickup current (I>) 10 ~ 900A (1A step)
- Fast TC curve 1 ~ 58 (1 step)
- Fast time multiplier 0.10 ~ 2.00 (0.01 step)
- Fast time adder 0.00 ~ 1.00sec (0.01sec step)
- Fast min. response time 0.00 ~ 1.00sec (0.01sec step)
- Fast reset type RDMT(Definite)/RIDMT(Inverse time)
- Fast reset definite time 0.00 ~ 100.00sec (0.01sec step)
- Delayed TC curve 1 ~ 58 (1 step)
- Delayed time multiplier 0.10 ~ 2.00 (0.01 step)
- Delayed time adder 0.00 ~ 1.00sec (0.01sec step)
- Delayed min. response time 0.00 ~ 1.00sec (0.01sec step)
- Delayed reset type RDMT(Definite)/RIDMT(Inverse time)
- Delayed reset definite time 0.00 ~ 100.00sec (0.01sec step)
- Definite time OC on/off ON/OFF
- Definite time OC pickup (I>>) 50 ~ 10,000A (1A step)
- Definite time OC response time 0.00 ~ 1.00sec (0.01sec step)
- High current pickup (I>>>) 50 ~ 10,000A (1A step)
- High current trip response time 0.00 ~ 1.00sec (0.01sec step)
- Cold-load multiplier 0 ~ 10 (1 step)
- Inrush restraint Yes/No

Earth fault detection

Earth fault detection has the same characteristics as the phase fault detection. This function can be enabled or disabled by "ground protection enable" button.

- Pickup current (Io>) 5 ~ 900A (1A step)
- Fast TC curve 1 ~ 58 (1 step)
- Fast time multiplier 0.10 ~ 2.00 (0.01 step)
- Fast time adder 0.00 ~ 1.00sec (0.01sec step)
- Fast min. response time 0.00 ~ 1.00sec (0.01sec step)
- Fast reset type RDMT(Definite)/RIDMT(Inverse time)
- Fast reset definite time 0.00 ~ 100.00sec (0.01sec step)
- Delayed TC curve 1 ~ 58 (1 step)
- Delayed time multiplier 0.10 ~ 2.00 (0.01 step)
- Delayed time adder 0.00 ~ 1.00sec (0.01sec step)
- Delayed min. response time 0.00 ~ 1.00sec (0.01sec step)
- Delayed reset type RDMT(Definite)/RIDMT(Inverse time)
- Delayed reset definite time 0.00 ~ 100.00sec (0.01sec step)
- Definite time OC on/off ON/OFF
- Definite time OC pickup (Io>>) 50 ~ 10,000A (1A step)
- Definite time OC response time 0.00 ~ 1.00sec (0.01sec step)
- High current pickup (Io>>>) 50 ~ 10,000A (1A step)
- High current trip response time 0.00 ~ 1.00sec (0.01sec step)
- Cold-load multiplier 0 ~ 10 (1 step)
- Inrush restraint Yes/No

Sensitive earth fault (SEF) detection

FTU can decide whether the earth fault occurred in it's own feeder or not selectively in ungrounded network. It has directional elements which is polarized by the calculated zero sequence voltage. It can be used only for alarm

- Pickup current (Io) 2 ~ 20A (1A step)
- Pickup voltage (Vo) 10 ~ 80% of rated phase voltage (1% step)
- Max. torque angle 0,30,60,90,270,300,330° Leading

- Detection time 0.1 ~ 30.00 sec (0.1sec step)
- Inrush restraint Yes/No
- Operation select Off/Alarm/Trip

Inrush detection
This function can be used to detect magnetizing inrush condition by comparing 2nd harmonic component to fundamental frequency component of current.

- 2nd harmonic pickup (%) 5 ~ 50% (1% step)
- Detection time 0.02 ~ 1.00 sec (0.01sec step)
- Operation select On/Off

Reclosing sequence
3-shot reclosing with sequence coordination.

- Phase Total Operation Count 1 ~ 4 times (1 step)
- Ground Total Operation Count 1 ~ 4 times (1 step)
- Phase Inst. Total Operation Count 0 ~ 4 times (1 step)
- Ground Inst. Total Operation Count 0 ~ 4 times (1 step)
- Phase HCT Operation Count 0 ~ 4 times (1 step)
- Ground HCT Operation Count 0 ~ 4 times (1 step)
- 1st dead time (reclosing time) 0.5 ~ 180sec (0.1sec step)
- 2nd dead time (reclosing time) 1 ~ 60sec (1sec step)
- 3rd dead time (reclosing time) 1 ~ 60sec (1sec step)
- 4th dead time (reclosing time) 1 ~ 60sec (1sec step)
- Reset time 3 ~ 180sec (1sec step)
- Cold-load duration 0.00 ~ 60.00sec (0.01sec step)
- Cold-load pickup restore time 0.00 ~ 30.00sec (0.01sec step)
- Sequence Coordination On / Off

2.7.3 Phase Sync. Check

- Phase difference pickup (°) 5 ~ 60° (1° step)
- Detection time 0.1 ~ 30.0 sec (0.1sec step)
- Operation select On/Off

2.7.4 Under-Frequency Detection

- Pickup 40 ~ 60Hz (0.1Hz step)
- Detection time 0 ~ 600 sec (0.01sec step)
- Operation select Off/LO/NR

2.7.5 Under-Voltage Detection

- Pickup 2.8 ~ 21.9 kV(0.1kV step, Phase-ground voltage)
- Detection time 0 ~ 200 sec (0.1sec step)
- Operation select Off/LO/NR

2.7.6 Setting group select

- Active setting group 1 ~ 4 (step : 1)

2.7.7 I/O configuration

- System frequency 50 or 60Hz
- Rated phase voltage 3.80 ~ 21.00kV (0.01kV step)

- External CT ratio 200 ~ 2000 (10 step)
- External neutral CT ratio 200 ~ 2000 (10 step)
- Demand interval 5 ~ 15min. (5min. step)
- Live load close blocking Yes, No
- Sync. Fail close blocking Yes, No
- DI debounce delay time for DI1..10 10 ~ 500ms (5ms step)
- DO pulse width for DO1..4 10 ~ 2000ms (10ms step)
- FI (Fault Indicator) reset Manual/Auto
- Phase rotation A-B-C / A-C-B

2.7.8 Communication configuration

- Baud rate 1200,2400,4800,9600,19200 Bps
- Protocol DNP / IEC (Factory setting)
- Modem line topology 2 wires (half-duplex) / 4 wires (full-duplex)
- RTS Off delay 10 ~ 500ms (5ms step)
- CTS checkout time 1 ~ 255s (1s step)
- DCD wait time 0.1 ~ 30.0s (0.1s step)

2.7.9 DNP3.0 protocol configuration

- Data link retry count 0 ~ 2 (1 step)
- Data link timeout 1 ~ 255s (1s step)
- Data link confirm Yes/No/Sometimes
- Application retry count 0 ~ 2 (1 step)
- Application retry timeout 1 ~ 255s (1s step)
- Initial unsolicited message Yes/No
- Unsolicited message delay 0 ~ 60s (1s step)
- SBO timeout 1 ~ 255s (1s step)
- Unsolicited destination address 0 ~ 65534 (1 step)
- Frame interval 10 ~ 500ms (10ms step)
- Class for BI objects (BI0~BI31) 0 ~ 3 (1 step)
- Class for AI objects (AI0~AI31) 0 ~ 3 (1 step)
- Class for Special AI objects 0 ~ 3 (1 step)
- Class for CNT objects (CNT0~22) 0 ~ 3 (1 step)
- VOC for AI objects (AI0~AI31) 0 ~ 50% (1% step)
- VOC lower limit for AI objects 0 ~ 65535 (1 step)
- VOC for CNT objects (CNT0~22) 0 ~ 65535 (1 step)

2.7.9 IEC60870-5-101 protocol configuration

- Cyclic period 0 ~ 60s (1 step)
- SBO timeout 1 ~ 255s (1s step)

2.8 Recording

2.8.1 Event recording

- 5msec Sequence-of-events are stored on non-volatile memory
- Storage size

I/O events	1023
Function events	1023
System events	63
Fault current events	127
Demand currents and power	511
Max. Currents and power	31

2.8.2 Waveform recording

- 32 samples/cycle, 10 cycle
- max. 8 fault waveforms can be captured on non-volatile memory

2.8.3 Counters

- FTU restart count
- Switch open count
- Fault count : a, b, c, n, all

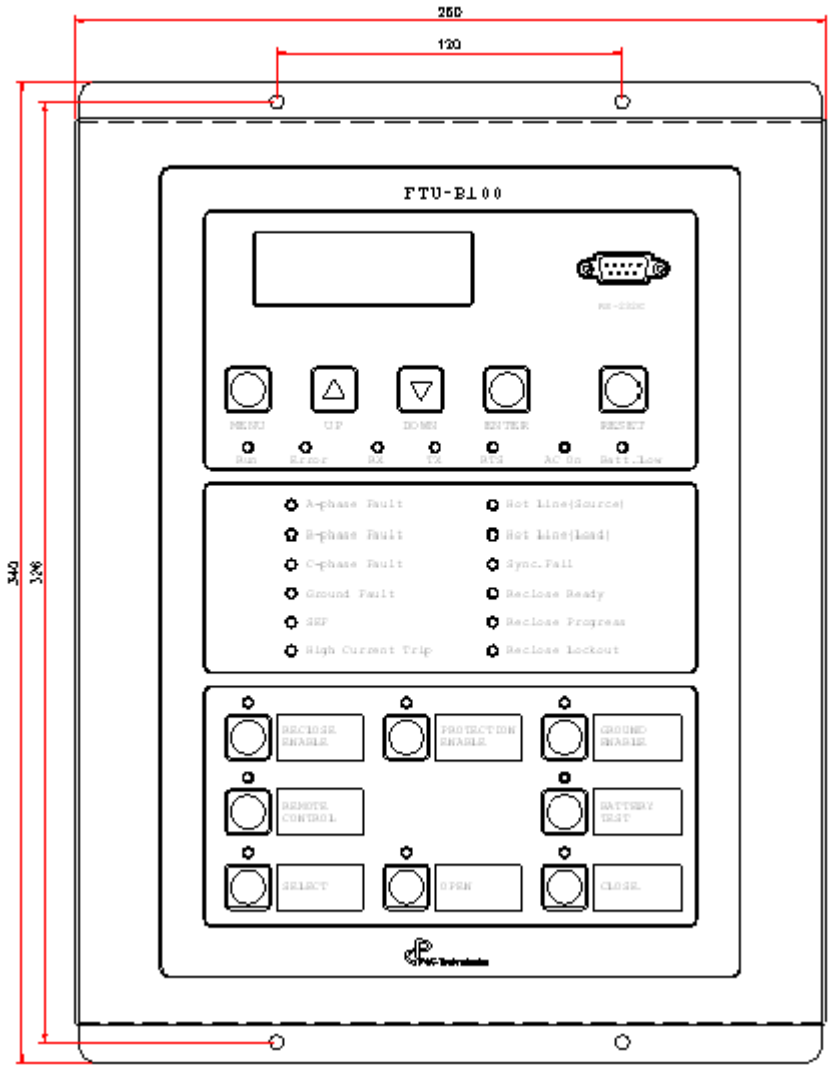
2.9 Maintenance software

- Microsoft Windows based application S/W connected to the serial port of front panel
- The software can be connected at remote station via DNP3.0 (optional IEC60870-5-101)
- Function setting upload & change
- FTU configuration upload & change
- Event upload & display
- Status monitoring & switch control
- Measurements display
- Waveform data uploading & graphical display
- Protocol monitor
- File & print operation
- Custom curve editing

3. CONSTRUCTION AND EXTERNAL CONNECTION

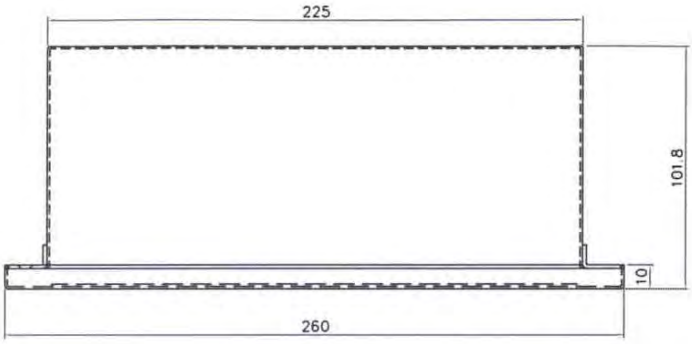
3.1 Appearance & Dimension

Front panel of FTU-R100 has an operational LCD display, a RS232C port for setting and maintenance, indicating LED's, and push buttons.



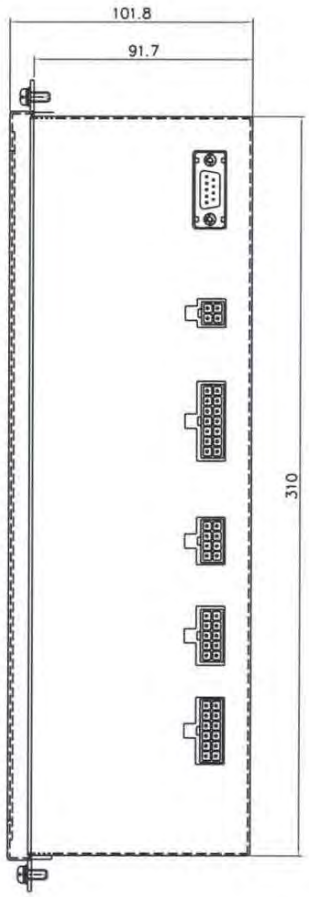
[Fig. 3-1] Front Panel Drawing of FTU

The following is the Top-view of FTU-R100 panel.



[Fig. 3-2] Top View of FTU Panel

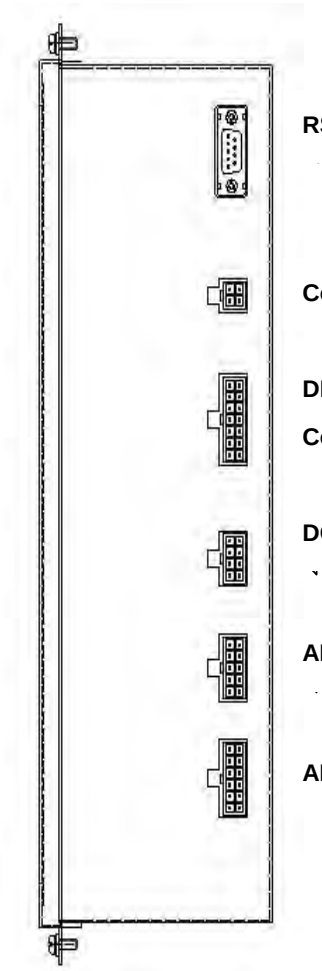
The next drawing is Side-view of FTU-R100 panel, and there are measurement module connector, control module connector, monitoring module connector, power connectors, and RS232 port for SCADA communication on the right side of FTU panel.



[Fig. 3-3] Side View of FTU Panel

3.2 Connectors of FTU

On the right side of FTU-R100 panel, there are RS232 communication port to SCADA, control source power connector, DI (Status Monitoring) connector, DO (Control) connector, AI (Measurement) connectors for Voltage and Current from top to bottom. RS232C port is DB9 male-type connector.



RS232C (SCADA Port)

Pin 1	: DCD	Pin 6	: DSR
Pin 2	: RX	Pin 7	: RTS
Pin 3	: TX	Pin 8	: CTS
Pin 4	: DTR	Pin 9	:
Pin 5	: GND		

Control Source Connector

DC-	DC+	3
FG	FG	1

DI (Status) Connector

COM4	Spare	COM3	Close Cmd.*	COM2	Trip Cmd.*	Door Open	8
Over-discharge	Ext.AC Loss	COM1		Handle Lock	Close	Open	1

DO (Control) Connector

Spare	Spare	Battery Test	Battery Test	5
Close	Close	Open	Open	1

AI (Voltage) Connector

Vt	Vr		Vcom (Source)	Vb	6
Vs	Vcom (Load)		Vc	Va	1

AI (Current) Connector

Io (-)	Io (+)	In	Ic	Ib	Ia	7
Io (-)	Io (+)	In	Ic	Ib	Ia	1

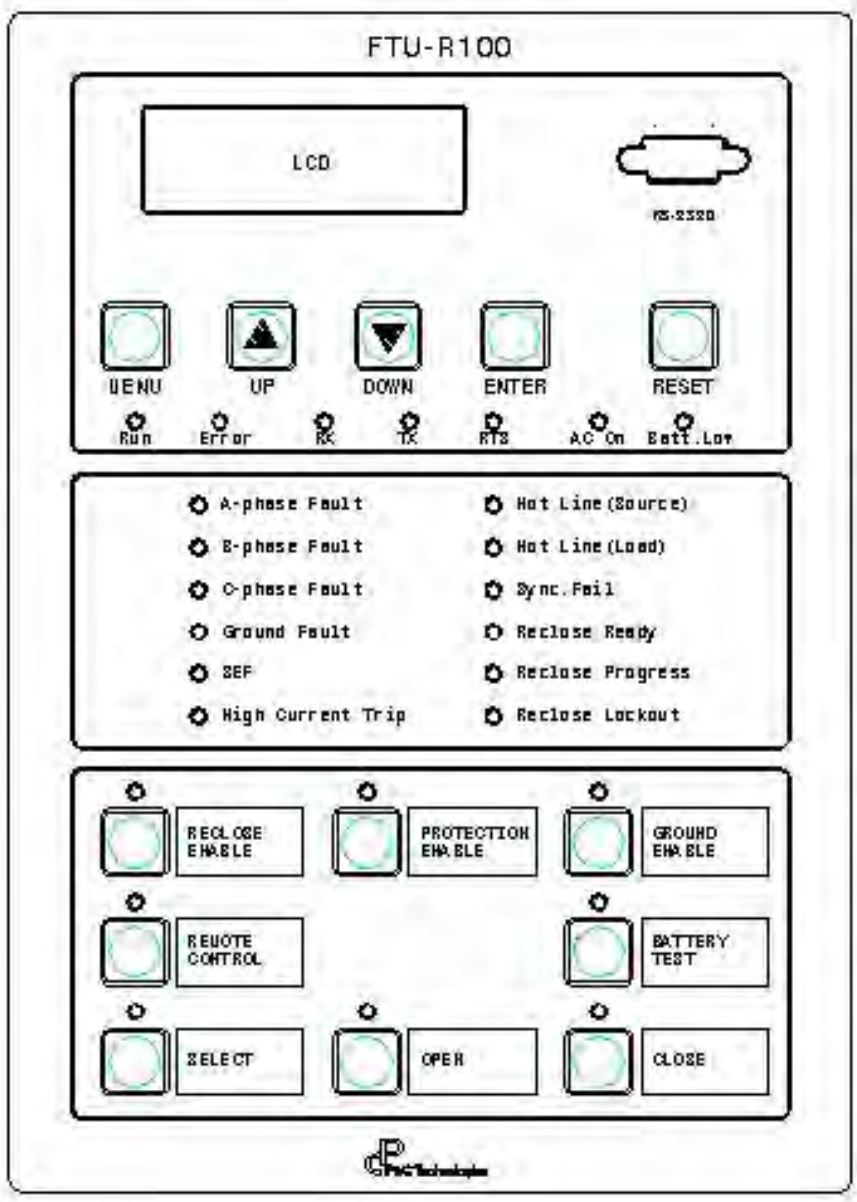
* Optional

[Fig. 3-4] Pin Connectors on the Right Side of FTU-R100

4. FRONT PANEL OPERATIONS

4.1 Button & LED Description

On the front panel, there are LED's indicating Recloser's status, function buttons and LED's, control buttons and LED's, LCD buttons, and a RS232 port for maintenance.



[Fig. 4-1] Front Panel Sheet of FTU-R100

(1) LCD Display

4 lines * 20 characters LCD is used and through MENU / UP / DOWN / ENTER / RESET buttons, operators can survey all data and correct set values.

(2) RS232 Communication Port

Engineering tool on Notebook computer is connected to this port for maintenance. RS232C port for maintenance is DB9 female-type connector.

(3) MENU/UP/DOWN/ENTER Buttons

These buttons are used to operate FTU-R100 in local position. Refer to Section 4.2 LCD Manipulation for detailed methods.

(4) RESET Button

This button is used for Annunciator LED Reset (LED Off). Annunciator LED represents all the LED's related to Protection, Reclosing, and Self-diagnosis Error.

(5) Run / Error / Rx / Tx / RTS / AC on / Batt. Low LED's

These LED's indicate status of FTU-R100.

- Run LED is on, when normal operation of FTU (CPU OK).
- Error LED is on, when Self-diagnosis Error & Communication Trouble.
- Rx LED is on, when communication data are received.
- Tx LED is on, when transmitting communication data.
- RTS LED is on, on data transmission request.
- AC On LED is on, when External AC Power is supplied.
- Batt. Low LED is on, when battery voltage is low (discharged).

(6) A-Phase/B-Phase/C-Phase/Ground Fault & SEF LED's

Each LED is on, when a fault related to each faulted phase occurs. For earth fault of non-grounded networks, SEF LED is on. In Auto FI Reset mode, after fault restoration, these fault indicating LED's are automatically reset (off). On the other hand, in Manual FI Reset mode, operators should do command action for Reset, locally or remotely, to extinguish these LED's. Manual FI Reset mode is for the operator's acknowledgement purpose.

(7) High Current Trip (HCT) LED

When tripped by a fault current over the set HCT pickup level, this LED is on. HCT function is similar to Instantaneous Protection Element in protective relays.

(8) Hot Line (Source/Load) LED's

These LED's indicate if the lines to source side and load side are activated or deactivated. LED's are on, when the line voltage goes up the set Voltage On Level and LED's are off, when the voltage goes down the set Voltage Off Level.

(9) Sync. Fail LED

This LED is on, when the phase angle difference between Source-side voltage (Va) and Load-side voltage (Vr) is over the set value. In this case, Close control command should be inhibited.

(10) Reclose Ready LED

This LED is on, when the reclosing action is normally operated. This represents the normal stand-by status for reclosing action.

(11) Reclose Progress LED

This LED indicates the status that reclosing action is normally processed according to the preset tripping and reclosing operation sequences.

(12) Reclose Lockout LED

This LED is on, when the reclosing action is locked out to open according to the operation sequences or the Recloser is opened by the manual control command.

(13) RECLOSE/PROTECTION/GROUND ENABLE Buttons and LED's

Push the Enable buttons and makes the respective LED's on to fulfill the Reclosing and Protection functions. These buttons are toggled between Enable and Disable.

- RECLOSE ENABLE button enables or disables the Reclosing Function.
  In Disable mode, the Recloser is locked out right after the 1st trip.
- PROTECTION ENABLE button enables or disables Phase Fault Detection and
  Earth Fault Detection Functions, simultaneously.
- GROUND ENABLE button enables or disables Earth Fault Detection Function only.

(14) REMOTE CONTROL Button and LED

To decide the control position to Remote, push this button and make the LED on. This button and LED are also toggled between Remote and Local. But, the manipulation of this button is possible only in the local for operator's safety.

(15) BATTERY TEST Button and LED

To test the battery and charger circuit, push this button. When the test result is OK, green color LED is on for 3 seconds and off thereafter. Otherwise, LED is not on.

(16) SELECT/OPEN/CLOSE Buttons and LED's

These buttons are used to locally control (Open / Close) the Recloser. Before local control command, check first if the control position is Local. SELECT button is a two-phase safety & confirmation check mechanism, and this concept is similar to SBO (Select Before Operate) in communication protocol. To manually and locally control the Recloser, SELECT button should be pushed down to make the corresponding LED on, and this SELECT function can be expanded to the scheme of Multiple Reclosers Control in the future.

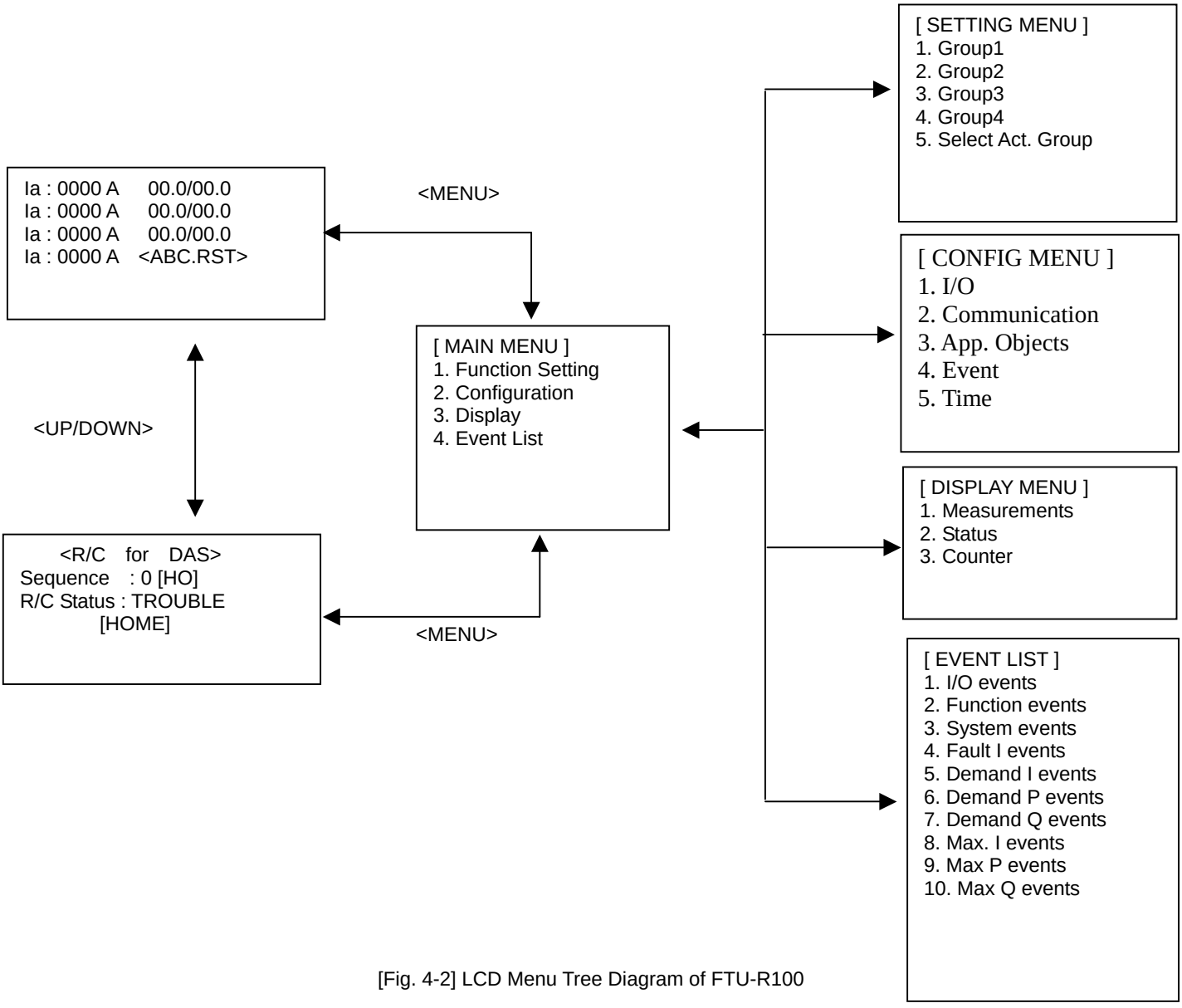
- SELECT → CLOSE : Push this button to control the Recloser manually to be closed. After closing, normal fault detection functions are re-performed. In case that Cold Load Pickup function is off or the load current is below the Cold Load
  Pickup Level, normal Phase & Ground Fault Detection is functioned.
- SELECT → OPEN : Manual open control opens the Recloser and makes the switch locked out to open.

4.2 LCD Manipulation

MENU / UP / DOWN / ENTER buttons are used to manipulate the LCD. The following table explains the common roles of 4 buttons.

Button	Description
MENU	- To toggle between Main Menu Display from Initial Display - To come back to Parent Menu from Child Menu - Be careful, because all the set value changes are canceled when this button is pushed down during the change of set values.
ENTER	- To select and enter into each menu item - To enter the changed set value and configuration - After entering the changed set value, this button again goes out from each item to menu tree. (Toggle between menu tree and each menu item) - After changing the set values, be sure to save the changed values in the Set Value Change Save Menu.
UP	- To move up the cursor in the menu tree - To increment the set values - The set values are rolled up and UP button at the highest value goes to the lowest value.
DOWN	- To move down the cursor in the menu tree - To decrement the set values - The set values are rolled down and DOWN button at the lowest value goes to the highest value.

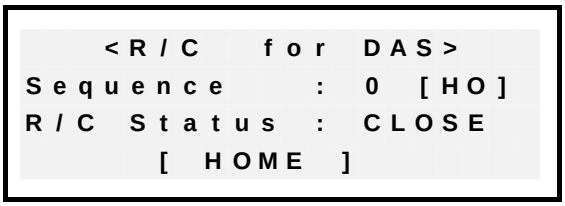
4.2.1 LCD Menus



[Fig. 4-2] LCD Menu Tree Diagram of FTU-R100

(1) Initial Display

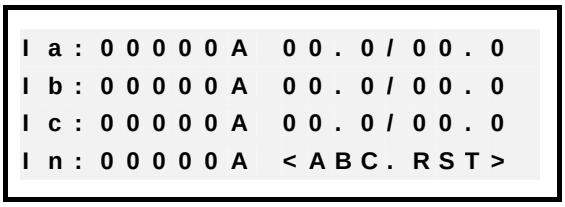
[Initial Display] shows up the reclosing status.



[Fig. 4-3] [Initial Display]

MENU button at [Initial Display] goes to [Main Menu Display]. MENU button toggles between [Initial Display] and [Main Menu Display].

UP or DOWN button at [Initial Display] goes to [Current / Voltage Measurement Display]. UP / DOWN button toggles between [Initial Display] and [Current / Voltage Measurement Display].



[Fig. 4-4] [Current / Voltage Measurement Display]

- Reclosing Sequence : 0, 1, 2, 3, 4 and 5
  - Total Reclosing Shot 4 Times : 0[HO], 1~4[SR], 5[LO]
    - ※ HO : Home
    - ※ SR : Sequence Running
    - ※ LO : Lock Out
- R/C Status : CLOSE / OPEN / TROUBLE (No Status Input)
- Current (Ia,Ib,Ic,In) : Each Phase Instantaneous Current Value (unit : A)
- Voltage (ABC.RST) : Source Side Voltage (Va,Vb,Vc) / Load Side Voltage (Vr,Vs,Vt), (unit : kV)

(2) Main Menu Display

[Main Menu Display] shows up 4 main menu items. And UP & DOWN buttons move up and down the main menu trees. “>” symbol indicates the cursor position and ENTER button enters into the selected main menu’s sub items.

[Table 4-1] Main Menus and Sub Items

Main Menus	Sub Items
Function Setting	Group1, Group2, Group3, Group4, Select Act. Group
Configuration	I/O, Communication, App. Objects, Event, Time
Display	Measurements, Status, Counter
Event List	I/O events, Function events, System events, Fault I events, Demand I events, Demand P events, Demand Q events, Max. I events, Max. P events, Max. Q events,

(3) Function Setting

In Function Setting, there are 4 different setting groups and the different setting values can be stored individually

in 4 different setting groups. Select Act. Group determines one of 4 setting groups, whose setting values are now applied. From Group1 to Group4, each group has the same setting items and the following table describes only the detailed setting items of Group 1. For other groups, the same setting items as Group 1 can be referred to.

[Table 4-2] Function Setting Menus

Function Setting	Setting Items	Sub Setting Items (1)	Sub Setting Items (2)	Setting Ranges <step>	Default
Group1	**Fault Detection**	**Phase** F : Fast D : Delayed	**Pickup Level**	10-900 <1A>	400
			F TCC Type	1-58 <1>	1
			F Multiplier	0.10-2.00 <0.01>	1.00
			F Time Adder	0.00-1.00 <0.01s>	0.00
			F Min. Resp. Time	0.00-1.00 <0.01s>	0.00
			F-Reset Type	0(RDMT)/1(RIDMT)	0(RDMT)
			F-Reset time	0.00-10.00 <0.01s>	0.00
			D TCC Type	1-58 <1>	2
			D Multiplier	0.10-2.00 <0.01>	1.00
			D Time Adder	0.00-1.00 <0.01s>	0.00
			D Min. Resp. Time	0.00-1.00 <0.01s>	0.00
			D-Reset Type	0(RDMT)/1(RIDMT)	0(RDMT)
			D-Reset time	0.00-10.00 <0.01s>	0.00
			HCT Level	50-10000 <1>	2000
			HCT Resp. Time	0.00-1.00 <0.01s>	0.00
			Cold L Multi	0-10 <1>	4
			Inrush Block	1(Yes) or 0(No)	1(Yes)
		Ground	**Pickup Level**	5-900 <1A>	60
			F TCC Type	1-58 <1>	20
			F Multiplier	0.10-2.00 <0.01>	1.00
			F Time Adder	0.00-1.00 <0.01s>	0.00
			F Min. Resp. Time	0.00-1.00 <0.01s>	0.00
			F-Reset Type	0(RDMT)/1(RIDMT)	0(RDMT)
			F-Reset time	0.00-10.00 <0.01s>	0.00
			D TCC Type	1-58 <1>	21
			D Multiplier	0.10-2.00 <0.01>	1.00
			D Time Adder	0.00-1.00 <0.01s>	0.00
			D Min. Resp. Time	0.00-1.00 <0.01s>	0.00
			D-Reset Type	0(RDMT)/1(RIDMT)	0(RDMT)
			D-Reset time	0.00-10.00 <0.01s>	0.00
			HCT Level	50-10000 <1>	2000
			HCT Resp. Time	0.00-1.00 <0.01s>	0.00
			Cold L Multi	0-10 <1>	2
			Inrush Block	1(Yes) or 0(No)	1(Yes)

		SEF	**I-Pickup**	2-20 <1A>	5
			V-Pickup	10-80 <1%>	30
			Angle	+/- 0,30,60,90	90
			Detect Time	0.1-30.0 <0.1s>	1.0
			Inrush Block	1(Yes) / 0(No)	1(Yes)
			Func. In Use	0(Off)/1(Alarm)/ 2(Trip)	0(Off)
		Inrush Detection	**2nd Harmonic**	5-50 <1%>	20
			Detect Time	0.02-1.00 <0.01s>	0.02
			Func. In Use	1(On) / 0(Off)	1(On)
	Sync. Check	**Phase Diff.**		5-60 <1D>	30
		Delay Time		0.1-30.0 <0.1s>	0.1
		Func. In Use		1(On) / 0(Off)	1(On)
	Under Frequency Protection	**Pickup Level**		40~60<0.1>	
		Detect Time		0~600<0.01s>	
		Func. In Use		Off/LO/NR	
	Under Voltage Protection	**Pickup Level**		2.8~21.9<0.1>	
		Detect Time		0~200<0.1s>	
		Func. In Use		Off/LO/NR	
	Trip & Reclosing	**Ph. Oper Cnt** (Phase Time-delayed)		1-4 <1>	4
		Gnd Oper Cnt (Ground Time-delayed)		1-4 <1>	4
		PF Oper Cnt (Phase Instantaneous)		0-4 <1>	2
		GF Oper Cnt (Ground Instantaneous)		0-4 <1>	2
		Ph. HCT Op Cnt (Phase HCT)		0-4 <1>	0
		Gnd HCT Op Cnt (Ground HCT)		0-4 <1>	0
		Dead Time 1st (Reclose Interval)		0.5-60 <0.1s>	0.6
		Dead Time 2nd		1-60 <1s>	2
		Dead Time 3rd		1-60 <1s>	15
		Dead Time 4th		1-60 <1s>	15
		Reset Time (Reclosing Reset Time)		3-180 <1s>	30
		Cold L Time (Cold Load Duration)		0.00-60.00 <0.01s>	3.00
		Reset. PC Time (Cold Load Pk Restore Time)		0.00-30.00 <0.01s>	0.30
		Seq. Coordi.		1(On) / 0(Off)	0(Off)
Group2	Same Setting Items and Sub Setting Items as Group 1				
Group3					
Group4					
Select Act. Group		Active Setting Group Selection		1-4 <1>	1

After finishing the set value change, when MENU button is pushed to return to [Main Menu Display], [Set Value Change Save Display] shows up to determine Yes or No. If selecting Yes and pushing ENTER button, the changed set values are all saved. However, if selecting No and ENTER button, or MENU button again, the changed set values are not saved and the existing set values are still applied.
* CAUTION: Be careful not to push down MENU buttons repeatedly! Then, the newly changed set values are neither saved nor applied.

