

# Automatic circuit recloser

**Strong Power Electric Co.,Ltd.**

Oct.28th, 2021

# Background and Meaning

**Business Background:** "The 14th Five-Year Plan for the Digital Transformation of Distribution, Networks", "Thirteenth Five-Year Distribution Network Automation Coverage Rate Over 90%", "Distribution Network Construction and Reconstruction Plan"

**Goal-oriented:** Standardization, integration, intelligence, digitization, lean

## Deep integration

- Further improve the standardization and integration of switch primary and secondary equipment, achieve a high degree of compatibility and integration, and further improve inspection and production efficiency
- Electronic transformers are all solidly sealed to the body, the first and second deep integration has been deeply rooted in the hearts of the people, related products have been applied on a large scale, and the advancement of standardization has begun to have conditions

# Background and Meaning

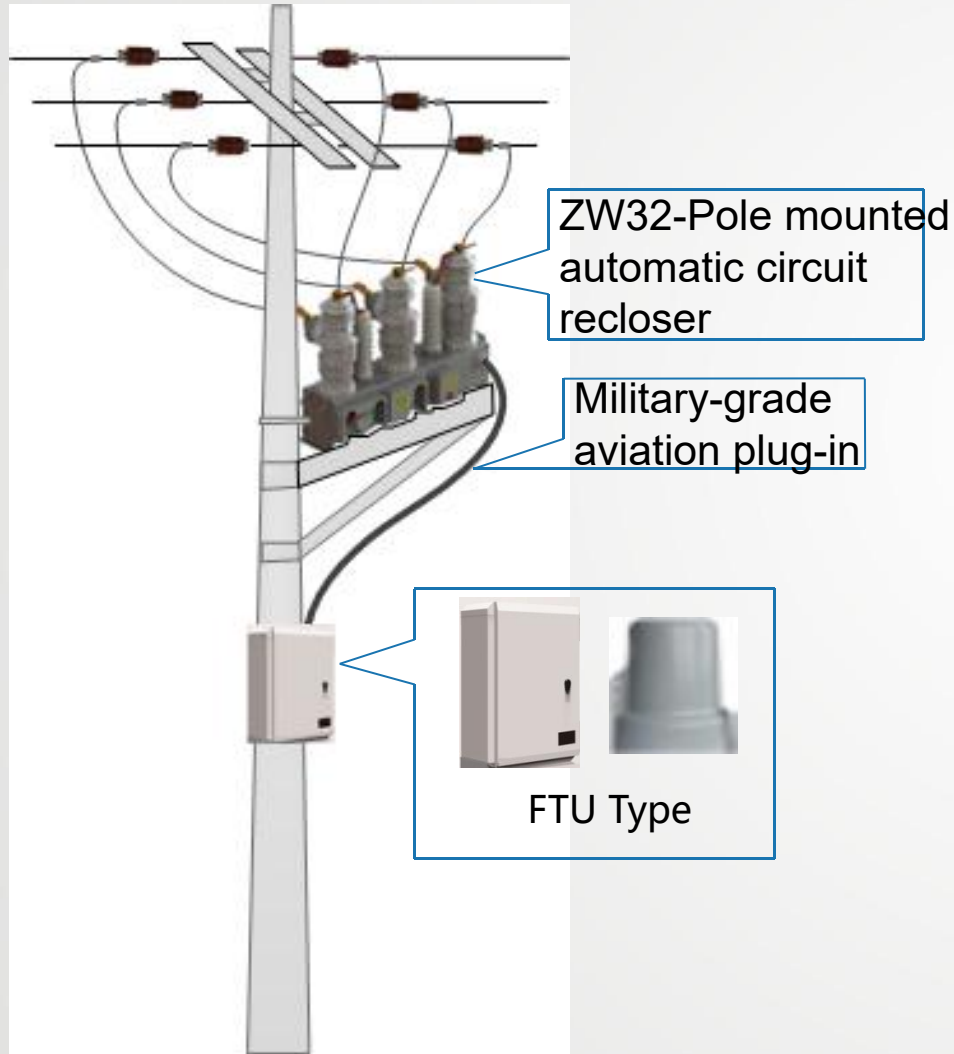
## **Intelligent distribution network**

- **Adopt more complex and smarter edge computing strategies to further improve the accuracy of fault diagnosis**
- **Further improve the intelligence of fault isolation and fault recovery control, and improve the self-healing ability of the distribution network**

## **Lean Operation and Maintenance**

- **In-depth integration of multiple functions to enhance the value of the switch and play the role of the switch as a platform for the implementation of lean operation and maintenance of the distribution network**
- **Deeply integrate a variety of IoT sensors, holographically perceive the switch status, support intelligent operation and maintenance, and improve the level of lean operation**

# Product Description



## Automatic circuit recloser

### Pole mounted automatic circuit recloser

- 11 electronic current and voltage sensors are sealed in 3 poles
- High-power, independent capacitor power PT

### Intelligent FTU

- Accurate fault diagnosis
- Advanced troubleshooting
- Multifunctional integration and expansion
- Support lean operation and maintenance

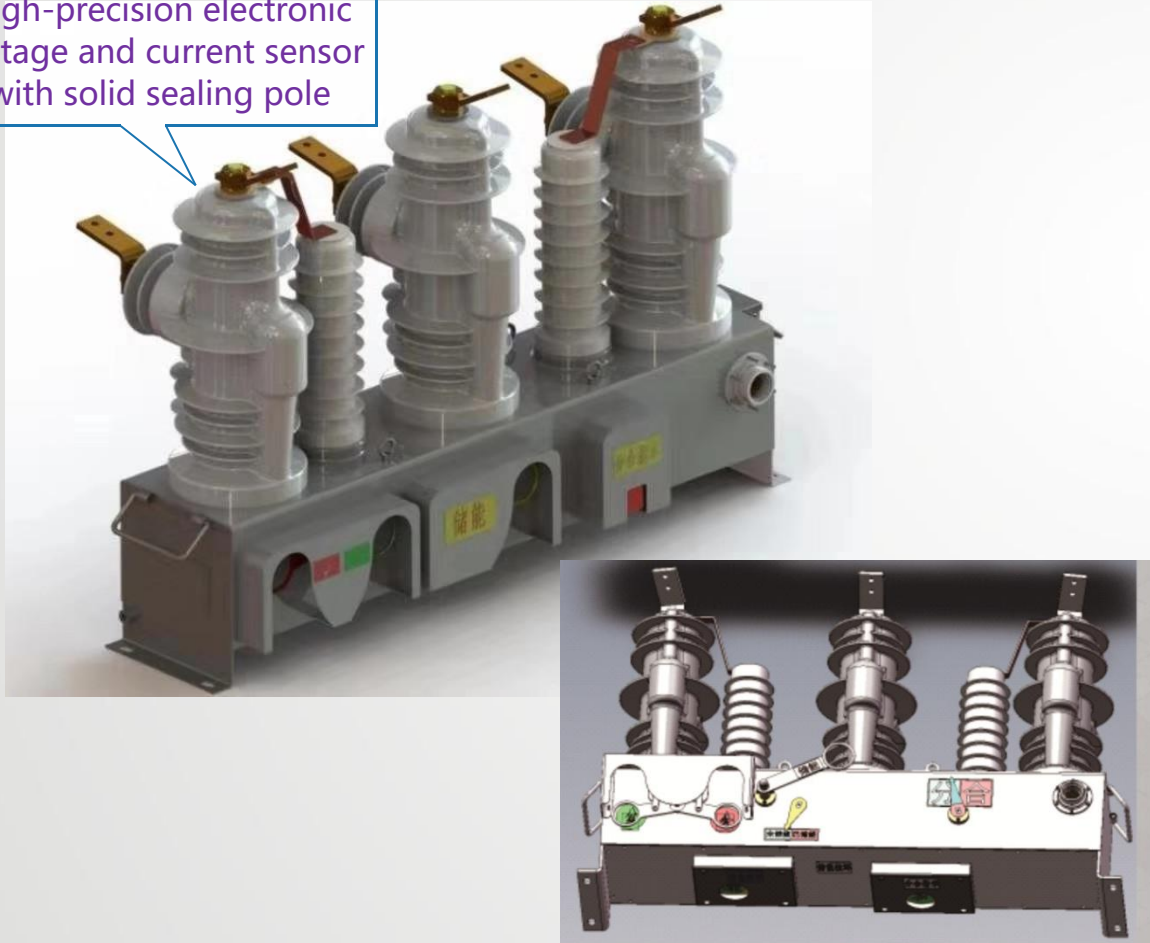
### High-quality accessories

- Military-grade aviation plug-in, interface standardization
- Reliable backup power supply, dual configuration of super capacitor and lithium battery

