BEPR- 830 U
Series
Digital Transformer Protection Device
Technical Manual
Operation Manual

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Contents

Part 1

Technical Manual

1 Brief Introduction

BEPR- 830U series digital transformer protection device is complete protection of transformer for 110kV and below voltage levels, providing two harmonic restraint differential protection, switch protection, backup protection fault and reaction phases. The whole device in hardware consists of several independent modules: differential protection unit, the switch quantity protection unit and the backup protection by side configuration unit, each part in the electrical and structure are independent of each other, each side of the backup protection unit at the same time measurement and control function of the side.

The protection device of each electrical protection basic configuration unit is two CPU plug-in, one for protection function unit 32 bit microprocessor, the unit with large capacity RAM and Flash Memory, have extremely strong data processing, logic and information storage capacity; another CPU by bus no chip microcontroller a man-machine interface unit general. Between two CPU plugins are independent of each other, no dependence. A variety of protection and automation functions are realized by the software.

1) Features:

1.use high speed processor is the most popular international, frequency is 166 MHz, with abundant resources, the peripheral circuit design is simple, to ensure product quality and stability. Sufficient hardware resources, 4M byte Flash Memory memory, 8M byte SDRAM.

2. measurement of three phase current (Ia, Ib, Ic), three-phase voltage (Uan, Ubn, Ucn), active power P, reactive power of non Q, power factor cos, frequency F.

3.a maximum of 10 users can input interface custom name.

4.protective element can be set by the trip matrix, is convenient for the user to select the relay action. All relay output contact can be selected for the trip contact (automatic) or signal contacts (return after the return).

5.with operating loop, adaptive 0.5A~5A switch tripping current.

6. when the GPS adopts hard contact pulse pair method.

7.differential protection is to prevent the equipment start or external fault in TA saturation criterion of differential protection malfunction.

8.effective, reliable PT breaking criterion, effectively prevent motor low voltage device malfunction.

9.100M Ethernet communication interface, support for IEC60870-5-103 protocol.

10.9 fault recorder, each record contains the sampling point and the amplitude of wave recording 1.9 seconds, sampling point recorded maximum contains 14 analog (1mS interval), the maximum amplitude wave record contains 40 analog amplitude and 32 switch (5mS interval). Start recording 2 motor (100mS interval), before the start of the 1S, 29S after start of.

11.using the programming technology, graphical and stable reliable protection relay, improve the reliability and validity.

12.the static power consumption is low (about 6W), liquid crystal module adopts new technology, greatly increased service life.

13. high anti-interference performance, through 10 electromagnetic compatibility testing and certification, the anti-jamming performance of fast transient, electrostatic discharge, surge reached the highest level (IV) standard.

14.the working environment temperature range: -25 ℃ ~ ＋55 ℃ (liquid crystal without fuzzy, slow phenomenon).

2) Complete protection function configuration

Table 1 Types and functional configuration of this series products

Function		BEPR- 831U	BEPR- 832U
Differential relay		√	
The two harmoin restaint differential		√	
TA (1) bolt locking differential		√	
Over current protection			√
Negative sequence voltage blocking			√
Zero sequence current			√
Gap flow			√
Clearance overvoltage protection			√
Current start fan			√
The current blocking voltage			√
Overload alarm			
Heavy gas		√	
Reg . Heavy gas		√	
Cooler Failure		√	
Pressure release		√	
light gas		√	
Reg . Light gas		√	
Temp . High		√	
Telecontrol function pressure plate			√
Telemeter	Measurement TA		√
	Protection TA		√
Telesignal		√	√
Telecontrol			√
KWH	Pulse measurement		√
GPS time-checking		√	√
False blocking prevention		√	√
Remote management		√	√

3) Monitoring

- Telemeter:Ia, Ib, Ic, Ua, Ub, Uc, P, Q, f and other analog telemetry
- Telecontrol:Division and the normal remote control circuit breaker
- Telesignal:16way telesignalling open into the volume of the collection, installation of remote signal deformation, events, letters and other remote
- Remote pulse：2-way electric-degree pulse input
- Out: Device has a 13 way out, of which 10 road trip because of the export-driven relay, 3-way signal drive for the notice of police.
- GPS time-checking

2 Technical Parameters

2.1 Rated parameters

2.1.1 Rated D.C. voltage : 220V or 110V (as required)

2.1.2 Rated A. C. data

a) Phase voltage $100/\sqrt{3}$ V

b)Tapped voltage of the line: 100V or $100/\sqrt{3}$ V

c) Rated frequency 50 Hz

2.1.3 Power consumption :

a) D.C circuit normal : not larger than 25W

operation: not larger than 40W

b) A.C voltage circuit not larger than 0.5VA for each phase

c) A.C current circuit not larger than 1VA for each phase (for 5A rating)

not larger than 0.5VA for each phase (for 1A rating)

2.1.4 Status voltage :

Input voltage to CPU and signal interface 24V (18V~ 30V)

Input voltage to GPS time checking 24V (18V ~ 30V)

Output status (optic coupled output) permissive voltage 24V (18V ~ 30V)

driving power 150 mA

2.2 Main technical performance

2.2.1 Operating range for sampling circuits (10% tolerance)

voltage : 0.4V ~120V

current : 0.08In ~ 20In

2.2.2 Contact capacity

current capacity of the signal circuit contact 400VA

arc-breaking capacity of the signal circuit contact 60VA

2.2.3 Tripping and closing current

CB tripping current 0.5A, 1A, 1.5A, 2A, 2.5A, 3A, 3.5A, 4A (as required)

CB closing current 0.5A, 1A, 1.5A, 2A, 2.5A, 3A, 3.5A, 4A (as required)

2.2.4 Precision of elements

current elements <± 5%

voltage element <± 5%

synchronism-check angle: <± 1°

timing element <± 20 ms

frequency deviation: <±0.02Hz

slip rated value: <± 5%

2.2.5 Operating Time of the complete protection (including time needed by relay)

Fixed operating time of the instantaneous zone when measured at 1.2 times of setting value: not longer than 40 ms

2.2.6 Precision of measuring circuits for analog variables monitoring device equipped with the special measurement sub-module :

current, voltage : class 0.2

power, KWH : class 0.5

2.3 Insulation property

2.3.1 Insulation resistance

Insulating resistance between active parts and passive parts or casings and electrically unrelated circuits is measured by the 500 megaohmmeter to be not less than 50MΩ for the various circuits at different levels under the normal test atmospheric conditions.

