

Instructions for using Intelligent Capacitors





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Notice

This manual is only for person who is responsible for installation, maintenance and operation.

1. This type capacitor bank (compensation bank) must use knife switch or MCCB
2. To install this product, connection wire must be strictly according to this manual
3. Before power on, all terminals must be tightened (reminder: transport vibration may make screw loose)
4. Before operation, please confirm the current sampling, communication, control function is normal
5. The environment and power supply must meet the requirement of product, this product can not used on the place where harmonic more than 5%, when the harmonic more than 5%, please use our harmonic restraining series products.

I. General

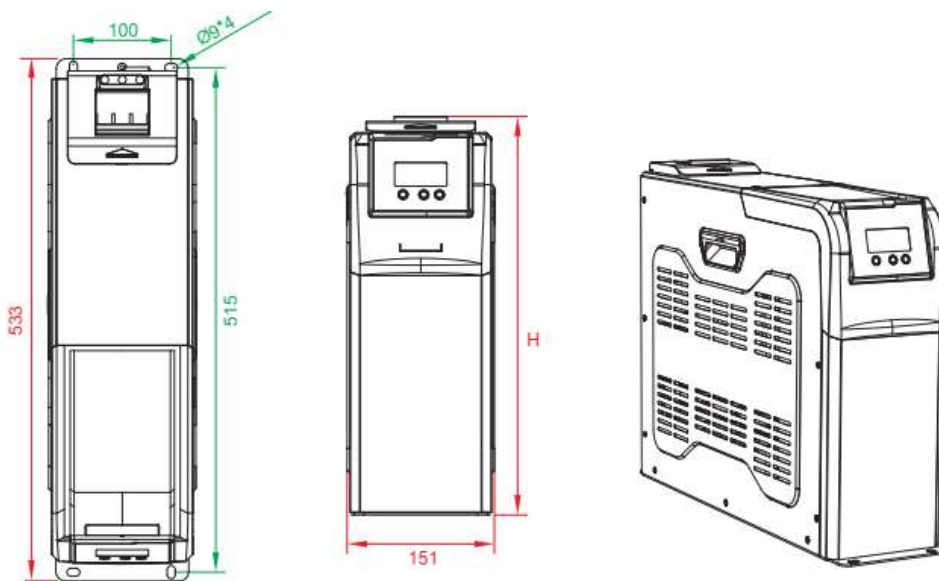
Working in a 0.4kv low voltage network, the intelligent reactive compensation installation (intelligent combination type low voltage energy saving power capacitor) can reduce line loss, raise power factor, improve power quality, and energy-saving. It combines advanced technologies like modern measurement and control, power electronics, network communication, auto-control, and power capacitor. Compared with traditional reactive compensation installations, it is smaller, cheaper, more cost-saving, more flexible, more convenient to maintain, with less power consumption, longer life span and more reliability, meeting a higher demand of modern power grid for reactive compensation.

1.1 Types and meanings

1	2	3	4		5	6		7
B	IC	3	7	-	48	10	/	10

1	Producer: BTB Electric	5	Capacitor voltage: 25: 250V; 30: 28: 280V; 30: 300V; 45: 450V; 52: 525V
2	Code: Intelligent Capacitors		
3	3: 3phase; 1: 1phase	6	Capacitor capacity: 10: 10kVAR; 20: 20kVAR...
4	Inductance ratio: 7% or 14%	7	Capacity of 2nd capacitor (if any)

1.2 Exterior and mounting size



Note:

The installation size is 50mm× 375mm.

The installation distance between two capacitors is ≥ 50 mm.

