

F-FTU200 Feeder Terminal Unit

For Automatic Circuit Recloser (15kV~38kV)

Technical Manual



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Forward

Please read this chapter carefully before using this product!

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

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

Safety items

- When the primary system is live working, secondary open circuit for the current transformer connected to the device is absolutely forbidden, and the open of this circuit may cause extremely dangerous high voltage.
- Take note that during operation of the recloser certain parts are subject to dangerous voltage. Mechanical parts, also remote-controlled, can move quickly. Failure to comply may result in death, severe personal injury or damage to equipment.
- Installation, operation and maintenance shall only be carried out by trained and experienced personnel who are familiar with the equipment and the electrical safety requirements.
- The device is only permitted to run in atmospheric environment that specified in the technical specifications, and abnormal vibrations shall be avoided in its running environment.
- When the output terminals of the device are connected to external circuit, please check carefully the voltage of external power to prevent overheating of the circuit.
- Carefully check the cable connected to the device, preventing applying too much external force on it.
- Grounding terminals of the device shall be firmly grounded.

1. INTRODUCTION

Intelligent distribution grid is the combination of traditional power grid and technology innovation of products, the application of sensors enables distribution grid to have the ability to observe the status, the application of control and communication technology enable distribution grid to have the ability of remote control, the application of artificial intelligence technology enables distribution grid to have the ability of self-diagnosis, and most of all, Feeder Terminal Unit (FTU) is the concentrated expression of these abilities.

In distribution power grid, Feeder Terminal Unit (FTU) is the key point to realize feeder automation. Its main function is to realize Fault Detection, Isolation and Restoration (FDIR), reducing outage time, improving reliability of power supply.

With the continuously development of distribution automation worldwide, more and more Feeder Terminal Units are applied in overhead lines, while protecting feeder, implementing local or centralized fault self-recovery control, and by communication network, connecting to SCADA system, realizing remote functions.

This Technical Manual applies to the following range of products manufactured by Four-Faith Smart Power:

- Automatic Circuit Recloser: F-ACR
- Control Cabinet: F-FTU200
- Feeder Protection Relay: F-RLY100

The model names are shown on the equipment nameplates. If your equipment does not correspond to these names then this Technical Manual is not applicable.

Important! Due to continuous product improvement, technical specifications and design are subject to change without notice.

1.1 Description

The F-ACR is designed for automatically interrupting and reclosing an AC circuit with a predetermined sequence of opening and reclosing followed by resetting, hold closed, or lockout.

The F-ACR is performed in the circuit interrupting device using vacuum as the arc interrupting medium. The arc interrupter contacts are designed to withstand heavy arcing when load breaking or when breaking / making during a fault . The external insulation is made of a kind of material suitable for outdoor using.

The F-ACR is hermetically sealed permanently, compact, lightweight, maintenance free, corrosion free, compatible and can be easily mounted either on poles or sub-station structures.

The F-ACR operating mechanism is driven by permanent magnetic actuator. Manual opening and lockout facilities are provided for maintenance purpose.

The OPEN and CLOSE position of the F-ACR are easy to see from ground level even under adverse weather condition by having a reliable, light reflecting, color-coded indicating device of the position of the arc interrupter.

The F-ACR is also come with a counter to record its operations.

The F-FTU200 is a fully digitalized and microprocessor-based control device which designed to provide protective coordination and fault clearance of distribution systems for the continuous best quality of electric service.

The F-FTU200 provides protection, measurements, status monitoring, control ,communication, data handling and distribution automation.

The F-FTU200 contains DT, IDMT and user defined curves according to IEC and ANSI standards to provide fully protective coordination for the continuous best quality of electric distribution. Users can select any time of current curve simply by programming and modifying.

The F-FTU200 can operate Close and Open and other actions with key buttons on the user interface panel: Local/Remote, Overcurrent Enabled, Ground Enabled, SEF Enabled, Reclose Enabled, Control Locked, Alternate-settings, Hot line tag, Program 1, Program 2, Authorization.

The F-FTU200 is a weatherproof cabinet with a door that can be pad lockable, and suitable for mounting on a pre-stressed concrete pole. A steel channel, fixed to the control cabinet for mounting purpose, is provided.

The F-FTU200 can be managed by software through portable PC for modification of settings, acquisition of event data, and management of operation history.

The F-FTU200 is include space for mounting the radio.

1.2 Safety Instructions

General hazard statements applicable to this equipment are described in this section. Statements related to specific tasks or procedures are located throughout this manual.

DANGER! Contact with hazardous voltage can cause death or severe personal injury. Contact with switching module or recloser control terminals should only be undertaken when equipment is isolated from applicable sources of voltage.

WARNING! Follow all locally approved safety procedures when installing or operating this equipment. Improper handling, installation, operation or maintenance can result in death, severe personal injury or damage to equipment.

WARNING! Power distribution equipment must be properly selected and used only for the intended purpose.

1.3 Summary of Features

Protection

- Three-phase Non-directional Over-current Protection (ANSI 50/51)
- Non-directional Earth-fault Protection (ANSI 50N/51N)
- Three-phase Directional Over-current Protection (ANSI 67)
- Directional Earth-fault Protection (ANSI 67N)
- Sensitive Earth-fault Protection (ANSI 64N)
- Inrush restraint Function (ANSI 68)
- Negative-sequence over-current Protection (ANSI 46)
- Three Phase Over-voltage Protection (ANSI 59)
- Three Phase Under-voltage Protection (ANSI 27)
- Over-frequency Protection (ANSI 81H)
- Under-frequency Protection (ANSI 81L)
- Rate of Change of Frequency Protection (ANSI 81R)
- Trip Circuit Supervision Function (ANSI TCM)
- Cold Load Pickup Function
- Hot Line Tag
- 5 Setting Groups

Measurement

- Phase, Ground and Sensitive Ground Current (I_a , I_b , I_c , I_o , I_0)
- Line and Phase Voltage on power and load side (U_a , U_b , U_c , U_r , U_s , U_t)
- Residual Voltage on power and load side (U_{o1} , U_{o2})
- Single and Three Phase Active Power (P_a , P_b , P_c , P_t)
- Single and Three Phase Reactive Power (Q_a , Q_b , Q_c , Q_t)
- Single and Three Phase Apparent Power (S_a , S_b , S_c , S_t)
- Single and Three Phase Active Energy (EP_a , EP_b , EP_c , EP_t)
- Single and Three Phase Reactive Energy (EQ_a , EQ_b , EQ_c , EQ_t)
- Single and Three Phase Apparent Energy (ES_a , ES_b , ES_c , ES_t)
- Single and Three Phase Power Factor (PF_a , PF_b , PF_c , PF_t)
- Frequency Magnitude and Rate (F)
- Synchronizing Difference Voltage
- Synchronizing Difference Frequency
- Synchronizing Difference Angle
- Sequence Components of Three Phase Voltages & Currents (I_1 , I_2 , I_0 , U_1 , U_2 , U_0)
- True RMS, Harmonics up to 11st and THD of Voltages & Currents
- Demand Currents, Voltages, Power, Energy, Power Factor, Frequency and Harmonics
- Power Quality, Load Profile, Disturbance Recorder Graphs for Analysis
- Battery Voltage (V_{dc})

Control

- Open and Close

- Local and Remote
- Reclosing Function (ANSI 79)
- Synchronization Check Function (ANSI 25)
- Battery Test
- Authorization Setting
- Clear Indications, Events, Fault Records, Disturbance Records, Power Quality, Load Profile
- Function Enable/Disable: Reclosing, Protection, Group Setting, Hot Line Tag

Monitoring

- Protection Start, Trip and Alarm
- Measurement High Alarm and Warn
- Trip Counter Limit
- Open/Close Status
- Local/Remote Status
- Reclosing Status
- Reclosing Lockout
- Reclosing Operation Fail
- Synchronism Check Status
- Synchronism Check Successful
- Synchronism Check Fail
- AC Fail & DC Fail
- Battery Low Alarm
- Battery Activation Status
- Door Open Alarm
- Device Internal Fault

Communication

- Front Panel RJ45 Ethernet Port: IEC104 protocol for debugging
- Rear Panel RS232 & RS485/232 Serial Port: IEC101/DNP3.0/Modbus for remote
- Rear Panel RJ45 Ethernet Port: IEC104/DNP3.0/Modbus for remote

Recorder

- Trip and fault counter
- System Event Recorder - last 10,000 events
- Fault Recorder - last 1,024 faults
- Load profile recorder - last 30 days
- Disturbance Recorder - Maximum 500 cycles × 10 (128 samples/cycle)

Distribution Automation

- Loop Automation Scheme
- Auto-changeover Scheme

User Interface

- Large LCD (10 lines * 20 characters)

- Fault Indicators
- 16 Programmable LEDs
- 10 Programmable buttons
- Access Security(Passcode)
- RJ45 Ethernet Debugging Port

Time/Date Format

- 24H:MM:SS:MS
- 12H:MM:SS:MS
- DD.MM.YYYY
- DD/MM/YYYY
- DD-MM-YYYY
- MM.DD.YYYY
- MM/DD/YYYY
- YYYY-MM-DD
- YYYY-DD-MM
- YYYY/DD/MM

1.4 Abbreviations

ACR	Automatic Circuit Recloser
FTU	Feeder Terminal Unit
IED	Intelligent Electronic Device
FDIR	Fault Detection, Isolation and Restoration
SCADA	Supervisory Control And Data Acquisition
VT	Voltage Transformer
CT	Current Transformer
VS	Voltage Sensor
SA	Surge Arrester
OC	Over Current Protection Element
EF	Earth Fault Protection Element
DOC	Directional Over Current Protection Element
DEF	Directional Earth Fault Protection Element
SEF	Sensitive Earth Fault Protection Element
IR	Inrush Restraint Function Element
NSOC	Negative Sequence Over Current Protection Element
OV	Over Voltage Protection Element
UV	Under Voltage Protection Element
OF	Over Frequency Protection Element
UF	Under Frequency Protection Element
FR	Frequency Rate of change Protection Element
PF	Power Factor
CSM	Current Sequence Measurement

VSM	Voltage Sequence Measurement
CTHD	Current Total Harmonic Distortion
VTHD	Voltage Total Harmonic Distortion
SOE	Sequence of Event
FR	Fault Recorder
DR	Disturbance Recorder
PQM	Power Quality Management
LPD	Load Profile Display
CLP	Cold Load Pickup
TCS	Trip Circuit Supervision
HLT	Hot Line Tag
BAT	Battery
Syn-Check	Synchronism Check Function
DT	Definite Time
IDMT	Inverse Definite Minimum Time
NI	Normal Inverse curve
VI	Very Inverse curve
EI	Extremely Inverse curve
MI	Moderately Inverse curve
LEI	Long time Extremely Inverse curve
LVI	Long time Very Inverse curve
LI	Long time Inverse curve
SI	Short time Inverse curve
RMS	Root Mean Square
DFT	Discrete Fourier Transform
HMI	Human Machine Interface
LHMI	Local Human Machine Interface
WHMI	Website Human Machine Interface
OHL	Overhead Line
SBO	Select Before Operate

1.5 Revision History

Revision No.	Date	Description
Ver 1.0	2022.08.24	First Revision
Ver 1.1	2025.05.24	Fixed pictures and text descriptions

2. TECHNICAL SPECIFICATIONS

F-ACR automatic circuit breaker and F-FTU200 control cubicle main technical parameters are presented in below chapters.

2.1 Automatic Circuit Recloser

Table 1-Recloser Technical Specifications

Parameter	F-ACR15	F-ACR27	F-ACR38
Normal operating voltage	2.4-14.4 kV	24.9 kV	34.5 kV
Rated maximum voltage	15.5 kV	27 kV	38 kV
Rated power frequency withstand voltage ⁽¹⁾	50/60 kV ⁽¹⁾	60/70 kV ⁽¹⁾	70/80 kV ⁽¹⁾
Rated lightning impulse withstand Voltage	110/125 kV	125/150 kV	150/170 kV
Rated continuous current	630 A ⁽²⁾	630 A ⁽²⁾	630 A ⁽²⁾
Rated Line-charging breaking Current	5 A	5 A	5 A
Rated cable-charging breaking Current	25 A	25 A	25 A
Rated short-circuit breaking current	12.5/16 kA	12.5/16 kA	12.5/16 kA
Rated peak withstand current	31.5/40 kA	31.5/40 kA	31.5/40 kA
Rated short-time withstand current	12.5/16 kA	12.5/16 kA	12.5/16 kA
Rated duration of short circuit	3s	3s	3s
Rated frequency	50/60 Hz	50/60 Hz	50/60 Hz
Extinguishing medium	Vacuum	Vacuum	Vacuum
Insulation medium	Embedded pole	Embedded pole	Embedded pole
Operation mechanism	Magnetic actuator	Magnetic actuator	Magnetic actuator
Bushing material	Epoxy	Epoxy	Epoxy
Mechanical endurance (CO-cycles)	10,000	10,000	10,000
Rated operating sequence	O-0.2s-CO-2s-CO	O-0.2s-CO-2s-CO	O-0.2s-CO-2s-CO
Maximum interrupting time	40 ms	40 ms	40 ms
Maximum closing time	60 ms	60 ms	60 ms
Creepage distance	640 mm	960 mm	1288 mm
Pollution level	IV (31mm/kV)	IV (31mm/kV)	IV (31mm/kV)
Main circuit resistance	≤65uΩ	≤65uΩ	≤65uΩ
Temperature range	-40° C ... +70° C	-40° C ... +70° C	-40° C ... +70° C
Humidity	100%, condensing	100%, condensing	100%, condensing
Altitude	2000 m ⁽³⁾	2000 m ⁽³⁾	2000 m ⁽³⁾
Degree of protection	IP65	IP65	IP65
Weight	130 kg	140 kg	150 kg
Reference Standard	IEC62271-111-2019	IEC62271-111-2019	IEC62271-111-2019
	IEEE C37 60	IEEE C37 60	IEEE C37 60

(1) 1 min dry, to earth and between phases/across the isolating distance.

(2) Up to 1000A for customers special required.

(3) If higher altitude required, please contact the manufacturer.

Table 2-Current Transformer Technical Specifications

Parameter	Value
CT ratio ⁽¹⁾	600/1 or 800/1 or 1000/1
CT accuracy	±0.5%, 5P20
CT burden	2.5VA

(1) Up to 1000A for customers special required.

Table 3-Voltage Sensor Technical Specifications

Parameter	Value
VS secondary range	0 ... 4 V AC
VS accuracy	±0.5%

2.2 Feeder Terminal Unit

Table 4-Control Cubicle Technical Specifications

Parameter	F-FTU200
Power supply range	100 ... 240 V AC
Maximum power consumption	<30 W
Duration of operation without auxiliary supply	24 hours
Rated frequency	50/60 Hz
Operation voltage	24 V DC (20 ... 29 V DC)
Rechargeable battery type	Sealed lead acid
Rechargeable battery voltage & capacity	12V/12AH
Analog input	4I+6Us
Current transformer input ratio	1/5A ⁽¹⁾
Current transformer input capacity	5A nominal 10A continuous 200A 1 second Border: <1VA
Current transformer input withstand voltage	Isolation withstand voltage: 2500V Surge withstand voltage: 4000 V
Voltage sensor input range	0~8V rms (input is optimized with secondary rated phase voltage 4Vrms)
Voltage sensor input capacity	1.4Un continuous 2Un 10 seconds Border: <0.5VA
Voltage sensor input withstand voltage	Isolation withstand voltage: 2500V Surge withstand voltage: 4000V
Binary input/output	8 BI/4BO ⁽²⁾
Binary input rated voltage	24 V DC
Binary input threshold voltage	>18 V DC
Binary input reaction time	<20 ms
Binary output rated voltage	220 V DC

Binary output rated current	5A
Binary output making capacity	5 A continuous 30A 0.2 second
Binary output breaking capacity (at L/R=40ms)	30W
RTD/mA inputs	4~20mA
Debugging port on front panel	RJ45 Ethernet port
Communication serial port on rear panel	RS232 & RS232/485 serial port
Communication ethernet port on rear panel	RJ45 Ethernet port
Communication protocol	IEC101/104, DNP3.0, MODBUS
Temperature range	-25° C ... +70° C
Degree of protection	IP55
Dimension	836*445*330 mm
Space room for radio	210*180*130 mm
Weight	60kg

(1) Residual current and/or phase current.

(2) Standard configuration, up to 16BI/8BO with expand option card if required.

Table 5-Charger Technical Specifications

Parameter	Value
Power supply range	165 ... 265V AC
Voltage output	20.5 ... 27.5V DC
Temperature range	-40° C ... +70° C
MTBF	$\geq 1 \times 10^5$ h (20° C)

Table 6-Permanent Actuator Driver Technical Specifications

Parameter	Value
Power supply range	100 ... 280V DC
Trip/Close current	0 ... 160A
Temperature range	-40° C ... +70° C
MTBF	$\geq 1 \times 10^5$ h (20° C)

Table 7-Thermostat Technical Specifications

Parameter	Value
Power supply range	AC220V $\pm 10\%$
Temperature range	-20° C ... +70° C
Humidity	$\leq 95\%$
Accuracy	$\pm 2^\circ\text{C}$
Response time	$\leq 5\text{S}$

2.3 Voltage Transformer

Table 8-VT Technical Specifications

Parameter	11 kV	22 kV	33 kV
Secondary range	100 ... 240V AC	100 ... 240V AC	100 ... 240V AC
Accuracy	6P	6P	6P
Burden	500VA	500VA	500VA

3. PRODUCT OVERVIEW

The specialized distribution automation components include the essential functions for the grid nodes. These components are able to carry out automatic functions, either on their own in a local automation scheme or in cooperation with a remote system, either automatically or manually. Four-Faith Smart Power strives to bring our customers the latest technology. Combined with superior performance, competitive pricing, and qualified service, our products are the natural choice for you. This is especially true of our feeder automation products, where years of knowledge and modular manufacturing techniques allow our ACRs and FTUs to meet any need and schedule.

3.1 Outdoor Primary Switch

Automatic Circuit Reclosers (ACRs) are outdoor intelligent primary switch applied in the field of distribution automation, usually mounted on outgoing line side of substation, tie point of ring network, feeder line of distribution grid, or at the head of important branch lines, with short-circuit current breaking and making ability, completed with feeder terminal unit (FTU), which can realize reclosing function. When a short-circuit fault occurs on the network, ACR implements reclosing operation according to the sequence and time interval.

If a permanent fault occurred, after implementing preset reclosing operation sequence, ACR would keep opening and blocked to close to isolate the faulted section. When the fault is removed, a manual or auto reset is needed to release blocking status and implement close operation.

If a transient fault occurred, the subsequent opening and closing operations are terminated in the reclosing operation, regardless of which reclosing is successful, and initial setting status is restored after a certain delay time.

Four-Faith Smart Power has developed F-ACR series, cover 15KV, 27KV, 38KV voltage levels, has assembled the latest magnetic actuation technology, highest quality vacuum interrupters, smallest sensor component and most durable epoxy insulating material into the most dependable, cost effective, and lowest maintenance solution for recloser products, meet IEC62271-111 and IEEE C37.60 international standards.

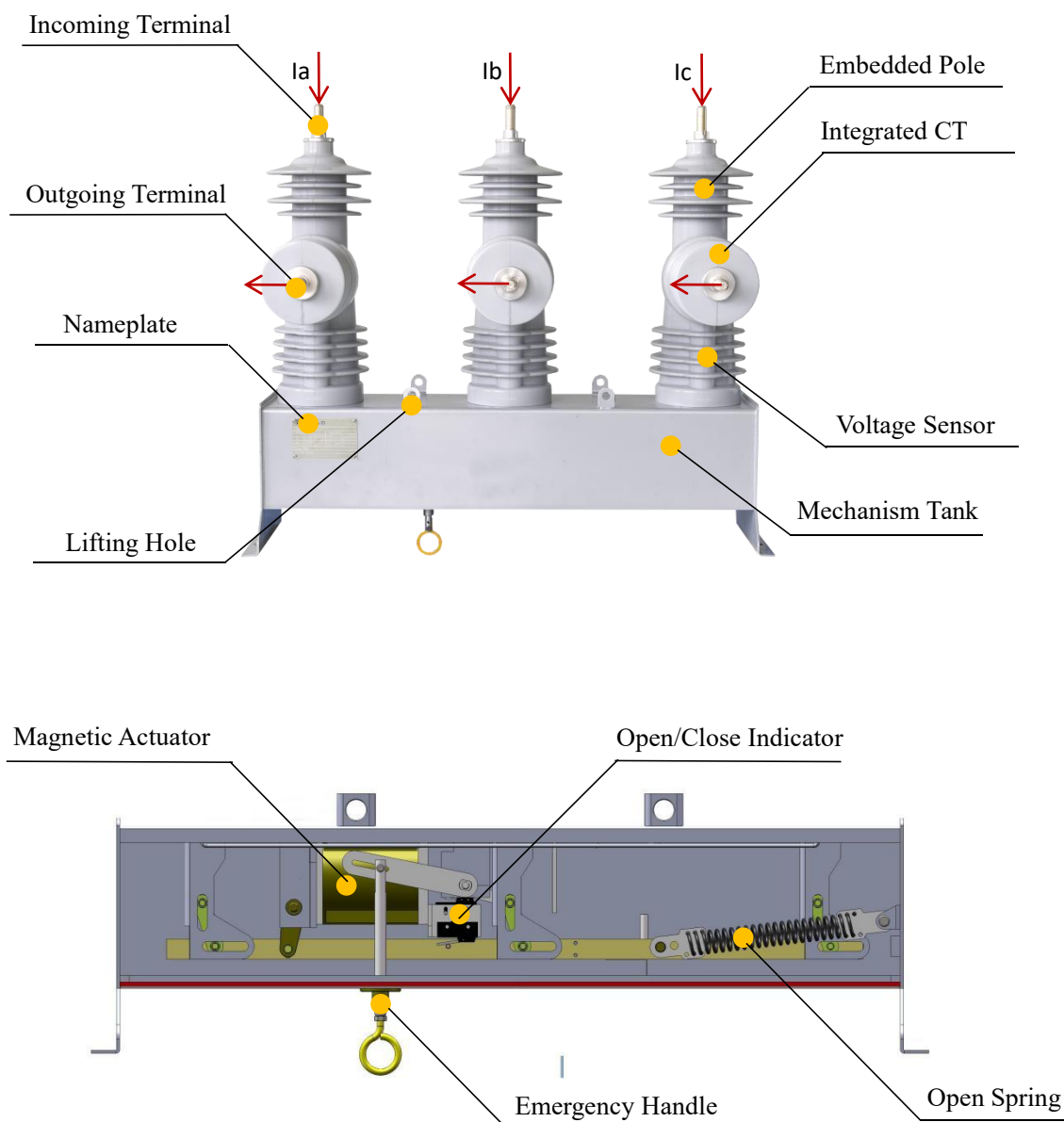


Figure 1

General arrangement of F-ACR reclosers

3.1.1 Permanent Magnetic Actuator

F-ACR reclosers were designed to have a lifetime of 10,000 mechanical operations which used a simple, magnetically actuated operating mechanism that could dependably operate 10,000 times with only one moving part, unlike ordinary spring charged mechanisms.

It applied bi-stable permanent magnet operating mechanism, compared with the spring operating mechanism, it greatly reduces the moving parts, simple maintenance, no need for power supply to hold during operation, improving reliability, realizing the customers' demand for quick opening and closing.

3.1.2 Vacuum Interrupters

The vacuum interrupter is vertically mounted inside the each pole, providing a long service life (25 years). They are the most compact in its class and show excellent mechanical, voltage withstand and current breaking capabilities.

The vacuum technology fits very well with automatic circuit recloser requirements because it can easily handle continuous operations. Additionally, vacuum interrupters do not need any extra time to recover, even through the first reclosing operation is in 200-300 ms.

3.1.3 Solid Embedded Pole

F-ACR is using enclosed pole technology, the whole vacuum interrupter is poured in epoxy resin, thus eliminating the influence of dust and moisture on the insulation capacity outside interrupter, which is not easy to age and enhance the corrosion resistance of the equipment in a highly polluted environment.

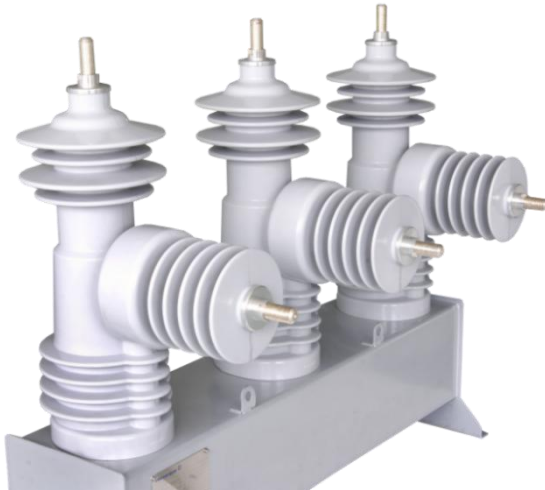


Figure 2

Solid enclosure pole technology

3.1.4 Current Transformer and Voltage Sensor

Current metering is performed by current transformers that are inbuilt into each pole. It ensures a precise acquisition of both phase and neutral currents, the range of primary side is up to 1000A according to customer selection.

Six precise low power capacitive voltage sensors on source and load side terminals are independently package in each pole, small size, maintenance-free, large linear measurement range, no magnetic saturation phenomenon, to meet the customer large scale, high-precision measurement requirements.

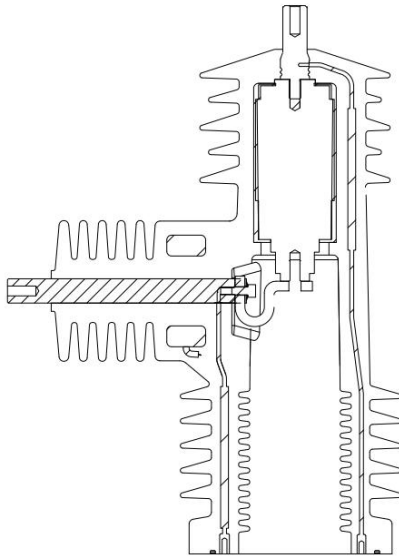


Figure 3

Voltage sensor in each pole

3.1.5 Emergency Trip and Mechanical Lockout

Recloser can support emergent opening operation, by lockout handle on the bottom, to realize manual opening, to meet the requirements of rapid power blackout in emergence, and ensure the first priority of the opening operation.

If the lockout handle was pulled, the recloser would open and locked out simultaneously; If would closed the recloser again, the lockout handle must be firstly pushed back to the operation position in order to release the lockout, then the recloser can be closed electrically by the control cubicle.



Figure 4

Mechanical Lockout Handle

3.1.6 Position Indicator

The position indicator of the recloser is easy to see from ground level even under adverse weather condition by having a reliable, light reflecting, color-coded indicating device of the position of the arc interrupter. The word of position indicator can be customized according to specification.

3.2 Control Cubicle

Control cubicle is intelligent terminal equipment for distribution automation, with local and remote functions, which applied to outdoor switches. The control box is made from 304 stainless steel type, and installed on the bottom of pole, connect to primary switches with control cable. The protection relay is core component in this control cubicle, to realize protection, metering, control, communication and logic functions. This cubicle also contains power management system which be composed of charger, battery, magnetic driver and capacitor, so that ensure uninterrupted power supply for at least 48 hours when auxiliary power that from potential voltage had cut off. The thermostat and heater are assembled into control cubicle, in order to keep the temperature and humidity in appropriate level.

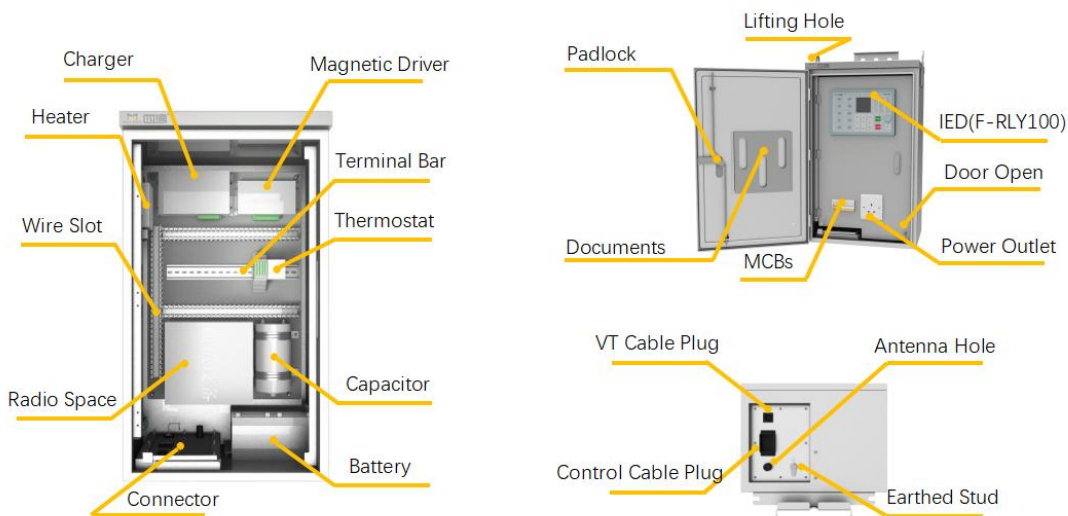


Figure 5

F-FTU200 Structure layout

The external door has a padlock provision that is suitable for a shackle with up to a 12 mm diameter. The external and internal doors can be securely fixed in the open position.

The door position switch is mounted on the control cubicle and is actuated by the lever mounted opposite to the switch on the inside of the door.

The SST earth stud is equipped at the bottom of control box with M12x30 mm bolt.

3.2.1 Feeder Protection Relay

Feeder protection relays are mainly used in overhead lines and cable lines, and are the core components of Feeder Terminal Units (FTU), Ring Main Units (RMU), and Primary Switch-gears (PSG), with the functions of protection, control, measurement, communication, data processing, power management, etc. They can be configured with a variety of distribution automation logic to realize fault detection, isolation and restoration (FDIR) of feeders, thus reducing outage time, improving power supply reliability, and helping the intelligent upgrading and transformation

development of distribution networks.

Based on the standard IEC 61850 Horizontal GOOSE Communication for substation automation, it can effect high-speed information transfer between multiple feeder protection relays. As it does not need the involvement of any master station, by setting up a local ring network for local fault diagnosis, the grid can self-heal within milliseconds, which is suitable for various network topology and can further improve power supply security and stability.