# Product Description

## ZW32-Pole mounted automatic circuit recloser

High-precision electronic voltage and current sensor with solid sealing pole



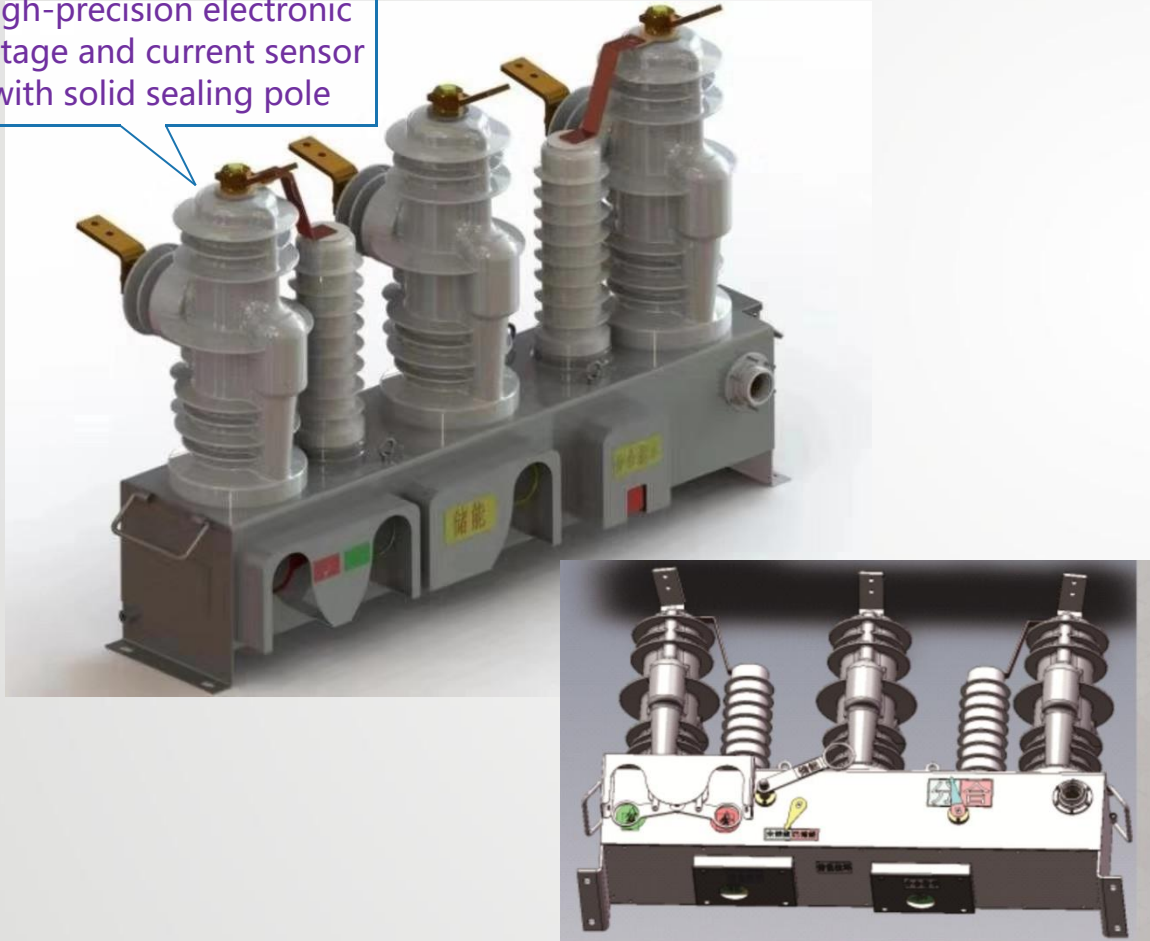
## Integrated switch

- 12KV outdoor vacuum circuit breaker, optimized and efficient operation of energy storage mechanism
- Leakage rate of vacuum bubble insulation medium <math><0.1\%/\text{year}</math>, maintenance-free for 20 years
- Insulating rod adopts epoxy resin material, and the insulating sleeve adopts an integrated structure
- 11 sensors are integrated and sealed in the pole, and the material temperature coefficient is highly consistent
- Adopting special materials and advanced technology, superior in voltage resistance, insulation and partial discharge performance
- The switch is small in size, light in weight, durable and maintenance-free, and has a lifespan of not less than 20 years

# Product Description

## ZW32-Pole mounted automatic circuit recloser

High-precision electronic voltage and current sensor with solid sealing pole



## Integrated switch

- Operation window is set at the bottom of the switch, which is more intuitive and convenient for transportation and inspection
- Switch remote/local linkage, reclosing on and off, easy to operate and confirm
- Tapered sealing gasket of the interface is fully sealed with silicone, and the sealing performance is superior
- Shell is made of 304 stainless steel, and the surface is plated with zinc-nickel alloy, which has strong anti-corrosion and salt spray resistance
- Switch body is safe and safe to operate, ensuring the safety of operation and maintenance
- Protection grade IP65

# Product Description

## ZW32-Pole mounted automatic circuit recloser core parameter

1	Rated voltage	kV	12
2	Rated current	A	630
3	Rated frequency	Hz	50
4	Rated breaking short-circuit current value	kA	20
5	Rated thermal stability current (effective value)	kA	20
6	Rated thermal stability time	s	4
7	Rated short-circuit making current (peak value)	kA	50
8	Rated dynamic stability current (peak value)	kA	50
9	Rated cable charging breaking current	A	25

1	Number of breaking rated short-circuit current		times	30
2	Fracture absolute level (complete machine test, including sensor and power supply)	Power frequency	kV/min	48
3		Lightning impulse test voltage		85
4	Insulation level between phases and ground (complete machine test, including sensor and power supply)	Power frequency	kV/min	42
5		Lightning impulse test voltage		75
6	Partial release of the whole machine	14.4kV	pC	≤10
7	Mechanical life		times	10000
8	Service life		year	20

# Product Description

## ZW32-Pole mounted automatic circuit recloser

### Fully integrated electronic sensor

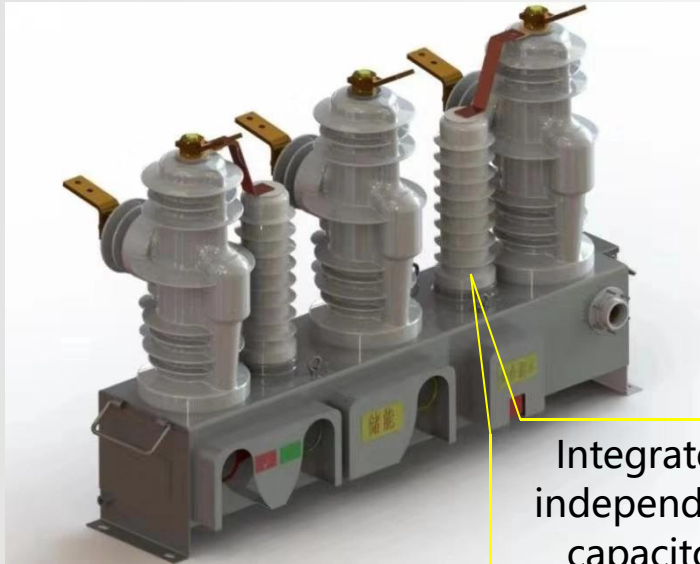
- A total of 11 high-precision electronic sensors including three-phase current, three-phase voltage on both sides, zero-sequence voltage and current are sealed by the pole, with superior terminal matching characteristics, which can match the control terminals of different manufacturers, support intelligent segmentation switches, and have a wide range of adaptability.
- Output internal resistance is small, can adapt to various cables, overcome the error caused by the cable, and the cable interchange error is less than 0.1%.
- Electronic voltage sensor uses ultra-high withstand voltage capacitor components to ensure that the life is matched with the switch body components.

Current part	Rated load		$\Omega$	>20k
	Rated current ratio			600A/1V
	Zero sequence current			20A/0.2V
	level of accuracy	Phase current	grade	0.5s (保护5P10)
Zero sequence current		grade	0.5 (保护10P10)	
Voltage part	Rated load			>2M
	Phase voltage			$(10kV/\sqrt{3}) / (3.25V/\sqrt{3})$
	Zero sequence voltage			$(10kV/\sqrt{3}) / (6.5V/3)$
	Load side voltage		1 PCS	$(10kV/\sqrt{3}) / (3.25V/\sqrt{3})$
	level of accuracy	Phase voltage	grade	0.5/3P
		Load side voltage	grade	0.5/3P
Zero sequence voltage		grade	1	



# Product Description

## ZW32-Pole mounted automatic circuit recloser



Integrated independent capacitor power PT

### High-power independent capacitor power PT

- Integrate two independently installed capacitor PT poles, separate the secondary energy from the switch body, and match the life of the switch body to ensure that the life of the switch body is not damaged
- A single capacitor PT takes more than 10W of power, which provides ample power supply for FTU to achieve edge computing, multi-function integration, and real-time 4G/5G communication
- Can be flexibly disassembled, capacity can be adjusted
- Medium voltage carrier can be connected through the coupling of the capacitor PT pole

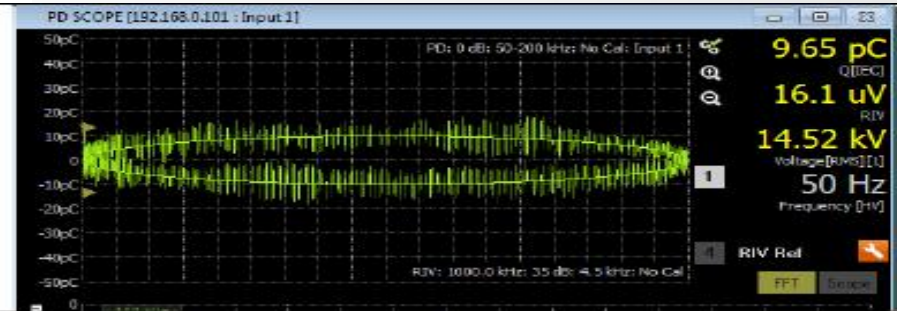
# Product Description

## Automatic circuit recloser without partial discharge

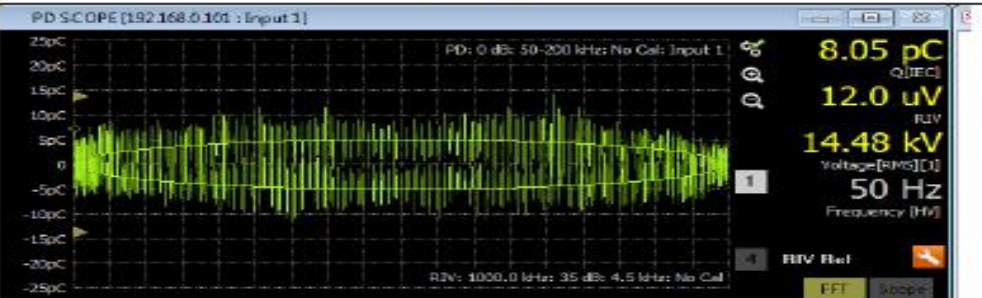
局放示波图:



背景



B



A



C

# Product Description

## Intelligent FTU

### Standardized FTU as core

- Basis of standardized FTU remote signaling, remote measurement and remote control, remote adjustment is added to support voltage adjustment, reactive power adjustment, etc.
- Standardize the fault, status and other indications and automatic reset functions required by the FTU.
- Standardized FTU communication protocol, 4G communication function.
- Standardized FTU three-stage protection, reclosing, grounding identification, as well as blocking, anti-misoperation and other fault handling functions.
- Beidou\GPS time synchronization function.
- Two-network hard encryption chip.
- Double backup of super capacitor and battery, BMS battery management.
- Other standardized FTU functions.

