天津市松正电动科技有限公司

Tianjin Santroll Electric Technology Co., Ltd.

User Manual

M A N U A L

SZ8XXX Series

PMSM Inverter

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SANTROLL

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Catalog

1. Product overview

For electric forklift manufacturers, it is a leading forklift inverter product, which uses the unique technology of FOC, dual CPU, bilingual operating system and IP67 IP Grade, and has the unique functions of high control accuracy, automatic verification, simple operation and high IP grade. The inverters are for PMSM, which can increase by 10% of the whole vehicle efficiency, and make your products more competitive.

Application:

Santroll AC motor inverter is suitable for all electric vehicles, such as electric forklifts, electric pallet trucks, golf carts, electric cars and other electric vehicles.

1.1 Product model and parameter list

Product Model	Rated Working Voltage (V)	Peak Current （2min）	Dimensions (See for inverter dimensions)	Application
SZ8535-M	48	350A	M	Forklift traction, pump control and field vehicle system
SZ8545-M	48	450A	M	
SZ8545-S	48	450A	S	
SZ8550-S	48	500A	S	
SZ8555-L	48	550A	L	
SZ8565-L	48	650A	L	
SZ8725-M	72-80	250A	M	
SZ8735-M	72-80	350A	M	
SZ8735-S	72-80	350A	S	
SZ8745-S	72-80	450A	S	
SZ8750-L	72-80	500A	L	
SZ8755-L	72-80	550A	L	
SZ8B25-M	96-114	250A	M	
SZ8B35-M	96-114	350A	M	
SZ8B45-S	96-114	450A	S	
SZ8B55-L	96-114	550A	L	
SZ8E25-M	144	250A	M	
SZ8E35-S	144	350A	S	
SZ8E50-L	144	500A	L	

Note: The specific model is subject to delivery goods, and the final model will be added with customer identification.

Naming Rule:			
Company abbreviation	Controller type	Voltage code (Rated voltage range)	Current code
SZ	7: Asynchronous motor inverter 8: PMSM motor inverter 9: DC brushless motor inverter	2:24V 3:36V 5:48V-55V 7:70V-80V 9:90V-100V A:100V-110V B:110V-120V C:120V-130V D:130V-140V E:140V-120V C:120V-130V 15:150V-160V 33:300V-400V 54:500V-600V	12:120A 20:200A 25:250A 30:300A 35:350A 40:400A 45:450A 50:500A 55:550A 60:600A

1.2 Product features

1. Compared to the AC motor inverter, these inverters will increase by more than 10% of the whole vehicle efficiency;

2. The inverter uses two chips, which communicate with each other and perform their respective duties. One is responsible for functions and the other is responsible for motor control. The single-chip microcomputer in charge of functions does not participate in motor control, has more resources to do function logic, and can accept function customization. Because the chip responsible for motor control does not participate in the function, the single cycle time is shorter, and the overcurrent protection of the motor is directly protected by the motor control chip, so that the response is faster.

3. The power cable has excellent performance, internal resistance of 3.9 mΩ (different products are different) and small parasitic parameters, which improves the switching speed of the power tube, reduces the switching loss and conduction loss, and reduces the calorific value.

4. Self-developed intelligent calibration current sensor tooling makes current more accurate and motor control more accurate;

5. The upper computer and instrument display can switching between Chinese and English;

6. More accurate electric quantity display. The electric quantity display of instruments on the market is by testing the voltage at the inverter end, which will be different from the voltage at the battery end. Santroll's power display voltage is at both ends of the battery;

7. More comprehensive product verification. Santroll has its own experimental center and comprehensive equipment for testing, including advanced experimental equipment such as dynamometer, power analyzer, shaking bench, thermal cycling chamber, water spray test box, dust test box, salt spray test box and drop test bench, which can fully guarantee the quality of products;

8. To provide more timely technical support and better after-sales service, Santroll has more than 100 offices all over the country to provide customers with better and more timely service;

9. Better braking performance. When the vehicle brakes suddenly, it can be braked in time by electronic control. The inverter will make a judgment, not according to the normal deceleration rate, otherwise the vehicle will rush forward after the brake is released;

10. 0 to 300 Hz frequency range, low noise operation;

11. The product voltage level ranges from 48V to 144V rated voltage level. The working current reaches 350A to 650A in 2 minutes;

12. A powerful operating system ensures that the vehicle control, motor control and client programs run simultaneously;

13. Advanced pulse width modulation technology ensures high efficient utilization of batteries and reduces the loss of motor energy consumption and torque conversion;

14. Santroll's AC inverter can adapt to any type of AC motor;

15. Adopting the high-speed CAN control mode can make the data exchange between traction, pump control and instruments, making the control more flexible;

16. Online programming of the inverter can ensure the upgradability of the product;

17. Double-layer aluminum substrate design process is adopted, which ensures the high safety, insulation and good heat dissipation of the product, which makes the inverter more reliable;

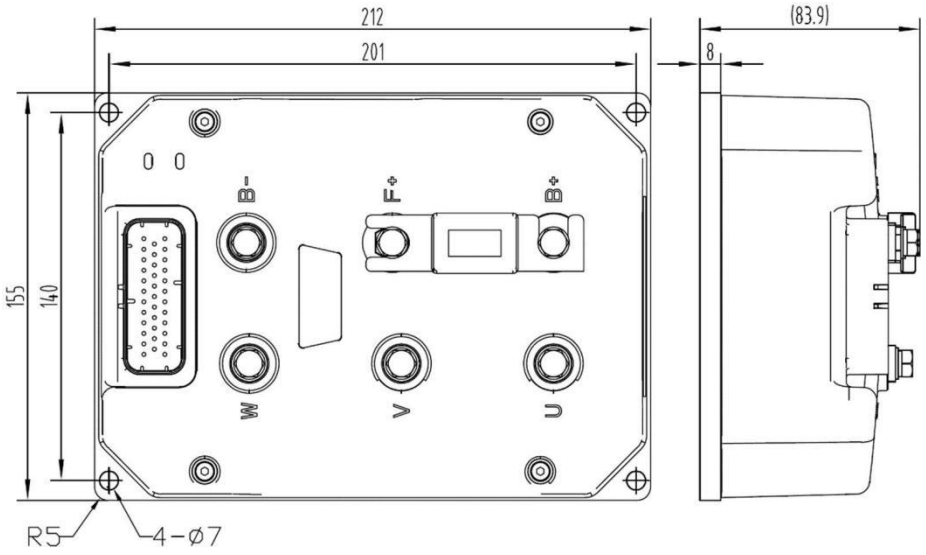
18. Hardware watchdog timer for safety failure power devices is designed;

19. Battery electrode reverse connection protection, short circuit and open circuit protection of output drive, overheat protection, warning and automatic shutdown settings provide protection for motor and electric inverter;