Four-Faith Smart Power has developed F-RLY series feeder protection relays with complete functions can be matched with indoor and outdoor primary equipment, and can provide customers with a variety of automation solutions, complying with IEC/ANSI international standards.

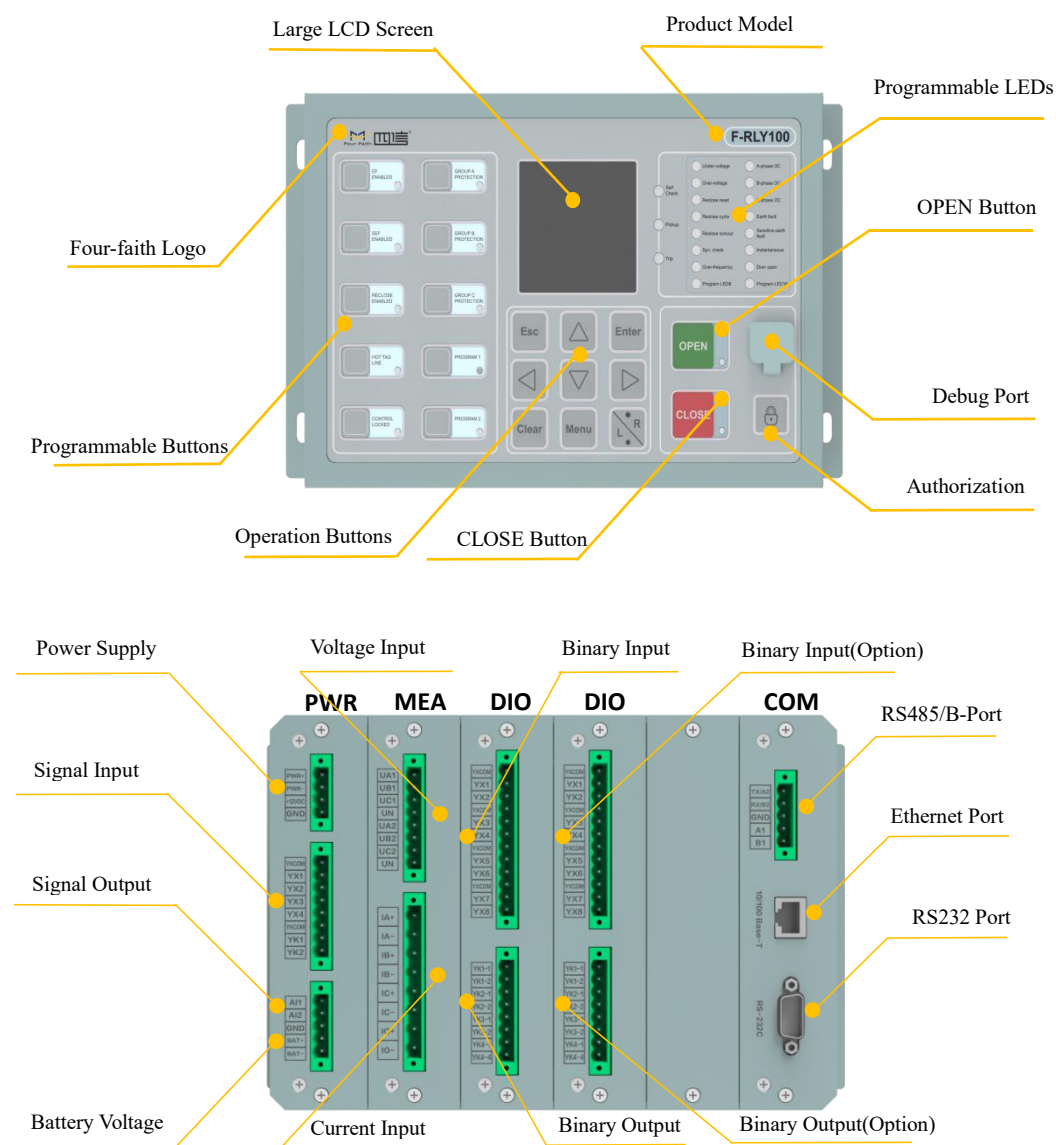


Figure 6

F-RLY100 Feeder Protection Relay layout

F-RLY100 feeder protection relay front panel consist of 7 sections as below.

a. Large LCD screen

- 10 parallels * 20 characters

b. Operation buttons

- Keyboard buttons are used for the moving menu and changing setting
- Menu button is used to select default display on LCD screen
- Clear button is used to clear or delete indicator and stored information
- L/R button is used to select local and remote control mode

c. Control buttons

- Pressing OPEN push-button sends a trip signal after selection to the recloser
- Pressing CLOSE push-button sends a close signal after selection to the recloser
- Indicates the position of the recloser

d. Indication leds

- The self-check is used to show the status of protection relay
- The pickup is used to show start signal from protection
- The trip is used to show trip signal from protection

e. Programmable leds

- The associated function of each led can be changed in signal matrix tool
- The color of each led can be changed between red and green
- The status of each led can be changed between follow and latch
- The default associated functions of programmable leds are as below:

- ✧ LED1: Under-voltage element
- ✧ LED2: Over-voltage element
- ✧ LED3: Reclose reset element
- ✧ LED4: Reclose cycle element
- ✧ LED5: Reclose lockout element
- ✧ LED6: Syn-successful element
- ✧ LED7: Over-frequency element
- ✧ LED8: Under-frequency element
- ✧ LED9: A-phase over-current element
- ✧ LED10: B-phase over-current element
- ✧ LED11: C-phase over-current element
- ✧ LED12: Earth fault element
- ✧ LED13: Sensitive earth fault element
- ✧ LED14: Instantaneous fault element
- ✧ LED15: Door open alarm element
- ✧ LED16: None

f. Programmable buttons

- The associated function of each button can be changed in button matrix tool
- The default associated function of programmable buttons are as below:
- ✧ Button1: EF ENABLED
- ✧ Button2: SEF ENABLED
- ✧ Button3: RECLOSE ENABLED
- ✧ Button4: HOT TAG LINE

- ✧ Button5: CONTROL LOCKED
- ✧ Button6: GROUP A PROTECTION
- ✧ Button7: GROUP B PROTECTION
- ✧ Button8: GROUP C PROTECTION
- ✧ Button9: None
- ✧ Button10: None

g. Authorization button

- There are four level authorization for selection:

- ✧ Administrator
- ✧ Engineer
- ✧ Operator
- ✧ Viewer

h. Debugging port

- RJ45 on front panel for debugging

F-RLY100 feeder protection relay is composed of four types of card.

a. PWR-power supply card

- The power input range is 20Vdc~29Vdc (PWR+, PWR-)
- Provide 12Vdc power for modem or radio (+12VDC, GND)
- Signal input such as “battery voltage low”, “AC fail”, “DC fail” alarm from charger (YXCOM, YX1, YX2, YX3, YX4)
- Signal output such as “battery activation on”, “battery activation off” control to charger (YKCOM, YK1, YK2)
- 2 channels 4~20mA analog input (AI1, AI2, GND)
- Battery voltage metering (BAT+, BAT-)

b. MEA-measurement card

- Three phases voltage input on power and load side from voltage sensors (UA1, UB1, UC1, UN, UA2, UB2, UC2, UN)
- Three phases and neutral current input from current transformer (IA+, IA-, IB+, IB-, IC+, IC-, IO+, IO-)

c. DIO-digital input and output card

- 8 channels binary input signal such as “open status”, “close status” from primary switch (YXCOM, YX1, YX2, YX3, YX4, YX5, YX6, YX7, YX8)
- 4 channels binary output control such as “open command”, “close command” (YK1-1, YK1-2, YK2-1, YK2-2, YK3-1, YK3-2, YK4-1, YK4-2)

d. COM-communication card

- RS232/485 terminal bar (TX/A2, RX/B2, GND)
- B-port for time synchronization (A1, B1)
- RJ45 ethernet port (10/100 Base-T)
- RS232 serial port (RS-232C)

Besides, we have reserved space for maximum two option cards in feeder protection relay, customer can choose “DIO” and “COM” as their required.

3.2.2 Battery Management System

The charger is mainly used to manage AC power supply from potential voltage and DC power supply from battery. The rechargeable battery provides the auxiliary power when the main power is not present. The battery management system is designed to provide optimum battery charging and to optimize battery lifetime.



Figure 7
Battery Charger

3.2.3 Permanent Magnetic Operation System

The permanent magnetic driver is used to manage capacitor charging and charged procedure. During the operation, capacitor will generate enough current to actuated permanent magnetic mechanism opening and closing. The power supply of the permanent magnetic drive is provided by the charger (250Vdc).



Figure 8
Permanent Magnetic Driver

3.2.4 Temperature and Humidity Monitoring System

So as to keep the temperature and humidity with properly level in control cubicle, thermostat and heater are applied. According to the data which feedback from temperature and humidity sensors, thermostat can adjust the heater to work or stop. Constant temperature and humidity environment is very important for components.



Figure 9

Thermostat

3.2.5 Control Cable

Control cable connects the outdoor switching module actuator, metering and auxiliary circuits to the feeder terminal unit. Control cable wires are well protected from UV radiation and sharp objects. The cable is equipped with a heavy duty 20 pin male connector on the outdoor switching module side and a heavy duty 20 pin female connector on the control cubicle side.

Control cable length can be 6, 8, 10, 12, 16 or 20 meters.



Figure 10

Control Cable

4. PRODUCT FUNCTIONALITY

F-FTU200 feeder terminal unit offers a comprehensive solution for protecting, metering and controlling outdoor primary switches, such as automatic circuit recloser. Besides the main protection functions, they include monitoring and operation features as well as distribution automation scheme, events and disturbance records providing data analysis capability in both local and remote.

4.1 Protection

Protective Elements Block diagram - IEC/ANSI Designations

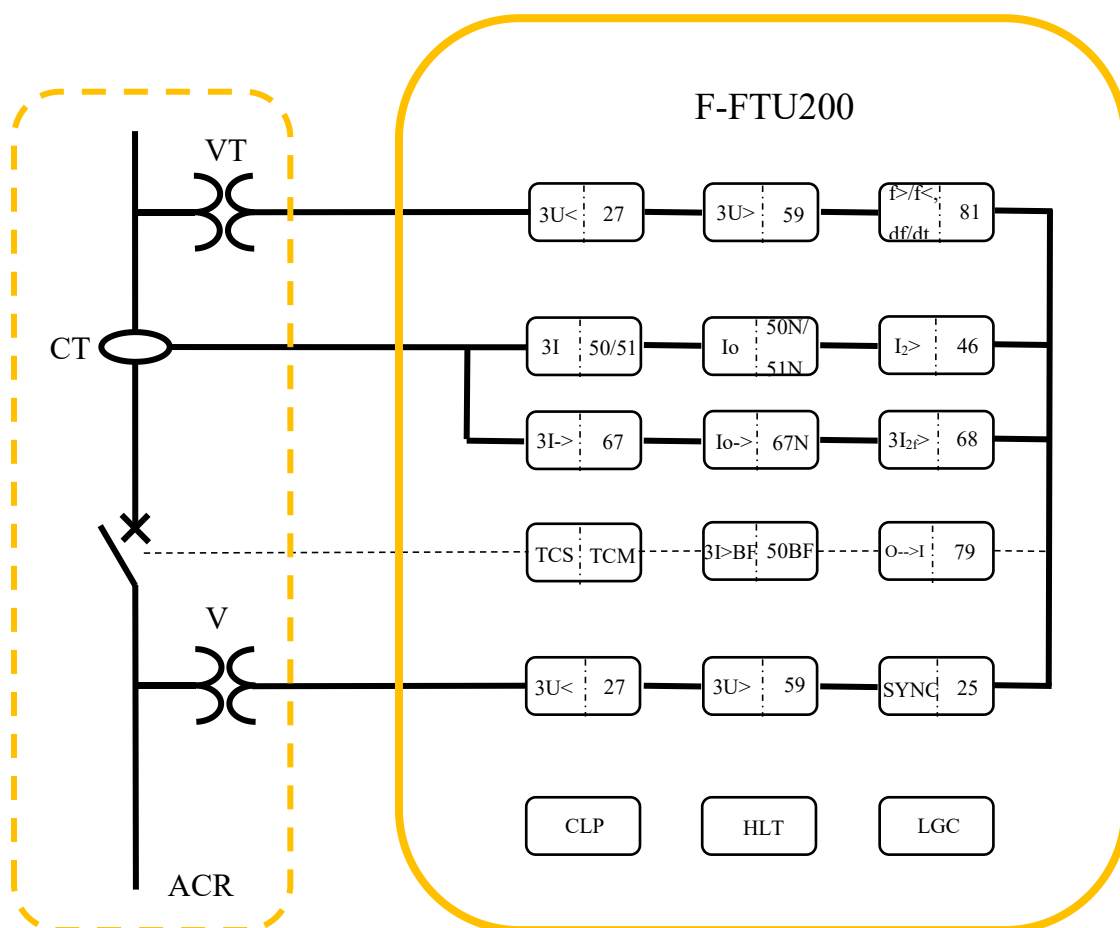


Figure 11

F-FTU200 Protective Element Block Diagram

4.1.1 Three-phase Non-directional Over-current Protection

The three-phase non-directional over-current protection is used as one-phase, two-phase

or three-phase overcurrent and short-circuit protection for feeders.

The function includes three stages:

- OC-Instantaneous stage
- OC-High stage
- OC-Low stage

The instantaneous stage always operates with the DT characteristic, high stage and low stage can be selected to be either definite time (DT) or inverse definite minimum time (IDMT). In the DT mode, the function operates after a predefined operate time and resets when the fault current disappears. The IDMT mode provides current-dependent timer characteristics.

The corresponding IEC / ANSI identifications are shown in below.

Table 9-Three-phase non-directional over-current protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
OC-Instantaneous stage	3I>>>>	50P/51P
OC-High stage	3I>>	51P-2
OC-Low stage	3I>	51P-1

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “trip”, “alarm”, “off”.

The operation principle of function can be described as below.

The measured phases current are compared with preset start value, if the measured value is greater than preset start value, the phase selection logic will detect which phase of the measured current exceeds the preset value. If the phase information matches the set value of the start phase number, the timer will activate the pickup signal output. According to the protection curve type, the time characteristics are definite time or inverse definite minimum time. When the timer has reached the value of operate delay time in DT mode or the maximum value in IDMT mode, the alarm or trip signal will be activated.

If the fault suddenly disappears before the operate delay time is reached, the reset delay time is activated. When the definite time characteristic is selected, the timer will not be reset until it exceeds the reset delay time value; when the immediately is selected, the timer will be reset instantaneously after detecting fault disappeared; when the inverse time characteristic is selected, the reset time depends on the current during the drop-off situation. The pickup signal is deactivated when the reset time has expired.

The inverse time reset mode is only supported with ANSI or user programmable types of the IDMT protection curves. If another protection curve type is selected, an immediately reset occurs during the drop-off situation.

The function operates on DFT measurement mode.

F-FTU200 provides 16 protection characteristic curves that including 5 IEC curves and 7 IEEE/ANSI curves. In addition to this, a user defined curve can be used if none of the standard curves are applicable.

The following table describes the characteristics supported by different stages.

Table 10-Characteristics supported by different stages

Curve Type	OC-High stage	OC-Low stage
IEC Very Inverse	■	■
IEC Extremely Inverse	■	■
IEC Normal Inverse	■	■
IEC Long Time Inverse		■
IEC Short Time Inverse		■
IEC Definite Time	■	■
ANSI Normal Inverse	■	■
ANSI Very Inverse	■	■
ANSI Extremely Inverse	■	■
ANSI Moderately Inverse		■
ANSI Long Time Extremely Inverse		■
ANSI Long Time Very Inverse		■
ANSI Long Time Inverse		■
ANSI Definite Time	■	■
RI Inverse		■
RD Inverse		■
User Defined	■	■

The following table shows the parameter settings among OC three stages.

Table 11-Over-current protection parameter settings

Parameter	Range	Default	Step	Unit	Description
OC-Instantaneous stage					
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Number of start phases	1 out of 3 2 out of 3 3 out of 3	1 out of 3			Number of phases required for operate activation.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
Start value	1.00~40.00	1.00	0.01	xIn	This parameter defines starting level of the protection.
Operate delay time	20~200000	20	1	ms	The protection would be alarm or trip if timer exceeded this value.
OC-High stage					
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an

					alarm without actual trip at fault. The protection would disabled if select “off”.
Number of start phases	1 out of 3 2 out of 3 3 out of 3	1 out of 3			Number of phases required for operate activation.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	20~60000	20	1	ms	Minimum operate time for IDMT curves.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user defined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.10~40.00	0.10	0.01	xIn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	Refer to table 10	IEC Def. Time			Selection of time delay curve type.
Reset curve type	Immediately Def.time Inv.time	Immediately			Selection of reset curve type.
OC-Low stage					
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Number of start phases	1 out of 3 2 out of 3 3 out of 3	1 out of 3			Number of phases required for operate activation.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded

					this value.
IDMT minimum operate time	20~60000	20	1	ms	Minimum operate time for IDMT curves.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user defined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.05~5.00	0.05	0.01	xIn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	Refer to table 10	IEC Def. Time			Selection of time delay curve type.
Reset curve type	Immediately Def.time Inv.time	Immediately			Selection of reset curve type.

The technical data of function shows below table.

Table 12-Over-current protection technical data

Parameter	Value
Operation accuracy	$\pm 1.5\%$ of set value or $\pm 0.005 \times I_n$ (at currents in the range of $0.05 \dots 20.0 \times I_n$)
Reset time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Reset time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$

4.1.2 Non-directional Earth-fault Protection

The earth-fault function is used as non-directional earth-fault protection for feeders.

The function includes three stages:

- EF-Instantaneous stage
- EF-High stage
- EF-Low stage

The instantaneous stage always operates with the DT characteristic, high stage and low stage can be selected to be either definite time (DT) or inverse definite minimum time (IDMT). In the DT mode, the function operates after a predefined operate time and resets when the fault current disappears. The IDMT mode provides current-dependent timer characteristics.

The corresponding IEC / ANSI identifications are shown in below.

Table 13-Non-directional earth fault protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
EF-Instantaneous stage	$I_o >>>$	50N/51N
EF-High stage	$I_o >>$	51N-2
EF-Low stage	$I_o >$	51N-1

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “trip”, “alarm”, “off”.

The operation principle of function can be described as below.

The measured or calculated residual current is compared with preset start value, if the value is greater than preset start value, the timer will activate the pickup signal output. According to the protection curve type, the time characteristics are definite time or inverse definite minimum time. When the timer has reached the value of operate delay time in DT mode or the maximum value in IDMT mode, the alarm or trip signal will be activated.

If the fault suddenly disappears before the operate delay time is reached, the reset delay time is activated. When the definite time characteristic is selected, the timer will not be reset until it exceeds the reset delay time value; when the immediately is selected, the timer will be reset instantaneously after detecting fault disappeared; when the inverse time characteristic is selected, the reset time depends on the current during the drop-off situation. The pickup signal is deactivated when the reset time has expired.

The inverse time reset mode is only supported with ANSI or user programmable types of the IDMT protection curves. If another protection curve type is selected, an immediately reset occurs during the drop-off situation.

The function operates on DFT measurement mode.

F-FTU200 provides 16 protection characteristic curves that including 5 IEC curves and 7 IEEE/ANSI curves. In addition to this, a user defined curve can be used if none of the standard curves are applicable.

The following table describes the characteristics supported by different stages.

Table 14-Characteristics supported by different stages

Curve Type	EF-High stage	EF-Low stage
IEC Very Inverse	■	■
IEC Extremely Inverse	■	■
IEC Normal Inverse	■	■
IEC Long Time Inverse		■
IEC Short Time Inverse		■
IEC Definite Time	■	■
ANSI Normal Inverse	■	■
ANSI Very Inverse	■	■
ANSI Extremely Inverse	■	■
ANSI Moderately Inverse		■
ANSI Long Time Extremely Inverse		■
ANSI Long Time Very Inverse		■
ANSI Long Time Inverse		■
ANSI Definite Time	■	■
RI Inverse		■
RD Inverse		■
User Defined	■	■

The following table shows the parameter settings among EF three stages.

Table 15-Earth fault protection parameter settings

Parameter	Range	Default	Step	Unit	Description
EF-Instantaneous stage					
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
Start value	1.00~10.00	1.00	0.01	xIn	This parameter defines starting level of the protection.
Operate delay time	20~200000	20	1	ms	The protection would be alarm or trip if timer exceeded this value.
EF-High stage					
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded

					this value.
IDMT minimum operate time	20~60000	20	1	ms	Minimum operate time for IDMT curves.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user defined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.10~10.00	0.10	0.01	xIn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	Refer to table 14	IEC Def. Time			Selection of time delay curve type.
Reset curve type	Immediately Def.time Inv.time	Immediately			Selection of reset curve type.
EF-Low stage					
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	20~60000	20	1	ms	Minimum operate time for IDMT curves.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user defined curve.

IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.01~5.00	0.01	0.01	xIn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	Refer to table 14	IEC Def. Time			Selection of time delay curve type.
Reset curve type	Immediately Def.time Inv.time	Immediately			Selection of reset curve type.

The technical data of function shows below table.

Table 16-Earth fault protection technical data

Parameter	Value
Operation accuracy	$\pm 1.5\%$ of set value or $\pm 0.005 \times I_n$ (at currents in the range of $0.01 \dots 20.0 \times I_n$)
Reset time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Reset time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$

4.1.3 Three-phase Directional Over-current Protection

The three-phase directional over-current protection is used as one-phase, two-phase or three-phase directional overcurrent and short-circuit protection for feeders.

The function includes two stages:

- DOC-High stage
- DOC-Low stage

High stage and low stage can be selected to be either definite time (DT) or inverse definite minimum time (IDMT). In the DT mode, the function operates after a predefined operate time and resets when the fault current disappears. The IDMT mode provides current-dependent timer characteristics.

The corresponding IEC / ANSI identifications are shown in below.

Table 17-Three-phase directional over-current protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
DOC-High stage	3I>> ->	67-2
DOC-Low stage	3I> ->	67-1

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “trip”, “alarm”, “off”.

The operation principle of function can be described as below.

The measured phases current are compared with preset start value, if the measured value is greater than preset start value, and directional calculation is fulfilled fault criteria, the phase selection logic will detect which phase of the measured current exceeds the preset value. If the phase information matches the set value of the start phase number, the timer will activate the pickup signal output. According to the protection curve type, the time characteristics are definite time or inverse definite minimum time. When the timer has reached the value of operate delay time in DT mode or the maximum value in IDMT mode, the alarm or trip signal will be activated.

If the fault suddenly disappears before the operate delay time is reached, the reset delay time is activated. When the definite time characteristic is selected, the timer will not be reset until it exceeds the reset delay time value; when the immediately is selected, the timer will be reset instantaneously after detecting fault disappeared; when the inverse time characteristic is selected, the reset time depends on the current during the drop-off situation. The pickup signal is deactivated when the reset time has expired.

The inverse time reset mode is only supported with ANSI or user programmable types of the IDMT protection curves. If another protection curve type is selected, an immediately reset occurs during the drop-off situation.

The forward and reverse sectors are defined separately. The forward operation area is limited with the min forward angle and max forward angle settings. The reverse operation area is limited with the min reverse angle and max reverse angle settings. The Characteristic angle setting is used to turn the directional characteristic. The following picture describes the angular relationship between voltage and current.

The function operates on DFT measurement mode.

F-FTU200 provides 16 protection characteristic curves that including 5 IEC curves and 7 IEEE/ANSI curves. In addition to this, a user defined curve can be used if none of the standard curves are applicable.

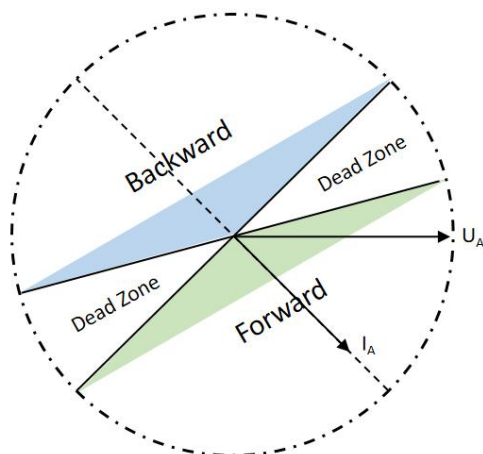


Figure 12

DOC directional operating sectors

The following table describes the characteristics supported by different stages.

Table 18-Characteristics supported by different stages

Curve Type	DOC-High stage	DOC-Low stage
IEC Very Inverse	■	■
IEC Extremely Inverse	■	■
IEC Normal Inverse	■	■
IEC Long Time Inverse		■
IEC Short Time Inverse		■
IEC Definite Time	■	■
ANSI Normal Inverse	■	■
ANSI Very Inverse	■	■
ANSI Extremely Inverse	■	■
ANSI Moderately Inverse		■
ANSI Long Time Extremely Inverse		■
ANSI Long Time Very Inverse		■
ANSI Long Time Inverse		■
ANSI Definite Time	■	■
RI Inverse		■
RD Inverse		■
User Defined	■	■

The following table shows the parameter settings among DOC two stages.

Table 19-Directional over-current protection parameter settings

Parameter	Range	Default	Step	Unit	Description
DOC-High stage					
Operation	trip/alarm/off	off			This protection element can be used as an

					alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Number of start phases	1 out of 3 2 out of 3 3 out of 3	1 out of 3			Number of phases required for operate activation.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	20~60000	20	1	ms	Minimum operate time for IDMT curves.
Allow non-direction	true false	false			Allows protection activation as non-dir when dir info is invalid.
Directional mode	forward reverse	forward			Select the operation area.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user defined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.10~40.00	0.10	0.01	xln	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	Refer to table 18	IEC Def. Time			Selection of time delay curve type.
Reset curve type	Immediately Def.time Inv.time	Immediately			Selection of reset curve type.
Characteristic angle	-179~180	60	1	deg	The angle between current and voltage.
Max forward angle	0~90	80	1	deg	Maximum phase angle in forward direction.

Min forward angle	0~90	80	1	deg	Minimum phase angle in forward direction.
Max reverse angle	0~90	80	1	deg	Maximum phase angle in reverse direction.
Min reverse angle	0~90	80	1	deg	Minimum phase angle in reverse direction.
DOC-Low stage					
Operation	trip/alarm/off	off			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Number of start phases	1 out of 3 2 out of 3 3 out of 3	1 out of 3			Number of phases required for operate activation.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	20~60000	20	1	ms	Minimum operate time for IDMT curves.
Allow non-direction	true false	false			Allows protection activation as non-dir when dir info is invalid.
Directional mode	forward reverse	forward			Select the operation area.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user defined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.05~5.00	0.05	0.01	xIn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve	Refer to table	IEC Def.			Selection of time delay curve type.

type	18	Time			
Reset curve type	Immediately Def.time Inv.time	Immediately			Selection of reset curve type.
Characteristic angle	-179~180	60	1	deg	The angle between current and voltage.
Max forward angle	0~90	80	1	deg	Maximum phase angle in forward direction.
Min forward angle	0~90	80	1	deg	Minimum phase angle in forward direction.
Max reverse angle	0~90	80	1	deg	Maximum phase angle in reverse direction.
Min reverse angle	0~90	80	1	deg	Minimum phase angle in reverse direction.

The technical data of function shows below table.

Table 20-Directional over-current protection technical data

Parameter	Value
Operation accuracy	$\pm 1.5\%$ of set value or $\pm 0.005 \times I_n$ (at currents in the range of $0.05 \dots 20.0 \times I_n$) Phase angle: $\pm 2^\circ$
Reset time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Reset time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$

4.1.4 Directional Earth-fault Protection

The directional earth-fault protection is used as ground fault for feeders.

The function includes two stages:

- DEF-High stage
- DEF-Low stage

High stage and low stage can be selected to be either definite time (DT) or inverse definite minimum time (IDMT). In the DT mode, the function operates after a predefined operate time and resets when the fault current disappears. The IDMT mode provides current-dependent timer characteristics.

The corresponding IEC / ANSI identifications are shown in below.

Table 21-Directional earth-fault protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
DEF-High stage	$I_o >> ->$	67N-2
DEF-Low stage	$o > ->$	67N-1

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “trip”, “alarm”, “off”.

The operation principle of function can be described as below.

The measured or calculated residual current is compared with preset start value, if the measured value is greater than preset start value, and directional calculation is fulfilled fault criteria, the timer will activate the pickup signal output. According to the protection curve type, the time characteristics are definite time or inverse definite minimum time. When the timer has reached the value of operate delay time in DT mode or the maximum value in IDMT mode, the alarm or trip signal will be activated.

If the fault suddenly disappears or directional calculation not fulfills fault criteria before the operate delay time is reached, the reset delay time is activated. When the definite time characteristic is selected, the timer will not be reset until it exceeds the reset delay time value; when the immediately is selected, the timer will be reset instantaneously after detecting fault disappeared; when the inverse time characteristic is selected, the reset time depends on the current during the drop-off situation. The pickup signal is deactivated when the reset time has expired. The inverse time reset mode is only supported with ANSI or user programmable types of the IDMT protection curves. If another protection curve type is selected, an immediately reset occurs during the drop-off situation.

The forward and reverse sectors are defined separately. The forward operation area is limited with the min forward angle and max forward angle settings. The reverse operation area is limited with the min reverse angle and max reverse angle settings. The Characteristic angle setting is used to turn the directional characteristic. The following picture describes the angular relationship between residual voltage and residual current.

The function operates on DFT measurement mode.

F-FTU200 provides 16 protection characteristic curves that including 5 IEC curves and 7 IEEE/ANSI curves. In addition to this, a user defined curve can be used if none of the standard curves are applicable.

