HJKL5CV/HJKL2CV

Intelligent Reactive Power Automatic Compensation Controller

User Manual

Standard: IEC 61000–6–2:2016, 1. 4, 4. 5
Please carefully read this User Manual before the installation and operation of this product,and keep it properly for future reference

Himel

1 Overview

1.1 Operation Instructions

This manual describes the installation, debugging, working parameters, and menu operations in details. Please carefully read this manual before the operation, and the installation must be carried out by a professional electrician; before installation, make sure that the product and each part of the equipment used shall be de-energized. It is prohibited to operate any energized part to prevent personal electrical shock.

1.2 Scope of Application

The product is suitable for the automatic adjustment of the capacitor compensation device of the low-voltage distribution system to make the power factor reach the state predetermined by user, increasing the utilization power of power transformer, reducing the line loss, and improving the voltage quality of the power supply.

2 Functions and Features

1. Calculate the switching capacitor capacity according to the fundamental reactive power to avoid any form of switching oscillation, and the power factor can be correctly displayed in the harmonics field.
2. With high power factor measurement accuracy and wide display range.
3. Real-time display of fundamental power factor.
4. Real-time display of voltage distortion rate and current distortion rate.
5. With various encoding output mode options for users.
6. With the outputs of up to 12 optional control loops.
7. Friendly human-machine interface with convenient operation.
8. Various control parameters are fully digital adjustable, with easy operation.
9. With two modes of automatic operation and manual operation.
10. With overvoltage and undervoltage protection function.
11. With voltage harmonic out-of-range protection function.
12. With power outage protection function without data loss.
13. The input impedance of the current signal is low≤ 0.01Ω.
14. With communication function optional.

Special notes: In the application of combining with the photovoltaic power generation, the photovoltaic access point shall be located at the front end of the transformer, and the lower end of the transformer only accommodates load current + capacitor current rather than photovoltaic.

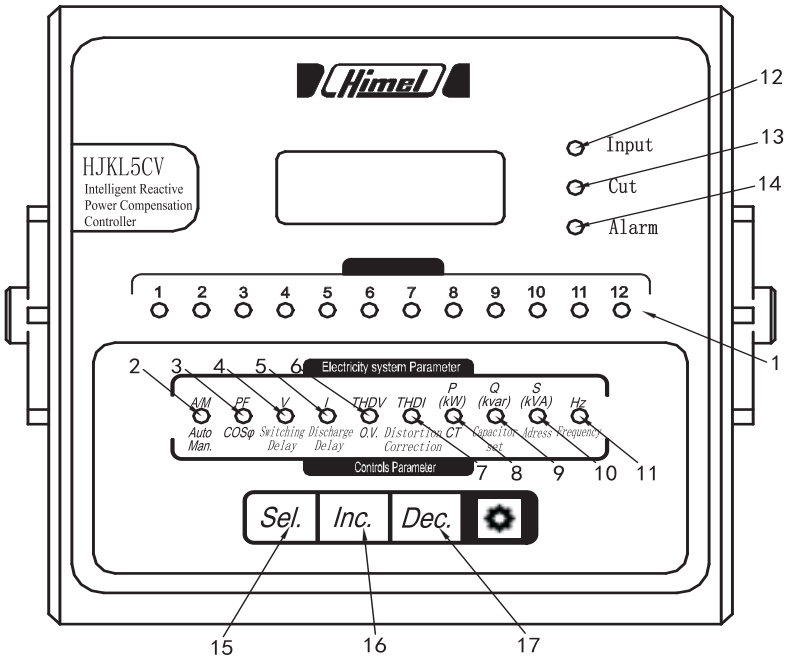
3 Working Conditions of

1. Altitude≤ 2000 meters (determined through negotiation for special requirements).
2. Ambient air temperature -25℃~+40℃.
3. Relative humidity: not more than 50% at 40℃; not more than 90% at 20℃.
4. There is no corrosive gas, no conductive dust, and no flammable and explosive medium in the surrounding environment.
5. There is no severe vibration at the installation site

4 Technical Data

Rated operating voltage: AC 380V (HJKL5CV) or AC 220V (HJKL2CV)
Rated operating current: AC 0~~5A
Rated operating frequency: 45Hz~~65Hz
Display power factor: lag 0,001 ~ ahead 0.001
Measured reactive power: 0~9999kvar
Measured active power: 0~9999kW
Measured apparent power: 0~9999 kVA
Undervoltage protection value: AC 300 V or AC 170 V
Output contact capacity: AC220V 5A resistive, AC380V 3A resistive
Sensitivity: 50 mA
Machine consumption power: 10 VA
Display: 4-digit red digital tube
Outline dimensions: 122mm×122mm
Hole size: 112mm×112mm
Installation mode: Embedded installation, and fixed by inverted tooth attachment
Connection method: Fixed by terminal screw
Protection grade: Enclosure IP30, operation panel IP40

