COOPER POWER SERIES

Effective October 2024

FXD Control User Manual

Powering Business Worldwide

Contents

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 switch 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.

1.1. Description

The FXD Control is a fully digitalized and 32-bit 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 FXD Control provides protection, measurements, status monitoring, control, communication, data handling and distribution automation.

The FXD Control 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 FXD Control can operate Close and Open and other actions with key buttons on the user interface panel: Local/Remote, Ground Enabled, SEF Enabled, Control Locked, Authorization.

The FXD Control is a weatherproof cabinet with a door that can be pad lockable, and suitable for mounting on a prestressed concrete pole. A steel channel, fixed to the Control cabinet for mounting purpose, is provided.

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

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 switch 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)
- Sensitive Earth-fault Protection (ANSI 64N)
- Negative-sequence over-current Protection (ANSI 46)
- Inrush restraint Function (ANSI 68)
- Three Phase Under-voltage Protection (ANSI 27)
- Sectionalizer function
- 5 Setting Groups

Measurement

- Phase, Ground and Sensitive Ground Current (Ia, Ib, Ic, Io, I0)
- Line and Phase Voltage on power and load side (Ua, Ub, Uc, Ur, Us, Ut)
- Residual Voltage on power and load side (Uo1, Uo2)
- Single and Three Phase Active Power (Pa, Pb, Pc, Pt)
- Single and Three Phase Reactive Power (Qa, Qb, Qc, Qt)
- Single and Three Phase Apparent Power (Sa, Sb, Sc, St)
- Single and Three Phase Active Energy (EPa, EPb, EPc, EPt)
- Single and Three Phase Reactive Energy (EQa, EQb, EQc, EQt)
- Single and Three Phase Apparent Energy (ESa, ESb, ESc, ESt)
- Single and Three Phase Power Factor (PFa, PFb, PFc, PFt)
- Frequency Magnitude and Rate (F)
- Synchronizing Difference Voltage
- Synchronizing Difference Frequency
- Synchronizing Difference Angle
- Sequence Components of Three Phase Voltages & Currents (I1, I2, Io, U1, U2, Uo)
- 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 (Vdc)

Control

- Open and Close
- Local and Remote
- Battery Test
- Authorization Setting
- Clear Indications, Events, Fault Records, Disturbance Records, Power Quality, Load Profile

Monitoring

- Protection Start, Trip and Alarm
- Measurement High Alarm and Warn
- Trip Counter Limit
- Open/Close Status
- Local/Remote Status
- AC Fail
- Battery Low Alarm
- 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)

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

FTU	Feeder Terminal Unit
IED	Intelligent Electronic Device
SCADA	Supervisory Control And Data Acquisition
VT	Voltage Transformer
CT	Current Transformer
VS	Voltage Sensor
SA	Surge Arrester
IR	Inrush Restraint Function Element
UV	Under Voltage 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
BAT	Battery
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

2. TECHNICAL SPECFICATIONS

2.1. Functional Diagram

A function block diagram of FXD Control is shown as Figure 1. In general, there are several main modules, including 32-bit microprocessor-based CPU, Switchgear Reaction Interface, Power Supply, Battery Management, I/O, Communications and User Interface. Current sensing is provided by three current transformers located in upper apparatus and interfaced to FXD Control via the Control cable. This cable also supplies Open/Close signal and feedbacks Apparatus status. Voltage sensing is connected to the analog inputs module which located on Mainboard.

