BEPR- 560U
Generator Protection Device
Technical Manual

Contents

1 Introduction to Device

BEPR- 560U generator protection device is designed specifically for small sized generators.

The device has the following features:

Function	BEPR-561U	BEPR-562U
Differential protection	√	
Transverse Differential Protection	√	
Overvoltage protection	√	
Rotatorone-point ground protection	√	
Rotator two-point ground protection	√	
3I0 Generator stator ground protection	√	
Non-electric signal protection	√	
Excitation-loss protection		√
Compound voltage lockout overcurrent protection		√
Negative sequence current protection		√
Generator stator ground protection		√
Reverse power protection		√
Low frequency protection		√
Over frequency protection		√
Overload protection		√
TA and TV wire protection		√

USES the international most popular fast processors, frequency is 166 MHz, the built-in rich resources, simple peripheral circuit design, ensure the manufacturing quality and stability of the product. Sufficient hardware resources, 4 MB Flash Memory storage, 8 MB SDRAM.

Measure three phase current (Ia, Ib, Ic), three phase voltage (Uan, Ubn, Ucn), active power P and reactive power Q, power factor cos phi, frequency F.

Most 10 road input intake interface which users can customize name.

Protection components's outlet style by trip matrix setting, convenient for users to choose to the action of the relay. All relay output interface can choose for the tripping contact (to be automatic return) or signal contact (return back).

Oneself take operation can be adaptive 0.5 A ~ 5 A jump switching current switch.

The style of GPS clock Correction time uses hard contact points of pulse pair.

Differential protection is a criterion to prevent the equipment start or outside a failure of the

criterion of TA saturation cause the differential protection misoperation.

Effective and reliable criterion PT wire break, effectively prevent the motor's low voltage components misoperation.

100 M Ethernet communication interface, supports IEC60870-5-103 specifications.

9 of the fault wave record, each wave record contains 1.9 seconds sample point and amplitude wave record, the sampling point wave record largest contains 14 road simulation (interval is 1 ms), amplitude wave record largest contains 40 analog amplitude and 32 switch for 5 ms (interval). Article 2 the motor start wave record (interval is 100 ms), before the start of the 1 s, started 29 s.

Using the graphical programming technology, as well as a stable and reliable protection relay library, improve the reliability and validity of the program.

The machine static low power consumption (about 6 w), LCD module to adopt new technology, life is greatly improved.

High anti-jamming performance, through 10 emc certification testing, transient, electrostatic discharge, surge anti-jamming performance achieves the highest grade (grade Ⅳ) standard.

working environment temperature range: 25 ℃ ~+ 55 ℃ (LCD no vague, dull phenomenon).

2 Hardware Configuration of the Device

With an aim to executing the above functions in a set of hardware system and taking flexibility and adaptability of the device into consideration, modular design is conducted for the device. The device is composed of the following modules:

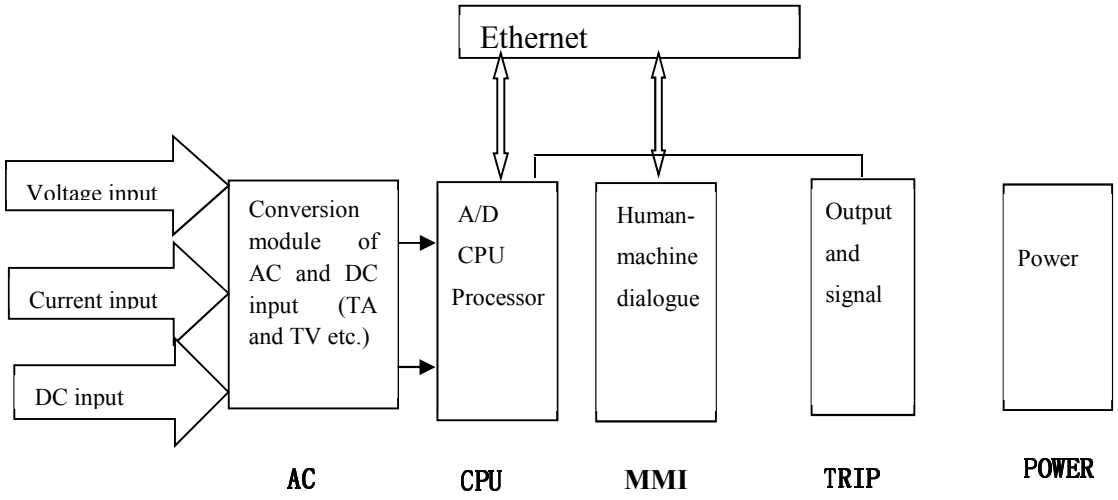


Figure 2-1: Hardware of NSC 560U generator protection device

2.1 AC and DC input module (AC/DC)

Three kinds of converting circuits are set according to different types of input signals.

AC voltage: set isolation conversion of intermediate transformer, such as extreme voltage of generator and high-tension side voltage of main transformer etc.

AC current: set isolation conversion of intermediat converter and obtain voltage at secondary side parallel resistance. 1A and 5A converters are selected and secondary resistance is changed to meet the requirement of measurement ranges of different currents, such as extreme current of generator and neutral point current etc.

DC voltage and current: set advanced isolated conversion of hall sensor, such as rotator voltage of generator and diverter voltage of rotator.

2.2 Host processing module (CPU)

All analogs resulting from conversion by AC and DC input modules can effectively filter out signals within pass band through active filter with lowpass filtering and bandpass filtering to meet filtering requirements of different frequency signals and achieve less than 1% of attenuation of fundamental wave, and concurrently attenuation ratio and phase shift of analogs of all channels can reach good consistency.

Central processing unit (CPU) is composed of A/D conversion, state quantity input, state quantity output (used for pulse output of trip and close, alarm signal output, opening of block relay and other signal outputs), microprocessor CPU, RAM, ROM, FLASH RAM and EEPROM. High performance microprocessor CPU (32-bit), large capacity ROM (256K bytes), RAM(256K bytes) and FLASH RAM (1M bytes) enable the CPU module to have strong data processing and recording capacity and achieve various complex fault handling schemes and record a lot of fault data. C language programming can enable the program to have strong reliability, portability and

maintainability.

All parts relevant to CPU are concentrated in a plug-in unit and all input and output state quantities go through photoelectric coupling isolation. If the parts in this module are in abnormal conditions, then main processor drives block relay and cuts off OPS at photoelectric coupling output side of state quantity output. Auxiliary processor drives the above block relay when main processor is in abnormal conditions. Block relay will not be reset unless it is powered down. Mutual monitoring of dual processors ensures operation reliability of the device.

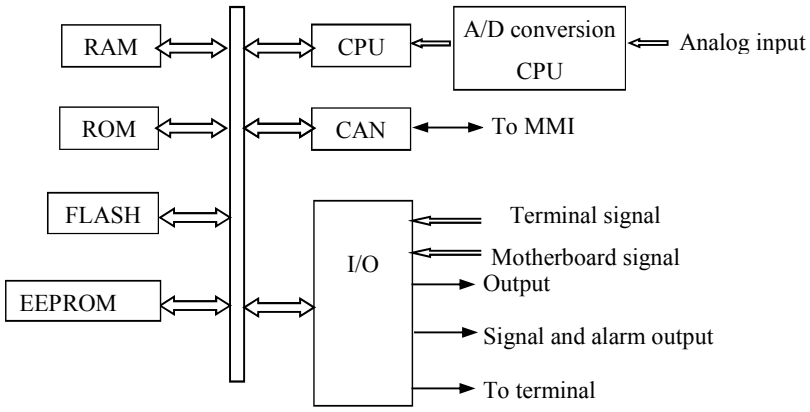


Figure 2-2 Schematic diagram of CPU module

The terminals of CPU module are used to connect in strap, dedicated input signal, output signal and position signal required by the CPU.