[Fig. 4-5] [Set Value Change Save Display]

[Fig. 4-6] [ENTER to Yes]

[Fig. 4-7] [ENTER to No]

(4) Configuration

Configuration menu has the setting items for communication, I/O, and system configuration. Setting items are I/O, Communication, App. Objects, Event, and Time. The following table describes each setting item and the corresponding setting range.

Configuration	Setting Items	Sub Setting Items	Setting Ranges <step>
I/O	**AC Rating**	**Frequency**	50 or 60
		Rated Volt.	3.80-21.00 <0.01kV>
		CT Ratio	100-2000 <10>
		NCT Ratio	100-2000 <10>
		Average Interval	5-15 <5min>
	DI Debounce Time	**DI1 ~ DI10**	10-500 <5ms>
	DO Pulse Width	**DO1 ~ DO4**	10-2000 <10ms>
	FI Reset Select	**FI Reset**	0(Manu.) / 1(Auto)
	Interlock	**Live load**	0(No) / 1(Yes)

		Sync. Fail	0(No) / 1(Yes)
Communication	**SCADA Port**	**Comm. Speed**	1200/2400/4800/9600/19200
		Slave Addr.	0-65534 <1>
		Protocol	0(DNP) / 1(IEC)
	Modem Control	**Comm. Line**	2 or 4 wire
		RTS Off Delay	10-500 <10ms>
		CTS Timeout	1-255 <1s>
		DCD Timeout	0.1-30.0 <0.1s>
	Protocol Parameter	**D/L Retry**	0-2 <1>
		D/L Timeout	1-255 <1s>
		D/L Confirm	0(No)/1(Yes)/2(Sometime)
		A/L Retry	0-2 <1>
		A/L Timeout	1-255 <1s>
		Initial Unsol.	0(No) / 1(Yes)
		Unsol. Delay	0-60 <1s>
		SBO Timeout	1-255 <1s>
		Master Address	0-65534 <1>
		Frame Interval	10-500 <10ms>
App. Objects	**BI Object Class**	**BI.0 ~ BI.31**	0-3 <1>
	AI Object Class	**AI.0 ~ AI.31**	0-3 <1>
	Special AI Class	**Fault I Event**	0-3 <1>
		Max. I Ev.	0-3 <1>
		Demand I Ev.	0-3 <1>
		Max. P Ev.	0-3 <1>
		Demand P Ev.	0-3 <1>
		Max. Q Ev.	0-3 <1>
		Demand Q Ev.	0-3 <1>
	CNT Object Class	**CNT.0 ~ CNT.15**	0-3 <1>
	AI Object VOC	**AI.0 ~ AI.31**	0-50 <1%>
	AI Obj. VOC-Limit	**AI.0 ~ AI.31**	0-65535 <1>
	CNT Object VOC	**CNT.0 ~ CNT.15**	0-65535 <1>
Event	**Set S/W Counter**	**S/W Count**	0-65535 <1>
	Clear Events	**Clear all events?**	Yes / No
	Clear Faults	**Clear all faults?**	Yes / No
Time	**<SETTING TIME>**		yyyy/mm/dd hh:nn:ss

After finishing the set value change, when MENU button is pushed to return to [Main Menu Display], [Set Value Change Save Display] shows up to determine Yes or No. If selecting Yes and pushing ENTER button, the changed set values are all saved. However, if selecting No and ENTER button, or MENU button again, the changed set values are not saved and the existing set values are still applied.

* CAUTION: Be careful not to push down MENU buttons repeatedly! Then, the newly changed set values are

neither saved nor applied.

[Fig. 4-8] [Set Value Change Save Display]

[Fig. 4-9] [ENTER to Yes]

[Fig. 4-10] [ENTER to No]

(5) Display

In Display menu, measurement values, monitored status, and counter values are displayed.

Display	**Items**	**Displayed Values [unit]**
Measurements	**Currents**	Ia, Ib, Ic, In, I1(Positive-sequence), I2(Negative-sequence) : Magnitude [A] & Phase Angle [Deg]
	Voltages	Va, Vb, Vc, Vr, Vs, Vt [kV] Zero-sequence : VoS, VoL, (S: Source-side, L: Load-side) Positive-sequence : V1S, V1L Negative-sequence : V2S, V2L : Magnitude [A] & Phase Angle [Deg]
	Active Power	Pa, Pb, Pc, P3p [MW]
	Reactive Power	Qa, Qb, Qc, Q3p [MVAR]
	Apparent Power	VAa, VAb, VAc, VA3 [MVA]
	Power factor	PFa, PFb, PFc, PF3 : Lead / Lag (Lead = 1)
	Energy	PEa, PEb, PEc, PE3 [MWh], QEa, QEb, QEc, QE3 [Mvarh]
	Phase Difference	Phase Difference between A-phase and R [Deg]
Status	**Switch**	OPEN / CLOSE / TROUBLE
	Handle	LOCK / UNLOCK

	Gas	NORMAL / LOW
	AC Power	NORMAL / OFF (External AC Power Loss)
	Battery	NORMAL / Low
	Door	CLOSED / OPEN
	Spare #1, #2, #3	ON / OFF (Spare #1,2 : Trip, Close command)
	Loc / Rem	LOCAL / REMOTE
	FRTU Addr	FTU-R100 Slave Address
	Master Addr	Control System Master Address
	Ver.	FTU-R100 Firmware Version
Counter	**Restart**	FTU-R100 Restart Count
	S/W Count	Recloser Body Open Count
	All Faults	All Faults Detection Count (Each Phase Fault Count + Reclosing Count)
	Faults (A) **Faults (B)** **Faults (C)** **Faults (N)**	Each Phase Fault Detection Count

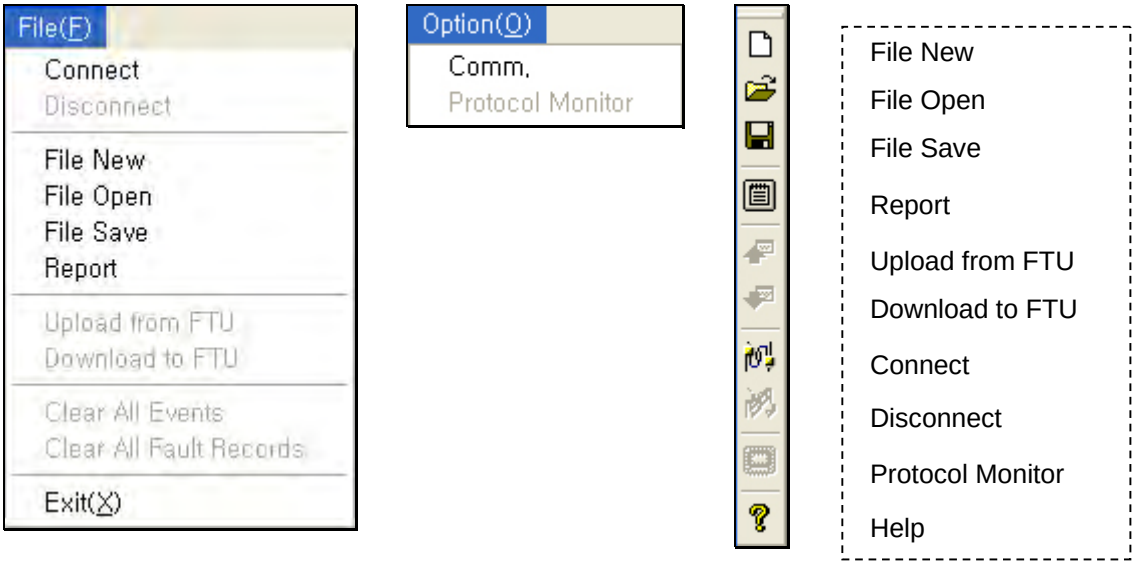
(6) Event List

In Event List menu, all types of events are displayed with occurred time and event description. Using UP & DOWN buttons, event list can be scrolled up and down in the LCD display.

Event List	Description	Max. Event No.
I/O events	Status Change of Binary Input/Output	**1023**
Function events	Operated Status of Protection Functions	**1023**
System events	Setting Change, Reset	**63**
Fault I events	Latest Fault Current, Faulted Phase, Time	**127**
Demand I events	Each Phase Daily Average Load Current, Time	**511**
Demand P events	Each Phase & 3-phase Daily Average Active Power, Time	**511**
Demand Q events	Each Phase & 3-phase Daily Average Reactive Power, Time	**511**
Max. I events	Each Phase Daily Peak Load Current, Time	**31**
Max. P events	Each Phase & 3-phase Daily Peak Active Power, Time	**31**
Max. Q events	Each Phase & 3-phase Daily Peak Reactive Power, Time	**31**

4.3 Setting & Operation Tool (FTU_SET)

FTU-R100 has a dedicated setting and operation tool, FTU_SET. This tool is operated on PC or Notebook computer, and through RS232 port on front panel of FTU-R100, setting & configuration changes, event list & fault waveform view, firmware download, communication protocol & data frame monitor, measurement & status display, and correction factor calibration are possible. For this communication, MODBUS protocol is used. Main menus of this tool are File(F), Option(O), Help(H).



[File Menu]

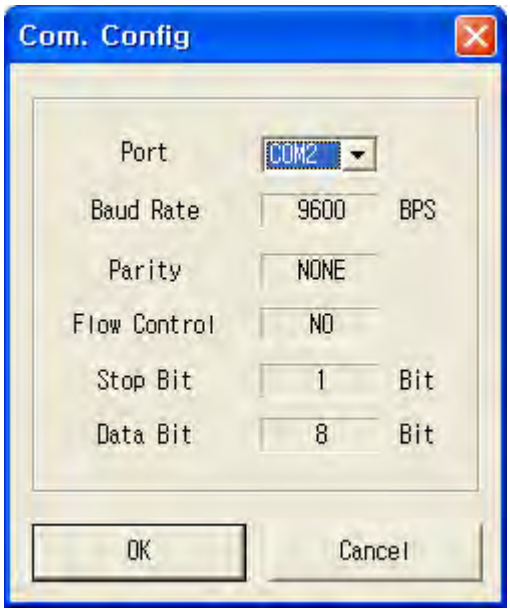
- Connect : to start communication with FTU-R100
- Disconnect : to quit communication
- File New : to create a new setting file
- File Open : to load a setting file (*.str) to use previously saved setting values
- File Save : to save edited values to a setting file for next use
- Report : to save a report text file(*.rpt) from converted setting value
- Upload from FTU : to upload data from FTU-R100 (setting, event, fault)
- Download to FTU : to download edited set values to FTU-R100
- Clear All Events : to delete all event data stored in FTU-R100
- Clear All Fault Records: to delete all fault data stored in FTU-R100
- Exit : to quit the program

[Option Menu]
- Comm. : to open a window for communication configuration of the tool
- Protocol monitor : to open a window for communication status monitoring

[Help Menu]
FTU_SET tool's program version information

(1) Connection between FTU_SET and FTU-R100

Before starting to connect to FTU-R100, communication options are firstly configured in the menu [Option – Comm.]. In this menu window, select a serial port of Notebook. MODBUS protocol has RTU mode



RS232C Port Pin Position on Front Panel of FTU-R100

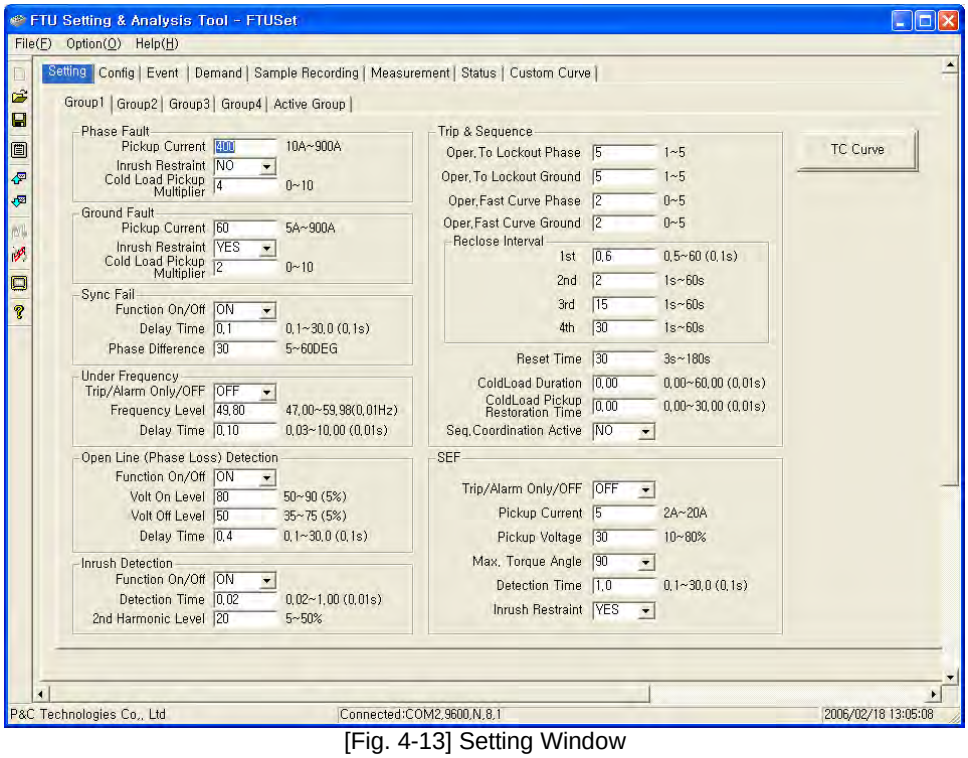
Pin 1	:	Pin 6	:
Pin 2	: RX	Pin 7	: RTS
Pin 3	: TX	Pin 8	: CTS
Pin 4	:	Pin 9	:
Pin 5	: GND		

Connector Type : DB9 Female

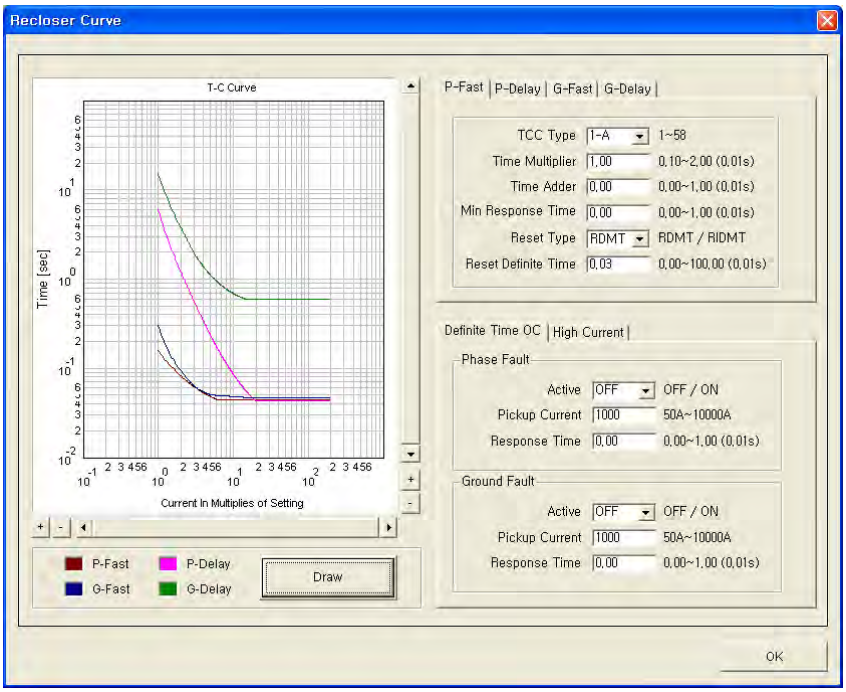
[Fig. 4-11] [Option – Comm] Window

(2) Setting Window

In Setting Window, existing setting values of FTU-R100 can be viewed through "Upload" button, or setting values are edited and downloaded to FTU-R100 by clicking "Download" button to apply new setting values to FTU-R100. In some cases, operators require to save and reuse these edited setting values. To satisfy this request, FTU_REC_SET tool has "New", "Open" and "Save" menu items in [File] menu. The file extension name is *.str (setting file) and "Report" menu item save to report file the edited setting values.

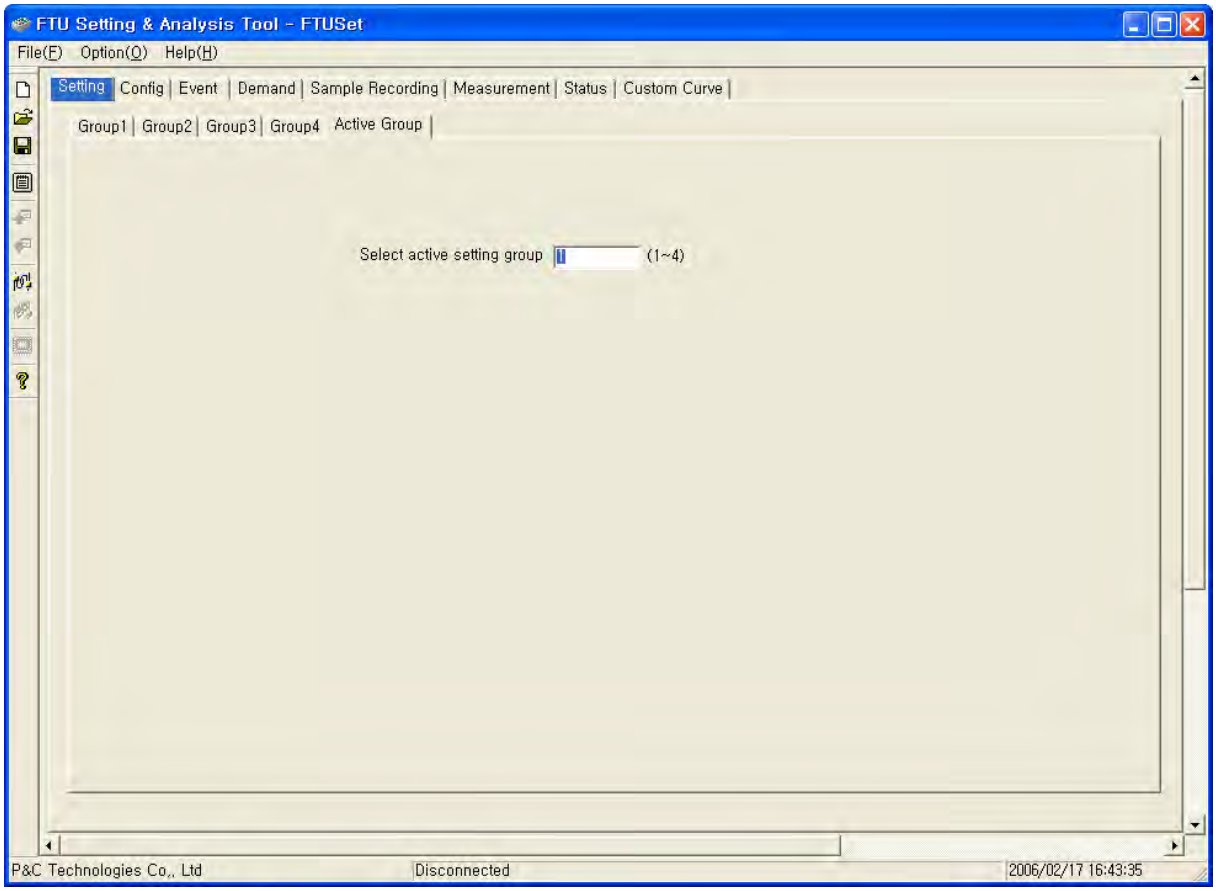


[Fig. 4-13] Setting Window



[Fig. 4-14] Recloser Curve Window

To facilitate operator's TC curve editing, FTU_REC_SET provides Recloser Curve Window.
As Setting Window is activated, click "TC Curve" button to open Recloser Curve Window. Through this Window, operators can refer to the shape of TC curves, which is now formed by some parameters.



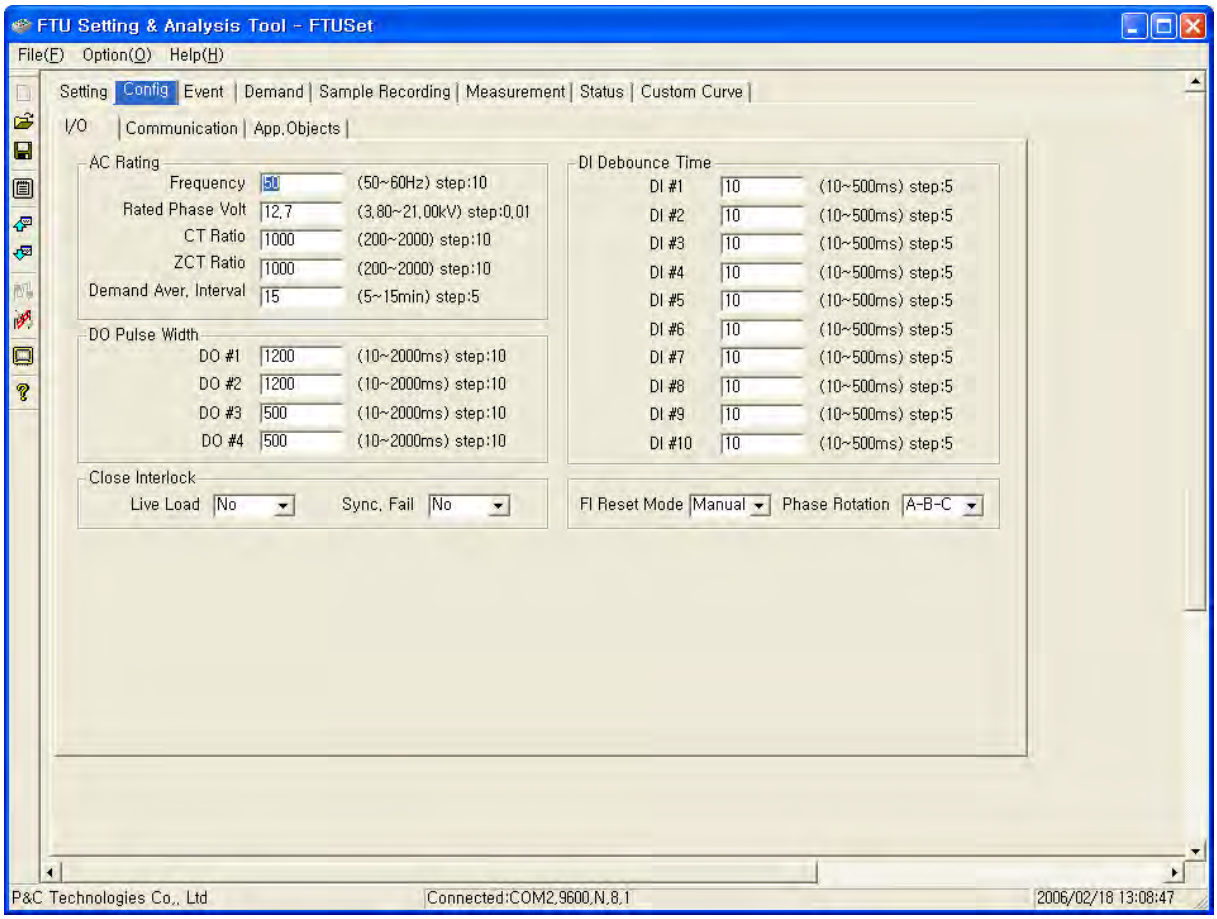
[Fig. 4-15] Active Setting Group Window

FTU-R100 can simultaneously store 4 different setting group's setting values in memory. All the setting items in each group are exactly the same and operators can select one group to apply as an Active Group.

(3) Config Window

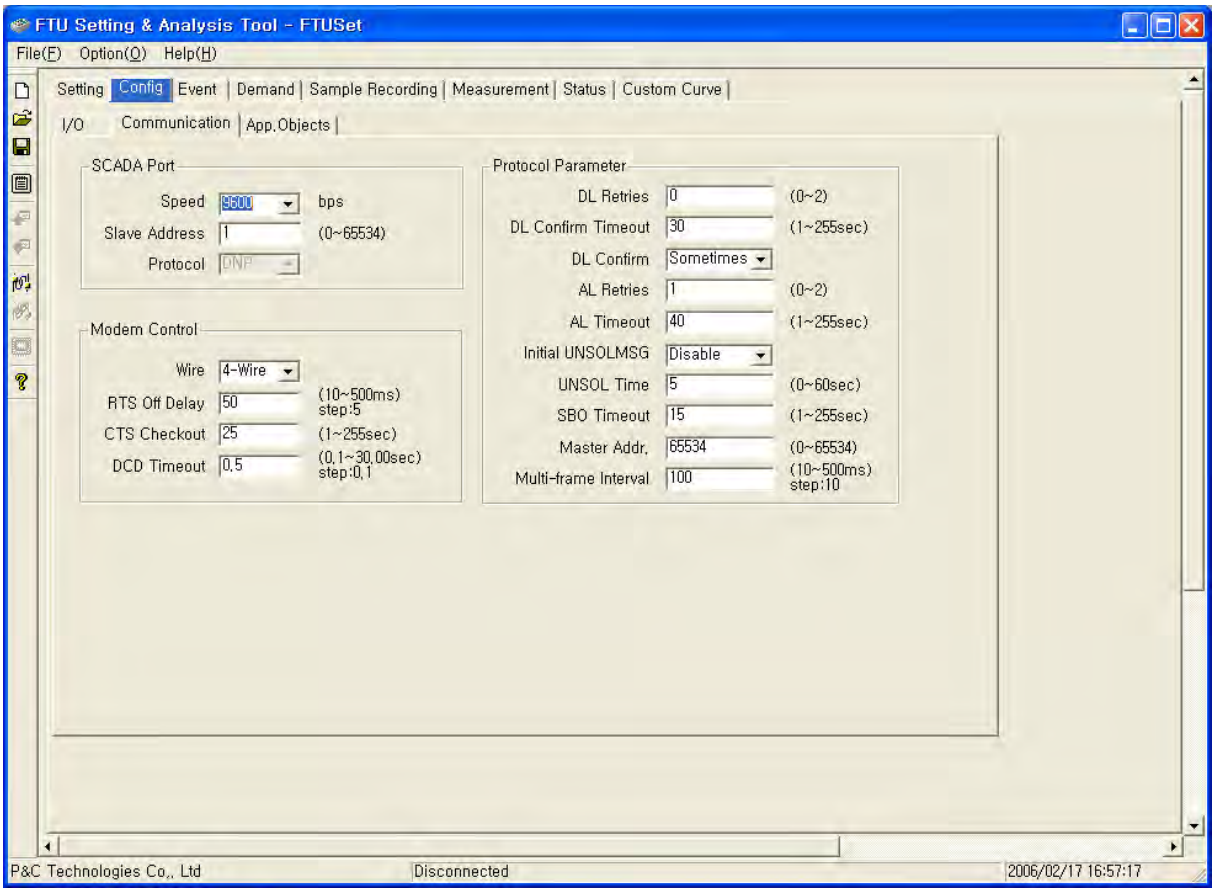
In Config Window, there are I/O Config Window, Communication Config Window, and App. Object Config Window. Current configuration values of FTU-R100 can be viewed through “Upload” button, or configuration values are edited and downloaded to FTU-R100 by clicking “Download” button to apply new configuration values to FTU-R100.

In I/O Config Window, Analog Circuit Ratings and Binary I/O setting values are configured.



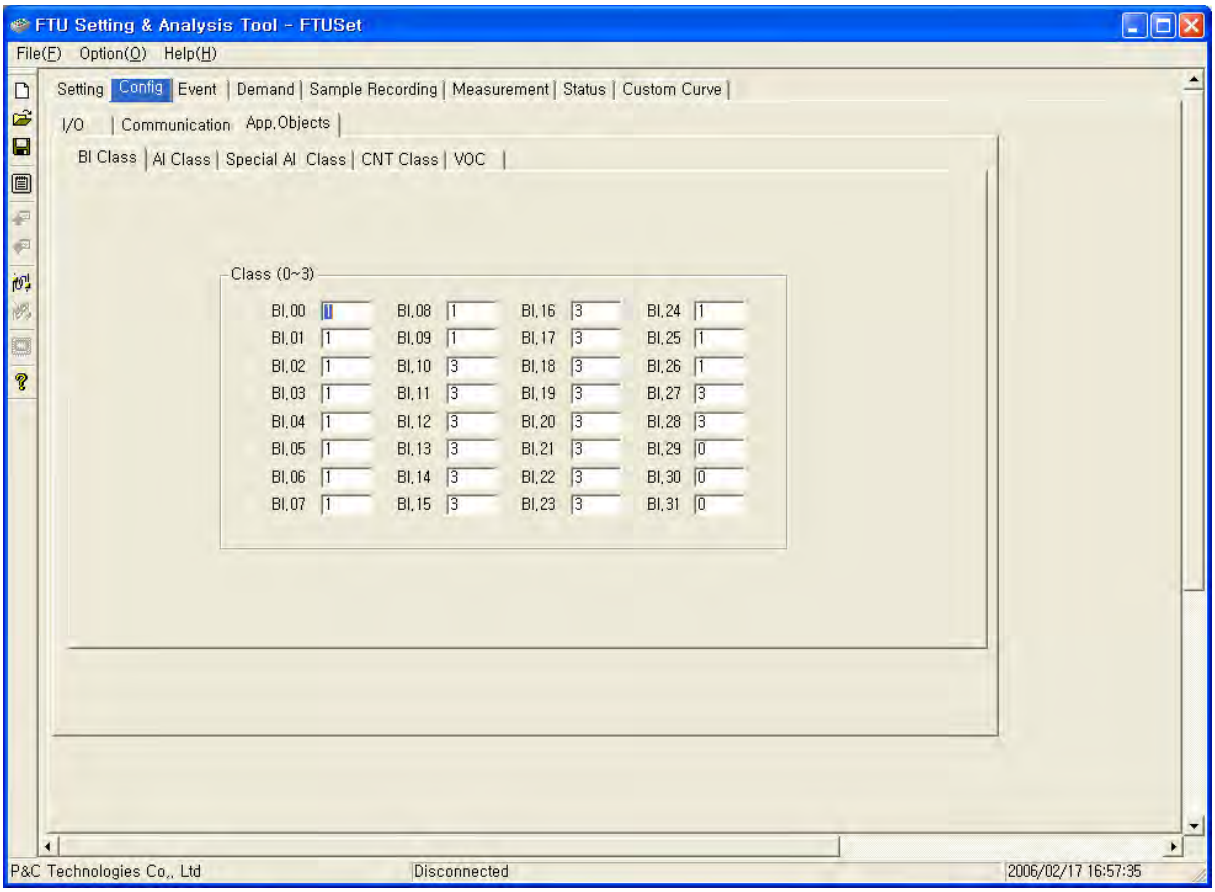
[Fig. 4-16 I/O Config. Window

In Communication Config Window (Fig. 4-17 on the next page), communication speed, protocol, slave address, modem control data, and protocol parameters are configured.



[Fig. 4-17] Communication Config. Window

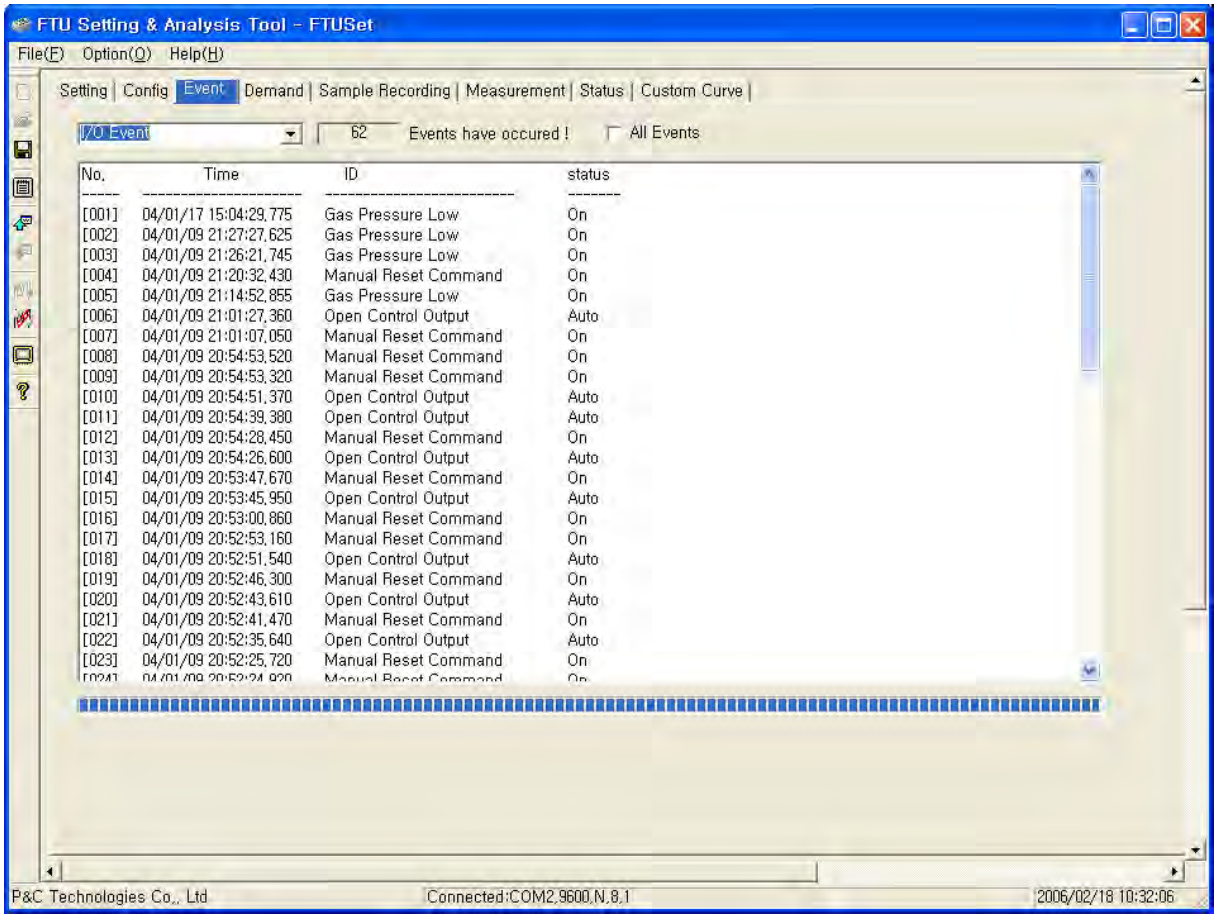
In App Object Config Window, all kinds of Application Object Classes for binary input, analog input, counter input and VOC (Value of Change) in DNP v3.0 communication protocol are configured.