5 Introduction on Panel Function



5.1 Description of the Indicator Light

1. Indicator for putting the capacitor of circuit 1~12 into operation;
2. A/M Manual/Auto operation indicator: Normally ON means automatic operation, and OFF means manual operation.
3. PF power factor indicator: Press the Increment/Decrement key to turn on this indicator in automatic operation mode; the digital tube will display the power factor of the power grid fundamental wave in real time.
4. V grid voltage indicator: Press the Increment/Decrement key to turn on this indicator in automatic operation mode; the digital tube will display the voltage of the power grid in real time.
5. I grid current indicator: Press the Increment/Decrement key to turn on this indicator in automatic operation mode; the digital tube will display the primary side current of the power grid in real time.
6. THDV voltage distortion rate indicator: Press the Increment/Decrement key to turn on this indicator in automatic operation mode; the digital tube will display the grid voltage distortion rate in real time.
7. THDI current distortion rate indicator: Press the Increment/Decrement key to turn on this indicator in automatic operation mode; the digital tube will display the grid current distortion rate in real time.
8. P (kW) power indicator: Press the Increment/Decrement key to turn on this indicator in automatic operation mode; the digital tube will display the active power of the grid in real time.
9. Q (kvar) reactive power indicator: Press the Increment/Decrement key to turn on this indicator in automatic operation mode; the digital tube will display the reactive power of the grid in real time.
10. S (kVA) apparent power indicator: Press the Increment/Decrement key to turn on this indicator in automatic operation mode; the digital tube will display the apparent power of the grid in real time.
11. Hz frequency indicator: Press the Increment/Decrement key to turn on this indicator in automatic operation mode; the digital tube will display the grid frequency in real time.
12. Pre-operation indicator: This indicator lights up to indicate that the controller is waiting until the capacitor bank is put into operation.
13. Pre-disconnection indicator: This indicator lights up to indicate that the controller is waiting until the capacitor bank stops operation.
14. Overvoltage, undervoltage, voltage distortion rate out-of-range alarm indicator: When this indicator is lit up, the controller will work to stop the working capacitor bank with a delay of 1 second per step.

5.2 Description of keys

1. Menu key: Press and hold the Menu key for 3 seconds to start the parameter adjustment program.
2. Increment key: Used for selection of the menu or for incremental adjustment of preset parameters.
3. Decrement key: Used for selection of the menu or for decremental adjustment of preset parameters.

6. Description of Parameter Setting

To change any preset parameter, please first press and hold the menu for 3 seconds, and the set data is saved in FLASH, and those data will not loss in the event of power outage. When the equipment starts after power-on, data in FLASH is used to set the control parameters. After entering the parameter preset menu, press and hold the Menu key for 3 seconds to save the modified parameters and return to the automatic or manual operation state.

6.1 (Auto mode / Manual mode) There are two working modes to put the capacitor bank into operation: Automatic mode is that the capacity bank puts into the operation automatically according to the preset program. Manual mode is that the capacity bank puts into the operation after receiving the command issued by the user. Select the working mode according to the following operation steps:

1. With the Menu key pressed and hold for 3 seconds, the digital tube starts to display: AUTo.
2. When the Menu key is pressed, if the digital tube displays on, the current working mode is Auto mode; if the digital tube displays oFF, the current working mode is Manual mode.
3. Operate the Increment/Decrement key to switch between the Auto operation mode and Manual operation mode; if the digital tube of the operation menu displays AUTo, please operate the Increment/Decrement key to select other preset parameters. When the Menu key is pressed and hold for 3 seconds, the modified control parameter will be saved, and the parameter preset menu exits. In manual working mode, the A/M indicator is off; in the automatic working mode, the A/M indicator is always on.

6.2 Preset of target power factor

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. By operating the Increment/Decrement key, the power factor indicator can light up, and the digital tube will display CoS.
3. By operating the Menu key, the target power factor value can be preset: The digital tube will display 0950. Press the Increment/Decrement key to adjust the target power factor between 0.700 lag and 0.700 ahead. By operating the Menu key, the power factor indicator will light up, and the digital tube will display CoS.
4. Operate the Increment/Decrement key to select other preset parameters. With the Menu key pressed and hold for 3 seconds, the modified control parameters are saved and the parameters preset menu will exit.

6.3 Preset of the switching delay time

1. With the menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, at this time the switching delay indicator is ON, and the digital tube will display dEL.
3. Operate the Menu key to preset the switching delay time: The digital tube displays 0020, and press the Increment/Decrement key to adjust the switching delay time between 1s and 240 s (for conventional model) or between 0s and 240 s (DC model, PS: 0s means less than 1s). By operating the Menu key, the switching delay indicator will be lit up, and the digital tube will display dEL.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified parameter and exit the parameter preset menu.

6.4 Preset of discharge delay time of capacitor bank

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, and the switching delay indicator is lit up, and the digital tube displays ddEL.
3. Operate the Menu key to preset the discharge delay time: 0001 is displayed on the digital tube. By operating the Increment/Decrement key, adjust the discharge delay time between 0s and 180s. By operating the Increment/Decrement key, the discharge delay indicator is lit up, and the digital tube displays ddEL.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

6.5 Preset of overvoltage protection value

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.

2. Operate the Increment/Decrement key for selection, and at this time the switching delay indicator is lit up, and the digital tube will display OL.
3. Operate the Menu key to preset the overvoltage protection value: 0450 is displayed on the digital tube. Operate the Increment/Decrement key to select the overvoltage protection value from line voltage 380 V or phase voltage 220 V to line voltage 456 V or phase voltage 264 V. By operating the Menu key, the overvoltage protection indicator is lit up, and the digital tube will display OL.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

6.6 Preset of voltage distortion rate protection value

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, and at this time the switching delay indicator is lit up, and the digital tube displays dISt.
3. Operate the Menu key to preset the distortion protection preset value: 0050 is displayed on the digital tube. By operating the Increment/Decrement key, adjust the distortion protection value between 1.0% and 30.0%. By operating the Menu key, the distortion protection indicator is lit up, and the digital tube displays dISt.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

6.7 Preset of the transformation ratio of the current transformer

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, and at this time the switching CT transformation ratio indicator is lit up, and the digital tube will display Cr.
3. Operate the Menu key to preset the distortion protection preset value: 0050 is displayed on the digital tube. By operating the Increment/Decrement key, adjust the CT transformation ratio from 50 to 5000. By operating the Menu key, the CT transformation ratio indicator is lit up, and the digital tube will display Cr.