### Advanced fault handling capabilities

- Accurate ground fault judgment and location function, identification of ground faults with transition resistance greater than 4K
- Realize the main station centralized, edge computing, and differential local feeder automation (FA) functions for short-circuit and permanent ground faults



### Multifunctional integration

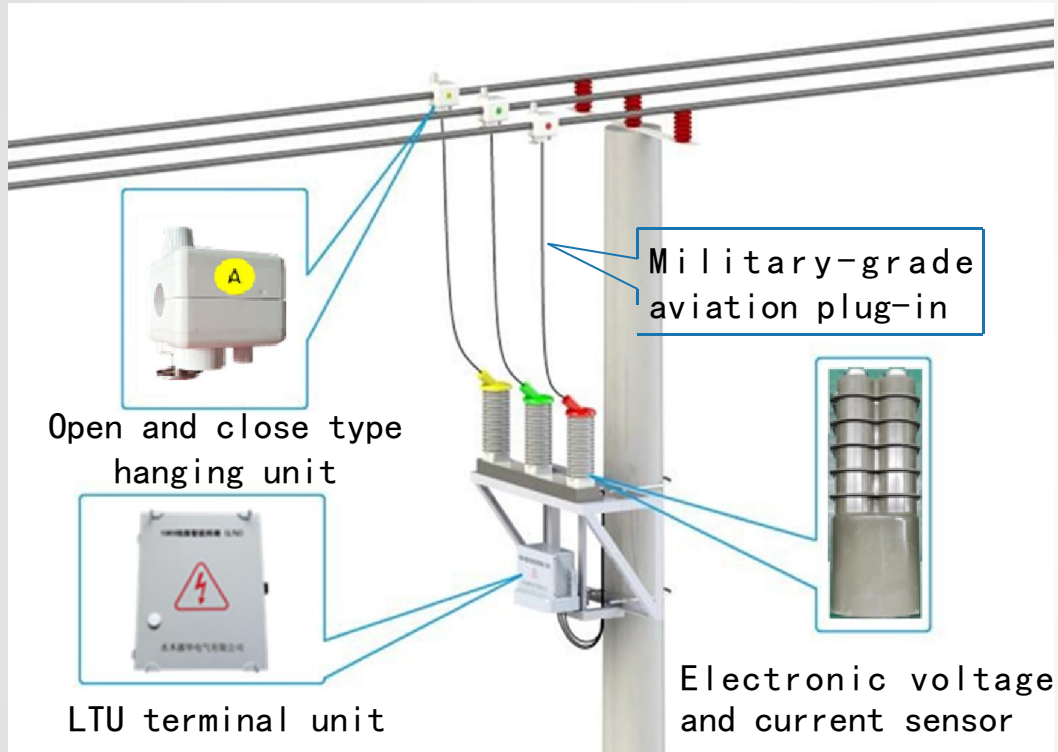
- Simultaneous line loss measurement to support lean management
- Energy efficiency monitoring, support reactive power compensation, voltage adjustment and remote adjustment
- Large-capacity real-time record wave value

### Lean operation and maintenance

- Comprehensive power measurement, switch contact temperature measurement, other environmental parameter monitoring, holographic perception of switch status
- Real-time 4G communication, supporting IoT protocols, realizing timely transmission of operation and maintenance data

# Product Description

## Intelligent terminal of distribution line LTU



## Technical index

- Three-phase current measurement accuracy 0.5%, measurement range 0~2500A
- Three-phase voltage measurement accuracy 0.5%, measurement range 0~10KV
- Single-phase power capacity 10VA, three-phase 30VA
- 4G\5G\GPRS and other communications, Beidou+GPS time synchronization

## Good partner for smart switches

Distribution Line Intelligent Terminal Unit (LTU) , LTU is a revolutionary product launched by the research institute for power distribution line faults. It specifically solves the problems of insufficient power supply and voltage accurate measurement of fault indicators, and then solves the problem of ground fault judgment and location. In addition to being able to replace the old finger, it can complement each other with the in-depth integration of intelligent switches, and realize the function of fault isolation in an integrated manner.

## Technical characteristics

- Highly integrated electronic sensor to achieve high-precision acquisition of three-phase current and three-phase voltage.
- Open-type wire-hanging unit can realize live installation, and is integrated with the electronic transformer using armored aerial plug.
- Adopt electronic capacitor PT, take power through voltage, provide reliable and abundant power supply for terminal unit.
- Terminal unit contains a high-performance edge computing gateway and is equipped with a container engine to realize functions such as "fault location and line selection", "fault recorder", "load and line loss monitoring", and "power quality management".

# Features

**Performance comparison of similar manufacturers** — Automatic circuit recloser have obvious advantages in 8 aspects, including power supply life, partial discharge function, consistency, and matching.

Compare items		Electromagnetic recloser	Other Automatic circuit recloser	Automatic circuit recloser
Automatic circuit recloser	Partial release (security)	<20pC	<20pC	<10pC
	Process	—	Unanimous	Temperature intensity of the solid sealing material and the sensor and other components are highly consistent
	Operation overhaul	inconvenient	convenient	Operation and energy storage mechanism optimization, instruction humanization
	Power technology	—	< 10VA	>30VA
	Service life	<10year	>20 years, partly less than 10 years	Overall lifespan>20 years

# Features

**Performance comparison of similar manufacturers** — Automatic circuit recloser have obvious advantages in 8 aspects, including power supply life, partial discharge function, consistency, and matching.

Compare items		Electromagnetic recloser	Other Automatic circuit recloser	Automatic circuit recloser
Transformer	Signal matching	—	Output characteristics are soft, and the third-party terminal matching is poor	Output characteristics are soft, the third-party terminal has strong matching, and the error is 0.1%
	Frequency Range	Narrow	Wide	Wide
	Linearity	Ferromagnetic distortion, magnetic saturation, local linearity	Good linearity	Completely linear
	Secondary protection	PT short circuit high current CT open circuit high voltage	Safety	Safety
	Ferromagnetic resonance	There is a ferromagnetic resonance	Not exist	Not exist
terminal	FA technology	Differential on-site, centralized main station	Differential on-site, centralized main station	Differential, centralized main station, edge computing, permanent ground isolation
	Edge computing capabilities	NO	With line loss	Multifunctional integration such as line loss, energy efficiency management, and real-time wave recording in the same period
	Backup power	Lead-acid batteries	lithium battery	Double backup of super capacitor and lithium battery

# Features

## Single-phase grounding problem solution:

### Why is it so difficult to detect a small current grounding system?

- ◆ The ground current is small-the resonant ground residual current is less than 10A, and the high-resistance fault has only 1A current; the high-resistance (resistance above 1k $\Omega$ ) has a high proportion of faults.
- ◆ Different fault location and fault time
- ◆ The compensation current of the arc suppression coil causes the zero-sequence current of the faulted line to have a smaller amplitude than the non-faulty line and the same direction.
- ◆ Intermittent grounding and unstable arc.