Analog/data conversion (A/D) uses 14-bit high accuracy, high stability, high speed and multi-channel concurrent conversion unit whose precision working current can reach 0.04In and precision working voltage can reach 0.2V to enhance measuring accuracy and speed. All analogs can effectively filter out, through lowpass filtering, higher harmonic wave and achieve less than 1% of attenuation of fundamental wave and attenuation ratio and phase shift of analogs of all channels can reach good consistency.

2.3 Human-machine module (MMI) module

Human-machine module (MMI) is installed in the rear of the whole panel of the device. The module includes microprocessor (32-bit), large capacity ROM (512K bytes), RAM (1M bytes), FLASH RAM (1M bytes), EEPROM, input and output state quantity, communication control unit, clock, LCD with big screen (240×128), full screen operating keyboard and signal indicating lamp etc.

The module is mainly used for human-machine interface management. Its main functions include keyboard operation, management of liquid crystal display, printing, signal lamp indication, communication with debug computer, monitoring system of transformer substation or remote safety automated device, GPS time calibration (minute/second pulse time) and information information with main CPU.

The communication with all CPUs uses CAN and the communication rate is 100Kbps, which

breaks through the bottleneck of internal communication of the device and enhances internal information transmission rate of the device.

External communication has three ports, with one being set on the panel and two being set on the back panel of communication interface module (COM panel). RS232 serial port on the panel is used to be connected with PC. Two communication ports on the back panel of communication interface module can be set as different physical interfaces as required.

Ethernet interface and optical fiber interface etc. are set up on the back panel to meet the needs of different automatic system when the device connects in the plant and station automatic systems. The port on the back panel can be set as RS232 interface (used to drive serial printer) or RS422/485 interface (it is used to communication with engineer station or for centralized printing).

Communication specification adopts IEC870-5-103 specification.

Electronic schematic of Human-machine module (MMI) is shown in Figure 2-3:

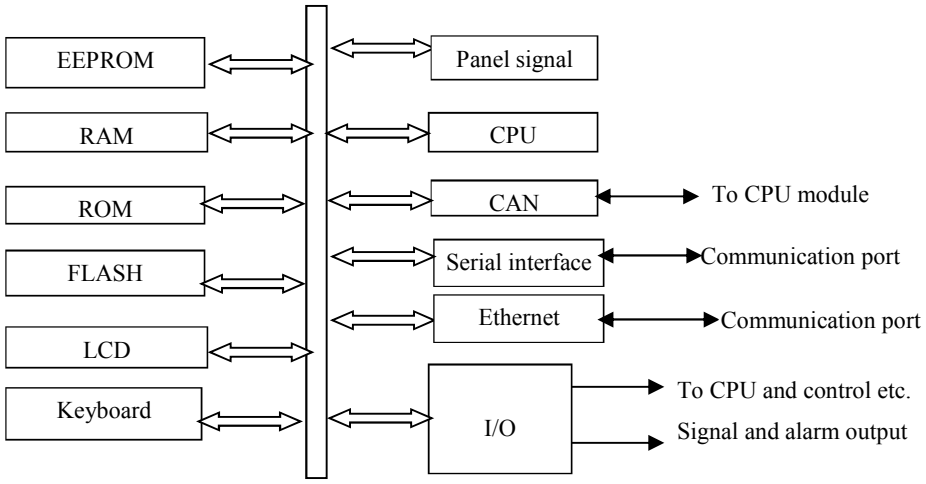


Figure 2-3 Electronic schematic of MMI module

2.4 Output and signal module (TRIP)

This module interfaces with the commands sent by CPU module and provides device actions and alarm signals which can be transmitted to either signal lamp on the panel or central signal device. Each unit is equipped with a set of three-phase operation circuit. Device can adaptive tripping current, without on-site adjustment.

2.5 Power module (POWER)

This module is used for convert the DC of the substation or power plant in power to the operation of the dc power what device need. This module output voltage one road 5 V and two road 24 V . Various power are independent of each other, not together.

Pover module schematic diagram is as follows：

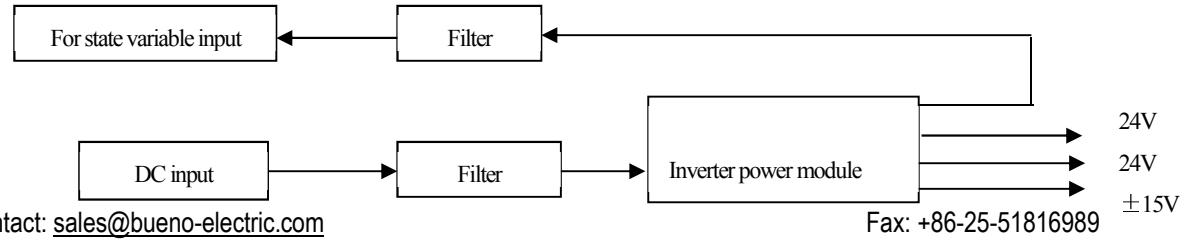


Figure2－5 Powermodul

3 Technical indicators

3.1 Operating environment

Working temperature:-20℃～60℃, average temperature within 24 hours does not exceed 35℃.

Storage temperature:-25℃～80℃, not apply excitation at limiting value; irreversible changes will not occur in the device. The device should normally work after temperature is recovered.

Relative humidity: not more than 95% (without dew).

Atmospheric pressure: 80～110kPa (below relative sea-level elevation of 2KM).

3.2 Nominal parameters

RatedDC voltage: 220V), around 10W, fluctuation range: -20%～ +10%.

Rated AC data:

Phase voltage: $100/\sqrt{3}$ V

Line voltage: 100V

AC: 5A/1A (indicated in the order)

Rate frequency: 50Hz

3.3 Technical parameters of device

Input circuit: 24V D.C. 2.4mA at each point

Output contact rating: 30W(τ=5ms), 220V D.C.or 0.5A D.C.

Trip time: ＜20ms

Each phase of AC voltage circuit of the device at nominal parameter ≤0.2VA

Each phase of AC current circuit of the device at nominal parameter≤0.3VA

Voltage, current and power: 0.5 grade

Phase angle measurement error ≤1°

Impedance measurement error ≤5%

4. Insulating Property

4.1 Insulation resistance

Megohmmeter with open circuit voltage 500V is used to measure insulation resistance of live part and dead part of the device and casings of the device and electrically unassociated circuits of the device and the insulation resistances of all circuits with different grades are not less than 100MΩ in atmospheric conditions of normal test.

4.2 Dielectric strength

The device can withstand line frequency pressure test with 50Hz frequency and 2000V voltage and duration of 1 minute without breakdown and flashover and destroyed components in atmospheric conditions of normal test. The electric potentials of the remaining circuits are interconnected and grounded when voltage is applied on any circuit during test.

4.3 Impulse voltage

Short-time impulse voltage test with 1.2/50μs standard lightning wave is applicable for grounding of power input circuit, AC input circuit and output contact circuit of the device and between circuits in atmospheric conditions of normal test and voltage of open circuit test is 5kV.

4.4 Humid-heat resistance property

The device can withstand humid heat test stated in Chapter 21 of GB7261. The highest test temperature is +40℃ and maximum humidity is 95% and test duration is 48 hours and each cycle lasts 24-hour alternating humid heat test. Insulation resistances of all conducting channels to exposed dead metal part, insulation resistance between casings and between all electrically unassociated circuits should be measured to be not less than 1.5MΩ and medium VOLTAGE WITHSTAND STRENGTH should be measured to be not lower than 75% of voltage amplitud in dielectric strength test voltage amplitude stated in 2.3.2 according to 2.3.1 within two hours before the test is finished.

4.5 Electromagnetic interference resistance property

4.5.1 Impulsive interference

The device can withstand interference test stated in GB6162 and test power frequencies are 100kHz and 1MHz and test voltage is attenuating oscillatory wave of common mode 2500V and differential mode 1000V. Power is applied on the tested device in advance and interference test voltages are added according to critical conditions listed in No.3.3 of GB6162 and the device will not have maloperation and reject operation.