4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

Note: CT transformation ratio refers to the molecular value used for the transformation ratio of the current transformer, if the transformer' transformation ratio is 500/5, 500 shall be entered by the user.

6.8 Preset of capacitor C1 capacity (capacity of capacitor controlled by terminal 1).

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, and at this time the capacitor setting indicator will be lit up, and the digital tube will display C- 1.
3. Operate the Menu key to preset the C1 capacitance capacity value: The digital tube will display 0.100. By operating the Increment/Decrement key, select the C1 capacitance capacity from 0 kvar to 150.0 kvar. By operating the Menu key, the capacitance setting indicator will be lit up, and the digital tube will display C- 1. Long press the Decrement key until the digital tube displays COPY. The preset value of C2~C12 will be changed to the value of C1 automatically.

Note: C1 capacity refers to the capacity value (unit: kvar) of C1 capacitor. For details, refer to the wiring diagram.

4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

6.9 Preset of capacitor CX capacity (capacity of the capacitor controlled by terminal X) (X range 1~12)

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, and at this time the capacitor setting indicator will be lit up, and the digital tube will display C- X.
3. Operate the Menu key to preset the CX capacitance capacity value: The digital tube will display 0.100. By operating the Increment/Decrement key, select the CX capacitance capacity from 0 kvar to 150.0 kvar. By operating the Menu key, the capacitance setting indicator will be lit up, and the digital tube will display C- X. Long press the Decrement key until the digital tube displays COPY. The preset value of C(X+1)~C12 will be changed to the value of CX automatically.

Note: CX capacity refers to the capacity value (unit: kvar) of CX capacitor. For details, refer to the wiring diagram.

6.10 Communication address presetting

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, and at this time the communication setting indicator will be lit up, and the digital tube will display Add.
3. Operate the Menu key to preset the communication address value: The digital tube will display 0001. By operating the Increment/Decrement key, select the communication address value from 1 to 247. By operating the Menu key, the communication setting indicator will be lit up, and the digital tube will display Add.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

6.11 Preset of communication rate

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, and at this time the communication setting indicator will be lit up, and the digital tube will display bAUd.
3. Operate the Menu key to preset the communication rate value: The digital tube will display 0004. By operating the Increment/Decrement key, select the communication rate value from 1 to 5. By operating the Menu key, the communication setting indicator will be lit up, and the digital tube will display bAUd.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

Note: The actual communication rate 1 means: 1200bps, 2 means: 2400bps, 3 means: 4800bps, 4 means: 9600bps,
5 means: 19200bps.

6.12 Preset of communication check

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, and at this time the communication setting indicator will be lit up, and the digital tube will display dArA.
3. Operate the Menu key to preset the communication check value: The digital tube will display 0001. By operating the Increment/Decrement key, select the communication check value from 1 to 5. By operating the Menu key, the communication setting indicator will be lit up, and the digital tube will display dArA.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

Note: For dArA, 1 means no check n81, 2 means odd check o81, and 3 means even check e81.

6.13 Preset of the number of output circuits

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUTo.
2. Operate the Increment/Decrement key for selection, and at this time the digital tube will display OUTP.
3. Operate the Menu key to preset the number of output circuits: The digital tube will display 0012. By operating the Increment/Decrement key, select the number of output circuits from 1 to 12. By operating the Menu key, the digital tube will display OUTP.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

6.14 Preset of the stop power factor

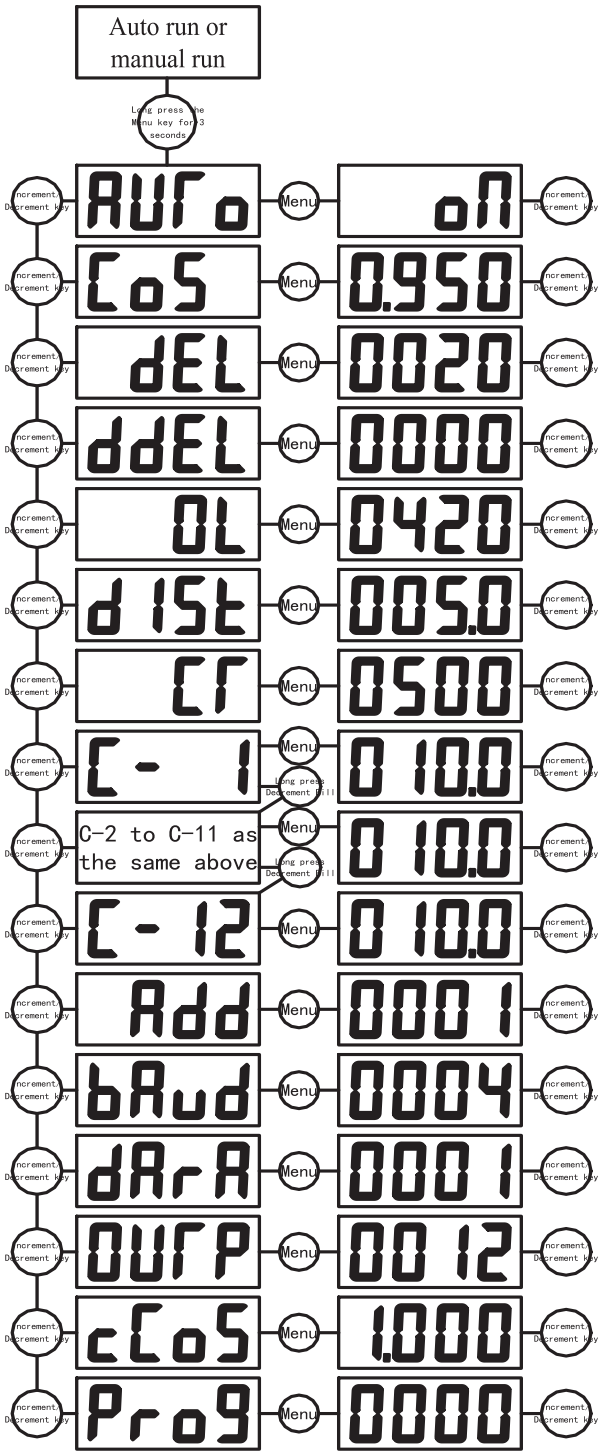
1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUto.
2. Operate the Increment/Decrement key for selection, and at this time the digital tube will display cCoS.
3. Operate the Menu key to preset the value of the stop power factor. The digital tube will display 1000. By operating the Increment/Decrement key, adjust the number of output circuits from lag 0.700 to ahead 0.700. By operating the Menu key, the digital tube will display cCoS.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