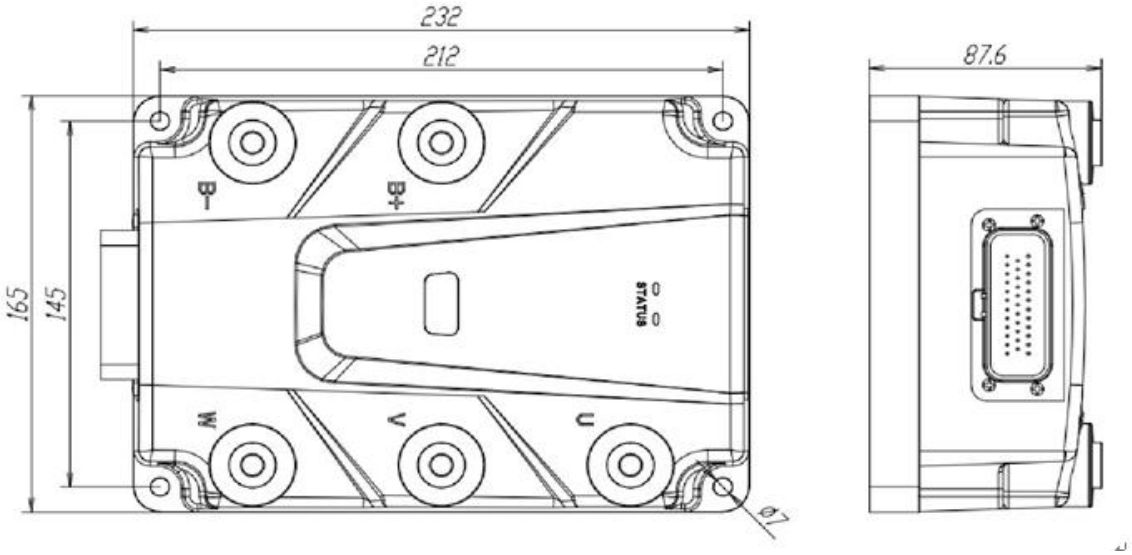
20. The instrument integrates intelligent fault diagnosis function, which can directly display the root cause of the fault, making the investigation more direct, and improving the after-sales service level;

21. IP67 IP Grade meets the requirements of harsh environment.

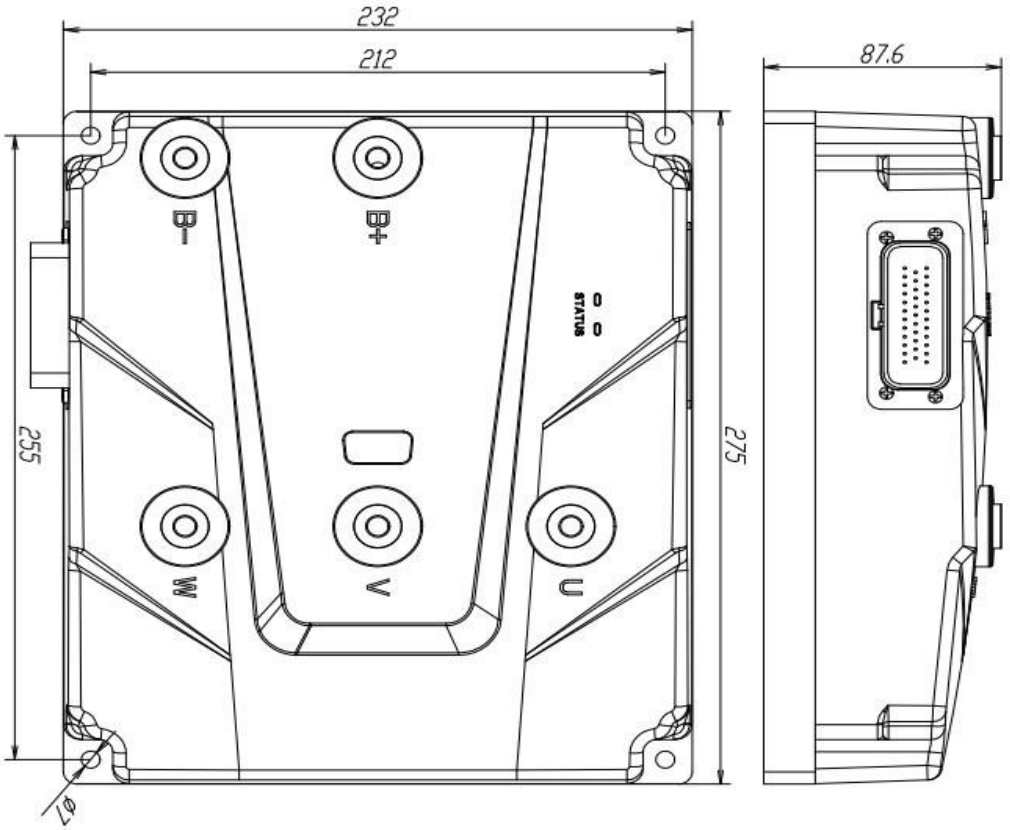
2. Overall dimensions of product



M series inverter dimension drawing



S series inverter dimension drawing



L series inverter dimension drawing

3. Interface definition

3.1 Installing and matching cables for inverter

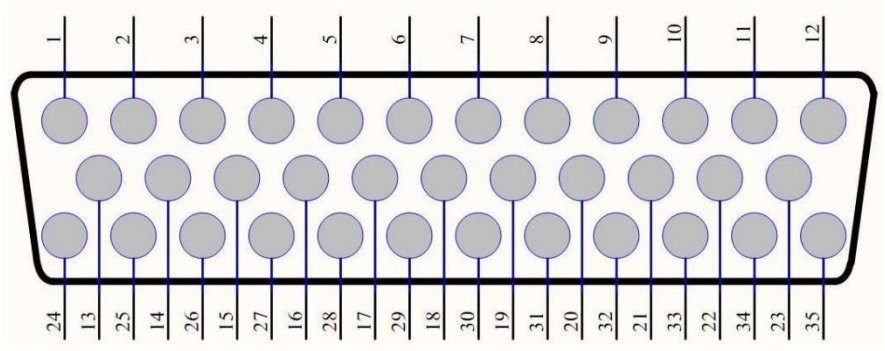
3.1.1 Power line cable selection

L Series inverters are recommended to match 50 mm^2 cables.
S and M series inverters are recommended to match 30-35 mm^2 cables.
The L and S screws are M8*12, and the M screws are M6*12.
When installing screws, the installation torque is 11N±1N (the torque of M inverter is 6±1N).

3.1.2 Inverter wiring definition

Number	Definition
B+	The positive electrode of the power supply is generally connected to the output of the main contactor.
B-	The negative electrode is connected to the negative electrode of the battery.
U	U-phase of three-phase motor
V	V-phase of three-phase motor
W	W phase of three-phase motor

3.1.3 Interface model and pin definition



The connector model AMPSEAL-35P(P/n-1-776163-1) and the plug model (P/n-1-776164-1)

M Series Pump-control Inverter Interface Defination

Interface No.	Function Definition	Interface No.	Function Definition
1	Key switch	19	Temperature sensor _L
2	+12V output connected to handheld programmer	20	Lifting throttle high end
3	+5V output	21	COS+ S1 cos+
4	Drive 3 (reserved)	22	SLN—S4 sin-
5	Drive 2 (lowering solenoid valve drive)	23	EXC+ R1 excitation+
6	Drive 1 (reserved)	24	+B Constant current
7	GND is connected to the negative pole of handheld programmer	25	GND
8	Drive 4	26	SW 7, buffer speed-down switch
9	SW 9(5V square wave signal input)	27	SW5, side shift switch
10	CAN_L	28	SW 3, power mode switch
11	CAN_H	29	Switch 1 (reserved)
12	CAN_Shield	30	Temperature sensor _H
13	Lowering solenoid return high end	31	Throttle lifting signal (0-5V)
14	SW 8, high position Speed-down Switch	32	Throttle lift low end
15	SW 6, attachment switch	33	COS—S3 cos-
16	SW 4, tilt switch	34	SLN+ S2 sin+
17	SW 2, safety mode switch	35	Exc-R2 excitation-
18	GND		

S & L Series Inverter interface Definition

Interface No.	Function Definition	Interface No.	Function Definition
1	Key switch	19	Digital signal output 6, handbrake alarm buzzer
2	EXC+ R1 excitation+	20	COS-S3 cos-