4.5.2 Fast transient disturbance

The device can withstand fast transient interference test with IV level (4kV±10%) stated in IEC255－22－4 standard.

4.5.3 Electrostatic discharge

The device can withstand electrostatic discharge test with IV level (space discharge 15kV and contact discharge 8kV) stated in IEC255－22－2 standard.

4.6 Mechanical property

4.6.1 Vibration

The device can withstand vibration and endurance test with rigorous ranking level I stated in 16.3 of GB7261.

4.6.2 Impact

The device can withstand vibration and endurance test with rigorous ranking level I stated in 17.5 of GB7261.

4.6.3 Collision

The device can withstand vibration and endurance test with rigorous ranking level I stated in 18 of GB7261.

5 Protection Configuration

Multiple protection functions and non-electric signal interface can be provided according to requirements on protection of generator transformer in *Technical Regulations on Relay Protection and Safety Automatic Device* to meet the requirement on protection of generator transformer unit of small sized generating unit. The protection requirement on generator, main transformer, station transformer, high voltage reserved transformer, excitation transformer and large synchronous phase modifier can be met. Protection configuration is flexible and reasonably designed to meet counter measures requirement of power system and ensure operational reliability of the device.

5.1 Differential protection of generator

Protection Principle

Generator differential cyclic lockout differential mode can be used.Single-phase differential action mode: any phase differential protection action, namely tripping. This mode is equipped with TA line broken detection function. Differential protection is transiently blocked in case of TA line broken and the signal of TA line broken is delayed. When protection braking current is more than knee current, locking of TA line broken is released, namely, setting TA line broken and not blocking differential action.

The protection is equipped with threshold crossing alarm function of differential current. Differential protection can be braked through secondary harmonic wave (indicated in the order).

Percentage restraint is improved in digital protection compared to traditional protection principle. It is composed of no restraint part and percentage restraint part and has higher sensitivity and capacity of anti-TA saturation.

Its action equation is as follows:

$$\begin{cases} \left|\dot{I}_N + \dot{I}_T\right| \geq K_S\left(\left|\dot{I}_N - \dot{I}_T\right|/2 - I_g\right) + I_q \\ \left|\dot{I}_N + \dot{I}_T\right| \geq I_q \end{cases}$$

Of which: I_g: - knee-point current of curve

I_q: -starting current of curve

K_s: - slope of curve

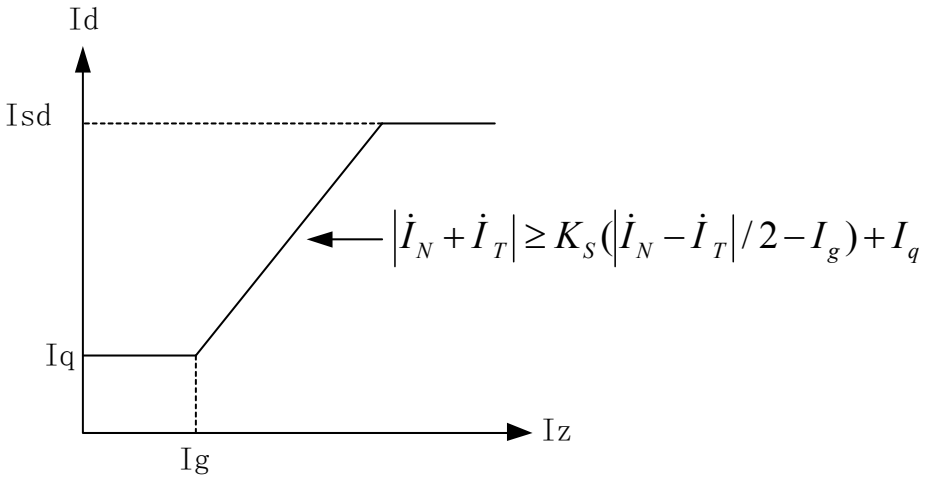


Figure 5-1 Ratio braking characteristic curve

5.1.1 Input analog

Current at generator end: I_{AT}, I_{BT}, I_{CT};

Neutral point current of generator: I_{AN}, I_{BN}, I_{CN};

Positive direction To flow into the generator for reference positive direction

5.1.2 Logic chart of protection is as follows:

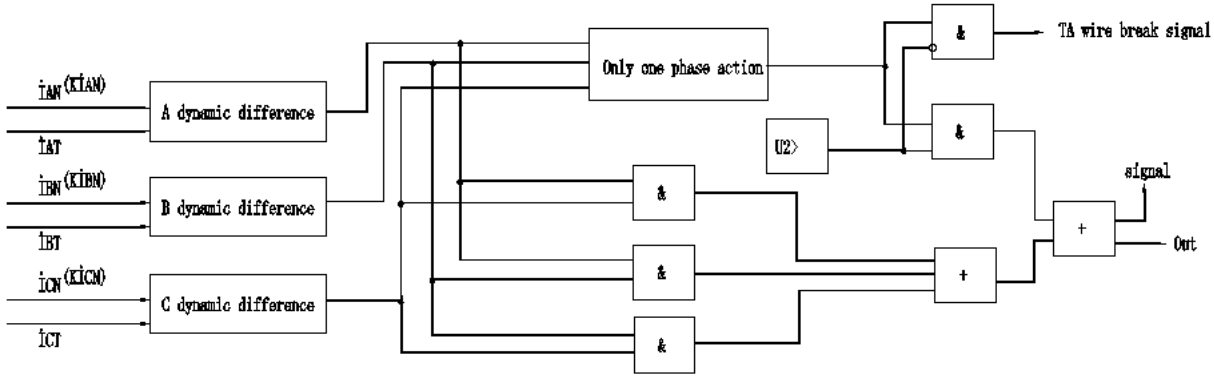


Figure 5-2 Cyclic lockout mode generator differential protection logic diagram

5.1.3 TA break line discriminant

For cyclic lockout mode, a motion nor negative sequence voltage difference, namely the judgement for the TA wire break. This is because the generator neutral point grounding directly, internal interphase short circuit usually two or three phase difference differential action at the same time.

5.1.4Setting contents and setting principles

1) Setting contents

Setting contents			
No.	Setting name	Unit	Setting range and instructions
1	Quick-break setting	A	See setting

2	Differential setting	A	principles and setting proposals
3	Proportional differential inflection point setting	A	
4	Differential braking proportion coefficient		
5	Remove break line blocking Uf2	V	
6	Differential current out limited setting	A	
7	Differential current out limited delay setting	S	
Control characters			
No.	Setting 1	Setting 0	
1	Quick-break protection input	Quick-break protection quit	
2	CT break line check input	CT break line check quit	
3	CT break line not bloking differential	CT break line bloking differential	

2) Setting principles and setting proposals

(a) Proportional coefficient of the brake Kz (rate of curve)

Kz should accord escape outside three-phase short circuit when the maximum transient unbalanced differential current to setting, usually, the generator differential use Kz = 0.3 ~ 0.5, unit: no.

(b) Starting current Iq

Pickup current of setting differential protection: Iq=0.3～0.4Ie, unit:A;

According to avoid the maximum unbalanced differential current under the condition of normal setting. Unbalanced differential current reasons: mainly is the variable ratio error of differential protection on both sides of the TA and the adjustment error of channel circuit protection device.

(c) Knee-point current Ig

Knee-point current of setting differential protection: Ig=0.5～0.8Ie, unit:A;

The size of the Ig, decided to start braking effect to protect the current size, avoid external fault is recommended after resection of the transient process of the maximum unbalanced differential current setting.

(d) Differential instantaneous Is

Differential instantaneous Isd Isd: Is=4～8Ie, unit: A

Differential action occurs when differential current of generator is more than the setting ID despite the breaking.

It is based on rated current of the generator.