[Fig. 4-18] Communication Config. Window

(4) Event Window

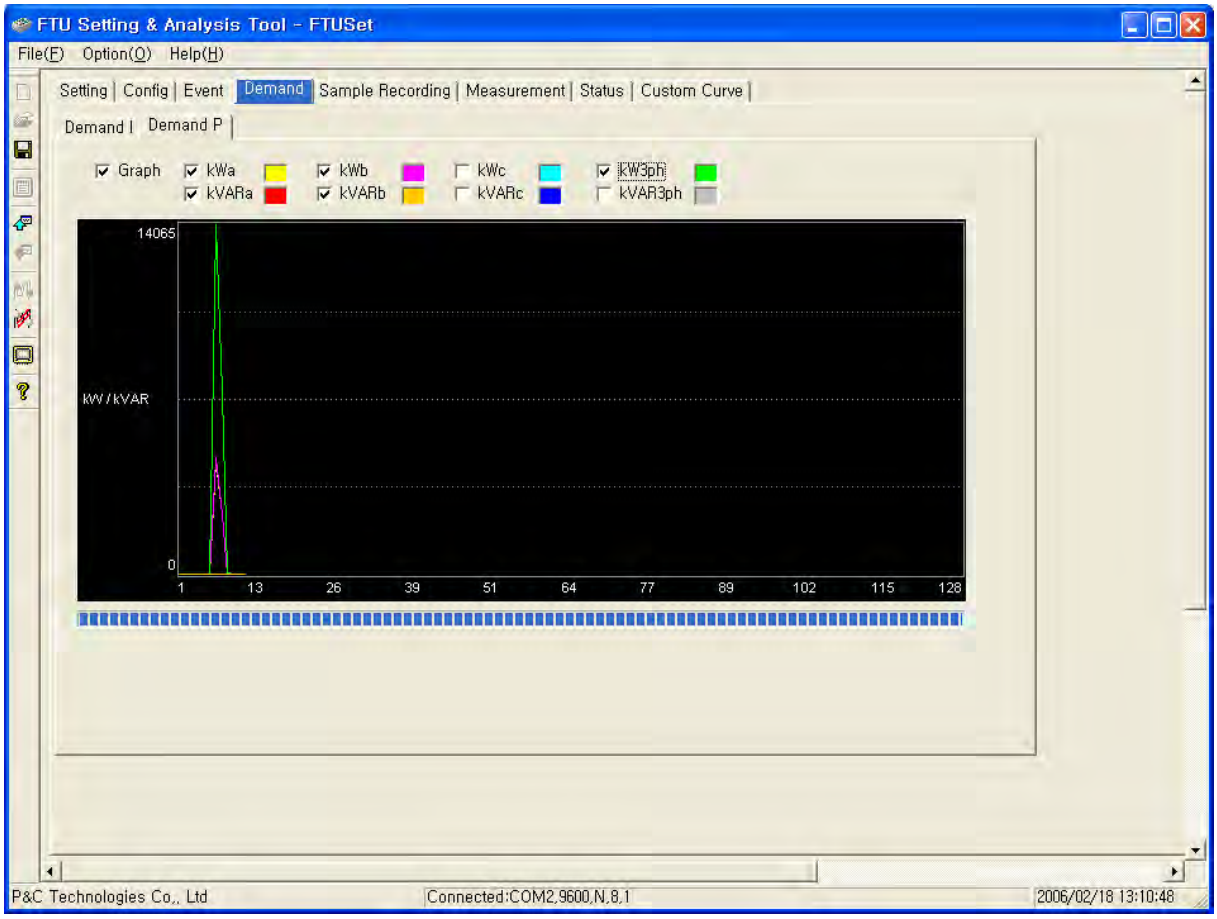
In Event Window, operators can list up all the event records, which are stored in the memory of FTU-R100 by clicking “Upload” button. All types of events can be uploaded or each type of event can be separately uploaded from FTU-R100. The kinds of event types are I/O Event (1023), Function Event (1023), System Event (63), Fault Event (127), Demand Event (511), Max Current Event (31), and Max Power Event (31). Each event type and descriptions are explained in the Section 4.2.1. Time Resolution for event recording is 5msec and Scanning Interval is 1msec.



[Fig. 4-19] Event Window

(5) Demand Window

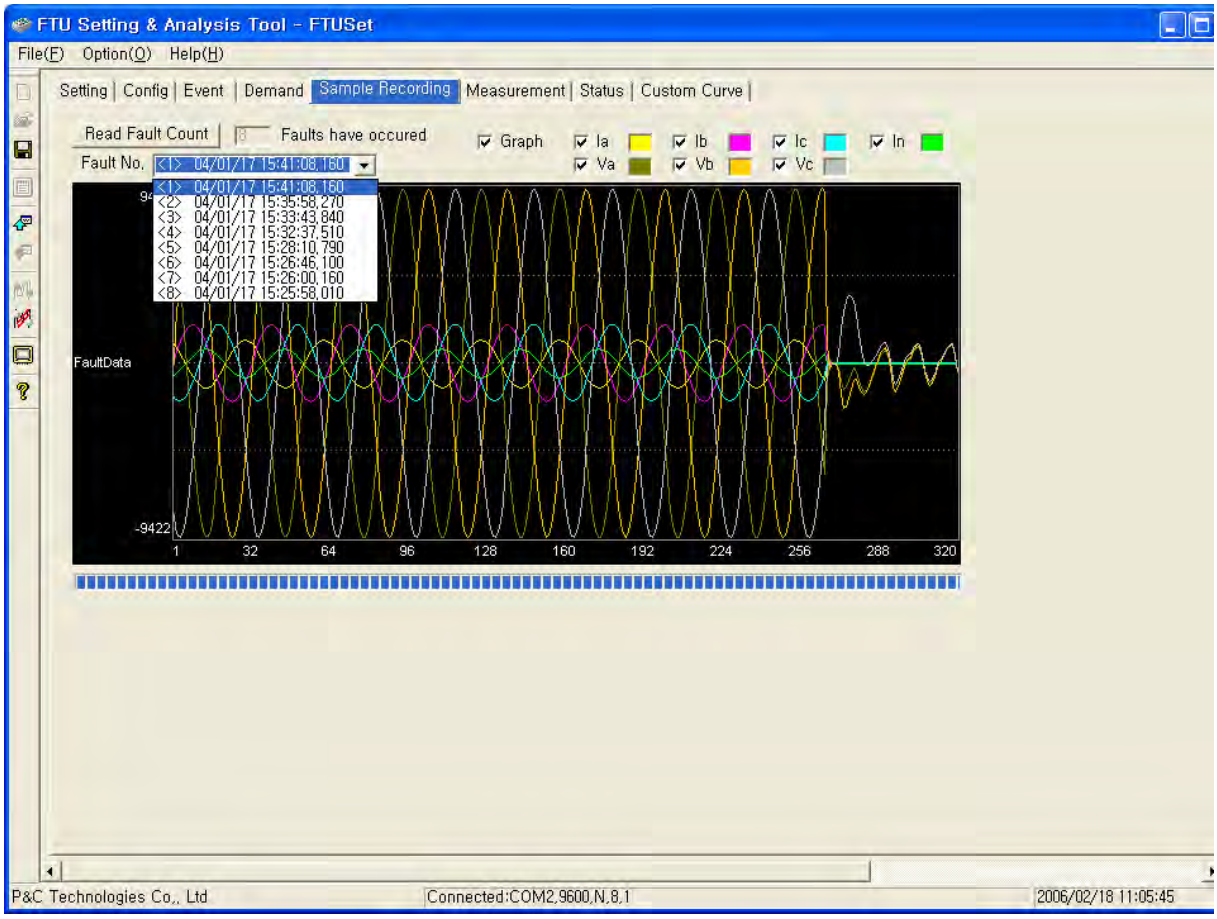
Demand Window displays Daily Average Demand Current and Power in the list form and waveform. When the Graph check box is unchecked, Demand Current and Power are listed as in the Event Window. Averaging Interval is between 5 and 15 minutes, and maximally 128 data are stored for each measurement. Demand Current Window displays average currents of Ia, Ib, Ic, In, and Demand Power Window displays the averages of active demand power and reactive demand power for each phase and 3 phases.



[Fig. 4-20] Demand Window

(6) Sample Recording Window

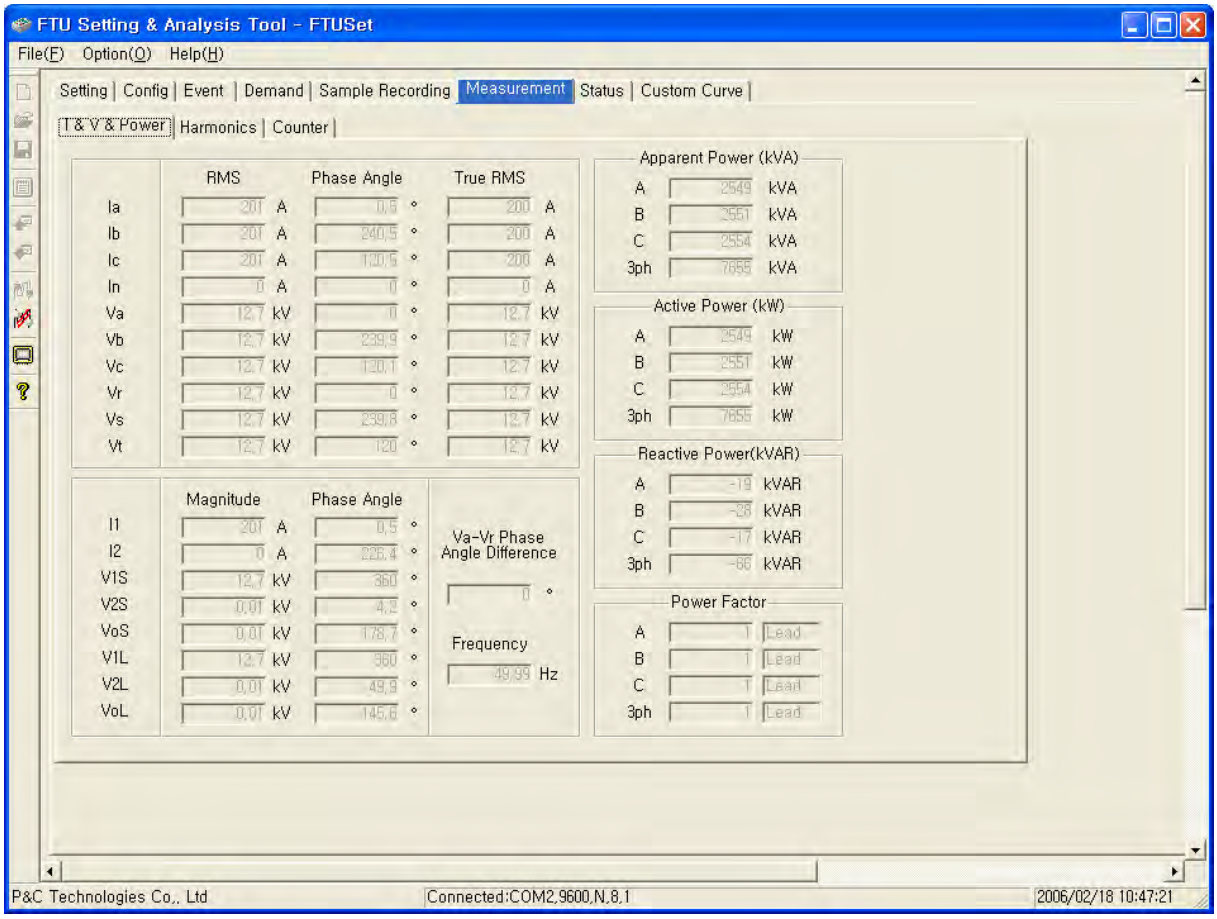
Sample Recording Window displays Fault Waveforms stored in FTU-R100. At first, click “Read Fault Count” to upload the recorded fault data to FTU_REC_SET tool, and select one of 8 recorded faults to view. As in Demand Window, fault data are listed or fault waveforms are drawn. Fault waveform drawings are displayed for each phase current and each phase voltage. And, each graph is distinguished by different color. FTU-R100 can record and store the data for up to 8 faults, and each waveform has the data of 10 cycles (7 cycles before line deactivation and 3 cycles after line deactivation). Sampling Rate is 32 sample/cycle.



[Fig. 4-21] Sample Recording Window

(7) Measurement Window

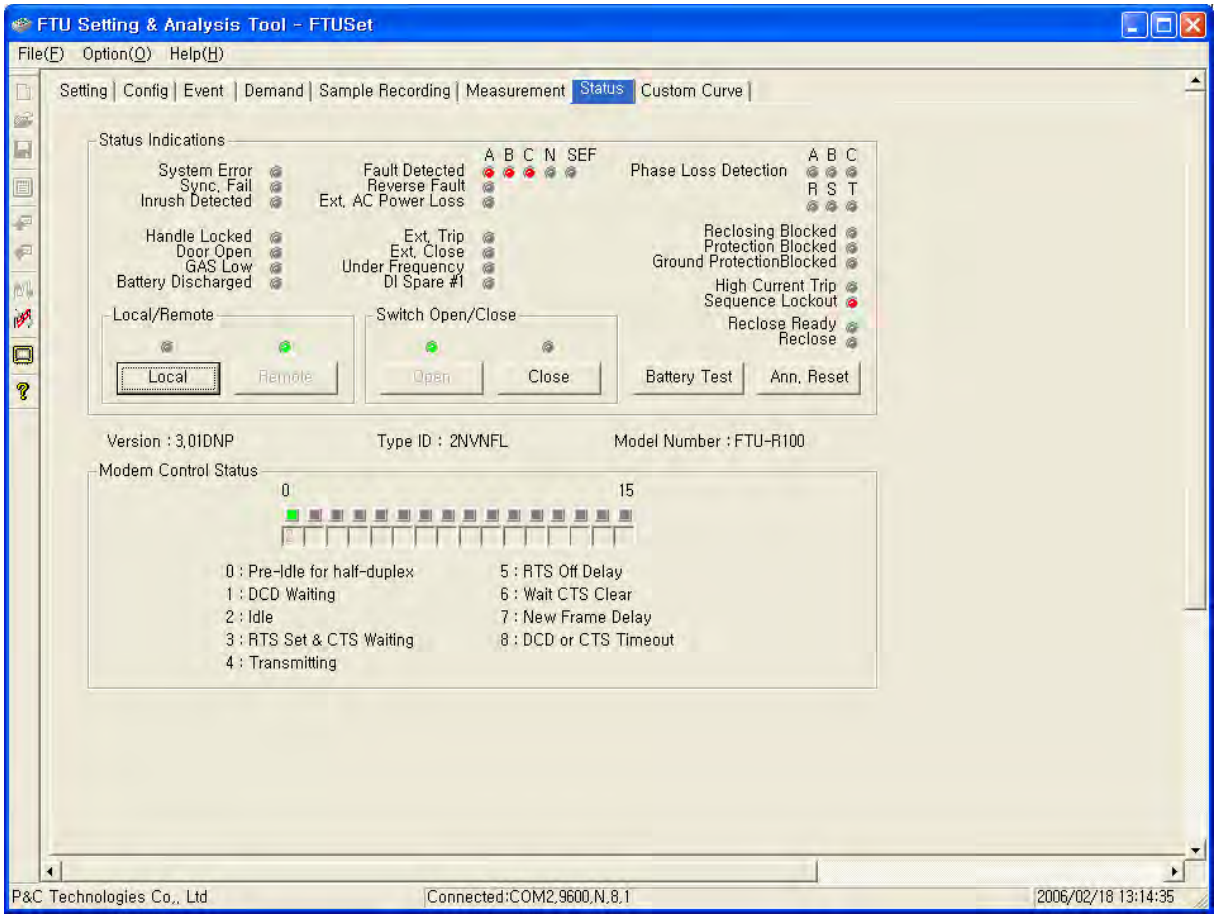
Operators can monitor all kinds of measurement values such as current, voltage, power, and energy, etc. on-line in I & V & Power Measurement Window. And, FTU-R100 has the function of Harmonic Analysis, therefore up to 8th harmonics RMS values and THD (Total Harmonic Distortion) for Ia, Ib, Ic, Va, Vb, Vc, Vr, Vs, Vt are measured and displayed in Harmonics Measurement Window. Lastly, in Counter Measurement Window, counter values (FTU Restart Count, Recloser Trip Count, Fault Count) and accumulation data (MWattHour, MVarHour) are displayed.



[Fig. 4-22] Measurement Window

(8) Status Window

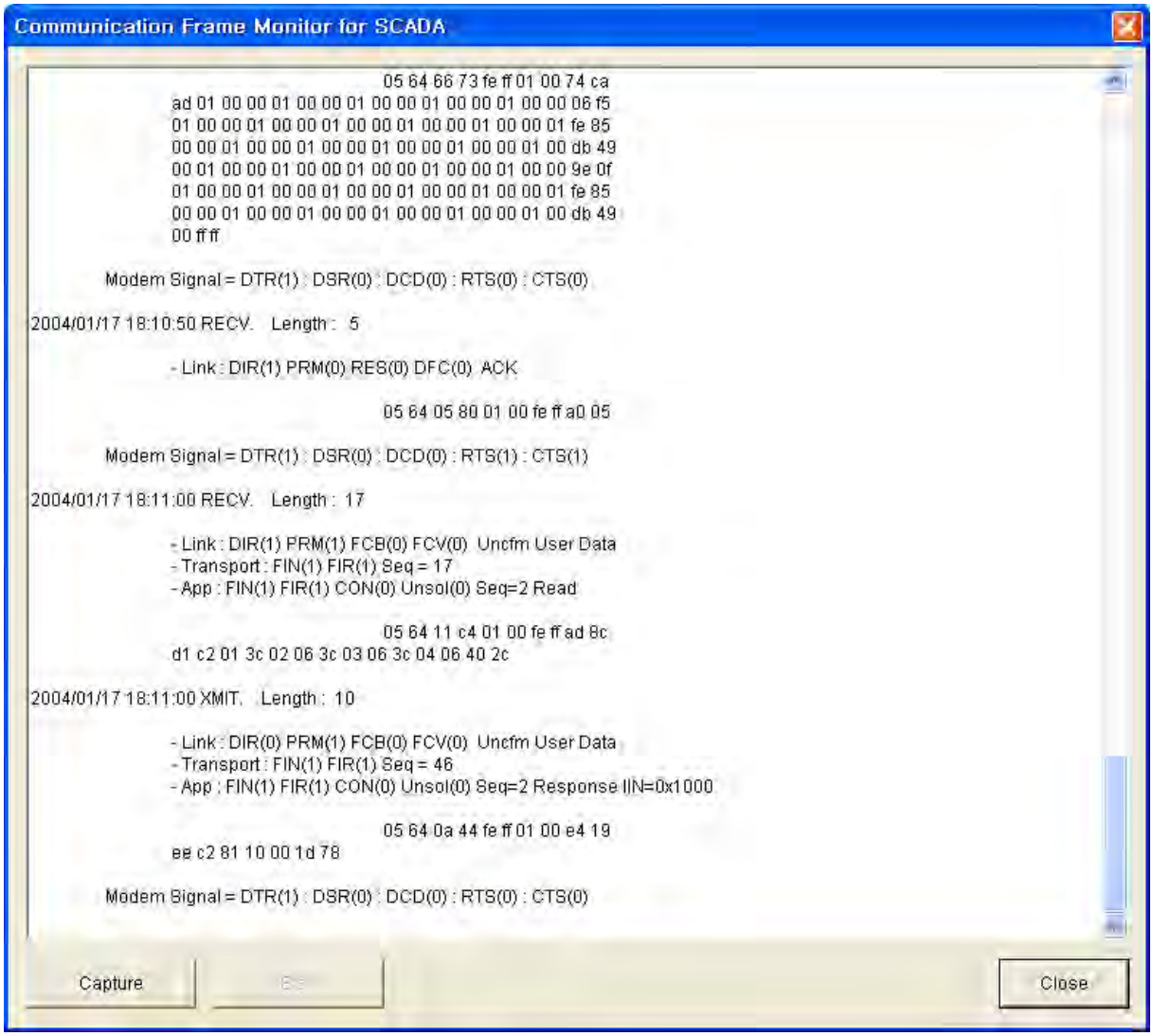
In Status Window, all the status indications and FTU-R100's firmware version and model ID, and modem control status data are displayed.



[Fig. 4-23] Status Window

(9) Protocol Monitor Window

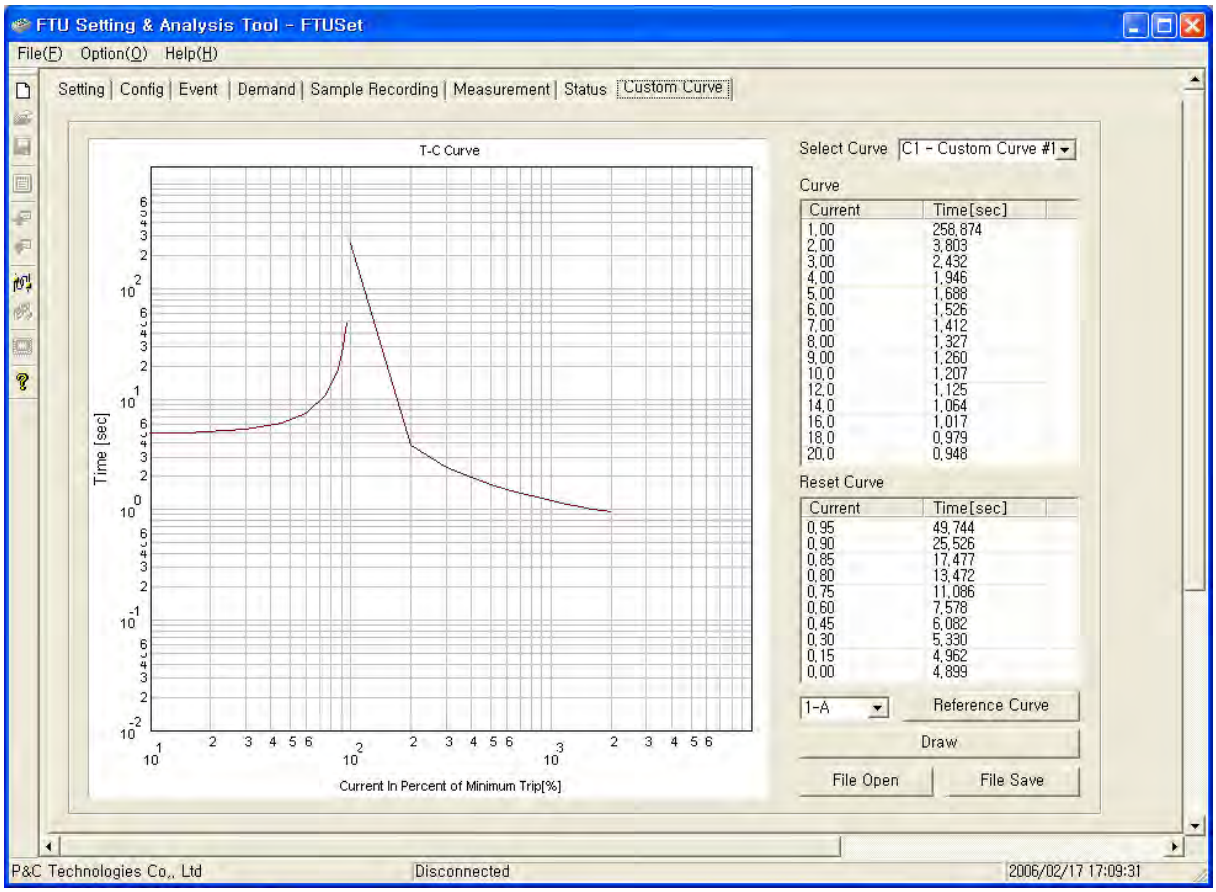
With FTU-R100 connected to the control center system (Master), through this Window, operators can check communication protocol and data frames. This Window's can be saved in a log file using "Capture" button



[Fig. 4-24] Protocol Monitor Window

(10) Custom Curve Window

The FTU-R100 has 4 custom editing curves. In Custom Curve Window, the current custom curve data of FTU-R100 can be viewed through “Upload” button, and those can be edited and downloaded to FTU-R100. Then the new custom curve data is applied. To open and save the curve data from or to a file, “File Open” and “File Save” button can be used. The file format is CSV that can be open in the MS-Excel.



[Fig. 4-25] Custom Curve Window

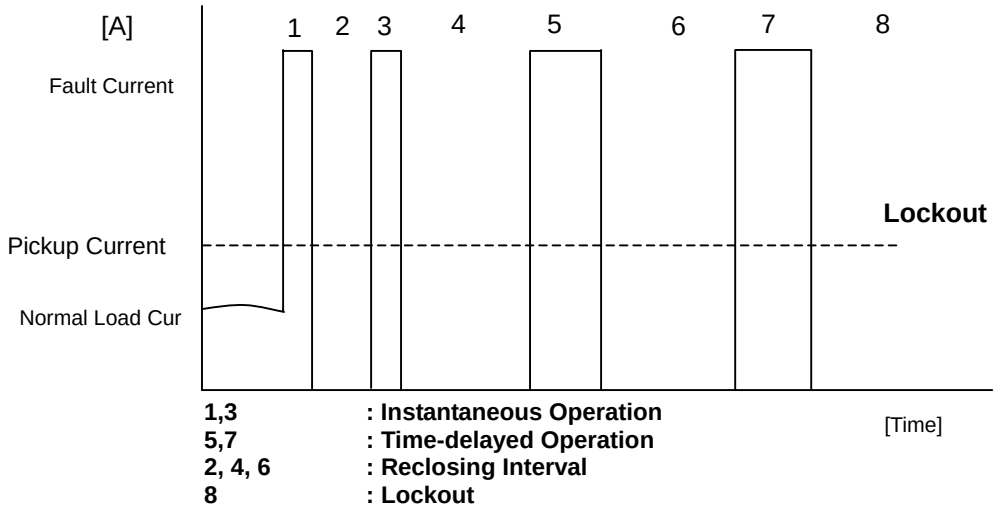
5. PROTECTION FUNCTIONS

5.1 Auto-Reclosing Sequence

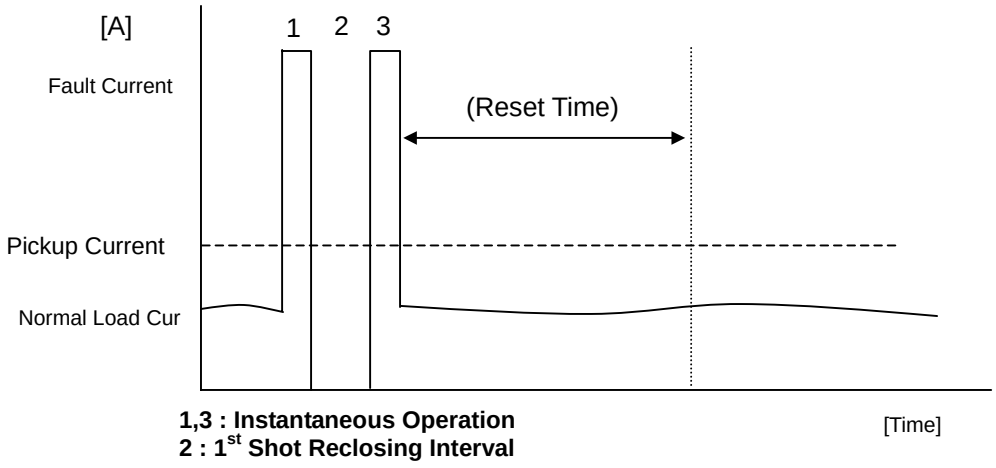
For permanent fault, under the condition of reclosing enabled, no other restraints such as Cold Load and Inrush, and no HCT, recloser will be locked out to open after the Reclosing Count repeating trip and reclose according to the preset settings.

For example in the below figure, the reclosing sequence is organized in 2F2D, which means the Recloser protection function operates as Instantaneous (Fast) element during first 2 reclosing shots and operates as Time-delayed element during last 2 reclosing shots. This composition also can be configured.

For temporary fault, if the fault is removed before the preset Reclosing Count and no fault is detected during the preset Reset Time, then the reclosing sequence is initialized to normal operation standby mode. When a fault is detected again during the Reset Time, the Recloser will be locked out after the remaining reclosing counts excluding the previously operated reclosing counts.



[Fig. 5-1] Permanent Fault: 3 Shots Reclosing & 2F2D



[Fig. 5-2] Temporary Fault: Fault Removal During 1st Reclosing Interval

5.2 HCT (High Current Trip)

Very high valued current can cause serious damage to the Recloser and the resultant fault spread-out, therefore HCT element should operate faster than Instantaneous or Time-delayed TC curve's operation time and its priority must be higher than the normal auto-reclosing sequence.

HCT can be configured up to 4 times for phase fault and ground fault, respectively. HCT Count setting value 0 means HCT element disabled.

5.3 Cold Load Pickup

On the line to which loads are connected, when the line is re-activated after deactivation (in case of first time line activation after line installation or re-activation after lockout-to-open due to a permanent fault), there can be such a phenomenon that the load current higher than fault detection pickup level flows instantly and goes down the pickup level. This is called Cold Load and Cold Load Pickup function is to prevent and distinguish Cold Load from the real fault current.

In Cold Load mode, without changing operational characteristics, pickup level is changed by the times of Cold Load Multiplier (1~10) and the characteristics of time-delayed element operate even if the setting is in the Instantaneous element. If the transient current goes down and retains below the pickup level within Cold Load Duration, then the normal sequence mode is restored after Cold Load Restore Time. These settings exist for both phase fault and earth fault separately, and the value 0 of Cold Load Multiplier means this Cold Load Pickup function disabled. (Normal Reclosing Sequence mode is applied.)

5.4 Inrush Restraints

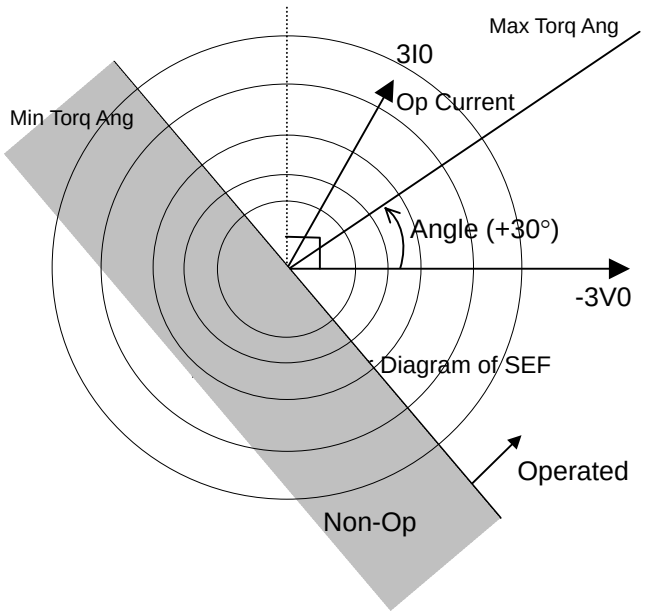
Inrush Current is an over-current higher than pickup level, which is mainly caused by transformer's excitation current at closing action. To distinguish inrush current from load current, 2^{nd} harmonics percentage is adopted as a criterion.

When, in the setting menu, [Fault Detection – Phase/Ground - Inrush Block] is set to Yes and [Fault Detection – Inrush Detection – Function In Use] is set to On, inrush current over pickup level is considered as normal load current and reclosing sequence is not processed.

5.5 SEF (Sensitive Earth Fault) Detection

On the non-grounded network, it is hard to detect fault current because ground current of non-grounded network is much low. Therefore, FTU-R100 is designed to measure zero-sequence values from either external Core Balanced Current Transformer (or ZCT) or Residual Connection of 3 Phase Current Transformers to detect earth fault in the non-grounded network. This function is generally called SEF detection.

In case of earth fault in the non-grounded network, since very small fault current due to line capacitance component flows into the fault point from both sides, SEF detection also considers the fault direction even in the radial network. Maximum Torque Angle is for setting the phase difference between zero-sequence voltage and zero-sequence current, and the protection zone is between -90° and +90° on the basis of Maximum Torque Angle.



5.6 Sequence Coordination

In case that there are over 2 Reclosers which operate in serial connections, Sequence Coordination function prevents unnecessary trip of source-side Recloser by instantaneous element due to load-side fault. When this function is set to on and the fault is restored to normal state by load-side Recloser during source-side Recloser's time-delayed operation, source-side Recloser only increments the reclosing counts without tripping. However, source-side Recloser performs tripping at the last reclosing count. If the Reclosing function is disabled, Sequence Coordination function is no longer carried out.

For Sequence Coordination, the following setting items should be issued and checked precisely between serially connected Reclosers.

- Identical Protection Characteristics such as
  TC Curves, Total Operation Count, Instantaneous Operation Count
- Identical Reclosing Interval (Dead Time)
- Source-side TC Curve Time Delay Over 100msec Than Load-side
- Source-side Reset Time Longer Than Load-side Longest Reclosing Interval
  (To Prevent Source-side Recloser Reset During Load-side Reclosing Action)

6. TC CURVE SETTING

FTU-R100 has 54 types of built-in TC curves including ANSI, IEC standard curves. And customer can define additional 4 curves as his own curves by using PC software. Basically, built-in curves have inverse time characteristics, but can be easily adjusted by three parameters such as multiplier, time adder and minimum response time. In engineering step, the selection and adjustments of TC curve shall be done for the protection coordination with other protection devices in the feeder.

The following parameters are related to change and editing of TC curve's characteristics.

- Time Dial Multiplier
- Time Adder
- Minimum Response Time

Time Multiplier is multiplied to the operating time of basic curve (TDM=1.0), Then Time Adder is added to the resulting operating time of the curve adjusted by multiplier. Minimum response time defines the fastest operating time of the curve. The following section 6.1 shows an example of TC curve adjustments.

The following tables describe the built-in TC curve types and the corresponding numbers in the setting. TC curve graphs are shown in the appendix.