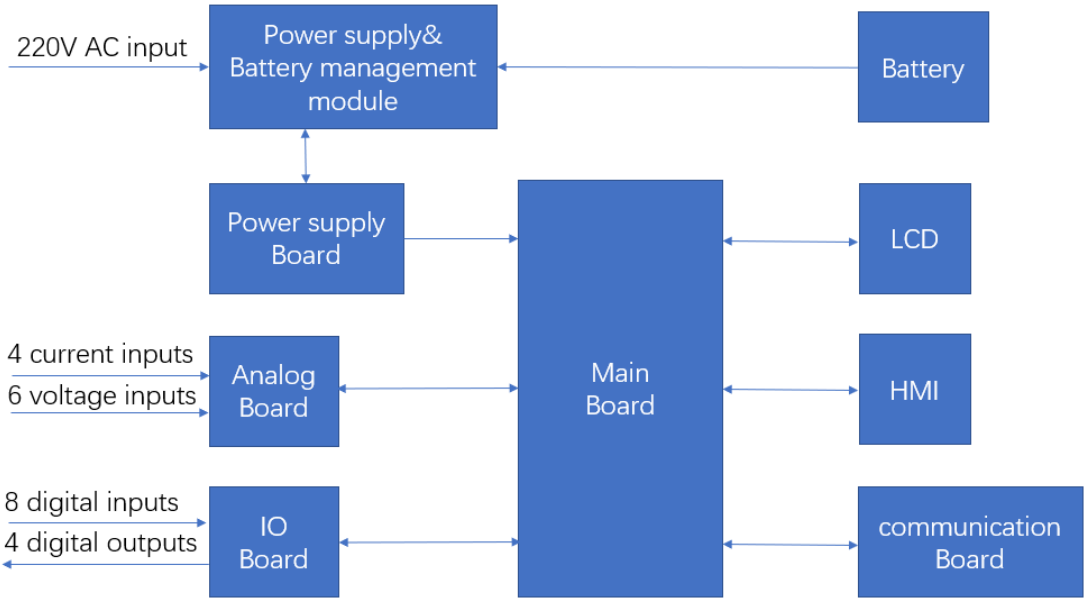

Figure1 FXD Control Functional Diagram

2.2. Summary of Features

Table 1 FXD Control Summary of Features

Parameter	FXD Control
Power supply range	220 V AC ±20%
Maximum power consumption	<30 W
Duration of operation without auxiliary supply	24 hours
Rated frequency	50Hz
Operation voltage	24 V DC (20 ... 29 V DC)
Rechargeable battery voltage & capacity	24V/9AH
Analog input	4I+6Us
Current transformer input ratio	1/5A(1)
Voltage sensor input range	0~8V rms (input is optimized with secondary rated phase voltage 4Vrms)
Binary input/output	8 BI/4BO(2)
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	-40°C ～+70°C
Humidity range	5~95%
Degree of protection	IP65
Anti corrosion	Yes
Anti Dust	Yes
MTBF	87600 hours
Dimension	765*459*354 mm
Weight	35kg

1.Residual current and/or phase current.

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

3. USER INTERFACE

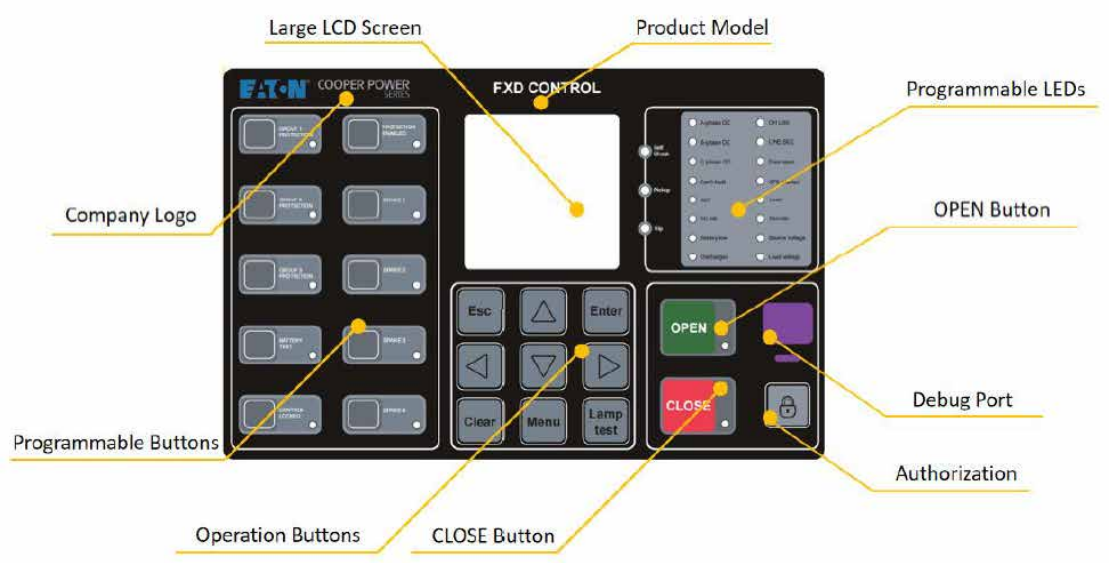

Figure2 FXD Control Front Panel

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
- Lamp test button is used to test LED lights

c. Control buttons

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

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: A-phase OC element
  - LED2: B-phase OC element
  - LED3: C-phase OC element
  - LED4: Earth fault element
  - LED5: SEF element
  - LED6: AC fail element
  - LED7: Battery low element
  - LED8: Discharged element
  - LED9: OH LBS element
  - LED10: LINE SEC element
  - LED11: Door open element
  - LED12: SF6 gas low element
  - LED13: Local element
  - LED14: Remote element
  - LED15: Source voltage element
  - LED16: Load voltage element