(e) Generator rated current Ie

Calculate based on

$$Ie = \frac{Pe}{\sqrt{3}Uen_T \cos\varphi}$$

Inside: Pe：Generator power rating , K;

Ue：Generator voltage rating, KV;

n_T ： ratio of differential TA;

$\cos\varphi$： The rated power factor of generator

(f) Differential protection sensitivity calibration

According to relevant technical regulations, longitudinal differential protection, the sensitivity of generator must meet the machine end two-phase metallicity short-circuit, the sensitive coefficient of the differential protection Ksen2, Ksen sensitive coefficient is defined as a machine side two-phase metallicity short-circuit, when the short circuit current and the ratio of the differential protection operating current, the bigger the Ksen, protective action is sensitive, the higher reliability.

Digital protection sensitivity calibration required by regulations, because only Ksen meet the requirements, to ensure that when the internal fault, there is all kinds of aperiodic component in fault current, TA saturation effects, TA transient characteristics influence and so on, reliable protection action.

Ksen、 Kz and differential protection setting values, Iq, Ig have relations, especially the Kz affected most. General advice according to this specification values, Ksen can meet the requirements.

5.1.5 The engineering application considerations

TA secondary circuit open circuit would cause the danger of high voltage, especially large generating units. For this purpose, the recommended TA break line not locking differential protection scheme.

5.2 Generator stator ground protection

5.2.1 The protection reflects zero sequence voltage size of generator

Fundamental wave type stator ground fault protection, protection for machine side to about 90% within the scope of the stator winding earth fault. As a small stator earthing protection of the unit. Also can use with the three times harmonic stator ground protection to protect fault protection of 100% of the large and medium-sized generator stator ground fault.

3U0 Protection principle

Protect access 3U0 current, from the zero sequence current transformer secondary qualification , in the generator terminal three-phase outlet.

Action equation 3Uo>3Uog, 3Uo On machine side three-phase line zero sequence current transformer of the secondary current; 3Uog is action current fixed value.

5.2.2 Logic chart of protection is as follows:

Figure 5-2-1 Tripping logic of 3Uo generator stator ground protection

5.2.3 Setting contents and setting principles

1)Setting contents

Setting contents			
No.	Setting name	Unit	Setting range and instructions
1	Stator ground 3Uo setting	V	See Setting principles and setting proposals
2	Stator 3Uo delay	S	

Control characters		
No.	Setting 1	Setting 0
1	TV Power atresia 3Uo	TV Power is not locking 3Uo

2)Setting principles and setting proposals

(a) Action is the voltage

In protection devices, set up three times with the good performance of harmonic filter, therefore, 3 uog should press escape when the normal operation of the TV or the open delta winding single-phase TV neutral point may appear the biggest wave of zero sequence voltage to setting .

When the generator stator lead is not enclosed bus bar and the wall casing from outdoor, preferable 10 ~ 13 v .

When the generator outlet is closed busbar, preferable 5 ~ 10 v .

(b)Action delay

Should be greater than main transformer high voltage side grounding short circuit when the backup protection action longest time setting. If the simplified calculation, generally take 6 to 9 seconds.

5.2.4 Zero sequence current generator stator ground fault protection

Zero sequence current of the stator ground fault protection, suitable for machine side position with zero sequence current transformer three-phase line of small generators. The protection can be separate as the internal generator stator winding of the stator ground fault protection

Protection principle

Protect access 3Io current, from three-phase generator pattern in end of zero sequence current transformer secondary qualification .

Action equation 3Io> 3 Iog, type in the three-phase line 3 Io machine end of zero sequence current transformer secondary current; 3 Iog action voltage setting value.

5.2.5 Logic chart of protection is as follows

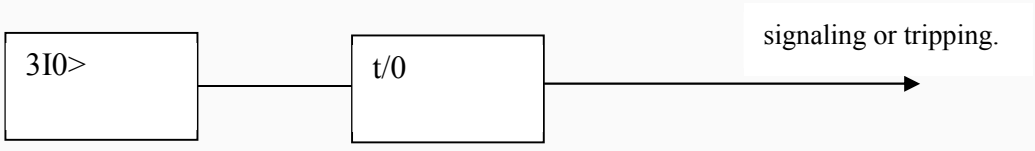


Figure 5-2-2 Tripping logic of 3Io generator stator ground protection

5.2.6 Setting contents and setting principles

3)Setting contents

Setting contents			
No.	Setting name	Unit	Setting range and

			instructions
1	Stator ground 3Io setting	A	See Setting principles and setting proposals
2	Stator 3Io delay	S	
Control characters			
No.	Setting 1	Setting 0	
1	3Io stator ground input	3Uo stator ground quit	

4)Setting principles and setting proposals

Of zero sequence current action value 3 I0g setting, quite tedious. The main reason is that zero sequence TVno strain ratio, a zero sequence current is by magnetic flux leakage to the secondary of TV.

For this purpose, the setting value should be issued by the generator primary side zero sequence current . Its value should refer to the security of the generator allows determining grounding current, such as 4 A or 3 A.

When the primary current action is determined, with a long wire through the zero sequence TA to check the single phase current. When is equal to a setting into the current when the current action, observation of the ma number as shown on the interface, the ma number as fixed values input device and curing.

Deferred operation time of setting protection, unit (s). t=6s～9s.

5.3 Overvoltage protection of generator

5.3.1 Protection principle

The protection reflects voltage size of generator terminal.

Voltage is obtained from line voltages of generator terminal TV and three line voltages are and/or relation, such as U_{CA} voltage.

Tripping mode: signaling or tripping.

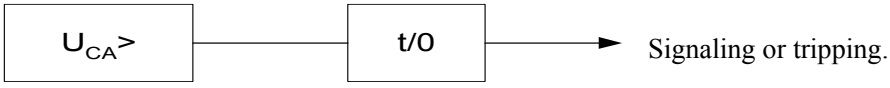


Figure 5-3 Overvoltage protection tripping logic of generator

5.3.2 Setting contents and setting principles Setting contents

Setting contents				
No.	Setting name	Seeting range	Unit	Instructions
1	Overvoltage setting	0～990.0	V	
2	Overvoltage delay setting	0～99.0	S	

Overvoltage protection voltage, shall, depending on the type of generator and excitation mode, allow the overvoltage of the ability and the condition of stator winding insulation to decide.

the steam turbine generator	the hydro-generator	For the hydro-generator with silicon controlled excitation
Ug=（1.3～1.35）Ue	Ug=1.5Ue	Ug=（1.3～1.4）Ue

Action delay t may be（0.3～0.5）S

5.4 Static stability excitation loss protection of generator

At normal operation, if Impedance complex plane is used expressing measured impedance at the end of generator, so the trajectory of the impedance is within the first quadrant (lag phase) or the fourth quadrant (in

the running phase).. After the generator is lost, the trajectory of the measuring impedance of the generator will be along the circle of the active impedance into the asynchronous impedance circle..

5.4.1 Protection principle

Impedance type excitation-loss protection, usually by the impedance criterion (mid-december, <), low rotor voltage criterion (VFDS), the system low voltage criterion (Un <).

Protection input includes: the machine end of three-phase voltage, three phase current generator, main transformer high voltage side three-phase voltage, rotor dc voltage.

(a) The asynchronous boundary impedance circle criterion

The machine end of the excitation-loss generator impedance eventually must be entered as shown on the right track in the small circle, the circle is called the asynchronous boundary impedance circle, in the figure

$$X_a = -\frac{X_d^{'}}{2} * \frac{U_{gn}^2 * n_a}{S_{gn} * n_v}$$

$$X_b = -X_d * \frac{U_{gn}^2 * n_a}{S_{gn} * n_v}$$

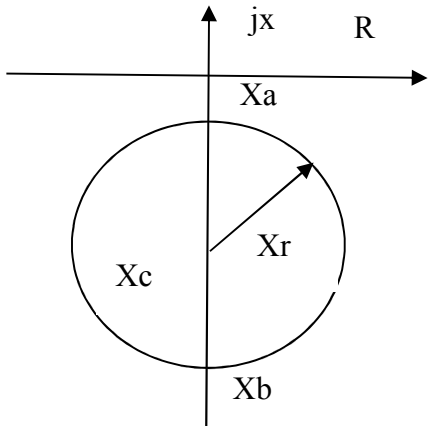


Figure 5-4-1

In the type, Xd'，Xdfor generator transient reactance and synchronous reactance table values ; U_{gn}， S_{gn} The rated voltage

When generator transverse differential protection, generator stator winding interturn short circuit (with branch turn-to-turn short circuit and phase between different branches of turn-to-turn short circuit), wire rod welding of main protection, also can protect the interphase short circuit of the stator winding.