2.3.2 Strength of insulating media

Under the normal test atmospheric conditions, the protection can withstand the power frequency withstand voltage test of 50 Hz, 2000V and 1 min. without any breakdown flashover and element damages. During the test, as a voltage is applied at any tested circuit, the other circuits are inter connected and grounded with an equivalent potential.

2.3.3 Impact voltage

Under the normal test atmospheric conditions, the short-duration impact voltage test of 1.2 /50 μs standard lightning wave is done on the power input circuits. AC input circuits, output contact circuit to the ground and between circuits. The open test voltage is 5 kV.

2.3.4 Heat and moisture-proof performance

The protection can withstand the heat and moisture-proof test stipulated in the Chapter 20, GB/T 7261. The alternating heat and moisture-proof test is to be done at the highest temperature +40ºC, the maximum humidity 95%, for 48 hrs and at a cycle of 24 hrs. In 2 hrs before the test is finished, according to the requirements in section 2.3.1, the insulation resistance between the conducting circuits and external passive metals and casings and electrically unrelated parts are measured to be not less than 1.5 MΩ, the withstand voltage strength of the media not less than 75% of the voltage magnitude of the media strength test stipulated in the section 2.3.2

2.4 Electromagnetic compatibility properties

2.4.1 Electrostatic discharge anti-interference

The protection conforms to the standard GB/T17626.2-1998, electrostatic discharge anti-interference test class 4

2.4.2 RF electromagnetic field radiation anti-interference

The protection conforms to the standard GB/T17626.3-1998, RF electromagnetic field radiation anti-interference test class 3

2.4.3 Electric fast transient pulse group anti-interference

The protection conforms to the standard GB/T17626.4-1998, electric fast transient pulse group anti-interference test class 4

2.4.4 Surge(impulse) anti-interference

The protection conforms to the standard GB/T17626.5-1998, surge (impulse) anti-interference test class3

2.4.5 RF field induced conduction interference

The protection conforms to the standard GB/T17626.6-1998, RF field induced conduction interference test class 3

2.4.6 Power frequency magnetic field anti-interference

The protection conforms to the standard GB/T17626.8-1998, Power frequency magnetic field anti-interference test class 5

2.4.7 Pulse magnetic field anti-interference

The protection conforms to the standard GB/T 17616.9-1998, Pulse magnetic field anti-interference test class 5

2.4.8 Damp oscillation magnetic field anti-interference

The protection conforms to the standard GB/T 17626.10, damp oscillation magnetic field anti-interference test class 5

2.4.9 Oscillation wave anti-interference

The protection conforms to the standard GB/T 17626.12-1998, Oscillation wave anti-interference test class 4

2.4.10 Radiated emission value limiting test

The protection conforms to the standard GB9254-1998, radiated emission value limiting test class A

2.5 Mechanical performance

2.5.1 Vibration

The protection can withstand the impact duration test of the severity class I stipulated in the section 16.2of GB 7261.

2.5.2 Impact

The protection can withstand the impact duration test of the severity class I stipulated in the section 17.4 of GB 7261.

2.5.3 Crash

The protection can withstand the impact duration test of the severity class I stipulated in the Chapter 18 of GB 7261.

2.6 Environment conditions

a) Ambient temperature :

operation : -20ºC~ +55ºC , less than 35ºC after 24 hours operation

storage : -25ºC ~ +70ºC , no exciting variables are applied at the limit value and no irreversible changes occur. The protection will operate normally after the recovery of temperature.

b) Relative humidity : maximum monthly average humidity 90 % at the lowest temperature of 25ºC, (no condensation). At the highest temperature of +40ºC, maximum humidity must not be over 50 %.

c) Atmospheric pressure : 86 ~ 106 kPa (relative altitude above sea level is less than 2 km).

3 Hardware

High reliability is fully considered both in the overall design and module design. It is reliable in program implementation signal indication and communication. Therefore in the panel-assembling operations or the installation of the protection into the switchboard, no additional AC and DC input anti-interference modules are required.

3.1 Casing structure

On the operation panel, there are the LCD, signal lamps and keyboard. Owing to its enclosed casing, water-proof, dust-free and shock-proof design will ensure its high reliability it even in the worst environmental situations.

3.2 AC modules

AC modules are composed of voltage input and current input modules. The number of the voltage and current input elements varies for the different types of the protections.

The voltage input modules are constructed of the voltage converters, whose input is 100 VAC, output about 3V. The linear range is 0.4V~120V.

The current input modules are constructed of the current converters and parallel-connected resistors. There are three sizes :

1) In=5A : when input is 100A, its output is $5/\sqrt{2}$ V, with 0.2A-100A. linear range
2) In=1A: when input is 20A , its output is $5/\sqrt{2}$ V, with 100mA-20A linear range
3) Ground protective TA: input 5.5A output when the $5/\sqrt{2}$ V, the input linear range 20mA-6A

3.3 CPU module

CPU module is composed of following elements :

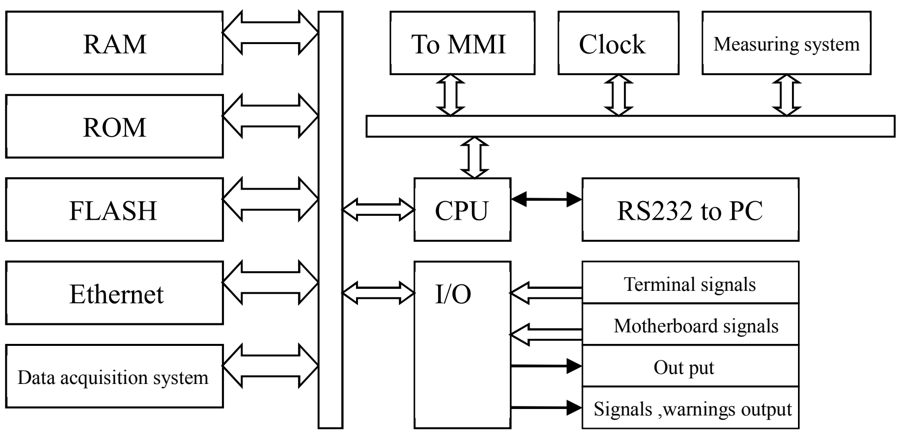

Fig 3-1 Schematic diagram of the CPU module

1) CPU system

The CPU system consists of microprocessor CPU, RAM, ROM, Flash Memory. High performance microprocessor CPU (32), large capacity ROM (1M bytes), RAM (1M bytes) and Flash Memory (1M bytes), the CPU module with data processing and recording ability strong, can realize fault fault data plan and record a lot of processing all kinds of complex. The protection of the C language programming, the program has a very strong reliability, portability and maintainability.