Note: The cCoS preset value should be greater than or equal to the CoS preset value, and the default value of cCoS is 1.000 and this value is not adjusted by the user.

6.15 Presets of the encoding output enable

1. With the Menu key pressed and hold for 3 seconds, the digital tube will display AUto.
2. Operate the Increment/Decrement key for selection, and at this time the digital tube will display Prog.
3. Operate the Menu key to preset the value of the stop power factor. The digital tube will display 000 1. By operating the Increment/Decrement key, adjust the encoding mode from 0 (closed) to 1 (open). By operating the Menu key, the digital tube will display Prog.
4. Operate the Increment/Decrement key to select other preset parameters. For example, press and hold the Menu key for 3 seconds to save the modified control parameters and exit the parameter preset menu.

Note: The Prog preset value is 0: Up to one set of capacitors can be switched after the next switching delay; the preset value is 1: Multiple sets of capacitors can be switched after the next switching delay.



oN Auto run mode

oFF Manual run mode

Target power factor
Range +0.700~1.000~-0.7000

Switching delay (s)
Range 0001～0240 (DC mode 0001～0240)

Discharge delay (S)
Range 0000～0180

Overvoltage protection threshold (V)
Range 0380～0456 (5CV), 0220～0246(2CV)

Voltage distortion rate protection threshold (%)
Range 1.0% (001.0)～30% (030.0)

Current transformer’s transformation ratio Range 0050～0500

C1 capacitor capacity (kvar)
Range 000.0～150.0

The same as above

C12 capacitor capacity (kvar)
Range 000.0～150.0

Communication address
Range 0001～0247

Communication rate
Range 0001～0005

Communication check
Range 0001～0003

Output circuit
Rang0001～0012

Target power factor
Range+0.700～1.000～-0.700

Encoding output enable
0: OFF 1: ON

7 Example of Application of Output Encoding

Various output encoding methods are provided, and the capacitance value of C1~C12 can be proportionally determined with reference to the 11 proportional types shown on the right.

Note: The capacitance arrangement sequence is not required. However, it shall ensure that the actual capacity shall one-to-one correspond with the set value.

Capacitor No.	C1	C2	C3	C4	C5	·····	C12
Proportional type 1	1	1	1	1	1	·····	1
Proportional type 2	1	2	2	2	2	·····	2
Proportional type 3	1	2	4	4	4	·····	4
Proportional type 4	1	2	4	8	8	·····	8
Proportional type 5	1	1	2	2	2	·····	2
Proportional type 6	1	1	2	4	4	·····	4
Proportional type 7	1	1	2	4	8	·····	8
Proportional type 8	1	2	3	3	3	·····	3
Proportional type 9	1	2	3	6	6	·····	6
Proportional type 10	1	1	2	3	3	·····	3
Proportional type 11	1	1	2	3	6	·····	6

1) Importance of encoding output

The greatest advantage of the encoding output is that various different capacity outputs can be obtained by combining with the capacitors with different capacity, avoiding defects such as undercompensation, overcompensation, and switching oscillation of the non-encoding output mode.

2) The capacitance capacity combination when the total compensation capacity is about 75 kvar, the output circuit takes circuit 4, and the encoding method takes type 1~4 is described as follows:

Capacitor No.	C1	C2	C3	C4
Proportional type 1 ===>	20:	20:	20:	20
Proportional type 2 ===>	10:	20:	20:	20
Proportional type 3 ===>	6 :	12:	24:	24
Proportional type 4 ===>	5 :	10:	20:	40

There are 4 output combination capacities of proportional type 1: 20, 40, 60, and 80;

There are 7 output combination capacities of proportional type 2: 10, 20, 30, 40, 50, 60, and 70;

There are 11 output combination capacities of proportional type 3: 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, and 66;

There are 15 output combination capacities of proportional type 4: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, and 75.

From the above results, it can be seen that the proportional type 4 has the maximum number of the combination modes, and the proportional type 1 has the minimum number of the combination modes. From the technical level, the proportional type 4 is the best compensation method, but as more capacitor specifications are required, so that this scheme causes certain inconvenience to component procurement and after-sales service. Therefore, users shall select the appropriate proportional type according to the comprehensive factors such as site needs, installation, procurement, and after-sales service.

