

Instruction Manual & User's Guide

15kV~27kV Pole mounted Epoxy Molded Automatic Vacuum Recloser with Microprocessor based controller integrated with Remote Terminal Unit(RTU)



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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 :

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

Warning :

- *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.*
- *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.*
- *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 IEC 60137, IEC 60587, IEC 60707, ANSI C29.11, IEEE C37.60, IEEE C37.71, ANSI C37.85, IEEE C37.90.1, IEEE C37.90.2, IEEE C62.45, and IEEE 1024.

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. 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 27kV.

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 service 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.

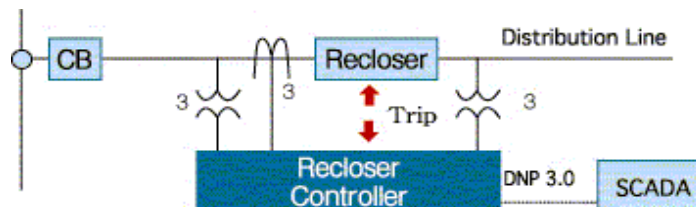
Should the fault clear before lockout, the recloser will reset automatically for another sequence of operations. The recloser can also be set for non-reclosing operation (lock out after the first trip operation) The recloser can be remotely set for non-reclosing operation via the remote non-reclosing 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-MREC recloser has a characteristic as followings.

- 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.

- Communication protocols to DAS make the automated protection coordination possible.
- The control has a total of 54 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.
- 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.
- All operating parameters and settings are easily programmable via handheld controller or PC using RS-232 port on the front panel.
- 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.

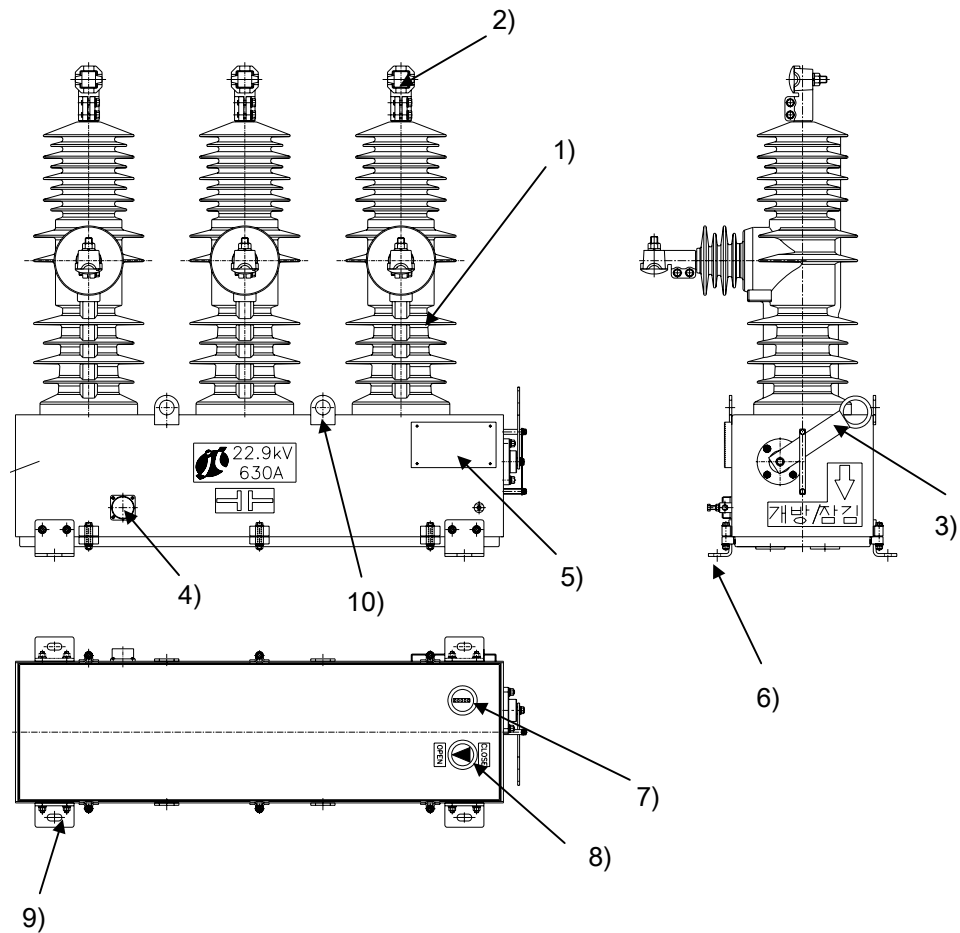


3. RATING & SPECIFICATIONS

No.	Description	Unit	Specifications
1	Type		JK-MREC
2	Insulation		Epoxy molded
3	Ratings		
	Maximum System Voltage	kV	27
	Rated Voltage	kV	22
	Rated Current	A	630
	Rated Frequency	Hz	50/60
	Mechanical Operation(Min.)	C-O	10,000
4	Breaking Capacity		
	Rated symmetrical interrupting current	kA	12.5/16
	Short Time Withstand Current(1sec)	kA	12.5/16
	Making Current(peak)	kA	32.5/41.6
	Cable Charging	A	5
	Transformer Magnetizing	A	22
5	Impulse Insulation Level($1.2 \times 50\mu\text{s}$)		
	Phase to Earth	kV	150
	Across Interrupter	kV	150
6	Power Frequency Insulation Level, dry		
	Phase to Earth	kV	60
	Across Interrupter	kV	60
7	Power Supply		
	Operation	V	AC127 or AC220
	Control Circuit	V	DC 24
8	Environmental		
	Ambient Temperature	°C	-30 ~ +50
	Humidity	%	0 ~ 100
	Altitude(*1)	m	1,000
9	Net Weight(Switch Body/ Control Cabinet)	kg	190/60

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.



1) Polymer bushing part

The VI, CT(1000/1) and Voltage sensor are included in polymer bushing part.

2) Terminal connector

Universal clamp, NEMA 2 hole terminal or NEMA 4 hole terminal are available.

3) Manual OPEN/LOCK handle

Manual OPEN is made with Manual OPEN handle by pulling it down with NEMA hook-stick. When Recloser is trip(open) by means of manual method, Recloser goes to 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) Control receptacle to interface with controller
- 5) Name plate
- 6) Ground terminal available for 4 ~ 35 mm² of conductor
- 7) Operation counter
- 8) ON/OFF position indicator

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.

- 9) Mounting bracket
- 10) Lifting & carrying handle

5. INSTALLATION PROCEDURE

Warning

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

Caution

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

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

7) 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.*

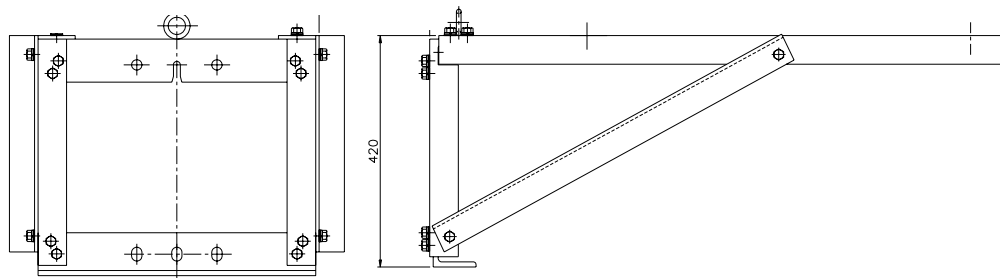
5.3 Installation procedure

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.

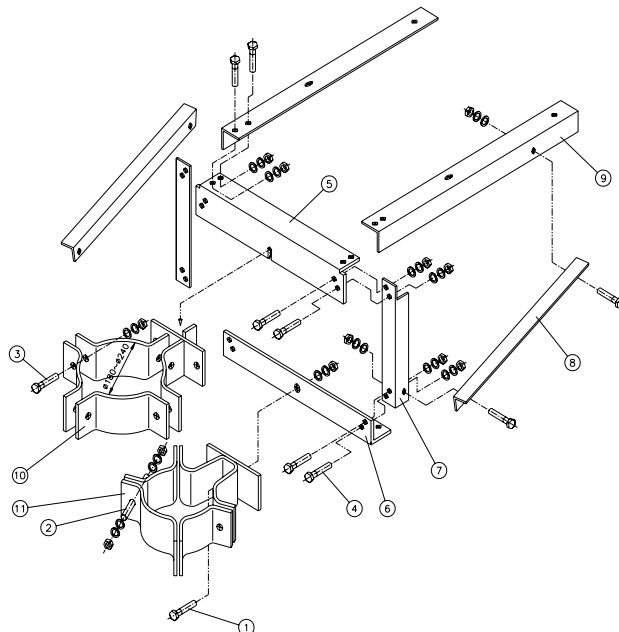
When lifting the recloser, use the lifting lugs located on the top of the tank and follow approved procedure. At this point, the contacts are opens. Never use its porcelain bushing, bushing terminals nor manual trip handle. These handling will cause the damage to the recloser.

- The following figure shows Jinkwang's mounting frames.



Mounting frames

- The assembly method of mounting frames as follows



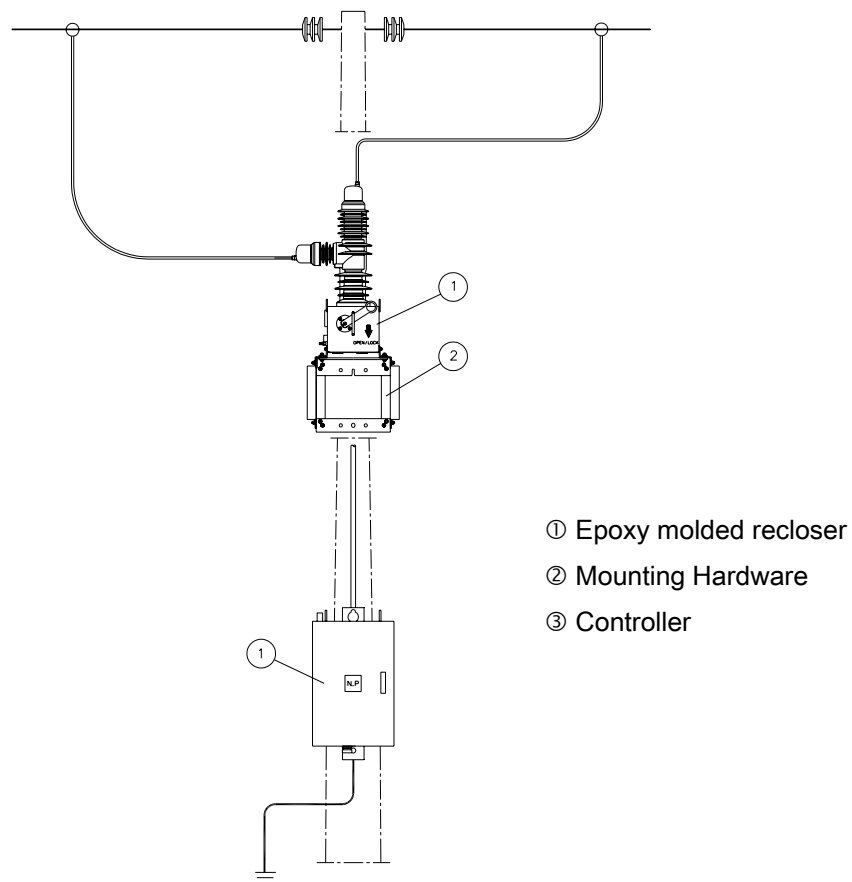
No.	Description	Q'ty
1	Hex bolt, nut, Spring washer, Plate washer	4
2	Stud washer	4
3	Hex bolt, nut, Spring washer, Plate washer	4
4	Hex bolt, nut, Spring washer, Plate washer	20
5	Upper band	1
6	Lower band	1
7	Vertical bracket	2
8	Bracket support	2
9	Vertical bracket	2
10	Hanger band "A"	1
11	Hanger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

5.3.2 Ground the recloser

Refer to our typical mounting arrangement as shown in figure.

Make ground connections to the recloser with the provided ground connector located on the side of the recloser. 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 controller

Ground the control using the ground connector provided at the upper of the control cabinet for connecting 22mm² to 60mm² 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.

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 250 mm).
- 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) 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).
- 5) Make sure a mounting condition of the control cabinet's components such as a batteries, power transformer for power supply, etc.
- 6) Check a charging condition and capacity of batteries using the battery test button in the control.
- 7) Check a grounding connection of main body and control cabinet.
- 8) 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.

6. RECLOER OPERATION

Warning

- *Do not rely 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

- *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. 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.*

7. MAINTENANCE

Warning

- *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

- *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 for 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 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 recloser including epoxy molded 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 3-phase and 3-phase
- Energy (4-quadrant metering)
- Displacement Power Factor
- Frequency

Control :

- Manual Recloser Open / Close at local or remote (SBO operation)
- Interlocking (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

Status Monitoring :

10 Contacts inputs

- Recloser Open / Closed,
- Locked
- 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
- 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 : 3 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

Power Supply Input

DC 24V (DC20 ~ 29V)

Power consumption : Max. 15W

2.3 Measurements

Current

RMS (A) & Phase angle (°)	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 (°)	Va, Vb, Vc
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
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	$\pm 0.02\text{Hz}$
----------	---------------------

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	$\pm 2\%$

Harmonics

Total harmonic distortion (THD, %)	3-phase currents THD (Ia, Ib, Ic, I3ph)
	Source side 3-phase voltages THD (Vsa, Vsb, Vsc, Vs3ph)
2 nd ~ 8 th harmonics RMS (A, kV)	Ia, Ib, Ic, Va, Vb, Vc,

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, live line (source-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

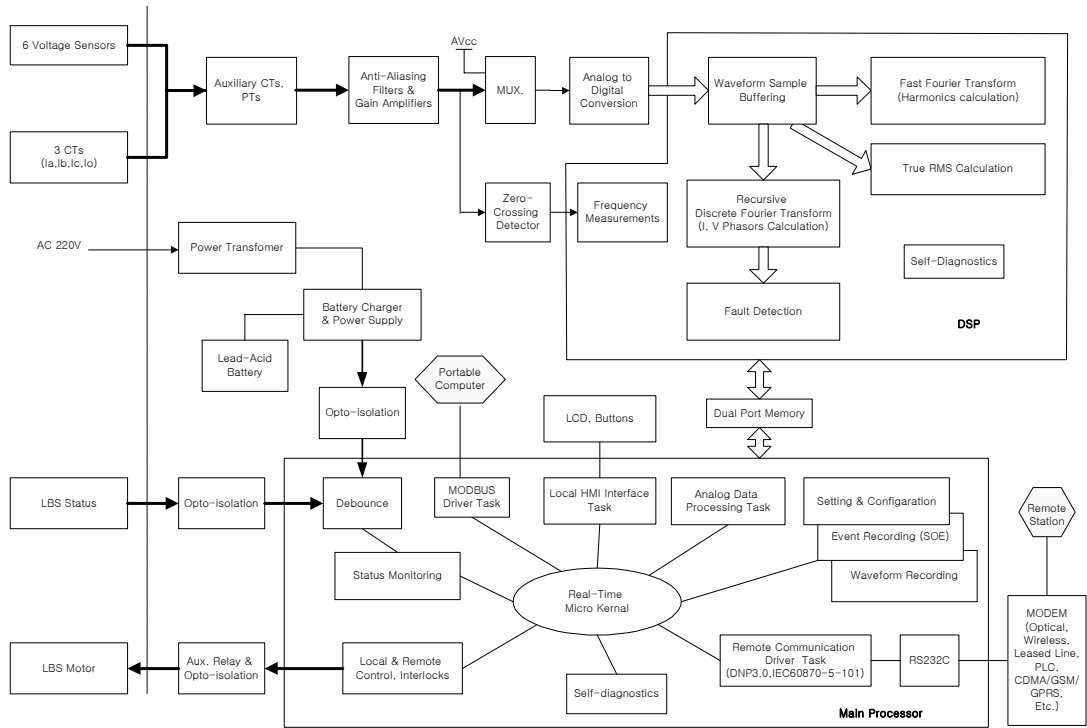
Local Human-Machine Interface

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 (I _o >)	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 (I _o >>)	50 ~ 10,000A (1A step)
- Definite time OC response time	0.00 ~ 1.00sec (0.01sec step)
- High current pickup (I _o >>>)	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 (I _o)	2 ~ 20A (1A step)
- Pickup voltage (V _o)	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

4-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

2.7.2 Open Line Detection

Open line is detected by under-voltage characteristics at unbalanced condition.

- Voltage on level (%) 50 ~ 90% (5% step)
- Voltage off level (%) 35 ~ 75% (5% step)
- Detection time 0.1 ~ 30.0 sec (0.1sec step)

- Operation select On/Off

2.7.3 Under-frequency detection

- Pickup 47.00~59.98Hz (0.01Hz step)
- Detection time 0.03 ~ 10.00 sec (0.01sec step)
- Operation select Off/Alarm/Trip

2.7.4 Setting group select

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

2.7.5 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)
- 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

2.7.7 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)

2.7.8 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

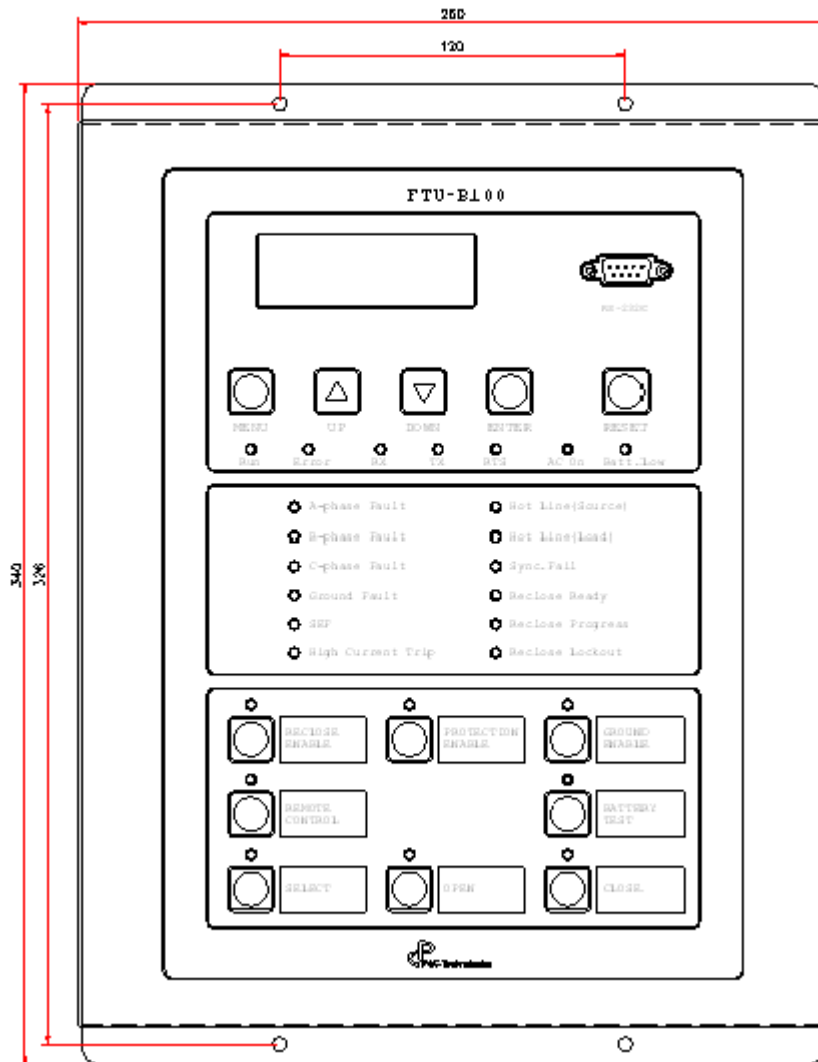
2.9 Maintenance software

- 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.



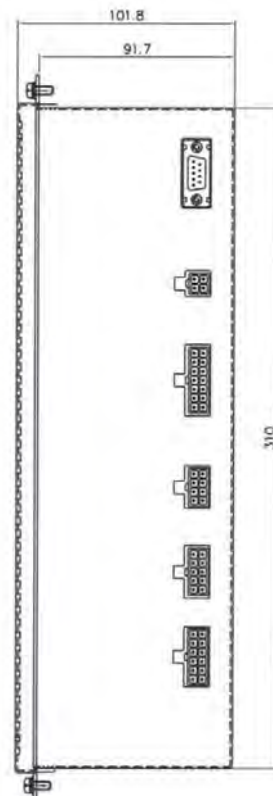
[Fig. 3-1] Front Panel Drawing of FTU

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



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

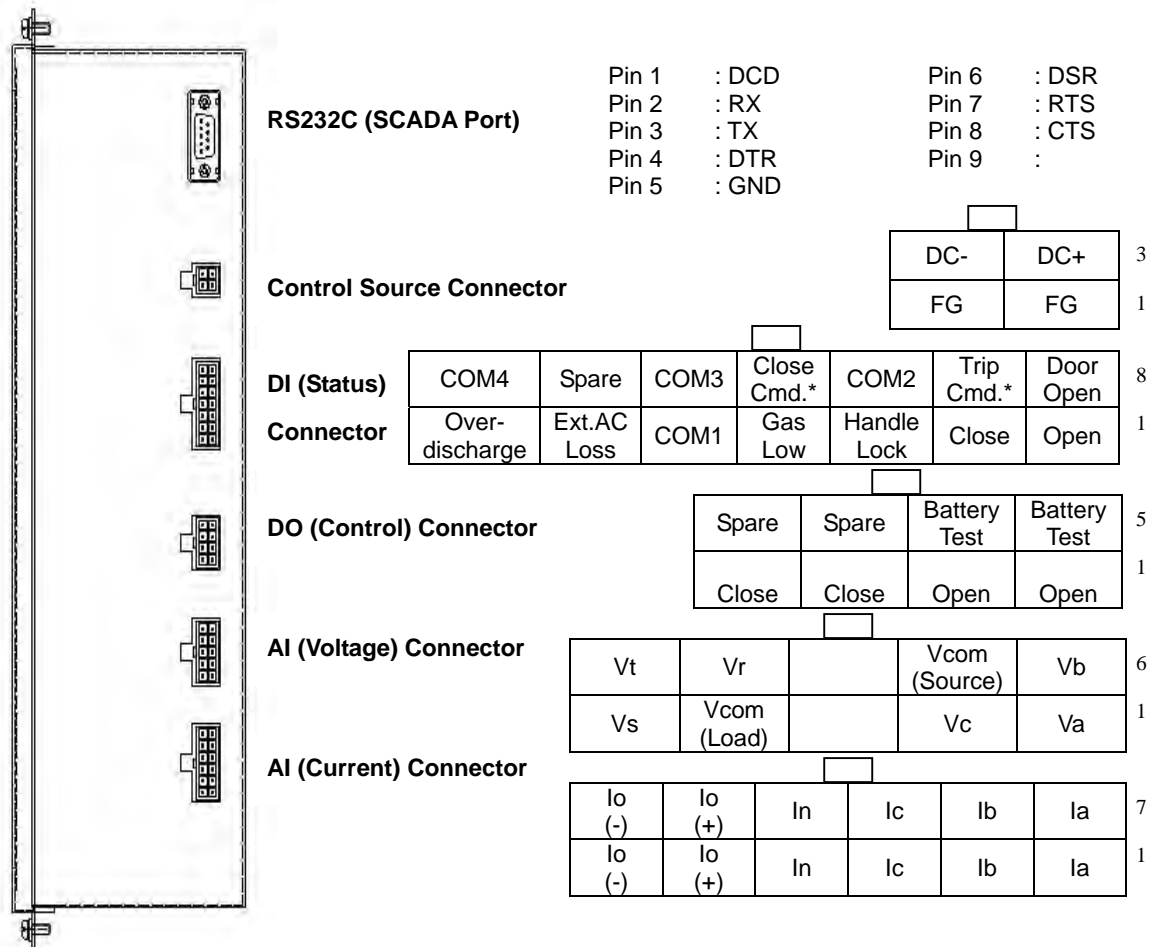
The next drawing is Side-view of FTU-R100 panel, and there are measurement module connector, control module connector, monitoring module connector, power connectors, and RS232 port for SCADA communication on the right side of FTU panel.