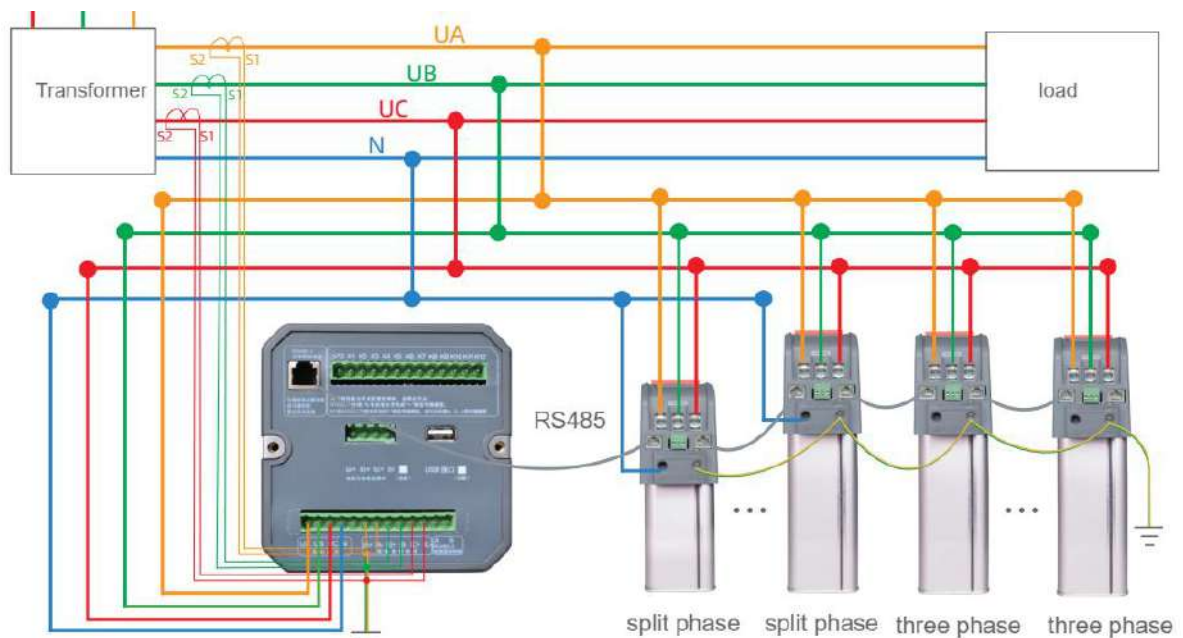
II. Connection diagram

2.1 2.1 Diagram of capacitor control via PFR-Z32 controller

Diagram used for both 3-phase capacitors and 3-phase phase-separated switching.

The maximum number of control capacitor steps is 32 steps

S1 to "+", S2 to "-"



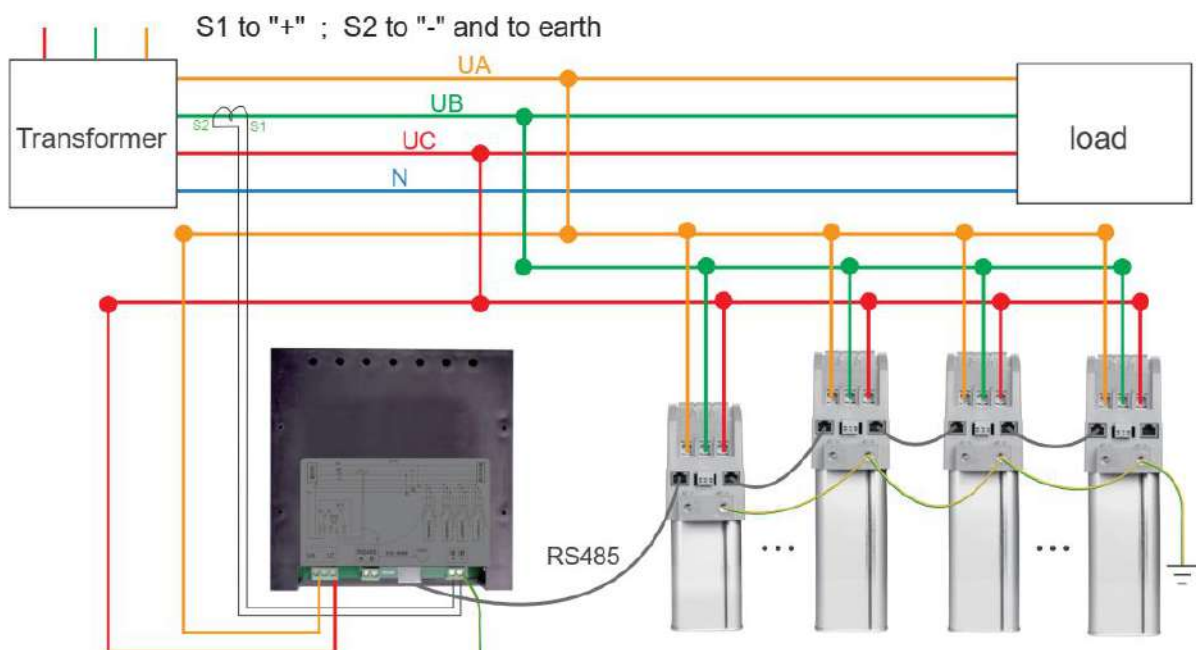
Note: S1 is connected positive pole,
S2 is connected negative pole and grounded

2.2 Diagram of capacitor control via PFR-Z20 controller

Diagram used for all 3-phase capacitors.