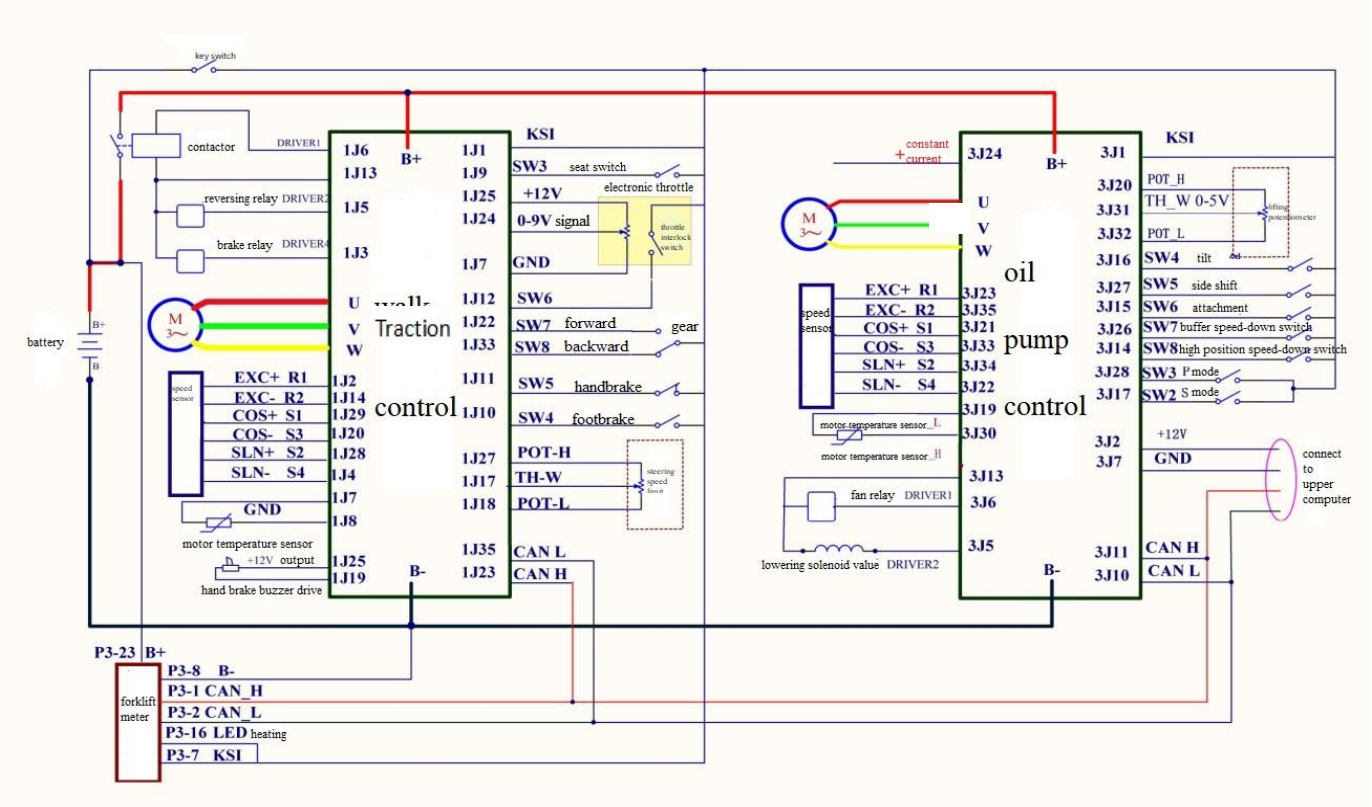
3	Driv 4, brake relay drive-	21	TX-DSP (serial port debugging sending reserved)
4	SLN—S4 sin-	22	SW 7, forward switch
5	Drive 2, the reversing relay	23	CAN_ H
6	Drive 1, main contactor drive	24	Analog input 1(0-9V) throttle signal
7	GND is used as negative pole of temperature sensor and negative pole of accelerator	25	+12V output throttle power supply and handbrake buzzer power supply.
8	Analog input 2, motor temperature signal acquisition	26	+5V output
9	SW 3, seat switch	27	Corner potentiometer high end
10	SW 4, brake switch	28	SLN+ S2 sin+
11	SW 5, handbrake switch	29	COS+cos+
12	SW 6, throttle interlock switch	30	No
13	High end of contactor drive reflow	31	No
14	EXC- R2 excitation-	32	No
15	High end of three-wire potentiometer (reserved)	33	SW 8, backforward switch
16	0-5V analog signal (reserved)	34	RX-DSP (serial port debugging reception reserved)
17	Signal input of corner potentiometer (0-5V)	35	CAN_L
18	Corner potentiometer low end		

3.2 Instrument wiring definition

3.2.1 Definition of P3-23 PIN interface (the connector model is 23-core plug -770680-1-AMP)

Terminal No.	Function Definition	Terminal No.	Function Definition
1	CAN_H	13	/
2	CAN_L	14	/
3	/	15	/
4	/	16	LED heating
5	/	17	/
6	/	18	/
7	KSI key	19	/
8	B-	20	/
9	/	21	/
10	/	22	/
11	/	23	B+
12	/		

4. Typical wiring diagram of PMSM forklift inverter



Different model has different wiring diagram.

Motor temprature sensor

Function module serial port

Control module serial port

5. Specification of configurable parameters of inverter

Inverter mode selection		
Parameter	Permitted Range	Description
Inverter mode	0-2	0 = speed mode 1 = torque mode 2 = Pump control mode
Speed mode		
Parameter	Permitted Range	Description
Max. speed	100-8000rpm	Define the maximum speed of the motor when the accelerator output is full. The accelerator output is proportional to the motor speed, for example, 50% of the accelerator output, and the motor speed is 50% of the maximum speed.
Kp	0-100%	Determine the strength of the speed loop to control the motor speed to match the given speed. The greater the value, the greater the control intensity. If the gain value is set too large, there may be chattering in the process of speed adjustment. If the gain value is set too small, the motor response will appear dull and difficult to control.
Ki	0-100%	The Ki determines the net difference of zero steady state, so the motor will run at a given speed accurately. The larger the value, the tighter the speed adjustment. If the gain value is set too large, there may be chattering in the process of speed adjustment. If the gain value is set too small, it will take a long time for the motor speed to approach the given speed accurately.
Acceleration rate of accelerator	0.1-30.0s	Set the speed at which the motor speed increases when the accelerator is increased. The larger the value, the slower the response.
Throttle deceleration rate	0.1-30.0s	Set the speed at which the motor speed decreases when the accelerator is reduced. The larger the value, the slower the response.
Braking rate	0.1-30.0s	Set the speed at which the motor speed decreases when the brake pedal is depressed or directly reversed. The larger the value, the response. The slower.
Reversing allowable speed	0-1000	When the absolute value of the vehicle speed is less than the parameter range, the reversing command will only respond.
Torque mode		
Parameter	Permitted Range	Description
Max. speed	200-8000rpm	Determine the maximum speed of the motor in the torque control mode. In the torque control mode, the full accelerator output corresponds to 100% of the torque output by the inverter, and the accelerator output is

