SIPROTEC 7SJ686

Multi-functional Protective Relay

Catalog Edition 7.5

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CERTIFICATE

This is to certify that

Siemens Power Automation Ltd.

Building 4, Huarui Industrial Park, No.88 Chengxin Avenue, Jiangning Economic and Technical Development Zone
211100, Nanjing, Jiangsu
P.R. China

Unified Social Credit Code: 91320115756897815N

has implemented and maintains a **Quality Management System**.

Scope:
Research & Development, Production Integration, Sales and Service of Microcomputer Relay Protection; Integration, Sales and Service of Power Quality product;
Research & Development, Integration, Sales and Service of Energy Management Systems;
Research & Development, Integration, Sales and Service of Substation Automation.
Research & Development of Microcomputer Relay Protection and Power Quality product.

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standard:

ISO 9001: 2015

Certificate registration no.	313069 QM15
Valid from	2021-05-30
Valid until	2024-05-29
Date of certification	2021-05-26

DAkkS
Deutsche Akkreditierungsstelle
D-ZM-16074-01-00

DQS GmbH

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The certificate can be verified at www.dqs-cn.com as well as CNCA official website www.cnca.gov.cn.
The certificate will be valid only in case that the certified organization undergoes successful periodic surveillance audit.

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Multi-functional Protective Relay

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May 2023

Features:

- Designed to user's hobby
- With operation-box function
- High accuracy measuring CT supported
- Integrated CFC programmable logic
- User-defined protection function
- Arc protection
- Wireless temperature measurement of switchgear
- USB2.0 front port
- IEC 61850/IEC 103/Modbus protocols
- Redundant star and ring network
- Access and modify parameter settings
- Convenient remote technical service
- Chinese and English bilingual changeable

Multi-functional Protective Relay

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Overview

Overview

The series of SIPROTEC 7SJ686 multi-functional protective relay are exclusively designed for MV market. It not only provides the large-screen display (resolution 240*128), operation-box function, independent measuring current input and redundant star network communication mode, but also inherits the rigorous and flexible style of Siemens protective relay. Therefore, it is a very cost-efficiency product.
This series of protective relay are applicable for kinds of distribution systems with various voltage level and different earthing method. It can provide protection, control and monitoring functions for feeder, capacitor, reactor, motor and transformer.

The device offers a variety of flexible hardware options, such as redundant RS485 communication module, redundant 100M Ethernet communication module, analog output (2x 0~20mA) module, analog input (4x 0~20mA) module and various I/O expansion modules.

The front USB port provides users with the convenience for remote maintenance and fault diagnosis. The user only needs to insert the USB flash disk into the device, and the relevant fault recordings and tripping events will be exported. Our after-sales service engineer will analyze the type of fault and instruct the user to deal with the scene. Both the downloading of the device configuration and the upgrading of the software can be completed through the USB flash disk.

The settings of the 7SJ686 series device are completely designed according to user's hobby. E.g, the overcurrent protection can be configured with direction release and compound voltage dependency, and it can be activated/de-activated via control function. And all BIs and BOs are pre-configured with the factory setting. The relay can be directly put into service after the customer sets the device parameters via HMI.

The integrated programmable logic tool (CFC) and user-defined functions allow customer to implement specific protection functions, interlocking and message.

The applied auxiliary voltages of 110VDC, 220VDC or 220VAC and 1A/5A CT input are to be adjusted via jumpers on site.

Communication interface

- IRIG-B GPS port
- Two RS485 ports, or
- Two 10/100M Ethernet ports, or
- Three 10/100M Ethernet ports, or
- Two 10/100M optical Ethernet ports and one 10/100M electrical Ethernet port

Communication redundancy

- Redundant Ethernet PRP
- Ethernet RSTP ring network
- Ethernet dual star network and dual IP
- Redundant serial network

Functional scope

Protection function

- Overcurrent protection
- Zero sequence overcurrent protection
- Current overload protection
- Instantaneous tripping at SOTF
- Synchro-check
- Automatic reclosing
- Sensitive earth fault detection
- Non-electric inter-tripping
- Switch onto fault
- Reverse power protection
- Over/under-voltage protection
- Circuit breaker failure protection
- Low frequency load-shedding
- Low voltage load-shedding
- User-defined protection
- FC circuit operate blocking
- Voltage phase rotation detection
- Negative sequence protection
- Thermal overload protection
- Motor starting time supervision
- Motor load jam protection
- Motor restarting inhibit
- Motor differential protection
- Motor core-balance protection
- Transformer differential protection
- Transformer backup protection
- Capacitor protection
- Station service transformer protection
- Two-end line differential protection
- Automatic busbar transfer
- Arc protection
- Line-transformer unit differential protection

Control functions/programmable logic

- Flexibly configured control objects
- Graphic display and local control
- User-defined interlocking via CFC

Measuring/monitoring function

- Operational measurement values V, I, P, Q, cos ϕ, f...
- Energy measurement values Wp, Wq
- Tripping/closing circuit supervision
- VT/CT broken-wire detection
- Circuit breaker wear monitoring
- Latest 20 fault records/16 trip logs
- Phase rotation supervision
- 512 event logs

Communication protocols

- IEC 60870-5-103 (RS485 or Ethernet)
- IEC 61850 MMS&GOOSE Edition1&2
- Modbus (RS485 or Ethernet)
- DIGSI 4 (USB, RS485 or Ethernet)
- GPS port IRIG-B (RS485 or TTL)
- SNTP network time synchronization

Basic hardware

- 4VT, 4CT
- 16BI, 7BO, 1LC
- 36BI, 23BO, 1LC

Expansion modules

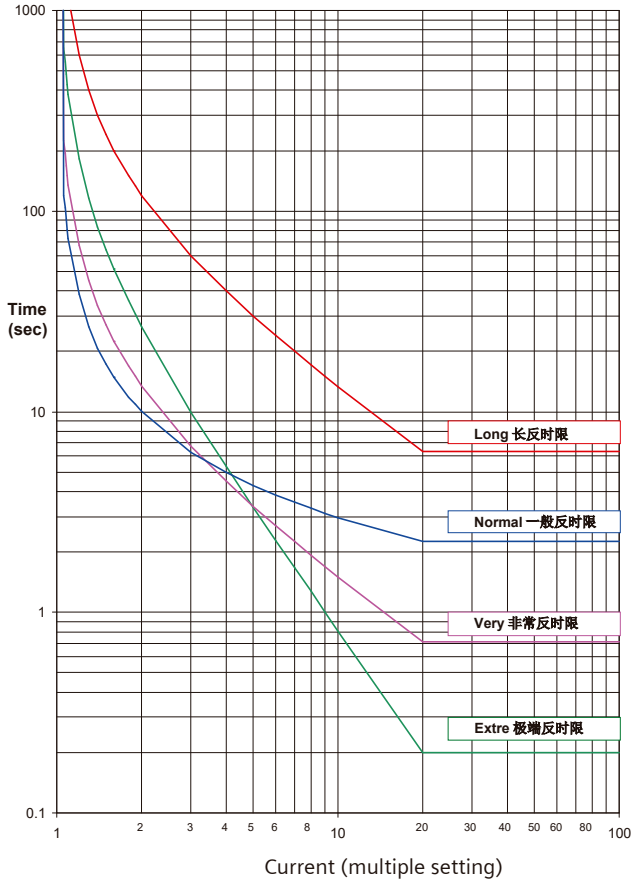
- Four 0-20mA analog input
- Two 0-20mA analog output
- 9BI
- 5BO
- 6BI, 3BO
- 4BI, 5BO
- 3 measurement CTs
- DC/AC operation module
- 3 optical ports for arc sensor, 2 high-speed BOs

Time overcurrent protection (ANSI 50, 51, 50V, 67, 67-TOC)

This function is instantiated in factory with three definite time stages and 1 inverse time stage that each stage can be individually set to on or off. This function provides – as an option – forward directional operating mode. Additionally, the definite time stage also provides – as an option – compound voltage released operating mode. The inverse time stage supports IEC Normal/Very/Extremely/Long characteristics. In case of measuring voltage failure, the behavior of direction element can be set to block OC or non-directional OC, and the behavior of compound voltage element can be set to block OC or release OC.

Ground overcurrent protection (ANSI 50N, 51N, 67N, 67N-TOC)

The ground overcurrent protection function is instantiated in factory with three definite time stages and one inverse time stage that each stage can be individually set to on or off. This function provides – as an option – forward directional operating mode. The quantity of zero-sequence current can be configured with measured value or calculated value, and the quantity of zero-sequence voltage will be adapted with measured value or calculated value on dependency of voltage connection type. The inverse time stage supports IEC Normal/Very/Extremely/Long characteristics. In case of measuring voltage failure, the behavior of direction element can be set to block ground OC or non-directional ground OC.



Current overload protection (ANSI 50)

This function is instantiated in factory with two definite-time stages. The behavior of this function can be settable trip or alarm. As of the backup function of transformer protection, the behavior of this function can be set to start ventilation and block on-load tap-changing.

Low frequency load-shedding (LFLSH)

This function is instantiated in factory with four stages that each stage can be individually set to on or off. This function is built-in with additional criterions of undervoltage element and change rate of frequency(df/dt) element. Additionally, each stage can be set to blocking in case of system frequency increasing, and the operate can be set to blocking in case of low current.

Low voltage load-shedding (LVLSH)

This function is instantiated in factory with four stages and operates with positive sequence voltage. This function is built-in with additional criterion of change rate of voltage(dv/dt) element. Additionally, each stage can be set to blocking in case of system voltage increasing, and the operate can be set to blocking in case of low current.

Instantaneous tripping at SOTF

If switch onto fault occurs in case of automatic reclosing or manual closing, it's required to instantaneously clear the fault. One individual overcurrent stage and one individual zero sequence overcurrent stage are exclusively designed for this purpose. Additionally, the over-current stage provides – as an option – compound voltage released operating mode.
Criterions to trigger this function in case of manual closing are as below,

a) at least 30s with CB open status
b) at least 30s with dead current
c) CB status change from open to closed

This function can be configured to behavior as pre-closing or post-closing in case of automatic reclosing.
The behavior of pre-closing provides – as an option – directional operating mode.

Synchro-check (ANSI 25)

This function is instantiated in factory with two methods. To flexibly adapt to different system conditions, the two methods are respectively designed for synchronous condition and asynchronous condition.
Asynchronous condition applies to the scenario which the systems of both sides of to-be-closed CB are galvanically isolated. To connect both systems, the delta voltage and delta frequency must be within the permitted limit, and then close the CB when the delta phase angle enters the permitted limit.
Synchronous condition applies to the scenario which the systems of both sides of to-be-closed CB are galvanically connected. To connect both systems, the delta voltage and delta phase angle must be within the permitted limit.