[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.

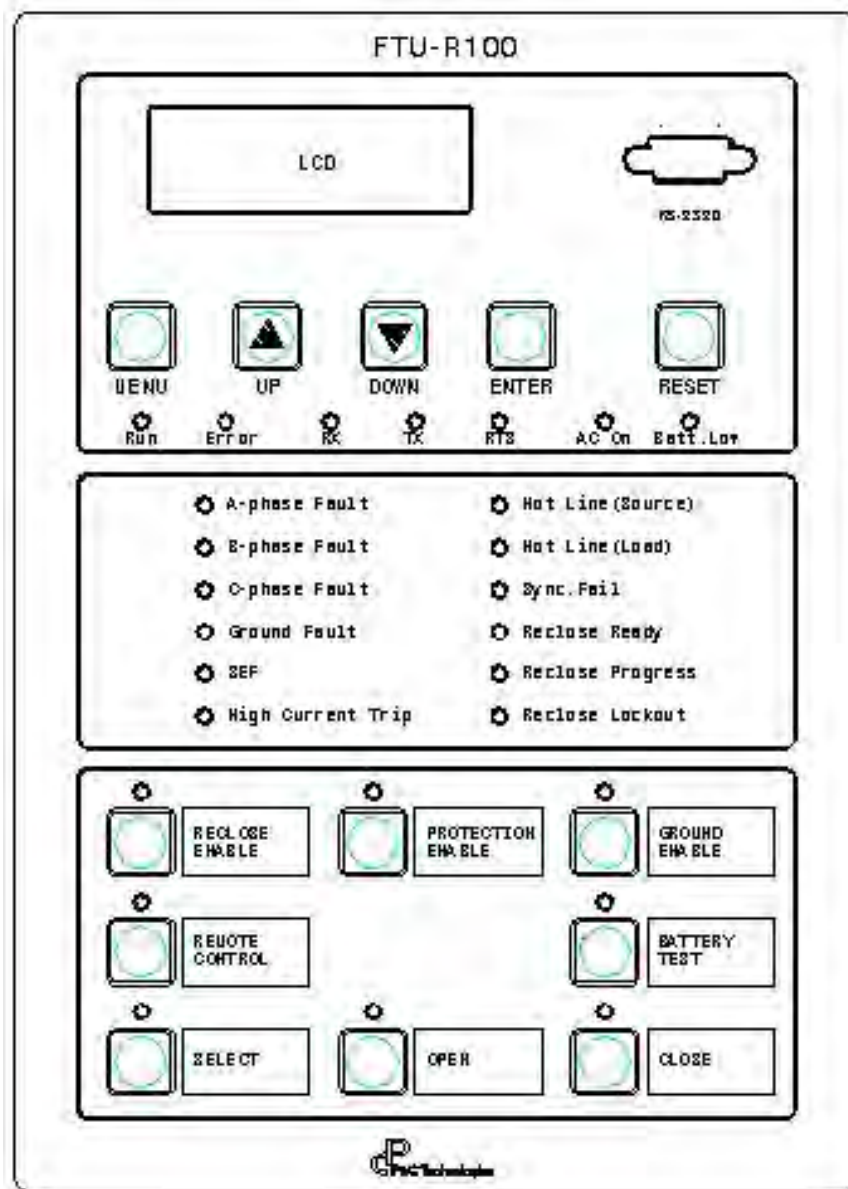


* Optional

[Fig. 3-4] Pin Connectors on the Right Side of FTU-R1004. 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 (V_a) and Load-side voltage (V_r) 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.

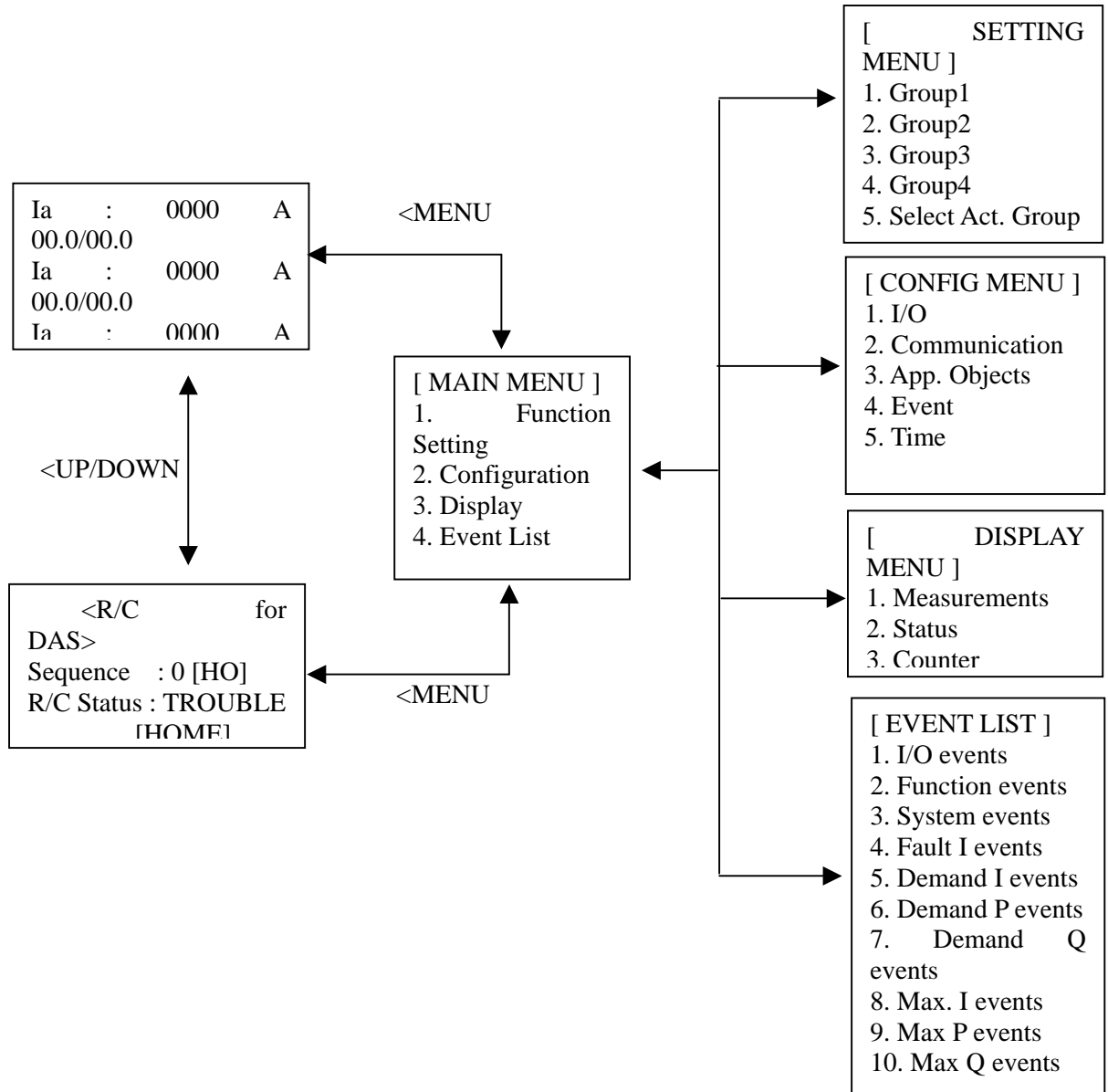
- SELECT → CLOSE : Push this button to control the Recloser manually to be closed. After closing, normal fault detection functions are re-performed. In case that Cold Load Pickup function is off or the load current is below the Cold Load Pickup Level, normal Phase & Ground Fault Detection is functioned.
- 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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.

```

      < R / C   f o r   D A S >
S e q u e n c e       :   0   [ H O ]
R / C   S t a t u s   :   C L O S E
                   [   H O M E   ]

```

[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].

```

I a : 0 0 0 0 0 A   0 0 . 0 / 0 0 . 0
I b : 0 0 0 0 0 A   0 0 . 0 / 0 0 . 0
I c : 0 0 0 0 0 A   0 0 . 0 / 0 0 . 0
I n : 0 0 0 0 0 A   < A B C >

```

[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) : Source Side Voltage (Va,Vb,Vc) /

(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 Menu

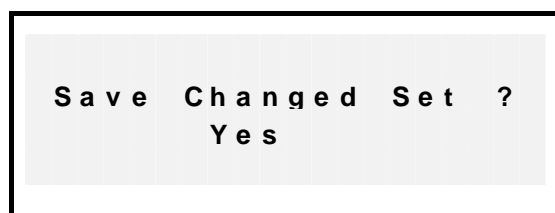
Function Setting	Setting Items	Sub Setting Items (1)	Sub Setting Items (2)	Setting Ranges <step>	Default
Group1	Fault Detection	Phase F : Fast D : Delayed	Pickup Level	10-900 <1A>	400
			F TCC Type	1-58 <1>	1
			F Multiplier	0.10-2.00 <0.01>	1.00
			F Time Adder	0.00-1.00 <0.01s>	0.00
			F Min. Resp. 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)
	Open Line Detect	Volt On		50-90 <5%>	80
		Volt Off		35-75 <5%>	50
		Delay Time		0.1-30.0 <0.1s>	0.4
		Func. In Use		1(On) / 0(Off)	1(On)
	Under frequency Detect	Pickup Level		47.00~59.98<0.01>	49.80Hz
		Detect Time		0.03~10.00<0.01s>	0.1s
		Func. In Use		Off/Alarm/Trip	Off
	Trip & Reclosing	Ph. Oper Cnt (Phase Time-delayed)		1-5 <1>	4
		Gnd Oper Cnt (Ground Time-delayed)		1-5 <1>	4
		PF Oper Cnt (Phase Instantaneous)		0-5 <1>	2
		GF Oper Cnt (Ground Instantaneous)		0-5 <1>	2
		Ph. HCT Op Cnt (Phase HCT)		0-5 <1>	0
		Gnd HCT Op Cnt (Ground HCT)		0-5 <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.

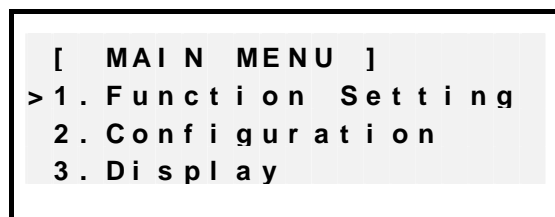
* CAUTION: Be careful not to push down MENU buttons repeatedly! Then, the newly changed set values are neither saved nor applied.



[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>
Event	CNT Object VOC	CNT.0 ~ CNT.15	0-65535 <1>
	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.

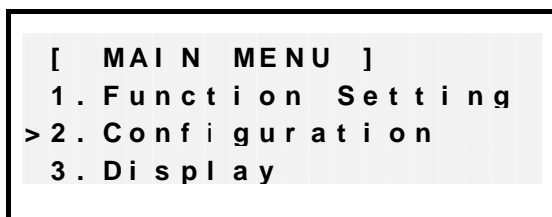
* CAUTION: Be careful not to push down MENU buttons repeatedly! Then, the newly changed set values are neither saved nor applied.



[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[kV] Zero-sequence : VoS, (S: Source-side) Positive-sequence : V1S Negative-sequence : V2S : 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]
Status	Switch	OPEN / CLOSE / TROUBLE
	Handle	LOCK / UNLOCK
	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

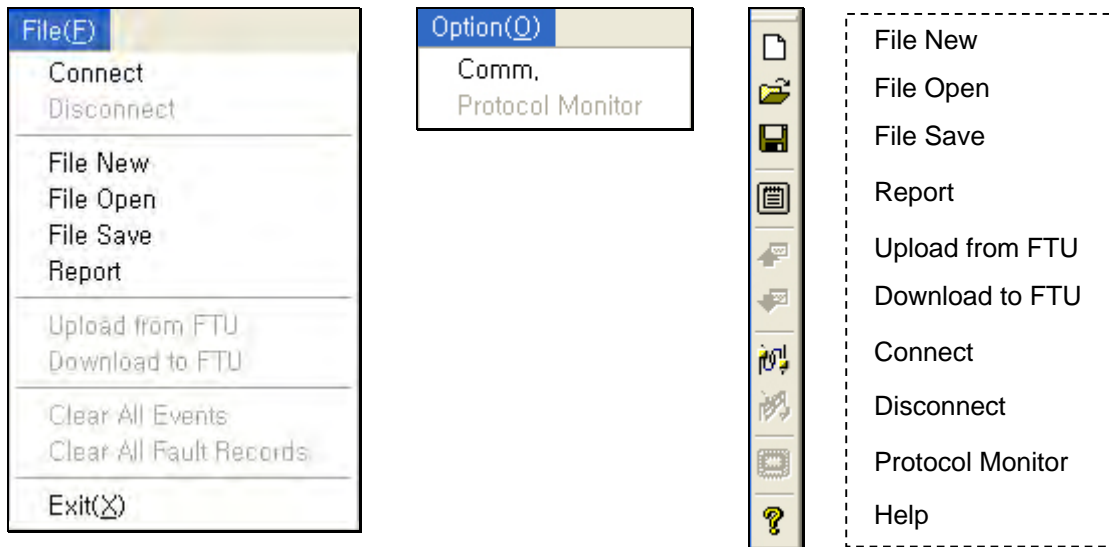
(6) Event List

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]

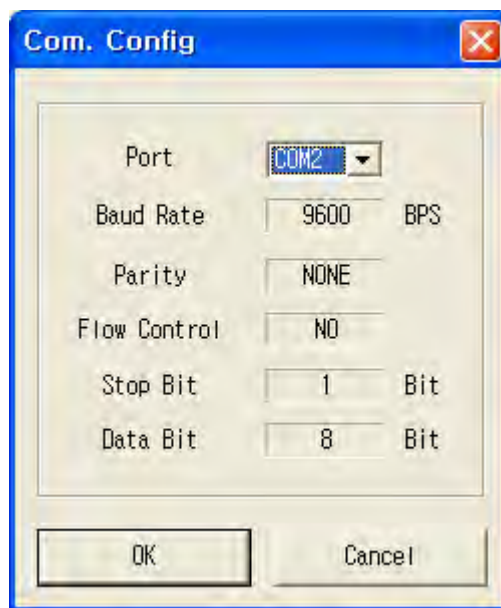
- Comm. : to open a window for communication configuration of the tool
- Protocol monitor : to open a window for communication status monitoring

[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		

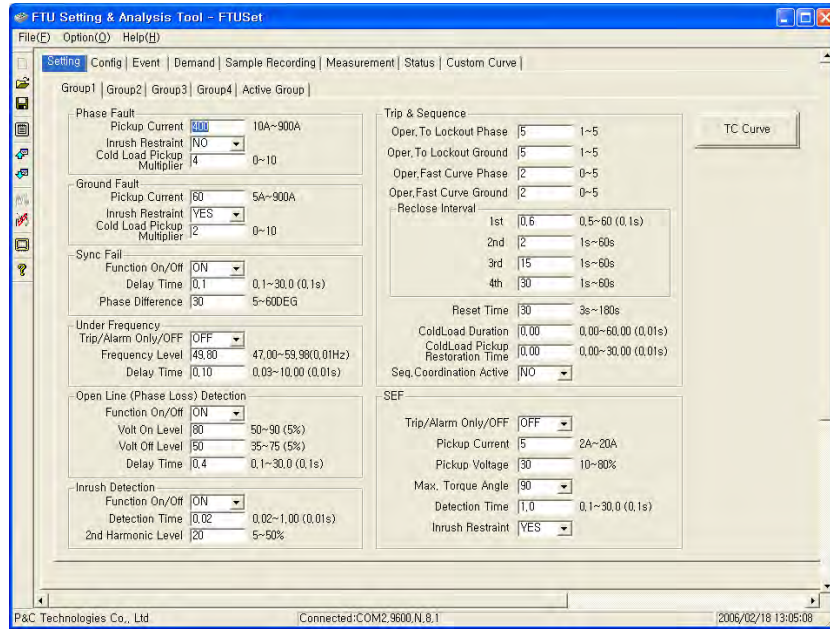
Connector Type : DB9 Female

[Fig. 4-11] [Option – Comm] Window

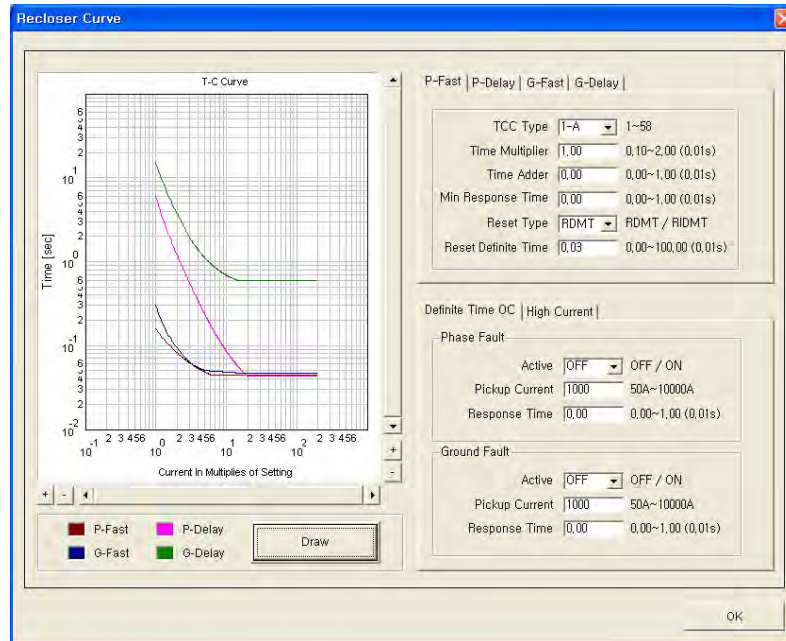
(2) Setting Window

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.

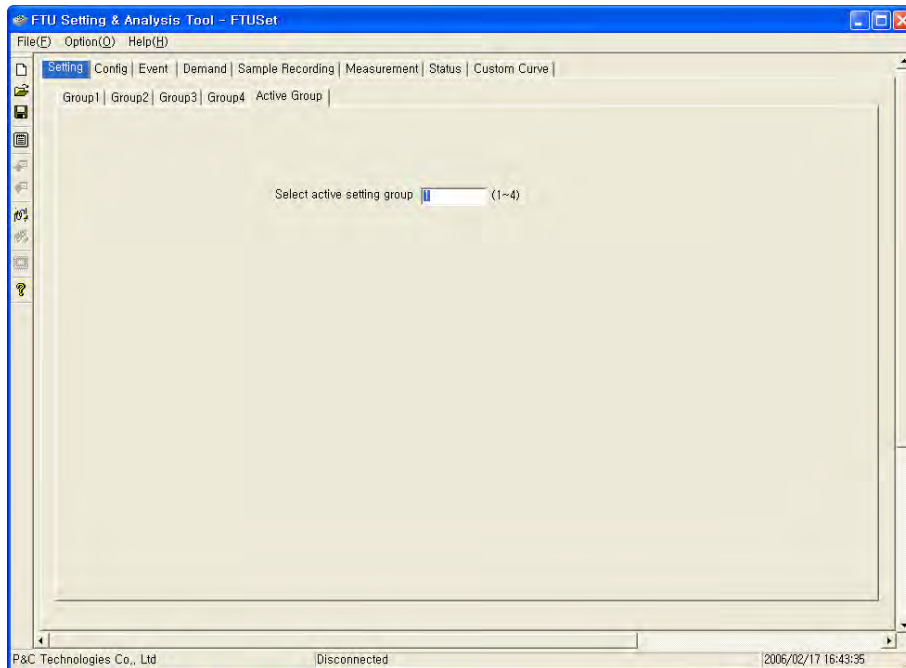


[Fig. 4-13] Setting Window



[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.



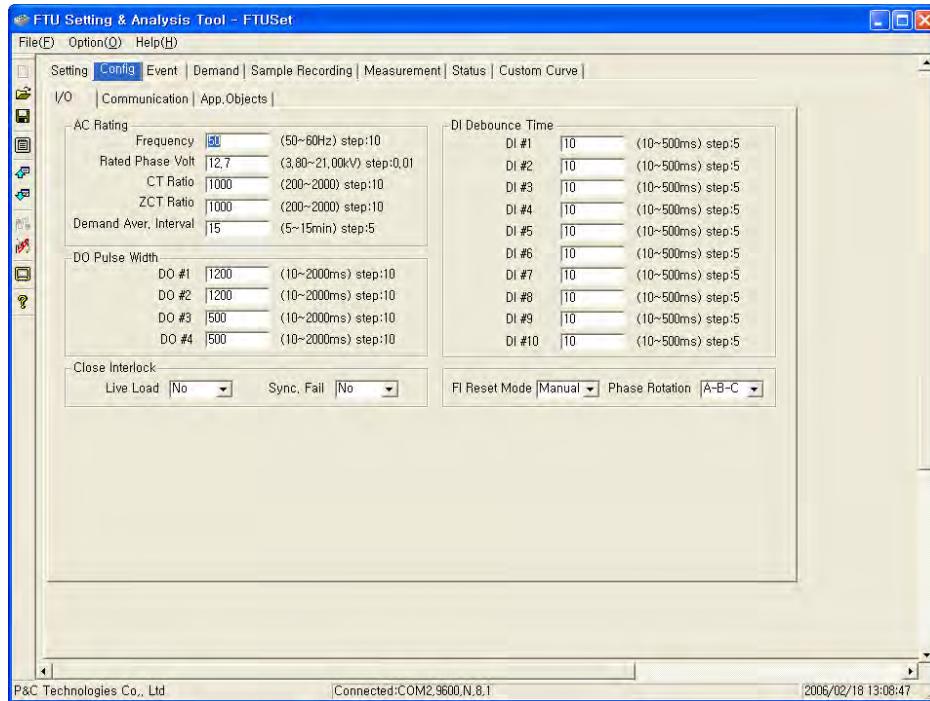
[Fig. 4-15] Active Setting Group Window

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

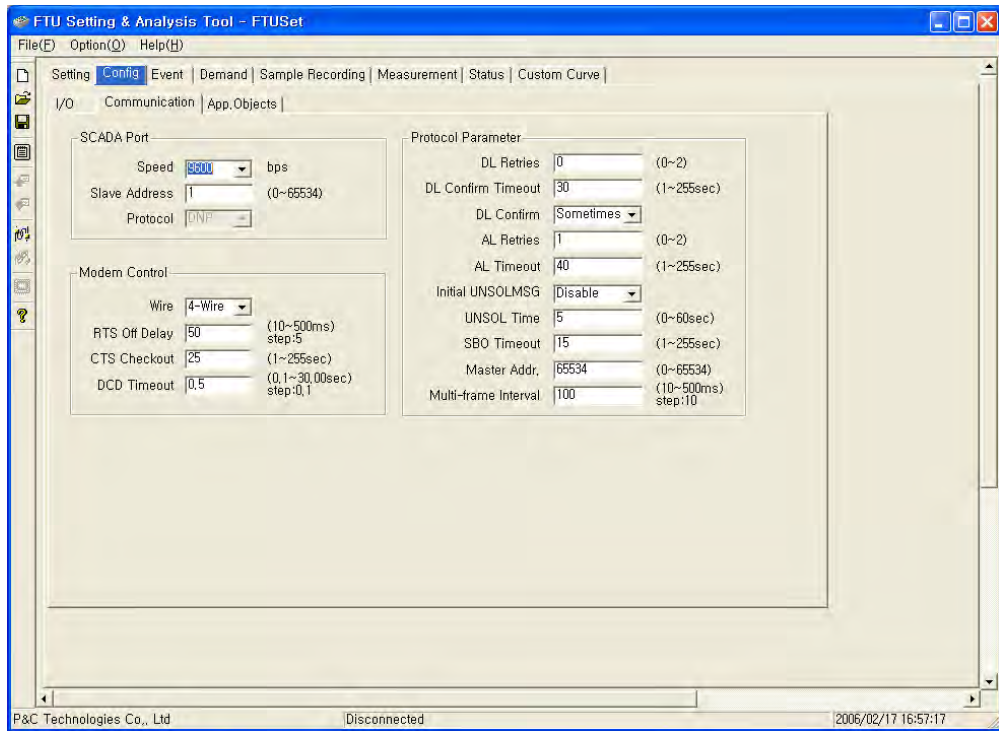
In Config Window, there are I/O Config Window, Communication Config Window, and App. Object Config Window. Current configuration values of FTU-R100 can be viewed through "Upload" button, or configuration values are edited and downloaded to FTU-R100 by clicking "Download" button to apply new configuration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