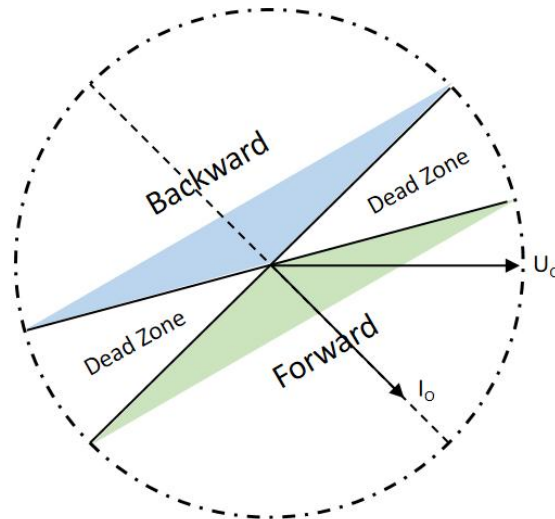


Figure 13

DEF directional operating sectors

The following table describes the characteristics supported by different stages.

Table 22-Characteristics supported by different stages

Curve Type	DEF-High stage	DEF-Low stage
IEC Very Inverse	■	■
IEC Extremely Inverse	■	■
IEC Normal Inverse	■	■
IEC Long Time Inverse		■
IEC Short Time Inverse		■
IEC Definite Time	■	■
ANSI Normal Inverse	■	■
ANSI Very Inverse	■	■
ANSI Extremely Inverse	■	■
ANSI Moderately Inverse		■
ANSI Long Time Extremely Inverse		■
ANSI Long Time Very Inverse		■
ANSI Long Time Inverse		■
ANSI Definite Time	■	■
RI Inverse		■
RD Inverse		■
User Defined	■	■

The following table shows the parameter settings among DEF two stages.

Table 23-Directional earth-fault protection parameter settings

Parameter	Range	Default	Step	Unit	Description
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DEF-High stage					
Operation	trip/alarm/off	off			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	40~60000	40	1	ms	Minimum operate time for IDMT curves.
Allow non-direction	true false	false			Allows protection activation as non-dir when dir info is invalid.
Directional mode	forward reverse	forward			Select the operation area.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user defined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.10~10.00	0.10	0.01	xIn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	Refer to table 22	IEC Def. Time			Selection of time delay curve type.
Reset curve type	Immediately Def.time Inv.time	Immediately			Selection of reset curve type.
Characteristic angle	-179~180	-90	1	deg	The angle between residual current and residual voltage.
Max forward angle	0~90	80	1	deg	Maximum phase angle in forward direction.
Min forward	0~90	80	1	deg	Minimum phase angle in forward

angle					direction.
Max reverse angle	0~90	80	1	deg	Maximum phase angle in reverse direction.
Min reverse angle	0~90	80	1	deg	Minimum phase angle in reverse direction.
DEF-Low stage					
Operation	trip/alarm/off	off			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	40~60000	50	1	ms	Minimum operate time for IDMT curves.
Allow non-direction	true false	false			Allows protection activation as non-dir when dir info is invalid.
Directional mode	forward reverse	forward			Select the operation area.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user defined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.01~5.00	0.01	0.01	xIn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	50	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	Refer to table 22	IEC Def. Time			Selection of time delay curve type.
Reset curve type	Immediately Def.time Inv.time	Immediately			Selection of reset curve type.

Characteristic angle	-179~180	-90	1	deg	The angle between current and voltage.
Max forward angle	0~90	80	1	deg	Maximum phase angle in forward direction.
Min forward angle	0~90	80	1	deg	Minimum phase angle in forward direction.
Max reverse angle	0~90	80	1	deg	Maximum phase angle in reverse direction.
Min reverse angle	0~90	80	1	deg	Minimum phase angle in reverse direction.

The technical data of function shows below table.

Table 24-Directional earth-fault protection technical data

Parameter	Value
Operation accuracy	$\pm 1.5\%$ of set value or $\pm 0.005 \times I_n$ (at currents in the range of $0.01 \dots 20.0 \times I_n$) Phase angle: $\pm 2^\circ$
Reset time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Reset time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$

4.1.5 Sensitive Earth-fault Protection

On the isolated or compensated network, it is hard to detect the earth fault current because it is too small to discriminate. In case of earth fault in the isolated network, the fault current is charged current in the stray capacitance of the line. The magnitude depends on number of feeders connected and length of the feeders. In addition, when an earth fault occurs, charged currents flow into the faulted point from all feeders.

In order to detect this kind of earth fault, the accurate residual current is needed. Generally, the core balance current transformer is used to detect residual current accurately, and then FTU can measure the current precisely even though it is very small. In addition, the residual current can also be detected by the way of connection of three phase CTs, but the precision will decrease, because the fault current and CT error current from load currents can't be distinguished. It means the earth fault on isolated network can't be detected securely with residual CT connection.

Therefore, the core balance CT is absolutely required for this protection function SEF.

Sensitive earth-fault protection can be selected to be either definite time (DT) or inverse definite minimum time (IDMT). In the DT mode, the function operates after a predefined operate time and resets when the fault current disappears. The IDMT mode provides current-dependent timer characteristics.

The corresponding IEC / ANSI identifications are shown in below.

Table 25-Sensitive earth-fault protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Sensitive earth-fault	$I_0 >$	50SEF

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “trip”, “alarm”, “off”.

The operation principle of function can be described as below.

The measured or calculated residual current is compared with preset start value, if the value is greater than preset start value, the timer will activate the pickup signal output. According to the protection curve type, the time characteristics are definite time or inverse definite minimum time. When the timer has reached the value of operate delay time in DT mode or the maximum value in IDMT mode, the alarm or trip signal will be activated.

If the fault suddenly disappears before the operate delay time is reached, the reset delay time is activated. When the definite time characteristic is selected, the timer will not be reset until it exceeds the reset delay time value; when the immediately is selected, the timer will be reset instantaneously after detecting fault disappeared; when the inverse time characteristic is selected, the reset time depends on the current during the drop-off situation. The pickup signal is deactivated when the reset time has expired.

The inverse time reset mode is only supported with ANSI or user programmable types of the IDMT protection curves. If another protection curve type is selected, an immediately reset occurs during the drop-off situation.

The function operates on DFT measurement mode.

F-FTU200 provides 16 protection characteristic curves that including 5 IEC curves and 7 IEEE/ANSI curves. In addition to this, a user defined curve can be used if none of the standard curves are applicable.

The following table shows the parameter settings among SEF protection.

Table 26-Sensitive earth-fault protection parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	40~60000	40	1	ms	Minimum operate time for IDMT curves.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user	0.0000~0.7120	0.1217			Parameter B for user defined curve.

defined parameter B					
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.002~2.000	0.002	0.001	xIn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	IEC Def. Time IEC VI IEC EI IEC NI IEC LI IEC SI ANSI NI ANSI VI ANSI EI ANSI MI ANSI LEI ANSI LVI ANSI LNI ANSI Def. Time RI Inv. RD Inv. User defined curve	IEC Def. Time			Selection of time delay curve type.
Reset curve type	Immediately Def.time Inv.time	Immediat ely			Selection of reset curve type.
Voltage start value	0.01~1.00	0.01	0.01	xUn	This parameter defines starting level of the voltage.
Enable voltage limit	True False	True			This function element can be enabled or disabled by true/false selection.

The technical data of function shows below table.

Table 27-Sensitive earth-fault protection technical data

Parameter	Value
Operation accuracy	$\pm 1.5\%$ of set value or $\pm 0.001 \times I_n$ (at currents in the range of $0.002 \dots 2.0 \times I_n$)
Reset time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Reset time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$

4.1.6 Inrush Restraint Function

When a distribution feeder supplies many transformers, magnetizing inrush current may cause current protection element to trip or alarm when the line is energized. The inrush restraint function can be used to selectively block overcurrent and earth-fault protection by the way of monitoring 2nd harmonic components.

The corresponding IEC / ANSI identifications are shown in below.

Table 28-Inrush restraint function identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Inrush restraint	3I2f>	68

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “on”, “off”.

The operation principle of function can be described as below.

When the transformers are energized and caused magnetizing inrush current, that contains large percentage of 2nd harmonic current relatively, if the current was larger than protection pickup value, and the ratio of second harmonic component over the fundamental component exceeds the preset value, the corresponding protection would be blocked and prevented to mis-operation.

The following table shows the parameter settings among IR function.

Table 29-Inrush restraint function parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	on/off	on			This protection element can be used as an alarm function. If this parameter is set as “on”, the protection will give an alarm. The protection would disabled if select “off”.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
Start value	5~100	20	1	%	This parameter defines starting level of the protection.

Operate delay time	20~200000	20	1	ms	The protection would be alarm if timer exceeded this value.
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The technical data of function shows below table.

Table 30-Inrush restraint function technical data

Parameter	Value
Operation accuracy	$\pm 1.5\%$ of set value or $\pm 0.005 \times I_n$ (at currents in the range of $0.1 \dots 10 \times I_n$) $\pm 5.0\%$ of set value (at ratio I_2/I_1 in the range of $5.0 \dots 100.0\%$)
Reset time accuracy	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy	$\pm 1.0\%$ or $\pm 20\text{ms}$

4.1.7 Negative-sequence Over-current Protection

The negative-sequence over-current protection is used to detect one phase, two phases faults or unbalanced loads due to broken conductor or unsymmetrical situations.

The negative-sequence over-current protection can be selected to be either definite time (DT) or inverse definite minimum time (IDMT). In the DT mode, the function operates after a predefined operate time and resets when the fault current disappears. The IDMT mode provides current-dependent timer characteristics.

The corresponding IEC / ANSI identifications are shown in below.

Table 31-Negative-sequence over-current protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Negative-sequence over-current	$I_2 >$	46

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “trip”, “alarm”, “off”.

The operation principle of function can be described as below.

The measured negative current is compared with preset start value, if the value is greater than preset start value, the timer will activate the pickup signal output. According to the protection curve type, the time characteristics are definite time or inverse definite minimum time. When the timer has reached the value of operate delay time in DT mode or the maximum value in IDMT mode, the alarm or trip signal will be activated.

If the fault suddenly disappears before the operate delay time is reached, the reset delay time is activated. When the definite time characteristic is selected, the timer will not be reset until it exceeds the reset delay time value; when the immediately is selected, the timer will be reset instantaneously after detecting fault disappeared; when the inverse time characteristic is selected, the reset time depends on the current during the drop-off situation. The pickup signal is deactivated when the reset time has expired.

The inverse time reset mode is only supported with ANSI or user programmable types of the IDMT protection curves. If another protection curve type is selected, an immediately reset occurs during the drop-off situation.

F-FTU200 provides 16 protection characteristic curves that including 5 IEC curves and 7 IEEE/ANSI curves. In addition to this, a user defined curve can be used if none of the standard curves are applicable.

The following table shows the parameter settings among NSOC protection.

Table 32-Negative-sequence over-current protection parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	20~60000	20	1	ms	Minimum operate time for IDMT curves.
IDMT user defined parameter A	0.0086~120.000 0	28.2000			Parameter A for user defined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user defined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user defined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user defined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user defined curve.
Start value	0.01~5.00	0.30	0.01	xIn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~200000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	IEC Def. Time IEC VI IEC EI	IEC Def. Time			Selection of time delay curve type.

	IEC NI IEC LI IEC SI ANSI NI ANSI VI ANSI EI ANSI MI ANSI LEI ANSI LVI ANSI LNI ANSI Def. Time RI Inv. RD Inv. User defined curve				
Reset curve type	Immediately Def.time Inv.time	Immediately			Selection of reset curve type.

The technical data of function shows below table.

Table 33-Negative-sequence over-current protection technical data

Parameter	Value
Operation accuracy	$\pm 1.5\%$ of set value or $\pm 0.005 \times I_n$ (at currents in the range of $0.01 \dots 5.0 \times I_n$)
Reset time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Reset time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$

4.1.8 Three-phase Over-voltage Protection

The three-phase over-voltage is used to protect the network from excessive voltages that could damage the insulation and cause insulation breakdown. The protection is usually applied on generators, transformers, motors, power lines, etc. It can be selected the type of operation required with any one phase, two phase and three phase.

The three-phase over-voltage protection can be selected to be either definite time (DT) or inverse definite minimum time (IDMT). In the DT mode, the function operates after a predefined operate time and resets when the fault disappears. The IDMT mode provides voltage-dependent timer characteristics.

The corresponding IEC / ANSI identifications are shown in below.

Table 34-Three-phase over-voltage protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Three-phase over-voltage	3U>	59

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “trip”, “alarm”, “off”.

The operation principle of function can be described as below.

The measured three phases voltage are compared with preset start value, if the measured value is greater than preset start value, the phase selection logic will detect which phase of the measured voltage exceeds the preset value. If the phase information matches the set value of the start phase number, the timer will activate the pickup signal output. The relative hysteresis parameter can be used for preventing unnecessary oscillations if the input signal slightly differs from the Start value setting. According to the protection curve type, the time characteristics are definite time or inverse definite minimum time. When the timer has reached the value of operate delay time in DT mode or the maximum value in IDMT mode, the alarm or trip signal will be activated.

If the fault suddenly disappears before the operate delay time is reached, the reset delay time is activated. When the definite time characteristic is selected, the timer will not be reset until it exceeds the reset delay time value; when the immediately is selected, the timer will be reset instantaneously after detecting fault disappeared. The pickup signal is deactivated when the reset time has expired.

The function operates on DFT measurement mode.

F-FTU200 provides 5 protection characteristic curves that including 2 DT curves and 3 IDMT curves . In addition to this, a user defined curve can be used if none of the standard curves are applicable.

The following table shows the parameter settings among OV protection.

Table 35-Three-phase over-voltage protection parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Number of start phases	1 out of 3 2 out of 3 3 out of 3	1 out of 3			Number of phases required for operate activation.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	40~60000	40	1	ms	Minimum operate time for IDMT curves.
Voltage selection	Phase to phase Phase to earth	Phase to phase			Selection of voltage type.

Relative hysteresis	1.0~5.0	4.0	0.1	%	Relative hysteresis for operation.
IDMT user defined parameter A	0.005~200.000	1.000			Parameter A for user defined curve.
IDMT user defined parameter B	0.50~100.00	1.00			Parameter B for user defined curve.
IDMT user defined parameter C	0.0~1.0	0.0			Parameter C for user defined curve.
IDMT user defined parameter D	0.000~60.000	0.000			Parameter D for user defined curve.
IDMT user defined parameter E	0.000~3.000	1.000			Parameter E for user defined curve.
Start value	0.05~2.00	1.10	0.01	xUn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	40~300000	40	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	IEC Def. Time ANSI Def. Time Inv. curve A Inv. curve B Inv. curve C User defined curve	IEC Def. Time			Selection of time delay curve type.
Reset curve type	Immediately Def.time	Immediately			Selection of reset curve type.

The technical data of function shows below table.

Table 36-Three-phase over-voltage protection technical data

Parameter	Value
Operation accuracy	$\pm 3.0\%$ of set value or $\pm 0.005 \times U_n$ (at voltages in the range of $0.05 \dots 2.00 \times U_n$)
Reset time accuracy	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$

4.1.9 Three-phase Under-voltage Protection

The three-phase under-voltage is used to disconnect from network when encountered low voltage conditions which can damage the devices. It can be selected the type of operation required with any one phase, two phase and three phase.

The three-phase under-voltage protection can be selected to be either definite time (DT) or inverse definite minimum time (IDMT). In the DT mode, the function operates after a predefined operate time and resets when the fault disappears. The IDMT mode provides voltage-dependent timer characteristics.

The corresponding IEC / ANSI identifications are shown in below.

Table 37-Three-phase under-voltage protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Three-phase under-voltage	3U<	27

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “trip”, “alarm”, “off”.

The operation principle of function can be described as below.

The measured three phases voltage are compared with preset start value, if the measured value is lower than preset start value, the phase selection logic will detect which phase of the measured voltage less than the preset value. If the phase information matches the set value of the start phase number, the timer will activate the pickup signal output. The relative hysteresis parameter can be used for preventing unnecessary oscillations if the input signal slightly differs from the Start value setting. According to the protection curve type, the time characteristics are definite time or inverse definite minimum time. When the timer has reached the value of operate delay time in DT mode or the maximum value in IDMT mode, the alarm or trip signal will be activated.

If the fault suddenly disappears before the operate delay time is reached, the reset delay time is activated. When the definite time characteristic is selected, the timer will not be reset until it exceeds the reset delay time value; when the immediately is selected, the timer will be reset instantaneously after detecting fault disappeared. The pickup signal is deactivated when the reset time has expired.

The function operates on DFT measurement mode.

F-FTU200 provides 4 protection characteristic curves that including 2 DT curves and 2 IDMT curves . In addition to this, a user defined curve can be used if none of the standard curves are applicable.

The following table shows the parameter settings among UV protection.

Table 38-Three-phase under-voltage protection parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	trip/alarm/off	trip			This protection element can be used as an

					alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Number of start phases	1 out of 3 2 out of 3 3 out of 3	1 out of 3			Number of phases required for operate activation.
Reset delay time	0~60000	20	1	ms	The timer would be reset if had exceeded this value.
IDMT minimum operate time	60~60000	60	1	ms	Minimum operate time for IDMT curves.
Voltage selection	Phase to phase Phase to earth	Phase to phase			Selection of voltage type.
Voltage block value	0.05~1.00	0.20	0.01	xUn	Blocking under-voltage protection under this value.
Enable block value	True/false	true			Enable/disable blocking under-voltage protection.
Relative hysteresis	1.0~5.0	4.0	0.1	%	Relative hysteresis for operation.
IDMT user defined parameter A	0.005~200.000	1.000			Parameter A for user defined curve.
IDMT user defined parameter B	0.50~100.00	1.00			Parameter B for user defined curve.
IDMT user defined parameter C	0.0~1.0	0.0			Parameter C for user defined curve.
IDMT user defined parameter D	0.000~60.000	0.000			Parameter D for user defined curve.
IDMT user defined parameter E	0.000~3.000	1.000			Parameter E for user defined curve.
Start value	0.05~1.20	0.90	0.01	xUn	This parameter defines starting level of the protection.
Time multiplier	0.05~15.00	1.00	0.01		Time multiplier in IDMT curves.
Operate delay time	60~300000	60	1	ms	The protection would be alarm or trip if timer exceeded this value.
Protection curve type	IEC Def. Time ANSI Def. Time Inv. curve A Inv. curve B User defined	IEC Def. Time			Selection of time delay curve type.

	curve				
Reset curve type	Immediately Def.time	Immediat ely			Selection of reset curve type.

The technical data of function shows below table.

Table 39-Three-phase under-voltage protection technical data

Parameter	Value
Operation accuracy	$\pm 3.0\%$ of set value or $\pm 0.005 \times U_n$ (at voltages in the range of $0.05 \dots 1.20 \times U_n$)
Reset time accuracy	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in DT	$\pm 1.0\%$ or $\pm 20\text{ms}$
Operate time accuracy in IDMT	$\pm 5.0\%$ or $\pm 20\text{ms}$

4.1.10 Frequency Protection

The frequency protection is used to protect power equipment against abnormal frequency conditions in network. The function contains over-frequency, under-frequency and frequency rate of change protection. The over-frequency protection is applicable in all situations where high levels of the fundamental frequency of a power system voltage must be reliably detected. The under-frequency is applicable in all situations where a reliable detection of a low fundamental power system voltage frequency is needed. The frequency rate of change protection is applicable in all the situations where the change of the fundamental power system voltage frequency should be detected reliably.

The corresponding IEC / ANSI identifications are shown in below.

Table 40-Frequency protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Over-frequency	$f >$	81O
Under-frequency	$f <$	81U
Frequency rate of change	df/dt	81R

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “trip”, “alarm”, “off”.

The operation principle of function can be described as below.

a. Over-frequency protection:

The measured frequency is compared with preset start value, if the measured value exceeds preset start value, the timer will activate the pickup signal output. When the timer has reached the value of operate delay time in DT mode, the alarm or trip signal will be activated. If the frequency returned to normal before the operate delay time is reached, the reset delay time is activated. The pickup signal is deactivated when the reset time has expired.

b. Under-frequency protection:

The measured frequency is compared with preset start value, if the measured value is lower than preset start value, the timer will activate the pickup signal output. When the timer has reached the value of operate delay time in DT mode, the alarm or trip signal will be activated. If the frequency returned to normal before the operate delay time is reached, the reset delay time is activated. The pickup signal is deactivated when the reset time has expired.

c. Frequency rate of change protection

The calculated frequency rate is compared with preset start value, if the measured value exceeds preset start value, the timer will activate the pickup signal output. When the timer has reached the value of operate delay time in DT mode, the alarm or trip signal will be activated. If the frequency rate returned to normal before the operate delay time is reached, the reset delay time is activated. The pickup signal is deactivated when the reset time has expired.

The following table shows the parameter settings among OF, UF, FR protection.

Table 41-Frequency protection parameter settings

Parameter	Range	Default	Step	Unit	Description
Over-frequency					
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	0	1	ms	The timer would be reset if had exceeded this value.
Start value	0.90~1.20	1.05	0.01	xFn	This parameter defines starting level of the protection.
Operate delay time	80~200000	200	1	ms	The protection would be alarm or trip if timer exceeded this value.
Under-frequency					
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	0	1	ms	The timer would be reset if had exceeded this value.
Start value	0.80~1.10	0.95	0.01	xFn	This parameter defines starting level of the protection.
Operate delay time	80~200000	200	1	ms	The protection would be alarm or trip if timer exceeded this value.
Frequency rate of change					
Operation	trip/alarm/off	trip			This protection element can be used as an alarm or trip function. If this parameter is set as “alarm”, the protection will give an

					alarm without actual trip at fault. The protection would disabled if select “off”.
Reset delay time	0~60000	0	1	ms	The timer would be reset if had exceeded this value.
Start value	-0.20~0.20	0.05	0.05	xFn/s	This parameter defines starting level of the protection.
Operate delay time	120~200000	400	1	ms	The protection would be alarm or trip if timer exceeded this value.

The technical data of function shows below table.

Table 42-Frequency protection technical data

Parameter	Value
Operation accuracy	± 20 mHz (at frequency in the range of $0.80 \dots 1.20 \times F_n$) ± 1 Hz/s (in the range of $2\text{Hz/s} \sim 10\text{Hz/s}$, $-2\text{Hz/s} \sim -10\text{Hz/s}$)
Reset time accuracy	$\pm 1.0\%$ or $\pm 30\text{ms}$
Operate time accuracy	$\pm 1.0\%$ or $\pm 30\text{ms}$

4.1.11 Cold Load Pickup Function

In some cases, when power supply is restored after prolonged outage, will result in greater than normal power demand, that because the large number of the thermostat controlled devices such as heaters, refrigeration, air conditioners etc. will turn on.

The longer the period without supply the greater the loss of diversity and the higher the load current will be when supply is restored. The increase in load current after a prolonged outage could cause current protection to operate unnecessarily.

The purpose of the cold load pickup function is to automatically compensate for the loss of diversity by adjusting the current protection pickup thresholds until the load regains its diversity and steady state load conditions return. It works by measuring the time that supply was lost and then temporarily raising the current protection settings for the selected elements according to the time the load has been without supply.

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “on”, “off”.

The operation principle of function can be described as below.

Whenever the cold load timer is running, the actual multiplier being applied is known as the “Operational cold load multiplier”. The operational cold load multiplier is calculated using the following equation:

Operational Multiplier = $1 + (\text{operational cold load time} / \text{user set cold load time}) * (\text{user set multiplier} - 1)$

Equation 1

Operational cold load multiplier

Where the operational cold load time is the time the supply has been lost minus any time it's been back on. So when the supply is off, the operational cold load time is increasing and when the supply is on, the operational cold load time is decreasing. This means the operational cold load multiplier will have a minimum value of 1, and a maximum value equal to the parameter cold load multiplier setting.

There is an example as below figure.

(Cold load multiplier and cold load time following default value: cold load multiplier=2.0; cold load time=120 mins. The protection element=100A)

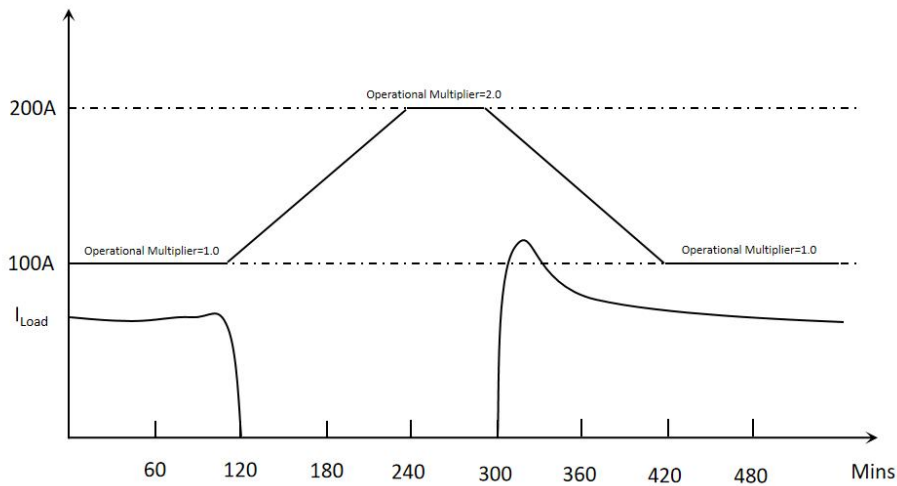


Figure 14

Cold load pickup function example

In this example the supply goes off for four hours. Over the first two hours, the operational cold load multiplier (OCLM) increases from x1 to x2. The supply stays off for another two hours but the operational cold load multiplier doesn't increase any further because it's reached its maximum setting. When the supply comes back on, the load current is significantly higher than usual but doesn't cause a protection pickup because it doesn't exceed the "Setting Current x the Operational Cold Load Multiplier". Over the next two hours the operational cold load multiplier ramps down from x2 to x1 and is always above the load current which also tapers off over that time.

The cold load pickup can be selected On or Off for the OC, EF, DOC, DEF, SEF and NSOC protection independently.

The following table shows the parameter settings among CLP function.

Table 43-Cold load pickup function parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	on/off	off			This protection element can be used as an

					alarm function. If this parameter is set as “on”, the protection will give an alarm. The protection would disabled if select “off”.
OC enable	on/off	off			Over-current protection active or inactive in cold load pickup function.
EF enable	on/off	off			Earth-fault protection active or inactive in cold load pickup function.
DOC enable	on/off	off			Directional over-current protection active or inactive in cold load pickup function.
DEF enable	on/off	off			Directional earth-fault protection active or inactive in cold load pickup function.
SEF enable	on/off	off			Sensitive earth fault protection active or inactive in cold load pickup function.
NSOC enable	on/off	off			Negative-sequence over-current protection active or inactive in cold load pickup function.
Cold load multiplier	1.0~10.0	2.0	0.1		The multiple of protection element.
Cold load time	1~480	120	1	min	The time that multiplier reach to maximum setting value.

The technical data of function shows below table.

Table 44-Cold load pickup function technical data

Parameter	Value
Cold load time	+/- 1 min

4.1.12 Hot Line Tag

The hot line tag enables to go to maintenance mode, the IED can trip at fault but not initiate closing, either by local, remote or automatically. Therefore, hot line tag affords protection for operators working on live lines.

The function can be enabled and disabled with the button on front panel.

4.1.13 Protection Setting Groups

The IED supports up to 5 setting groups, each setting group can be configured with completely separate characteristics and parameters. The customer can change the active setting group at run time.

The following table shows the parameter settings among CLP function.

Table 45-Protection setting groups parameter settings

Parameter	Range	Default	Step	Unit	Description
Active group	1~5	1	1		Currently active group

4.2 Measurement

The F-FTU200 gets analog signals from automatic circuit recloser current transformers and voltage sensors, convert them into digital format. The following values are contained in the measurement element.

Table 46-The measurement element applicability

Parameter	Range	Applicability	
		Protection	Indication
Three-phase Current (Ia/Ib/Ic)	0.00~40.00In	√	√
Residual Current (Io)	0.00~10.00In	√	√
Three-phase Voltage (Ua/Ub/Uc)	0.00~2.00Un	√	√
Three-phase Voltage (Ur/Us/Ut)	0.00~2.00Un	√	√
Residual Voltage (Uo1/Uo2)	0.00~2.00Un	√	√
Active Power (Pa/Pb/Pc/Pt)	0~999999999kw		√
Reactive Power (Qa/Qb/Qc/Qt)	0~999999999kvar		√
Apparent Power(Sa/Sb/Sc/St)	0~999999999kva		√
Active Energy (EPa/EPb/EPc/EPt)	0~999999999kwh		√
Reactive Energy (EQa/EQb/EQc/EQt)	0~999999999kvarh		√
Apparent Energy (ESa/ESb/ESc/EST)	0~999999999kvah		√
Power Factor (PFa/PFb/PFc/PFt)	-1.00~1.00		√
Frequency (F)	30Hz~90Hz	√	√
Current Sequence Measurement (I1/I2)	0.00~40.00In	√	√
Voltage Sequence Measurement (U1/U2)	0.00~2.00Un		√
Battery Voltage (Vdc)	18~26 Vdc		√

4.2.1 Fundamental Measurement

The F-FTU200 performs current, voltage, power and energy metering using the fundamental signals. These values are measured on account of system frequency, which is usually near 50 Hz or 60 Hz. Frequency tracking ensures that frequency variations do not adversely affect metering accuracy. The F-FTU200 presents also phasor quantities calculated through fundamental power frequency components extracted by FFT (Fast Fourier Transform) algorithm.

Moreover, the calibration is performed in the factory before delivery using precise current and voltage signal generator. The calibration compensates the measurements error caused by the components in the circuit of input.

The corresponding IEC / ANSI identifications are shown in below.

Table 47-The fundamental measurement identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Three-phase current	3I	3I
Residual current	Io	Io
Three-phase voltage	3U	3U
Residual voltage	Uo	Uo
Power	P	P
Energy	E	E
Power factor	PF	PF
Frequency	F	F

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “on”, “off”.

Current and voltage measurement functions operate on two alternative measurement modes: DFT and RMS, other measurement functions mode are DFT.

The demand values are calculated separately for each measurement function and per phase when applicable.

The limit value supervision function indicates whether the measured value exceeds or falls below the set limits.

The deadband supervision function reports the measured value according to integrated changes over a time period. The reporting delay of the integral algorithms in seconds is calculated with the following equation:

$$T = (\max - \min) * \text{deadband} / |\Delta Y| * 100$$

Equation 2

Reporting delay time

The following table shows the parameter settings among fundamental measurement function.