2) Data acquisition system

Data acquisition system is composed of two parts.

One of the data acquisition components is the 14-bit A/D converter with multi- switches and filtering circuits. The latest A/D conversion chip contains the sampling hold and synchronism circuit which features more accurate, higher in speed, and less in power consumption and more stable. No adjustable part is installed and no adjustments are necessary at site and highly reliable.

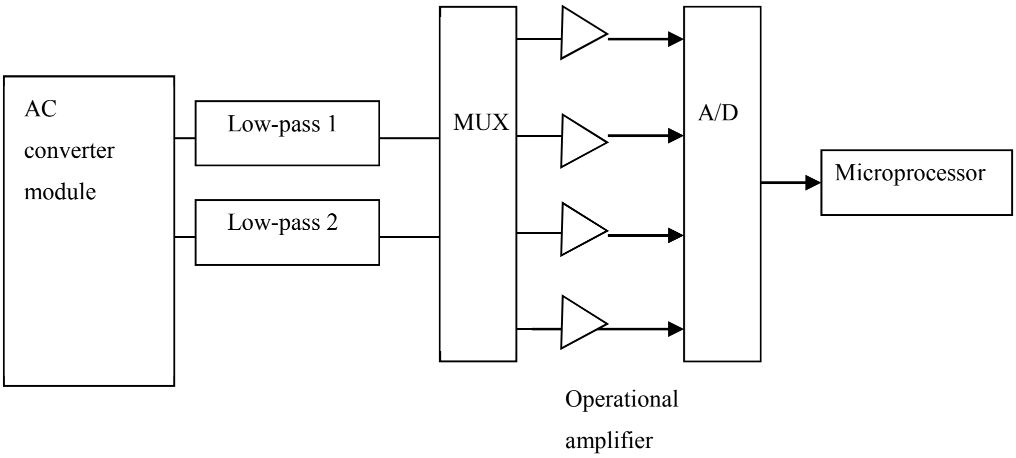

Fig 3-2 Schematic diagram of A / D system

Newly developed high precision 24-bit sample measuring chip is adopted in the measuring system, which eliminates any measuring error caused by fluctuation of frequency without any software. Once the measuring precision is set in a single time, it will automatically get the memory function and it is unnecessary to adjust it at site. This data acquisition system is provided for selection in ordering.

3) Communication

The communication module contains high speed and generally interfaced Ethernet chip which is the main communication interface for the connection of the protection with system. Generally, RJ45 acts as the communication interface UTP5 wire as the media. In the special case, optic fiber communication modules are added as the interface. This nodule is provided for selection and a special order should be tendered.

4) Clock circuit

The hardware clock circuit is set up in the module.

Besides, the CPU module is constructed of the multi-layer PCBs and surface-sealed in technology. It is small and compact in structure. The reliability and anti-interference capability of the protection are thus greatly enhanced. For the principle of the CPU module, refer to the appended diagrams.

3.4 Power supply module

This is a DC inverted power supply module 220V or 110V DC voltage input passing through the anti-interference filtering circuit, is converted into three groups of DC voltage: i.e. 5V, 24V(1) and 24V(2), using the inversion principle. They are not in the common ground mode but in the floating ground mode without any connection with the casing.

a) +5V is used as the CPU power supply

b) 24V (1) is used as the power supply to drive relays

c) 24V (2) is used as the power supply for external switch-in variables.

In order to improve anti-interference ability of the power supply module, filters were added for DC inputs and 24V power supply for the outgoing terminals. For the principle of the power supply module, see the appended diagrams.

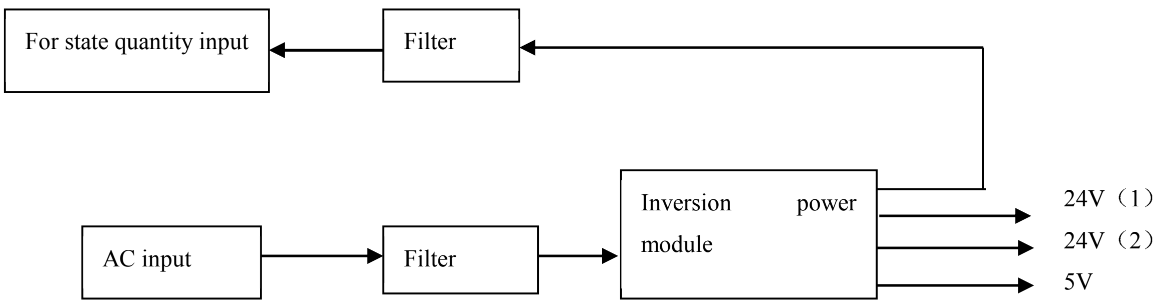

Fig 3-3 Schematic diagram of power supply module

3.5 Man-machine interaction (MMI) module

The man-machine interaction module is a single chip processor with its bus out of core. It is used to display the information from the protection's CPU and scan the key board status and then transmit it to the CPU. So the MMI module is one of its peripherals. The communication between protection's CPU and MMI is made via the SPI interface. It is high in its communication rate (up to 2Mb/s)and quite reliable. This configuration not only frees from the heavily outgoing of the CPU bus to enhance the reliability, but almost does not add the cost to lift the performance-price ratio of the protection.

The display window of the module uses the LCD unit of 4 lines and 12 Chinese characters for each line.

The man-machine interface is clear to see and easy to understand. It is provided with a general keyboard operation for BEPR- series protections to make the MMI feasible and simple. At the same time, in view of the operating features of the LV protection, the sufficient lighting indication facilities are provided to make the operating information more visible. The MMI interface and feasible operating circuit have greatly riched the selection of the operating modes at site.