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



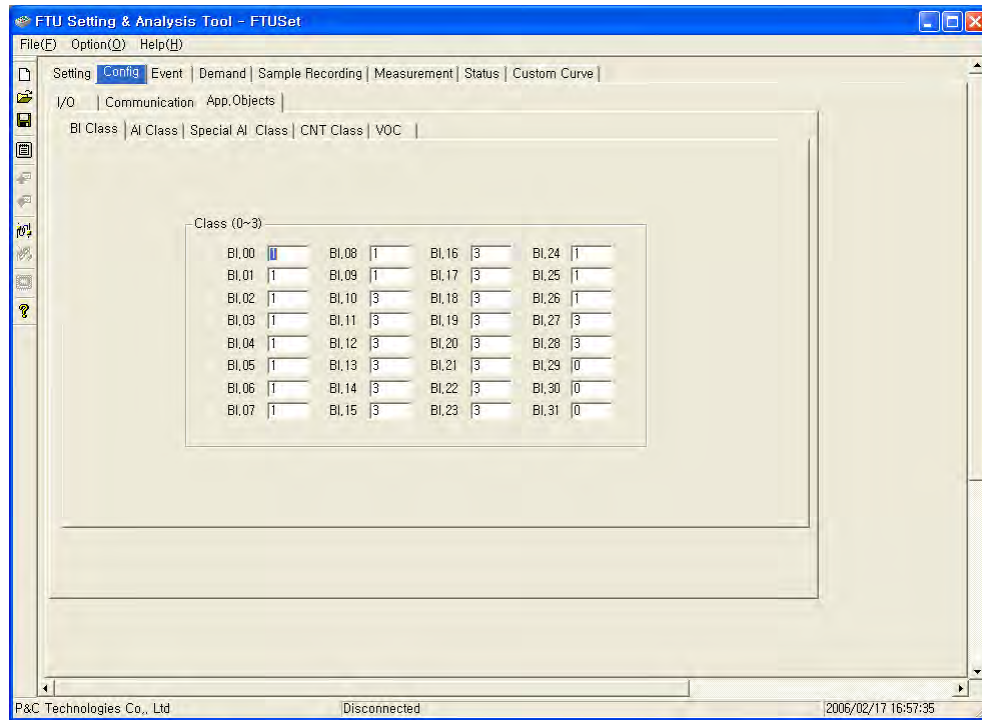
[Fig. 4-16 I/O Config. Window

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

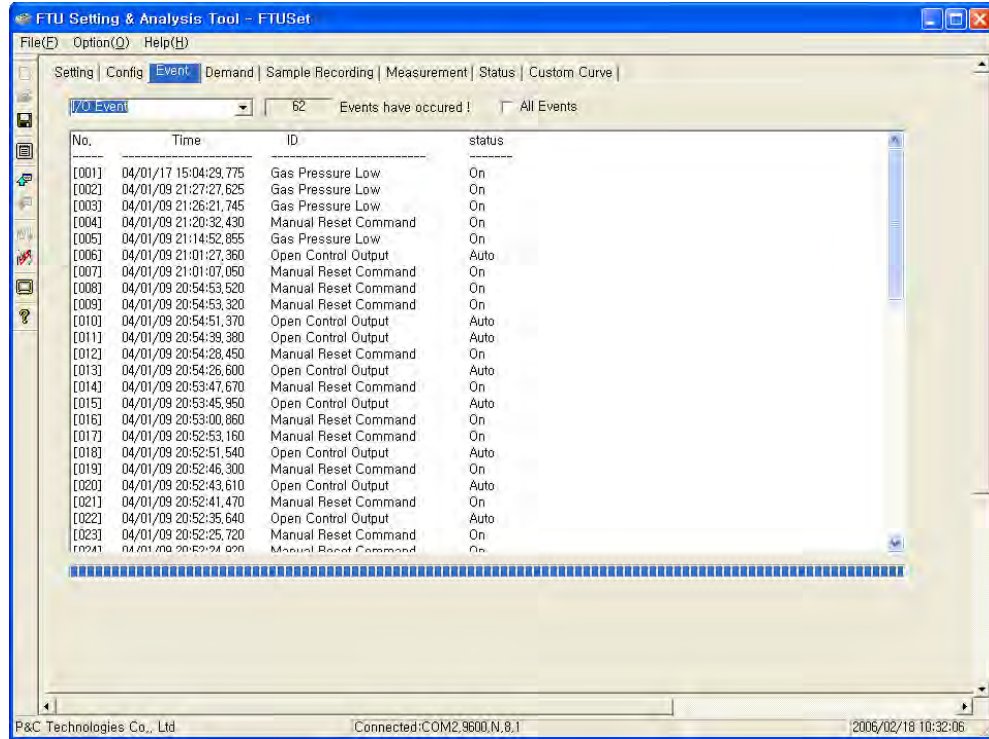
In App Object Config Window, all kinds of Application Object Classes for binary input, analog input, counter input and VOC (Value of Change) in DNP v3.0 communication protocol are configured.



[Fig. 4-18] Communication Config. Window

(4) Event Window

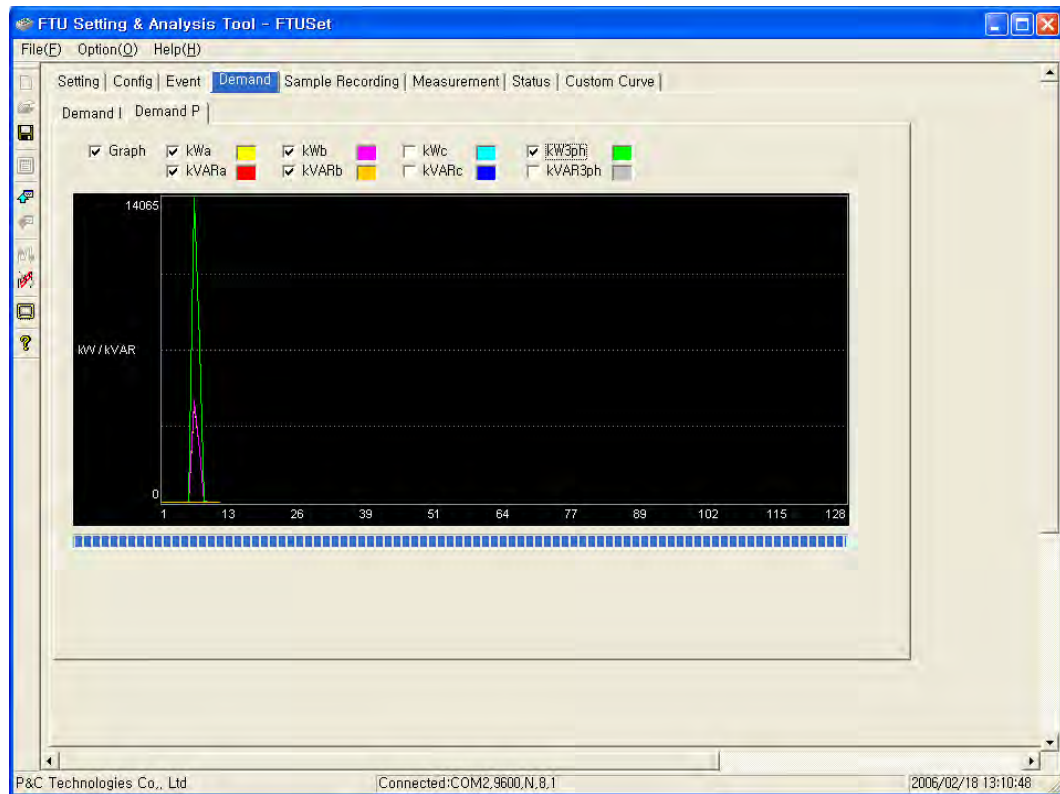
In Event Window, operators can list up all the event records, which are stored in the memory of FTU-R100 by clicking "Upload" button. All types of events can be uploaded or each type of event can be separately uploaded from FTU-R100. The kinds of event types are I/O Event (1023), Function Event (1023), 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

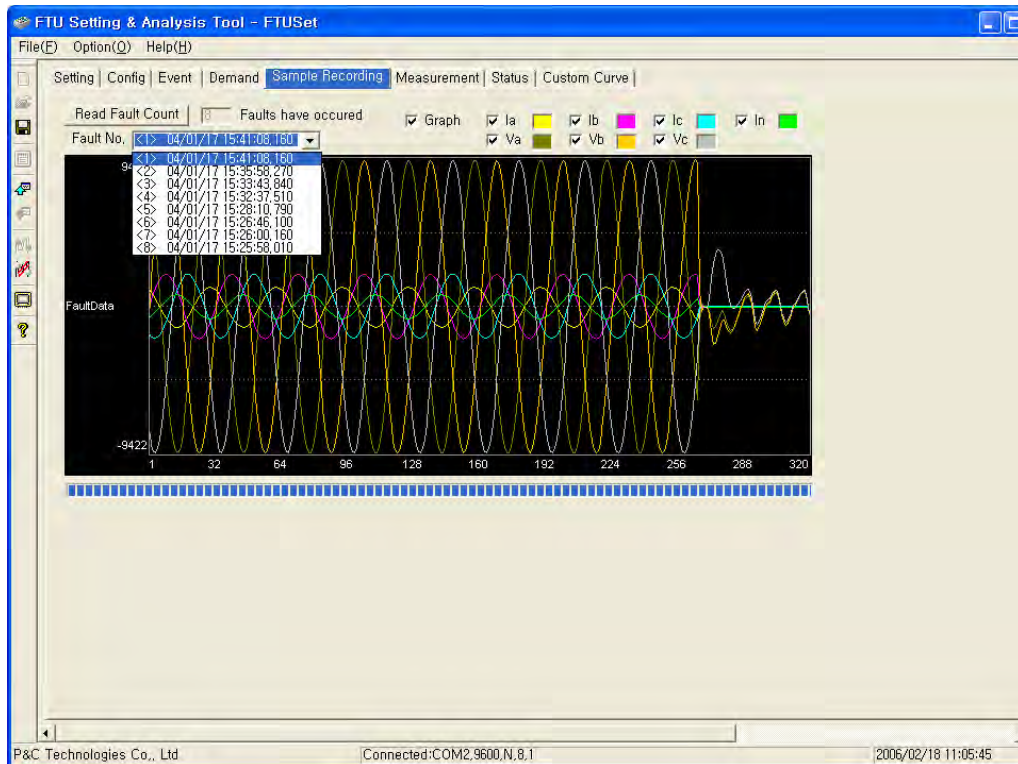
Demand Window displays Daily Average Demand Current and Power in the list form and waveform. When the Graph check box is unchecked, Demand Current and Power are listed as in the Event Window. Averaging Interval is between 5 and 15 minutes, and maximally 128 data are stored for each measurement. Demand 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

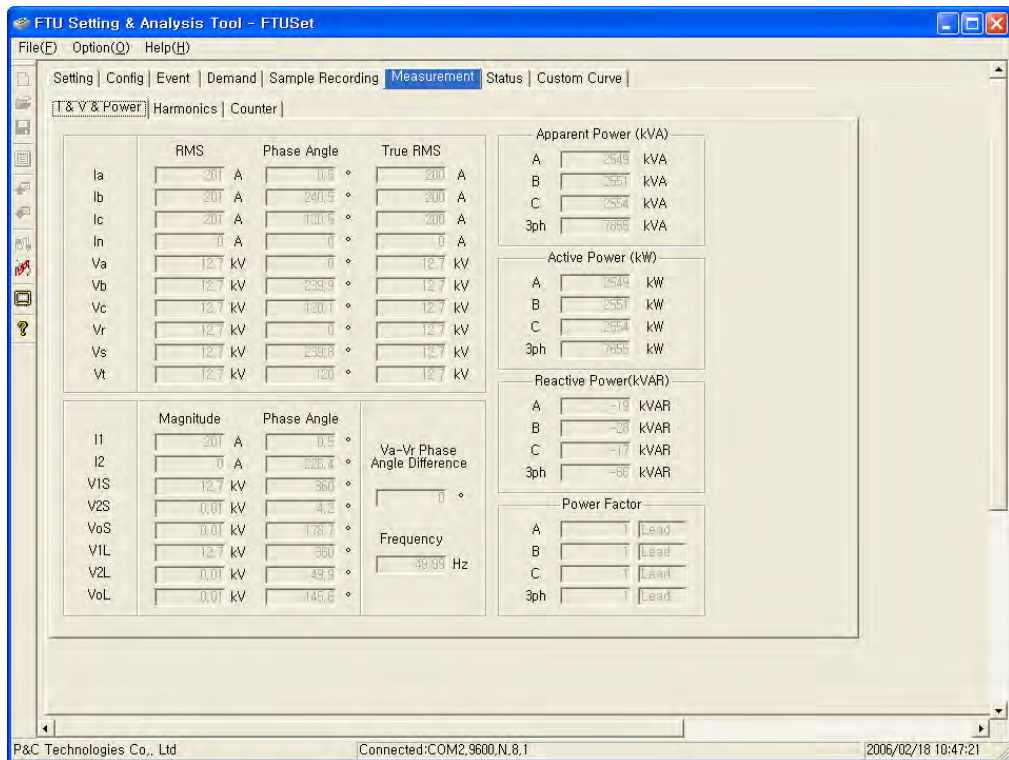
Sample Recording Window displays Fault Waveforms stored in FTU-R100. At first, click "Read Fault Count" to upload the recorded fault data to FTU_REC_SET tool, and select one of 8 recorded faults to view. As in Demand Window, fault data are listed or fault waveforms are drawn. Fault waveform drawings 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

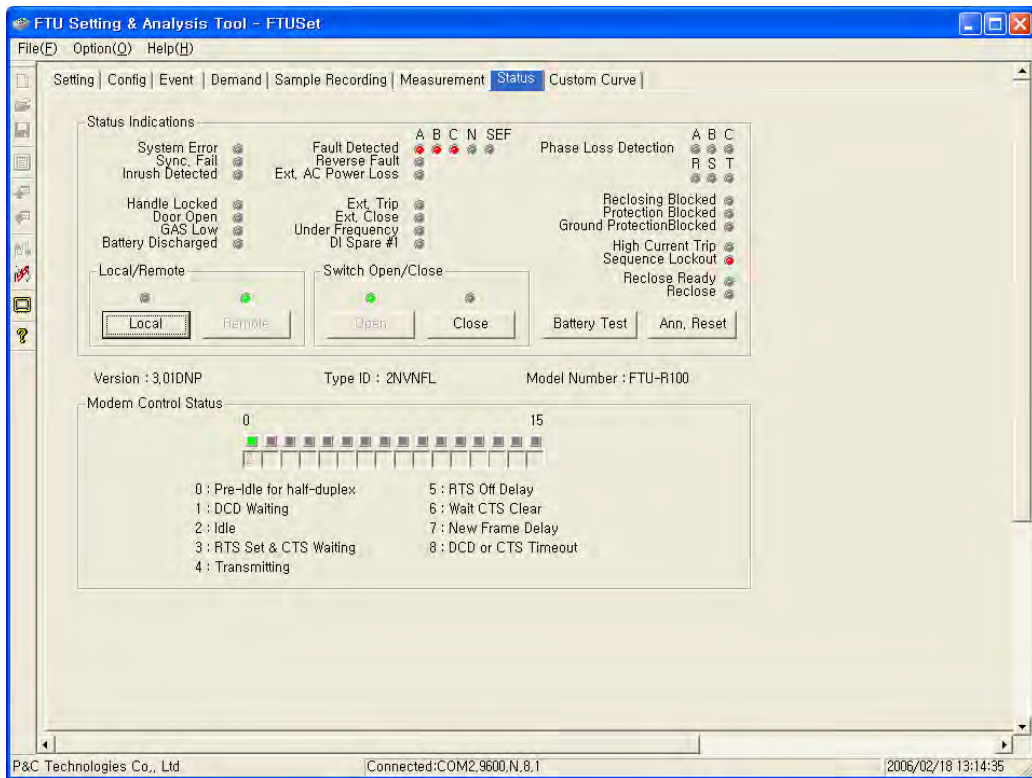
Operators can monitor all kinds of measurement values such as current, voltage, power, and energy, etc. on-line in I & V & Power Measurement Window. And, FTU-R100 has the function of Harmonic Analysis, therefore up to 8th harmonics RMS values and THD (Total Harmonic Distortion) for Ia, Ib, Ic, Va, Vb, Vc 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

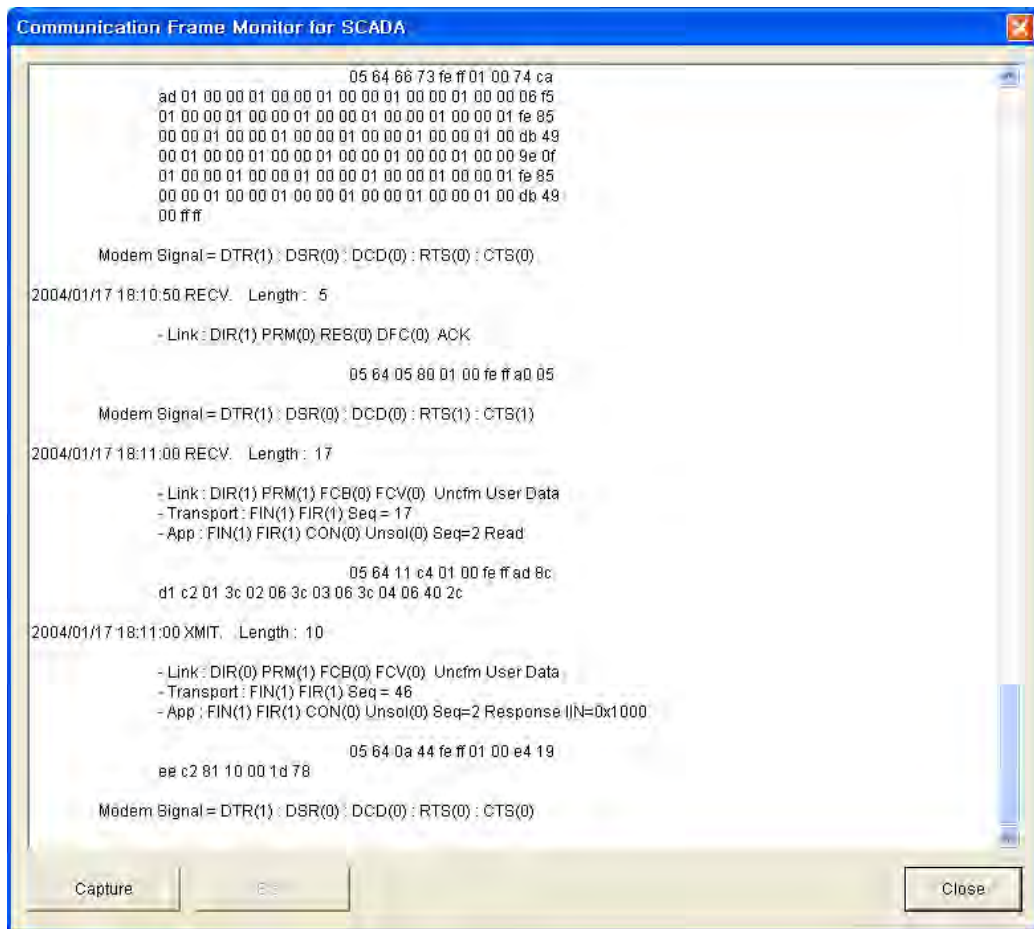
In Status Window, all the status indications and FTU-R100's firmware version and model ID, and modem control status data are displayed.



[Fig. 4-23] Status Window

(9) Protocol Monitor Window

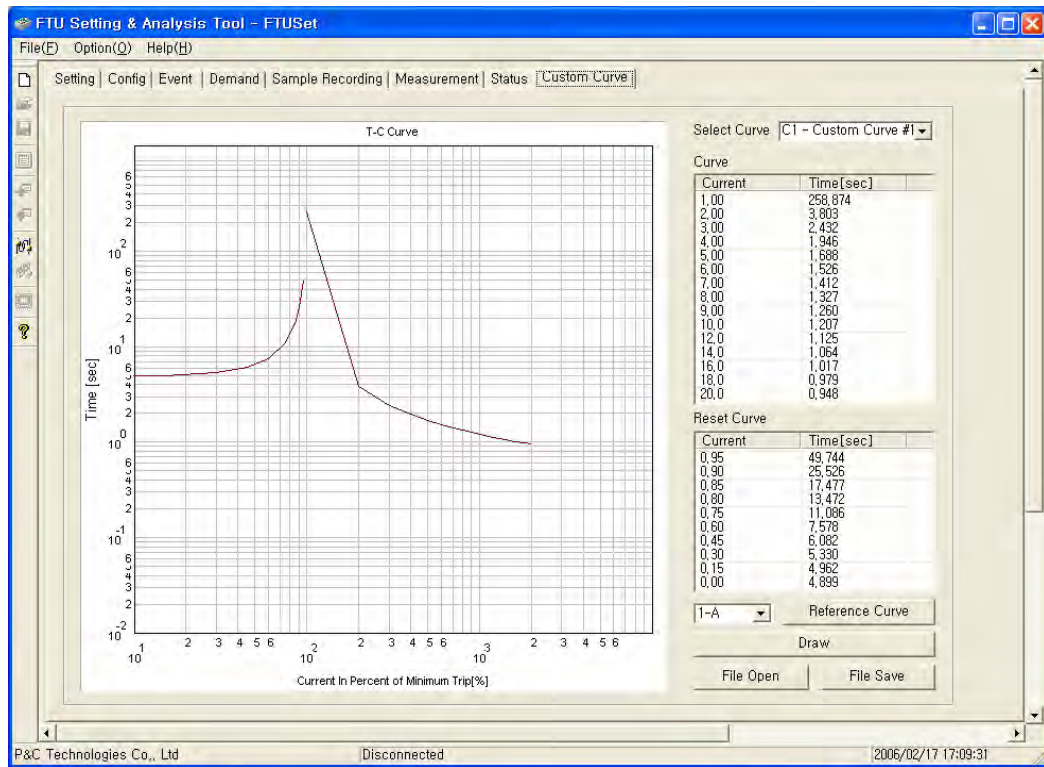
With FTU-R100 connected to the control center system (Master), through this Window, operators can check communication protocol and data frames. This Window's can be saved in a log file using "Capture" button



[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

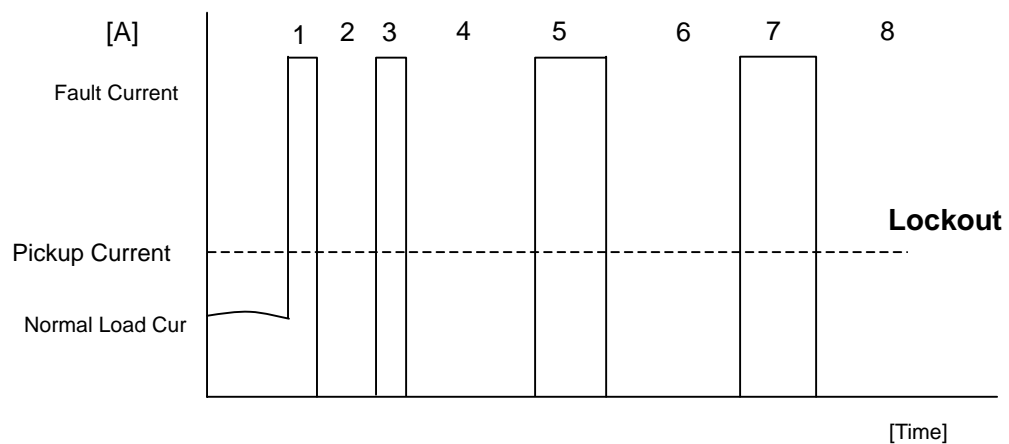
5. PROTECTION FUNCTIONS

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.