[Table 6-1] Built-in TC Curves and Corresponding Setting Code

Setting No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Curve	A	B	C	D	E	EI	K(P)	L	M	N
Setting No.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Curve	NI	P	R	T	V	VI	W	Y	Z	1
Setting No.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Curve	2	3	4	5	6	7	8	8*	9	11
Setting No.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Curve	13	14	15	16	18	N1	N2	N3	N4	F
Setting No.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
Curve	G	H	J	LI	8+	17	K(G)	A*	SI	IM
Setting No.	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**		
Curve	IV	IE	U8	U2	C1	C2	C3	C4		

Curve Type	Curve Name
Recloser Curves	**A, A*, B, C, D, E, F, G, H, J, K-P, K-G, L, M, N, P, R, T, V, W, Y, Z, 1, 2, 3, 4, 5, 6, 7, 8, 8*, 8+, 9, 11, 13, 14, 15, 16, 17, 18,**
IEC Standard Curve	**Standard inverse (NI), Very inverse (VI), Extremely inverse (EI), Long-time inverse (LI), Short-time inverse (SI)**
ANSI/IEEE Standard Curve	**Moderately inverse (IM), Very inverse (IV), Extremely inverse (IE), Long-time inverse (U8), Short-time inverse (U2)**
KEPCO Standard Curve	**N1, N2, N3, N4**
User Customized Curve	**C1, C2, C3, C4**

*** IEC, ANSI/IEEE, US Standard TC Curve Equation**

$$T = TDM \bullet \{\alpha / (M^{\beta} - 1) + \gamma\}$$
$$T_{RESET} = TDM \bullet \{\tau / (M^{\beta} - 1)\}$$

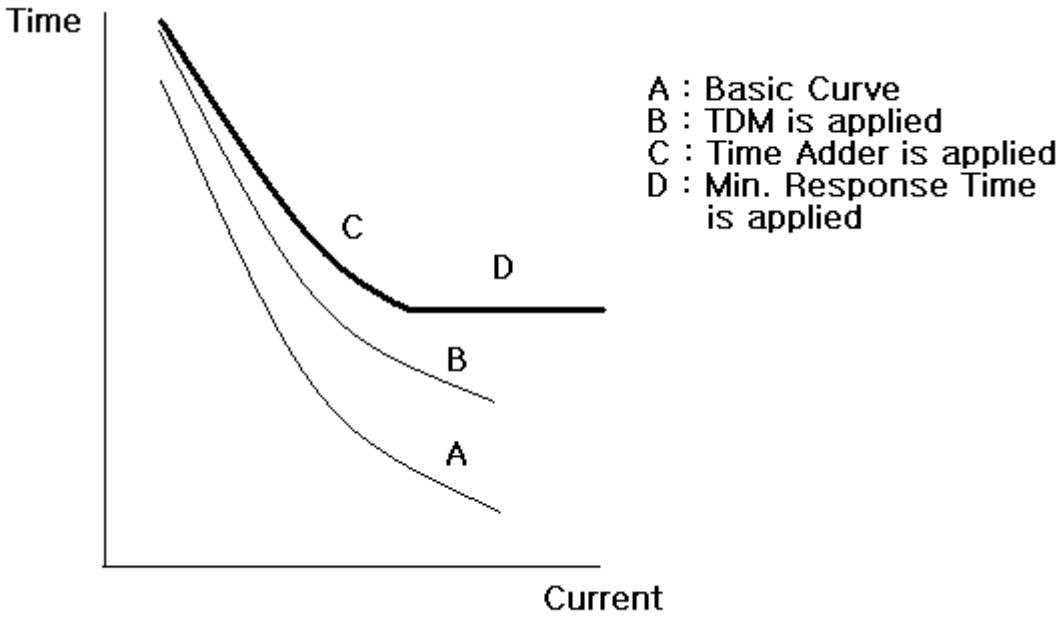
T = Operate Time
TDM = Multiplier Setting
T_{RESET} = Reset Time

Curve Type	Standard	α	β	γ	τ
Standard Inverse (NI)	IEC	0.14	0.02	-	-
Very Inverse (VI)		13.5	1	-	-
Extremely Inverse (EI)		80.0	2	-	-
Short -Time Inverse (SI)		0.05	0.04	-	-
Long -Time Inverse (LI)		120	1	-	-
Very Inverse (IV)	IEEE	19.61	2	0.491	21.6
Extremely Inverse (IE)		28.2	2	0.1215	29.1
Moderately Inverse (IM)		0.0515	0.02	0.114	4.85
Short -Time Inverse (U2)	CO2	0.2394	0.02	0.01694	2.261
Long -Time Inverse(U8)	CO8	5.95	2	0.18	5.95

6.1 Example of TC Curve Editing

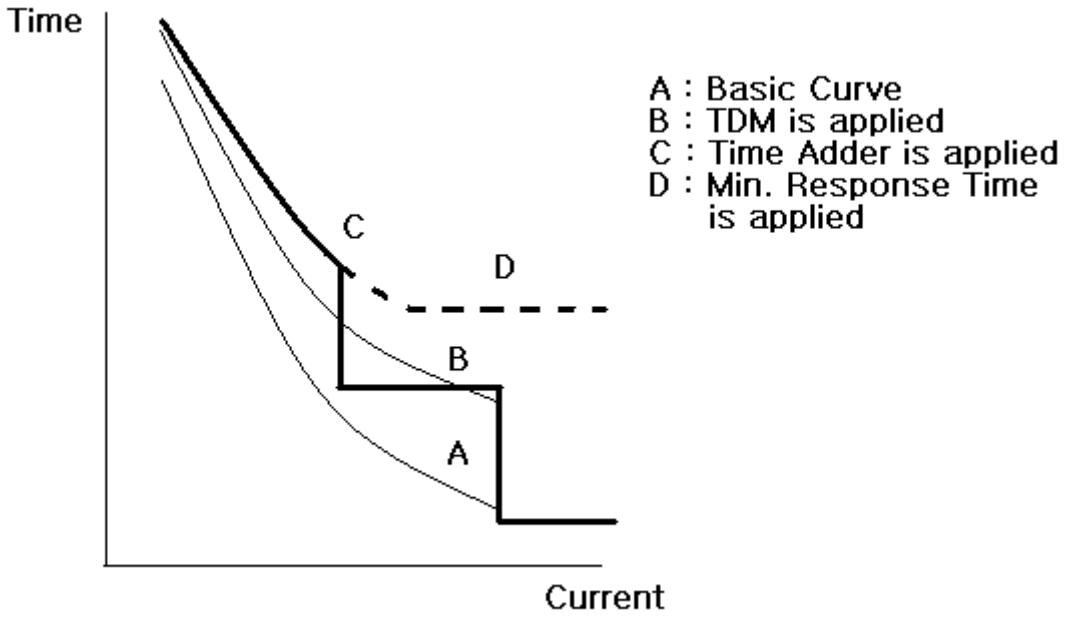
3 parameters are applied in the following order. The values in the parenthesis are examples.
(1) Time Multiplier (1.5)
(2) Time Adder (0.03)
(3) Minimum Response Time (0.1)

In the next figure, for example, the curve A is the basic curve. Assume the operating time of the basic curve (A) at 16 times pickup current is 0.04 sec. When applying Multiplier, Curve A changes its shape, that is, the curve becomes less steep in time axis and operation time becomes longer by a multiplier at the same current value like B in the figure. The operating time at 16 times pickup becomes 0.06sec. Then Time Adder shall be applied. The operating time over all current range becomes longer by that value. In this example the operating time of the resulting curve C is 0.09sec. Finally Minimum Response Time cuts the curve part, which is shorter than this time. Then the actual operating time of the example at 16 times becomes 0.1 sec.



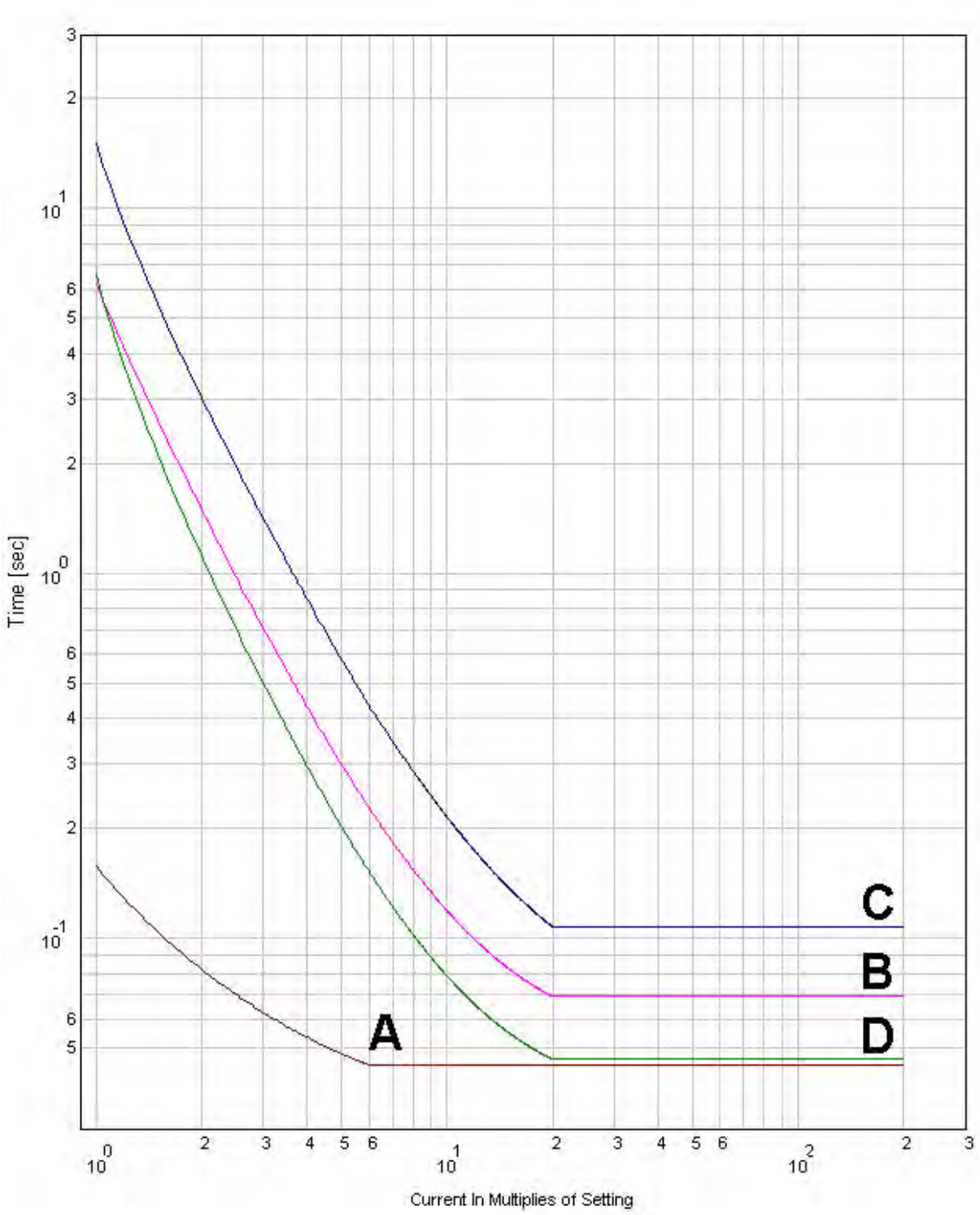
[Fig. 6-1] TC Curve Editing Example 1

There are two additional definite-time over-current elements in the controller. The next figure shows 3-stage over-current protection characteristics. The third stage is prepared for instantaneous protection. Therefore the harmonic restraint is not applied to third stage element, but the second stage definite time over-current element.

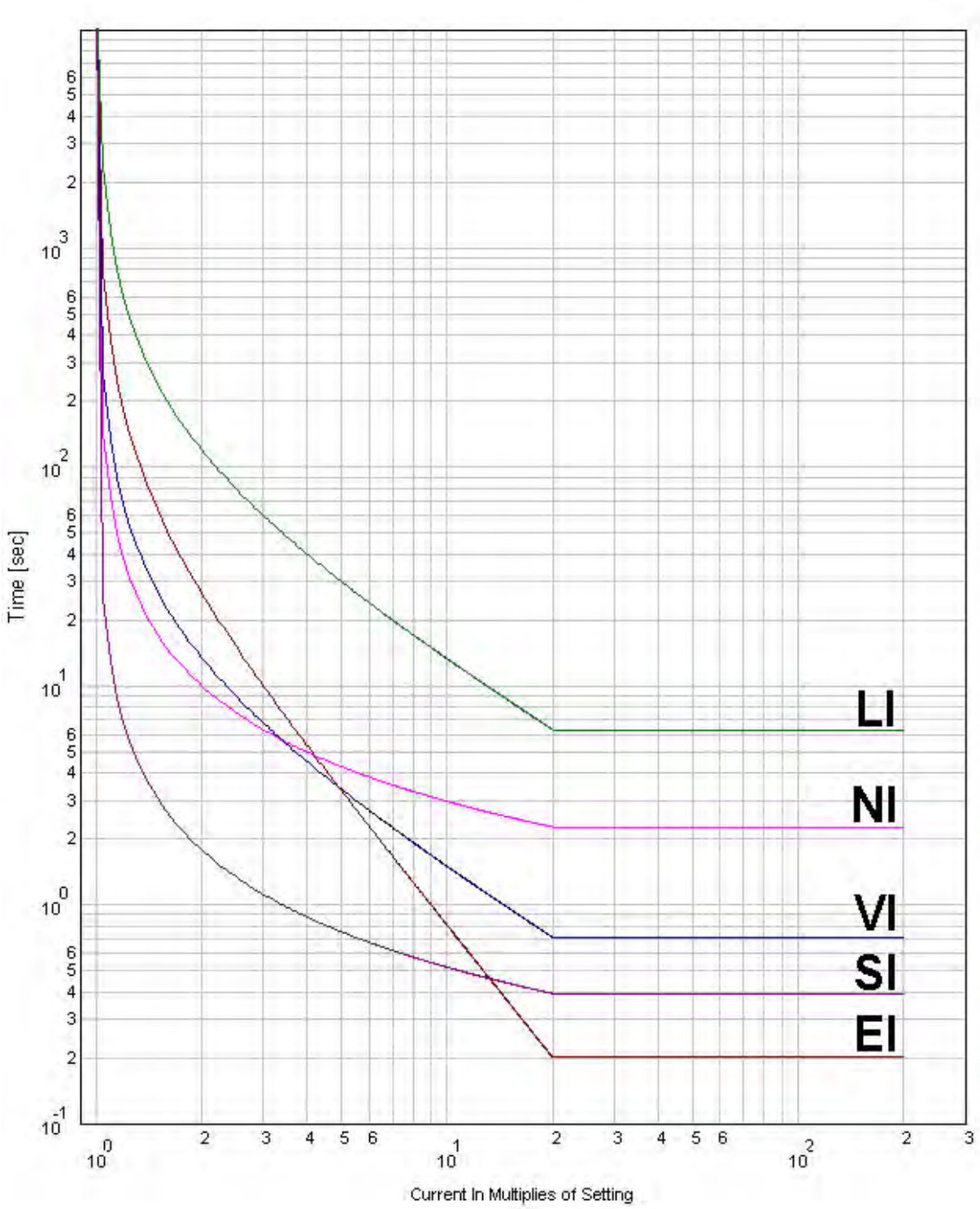


[Fig. 6-2] TC Curve Editing Example 2

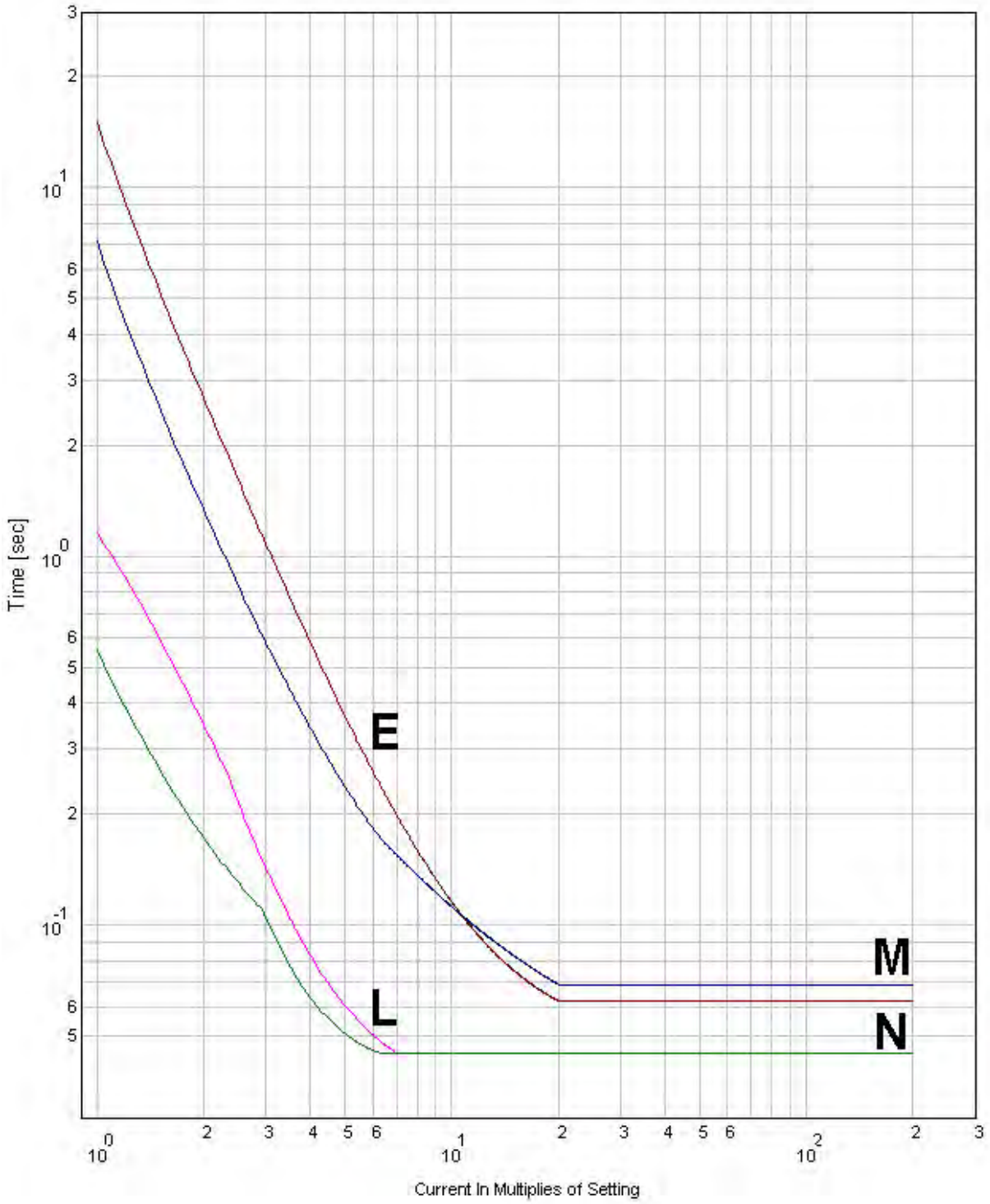
Appendix 1. TC (Time-Current) Characteristic Curves



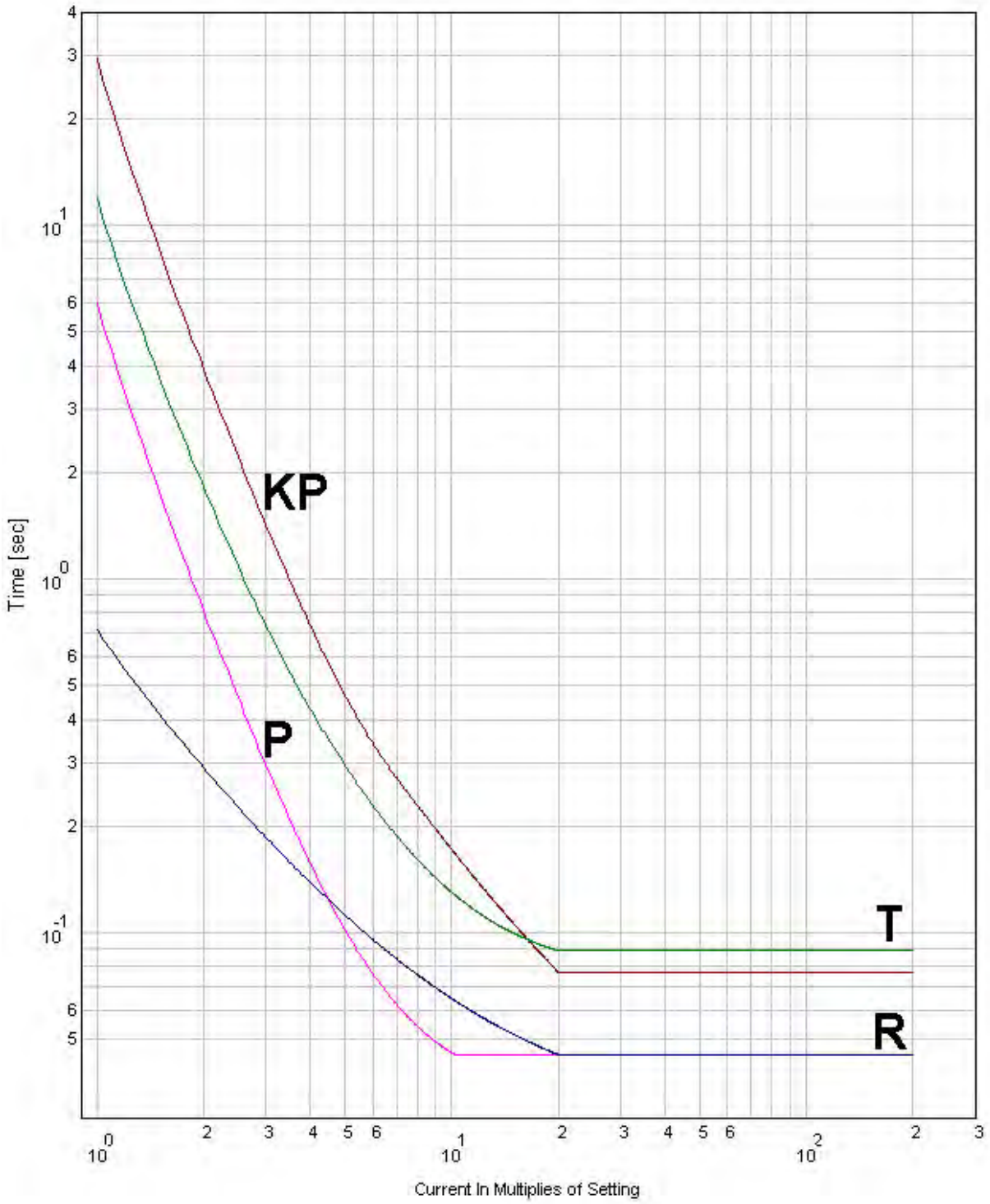
[Fig. A-1-1] A, B, C, D curves



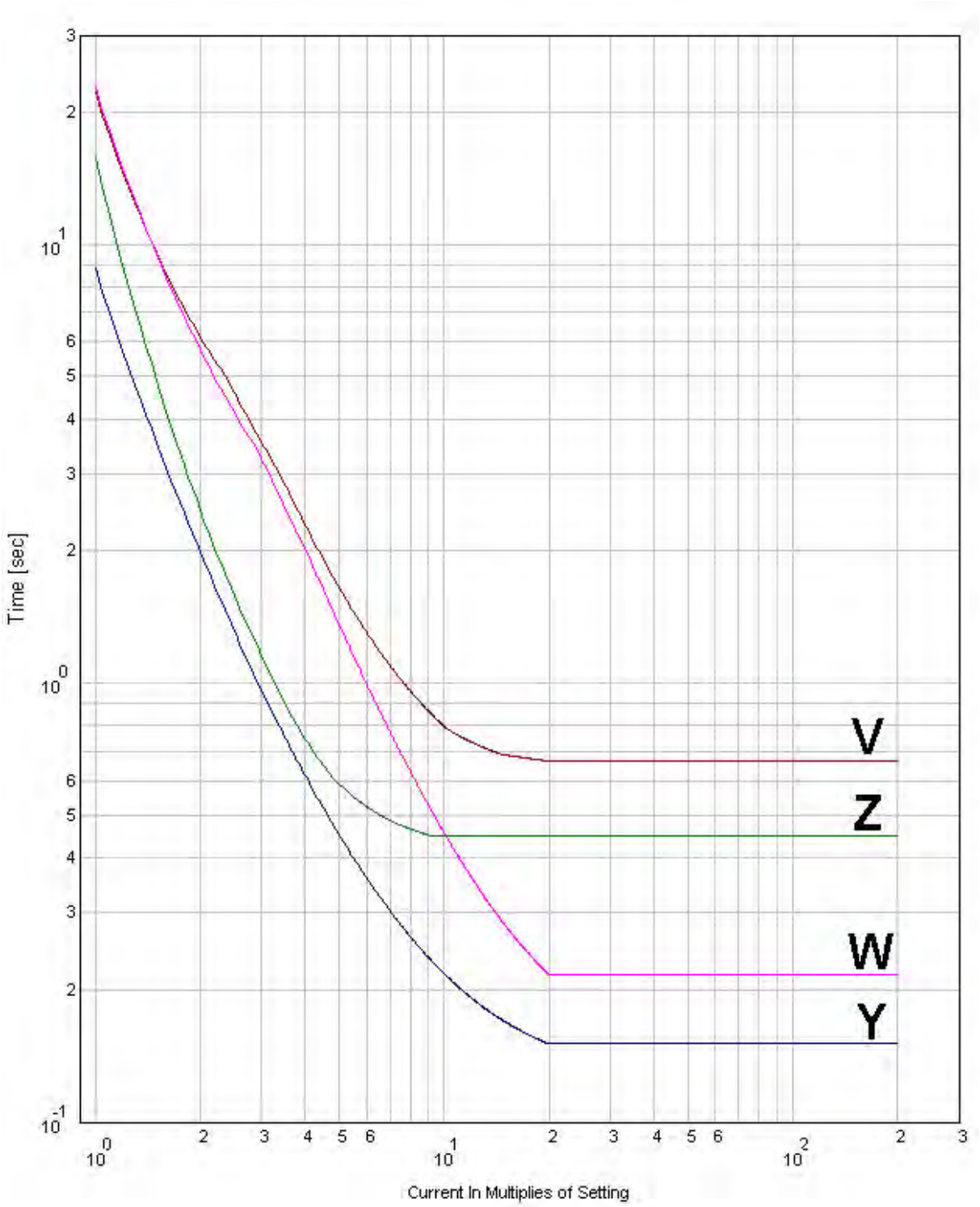
[Fig. A-1-2] IEC Standard Curves (EI, NI, VI, LI) curves