The maximum number of control capacitor steps is 20 steps

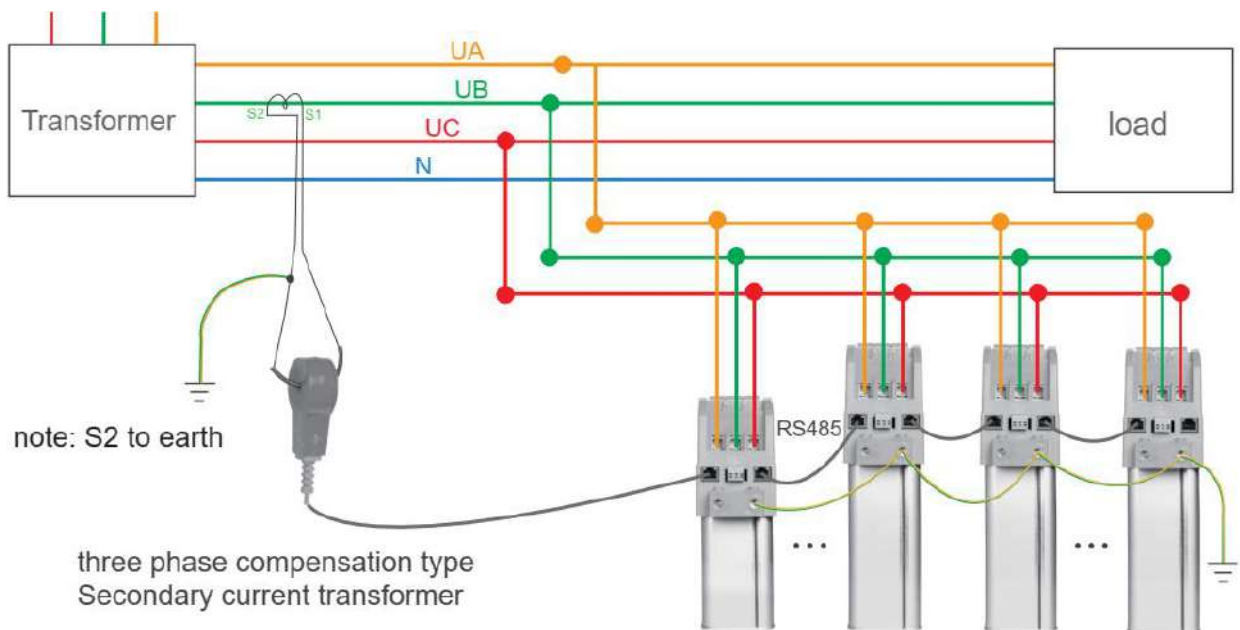
S1 to "+", S2 to "-"



2.3 Diagram of capacitor control via 1-phase secondary current transformer

Diagram used for 3-phase capacitors

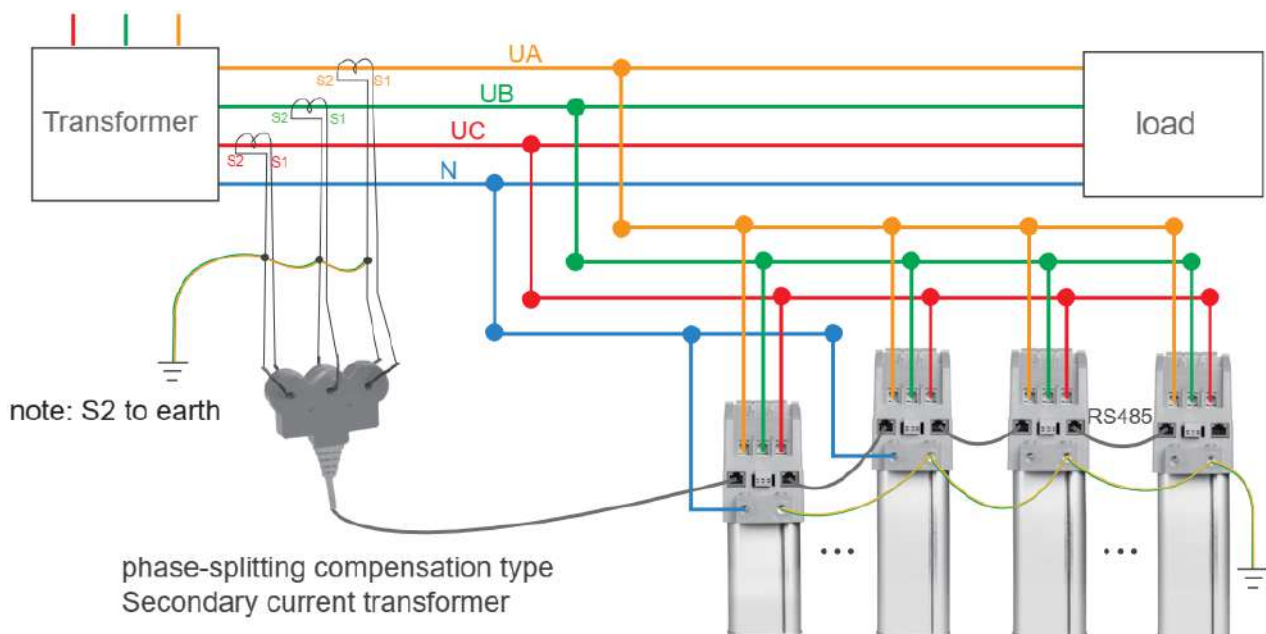
The number of control steps is single step (1 capacitor step) and multi-step capacitor (≤ 30 capacitor steps)
S1 to "+", S2 to "-" and earth