3) Glossary explanation: output encoding

The output encoding has two meanings in this manual:

a. To define the proportional relationship of capacity between capacitor banks:

With the capacitor capacity of C1 capacity as the reference capacity, the user can calculate the capacity value of other capacitor bank according to the capacitor capacity proportional relationship defined by the selected proportional type. If the user selects proportional type 3, output circuit 4, and 5.0 kvar capacity of C1 capacitor, the capacity of C1~C4 capacity bank shall be C1: 5.0 kvar, C2: 10.0 kvar, C3: 20.0 kvar, and C4: 20.0 kvar, respectively according to the proportional relationship specified by the proportional type 3; the encoding modes of other capacitors are made like this.

b. To define the control scheme of control output:

For explanation, "1" is used to indicate the capacitor bank is in the Enable state, "0" is used to indicate that the capacity bank is in the Disenable state, and the control parameters assumed in Section a are used to explain the encoding output control process as shown in the table below.

C1	C2	C3	C4	Capacity No.
5kvar	10kvar	20kvar	20kvar	Output capacity
0	0	0	0	0kvar
1	0	0	0	5kvar
1	1	0	0	15kvar
0	0	1	0	20kvar
1	0	1	0	25kvar
0	1	1	0	30kvar
1	1	1	0	35kvar
0	0	1	1	40kvar
1	0	1	1	45kvar
0	1	1	1	50kvar
1	1	1	1	55kvar

8 Switching Principle

1) When the capacitor bank cannot be automatically put into operation, whether the following conditions are met shall be considered by the user: Note: The following conditions are necessary conditions and must be met.

a. The system power factor value is lower than the target power factor value.

b. The alarm indicator does not work.

c. P is used to represent the active power of the current power grid, Q is used to represent the reactive power of the current power grid, and cosφ is used to to represent the target power factor, and the condition of Equation 1 must be met.

*C*1 capacity $< Q - P \times \sqrt{\frac{1}{\cos\varphi^2} - 1}$ Equation 1

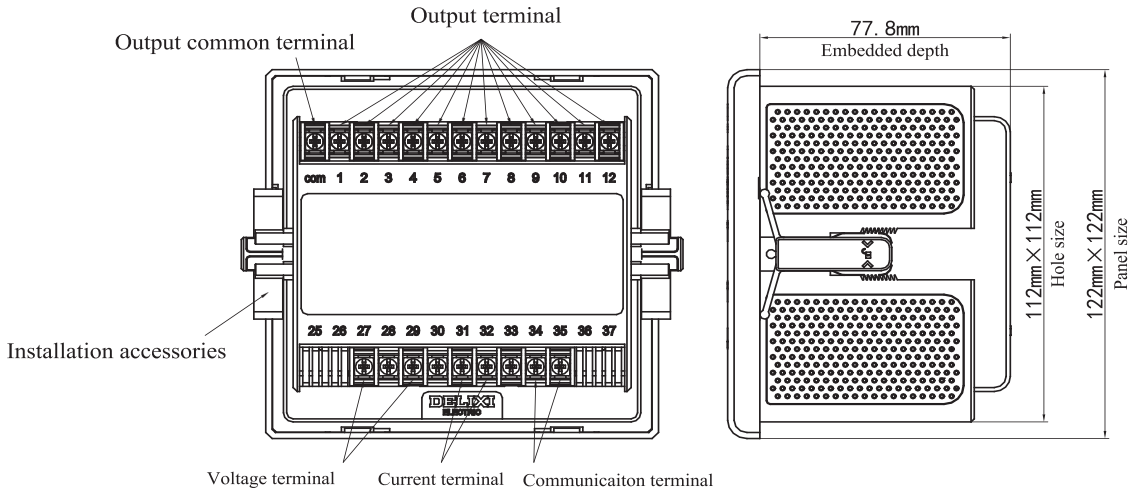
*C*1 capacity $< P \times \sqrt{\frac{1}{\cos\varphi^2} - 1} - Q$ Equation 2

2) When the power factor of the power grid is higher than the target power factor, the capacitor bank cannot automatically stop, whether the following conditions are met shall be considered by user: Similarly, P is used to represent the active power of the current power grid, Q is used to represent the reactive power of the current power grid, and cosφ is used to represent the target power factor 1, and the condition of Equation 2 must be met.

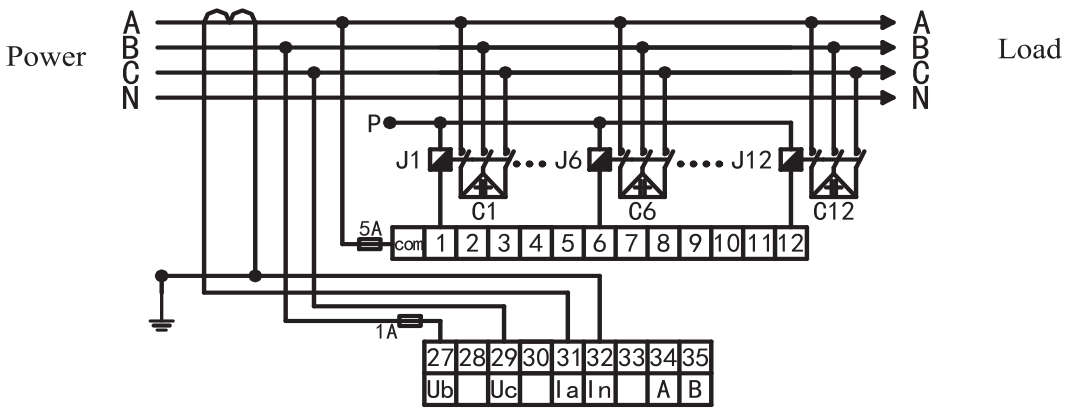
9 Factory Parameters

(1) Auto/manual operation	Auto
(2) Target power factor	0.980
(3) Switching delay time	15 s
(4) Capacitor discharge time	0 s
(5) Overvoltage	HJKL5CV line voltage 430V (HJKL2CV phase voltage 245V)
(6) Distortion rate	5.0 %
(7) CT transmission ratio	500 (500/5)
(8) C1~C2 capacity	10.0 kvar (proportional type 1)
(9) Output circuit	Max. number of the circuit supported by the hardware (max. 12 circuits)
(10) Communication address	1
(11) Communication rate	4 (9600 bps)
(12) Communication check	1 (no check)
(13) Stop power factor	1.000
(14) Encoding output enable	0 (off)