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: GROUP 1 PROTECTION
  - Button2: GROUP 2 PROTECTION
  - Button3: GROUP 3 PROTECTION
  - Button4: BATTERY TEST
  - Button5: CONTROL LOCKED
  - Button6: PROTECTION ENABLED
  - Button7: SPARE 1
  - Button8: SPARE 2
  - Button9: SPARE 3
  - Button10: SPARE 4

g. Authorization button

- There are four level authorization for selection:
  - Administrator
  - Engineer
  - Operator
  - Viewer

h. Debugging port

- RJ45 on front panel for debugging

4. PRODUCT FUNCTIONALITY

FXD Control offers a comprehensive solution for protecting, metering and controlling outdoor primary switches, such as automatic circuit switch. 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

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 2-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 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.

FXD Control 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 3-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 4-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	0.0086~120.0000	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	0.0086~120.0000	28.2000			Parameter A for user difined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user difined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user difined curve.

Parameter	Range	Default	Step	Unit	Description
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user difined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user difined 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 5-Over-current protection technical data

Parameter	Value
Operation accuracy	±1.5% of set value or ±0.005 x In (at currents in the range of 0.05...20.0 x In)
Reset time accuracy in DT	±1.0% or ±20ms
Reset time accuracy in IDMT	±5.0% or ±20ms
Operate time accuracy in DT	±1.0% or ±20ms
Operate time accuracy in IDMT	±5.0% or ±20ms

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 6-Non-directional earth fault protection identifications

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

FXD Control 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 7-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 8-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	1.00~40.00	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.
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	0.0086~120.0000	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 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	0.0086~120.0000	28.2000			Parameter A for user difined curve.
IDMT user defined parameter B	0.0000~0.7120	0.1217			Parameter B for user difined curve.
IDMT user defined parameter C	0.02~2.00	2.00			Parameter C for user difined curve.
IDMT user defined parameter D	0.46~30.00	29.10			Parameter D for user difined curve.
IDMT user defined parameter E	0.0~1.0	1.0			Parameter E for user difined 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 9-Earth fault protection technical data

Parameter	Value
Operation accuracy	±1.5% of set value or ±0.005 x In (at currents in the range of 0.01...20.0 x In)
Reset time accuracy in DT	±1.0% or ±20ms
Reset time accuracy in IDMT	±5.0% or ±20ms
Operate time accuracy in DT	±1.0% or ±20ms
Operate time accuracy in IDMT	±5.0% or ±20ms

4.1.3 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 FXD Control 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 10-Sensitive earth-fault protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Sensitive earth-fault	I0>	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.

FXD Control 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 11-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	0.0086~120.0000	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	0.002~2.000	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	Immediately			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 12-Sensitive earth-fault protection technical data

Parameter	Value
Operation accuracy	±1.5% of set value or ±0.001 x In (at currents in the range of 0.002...2.0 x In)
Reset time accuracy in DT	±1.0% or ±20ms
Reset time accuracy in IDMT	±5.0% or ±20ms
Operate time accuracy in DT	±1.0% or ±20ms
Operate time accuracy in IDMT	±5.0% or ±20ms

4.1.4 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 13-Negative-sequence over-current protection identifications

Function Description	IEC 60617	ANSI/IEEE C37.2
Negative-sequence over-current	I2>	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.

FXD Control 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 14-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	0.0086~120.0000	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 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	Immediately			Selection of reset curve type.

The technical data of function shows below table.

Table 15-Negative-sequence over-current protection technical data

Parameter	Value
Operation accuracy	±1.5% of set value or ±0.005 x In (at currents in the range of 0.01...5.0 x In)
Reset time accuracy in DT	±1.0% or ±20ms
Reset time accuracy in IDMT	±5.0% or ±20ms
Operate time accuracy in DT	±1.0% or ±20ms
Operate time accuracy in IDMT	±5.0% or ±20ms

4.1.5 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 16-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 17-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.

The technical data of function shows below table.