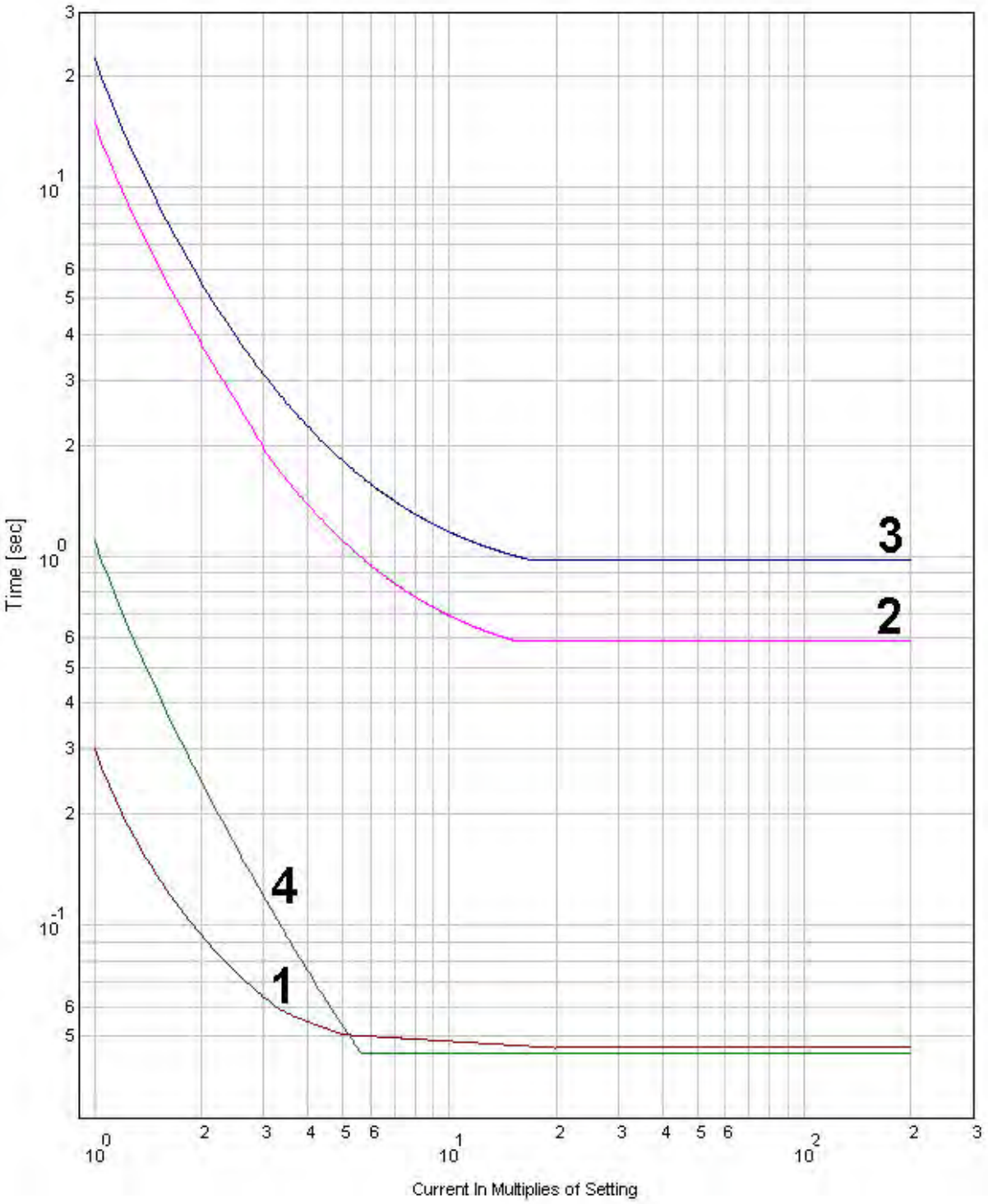
[Fig. A-1-3] E, L, M, N curves



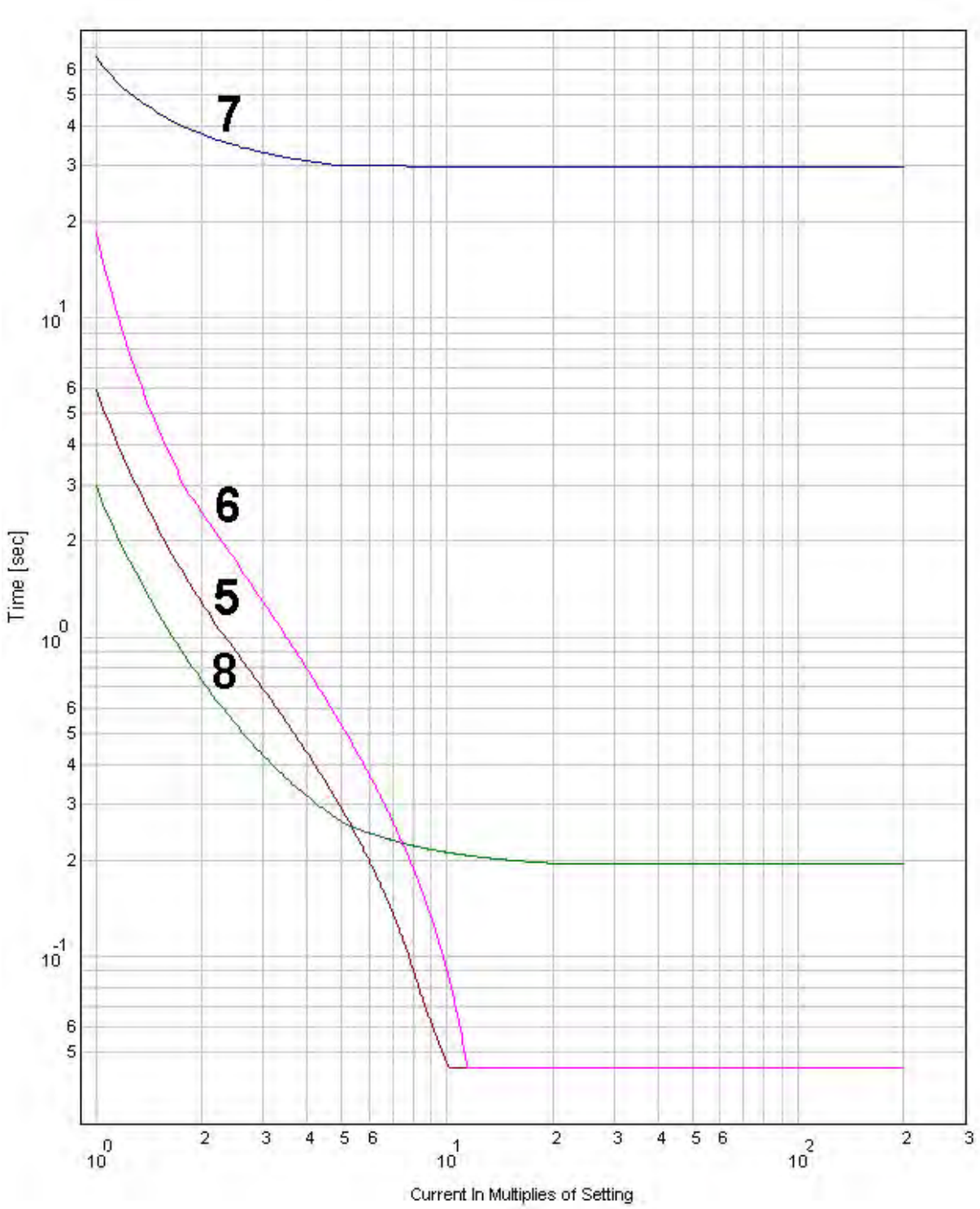
[Fig. A-1-4] K(P), P, R, T curves



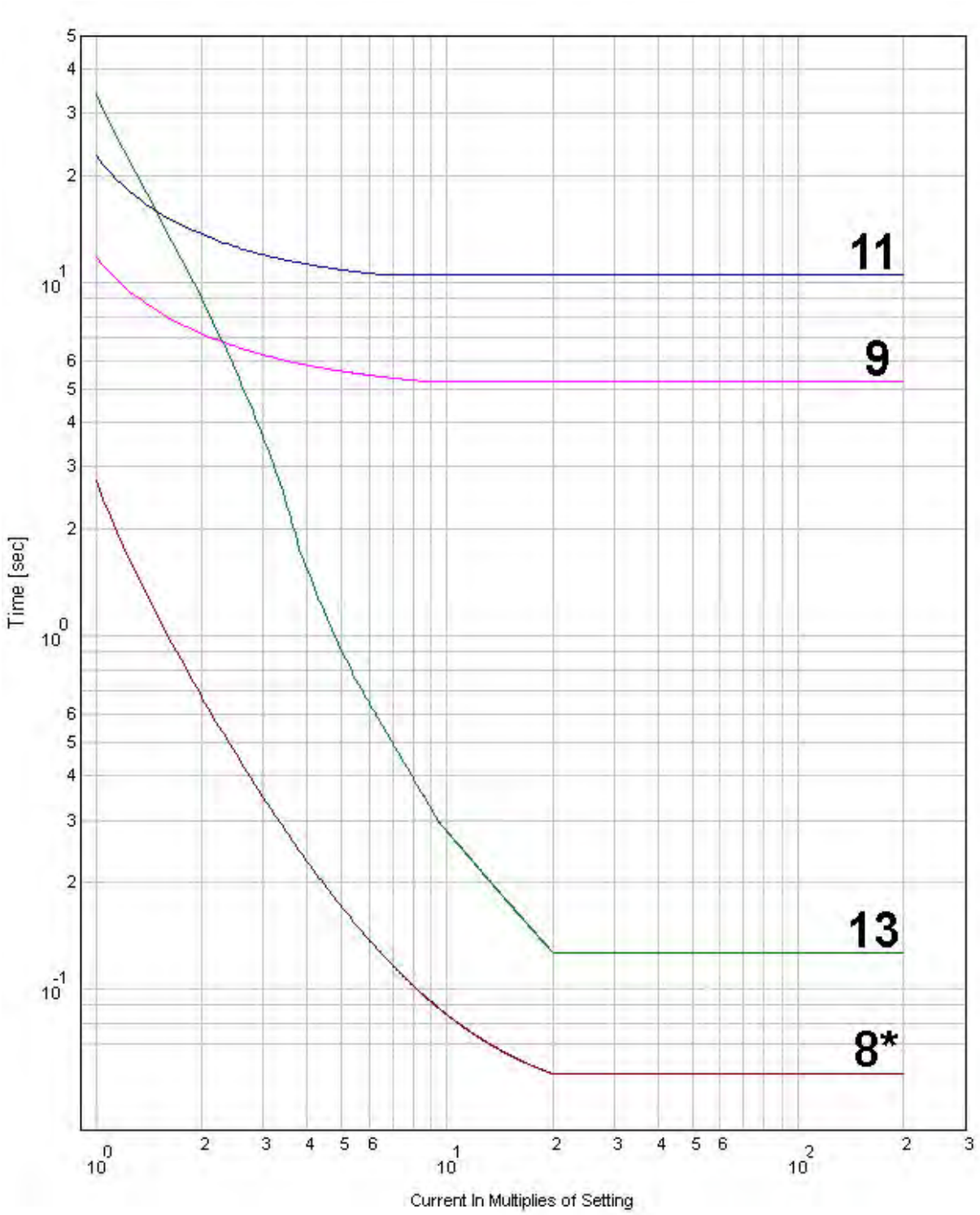
[Fig. A-1-5] V, W, Y, Z curves



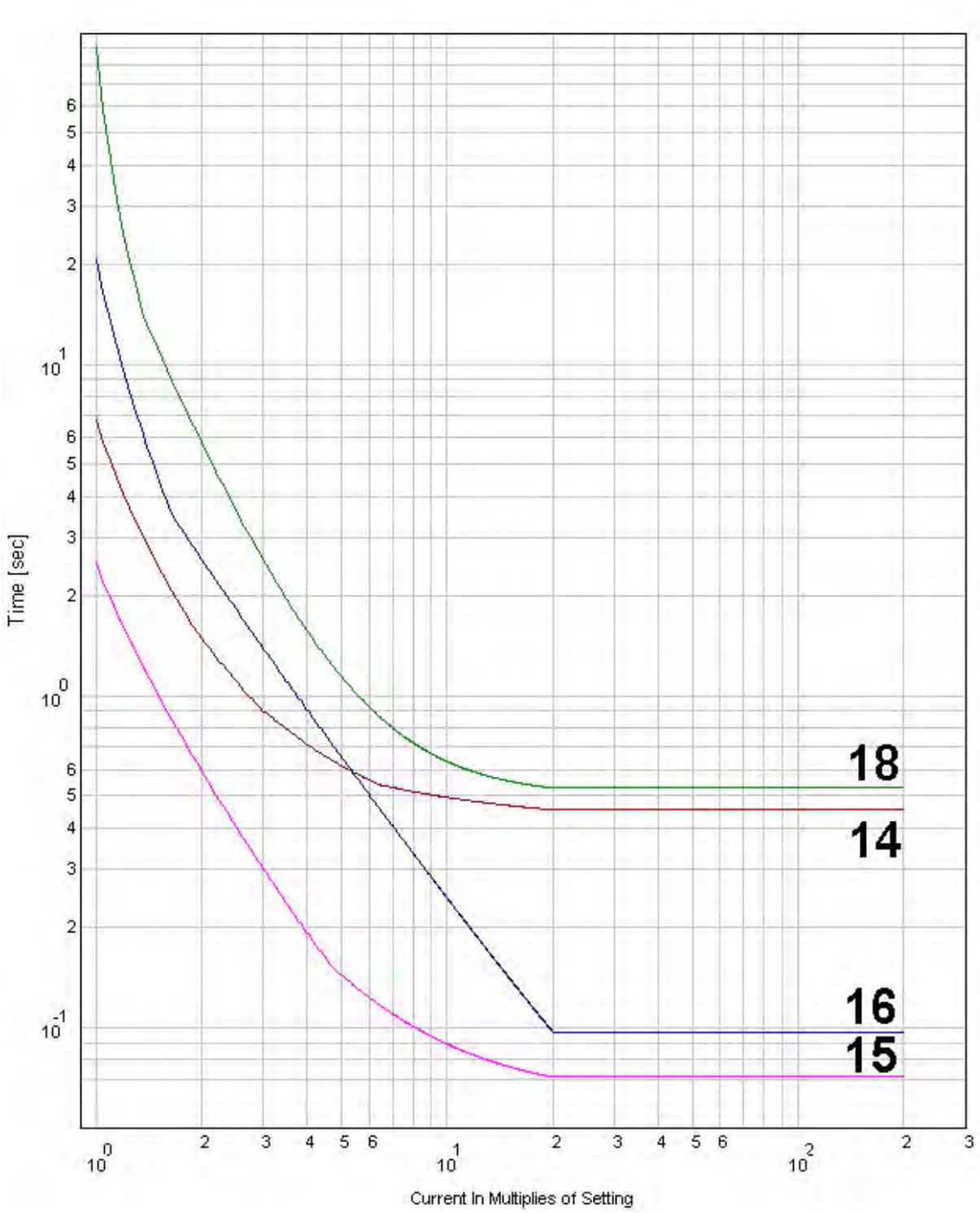
[Fig. A-1-6] 1, 2, 3, 4 curves



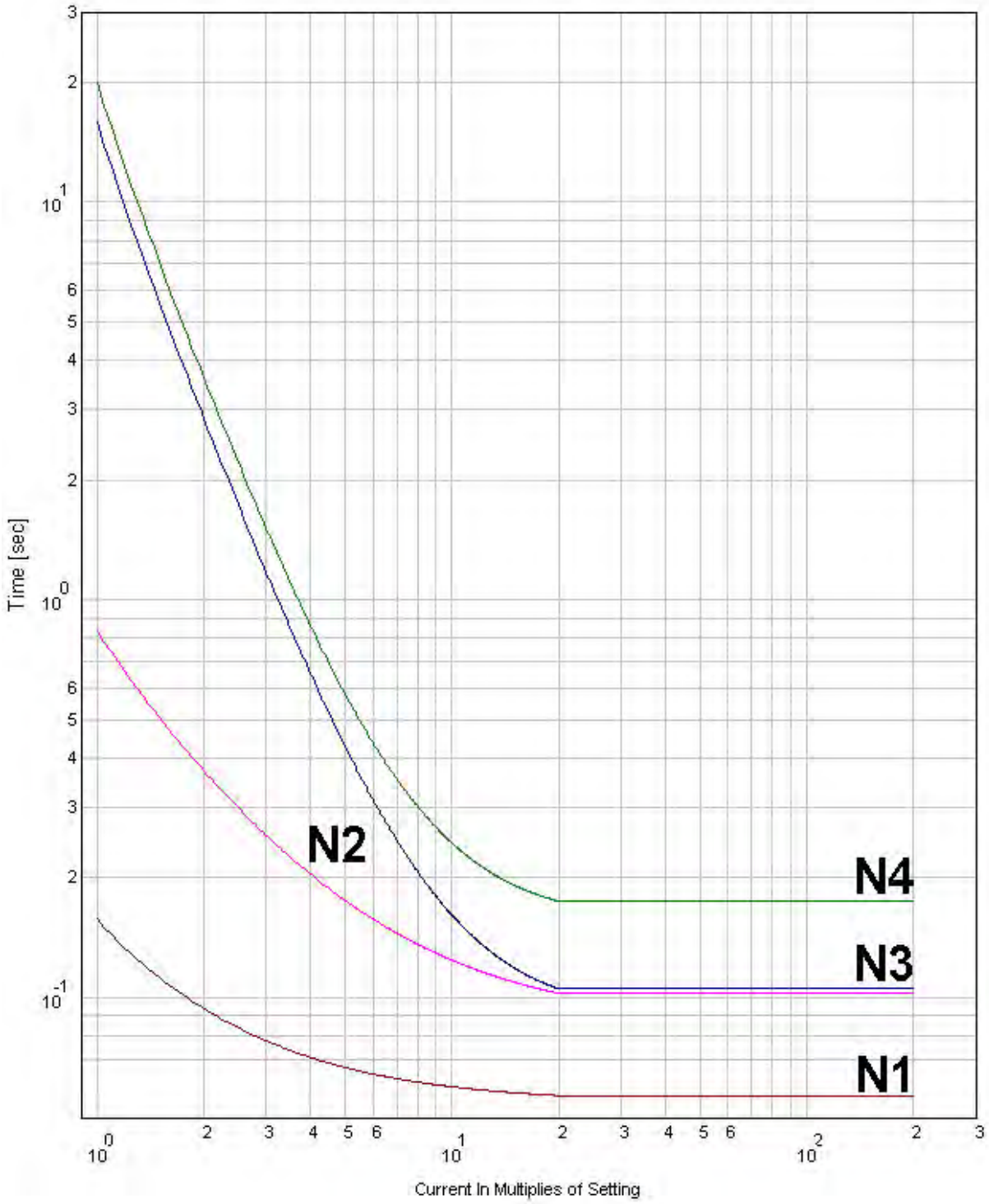
[Fig. A-1-7] 5, 6, 7, 8 curves



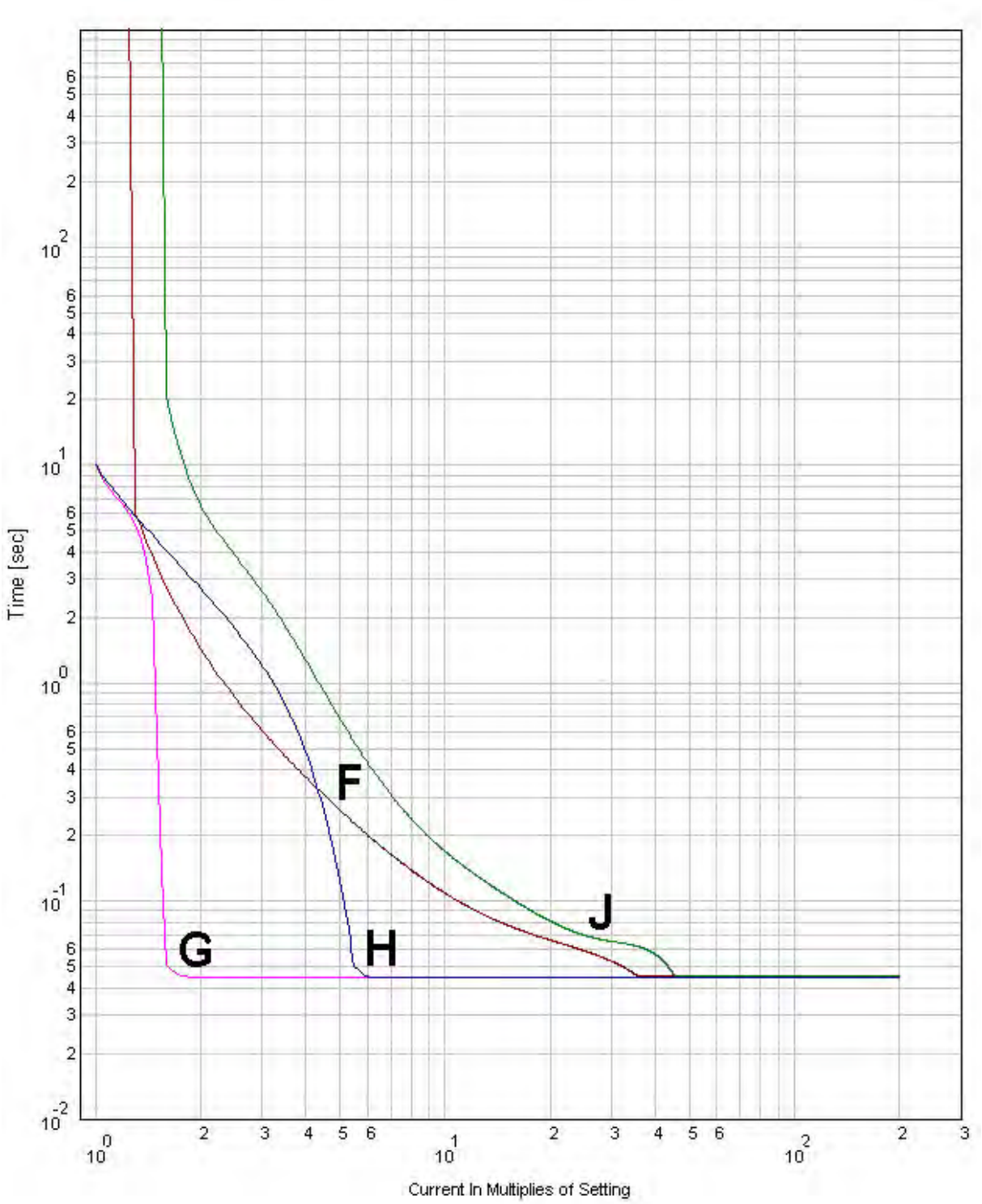
[Fig. A-1-8] 8*, 9 , 11, 13 curves



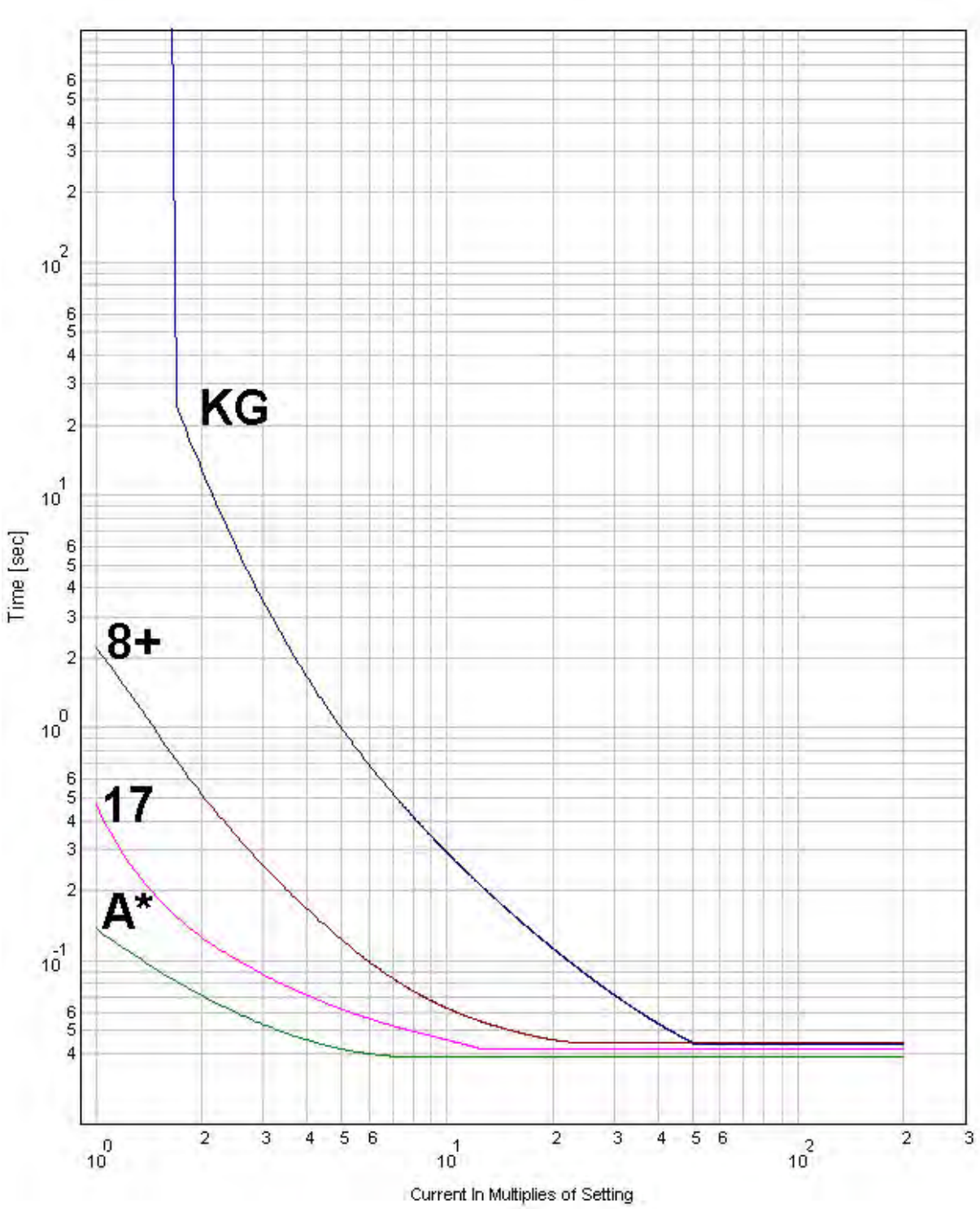
[Fig. A-1-9] 14, 15, 16, 18 curves



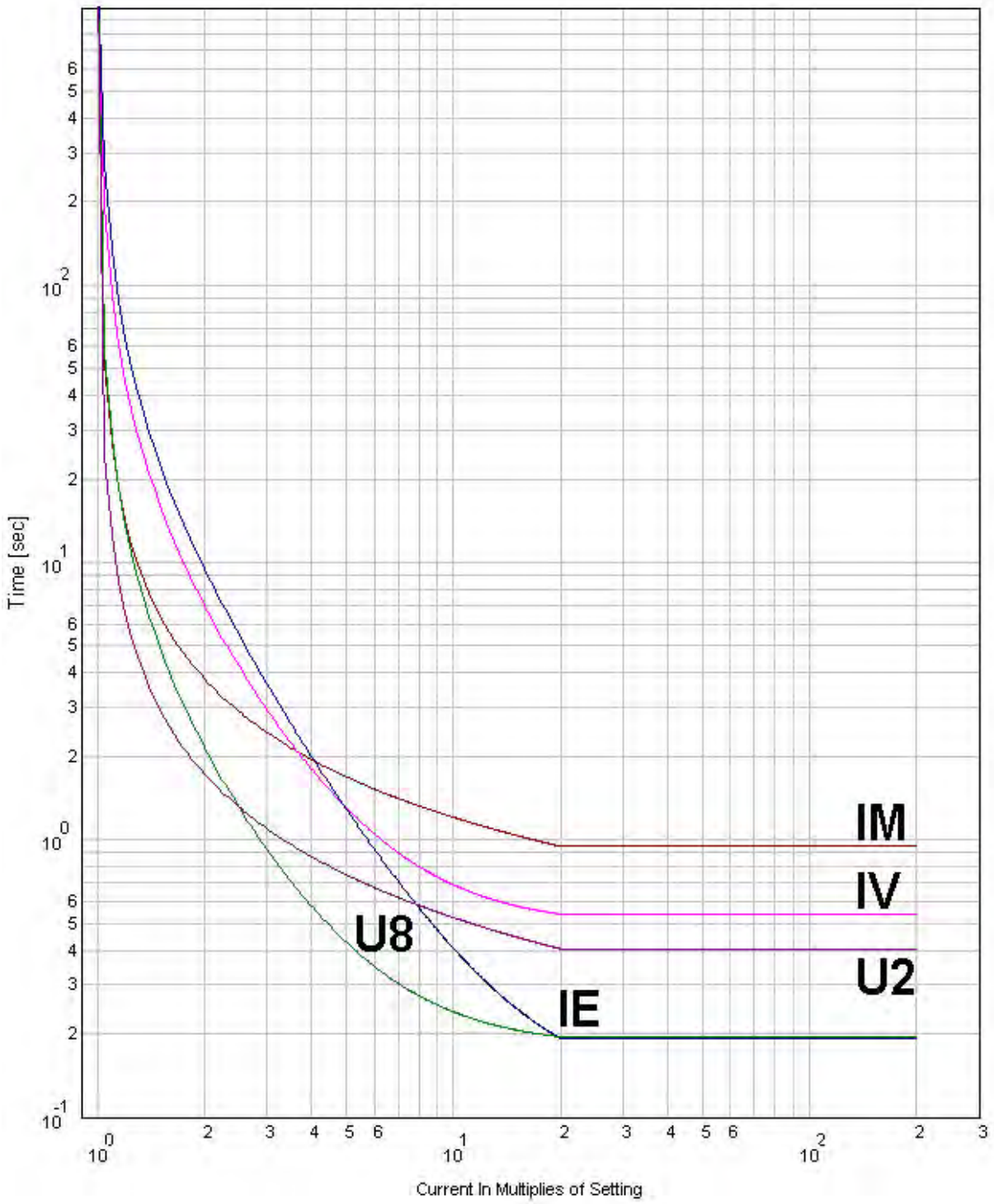
[Fig. A-1-10] N1, N2, N3, N4 curves



[Fig. A-1-11] F, G, H, J curves



[Fig. A-1-12] 8+, 17, K(G), A* curves



[Fig. A-1-13] ANSI/IEEE curves (MI, VI, EI, CO2, CO8)

Appendix 2. DNP V3.0 PROTOCOL POINT INDEX

DNP3.0 PROTOCOL

Object Index Table

FTU-Recloser

Rev Date: 24-Feb-09

Revision Document: 3.3

Firmware:

Hardware:

Object Index Table

Index No.	Description	Default Class	Object/Variation	Remark
Binary Inputs				
0	Switch Status	1	01/01,01/02,02/02	Closed = 1
1	Control Mode	1	01/01,01/02,02/02	Local = 1
2	Handle Locked	1	01/01,01/02,02/02	
3	Gas low	1	01/01,01/02,02/02	
4	Ext. AC Power Loss	1	01/01,01/02,02/02	
5	Battery Discharged	1	01/01,01/02,02/02	
6	Door Open	1	01/01,01/02,02/02	
7	DI Spare #1	1	01/01,01/02,02/02	Contact closed = 1
8	DI Spare #2	1	01/01,01/02,02/02	Contact closed = 1
9	DI Spare #3	1	01/01,01/02,02/02	Contact closed = 1
10	Fault Indicator (A)	3	01/01,01/02,02/02	
11	Fault Indicator (B)	3	01/01,01/02,02/02	
12	Fault Indicator (C)	3	01/01,01/02,02/02	
13	Fault Indicator (N)	3	01/01,01/02,02/02	
14	Fault Indicator (SEF)	3	01/01,01/02,02/02	
15	Reverse Direction Fault	3	01/01,01/02,02/02	
16	Open Line Detection A	3	01/01,01/02,02/02	
17	Open Line Detection B	3	01/01,01/02,02/02	
18	Open Line Detection C	3	01/01,01/02,02/02	
19	Open Line Detection R	3	01/01,01/02,02/02	

20	Open Line Detection S	3	01/01,01/02,02/02	
21	Open Line Detection T	3	01/01,01/02,02/02	
22	Sync. fail	3	01/01,01/02,02/02	
23	System Error	3	01/01,01/02,02/02	
24	Inrush Detected	3	01/01,01/02,02/02	
25	Reclosing Blocked	1	01/01,01/02,02/02	
26	Protection Blocked	1	01/01,01/02,02/02	
27	Ground Protection Blocked	1	01/01,01/02,02/02	
28	High Current Trip	3	01/01,01/02,02/02	
29	Sequence Lockout	3	01/01,01/02,02/02	
30	Reserved	0	01/01,01/02,02/02	
31	Under Frequency Op.	0	01/01,01/02,02/02	
Binary Outputs				
0	Switch Open/Close Control	Pulse	12/01	CLOSE=Close, TRIP=Open
1	Battery Test	Pulse	12/01	CLOSE
2	DO spare Output	Pulse	12/01	CLOSE
3	Annunciator Manual Reset	Pulse	12/01	CLOSE
4	Reserved	Pulse	12/01	CLOSE
5	Enable/Disable Reclosing	Pulse	12/01	CLOSE=En.,TRIP=Dis.
6	Enable/Disable Protection	Pulse	12/01	CLOSE=En.,TRIP=Dis.
7	Enable/Disable Ground Protection	Pulse	12/01	CLOSE=En.,TRIP=Dis.
8	Reserved	Pulse	12/01	CLOSE
Analog Inputs				
0	Ia RMS	2	30/02,30/04,32/02	A
1	Ib RMS	2	30/02,30/04,32/02	A
2	Ic RMS	2	30/02,30/04,32/02	A
3	In RMS	0	30/02,30/04,32/02	A
4	Source side Va RMS	0	30/02,30/04,32/02	kV100
5	Source side Vb RMS	0	30/02,30/04,32/02	kV100
6	Source side Vc RMS	0	30/02,30/04,32/02	kV100
7	Source side Vo RMS	0	30/02,30/04,32/02	kV100
8	Load side Va RMS	0	30/02,30/04,32/02	kV100
9	Load side Vb RMS	0	30/02,30/04,32/02	kV100
10	Load side Vc RMS	0	30/02,30/04,32/02	kV100
11	Load side Vo RMS	0	30/02,30/04,32/02	kV100

12	KVAa	0	30/02,30/04,32/02	kVA
13	KVAb	0	30/02,30/04,32/02	kVA
14	KVAc	0	30/02,30/04,32/02	kVA
15	kVA3ph	0	30/02,30/04,32/02	kVA
16	KWa	0	30/02,30/04,32/02	kW
17	KWb	0	30/02,30/04,32/02	kW
18	KWc	0	30/02,30/04,32/02	kW
19	kW3ph	0	30/02,30/04,32/02	kW
20	KVARa	0	30/02,30/04,32/02	kVAR
21	KVARb	0	30/02,30/04,32/02	kVAR
22	KVARc	0	30/02,30/04,32/02	kVAR
23	kVAR3ph	0	30/02,30/04,32/02	kVAR
24	PFa	0	30/02,30/04,32/02	X100
25	PFb	0	30/02,30/04,32/02	X100
26	PFc	0	30/02,30/04,32/02	X100
27	PF3ph	0	30/02,30/04,32/02	X100
28	Va-Vr Phase Angle Diff	0	30/02,30/04,32/02	° 10
29	Frequency	0	30/02,30/04,32/02	HZ100
30	Reserved (Temperature)	0	30/02,30/04,32/02	
31	Reserved	0	30/02,30/04,32/02	
32	Ia phase angle	0	30/02,30/04	° 10
33	Ib phase angle	0	30/02,30/04	° 10
34	Ic phase angle	0	30/02,30/04	° 10
35	In phase angle	0	30/02,30/04	° 10
36	Source side Va phase angle	0	30/02,30/04	° 10
37	Source side Vb phase angle	0	30/02,30/04	° 10
38	Source side Vc phase angle	0	30/02,30/04	° 10
39	Source side Vo phase angle	0	30/02,30/04	° 10
40	Load side Va phase angle	0	30/02,30/04	° 10
41	Load side Vb phase angle	0	30/02,30/04	° 10
42	Load side Vc phase angle	0	30/02,30/04	° 10
43	Load side Vo phase angle	0	30/02,30/04	° 10
44	I1 RMS	0	30/02,30/04	A
45	I1 phase angle	0	30/02,30/04	° 10
46	I2 RMS	0	30/02,30/04	A

47	I2 phase angle	0	30/02,30/04	° 10
48	Source side V1 RMS	0	30/02,30/04	kV100
49	Source side V1 phase angle	0	30/02,30/04	° 10
50	Source side V2 RMS	0	30/02,30/04	kV100
51	Source side V2 phase angle	0	30/02,30/04	° 10
52	Load side V1 RMS	0	30/02,30/04	A
53	Load side V1 phase angle	0	30/02,30/04	° 10
54	Load side V2 RMS	0	30/02,30/04	A
55	Load side V2 phase angle	0	30/02,30/04	° 10
56	PFa lead	0	30/02,30/04	Leading = 1
57	PFb lead	0	30/02,30/04	Leading = 1
58	PFc lead	0	30/02,30/04	Leading = 1
59	PF3ph lead	0	30/02,30/04	Leading = 1
60	Last Fault Ia	3	30/02,30/04,32/04	A
61	Last Fault Ib	3	30/02,30/04,32/04	A
62	Last Fault Ic	3	30/02,30/04,32/04	A
63	Last Fault In	3	30/02,30/04,32/04	A
64	Last Fault vo	0	30/02,30/04	A
65	Reserved (Last Fault location)	0	30/02,30/04	km
66	Reserved (Last Fault I2t)	0	30/02,30/04	
67	Reserved	0	30/02,30/04	
68	Demand I Ia	2	30/02,30/04,32/04	A
69	Demand I Ib	2	30/02,30/04,32/04	A
70	Demand I Ic	2	30/02,30/04,32/04	A
71	Demand I In	2	30/02,30/04,32/04	A
72	Demand P kWa	2	30/02,30/04,32/04	kW
73	Demand P kWb	2	30/02,30/04,32/04	kW
74	Demand P kWc	2	30/02,30/04,32/04	kW
75	Demand P kW3ph	2	30/02,30/04,32/04	kW
76	Demand P kVARa	2	30/02,30/04,32/04	kVAR
77	Demand P kVARb	2	30/02,30/04,32/04	kVAR
78	Demand P kVARc	2	30/02,30/04,32/04	kVAR
79	Demand P kVAR3ph	2	30/02,30/04,32/04	kVAR
80	Max. I Ia	2	30/02,30/04,32/04	A
81	Max. I Ib	2	30/02,30/04,32/04	A

82	Max. I Ic	2	30/02,30/04,32/04	A
83	Max. I In	2	30/02,30/04,32/04	A
84	Max. P1 kWa	2	30/02,30/04,32/04	kW
85	Max. P1 kWb	2	30/02,30/04,32/04	kW
86	Max. P1 kWc	2	30/02,30/04,32/04	kW
87	Max. P1 kW3ph	2	30/02,30/04,32/04	kW
88	Max. P1 kVARa	2	30/02,30/04,32/04	kVAR
89	Max. P1 kVARb	2	30/02,30/04,32/04	kVAR
90	Max. P1 kVARc	2	30/02,30/04,32/04	kVAR
91	Max. P1 kVAR3ph	2	30/02,30/04,32/04	kVAR
92	3-phase currents THD	0	30/02,30/04	%
93	Ia THD	0	30/02,30/04	%
94	Ib THD	0	30/02,30/04	%
95	Ic THD	0	30/02,30/04	%
96	Source side 3-phase voltages THD	0	30/02,30/04	%
97	Source side Va THD	0	30/02,30/04	%
98	Source side Vb THD	0	30/02,30/04	%
99	Source side Vc THD	0	30/02,30/04	%
100	Load side 3-phase voltages THD	0	30/02,30/04	%
101	Load side Va THD	0	30/02,30/04	%
102	Load side Vb THD	0	30/02,30/04	%
103	Load side Vc THD	0	30/02,30/04	%
104	Ia true RMS	0	30/02,30/04	A
105	Ib true RMS	0	30/02,30/04	A
106	Ic true RMS	0	30/02,30/04	A
107	Va true RMS	0	30/02,30/04	kV100
108	Vb true RMS	0	30/02,30/04	kV100
109	Vc true RMS	0	30/02,30/04	kV100
110	Vr true RMS	0	30/02,30/04	kV100
111	Vs true RMS	0	30/02,30/04	kV100
112	Vt true RMS	0	30/02,30/04	kV100
113	Ia 2nd harmonic RMS	0	30/02,30/04	A
114	Ib 2nd harmonic RMS	0	30/02,30/04	A
115	Ic 2nd harmonic RMS	0	30/02,30/04	A
116	Ia 3rd harmonic RMS	0	30/02,30/04	A

117	Ib 3rd harmonic RMS	0	30/02,30/04	A
118	Ic 3rd harmonic RMS	0	30/02,30/04	A
119	Ia 4th harmonic RMS	0	30/02,30/04	A
120	Ib 4th harmonic RMS	0	30/02,30/04	A
121	Ic 4th harmonic RMS	0	30/02,30/04	A
122	Ia 5th harmonic RMS	0	30/02,30/04	A
123	Ib 5th harmonic RMS	0	30/02,30/04	A
124	Ic 5th harmonic RMS	0	30/02,30/04	A
125	Ia 6th harmonic RMS	0	30/02,30/04	A
126	Ib 6th harmonic RMS	0	30/02,30/04	A
127	Ic 6th harmonic RMS	0	30/02,30/04	A
128	Ia 7th harmonic RMS	0	30/02,30/04	A
129	Ib 7th harmonic RMS	0	30/02,30/04	A
130	Ic 7th harmonic RMS	0	30/02,30/04	A
131	Ia 8th harmonic RMS	0	30/02,30/04	A
132	Ib 8th harmonic RMS	0	30/02,30/04	A
133	Ic 8th harmonic RMS	0	30/02,30/04	A
134	Source side Va 2nd harmonic RMS	0	30/02,30/04	KV100
135	Source side Vb 2nd harmonic RMS	0	30/02,30/04	KV100
136	Source side Vc 2nd harmonic RMS	0	30/02,30/04	KV100
137	Source side Va 3rd harmonic RMS	0	30/02,30/04	KV100
138	Source side Vb 3rd harmonic RMS	0	30/02,30/04	KV100
139	Source side Vc 3rd harmonic RMS	0	30/02,30/04	KV100
140	Source side Va 4th harmonic RMS	0	30/02,30/04	KV100
141	Source side Vb 4th harmonic RMS	0	30/02,30/04	KV100
142	Source side Vc 4th harmonic RMS	0	30/02,30/04	KV100
143	Source side Va 5th harmonic RMS	0	30/02,30/04	KV100
144	Source side Vb 5th harmonic RMS	0	30/02,30/04	KV100
145	Source side Vc 5th harmonic RMS	0	30/02,30/04	KV100
146	Source side Va 6th harmonic RMS	0	30/02,30/04	KV100
147	Source side Vb 6th harmonic RMS	0	30/02,30/04	KV100
148	Source side Vc 6th harmonic RMS	0	30/02,30/04	KV100
149	Source side Va 7th harmonic RMS	0	30/02,30/04	KV100
150	Source side Vb 7th harmonic RMS	0	30/02,30/04	KV100
151	Source side Vc 7th harmonic RMS	0	30/02,30/04	KV100

152	Source side Va 8th harmonic RMS	0	30/02,30/04	KV100
153	Source side Vb 8th harmonic RMS	0	30/02,30/04	KV100
154	Source side Vc 8th harmonic RMS	0	30/02,30/04	KV100
155	Load side Va 2nd harmonic RMS	0	30/02,30/04	KV100
156	Load side Vb 2nd harmonic RMS	0	30/02,30/04	KV100
157	Load side Vc 2nd harmonic RMS	0	30/02,30/04	KV100
158	Load side Va 3rd harmonic RMS	0	30/02,30/04	KV100
159	Load side Vb 3rd harmonic RMS	0	30/02,30/04	KV100
160	Load side Vc 3rd harmonic RMS	0	30/02,30/04	KV100
161	Load side Va 4th harmonic RMS	0	30/02,30/04	KV100
162	Load side Vb 4th harmonic RMS	0	30/02,30/04	KV100
163	Load side Vc 4th harmonic RMS	0	30/02,30/04	KV100
164	Load side Va 5th harmonic RMS	0	30/02,30/04	KV100
165	Load side Vb 5th harmonic RMS	0	30/02,30/04	KV100
166	Load side Vc 5th harmonic RMS	0	30/02,30/04	KV100
167	Load side Va 6th harmonic RMS	0	30/02,30/04	KV100
168	Load side Vb 6th harmonic RMS	0	30/02,30/04	KV100
169	Load side Vc 6th harmonic RMS	0	30/02,30/04	KV100
170	Load side Va 7th harmonic RMS	0	30/02,30/04	KV100
171	Load side Vb 7th harmonic RMS	0	30/02,30/04	KV100
172	Load side Vc 7th harmonic RMS	0	30/02,30/04	KV100
173	Load side Va 8th harmonic RMS	0	30/02,30/04	KV100
174	Load side Vb 8th harmonic RMS	0	30/02,30/04	KV100
175	Load side Vc 8th harmonic RMS	0	30/02,30/04	KV100
176	In THD	-	30/02,30/04	%
177	In true RMS	-	30/02,30/04	A
178	In 2nd harmonic RMS	-	30/02,30/04	A
179	In 3rd harmonic RMS	-	30/02,30/04	A
180	In 4th harmonic RMS	-	30/02,30/04	A
181	In 5th harmonic RMS	-	30/02,30/04	A
182	In 6th harmonic RMS	-	30/02,30/04	A
183	In 7th harmonic RMS	-	30/02,30/04	A
184	In 8th harmonic RMS	-	30/02,30/04	A
Counters				
0	Restart Count	0	20/02,20/06	--