4 Principle of Protection

Since the 32-bit micro-processors are adopted, the operational speed is greatly increased. In this system, nostarting element is provided and all the computations for the elements are made in real-time, which simplifies protection logic and makes the protection more reliable. There are five output circuits. User's output logic requirements can be satisfied by amending the protection logic diagram. The protection has an operation circuit of its own which is corresponding to the protection output 1. The others only output dead contact. If they are used to separate the circuit breakers, the related external operating mechanism will be required.

4.1 Differential protection

The analogue quantity inputs of BEPR- 565 are the currents I1,I2,I3 from the transformer three sides. The "Y" connection is adopted for the current transformers on the various sides of the transformer.

The adoption of the full "Y" shape connections simplifies the secondary wiring of CTs. And this can not only decrease the secondary burden of the current transformer, but also improve the working performance of the current transformer. And also in this way, the reliability of the current circuit is enhanced.

The balance coefficent of the currents from the various sides are regulated by the software, and therefore ,external auxiliary current transformers for this purpose is not required.

The polarities which are toward the direction of the protection equipment are of the homopolarity end for the polarities of the CT various sides.

For the differential protection, percentage restraint principle and the second harmonic restraint principle are adopted. The CT wire break can block or does not block the differential protection exit.

Any phase differential current: $I_{cl} = | \dot{I}_1 + \dot{I}_2 + \dot{I}_3 |$

Any phase restraint current: $I_{zd} = \max\{ | \dot{I}_1 |, | \dot{I}_2 |, | \dot{I}_3 | \}$

For this protection, the differential current calculation is based on the current which has been balancedly compensated and phase-corrected.

4.1.1 Current Phase Correction

The device requires that the connections of CTs on the various sides of the transformer should be of the "Y" connection, and that the secondary current should directly come into the device.

The phase of the secondary current of the CTs on the various sides of the transformer is corrected by the software according to the wiring connection selection in the device parameter list.

If the connections on the various sides of the transformer are the same, then the phase correction process is not needed.

For example, for a Y0/Y/Δ-12-11 wiring connection transformer, the secondary current phases of Y0 and Y wiring side CT are needed to be corrected. The correcting method is as follows:

$$\dot{I}'_a = (\dot{I}_a - \dot{I}_b);$$

$$\dot{I}'_b = (\dot{I}_b - \dot{I}_c);$$

$$\dot{I}'_c = (\dot{I}_c - \dot{I}_a);$$

Where, $\dot{I}_a$, $\dot{I}_b$ and $\dot{I}_c$ are the secondary currents of Y side CT. $\dot{I}'_a$, $\dot{I}'_b$ and $\dot{I}'_c$ are the corrected currents of the various phases.

Supposing that $\dot{I}_{1a}$, $\dot{I}_{1b}$, $\dot{I}_{1c}$; $\dot{I}_{2a}$, $\dot{I}_{2b}$, $\dot{I}_{2c}$; $\dot{I}_{3a}$, $\dot{I}_{3b}$ and $\dot{I}_{3c}$ are the three phase currents input from the three sides of I1,I2 and I3,then, the three phase differential currents and the three phase restraint currents calculated based the compensation and the phase correction , are as follows:

$$\dot{I}_{acl} = [(\dot{I}_{1a} - \dot{I}_{1b})] + k1 * [(\dot{I}_{2a} - \dot{I}_{2b})] + k2 * \dot{I}_{3a};$$

$$\dot{I}_{bcl} = [(\dot{I}_{1b} - \dot{I}_{1c})] + k1 * [(\dot{I}_{2b} - \dot{I}_{2c})] + k2 * \dot{I}_{3b};$$

$$\dot{I}_{ccl} = [(\dot{I}_{1c} - \dot{I}_{1a})] + k1 * [(\dot{I}_{2c} - \dot{I}_{2a})] + k2 * \dot{I}_{3c};$$

$$\dot{I}_{azd} = \max\{(\dot{I}_{1a} - \dot{I}_{1b}), k1 * (\dot{I}_{2a} - \dot{I}_{2b}), k2 * \dot{I}_{3a}\};$$

$$\dot{I}_{bzd} = \max\{(\dot{I}_{1b} - \dot{I}_{1c}), k1 * (\dot{I}_{2b} - \dot{I}_{2c}), k2 * \dot{I}_{3b}\};$$

$$\dot{I}_{czd} = \max\{(\dot{I}_{1c} - \dot{I}_{1a}), k1 * (\dot{I}_{2c} - \dot{I}_{2a}), k2 * \dot{I}_{3c}\};$$

Where, k1, k2 are respectively the coefficents for I2 side and I3 side；

Balance coefficent 1：k1 = I1n / I2n

Balance coefficent 2：k2 = I1n / I3n

I1n, I2n, I3n are respectively the secondary rated currents of I1,I2 and I3 sides of the transformer.

4.1.2 Instant differential current protection

The differential current quick break protection is used for the same range of the differential protection. It is used to quickly cut off a severe internal fault when it occurs in the differential protection range. The differential current quick break protection is not through the process of restraint judging. If any phase differential current becomes greater than the quick break setting, the protection will exit for tripping.

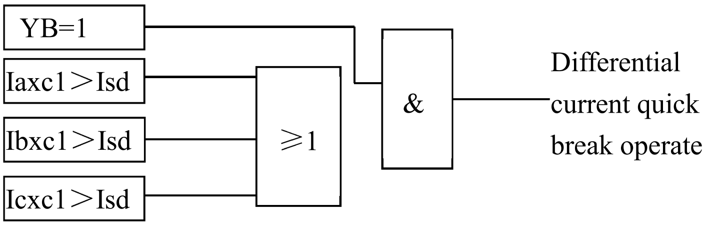

Fig. 1 Logic Diagram For Differential Current Quick Break Protection

In the diagram:

YB=1 indicates that the software connection plate for the differential current quick break protection has enabled.

Isd indicates the setting for the differential current quick break protection.

Iaxcl, Ibxcl and Icxcl are respectively the differential currents of Phase A , Phase B and Phase C.