2.4 Diagram of capacitor control via 3-phase secondary current transformer

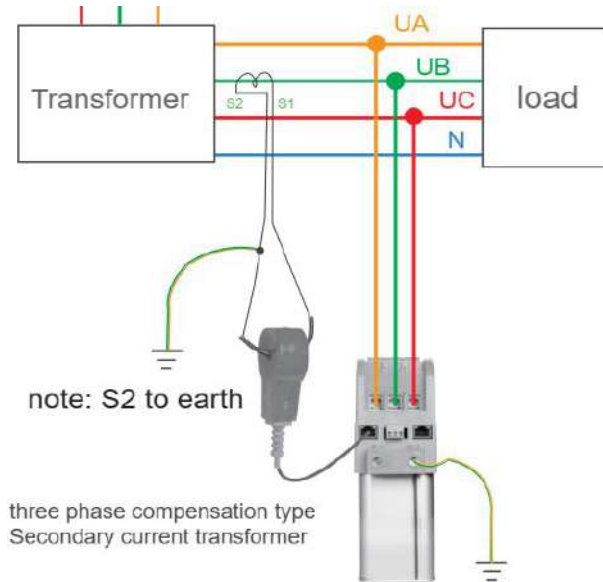
Diagram used for 3-phase capacitor switching and phase separation

The number of control steps is single step (1 capacitor step) and multi-step capacitor (≤ 30 capacitor steps)
S1 to "+", S2 to "-" and earth

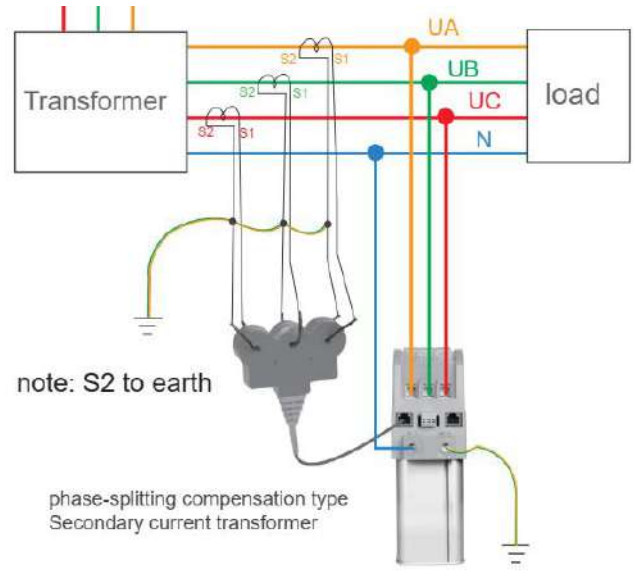


2.5 Diagram of controlling a single capacitor through a secondary current transformer

- Connect the 3-phase capacitor to operate independently

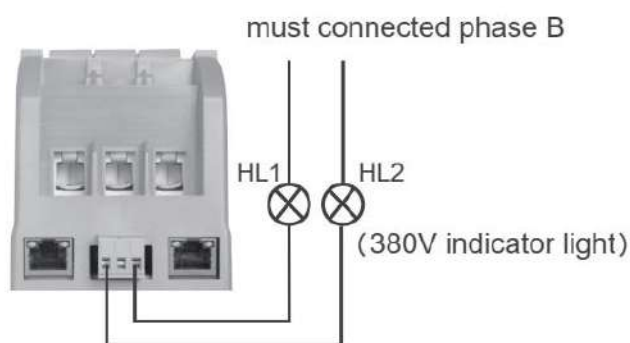


- Connecting a 3-phase capacitor operates in phase separation when operating independently

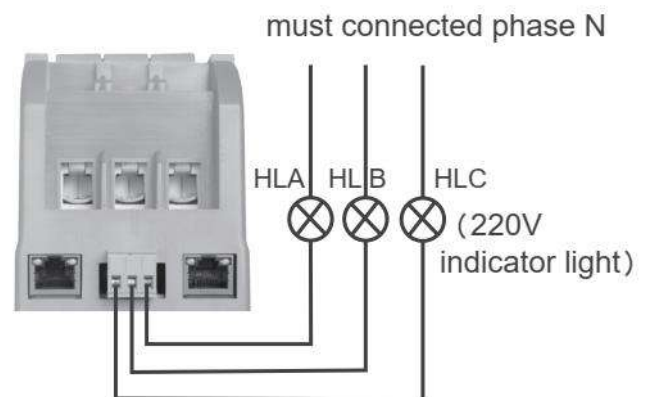


2.6 Wiring diagram of indicator light showing the operating status of the capacitor

- Connect the 3-phase capacitor C1 and C2 operating status indicator



- Connect the operating status indicator Ca, Cb, Cc to the 3-phase capacitor for phase-separated operation