Table 18-Inrush restraint function technical data

Parameter	Value
Operation accuracy	±1.5% of set value or ±0.005 x In (at currents in the range of 0.1...10 x In) ±5.0% of set value (at ratio I2f/I1f in the range of 5.0...100.0%)
Reset time accuracy	±1.0% or ±20ms
Operate time accuracy	±1.0% or ±20ms

4.1.6 Sectionalizer function

The sectionalizer function uses the current count mode ,which uses current conditions to process the sectionalizing logic.It detects the current fault to open the FXD control. And it detects no current fault to close the FXD control. The recloser will be lockout when it reaches the maximum number of trip operations in a sequence, meanwhile, the operating type is trip.

The following table shows the parameter settings among Current counter function. At the same time, the overcurrent protection function needs to be enabled.

Table 19- Current counter parameter settings

Parameter	Range	Default	Step	Unit	Description
counter	1~3	1	1		Record fault current count times
Reset time	0~3600	30	1	S	Number of phases required for operate activation.

4.1.7 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 20-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.

FXD Control 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 21-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 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 22-Three-phase under-voltage protection technical data

Parameter	Value
Operation accuracy	±3% of set value or ±0.005 x Un (at voltages in the range of 0.05...1.20 x Un)
Reset time accuracy	±1.0% or ±20ms
Operate time accuracy in DT	±1.0% or ±20ms
Operate time accuracy in IDMT	±5.0% or ±20ms

4.1.8 Protection Setting Groupsn

FXD Control 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 23-Protection setting groups parameter settings

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

4.2 Measurement

The FXD Control gets analog signals from automatic circuit switch current transformers and voltage sensors, convert them into digital format. The following values are contained in the measurement element.

Table 24-The measurement element applicability

Parameter	Range	Applicability	
		Protection	Indication
Three-phase Current (Ia/Ib/Ic)	0.00~40.00In	√	√
Residual Current (Io)	0.00~40.00In	√	√
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 (Vbat)	18~26 Vdc		√

4.2.1 Fundamental Measurement

The FXD Control 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 FXD CONTROL 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 25-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:

$T=(max-min)*deadband/|\triangle Y|*100$

Equation 2

Reporting delay time

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

Table 26-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 60 mins 180 mins	1 min			The average value during interval time.
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.

Parameter	Range	Default	Step	Unit	Description
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 27-The fundamental measurement technical data

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

4.2.2 Sequence Components

The FXD Control 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 28-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 29-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 A 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 A 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 current high warn limit	0.00~40.00	0.05	0.01	xIn	High warn zero sequence current 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 30-The sequence components technical data

Parameter	Value
CSM accuracy	±1.0% (at currents in the range of 0.01...20.00 In)
VSM accuracy	±1.0% (at voltages in the range of 0.05...2.00Un)

4.2.3 Harmonics

The FXD Control provides 2nd to 11th 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 31-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 32-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 FXD Control provides Control functions, including open/close operation, local/remote operation.

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 FXD Control 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.

4.4 Communication

In the local mode, the switch is controlled via the front panel on FXD Control, in the remote mode the switch is controlled via communication. The FXD Control 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 33-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 34-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					
Baud rate	1200 2400 4800 9600 19200 38400 57600 115200	9600			Baud rate 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)					
Baud rate	1200 2400 4800 9600 19200 38400 57600 115200	9600			Baud rate 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 35-Communication protocol parameter settings

Parameter	Range	Default	Step	Unit	Description
IEC 60870-5-101/104					
IEC 60870 General					
ASDU(Common) 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 Enable	Disable			It selects if the cyclic update will be done 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-TCP Client, IEC104-Eth-TCPServer	IEC104-Eth-TCPServer			Ethernet mode selection.
Remote IP Address		0.0.0.0			Remote IP address for IEC104.
Port	1~65535	2404	1		Server TCP port.

Parameter	Range	Default	Step	Unit	Description
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 t2 < t1.
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	1~65531	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_RS232			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	Sometimes			This parameter Controls data link confirm for sending frames.

Parameter	Range	Default	Step	Unit	Description
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 beallowed before an unsolicited response is generated.
Unsolicited class 3 Number	1~512	5	1		The maximum number of events in the corresponding class to beallowed 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 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	Sometimes			This parameter Controls data link confirm for sending frames.

Parameter	Range	Default	Step	Unit	Description
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.

4.5 Data Handling

The FXD CONTROL 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 FXD Control 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 FXD Control 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 software as below picture.