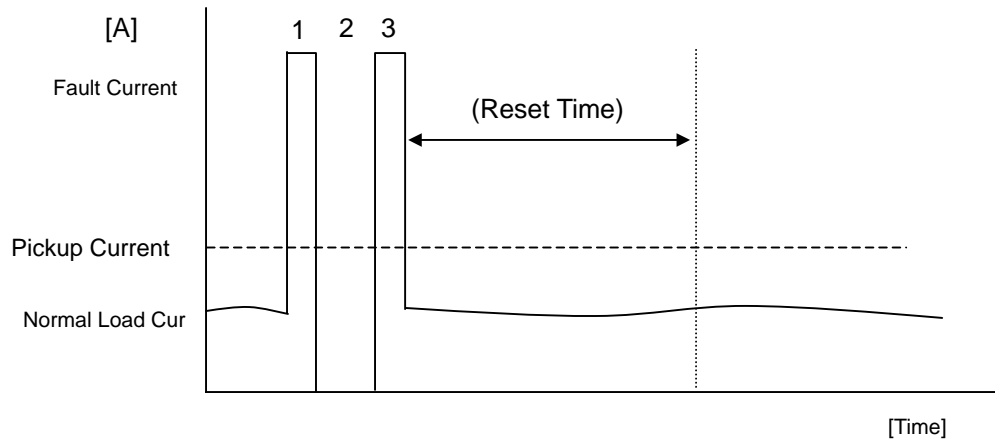
For example in the below figure, the reclosing sequence is organized in 2F2D, which means the Recloser protection function operates as Instantaneous (Fast) element during first 2 reclosing shots and operates as Time-delayed element during last 2 reclosing shots. This composition also can be configured.

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.



- 1,3** : Instantaneous Operation
- 5,7** : Time-delayed Operation
- 2, 4, 6** : Reclosing Interval
- 8** : Lockout

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



1,3 : Instantaneous Operation

2 : 1st Shot Reclosing Interval

[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

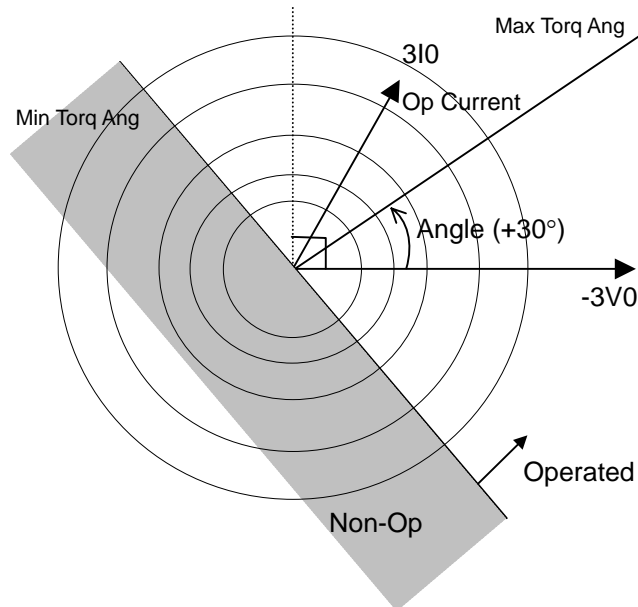
Inrush Current is an over-current higher than pickup level, which is mainly caused by transformer's excitation current at closing action. To distinguish inrush current from load current, 2nd harmonics percentage is adopted as a criterion.

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 $+90^\circ$ on the basis of Maximum Torque Angle.



[Fig. 5-3] Phasor Diagram of SEF

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

$$T = TDM \cdot \{\alpha / (M^\beta - 1) + \gamma\}$$

$$T_{\text{RESET}} = TDM \cdot \{\tau / (M^\beta - 1)\}$$

T = Operate Time

TDM = Multiplier Setting

T_{RESET} = Reset Time

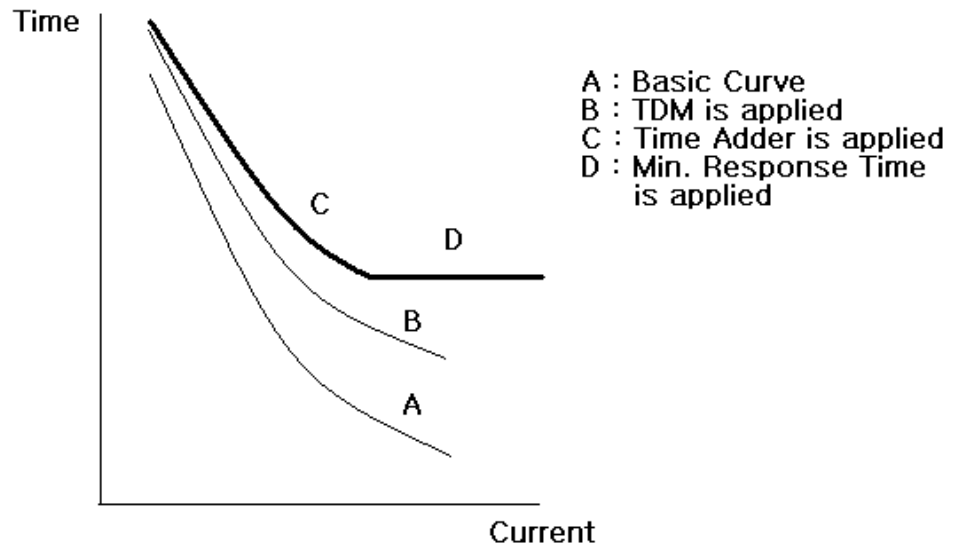
Curve Type	Standard	α	β	γ	τ
Standard Inverse (NI)	IEC	0.14	0.02	-	-
Very Inverse (VI)		13.5	1	-	-
Extremely Inverse (EI)		80.0	2	-	-
Short -Time Inverse (SI)		0.05	0.04	-	-
Long -Time Inverse (LI)		120	1	-	-
Very Inverse (IV)	IEEE	19.61	2	0.491	21.6
Extremely Inverse (IE)		28.2	2	0.1215	29.1
Moderately 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

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)

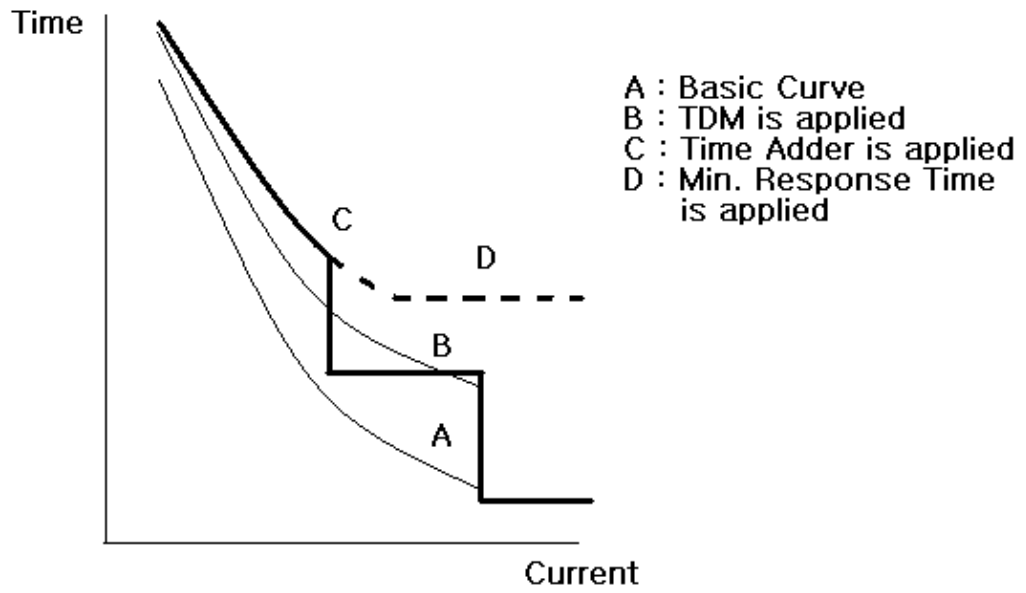
In the next figure, for example, the curve A is the basic curve. Assume the operating time of the basic curve (A) at 16 times pickup current is 0.04 sec. When applying Multiplier, Curve A changes its shape, that is, the curve becomes less steep in time axis and operation time becomes longer by a multiplier 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

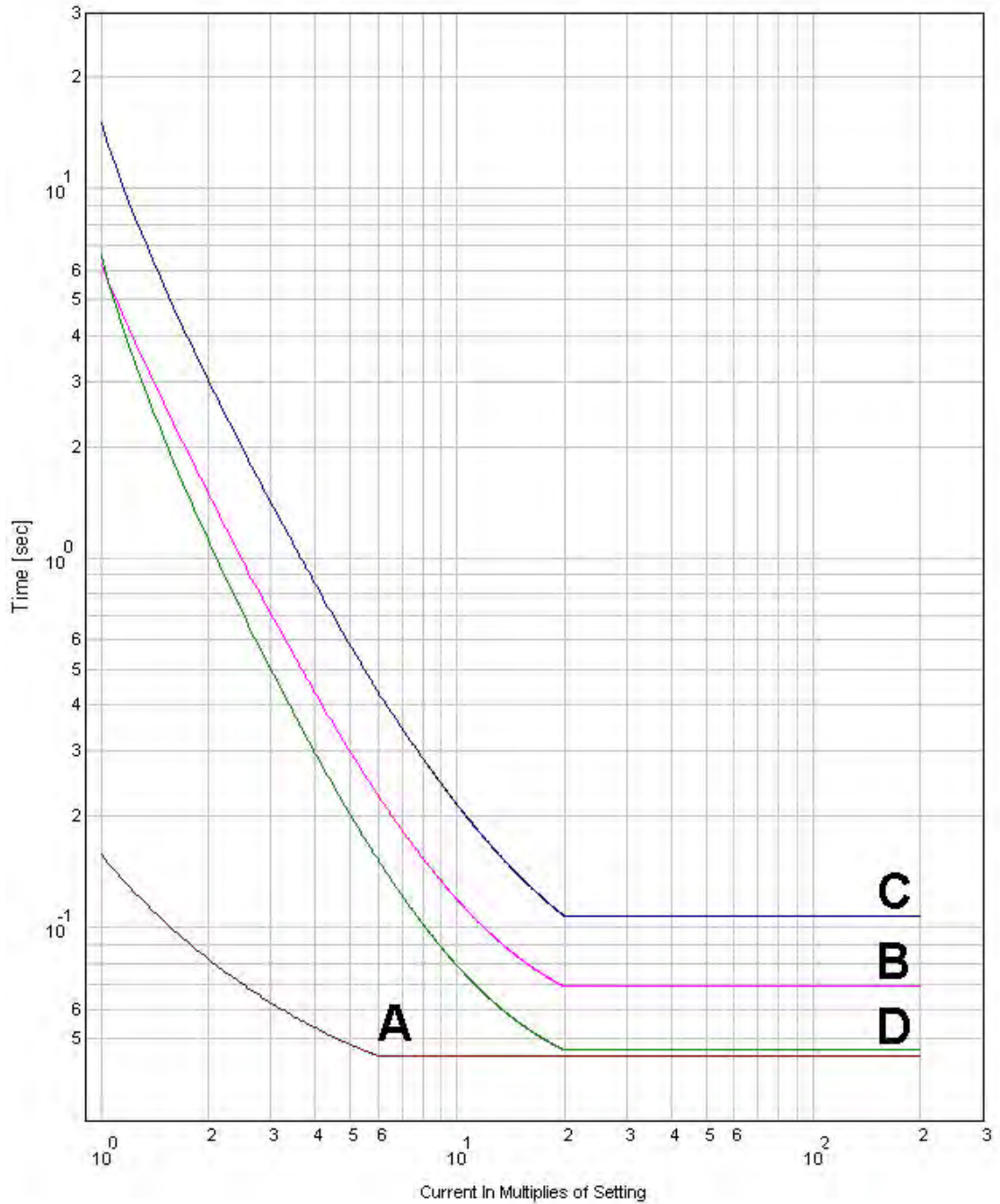
There are two additional definite-time over-current elements in the controller. The next figure shows 3-stage over-current protection characteristics. The third stage is prepared for instantaneous protection. Therefore the harmonic restraint is not applied to third stage

element, but the second stage definite time over-current element.

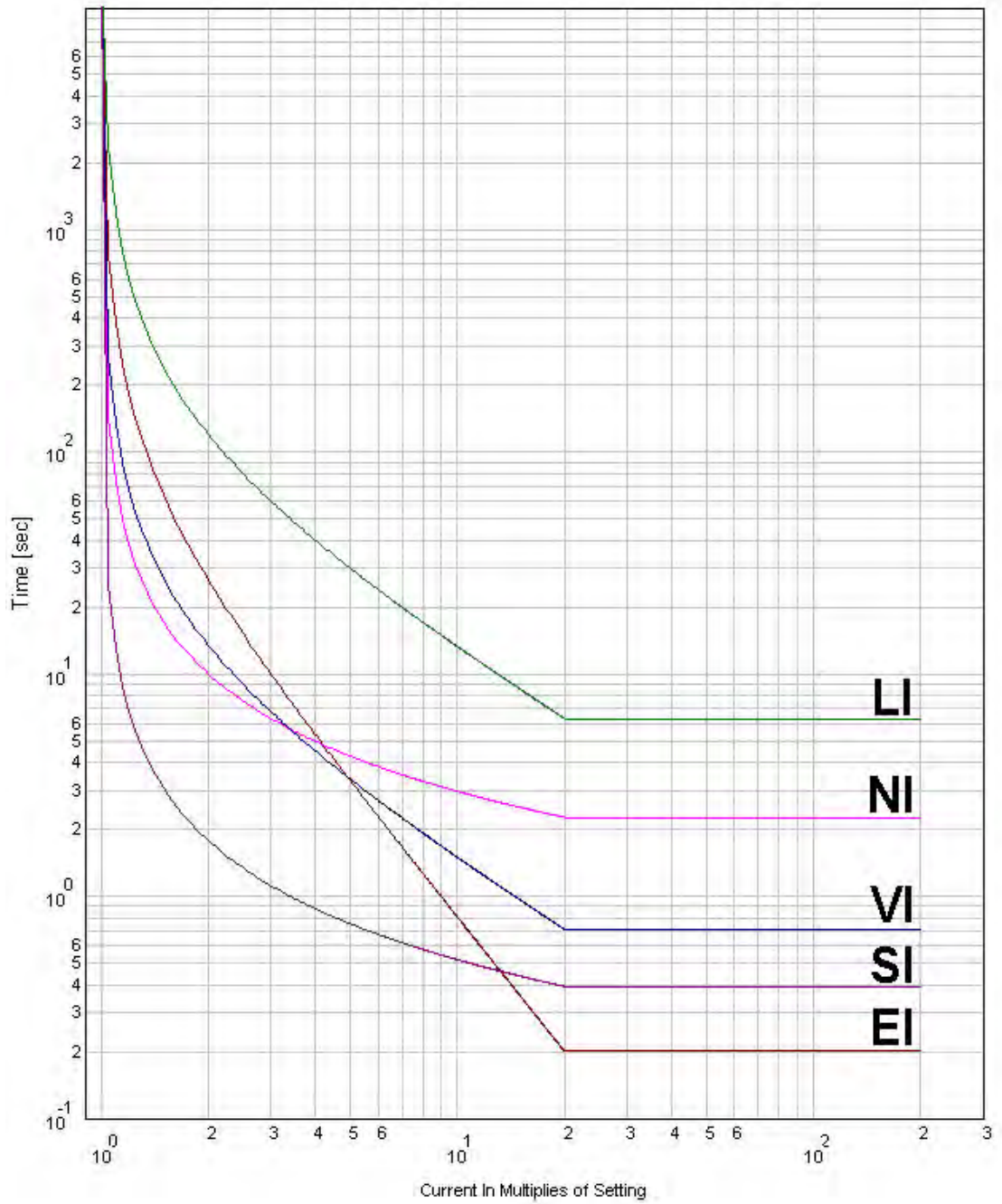


[Fig. 6-2] TC Curve Editing Example 2

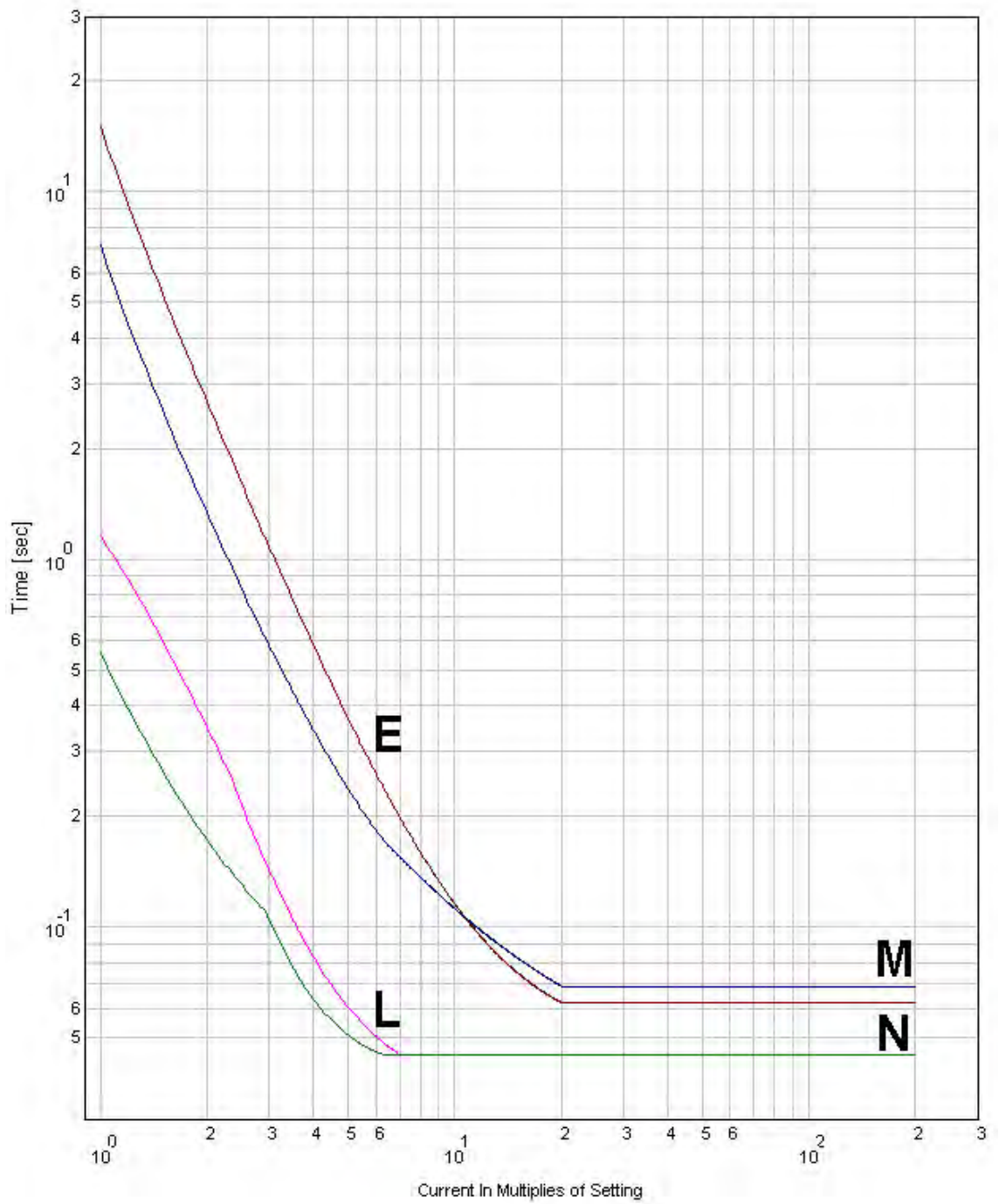
Appendix 1. TC (Time-Current) Characteristic Curves