		proportional to the torque value. For example, 50% of the accelerator output corresponds to 50% of the torque output by the inverter.
Kp	0-100%	Determine the intensity of the inverter's attempt to limit the motor speed to the maximum speed. The greater the value, the greater the control intensity. If the Kp value is set too large, when the motor speed is limited to the set maximum speed, there may be chattering. If the setting is too small, the motor speed will exceed the set maximum speed during adjustment.
Ki	0-100%	The Ki determines the net difference of zero steady state, so the motor speed will be limited to the set maximum speed. The larger the value, the faster the response. If the gain value is set too large, limit the motor speed to the set maximum speed, there may be chattering. If the setting is too small, it will take a long time to adjust the motor speed from the excessive speed to the maximum speed.
Kd	0-100%	The overshoot of the motor speed can be reduced. If the Kd value is set too high, it may take a long time for the motor to reach the maximum speed. If the setting is too small, the motor speed may exceed the maximum speed, especially when going downhill.
Rate of acceleration	0.1-30s	Set the rate of torque increase when the accelerator output increases. The larger the value, the slower the response.
Release rate of acceleration	0.1-2s	Set the rate of torque reduction when accelerator output decreases. If the value is set too small, the switch from acceleration to deceleration will appear sudden. If the value is large, the switch will be smoother. However, if the value is set too large, when the accelerator is reduced, the vehicle will not slow down for a short time, and it will feel like the vehicle is out of control.
Braking rate	0.1-5s	Adjust the speed at which the braking torque is established when the vehicle transitions from driving to braking. These states include direct commutation, brake pedal depression or neutral. The smaller the value, the faster the response, so the harder the braking. The larger the value, the smoother the braking.
Release rate of brake	0.1-2s	Adjust the rate of brake torque reduction.
Neutral braking force	0-100%	Neutral braking occurs when the accelerator output is reduced to zero or given neutral. The base of this values is limited by the regenerative current.
The speed at which the neutral braking force gradually decreases	200-6000rpm	When the accelerator output decreases and the motor speed is lower than this set value, the regenerative braking current will be adjusted in both positive and negative directions. When the speed of the motor is positive, and the speed drops from this value to 0, the neutral braking current linearly decreases from 100% to the current value at idle torque. When the motor speed is in the reverse direction and the speed increases from 0 to this value, the restraining force current linearly increases from the current value at idle speed to the set restraining force current value. Setting this value too small may cause chattering.

Idle torque	0-100%	Determine the torque at idle speed (with a given direction but no accelerator output). To emulate the function of automatic cars.
Brake setpoint required to offset idle torque	25-100%	Determine how much brake pedal output can completely offset the idle torque value.
The rate at which idle torque is established.	0.1-5s	When the direction is given, the speed at which the idle torque gradually increases.
Idle torque release rate	0.1-5s	The rate at which the idle torque gradually decreases when no direction is given.
Gear softness	0-100%	The establishment process of accelerator output is changed from linear to S-shaped. The larger the value, the greater the curvature of the S curve. When the speed increases to a certain extent, the softening effect will gradually disappear.
The speed at which the braking torque gradually decreases	200-6000rpm	When the motor speed decreases from this value to 0, the maximum braking current decreases from 100% to 0%. When this value is set too small, it may cause the vehicle to shake.
Reverse softness	0-100%	When the speed is close to 0, the larger this value is, the softer the switching from regenerative braking to driving will be.
Max. speed deceleration rate	0.1-30s	When the maximum speed is modified to become larger, the inverter gives the speed increase rate.
Maxi. speed acceleration rate	0.1-30s	When the maximum speed is modified, the inverter gives the speed reduction rate.

Pump control mode

Parameter	Permitted Range	Description
Max. speed	200-8000rpm	Maximum permitted output speed in pump control mode
Speed superposition enable	0/1	0 = prohibit, make each maximun given quantity of pump control (including power steering, lifting, tilting, etc.) the given speed of the inverter. 1 = enable, each given quantity of pump control is superimposed as the given speed of the inverter in turn, but it will not exceed the set maximum speed.
Main contactor enable	0/1	1: Interlocking disconnection delay = sequence delay+disconnection delay; 0: Interlock disconnection delay = sequence delay.
Pump controlled idle speed value	0-4000rpm	After interlocking, the given speed of the inverter without other given conditions.
Power steering speed	0-4000rpm	Only when the power steering signal is given, the given speed of the inverter.
Lifting speed	0-4000rpm	Only when the lifting signal is given, the given speed of the inverter.

Tilting speed	0-4000rpm	Only when the tilt signal is given, the given speed of the inverter.
Standby speed	0-4000rpm	A given speed that can be used as other switching signals.
Power steering stop delay	0-60s	Time for the motor to continue running after the steering signal disappears.
Pump throttle enable	0/1	In some applications, the lifting signal is not a switch value but an analog value. If enabled, analog input is used instead of switch input as the given speed of the inverter. When lifting in this way, the speed of the motor will change continuously with the input of analog quantity.

Suppression menu

Parameter	Permitted Range	Description
Forward slope velocity restraining force	0-100%	Without the accelerator given, the maximum restraining torque output by the inverter is used to reduce the slope speed of the vehicle when the vehicle slopes forward.
Backward slope speed inhibition force	0-100%	When there is no accelerator given time, the maximum restraining torque output by the inverter is used to reduce the rolling speed of the vehicle.
Flexible parking speed	0-500rpm	When the speed is lower than this set value, the inverter will brake at a smaller deceleration rate. If set to 0, there is no such function. This parameter only applies to speed mode.

Position keeping menu

Parameter	Permitted Range	Description
Position hold enable	0/1	Enable and disable of slope standing function. 0 = disable 1 = enable
Kp	2 – 100%	Proportional gain value of position adjustment. Increasing this gain value can reduce the backward sliding distance of the vehicle when parking on the slope, but it may cause jitter. If the setting is too small, the distance of the vehicle sliding backwards will become longer when parking on the slope.
Ki	2 – 100%	Reserved items.
Kd	0 – 100%	Differential gain value of position adjustment. If the gain value is set too large, jitter may occur during the position adjustment. If the setting is too small, the vehicle's backward sliding distance will be longer when parking on the slope.

Current limit menu

Parameter	Permitted Range	Description

Driving current limit	5-100%	The maximum driving current allowed by the inverter. Reducing this value will reduce the maximum driving torque of the inverter.
Regenerative current limit	5-100%	The maximum regenerative current allowed by the inverter. Reducing this value will reduce the maximum regenerative torque of the inverter.
Brake current limit	5-100%	When the output is effective, limit the maximum regenerative current given by the brake pedal.
Interlocking braking current limit	5-100%	The maximum regenerative current allowed by the inverter during interlocking braking.
Walking BDI restriction percentage	0-100%	When BDI is low, it will affect the output power limit value of tractor.
Power limit curve menu		
Parameter	Permitted Range	Description
Base speed value	100-4000rpm	Basic speed values used for driving limit curve and regeneration limit curve.
Delta step value	50-1000rpm	Δ step value used for driving limit curve and regeneration limit curve.
Base speed driving current	0-100%	These parameters define the driving current limiting ratio at different speeds, in which the speed is determined by the base speed value and the delta step value. This allows the inverter to increase or decrease the driving current according to the change of speed.
Base speed+Δ driving current	0-100%	
Base speed+2Δ driving current	0-100%	
Base speed +4Δ driving current	0-100%	
Base speed+8Δ driving current	0-100%	
Base speed regenerative current	0-100%	These parameters define the regenerative current limiting ratio at different rotating speeds, in which the speed is determined by the base speed value and the delta step value. This allows the inverter to increase or decrease the regenerative current according to the change of speed.
Base speed+Δ regenerative current	0-100%	
Base speed+2Δ regenerative current	0-100%	
Base speed+4Δ regenerative current	0-100%	
Base speed+8Δ regenerative current	0-100%	