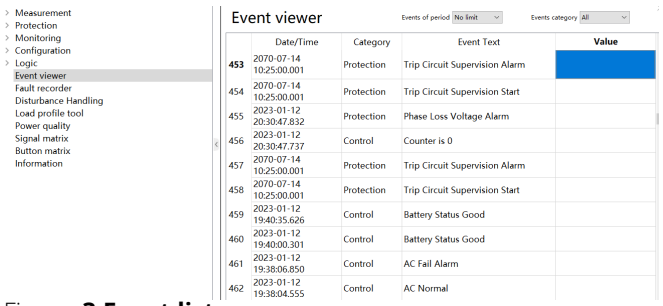

Figure 3 Event list

4.5.2 Disturbance Recorder

The FXD Control 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 waveforms 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:

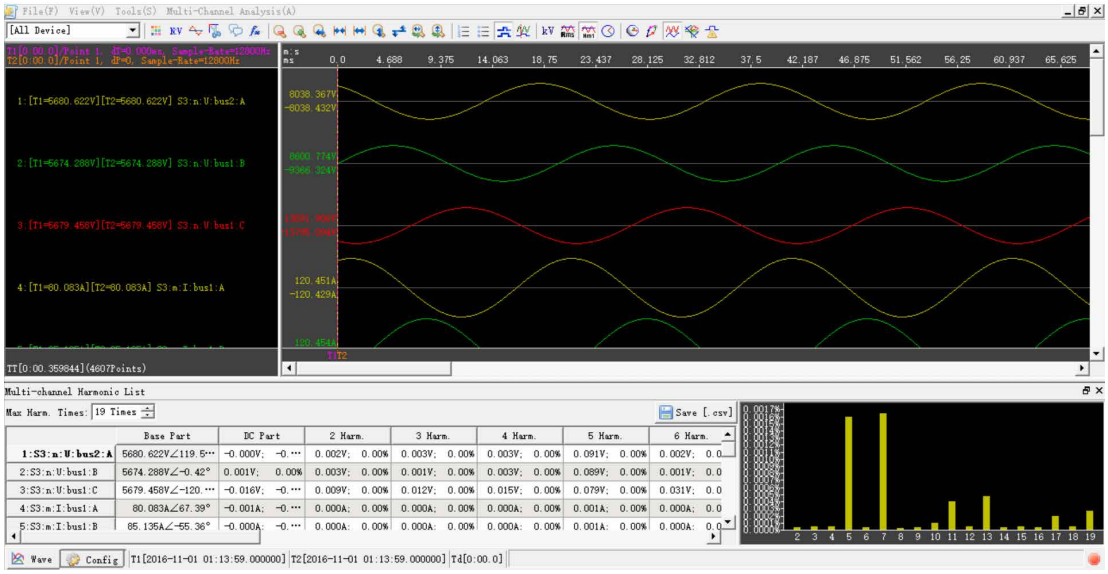

Figure 4 Disturbance recorder

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

Table 36-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 operation	on/off	on			This function element can be enabled or disabled by on/off selection.
Ch1 selection	Ia/Ib/Ic/Io/Ua/Ub/Uc/Uo1/ Ur/Us/Ut/Uo2/Uab/Ubc/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 FXD CONTROL 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.

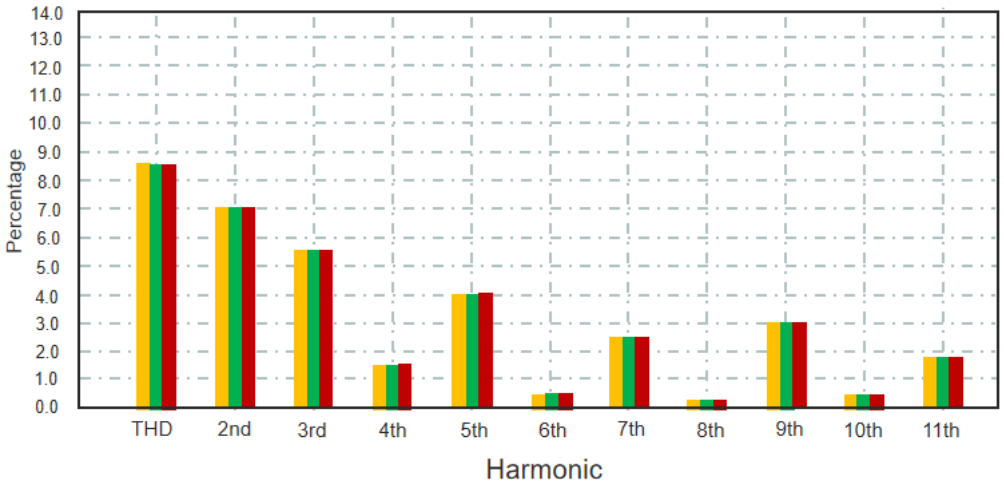

Figure 5 Power quality analysis

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.