4.1.3 Ratio differential protection

In order to keep the differential protection stable against a breakthrough fault and prevent the protection from misoperating, the device is furnished with two stages of percentage restraint characteristics. The operation criterions are:

$$I_d = I_{cl} \geqslant I_{set} \qquad (I_{zd} \leqslant I_{Gd})$$

$$I_d = [I_{cl} - k*(I_{zd} - I_{Gd})] \geqslant I_{set} \qquad (I_{zd} > I_{Gd})$$

Where, I_d is the operation current, I_{cl} is the differential current, I_{Gd} is the restraint current knee point setting.

I_{zd} is the restraint current, k is the percentage restraint characteristic slope. I_{set} is the differential protection setting.

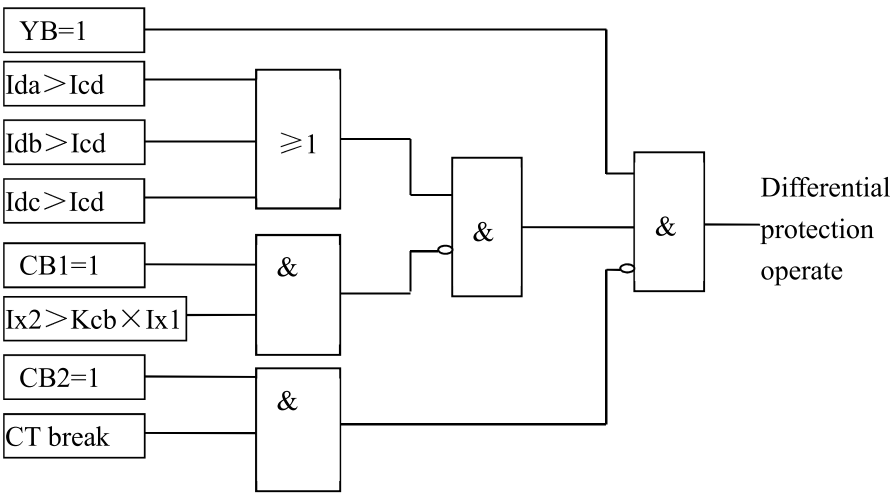

Fig. 2 Logic Diagram for Differential Protection

In the diagram:

YB=1 indicates that the differential protection software connection plate has been enabled.

Ida,Idb and Idc are the operation currents of Phase A, Phase B and Phase C.

Icd is the differential protection setting.

CB1=1 indicates that the second harmonic restraint has been enabled.

CB2=1 indicates that CT wire break blocking differential has been enabled.

4.1.4 Second Harmonic Restraint

When a no-load transformer is put to the power network, or after an outside-zone fault has been cut off and the voltage has been restored to the normal value, a large excitation surge will be produced. In order to prevent the differential protection from misoperating in this condition, the protection is furnished with the function of the second harmonic restraint.

The ratio of the second harmonic component to the fundamental component within the three phase differential currents is used as the excitation surge blocking criterion. The restraint criterion is as follows:

$$I_{x2} \geqslant KCB \times I_{x1}$$

Where, Ix 2 is the second harmonic in the differential current of each phase.

Ix 1 is the fundamental component in the corresponding differential current.

KCB is the second harmonic restraint coefficent.

If only one phase among the three phases satisfies the restraint condition, then the differential protection will be blocked, that is, three phase Or gate restricts the differential protection.

4.1.5 CT Wire Break blocking and alarming

In order to prevent the protection from misoperating due to the CT wire breaking, the device is furnished with the function of CT wire break blocking and alarming. In order to easily judge whether CT wire has broken or not or in order to increase the reliability of the current circuit, the protection requires that all the CTs on the various sides should be in “Y” shape connection.

The device only considers one phase wire breaking condition.

When a load current is greater than 0.2 times the reference side secondary rated current, the CB wire break alarm function will be started.

On normal conditions, the currents of all phases are checked. When only one phase has no current, then CT wire break of this phase is regarded.

When the differential protection picks up, one phase among the three phases on a certain side has no current, and also the three phase currents on other sides have no changes. In this case, the CT wire breaking is regarded. Then the CT wire breaking alarm will be sent out.

When CT secondary side wire breaks, an alarm signal can also be sent out. Here you can use the control word to select whether to block or not block the differential protection exit.

On normal conditions, the differential currents of the various phases are supervised. If any phase differential current becomes greater than the out-of-limit setting, then via a time delay, the differential current out-of-limit alarm will be sent out.

4.2 Non-electric quantity protection

This protection must be coordinated with the optic-controlled relay. The non-electric quantity contacts from the transformer proper are converted into the 24V signals and the signals are output to the switching variable input terminals of the protection. As the non-electric quantity signals are received, it is up to the soft pressure plates to decide whether to trip or not. If the soft pressure plates are out of service, then only the alarm signals will be sent out, otherwise the related breakers will be simultaneously tripped. As the protection trips and the alarm signals are sent, the event recording will be done and the records can be upstream transmitted to the background computer via MMI.

4.3 Three Stages Compound Voltage Blocking Direction Over Current Protection

The device is furnished with three stages of definite time compound voltage blocking direction over current protections. For all the three stages, a same one compound voltage blocking element is adopted.

Both the negative-sequence voltage setting and the under voltage setting in the compound voltage blocking element can be set separately. They can be enabled or disabled by the control word.

The various line voltages which the device needs are derived by calculating based on the input phase voltages.

The negative -sequence voltage on the local side is calculated based on U2= (Ua + α 2 Ub + α Uc) /3 . The under voltage is derived by calculating Uab.

When the local side negative -sequence voltage is greater than the setting or the under voltage is less than the setting, the local side compound voltage element picks up to permit the various stages of direction over current elements to pick up.

If any phase current among the three phases exceeds the setting of any zone, and the operation conditions for the direction element and the compound voltage element are satisfied, then the time delay of the corresponding zone will be started. When the time delay expires, the protection will operate to trip and send the corresponding messages to the background computer.