# Features

## Single-phase grounding problem solution:

### Why is it so difficult to detect a small current grounding system?

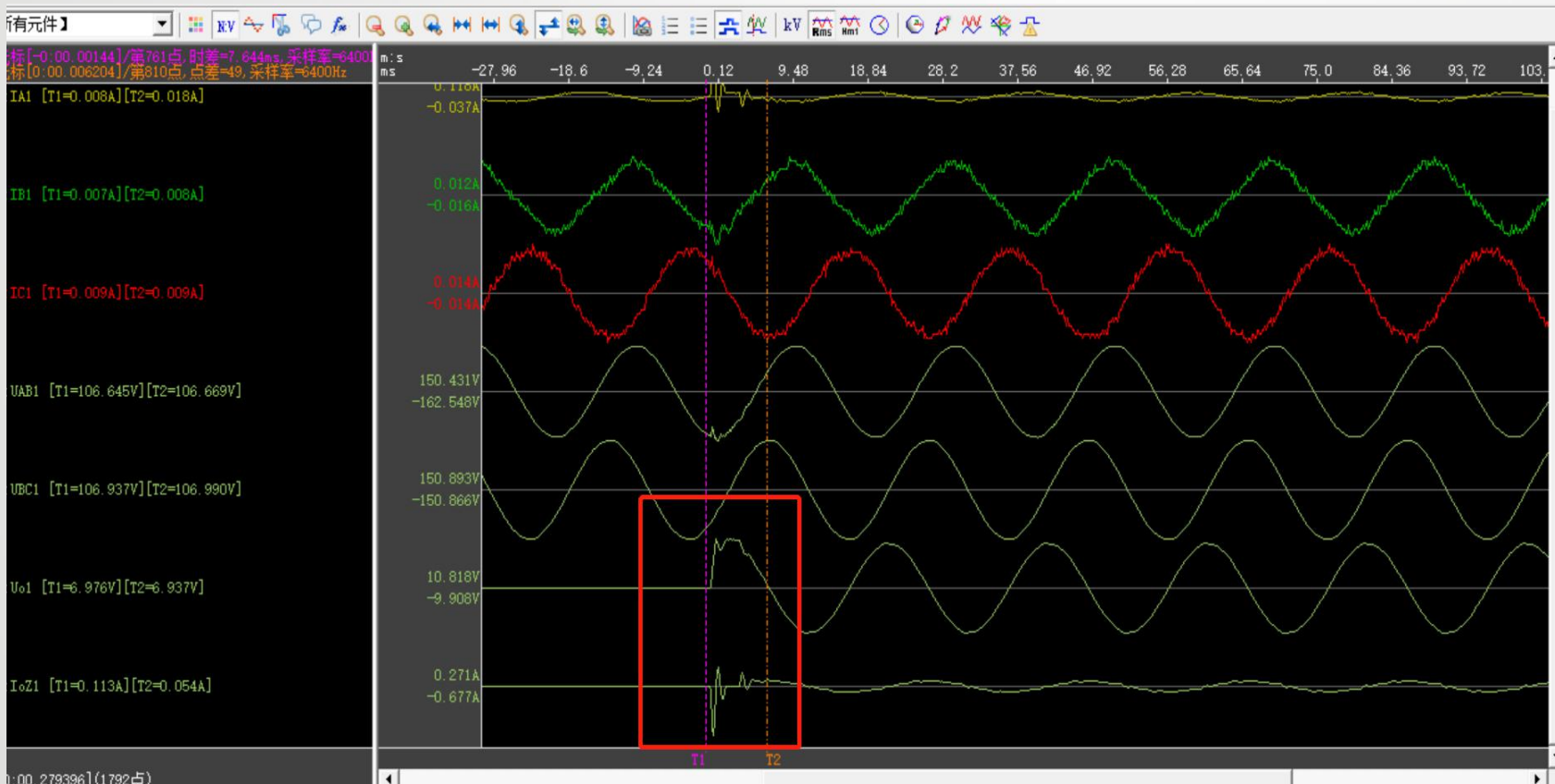
- ◆ In addition, the fault signal is superimposed on the load current and the electromagnetic interference of the environment affects the correctness of the fault resolution; the system operation mode is changeable, the fault state is changeable, and there are many uncertain factors.

Therefore, in order to improve the accuracy of single-phase grounding judgment in the distribution network, it is necessary to solve the problem of power distribution equipment from various aspects such as the accuracy of the sensor, the single-phase grounding algorithm, and anti-interference.



# Features

## Ground fault judgment-intelligent switch on-site diagnosis



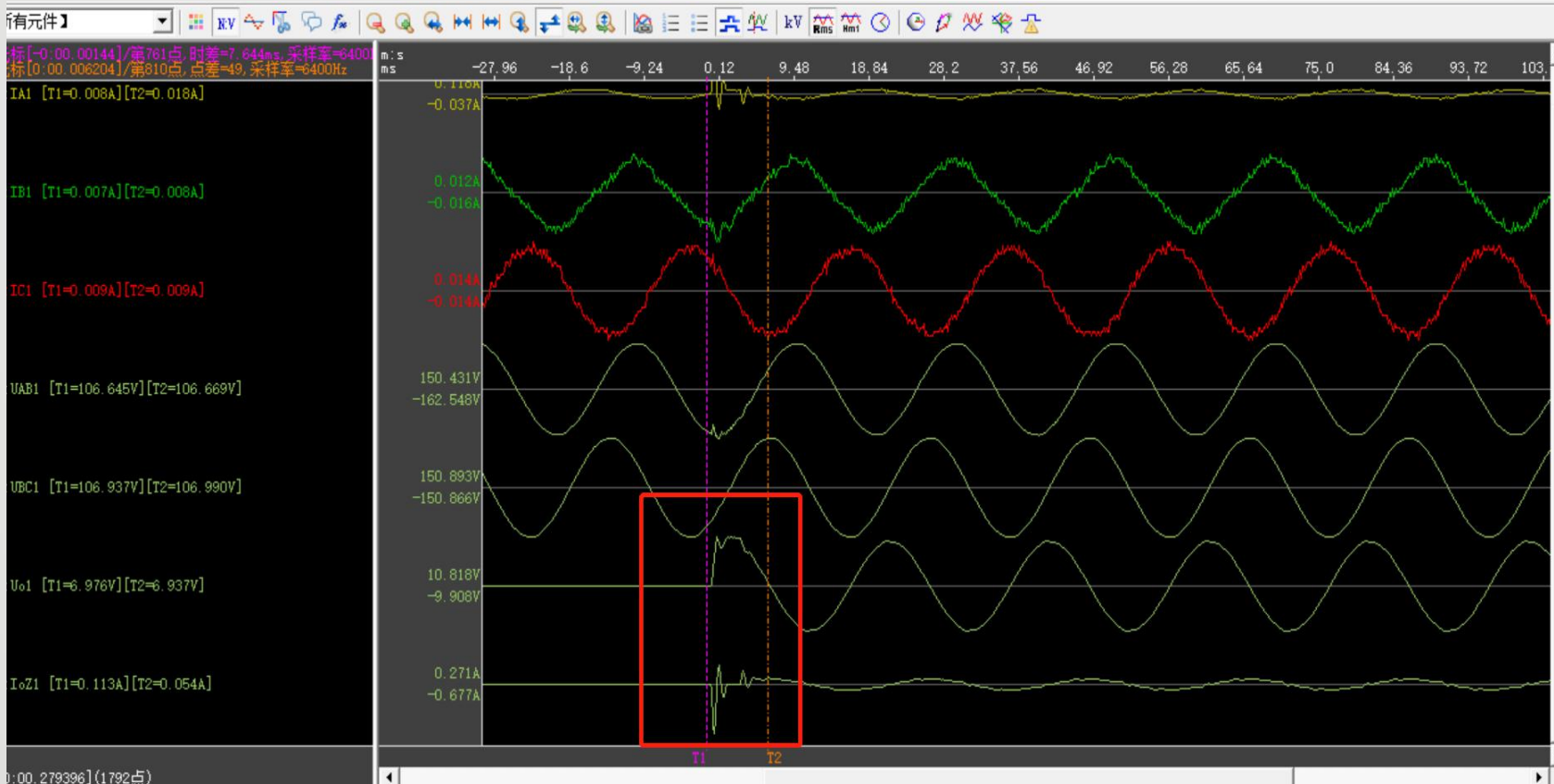
## Phase asymmetry (three-phase incremental method) principle

- The direction of the zero sequence current increase before the fault point is opposite, the phase current increase is relatively large, after the fault point, the change is not large, and the increase is relatively small

**The phase current increment amplitude is inconsistent with the other two phases and is relatively large, then it is judged to be grounded.**