Automatic reclosing (ANSI 79)

This function is instantiated in factory with 2 cycles and can be started by overcurrent protection, ground overcurrent protection, binary input and CB discrepancy status.
This function behaviors - as a setting – with or without synchro-check, V1</V2>.

Protection Function

Sensitive ground fault detection (ANSI 64, 59N, 67Ns, 50Ns)

For isolated system, zero-sequence reactive power criterion is applied to detect the earthing feeder. For Peterson coil earthing system, zero-sequence active power criterion is applied to detect the earthing feeder.
The behavior of this function can be settable trip or alarm.
Additionally, sensitive zero sequence overcurrent with or without direction and zero sequence overvoltage are available.

External trip

The device has 5 external tripping functions to incorporate the external non-electric inter-tripping commands. The customer can set the chatter blocking and filtering time to suppress the external disturbance. The behavior of these functions can be settable trip or alarm.

Switch onto fault (SOTF)

The overcurrent protection function for switch onto fault is instantiated in factory with two definite time stages to detect the short circuit fault. Additionally, the function also provides – as an option – compound voltage released operating mode.
The ground overcurrent protection function for switch onto fault is instantiated in factory with two definite time stages to detect the earthing fault. Additionally, the function also provides – as an option – zero-sequence overvoltage released operating mode.

FC circuit operate blocking

For FC diagram, if the circuit current is larger than the maximum breaking current of load switch, the circuit can only be disconnected by the fuse. If any phase current is detected to be larger than the setting value, the device will block the operate of all protections.

Reverse power protection (ANSI 32R)

This function is used to detect the reverse power and to prevent the power flow from the industrial grid to utility grid.

Over-/undervoltage protection (ANSI 59, 27)

The quantity of voltage can be configured with phase-ground Vph, phase-phase Vpp, positive-sequence V1 and negative-sequence V2.
The overvoltage protection function is instantiated in factory with two stages. This function operates with one or all of three voltages.
The undervoltage protection function is instantiated in factory with two stages. This function operates with one or all of three voltages. Additionally, this function can only pickup when CB is closed.

Circuit breaker failure protection (ANSI 50BF)

The circuit breaker failure protection function is instantiated in factory with two timers of T1 and T2. If this function is started, phase current, zero-sequence current and negative-sequence current are monitored. If the current criterions are fulfilled after the time expired, this function will re-trip the local CB via T1 and trip the upstreaming CB via T2.

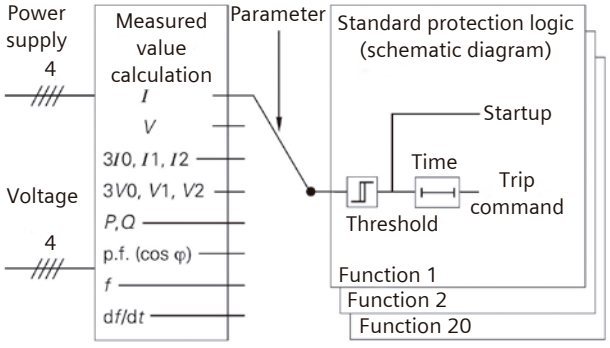
Undercurrent protection (ANSI 37)

The undercurrent protection function is used to monitor the motor current. If all the currents are lower than the setting value, this function picks up. The behavior of this function can be settable trip or alarm with operate delay. Via the auxiliary contact criterion, the CB open status can be acquired to block this function.

User-defined protection

The user-defined protection function allows the customer to apply 20 non-standard protection functions based on the measuring values of voltage, current, power, symmetric value and frequency. These functions can operate with 1-ph, 3-ph and others.

3-phase	I, In, Ins, 3I0, I1, I2, I2/I1, U, Un,
	3U0, U1, U2, P, Q, cosφ, du/dt
1-phase	I, In, Ins, U, Un, P, Q, cosφ
Others	f, df/dt, BI
I, V measurands	Fundamental value
	RMS value
	Positive sequence value
	Negative sequence value
Pickup	Overshoot or undershoot



Negative-sequence protection (ANSI 46)

The negative-sequence protection is to detect the unbalanced current in the system, which is of special significance for motor. The unbalanced load of the 3-phase inductive motor generates a reversed electromagnetic field, and the eddy current is induced on the surface of the rotor, causing the rotor end and the edge of the slot to overheat and damage the motor. The negative-sequence protection is also to detect the 1-phase and 2-phase faults where the fault current is less than the maximum load current.

Two-end line differential protection (ANSI 87L)

This function is valid for line application and line-transformer unit application. This function is featured with CT different ratio and characteristics. It's free from CT saturation. The device supports direct connection of 24km distance via mono-mode optical fiber and can bi-directionally transmit 32 messages and 1 inter-trip command.

Voltage phase rotation detection
This function is to detect the phase sequence of bus voltage to prevent motors or other loads from running in the wrong phase sequence.

Thermal overload protection (ANSI 49)
This function is to prevent the protected object from overheating due to overloading. This function is modeled on the thermal replica of protected object (overload protection with memorized capacity). Overloading heat accumulation and heat dissipation processes are considered. With an additional temperature input, the thermal replica can take the actual ambient or coolant temperature into account.

Motor starting time supervision (ANSI 48)
This function is to prevent the motor from too long starting-up process. The temperature of the high voltage motor with the rotor in a critical state can quickly rise above its heat limit. If the duration of the startup is prolonged due to the voltage dip during the motor starting, over-torque, load jam and other reasons, the function can issue a tripping command to disconnect the motor.

Motor load jam protection (ANSI 50L)
This function can quickly response to un-expected load jam and disconnect the motor. This is to avoid or reduce the damage to driver, bearing and other motor parts.

Motor restarting inhibit (ANSI 66)
The rotor temperature of motor is generally kept below its maximum allowable temperature under conditions of rated operation and increased loading. However, the occurred higher stator current during the motor starting-up raises the rotor damage risk due to overheating. If the temperature of rotor is un-ambiguously expected to exceed the thermal limit during starting, the motor must be prohibited from restarting. This function will response to this scenario and prevent the motor from restarting.

Core-balance protection for motor (ANSI 50)
An exclusive core balanced current transformer is used for this function. The settable operate delay is used to overcome the transient peak current caused by motor starting-up to increase the stability.

Transformer differential protection (ANSI 87T)
This function can be used for up to 4-side application of transformer differential protection. It's applicable for 2-winding or 3-winding transformer with up to 220kV voltage level. 2nd harmonics criterion is used to recognize the inrush current.

Transformer backup protection (ANSI 50)
The device provides the complete backup protections for transformer. They are directional/non-directional and compound voltage released overcurrent protection with 3 operate delays, zero-sequence overvoltage protection, ground overcurrent protection for transformer neutral earthing system, ground overcurrent protection for transformer neutral surge arrester earthing system, overexcitation protection, CB discrepancy detection, 2nd harmonics restrained overcurrent, overload protection (behaviors to start the ventilation and block the on-load tap-changer).

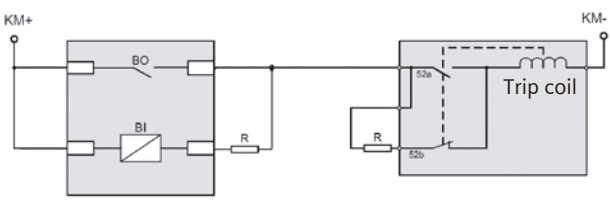
Capacitor protection
Four protection functions are available for capacitor bank application. They are voltage-unbalance protection, current-unbalance protection, voltage differential protection and current differential protection.

Arc protection
The device supports the module expansion for arc protection, which can detect the arc of bus, circuit breaker and cable end. The shortest arc response time is less than 4ms.

Station service transformer (SST) protection
The device provides multi-functions for this application. They are overcurrent protection, zero sequence overcurrent protection, voltage protection, low frequency load-shedding, low voltage load-shedding, overload protection, ground overcurrent protection for low voltage side and 5 external trips.

Automatic busbar transfer (ABT)
The device supports the automatic incomer and busbar transfer function for single busbar and sectionized busbar application. Optionally this function can be blocked during low frequency load-shedding and low voltage load-shedding. Additional functions of synchro-check and automatic restore are available.

Monitoring function (ANSI 74)
1) Tripping/closing circuit supervision
   The device provides the function of tripping/closing circuit supervision with 1-BI.



   If the device has the operation module, the NC contacts of TWJ and HWJ are used to generate the control circuit broken-wire signal.

2) VT broken-wire detection
   This function is to recognize the 1-ph, 2-ph and 3-ph measuring voltage failure and to alarm. This function is used to block the protections of directional overcurrent, undervoltage, low voltage load-shedding, sensitive earth fault detection and voltage-related use-defined protection.
3) CT broken-wire detection
   This function is to recognize the current circuit failure and to alarm or block the differential protection.
4) Measuring voltage supervision
   This function is to monitor the measuring voltage. The respective indications of 3-ph live voltage, 3-ph dead voltage and 1-ph live voltage are available.
5) Cold load pick-up

   To energize some loads (such as air conditioning system, heating equipment and motor) will cause large starting-up current. This function is to detect this scenario and to issue the indication to dynamically change the setting group.
6) Phase sequence supervision
   This function is to monitor the voltage phase sequence and to indicate the positive and negative sequence which can be used for alarming, tripping and dynamic blocking of protection functions.