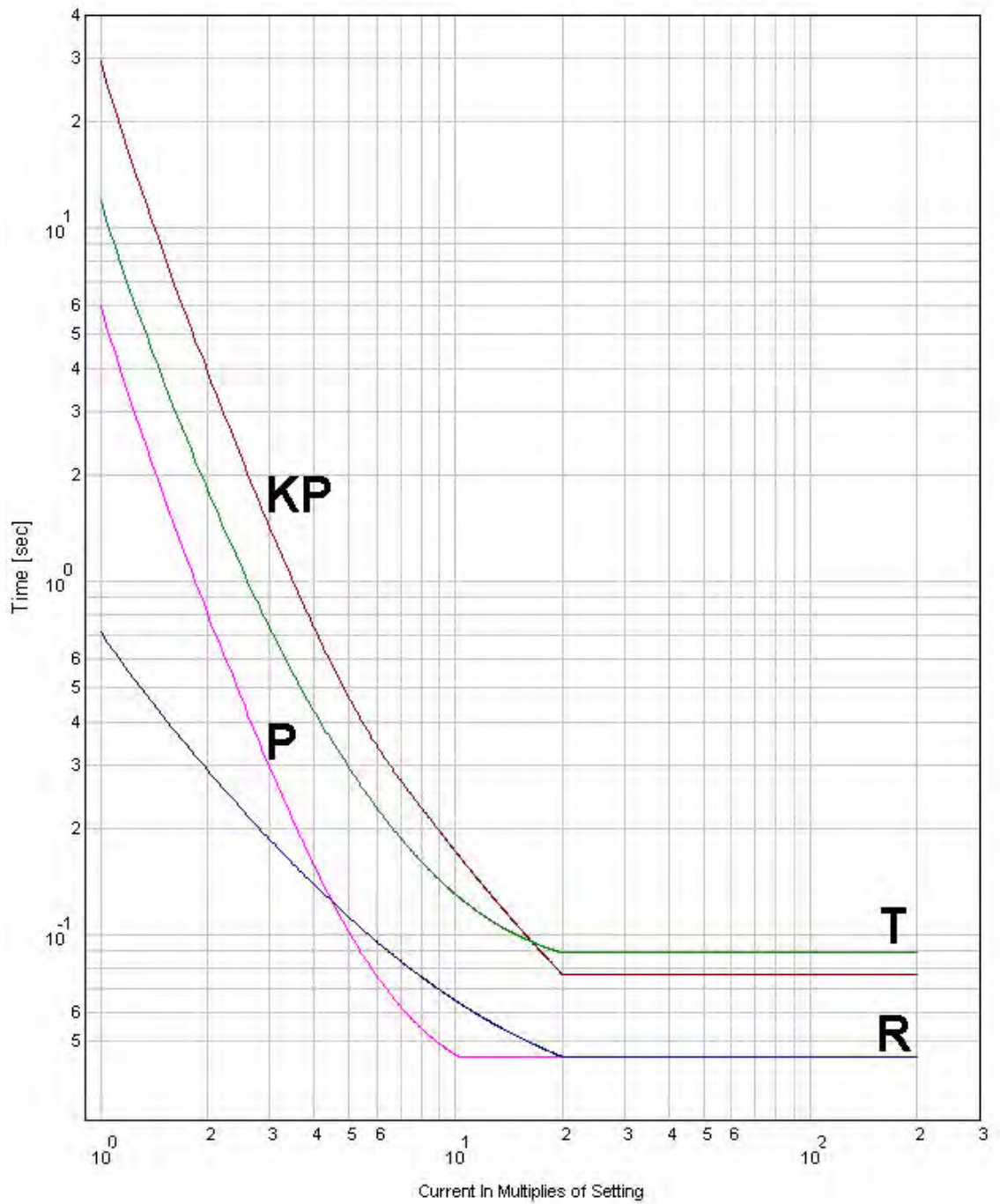
[Fig. A-1-1] A, B, C, D curves



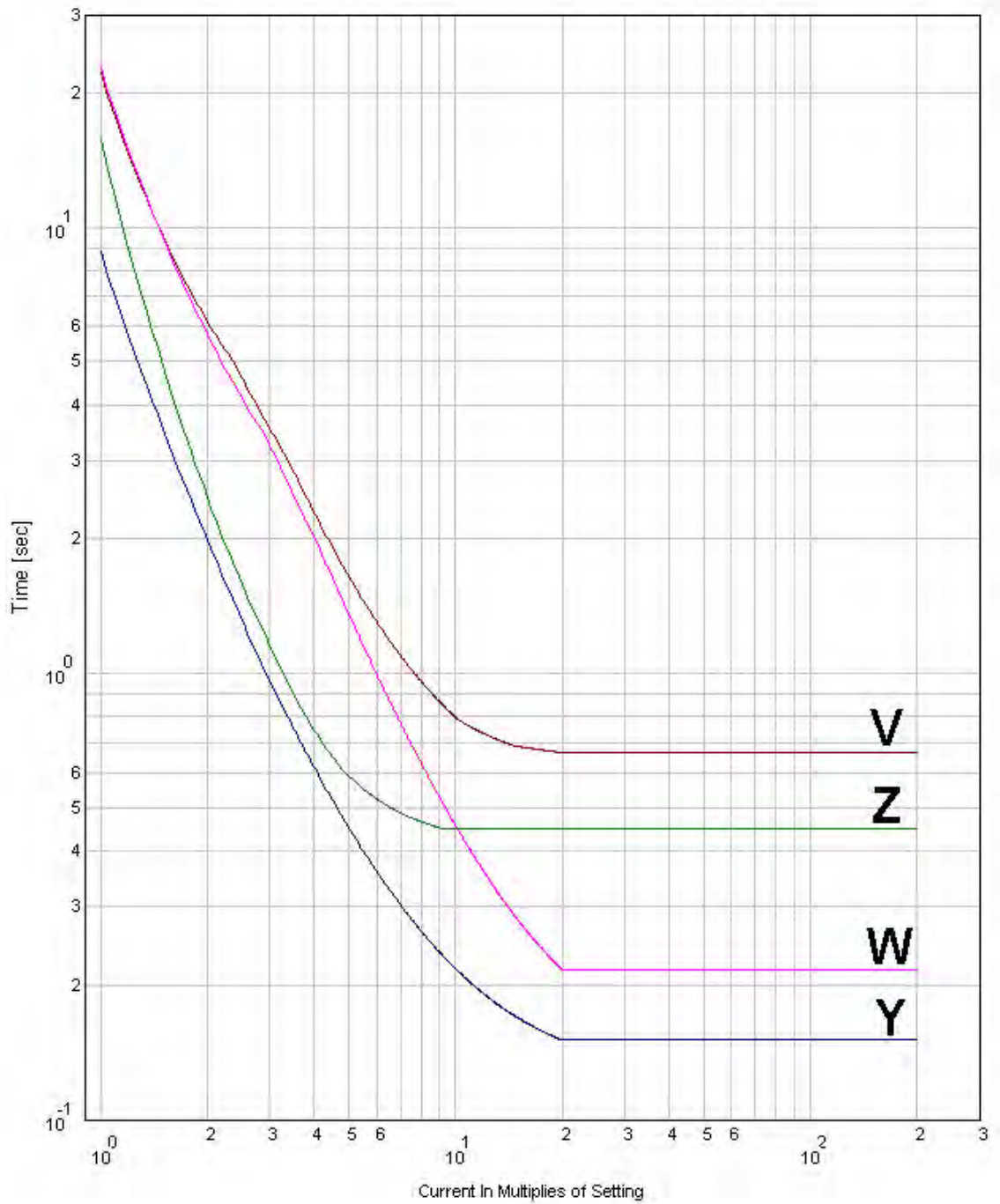
[Fig. A-1-2] IEC Standard Curves (EI, NI, VI, LI) curves