# Features

## Ground fault judgment-intelligent switch on-site diagnosis

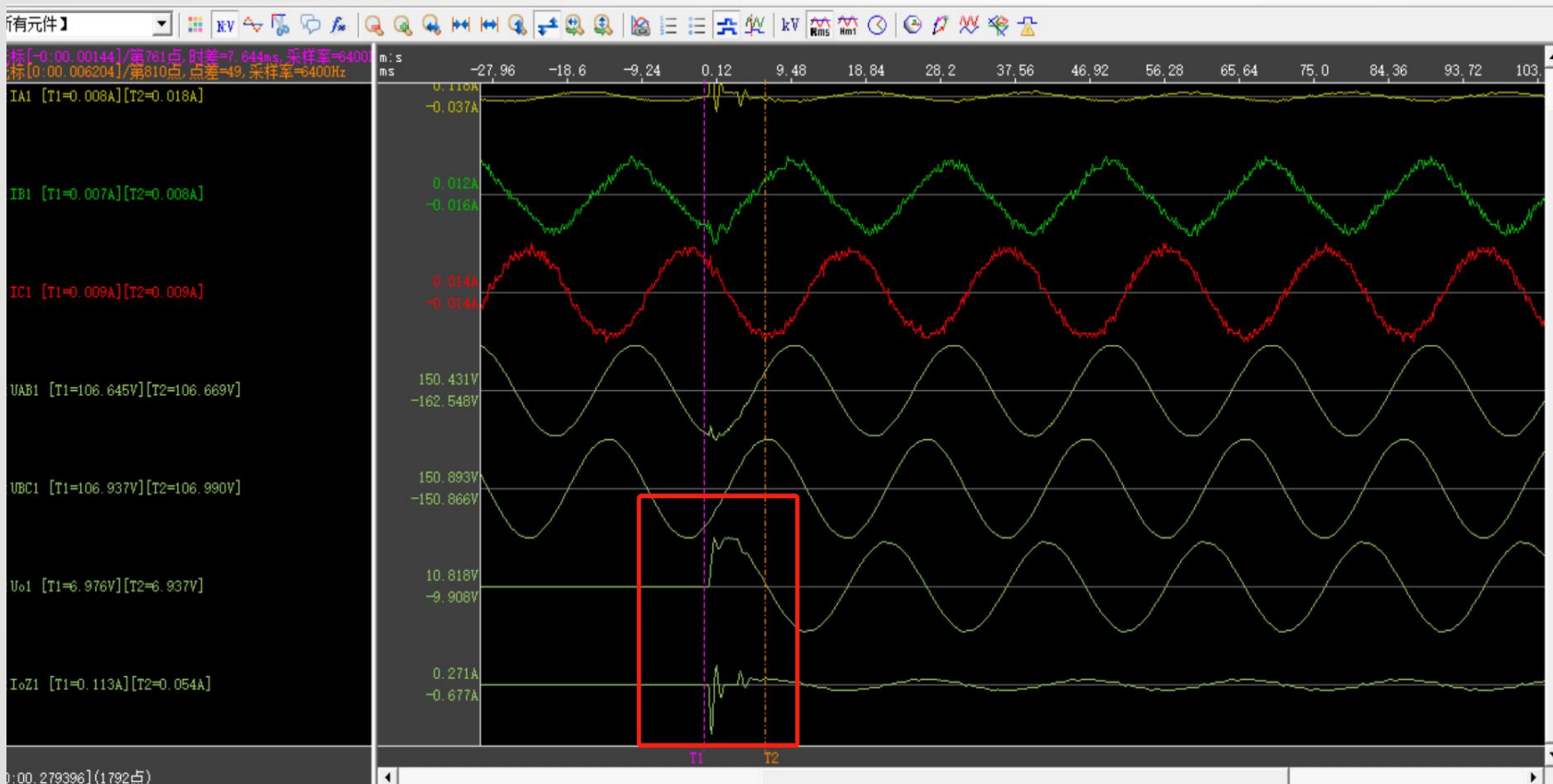


## Phase asymmetry (three-phase incremental method) principle

Before and after the fault, the three-phase of the non-faulty line and the non-faulty phase of the faulty line, because the zero sequence current is basically unchanged, the phase current increment is basically the same and small;

# Features

## Ground fault judgment-intelligent switch on-site diagnosis



The Internet of Things FTU, which integrates intelligent switches once and twice, uses steady-state and transient algorithms, phase asymmetry algorithms, etc. for comprehensive fault identification. It can identify metallic grounding, arc grounding, and transition resistance within 4K under different grounding methods. Phase-to-ground fault;

# Features

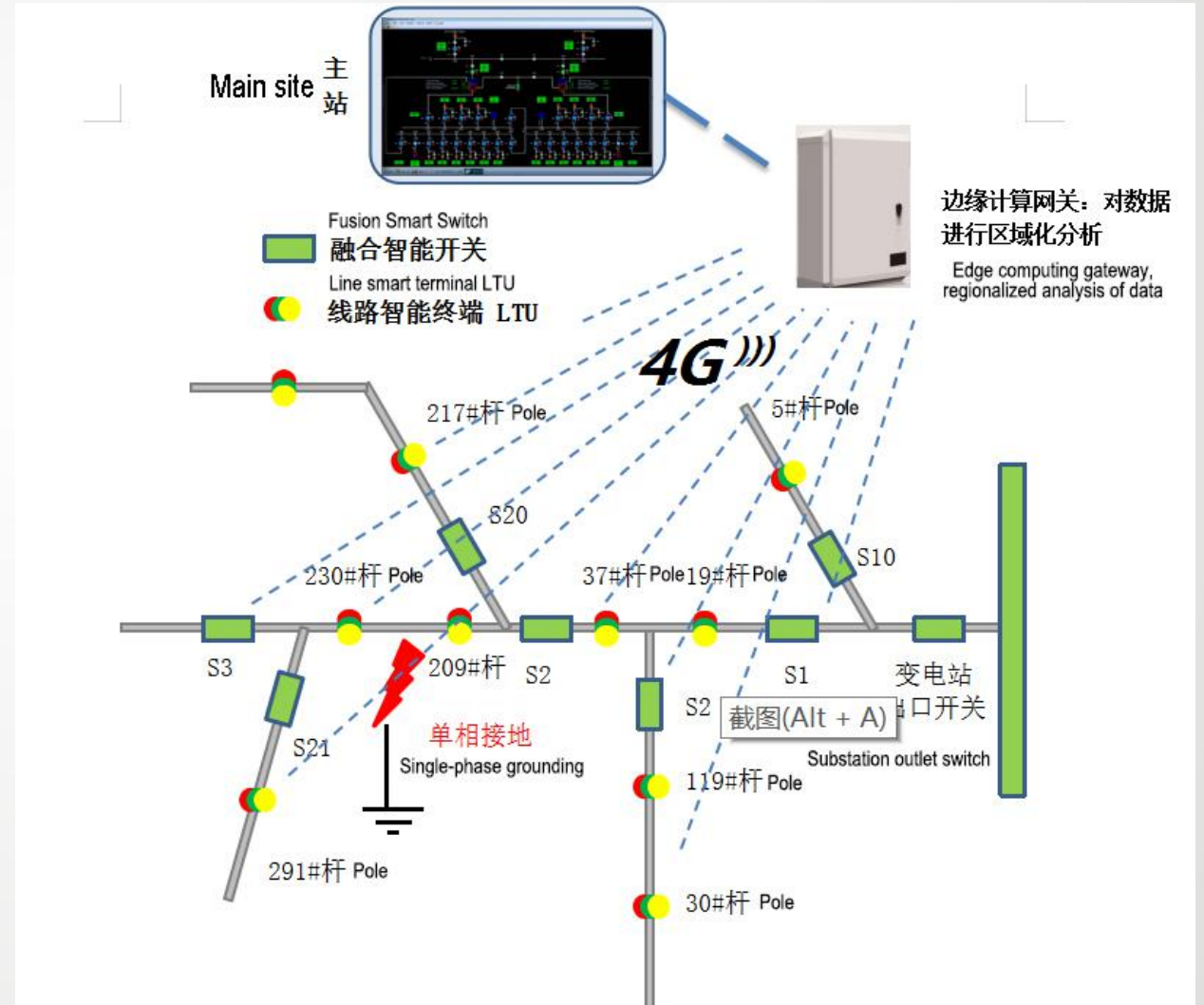
## Single-phase ground fault location and isolation-smart switch + edge computing gateway

### Ground fault location and isolation

- After the grounding occurs, the intelligent switch and the line terminal LTU upload the ground fault results identified by each to the edge computing gateway, and the gateway combines the topology information to comprehensively analyze the fault and its location.



Edge Computing Gateway

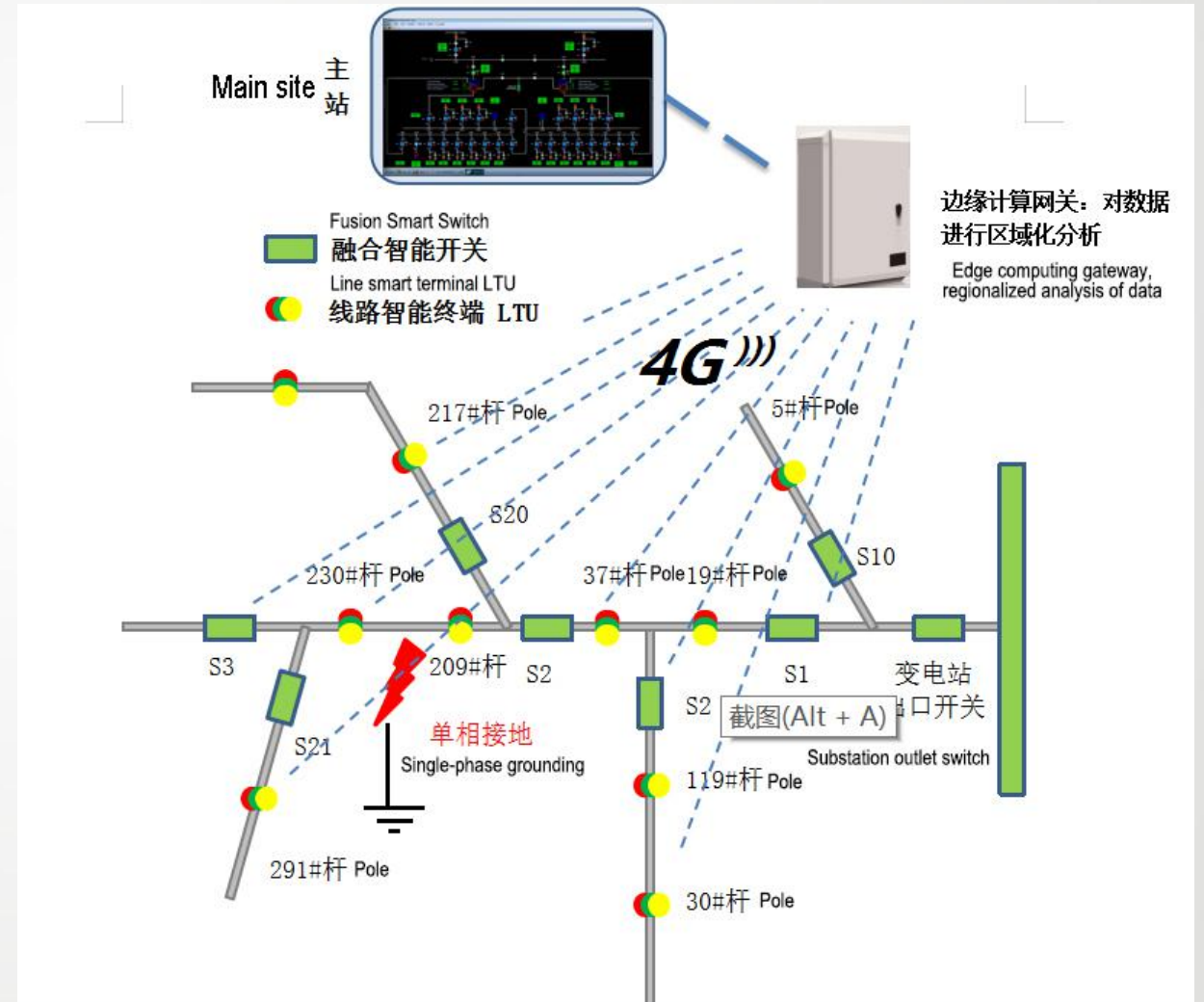


# Features

## Single-phase ground fault location and isolation-smart switch + edge computing gateway

- Thanks to the intelligent switch and LTU's accurate fault identification results, when it is judged as a permanent fault, the master station can accurately determine the switch that needs to be tripped, remotely trip to eliminate the fault, and realize ground fault isolation
- Disposing an appropriate number of LTUs between smart switches can improve positioning accuracy and accuracy, **The positioning accuracy can be less than 1Km**