Table 48-The fundamental measurement function parameter settings

Parameter	Range	Default	Step	Unit	Description
Three-phase Current					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Measurement Mode	DFT/RMS	DFT			measurement mode selection.
Demand Interval	1 min 5 mins 15 mins 30 mins	1 min			The average value during interval time.

	60 mins 180 mins				
Current high alarm limit	0.00~40.00	1.40	0.01	xIn	High alarm current limit.
Current high warn limit	0.00~40.00	1.20	0.01	xIn	High warn current limit.
A deadband	0.1~100.0	2.5	0.1	%	Deadband configuration value.
Residual Current					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Measurement Mode	DFT/RMS	DFT			measurement mode selection.
Demand Interval	1 min 5 mins 15 mins 30 mins 60 mins 180 mins	1 min			The average value during interval time.
Current high alarm limit	0.00~40.00	0.20	0.01	xIn	High alarm current limit.
Current high warn limit	0.00~40.00	0.05	0.01	xIn	High warn current limit.
A deadband	0.1~100.0	2.5	0.1	%	Deadband configuration value.
Three-phase Voltage					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Measurement Mode	DFT/RMS	DFT			measurement mode selection.
Demand Interval	1 min 5 mins 15 mins 30 mins 60 mins 180 mins	1 min			The average value during interval time.
Voltage high alarm limit	0.00~2.00	1.40	0.01	xUn	High alarm voltage limit.
Voltage high warn limit	0.00~2.00	1.20	0.01	xUn	High warn voltage limit.
V deadband	0.1~100.0	10.0	0.1	%	Deadband configuration value.
Residual Voltage					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Measurement Mode	DFT/RMS	DFT			measurement mode selection.

Demand Interval	1 min 5 mins 15 mins 30 mins 60 mins 180 mins	1 min			The average value during interval time.
Voltage high alarm limit	0.00~2.00	0.20	0.01	xUn	High alarm voltage limit.
Voltage high warn limit	0.00~2.00	0.05	0.01	xUn	High warn voltage limit.
V deadband	0.1~100.0	10.0	0.1	%	Deadband configuration value.
Power					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Measurement mode	total & each phase; Total; each phase	total & each phase			Measurement mode selection.
Demand Interval	1 min 5 mins 15 mins 30 mins 60 mins 180 mins	1 min			The average value during interval time.
Energy					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Measurement mode	total & each phase; Total; each phase	total & each phase			Measurement mode selection.
Demand Interval	1 min 5 mins 15 mins 30 mins 60 mins 180 mins	1 min			The maximum value during interval time.
Power Factor					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Measurement mode	total & each phase; Total; each phase	total & each phase			Measurement mode selection.

Demand Interval	1 min 5 mins 15 mins 30 mins 60 mins 180 mins	1 min			The average value during interval time.
Frequency					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Demand Interval	1 min 5 mins 15 mins 30 mins 60 mins 180 mins	1 min			The average value during interval time.
Freq. high alarm limit	45.00~65.00	54.00	0.01	Hz	High alarm frequency limit.
Freq. high warn limit	45.00~65.00	52.00	0.01	Hz	High warn frequency limit.
Freq. low warn limit	45.00~65.00	48.00	0.01	Hz	Low warn frequency limit.
Freq. low alarm limit	45.00~65.00	46.00	0.01	Hz	Low alarm frequency limit.
F deadband	0.1~100.0	1.0	0.1	%	Deadband configuration value.

The technical data of function shows below table.

Table 49-The fundamental measurement technical data

Parameter	Value
Current operation accuracy	$\pm 0.5\%$ (at currents in the range of 0.01...20.00 In)
Voltage operation accuracy	$\pm 0.5\%$ (at voltages in the range of 0.05...2.00Un)

4.2.2 Sequence Components

The F-FTU200 provides the sequence components of three-phase currents and voltages. They are positive sequence current (I1) and voltage (U1), negative sequence current (I2) and voltage (U2), and zero sequence current (I0) and voltage (U0) which are calculated by three-phase phasor quantities. This information can be used to monitor unbalance of distribution line.

The corresponding IEC / ANSI identifications are shown in below.

Table 50-The sequence components identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Current sequence	I1, I2, I0	I1, I2, I0
Voltage sequence	U1, U2, U0	U1, U2, U0

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “on”, “off”.

The limit value supervision function indicates whether the measured value exceeds or falls below the set limits.

The deadband supervision function reports the measured value according to integrated changes over a time period.

The following table shows the parameter settings among sequence components function.

Table 51-The sequence components function parameter settings

Parameter	Range	Default	Step	Unit	Description
Current Sequence Measurement					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Positive sequence current high alarm limit	0.00~40.00	1.40	0.01	xIn	High alarm positive sequence current limit.
Positive sequence current high warn limit	0.00~40.00	1.20	0.01	xIn	High warn positive sequence current limit.
Positive sequence deadband	0.1~100.0	2.5	0.1	%	Deadband configuration value.
Negative sequence current high alarm limit	0.00~40.00	0.20	0.01	xIn	High alarm negative sequence current limit.
Negative sequence current high warn limit	0.00~40.00	0.05	0.01	xIn	High warn negative sequence current limit.
Negative sequence deadband	0.1~100.0	2.5	0.1	%	Deadband configuration value.
Zero sequence current high alarm limit	0.00~40.00	0.20	0.01	xIn	High alarm zero sequence current limit.
Zero sequence	0.00~40.00	0.05	0.01	xIn	High warn zero sequence current limit.

current high warn limit					
Zero sequence A deadband	0.1~100.0	2.5	0.1	%	Deadband configuration value.
Voltage Sequence Measurement					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Positive sequence voltage high alarm limit	0.00~2.00	1.40	0.01	xUn	High alarm positive sequence voltage limit.
Positive sequence voltage high warn limit	0.00~2.00	1.20	0.01	xUn	High warn positive sequence voltage limit.
Positive sequence V deadband	0.1~100.0	10.0	0.1	%	Deadband configuration value.
Negative sequence voltage high alarm limit	0.00~2.00	0.20	0.01	xUn	High alarm negative sequence voltage limit.
Negative sequence voltage high warn limit	0.00~2.00	0.05	0.01	xUn	High warn negative sequence voltage limit.
Negative sequence V deadband	0.1~100.0	10.0	0.1	%	Deadband configuration value.
Zero sequence voltage high alarm limit	0.00~2.00	0.20	0.01	xUn	High alarm zero sequence voltage limit.
Zero sequence voltage high warn limit	0.00~2.00	0.05	0.01	xUn	High warn zero sequence voltage limit.
Zero sequence V deadband	0.1~100.0	10.0	0.1	%	Deadband configuration value.

The technical data of function shows below table.

Table 52-The sequence components technical data

Parameter	Value
CSM accuracy	$\pm 1.0\%$ (at currents in the range of 0.01...20.00 In)

VSM accuracy	$\pm 1.0\%$ (at voltages in the range of 0.05...2.00Un)
--------------	--

4.2.3 Harmonics

The F-FTU200 provides 2nd to 31th harmonic magnitudes and THDs (Total Harmonic Distortion) for each phase. THD is the total harmonic percentage to the fundamental frequency component. These values may be used to monitor the power quality of distribution line.

The corresponding IEC / ANSI identifications are shown in below.

Table 53-The total harmonic distortion identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Current total harmonic distortion	PQM3I	PQM3I
Voltage total harmonic distortion	PQM3U	PQM3U

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “on”, “off”.

The demand values are calculated separately for each measurement function and per phase when applicable.

The limit value supervision function indicates whether the measured value exceeds below the set limits.

The following table shows the parameter settings among harmonics function.

Table 54-The harmonics function parameter settings

Parameter	Range	Default	Step	Unit	Description
Current Total Harmonic Distortion					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.
Demand interval	1 min 5 mins 15 mins 30 mins 60 mins 180 mins	1 min			The maximum value during interval time.
Total demand distortion alarm limit	1.0~100.0	50.0	0.1	%	Current THD alarm limit.
Voltage Total Harmonic Distortion					
Operation	on/off	on			This measurement element can be enabled or disabled by on/off selection.

Demand interval	1 min 5 mins 15 mins 30 mins 60 mins 180 mins	1 min			The maximum value during interval time.
Total demand distortion alarm limit	1.0~100.0	50.0	0.1	%	Voltage THD alarm limit.

4.3 Control

In the field of distribution automation, reliable control and status indication of primary switching components both locally and remotely is in a significant role. The F-FTU200 provides control functions, including open/close operation, local/remote operation, reclosing and synchronization check.

4.3.1 Opening and Closing Operations

The corresponding opening and closing operations are available via local or remote commands. There are open and close button on the front of IED panel, and need to be confirmed before execute which named SBO operation.

4.3.2 Local and Remote Operations

Local/Remote control is by default realized through the R/L button on the front panel. Switch can be controlled from local, remote and off status. Local mode allows opening and closing from control button on front panel, remote mode allows opening and closing from SCADA, and automation scheme as well. If selected off status, it would forbid neither local nor remote control.

4.3.3 Reclosing Function

Almost 80% ~ 85% of faults in medium voltage overhead lines are instantaneous faults, which can be automatically cleared by reclosing function. In case of permanent fault, the switch will trip finally after auto reclosing. The location of the permanent fault must be determined and cleared before the fault location is re-energized.

Any switch suitable for automatic reclosing can use this function. The switch generally adopts spring operating mechanism. If the switch is matched with a permanent magnet operating mechanism, a high-power current generator is required.

This function can provide up to five reclosing times. The reclosing times and interval time, including reclaim time, can be set by the user.

The corresponding IEC / ANSI identifications are shown in below.

Table 55-Reclosing function identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Reclosing	O-->I	79

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “on”, “off”.

The operation principle of function can be described as below.

When the reclosing function is performed by starting the protection function (current protection), if the fault still exists after reclosing, the function can perform the final tripping operation of the switch in a very short time. When the fault disappears when the automatic reclosing sequence is in progress, the reclosing times will be cleared after the reclaim time.

The reclosing has secondary reclosure locking function. When reclosing operation is carried out by starting the protection function, the fault still exists after the first reclosing time, the switch accelerates opening and locks the second reclosing operation.

When the switch is operated and closed at the fault point, resulting in the direct opening, the switch keeps opening and blocking close. This function is called exist fault block function.

The following table shows the parameter settings among reclosing function.

Table 56-Reclosing function parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	on/off	off			This function element can be enabled or disabled by on/off selection.
Reclose cycle	1~5	1	1		Reclosing times.
First reclose time	0~300000	5000	1	ms	First interval time.
Second reclose time	0~300000	5000	1	ms	Second interval time.
Third reclose time	0~300000	5000	1	ms	Third interval time.
Fourth reclose time	0~300000	5000	1	ms	Fourth interval time.
Fifth reclose time	0~300000	5000	1	ms	Fifth interval time.
Reclaim time	100~1800000	10000	1	ms	Reclosing reclaim time.
Second reclose block	on/off	off			This function element can be enabled or disabled by on/off selection.
Second reclose block time	0~300000	2000	1	ms	Second reclosing block reclaim time.
Exist fault block	on/off	off			This function element can be enabled or disabled by on/off selection.

The technical data of function shows below table.

Table 57-Reclosing function technical data

Parameter	Value
Operation time accuracy	$\pm 1.0\%$ or $\pm 20\text{ms}$

4.3.4 Synchronization Check Function

The synchrocheck function checks the condition across the switch (circuit breaker or automatic circuit recloser) from separate power system parts and gives the permission to close the switch. The synchrocheck function includes the functionality of synchrocheck and energizing check.

The corresponding IEC / ANSI identifications are shown in below.

Table 58-Synchronization check function identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Synchrocheck	SYNC	25

The function can be enabled and disabled with the Operation setting, corresponding parameter values are “on”, “off”.

The operation principle of function can be described as below.

The synchronization check function checks that the voltages on both sides of the switch are perfectly synchronized. It is used to perform a controlled reconnection of two systems which are divided after islanding and it is also used to perform a controlled reconnection of the system after reclosing. The energizing check function checks that at least one side is dead to ensure that closing can be done safely.

There are two modes in synchronization check function: continuous and command.

In the continuous mode, synchronization check is continuously checking the synchronism. When synchronism is detected, gives the permission to the control block that executes the CB closing.

In the command mode, the control function block delivers the command signal to close the synchronization check function for the releasing of a closing signal pulse to the switch. If the closing conditions are fulfilled during a permitted check time, the synchronization check function delivers a closing signal to the switch after the command signal is delivered for closing.

The following table shows the parameter settings among Synchronization Check function.

Table 59-Synchronization check function parameter settings

Parameter	Range	Default	Step	Unit	Description
Synchronism check mode	on/off	off			This function element can be enabled or disabled by on/off selection.
Synchronism check control	Continuous Command	Continuous			Synchronism check mode selection.
Difference	0.01~0.50	0.05	0.01	xUn	Maximum voltage difference limit.

voltage					
Difference frequency	0.001~0.100	0.001	0.001	xFn	Maximum frequency difference limit.
Difference angle	5~90	5	1	deg	Maximum angle difference limit.
Synchronism check time	100~6000000	2000	1	ms	Synchronism delay time.
Energizing check mode	Off; both side dead; live line & busbar dead; line dead & busbar live; busbar dead & line any; line dead & busbar any; one live & dead; not both live	off			Energizing check mode.
Dead line value	0.1~0.8	0.2	0.1	xUn	Voltage low-limit line for energizing check.
Live line value	0.2~1.0	0.5	0.1	xUn	Voltage high-limit line for energizing check.
Energizing check time	100~60000	100	1	ms	Energizing delay time.

The technical data of function shows below table.

Table 60-Synchronization check function technical data

Parameter	Value
Operation accuracy	Voltage: $\pm 3.0\%$ Frequency: ± 50 mHz Phase angle: $\pm 3^\circ$
Reset time accuracy	$\pm 1.0\%$ or ± 20 ms
Operate time accuracy	$\pm 1.0\%$ or ± 20 ms

4.4 Communication

In the local mode, the recloser is controlled via the front panel on IED, in the remote mode the recloser is controlled via communication. The F-FTU200 supports a variety of communication protocols, so as to realize the connection with SCADA or DMS station. Available communication protocols are IEC 60870-5-101/104, DNP3 and Modbus.

The supported remote communication interfaces and protocols are as below table.

Table 61-Interfaces and protocols

Protocol	Ethernet	Serial	
	RJ45	RS232/RS485	RS232 (DB9)
IEC 60870-5-101	-	√	√
IEC 60870-5-104	√	-	-
DNP3.0	√	√	√
MODBUS(RTU/ASCII)	-	√	√
MODBUS(TCP/IP)	√	-	-

The following table shows the parameter settings among communication port.

Table 62-Communication port parameter settings

Parameter	Range	Default	Step	Unit	Description
Ethernet					
Ethernet (Rear)					
Local IP address		192.168. 1.100			IP address for remote communication.
Subnet mask		255.255. 255.0			Subnet mask for rear port.
Default gateway		192.168. 1.1			Default gateway for rear port.
MAC address		8c-00-00- 00-00-00			MAC address for rear port.
Keep Alive Time	1~60	5	1	sec	Keep alive time.
Lost Detection Time	10~255	20	1	sec	Lost detection time.
Ethernet (Front)					
IP Address		192.168. 4.100			IP address for commissioning.
Subnet mask		255.255. 255.0			Subnet mask for front port.
Default gateway		192.168. 4.1			Default gateway for front port.
MAC address		8c-00-00- 00-00-00			MAC address for front port.
RS232					
Baudrate	2400 4800 9600 19200 38400 57600 115200	9600			Baudrate for RS232 port.

Data bits		8			Data bits for RS232 port.
Parity	None Even Odd	None			Parity for RS232 port.
Stop bit		1			Stop bit for RS232 port.
Frame timeout	1~60000	20	1	ms	Frame timeout for RS232 port.
RS232/485 (default is RS485)					
Baudrate	2400 4800 9600 19200 38400 57600 115200	9600			Baudrate for RS232/485 port.
Data bits		8			Data bits for RS232/485 port.
Parity	None Even Odd	None			Parity for RS232/485 port.
Stop bit		1			Stop bit for RS232/485 port.
Frame timeout	1~60000	20	1	ms	Frame timeout for RS232/485 port.

The following table shows the parameter settings among communication protocol.

Table 63-Communication protocol parameter settings

Parameter	Range	Default	Step	Unit	Description
IEC 60870-5-101/104					
IEC 60870 General					
ASDU(Commo n) Address	1~65535	1	1		Application Service Data Unit address.
C_SE General Interrogation	Disable Enable	Disable			C_SE General Interrogation.
Analog Value Type	Normalized Scaled Float	Scaled			M_ME type identification.
Analog Event Mode	SOE Most recent	SOE			Determine to transmit analog event with all or only with most recent events.
Select/Operate Timeout	1~255	15	1	sec	This parameter will be used for SBO (Select before Operate) operation.
Cyclic Period	0~60	0	1	sec	Data update for transmission can be triggered periodically through this parameter.
M_SP Cyclic	Disable Enable	Disable			It selects if the cyclic update will be done or not for each type identification.
M_DP Cyclic	Disable	Disable			It selects if the cyclic update will be done

	Enable				or not for each type identification.
M_ME Cyclic	Disable Enable	Enable			It selects if the cyclic update will be done or not for each type identification.
M_SP Start Address	1~65535	100	1		It defines the base address of information points for each type identification.
C_SC Start Address	1~65535	200	1		It defines the base address of information points for each type identification.
M_DP Start Address	1~65535	300	1		It defines the base address of information points for each type identification.
C_DC Start Address	1~65535	400	1		It defines the base address of information points for each type identification.
M_ME Start Address	1~65535	1000	1		It defines the base address of information points for each type identification.
C_SE Start Address	1~65535	2000	1		It defines the base address of information points for each type identification.
M_IT Start Address	1~65535	4000	1		It defines the base address of information points for each type identification.
IEC 60870-5-101					
Operation	on/off	off			This function element can be enabled or disabled by on/off selection.
Type	IEC101-RS232 IEC101-RS232/ 485	IEC101- RS232			Serial mode selection.
Device Address	1~65535	1	1		Link address for IEC101.
Link Address Size	1~2	1	1		Link address size for IEC101.
Common Address Size	1~2	1	1		Common address size for IEC101.
Object Address Size	1~3	2	1		Object address size for IEC101.
COT Size	1~2	1	1		The size of "Cause Of Transmission".
Time Marker	None CP24 CP56	CP56			The time tag can be selected as 24-bit or 56-bit.
Single NACK Control	Yes No	Yes			This function element can be enabled or disabled by yes/no selection.
Link Mode	Unbalanced Balanced	Balanced			Link mode setting for IEC101.
IEC 60870-5-104					
Operation	on/off	off			This function element can be enabled or disabled by on/off selection.
Type	IEC104-Eth-TC PClient,	IEC104- Eth-TCP			Ethernet mode selection.

	IEC104-Eth-TC PServer	Server			
Remote IP Address		0.0.0.0			Remote IP address for IEC104.
Port	1~65535	2404	1		Server TCP port.
T0 Connection Timeout	1~255	30	1	sec	Time-out of connection establishment.
T1 Response Timeout	1~255	15	1	sec	Time-out of send or test APDUs.
T2 S-Frame Period	1~255	10	1	sec	Time-out for acknowledges in case of no data messages $t_2 < t_1$.
T3 Test Period	1~255	20	1	sec	Time-out for sending test frames in case of a long idle state.
Time Marker	None CP24 CP56	CP56			The time tag can be selected as 24-bit or 56-bit.
Modbus					
Operation	on/off	off			This function element can be enabled or disabled by on/off selection.
Type	Eth-TCP Server, RS232, RS232/485	Eth-TCP Server			Mode selection.
IP address		0.0.0.0			IP address for Modbus.
TCP port	1~65535	502	1		TCP port for Modbus.
Slave address	1~65535	1	1		Modbus unit address.
Link mode	ASCII RTU	RTU			Link mode selection.
CRC order	Hi-Lo Lo-Hi	Hi-Lo			CRC order for Modbus.
Write authority	Read only Full access	Read only			Write authority selection.
Time format	Local UTC	Local			Time format for Modbus.
Event ID selection	Address UID	Address			Event ID selection.
Event buffering	Keep oldest Keep newest	Keep newest			Event buffering mode selection.
Event backoff	1~1000	100			Event backoff for Modbus.
DNP3.0					
Slave address	0~65531	1	1		DNP unit address.
DNP3.0 Serial					
Operation	on/off	off			This function element can be enabled or disabled by on/off selection.

Type	DNP3_RS232, DNP3_ RS232/485	DNP3_R S232			Serial port selection.
Index Table Number	1~3	1	1		Index table number for DNP serial.
Analog Event Mode	SOE Most recent	SOE			Determine to transmit analog event with all or only with most recent events.
Analog Input Object Type	16BIT 32BIT FLOAT	16BIT			Analog Input Object Type.
Counter Object Size	16BIT 32BIT	16BIT			Counter Object Size.
Select/Operate Timeout	1~255	15	1	sec	This parameter will be used for SBO (Select before Operate) operation.
Interval to Request Link Status	0~60000	0	1	sec	Indicates how often Data Link Layer status request is sent while the communication is idle.
Interval to Set IIN1.4 (Need Time)	0~60000	0	1	sec	For requesting time synchronization to master station this every interval.
Data Link Layer Frame Size	64~292	292	1		It defines the maximum size of data link frame.
Data Link Layer Frame Interval	10~500	100	10	ms	Data Link Layer Frame Interval time.
Data Link Layer Retries	0~2	0	1		Number of data link layer retries when the data link the confirm timeout take places.
Data Link Layer Timeout	1~255	30	1	sec	Data link timeout for waiting the data link layer confirm from master station.
Data Link Layer Confirm	No Yes Sometimes	Sometim es			This parameter controls data link confirm for sending frames.
Application Layer Fragment Size	256 512 1024 2048	2048			Maximum size of each application fragment.
Application Layer Retries	0~100	1	1		Application Layer Retries.
Application Layer Timeout	1~255	40	1	sec	Application Layer Timeout.
Unsolicited Mode	on/off	off			This function element can be enabled or disabled by on/off selection.
Unsolicited Address (Master Address)	1~65531	65531	1		The address of the master station which the unsolicited response will be sent.

Unsolicited class 1 Number	1~512	5	1		The maximum number of events in the corresponding class to be allowed before an unsolicited response is generated.
Unsolicited class 2 Number	1~512	5	1		The maximum number of events in the corresponding class to be allowed before an unsolicited response is generated.
Unsolicited class 3 Number	1~512	5	1		The maximum number of events in the corresponding class to be allowed before an unsolicited response is generated.
Unsolicited class 1 Delay Time	0~60	5	1	sec	The waiting time to send an unsolicited response after a first event occurred.
Unsolicited class 2 Delay Time	0~60	5	1	sec	The waiting time to send an unsolicited response after a first event occurred.
Unsolicited class 3 Delay Time	0~60	5	1	sec	The waiting time to send an unsolicited response after a first event occurred.
Unsolicited Offline Retry Delay	0~255	15	1	min	Unsolicited Offline Retry Delay.
Unsolicited class 1	Disable Enable	Disable			Unsolicited setting for Class 1, 2, 3.
Unsolicited class 2	Disable Enable	Disable			Unsolicited setting for Class 1, 2, 3.
Unsolicited class 3	Disable Enable	Disable			Unsolicited setting for Class 1, 2, 3.
DNP3.0 TCP/IP					
Operation	on/off	off			This function element can be enabled or disabled by on/off selection.
Type	DNP3-TCPServer, DNP3-TCPClient	DNP3-TCPServer			Ethernet port selection.
Remote IP		0.0.0.0			IP address for DNP.
Port	1~65534	20000	1		TCP port for DNP.
Index Table Number	1~3	1	1		Index table number for DNP TCP/IP.
Analog Event Mode	SOE Most recent	SOE			Determine to transmit analog event with all or only with most recent events.
Analog Input Object Type	16BIT 32BIT FLOAT	16BIT			Analog Input Object Type.
Counter Object	16BIT	16BIT			Counter Object Size.

Size	32BIT				
Select/Operate Timeout	1~255	15	1	sec	This parameter will be used for SBO (Select before Operate) operation.
Interval to Request Link Status	0~60000	0	1	sec	Indicates how often Data Link Layer status request is sent while the communication is idle.
Interval to Set IIN1.4 (Need Time)	0~60000	0	1	sec	For requesting time synchronization to master station this every interval.
Data Link Layer Frame Size	64~292	292	1		It defines the maximum size of data link frame.
Data Link Layer Frame Interval	10~500	100	10	ms	Data Link Layer Frame Interval time.
Data Link Layer Retries	0~2	0	1		Number of data link layer retries when the data link the confirm timeout take places.
Data Link Layer Timeout	1~255	30	1	sec	Data link timeout for waiting the data link layer confirm from master station.
Data Link Layer Confirm	No Yes Sometimes	Sometimes			This parameter controls data link confirm for sending frames.
Application Layer Fragment Size	256 512 1024 2048	2048			Maximum size of each application fragment.
Application Layer Retries	0~100	1	1		Application Layer Retries.
Application Layer Timeout	1~255	40	1	sec	Application Layer Timeout.
Unsolicited Mode	on/off	off			This function element can be enabled or disabled by on/off selection.
Unsolicited Address (Master Address)	1~65531	65531	1		The address of the master station which the unsolicited response will be sent.
Unsolicited class 1 Number	1~512	5	1		The maximum number of events in the corresponding class to be allowed before an unsolicited response is generated.
Unsolicited class 2 Number	1~512	5	1		The maximum number of events in the corresponding class to be allowed before an unsolicited response is generated.
Unsolicited class 3 Number	1~512	5	1		The maximum number of events in the corresponding class to be allowed before an unsolicited response is generated.
Unsolicited class 1 Delay	0~60	5	1	sec	The waiting time to send an unsolicited response after a first event occurred.

Time					
Unsolicited class 2 Delay Time	0~60	5	1	sec	The waiting time to send an unsolicited response after a first event occurred.
Unsolicited class 3 Delay Time	0~60	5	1	sec	The waiting time to send an unsolicited response after a first event occurred.
Unsolicited Offline Retry Delay	0~255	15	1	min	Unsolicited Offline Retry Delay.
Unsolicited class 1	Disable Enable	Disable			Unsolicited setting for Class 1, 2, 3.
Unsolicited class 2	Disable Enable	Disable			Unsolicited setting for Class 1, 2, 3.
Unsolicited class 3	Disable Enable	Disable			Unsolicited setting for Class 1, 2, 3.

4.5 Data Handling

The F-FTU200 has data handling function for following items:

- ✧ Sequence of event recorder
- ✧ Fault recorder
- ✧ Disturbance recorder
- ✧ Power quality analysis
- ✧ Load profile

4.5.1 SOE and Fault recorder

This function is used to verify shortly the operated history of FTU in normal operation and fault situation. Sequence of event is triggered by control, set value change, operation of protection, communication, measurement alarm, system error or self-diagnosis, etc. The F-FTU200 can store 10,000 events in a nonvolatile memory including occurred time/date, type, values of current / voltage alarm and warn. All events can view through LCD screen. The capacity of fault recorder is 1,024 pieces, which contains all protection occurred time/date, type and values of fault current, voltage and frequency. The SOE and fault recorder follows FIFO (First In First Out) principle. The types of SOE include “protection”, “measurement”, “control”, “settings”, “switch”, “communication” and “internal fault”; the types of FR includes “start”, “alarm” and “trip”. Stored events and faults can be uploaded and listed on Maintenance Software and web-server through commissioning port on front panel. The event and fault list are shown in web-server as below picture.

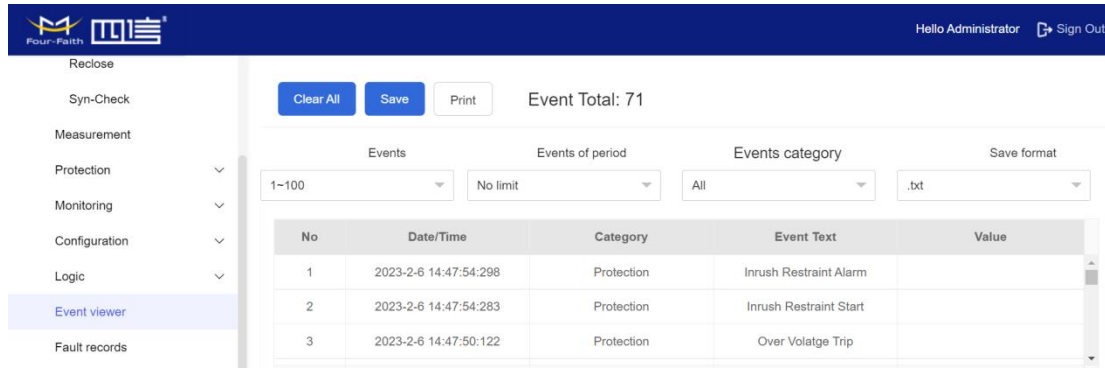


Figure 15

Event list

4.5.2 Disturbance Recorder

The F-FTU200 supports disturbance recorder function including 12 analog and 64 binary signal channels, which can store 10 records with a maximum of 10 seconds at the storage rate of 128 sampling points in each fundamental frequency period, and store up to 100 records to help customers comprehensively analyze the reason of the fault, tracing the rooting cause to solve the problem. The record length and storage rate are adjustable.

The function can be enabled and disabled with the operation setting , corresponding parameter values are “on”, “off”.

Disturbance recorder can be triggered by the following methods:

- A. Triggered according to the state change of any or more binary channels, triggering on the rising edge of the binary input signal indicates that the recording sequence is enabled when the input signal is activated. Correspondingly, triggering on the falling edge indicates that the recording sequence is enabled when the effective input signal is reset. It can also be triggered from both edges at the same time. In addition, it can also not trigger the monitoring signal if necessary.
- B. Trigger according to the limit value of analog channel (high limit value or low limit value), the filtering time of all analog channels are the same, about 50ms.
- C. Manually trigger by disturbance recorder parameters on LCD menu.
- D. Regularly triggered , which means that the disturbance recorder will be recorded automatically at a specific time interval. The user can adjust this interval time through the periodic trigger time parameter. If the parameter value is changed, the new setting will be adopted at the next periodic trigger.

Disturbance recorder has two operation modes: saturation mode and overwrite mode.