1	Switch Trip (or Open) Count	0	20/02,20/06	--
2	All Faults Count	0	20/02,20/06	--
3	A-phase Fault Count	0	20/02,20/06	--
4	B-phase Fault Count	0	20/02,20/06	--
5	C-phase Fault Count	0	20/02,20/06	--
6	N-phase Fault Count	0	20/02,20/06	--
7	kWattHour-a (Import)	0	20/02,20/06,22/08	kWh
8	kWattHour-b (Import)	0	20/02,20/06,22/08	kWh
9	kWattHour-c (Import)	0	20/02,20/06,22/08	kWh
10	kWattHour-3ph (Import)	0	20/02,20/06,22/08	kWh
11	kVarHour-a (Import)	0	20/02,20/06,22/08	kVarh
12	kVarHour-b (Import)	0	20/02,20/06,22/08	kVarh
13	kVarHour-c (Import)	0	20/02,20/06,22/08	kVarh
14	kVarHour-3ph (Import)	0	20/02,20/06,22/08	kVarh
15	kWattHour-a (Export)	0	20/02,20/06,22/08	kWh
16	kWattHour-b (Export)	0	20/02,20/06,22/08	kWh
17	kWattHour-c (Export)	0	20/02,20/06,22/08	kWh
18	kWattHour-3ph (Export)	0	20/02,20/06,22/08	kWh
19	kVarHour-a (Export)	0	20/02,20/06,22/08	kVarh
20	kVarHour-b (Export)	0	20/02,20/06,22/08	kVarh
21	kVarHour-c (Export)	0	20/02,20/06,22/08	kVarh
22	kVarHour-3ph (Export)	0	20/02,20/06,22/08	kVarh
Analog outputs				
Setting Group1				
0	Phase Pickup Current		40/02,41/02	10~900A
1	Phase Fast TCC type		40/02,41/02	1~48
2	Phase Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
3	Phase Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
4	Phase Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
5	Phase Fast Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
6	Phase Fast RDMT		40/02,41/02	0.00~100.00,step:0.01
7	Phase Delay TCC type		40/02,41/02	1~48
8	Phase Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
9	Phase Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
10	Phase Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01

11	Phase Delay Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
12	Phase Delay RDMT		40/02,41/02	0.00~100.00,step:0.01
13	Phase Definite Time O/C Active		40/02,41/02	ON(1),OFF(0)
14	Phase Definite Time O/C Level		40/02,41/02	50~10000A
15	Phase Definite Time O/C Response Time		40/02,41/02	0.00~1.00sec,step:0.01
16	Phase High Current Pickup		40/02,41/02	50~10000A
17	Phase High Current Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
18	Phase Cold Load Pickup Multiplier		40/02,41/02	0~10
19	Phase Inrush Restraint		40/02,41/02	0(No),1(Yes)
20	Ground Pickup Current		40/02,41/02	5~900A
21	Ground Fast TCC type		40/02,41/02	1~48
22	Ground Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
23	Ground Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
24	Ground Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
25	Ground Fast Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
26	Ground Fast RDMT		40/02,41/02	0.00~100.00,step:0.01
27	Ground Delay TCC type		40/02,41/02	1~48
28	Ground Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
29	Ground Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
30	Ground Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
31	Ground Delay Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
32	Ground Delay RDMT		40/02,41/02	0.00~100.00,step:0.01
33	Ground Definite Time O/C Active		40/02,41/02	ON(1),OFF(0)
34	Ground Definite Time O/C Level		40/02,41/02	50~10000A
35	Ground Definite Time Response Time		40/02,41/02	50~10000A
36	Ground High Current Pickup		40/02,41/02	50~10000A
37	Ground High Current Time Adder		40/02,41/02	0.00~1.00,step:0.01
38	Ground Cold Load Pickup Multiplier		40/02,41/02	0~10
39	Ground Inrush Restraint		40/02,41/02	0(No),1(Yes)
40	SEF -Pickup Current(Io)		40/02,41/02	2~20A
41	SEF -Pickup Voltage(Vo)		40/02,41/02	10~80%
42	SEF -Max. Torque Angle		40/02,41/02	0~(-)90,step:15 DEG
43	SEF -Detection Time		40/02,41/02	0.1~30.0 step:0.1 Sec
44	SEF -Inrush restraint		40/02,41/02	No(0),Yes(1)
45	SEF - On/Off		40/02,41/02	0(Off),1(On)

46	Inrush restraint-2nd harmonic level		40/02,41/02	5~50%
47	Inrush restraint-Detection Time		40/02,41/02	0.02~1.00,step:0.01
48	Inrush restraint -On/Off		40/02,41/02	0(Off),1(On)
49	Oper. To Lockout Phase		40/02,41/02	1~4
50	Oper. To Lockout Ground		40/02,41/02	1~4
51	Oper. To Lockout SEF		40/02,41/02	1~4
52	Oper. Fast Curve Phase		40/02,41/02	0~4
53	Oper. Fast Curve Ground		40/02,41/02	0~4
54	High Current Phase Active		40/02,41/02	0~4
55	High Current Ground Active		40/02,41/02	0~4
56	Reclose Interval 1st		40/02,41/02	0.5~60.0sec, step:0.1
57	Reclose Interval 2nd		40/02,41/02	1~60sec
58	Reclose Interval 3rd		40/02,41/02	1~60sec
59	Reclose Interval 4th		40/02,41/02	1~60sec
60	Reset Time		40/02,41/02	3~180sec
61	Single Shot Time		40/02,41/02	0~180sec [3s]
62	Cold Load Pickup Restore Time		40/02,41/02	0.00~30.00sec step:0.01
63	Cold Load Duration		40/02,41/02	0.00~60.00sec step:0.01
64	Seq. Coordination Active		40/02,41/02	ON(1),OFF(0)
UNDER VOLTAGE				
65	UV -Pickup		40/02,41/02	2.8~21.9kV step:0.1 [8.0kV]
66	Reserved		40/02,41/02	
67	UV -Delay Time		40/02,41/02	0.0~200.0sec step:0.1
68	UV -On/Off		40/02,41/02	0(OFF),1(LO),2(NR)
PHASE LOSS				
65	Phase Loss -Volt On level		40/02,41/02	50~90,step:5%
66	Phase Loss -Volt Off level		40/02,41/02	35~75,step:5%
67	Phase Loss -Delay Time		40/02,41/02	0.1~30.0sec step:0.1
68	Phase Loss -On/Off		40/02,41/02	0(Off),1(On)
69	Sync Fail-Phase difference		40/02,41/02	5~60DEG
70	Sync Fail-Delay Time		40/02,41/02	0.1~30.0sec step:0.1
71	Sync Fail -On/Off		40/02,41/02	0(Off),1(On)
72	UFR Frequency Level		40/02,41/02	47.00~59.98Hz,step:0,01
73	UFR Delay Time		40/02,41/02	0.1~30.0sec step:0.1
74	UFR On/Off		40/02,41/02	0(Off),1(On)

				0(OFF),1(LO),2(NR) - Option
Setting Group2				
75	Phase Pickup Current		40/02,41/02	10~900A
76	Phase Fast TCC type		40/02,41/02	1~48
77	Phase Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
78	Phase Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
79	Phase Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
80	Phase Fast Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
81	Phase Fast RDMT		40/02,41/02	0.00~100.00,step:0.01
82	Phase Delay TCC type		40/02,41/02	1~48
83	Phase Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
84	Phase Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
85	Phase Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
86	Phase Delay Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
87	Phase Delay RDMT		40/02,41/02	0.00~100.00,step:0.01
88	Phase Definite Time O/C Active		40/02,41/02	ON(1),OFF(0)
89	Phase Definite Time O/C Level		40/02,41/02	50~10000A
90	Phase Definite Time O/C Response Time		40/02,41/02	0.00~1.00sec,step:0.01
91	Phase High Current Pickup		40/02,41/02	50~10000A
92	Phase High Current Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
93	Phase Cold Load Pickup Multiplier		40/02,41/02	0~10
94	Phase Inrush Restraint		40/02,41/02	0(No),1(Yes)
95	Ground Pickup Current		40/02,41/02	5~900A
96	Ground Fast TCC type		40/02,41/02	1~48
97	Ground Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
98	Ground Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
99	Ground Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
100	Ground Fast Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
101	Ground Fast RDMT		40/02,41/02	0.00~100.00,step:0.01
102	Ground Delay TCC type		40/02,41/02	1~48
103	Ground Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
104	Ground Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
105	Ground Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
106	Ground Delay Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
107	Ground Delay RDMT		40/02,41/02	0.00~100.00,step:0.01

108	Ground Definite Time O/C Active		40/02,41/02	ON(1),OFF(0)
109	Ground Definite Time O/C Level		40/02,41/02	50~10000A
110	Ground Definite Time Response Time		40/02,41/02	50~10000A
111	Ground High Current Pickup		40/02,41/02	50~10000A
112	Ground High Current Time Adder		40/02,41/02	0.00~1.00,step:0.01
113	Ground Cold Load Pickup Multiplier		40/02,41/02	0~10
114	Ground Inrush Restraint		40/02,41/02	0(No),1(Yes)
115	SEF -Pickup Current(Io)		40/02,41/02	2~20A
116	SEF -Pickup Voltage(Vo)		40/02,41/02	10~80%
117	SEF -Max. Torque Angle		40/02,41/02	0~(-)90,step:15 DEG
118	SEF -Detection Time		40/02,41/02	0.1~30.0 step:0.1 Sec
119	SEF -Inrush restraint		40/02,41/02	No(0),Yes(1)
120	SEF - On/Off		40/02,41/02	0(Off),1(On)
121	Inrush restraint-2nd harmonic level		40/02,41/02	5~50%
122	Inrush restraint-Detection Time		40/02,41/02	0.02~1.00,step:0.01
123	Inrush restraint -On/Off		40/02,41/02	0(Off),1(On)
124	Oper. To Lockout Phase		40/02,41/02	1~4
125	Oper. To Lockout Ground		40/02,41/02	1~4
126	Oper. To Lockout SEF		40/02,41/02	1~4
127	Oper. Fast Curve Phase		40/02,41/02	0~4
128	Oper. Fast Curve Ground		40/02,41/02	0~4
129	High Current Phase Active		40/02,41/02	0~4
130	High Current Ground Active		40/02,41/02	0~4
131	Reclose Interval 1st		40/02,41/02	0.5~60.0sec, step:0.1
132	Reclose Interval 2nd		40/02,41/02	1~60sec
133	Reclose Interval 3rd		40/02,41/02	1~60sec
134	Reclose Interval 4th		40/02,41/02	1~60sec
135	Reset Time		40/02,41/02	3~180sec
136	Single Shot Time		40/02,41/02	0~180sec [3s]
137	Cold Load Pickup Restore Time		40/02,41/02	0.00~30.00sec step:0.01
138	Cold Load Duration		40/02,41/02	0.00~60.00sec step:0.01
139	Seq. Coordination Active		40/02,41/02	ON(1),OFF(0)
UNDER VOLTAGE				
140	UV -Pickup		40/02,41/02	2.8~21.9kV step:0.1 [8.0kV]
141	Reserved		40/02,41/02	

142	UV -Delay Time		40/02,41/02	0.0~200.0sec step:0.1
143	UV -On/Off		40/02,41/02	0(OFF),1(LO),2(NR)
PHASE LOSS				
140	Phase Loss -Volt On level		40/02,41/02	50~90,step:5%
141	Phase Loss -Volt Off level		40/02,41/02	35~75,step:5%
142	Phase Loss -Delay Time		40/02,41/02	0.1~30.0sec step:0.1
143	Phase Loss -On/Off		40/02,41/02	0(Off),1(On)
144	Sync Fail-Phase difference		40/02,41/02	5~60DEG
145	Sync Fail-Delay Time		40/02,41/02	0.1~30.0sec step:0.1
146	Sync Fail -On/Off		40/02,41/02	0(Off),1(On)
147	UFR Frequency Level		40/02,41/02	47.00~59.98Hz,step:0,01
148	UFR Delay Time		40/02,41/02	0.1~30.0sec step:0.1
149	UFR On/Off		40/02,41/02	0(Off),1(On) 0(OFF),1(LO),2(NR) - Option
Setting Group3				
150	Phase Pickup Current		40/02,41/02	10~900A
151	Phase Fast TCC type		40/02,41/02	1~48
152	Phase Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
153	Phase Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
154	Phase Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
155	Phase Fast Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
156	Phase Fast RDMT		40/02,41/02	0.00~100.00,step:0.01
157	Phase Delay TCC type		40/02,41/02	1~48
158	Phase Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
159	Phase Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
160	Phase Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
161	Phase Delay Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
162	Phase Delay RDMT		40/02,41/02	0.00~100.00,step:0.01
163	Phase Definite Time O/C Active		40/02,41/02	ON(1),OFF(0)
164	Phase Definite Time O/C Level		40/02,41/02	50~10000A
165	Phase Definite Time O/C Response Time		40/02,41/02	0.00~1.00sec,step:0.01
166	Phase High Current Pickup		40/02,41/02	50~10000A
167	Phase High Current Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
168	Phase Cold Load Pickup Multiplier		40/02,41/02	0~10
169	Phase Inrush Restraint		40/02,41/02	0(No),1(Yes)

170	Ground Pickup Current		40/02,41/02	5~900A
171	Ground Fast TCC type		40/02,41/02	1~48
172	Ground Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
173	Ground Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
174	Ground Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
175	Ground Fast Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
176	Ground Fast RDMT		40/02,41/02	0.00~100.00,step:0.01
177	Ground Delay TCC type		40/02,41/02	1~48
178	Ground Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
179	Ground Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
180	Ground Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
181	Ground Delay Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
182	Ground Delay RDMT		40/02,41/02	0.00~100.00,step:0.01
183	Ground Definite Time O/C Active		40/02,41/02	ON(1),OFF(0)
184	Ground Definite Time O/C Level		40/02,41/02	50~10000A
185	Ground Definite Time Response Time		40/02,41/02	50~10000A
186	Ground High Current Pickup		40/02,41/02	50~10000A
187	Ground High Current Time Adder		40/02,41/02	0.00~1.00,step:0.01
188	Ground Cold Load Pickup Multiplier		40/02,41/02	0~10
189	Ground Inrush Restraint		40/02,41/02	0(No),1(Yes)
190	SEF -Pickup Current(Io)		40/02,41/02	2~20A
191	SEF -Pickup Voltage(Vo)		40/02,41/02	10~80%
192	SEF -Max. Torque Angle		40/02,41/02	0~(-)90,step:15 DEG
193	SEF -Detection Time		40/02,41/02	0.1~30.0 step:0.1 Sec
194	SEF -Inrush restraint		40/02,41/02	No(0),Yes(1)
195	SEF - On/Off		40/02,41/02	0(Off),1(On)
196	Inrush restraint-2nd harmonic level		40/02,41/02	5~50%
197	Inrush restraint-Detection Time		40/02,41/02	0.02~1.00,step:0.01
198	Inrush restraint -On/Off		40/02,41/02	0(Off),1(On)
199	Oper. To Lockout Phase		40/02,41/02	1~4
200	Oper. To Lockout Ground		40/02,41/02	1~4
201	Oper. To Lockout SEF		40/02,41/02	1~4
202	Oper. Fast Curve Phase		40/02,41/02	0~4
203	Oper. Fast Curve Ground		40/02,41/02	0~4
204	High Current Phase Active		40/02,41/02	0~4

205	High Current Ground Active		40/02,41/02	0~4
206	Reclose Interval 1st		40/02,41/02	0.5~60.0sec, step:0.1
207	Reclose Interval 2nd		40/02,41/02	1~60sec
208	Reclose Interval 3rd		40/02,41/02	1~60sec
209	Reclose Interval 4th		40/02,41/02	1~60sec
210	Reset Time		40/02,41/02	3~180sec
211	Single Shot Time		40/02,41/02	0~180sec [3s]
212	Cold Load Pickup Restore Time		40/02,41/02	0.00~30.00sec step:0.01
213	Cold Load Duration		40/02,41/02	0.00~60.00sec step:0.01
214	Seq. Coordination Active		40/02,41/02	ON(1),OFF(0)
UNDER VOLTAGE				
215	UV -Pickup		40/02,41/02	2.8~21.9kV step:0.1 [8.0kV]
216	Reserved		40/02,41/02	
217	UV -Delay Time		40/02,41/02	0.0~200.0sec step:0.1
218	UV -On/Off		40/02,41/02	0(OFF),1(LO),2(NR)
PHASE LOSS				
215	Phase Loss -Volt On level		40/02,41/02	50~90,step:5%
216	Phase Loss -Volt Off level		40/02,41/02	35~75,step:5%
217	Phase Loss -Delay Time		40/02,41/02	0.1~30.0sec step:0.1
218	Phase Loss -On/Off		40/02,41/02	0(Off),1(On)
219	Sync Fail-Phase difference		40/02,41/02	5~60DEG
220	Sync Fail-Delay Time		40/02,41/02	0.1~30.0sec step:0.1
221	Sync Fail -On/Off		40/02,41/02	0(Off),1(On)
222	UFR Frequency Level		40/02,41/02	47.00~59.98Hz,step:0,01
223	UFR Delay Time		40/02,41/02	0.1~30.0sec step:0.1
224	UFR On/Off		40/02,41/02	0(Off),1(On) 0(OFF),1(LO),2(NR) - Option
Setting Group4				
225	Phase Pickup Current		40/02,41/02	10~900A
226	Phase Fast TCC type		40/02,41/02	1~48
227	Phase Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
228	Phase Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
229	Phase Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
230	Phase Fast Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
231	Phase Fast RDMT		40/02,41/02	0.00~100.00,step:0.01

232	Phase Delay TCC type		40/02,41/02	1~48
233	Phase Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
234	Phase Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
235	Phase Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
236	Phase Delay Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
237	Phase Delay RDMT		40/02,41/02	0.00~100.00,step:0.01
238	Phase Definite Time O/C Active		40/02,41/02	ON(1),OFF(0)
239	Phase Definite Time O/C Level		40/02,41/02	50~10000A
240	Phase Definite Time O/C Response Time		40/02,41/02	0.00~1.00sec,step:0.01
241	Phase High Current Pickup		40/02,41/02	50~10000A
242	Phase High Current Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
243	Phase Cold Load Pickup Multiplier		40/02,41/02	0~10
244	Phase Inrush Restraint		40/02,41/02	0(No),1(Yes)
245	Ground Pickup Current		40/02,41/02	5~900A
246	Ground Fast TCC type		40/02,41/02	1~48
247	Ground Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
248	Ground Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
249	Ground Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
250	Ground Fast Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
251	Ground Fast RDMT		40/02,41/02	0.00~100.00,step:0.01
252	Ground Delay TCC type		40/02,41/02	1~48
253	Ground Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
254	Ground Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
255	Ground Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
256	Ground Delay Reset Type		40/02,41/02	RDMT(0)/RIDMT(1)
257	Ground Delay RDMT		40/02,41/02	0.00~100.00,step:0.01
258	Ground Definite Time O/C Active		40/02,41/02	ON(1),OFF(0)
259	Ground Definite Time O/C Level		40/02,41/02	50~10000A
260	Ground Definite Time Response Time		40/02,41/02	50~10000A
261	Ground High Current Pickup		40/02,41/02	50~10000A
262	Ground High Current Time Adder		40/02,41/02	0.00~1.00,step:0.01
263	Ground Cold Load Pickup Multiplier		40/02,41/02	0~10
264	Ground Inrush Restraint		40/02,41/02	0(No),1(Yes)
265	SEF -Pickup Current(Io)		40/02,41/02	2~20A
266	SEF -Pickup Voltage(Vo)		40/02,41/02	10~80%

267	SEF -Max. Torque Angle		40/02,41/02	0~(-)90,step:15 DEG
268	SEF -Detection Time		40/02,41/02	0.1~30.0 step:0.1 Sec
269	SEF -Inrush restraint		40/02,41/02	No(0),Yes(1)
270	SEF - On/Off		40/02,41/02	0(Off),1(On)
271	Inrush restraint-2nd harmonic level		40/02,41/02	5~50%
272	Inrush restraint-Detection Time		40/02,41/02	0.02~1.00,step:0.01
273	Inrush restraint -On/Off		40/02,41/02	0(Off),1(On)
274	Oper. To Lockout Phase		40/02,41/02	1~4
275	Oper. To Lockout Ground		40/02,41/02	1~4
276	Oper. To Lockout SEF		40/02,41/02	1~4
277	Oper. Fast Curve Phase		40/02,41/02	0~4
278	Oper. Fast Curve Ground		40/02,41/02	0~4
279	High Current Phase Active		40/02,41/02	0~4
280	High Current Ground Active		40/02,41/02	0~4
281	Reclose Interval 1st		40/02,41/02	0.5~60.0sec, step:0.1
282	Reclose Interval 2nd		40/02,41/02	1~60sec
283	Reclose Interval 3rd		40/02,41/02	1~60sec
284	Reclose Interval 4th		40/02,41/02	1~60sec
285	Reset Time		40/02,41/02	3~180sec
286	Single Shot Time		40/02,41/02	0~180sec [3s]
287	Cold Load Pickup Restore Time		40/02,41/02	0.00~30.00sec step:0.01
288	Cold Load Duration		40/02,41/02	0.00~60.00sec step:0.01
289	Seq. Coordination Active		40/02,41/02	ON(1),OFF(0)
UNDER VOLTAGE				
290	UV -Pickup		40/02,41/02	2.8~21.9kV step:0.1 [8.0kV]
291	Reserved		40/02,41/02	
292	UV -Delay Time		40/02,41/02	0.0~200.0sec step:0.1
293	UV -On/Off		40/02,41/02	0(OFF),1(LO),2(NR)
PHASE LOSS				
290	Phase Loss -Volt On level		40/02,41/02	50~90,step:5%
291	Phase Loss -Volt Off level		40/02,41/02	35~75,step:5%
292	Phase Loss -Delay Time		40/02,41/02	0.1~30.0sec step:0.1
293	Phase Loss -On/Off		40/02,41/02	0(Off),1(On)
294	Sync Fail-Phase difference		40/02,41/02	5~60DEG
295	Sync Fail-Delay Time		40/02,41/02	0.1~30.0sec step:0.1

296	Sync Fail -On/Off		40/02,41/02	0(Off),1(On)
297	UFR Frequency Level		40/02,41/02	47.00~59.98Hz,step:0,01
298	UFR Delay Time		40/02,41/02	0.1~30.0sec step:0.1
229	UFR On/Off		40/02,41/02	0(Off),1(On) 0(OFF),1(LO),2(NR) - Option
Common Setting				
300	Normal power flow setting group		40/02,41/02	1~4
301	Reserved		40/02,41/02	
302	Reserved		40/02,41/02	
303	Reserved		40/02,41/02	
VOC Setting				
304	AI.0 VOC		40/02,41/02	0~50%
305	AI.1 VOC		40/02,41/02	0~50%
306	AI.2 VOC		40/02,41/02	0~50%
307	AI.3 VOC		40/02,41/02	0~50%
308	AI.4 VOC		40/02,41/02	0~50%
309	AI.5 VOC		40/02,41/02	0~50%
310	AI.6 VOC		40/02,41/02	0~50%
311	AI.7 VOC		40/02,41/02	0~50%
312	AI.8 VOC		40/02,41/02	0~50%
313	AI.9 VOC		40/02,41/02	0~50%
314	AI.10 VOC		40/02,41/02	0~50%
315	AI.11 VOC		40/02,41/02	0~50%
316	AI.12 VOC		40/02,41/02	0~50%
317	AI.13 VOC		40/02,41/02	0~50%
318	AI.14 VOC		40/02,41/02	0~50%
319	AI.15 VOC		40/02,41/02	0~50%
320	AI.16 VOC		40/02,41/02	0~50%
321	AI.17 VOC		40/02,41/02	0~50%
322	AI.18 VOC		40/02,41/02	0~50%
323	AI.19 VOC		40/02,41/02	0~50%
324	AI.20 VOC		40/02,41/02	0~50%
325	AI.21 VOC		40/02,41/02	0~50%
326	AI.22 VOC		40/02,41/02	0~50%
327	AI.23 VOC		40/02,41/02	0~50%

328	AI.24 VOC		40/02,41/02	0~50%
329	AI.25 VOC		40/02,41/02	0~50%
330	AI.26 VOC		40/02,41/02	0~50%
331	AI.27 VOC		40/02,41/02	0~50%
332	AI.28 VOC		40/02,41/02	0~50%
333	AI.29 VOC		40/02,41/02	0~50%
334	AI.30 VOC		40/02,41/02	0~50%
335	AI.31 VOC		40/02,41/02	0~50%
336	AI.0 VOC Limit		40/02,41/02	0~65535
337	AI.1 VOC Limit		40/02,41/02	0~65535
338	AI.2 VOC Limit		40/02,41/02	0~65535
339	AI.3 VOC Limit		40/02,41/02	0~65535
340	AI.4 VOC Limit		40/02,41/02	0~65535
341	AI.5 VOC Limit		40/02,41/02	0~65535
342	AI.6 VOC Limit		40/02,41/02	0~65535
343	AI.7 VOC Limit		40/02,41/02	0~65535
344	AI.8 VOC Limit		40/02,41/02	0~65535
345	AI.9 VOC Limit		40/02,41/02	0~65535
346	AI.10 VOC Limit		40/02,41/02	0~65535
347	AI.11 VOC Limit		40/02,41/02	0~65535
348	AI.12 VOC Limit		40/02,41/02	0~65535
349	AI.13 VOC Limit		40/02,41/02	0~65535
350	AI.14 VOC Limit		40/02,41/02	0~65535
351	AI.15 VOC Limit		40/02,41/02	0~65535
352	AI.16 VOC Limit		40/02,41/02	0~65535
353	AI.17 VOC Limit		40/02,41/02	0~65535
354	AI.18 VOC Limit		40/02,41/02	0~65535
355	AI.19 VOC Limit		40/02,41/02	0~65535
356	AI.20 VOC Limit		40/02,41/02	0~65535
357	AI.21 VOC Limit		40/02,41/02	0~65535
358	AI.22 VOC Limit		40/02,41/02	0~65535
359	AI.23 VOC Limit		40/02,41/02	0~65535
360	AI.24 VOC Limit		40/02,41/02	0~65535
361	AI.25 VOC Limit		40/02,41/02	0~65535
362	AI.26 VOC Limit		40/02,41/02	0~65535

363	AI.27 VOC Limit		40/02,41/02	0~65535
364	AI.28 VOC Limit		40/02,41/02	0~65535
365	AI.29 VOC Limit		40/02,41/02	0~65535
366	AI.30 VOC Limit		40/02,41/02	0~65535
367	AI.31 VOC Limit		40/02,41/02	0~65535
368	CNT.0 VOC		40/02,41/02	0~65535
369	CNT.1 VOC		40/02,41/02	0~65535
370	CNT.2 VOC		40/02,41/02	0~65535
371	CNT.3 VOC		40/02,41/02	0~65535
372	CNT.4 VOC		40/02,41/02	0~65535
373	CNT.5 VOC		40/02,41/02	0~65535
374	CNT.6 VOC		40/02,41/02	0~65535
375	CNT.7 VOC		40/02,41/02	0~65535
376	CNT.8 VOC		40/02,41/02	0~65535
377	CNT.9 VOC		40/02,41/02	0~65535
378	CNT.10 VOC		40/02,41/02	0~65535
379	CNT.11 VOC		40/02,41/02	0~65535
380	CNT.12 VOC		40/02,41/02	0~65535
381	CNT.13 VOC		40/02,41/02	0~65535
382	CNT.14 VOC		40/02,41/02	0~65535
383	CNT.15 VOC		40/02,41/02	0~65535
384	CNT.16 VOC		40/02,41/02	0~65535
385	CNT.17 VOC		40/02,41/02	0~65535
386	CNT.18 VOC		40/02,41/02	0~65535
387	CNT.19 VOC		40/02,41/02	0~65535
388	CNT.20 VOC		40/02,41/02	0~65535
389	CNT.21 VOC		40/02,41/02	0~65535
390	CNT.22 VOC		40/02,41/02	0~65535
File Transfer				
	“EV_BIO”		70/01	I/O Event history
	“EV_FUNC”		70/01	Function Event History
	“EV_SYS”		70/01	System Event History
	“EV_FAULT”		70/01	Fault Event History
	“EV_DMD_I”		70/01	Demand I History
	“EV_DMD_P”		70/01	Demand P History

	“EV_MAX_I”		70/01	Max. I History
	“EV_MAX_P”		70/01	Max. P History
	“FI_WAVE_0”		70/01	Fault Waveform (Recent)
	“FI_WAVE_1”		70/01	Fault Waveform
	“FI_WAVE_2”		70/01	Fault Waveform
	“FI_WAVE_3”		70/01	Fault Waveform (Oldest)
I/O Event File Record Format				
	I/O Event ID			Unsigned short
	I/O Event Date & Time			DNP Time
	I/O Event Status Flags			Unsigned short
Function Event File Record Format				
	Function Event ID			Unsigned short
	Function Event Date & Time			DNP Time
	Function Event Status Flags			Unsigned short
System Event File Record Format				
	System Event ID			Unsigned short
	System Event Date & Time			DNP Time
	System Event Status Flags			Unsigned short
Fault Event File Record Format				
	Fault Event Date & Time			DNP Time
	Fault Event Status			Unsigned short
	Fault Event Ia			Unsigned short
	Fault Event Ib			Unsigned short
	Fault Event Ic			Unsigned short
	Fault Event In			Unsigned short
	Fault Event Vo			Unsigned short
	Reserved			Unsigned short
	Reserved			Unsigned short
	Reserved			Unsigned short
Demand I Event File Record Format				
	Demand I Date & Time			DNP Time
	Demand I Ia			Unsigned short
	Demand I Ib			Unsigned short
	Demand I Ic			Unsigned short
	Demand I In			Unsigned short

Demand P Event File Record Format				
	Demand P Date & Time			DNP Time
	Demand P kWa			short
	Demand P kWb			short
	Demand P kWc			short
	Demand P kW3ph			short
	Demand P kVARa			short
	Demand P kVARb			short
	Demand P kVARc			short
	Demand P kVAR3ph			short
Max. I Event File Record Format				
	Max. I Date & Time			DNP Time
	Max. I Ia			Unsigned short
	Max. I Ib			Unsigned short
	Max. I Ic			Unsigned short
	Max. I In			Unsigned short
Max. P Event File Record Format				
	Max. P Date & Time			DNP Time
	Max. P kWa			short
	Max. P kWb			short
	Max. P kWc			short
	Max. P kW3ph			short
	Max. P kVARa			short
	Max. P kVARb			short
	Max. P kVARc			short
	Max. P kVAR3ph			short
Sample waveform File Record Format				
	Sample Waveform Date & Time		Record	DNP Time
	Fault Status		0	Unsigned short
	Sampling Rate = 32			Unsigned short
	Reserved			10 Bytes
	Sample Op. Status[]		Record	Unsigned short
	Sample Ia[0]		1~320	-32768 ~ +32767
	Sample Ib[0]			-32768 ~ +32767
	Sample Ic[0]			-32768 ~ +32767

	Sample In[0]			-32768 ~ +32767
	Sample Va[0]			-32768 ~ +32767
	Sample Vb[0]			-32768 ~ +32767
	Sample Vc[0]			-32768 ~ +32767
	Sample Vo[0]			-32768 ~ +32767
	Reserved			Unsigned short

Appendix 3. DNP V3.0 DEVICE PROFILE

& Implementation Table (V3.1)

DNP V3.00
DEVICE PROFILE DOCUMENT
This document must be accompanied by a table having the following headings:

Object Group Request Function Codes Response Function Codes
Object Variation Request Qualifiers Response Qualifiers
Object Name (optional)

Vendor Name: **P&C Technologies CO.,LTD**

Device Name: **FTU-R100**

Highest DNP Level Supported:	Device Function:
For Requests **Level 2**	Master ■ **Slave**
For Responses **Level 2**	

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

Supports Enabling and Disabling of Unsolicited Report On a Class basis.

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted ____**292**_____	Transmitted **_2048_** (if>2048,must be configurable)
Received (must be 292)	Received **_2048_** (must be >= 249)

Maximum Data Link Re-tries:	Maximum Application Layer Re-tries:
None Fixed at _____ ■ **Configurable, range __0_ to __2__**	None ■ **Configurable, range _0_ to __2_** (Fixed is not permitted)

Requires Data Link Layer Confirmation:

Never
Always
Sometimes If 'Sometimes', when? _____

■ **Configurable If 'Configurable', how? _____By Setting_____**

Requires Application Layer Confirmation:

Never
Always (not recommended)
■ **When reporting Event Data (Slave devices only)**
When sending multi-fragment responses (Slave devices only)

Sometimes If 'Sometimes', when? _____

Configurable If 'Configurable', how? _____

Timeouts while waiting for:

Data Link Confirm	None	Fixed at ___	Variable	■ **Configurable**
Complete Appl. Fragment	■ None	Fixed at ___	Variable	Configurable
Application Confirm	None	Fixed at ___	Variable	■ Configurable
Complete Appl. Response	■ None	Fixed at ___	Variable	Configurable

Others _____

Attach explanation if 'Variable' or 'Configurable' was checked for any timeout

Sends/Executes Control Operations:

WRITE Binary Outputs	■ **Never**	Always	Sometimes	Configurable
SELECT/OPERATE	Never	Always	■ **Sometimes**	Configurable
DIRECT OPERATE	Never	Always	■ **Sometimes**	Configurable
DIRECT OPERATE - NO ACK	■ **Never**	Always	Sometimes	Configurable

Count > 1	■ Never	Always	Sometimes	Configurable
Pulse On	Never	■ Always	Sometimes	Configurable
Pulse Off	■ Never	Always	Sometimes	Configurable
Latch On	■ Never	Always	Sometimes	Configurable
Latch Off	■ Never	Always	Sometimes	Configurable

Queue	■ Never	Always	Sometimes	Configurable
Clear Queue	■ Never	Always	Sometimes	Configurable

Attach explanation if 'Sometimes' or 'Configurable' was checked for any operation.