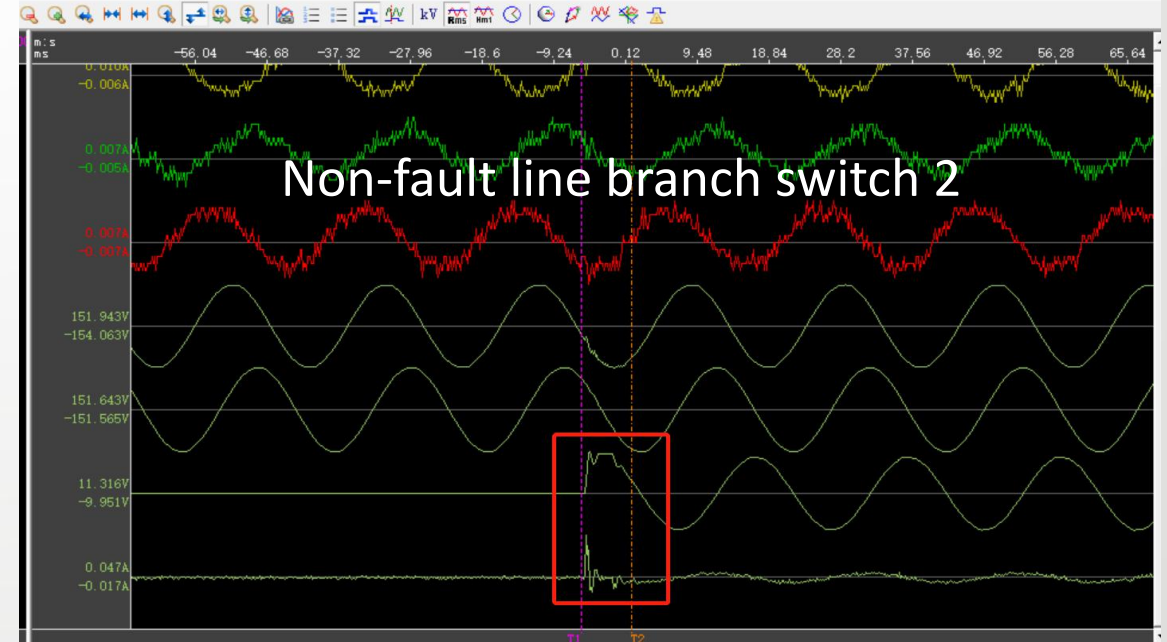
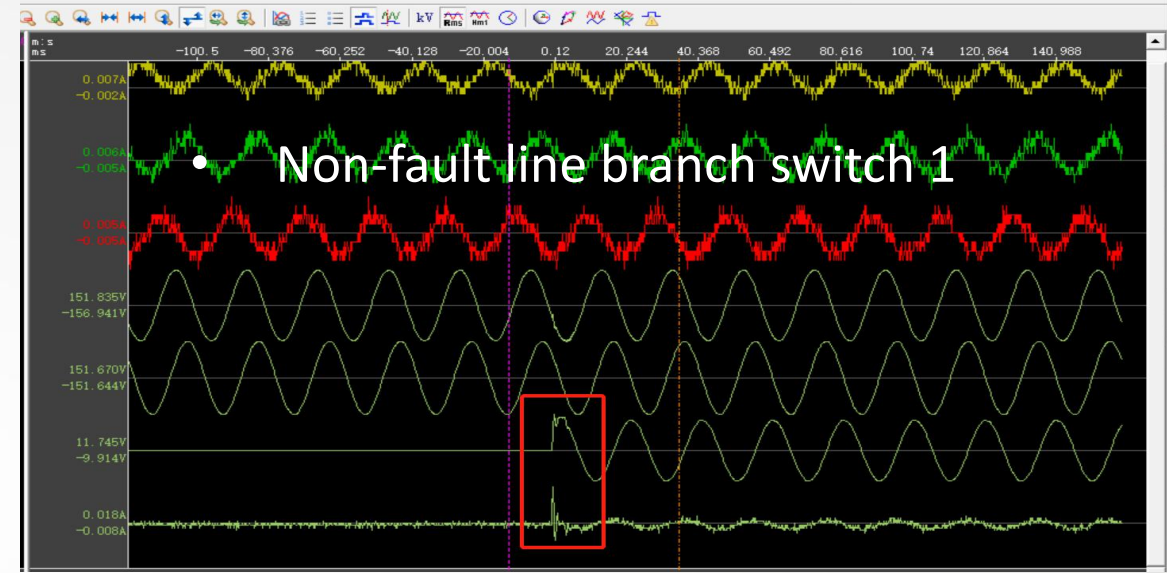
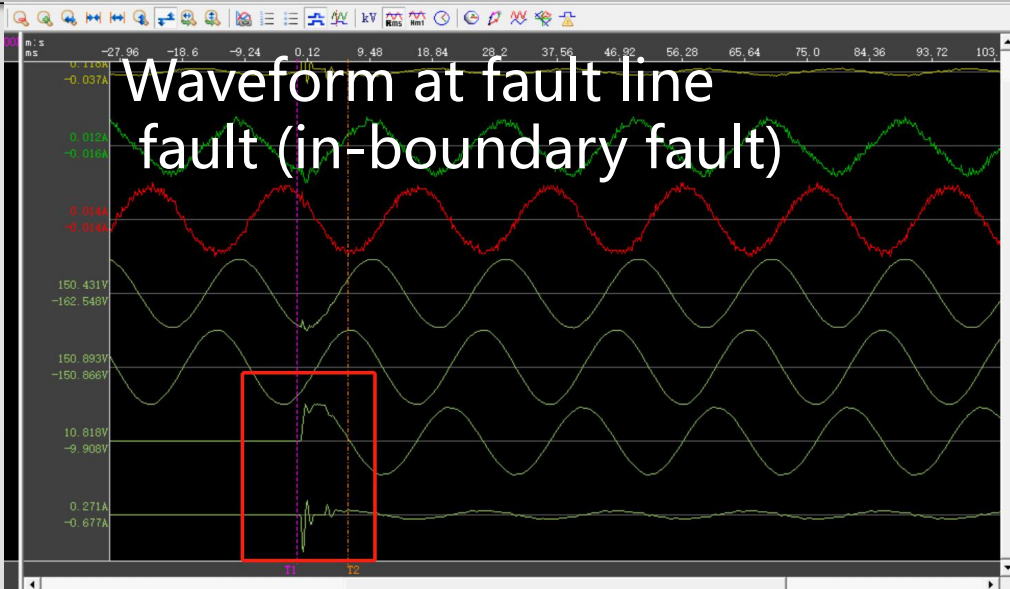
Edge Computing Gateway



# Features

Fault waveforms and non-faulty lines of a certain line; use regional data analysis to more accurately determine the location of the fault.