Accelerator menu		
Parameter	Permitted Range	Description
Accelerator type	1-4	1 = two-wire potentiometer, 5kΩ-0 input 2 = three-wire 1kΩ-10kΩ potentiometer or 0-5v voltage source 3 = Two-wire potentiometer, 0-5k ohms input 4 = No accelerator
Forward starting voltage	0-5v	Given forward, it define the effective threshold voltage of accelerator output. Increasing this value will increase the empty travel range of large accelerator.
Forward midpoint percentage	0-100%	Given forward, it define the output percentage of half of the effective voltage of the accelerator ((forward starting voltage+ Forward terminal voltage)/2).
Forward terminal voltage	0-5v	Given forward, the accelerator output is 100% of the corresponding accelerator voltage. Select appropriate voltage value to ensure that the accelerator can have 100% output.
Forward starting voltage offset	0-100%	Given the offset corresponding to the starting voltage of the accelerator when moving forward.
Backward starting voltage	0-5v	Given backward, it defines the effective threshold voltage of accelerator output. Increasing this value will increase the empty travel range of large accelerator.
Backward midpoint percentage	0-100%	Given backward, it defines the output percentage of half of the effective voltage of the accelerator ((back start voltage+back terminal voltage) /2).
Backward terminal voltage	0-5v	When the accelerator output is set to retreat, it is the accelerator voltage corresponding to 100%. Select appropriate voltage value to ensure that the accelerator can have 100% output.
Backward starting voltage offset	0-100%	Given backward, the offset corresponding to the starting voltage of the accelerator.
High pedal/sequence fault type	0-3	0 = High pedal/sequence fault protection is prohibited. 1 = After the key is closed, check once whether the relevant inputs are operated in the correct order: first close the key, then close the interlock switch, and finally the given direction or throttle input is greater than 25%. When the key is not turned off but the interlock is turned off and the sequential delay time has passed, the inverter will continuously check whether the' interlock switch is closed' is before the' given direction or throttle input is greater than 25%'. 2 = After the key is closed, check whether the primary throttle input is less than 25%. When the vehicle is in a stable state (the vehicle speed is 0 for a short time), the inverter continuously detects whether the' interlock switch closed or given direction' is before the' throttle input is greater than 25%'. Regardless of the sequence of' interlock switch closed' and' given direction'. When the vehicle is in the running state (the vehicle speed is not 0), this sequence fault is not detected. 3 = After the key is closed, check whether the primary throttle input is less than 25%.

		The inverter continuously checks whether' interlock switch closed or given direction' is before' throttle input is greater than 25%'. Regardless of the sequence of' interlock switch closed' and' given direction'. The difference between Type 3 and Type 2 is that Type 2 only detects the sequence failure when the vehicle is in a stable state, while Type 3 continuously detects whether the input sequence is correct, that is,' the interlock switch is closed or the given direction' must be before' the throttle input is greater than 25%'.
Sequential delay	0-5.0s	Cooperate with the detection of high pedal/sequential fault type 1. It is helpful to prevent inadvertent triggering of high pedal/sequence faults, especially in situations where interlocking switches are frequently opened and closed.
Accelerator output too low voltage		The lowest voltage output when the accelerator pedal is trouble-free.
Accelerator output excessive voltage		The maximum voltage output when the accelerator pedal has no fault.

Brake menu

Parameter	Permitted Range	Description
Brake pedal enable	0/1	0 = the brake pedal is not enabled. 1 = enable the brake pedal
Type of brake pedal	1-4	1 = two-wire potentiometer, 5KΩ-0 input; 2 = single-ended three-wire 1KΩ-10KΩ potentiometer, 0-5V voltage source or current source; 3 = Two-wire potentiometer, 0-5KΩ input; 4 = On-off braking; Note: Do not change this parameter when the inverter is working. After the change, a parameter change fault will occur, which cannot be cleared until it is reset.
Brake starting voltage	0-5v	Refer to the accelerator configuration parameters, similar to the accelerator curve.
Brake midpoint percentage	0-100%	
Brake terminal voltage	0-5v	
Brake starting voltage offset	0-100%	
Effective level of brake	0/1	When the brake type is set to switch input, the effective level of the brake can be selected. 0 = low level is active 1 = high level is active.
Maximum output torque of brake	0-4096	As the maximum value for reference when calculating the braking rate. By matching with the braking rate, a suitable value can be selected to make the braking effect match different applications.

Low brake voltage output		The lowest voltage output when the brake pedal has no fault.
Excessive brake voltage output		The maximum voltage output when the brake pedal has no fault.
Main contactor menu		
Parameter	Permitted Range	Description
Main contactor detection enable	0/1	0 = Turn off contactor detection. 1 = Enable contactor detection. After enabling, the inverter will detect whether the main contactor is stuck or not and the main contactor is not closed, and also enable related fault detection.
Main contactor pull-in voltage	0-100%	The percentage of the voltage of the main contactor when closing to the current battery voltage, closing the main contactor with a higher closing voltage can ensure the complete closing of the main contactor, and the control of the main contactor after 1s. The terminal voltage is reduced to maintain voltage to reduce power consumption and heat generation.
Main contactor holding voltage	0-100%	The voltage that keeps the contactor engaged after the main contactor is engaged, expressed as a percentage of the current battery voltage.
Battery voltage compensation	0/1	0 = No battery voltage compensation is enabled; 1 = Enable battery voltage compensation; After being enabled, the holding voltage of the contactor is the percentage of the current battery rated voltage, which will not change with the change of the battery voltage. For example, the set holding voltage is 80% and the battery rated voltage is 48V. If this item is not enabled, the holding voltage = 80% of the battery voltage; if this item is enabled, the holding voltage = 48 *80% = 38.4VV. If the power supply voltage is higher than 48V, the driving will reduce the duty ratio to maintain the holding voltage.
Interlocking type	0/1	0 = Interlocking state is controlled by switch 3; 1 = The interlocking state is consistent with the key switch.
Interlocking delay	0-40.0s	After the interlock switch is opened, the main contactor will delay this set value before opening.
Unbuckle detection voltage	0-84V	The threshold voltage of the main contactor failure detection is not closed. When the difference between the key terminal voltage and the capacitor voltage is greater than this set value, it is regarded as the main contactor failure.
Precharge enable	0/1	0 = No precharging will be carried out inside the inverter, and the main contactor will be closed when the condition of closing the main contactor is met. 1 = The inverter will be precharged internally, and the main contactor will be closed after the capacitor voltage is charged to a certain value, which will also enable the relevant fault detection.

Fault detection menu		
Parameter	Permitted Range	Description
Drive 1 detection enable	0/1	These five parameters can configure whether to detect the five-way drive. When a certain drive detection is enabled, it will detect the open circuit of the corresponding drive circuit. When the fault is detected, the inverter will turn off the corresponding drive circuit and report the failure. If the corresponding load is not connected to the driving circuit, the corresponding fault detection should be turned off to avoid affecting the normal function. For short circuit protection, the inverter is always enabled, regardless of whether the detection is enabled or not.
Drive 2 detection enable	0/1	
Drive 3 detection enable	0/1	
Drive 4 detection enable	0/1	
Drive 5 detection enable	0/1	
Maximum current of auxiliary power supply	0-200mA	Maximum current limit of external +5V and +12V outputs. When this limit is exceeded, the inverter will turn off the output and report a fault.
Minimum current of auxiliary power supply	0-200mA	The minimum current limit of external +5V and +12V outputs, below which the inverter will turn off the output and report a fault.
Motor menu		
Parameter	Permitted Range	Description
Inverter current limiting value	0-650A	The maximum line current that the inverter can bear, this parameter cannot be changed at will to ensure that the inverter will not be damaged.
Motor temperature control menu		
Parameter	Permitted Range	Description
Temperature sensor enable	0/1	When this parameter is set to 1, the inverter will protect the temperature of the motor. When the temperature exceeds the overtemperature point, the output power will be linearly reduced, and the output will be turned off until the severe overtemperature point is reached.
Temperature sensor type	1-5	The five sensor types are as follows: 1 = KTY83-122 2 = Reserved 3 = KTY84-130 or KTY84-150 4 = Reserved 5 = PT1000
Motor temperature compensation	-20-20℃	Through this configuration, the consistency problem of different motor temperature sensors can be corrected to achieve accurate display.
Motor overtemperature value	0-250℃	When the motor temperature reaches the set value, the inverter will give an alarm and start linearly reducing the output power. When the temperature is lower than the set value, the warning will be lifted.