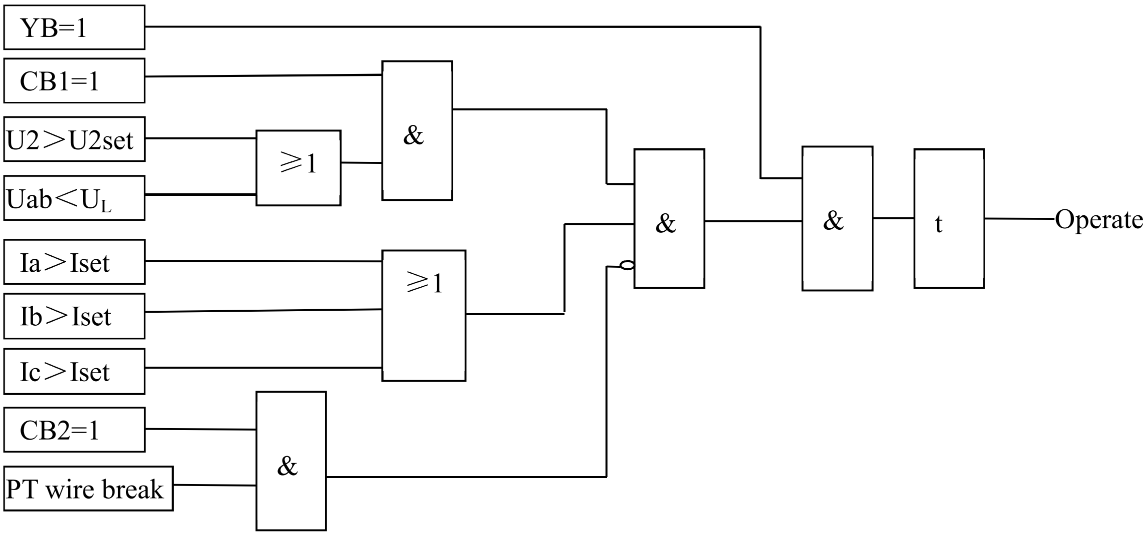

Fig. 3 Logic Diagram for Compound Voltage Blocking Direction Over Current

In the diagram:

YB=1 indicates that the software connection plate for a certain zone of over current protection has been enabled.

CB1=1 indicates that the compound voltage blocking has been enabled.

CB2=1 indicates that the PT wire break has been enabled.

U2 is the negative sequence voltage.

U2set is the negative sequence voltage setting.

Uab is the line voltage, UL is the under voltage setting.

t indicates the time delay of a certain zone. Iset indicates the setting of a certain zone of over current.

4.4 Two Stage Zero-sequence Current Protection

The device is furnished with two stages of zero-sequence over current protections. Each zone has two time delays. The zero-sequence current is taken from the transformer neutral line zero-sequence current.

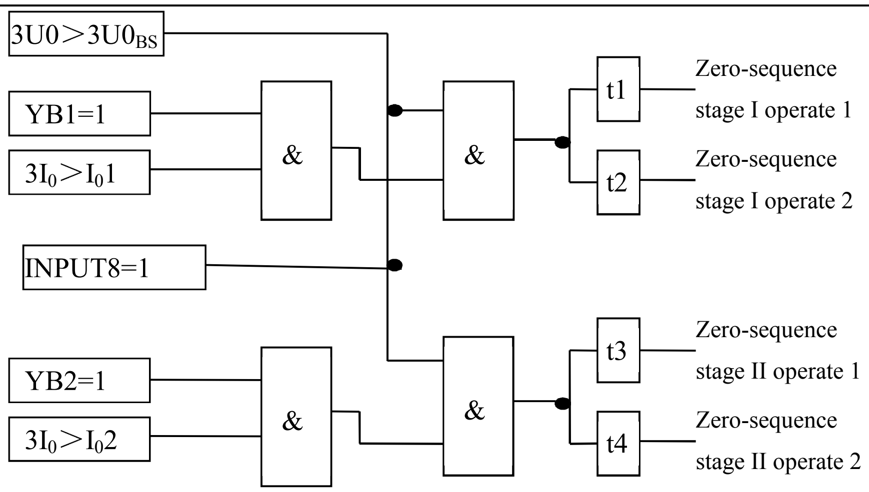

Fig.4 Logic Diagram for Two Stage Zero-Sequence Current Protection

In the diagram:

YB1=1 and YB2=1 indicate respectively that the software connection plates for zero-sequence zone I and zone II have been enabled.

3Io is the neutral line zero-sequence current.

Io1 and Io2 are respectively the settings for the two stages of zero-sequence current protections.

4.5Gap protection element

Transformer neutral point grounding through gap grounding protection based on zero sequence current relay and zero sequence voltage relay in parallel mode, the delay tripping. When grounding fault occurs, a zero sequence current in the discharge gap, the special zero sequence current transformer in the discharge gap grounding end of the zero sequence current relay; if the discharge gap does not discharge, is the use of zero sequence voltage relay. When intermittent arc grounding, protection gap time element shared shall not return, in orderto ensure reliable action gap grounding protection.

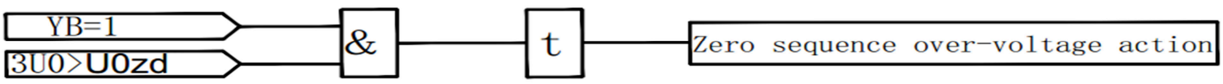

Fig. 5 clearance overvoltage protection logic diagram

3U0 is the zero sequence voltage, fixed from the side open delta voltage; constant voltage gap zero sequence overvoltage. Due to the adoption of voltage transformer dedicated, the linear range of zero sequence voltage can reach 300V.

Gap zero sequence overcurrent protection.

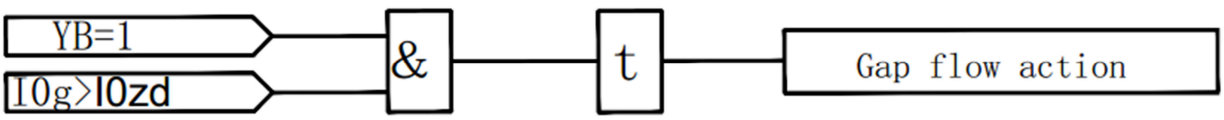

Fig. 6 gap over-current protection logic diagram

Among them, $I0g$ as the gap of zero sequence current, from the side of the neutral point gap CT; $I0zd$ constant current flow through the clearance for the zero sequence.

Protection by the gap zero sequence overvoltage element and the gap zero sequence overcurrent element connected in parallel, the delay in export.