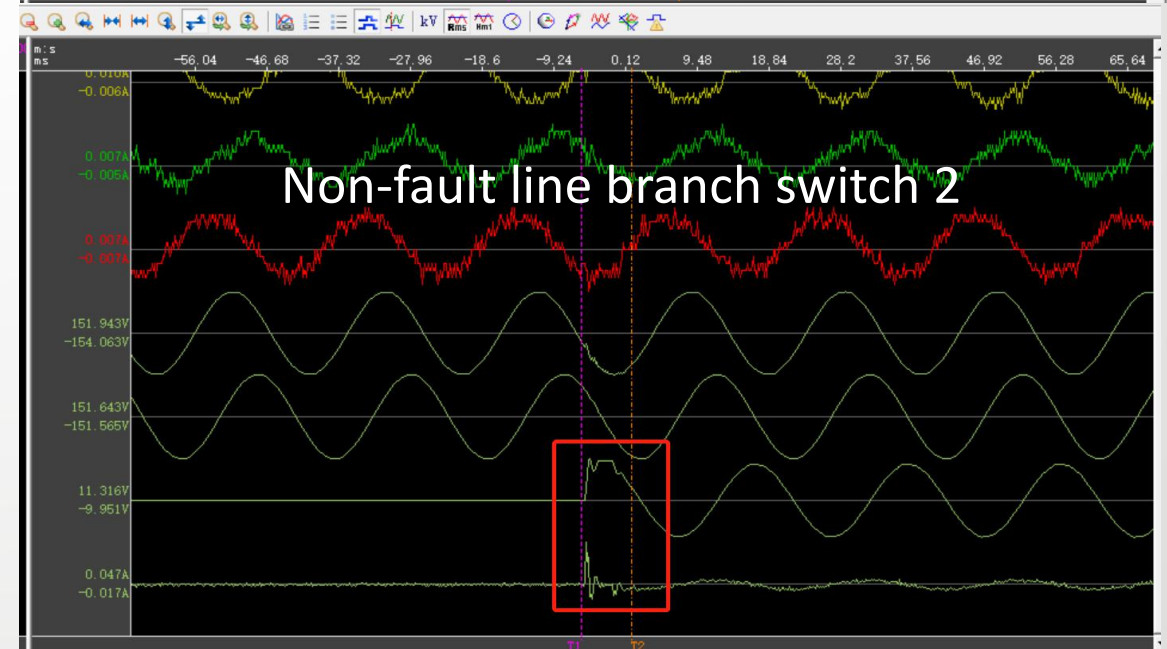
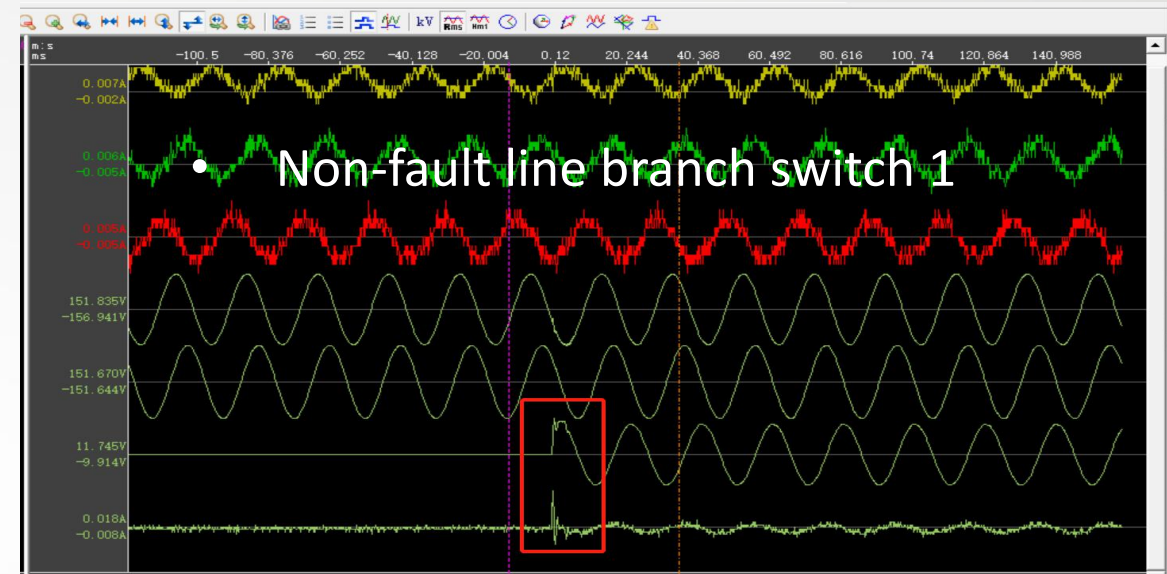
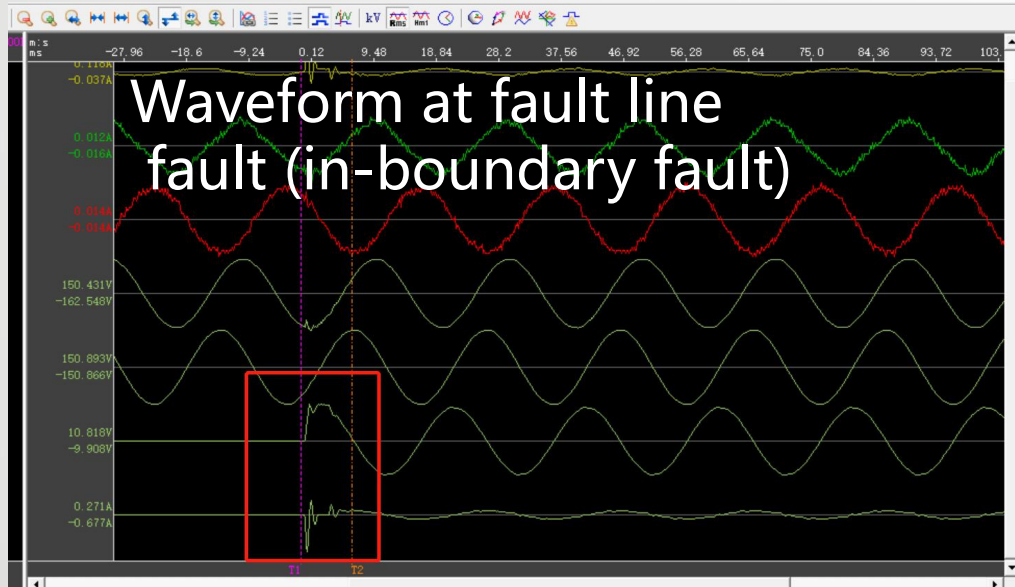
(1) After the zero-sequence voltage of the faulted line is activated, the polarity of the zero-sequence current and the zero-sequence voltage are opposite; for the non-faulty line, the polarity of the zero-sequence current and the zero-sequence voltage are the same;



# Features


Fault waveforms and non-faulty lines of a certain line; use regional data analysis to more accurately determine the location of the fault.

(2) The zero-sequence voltage of the faulty line and the non-faulty line are in phase, the direction of the zero-sequence current is opposite, and the zero-sequence current amplitude of the faulty line is the largest



# Features

The product has passed the RTDS simulation system test and the true type test of the Electric Power Research Institute, with superior performance; The true type detection has passed the high-impedance 4K fault grounding and arc grounding detection.

## 检测报告

CEPRI=2020-DQ-034

样品名称：融合式故障隔离装置、一体化智能终端  
样品型号：ZW32-12(RH)/630-20、ZFTU-2000/3  
检测类别：委托试验  
生产单位：中宝电气有限公司  
委托单位：中宝电气有限公司

中国电力科学研究院有限公司

地址：湖北省武汉市洪山区珞喻路143号，430074    联系电话：027-59258249  
网址：http://www.cpri.cn    监督电话：010-87813486

检测报告	中国电力科学研究院有限公司		CEPRI-2020-DQ-034 共9页 第2页
样品名称	融合式故障隔离装置、一体化智能终端	型号	ZW32-12(RH)/630-20、ZFTU-2000/3
委托单位	中宝电气有限公司	生产单位	中宝电气有限公司
检测项目	1项	样品数量	2套
检测类别	委托试验	试验日期	2020年11月26日
样品编号	样品1: ZB20201102001、F3020201102001 样品2: ZB20201102002、F3020201102002		
检测依据	委托试验服务协议		
检测结论	依据委托试验服务协议的要求，中宝电气有限公司委托开展的单相接地故障真型试验，所检项目结果符合要求。 <p style="text-align: right;">检测结论：通过</p>		
有效期	本报告有效期至2022年11月26日止		
备注			
检测人	[Red Seal] 陈程		
校核	[Red Seal] 陈江波		
批准	[Red Seal] 签发日期：2020年11月27日		

检测报告	中国电力科学研究院有限公司		CEPRI-2020-DQ-034 共9页 第5页
检测条件(二): 网架结构：单辐射，4区10kV馈线； 系统接地方式：中性点经消弧线圈接地，过补偿，故障点残流<10A； 系统感性电流：112A； 故障类型：单相接地故障（经金属接地、经1000Ω、4000Ω过渡电阻接地）。			
检测项目及结果:			
序号	检测项目	检测要求	检测结果
1	经金属单相接地故障	(1) 单相接地故障时，样品动作正确。 (2) 故障馈线的馈线终端样品发出分闸信号，户外高压真空断路器样品分闸。 (3) 非故障馈线的馈线终端样品不发出动作信号，户外高压真空断路器样品不动作。	符合要求
2	经1000Ω过渡电阻单相接地故障	(1) 单相接地故障时，样品动作正确。 (2) 故障馈线的馈线终端样品发出分闸信号，户外高压真空断路器样品分闸。 (3) 非故障馈线的馈线终端样品不发出动作信号，户外高压真空断路器样品不动作。	符合要求
3	经4000Ω过渡电阻单相接地故障	(1) 单相接地故障时，样品动作正确。 (2) 故障馈线的馈线终端样品发出分闸信号，户外高压真空断路器样品分闸。 (3) 非故障馈线的馈线终端样品不发出动作信号，户外高压真空断路器样品不动作。	符合要求
注：检测时，样品单相接地故障前电压突变量：0.216V（二次值）。			



# Case analysis

On-site operation process:

The intersection line and the agate line are the same bus line.

1. If the fault point is not found before 11:38, try to turn on the "Jiaoguan Line Longtai Branch #1 Switch", throw it on the fault, and report the internal fault trip.
2. 12 o'clock-1 o'clock Remove two fault points, one bamboo pole is connected to the high-voltage line, and one bare wire and insulated wire are connected together. After the fault was eliminated, “try to put the switch of Guanxian Longtai branch line #1” again at 13:46, and put it on the fault again and trip again.
3. Remove all the transformers of this branch at 16:00, try to switch on the "Jiaoguan Line Longtai Branch #1 Switch", the closing is successful, and the transformers are turned on one by one, and one transformer is determined to become the fault point.