FILL OUT THE FOLLOWING ITEM FOR MASTER DEVICES ONLY:

Expects Binary Input Change Events:

Either time-tagged or non-time-tagged for a single event
Both time-tagged and non-time-tagged for a single event
Configurable (attach explanation)

FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:

Reports Binary Input Change Events when no specific variation requested:

■ Never
Only time-tagged
Only non-time-tagged

Reports time-tagged Binary Input Change Events when no specific variation requested:

■ Never
Binary Input Change With Time
Binary Input Change With Relative Time

Configurable to send both, one or the other (attach explanation)	Configurable (attach explanation)
Sends Unsolicited Responses: Never ■ Configurable (attach explanation) Only certain objects Sometimes (attach explanation) ■ ENABLE/DISABLE UNSOLICITED Function codes supported	Sends Static Data in Unsolicited Responses: ■ Never When Device Restarts When Status Flags Change No other options are permitted.
Default Counter Object/Variation: No Counters Reported Configurable (attach explanation) Default Object ___**20**_ _____ Default Variation _____**6**_____ Point-by-point list attached	Counters Roll Over at: No Counters Reported Configurable (attach explanation) ■ 16 Bits 32 Bits Other Value _____ Point-by-point list attached
Sends Multi-Fragment Responses: Yes ■ No	

Implementation Table

Version 3.1

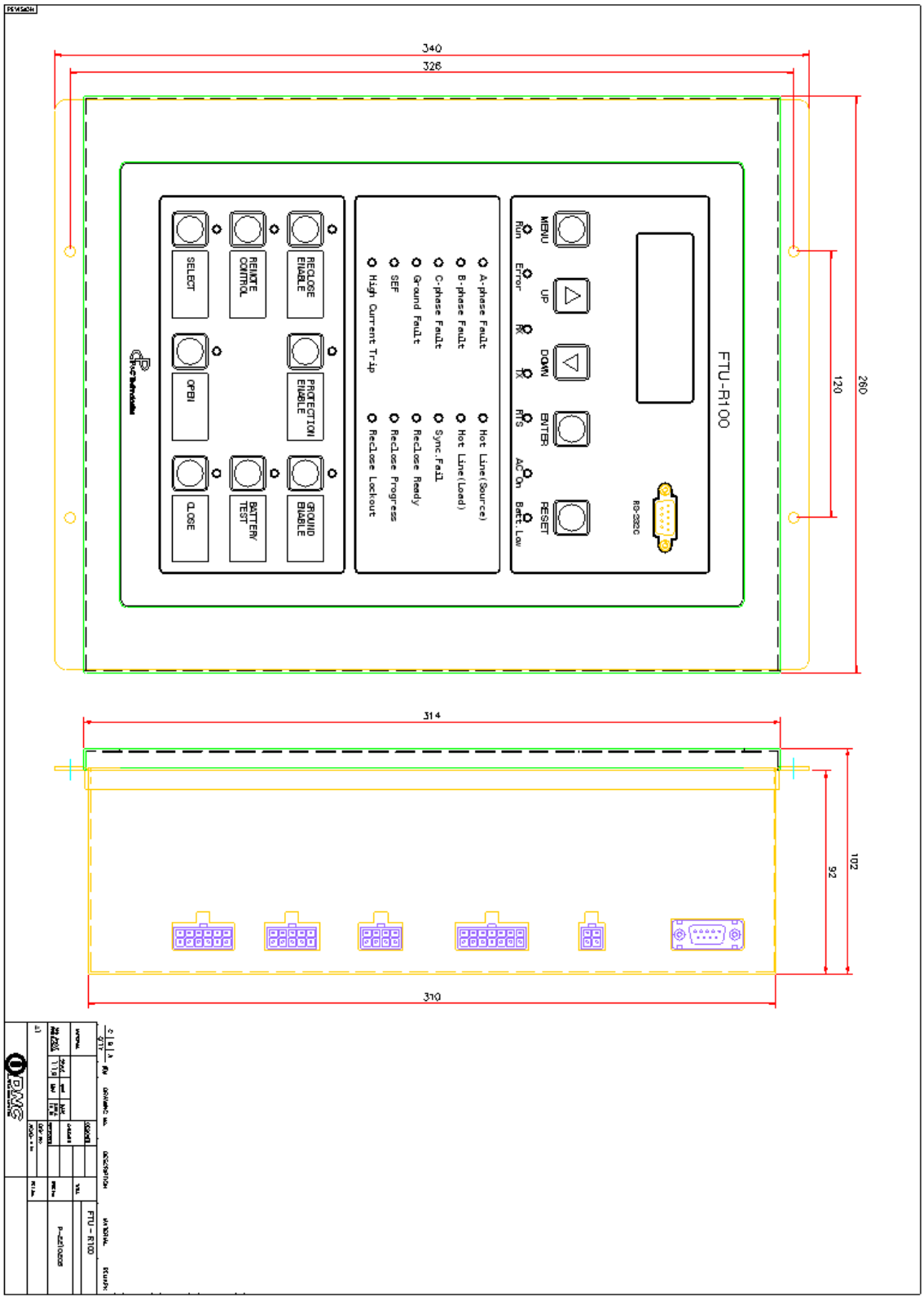
OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)
1	0	Binary Input - All Variations	1	**00, 01,** 06		
1	1	Binary Input	1	00, 01, 06	129	00, 01
1	2	Binary Input with Status	1	00, 01, 06	129	00, 01
2	0	Binary Input Change - All Variations	1	06, 07, 08		
2	1	Binary Input Change without Time	1	06, 07, 08	129, 130	17, 28
2	2	Binary Input Change with Time	1	06, 07, 08	129, 130	17, 28
2	3	Binary Input Change with Relative Time	1	06, 07, 08	**Does not support Obj 2 Var 3 , NULL Response**	
10	0	Binary Output - All Variations	1	**00, 01,** 06		
10	1	Binary Output				
10	2	Binary Output Status	1	00, 01, 06	129	00, 01
12	0	Control Block - All Variations				
12	1	Control Relay Output Block	3, 4, 5, 6	17, 28	129	echo of request
12	2	Pattern Control Block				
12	3	Pattern Mask				
20	0	Binary Counter - All Variations	1	00, 01, 06		
20	1	32-bit Binary Counter				
20	2	16-bit Binary Counter	1	00, 01, 06	129	00, 01
20	3	32-bit Delta Counter				
20	4	16-bit Delta Counter				
20	5	32-bit Binary Counter without Flag				
20	6	16-bit Binary Counter without Flag	1	00, 01, 06	129, 130	00, 01
20	7	32-bit Delta Counter without Flag				
20	8	16-bit Delta Counter without Flag				
21	0	Frozen Counters - All Variations				
21	1	32-bit Frozen Counter				
21	2	16-bit Frozen Counter				
21	3	32-bit Frozen Delta Counter				
21	4	16-bit Frozen Delta Counter				
21	5	32-bit Frozen Counter with Time of Freeze				
21	6	16-bit Frozen Counter with Time of Freeze				
21	7	32-bit Frozen Delta Counter with Time of Freeze				
21	8	16-bit Frozen Delta Counter with Time of Freeze				
21	9	32-bit Frozen Counter without Flag				

21	10	16-bit Frozen Counter without Flag				
21	11	32-bit Frozen Delta Counter without Flag				
21	12	16-bit Frozen Delta Counter without Flag				
22	0	Counter Change Event - All Variations	1	06, 07, 08		
22	1	32-Bit Counter Change Event without Time				
22	2	16-Bit Counter Change Event without Time				
22	3	32-Bit Delta Counter Change Event without Time				
22	4	16-Bit Delta Counter Change Event without Time				
22	5	32-Bit Counter Change Event with Time				
22	6	16-Bit Counter Change Event with Time				
22	7	32-Bit Delta Counter Change Event with Time				
22	8	16-Bit Delta Counter Change Event with Time	1	06, 07, 08	129, 130	17, 28
23	0	Frozen Counter Events - All Variations				
23	1	32-Bit Frozen Counter Event without Time				
23	2	16-Bit Frozen Counter Event without Time				
23	3	32-Bit Frozen Delta Counter Event without Time				
23	4	16-Bit Frozen Delta Counter Event without Time				
23	5	32-Bit Frozen Counter Event with Time				
23	6	16-Bit Frozen Counter Event with Time				
23	7	32-Bit Frozen Delta Counter Event with Time				
23	8	16-Bit Frozen Delta Counter Event with Time				
30	0	Analog Input - All Variations	1	00, 01, 06		
30	1	32-Bit Analog Input				
30	2	16-Bit Analog Input	1	00, 01, 06	129	00, 01
30	3	32-Bit Analog Input without Flag				
30	4	16-Bit Analog Input without Flag	1	00, 01, 06	129	00, 01
31	0	Frozen Analog Input - All Variations				
31	1	32-Bit Frozen Analog Input				
31	2	16-Bit Frozen Analog Input				
31	3	32-Bit Frozen Analog Input with Time of Freeze				
31	4	16-Bit Frozen Analog Input with Time of Freeze				
31	5	32-Bit Frozen Analog Input without Flag				
31	6	16-Bit Frozen Analog Input without Flag				
32	0	Analog Change Event - All Variations	1	06, 07, 08		
32	1	32-Bit Analog Change Event without Time				
32	2	16-Bit Analog Change Event without Time	1	06, 07, 08	129, 130	17, 28

32	3	32-Bit Analog Change Event with Time				
32	4	16-Bit Analog Change Event with Time	1	06, 07, 08	129, 130	17, 28
33	0	Frozen Analog Event - All Variations				
33	1	32-Bit Frozen Analog Event without Time				
33	2	16-Bit Frozen Analog Event without Time				
33	3	32-Bit Frozen Analog Event with Time				
33	4	16-Bit Frozen Analog Event with Time				
40	0	Analog Output Status - All Variations	1	00, 01, 06		
40	1	32-Bit Analog Output Status				
40	2	32-Bit Analog Output Status	1	00, 01, 06	129	00, 01
41	0	Analog Output Block - All Variations				
41	1	32-Bit Analog Output Block				
41	2	16-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
50	0	Time and Date - All Variations				
50	1	Time and Date	2	07 quantity=1		
			1	07 quantity=1	129	07 quantity=1
50	2	Time and Date with Interval				
51	0	Time and Date CTO - All Variations				
51	1	Time and Date CTO			129	07, quantity=1
51	2	Unsynchronized Time and Date CTO			129	07, quantity=1
52	0	Time Delay - All Variations				
52	1	Time Delay Coarse			129	07, quantity=1
52	2	Time Delay Fine			129	07, quantity=1
60	0	Not Defined				
60	1	Class 0 Data	1	06		
60	2	Class 1 Data	1	06, 07, 08		
			20, 21	06		
60	3	Class 2 Data	1	06, 07, 08		
			20, 21	06		
60	4	Class 3 Data	1	06, 07, 08		
			20, 21	06		
70	1	File Identifier				
80	1	Internal Indications	2	00, index=7		
81	1	Storage Object				
82	1	Device Profile				
83	1	Private Registration Object				

83	2	Private Registration Object Descriptor				
90	1	Application Identifier				
100	1	Shot Floating Point				
100	2	Long Floating Point				
100	3	Extended Floating Point				
101	1	Small Packed Binary-Coded Decimal				
101	2	Medium Packed Binary-Coded Decimal				
101	3	Large Packed Binary-Coded Decimal				
No Object			13			
No Object			14			
No Object			23			

Appendix 4. DIMENSIONS



Appendix 5. FTU INSPECTION CHECK LIST

1. Connections check

- Check if all connectors except Battery in the control box are plugged.

- <Caution> The connector to Battery should be unplugged when the box is stored or delivered to site. If not so, the battery can be discharged by the power consumption of the Power & Control Board regardless of MCCB or RTU power switch.

- Check if all screw terminals in the control box is locked tightly.

Test Result	
□ OK	□ Fail

2 . Battery Status check

- Plug-in the Battery connector to the connector on the Power & Control Board

- Press the Battery Start button on the panel inside the box.

- Check if RTU is powered on and runs without error and check the Battery voltage and current through Battery Test Terminal on the panel by using portable Meter.
- <Caution> Be careful of avoiding short of voltage test terminal.

- <Caution> The connector to Battery should be unplugged when the box is stored or delivered to site.

Test Result	
□ OK	□ Fail

3. Power & Fuses

- For protection of circuits in the control box, there are some fuses.
AC(220V) input circuit, Battery voltage test terminal, 3 fuses on the Power & Control Board. (AC input/DC output for FTU & Control /DC output for Modem)

- Use fuse of the specified rating for exchange.
- Modem power output voltage is 24V. The voltage is adjustable for 13V~24V range. For the adjustment, you have to remove the upper case of the Power & Control Board. You should be very careful.

Test Result	
□ OK	□ Fail

4 . Insulation Test

- <Caution> Before Test, Disconnect two frame ground jumper wires on I/O Board in the RTU and one on Power & Control Board
* Use cables connected to the control & power connector outside control box and earth-terminal of the control box. Refer to the external connection diagram.

4.1 DC Resistance

- Measure the DC resistance of the following circuits by DC 500V Mega Ohm Tester

Circuit	Criteria	Test Result	
All Circuit – Earth	≥ 10MΩ	□ OK	□ Fail

4.2 AC Insulation

- Leakage current should be below 5mA under the following test condition.

Circuit	Criteria	Test Result	
All Circuit – Earth	AC 2kV, 1min	□ OK	□ Fail

* The insulation test between the circuits shall be performed after MOVs in the RTU or on Power & Control Board and also the biased connections are removed. This test shall be performed with our engineer as type test.

5. RTU Run Status Check

- Check if RUN LED blinks, Sys Error LED is lit off.

Test Result	
□ OK	□ Fail

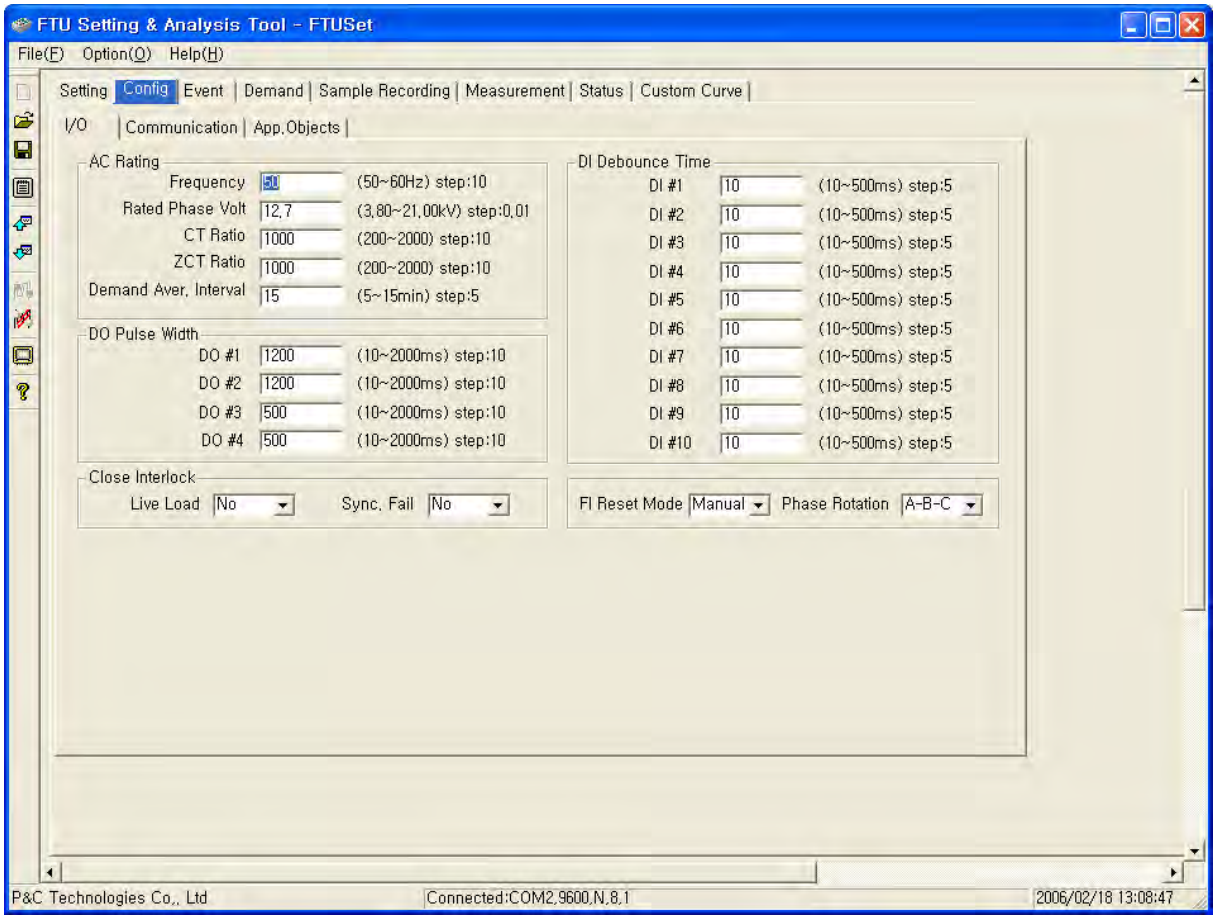
6. Communication link Check

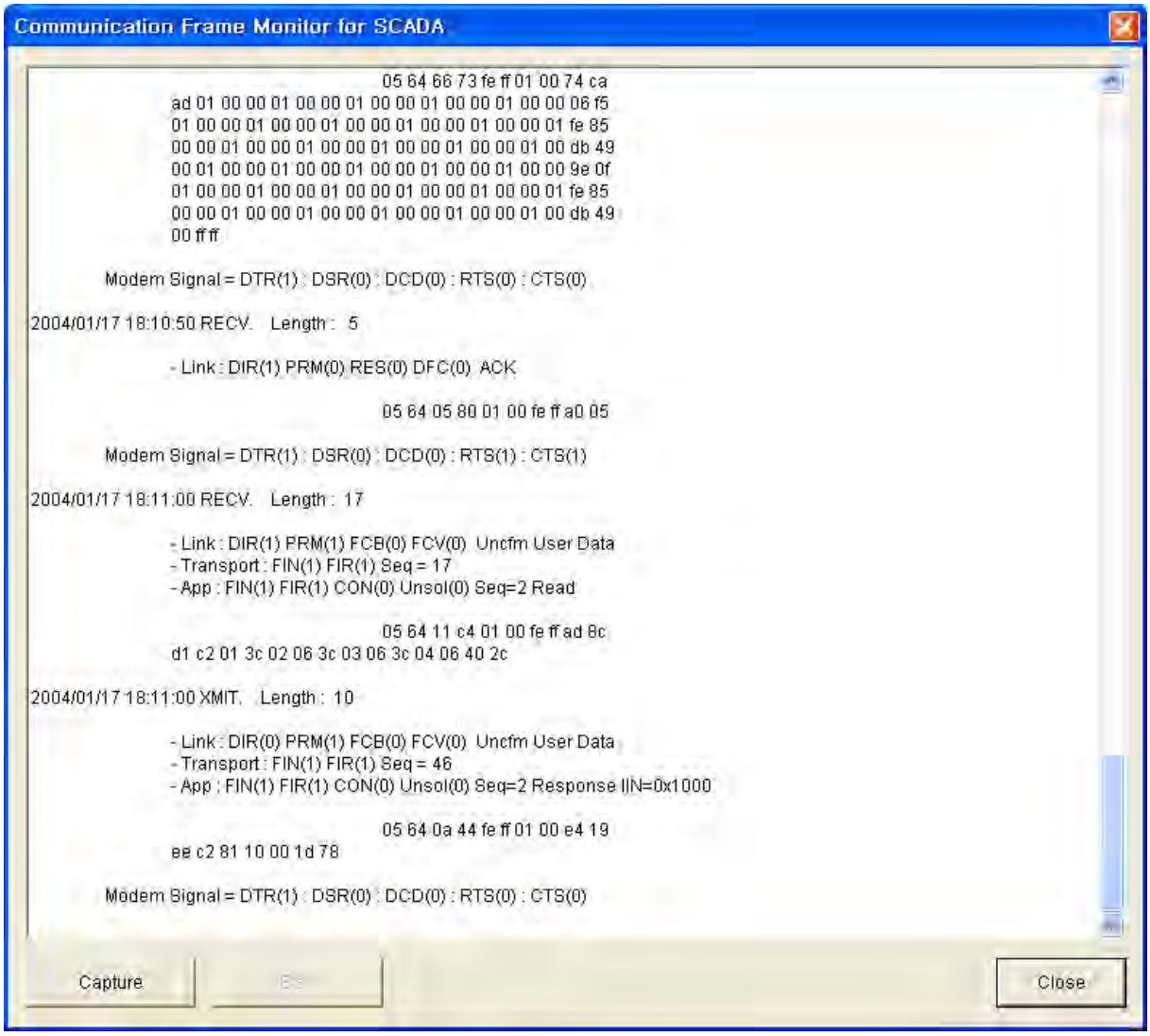
- Check if BPS, Address, Modem control of RTU was set appropriately.
  BPS setting change needs the restart of RTU.

- Check if RX LED blinks while receiving data from Master Station.

- Check if RTU responds to the request from master by looking at RTS, TX LED.
 * If only RTS LED is turned on during CTS checkout time, please check CTS signal from MODEM.

- Protocol Monitor built in the RTU can be used to check if the RTU receives or transmits data correctly.


FTU Setting & Analysis Tool - FTUSet
File(F) Option(O) Help(H)
Setting Config Event Demand Sample Recording Measurement Status Custom Curve
I/O Communication App.Objects
AC Rating
Frequency 50 (50~60Hz) step:10
Rated Phase Volt 12.7 (3.80~21.00kV) step:0.01
CT Ratio 1000 (200~2000) step:10
ZCT Ratio 1000 (200~2000) step:10
Demand Aver. Interval 15 (5~15min) step:5
DO Pulse Width
DO #1 1200 (10~2000ms) step:10
DO #2 1200 (10~2000ms) step:10
DO #3 500 (10~2000ms) step:10
DO #4 500 (10~2000ms) step:10
Close Interlock
Live Load No
Sync. Fail No
DI Debounce Time
DI #1 10 (10~500ms) step:5
DI #2 10 (10~500ms) step:5
DI #3 10 (10~500ms) step:5
DI #4 10 (10~500ms) step:5
DI #5 10 (10~500ms) step:5
DI #6 10 (10~500ms) step:5
DI #7 10 (10~500ms) step:5
DI #8 10 (10~500ms) step:5
DI #9 10 (10~500ms) step:5
DI #10 10 (10~500ms) step:5
FI Reset Mode Manual
Phase Rotation A-B-C
P&C Technologies Co,, Ltd
Connected:COM2,9600,N,8,1
2006/02/18 13:08:47

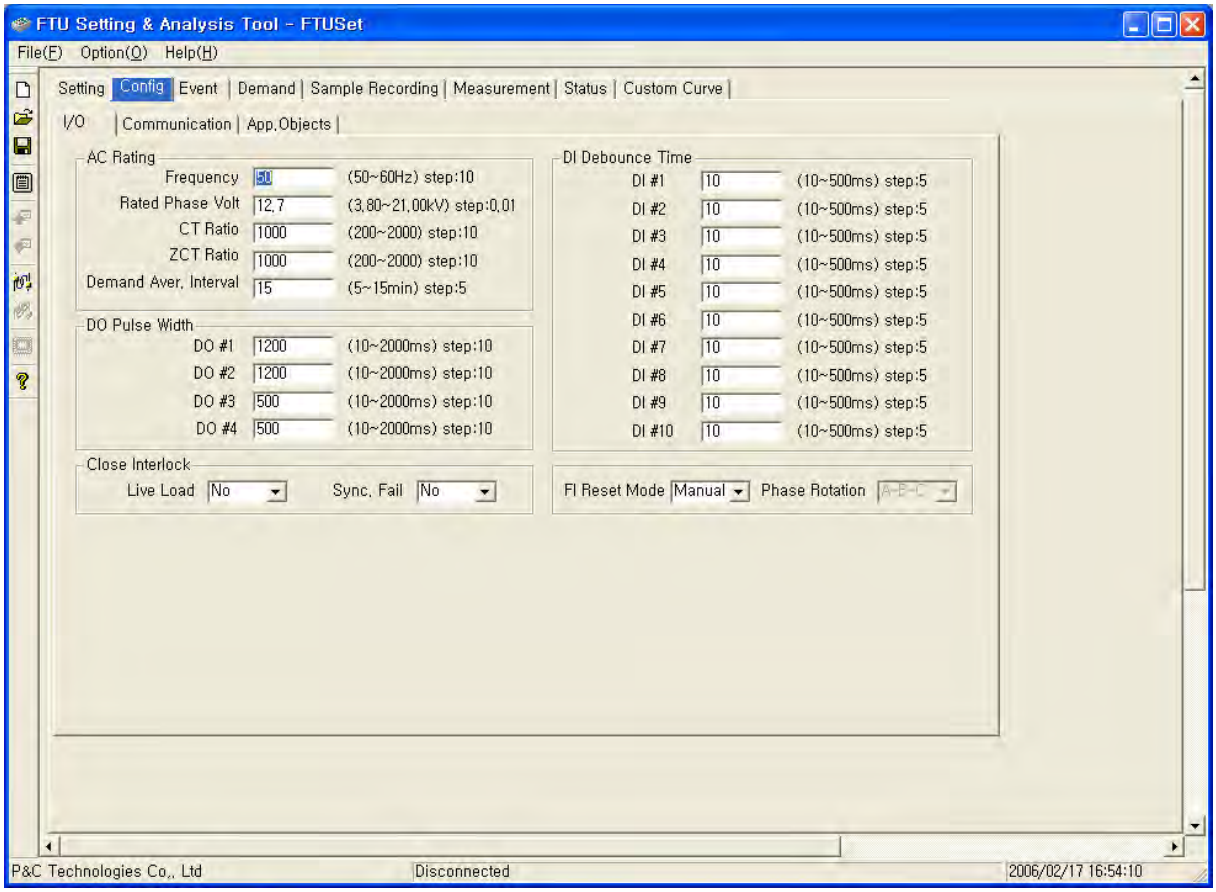


Test Result	
□ OK	□ Fail

7. Switch Control Problem Check

- Check Interlock condition: Local/Remote, Switch Status, Gas Low, Handle Lock

Gas low, handle lock condition interlocks switch open/close operation.
Switch status is determined by double binary inputs (open/closed contact inputs). If the statuses of double binary inputs are identical, the control operation is blocked. The same operation to the current switch status is inhibited. At local the control can be executed after select. (SELECT button/LED) Select state is canceled at SBO timeout.
- Type of open/close command output is pulsed-on contact. Pulse width can be set through setting. (Configuration Menu.) In case of control operation from master, the pulse width is given through DNP object O12V1. Long trip pulse time may block the correct reclosing and lockout the Recloser. The trip pulse time shall be shorter than the dead time for the fast reclosing.



- The control command is transmitted to the Recloser Switch as battery-voltage biased contact. No drive interlock scheme is equipped in the control box.

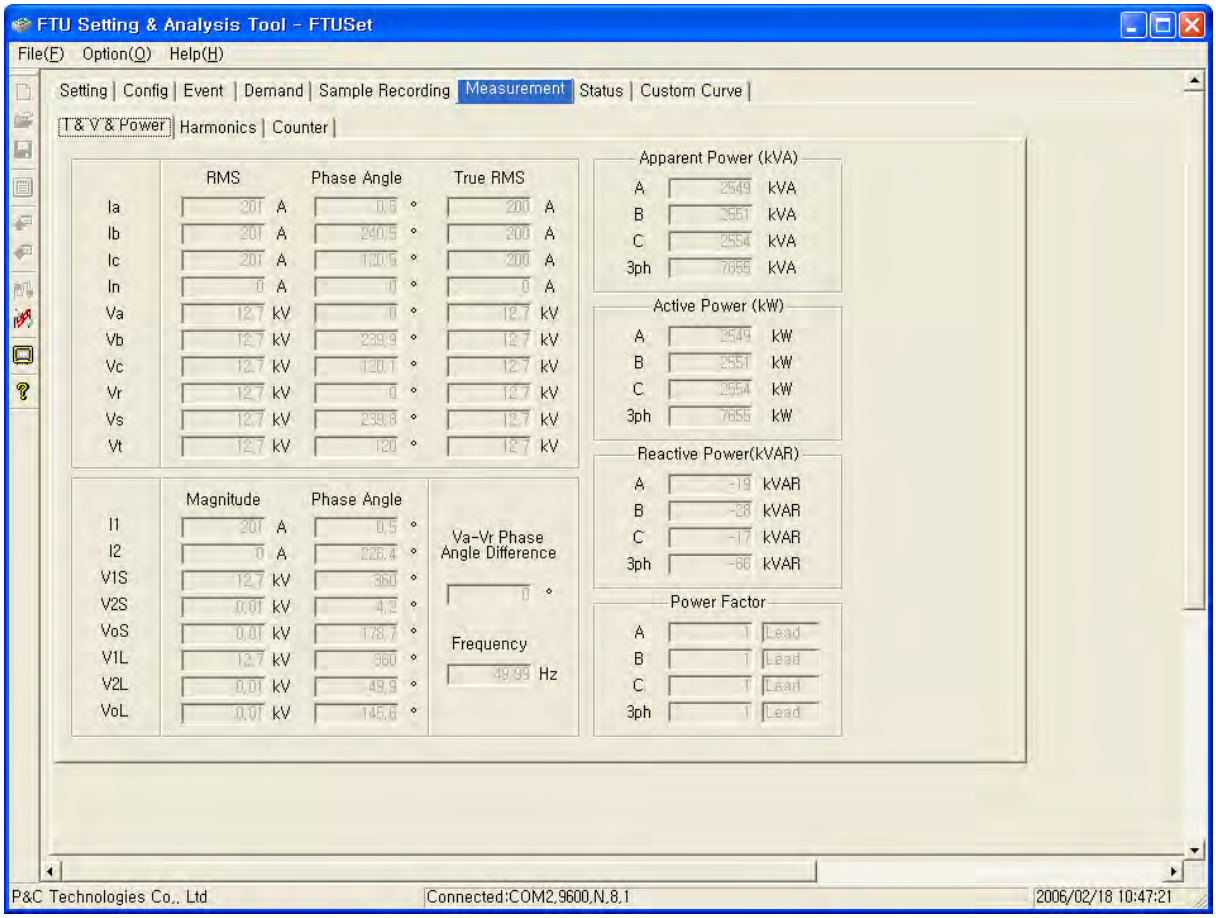
Test Result	
□ OK	□ Fail

8. Measurements Check

- Check the settings of Analog input rating.
Frequency, CT Ratio, Rated Phase voltage

- Inject the accurate 3-phase voltages and currents to the Cable instead of switch, and check the value through the measurements window or LCD. The value of voltages and currents that are injected is the secondary value of sensor installed inside the Recloser Switch. For 1000A, inject 1A on the terminals of the control box in case of 1000:1 CT ratio. For Rated phase voltage, 4V~10V shall be applied to the control box. The exact value depends on the calibrating state of the Recloser Switch.

- For the accuracy improvement, the calibration is needed on panel.



Test Result	
□ OK	□ Fail

9. Status Monitoring Check

- Check if the status monitored by RTU is correct through Display/Status Menu on LCD or Status Page on PC Tool.

- The physical dry contacts from Recloser Switch is biased in the control box and transmitted to the binary input circuits of RTU.

Test Result	
□ OK	□ Fail

Appendix 6. IEC60870-5-101 Interoperability

1. System or device

- [ ] System definition
- [ ] Controlling station definition (Master)
- [x] Controlled station definition (Slave)

2. Network configuration

- [x] Point-to-point
- [ ] Multiple point-to-point
- [ ] Multipoint-partyline
- [ ] Multipoint-star

3. Physical layer

Transmission speed (control direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange Circuit X.24/X.27
[ ] 100 bits/sec	[x] 2400 bits/sec	[ ] 2400 bits/sec
[ ] 200 bits/sec	[x] 4800 bits/sec	[ ] 4800 bits/sec
[ ] 300 bits/sec	[x] 9600 bits/sec	[ ] 9600 bits/sec
[ ] 600 bits/sec	[x] **19200 bits/sec**	[ ] 19200 bits/sec
[x] 1200 bits/sec		[ ] 38400 bits/sec
		[ ] 56000 bits/sec
		[ ] 64000 bits/sec

Transmission speed (monitor direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange Circuit X.24/X.27
[ ] 100 bits/sec	[x] 2400 bits/sec	[ ] 2400 bits/sec
[ ] 200 bits/sec	[x] 4800 bits/sec	[ ] 4800 bits/sec
[ ] 300 bits/sec	[x] 9600 bits/sec	[ ] 9600 bits/sec
[ ] 600 bits/sec	[x] **19200 bits/sec**	[ ] 19200 bits/sec
[x] 1200 bits/sec		[ ] 38400 bits/sec
		[ ] 56000 bits/sec
		[ ] 64000 bits/sec

4. Link layer

Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.

Link transmission procedure

- [ ] Balanced transmission
- [x] Unbalanced transmission

Address field of the link

- [ ] Not present (balanced transmission only)
- [ ] One octet
- [x] Two octets
- [ ] Structured
- [ ] Unstructured

Frame length

- [ ] **261** Maximum length L

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

[X] The standard assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission
9, 11, 13, 21	<1>

[ ] A special assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission

NOTE In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available.

5. Application layer

Transmission mode for application data

Common address of ASDU

☐ One octet ☒ Two octets

Information object address

☐ One octet
☒ Two octets
☐ Three octets

☐ Structured
☐ Unstructured

Cause of transmission

☒ One octet ☐ Two octets (with originator address)
Set to zero in case of no originator address

Selection of standard ASDUs

Process information in monitor direction

☒	<1> := Single-point information	M_SP_NA_1
☒	<2> := Single-point information with time tag	M_SP_TA_1
	<3>:= Double-point information	M_DP_NA_1
☒	<4> := Double-point information with time tag	M_DP_TA_1
☐	<5> := Step position information	M_ST_NA_1
☐	<6>:= Step position information with time tag	M_ST_TA_1
☐	<7> := Bitstring of 32 bit	M_BO_NA_1
☐	<8>:= Bitstring of 32 bit with time tag	M_BO_TA_1
☐	<9> := Measured value, normalized value	M_ME_NA_1
☐	<10>:=Measured value, normalized value with time tag	M_ME_TA_1
☒	<11>:=Measured value, scaled value	M_ME_NB_1
☒	<12>:=Measured value, scaled value with time tag	M_ME_TB_1
☐	<13>:=Measured value, short floating point value	M_ME_NC_1
☐	<14>:=Measured value, short floating point value with time tag	M_ME_TC_1
☒	<15>:=Integrated totals	M_IT_NA_1
☒	<16>:=Integrated totals with time tag	M_IT_TA_1
☐	<17>:=Event of protection equipment with time tag	M_EP_TA_1
☐	<18>:=Packed start events of protection equipment with time tag	M_EP_TB_1
☐	<19>:=Packed output circuit information of protection equipment with time tag	M_EP_TC_1
☐	<20>:=Packed single-point information with status change detection	M_PS_NA_1
☐	<21>:=Measured value, normalized value without quality descriptor	M_ME_ND_1
☐	<30>:=Single-point information with time tag CP56Time2a	M_SP_TB_1
☐	<31>:=Double-point information with time tag CP56Time2a	M_DP_TB_1
☐	<32>:=Step position information with time tag CP56Time2a	M_ST_TB_1
☐	<33>:=Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☐	<34>:=Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☐	<35>:=Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1

☐	<36>:=Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☐	<37>:=Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38>:=Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐	<39>:=Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐	<40>:=Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Either ASDUs of the set <2>, <4>, <6>, <8>, <10>, <12>, <14>, <16>, <17>, <18>, <19> or of the set <30 –40> are used.