III. Connection of power line

The total capacity of capacitor	5 ~ 15 kVAr	20 ~ 35 kVAr	40 ~ 70 kVAr
Multi-core copper wire cross-sectional area A, B, C, N	10 mm ²	16 mm ²	25 mm ²
Minimum cross-section of copper wire connected to ground (E)	2,5 mm ²		

- Note:**
- Select copper cables with corresponding specifications. Tighten the screws and pull the wires to ensure the connection is secure enough or the connector will become too hot and cause damage to the capacitor.
 - The phase separation compensation must be connected to the neutral line (N) with a diameter equal to the three-phase power supply line.
 - The ground wire must be well connected and connected to the station's grounding system.

IV. Check before turning on the switch

4.1 Check before turning on the power switch

- If line is well connected, phase sequence is connected right?
- Check using multimeter buzzer to see if short-circuit occurs between phase lines, phase and grounding line.
- Signal line plug-type connection must be secure and reliable.

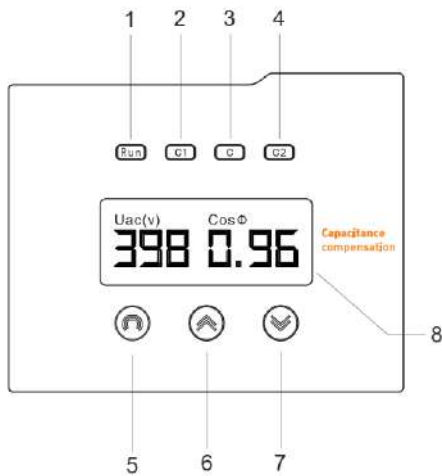
4.2 Check after turning on the power switch

- Set the primary current transformer ratio
- When power switch is turned on, the interface displays "HY □□□", after approx. 1s, the system enters communication network mode, the interface displays : "- - -", within 60s, each capacitor shows "Adr001" , "adr002"... address code, it means communication networking successful.
- Without controller, systems assigned one capacitor as master automatically, master address is "Ad-000" , slave address will be 001, 002
- When the master display "000" after approx. 180s, it will enter automatic running mode based on factory default value 100 (100 is ratio of primary current transformer)
- If the ratio of primary current transformer is not 100, the master will enter automatic identification of variable ratio of primary current transformer mode, it takes long time (our suggestion: set the ratio of primary current transformer in the master by manual, eg:600/5 set 120)
- Setting method: for three phase compensation type, see page no.7, under the setting mode, interface display "05 100", then set the ratio; for phase-splitting compensation type, see page no.9, under setting mode, interface display "04-100", then set the ratio.
- With controller (please set the ratio of primary current transformer in the controller, for example 500/5 set 100) setting method: see manual of controller, after setting, system enters the automatic running status.

- Note:**
- In section 16, set the discharge time for the capacitor (waiting time before re-closing the next time).
 - For 3-phase capacitors, it can be set to 10s – 180s, the default value is 90s, we recommend setting it to 90s – 180s
 - For 3-phase capacitors with phase separation, it can be set to 10s – 180s, the default value is 30s, we recommend setting it to 30s – 180s

V. Settings 3-phase capacitor

5.1 Operating interface



No	LED/ Name	Instruction
1	Run	System is in auto running status when green indicator light is on System is in manual running status when red indicator light is on System is in Analog status when doublecolor indicator light is on
2	C1	The first capacitor is working
3	C	N/a
4	C2	The second capacitor is working
5	⌂ "menu"	Press menu button (automatic state: circular display parameters) (under manual, debugging, setting state, back to automatic state) usage of combination keys see operating instructions
6	^ "up"	Press down (setting state), cutting off manually (manual state)
7	∨ "down"	Press down (setting state), cutting off manually (manual state)
8	LCD	Display of faults, setting and measuring parameters

5.2 Operating parameters

In the automatic operating state, press the "menu" key to access and view the parameters V, I, THD, Adr...

No	Display legend	Description
1	380 0.86 Uac(V) cos Φ	UAC(V), power factor
2	2.50 82.3 Ib(A) Q(kvar)	secondary current value of phase B(A), total reactive power
3	045 045 tc1(°C) C1 tc2(°C) C2	temperature of capacitor (C1) & (C2)
4	00.0 00.0 IA(A) C1 IB(A) C2	Current of phase A and phase B capacitor (A)
5	00.0 - 00 IC(A) C1 CODE C2	Current of phase C capacitor, switch on and off error code

No	Display legend	Description
6	Adr 00 1	The capacitor communication address
7	7Hd - 0.0 Uac(V)	THDV (V)(Uac)
8	7Hd - 0.0 Ib(A)	THDI (Ib)
9	Err - 00	warning code details see page no.12
10	Srr - 00	Quantity of slave

Note: as master, eg." Srr-00" show quantity of slave, as slave, eg"" Srr-00" without any meaning

5.3 Setting status

Systems is under automatic running status, ("running" LED indicator light in green), simultaneously press up and menu button, and then released immediately, systems enters setting status.