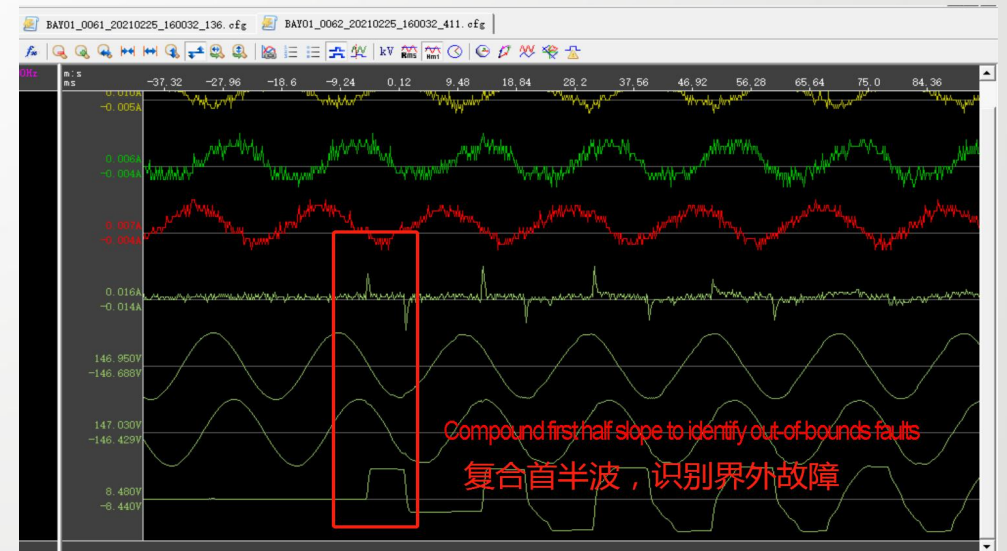
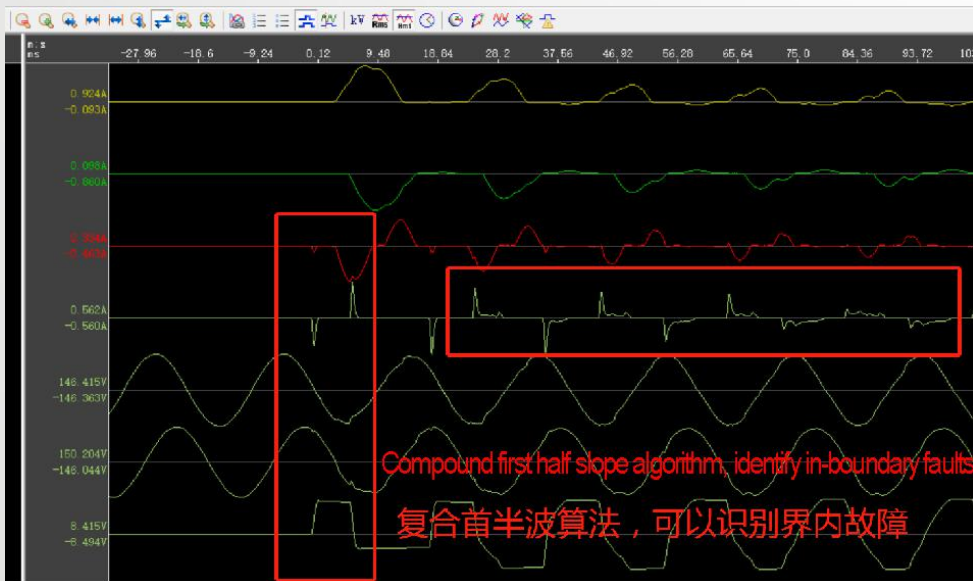
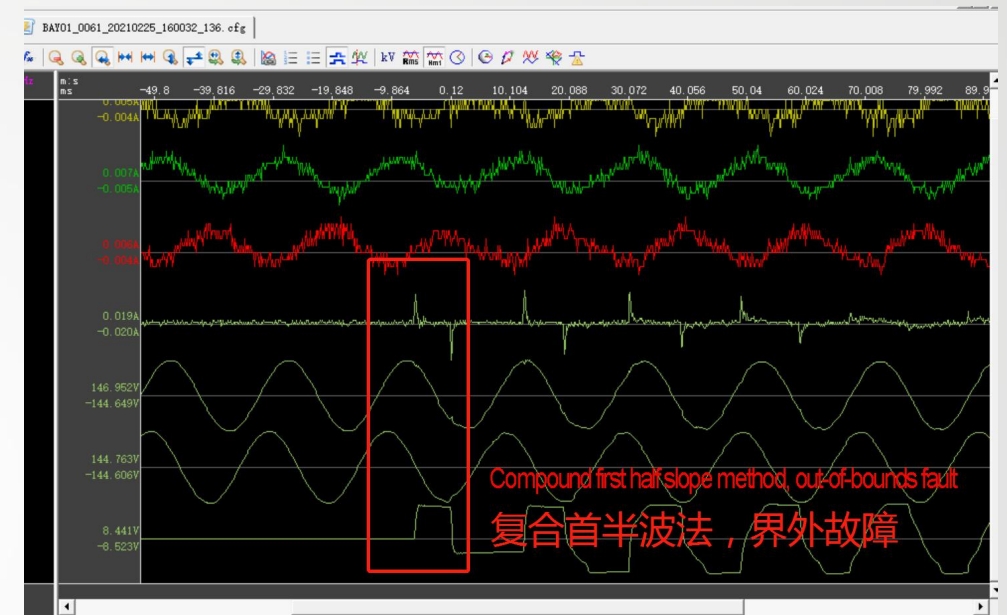
# Case analysis

Time period: 13:46						
Line name	Grounding properties	Zero flow	Zero pressure	Waveform judgment		
Switch 1	In-bound action	3I0=0.492645A	3U0=8.207291V	Correct judgment	Fault line	Ground trip
Switch 2	Owe deputy	3I0=-0.031311A	3U0=-8.120651V	Out-of-bounds judgment is correct		Not tripped
Switch 3	Out-of-bounds action	3I0=-0.014435A	3U0=8.550186V	Out-of-bounds judgment is correct		Not tripped
Switch 4	Runt	3I0=-0.007217A	3U0=-8.157028V	Out-of-bounds judgment is correct		Not tripped
Time period: 16:00						
Line name	Grounding properties	Zero flow	Zero pressure	Waveform judgment		
Switch 1	In-bound grounding at tribute action	3I0=-0.428818A	3U0=-7.871841V	Correct judgment	Fault line	Ground trip
Switch 2	Out-of-bounds action	3I0=0.020477A	3U0=7.818085V	Out-of-bounds judgment is correct		Not tripped
Switch 3	界外动作	3I0=0.015640A	3U0=-8.000580V	Out-of-bounds judgment is correct		Not tripped
Switch 4	界外动作	3I0=0.012039A	3U0=7.828674V	Out-of-bounds judgment is correct		Not tripped

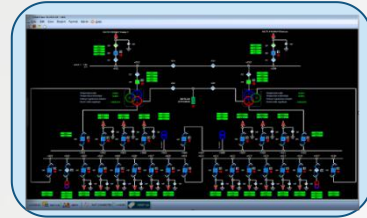
# Case analysis

## Typical waveform for single-phase connection judgment

1. In-situ judgment adopts the compound first half-wave algorithm
2. Edge gateway judgment: the characteristics of faulty lines and non-faulty lines are obvious



# Application solution

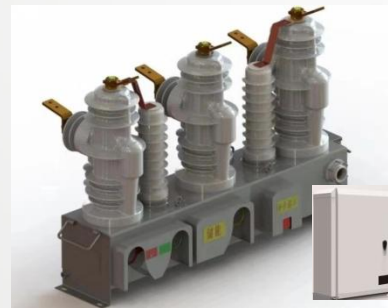
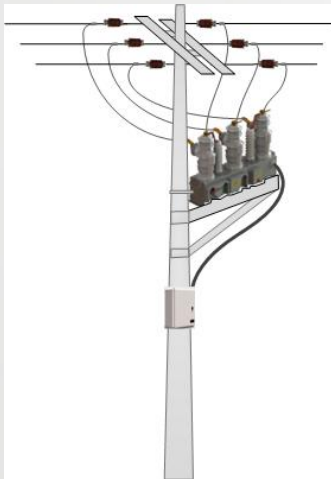


Main power  
distribution  
station

Main site



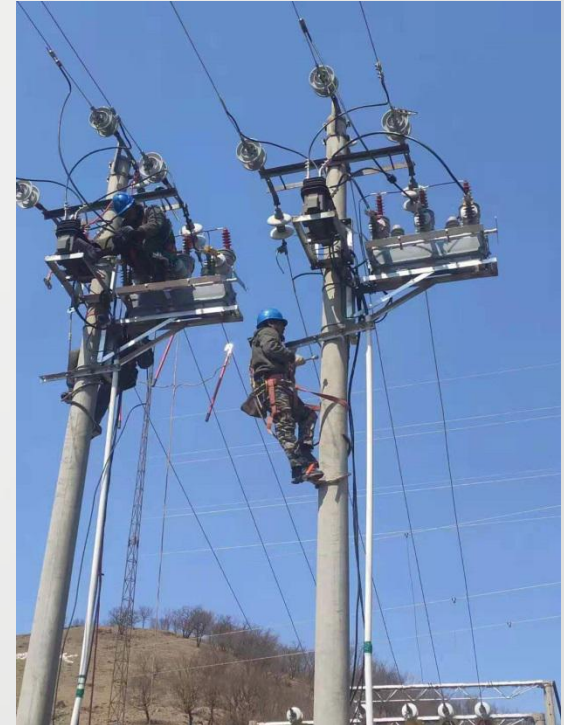
4G/5G Communication



Deep integration of  
smart switches and  
edge computing  
gateways

# Application solution

- Differential protection effectively prevents short-circuit faults from overstepping and reduces power outage area
- Single-phase ground fault search reduced from 6 hours to 1 hour
- The number of personnel has been reduced from 5-6 to 2 people.



# Thank you

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