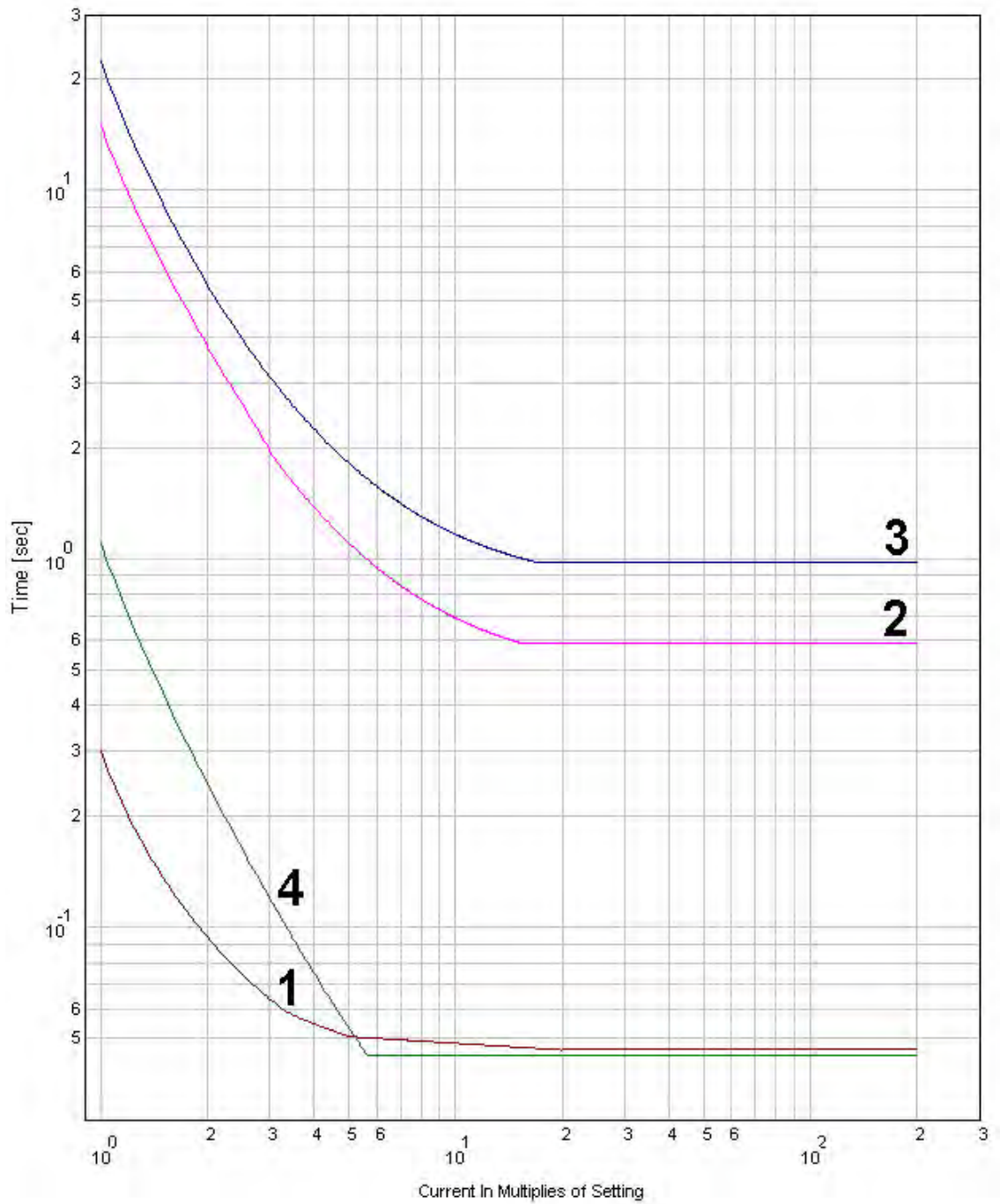
[Fig. A-1-3] E, L, M, N curves



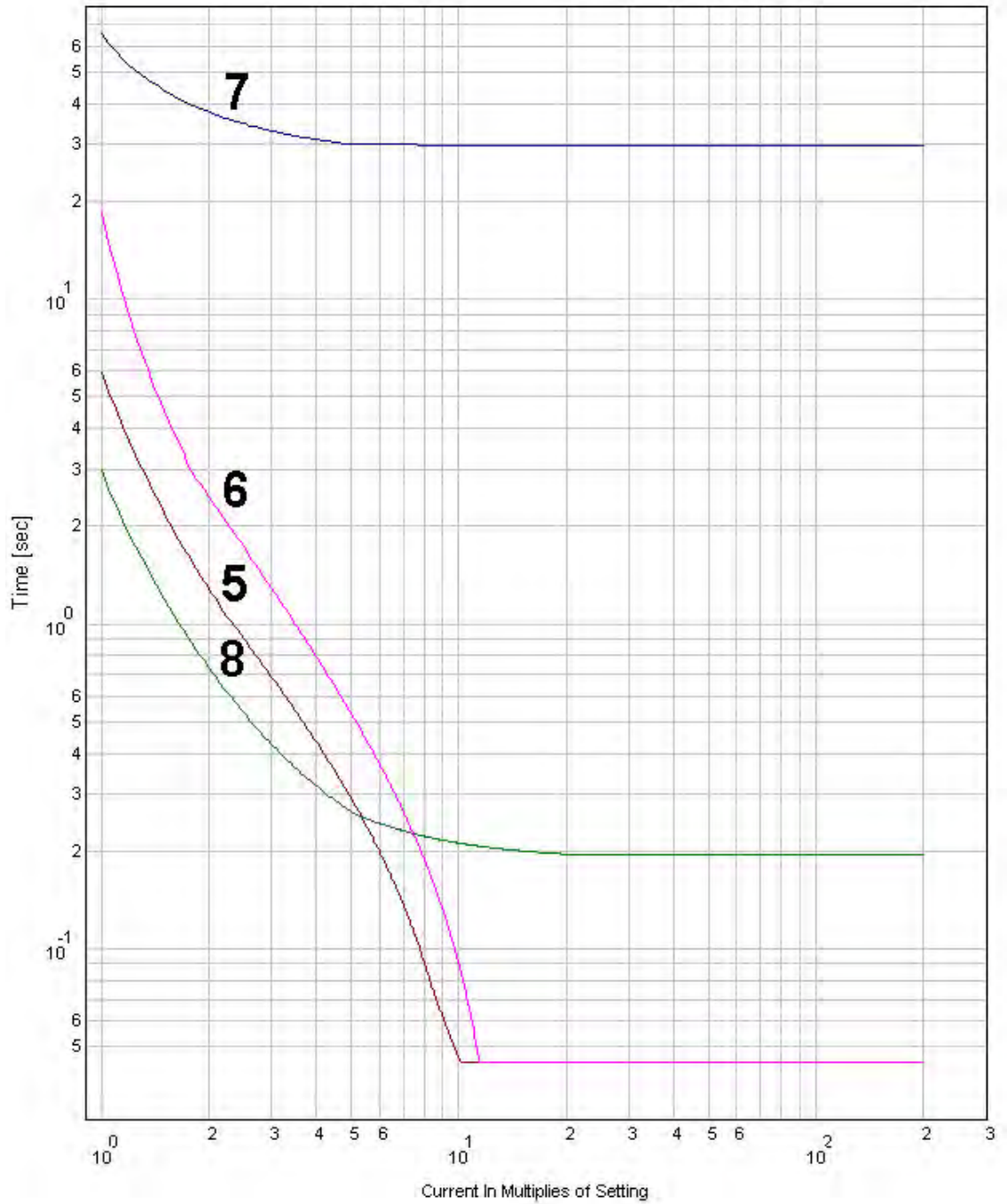
[Fig. A-1-4] K(P), P, R, T curves



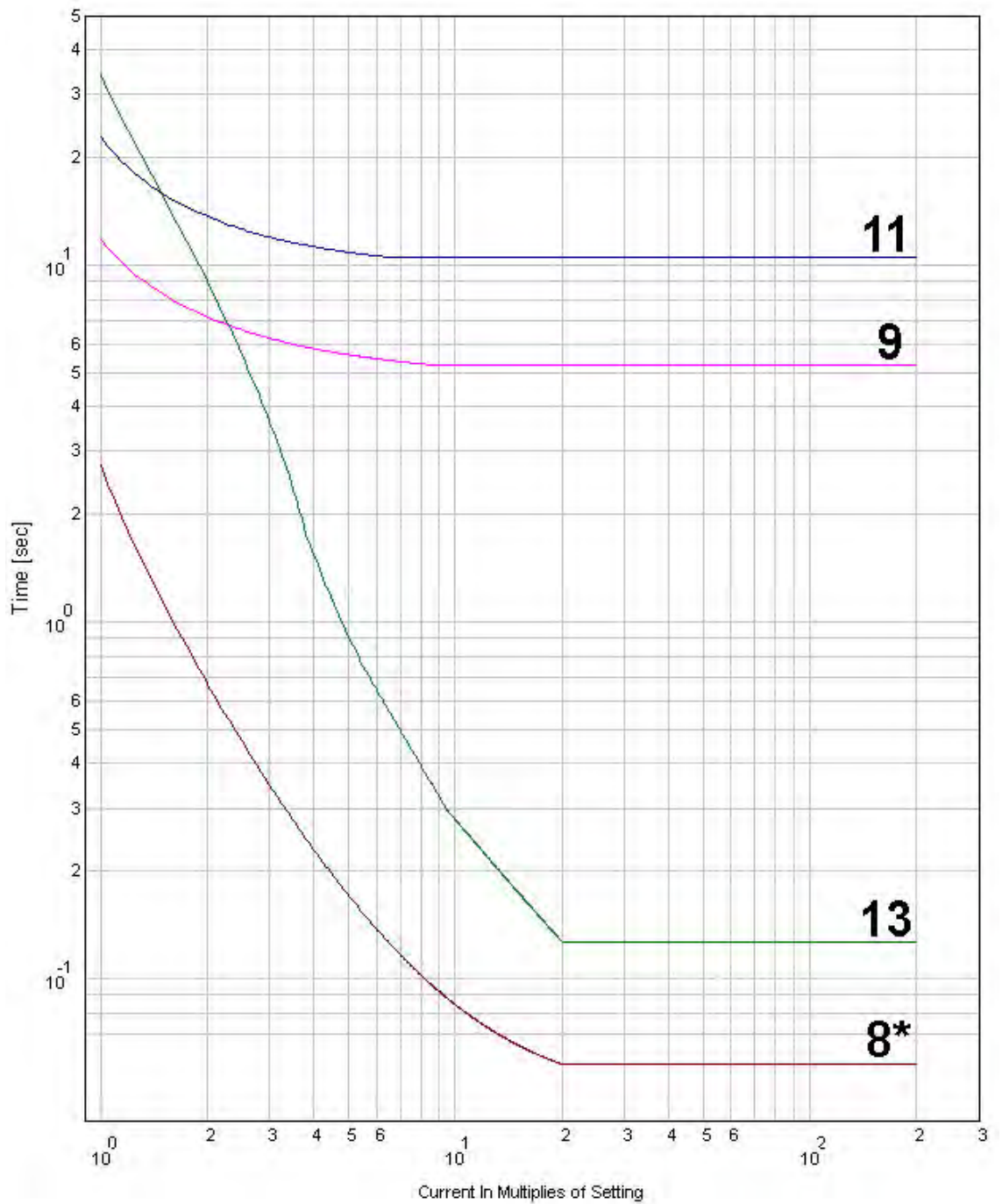
[Fig. A-1-5] V, W, Y, Z curves



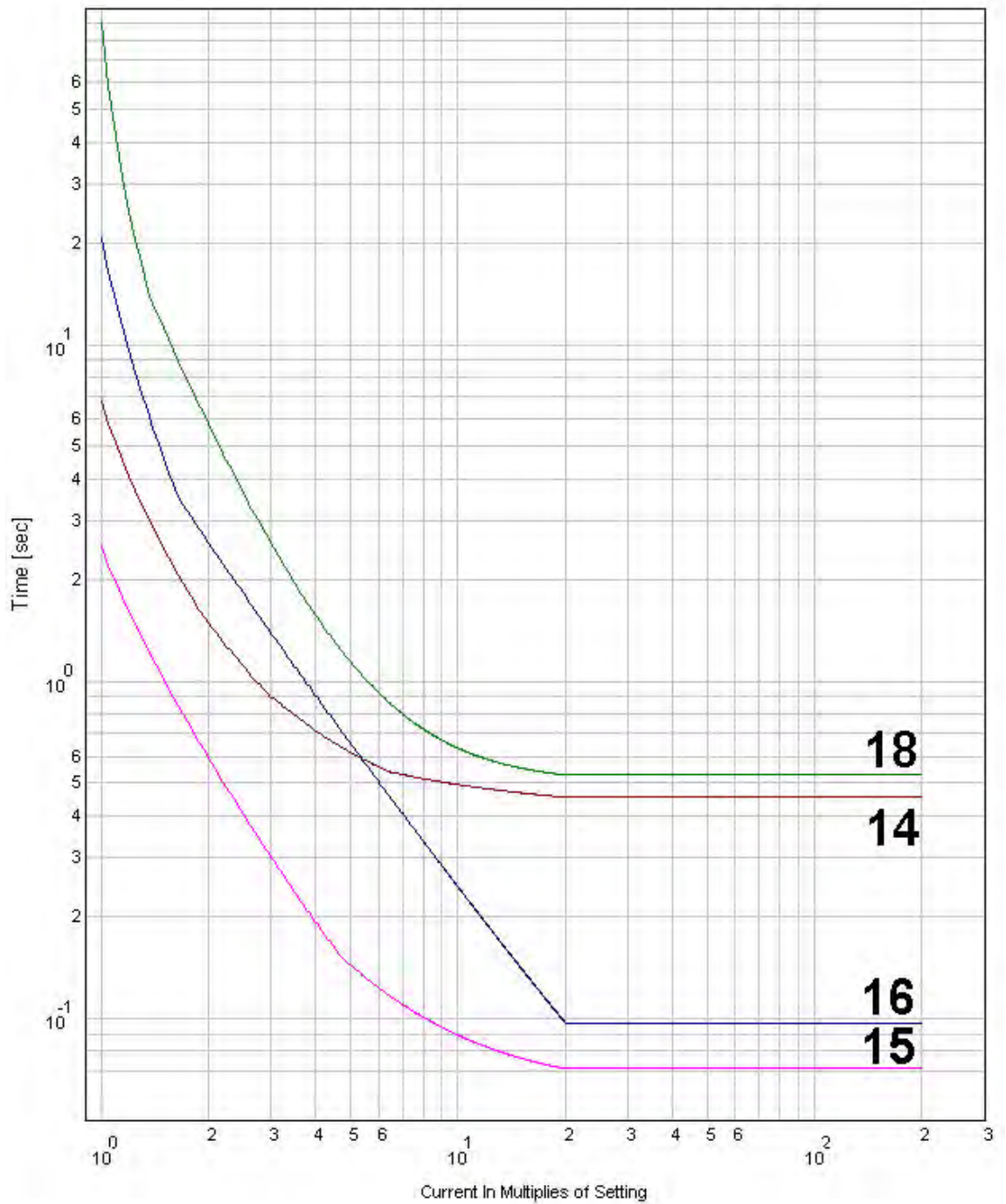
[Fig. A-1-6] 1, 2, 3, 4 curves



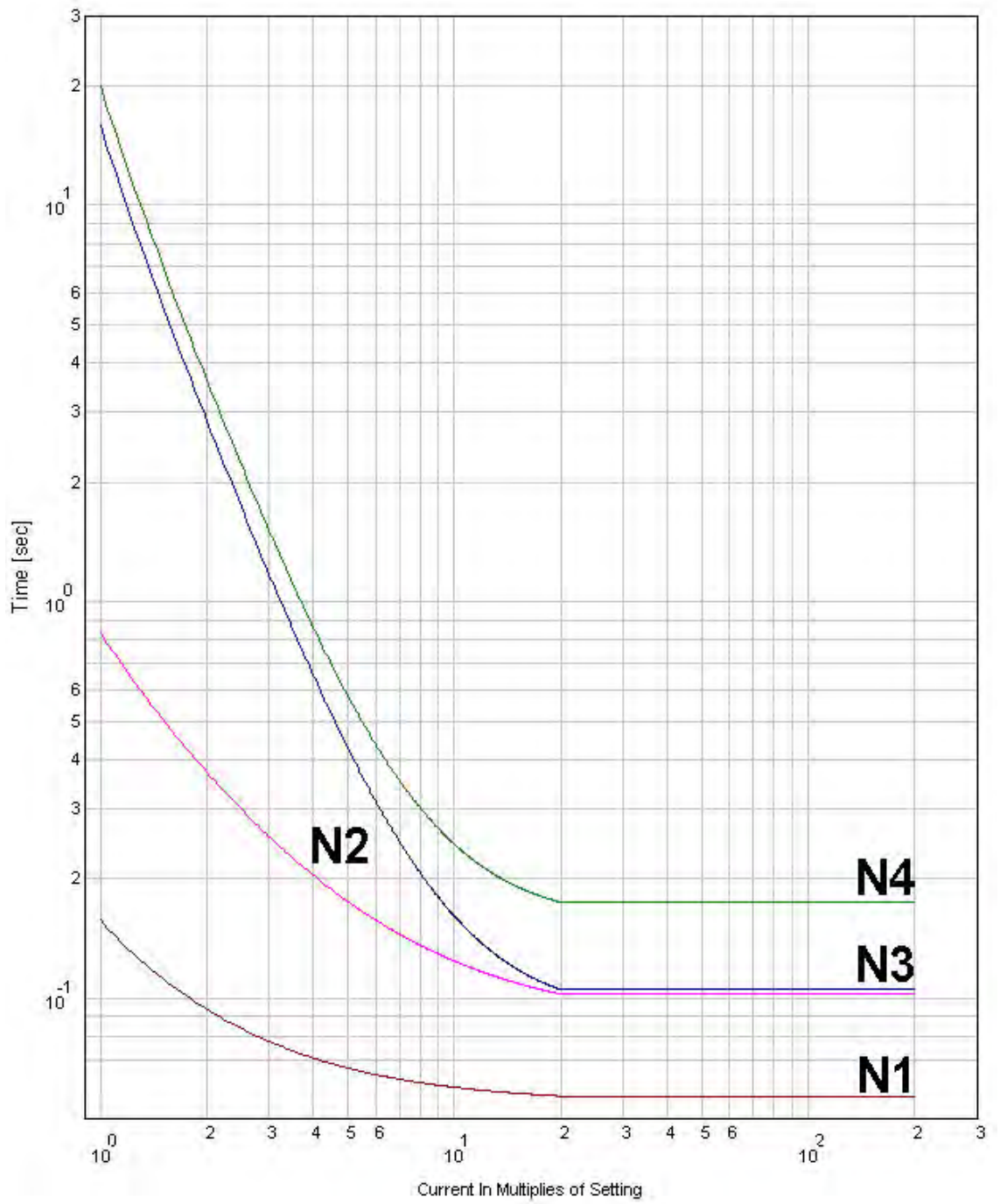
[Fig. A-1-7] 5, 6, 7, 8 curves



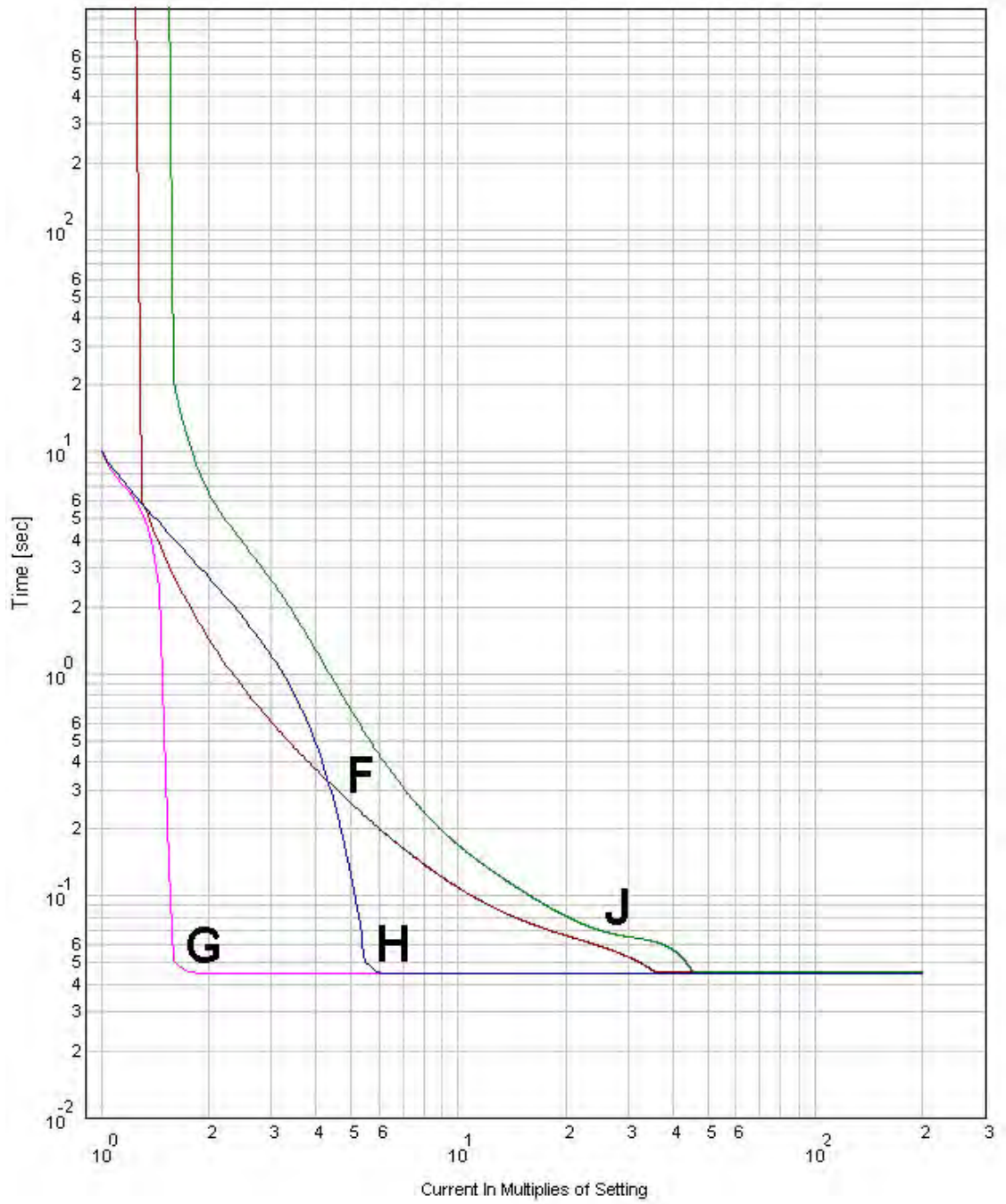
[Fig. A-1-8] 8*, 9, 11, 13 curves



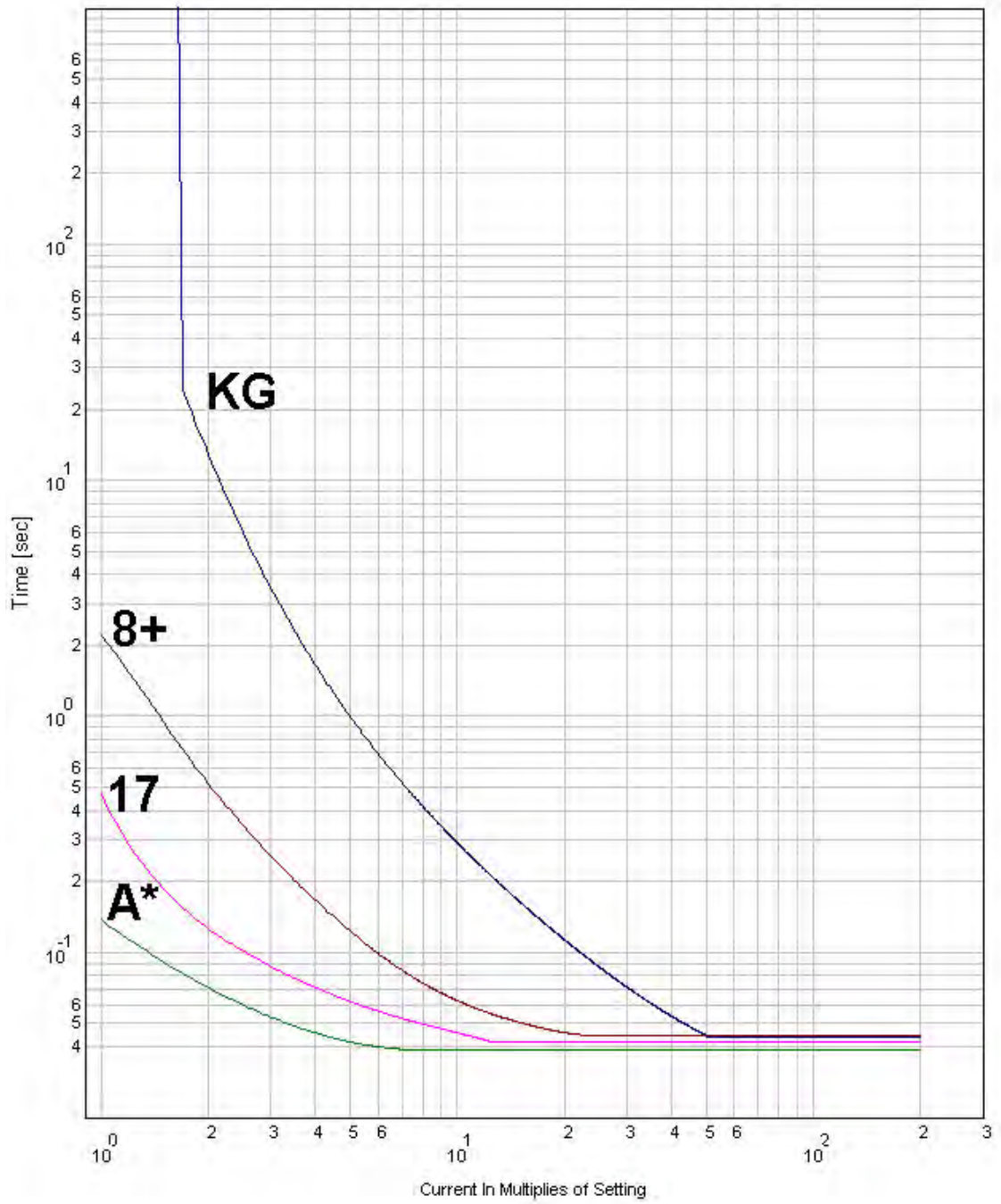
[Fig. A-1-9] 14, 15, 16, 18 curves



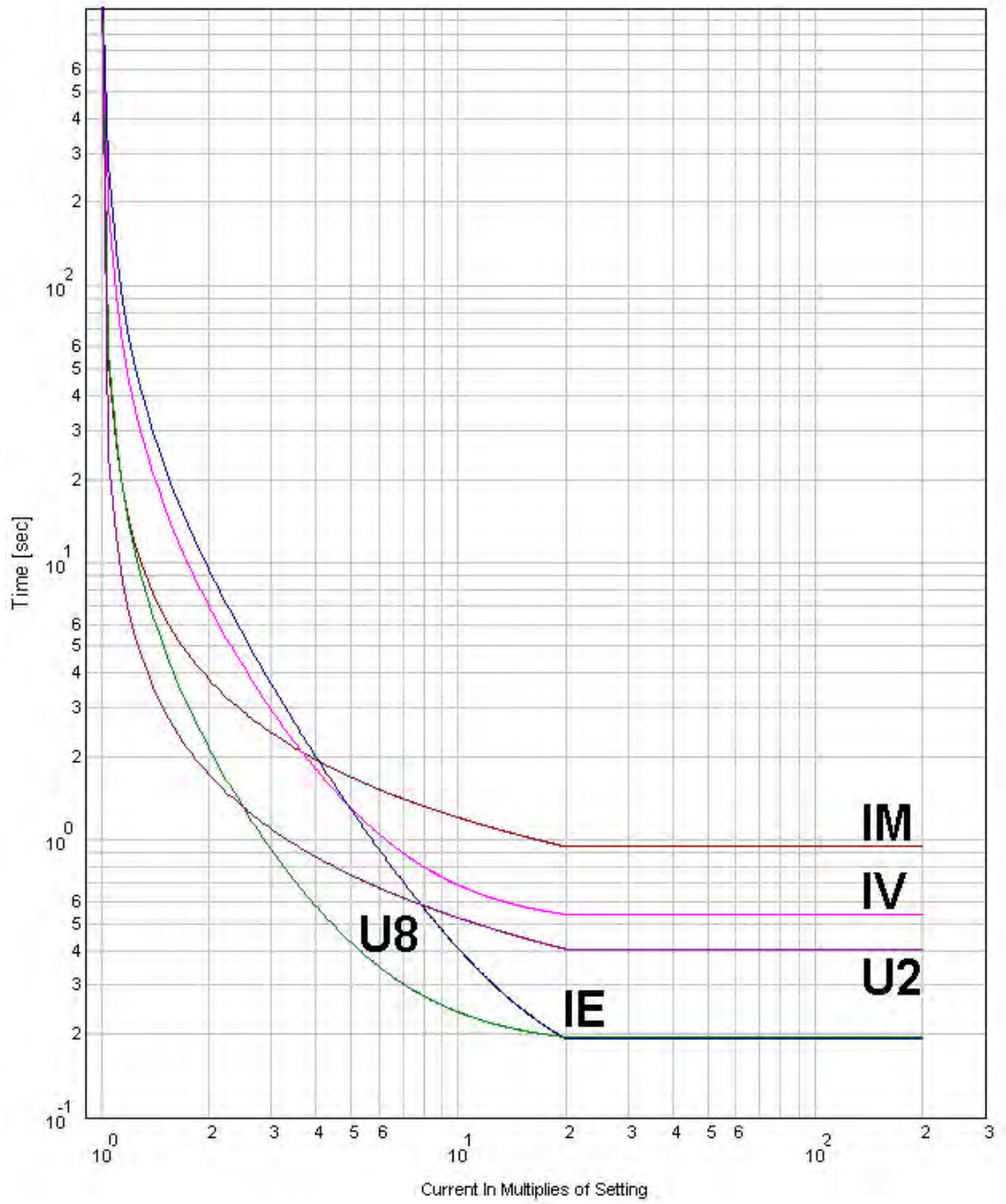
[Fig. A-1-10] N1, N2, N3, N4 curves



[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

1. FTU-R100 for Automatic Circuit Recloser

REVISIONS

REV	Date	Description/Reason	Initiated By
1.0	14-July-02	Draft	NS Yoon
1.1	27-July-02	AI Index Re-ordering New Setting Item was added	NS Yoon
1.2	02-Sep-02	AO Index Re-ordering	NS Yoon
1.3	03-Mar-13	BO Index was modified	NS Yoon

Object Index Table

Index No.	Description	Default Class	Object/Variation	Remark
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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				
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				
20				
21				
22				
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 detect	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				
9				
10				
11				
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				
29	Reserved (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				
41				
42				
43				
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				
53				
54				
55				
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	-	30/02,30/04	%
93	Ia THD	-	30/02,30/04	%
94	Ib THD	-	30/02,30/04	%
95	Ic THD	-	30/02,30/04	%
96	Source side 3-phase voltages THD	-	30/02,30/04	%
97	Source side Va THD	-	30/02,30/04	%
98	Source side Vb THD	-	30/02,30/04	%
99	Source side Vc THD	-	30/02,30/04	%
100				
101				
102				
103				
104	Ia true RMS	-	30/02,30/04	A
105	Ib true RMS	-	30/02,30/04	A
106	Ic true RMS	-	30/02,30/04	A
107	Va true RMS	-	30/02,30/04	kV100

108	Vb true RMS	-	30/02,30/04	kV100
109	Vc true RMS	-	30/02,30/04	kV100
110				
111				
112				
113	Ia 2 nd harmonic RMS	-	30/02,30/04	A
114	Ib 2 nd harmonic RMS	-	30/02,30/04	A
115	Ic 2 nd harmonic RMS	-	30/02,30/04	A
116	Ia 3 rd harmonic RMS	-	30/02,30/04	A
117	Ib 3 rd harmonic RMS	-	30/02,30/04	A
118	Ic 3 rd harmonic RMS	-	30/02,30/04	A
119	Ia 4 th harmonic RMS	-	30/02,30/04	A
120	Ib 4 th harmonic RMS	-	30/02,30/04	A
121	Ic 4 th harmonic RMS	-	30/02,30/04	A
122	Ia 5 th harmonic RMS	-	30/02,30/04	A
123	Ib 5 th harmonic RMS	-	30/02,30/04	A
124	Ic 5 th harmonic RMS	-	30/02,30/04	A
125	Ia 6 th harmonic RMS	-	30/02,30/04	A
126	Ib 6 th harmonic RMS	-	30/02,30/04	A
127	Ic 6 th harmonic RMS	-	30/02,30/04	A
128	Ia 7 th harmonic RMS	-	30/02,30/04	A
129	Ib 7 th harmonic RMS	-	30/02,30/04	A
130	Ic 7 th harmonic RMS	-	30/02,30/04	A
131	Ia 8 th harmonic RMS	-	30/02,30/04	A
132	Ib 8 th harmonic RMS	-	30/02,30/04	A
133	Ic 8 th harmonic RMS	-	30/02,30/04	A
134	Source side Va 2 nd harmonic RMS	-	30/02,30/04	KV100
135	Source side Vb 2 nd harmonic RMS	-	30/02,30/04	KV100
136	Source side Vc 2 nd harmonic RMS	-	30/02,30/04	KV100
137	Source side Va 3 rd harmonic RMS	-	30/02,30/04	KV100
138	Source side Vb 3 rd harmonic RMS	-	30/02,30/04	KV100
139	Source side Vc 3 rd harmonic RMS	-	30/02,30/04	KV100
140	Source side Va 4 th harmonic RMS	-	30/02,30/04	KV100
141	Source side Vb 4 th harmonic RMS	-	30/02,30/04	KV100
142	Source side Vc 4 th harmonic RMS	-	30/02,30/04	KV100

143	Source side Va 5 th harmonic RMS	-	30/02,30/04	KV100
144	Source side Vb 5 th harmonic RMS	-	30/02,30/04	KV100
145	Source side Vc 5 th harmonic RMS	-	30/02,30/04	KV100
146	Source side Va 6 th harmonic RMS	-	30/02,30/04	KV100
147	Source side Vb 6 th harmonic RMS	-	30/02,30/04	KV100
148	Source side Vc 6 th harmonic RMS	-	30/02,30/04	KV100
149	Source side Va 7 th harmonic RMS	-	30/02,30/04	KV100
150	Source side Vb 7 th harmonic RMS	-	30/02,30/04	KV100
151	Source side Vc 7 th harmonic RMS	-	30/02,30/04	KV100
152	Source side Va 8 th harmonic RMS	-	30/02,30/04	KV100
153	Source side Vb 8 th harmonic RMS	-	30/02,30/04	KV100
154	Source side Vc 8 th harmonic RMS	-	30/02,30/04	KV100
155				
156				
157				
158				
159				
160				
161				
162				
163				
164				
165				
166				
167				
168				
169				
170				
171				
172				
173				
174				
175				
176	In True RMS	-	30/02,30/04	KV100
177	In THD	-	30/02,30/04	KV100

178	In 2 nd harmonic RMS	-	30/02,30/04	KV100
179	In 3 rd harmonic RMS	-	30/02,30/04	KV100
180	In 4 th harmonic RMS	-	30/02,30/04	KV100
181	In 5 th harmonic RMS	-	30/02,30/04	KV100
182	In 6 th harmonic RMS	-	30/02,30/04	KV100
183	In 7 th harmonic RMS	-	30/02,30/04	KV100
184	In 8 th harmonic RMS	-	30/02,30/04	KV100
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 Export	0	20/02,20/06,22/08	kWh
8	kWattHour-b Export	0	20/02,20/06,22/08	kWh
9	kWattHour-c Export	0	20/02,20/06,22/08	kWh
10	kWattHour-3ph Export	0	20/02,20/06,22/08	kWh
11	kVarHour-a Export	0	20/02,20/06,22/08	kVarh
12	kVarHour-b Export	0	20/02,20/06,22/08	kVarh
13	kVarHour-c Export	0	20/02,20/06,22/08	kVarh
14	kVarHour-3ph Export	0	20/02,20/06,22/08	kVarh
15	kWattHour-a Import	0	20/02,20/06,22/08	kWh
16	kWattHour-b Import	0	20/02,20/06,22/08	kWh
17	kWattHour-c Import	0	20/02,20/06,22/08	kWh
18	kWattHour-3ph Import	0	20/02,20/06,22/08	kWh
19	kVarHour-a Import	0	20/02,20/06,22/08	kVarh
20	kVarHour-b Import	0	20/02,20/06,22/08	kVarh
21	kVarHour-c Import	0	20/02,20/06,22/08	kVarh
22	kVarHour-3ph Import	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	1~58

2	Phase Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
3	Phase Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
4	Phase Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
5	Phase Delay TCC type		40/02,41/02	1~58
6	Phase Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
7	Phase Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
8	Phase Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
9	Phase High Current Pickup		40/02,41/02	50~10000A
10	Phase High Current Response Time		40/02,41/02	0.00~1.00sec,step:0.01
11	Phase Cold Load Pickup Multiplier		40/02,41/02	0~10
12	Phase Inrush Restraint		40/02,41/02	0(OFF), 1(ON)
13	Ground Pickup Current		40/02,41/02	5~900A
14	Ground Fast TCC type		40/02,41/02	1~58
15	Ground Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
16	Ground Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
17	Ground Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
18	Ground Delay TCC type		40/02,41/02	1~58
19	Ground Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
20	Ground Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
21	Ground Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
22	Ground High Current Pickup		40/02,41/02	50~10000A
23	Ground High Current Response Time		40/02,41/02	0.00~1.00,step:0.01
24	Ground Cold Load Pickup Multiplier		40/02,41/02	0~10
25	Ground Inrush Restraint		40/02,41/02	0(OFF), 1(ON)
26	SEF -Pickup Current(Io)	-	40/02,41/02	2 - 20A
27	SEF -Pickup Voltage(Vo)	-	40/02,41/02	10~80%
28	SEF -Max. Torque Angle	-	40/02,41/02	0,30,60,90,270,300,330
29	SEF -Detection Time	-	40/02,41/02	0.1~30.0 step:0.1 Sec
30	SEF -Inrush restraint	-	40/02,41/02	No(0),Yes(1)

31	SEF – Output select	-	40/02,41/02	0(Off),1(Alarm),2(Trip)
32	Inrush restraint-2 nd harmonic level	-	40/02,41/02	5~50%
33	Inrush restraint-Detection Time	-	40/02,41/02	0.02~1.00,step:0.01
34	Inrush restraint -On/Off	-	40/02,41/02	0(Off),1(On)
35	Oper. To Lockout Phase		40/02,41/02	1~5
36	Oper. To Lockout Ground		40/02,41/02	1~5
37	Oper. Fast Curve Phase		40/02,41/02	0~5
38	Oper. Fast Curve Ground		40/02,41/02	0~5
39	High Current Phase Active		40/02,41/02	0~5
40	High Current Ground Active		40/02,41/02	0~5
41	Reclose Interval 1 st		40/02,41/02	0.5~60sec, step:0.1
42	Reclose Interval 2 nd		40/02,41/02	1~60sec
43	Reclose Interval 3 rd		40/02,41/02	1~60sec
44	Reset Time		40/02,41/02	3~180sec
45	Cold Load Pickup Restore Time		40/02,41/02	0.00~30.00sec step:0.01
46	Cold Load Duration		40/02,41/02	0.00~60.00sec step:0.01
47	Seq. Coordination Active		40/02,41/02	ON(1),OFF(0)
48	Phase Loss -Volt On level	-	40/02,41/02	50~90,step:5%
49	Phase Loss -Volt Off level	-	40/02,41/02	35~75,step:5%
50	Phase Loss -Delay Time	-	40/02,41/02	1~30Sec
51	Phase Loss -On/Off	-	40/02,41/02	0(Off),1(On)
52				
53				
54				
Setting Group2				
55	Phase Pickup Current		40/02,41/02	10~900A
56	Phase Fast TCC type		40/02,41/02	1~58
57	Phase Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
58	Phase Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
59	Phase Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
60	Phase Delay TCC type		40/02,41/02	1~58
61	Phase Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01

62	Phase Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
63	Phase Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
64	Phase High Current Pickup		40/02,41/02	50~10000A
65	Phase High Current Response Time		40/02,41/02	0.00~1.00sec,step:0.01
66	Phase Cold Load Pickup Multiplier		40/02,41/02	0~10
67	Phase Inrush Restraint		40/02,41/02	0(OFF), 1(ON)
68	Ground Pickup Current		40/02,41/02	5~900A
69	Ground Fast TCC type		40/02,41/02	1~58
70	Ground Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
71	Ground Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
72	Ground Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
73	Ground Delay TCC type		40/02,41/02	1~58
74	Ground Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
75	Ground Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
76	Ground Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
77	Ground High Current Pickup		40/02,41/02	50~10000A
78	Ground High Current Response Time		40/02,41/02	0.00~1.00,step:0.01
79	Ground Cold Load Pickup Multiplier		40/02,41/02	0~10
80	Ground Inrush Restraint		40/02,41/02	0(OFF), 1(ON)
81	SEF -Pickup Current(Io)	-	40/02,41/02	2 - 20A
82	SEF -Pickup Voltage(Vo)	-	40/02,41/02	10~80%
83	SEF -Max. Torque Angle	-	40/02,41/02	0,30,60,90,270,300,330
84	SEF -Detection Time	-	40/02,41/02	0.1~30.0 step:0.1 Sec
85	SEF -Inrush restraint	-	40/02,41/02	No(0),Yes(1)
86	SEF – Output select	-	40/02,41/02	0(Off),1(Alarm),2(Trip)
87	Inrush restraint-2 nd harmonic level	-	40/02,41/02	5~50%
88	Inrush restraint-Detection Time	-	40/02,41/02	0.02~1.00,step:0.01
89	Inrush restraint -On/Off	-	40/02,41/02	0(Off),1(On)

90	Oper. To Lockout Phase		40/02,41/02	1~5
91	Oper. To Lockout Ground		40/02,41/02	1~5
92	Oper. Fast Curve Phase		40/02,41/02	0~5
93	Oper. Fast Curve Ground		40/02,41/02	0~5
94	High Current Phase Active		40/02,41/02	0~5
95	High Current Ground Active		40/02,41/02	0~5
96	Reclose Interval 1 st		40/02,41/02	0.5~60sec, step:0.1
97	Reclose Interval 2 nd		40/02,41/02	1~60sec
98	Reclose Interval 3 rd		40/02,41/02	1~60sec
99	Reset Time		40/02,41/02	3~180sec
100	Cold Load Pickup Restore Time		40/02,41/02	0.00~30.00sec step:0.01
101	Cold Load Duration		40/02,41/02	0.00~60.00sec step:0.01
102	Seq. Coordination Active		40/02,41/02	ON(1),OFF(0)
103	Phase Loss -Volt On level	-	40/02,41/02	50~90,step:5%
104	Phase Loss -Volt Off level	-	40/02,41/02	35~75,step:5%
105	Phase Loss -Delay Time	-	40/02,41/02	1~30Sec
106	Phase Loss -On/Off	-	40/02,41/02	0(Off),1(On)
107				
108				
109				
Setting Group3				
110	Phase Pickup Current		40/02,41/02	10~900A
111	Phase Fast TCC type		40/02,41/02	1~58
112	Phase Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
113	Phase Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
114	Phase Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
115	Phase Delay TCC type		40/02,41/02	1~58
116	Phase Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
117	Phase Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
118	Phase Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
119	Phase High Current Pickup		40/02,41/02	50~10000A
120	Phase High Current Response		40/02,41/02	0.00~1.00sec,step:0.01