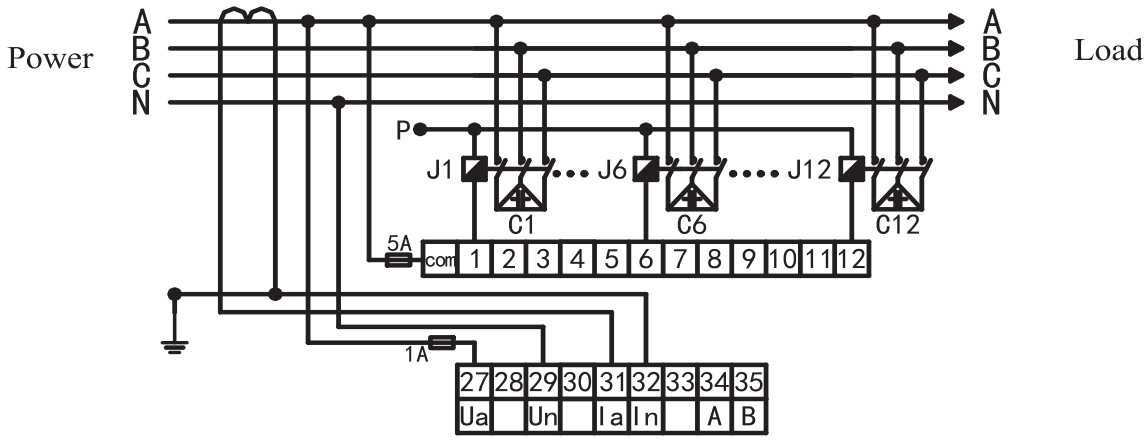
10 Outline and Installation Dimensions



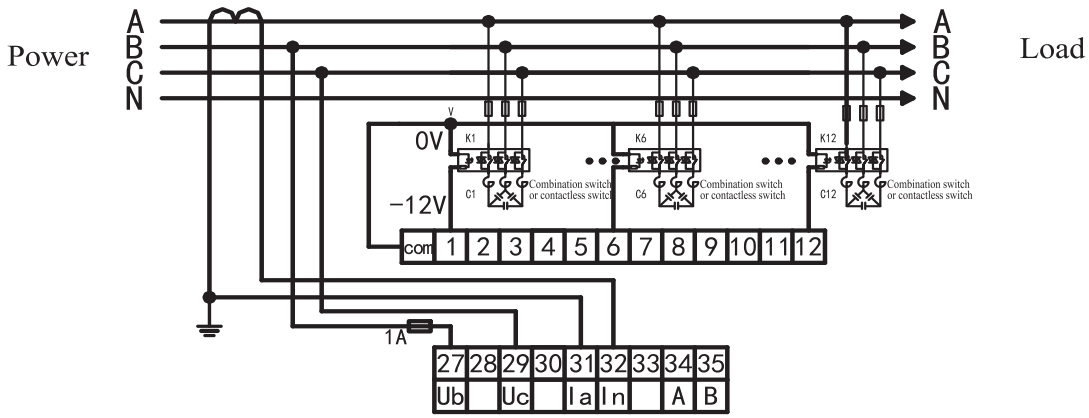
11 Wiring



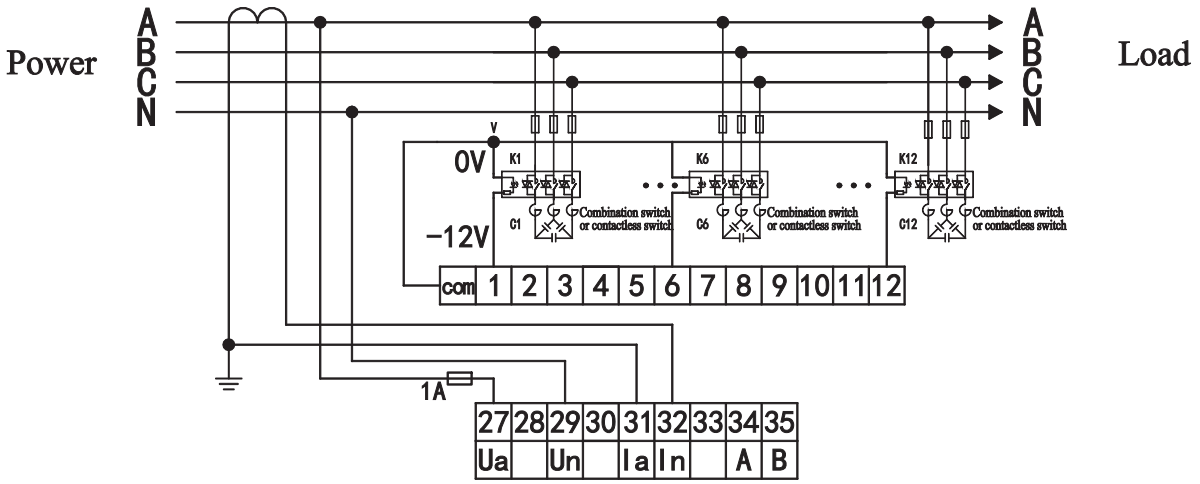
HJKL5CV wiring diagram



HJKL2CV wiring diagram



HJKL5CV-DC wiring diagram



HJKL2CV-DC wiring diagram

When the voltage of AC contactor is 380 V, P point is connected to B or C; when the voltage is 220 V, connected to N. If this product is used in an environment with poor power quality, it is recommended to install power quality control equipment in the power circuit. Note: The specific wiring of the actual product will prevail.