4.6 Overload device

When any phase current among the three phases exceeds the setting over load protection, the time delay of the protection will be started. When the time delay expires, operation will be performed.

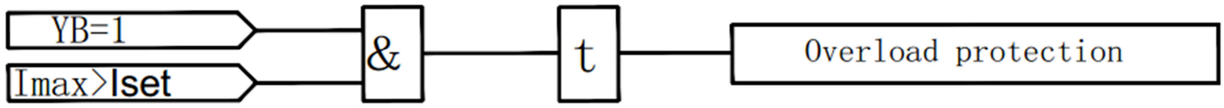

Fig.6 Logic Diagram for Over Load Protection

In the diagram:YB=1 indicates that the software connection plate for a certain zone of over load protection has been enabled.

Imax is the maximal current among the three phase currents.

Iset is the setting for a certain zone of over load protection.

t is the time delay setting for a certain zone of over load protection.

4.7 start the ventilation element

When any phase of three-phase current over load current exceeds the set value, when the delay to meet the after action.

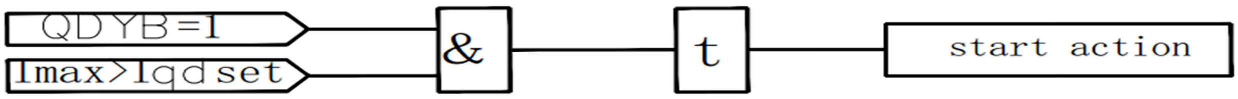

Fig. 8 start ventilation logic diagram

Map: QDYB=1 said start ventilation protective soft pressing plate T input, for the start of the ventilation time delay value;

Imax is the largest three-phase current, Iqdset to start the ventilation value.

4.8 The locking element of pressure regulator

When any phase of three-phase current over load current exceeds the set value, when the delay to meet the after action.

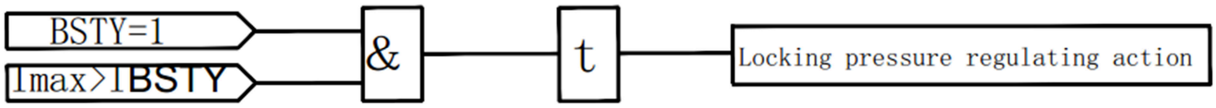

Fig. 9 blocking voltage logic diagram

Map: BSTY=1 said blocking voltage protective soft pressing plate T input, for locking adjustable rolling set values;

Imax is the largest three-phase current, IBSTY blocking voltage protection value.

4.9 TV wire break detection

When one of the following conditions occurs, the alarm lamp will be lit and the information "TV wire break" will be sent :

1. All the three phase voltages are lower than 8V, one of the phase current (phase a or c) is higher than 0.25A, it is the three phase loss of voltage.
2. When the sum of the three phase voltages is larger than 8V, and the minimum line voltage is lower than 16V, the condition is a two-phase TV wire break.
3. When the sum of the three phase voltage is larger than 8V, and the difference between the maximum and the minimum line voltage is greater than 16V, the condition is a single phase TV wire break.

When the TV wire break is detected, the low voltage element is withdrawn. The in-service or out of service of the function of TV wire break detection can be performed by the control characters "self-detection of analog variables summation".

4.10 Data recording

This protection can perform the fault recording function. The analog variables that can be recorded are : Ia, Ib, Ic, 3Ioj, Ua, Ub, Uc, 3Ioh, and the status variable CB position, tripping and closing commands of the protection.

To avoid storing too much unnecessary data during the frequent startings caused by system disturbances, the necessary recorded data will only be recorded in the Flash RAM (hold for loss of power) after the protection operates, otherwise, these data will be stored in the RAM, (no hold for loss of power).

8 to 50 reports can be recorded and can be read by PC, and no less than 1000 events can be recorded. These data will be stored in FLASH RAM. Besides the system disturbance data, the operating events, status input change event, setting change events and alarm events can also be recorded.

5 Rated Values and Setting Descriptions

5.1 BEPR- 831U

1) List of the rated values for the BEPR- 831U Digital Transformer differential Protection and setting

descriptions

Ser. No	Names of rated values	Range	Unit	Remarks
1	Control character 1	0000~FFFF	none	See the descriptions for control character 1
2	Control character 2	0000~FFFF	none	Stand by
3	Rated current of high side	0.2～15.0	A	
4	Rated current of middle side	0.2～15.0	A	
5	Rated current of low side	0.2～15.0	A	
6	Differential quick break current	0.02～100.0	A	
7	Differential protection current	0.02～40.0	A	
8	Restraint inflection current	0.10～10.0	A	
9	Differential restraint coefficient	0.00～1.00	none	
10	Second harmonics restraint coefficient	0.01～0.50	none	
11	Cooler fault trip time	0～9000	s	
12	Pressure release trip time	0～9000	s	

control character 1

Bit	Meanings for 1	Meanings for 0
15	Standby	Standby
14	Y/Y/△connection	Y/△/△connection
13	Standby	Standby
12	Standby	Standby
11	Standby	Standby
10	Standby	Standby
9	Standby	Standby
8	Standby	Standby
7	Standby	Standby
6	Ultra high temperature tripping investment	Ultra high temperature tripping out
5	Pressure release on	Pressure release off
4	Regulator heavy gas trip	Regulator heavy gas alarm
3	Heavy gas trip	Heavy gas alarm
2	Second harmonic restraint on	Second harmonic restraint off
1	TA break blocking differential	TA break only alarm
0	Cooler trip on	Cooler trip off

Setting Principle

(1) Rate Current Calculation For Transformer Various Sides：

$$In = Sn / \sqrt{3}\ Ue$$

Where, Sn is the transformer maximal rated capacity. in KVA

Un is the rated voltages of the transformer various sides. in KV

(2) Calculated rated current taking into consideration of CT connection coefficient will still be used as rated current for differential protection at each side of the device.

Ie = Kjx×In/Klh

Where： Klh——CT transformation ratio

Kjx——Transformer connection coefficient. Y side of transformer is $\sqrt{3}$, Δ side is 1.