Protection Function

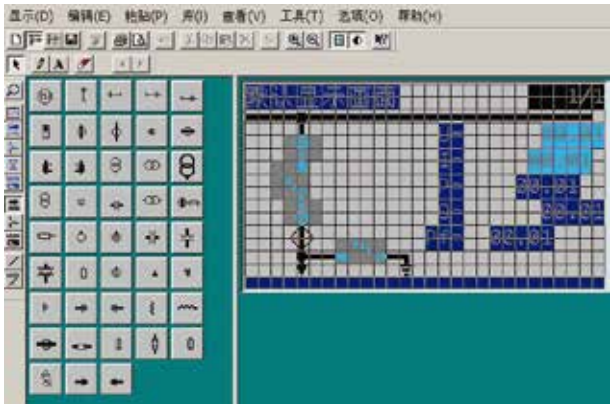
Summary of protection functions

No		Function \ Type	Feeder	Motor OC	Motor diff.	Capacitor (I-unbal.)	Capacitor (V-unbal.)	Capacitor (V-diff.)	Capacitor (I-diff.)	Reactor (I-diff.)	2-side TFR diff.	TFR backup	SST	Up to 4-side TFR diff	Line I Comparison	Line diff.	ABT
		MLFB 14th pos.	A	B	C	D	E	F	G	H	H	J	K	L	M	M	N
1	Overcurrent protection	Non-directional OC, 3 stages	•	•	•	•	•	•	•	•	•	•	•		•	•	•
		Directional OC, 3 stages	•									•			•	•	
		Undervoltage release	•								•	•	•		•	•	•
		Compound voltage release	•								•	•	•		•	•	•
		3 time-delays										•					
		IEC inv.-T OC, 1 stage	•	•	•	•	•	•	•	•			•		•	•	
		IEC inv.-T directional OC, 1 stage	•												•	•	
2	Ground OC prot.	Non-directional ground OC, 3 stages	•	•	•	•	•	•	•	•	•	•	•		•	•	•
		Directional ground OC, 3 stages	•	•	•							•			•	•	
		IEC inv.-T ground OC, 1 stage	•	•	•	•	•	•	•	•			•		•	•	
		IEC inv.-T ground directional OC, 1 stage	•												•	•	
		3 time-delays										•					
3	Neg.-seq	Negative-sequence def.-T OC, 2 stages	•	•	•								•				
		Negative-sequence IEC inv. -T OC, 1 stage	•	•	•								•				
4	Voltage prot.	Def.-T overvoltage, 2 stages	•	•	•	•	•	•	•			•	•		•	•	
		Def.-T undervoltage, 2 stages	•	•	•	•	•	•	•			•	•		•	•	
		3-phase line live voltage 3-phase line dead voltage 1-phase line live voltage	•	•	•	•	•	•	•	•	•	•	•		•	•	
5		Instantaneous tripping at SOTF	•	•	•	•	•	•	•	•	•	•	•		•	•	
6		Low voltage load-shedding, 4 stages	•	•	•								•		•	•	
7		Low frequency load-shedding, 4 stg.	•	•	•								•		•	•	
8		Instantaneous tripping pre/post-closing AR	•												•	•	
9		Phase rotation detection	•	•	•	•	•	•	•	•	•	•	•		•	•	
10		2nd harm. restrained OC	•								•	•					
11		Thermal overload protection		•	•												
12		Undercurrent protection		•	•												
13		Motor starting time supervision		•	•												
14		Motor load jam protection		•	•												
15		Motor restarting inhibit		•	•												
16		Reverse power protection	•	•	•												
17	Differential protection	Motor core-balance			•												
		I-DIFF>			•					•	•			•			
		I-DIFF>			•					•	•			•			
		Restricted earth fault												•			
		Line current comparison													•		
		Line differential														•	
		Line-transformer unit diff.														•	
		2nd /5th harm. restrained I diff									•			•			
18		Capacitor I-unbalance prot., 1 stage				•											
19		Capacitor V-unbalance prot., 1 stage					•										
20		Capacitor V-diff, 1 stage						•									
21		Capacitor I-diff, 1 stage							•								
22		Ground OC surge arrester, 2 stages										•					
23		Zero-sequence overvoltage, 2 stages	•									•	•				
24		Overexcitation protection										•					
25		Start ventilation									•	•					
26		Overload blocking on-load tap-changer									•	•					
27		Overload protection, 2 stages	•	•	•					•	•	•	•		•	•	
28		Ground overcurrent for SST LV side, 3 def.-time stages, 1 inv.-T stage											•				
29		20 user-defined protection	•	•	•	•	•	•	•	•	•	•	•		•	•	
30		FC circuit operate blocking	•	•	•												
31		Switch onto fault	•					•									•
32		CB failure protection	•	•	•	•	•	•	•	•	•	•	•		•	•	•
33		CB discrepancy detection										•					
34		Synchro-check	•														•
35		Automatic reclosing with 2 cycles	•												•	•	
36		5 external trips	•	•	•					•	•	•	•				
37		Four 0-20mA analog inputs	•	•	•	•	•	•	•	•	•	•	•	•			
38		Sensitive ground fault detection	•	•	•	•	•	•	•	•	•	•	•		•	•	
39		Cold load pick-up	•	•	•	•	•	•	•	•	•	•	•		•	•	
40		Tripping/closing circuit supervision (via 1-BI)	•	•	•	•	•	•	•	•	•	•	•		•	•	•
		Control circuit broken-wire monitoring (via operation circuit)	•	•	•	•	•	•	•	•	•	•	•		•	•	•
41		VT broken-wire detection	•	•	•	•	•	•	•	•	•	•	•		•	•	•
42		CT broken-wire detection	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
43		Automatic busbar transfer															•
44		LFLSH/LVLSH blocking ABT															•
45		Overcurrent protection, 2 stages at LV side									•						
46		Ground overcurrent protection, 2 stages at LV side									•						
47		Ground overcurrent protection, transformer neutral point									•						
48		Arc protection	•	•	•	•	•	•	•	•	•	•	•				
49		Wireless temperature measurement	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Monitoring Function

Control

In addition to protection functions, the device provides control and monitoring functions for circuit breaker, disconnector and transformers. The status of primary equipment and auxiliary equipment can be acquired via auxiliary contacts. The CB position of "open", "closed" and “intermediate” and the position of tap-changer can be recognized and indicated.
The single line diagram of system is customer editable.

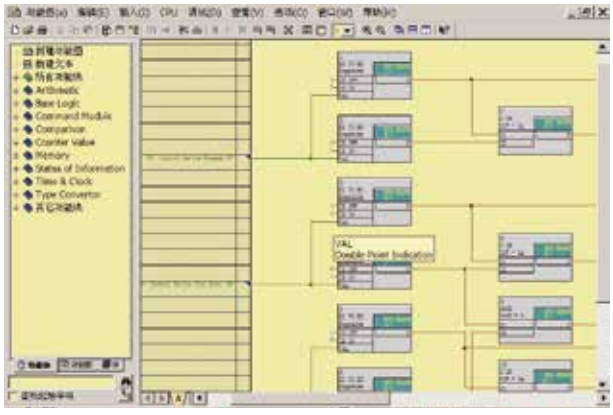


Circuit breaker, transformer tap-changer, or other equipment can be controlled by:

- Front LCD display
- Substation control system
- DIGSI 4

User-defined programmable logic

The user can define the specific functions of substation automation through the graphical interface tool (CFC), such as interlocking, sequence control, automatic busbar transfer, and analog threshold supervision. These functions can be activated through control command, binary input or communication protocol. And the output can be routed to BOs, LEDs and transmitted to control center via protocol.



Switching

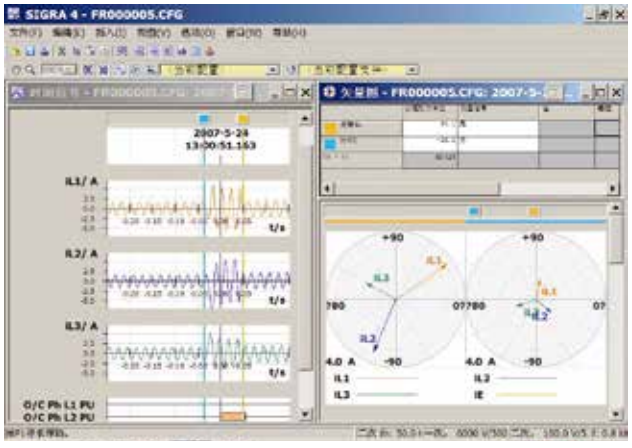
The switching authority (local/remote) is determined by parameters or BI.
All switching operations or CB position changes are recorded in the event log. Information including control command source, switching device, cause of switching (i.e., spontaneous change or command) and consequence are also recorded.

Metering values

For internal metering, the device can calculate electrical energy via measured current and voltage. If there is an external energy meter with the metered pulse output, the device can receive and process the energy pulse via BI. The metering value can be displayed locally as a resettable cumulant and transmitted to the control center to calculate and accumulate the positive and negative active and reactive energy respectively.

Fault record

20 latest fault records are stored. The maximum time of every record is 5s and the total time of all records is 20s. Maximum of 12 analog inputs and 60 configurable BIs are recorded. Recording can be triggered by the device pick-up, trip or the combined indication.



6/12 temperature inputs

If the MLFB 12th position is selected with external expansion module, the device supports to connect with 1 or 2 temperature measuring modules of Advantech ADAM-4015 PT100 (accuracy 0.5%) via the rear communication Port A. The device can display the temperature and transmit it to remote control center. The temperature can also be processed for alarming via CFC. The function is to monitor the temperature of motor winding and bearing. ADAM module requires an external 24V DC power supply.

Monitoring Function

Event logs
512 events with a timestamp of 1ms resolution are supported.

Control command processing
The device provides all functions for control command processing, including single/ double-command processing with or without feedback, runtime monitoring of controlled equipment, and automatic command termination after output. Some typical applications are as follows:
- Single or double command
- User-defined bay interlocking
- Sequence control considering CB, disconnector, and earthing disconnector
- Triggering of switching operations, indications or alarming message by combining existing information

BI chatter blocking
It is suppressed by determining whether the number of BI chattering within the specified time exceeds the setting value. If so, the input status will be blocked for a period to avoid overflow of the event log buffer.

BI filtering time
BI can be filtered, or time delayed by the software. Filtering is to suppress the BI transient change. Only if the status change is still existing after the settable time, the change will be recognized. The SOE can be time stamped since the initial or steady instant of status change.

Commissioning and testing
DIGSI 4 tool is facilitated for site commissioning. The I/O status can be on-line accessible. To facilitate the testing of protection function and user-defined logic without any primary aid, it's possible to manually set the value of BI and BO.
The value of indications transmitted to remote control center can also be manually set one by one to facilitate the communication test. To prevent the massive testing indication from disturbing the normal operation of control center during the commissioning, the customer can activate the "test" mode to block the transmitting even if the communication is working.