12 How to determine whether the voltage and current signal is at the dotted terminal

Under the condition of ensuring correct voltage and current signal sampling, the manual function is enabled to put the capacitor bank into operation, and the treatment is carried out according to the following situations:

1) The power factor is inductive before the capacitor bank is put into operation, and will become capacitive as the power factor is increased continuously when the capacitor bank is put into operation; therefore, that the voltage and current signal is at the dotted terminal can be determined according to this situation.

2) The power factor is capacitive before the capacitor bank is put into operation, and will be still capacitive as the power factor is decreased continuously when the capacitor bank is put into operation; therefore, that the voltage and current signal is at the dotted terminal can be determined according to this situation.

3) The power factor is inductive before the capacitor bank is put into operation, and will be still capacitive as the power factor is decreased continuously when the capacitor bank is put into operation; therefore, that the voltage and current signal is at the non-dotted terminal can be determined according to this situation, and the user shall exchange the position of the connecting current signal cable.

4) The power factor is capacitive before the capacitor bank is put into operation, and will be inductive as the power factor is increased continuously when the capacitor bank is put into operation; therefore, that the voltage and current signal is at the non-dotted terminal can be determined according to this situation, and the user shall exchange the position of the connecting current signal cable.

5) When the display values of voltage and current are both normal, the active power (kW) shall be positive; if it is negative, it means that the voltage and current signal is in a non-dotted terminal, and the user shall exchange the position of the connecting current signal cable.

13 Communications

Standard MODBUS-RTU protocol. The default factory baud rate is 9600bps, no check.

Example of reading a single register:

Host send (read 0x01 register (target power factor) content)

Address	Command	Initial register address (high bit)	Initial register address (low bit)	Number of registers (high bit)	Number of registers (low bit)	CRC16 (Low bit)	CRC16 (High bit)
0x01	0x03	0x00	0x01	0x00	0x01	0xD5	0xCA

Slave response (target power factor = 0x03 CA, decimal is 970)

Address	Command	Data length	Data		CRC16 (Low bit)	CRC16 (High bit)
0x01	0x03	0x02	0x03	0xCA	0x38	0xE3

Example of write register:
Host sends (0x01 register (target power factor) content modified to 950, hexadecimal is 0x03B6)

Address	Command	Initial register address (high bit)	Initial register address (low bit)	Number of registers (high bit)	Number of registers (low bit)	Data length	Data		CRC16 (Low bit)	CRC16 (High bit)
0x01	0x10	0x00	0x01	0x00	0x01	0x02	0x03	0xB6	0x26	0xC7

Slave response

Address	Command	Initial register address (high bit)	Initial register address (low bit)	Number of registers (high bit)	Number of registers (low bit)	CRC16 (Low bit)	CRC16 (High bit)
0x01	0x10	0x00	0x01	0x00	0x01	0x50	0x09

Answers to frequently asked communication questions

1) If the controller does not send back data, first ensure that the communication setting information, such as slave address, baud rate, and check mode, of the controller shall be consistent with the requirements of the host computer; if multiple controllers do not send back data on site, please check whether the field communication bus is connected accurately and reliably, and whether the RS485 converter works normally. If only a single or a few controllers has abnormal communication, the corresponding communication line shall also be checked, and the testing can be carried out by modifying the address of the controller slave that is converted abnormally and normally to exclude or confirm the problem of the host computer, or the testing can also be carried out by exchanging the installation positions of the abnormal and normal controller to exclude or confirm the controller failure.

2) The controller sends back data inaccurately; please carefully read the instructions on the data storage address and storage format in the communication address table, and ensure to convert them according to the corresponding data format.

The communication addresses are listed in Table below.