And then press "menu" button, contents display relative data according to following legend.

Press "up" button to increase the setting parameters, press "down" button to decrease the setting parameters, setting parameters are saved automatically. press "menu" button to return to automatic running status

No	Display legend	Description
1	01- 20.0 C1 Q(kvar)	Capacity of capacitor (C1) Kvar
2	02- 10.0 Q(kvar) C2	Capacity of capacitor(C2) Kvar
3	03- 0.96 cos Φ	Power factor switching threshold
4	04- 0 10	Switching time delay(S)
5	05- 100	Ratio of current transformer
6	06 001	The capacitor communication address
7	07 060 tc1(°C)	Temperature protection value (°C)
8	Over voltage 08- 4 32 Uac(V)	I grade over voltage protection value (V)

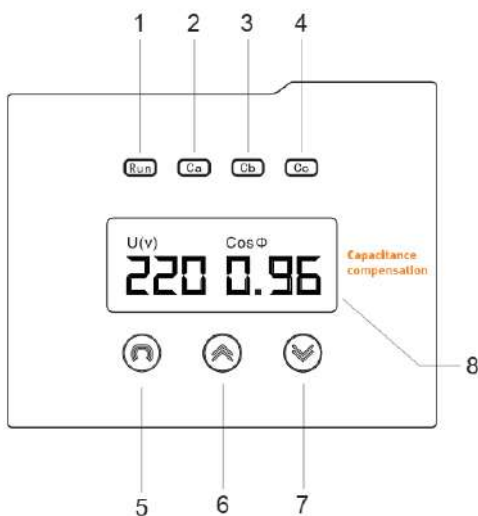
No	Display legend	Description
9	Over voltage 09- 4 49 Uac(V)	II grade over voltage protection value (V)
10	Under voltage 10- 2 90 Uac(V)	Under voltage protection value (V)
11	Over voltage 11- 0 05 Uac(V)	over THDV protection threshold
12	Over current 12 - 0 10 Ib(A)	Over THDI protection threshold
13	13 - 0 10	Alarm time judgment (S)
14	14 - 1.3 IA(A) IC(A) IB(A) C1 C2	Over current multiples of capacitor
15	under current 15 - 100 Ib(A)	Secondary down current threshold (mA)
16	16 090	Capacitor discharge time (S)

Note:

- Legend No. 06(The capacitor communication address):
 - Under the legend no.06 interface, press "menu" button, just skip it, systems is in automatic communication internet status.
 - if press "up" or "down" button, it will be considered as manual intervention, when manual intervention, the biggest value ≤ 20 or (≤ 32), it based on the biggest internet quantity of controller or master. After manual intervention, if need to enter automatic communication internet status manually, please set value :255.
- Legend No. 08 (over voltage protection): Voltage exceed I grade protection value, capacitor didn't switch on and off, stop to response
- . Legend No. 09 (over voltage protection): Voltage exceed II grade protection value, capacitors which switched on will be cutted off one by one automatically, quit working
- Legend No. 16(capacitor discharge time):
 - Combination switch type: factory default is 30s (adjusted from 30s to 180s)
 - Synchronous switch type: factory default is 90s (adjusted from 90s to 180s)

VI. Settings 3-phase capacitors for phase separation

6.1 Operating interface



No	LED/ Name	Instruction
1	Run	System is in auto running status when green indicator light is on System is in manual running status when red indicator light is on System is in Analog status when doublecolor indicator light is on
2	Ca	The capacitor of phase A is working
3	Cb	The capacitor of phase B is working
4	Cc	The capacitor of phase C is working
5	⌂ "menu"	Press menu button (automatic state: circular display parameters) (under manual, debugging, setting state, back to automatic state) usage of combination keys see operating instructions
6	^ "up"	Press down (setting state), cutting off manually (manual state)
7	∨ "down"	Press down (setting state), cutting off manually (manual state)
8	LCD	Display of faults, setting and measuring parameters

Operating parameters

6.2 In the automatic operating state, press the "menu" key to access and view the parameters V, I, THD, Adr...

No	Display legend	Description
1, 2, 3	220 0.86 U(V) phase A cosφ	Display voltage and power factor of phase A, B and C in turn
4, 5, 6	1.46 16.3 I(A) phase A Q(kvar)	Display secondary current and reactive power of phase A, B and C in turn
7, 8, 9	7.1R - 7.8 U(V) phase A	Display THDV of phase A, B and C in turn
10, 11, 12	7.1R - 2.3 I(A) phase A	Display THDI of phase A, B and C in turn
13	035 035 t(°C)	Temperature of capacitor