Measurands
RMS values of current and voltage can be obtained from CT (measurement or protection CT) and VT, and can furtherly calculate active power, reactive power, power factor, etc.
The device provides the following measurands:
- Current Ia, Ib, Ic, In, Ins
- Voltage
  Va, Vb, Vc, Vab, Vbc, Vca, Vn
- Symmetric quantity
  I1, I2, 3I0; V1, V2, 3V0
- Active power P, reactive power Q, apparent power S
- Power factor
- Frequency
- Electric energy ±kWh, ±kVarh
- Harmonics
- phi (3Vo, INs)
- INs Real
- INs Reac
- Four 20mA analog value
- Differential related values
- Temperature

Statistics function
- Operating hours
- Cumulative breaking current of each phase
- Number of trips
- Maximum/minimum current
- Motor starting time and current

Wireless temperature measurement of switchgear
It is used for over-temperature caused by current and situations where high-voltage insulation is required. It can monitor the temperature of circuit breaker contacts, bus connection points, and cable heads so that potential equipment hidden dangers can be detected in advance in combination with the current criterion.
- Range: -25~+125 ℃
- Accuracy: 1 ℃
- Updating interval: 2~100 s
- Operating current range: 10~5,000 A
- Wireless frequency: 433MHz
- Self-powered and maintenance-free sensor
- One protection device can connecte with 60 temperature sensors of 5 bays
- Intelligent alarming algorithm based on real-time current

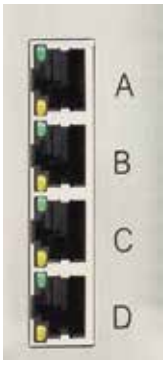
Front interface

There is a Type A USB2.0 port on the front panel of device. By this port, a PC installation with software tool DIGSI 4 can connect with the device. DIGSI 4 integrates the tools for commissioning and fault analysis, so the on-site testing and power system fault analysis can also be implemented via this port.
Meanwhile, this port also supports reading and writing of USB flash disk. The customer can read out and download the configuration and tripping logs of device, upgrade the device software, and modify device MLFB through the USB disk.

Rear communication interface

4 communication modules are available.

1) Serial module (Type V)
   Port A: GPS (RS485 or TTL)
   Port B: RS485 electrical port
   Port C: RS485 electrical port
2) Ethernet module (Type W)
   Port A: GPS (RS485 or TTL)
   Port B: 100M electrical Ethernet port
   Port C: 100M electrical Ethernet port
3) Ethernet module (Type X)
   Port A: GPS (RS485 or TTL)
   Port B: 100M electrical Ethernet port
   Port C: 100M electrical Ethernet port
   Port D: 100M electrical Ethernet port
4) Combined Ethernet module (Type Y)
   Port A: GPS (RS485 or TTL)
   Port B: 100M optical Ethernet port
   Port C: 100M optical Ethernet port
   Port D: 100M electrical Ethernet port



Type V, W and X module

Type Y module

Communication protocols

Port B, C and D of the device can support the following protocols simultaneously or individually:

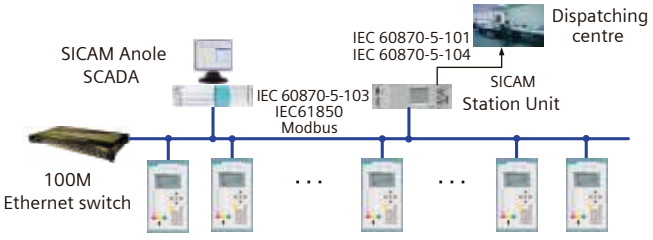
- IEC 60870-5-103 (RS485 Port C or Ethernet Port B)
- IEC 61850 MMS & GOOSE Edition1&2
- Modbus RTU (RS485 or Ethernet)
- DIGSI 4 (USB, RS485 Port C or Ethernet port B)
- IEC 60870-5-103 and IEC 61850 supports the access and modification of settings

Time synchronization

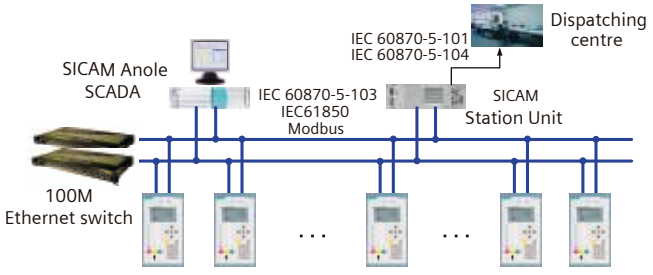
- System port
- SNTP
- GPS IRIG-B (RS485 or TTL)
- PPM

Solutions for protection and substation automation

7SJ686 provides a flexible communication networking mode. Protection device can be connected with the control center via a single star bus mode, or by a redundant star bus mode. These buses can be RS485 interfaces or Ethernet ports.



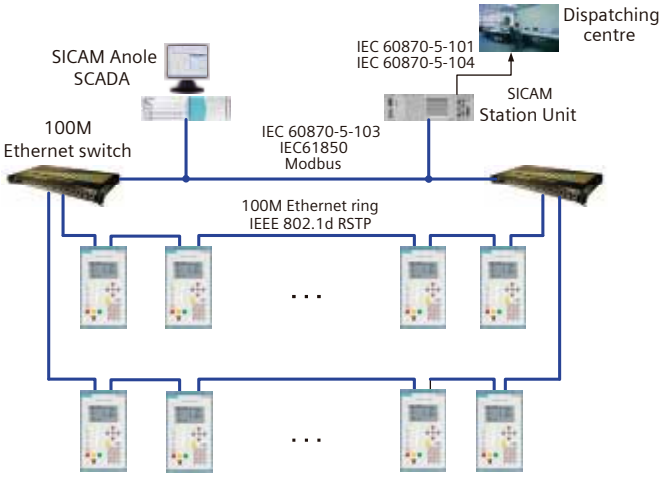
Star Ethernet Connection



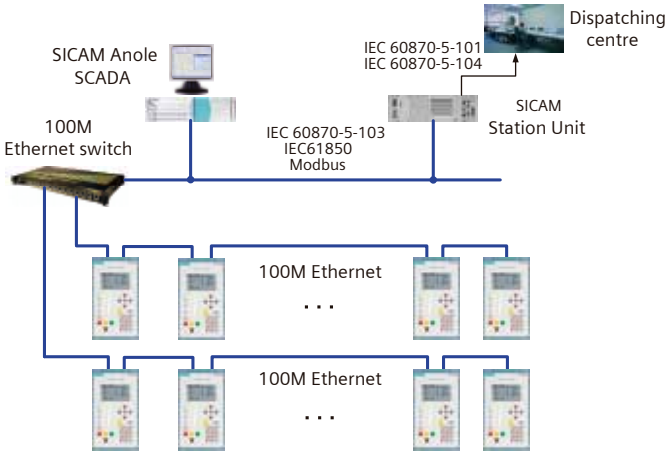
Redundant Star Ethernet Connection

Communication Function

When the Ethernet interface is used, Ports B and C support the RSTP ring network operation mode, which will provide a more reliable connection than the single star mode and can reduce the number of switches used.



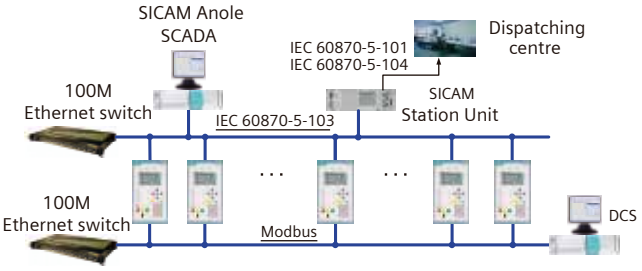
Ethernet Ring Network Connection



Daisy Chain Ethernet Connection

Multi-protocol and multi-master communication mode

To adapt to the communication with different control center, the device allows different communication protocols to be used at different communication interfaces, and the mapping table of each protocol can be different.



Dual-master Star Ethernet Connection Scheme

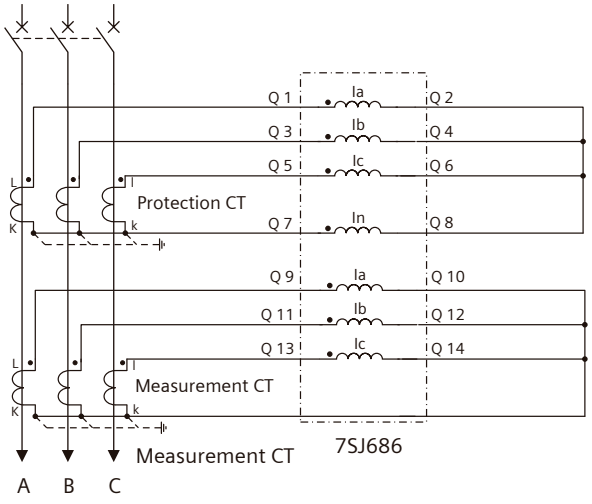
T103 TCP/IP protocol: The device supports a maximum of 15 slaves to access through the network port.
Modbus TCP/IP protocol: The device supports a maximum of 9 slaves to access through the network port.
IEC 61850 protocol: The device supports a maximum of 15 clients to access through the network port, and a maximum of 8 clients to access the same report at the same time.
For the actual user system, various network topologies, time synchronization modes, and communication protocols can be used together.

Typical connections

■ Current transformer

Standard connection

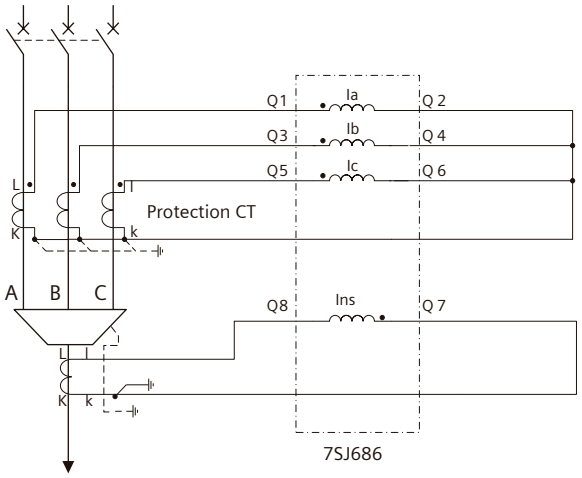
For a solidly grounded power grid, the ground current can be measured from common return conductor.