Process information in control direction

X	<45>:=Single command	C_SC_NA_1
X	<46>:=Double command	C_DC_NA_1
	<47>:=Regulating step command	C_RC_NA_1
	<48>:=Set point command, normalized value	C_SE_NA_1
X	<49>:=Set point command, scaled value	C_SE_NB_1
	<50>:=Set point command, short floating point value	C_SE_NC_1
	<51> :=Bitstring of 32 bit	C_BO_NA_1

System information in monitor direction

X	<70>:=End of initialization	M_EI_NA_1

System information in control direction

X	<100>:=Interrogation command	C_IC_NA_1
X	<101>:=Counter interrogation command	C_CI_NA_1
X	<102>:=Read command	C_RD_NA_1
X	<103>:=Clock synchronization command	C_CS_NA_1
X	<104>:=Test command	C_TS_NA_1
X	<105>:=Reset process command	C_RP_NA_1
X	<106>:=Delay acquisition command	C_CD_NA_1

Parameter in control direction

	<110>:=Parameter of measured value, normalized value	P_ME_NA_1
	<111>:=Parameter of measured value, scaled value	P_ME_NB_1
	<112>:=Parameter of measured value, short floating point value	P_ME_NC_1
	<113>:=Parameter activation	P_AC_NA_1

File transfer

	<120>:=File ready	F_FR_NA_1
	<121>:=Section ready	F_SR_NA_1
	<122>:=Call directory, select file, call file, call section	F_SC_NA_1
	<123>:=Last section, last segment	F_LS_NA_1
	<124>:=Ack file, ack section	F_AF_NA_1
	<125>:=Segment	F_SG_NA_1
	<126>:= Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1

(station-specific parameters)

Shaded boxes are not required.
Blank = function or ASDU is not used.
"**X**" if used only in the standard direction

Type identification	Cause of transmission																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1			X		X						X			X					
<2>	M_SP_TA_1			X																
<3>	M_DP_NA_1			X		X						X			X					
<4>	M_DP_TA_1			X																
<5>	M_ST_NA_1																			
<6>	M_ST_TA_1																			
<7>	M_BO_NA_1																			
<8>	M_BO_TA_1																			
<9>	M_ME_NA_1																			
<10>	M_ME_TA_1																			
<11>	M_ME_NB_1	X				X									X					
<12>	M_ME_TB_1																			
<13>	M_ME_NC_1																			
<14>	M_ME_TC_1																			
<15>	M_IT_NA_1			X												X				
<16>	M_IT_TA_1			X												X				
<17>	M_EP_TA_1																			
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1																			
<31>	M_DP_TB_1																			
<32>	M_ST_TB_1																			
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1																			
<37>	M_IT_TB_1																			
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X									
<46>	C_DC_NA_1						X	X	X	X	X									
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1						X	X	X	X	X									
<50>	C_SE_NC_1																			
<51>	C_BO_NA_1																			
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X	X	X	X									
<101>	C_CI_NA_1						X	X			X									
<102>	C_RD_NA_1					X														
<103>	C_CS_NA_1			X			X	X												

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<104>	C_TS_NA_1						X	X												
<105>	C_RP_NA_1						X	X												
<106>	C_CD_NA_1						X	X												
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1																			
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*																			
** Blank or X only.*																				

6. Basic application functions

Station initialization

[X] Remote initialization

Cyclic data transmission

[X] Cyclic data transmission

Read procedure

[X] Read procedure

Spontaneous transmission

[X] Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

- ☐ Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
- ☐ Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
- ☐ Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1(if defined for a specific project)
- ☐ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
- ☐ Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
- ☐ Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

- ☒ global
- ☒ group 1
- ☒ group 2
- ☒ group 3
- ☒ group 4
- ☐ group 5
- ☒ group 6
- ☒ group 7
- ☒ group 8
- ☒ group 9
- ☒ group 10
- ☒ group 11
- ☒ group 12
- ☒ group 13
- ☒ group 14
- ☒ group 15
- ☒ group 16

Clock synchronization

- ☒ Clock synchronization

Command transmission

- ☒ Direct command transmission
- ☒ Direct set-point command transmission
- ☐ Select and execute command
- ☐ Select and execute set-point command
- ☒ C_SE ACTTERM used
- ☒ No additional definition
- ☒ Short-pulse duration (duration determined by a system parameter in the controlled station)
- ☒ Long-pulse duration (duration determined by a system parameter in the controlled station)
- ☐ Persistent output

Transmission of integrated totals

- [x] Mode A: local freeze with spontaneous transmission
- [x] Mode B: local freeze with counter interrogation
- [x] Mode C: freeze and transmit by counter interrogation commands
- [x] Mode D: freeze by counter interrogation command, frozen values reported spontaneously

- [x] Counter read
- [x] Counter freeze without reset
- [x] Counter freeze with reset
- [x] Counter reset

- [x] General request counter
- [x] Request counter group 1
- [x] Request counter group 2
- [x] Request counter group 3
- [x] Request counter group 4

Parameter loading

- [ ] Threshold value
- [ ] Smoothing factor
- [ ] Low limit for transmission of measured value
- [ ] High limit for transmission of measured value

Parameter activation

- [ ] Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

- [ ] Test procedure

File transfer

File transfer in monitor direction

☐ Transparent file
☐ Transmission of disturbance data of protection equipment
☐ Transmission of sequences of events
☐ Transmission of sequences of recorded analog values

File transfer in control direction

☐ Transparent file

Background scan

☐ Background scan

Acquisition of transmission delay

☒ Acquisition of transmission delay

Appendix 7. IEC60870-5-101 Protocol Point Index

Point Address	Description	Remark
M_SP_NA_1 points		
100	Reserved	
101	Battery Discharged	
102	Control Mode	Local = 1
103	Handle Locked	
104	Gas low	
105	Ext. AC Power Loss	
106	Door Open	
107	DI Spare #1	Contact closed = 1
108	DI Spare #2	Contact closed = 1
109	DI Spare #3	Contact closed = 1
110	Fault Indicator (A)	
111	Fault Indicator (B)	
112	Fault Indicator (C)	
113	Fault Indicator (N)	
114	Fault Indicator (SEF)	
115	Reverse Direction Fault	
116	Open Line Detection A	
117	Open Line Detection B	
118	Open Line Detection C	
119	Open Line Detection R	
120	Open Line Detection S	
121	Open Line Detection T	
122	Sync. fail	
123	System Error	
124	Inrush Detected	
125	Reclosing Blocked	
126	Protection Blocked	
127	Ground Protection Blocked	
128	High Current Trip	
129	Sequence Lockout	
130	Reserved #1	
131	Reserved #2	
M_DP_NA_1 points		

200	Switch Status	
C_SC_NA_1 points		
1000	Annunciator Manual Reset	No Select Required
1001	Battery Test Output	No Select Required
C_DC_NA_1 points		
1200	Switch Open/Close Control	Select Required Before Execute
M_ME_NB_1 points		
2000	Ia RMS	A
2001	Ib RMS	A
2002	Ic RMS	A
2003	In RMS	A
2004	Source side Va RMS	V
2005	Source side Vb RMS	V
2006	Source side Vc RMS	V
2007	Source side Vo RMS	V
2008	Load side Va RMS	V
2009	Load side Vb RMS	V
2010	Load side Vc RMS	V
2011	Load side Vo RMS	V
2012	KVAa	kVA
2013	KVAb	kVA
2014	KVAc	kVA
2015	kVA3ph	kVA
2016	KWa	kW
2017	KWb	kW
2018	KWc	kW
2019	kW3ph	kW
2020	KVARa	kVAR
2021	KVARb	kVAR
2022	KVARc	kVAR
2023	kVAR3ph	kVAR
2024	PFa	X100
2025	PFb	X100
2026	PFc	X100
2027	PF3ph	X100
2028	Va-Vr Phase Angle Diff	^{o} 10
2029	Frequency	HZ100

2030	Temperature	Degree
2031	Reserved	
2032	Ia phase angle	^{o} 10
2033	Ib phase angle	^{o} 10
2034	Ic phase angle	^{o} 10
2035	In phase angle	^{o} 10
2036	Source side Va phase angle	^{o} 10
2037	Source side Vb phase angle	^{o} 10
2038	Source side Vc phase angle	^{o} 10
2039	Source side Vo phase angle	^{o} 10
2040	Load side Va phase angle	^{o} 10
2041	Load side Vb phase angle	^{o} 10
2042	Load side Vc phase angle	^{o} 10
2043	Load side Vo phase angle	^{o} 10
2044	I1 RMS	A
2045	I1 phase angle	^{o} 10
2046	I2 RMS	A
2047	I2 phase angle	^{o} 10
2048	Source side V1 RMS	V
2049	Source side V1 phase angle	^{o} 10
2050	Source side V2 RMS	V
2051	Source side V2 phase angle	^{o} 10
2052	Load side V1 RMS	A
2053	Load side V1 phase angle	^{o} 10
2054	Load side V2 RMS	A
2055	Load side V2 phase angle	^{o} 10
2056	PFa lead	Lead=1/Lag=0
2057	PFb lead	Lead=1/Lag=0
2058	PFc lead	Lead=1/Lag=0
2059	PF3ph lead	Lead=1/Lag=0
2060	Last Fault Ia	A
2061	Last Fault Ib	A
2062	Last Fault Ic	A
2063	Last Fault In	A
2064	Last Fault vo	A
2065	Reserved	
2066	Reserved	

2067	Reserved	
2068	Demand I Ia	A
2069	Demand I Ib	A
2070	Demand I Ic	A
2071	Demand I In	A
2072	Demand P kWa	kW
2073	Demand P kWb	kW
2074	Demand P kWc	kW
2075	Demand P kW3ph	kW
2076	Demand P kVARa	kVAR
2077	Demand P kVARb	kVAR
2078	Demand P kVARc	kVAR
2079	Demand P kVAR3ph	kVAR
2080	Max. I Ia	A
2081	Max. I Ib	A
2082	Max. I Ic	A
2083	Max. I In	A
2084	Max. P1 kWa	kW
2085	Max. P1 kWb	kW
2086	Max. P1 kWc	kW
2087	Max. P1 kW3ph	kW
2088	Max. P1 kVARa	kVAR
2089	Max. P1 kVARb	kVAR
2090	Max. P1 kVARc	kVAR
2091	Max. P1 kVAR3ph	kVAR
2092	3-phase currents THD	%
2093	Ia THD	%
2094	Ib THD	%
2095	Ic THD	%
2096	Source side 3-phase voltages THD	%
2097	Source side Va THD	%
2098	Source side Vb THD	%
2099	Source side Vc THD	%
2100	Load side 3-phase voltages THD	%
2101	Load side Va THD	%
2102	Load side Vb THD	%
2103	Load side Vc THD	%

2104	Ia true RMS	A
2105	Ib true RMS	A
2106	Ic true RMS	A
2107	Va true RMS	V
2108	Vb true RMS	V
2109	Vc true RMS	V
2110	Vr true RMS	V
2111	Vs true RMS	V
2112	Vt true RMS	V
2113	Ia 2nd harmonic RMS	A
2114	Ib 2nd harmonic RMS	A
2115	Ic 2nd harmonic RMS	A
2116	Ia 3rd harmonic RMS	A
2117	Ib 3rd harmonic RMS	A
2118	Ic 3rd harmonic RMS	A
2119	Ia 4th harmonic RMS	A
2120	Ib 4th harmonic RMS	A
2121	Ic 4th harmonic RMS	A
2122	Ia 5th harmonic RMS	A
2123	Ib 5th harmonic RMS	A
2124	Ic 5th harmonic RMS	A
2125	Ia 6th harmonic RMS	A
2126	Ib 6th harmonic RMS	A
2127	Ic 6th harmonic RMS	A
2128	Ia 7th harmonic RMS	A
2129	Ib 7th harmonic RMS	A
2130	Ic 7th harmonic RMS	A
2131	Ia 8th harmonic RMS	A
2132	Ib 8th harmonic RMS	A
2133	Ic 8th harmonic RMS	A
2134	Source side Va 2nd harmonic RMS	V
2135	Source side Vb 2nd harmonic RMS	V
2136	Source side Vc 2nd harmonic RMS	V
2137	Source side Va 3rd harmonic RMS	V
2138	Source side Vb 3rd harmonic RMS	V
2139	Source side Vc 3rd harmonic RMS	V
2140	Source side Va 4th harmonic RMS	V

2141	Source side Vb 4th harmonic RMS	V
2142	Source side Vc 4th harmonic RMS	V
2143	Source side Va 5th harmonic RMS	V
2144	Source side Vb 5th harmonic RMS	V
2145	Source side Vc 5th harmonic RMS	V
2146	Source side Va 6th harmonic RMS	V
2147	Source side Vb 6th harmonic RMS	V
2148	Source side Vc 6th harmonic RMS	V
2149	Source side Va 7th harmonic RMS	V
2150	Source side Vb 7th harmonic RMS	V
2151	Source side Vc 7th harmonic RMS	V
2152	Source side Va 8th harmonic RMS	V
2153	Source side Vb 8th harmonic RMS	V
2154	Source side Vc 8th harmonic RMS	V
2155	Load side Va 2nd harmonic RMS	V
2156	Load side Vb 2nd harmonic RMS	V
2157	Load side Vc 2nd harmonic RMS	V
2158	Load side Va 3rd harmonic RMS	V
2159	Load side Vb 3rd harmonic RMS	V
2160	Load side Vc 3rd harmonic RMS	V
2161	Load side Va 4th harmonic RMS	V
2162	Load side Vb 4th harmonic RMS	V
2163	Load side Vc 4th harmonic RMS	V
2164	Load side Va 5th harmonic RMS	V
2165	Load side Vb 5th harmonic RMS	V
2166	Load side Vc 5th harmonic RMS	V
2167	Load side Va 6th harmonic RMS	V
2168	Load side Vb 6th harmonic RMS	V
2169	Load side Vc 6th harmonic RMS	V
2170	Load side Va 7th harmonic RMS	V
2171	Load side Vb 7th harmonic RMS	V
2172	Load side Vc 7th harmonic RMS	V
2173	Load side Va 8th harmonic RMS	V
2174	Load side Vb 8th harmonic RMS	V
2175	Load side Vc 8th harmonic RMS	V
2176	In THD	%
2177	In true RMS	A

2178	In 2nd harmonic RMS	A
2179	In 3rd harmonic RMS	A
2180	In 4th harmonic RMS	A
2181	In 5th harmonic RMS	A
2182	In 6th harmonic RMS	A
2183	In 7th harmonic RMS	A
2184	In 8th harmonic RMS	A
M_IT_NA_1 points		
4000	Restart Count	--
4001	Switch Trip (or Open) Count	--
4002	All Faults Count	--
4003	A-phase Fault Count	--
4004	B-phase Fault Count	--
4005	C-phase Fault Count	--
4006	N-phase Fault Count	--
4007	kWattHour-a Export	kWh
4008	kWattHour-b Export	kWh
4009	kWattHour-c Export	kWh
4010	kWattHour-3ph Export	kWh
4011	kVarHour-a Export	kVarh
4012	kVarHour-b Export	kVarh
4013	kVarHour-c Export	kVarh
4014	kVarHour-3ph Export	kVarh
4015	kWattHour-a Import	kWh
4016	kWattHour-b Import	kWh
4017	kWattHour-c Import	kWh
4018	kWattHour-3ph Import	kWh
4019	kVarHour-a Import	kVarh
4020	kVarHour-b Import	kVarh
4021	kVarHour-c Import	kVarh
4022	kVarHour-3ph Import	kVarh
C_SE_NB_1 points (Current Setting : M_ME_NB_1 points)		
Setting Group1		
3000	Phase - Pickup Current	10~900A
3001	Phase Fast - TCC Type	1~58
3002	Phase Fast - Time Multiplier	0.10~2.00,step:0.01
3003	Phase Fast - Time Adder	0.00~1.00,step:0.01Sec

3004	Phase Fast - Min Response Time	0.00~1.00,step:0.01Sec
3005	Phase Fast - Reset Type	RDMT(0),RIDMT(1)
3006	Phase Fast - Reset Definite Time	0.00~100.00,step:0.01Sec
3007	Phase Delay - TCC Type	1~58
3008	Phase Delay - Time Multiplier	0.10~2.00,step:0.01
3009	Phase Delay - Time Adder	0.00~1.00,step:0.01Sec
3010	Phase Delay - Min Response Time	0.00~1.00,step:0.01Sec
3011	Phase Delay - Reset Type	RDMT(0),RIDMT(1)
3012	Phase Delay - Reset Definite Time	0.00~100.00,step:0.01Sec
3013	Phase Definite Time OC - Active	0(Off),1(On)
3014	Phase Definite Time OC - Pickup Current	50~10000A
3015	Phase Definite Time OC - Response Time	0.00~1.00,step:0.01Sec
3016	Phase High Current - Pickup	50~10000A
3017	Phase High Current - Response Time	0.00~1.00,step:0.01Sec
3018	Phase - Cold Load Pickup Multiplier	1.0~5.0,step:0.1
3019	Phase - Inrush Restraint	No(0),Yes(1)
3020	Ground - Pickup Current	5~900A
3021	Ground Fast - TCC Type	1~58
3022	Ground Fast - Time Multiplier	0.10~2.00,step:0.01
3023	Ground Fast - Time Adder	0.00~1.00,step:0.01Sec
3024	Ground Fast - Min Response Time	0.00~1.00,step:0.01Sec
3025	Ground Fast - Reset Type	RDMT(0),RIDMT(1)
3026	Ground Fast - Reset Definite Time	0.00~100.00,step:0.01Sec
3027	Ground Delay - TCC Type	1~58
3028	Ground Delay - Time Multiplier	0.10~2.00,step:0.01
3029	Ground Delay - Time Adder	0.00~1.00,step:0.01Sec
3030	Ground Delay - Min Response Time	0.00~1.00,step:0.01Sec
3031	Ground Delay - Reset Type	RDMT(0),RIDMT(1)
3032	Ground Delay - Reset Definite Time	0.00~100.00,step:0.01Sec
3033	Ground Definite Time OC - Active	0(Off),1(On)
3034	Ground Definite Time OC - Pickup Current	50~10000A
3035	Ground Definite Time OC - Response Time	0.00~1.00,step:0.01Sec
3036	Ground High Current - Pickup	50~10000A
3037	Ground High Current - Response Time	0.00~1.00,step:0.01Sec
3038	Ground - Cold Load Pickup Multiplier	1.0~5.0,step:0.1
3039	Ground - Inrush Restraint	No(0),Yes(1)
3040	SEF -Pickup Current(Io)	2 - 20A

3041	SEF -Pickup Voltage(Vo)	10~80%
3042	SEF -Max. Torque Angle	0~345,step:15 DEG
3043	SEF -Detection Time	0.1~30.0 step:0.1 Sec
3044	SEF -Inrush restraint	No(0),Yes(1)
3045	SEF -Operation Select	0(Off),Alarm(1),Trip(2)
3046	Inrush restraint - 2nd harmonic Pickup	5~50%
3047	Inrush restraint - Detection Time	0.02~1.00,step:0.01
3048	Inrush restraint - Operation Select	0(Off),1(On)
3049	Operation to Lockout Phase	1~5 times
3050	Operation to Lockout Ground	1~5 times
3051	Operation Fast Curve Phase	0~5 times
3052	Operation Fast Curve Ground	0~5 times
3053	High Current Phase Active	0(OFF), 1~5 times
3054	High Current Ground Active	0(OFF), 1~5 times
3055	Reclose Interval 1st	0.5~60.0,step:0.1Sec
3056	Reclose Interval 2nd	1~60s
3057	Reclose Interval 3rd	1~60s
3058	Reclose Interval 4th	1~60s
3059	Reset Time	3~180s
3060	Cold Load Duration	0.00~60.00,step:0.01Sec
3061	Cold Load Pickup Restore Time	0.00~30.00,step:0.01Sec
3062	Sequence Coordination Active	No(0),Yes(1)
3063	Phase Loss - Volt On level	50~90,step:5%
3064	Phase Loss - Volt Off level	35~75,step:5%
3065	Phase Loss - Detection Time	0.1~30.0,step:0.1Sec
3066	Phase Loss - Operation Select	0(Off),1(On)
3067	Sync Fail - Phase difference	5~60DEG
3068	Sync Fail - Detection Time	0.1~30.0,step:0.1Sec
3069	Sync Fail - Operation Select	0(Off),1(On)
3070	Under Frequency - Frequency Pickup	47.00~59.98,step:0.01Hz
3071	Under Frequency - Detection Time	0.03~10.00,step:0.01Sec
3072	Under Frequency - Operation Select	0(Off),1(On)
Setting Group2		
3100	Phase - Pickup Current	10~900A
3101	Phase Fast - TCC Type	1~58
3102	Phase Fast - Time Multiplier	0.10~2.00,step:0.01
3103	Phase Fast - Time Adder	0.00~1.00,step:0.01Sec

3104	Phase Fast - Min Response Time	0.00~1.00,step:0.01Sec
3105	Phase Fast - Reset Type	RDMT(0),RIDMT(1)
3106	Phase Fast - Reset Definite Time	0.00~100.00,step:0.01Sec
3107	Phase Delay - TCC Type	1~58
3108	Phase Delay - Time Multiplier	0.10~2.00,step:0.01
3109	Phase Delay - Time Adder	0.00~1.00,step:0.01Sec
3110	Phase Delay - Min Response Time	0.00~1.00,step:0.01Sec
3111	Phase Delay - Reset Type	RDMT(0),RIDMT(1)
3112	Phase Delay - Reset Definite Time	0.00~100.00,step:0.01Sec
3113	Phase Definite Time OC - Active	0(Off),1(On)
3114	Phase Definite Time OC - Pickup Current	50~10000A
3115	Phase Definite Time OC - Response Time	0.00~1.00,step:0.01Sec
3116	Phase High Current - Pickup	50~10000A
3117	Phase High Current - Response Time	0.00~1.00,step:0.01Sec
3118	Phase - Cold Load Pickup Multiplier	1.0~5.0,step:0.1
3119	Phase - Inrush Restraint	No(0),Yes(1)
3120	Ground - Pickup Current	5~900A
3121	Ground Fast - TCC Type	1~58
3122	Ground Fast - Time Multiplier	0.10~2.00,step:0.01
3123	Ground Fast - Time Adder	0.00~1.00,step:0.01Sec
3124	Ground Fast - Min Response Time	0.00~1.00,step:0.01Sec
3125	Ground Fast - Reset Type	RDMT(0),RIDMT(1)
3126	Ground Fast - Reset Definite Time	0.00~100.00,step:0.01Sec
3127	Ground Delay - TCC Type	1~58
3128	Ground Delay - Time Multiplier	0.10~2.00,step:0.01
3129	Ground Delay - Time Adder	0.00~1.00,step:0.01Sec
3130	Ground Delay - Min Response Time	0.00~1.00,step:0.01Sec
3131	Ground Delay - Reset Type	RDMT(0),RIDMT(1)
3132	Ground Delay - Reset Definite Time	0.00~100.00,step:0.01Sec
3133	Ground Definite Time OC - Active	0(Off),1(On)
3134	Ground Definite Time OC - Pickup Current	50~10000A
3135	Ground Definite Time OC - Response Time	0.00~1.00,step:0.01Sec
3136	Ground High Current - Pickup	50~10000A
3137	Ground High Current - Response Time	0.00~1.00,step:0.01Sec
3138	Ground - Cold Load Pickup Multiplier	1.0~5.0,step:0.1
3139	Ground - Inrush Restraint	No(0),Yes(1)
3140	SEF -Pickup Current(Io)	2 - 20A

3141	SEF -Pickup Voltage(Vo)	10~80%
3142	SEF -Max. Torque Angle	0~345,step:15 DEG
3143	SEF -Detection Time	0.1~30.0 step:0.1 Sec
3144	SEF -Inrush restraint	No(0),Yes(1)
3145	SEF -Operation Select	0(Off),Alarm(1),Trip(2)
3146	Inrush restraint - 2nd harmonic Pickup	5~50%
3147	Inrush restraint - Detection Time	0.02~1.00,step:0.01
3148	Inrush restraint - Operation Select	0(Off),1(On)
3149	Operation to Lockout Phase	1~5 times
3150	Operation to Lockout Ground	1~5 times
3151	Operation Fast Curve Phase	0~5 times
3152	Operation Fast Curve Ground	0~5 times
3153	High Current Phase Active	0(OFF), 1~5 times
3154	High Current Ground Active	0(OFF), 1~5 times
3155	Reclose Interval 1st	0.5~60.0,step:0.1Sec
3156	Reclose Interval 2nd	1~60s
3157	Reclose Interval 3rd	1~60s
3158	Reclose Interval 4th	1~60s
3159	Reset Time	3~180s
3160	Cold Load Duration	0.00~60.00,step:0.01Sec
3161	Cold Load Pickup Restore Time	0.00~30.00,step:0.01Sec
3162	Sequence Coordination Active	No(0),Yes(1)
3163	Phase Loss - Volt On level	50~90,step:5%
3164	Phase Loss - Volt Off level	35~75,step:5%
3165	Phase Loss - Detection Time	0.1~30.0,step:0.1Sec
3166	Phase Loss - Operation Select	0(Off),1(On)
3167	Sync Fail - Phase difference	5~60DEG
3168	Sync Fail - Detection Time	0.1~30.0,step:0.1Sec
3169	Sync Fail - Operation Select	0(Off),1(On)
3170	Under Frequency - Frequency Pickup	47.00~59.98,step:0.01Hz
3171	Under Frequency - Detection Time	0.03~10.00,step:0.01Sec
3172	Under Frequency - Operation Select	0(Off),1(On)
Setting Group3		
3200	Phase - Pickup Current	10~900A
3201	Phase Fast - TCC Type	1~58
3202	Phase Fast - Time Multiplier	0.10~2.00,step:0.01
3203	Phase Fast - Time Adder	0.00~1.00,step:0.01Sec

3204	Phase Fast - Min Response Time	0.00~1.00,step:0.01Sec
3205	Phase Fast - Reset Type	RDMT(0),RIDMT(1)
3206	Phase Fast - Reset Definite Time	0.00~100.00,step:0.01Sec
3207	Phase Delay - TCC Type	1~58
3208	Phase Delay - Time Multiplier	0.10~2.00,step:0.01
3209	Phase Delay - Time Adder	0.00~1.00,step:0.01Sec
3210	Phase Delay - Min Response Time	0.00~1.00,step:0.01Sec
3211	Phase Delay - Reset Type	RDMT(0),RIDMT(1)
3212	Phase Delay - Reset Definite Time	0.00~100.00,step:0.01Sec
3213	Phase Definite Time OC - Active	0(Off),1(On)
3214	Phase Definite Time OC - Pickup Current	50~10000A
3215	Phase Definite Time OC - Response Time	0.00~1.00,step:0.01Sec
3216	Phase High Current - Pickup	50~10000A
3217	Phase High Current - Response Time	0.00~1.00,step:0.01Sec
3218	Phase - Cold Load Pickup Multiplier	1.0~5.0,step:0.1
3219	Phase - Inrush Restraint	No(0),Yes(1)
3220	Ground - Pickup Current	5~900A
3221	Ground Fast - TCC Type	1~58
3222	Ground Fast - Time Multiplier	0.10~2.00,step:0.01
3223	Ground Fast - Time Adder	0.00~1.00,step:0.01Sec
3224	Ground Fast - Min Response Time	0.00~1.00,step:0.01Sec
3225	Ground Fast - Reset Type	RDMT(0),RIDMT(1)
3226	Ground Fast - Reset Definite Time	0.00~100.00,step:0.01Sec
3227	Ground Delay - TCC Type	1~58
3228	Ground Delay - Time Multiplier	0.10~2.00,step:0.01
3229	Ground Delay - Time Adder	0.00~1.00,step:0.01Sec
3230	Ground Delay - Min Response Time	0.00~1.00,step:0.01Sec
3231	Ground Delay - Reset Type	RDMT(0),RIDMT(1)
3232	Ground Delay - Reset Definite Time	0.00~100.00,step:0.01Sec
3233	Ground Definite Time OC - Active	0(Off),1(On)
3234	Ground Definite Time OC - Pickup Current	50~10000A
3235	Ground Definite Time OC - Response Time	0.00~1.00,step:0.01Sec
3236	Ground High Current - Pickup	50~10000A
3237	Ground High Current - Response Time	0.00~1.00,step:0.01Sec
3238	Ground - Cold Load Pickup Multiplier	1.0~5.0,step:0.1
3239	Ground - Inrush Restraint	No(0),Yes(1)
3240	SEF -Pickup Current(Io)	2 - 20A

3241	SEF -Pickup Voltage(Vo)	10~80%
3242	SEF -Max. Torque Angle	0~345,step:15 DEG
3243	SEF -Detection Time	0.1~30.0 step:0.1 Sec
3244	SEF -Inrush restraint	No(0),Yes(1)
3245	SEF -Operation Select	0(Off),Alarm(1),Trip(2)
3246	Inrush restraint - 2nd harmonic Pickup	5~50%
3247	Inrush restraint - Detection Time	0.02~1.00,step:0.01
3248	Inrush restraint - Operation Select	0(Off),1(On)
3249	Operation to Lockout Phase	1~5 times
3250	Operation to Lockout Ground	1~5 times
3251	Operation Fast Curve Phase	0~5 times
3252	Operation Fast Curve Ground	0~5 times
3253	High Current Phase Active	0(OFF), 1~5 times
3254	High Current Ground Active	0(OFF), 1~5 times
3255	Reclose Interval 1st	0.5~60.0,step:0.1Sec
3256	Reclose Interval 2nd	1~60s
3257	Reclose Interval 3rd	1~60s
3258	Reclose Interval 4th	1~60s
3259	Reset Time	3~180s
3260	Cold Load Duration	0.00~60.00,step:0.01Sec
3261	Cold Load Pickup Restore Time	0.00~30.00,step:0.01Sec
3262	Sequence Coordination Active	No(0),Yes(1)
3263	Phase Loss - Volt On level	50~90,step:5%
3264	Phase Loss - Volt Off level	35~75,step:5%
3265	Phase Loss - Detection Time	0.1~30.0,step:0.1Sec
3266	Phase Loss - Operation Select	0(Off),1(On)
3267	Sync Fail - Phase difference	5~60DEG
3268	Sync Fail - Detection Time	0.1~30.0,step:0.1Sec
3269	Sync Fail - Operation Select	0(Off),1(On)
3270	Under Frequency - Frequency Pickup	47.00~59.98,step:0.01Hz
3271	Under Frequency - Detection Time	0.03~10.00,step:0.01Sec
3272	Under Frequency - Operation Select	0(Off),1(On)
Setting Group4		
3300	Phase - Pickup Current	10~900A
3301	Phase Fast - TCC Type	1~58
3302	Phase Fast - Time Multiplier	0.10~2.00,step:0.01
3303	Phase Fast - Time Adder	0.00~1.00,step:0.01Sec

3304	Phase Fast - Min Response Time	0.00~1.00,step:0.01Sec
3305	Phase Fast - Reset Type	RDMT(0),RIDMT(1)
3306	Phase Fast - Reset Definite Time	0.00~100.00,step:0.01Sec
3307	Phase Delay - TCC Type	1~58
3308	Phase Delay - Time Multiplier	0.10~2.00,step:0.01
3309	Phase Delay - Time Adder	0.00~1.00,step:0.01Sec
3310	Phase Delay - Min Response Time	0.00~1.00,step:0.01Sec
3311	Phase Delay - Reset Type	RDMT(0),RIDMT(1)
3312	Phase Delay - Reset Definite Time	0.00~100.00,step:0.01Sec
3313	Phase Definite Time OC - Active	0(Off),1(On)
3314	Phase Definite Time OC - Pickup Current	50~10000A
3315	Phase Definite Time OC - Response Time	0.00~1.00,step:0.01Sec
3316	Phase High Current - Pickup	50~10000A
3317	Phase High Current - Response Time	0.00~1.00,step:0.01Sec
3318	Phase - Cold Load Pickup Multiplier	1.0~5.0,step:0.1
3319	Phase - Inrush Restraint	No(0),Yes(1)
3320	Ground - Pickup Current	5~900A
3321	Ground Fast - TCC Type	1~58
3322	Ground Fast - Time Multiplier	0.10~2.00,step:0.01
3323	Ground Fast - Time Adder	0.00~1.00,step:0.01Sec
3324	Ground Fast - Min Response Time	0.00~1.00,step:0.01Sec
3325	Ground Fast - Reset Type	RDMT(0),RIDMT(1)
3326	Ground Fast - Reset Definite Time	0.00~100.00,step:0.01Sec
3327	Ground Delay - TCC Type	1~58
3328	Ground Delay - Time Multiplier	0.10~2.00,step:0.01
3329	Ground Delay - Time Adder	0.00~1.00,step:0.01Sec
3330	Ground Delay - Min Response Time	0.00~1.00,step:0.01Sec
3331	Ground Delay - Reset Type	RDMT(0),RIDMT(1)
3332	Ground Delay - Reset Definite Time	0.00~100.00,step:0.01Sec
3333	Ground Definite Time OC - Active	0(Off),1(On)
3334	Ground Definite Time OC - Pickup Current	50~10000A
3335	Ground Definite Time OC - Response Time	0.00~1.00,step:0.01Sec
3336	Ground High Current - Pickup	50~10000A
3337	Ground High Current - Response Time	0.00~1.00,step:0.01Sec
3338	Ground - Cold Load Pickup Multiplier	1.0~5.0,step:0.1
3339	Ground - Inrush Restraint	No(0),Yes(1)
3340	SEF -Pickup Current(Io)	2 - 20A

3341	SEF -Pickup Voltage(Vo)	10~80%
3342	SEF -Max. Torque Angle	0~345,step:15 DEG
3343	SEF -Detection Time	0.1~30.0 step:0.1 Sec
3344	SEF -Inrush restraint	No(0),Yes(1)
3345	SEF -Operation Select	0(Off),Alarm(1),Trip(2)
3346	Inrush restraint - 2nd harmonic Pickup	5~50%
3347	Inrush restraint - Detection Time	0.02~1.00,step:0.01
3348	Inrush restraint - Operation Select	0(Off),1(On)
3349	Operation to Lockout Phase	1~5 times
3350	Operation to Lockout Ground	1~5 times
3351	Operation Fast Curve Phase	0~5 times
3352	Operation Fast Curve Ground	0~5 times
3353	High Current Phase Active	0(OFF), 1~5 times
3354	High Current Ground Active	0(OFF), 1~5 times
3355	Reclose Interval 1st	0.5~60.0,step:0.1Sec
3356	Reclose Interval 2nd	1~60s
3357	Reclose Interval 3rd	1~60s
3358	Reclose Interval 4th	1~60s
3359	Reset Time	3~180s
3360	Cold Load Duration	0.00~60.00,step:0.01Sec
3361	Cold Load Pickup Restore Time	0.00~30.00,step:0.01Sec
3362	Sequence Coordination Active	No(0),Yes(1)
3363	Phase Loss - Volt On level	50~90,step:5%
3364	Phase Loss - Volt Off level	35~75,step:5%
3365	Phase Loss - Detection Time	0.1~30.0,step:0.1Sec
3366	Phase Loss - Operation Select	0(Off),1(On)
3367	Sync Fail - Phase difference	5~60DEG
3368	Sync Fail - Detection Time	0.1~30.0,step:0.1Sec
3369	Sync Fail - Operation Select	0(Off),1(On)
3370	Under Frequency - Frequency Pickup	47.00~59.98,step:0.01Hz
3371	Under Frequency - Detection Time	0.03~10.00,step:0.01Sec
3372	Under Frequency - Operation Select	0(Off),1(On)
Common Setting		
3400	Active setting group	1~4
3401	Reversed	
3402	Reserved	
3403	Reserved	