Maximum temperature value of motor	0-250℃	When the motor temperature reaches this set value, the inverter will perform output shutdown protection. Once it enters this shutdown protection, even if the temperature is lower than this set value again, the inverter needs to restart the key to remove the fault.
Turning speed limit function		
Turn speed limit enable	0/1	Whether the turning speed limit function is enabled.
Minimum allowable turning speed limit	0-3000	When the vehicle speed is higher than this value, the turning speed limit function is effective, but it is invalid when the vehicle speed is lower than this value.
Turning voltage midpoint	0-500	The voltage value output by the sensor when the vehicle is not turning.
Limit percentage corresponding to midpoint+△	0-1000	Speed limit ratio within △ angle.
Limit percentage corresponding to midpoint +2△	0-1000	Speed limit ratio within 2△ of rotation angle.
Turning left dead angle voltage	0-500	Dead-time voltage value when turning left.
Turning right dead angle voltage	0-500	Dead-time voltage value of right turn.
Turn-up delay	0-300	Recovery time after speed limit is cancelled.
Speed limit delay	0-300	Action time after turning speed limit is triggered.
Battery menu		
Parameter	Permitted Range	Description
Nominal voltage	24.0-84.0V	The nominal voltage of the whole vehicle battery, this parameter is very important, which involves the voltage protection of the battery and the electrical system of the whole vehicle. Overvoltage protection will reduce regenerative braking current, which can avoid the damage of batteries and other electrical system parts caused by overvoltage; Under-voltage protection prevents the system from working under the design threshold, and can effectively prevent the battery from over-discharging, thus protecting the battery more effectively. User-defined under-voltage value and user-defined over-voltage value are calculated by nominal voltage. Note: The inverter with low rated voltage can't be used in high voltage system, for example, the inverter with 36-48V can't be used in 60V system, which may cause the capacitor and power tube to be damaged due to overvoltage, while the system with high rated voltage can be properly

		compatible with low voltage and its power is less than that of the original inverter, otherwise the inverter may not be able to provide the required current due to the limitation of capacitor capacity. Please contact Santroll for details.
User-defined overvoltage value	115-200%	The overvoltage value that can be set by the user is set according to the performance requirements of the battery and the highest voltage that the electrical system of the whole vehicle can bear. The base of the overvoltage value is the nominal voltage of the battery. For example, if it is set to 120% and the nominal voltage is 48V, the protection voltage is 120% * 48 = 57.6V.
User-defined undervoltage value	50-80%	The user-settable undervoltage value is set according to the performance requirements of the battery and the lowest voltage that the electrical system of the whole vehicle can bear. The base of the overvoltage value is the nominal voltage of the battery. For example, if it is set to 80% and the nominal voltage is 48V, the protection voltage is 80% * 48 = 38.4V.
Undervoltage power reduction range	2.0-14.0V	The voltage difference corresponding to the inverter's drive current decreasing from 100% to 0%, and the inverter's severe undervoltage value can be set by this parameter. For example, if the power reduction range is set to 10V, the severe undervoltage value = undervoltage value -10V.
Overvoltage power reduction range	2.0-14.0V	When the brake current of the inverter drops from 100% of the set brake current to 0% of the corresponding voltage difference, the severe overvoltage value of the inverter can be set by this parameter. For example, if the power reduction range is set to 10V, the severe overvoltage value = overvoltage value +10V, which must be lower than the maximum voltage of the inverter.
The maximum voltage of the inverter	0-125.0V	The highest voltage that the current inverter can bear.
Monomer reset voltage	0-300	The voltage value at which the battery is fully charged to meet the reset condition.
Monomer full voltage	0-300	The voltage value of the battery when the battery is fully charged.
Monomer empty voltage	0-300	Cell voltage value when the battery is zero.
Minimum discharge time	0-600	When the voltage decreases continuously for more than this value when the battery is discharged, BDI decreases.
Maximum percentage of BDI reset compare	0-100	When the current BDI value is greater than this value, power on again. Even if BDI reaches the reset voltage, it will not perform a reset action.
Low battery warning value	0-100	When BDI power is lower than this value, the inverter reports a fault and sends it to the instrument.
Interlocking brake menu		
Parameter	Permitted Range	Description

Interlock brake enable	0/1	Enable the interlocking braking function of the inverter? 1 = When the interlock signal is cancelled, the inverter stops the brake according to the deceleration rate set by the interlock brake; 0 = When the interlock signal is cancelled, the inverter will brake at the normal deceleration rate.
Deceleration rate at high speed	0.1-30.0s	When the interlock switch is turned off, set the deceleration rate (seconds) of the vehicle in the high-speed section. The larger this value is, the slower the response of the system will be.
Deceleration rate at low speed	0.1-30.0s	When the interlock switch is cancelled, set the deceleration rate (in seconds) of the vehicle in the low speed section. The larger this value is configured, the slower the system will respond.
Extra (custom) menu		
Parameter	Permitted Range	Description
Speed/speed ratio coefficient	10.0-3000.0	According to the motor speed, it is converted into the actual vehicle speed. When setting this parameter, you need to know the variable ratio (G) of the vehicle and the diameter (D) of the wheels. Assuming that the unit of wheel diameter is cm, k =（G/d）*530.5.
Vehicle mode type	0 – 3	0 = custom mode 1 = economic mode 2 = power mode 3 = Super Mode
Reverse speed	0 – 100%	Configuration items can reduce the speed of reversing, and can be set to different percentages according to different vehicle requirements. When set to 100%, the maximum reverse speed is same as the forward speed.
The maximum speed displayed by the instrument	200 – 8000rpm	The maximum speed of the speed bar displayed on the corresponding instrument.
Slope inhibition Kp	0-100	Parameters used in the adjustment of the speed loop of the slope are used to adjust the initial torque of the slope, and generally do not change.
Slope inhibition Ki	0-100	Parameters used in the adjustment of the ramp speed loop are used to adjust the ramp maintenance torque, and generally do not change.
Allowable speed of sliding slope	10-3000rpm	Speed of motor when sliding.