CT 3-ph connection

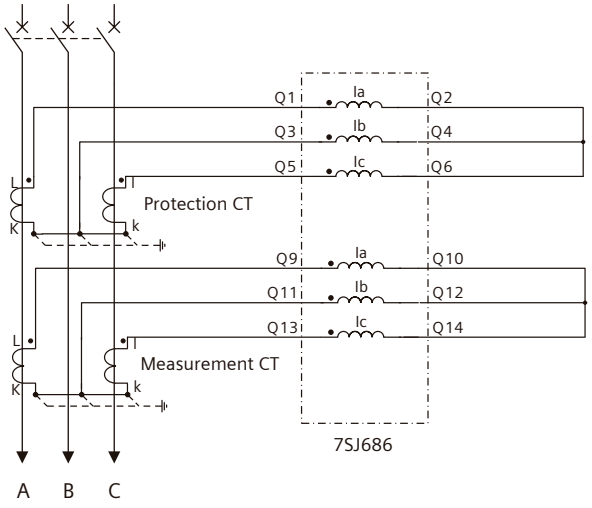
Sensitive CT in isolated system

A single bushing CT is used, which ensures maximum accuracy for ground fault.



Sensitive CT connection

CT 2-ph connection in isolated system.

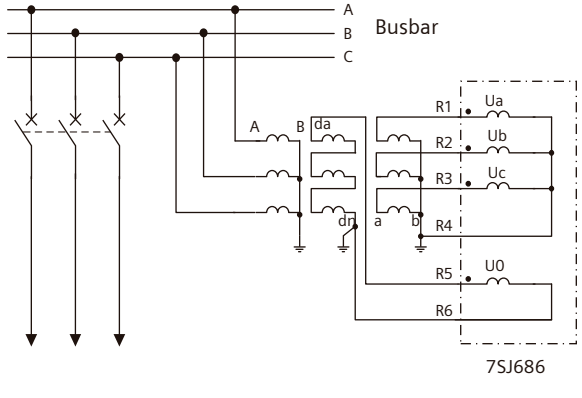


CT 2-ph connection

■ Voltage transformer

VT 3-ph+ VT displacement

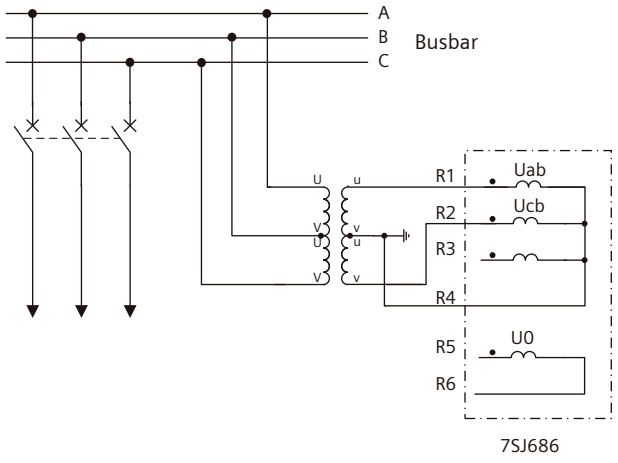
The figure shows the connection of VT 3-ph + displacement VT.



VT 3-ph + VT displacement

Typical Wiring

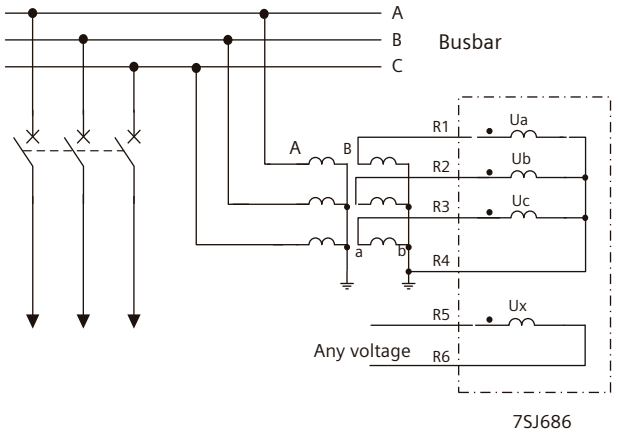
VV connection



VV connection

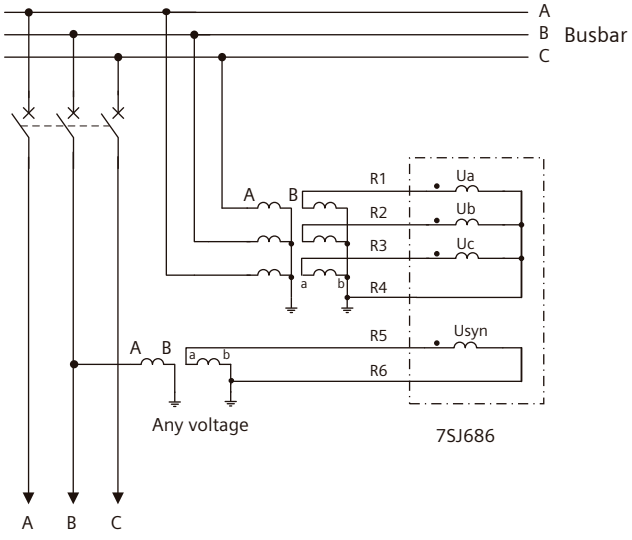
Vx connection

Vx input can be connected to any voltage quantity and be used for user-defined overvoltage or undervoltage.