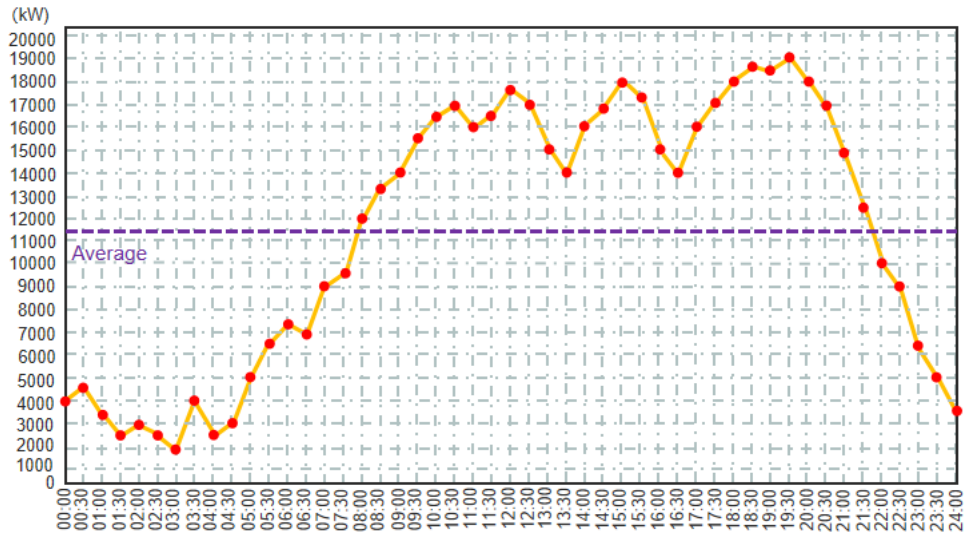

Figure 6 Load profile

4.6 LED and Button Matrix Functions

The LEDs and Buttons on front panel of FXD Control has programmable function. Each LED and button can be customized by user through software. User can select associated function what he want, and download the parameter so as to active relatively configuration.

4.7 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 37-Predifined 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 38-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)

4.8 Internal Fault

When an internal fault is detected, protection operation will be disabled, the self-check LED change from green to red. Internal fault indications have the highest priority on the LCD. When the internal faut 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 FXD Control returns to the normal service state, The fault information remains on the SOE event list.

The following table shows types of internal fault.