Constitute principle

Generator unit transverse differential protection input current, two for the generator neutral point of attachment of TA secondary current.

Logic diagram

Transverse differential protection is Lord of the generator's internal fault protection, action should be no delay. But considering the two-point grounding short circuit when the generator rotor winding of the generator air-gap magnetic field distortion may cause protection misoperation, so after the rotor one-point earthing, the transverse differential protection with a time delay. Logic diagram 5-6:

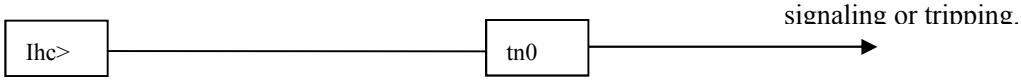


Figure5-4-2 Transverse differential logic for out

(c) List of fixed value and setting principle

Setting value list				
NO	Constant value name	Setting range	Unit	Instructions
1	Transverse differential protection fixed value		A	
2	Transverse differential protection time delay		S	

(1)the current action Ig

In transverse differential protection, has a special filter harmonic measures three times. As a result, the action of transverse differential protection current, should press escape in asymmetric short circuit or system generator rotor eccentricity by the loss of excitation maximum unbalance current. Advice:

$Ig =$（0.3～0.4）I_e （I_e Generator secondary rated current）

(2) action time t

To match the rotor two-point grounding protection operation delay, usually take t=0.5～1.0 s

5.5 Generator set time limit negative sequence current protection

5.5.1 Protection principle

Protect access to three phase current generator (TA secondary values). When the negative sequence current is greater than the setting value, negative sequence current protection action, by the time delay removal of generators.

Current from the generator neutral point (or end) of TA.

Protection logic diagram is as follows:

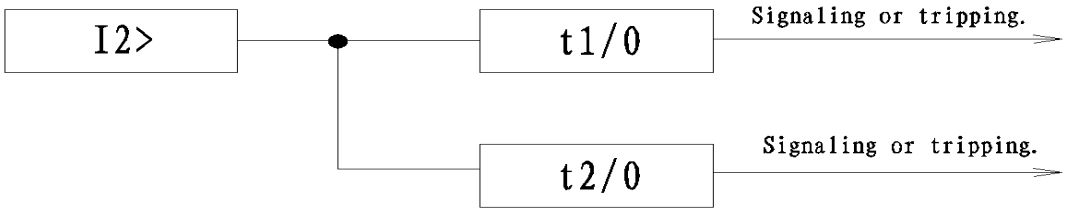


Figure5-5 Generator negative sequence over-current protection logic for out

5.5.2 Setting value list

Setting value list				
Serial NO.	Setting name	Setting range	Unit	Instruction
1	Negative sequence setting value		A	
2	Negative sequence over current delay t1		S	
3	Negative sequence over current delay t2		S	

Definite time negative sequence current setting value I_{2g} calculation, According to the generator through long-term continuous operation allows the negative sequence current calculation,

$$I_{2g} = K_{rel} \frac{I^*_{2.\infty}}{K_{re}} I_{g.n}$$

Among K_{rel} is reliable factor, general values $K_{rel}=1.05$

K_{re} Return factor

$I_{g.n}$ Generator rated secondary current

Action time: negative sequence over-current action delay should be made to match the adjacent equipment asymmetric short-circuit backup protection.

5.6 Generator overload protection

5.6.1 Protection principle

Protection reflects the size of the generator stator current, current from the generator neutral point (or end) of TA secondary one phase , or for the three phase current.

Out style : signaling or tripping

Figure5-6 Generator overload protection logic for out

5.6.2 Setting value list

Setting value list				
Serial NO.	Setting name	Setting range	Unit	Instruction
1	Overload current setting value		A	
2	Overload delay t1		S	

Overload current setting value I_g

According to avoid generator rated current setting

$$I_g = K_{rel} I_e / 0.95$$

Among K_{rel} is reliable factor, general values K_{rel} =1.05

I_e is generator rated current, general values（1.05～1.1）I_e

Action relay ,general value 6~9s

5.7 Generator Transverse Differential Protection

5.7.1 Protection principle

When generator transverse differential protection, generator stator winding interturn short circuit (with branch turn-to-turn short circuit and phase between different branches of turn-to-turn short circuit), wire rod welding of main protection, also can protect the interphase short circuit of the stator winding.

Constitute principle

Generator unit transverse differential protection input current, two for the generator neutral point of attachment of TA secondary current.

Logic diagram

Transverse differential protection is Lord of the generator's internal fault protection, action should be no delay. But considering the two-point grounding short circuit when the generator rotor winding of the generator air-gap magnetic field distortion may cause protection misoperation, so after the rotor one-point earthing, the transverse differential protection with a time delay. Logic diagram 5-7:

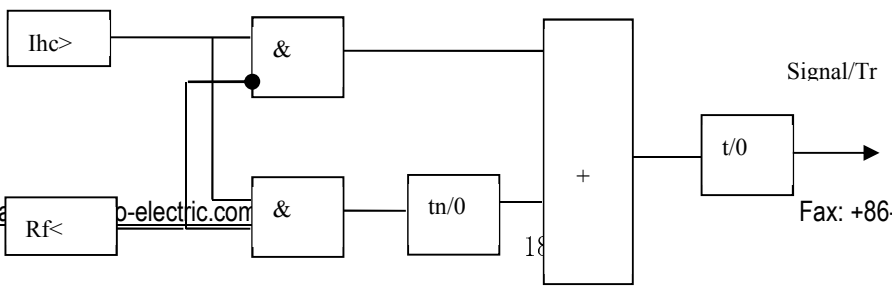


Figure5-7 Transverse differential logic for out

5.7.2 Setting value list

Setting value list				
NO	Constant value name	Setting range	Unit	Instructions
1	Transverse differential protection fixed value		A	
2	Transverse differential protection time delay		S	

(1)the current action Ig

In transverse differential protection, has a special filter harmonic measures three times. As a result, the action of transverse differential protection current, should press escape in asymmetric short circuit or system generator rotor eccentricity by the loss of excitation maximum unbalance current. Advice:

$Ig =$ （0.3～0.4） I_e （I_e Generator secondary rated current）

(2) action time t

To match the rotor two-point grounding protection operation delay, usually take t=0.5～1.0 s

5.8 One-point ground protection of overlying DC rotator of generator

5.8.1 Protection principle

New type of overlying DC method is used and overlying source voltage is 50V and internal resistance is more than 50kΩ. Microcomputer intelligent measurement is used to overcome the shortcoming of asymmetric positive and negative electrode sensitivity of winding in traditional protection and accurately calculate insulation resistance of rotator over the ground with up to 200kΩ. Rotator's distributed capacitance has no impact on measurement. The protection will remain valid when electrical motor is started and rotator has no voltage.

Protection introduces negative electrode and shaft earth connection of rotator and can signal or trip (indicated in the order).