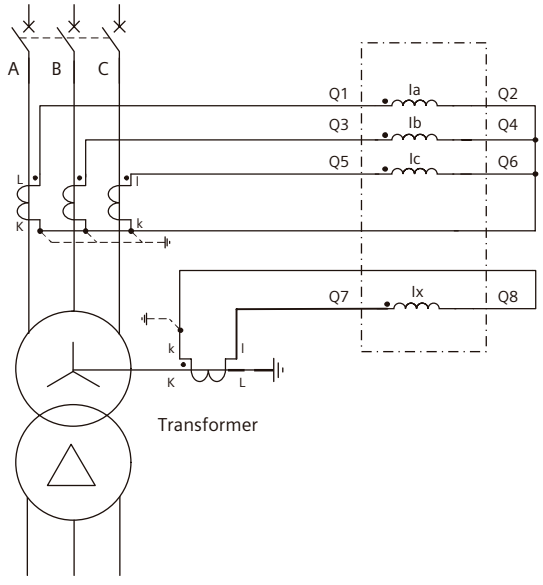
VT 3-ph + Vx connection

Connection for synchro-check



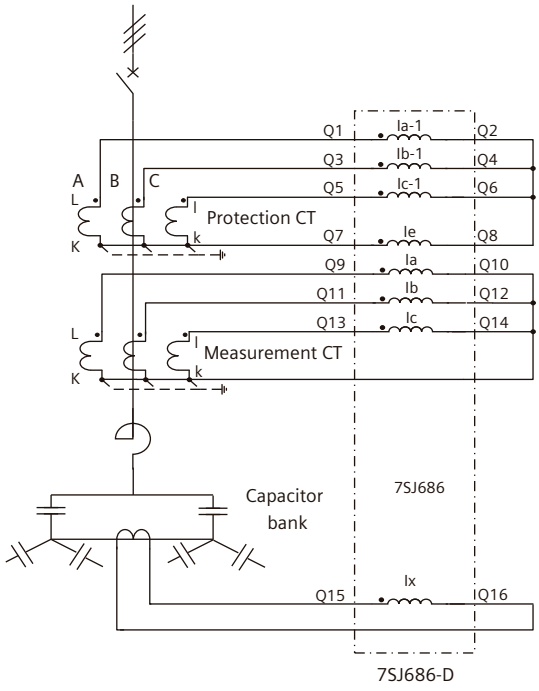
Synchro-check application

Connection for Restricted earth fault protection

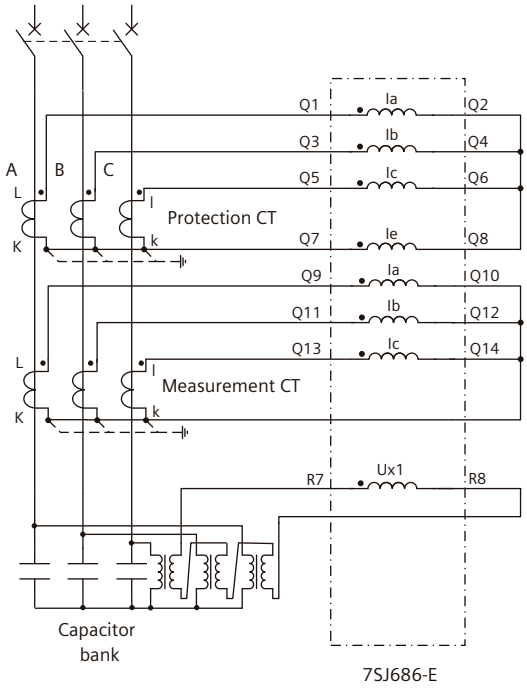


Application of restricted earth fault protection

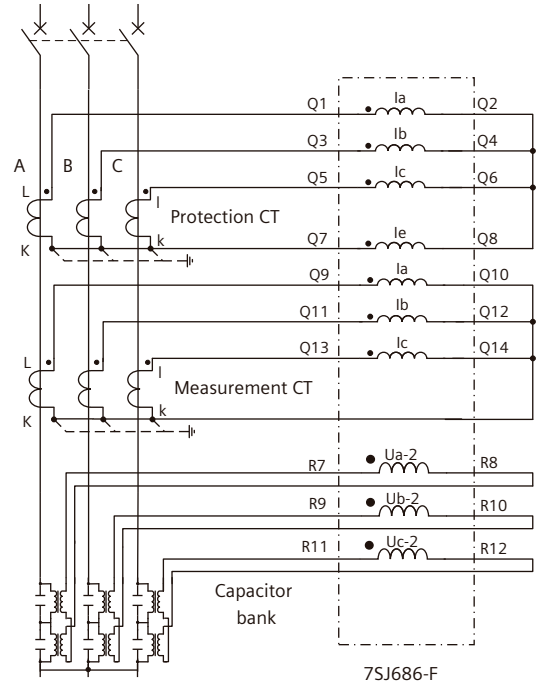
Connection for capacitor application



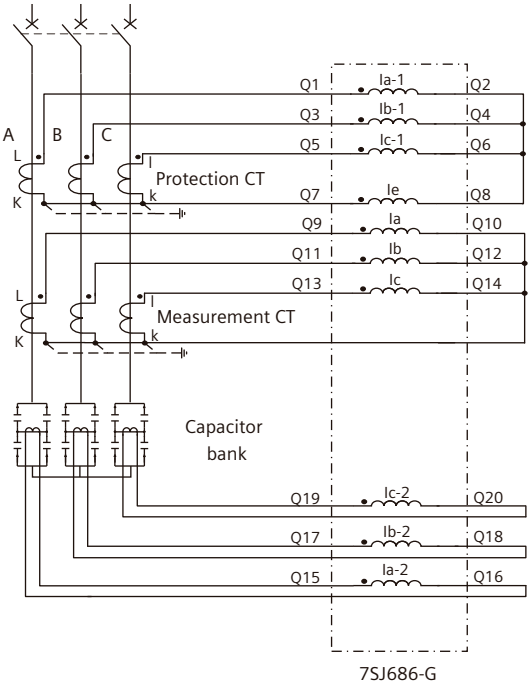
Current-unbalance protection



Voltage-unbalance protection



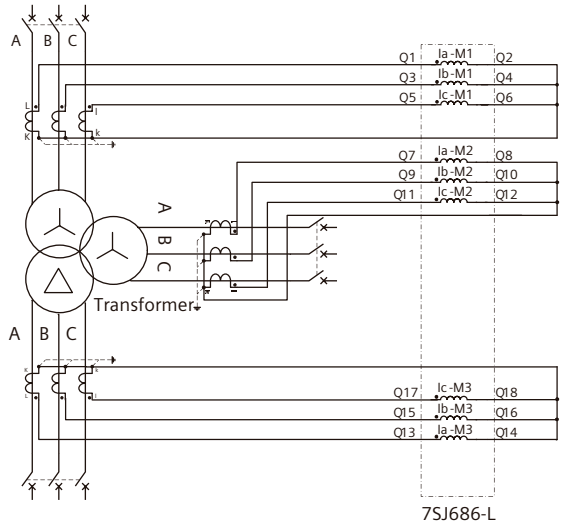
Voltage differential protection



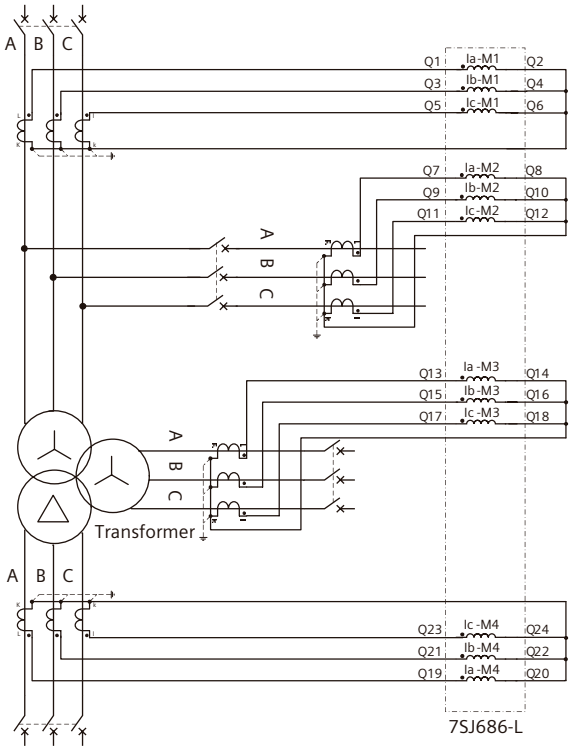
Current differential protection

Typical Wiring

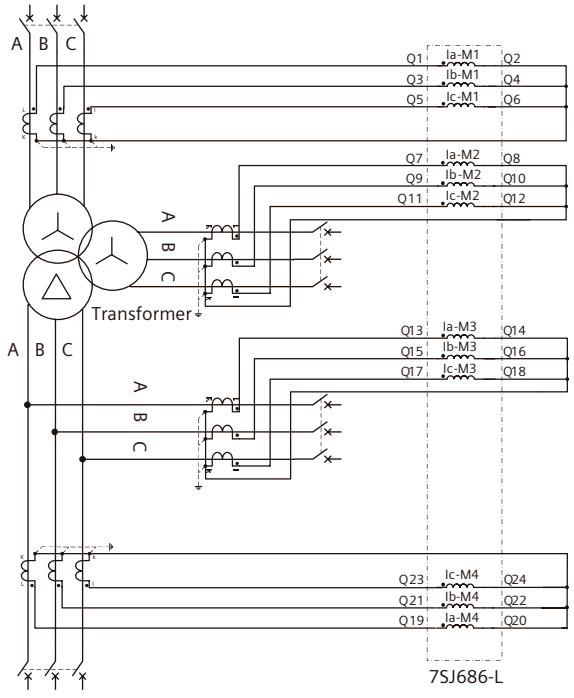
Connection of 3-winding transformer application



3-winding transformer

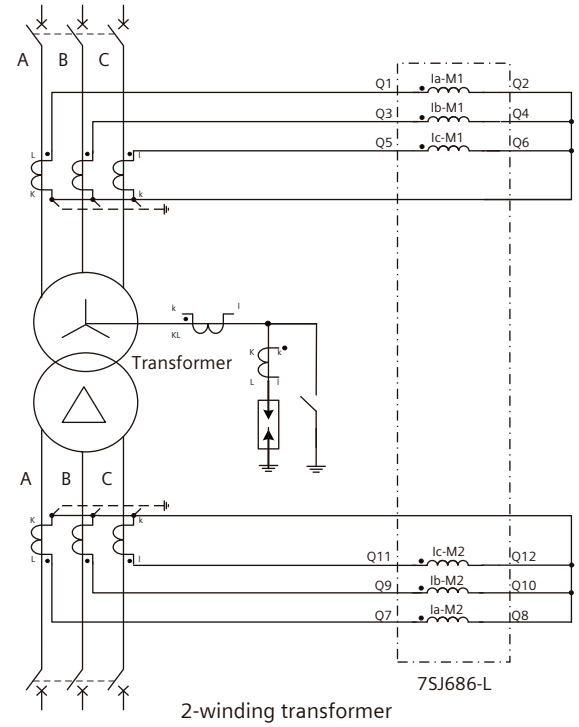


3-winding transformer with 2 HV measuring points

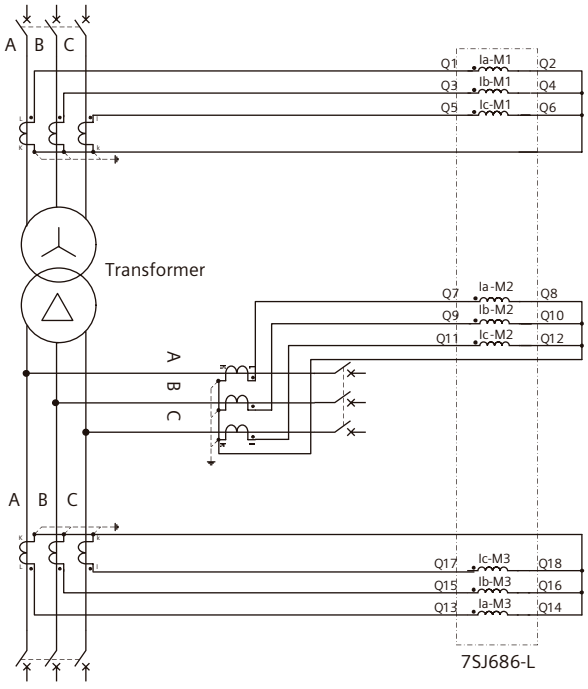


3-winding transformer with 2 LV measuring points

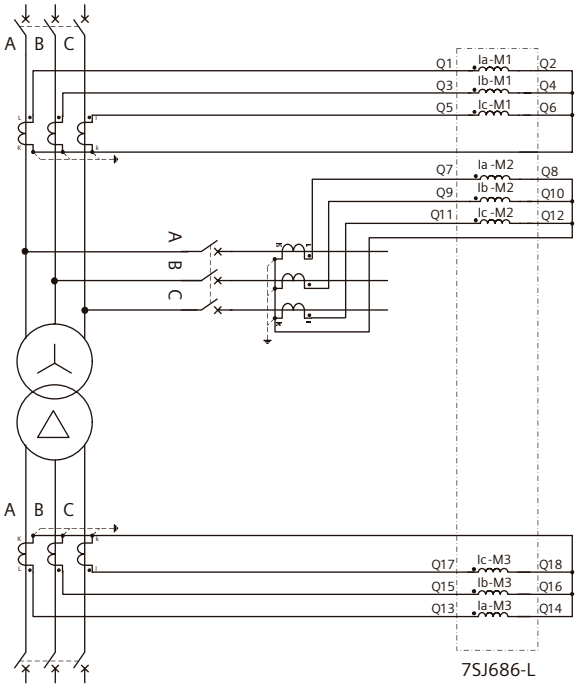
Connection of 2-winding transformer application



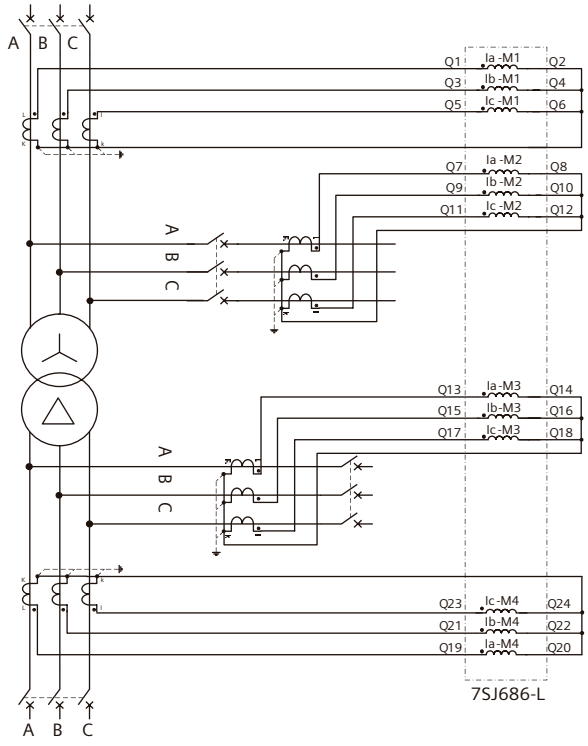
2-winding transformer



2-winding transformer with 2 LV measuring points



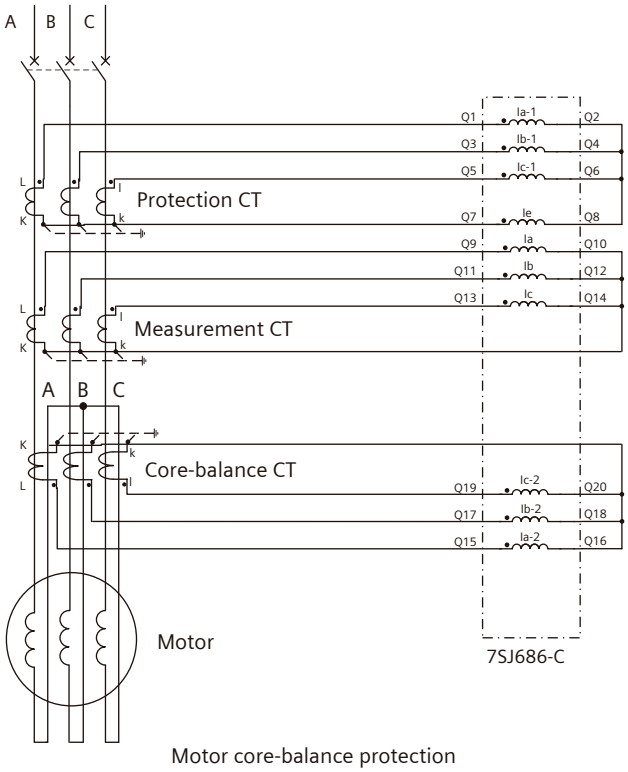
2-winding transformer with 2 HV measuring points