	Time			
121	Phase Cold Load Pickup Multiplier		40/02,41/02	0~10
122	Phase Inrush Restraint		40/02,41/02	0(OFF), 1(ON)
123	Ground Pickup Current		40/02,41/02	5~900A
124	Ground Fast TCC type		40/02,41/02	1~58
125	Ground Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
126	Ground Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
127	Ground Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
128	Ground Delay TCC type		40/02,41/02	1~58
129	Ground Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
130	Ground Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
131	Ground Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
132	Ground High Current Pickup		40/02,41/02	50~10000A
133	Ground High Current Response Time		40/02,41/02	0.00~1.00,step:0.01
134	Ground Cold Load Pickup Multiplier		40/02,41/02	0~10
135	Ground Inrush Restraint		40/02,41/02	0(OFF), 1(ON)
136	SEF -Pickup Current(Io)	-	40/02,41/02	2 - 20A
137	SEF -Pickup Voltage(Vo)	-	40/02,41/02	10~80%
138	SEF -Max. Torque Angle	-	40/02,41/02	0,30,60,90,270,300,330
139	SEF -Detection Time	-	40/02,41/02	0.1~30.0 step:0.1 Sec
140	SEF -Inrush restraint	-	40/02,41/02	No(0),Yes(1)
141	SEF – Output select	-	40/02,41/02	0(Off),1(Alarm),2(Trip)
142	Inrush restraint-2 nd harmonic level	-	40/02,41/02	5~50%
143	Inrush restraint-Detection Time	-	40/02,41/02	0.02~1.00,step:0.01
144	Inrush restraint -On/Off	-	40/02,41/02	0(Off),1(On)
145	Oper. To Lockout Phase		40/02,41/02	1~5
146	Oper. To Lockout Ground		40/02,41/02	1~5
147	Oper. Fast Curve Phase		40/02,41/02	0~5
148	Oper. Fast Curve Ground		40/02,41/02	0~5

149	High Current Phase Active		40/02,41/02	0~5
150	High Current Ground Active		40/02,41/02	0~5
151	Reclose Interval 1 st		40/02,41/02	0.5~60sec, step:0.1
152	Reclose Interval 2 nd		40/02,41/02	1~60sec
153	Reclose Interval 3 rd		40/02,41/02	1~60sec
154	Reset Time		40/02,41/02	3~180sec
155	Cold Load Pickup Restore Time		40/02,41/02	0.00~30.00sec step:0.01
156	Cold Load Duration		40/02,41/02	0.00~60.00sec step:0.01
157	Seq. Coordination Active		40/02,41/02	ON(1),OFF(0)
158	Phase Loss -Volt On level	-	40/02,41/02	50~90,step:5%
159	Phase Loss -Volt Off level	-	40/02,41/02	35~75,step:5%
160	Phase Loss -Delay Time	-	40/02,41/02	1~30Sec
161	Phase Loss -On/Off	-	40/02,41/02	0(Off),1(On)
162				
163				
164				
Setting Group4				
165	Phase Pickup Current		40/02,41/02	10~900A
166	Phase Fast TCC type		40/02,41/02	1~58
167	Phase Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
168	Phase Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
169	Phase Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
170	Phase Delay TCC type		40/02,41/02	1~58
171	Phase Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
172	Phase Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
173	Phase Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
174	Phase High Current Pickup		40/02,41/02	50~10000A
175	Phase High Current Response Time		40/02,41/02	0.00~1.00sec,step:0.01
176	Phase Cold Load Pickup Multiplier		40/02,41/02	0~10
177	Phase Inrush Restraint		40/02,41/02	0(OFF), 1(ON)

178	Ground Pickup Current		40/02,41/02	5~900A
179	Ground Fast TCC type		40/02,41/02	1~58
180	Ground Fast Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
181	Ground Fast Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
182	Ground Fast Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
183	Ground Delay TCC type		40/02,41/02	1~58
184	Ground Delay Time Adder		40/02,41/02	0.00~1.00sec,step:0.01
185	Ground Delay Time Multiplier		40/02,41/02	0.10~2.00,step:0.01
186	Ground Delay Min Response Time		40/02,41/02	0.00~1.00sec,step:0.01
187	Ground High Current Pickup		40/02,41/02	50~10000A
188	Ground High Current Response Time		40/02,41/02	0.00~1.00,step:0.01
189	Ground Cold Load Pickup Multiplier		40/02,41/02	0~10
190	Ground Inrush Restraint		40/02,41/02	0(OFF), 1(ON)
191	SEF -Pickup Current(Io)	-	40/02,41/02	2 - 20A
192	SEF -Pickup Voltage(Vo)	-	40/02,41/02	10~80%
193	SEF -Max. Torque Angle	-	40/02,41/02	0,30,60,90,270,300,330
194	SEF -Detection Time	-	40/02,41/02	0.1~30.0 step:0.1 Sec
195	SEF -Inrush restraint	-	40/02,41/02	No(0),Yes(1)
196	SEF – Output select	-	40/02,41/02	0(Off),1(Alarm),2(Trip)
197	Inrush restraint-2 nd harmonic level	-	40/02,41/02	5~50%
198	Inrush restraint-Detection Time	-	40/02,41/02	0.02~1.00,step:0.01
199	Inrush restraint -On/Off	-	40/02,41/02	0(Off),1(On)
200	Oper. To Lockout Phase		40/02,41/02	1~5
201	Oper. To Lockout Ground		40/02,41/02	1~5
202	Oper. Fast Curve Phase		40/02,41/02	0~5
203	Oper. Fast Curve Ground		40/02,41/02	0~5
204	High Current Phase Active		40/02,41/02	0~5
205	High Current Ground Active		40/02,41/02	0~5
206	Reclose Interval 1 st		40/02,41/02	0.5~60sec, step:0.1
207	Reclose Interval 2 nd		40/02,41/02	1~60sec

208	Reclose Interval 3 rd		40/02,41/02	1~60sec
209	Reset Time		40/02,41/02	3~180sec
210	Cold Load Pickup Restore Time		40/02,41/02	0.00~30.00sec step:0.01
211	Cold Load Duration		40/02,41/02	0.00~60.00sec step:0.01
212	Seq. Coordination Active		40/02,41/02	ON(1),OFF(0)
213	Phase Loss -Volt On level	-	40/02,41/02	50~90,step:5%
214	Phase Loss -Volt Off level	-	40/02,41/02	35~75,step:5%
215	Phase Loss -Delay Time	-	40/02,41/02	1~30Sec
216	Phase Loss -On/Off	-	40/02,41/02	0(Off),1(On)
217				
218				
219				
Common Setting				
220	Active setting group	-	40/02,41/02	1~4
221	Reversed	-	40/02,41/02	
222	Reserved	-	40/02,41/02	
223	Reserved	-	40/02,41/02	
VOC Setting				
224	AI.0 VOC	-	40/02,41/02	0~50%
225	AI.1 VOC	-	40/02,41/02	0~50%
226	AI.2 VOC	-	40/02,41/02	0~50%
227	AI.3 VOC	-	40/02,41/02	0~50%
228	AI.4 VOC	-	40/02,41/02	0~50%
229	AI.5 VOC	-	40/02,41/02	0~50%
230	AI.6 VOC	-	40/02,41/02	0~50%
231	AI.7 VOC	-	40/02,41/02	0~50%
232	AI.8 VOC	-	40/02,41/02	0~50%
233	AI.9 VOC	-	40/02,41/02	0~50%
234	AI.10 VOC	-	40/02,41/02	0~50%
235	AI.11 VOC	-	40/02,41/02	0~50%
236	AI.12 VOC	-	40/02,41/02	0~50%
237	AI.13 VOC	-	40/02,41/02	0~50%
238	AI.14 VOC	-	40/02,41/02	0~50%

239	AI.15 VOC	-	40/02,41/02	0~50%
240	AI.16 VOC	-	40/02,41/02	0~50%
241	AI.17 VOC	-	40/02,41/02	0~50%
242	AI.18 VOC	-	40/02,41/02	0~50%
243	AI.19 VOC	-	40/02,41/02	0~50%
244	AI.20 VOC	-	40/02,41/02	0~50%
245	AI.21 VOC	-	40/02,41/02	0~50%
246	AI.22 VOC	-	40/02,41/02	0~50%
247	AI.23 VOC	-	40/02,41/02	0~50%
248	AI.24 VOC	-	40/02,41/02	0~50%
249	AI.25 VOC	-	40/02,41/02	0~50%
250	AI.26 VOC	-	40/02,41/02	0~50%
251	AI.27 VOC	-	40/02,41/02	0~50%
252	AI.28 VOC	-	40/02,41/02	0~50%
253	AI.29 VOC	-	40/02,41/02	0~50%
254	AI.30 VOC	-	40/02,41/02	0~50%
255	AI.31 VOC	-	40/02,41/02	0~50%
256	AI.0 VOC Limit	-	40/02,41/02	0~65535
257	AI.1 VOC Limit	-	40/02,41/02	0~65535
258	AI.2 VOC Limit	-	40/02,41/02	0~65535
259	AI.3 VOC Limit	-	40/02,41/02	0~65535
260	AI.4 VOC Limit	-	40/02,41/02	0~65535
261	AI.5 VOC Limit	-	40/02,41/02	0~65535
262	AI.6 VOC Limit	-	40/02,41/02	0~65535
263	AI.7 VOC Limit	-	40/02,41/02	0~65535
264	AI.8 VOC Limit	-	40/02,41/02	0~65535
265	AI.9 VOC Limit	-	40/02,41/02	0~65535
266	AI.10 VOC Limit	-	40/02,41/02	0~65535
267	AI.11 VOC Limit	-	40/02,41/02	0~65535
268	AI.12 VOC Limit	-	40/02,41/02	0~65535
269	AI.13 VOC Limit	-	40/02,41/02	0~65535
270	AI.14 VOC Limit	-	40/02,41/02	0~65535
271	AI.15 VOC Limit	-	40/02,41/02	0~65535
272	AI.16 VOC Limit	-	40/02,41/02	0~65535
273	AI.17 VOC Limit	-	40/02,41/02	0~65535

274	AI.18 VOC Limit	-	40/02,41/02	0~65535
275	AI.19 VOC Limit	-	40/02,41/02	0~65535
276	AI.20 VOC Limit	-	40/02,41/02	0~65535
277	AI.21 VOC Limit	-	40/02,41/02	0~65535
278	AI.22 VOC Limit	-	40/02,41/02	0~65535
279	AI.23 VOC Limit	-	40/02,41/02	0~65535
280	AI.24 VOC Limit	-	40/02,41/02	0~65535
281	AI.25 VOC Limit	-	40/02,41/02	0~65535
282	AI.26 VOC Limit	-	40/02,41/02	0~65535
283	AI.27 VOC Limit	-	40/02,41/02	0~65535
284	AI.28 VOC Limit	-	40/02,41/02	0~65535
285	AI.29 VOC Limit	-	40/02,41/02	0~65535
286	AI.30 VOC Limit	-	40/02,41/02	0~65535
287	AI.31 VOC Limit	-	40/02,41/02	0~65535
288	CNT.0 VOC	-	40/02,41/02	0~65535
289	CNT.1 VOC	-	40/02,41/02	0~65535
290	CNT.2 VOC	-	40/02,41/02	0~65535
291	CNT.3 VOC	-	40/02,41/02	0~65535
292	CNT.4 VOC	-	40/02,41/02	0~65535
293	CNT.5 VOC	-	40/02,41/02	0~65535
294	CNT.6 VOC	-	40/02,41/02	0~65535
295	CNT.7 VOC	-	40/02,41/02	0~65535
296	CNT.8 VOC	-	40/02,41/02	0~65535
297	CNT.9 VOC	-	40/02,41/02	0~65535
298	CNT.10 VOC	-	40/02,41/02	0~65535
299	CNT.11 VOC	-	40/02,41/02	0~65535
300	CNT.12 VOC	-	40/02,41/02	0~65535
301	CNT.13 VOC	-	40/02,41/02	0~65535
302	CNT.14 VOC	-	40/02,41/02	0~65535
303	CNT.15 VOC	-	40/02,41/02	0~65535
304	CNT.16 VOC	-	40/02,41/02	0~65535
305	CNT.17 VOC	-	40/02,41/02	0~65535
306	CNT.18 VOC	-	40/02,41/02	0~65535
307	CNT.19 VOC	-	40/02,41/02	0~65535
308	CNT.20 VOC	-	40/02,41/02	0~65535

309	CNT.21 VOC	-	40/02,41/02	0~65535
310	CNT.22 VOC	-	40/02,41/02	0~65535
Additional Function Setting Group 1				
311	Phase Fast Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
312	Phase Fast Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
313	Phase Delayed Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
314	Phase Delayed Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
315	Phase Definite Time OC On/Off		40/02,41/02	0(OFF), 1(ON)
316	Phase Definite Time OC Pickup		40/02,41/02	50 - 10000A , step : 1A
317	Phase Definite Time OC Response Time		40/02,41/02	0.00-1.00s, step : 0.01s
318	Ground Fast Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
319	Ground Fast Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
320	Ground Delayed Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
321	Ground Delayed Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
322	Ground Definite Time OC On/Off		40/02,41/02	0(OFF), 1(ON)
323	Ground Definite Time OC Pickup		40/02,41/02	50 - 10000A , step : 1A
324	Ground Definite Time OC Response Time		40/02,41/02	0.00-1.00s, step : 0.01s
325	Reclose Interval 4th		40/02,41/02	1~60sec
326	Under-frequency pickup	-	40/02,41/02	47.00-59.98, step :0.01Hz
327	Under-frequency detection time	-	40/02,41/02	0.03-10.00s, step: 0.01s
328	Under-frequency detection ON/OFF	-	40/02,41/02	0(Off),1(Alarm),2(On)
Additional Function Setting Group 2				
329	Phase Fast Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
330	Phase Fast Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
331	Phase Delayed Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
332	Phase Delayed Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s

333	Phase Definite Time OC On/Off		40/02,41/02	0(OFF), 1(ON)
334	Phase Definite Time OC Pickup		40/02,41/02	50 - 10000A , step : 1A
335	Phase Definite Time OC Response Time		40/02,41/02	0.00-1.00s, step : 0.01s
336	Ground Fast Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
337	Ground Fast Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
338	Ground Delayed Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
339	Ground Delayed Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
340	Ground Definite Time OC On/Off		40/02,41/02	0(OFF), 1(ON)
341	Ground Definite Time OC Pickup		40/02,41/02	50 - 10000A , step : 1A
342	Ground Definite Time OC Response Time		40/02,41/02	0.00-1.00s, step : 0.01s
343	Reclose Interval 4th		40/02,41/02	1~60sec
344	Under-frequency pickup	-	40/02,41/02	47.00-59.98, step :0.01Hz
345	Under-frequency detection time	-	40/02,41/02	0.03-10.00s, step: 0.01s
346	Under-frequency detection ON/OFF	-	40/02,41/02	0(Off),1(Alarm),2(On)
Additional Function Setting Group 3				
347	Phase Fast Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
348	Phase Fast Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
349	Phase Delayed Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
350	Phase Delayed Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
351	Phase Definite Time OC On/Off		40/02,41/02	0(OFF), 1(ON)
352	Phase Definite Time OC Pickup		40/02,41/02	50 - 10000A , step : 1A
353	Phase Definite Time OC Response Time		40/02,41/02	0.00-1.00s, step : 0.01s
354	Ground Fast Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
355	Ground Fast Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
356	Ground Delayed Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
357	Ground Delayed Reset Time		40/02,41/02	0.00-100.00s:,

				step :0.01s
358	Ground Definite Time OC On/Off		40/02,41/02	0(OFF), 1(ON)
359	Ground Definite Time OC Pickup		40/02,41/02	50 - 10000A , step : 1A
360	Ground Definite Time OC Response Time		40/02,41/02	0.00-1.00s, step : 0.01s
361	Reclose Interval 4th		40/02,41/02	1~60sec
362	Under-frequency pickup	-	40/02,41/02	47.00-59.98, step :0.01Hz
363	Under-frequency detection time	-	40/02,41/02	0.03-10.00s, step: 0.01s
364	Under-frequency detection ON/OFF	-	40/02,41/02	0(Off),1(Alarm),2(On)
Additional Function Setting Group 4				
365	Phase Fast Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
366	Phase Fast Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
367	Phase Delayed Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
368	Phase Delayed Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
369	Phase Definite Time OC On/Off		40/02,41/02	0(OFF), 1(ON)
370	Phase Definite Time OC Pickup		40/02,41/02	50 - 10000A , step : 1A
371	Phase Definite Time OC Response Time		40/02,41/02	0.00-1.00s, step : 0.01s
372	Ground Fast Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
373	Ground Fast Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
374	Ground Delayed Reset type		40/02,41/02	0(RDMT), 1(RIDMT)
375	Ground Delayed Reset Time		40/02,41/02	0.00-100.00s:, step :0.01s
376	Ground Definite Time OC On/Off		40/02,41/02	0(OFF), 1(ON)
377	Ground Definite Time OC Pickup		40/02,41/02	50 - 10000A , step : 1A
378	Ground Definite Time OC Response Time		40/02,41/02	0.00-1.00s, step : 0.01s
379	Reclose Interval 4th		40/02,41/02	1~60sec
380	Under-frequency pickup	-	40/02,41/02	47.00-59.98, step :0.01Hz
381	Under-frequency detection time	-	40/02,41/02	0.03-10.00s, step: 0.01s

382	Under-frequency detection ON/OFF	-	40/02,41/02	0(Off),1(Alarm),2(On)
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	Daily Peak I History
	“EV_MAX_P”	-	70/01	Daily Peak P History
	“FI_WAVE_0”	-	70/01	Fault waveform (most recent)
	“FI_WAVE_1”	-	70/01	Fault waveform
	“FI_WAVE_2”	-	70/01	Fault waveform
	“FI_WAVE_3”	-	70/01	Fault waveform
	“FI_WAVE_4”	-	70/01	Fault waveform
	“FI_WAVE_5”	-	70/01	Fault waveform
	“FI_WAVE_6”	-	70/01	Fault waveform
	“FI_WAVE_7”	-	70/01	Fault waveform (Oldest)
I/O Event File Record format				
	I/O Event ID			Unsigned short
	I/O Event Date & Time			DNP Time format
	I/O Event Status Flags			Unsigned short
Function Event File Record format				
	Function Event ID			Unsigned short
	Function Event Date & Time			DNP Time format
	Function Event Status Flags			Unsigned short
System Event File Record format				
	System Event ID			Unsigned short
	System Event Date & Time			DNP Time format
	System Event Status Flags			Unsigned short
Fault Event File Record format				
	Fault Event Date & Time			DNP Time format
	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
Fault Event Reserved			Unsigned short
Fault Event Reserved			Unsigned short
Fault Event Reserved			Unsigned short
Demand I Event File Record format			
Demand I Date & Time			DNP Time format
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 format
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 format
Max. I Ia			Unsigned short
Max. I Ib			Unsigned short
Max. I Ic			Unsigned short
Max. I In			Unsigned short
Demand P Event File Record format			
Max. P Date & Time			DNP Time format
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
Fault waveform File Record format			
Fault waveform Date & Time		Record 0	DNP Time format
Fault Status			Unsigned short
Sampling Rate = 32			Unsigned short
Reserved			10 bytes
Sample Op. Status[x]		x=Record 1-320	Unsigned short
Sample Ia[x]			short
Sample Ib[x]			short
Sample Ic[x]			short
Sample In[x]			short
Sample Va[x]			short
Sample Vb[x]			short
Sample Vc[x]			short
SampleVo[x]			short
Sample reserved			Unsigned short

Appendix 3. DNP V3.0 DEVICE PROFILE

& Implementation Table (V3.1)

<p>DNP V3.00</p> <p>DEVICE PROFILE DOCUMENT</p> <p>This document must be accompanied by a table having the following headings:</p> <table style="margin-left: 40px; border: none;"> <tr> <td style="padding-right: 20px;">Object Group</td> <td style="padding-right: 20px;">Request Function Codes</td> <td>Response Function Codes</td> </tr> <tr> <td>Object Variation</td> <td>Request Qualifiers</td> <td>Response Qualifiers</td> </tr> <tr> <td colspan="3">Object Name (optional)</td> </tr> </table>		Object Group	Request Function Codes	Response Function Codes	Object Variation	Request Qualifiers	Response Qualifiers	Object Name (optional)		
Object Group	Request Function Codes	Response Function Codes								
Object Variation	Request Qualifiers	Response Qualifiers								
Object Name (optional)										
<p>Vendor Name: P&C Technologies CO.,LTD</p>										
<p>Device Name: FTU-R100</p>										
<p>Highest DNP Level Supported:</p> <p style="margin-left: 40px;">For Requests Level 2</p> <p style="margin-left: 40px;">For Responses Level 2</p>	<p>Device Function:</p> <p style="margin-left: 40px;">Master <input checked="" type="checkbox"/> Slave</p>									
<p>Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):</p> <p><u>Supports Enabling and Disabling of Unsolicited Report On a Class basis.</u></p> <hr style="border: 0; border-top: 1px solid black; margin: 10px 0;"/> <hr style="border: 0; border-top: 1px solid black; margin: 10px 0;"/> <hr style="border: 0; border-top: 1px solid black; margin: 10px 0;"/>										

<p>Maximum Data Link Frame Size (octets):</p> <p>Transmitted <u> 292 </u></p> <p>Received (must be 292)</p>	<p>Maximum Application Fragment Size (octets):</p> <p>Transmitted <u> 2048 </u> (if>2048,must be configurable)</p> <p>Received <u> 2048 </u> (must be >= 249)</p>
<p>Maximum Data Link Re-tries:</p> <p>None</p> <p>Fixed at _____</p> <p>■ Configurable, range <u> 0 </u> to <u> 2 </u></p>	<p>Maximum Application Layer Re-tries:</p> <p>None</p> <p>■ Configurable, range <u> 0 </u> to <u> 2 </u> (Fixed is not permitted)</p>
<p>Requires Data Link Layer Confirmation:</p> <p>Never</p> <p>Always</p> <p>Sometimes If 'Sometimes', when? _____</p> <p>■ Configurable If 'Configurable', how? _____ By Setting _____</p>	
<p>Requires Application Layer Confirmation:</p> <p>Never</p> <p>Always (not recommended)</p> <p>■ When reporting Event Data (Slave devices only) When sending multi-fragment responses (Slave devices only)</p>	

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:

<p>Expects Binary Input Change Events:</p> <p>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)</p>	
<p>FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:</p>	
<p>Reports Binary Input Change Events when no specific variation requested:</p> <ul style="list-style-type: none"> ■ Never <ul style="list-style-type: none"> Only time-tagged Only non-time-tagged Configurable to send both, one or the other (attach explanation) 	<p>Reports time-tagged Binary Input Change Events when no specific variation requested:</p> <ul style="list-style-type: none"> ■ Never <ul style="list-style-type: none"> Binary Input Change With Time Binary Input Change With Relative Time Configurable (attach explanation)
<p>Sends Unsolicited Responses:</p> <ul style="list-style-type: none"> Never ■ Configurable (attach explanation) <ul style="list-style-type: none"> Only certain objects Sometimes (attach explanation) ■ ENABLE/DISABLE UNSOLICITED <ul style="list-style-type: none"> Function codes supported 	<p>Sends Static Data in Unsolicited Responses:</p> <ul style="list-style-type: none"> ■ Never <ul style="list-style-type: none"> When Device Restarts When Status Flags Change <p>No other options are permitted.</p>
<p>Default Counter Object/Variation:</p> <p>No Counters Reported Configurable (attach explanation) Default Object <u> 20 </u></p>	<p>Counters Roll Over at:</p> <p>No Counters Reported Configurable (attach explanation)</p> <ul style="list-style-type: none"> ■ 16 Bits

Default Variation <u> 6 </u> Point-by-point list attached	32 Bits Other Value _____ Point-by-point list attached
Sends Multi-Fragment Responses: Yes <input checked="" type="checkbox"/> No	