For example:

Given that transformer parameter is:

Main transformer capacity Sn＝20MVA，rated voltage 35±4×2.5%/10.5kV，connection group class Y/Δ-11，CT rated secondary value is 5A。

Names	Values at various sides	
Rated voltage（kV）	35	10.5
Rated current（A）	20000/($\sqrt{3}$ ×35)＝329.9	20000/($\sqrt{3}$ ×10.5)＝1099.7
CT connection method	Y	Y
CT transformation ratio selected	600/5=120	1200/5=240
Rated calculated current （A）	$\sqrt{3}$ ×329.9/120＝4.76	1099.7/240=4.58

（3）Enabling value of ratio differential element will normally use 30%～50% of "HV side calculated rated current".

（4）Percentage differential inflection point in general to take 1.0 times of "HV side calculated rated current".

（5）Approximately 0.3～0.7 will usually be used for ratio restraint coefficient.

（6）Normally a value between 0.10～0.3 can be used for secondary harmonic restraint coefficient.

（7）Instant differential element shall be set up to be away from unbalanced current caused by excitation inrush at closing of transformer in case of most serious external fault etc.

2）**List of soft pressure plates in the BEPR- 831U Digital Transformer Differential Protection:**

Names	Functions
Diff. Qu. Brk	Differential quick break protection function switched on/off
Diff.	Differential protection function switched on/off
TA circt. brk	Always on state
Heavy gas	Heavy gas function switched on/off
Reg. Heavy gas	Regulator heavy gas function switched on/off
Cooler fault	Cooler fault function switched on/off
Pressure release	Pressure release function switched on/off
Light gas	Light gas function switched on/off
Reg. Light gas	Regulator light gas function switched on/off
High oil T	High oil temperature function switched on/off

When the corresponding software connection plate is enabled, the various settings can be effective. The “TV break off” plate should be switched on.

5.2 BEPR- 832U

1) List of the rated values for the BEPR- 832U Digital Transformer Backup Protection and setting descriptions :

No.	Names	Range	Unit	Remarks
1	Control character 1	0000~FFFF	none	See the descriptions for control character
2	Control character 2	0000~FFFF	none	See the descriptions for control character
3	Current zone I	0.2～100.0	A	
4	Current zone II	0.2～100.0	A	
5	Current zone III	0.2～100.0	A	
6	Time for current zone I	0.0～20.00	s	
7	Time for current zone II	0.0～20.00	s	
8	Time for current zone III	0.0～20.00	s	
9	Current I export	0000～003F		
10	Current II export	0000～003F		
11	Current III export	0000～003F		
12	Lower voltage	1.0～120.0	V	Line voltage
13	Negative sequence overvoltage	1.0～120.0	V	
14	Zero-sequence overvoltage	1.0～120.0	V	
15	Zero-sequence overcurrent I	0.2～100.0	A	
16	Zero-sequence overcurrent time 1	0.0～20.00	s	
17	Zero-sequence overcurrent time 2	0.0～20.00	s	
18	Zero flow t1 export	0000～003F		
19	Zero flow t2 export	0000～003F		
20	Zero-sequence overcurrent II	0.2～100.0	A	
21	Zero-sequence overcurrent time 3	0.0～20.00	s	
22	Zero-sequence overcurrent time 4	0.0～20.00	s	
23	Zero flow t3 export	0000～003		
24	Zero flow t4 export	0000～003		
25	Gap overcurrent	0.2～100.0	A	
26	Time for gap overcurrent	0.0～20.00	s	
27	Clearance outlet way	0000～003F		
28	Gap overvoltage	0.0～300.0	V	
29	Time for gap overvoltage	0.0～20.00	s	
30	Overvoltage export clearance	0000～003F		
31	Overload current	0.2～100.0	A	
32	Time for overload current	0.0～100.00	s	
33	Startup BUF current	0.2～100.0	A	

No.	Names	Range	Unit	Remarks
34	Startup BUF current delay	0.0～100.00	s	
35	Atresia adjust voltage current	0.2～100.0	A	
36	Atresia adjust voltage current delay	0.0～100.00	s	
37	TA ratio(kA/A)	0.01～10.0	none	Primary protection, TA ratio/1000
38	TV ratio(KV/V)	0.01～10.0	none	Primary TV ratio/1000

Definition of control character 1 :

Bit	Meaning of set to 1	Meaning of set to 0
15	Summation of analog variable and in-service of self-detection	Summation of analog variables and out of service of self-detection
14	TA rated current 1 A	TA rated current 5 A
13	Zero-sequence overcurrent time 4 switched on	Zero-sequence overcurrent time 4 switched off
12	Zero-sequence overcurrent time 3 switched on	Zero-sequence overcurrent time 3 switched off
11	Zero-sequence overcurrent time 2 switched on	Zero-sequence overcurrent time 2 switched off
10	Zero-sequence overcurrent time 1 switched on	Zero-sequence overcurrent time 1 switched off
9	Complex voltage outlet switched on	Complex voltage outlet switched off
8	Control circuit off switched on	Control circuit off switched off
7	Standby	Standby
6	Complex voltage select the local side	Complex voltage select local side or the opposite
5	Low voltage blocking zone I switched on	Low voltage blocking zone I switched off
4	Low voltage blocking zone II switched on	Low voltage blocking zone II switched off
3	Low voltage blocking zone III switched on	Low voltage blocking zone III switched off
2	Negative sequence overvoltage blocking zone I switched on	Negative sequence overvoltage blocking zone I switched off
1	Negative sequence overvoltage blocking zone II switched on	Negative sequence overvoltage blocking zone II switched off
0	Negative sequence overvoltage blocking zone III switched on	Negative sequence overvoltage blocking zone III switched off
0		

2) List of soft pressure plates in the BEPR- 832U Digital Transformer Backup Protection:

Names	Functions
Current zone I	Current zone I switched function switched on/off
Current zone II	Current zone II switched function switched on/off
Current zone III	Current zone III switched function switched on/off
Overload	Overload switched function switched on/off
Startup BUF	Startup BUF function switched on/off
Atresia adjust voltage	Atresia adjust voltage current function switched on/off
Zero-sequence overcurrent I	Zero-sequence overcurrent I function switched on/off
Zero-sequence overcurrent II	Zero-sequence overcurrent II function switched on/off
Gap zero-sequence overcurrent	Gap zero-sequence overcurrent function switched on/off
Gap zero-sequence overvoltage	Gap zero-sequence overvoltage function switched on/off