The user can change the operation mode through the parameter. In saturation mode, the records cannot be overwritten by new one. When the recording memory is full (reaching the maximum number of records), the wave-forms will be stopped to capture. When the operation mode is overwrite and the recording memory is full, the records will be updated by new one. If you want to get the latest record in the memory, it is recommended to adopt the overwrite mode, if the old

record is more important, the saturation mode is adopted.

The disturbance recorder is also uploaded to software, and current/voltage waveforms at fault and protection elements operation can be analyzed with report. This disturbance recorder function follows the COMTRADE file format rule. The waveforms picture is shown in software as below:

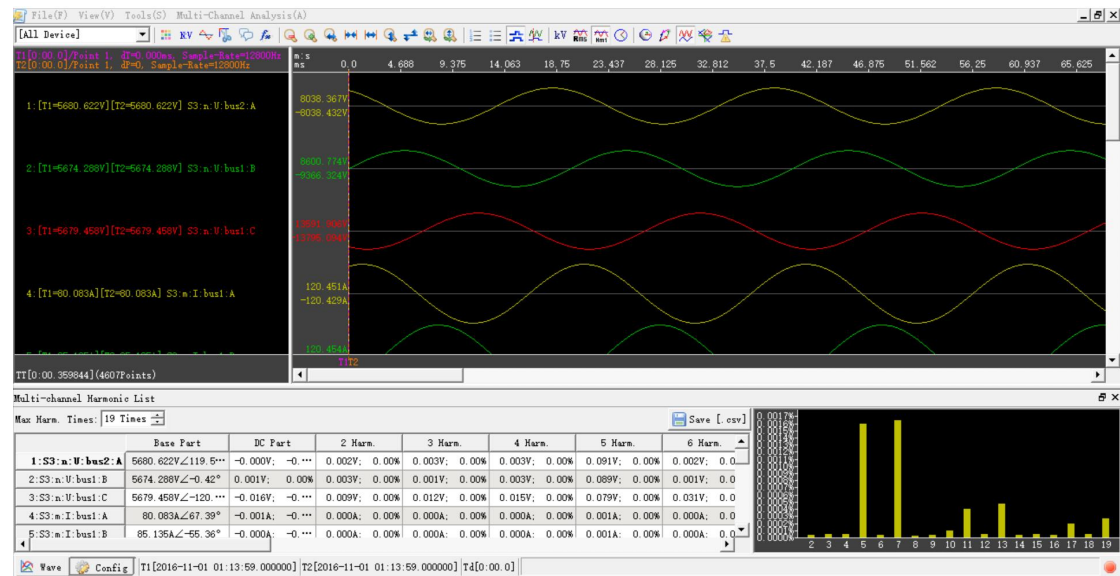


Figure 16

Disturbance recorder

The following table shows the parameter settings among disturbance recorder function.

Table 64-Disturbance recorder function parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	on/off	on			This function element can be enabled or disabled by on/off selection.
Record length	10~500	50	1	cycles	Size of the recording in fundamental cycles.
Pre-trg length	0~100	50	1	%	Length of the recording preceding the triggering.
Operation mode	Overwrite Saturation	Overwrite			Operation mode of the recorder.
Exclusion time	0~100000	0	1	ms	The time during which triggerings of same type are ignored.
Storage rate	128 64 32 16 8	128			Storage rate of the waveform recording.
Periodic trigger time	0~600000	0	1	sec	Time between periodic triggerings.
Analog ch1	on/off	on			This function element can be enabled or

operation					disabled by on/off selection.
Ch1 selection	Ia/Ib/Ic/Io/Ua/U b/Uc/Uo1/Ur/U s/Ut/Uo2/Uab/U bc/Uca/Urs/Ust/ Utr/none	Ia			Select the analog to be recorded by this channel.
Analog high trigger level	0.00~60.00	10.00	0.01	pu	High trigger level for the analog channel. (0.00 means disable this function)
Analog low trigger level	0.00~2.00	0.00	0.01	pu	Low trigger level for the analog channel. (0.00 means disable this function)
OC ch1 operation	on/off	on			This function element can be enabled or disabled by on/off selection.
OC ch1 selection	OC inst.start OC high start OC low start A phase OC start B phase OC start C phase OC start OC start OC inst.trip OC high trip OC low trip OC trip/none	OC inst.start			Select the binary to be recorded by this channel.
Binary trigger mode	rising edge falling edge Both trigger off	rising edge			Level trigger mode for the binary channel.

4.5.3 Power Quality Analysis

The F-FTU200 Supports power quality analysis, which can check the proportion of harmonic components of up to 6 analog quantity in real time, including three phase currents and three phase voltages, and up to 11 harmonics can be calculated to meet Customers' high-quality electricity demands. The power quality data is uploaded to software, and shown in power quality analysis tool as below picture. The power quality data can be deleted by web-server and software.

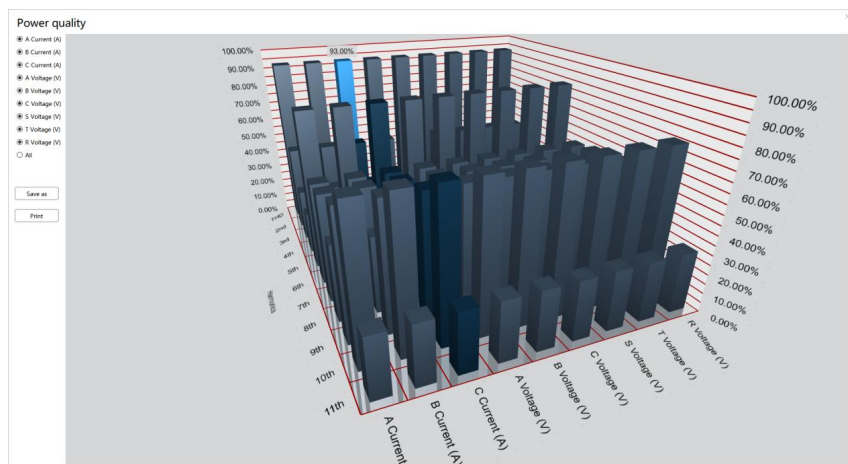


Figure 17

Power quality analysis

4.5.4 Load Profile

Record the demand value when reaches in setting time (1, 5, 15, 30, 60, 180 minutes). Load profile can store values of 30 days even through the setting time is 1 minute, and could check the historical data curve of 29 analog quantities, including current, voltage, power, energy, power factor, frequency and harmonic, to be convenient for customers to track and save the data.

The load profile data is uploaded to software, and shown in load profile tool as below picture. The load profile data can be deleted by LCD menu, web-server and software.

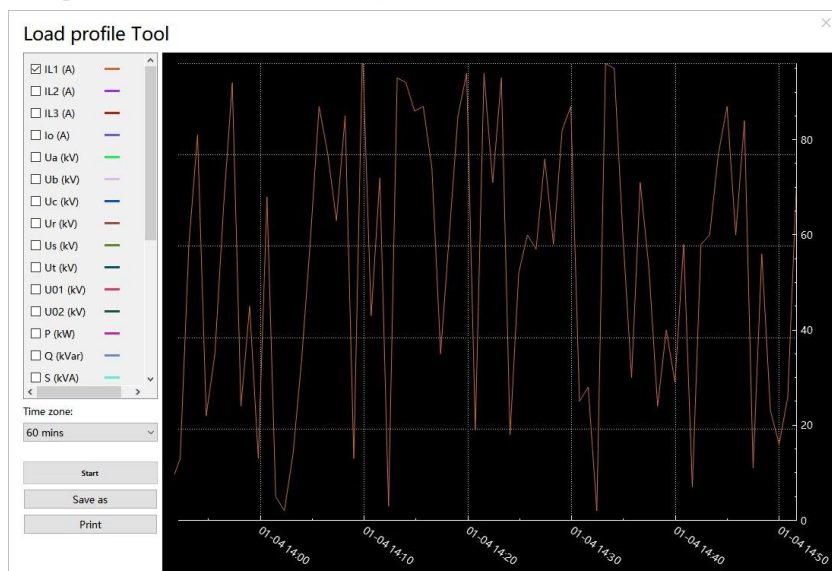


Figure 18

Load profile

4.6 Distribution Automation Scheme

Distribution automation schemes enable rapid detection, isolation and restoration of feeder faults

through the cooperation between reclosers, or between circuit breakers and load break switches. The schemes are mainly divided into local and centralized types: the local type does not depend on the communication and SCADA systems. It can realize various logical actions through the local FTU; the centralized type needs to establish communication and SCADA, the master station sends control commands to the intelligent terminal, so as to realize the distribution network automation functions.

The overhead line automation solutions, mainly local and partly centralized, with the innovative combination of both types, will meet the needs of customers for automation with different grid topology. The solutions are mainly: loop automation scheme and auto-changeover scheme.

4.6.1 Loop Automation Scheme

The loop automation scheme is applied in a ring network, and completed by the recloser and FTU it is equipped with. Depending on where the recloser is installed on the overhead line, it can be divided into: Feeder ACR, Mid-point ACR and Tie ACR.

When over-current and ground fault occur on the line, if the Feeder ACR detects the fault current and reaches the trip time, it trips for line protection, and filters the instantaneous fault through the first reclosing. It will trip again for reclosing lock out when it is a permanent fault; if no voltage is detected on both sides, it trips directly and locks out the closing after a set delay time. If the Mid-point ACR detects a fault current, it will trip before the Feeder ACR, and if it is a permanent fault, it will open and locks out; if it detects the absence of voltage on the power side, the current protection direction is reversed, and at the same time, the reclosing function is not activated and it becomes a single trip mode. When the Tie ACR detects voltage on one side and no voltage on the other side, it closes after a set delay time to complete the transfer of power; after the Tie ACR has closed, it plays the role of the Mid-point ACR. If the fault current is detected, it directly opens and locks out reclosing.

Through the above logic process, the recloser finally achieves faulty section isolation and restoration of power supply in the non-faulty sections within seconds.

Users may, according to their need, choose to establish communication and SCADA system for remote monitoring and control.

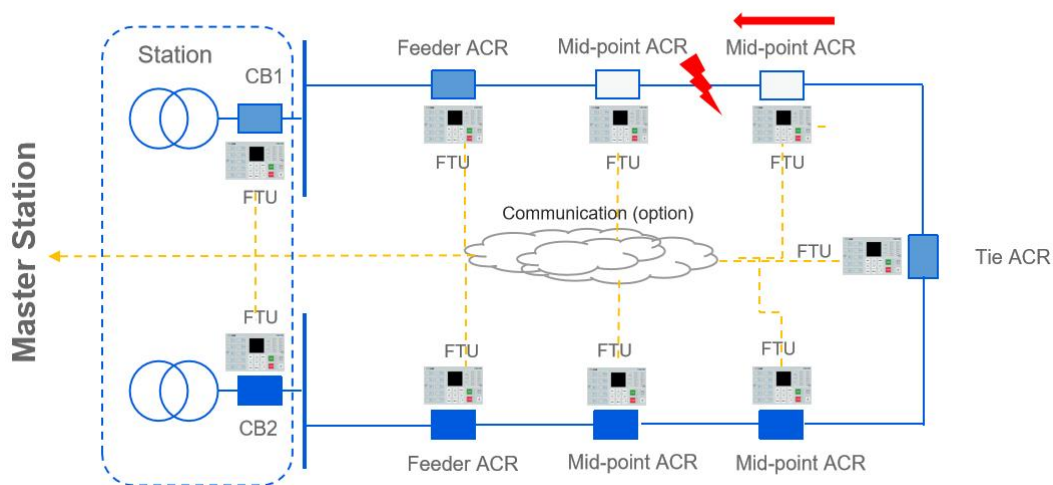


Figure 19

Loop automation scheme

The following table shows the parameter settings among loop automation scheme.

Table 65-Loop automation scheme parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	on/off	off			This function element can be enabled or disabled by on/off selection.
Device type	Feeder Midpoint Tie	Feeder			The type of logic for automatic circuit recloser.
Open Delay time	0.1~180.0	5	0.1	sec	Delay time for operation.
Close Delay time	1.0~600.0	30	1.0	sec	Delay time for operation.
Auto change	On/off	off			Automatically change the set group
Alternative setting group	1~5	2			Alternative group
Auto change time	1.0~180.0	10.0		sec	Automatically change the set group time
Dead line value	0.1~0.8	0.2	0.1	xUn	Voltage low-limit line for solution.
Live line value	0.2~1.0	0.5	0.1	xUn	Voltage high-limit line for solution.

4.6.2 Auto-changeover Scheme

Auto-changeover scheme is used in dual power supply system, usually the object of power supply is an important load, such as hospitals, factories, etc. The function logic is realized by the recloser and its own FTU. Depending on where the recloser is installed in the dual power supply system, it can be divided into: Feeder ACR and Tie ACR.

Normally it is powered by the main power supply. The Feeder ACR is installed on the terminal of the main power supply and is normally closed; the backup power supply is disconnected by the Tie ACR to prevent a closed loop.

When an over-current or ground fault occurs on the main power side, the circuit breaker in station trips, and the main circuit loses voltage. The Feeder ACR detects the absence of voltage on both sides, and after a set delay time, it trips and lock out the closing action directly; when the Tie ACR detects the absence of voltage on the load side, it closes after a set delay time to switch to the backup power supply and restore the power supply to the important load.

Through the above logic process, the recloser achieves automatic power transfer function within seconds.

Users may, according to their need, choose to establish communication and SCADA system for background monitoring and control.

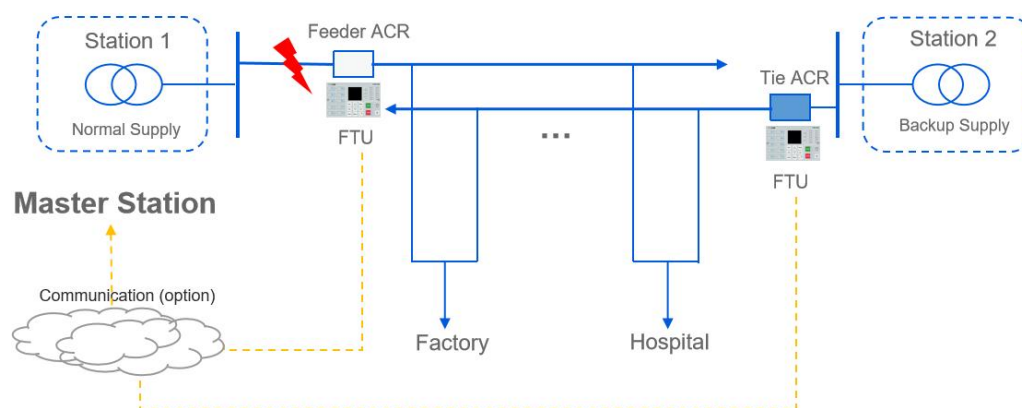


Figure 20

Auto-changeover scheme

The following table shows the parameter settings among auto-changeover scheme.

Table 66-Auto-changeover scheme parameter settings

Parameter	Range	Default	Step	Unit	Description
Operation	on/off	off			This function element can be enabled or disabled by on/off selection.
Device type	Feeder Tie	Feeder			The type of logic for automatic circuit recloser.
Open Delay time	0.1~180.0	5	0.1	sec	Delay time for operation.
Close Delay time	1.0~600.0	30	1.0	sec	Delay time for operation.
Dead line value	0.1~0.8	0.2	0.1	xUn	Voltage low-limit line for solution.
Live line value	0.2~1.0	0.5	0.1	xUn	Voltage high-limit line for solution.

4.7 LED and Button Matrix Functions

The LEDs and Buttons on front panel of IED has programmable function. Each LED and button can be customized by user through software.

The LED programmable (signal matrix tool) in software is as below picture, user can select associated function what he want, and download the parameter so as to active relatively configuration.

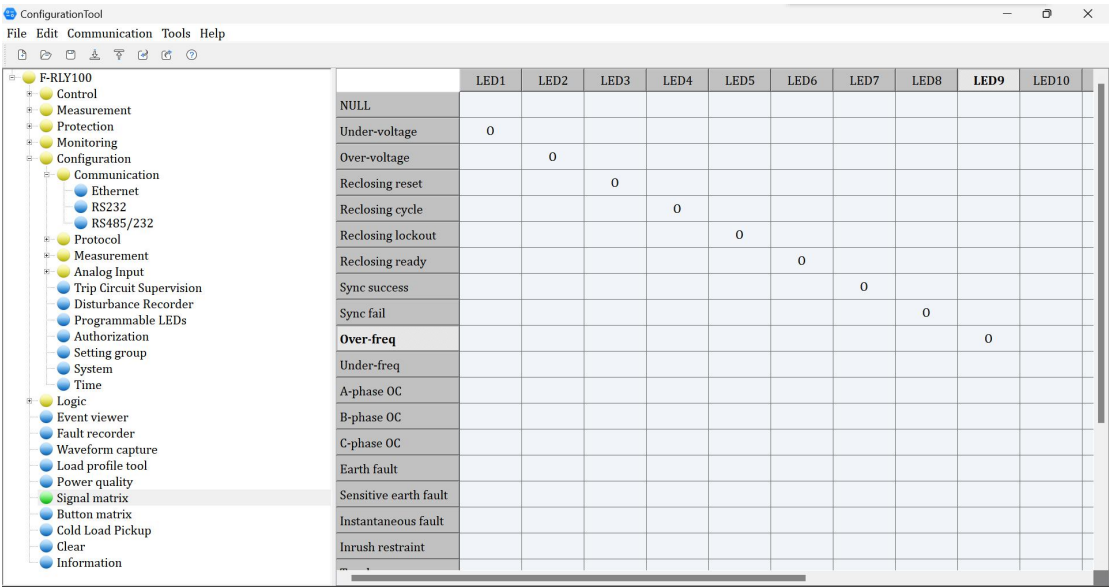


Figure 21
Signal matrix tool

The button programmable (button matrix tool) in software is as below picture, user can select associated function what he want, and download the parameter so as to active relatively configuration.

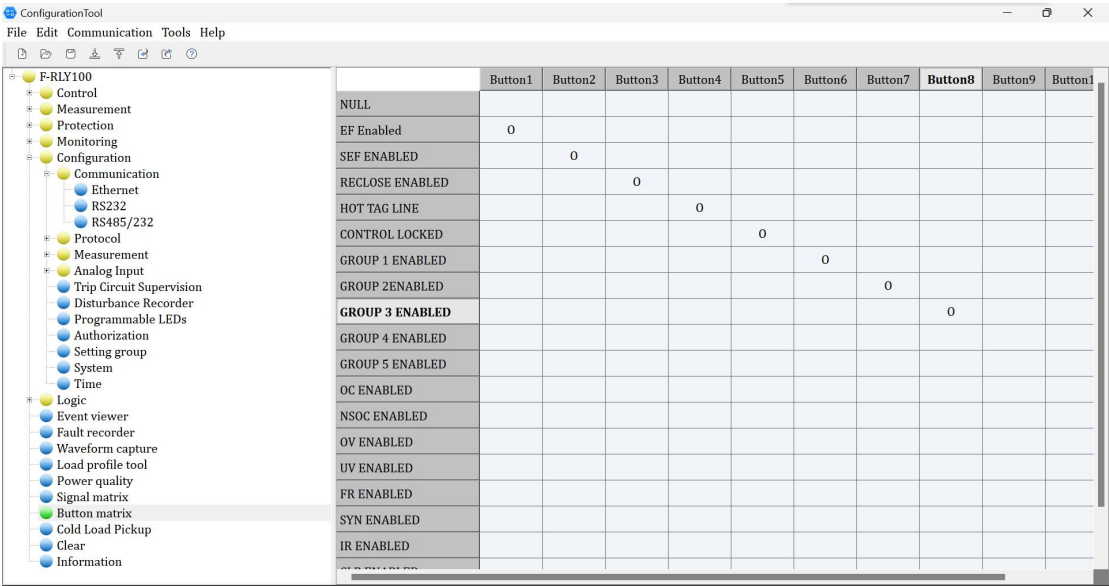


Figure 22
Button matrix tool

4.8 Authorization Function

There are four roles of user which predefined for LCD and web-server with different rights and default password.

- ✧ Administrator

- ✧ Engineer
- ✧ Operator
- ✧ Viewer

The default password of all roles can be changed with administrator rights.

The following table shows rights for four roles.

Table 67-Predefined authorization

User	LCD Authorization	Web-server Authorization
Viewer	Read only	Read only
Operator	R/L selection (only local operation)	Setting Group selection
	Local Open/Close	LEDs alarm clear
	Local buttons operation	
	Setting Group selection	
	LEDs alarm clear	
Engineer	Control parameter setting change	Control parameter setting change
	Protection parameter setting change	Protection parameter setting change
	Configuration setting change (except for authorization)	Configuration setting change (except for authorization)
	Logic parameter setting change	Logic parameter setting change
	Clear operation	Event Viewer delete/save as/print
	Cold Load Pickup setting change	Fault Records delete/save as/print
	Language setting change	Disturbance Records operation
		Load Profile Records operation
		Cold Load Pickup setting change
		Parameter List download/print
		Clear operation
		Language setting change
		File import/export
Administrator	All list above	All list above
	Changing password	Changing password

The following table shows the parameter settings among authorization function.

Table 68-Authorization function parameter settings

Parameter	Range	Default	Step	Unit	Description
Remote update	Enable Disable	Enable			Allow or not allow the software to change password by enable/disable
Remote override	True False	False			Show the below menu if selected true. (Only administrator have permission)
Viewer password		*****			Viewer password. (Only administrator have permission)
Operator password		*****			Operator password. (Only administrator have permission)

Engineer password		*****			Engineer password. (Only administrator have permission)
Administrator password		*****			Administrator password. (Only administrator have permission)

4.9 Internal Fault

When an IED internal fault is detected, IED protection operation is disabled, the self-check LED change from green to red. Internal fault indications have the highest priority on the LCD. When the internal fault is found to be permanent, all other output contacts are released and locked for the internal fault, the internal fault information is shown as a SOE on the event list. When the internal fault disappears, the self-check LED will recovery to green LED flashing and the IED returns to the normal service state, The fault information remains on the SOE event list.

The following table shows types of internal fault.

Table 69-Internal fault type

Internal Fault Type	Fault code
Internal Fault File error	1
Internal Fault PWR CAN Comm. error	2
Internal Fault MEA CAN Comm. error	3
Internal Fault LCD CAN Comm. error	4
Internal Fault COM CAN Comm. error	5
Internal Fault DIO1 CAN Comm. error	6
Internal Fault DIO2 CAN Comm. error	7
Internal Fault LCD and COM Comm. error	8
Internal Fault LHMI Module error	9
Internal Fault MEA Flash error	10
Internal Fault LCD Flash error	11
Internal Fault COM Flash error	12
Internal Fault RTC error	13
Internal Fault LCD RJ45 error	14
Internal Fault COM RJ45 error	15
Internal Fault ADC Sample error	16
Internal Fault Frequency error	17
Internal Fault MEA Timer error	18
Internal Fault PWR Timer error	19
Internal Fault DIO1 Timer error	20
Internal Fault DIO2 Timer error	21
Internal Fault MEA Buffer error	22
Internal Fault MEA Configure error	23

5. PRODUCT OPERATION

Safety information: All the operations must be carried out by qualified personnel from Four - Faith Smart Power or customer, with in depth knowledge of the power equipment and distribution network. If the operations would be prevented, please check the operation sequence that whether correct or not, do not forcedly and fiercely operate the mechanical or else personnel or equipment safety can be jeopardized.

Totally three ways to operate and configure: LCD menu, Web-server, Configuration tool.

The maintenance content please find as below table:

Table 70-Maintenance content

Content	LCD Menu	Web-server	Configuration Tool
Parameter View	■	■	■
Parameter setting	■	■	■
Parameter saving	■	■	■
Parameter Import/Export		■	■
Project Import/Export			■
Event list	■	■	■
Fault recorder		■	■
Disturbance recorder		■	■
Load Profile Tool			■
Power Quality Management			■
Authorization	■	■	■
Signal Matrix			■
Button Matrix			■
Communication management			■
IED Update			■

5.1 Authorization Login

When power on the feeder protection relay, need to select authorization and login on menu. There are four roles and default passwords with different authority which mentioned in chapter 4.8. The user can change the role during operation through authorization button (Figure 23).

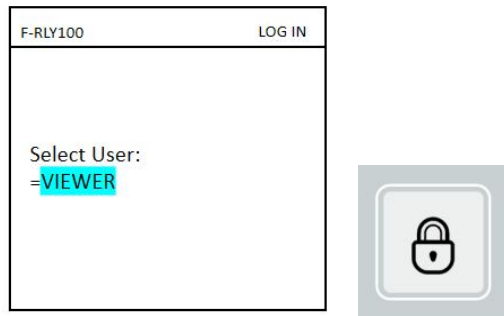


Figure 23

Login system on LCD

The user can login system through web-server as well, select properly role and put into password to get permission (Figure 24).

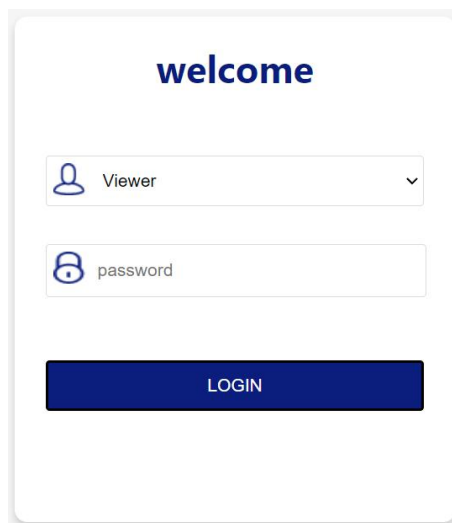


Figure 24

Login system on web-server

5.2 Closing and Opening

The closing and opening operations including three modes as below:

- ✧ Mechanical tripping
- ✧ Electrical operations
- ✧ Remote operations

5.2.1 Mechanical Tripping

The recloser can be tripped manually. If the handle is pulled, recloser opens and simultaneously lockout electrically and mechanically. The handle stays extending so as to indicate the interlock state (Figure 25).



Figure 25

Mechanical trip and lockout

To Close the recloser again, the handle must be pushed back to the operation position firstly in order to release the lockout. Then the recloser can be closed via button on the front panel (Figure 26).

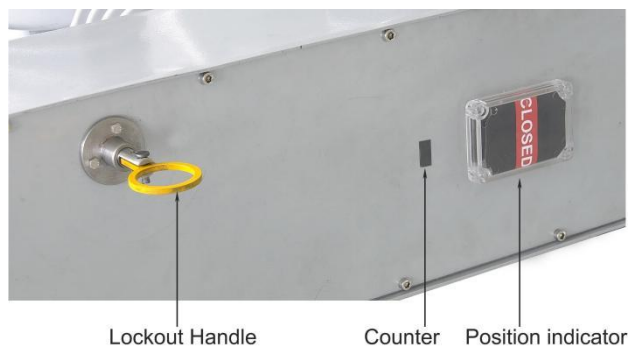


Figure 26

Release lockout and close

5.2.2 Electrical Operations

To operate the device via the front panel, change the mode to “local” by pressing the “R/L” button. Local device mode indication is: “local” LED above the “R/L” button is active (Figure 27).



Figure 27

Local position

To open the primary switch via front panel, push the green button and confirm the selection on menu (Figure 28).



Figure 28

Local Open

To close the primary switch via front panel, push the red button and confirm the selection on menu (Figure 29).



Figure 29

Local close

5.2.3 Remote operations

Opening and closing are available in Remote mode as well.