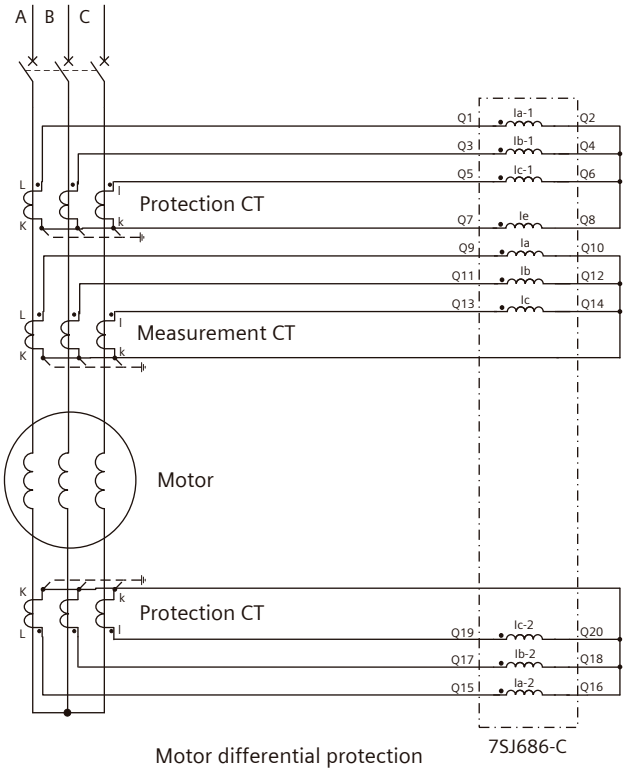
2-winding transformer with 4 measuring points

Typical Wiring

Connection for motor application

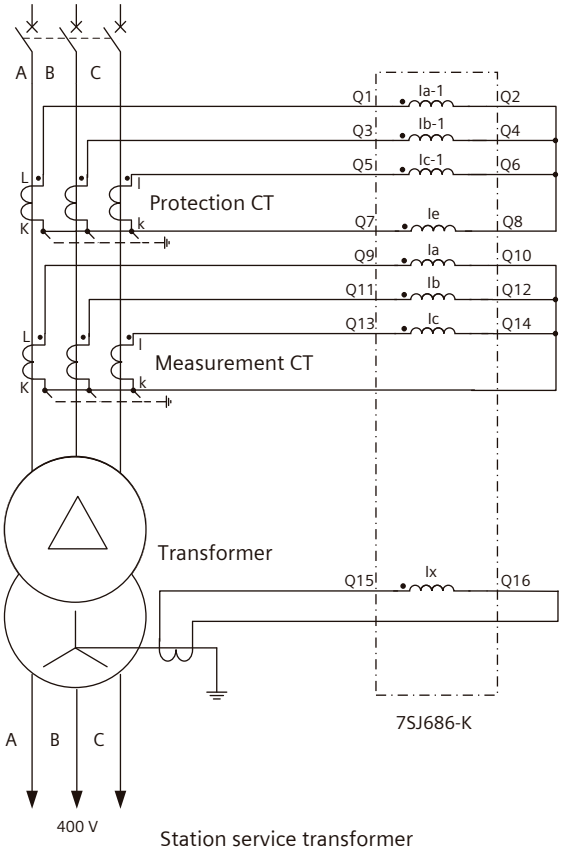


Motor core-balance protection



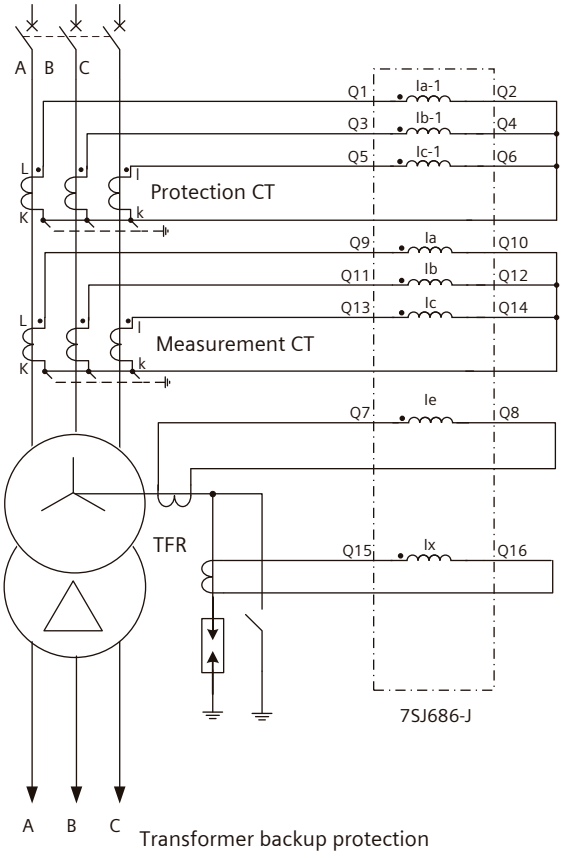
Motor differential protection

Connection for SST application



Station service transformer

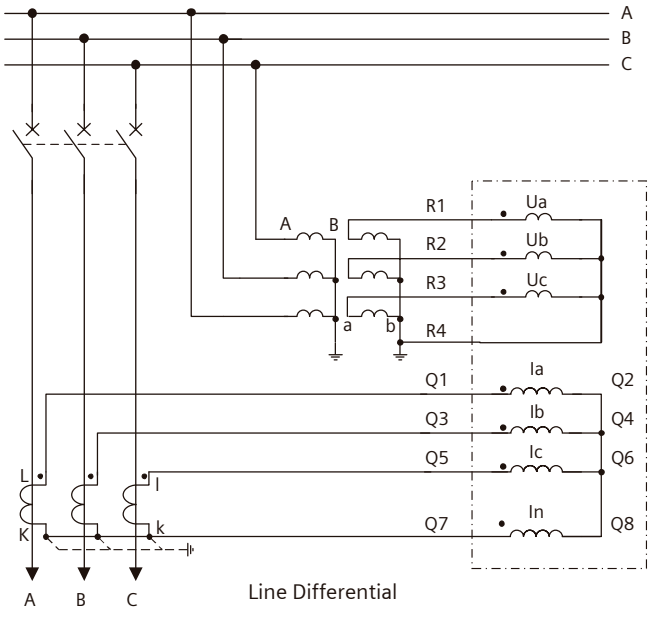
Connection for transformer backup protection