No	Display legend	Description
14	20.5 20.5 CIA(A) phase A phase B	Current of phase A and B capacitor
15	IC(A) CODE 20.5 - 7.7 phase C	Current of phase C capacitor, switch on and off error code
16, 17, 18	E r R - 20 phase A	Warning code of Phase AB and C in turn, details see page no.12
19	Rdr 00 1	The capacitor communication address
20	Srr - 09	Quantity of slave

- Note:**
- Legend no.19, adr-005 means address of slave is 005; ad-001 means independent operation or offline. Ad-000 means master.
 - Legend no.20, as master, eg: "Srr-00" show quantity of slave, as slave, eg: "Srr-00" without any meanin

6.3 Setting status

Systems is under automatic running status, ("running" LED indicator light in green), simultaneously press up and menu button, and then released immediately, systems enters setting status.

And then press "menu" button, contents display relative data according to following legend

Press "up" button to increase the setting parameters, press "down" button to decrease the setting parameters, setting parameters are saved automatically. press "menu" button to return to automatic running status

No	Display legend	Description
1	01- 20.0 C1 Q(kvar)	Capacity of capacitor(kvar)
2	02- 0.96 cos ϕ	Power factor switching threshold
3	03- 0 10	Switching time delay(S)
4	04- 100	Ratio of current transformer
5	05- 100	The capacitor communication address
6	06 - 060 t(°C)	Temperature protection value (°C)
7	over voltage 07- 250 U(V)	I grade over voltage protection value (V)
8	over voltage 08- 260 U(V)	II grade over voltage protection value (V)

No	Display legend	Description
9	under voltage 09- 170 U(V)	down voltage protection value (V)
10	over voltage 10- 005 U(V)	Over THDV protection threshold
11	over current 11 - 0 10 I(A)	Over THDI protection threshold
12	12 - 0 10	Alarm time judgment(S)
13	over current 13 - 1.3 CIA(A) IA phase A	Over current multiples of capacitor
14	under current 14 - 100 I(A)	Secondary down current threshold (mA)
15	15 030	Capacitor discharge time(s)
16	Imbalance 16 - 005	Voltage imbalance degree

Note:

- Legend No.05 (The capacitor communication address):
 - Under the legend No.05 interface, press "menu" button, just skip it, systems is in automatic communication internet status.
 - If press "up" or "down" button, it will be considered as manual intervention, when manual intervention, the biggest values ≤ 20 or (≤ 32), it based on the biggest internet quantity of controller or master. After manual intervention, if need to enter automatic communication internet status manually, please set value: 255.
- Legend No.07 (over voltage protection): Voltage exceed I grade protection value, capacitor didn't switch on and off, stop to response
- Legend No.08 (over voltage protection): Voltage exceed II grade protection value, capacitors which switched on will be cutted off one by one automatically, quit working
- Legend No.15 (capacitor discharge time):
 - Combination switch type: factory default is 30s (adjusted from 30s to 180s).
 - Synchronous switch type: factory default is 90s(adjusted from 90s to 180s)

VII. Operation instructions and error codes

7.1 Automatic operation

As soon as the capacitor is energized, it will default to automatic operation mode

- If the capacitor is connected to a secondary current transformer, automatic operation will be controlled by the capacitor's microprocessor based on the power factor and power quality monitoring parameters installed on the capacitor.
- If the capacitor is connected to the PFR-Z20 controller, the capacitor on/off control is performed by the controller and the power quality from the capacitor is monitored.

7.2 Manual operation

To operate manually, press the "menu" and "down" buttons simultaneously for 1 second, the system will switch to manual mode and the "Run" light will turn red.

- Three phase compensation:

In manual switching test, Simultaneously press the down button and menu button, and then quickly released, after system enters manual status ("Manual" indicator light illuminates), press "up" button to successively switch on C1, C2 capacitors (if there are two groups), press "down" button to successively switch off C1, C2 capacitors (if there are two groups); switching off and on are performed in order and repeatedly; press "menu" button to return to auto running status. While switching on, use clip-on ammeter to monitor the three-phase current, in normal condition, the currents are almost the same; three phase current is zero when capacitor is completely switched off.

- Phase-Splitting compensation:

In manual switching test, Simultaneously press the down button and menu button, and then quickly released, after system enters manual status ("Manual" indicator light illuminates), press "up" button to successively switch on Ca, Cb, Cc capacitors, press "down" button to successively switch off Ca, Cb, Cc capacitors; switching off and on are performed in order and repeatedly; press "menu" button to return to auto running status. While switching on, use clip-on ammeter to monitor the three-phase current, in normal condition, the currents are almost the same; three phase current is zero when capacitor is completely switched off.