Implementation Table

Version 3.1

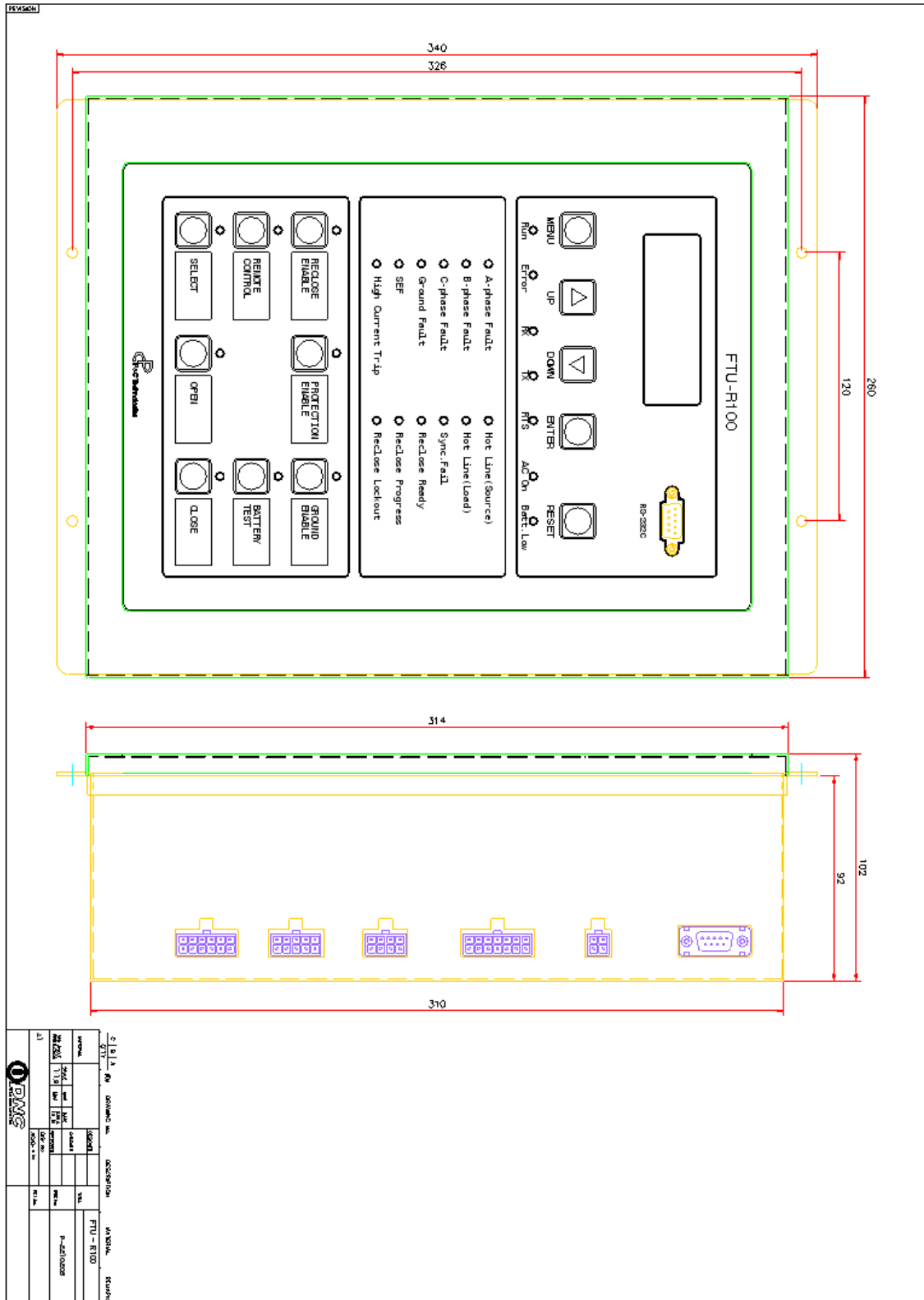
OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)
1	0	Binary Input - All Variations	1	00, 01, 06		
1	1	Binary Input	1	00, 01, 06	129	00, 01
1	2	Binary Input with Status	1	00, 01, 06	129	00, 01
2	0	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	
<input type="checkbox"/> OK	<input type="checkbox"/> 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	
<input type="checkbox"/> OK	<input type="checkbox"/> 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	
<input type="checkbox"/> OK	<input type="checkbox"/> 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	$\geq 10M\Omega$	<input type="checkbox"/> OK <input type="checkbox"/> 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	<input type="checkbox"/> OK <input type="checkbox"/> 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	
<input type="checkbox"/> OK	<input type="checkbox"/> Fail

6. Communication link Check

- Check if BPS, Address, Modem control of RTU was set appropriately.

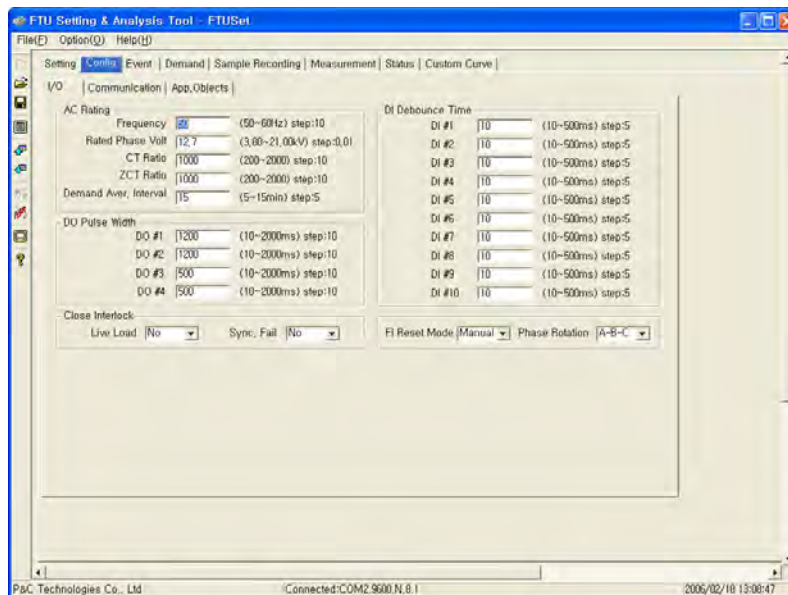
BPS setting change needs the restart of RTU.

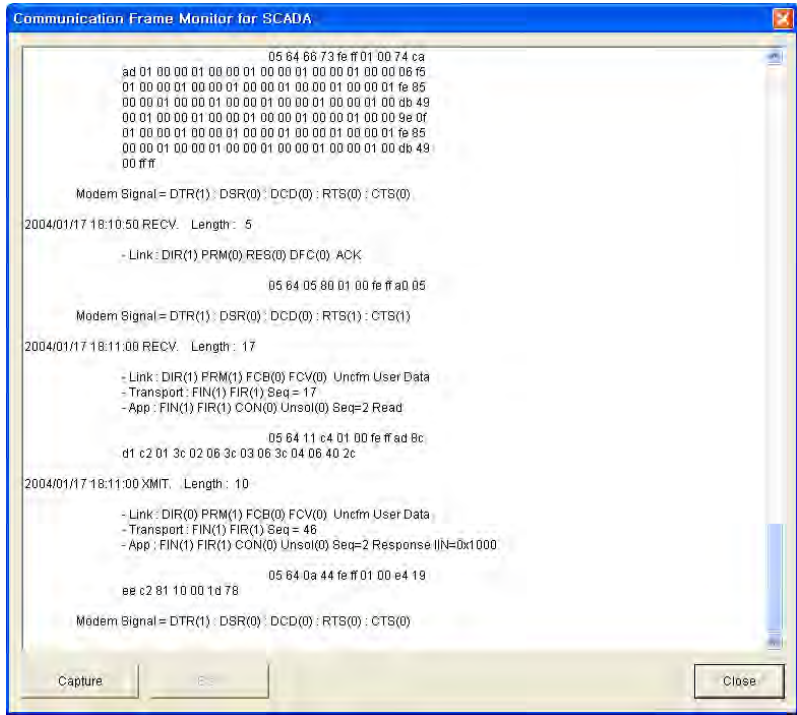
- Check if RX LED blinks while receiving data from Master Station.

- 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.





Test Result	
<input type="checkbox"/> OK	<input type="checkbox"/> Fail

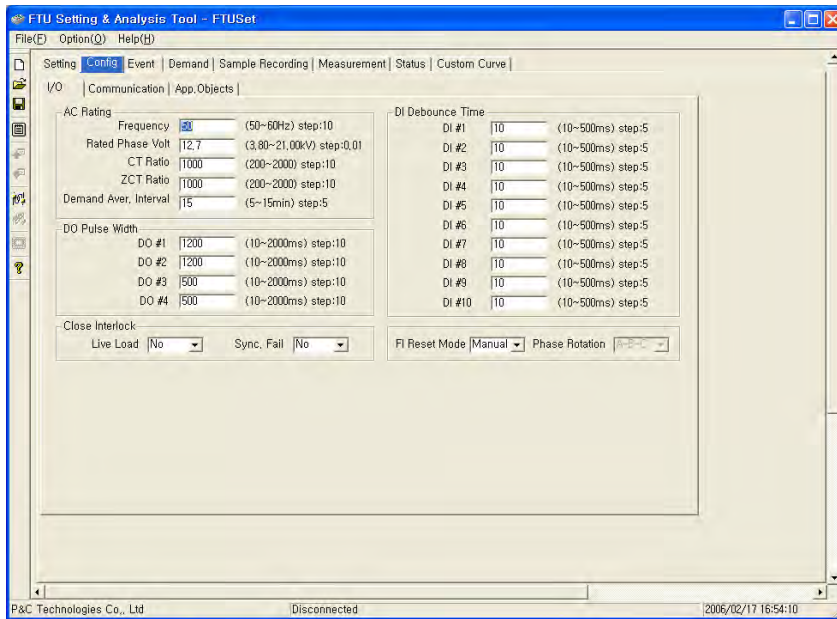
7. Switch Control Problem Check

- 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.

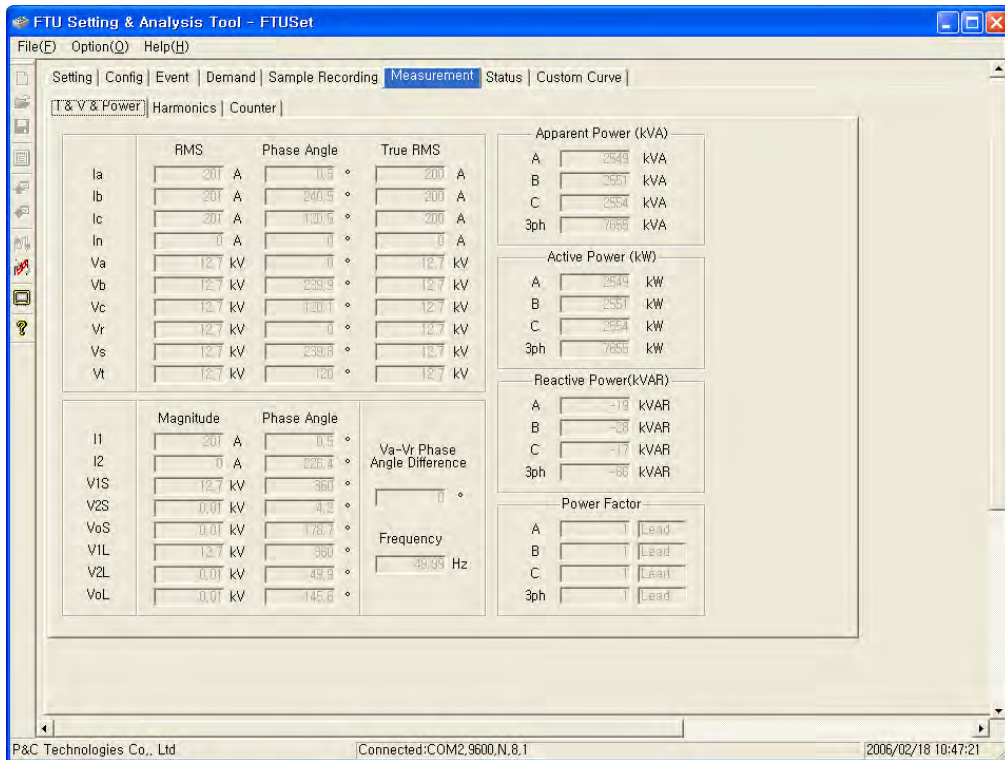
Test Result	
<input type="checkbox"/> OK	<input type="checkbox"/> Fail

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	
<input type="checkbox"/> OK	<input type="checkbox"/> 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	
<input type="checkbox"/> OK	<input type="checkbox"/> Fail

Appendix 6. IEC60870-5-101 Interoperability

1. System or device

- System definition
- Controlling station definition (Master)
- Controlled station definition (Slave)

2. Network configuration

- 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 2400 bits/sec
<input type="checkbox"/> 100 bits/sec	<input checked="" type="checkbox"/> 2400 bits/sec	<input type="checkbox"/>
<input type="checkbox"/> 200 bits/sec	<input checked="" type="checkbox"/> 4800 bits/sec	<input type="checkbox"/> 4800 bits/sec
<input type="checkbox"/> 300 bits/sec	<input checked="" type="checkbox"/> 9600 bits/sec	<input type="checkbox"/> 9600 bits/sec
<input type="checkbox"/> 600 bits/sec	<input checked="" type="checkbox"/> 19200 bits/sec	<input type="checkbox"/> 19200 bits/sec
<input checked="" type="checkbox"/> 1200 bits/sec		<input type="checkbox"/> 38400 bits/sec
		<input type="checkbox"/> 56000 bits/sec
		<input type="checkbox"/> 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

- | | | |
|---|---|---|
| <input type="checkbox"/> 100 bits/sec | <input checked="" type="checkbox"/> 2400 bits/sec | <input type="checkbox"/> 2400 bits/sec |
| <input type="checkbox"/> 200 bits/sec | <input checked="" type="checkbox"/> 4800 bits/sec | <input type="checkbox"/> 4800 bits/sec |
| <input type="checkbox"/> 300 bits/sec | <input checked="" type="checkbox"/> 9600 bits/sec | <input type="checkbox"/> 9600 bits/sec |
| <input type="checkbox"/> 600 bits/sec | <input checked="" type="checkbox"/> 19200 bits/sec | <input type="checkbox"/> 19200 bits/sec |
| <input checked="" type="checkbox"/> 1200 bits/sec | | <input type="checkbox"/> 38400 bits/sec |
| | | <input type="checkbox"/> 56000 bits/sec |
| | | <input type="checkbox"/> 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
- Unbalanced transmission

Frame length

Maximum length L

Address field of the link

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

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

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 Structured
 Two octets Unstructured
 Three octets

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

- | | |
|---|-----------|
| <input checked="" type="checkbox"/> <1> := Single-point information | M_SP_NA_1 |
| <input checked="" type="checkbox"/> <2> := Single-point information with time tag | M_SP_TA_1 |
| <input checked="" type="checkbox"/> <3> := Double-point information | M_DP_NA_1 |
| <input checked="" type="checkbox"/> <4> := Double-point information with time tag | M_DP_TA_1 |
| <input type="checkbox"/> <5> := Step position information | M_ST_NA_1 |
| <input type="checkbox"/> <6> := Step position information with time tag | M_ST_TA_1 |
| <input type="checkbox"/> <7> := Bitstring of 32 bit | M_BO_NA_1 |
| <input type="checkbox"/> <8> := Bitstring of 32 bit with time tag | M_BO_TA_1 |
| <input type="checkbox"/> <9> := Measured value, normalized value | M_ME_NA_1 |

<input type="checkbox"/>	<10>:=Measured value, normalized value with time tag	M_ME_TA_1
<input checked="" type="checkbox"/>	<11>:=Measured value, scaled value	M_ME_NB_1
<input checked="" type="checkbox"/>	<12>:=Measured value, scaled value with time tag	M_ME_TB_1
<input type="checkbox"/>	<13>:=Measured value, short floating point value	M_ME_NC_1
<input type="checkbox"/>	<14>:=Measured value, short floating point value with time tag	M_ME_TC_1
<input checked="" type="checkbox"/>	<15>:=Integrated totals	M_IT_NA_1
<input checked="" type="checkbox"/>	<16>:=Integrated totals with time tag	M_IT_TA_1
<input type="checkbox"/>	<17>:=Event of protection equipment with time tag	M_EP_TA_1
<input type="checkbox"/>	<18>:=Packed start events of protection equipment with time tag	M_EP_TB_1
<input type="checkbox"/>	<19>:=Packed output circuit information of protection equipment with time tag	M_EP_TC_1
<input type="checkbox"/>	<20>:=Packed single-point information with status change detection	M_PS_NA_1
<input type="checkbox"/>	<21>:=Measured value, normalized value without quality descriptor	M_ME_ND_1
<input type="checkbox"/>	<30>:=Single-point information with time tag CP56Time2a	M_SP_TB_1
<input type="checkbox"/>	<31>:=Double-point information with time tag CP56Time2a	M_DP_TB_1
<input type="checkbox"/>	<32>:=Step position information with time tag CP56Time2a	M_ST_TB_1
<input type="checkbox"/>	<33>:=Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
<input type="checkbox"/>	<34>:=Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
<input type="checkbox"/>	<35>:=Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
<input type="checkbox"/>	<36>:=Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
<input type="checkbox"/>	<37>:=Integrated totals with time tag CP56Time2a	M_IT_TB_1
<input type="checkbox"/>	<38>:=Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
<input type="checkbox"/>	<39>:=Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
<input type="checkbox"/>	<40>:=Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1
<input type="checkbox"/>	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

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

System information in monitor direction

<input checked="" type="checkbox"/> <70>:=End of initialization	M_EI_NA_1
---	-----------

System information in control direction

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

Parameter in control direction

<input type="checkbox"/> <110>:=Parameter of measured value, normalized value	P_ME_NA_1
<input type="checkbox"/> <111>:=Parameter of measured value, scaled value	P_ME_NB_1
<input type="checkbox"/> <112>:=Parameter of measured value, short floating point value	P_ME_NC_1
<input type="checkbox"/> <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

Type identifier and cause of transmission assignments

(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	14	15	16
<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																

Type identification		Cause of transmission																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
<10>	M_ME_TA_1																												
<11>	M_ME_NB_1	X				X																							
<12>	M_ME_TB_1																												
<13>	M_ME_NC_1																												
<14>	M_ME_TC_1																												
<15>	M_IT_NA_1			X																									
<16>	M_IT_TA_1			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																												

Type identification		Cause of transmission															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<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									
<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																

Type identification		Cause of transmission																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
<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

Remote initialization

Cyclic data transmission

Cyclic data transmission

Read procedure

Read procedure

Spontaneous transmission

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.

- Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
- 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

- | | | |
|---|--|--|
| <input checked="" type="checkbox"/> global | | |
| <input checked="" type="checkbox"/> group 1 | <input checked="" type="checkbox"/> group 7 | <input checked="" type="checkbox"/> group 13 |
| <input checked="" type="checkbox"/> group 2 | <input checked="" type="checkbox"/> group 8 | <input checked="" type="checkbox"/> group 14 |
| <input checked="" type="checkbox"/> group 3 | <input checked="" type="checkbox"/> group 9 | <input checked="" type="checkbox"/> group 15 |
| <input checked="" type="checkbox"/> group 4 | <input checked="" type="checkbox"/> group 10 | <input checked="" type="checkbox"/> group 16 |
| group 5 | <input checked="" type="checkbox"/> group 11 | |
| | <input checked="" type="checkbox"/> group 12 | |
| <input checked="" type="checkbox"/> group 6 | | |

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

Long-pulse duration (duration determined by a system parameter in the controlled station)

Persistent output (duration determined by a system parameter in the controlled station)

Transmission of integrated totals

Mode A: local freeze with spontaneous transmission

Mode B: local freeze with counter interrogation

Mode C: freeze and transmit by counter interrogation commands

Mode D: freeze by counter interrogation command, frozen values reported spontaneously

Test procedure

- Counter read
- Counter freeze without reset
- Counter freeze with reset
- Counter reset

- GTest procedure
- Request counter group 1

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

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		
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		
120		
121		
122		
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		
2009		
2010		
2011		
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	° 10
2029	Frequency	HZ100
2030	Temperature	Degree
2031	Reserved	
2032	Ia phase angle	° 10
2033	Ib phase angle	° 10
2034	Ic phase angle	° 10
2035	In phase angle	° 10
2036	Source side Va phase angle	° 10
2037	Source side Vb phase angle	° 10
2038	Source side Vc phase angle	° 10
2039	Source side Vo phase angle	° 10
2040		
2041		
2042		
2043		
2044	I1 RMS	A
2045	I1 phase angle	° 10
2046	I2 RMS	A
2047	I2 phase angle	° 10
2048	Source side V1 RMS	V
2049	Source side V1 phase angle	° 10
2050	Source side V2 RMS	V
2051	Source side V2 phase angle	° 10
2052		
2053		
2054		
2055		

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		
2101		
2102		
2103		
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		
2111		
2112		
2113	Ia 2 nd harmonic RMS	A
2114	Ib 2 nd harmonic RMS	A
2115	Ic 2 nd harmonic RMS	A
2116	Ia 3 rd harmonic RMS	A
2117	Ib 3 rd harmonic RMS	A
2118	Ic 3 rd harmonic RMS	A
2119	Ia 4 th harmonic RMS	A
2120	Ib 4 th harmonic RMS	A
2121	Ic 4 th harmonic RMS	A
2122	Ia 5 th harmonic RMS	A
2123	Ib 5 th harmonic RMS	A
2124	Ic 5 th harmonic RMS	A
2125	Ia 6 th harmonic RMS	A

2126	Ib 6 th harmonic RMS	A
2127	Ic 6 th harmonic RMS	A
2128	Ia 7 th harmonic RMS	A
2129	Ib 7 th harmonic RMS	A
2130	Ic 7 th harmonic RMS	A
2131	Ia 8 th harmonic RMS	A
2132	Ib 8 th harmonic RMS	A
2133	Ic 8 th harmonic RMS	A
2134	Source side Va 2 nd harmonic RMS	V
2135	Source side Vb 2 nd harmonic RMS	V
2136	Source side Vc 2 nd harmonic RMS	V
2137	Source side Va 3 rd harmonic RMS	V
2138	Source side Vb 3 rd harmonic RMS	V
2139	Source side Vc 3 rd harmonic RMS	V
2140	Source side Va 4 th harmonic RMS	V
2141	Source side Vb 4 th harmonic RMS	V
2142	Source side Vc 4 th harmonic RMS	V
2143	Source side Va 5 th harmonic RMS	V
2144	Source side Vb 5 th harmonic RMS	V
2145	Source side Vc 5 th harmonic RMS	V
2146	Source side Va 6 th harmonic RMS	V
2147	Source side Vb 6 th harmonic RMS	V
2148	Source side Vc 6 th harmonic RMS	V
2149	Source side Va 7 th harmonic RMS	V
2150	Source side Vb 7 th harmonic RMS	V
2151	Source side Vc 7 th harmonic RMS	V
2152	Source side Va 8 th harmonic RMS	V
2153	Source side Vb 8 th harmonic RMS	V
2154	Source side Vc 8 th harmonic RMS	V
2155		
2156		
2157		
2158		
2159		
2160		

2161		
2162		
2163		
2164		
2165		
2166		
2167		
2168		
2169		
2170		
2171		
2172		
2173		
2174		
2175		
2176	In THD	%
2177	In true RMS	A
2178	In 2 nd harmonic RMS	A
2179	In 3 rd harmonic RMS	A
2180	In 4 th harmonic RMS	A
2181	In 5 th harmonic RMS	A
2182	In 6 th harmonic RMS	A
2183	In 7 th harmonic RMS	A
2184	In 8 th 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 - 2 nd 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 1 st	0.5~60.0,step:0.1Sec
3056	Reclose Interval 2 nd	1~60s
3057	Reclose Interval 3 rd	1~60s
3058	Reclose Interval 4 th	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		
3068		
3069		
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 - 2 nd 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 1 st	0.5~60.0,step:0.1Sec
3156	Reclose Interval 2 nd	1~60s
3157	Reclose Interval 3 rd	1~60s
3158	Reclose Interval 4 th	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		
3168		
3169		
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 - 2 nd 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 1 st	0.5~60.0,step:0.1Sec
3256	Reclose Interval 2 nd	1~60s
3257	Reclose Interval 3 rd	1~60s
3258	Reclose Interval 4 th	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		
3268		
3269		
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 - 2 nd 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 1 st	0.5~60.0,step:0.1Sec
3356	Reclose Interval 2 nd	1~60s
3357	Reclose Interval 3 rd	1~60s
3358	Reclose Interval 4 th	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		
3368		
3369		
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	