5.3 Protection Settings

Protection settings can be edited locally via three ways:

- ✧ LCD menu on front panel
- ✧ Web-server on PC
- ✧ Configuration tool on PC

If using the LCD menu on front panel to change protection settings:

Main Menu -> Protection -> Edit Group#

Protection settings can be changed in each group independently (Figure 30)

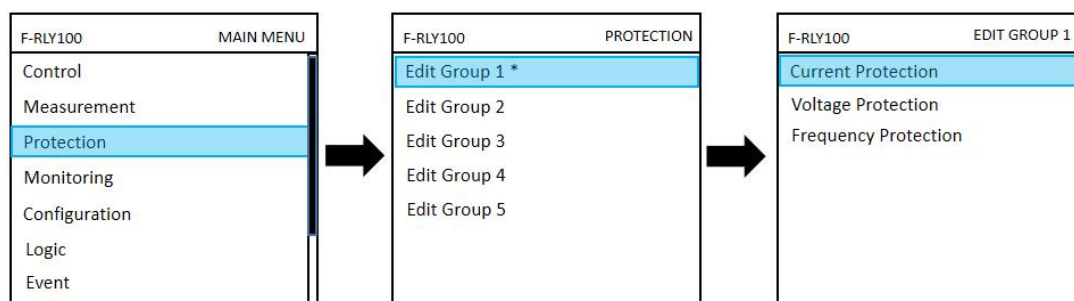


Figure 30

Protection settings on LCD menu

If using web-server on PC to change protection settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
 - 2) Visit 192.168.4.100 address in website and find login button;
 - 3) Select properly role (Engineer or administrator) and put into correctly password;
 - 4) Find the “Protection” button in the menu tree;
 - 5) Click the “Protection” and parameter settings window will popup where it is possible to edit.
- (Figure 31)

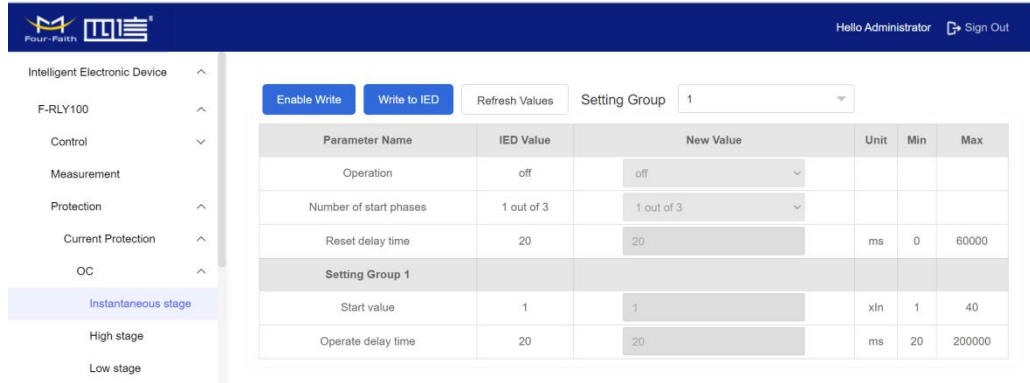


Figure 31

Protection settings on web-server

If using configuration tool on PC to change protection settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
 - 2) Change the communication status from offline to online;
 - 3) Find the “Protection” button in the menu tree;
 - 4) Click the “Protection” and parameter settings window will popup where it is possible to edit.
- (Figure 32)

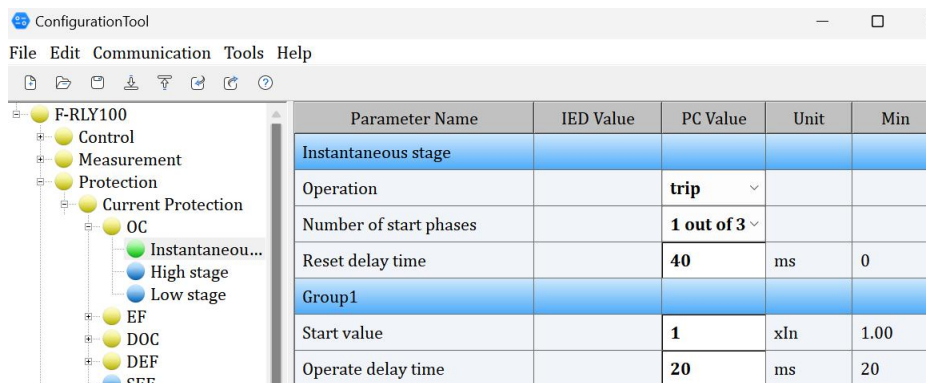


Figure 32

Protection settings on configuration tool

5.4 Measurement Settings

Measurement values can be viewed locally via three ways:

- ✧ LCD menu on front panel
- ✧ Web-server on PC

✧ Configuration tool on PC

If using the LCD menu on front panel to view measurement values:

Main Menu -> Measurement -> values#

Shown as figure 33 below

F-RLY100	MAIN MENU		F-RLY100	MEASUREMENT
Control			IL1 (A)	0.0
Measurement			IL2 (A)	0.0
Protection			IL3 (A)	0.0
Monitoring			Io (A)	0.0
Configuration			Ua (kV)	0.000
Logic			Ub (kV)	0.000
Event			Uc (kV)	0.000

Figure 33

Measurement values on LCD menu

If using web-server on PC to view measurement values:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Visit 192.168.4.100 address in website and find login button;
- 3) Select properly role (any) and put into correctly password;
- 4) Find the “Measurement” button in the menu tree;
- 5) Click the “Measurement” and values window will popup. (Figure 34)

 Hello Administrator Sign Out			
Intelligent Electronic Device			
F-RLY100			
Control			
Measurement			
Protection			
Monitoring			
Configuration			
Logic			
Event viewer			
Fault records			

Group Select	All	Refresh Values
Description	Value	Unit
IL1	0	A
IL2	0.1043	A
IL3	0.1132	A
IL0	0	A
Ua	0.0055	kV
Ub	0.007	kV
Uc	0.0066	kV

Figure 34

Measurement values on web-server

If using configuration tool on PC to view measurement values:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Change the communication status from offline to online;
- 3) Find the “Measurement” button in the menu tree;
- 4) Click the “Measurement” and values window will popup. (Figure35)

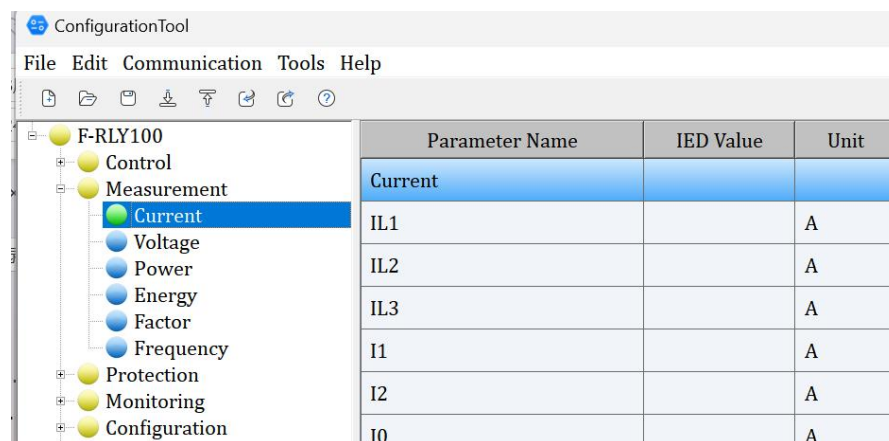


Figure 35

Measurement values on configuration tool

There are current and voltage analog input configuration which defined “In”(Primary current) and “Un”(Primary voltage) values.

If using the LCD menu on front panel to change the analog input settings:

Main Menu -> Configuration -> Analog Input

Shown as figure 36 below

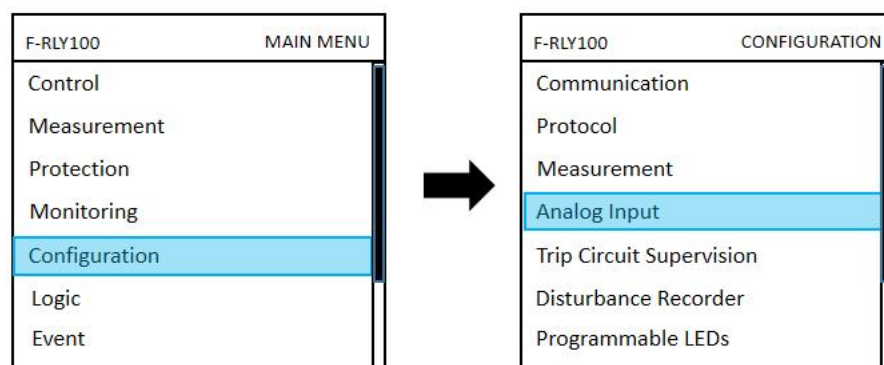


Figure 36

Analog input on LCD menu

If using web-server on PC to change the analog input settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Visit 192.168.4.100 address in website and find login button;
- 3) Select properly role (Engineer or administrator) and put into correctly password;
- 4) Find the “Configuration” button in the menu tree;
- 5) Click the “Analog Input” and parameter settings window will popup where it is possible to edit. (Figure 37)

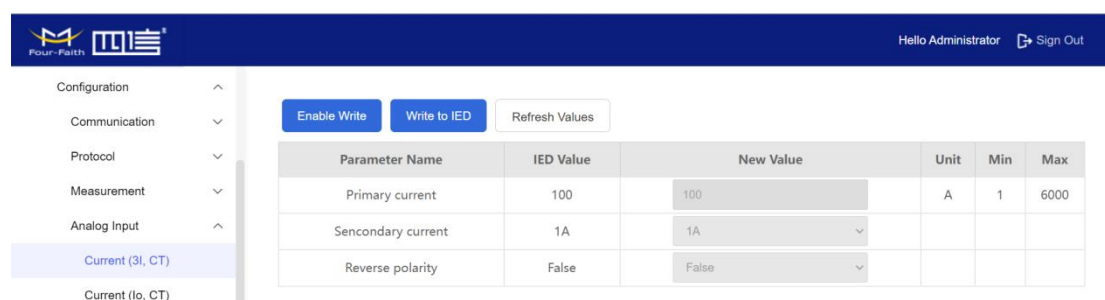


Figure 37

Analog input on web-server

If using configuration tool on PC to change the analog input settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Change the communication status from offline to online;
- 3) Find the “Configuration” button in the menu tree;
- 4) Click the “Analog input” and parameter settings window will popup where it is possible to edit. (Figure 38)

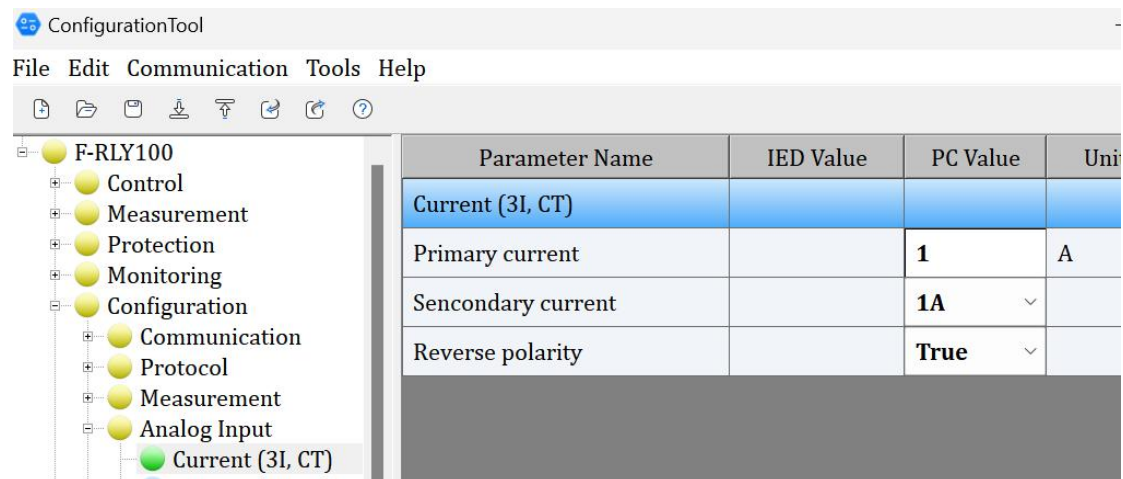


Figure 38

Analog input on configuration tool

5.5 Communication settings

Communication settings can be edited locally via three ways:

- ✧ LCD menu on front panel
- ✧ Web-server on PC
- ✧ Configuration tool on PC

If using the LCD menu on front panel to edit communication settings:

Main Menu -> Configuration -> Communication -> Ethernet/RS232/485

Shown as figure 39 below

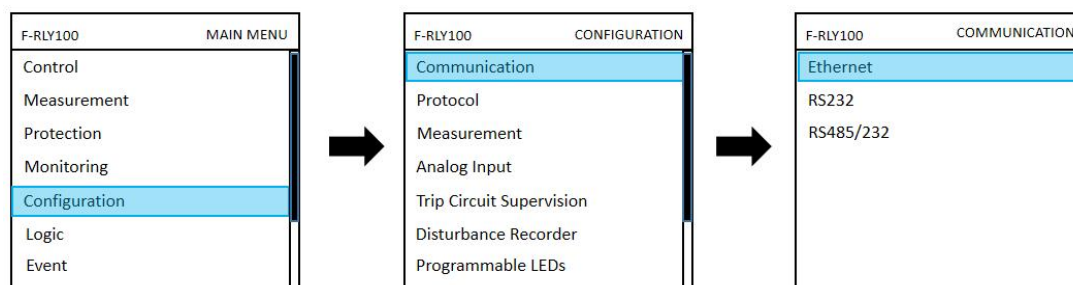


Figure 39

Communication settings on LCD menu

If using web-server on PC to edit communication settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Visit 192.168.4.100 address in website and find login button;
- 3) Select properly role (Engineer or administrator) and put into correctly password;
- 4) Find the “Configuration” button in the menu tree;
- 5) Click the “Communication” and parameter settings window will popup where it is possible to edit. (Figure 40)

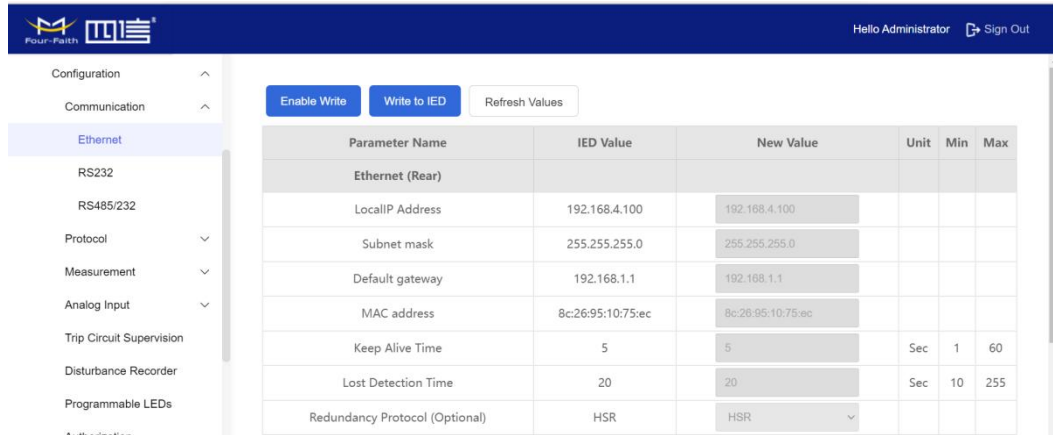


Figure 40

Communication settings on web-server

If using configuration tool on PC to edit communication settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Change the communication status from offline to online;
- 3) Find the “Configuration” button in the menu tree;
- 4) Click the “Communication” and parameter settings window will popup where it is possible to edit. (Figure 41)

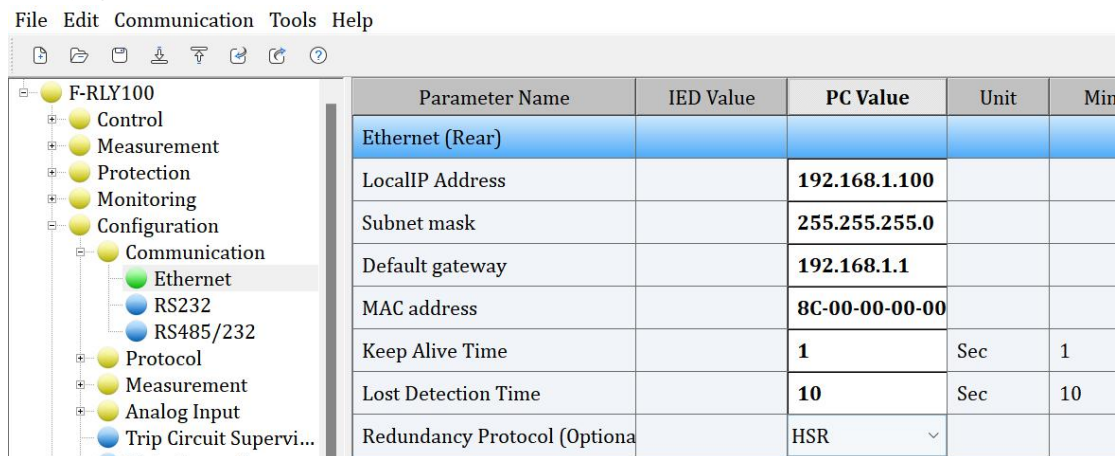


Figure 41

Communication settings on configuration tool

5.6 Monitoring Settings

Monitor settings can be viewed locally via three ways:

- ✧ LCD menu on front panel
- ✧ Web-server on PC
- ✧ Configuration tool on PC

If using the LCD menu on front panel to view monitoring settings:

Main Menu -> Monitoring-> True/False#

Shown as figure 42 below

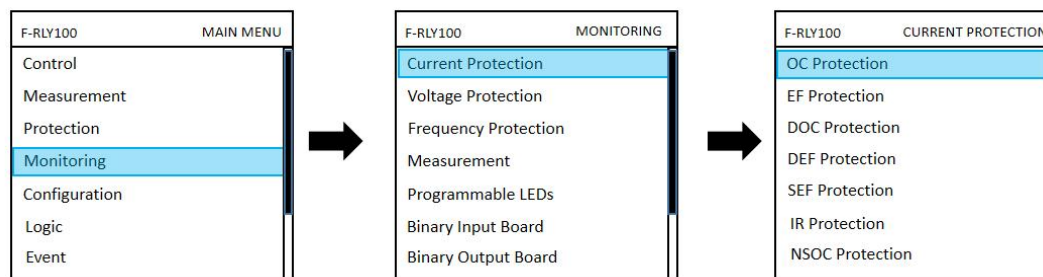


Figure 42

Monitoring settings on LCD menu

If using web-server on PC to view monitoring settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Visit 192.168.4.100 address in website and find login button;
- 3) Select properly role (any) and put into correctly password;
- 4) Find the “Monitoring” button in the menu tree;
- 5) Click the “Monitoring” and status window will popup. (Figure 43)

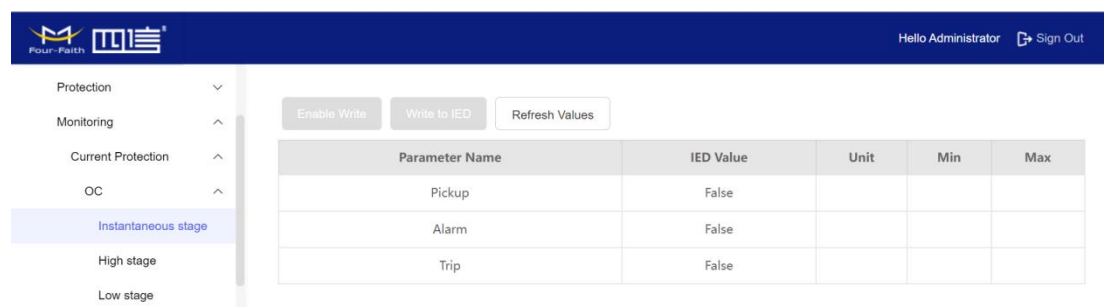


Figure 43

Monitoring settings on web-server

If using configuration tool on PC to view monitoring settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Change the communication status from offline to online;
- 3) Find the “Monitoring” button in the menu tree;
- 4) Click the “Monitoring” and status window will popup. (Figure 44)

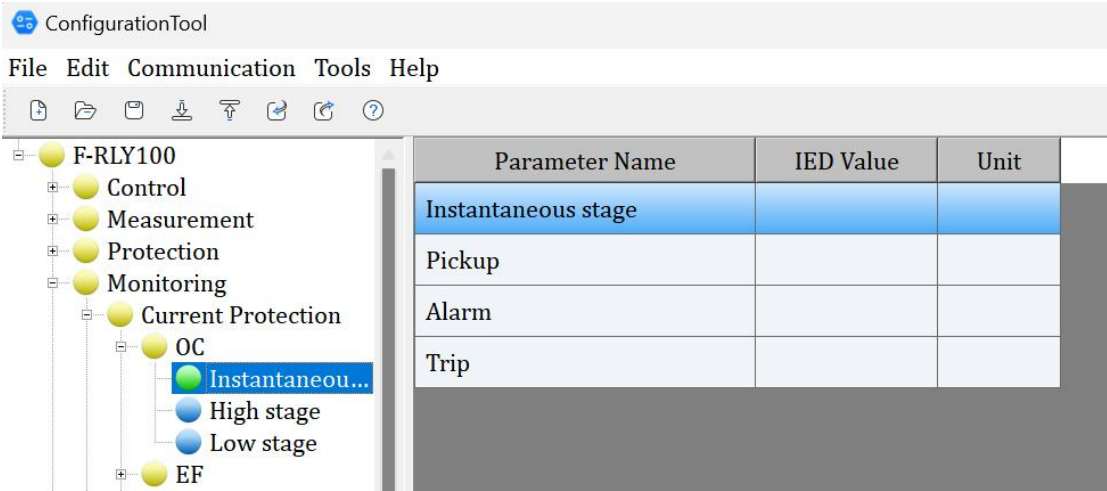


Figure 44
Monitoring settings on configuration tool

The status (True or false) of monitoring settings includes protection (pickup/alarm/trip), measurement (alarm/warn), control (local/remote/off), input, output, programmable led, internal fault.

5.7 Logging

From the front panel the following logs can be read:

- ✧ Sequence of event (SOE)
- * includes internal fault messages.

Main Menu -> Event

Shown as figure 44 below

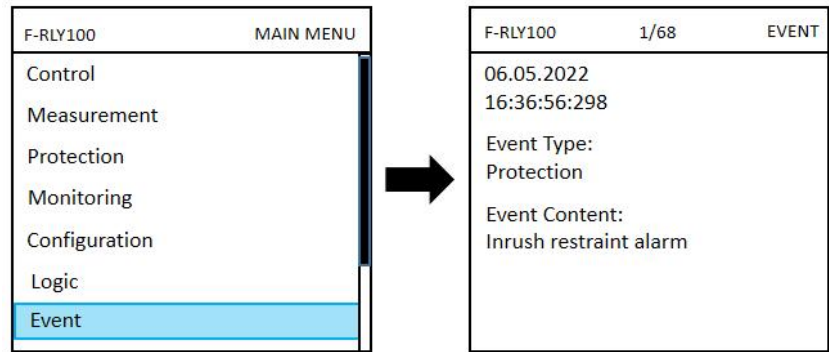


Figure 44
Sequence of event on LCD menu

Regarding the delete SOE operation on LCD, click the “clear” button , and change the “events” setting from “remain” to “clear”, and all of events will be deleted after confirmation.

From the web-server the following logs can be read:

- ✧ Sequence of event (SOE)
- ✧ Fault recorder (FR)

✧ Disturbance recorder (DR)

✧ Load profile recorder (LP)

* DR and LP only support file download from web-server.

From the configuration tool the following logs can be read:

✧ Sequence of event (SOE)

✧ Fault recorder (FR)

✧ Disturbance recorder (DR)

✧ Load profile recorder (LP)

✧ Power quality management (PQM)

The sequence of event on the web-server and configuration tool are as below:

No	Date/Time	Category	Event Text	Value
1	2023-2-6 14:47:54.298	Protection	Inrush Restraint Alarm	
2	2023-2-6 14:47:54.283	Protection	Inrush Restraint Start	
3	2023-2-6 14:47:50.122	Protection	Over Voltage Trip	

Figure 45

Sequence of event on web-server

Event viewer				
		Events of period	No limit	Events category All
	Date/Time	Category	Event Text	Value
0	2022-04-29 00:00:00	0x3316	Events Clear	13078
1	2022-05-05 00:00:00	0x3703	Internal Fault LCD CAN Comm. error	14083
2	2022-05-05 00:00:00	0x343f	Reclose Setting is On	13375
3	2022-05-05 00:00:00	0x3401	Setting Group 2 Active	13313
4	2022-05-11 15:31:18	0x3407	OC Inst. stage Setting is Trip	13319
5	2022-05-13 10:08:05	0x3701	Internal Fault PWR CAN Comm. error	14081

Figure 46

Sequence of event on configuration tool

The latest SOE is placed at the top of the list. Time and date of the SOE is displayed on the table.

There are many options for event scope: “1~100; 101~200; 201~300; 301~400; 401~500; 501~600; 601~700; 701~800; 801~900; 901~1000; all”.

There are many options for event period: “1 min; 15 mins; 30 mins; 1 hour; 2 hours; 4 hours; 8 hours; 12 hours; 1 day; 1 week; 1 month; 1 year; all”.

The types of SOE include “protection”, “measurement”, “control”, “settings”, “switch”, “communication” and “internal fault”.

The user can save SOE file as .txt and .csv format, and print as well.

The user can delete all SOE information by “Clear All” button under “engineer” and “administrator” authorization.

The fault recorder on the web-server and configuration tool are as below:

F-RLY100		Hello Administrator Sign Out	
Control		Clear All Save Print Fault Total: 1024	
Measurement		Events Events of period Events category Save format	
Protection		1~100 No limit All .txt	
Monitoring			
Configuration			
Logic			
Event viewer			
Fault records			
Disturbance Records			
Cold Load Pickup			

No	Date/Time	Category	Event Text	Value
1	2023-2-6 14:47:50:122	Trip	Over Volatge Trip	F=25.0029KV
2	2023-2-6 14:47:50:82	Start	Over Volatge Start	F=25.0031KV
3	2023-2-6 14:47:30:473	Start	FR Start	dI/dt=0.0099HZ

< 1 > GoTo 1 Page Confirm 共 100 条 100 Strip/Page

Figure 47

Fault recorder on web-server

Fault recorder			
Fault read		All recorders	
Fault category		All	
Date/Time	Category	Event Text	Value

Figure 48

Fault recorder on configuration tool

The latest FR is placed at the top of the list. Time and date of the FR is displayed on the table.

There are many options for event scope: “10; 50; 100; 200; 300; all”.

The types of FR includes “start”, “alarm” and “trip”.

The user can save FR file as .txt and .csv format, and print as well.

The user can delete all FR information by “Clear All” button under “engineer” and “administrator” authorization.

The disturbance recorder on the web-server is as below:



Four-Faith

四信®

Hello Administrator

 Sign Out

F-RLY100

Control

Measurement

Protection

Monitoring

Configuration

Logic

Event viewer

Fault records

Disturbance Records

Enable Write

Write to IED

Manual triggering

Refresh Values

#		Description	Date/Time	Length (ms)	Download Files
0	☐				
1	☐				
2	☐				
3	☐				
4	☐				

Figure 49

Disturbance recorder on web-server

The user can read all the DR file from web-server after download and delete corresponding or all disturbance records by “Delete” or “Delete All” buttons.

The disturbance recorder on the configuration tool is as below:

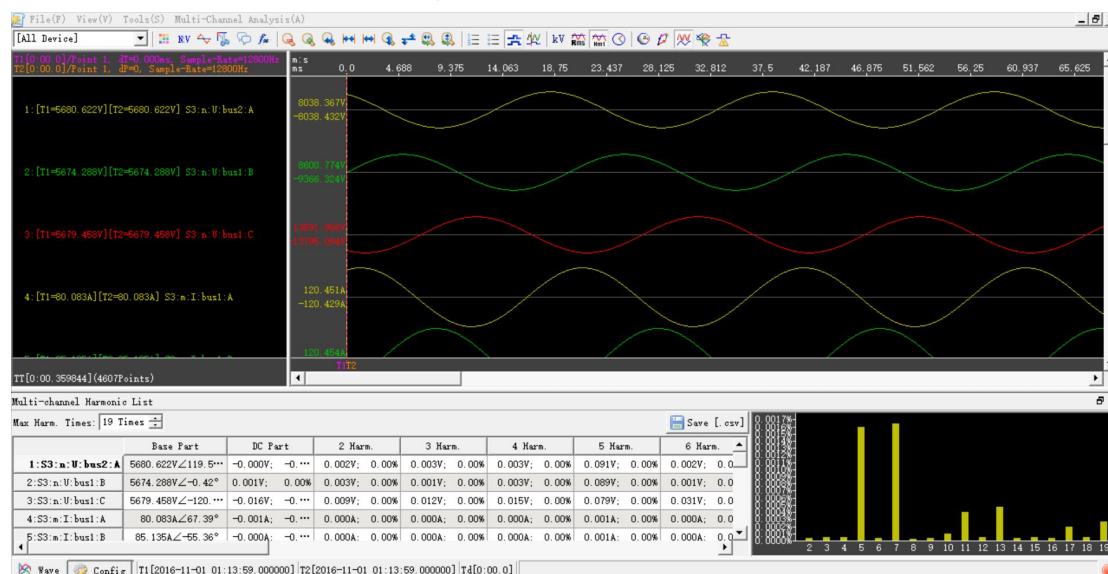


Figure 50

Disturbance recorder on configuration tool

The user can save DR file as .csv format and print as well. The file includes waveforms and report.

5.8 Date and Time Settings

Date and time settings can be edited locally via three ways:

- ✧ LCD menu on front panel
- ✧ Web-server on PC
- ✧ Configuration tool on PC

If using the LCD menu on front panel to edit date and time settings:

Main Menu -> Configuration-> Time

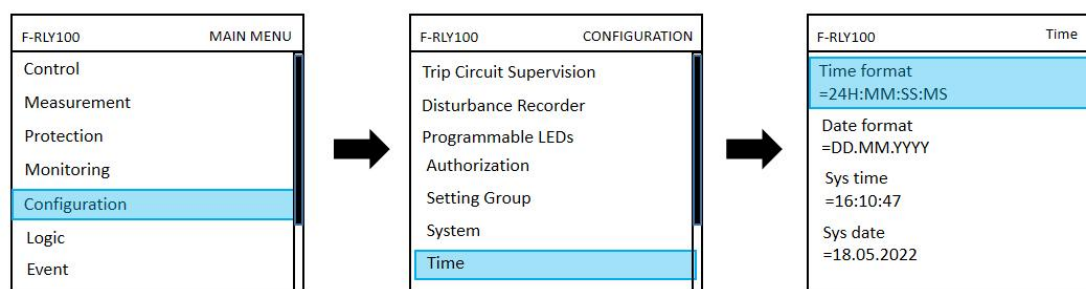


Figure 54

Date and time settings on LCD menu

If using web-server on PC to edit date and time settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Visit 192.168.4.100 address in website and find login button;

- 3) Select properly role (Engineer or administrator) and put into correctly password;
- 4) Find the “Configuration” button in the menu tree;
- 5) Click the “time” and parameter settings window will popup where it is possible to edit. (Figure 55)

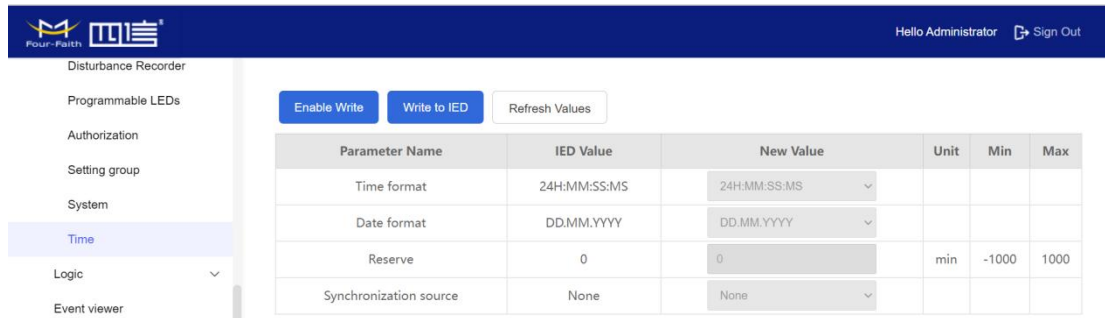


Figure 55

Date and time settings on web-server

If using configuration tool on PC to edit date and time settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
- 2) Change the communication status from offline to online;
- 3) Find the “Configuration” button in the menu tree;
- 4) Click the “Time” and parameter settings window will popup where it is possible to edit. (Figure 56)

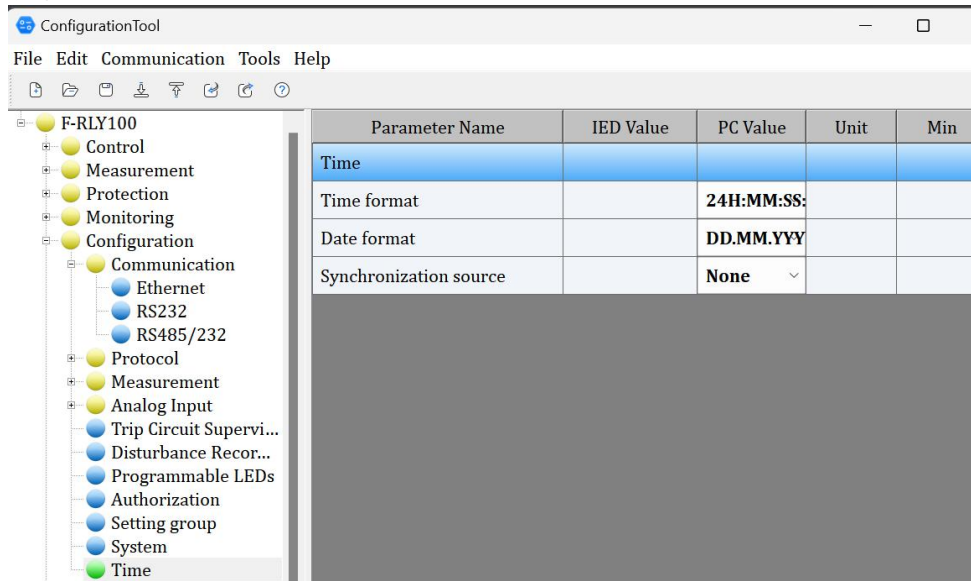


Figure 56

Date and time settings on configuration tool

The user can select time and date format which shows on logs. And synchronization source can be selected between protocol and B code.