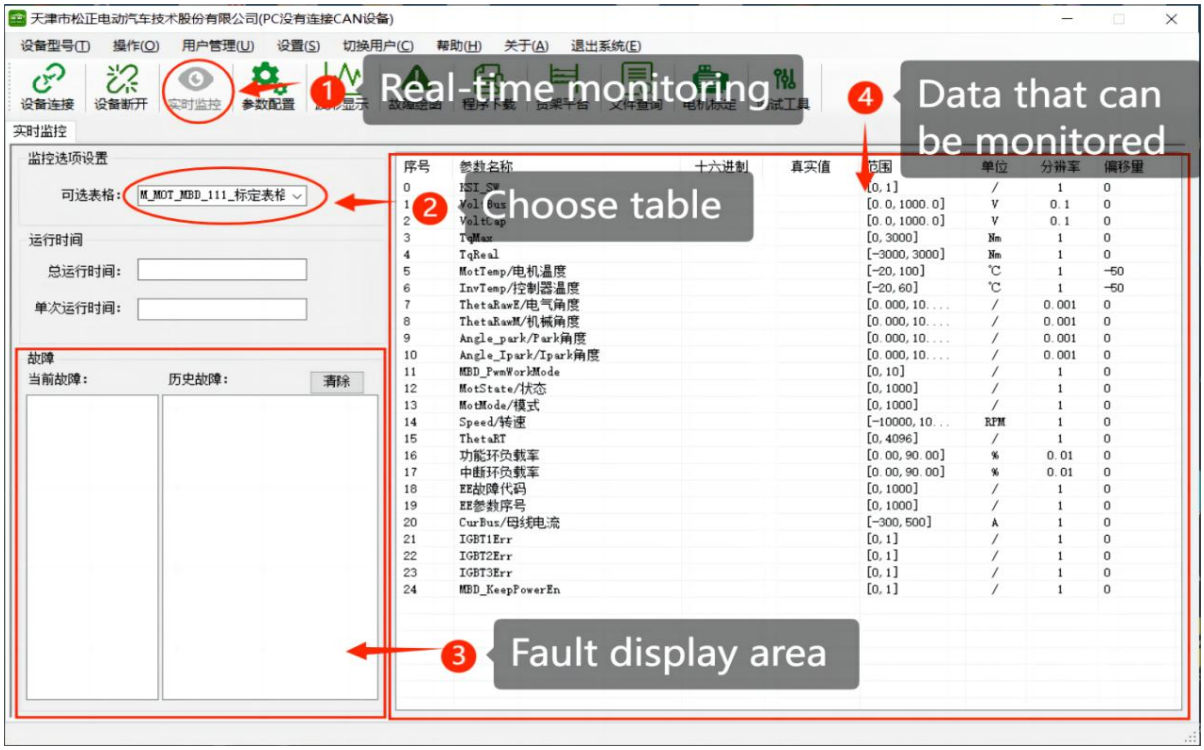
6. Common faults and codes of inverters

No.	Fault	Fault judgment	Fault handling	Fault exit condition	Fault level
1	Phase current sensor	AD of phase current acquisition is too large or too small during initialization.	Close tube	No recovery	3
2	Motor stall	The motor speed is 0 and still outputs a certain torque.	0 torque	The motor has a certain speed when it outputs torque.	2
3	Overcurrent 2	The phase current exceeds threshold 2.	Close tube	No recovery	3
4	Overcurrent 1	The phase current exceeds threshold 1.	Linear recovery in 1 second after 0 torque.	The phase current is less than half of threshold 1.	2
5	Overvoltage 3	Bus voltage exceeds overvoltage threshold 3.	Close tube	No recovery	3
6	Overvoltage 2	Bus voltage is greater than overvoltage 2 threshold.	Electricity feedback 0 torque	Bus voltage is less than overvoltage 2 threshold.	3
7	Overvoltage 1	Bus voltage is greater than overvoltage 1 threshold and less than overvoltage 2 threshold.	Electricity feedback coefficient limitation	Bus voltage is less than overvoltage 1 threshold.	2
8	Undervoltage 1	When the main contactor is engaged, the bus voltage is greater than the undervoltage 2 threshold and less than the undervoltage 1 threshold.	Driving coefficient limit	Bus voltage is greater than undervoltage 1 threshold.	2
9	Undervoltage 2	When the main contactor is engaged, the bus voltage is less than the undervoltage 2 threshold.	Drive 0 torque	Bus voltage is greater than undervoltage 2 threshold.	2
10	Undervoltage 3	The bus voltage is lower than the threshold value of 3 when the main contactor is engaged.	Close tube	Bus voltage is higher than threshold 3 or main contactor is disconnected.	3
11	Overspeed 2	Motor speed exceeds overspeed 2 threshold.	Close tube	No recovery	3
12	Overspeed 1	Motor speed exceeds overspeed 1 threshold.	Drive 0 torque	Motor speed is less than overspeed 1 threshold -100.	3

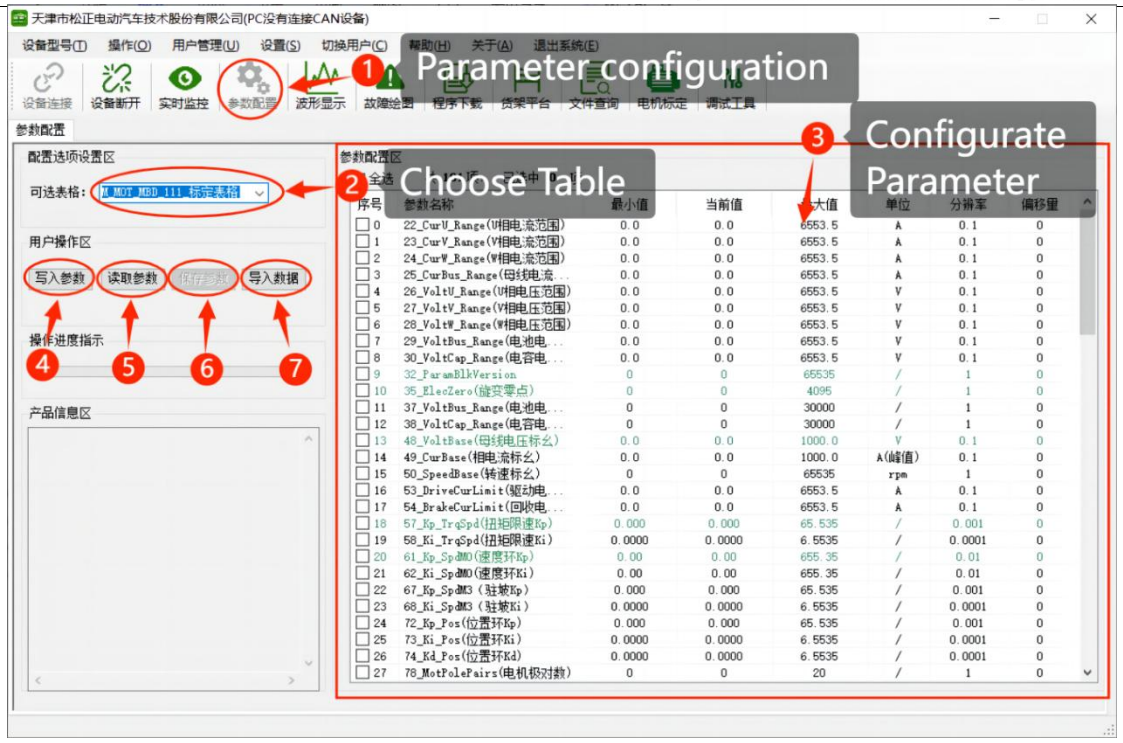
13	Motor overtemperature 3	Motor temperature exceeds overtemperature 3 threshold.	0 torque	No recovery	3
14	Inverter overtemperature 3	Inverter temperature exceeds overtemperature 3 threshold.	0 torque	No recovery	3
15	Encoder	The encoder is malfunction	Close tube	No recovery	3
16	Motor overtemperature 2	Motor temperature exceeds overtemperature 2 threshold.	0 torque	Motor temperature is less than overtemperature 2 threshold.	3
17	Motor overtemperature 1	Motor temperature exceeds overtemperature 1 threshold and is less than overtemperature 2 threshold.	Torque coefficient limit	Motor temperature is less than overtemperature 1 threshold.	2
18	PT1000#1(-50~200℃)	PT1000#1 resistance is out of range.	Alarm	The resistance of PT1000#1 is within the normal range.	1
19	PT1000#2(-50~200℃)	PT1000#2 resistance is out of range.	Alarm	The resistance of PT1000#2 is within the normal range.	1
20	EepRom	The value written in Eeprom is out of the maximum and minimum range.	Alarm	Modify the value in eeprom within a reasonable range.	1
21	VCU instruction communication	The instruction message is not received within a certain period of time.	0 torque	Received instruction message	3
22	VCU restricted communication	The instruction message is not received within a certain period of time.	0 torque	Received instruction message	3
23	Active discharge timeout	The discharge time exceeds the threshold and the voltage exceeds 36V	Alarm	The voltage is below 36V.	1
24	Inverter overtemperature 2	Inverter temperature exceeds overtemperature 2 threshold.	0 torque	Inverter temperature is less than overtemperature 2 threshold.	3
25	Inverter overtemperature 1	The inverter temperature exceeds the overtemperature 1 threshold and is less than the overtemperature 2 threshold.	Torque coefficient limit	Inverter temperature is less than overtemperature 1 threshold.	2
Fault level of electronic control system		**0: No fault** **1: First-class fault (linear torque limit)** **2: Second-class fault (0 torque)** **3. Three-class failure (close tube)**			

7. Introduction to the instructions of the upper computer

The following figure shows the monitoring interface of the upper computer. In Figure 2.6.2, the real-time parameters, faults and historical faults of the motor can be viewed under the real-time monitoring interface.