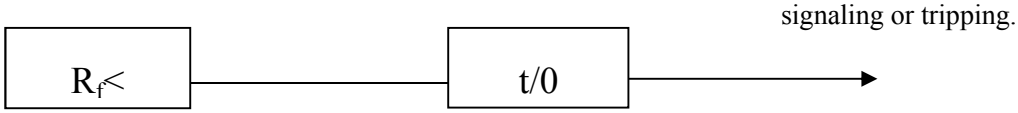


Figure 5-8 Tripping logic of generator rotator one-point ground protection

5.8.2 Setting value list

Setting contents			
No.	Setting name	Unit	Setting range and instructions
1	Rotator one-point ground Rf	KΩ	See setting principles and
2	Rotator one-point ground delay time	S	

			setting proposals

Setting principles and setting proposals

(a) R_f: unit: (kΩ)

Earth fault signaling setting ID (setting range 10KΩ～20kΩ).

(b) Action time t

Protection operation delay (setting range 1s～10s). generally t=9s.

5.9 Rotator two-point ground protection of Harmonic wave negative sequence voltage type of generator

5.9.1 Protection principle

"Negative sequence" component of secondary harmonic wave in stator voltage is reflected and it is resulting in stator winding from forward direction rotation of magnetic field with secondary harmonic wave at synchronous speed in case of short circuit of asymmetric loops of rotator winding. The protection is blocked by one-point ground protection and protection is automatically input in case of one-point ground.

Protection introduces three-phase voltage of generator terminal.

Protection operation logic chart:

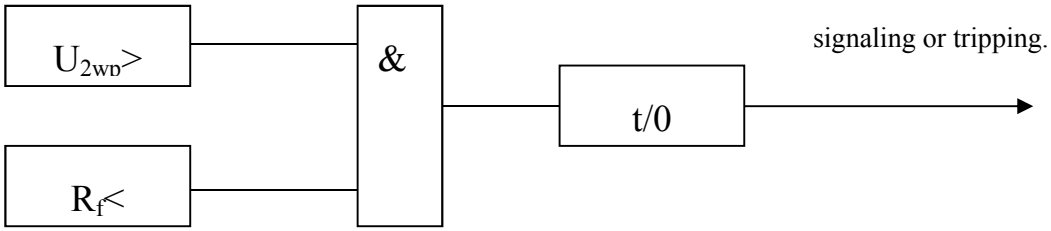


Figure 5-9 Tripping logic of generator rotator two-points ground protection

5.9.2 Setting value list

Setting contents			
No.	Setting name	Unit	Setting range and instructions
1	rotator two-points ground U2wg	V	See setting principles and setting proposals
2	rotator two-points ground delay time	S	

Setting principles and setting proposals

(a) Operating valueU_{2wg} of secondary harmonic wave voltage.

$$U_{2wg} = K_{rel} U_{2w2He\delta}$$

K_{rel} confidence coefficient, take 8～10;

$U_{2w2He\delta}$ is measured value of secondary harmonic wave voltage at rated load; can take 0.1～0.2。

(b) Protection operation delay t , Protection operation delay (setting range 0.5s～1s) is set to increase reliability.

5.10 AC excitation of generator (three-phase) circuit current protection

Protection principle and logic

Protection reflects excitation AC circuit current size.

Out style : signaling or tripping

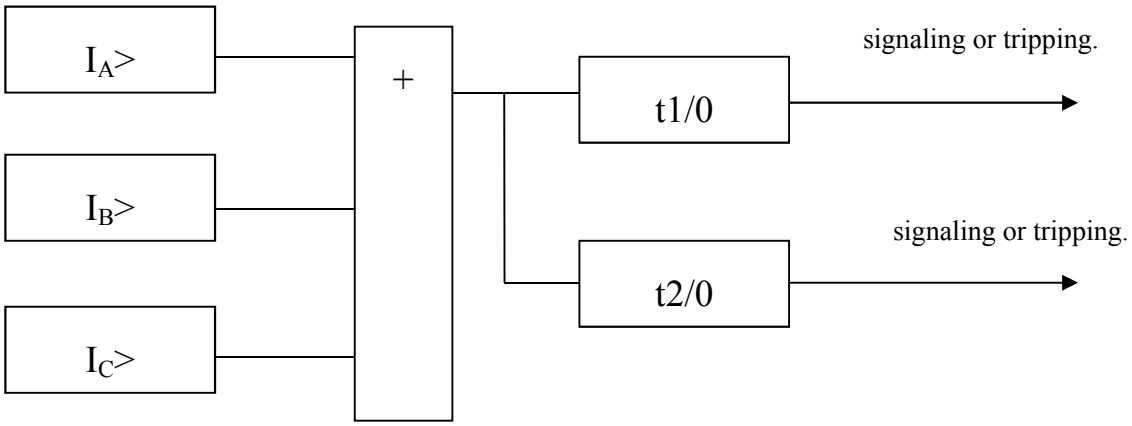


Figure 5-10 AC excitation of generator (three-phase) circuit current protection logic for out

Setting value list				
NO.	Set value name	Setting range	Unit	Instructions
1	Excitation variable-speed quick-break set value	0~100	A	
2	Excitation over current set value	0~100	A	
3	Excitation over current set delay	0~100	S	

5.11 Generator frequency abnormal protection

Turbine blade has its own natural frequencies. Parallel operation of generator, when the system frequency abnomaly, turbine blade may produce resonance, so that the blade fatigue, go down for a long time may damage the turbine blades.

Generator abnormal frequency protection is to protect the safety of steam turbine.

5.11.1 Protection principle

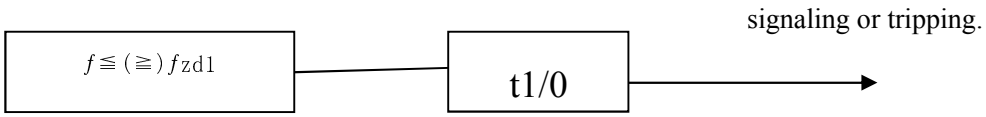


Figure 5-11 Generator frequency protection logic for out

5.11.2 Setting value list

Setting value list				
NO.	Set value name	Setting range	Unit	Instructions
1	Low voltage locking frequency	0~100	V	Line voltage
2	Low frequency set value	45~55	Hz	
3	Frequency slip locking set value	0~100	Hz/s	
4	Low frequency protection delay set value	0~100	S	
Control word				

NO.	Set 1	Set 0
KG1.7	Frequency: the voltage of end generator	Frequency: the voltage of system
KG1.8	Input over- frequency protection	Input low- frequency protection

5.12 Generator reverse power protection

Parallel operation of the steam turbine generator, the main valve is turned off, then as a synchronous motor running. But absorb energy from the power grid, dragging turbine rotation. Because of the cylinder is filled with steam, it and turbine blade friction generates heat, make the turbine blade is overheating. Run for a long time, damage to the turbine blade.

Protection principle and logic

Reverse power protection input TV secondary three-phase voltage of end generator and TA secondary current of generator . When the generator active power absorption.

Out style : signaling or tripping

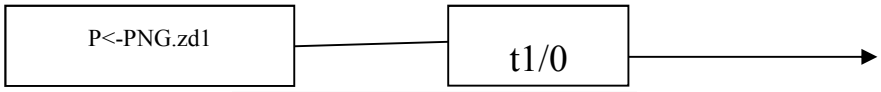


Figure 5-12 Generator reverse power protection logic for out

5.13 Setting value list

Setting value list				
NO.	Set value name	Setting range	Unit	Instructions
1	Reverse power protection set value	0～100	MW	
2	Reverse power delay set value	0～100	S	
Control word				
NO.	Set 1	Set 0		
KG1.6	PT wire break locking reverse power	PT wire break unlocking reverse power		

5.14 Non-electric signal protection (demagnetization tripping of generator, hot working (or water machine faults) protection etc.)

For non-electric signal protection of the device, direct tripping without through CPU and signaling through CPU at transient tripping.