5.9 System Settings

System settings can be edited locally via three ways:

- ✧ LCD menu on front panel

- ✧ Web-server on PC
- ✧ Configuration tool on PC

If using the LCD menu on front panel to edit system settings:

Main Menu -> Configuration-> System

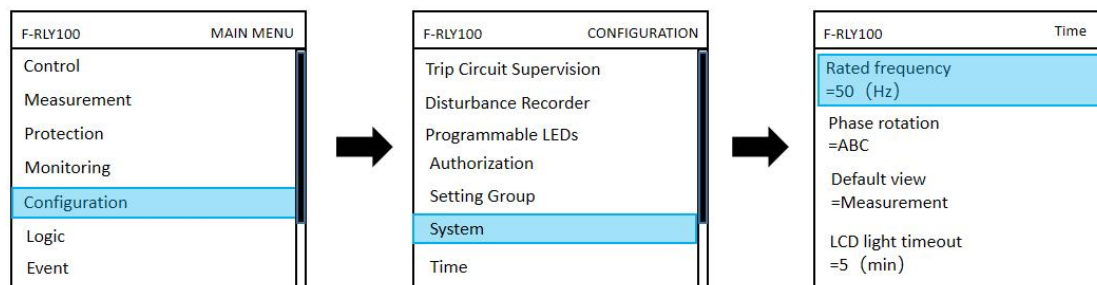


Figure 57

System settings on LCD menu

If using web-server on PC to edit system settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
 - 2) Visit 192.168.4.100 address in website and find login button;
 - 3) Select properly role (Engineer or administrator) and put into correctly password;
 - 4) Find the “Configuration” button in the menu tree;
 - 5) Click the “system” and parameter settings window will popup where it is possible to edit.
- (Figure 57)

Four-Faith

Figure 57

System settings on web-server

If using configuration tool on PC to edit system settings:

- 1) Connect the PC with the feeder protection relay through front ethernet port (RJ45);
 - 2) Change the communication status from offline to online;
 - 3) Find the “Configuration” button in the menu tree;
 - 4) Click the “system” and parameter settings window will popup where it is possible to edit.
- (Figure 58)

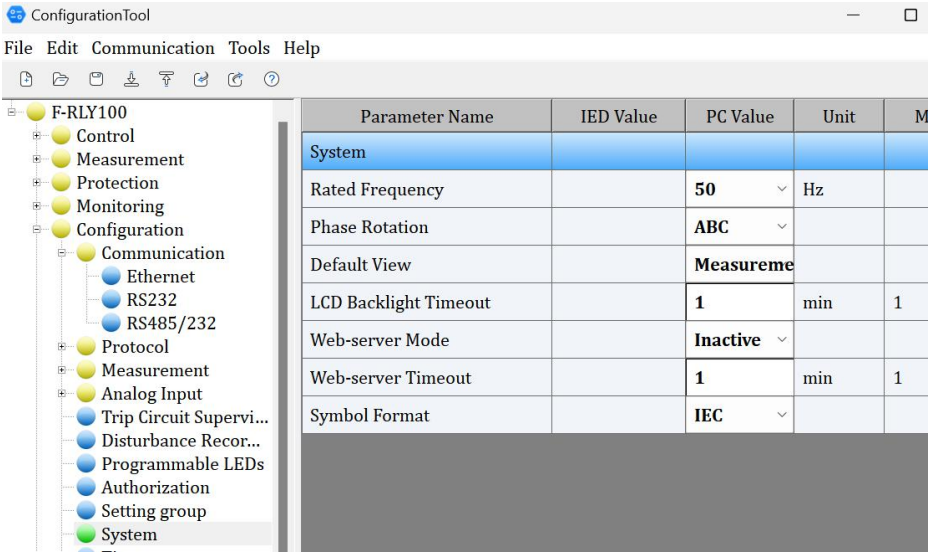


Figure 58
System settings on configuration tool

There is rated frequency selection (50Hz or 60Hz) which defined “Fn” values.
The user can change phase rotation from ABC to ACB if required.
Default menu is used to defined the LCD menu on the front of panel.
There are two times on system settings, one is “LCD backlight timeout” which defined the duration of backlight if not used; another is “Web-server timeout” which defined duration of connection between PC and IED if not used.
If user want to operate through web-server mode, should be changed “Web-server mode” to active at first (default setting is inactive).

5.10 Download and Upload Settings

In conclusion, there are three ways to configure feeder protection relay:

- ✧ LCD menu on front panel
- ✧ Web-server on PC
- ✧ Configuration tool on PC

If using LCD menu, please click “left” button (back to previous page) and confirm the settings after configuration.

If using web-server, please click “Enable write” at first, and then “write to IED” after configuration, and click “refresh values” to confirm the settings is successful or not.



Figure 59
Download and upload settings on web-server

The user can download and upload all parameter as file through “Export/Import” button.

Import/Export Settings

Import:

Browse for IED import file on computer and select Import Settings to start import.

Select File

No files selected

Import Settings

Export:

Export settings from IED, exported file is saved as csv.

Export Settings

Figure 60
Parameter download and upload

If using configuration tool, please click “write to IED” after configuration, and click “read from IED” to confirm the settings is successful or not.

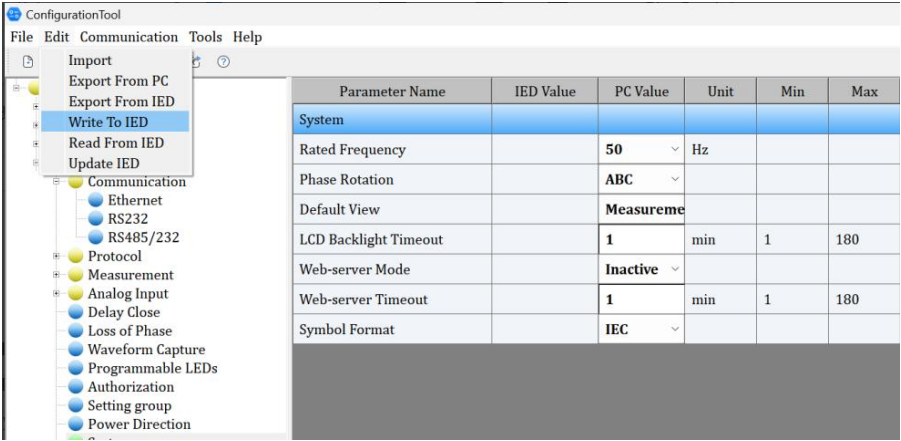


Figure 61
Download and upload settings on configuration tool

There are two kinds of files in configuration tool, one is parameter file, another is project file. For parameter file, the user can select current page or all parameter to download and upload by click “Export” and “Import” buttons.

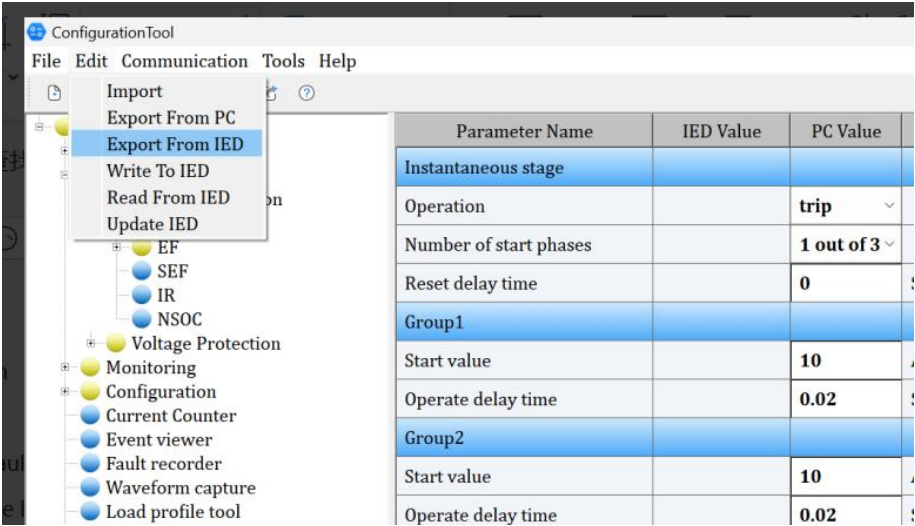


Figure 62

Parameter file download and upload

For project file, the user can download and upload by click “save as” and “open project” buttons.

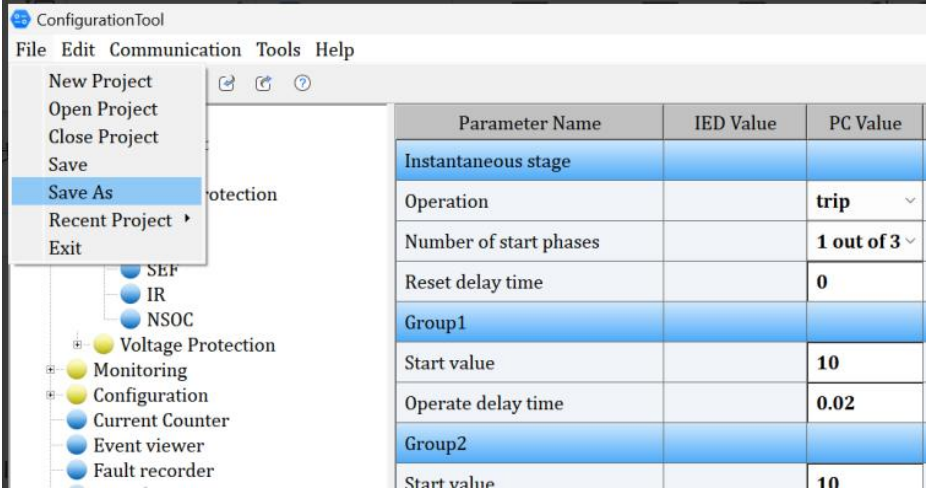


Figure 63

Project download and upload

The user can update feeder protection relay through configuration tool only by click “Update IED” button on file menu.

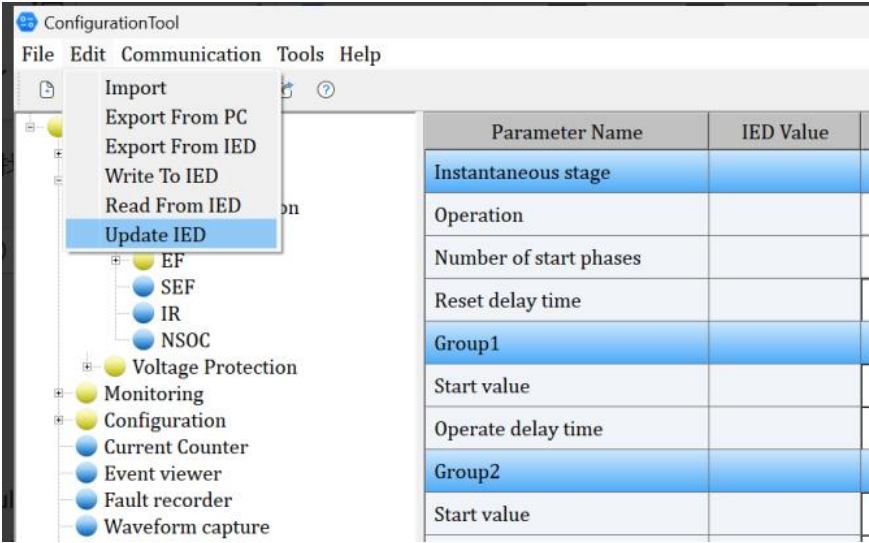


Figure 64
Update IED on configuration tool

6. PRODUCT COMMISSIONING

Four-Faith Smart Power performs a complete function check and calibration of each control cubicle before it is shipped. This helps ensure that user receive a recloser control operates correctly and accurately. Before powering the feeder line, the recloser should be in the open position.

6.1 Power Supply Check

Switch on the AC and DC MCB from front panel on control cubicle, and observe battery status on charger, if in charging state, that's correct. Then, switch off AC MCB, the battery status should be change to discharge.

After that please switch on control MCB, the feeder protection relay should be power on. Please make sure that local date/time settings are correct. If not, you can rectify date/time through LCD menu: **Main Menu -> Configuration-> Time**. You can also synchronize date and time by protocol and B code from station. Date and time is visible at the LCD screen.

Besides date/time settings, please make sure the LCD menu navigation, LED indication and button function are OK.

6.2 System and Analog Input Check

After checking power supply, please find the system settings on LCD menu:

Main Menu -> Configuration-> System

Make sure the rated frequency (default=50Hz) and phase rotation (default=ABC) are OK for you.

Then turn to analog input configuration on LCD menu:

Main Menu -> Configuration-> Analog Input

Checking the primary and secondary value of current and voltage are consistent with the actual situation or not, the primary value determine the value of In and Un in protection and measurement.

6.3 Protection Settings Check

There are five protection setting groups (default active group=1) with the same default values, please check and change if need that according to your actual situation. The path on LCD menu:

Main Menu -> Protection -> Current Protection

Main Menu -> Protection -> Voltage Protection

Main Menu -> Protection -> Frequency Protection

Main Menu -> Configuration-> Setting Group

6.4 Measurement Values Check

After powering the feeder line and closing the recloser via button on front panel, please check that measurements of phase currents, voltages, power, energy, power factors and frequency are correct.

The path on LCD menu:

Main Menu -> Measurement -> Values#

7. PRODUCT HANDLING

Safety information: All the handling should follow instructions on this chapter.

7.1 Packing and Transportation

The shipping package is designed to provide reasonable protection during shipment and to provide convenient handling. Before packing please make sure that:

- The F-ACR is open and lockout
- All the MCBs on F-FTU200 is off
- Recloser, FTU and other important parts are protected by plastic cover to prevent from water
- Mounting brackets of recloser and FTU are put into packing box

The outline of the package is shown below picture.



Figure 65

F-ACR and F-FTU200 package

It is important to adequately ensure the equipment to minimize the risk of damage during transportation. To move this package, please use a hydraulic lift or fork lift truck.

7.2 Receiving and Inspection

Before delivering from factory, F-ACR and F-FTU200 have been packed into one box, if required potential voltage as well, another box will be seen.

- Package 1: F-ACR+F-FTU200+mounting brackets+parts
- Package 2: Potential voltage+mounting bracket (if ordered)

When you received package(s), please check the status of recloser and MCBs on control cubicle,

correspondence with the nameplate data and integrity of the packing with what is specified in the order confirmation. Also make sure that all the materials described in the shipping notes are included in the supply. There are some documents put together with products:

- Technical manual
- Routine test report
- Electrical circuit diagram
- Copy of shipping information

The nameplate contains product type, name, reference standard, production date, serial number and rated values, all content can be changed by order.

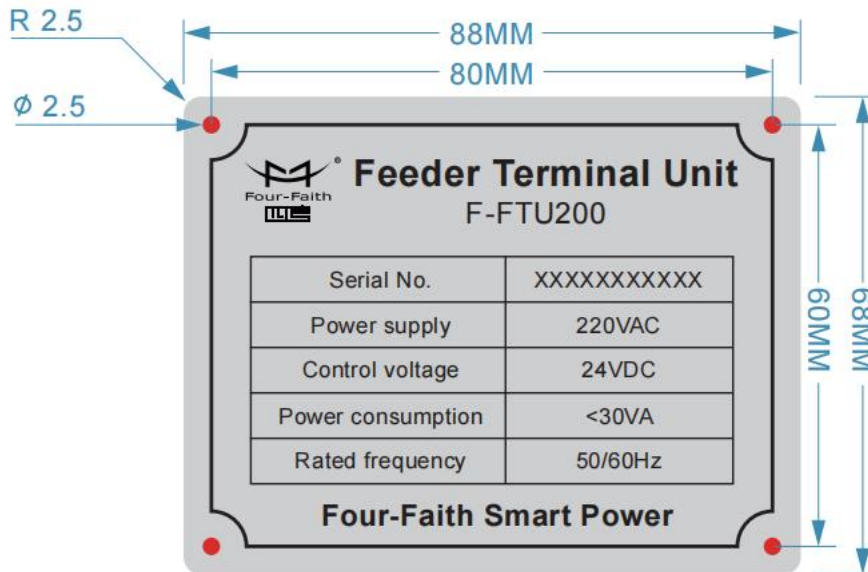


Figure 66

Product nameplate

All products should be in good condition when accepted by the carrier for shipment, because each recloser and control cubicle are complete tested and inspected at the factory. If damage is noticed, file a claim with the carrier immediately.

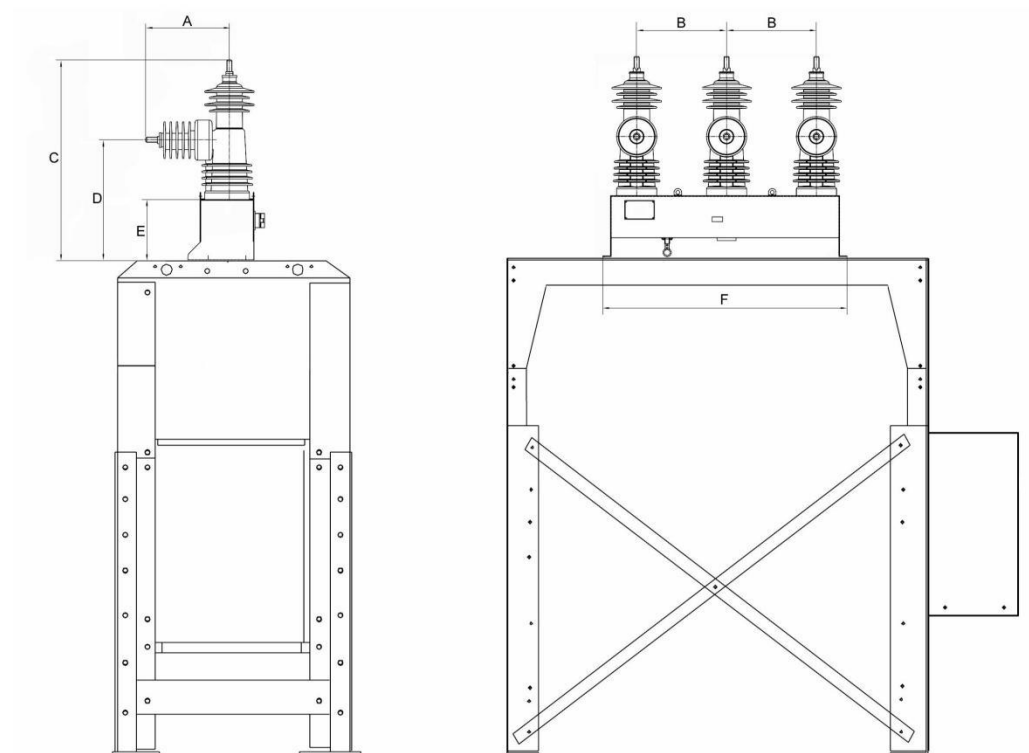
7.3 Storage Conditions

If the installation is not possible immediately, the package should be stored in a covered, dry, natural ventilated, non-corrosive condition and suitable temperature between -40°C and +60°C to prevent condensation. Insulation must be protected against dirt and moisture.

8. PRODUCT INSTALLATION

Installation operations are carried out by utility technical personnel and can be supervised by Four-Faith Smart Power technical representatives. This chapter describes dimension and installation. For more detailed information about the installation process contact Four-Faith Smart Power technical representative.

8.1 Overall Structure



Size	Unit	A	B	C	D	E	F
15kV	mm	460	380	850	508	270	970
27kV	mm	460	380	850	508	270	970
38kV	mm	512	380	970	590	270	970

Figure 67

Recloser dimension

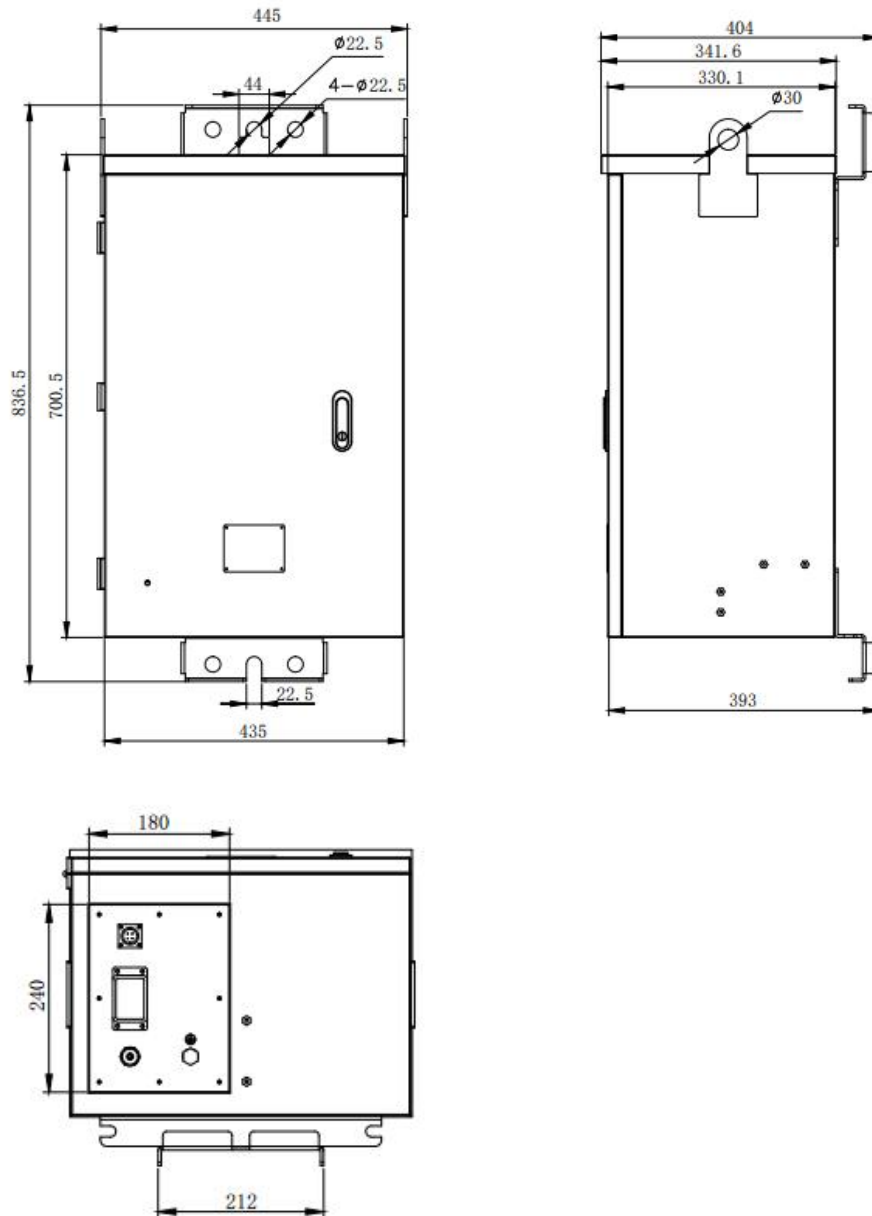


Figure 68

Control cubicle dimension

The size of the control cubicle is: 700mm(L) * 435mm(W) * 330mm(H).

The material of control box is 304 SST.

There is spare space to be reserved for radio mounting, the size is:

210mm(L) * 180mm(W) * 130mm(H).

The handle has locked function.

There are two lifting holes, which convenient for on-site installation.

8.2 Installation Mode

WARNING! The installation procedure in this manual is offered as a guide only. It should be used in conjunction with the utility's own safety procedures. Before installation begins, all necessary precautions should be carried out.

WARNING! Do not use the bushing insulators for lifting purposes. Failure to comply may result in damage to the equipment.

8.2.1 Recloser Installation

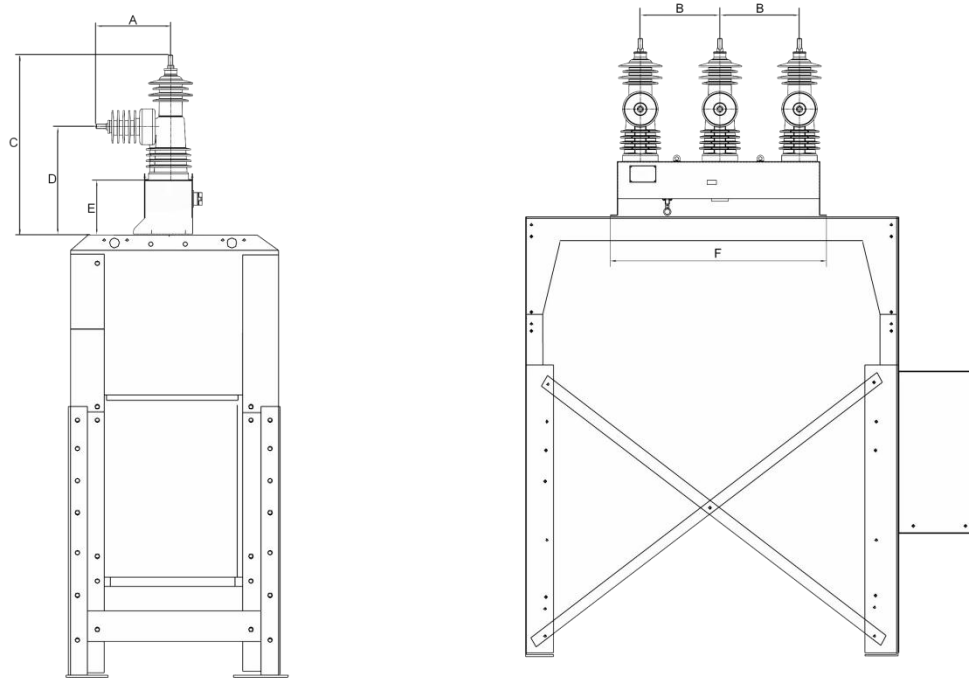


Figure 69

Substation mounting

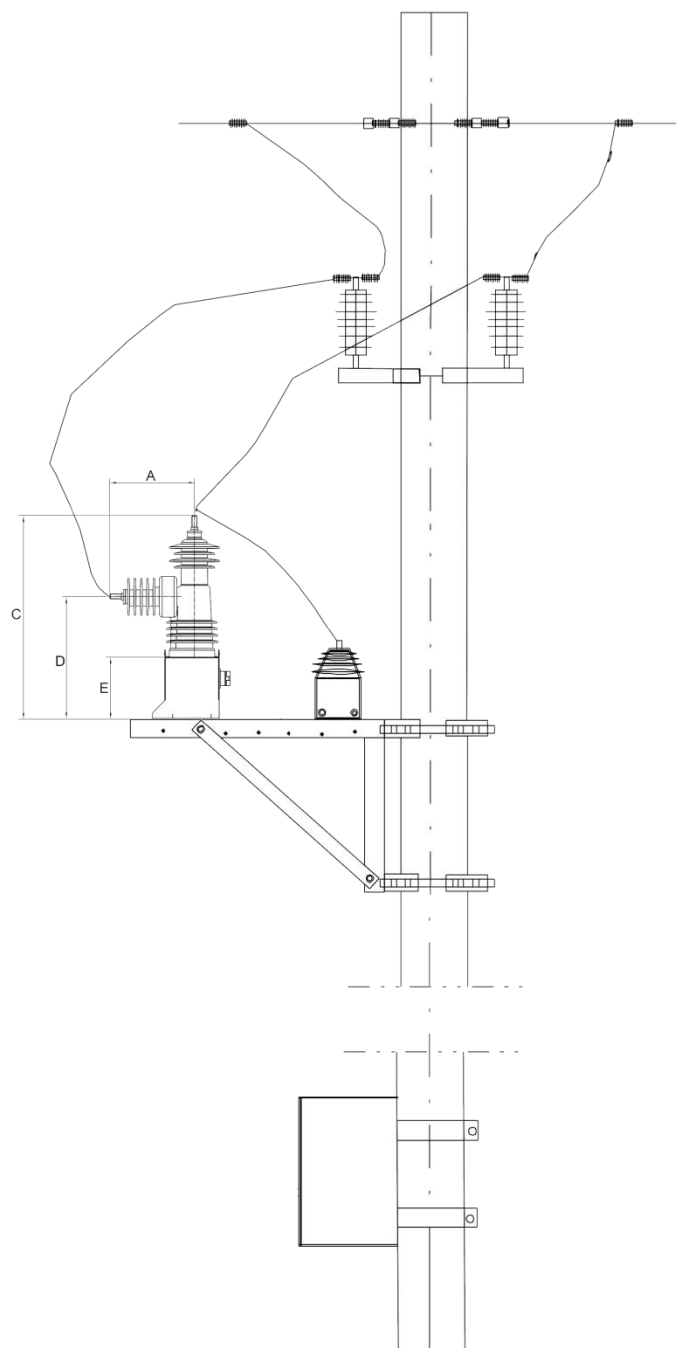


Figure 70
Pole mounting

8.2.2 Control Cubicle Installation

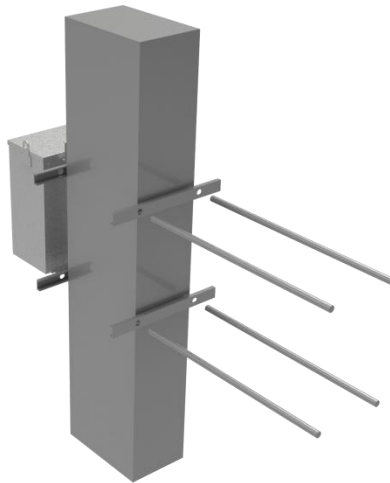


Figure 71
Pole mounting

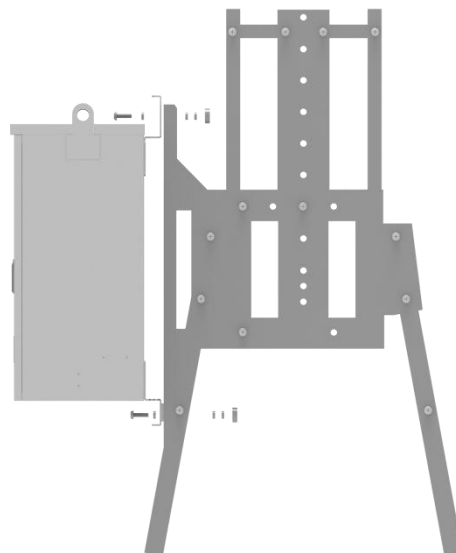


Figure 72
Substation mounting

8.3 Earthing

ATTENTION! Make sure that the system impedance to ground is less than 5 ohms. In case this requirement is not met it may lead to death or injury to people during operation.