Note: The same one capacitor Manual switch off, once again switch on, You must wait 30 seconds, Internal capacitor voltage drops below 50V, in order to respond (30 s-180 s can be set).

7.3 Simulation switching function (Analog)

Long press menu button after 3s to loose, running LED indicator changed from green color to two colors (red and green), systems enter simulation switching status.at this time, controller output control signal, switching status indicator of controller changed, not practical switching on or cutting off capacitor. then long press "menu" button again, after 3s to loose, quit simulation switching status, running LED indicator changed into green color.

7.4 Parameter factory default setting

No.	Category	Three-phase capacitor	Three-phase capacitor with single-phase switching
1	Capacitor capacity	20+10kVAr	15kVAr
2	Lower limit of power factor	0.96	0.96
3	Switching capacitor delay	10s	10s
4	Ratio of current transformer	100 (500/5A)	100 (500/5A)
5	Voltage harmonic protection (THDu)	4%	4%
6	Current harmonic protection (THDi)	12%	12%
7	Level I overvoltage protection	432	250
8	Level II overvoltage protection	449	260
9	Low voltage protection	290	170
10	Overcurrent protection (x In)	1.3	1.3
11	Over-temperature protective value	60°C	60°C
12	Communication address	255	255
13	LAN connection cable 20cm	01	01

7.5 Analysis of common faults

Fault	Cause	Solution
No display of smart capacitor after power on	<ol style="list-style-type: none"> 1. No operating power. 2. Cables get loosened in the control board of smart capacitor 	<ol style="list-style-type: none"> 1. Check if there is input of voltage to the module; zf MCD swith on 2. Open the shell of module and plug in the cable or press tight.
Abnormal communication occurs after power is on	<ol style="list-style-type: none"> 1. Communication line of this module is badly connected or unconnected. 2. Loosened terminals and bad contact. 3. Short circuit between two communication lines. 4. Modules of the same ID number occur in the same system. 	<ol style="list-style-type: none"> 1. Connect the communication line and use multimeter to measure if the line is connected or not. 2. Fasten the modular terminal. 3. Check communication lines and remove the short-circuit trouble. 4. Change ID numbers of the same modules to different numbers to ensure the communication is normal.
Threshold-crossing light illuminates or hinting texts occur after power is on	<ol style="list-style-type: none"> 1. Incorrect voltage measuring, over-voltage fault; phase loss 2. Bus voltage is too high or too low. 3. Wrong setting of over voltage threshold. 4. Wrong setting of over temperature threshold 	<ol style="list-style-type: none"> 1. Measure voltage of smart capacitor terminal and remove phase-loss faults. 2. Check the bus voltage and try to keep it within the threshold value. 3. Reset the over-voltage threshold value. 4. Reset the over-temperature threshold value.
Smart capacitor shows a lead value of power factor when no capacitor is put into operation.	<ol style="list-style-type: none"> 1. Wrong phase sequence of voltage or current. 2. Electrical load has large harmonic wave. 3. When used as slave, fetch the power factor of master. 	<ol style="list-style-type: none"> 1. Connect phase sequence of voltage according to the mark on the shell; connect current signal of corresponding phase sequence according to terminal marks; take UA, UB, UC voltage and B phase current only for co-compensation; take UA, UB, UC, UN voltage, IA, IB, IC three phase current for split compensation; connect to secondary terminals in accordance with phase sequence of voltage. 2. Take filtering measures, otherwise capacitor will be damaged.
The current value displayed on the smart capacitor is not in consistent with existing test current value, i.e. measuring error exists.	<ol style="list-style-type: none"> 1. Secondary current transformer is damaged. 2. Short-circuit occurs at the output end of secondary current transformer. 3. Secondary side of current transformer in the general cabinet is not through the center of secondary current transformer. 4. Open-circuit of current transformer in the general cabinet 	<ol style="list-style-type: none"> 1. Replace secondary current transformer. 2. Check the wiring from secondary current transformer to the module. 3. Check the wiring.

7.6 The meaning of the Warning code

For example, the LCD screen displays Err – 2 1 which means: 2 – large voltage harmonic and 1 – overvoltage

Err – 2 1

Meaning				
Code	Over-current	Large current harmonics	Large voltage harmonics	Voltage phase failure
0				
1				√
2			√	
3			√	√
4		√		
5		√		√
6		√	√	
7		√	√	√
8	√			
9	√			√
A	√		√	
B	√		√	√
C	√	√		
D	√	√		√
E	√	√	√	
F	√	√	√	√

Err – 2 1

Meaning				
Code	Over-current	Large current harmonics	Large voltage harmonics	Voltage phase failure
0				
1				√
2			√	
3				
4		√		
5		√		√
6		√	√	
7				
8	√			
9	√			√
A	√		√	
B				
C	√	√		
D	√	√		√
E	√	√	√	
F				

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