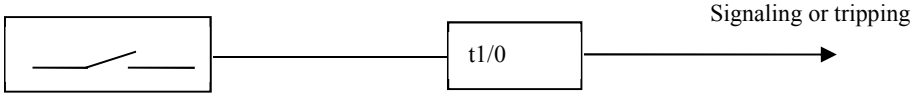


Figure 5-9 Non-electrical quantity protection quantity

6. Setting List

6.1 BEPR- 561U Protection setting

No	Setting ID name	Setting	Unit	Min	Max
1	Control word 1	0000		0000	FFFF
2	Control word 2	0000		0000	FFFF
3	Inst.D.setting	50.00	A	0.00	99.99
4	Diff.setting	20.20	A	0.00	99.99
5	Inflect.pnt.Set	5.00	A	0.00	99.99
6	Diff.P.R.factor	0.400		0.000	9.999
7	Remove lock. Uf2	10.0	V	0.0	999.9
8	Diff.C.overlimit	5.00	A	0.00	99.99
9	overlimit delay	10.00	S	0.00	99.99
10	Diff.C. Trip mode	00FF		0000	00FF
11	T. Diff.C setting	1.20	A	0.00	99.99
12	T. Diff.C delay	1.20	S	0.00	99.99
13	T. Diff.C trip Mode	00FF		0000	00FF
14	O/volt.setting	120.0	V	0.0	999.9
15	O/volt.delay	10.00	S	0.00	99.99
16	O/volt.trip mode	00FF		0000	00FF
17	1 point Gnd.Rf	5.0		0.0	999.9
18	1 point Gnd. delay	10.00	S	0.00	99.99
19	2 point Gnd.U2w	50.0	V	0.0	999.9
20	2 point Gnd. delay	10.00	S	0.00	99.99
21	2 point Gnd. trip mode	00FF		0000	00FF
22	Rator Gnd. 3Io	1.20	A	0.00	99.99
23	3Io Gnd. delay	1.20	S	0.00	99.99
24	3Io Gnd. trip mode	00FF		0000	00FF
25	Non-Elec.1 delay	10.00	S	0.00	99.99
26	N.E.l trip mode	00FF		0000	00FF
27	Non-Elec.2 delay	10.00	S	0.00	99.99
28	N.E.2 trip mode	00FF		0000	00FF
29	Non-Elec.2 delay	10.00	S	0.00	99.99
30	N.E.2 trip mode	00FF		0000	00FF
31	Curr. fator Ki	0.100		0.000	9.999
32	Volt. fator Ku	0.120		0.000	9.999

KG1 control word description:

No.	1	0
KG1.0	Ie= 5A	Ie= 1A
KG1.1	Ue=57.7 V	Ue=100 V
KG1.2	Inst.D.relay on	Inst.D.relay off
KG1.3	Spare	Spare

KG1.4	TADX&&D.Current	TADX//D.Current
KG1.5	Diff.C.O/limit ON	Diff.C.O/lmt OFF
KG1.6	3 I0 Criterion on	3 I0 Crit. off
KG1.7	Spare	Spare
KG1.8	Detct TVwire on	Detct TVwire off
KG1. 9	Spare	Spare
KG1.10	Spare	Spare
KG1.11	2 point Gnd on	2 point Gnd off
KG1.12	Not Elec .1 on	Not Elec .1 off
KG1.13	Not Elec .2 on	Not Elec .2 off
KG1.14	Not Elec .3 on	Not Elec .3 off
KG1.15	Spare	Spare

6.2 BEPR- 562U Protection setting

No	Setting ID name	Setting	Unit	Min
1	Control word 1	0000～00FF		
2	Control word 2	0000～00FF		
3	tart-up RX current Iqd	0.00～99.99	A	
4	System low-voltage	0.0～999.9	V	
5	Impedance circle center –Xc	0.00～99.99	Ω	
6	Impedance radius Rc	0.00～99.99	Ω	
7	Rotor-voltage low Ufd	0.0～999.9	V	
8	Rotor low voltage proportional Kd	0.00～99.99		
9	Reaction power Pf	0.00～99.99	MW	
10	Loss-of-field delay t1	0.00～99.99	S	
11	Loss-of-field delay t1 trip mode	0000～00FF		
12	Loss-of-field delay t2	0.00～99.99	S	
13	Loss-of-field delay t2 trip mode	0000～00FF		
14	Loss-of-field delay t3	0.00～99.99	S	
15	Loss-of-field delay t3 trip mode	0000～00FF		
16	Low voltage setting	0.0～999.9	V	
17	Negative sequence voltage	0.0～999.9	V	
18	Overcurrent 1 setting	0.00～99.99	A	
19	Compound voltage overcurrent delay t1	0.00～99.99	S	
20	Compound voltage overcurrent t1 trip mode	0000～00FF		
21	Compound voltage overcurrent delay t2	0.00～99.99	S	
22	Compound voltage overcurrent t2 trip mode	0000～00FF		
23	Overcurrent 3 setting	0.00～99.99	A	

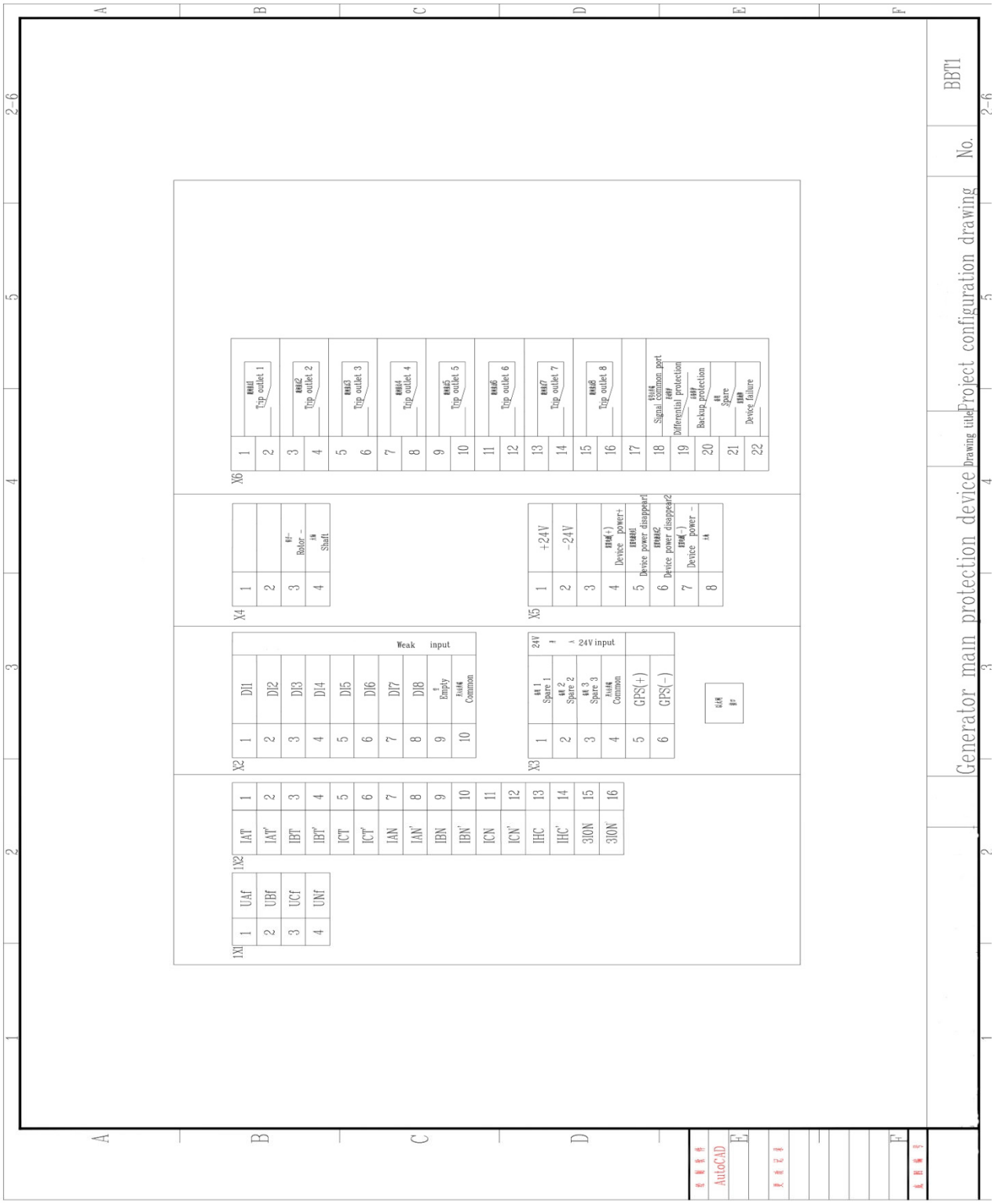
No	Setting ID name	Setting	Unit	Min
24	Compound voltage overcurrent delay t3	0.00～99.99	S	
25	Compound voltage overcurrent t3trip mode	0000～00FF		
26	Negative sequence current	0.00～99.99	A	
27	Negative sequence current delay 1	0.00～99.99	S	
28	Negative sequence current t1 trip mode	0000～00FF		
29	Negative sequence current delay 2	0.00～99.99	S	
30	Negative sequence current t2 trip mode	0000～00FF		
31	Reverse power protection setting P	0.00～99.99	MW	
32	Reverse power protection delay setting t	0.00～99.99	S	
33	Reverse power protection trip mode	0000～00FF		
34	Low voltage blocking frequency protection	0.0～999.9	V	
35	Low frequency protection setting	0.00～55.00	Hz	
36	Frequency slide difference blocking setting	0.00～99.99	Hz/s	
37	Low frequency protection delay setting	0.00～99.99	S	
38	Low frequency protection trip mode	0000～00FF		
39	Over frequency protection setting	0.00～55.00	Hz	
40	Over frequency protection delay setting	0.00～99.99	S	
41	Over frequency protection trip mode	0000～00FF		
42	Stator ground 3Uo setting	0.0～999.9	V	
43	Stator ground 3Uo delay setting	0.00～99.99	S	
44	Stator ground 3Uo trip mode	0000～00FF		
45	Excitation Quick-break setting	0.00～99.99	A	
46	Excitation over current setting	0.00～99.99	A	
47	Excitation over current delay	0.00～99.99	S	
48	Excitation over load setting	0.00～99.99	A	
49	Excitation trip mode	0000～00FF		
50	Over-load current setting	0.00～99.99	A	
51	Over-load delay T	0.00～99.99	S	
52	Current factor Ki	0.000～9.999		
53	Voltage factor Ku	0.000～9.999		