Table 39-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 Config error	23

5. INSTALLATION

5.1 Enclosure Dimension

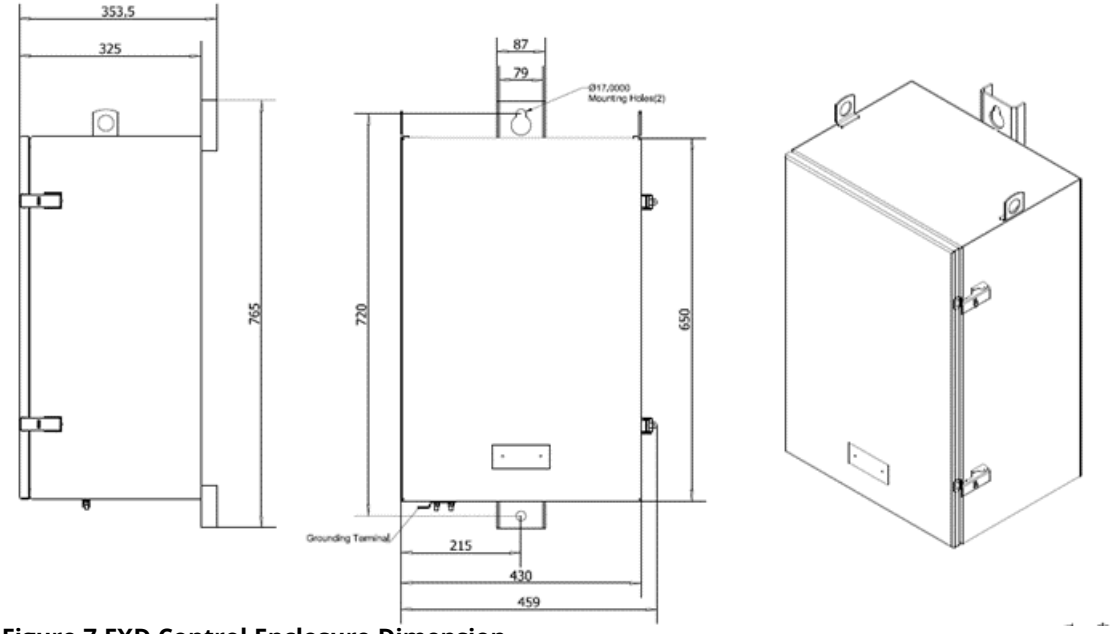

Figure 7 FXD Control Enclosure Dimension

5.2 Earthing

Installation of a FXD Control with a local supply voltage transformer must include the following:

Protection of the bushings and the supplying transformer with lightning arresters.

- Grounding of the head and tank
- Grounding of the transformer tank
- Grounding of the Control enclosure
- Grounding of the SCADA equipment
- All the grounding must be connected together

Figure 29 shows the recommended grounding diagram for the FXD Control installed with relevant voltage transformer.

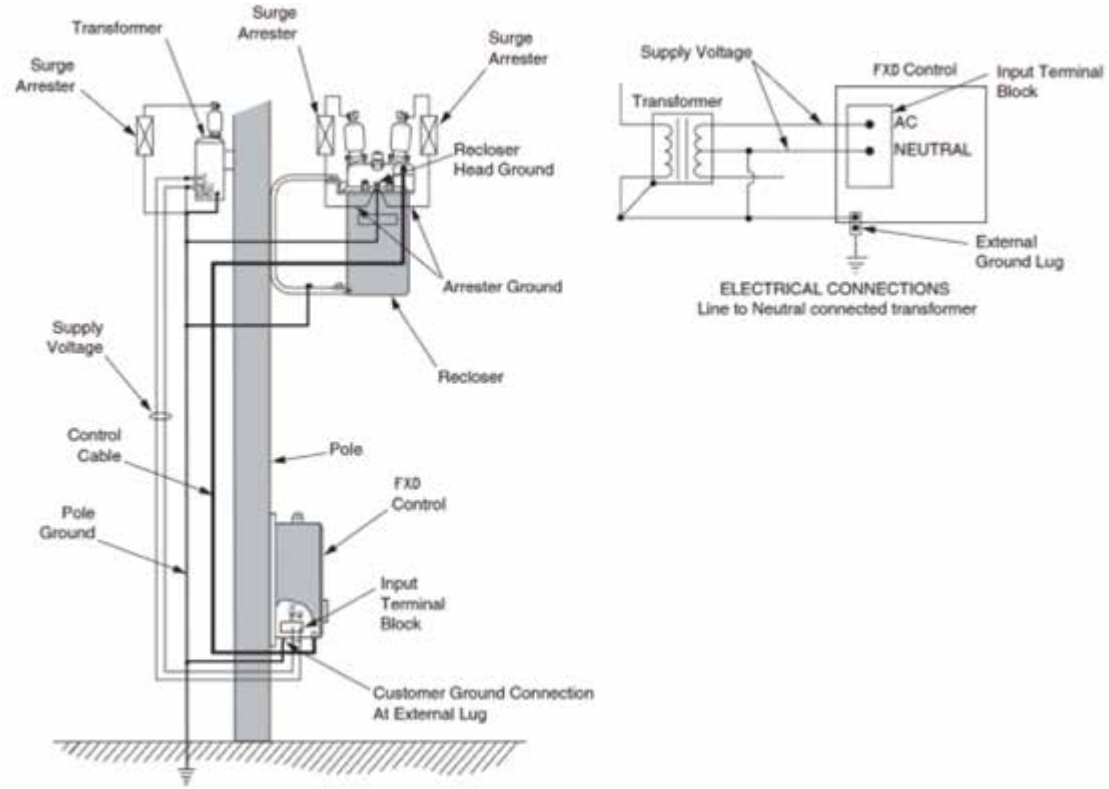

Figure 8 Recommended earth wiring diagram for FXD Control With Local Supply Voltage Transformer

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