The following figure below shows the upper computer parameter configuration interface. Under this interface, users can configure parameters by themselves. ④ is writing the modified parameters into the inverter, ⑤ is reading the parameters stored in the inverter, ⑤ is saving all the parameters into the computer, and ⑦ is writing the parameters in the table saved in the computer into the inverter.



Fault records are divided into current fault and historical fault. The current fault feedback is shown in the fault area of Figure 7.1 and Figure 7.2, and the historical fault is only shown in the fault removal of Figure 7.1.

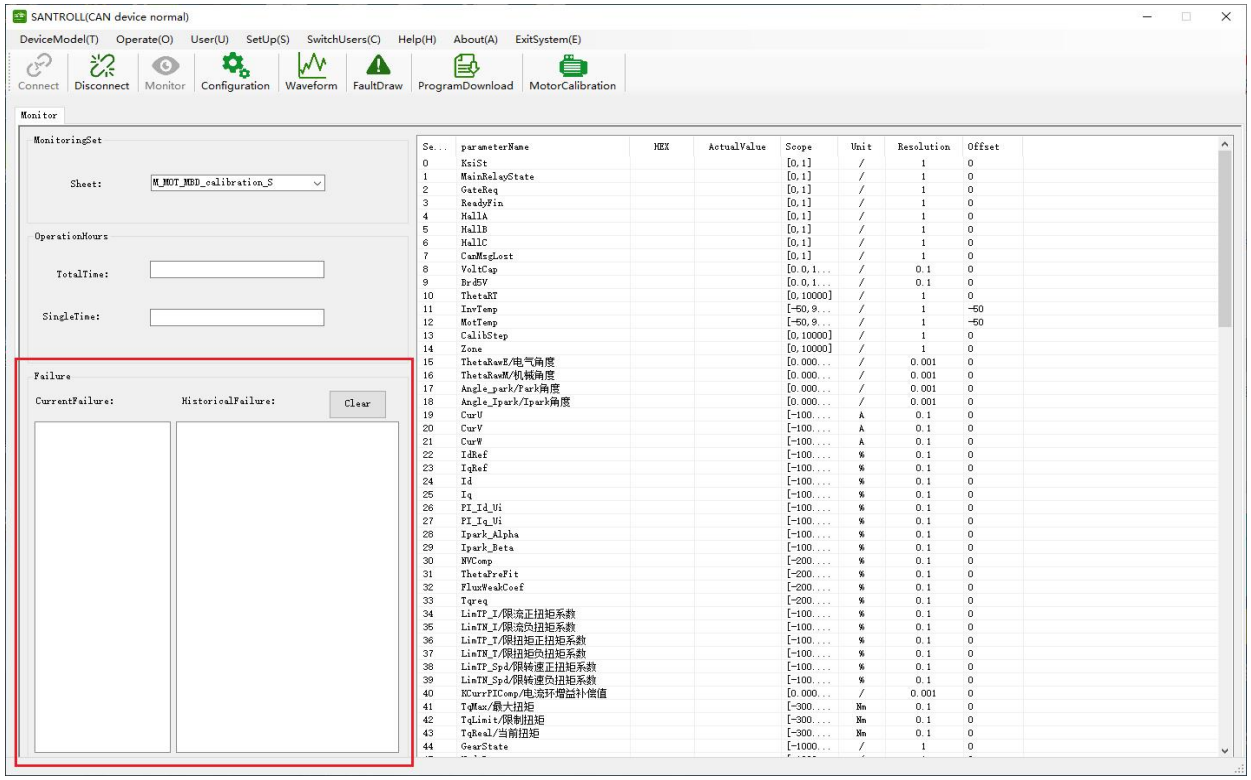


Figure 7.1 Real-time monitoring interface fault area

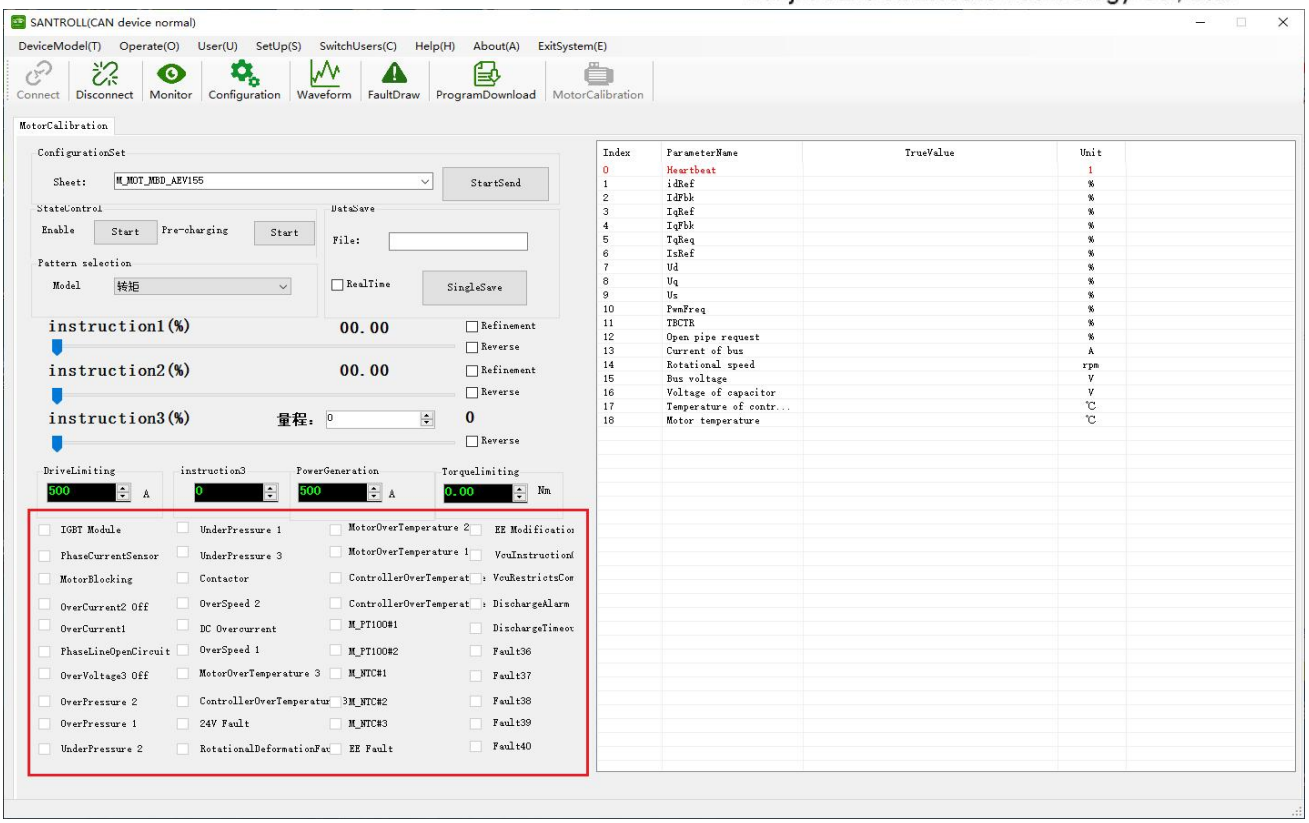


Figure 7.2 Fault area of motor calibration interfac