KG1 control word description:

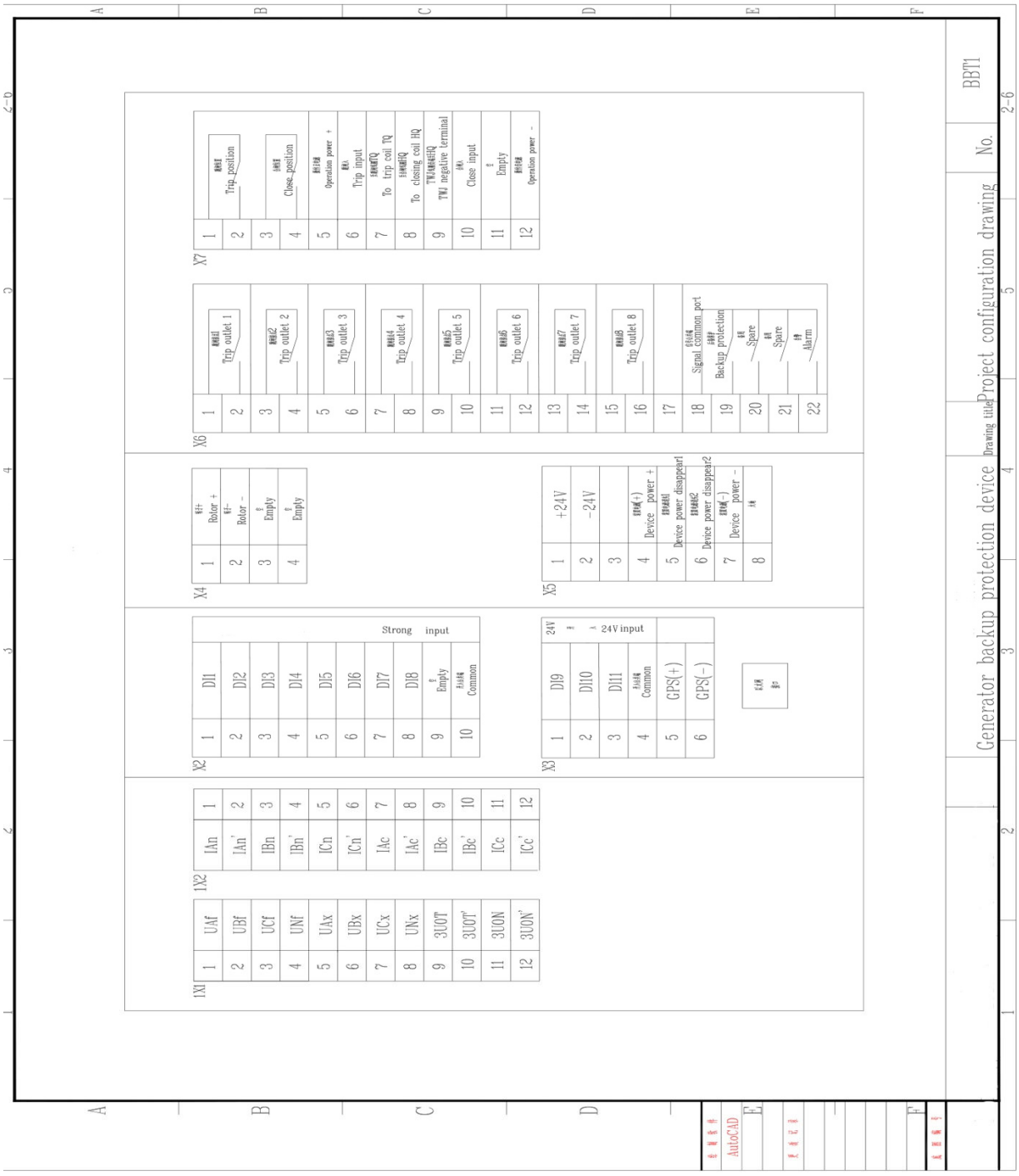
	1	0
KG1.0	CT rated current 5A	CT rated current 1A
KG1.1	PT rated voltage 57.7V	PT rated voltage 100V
KG1.2	System low voltage criterion put into	System low voltage criterion exit
KG1.3	Compound voltage put into	Compound voltage exit
KG1.4	Current memory put into	Current memory exit
KG1.5	Spare 1	Spare 0
KG1.6	TV breakage blocking inverse power protection	TV breakage non-blocking inverse power protection
KG1.7	Frequency: the voltage of end generator	Frequency: the voltage of end generator
KG1.8	Put into over frequency protection	Put into low frequency protection
KG1. 9	Genertor TVDX break line detection puet into	Genertor TVDX break line detection exit
KG1.10	Syetem TVDX break line detection put into	Syetem TVDX break line detection exit
KG1. 11	TV breakage blocking loss of excitation protection	TV breakage nonblocking loss of excitation protection
KG1. 12	TV breakage blocking compound voltage overcurrent protection	TV breakage nonblocking compound voltage overcurrent protection
KG1. 13	Generator Overload protection on	Generator Overload protection off
KG1. 14	Generator unit power positive output	Generator unit power reverse output
KG1. 15	Sum self-inspection put into	Sum self-inspection exit
KG1. 16	TV breakage blocking 3U0	TV breakage nonblocking 3U0

7 Figures

7.1 BEPR-561U Device back layout drawing



7.2 BEPR-562U Device back layout drawing



7.3 Device holes size figure