The automatic circuit recloser (includes mounting bracket) and control cubicle should be connected from its earthed nuts to the same earthing through separately earthed lines.

Earthed nuts on automatic circuit recloser and control cubicle are shown below:

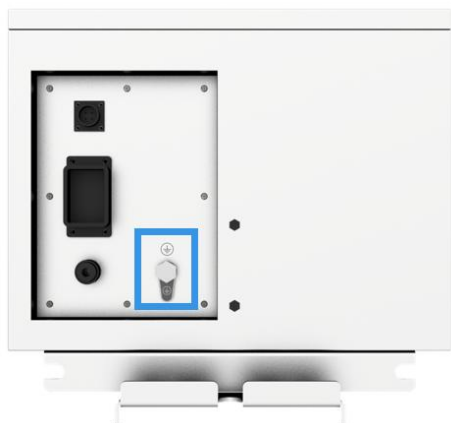


Figure 73

Earthed nuts on recloser and control box

About lightning arrester, its earthed cable should be as straight as possible, and should avoid sharp bends, the minimum square of cable is 16mm², and the material is copper.

Remark: Lightning arrester and earthed cable are out of our service.

8.4 Primary Line Connection

Primary line connector as optional accessories, Four-Faith Smart Power can provide two-hole and four-hole NEMA connectors. The power line connection can be used M12 bolts and nuts (out of service). It is recommended to use stainless steel material to prevent corrosion.

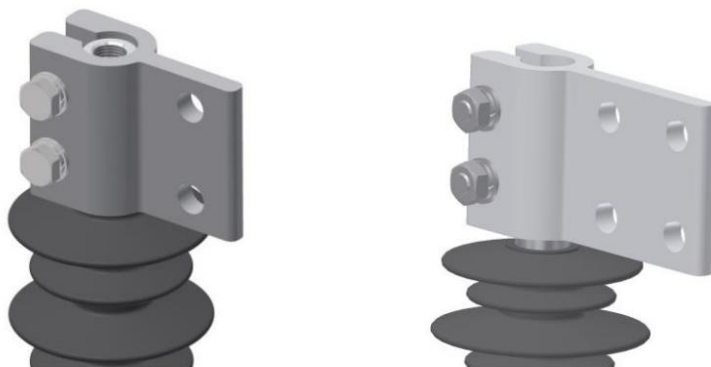


Figure 74

NEMA Connector

8.5 Auxiliary Circuit Connection

Potential transformer should connect to control cubicle through power supply cable (4 pins), after powering on main line, the engineer should make sure the auxiliary supply is connected correctly. The minimum wire section of auxiliary circuit should be larger than internal wire section, and its power frequency withstand voltage should be more than 2 kV/1 min.



Figure 75

Auxiliary supply connection

9. PRODUCT MAINTENANCE

The reclosers produced from Four-Faith Smart Power are designed for minimum amount of maintenance. If applied in dry, clean and noncorrosive environment, only need annual inspection.

The annual maintenance items are as below:

- 10 CO operations to check the mechanism and relative signals
- Poles inspection to make sure the surface is clean, no cracks and no discharge
- Appearance inspection to make sure no deformation and no slack fasteners

10. APPENDIX

10.1 Type Test



中国认可
国际互认
检测
TESTING
CNAS L0685

TEST REPORT

No:JW221191E



Sample Name	Feeder Protection Relay
Sample Type	F-RLY100
Client	Four-Faith Smart Power Technology Co., Ltd
Manufacturer	Four-Faith Smart Power Technology Co., Ltd
Issued Date	Aug. 19, 2022

Xuchang KETOP Testing Research Institute Co., Ltd.

(National Quality Inspection & Testing Center for
Relay Protection and Automation Equipment)

№: JW221191E

Sample Name: Feeder Protection Relay Sample Type: F-RLY100 Sample Specification: Power supply circuit: DC24V AC circuit: AC4V 5A 50Hz Sample Quantity: 2 Sample №: YPJW221191-1, YPJW221191-2 Sample Received Date: May. 12, 2022 Sample Received Status: Visual check acceptable, performance to be checked	Client: Four-Faith Smart Power Technology Co., Ltd Address: Unit 1103, No.370 ,Chengyi Street, Phase III, Xiamen Software Park Manufacturer: Four-Faith Smart Power Technology Co., Ltd Address: Unit 1103, No.370 ,Chengyi Street, Phase III, Xiamen Software Park Testing Site: Xuchang KETOP Testing Research Institute Co., Ltd.
Testing date: Jun. 27 2022 – Aug. 19, 2022	
Testing for: ☒ Consignment Test ☐ Certification Test ☐ Licence Test ☐ Supervision Test ☐ Other test	
Test classification: ☒ Type Test ☐ Performance Test ☐ Others	
References: International standards IEC 60255-1:2009 Measuring relays and protection equipment-Part 1:Common requirements IEC 60255-26:2013 Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements National standard GB/T 7261-2016 Basic testing method for relaying protection and security automatic equipment Industry standard DL/T 478-2013 General specification for relaying protection and security automatic equipment Enterprise standard F-RLY100 Feeder Protection Relay For Overhead Line Primary Switch(10kV~40.5kV) Technical Manual (Assess criteria)	
Conclusion: Based on the test results described in this report, our lab declares that the test items are in conformance with the requirements of references above.	
Approved by: 李亚萍	Issued date: Aug 19, 2022
Remark: /	

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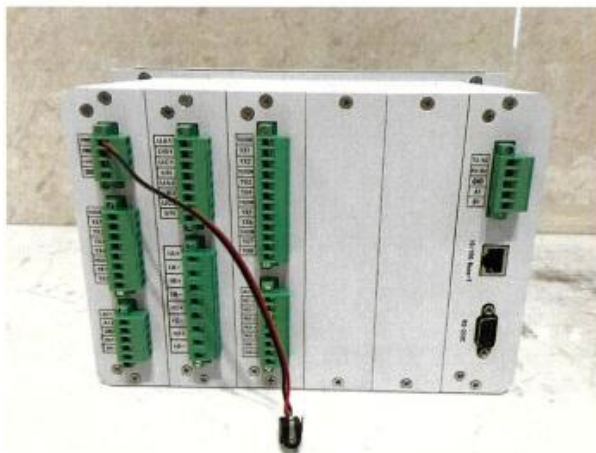
No: JW221191E

Sample Photos

1. Sample photo A-side



2. Sample photo B-side



№: JW221191E

Test Items Summary

№	Test Items	Standards	Verdict
Electrical Performance & Safety Test			
1	Visual inspection	IEC 60255-27:2013	Pass
2	Basic functions	IEC 60255-1:2009	Pass
2.1	Non-directional instantaneous stage over-current protection	/	Pass
2.2	Non-directional high stage over-current protection	/	Pass
2.3	Non-directional low stage over-current protection	/	Pass
2.4	Non-directional instantaneous stage earth-fault protection	/	Pass
2.5	Non-directional high stage earth-fault protection	/	Pass
2.6	Non-directional low stage earth-fault protection	/	Pass
2.7	Directional high stage over-current protection	/	Pass
2.8	Directional low stage over-current protection	/	Pass
2.9	Directional high stage earth-fault protection	/	Pass
2.10	Directional low stage earth-fault protection	/	Pass
2.11	Sensitive earth-fault protection	/	Pass
2.12	Inrush restraint function	/	Pass
2.13	Negative-sequence over-current protection	/	Pass
2.14	Over-voltage protection	/	Pass
2.15	Under-voltage protection	/	Pass
2.16	Over-frequency protection	/	Pass
2.17	Under-frequency protection	/	Pass
2.18	Frequency rate-of-change protection	/	Pass
2.19	Cold load pickup function	/	Pass
2.20	Auto-reclosing function	/	Pass
3	Burden	IEC 60255-1:2009	Pass
4	Insulation resistance	IEC 60255-27:2013	Pass
5	Dielectric withstand	IEC 60255-27:2013	Pass

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№: JW221191E

№	Test Items	Standards	Verdict
6	Impulse voltage	IEC 60255-27:2013	Pass
7	Clearance	IEC 60255-27:2013	Pass
8	Creepage distance	IEC 60255-27:2013	Pass
9	Protective bonding resistance	IEC 60255-27:2013	Pass
10	Degrees of protection provided by enclosure	IEC 60529:2013	Pass
11	Operative ranges of auxiliary energizing quantities	IEC 60255-1:2009	Pass
12	Dry heat - operational	IEC 60068-2-2:2007	Pass
13	Cold - operational	IEC 60068-2-1:2007	Pass
14	Dry heat - storage	IEC 60068-2-2:2007	Pass
15	Cold - storage	IEC 60068-2-1:2007	Pass
16	Change of temperature	IEC 60068-2-14:2009	Pass
17	Damp heat, steady state	IEC 60068-2-30:2005	Pass
18	Damp heat, cyclic	IEC 60068-2-30:2005	Pass
19	Vibration response	IEC 60255-21-1:1988	Pass
20	Vibration endurance	IEC 60255-21-1:1988	Pass
21	Shock response	IEC 60255-21-2:1988	Pass
22	Shock withstand	IEC 60255-21-2:1988	Pass
23	Bump	IEC 60255-21-2:1988	Pass
24	Thermal withstand capability	IEC 60255-1:2009	Pass
25	Contact performance	IEC 60255-1:2009	Pass
26	Stability	DL/T 478-2013	Pass
EMC			
1	Radiated emission test	IEC 60255-26:2013	Pass
2	Conducted emission test	IEC 60255-26:2013	Pass
3	Radiated electromagnetic field immunity test	IEC 60255-26:2013	Pass
4	Electrostatic discharge immunity test	IEC 60255-26:2013	Pass
5	Conducted immunity test	IEC 60255-26:2013	Pass

№: JW221191E

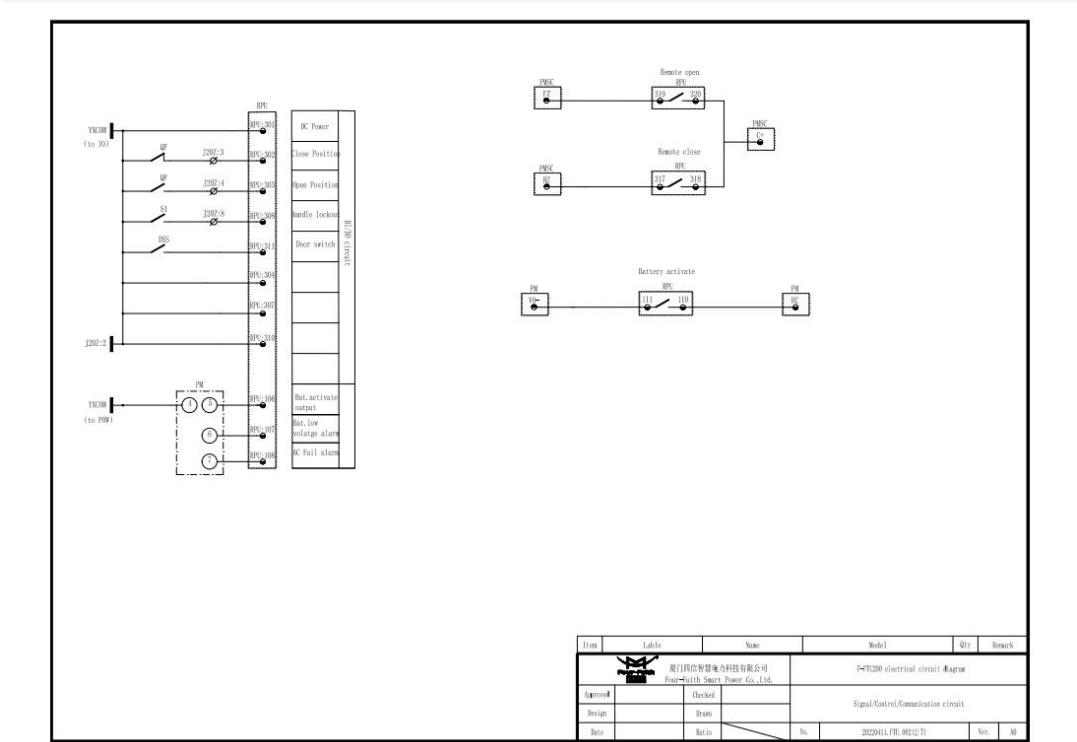
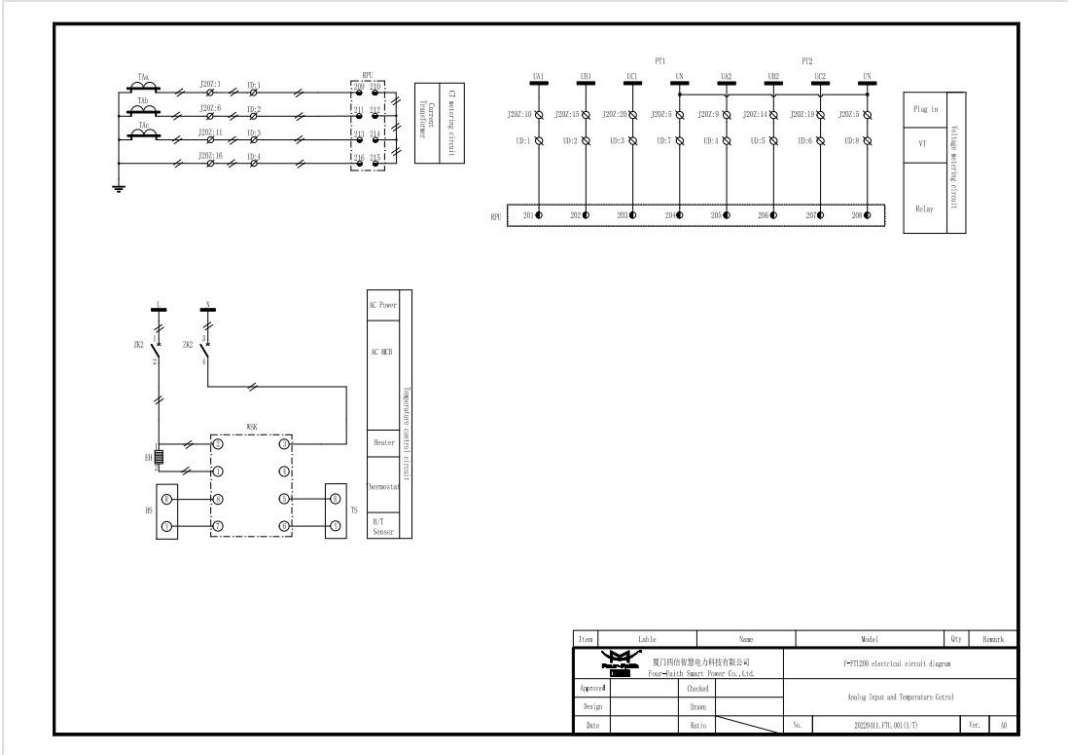
№	Test Items	Standards	Verdict
6	Electrical fast transient/burst immunity test	IEC 60255-26:2013	Pass
7	Slow damped oscillatory wave immunity test	IEC 60255-26:2013	Pass
8	Surge immunity test	IEC 60255-26:2013	Pass
9	Power frequency immunity test	IEC 60255-26:2013	Pass
10	Power frequency magnetic field immunity test	IEC 60255-26:2013	Pass
11	Pulse magnetic field immunity test	DL/T 478-2013	Pass
12	Damped oscillatory magnetic field immunity test	DL/T 478-2013	Pass
13	A.C. and D.C. voltage dips test	IEC 60255-26:2013	Pass
14	A.C. and D.C. voltage interruptions test	IEC 60255-26:2013	Pass
15	A.C. component in D.C.(ripple) test	IEC 60255-26:2013	Pass
16	Gradual shut-down/start-up(for D.C. power supply) test	IEC 60255-26:2013	Pass

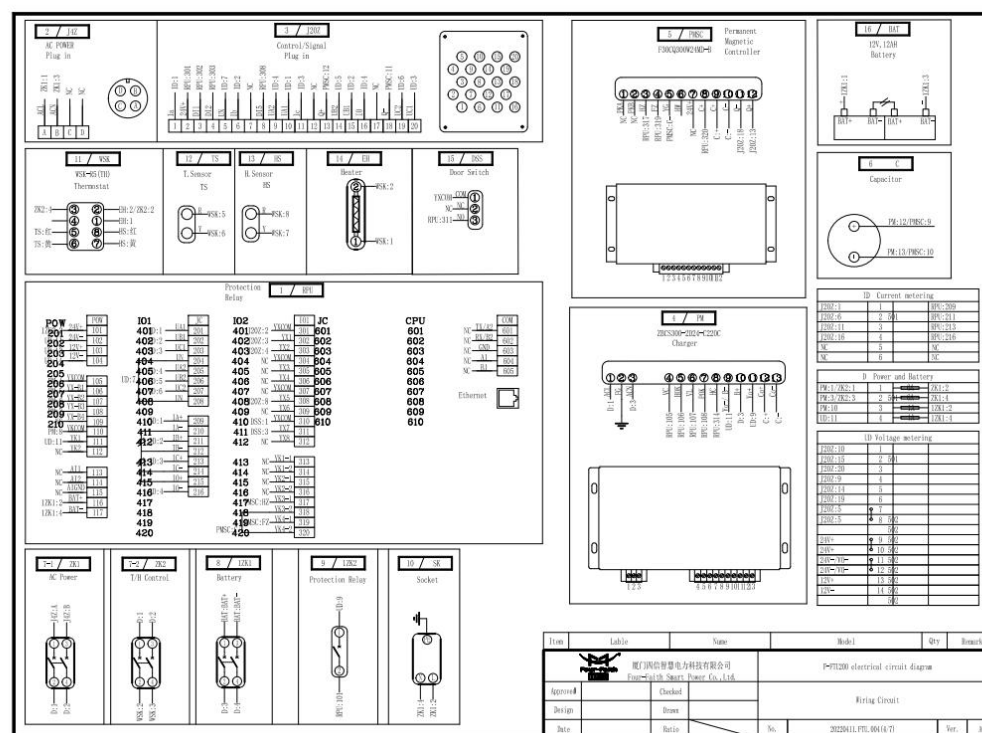
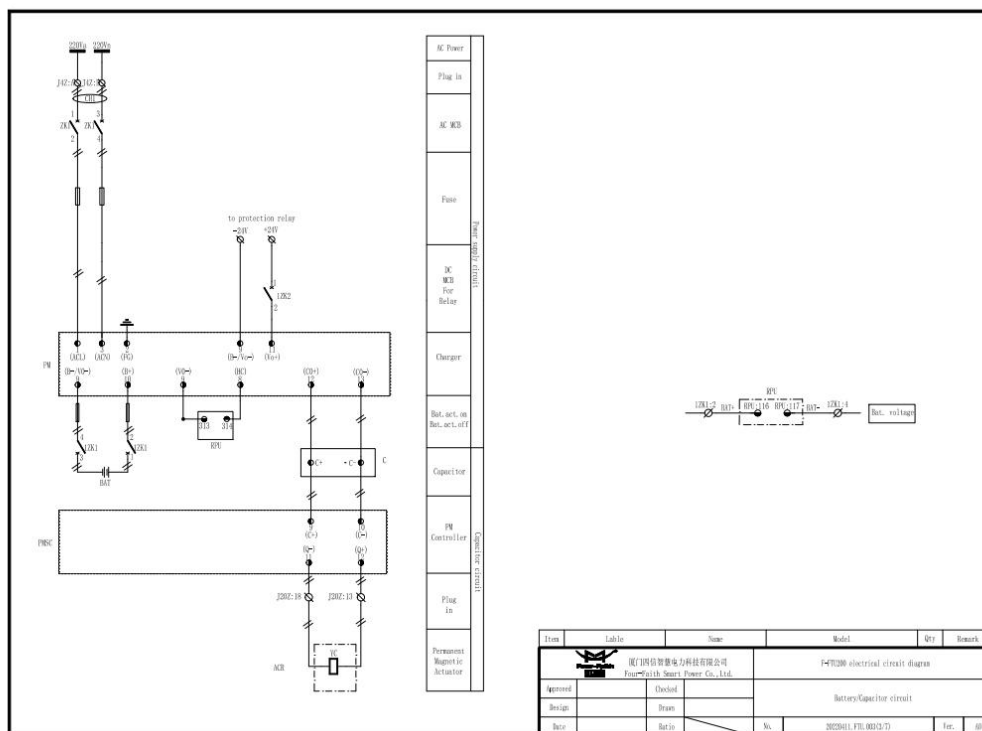
№: JW221191E

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EMC Test Report	JW221191E -EMC
Back cover	JW221191E

10.2 Electrical Circuit Diagram





10.3 Product Checklist

Maximum Voltage

- ☐ 15 kV
- ☐ 27 kV
- ☐ 38 kV

Rated Current

- ☐ 630 A
- ☐ 800 A
- ☐ 1000 A

Breaking Current

- ☐ 12.5 kA
- ☐ 16 kA

Analog Input

- ☐ 3 Current Transformers + 3 Voltage Sensors
- ☐ 3 Current Transformers + 6 Voltage Sensors
- ☐ 3 Current Sensors + 3 Voltage Sensors
- ☐ 3 Current Sensors + 6 Voltage Sensors

Control Cabinet

- ☐ With FTU
- ☐ W/O FTU

Power Supply

- ☐ With Single-phase VT
- ☐ W/O Single-phase VT

Control Cable Length

- ☐ No Required ☐ 6M ☐ 8M ☐ 10M ☐ 12M
- ☐ 14M ☐ 16M

Power Supply Cable Length

- ☐ No Required ☐ 6M ☐ 8M ☐ 10M ☐ 12M
- ☐ 14M ☐ 16M

Optional Accessories

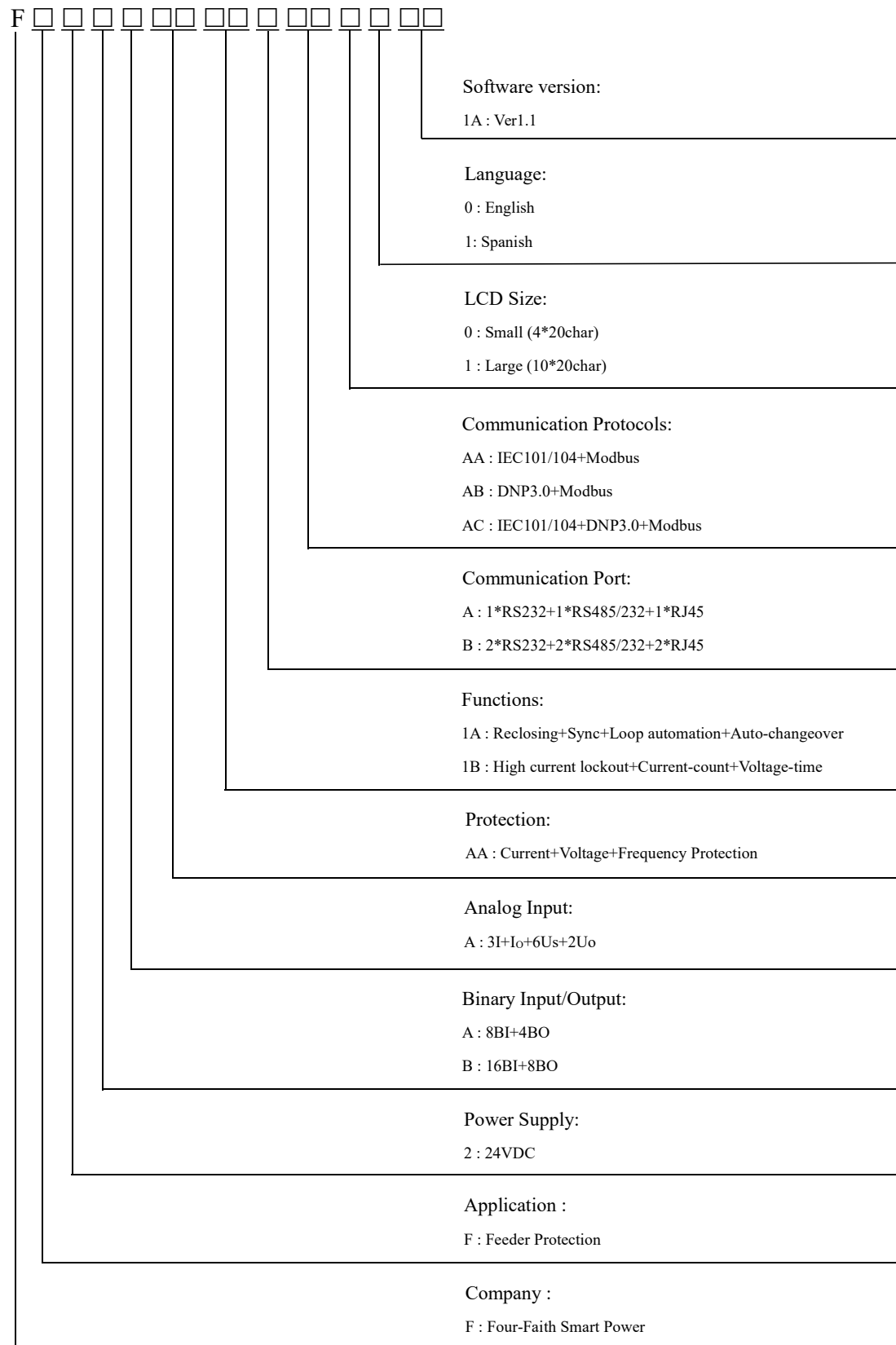
- ☐ NEMA Connectors ☐ Line Jumpers ☐ Bushing Protective Covers
- ☐ Silicon Rubber Bushing

Additional Requests/Comments

--

* Lightning arrester is out of our service.

10.4 Protection Relay Order Code



Standard Configuration: FF2AAAA1AAAC101A

10.5 FTU Standard Components

Item	Component	Description	Quantity
1	Protection relay	F-RLY100 (FF2AAAA1AAAC101A).	1 PC
2	Cubicle housing	304 SST with padlock design, comply with IP55 protection degree.	1 PC
3	Lead acid battery	12Vdc/12AH	2 PCS
4	Charger	Three-stage charging and discharging with temperature compensation for battery, and has AC fail alarm, DC fail alarm and battery activation functions.	1 PC
5	Permanent magnet driver device	Manage the charging and discharging of electrolytic capacitor and drive the permanent magnet mechanism.	1 PC
6	Electrolytic capacitor	For fast energy storage and discharge.	1 PC
7	Thermostat	According to the ambient temperature detected by the sensor, control the heater to keep constant temperature and humidity in control box.	1 PC
8	Heater	Controlled by thermostat, keep the control box in properly temperature.	1 PC
9	Control cable	Connect recloser and control box, the length can be customized with requirement.	1 PC
10	Power supply cable	Connect potential transformer and control box, length can be customized with requirement.	1 PC
11	MCBs	There are power supply circuit switch, heater circuit switch, control circuit switch and battery circuit switch on control box.	4 PCS
12	Outlet	Default type is UK, provide power for PC on site.	1 PC
13	Terminal bar	Several terminals which divided into power supply, current, voltage, battery and control circuits.	many
14	Micro switch	Install on control box door, send out door open alarm to protection relay.	1 PC
15	Earthed cooper bar	Ensure reliable grounding of secondary wiring in control box.	1 PC
16	Grounding nut	Ensure reliable grounding of cubicle housing.	1 PC
17	Nameplate	Stick on surface of control box, show product information.	1 PC

Remark: The components of the FTU can be designed to order according to requirements.

10.6 Spare Parts and Accessories

Spare parts and accessories can be ordered separately in case of damage. For availability and to order spare parts, please contact our after-sale service engineer.

Spare parts list please find below.

Item	Part name	Description
1	15kV Automatic Circuit Recloser	Overhead line primary switch.
2	27kV Automatic Circuit Recloser	Overhead line primary switch.
3	38kV Automatic Circuit Recloser	Overhead line primary switch.
4	Line connectors	Connect primary switch with power line.
5	Bushing Protective Covers	Protect birds from electricity parts.
6	Recloser bracket	Fixed primary switch on the top of pole.
7	Control cubicle	Provide protection/ measurement /control /monitoring function for recloser.
8	Protection relay	F-RLY100 (FF2AAAA1AAAC101A).
9	Control Cable	Connect recloser and control box, the length can be customized with requirement.
10	Lead acid battery	12Vdc/12AH
11	Charger	Three-stage charging and discharging with temperature compensation for battery, and has AC fail alarm, DC fail alarm and battery activation functions.
12	Control cubicle bracket	Fixed control box on the bottom of pole.
13	12kV potential transformer	Power supply voltage transformer.
14	24kV potential transformer	Power supply voltage transformer.
15	36kV potential transformer	Power supply voltage transformer.