Address	Item	Description	Data type	Data length	Read & Write	Remarks
Set register						
0000H	AUTO	Operation mode	unsigned int	2 byte	R/W	0 indicates automatic operation mode and 1 indicates manual operation mode.
0001H	COS	Target power factor	int	2 byte	R/W	Power factor range: 700~1000~-700; unit: 0.001
0002H	dEL	Switching delay	unsigned int	2 byte	R/W	1-240S: DC mode: 0-240S (0 indicates less than 1S)
0003H	ddEL	Discharge delay	unsigned int	2 byte	R/W	0-180S
0004H	0L	Overvoltage protection threshold	unsigned int	2 byte	R/W	Overvoltage range 380~456(HJKL5CV) Overvoltage range 220~264(HJKL2CV) Unit V
0005H	dISt	Voltage distortion rate protection threshold	unsigned int	2 byte	R/W	Voltage distortion rate range 10~300 Unit: 0.1%
0006H	CT	Current transformer's transformation ratio	unsigned int	2 byte	R/W	Transformer's transmission ratio range: 50~5000
0007H	cCOS	Stop power factor	int			Power factor range: 700~1000~-700 Unit 0.001
0008H	Add	Communication address	unsigned int	2 byte	R/W	Communication address range 1~247
0009H	bAud	Communication rate	unsigned int	2 byte	R/W	1:1200bps 2:2400bps 3:4800bps 4:9600bps 5:19200bps
000AH	dArA	Communication check	unsigned int	2 byte	R/W	1: none 2: odd 3: even
000BH	OUTP	Number of output circuits	unsigned int	2 byte	R/W	Range of number of circuits: 1~12 (max. Value is determined according to the specific model)
00CH	PROG	Capacitor output mode	unsigned int	2 byte	R/W	0: Cycle mode 1: Encode output
000DH	C-1	Capacity of C1 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
000EH	C-2	Capacity of C2 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
000FH	C-3	Capacity of C3 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
0010H	C-4	Capacity of C4 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
0011H	C-5	Capacity of C5 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
0012H	C-6	Capacity of C6 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
0013H	C-7	Capacity of C7 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
0014H	C-8	Capacity of C8 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
0015H	C-9	Capacity of C9 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
0016H	C-10	Capacity of C10 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
0017H	C-11	Capacity of C11 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
0018H	C-12	Capacity of C12 capacitor	unsigned int	2 byte	R/W	Capacity range 0-1500 Unit 0.1kvar
.....	.....	.....	unsigned int	2 byte	R	Reserved address
Read-only register						
0031H	K1-16	Relay output status register 1	unsigned int	2 byte	R	bit0 ~ bit15 corresponding to K1~K16 1 indicates ON; 0 indiates OFF
0032H 0033H	U	Voltage	float	4 byte	R	Unit V
0034H 0035H	I	Current	float	4 byte	R	Unit A
0036H 0037H	P	Active power	float	4 byte	R	Unit kW
0038H 0039H	Q	Reactive power	float	4 byte	R	Unit kvar
003AH 003BH	S	Apparent power	float	4 byte	R	Unit kVA
003CH 003DH	PF	Power factor	float	4 byte	R	
003EH 003FH	FREQ	Frequency	float	4 byte	R	Unit Hz
0040H 0041H	THDV	Voltage distortion rate	float	4 byte	R	%
0042H 0043H	THDA	Current distortion rate	float	4 byte	R	%
0044H 0045H	YU	Fundamental voltage	float	4 byte	R	Unit V
0046H 0047H	YI	Fundamental current	float	4 byte	R	Unit A
0048H 0049H	YP	Fundamental active power	float	4 byte	R	Unit kW
004AH 004BH	YQ	Fundamental reactive power	float	4 byte	R	Unit kvar
004CH 004DH	YS	Fundamental apparent power	float	4 byte	R	Unit kVA
004EH 004FH	YPF	Fundamental power factor	float	4 byte	R	

14 Troubleshooting and Solution

No.	Fault	Cause	Solution
1	The load device is turned on, but the controller power factor always shows C-0 (undercurrent state).	The sampling current is less than 50mA or the secondary side of the current transformer is open circuited.	1. Check the current transformer and the secondary circuit for open circuit. 2. Detect the actual current value of the transformer; if it is greater than 50 mA, it indicates that the controller is internally failed.
2	After the capacitor is put into operation, the power factor is almost unchanged.	The current sampling transformer is installed incorrectly, not containing the primary current of the capacitor cabinet.	The total current should be taken, that is: sampling current = load current + capacitor current; that is, the primary line of the capacitor cabinet is connected at the back of the sampling transformer.
3	The power factor display value is constantly jittering, or switching back and forth between ahead and lag states.	1. The load is too low. 2. Caused by rapid load changes, such as welding machines, rolling mills, stamping equipment, and traction equipment. 3. The electricity load is unstable, the transformer load rate is too low, and there is a phenomen of large power used to deive small load.	1. Turn on the motor load and observe the display of the controller. 2. For quick changed loads, dynamic reactive power compensation equipment shal be selected. 3. The compensation is realized using the encoding mode.
4	Capacitor switching operation is too frequent.	1. The load current changes rapidly, and too short delay time is set. 2. Too high power factor is set.	1. It is recommended to replace by a capacity with small capacity. 2. The compensation is realized using the encoding mode.
5	The power factor is less than the target power factor, but the capacitor is not put into operation automatically.	1. The load is too light, and the reactive power to be compensated cannot meet the operation requirements. 2. Too small transformer's tranformation ratio is set, or is not set correctly.	1. It is recommended to replace by a capacity with small capacity. 2. Set the transformer's transformation ratio correctly.
6	The controller screen becomes black without any disiplay.	The sampling voltage is not connected or the controller is fauled.	1. Check whether the fuse works normally. 2. Check whether there is a voltage signal at the voltage terminals 27 and 29 (HJKL5CV: 380V: HJKL2CV: 220V), otherwise the controller shall be replaced.
7	The controller has confusion code or does not work.	1. Subject to abnormal situations such as lightning strikes. 2. Electromagnetic interference.	Please power off and restart; if it appears repeatedly, it is recommended to replace the product.

15 Transportation and Storage

15.1 The controller should not be subject to severe impact during transportation, packaging, and unpacking, and should comply with the provisions of GB/T 25480-2010.

15.2 The storage environment temperature is -25℃ ~ +55℃, the annual mean relative humidity does not exceed 85%, there is no corrosive gas in the storage environment, and it should be moisture-proof.

16 Company's Commitment

The "three guarantees" service is provided if the product does not work normally due to the manufacturing problems under the conditions of normal storage, maintenance, and operation of the product and of intact and unopened company's seal within 24 months from the production date.

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