Transformer backup protection

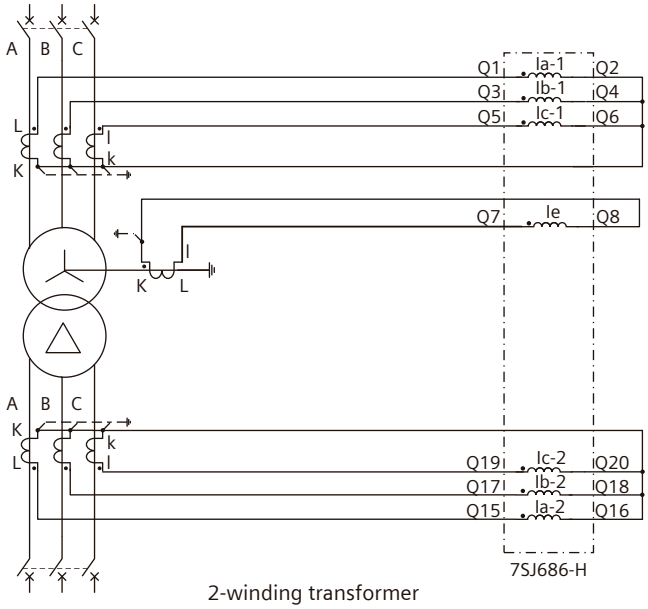
Typical Wiring

Connection for line differential application

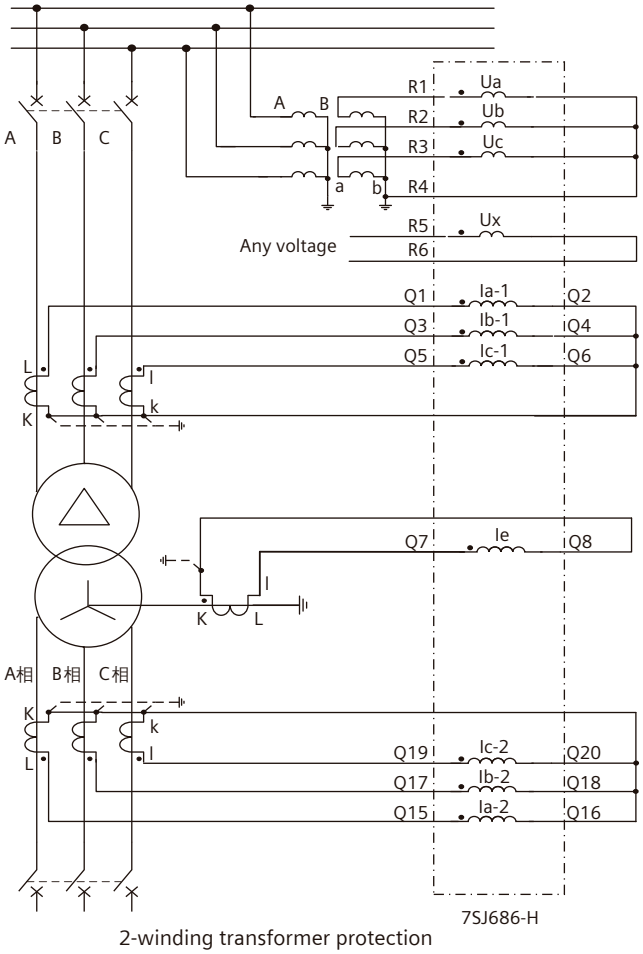


Line Differential

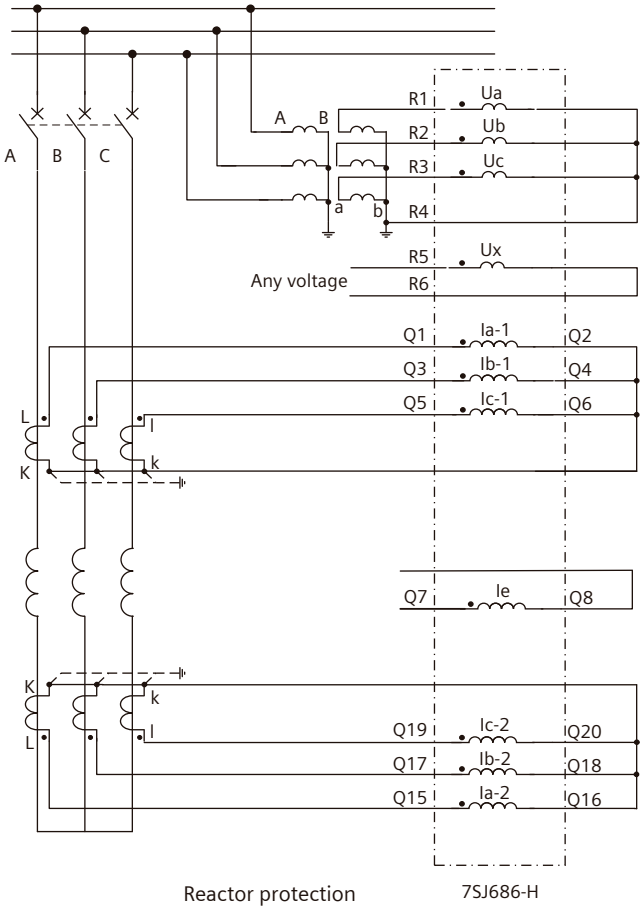
7SJ686-H typical connection



2-winding transformer

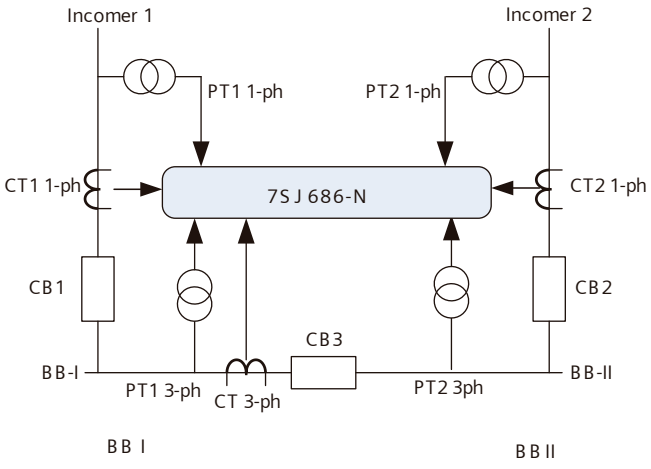


2-winding transformer protection

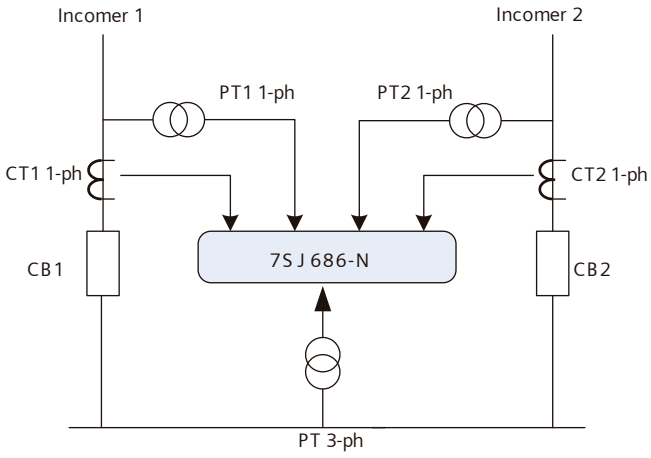


Reactor protection

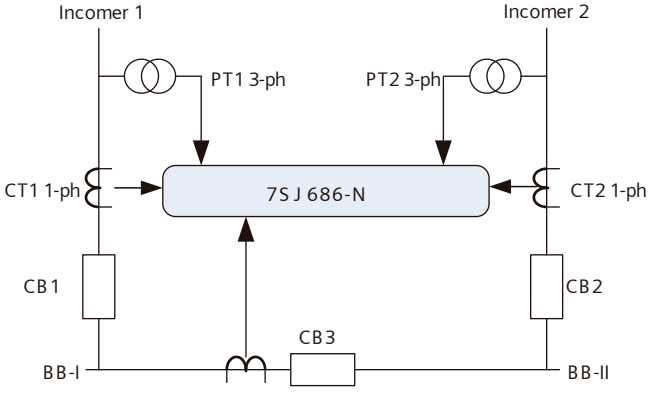
Connection for automatic busbar transfer application



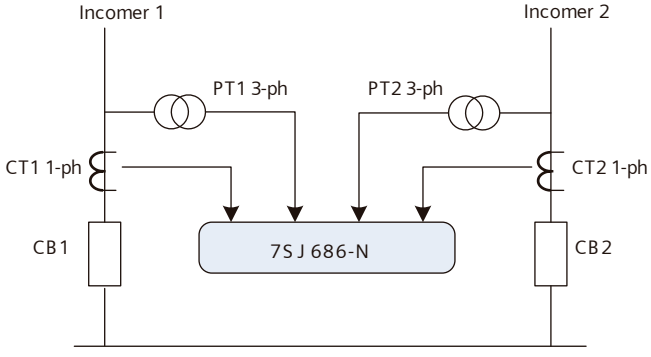
Sectionalized busbar (PT on the bus side)



Single busbar (PT on the bus side)

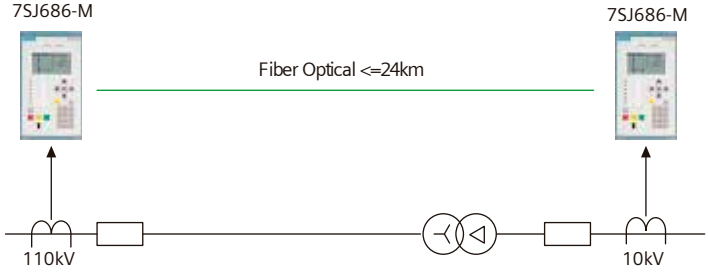


Sectionalized busbar (PT on the incomer side)



Single busbar (PT on the incomer side)

Line-transformer unit application



Technical Data

Input and output

Measuring circuit

Current input (CT)

Rated frequency f_N	50 Hz
Rated current I_{Nom}	1A or 5A (changed by jumper)
Sensitive ground current Ins	Linear range ≤2.1 A
Burden, protection CT per phase	
- INom=1A	Approx. 0.02 VA
- INom=5A	Approx. 0.40 VA
- Ins=1A for sensitive ground fault detection	Approx. 0.10 VA
Burden, measurement CT per phase	
- INom=1A	Approx. 0.02 VA
- INom=5A	Approx. 0.50 VA
Current overload capability	
- Thermal rating of protection CT (RMS)	500 A for 1s
	4·INom continuously
- Thermal rating of measurement CT (RMS)	20·INom for 1s
	3·INom continuously
- Thermal rating of sensitive CT (RMS)	150A for 1s
	6A continuously

Voltage input (VT)

Rated voltage	100VAC or 220VAC (changed by jumper)
Measurement range	
-100 VAC	1~190 VAC
-220 VAC	2~292 VAC
- Zero-sequence VT	1~292 VAC
Burden (at 100V)	Approx. 0.15VA, per phase
Voltage overload capacity - thermal rating (RMS)	300 VAC continuously

Auxiliary voltage

DC/AC voltage

Rated auxiliary voltage UAux		110/220VDC or 110/220VAC	
Allowable voltage range		88~253VDC or 88~253VAC	
DC power ripple peak		<15% of rated voltage	
Power consumption			
1/3 19" device		<=8W	
1/2 19" device		<=9W	
Stored-energy time to for auxiliary voltage outage or short circuit	1/3 19" device	<=100ms	When U>=110VDC
		<=450ms	When U>=220VDC
	1/2 19" device	<=55ms	When U>=110VDC
		<=320ms	When U>=220VDC
Energization inrush current amplitude		<=30A	Time<=15ms

Binary input and binary output

Binary input

Number	1/3 19" device	1/2 19" device
	16	36
D-type expansion module	9	
F-type expansion module	6	
Rated voltage range	110 or 220 VDC (changed by jumper), unipolar, support 220 VAC	
Current consumption (independent of voltage)	Approx. 2 mA	
Pickup/dropout time	Approx. 2 ms	
Pickup voltage		
For rated voltage 110 VDC	Approx. 69 VDC	
For rated voltage 220 VDC	Approx. 132 VDC	
Maximum allowable voltage	250 VAC	

Input and output

Binary output

Number	1/3 19" device	1/2 19" device
	1 NC life contact	1 NC life contact
	6 NO contacts	21 NO contacts
	1 NO/NC contact	2 NO/NC contacts
E-type expansion module	5 NO contacts	
F-type expansion module	3 NO contacts (including 1 NO or NC contact)	
Switching capacity		
Make	1000 W/VA	
Break	30 VA	
Break (resistive)	40 W	
Break (L/R≤40 ms)	30 W	
Switching voltage	250 VDC/VAC	
Permissible current per contact (continuous)	5 A	
Permissible current per contact (switching on and holding)	30A for 0.5s (make contacts)	
Total permissible current for contacts connected to common potential	5 A continuously, 30A for 0.5s	
Response time	Approx. 8ms	

Analog input and analog output

Analog input AI

Number	
B-type expansion module	Four 0~22 mA DC
Accuracy	0.2%*20 mA
Internal resistance	120 Ω
Insulation and voltage resistance	500 V AC; 50Hz

Analog output AO

Number	
C-type expansion module	Two 0~24mADCs
Accuracy	0.2%*20mA
Maximum load	350 Ω
Insulation and voltage resistance	500 V AC; 50Hz

Operating module

This operating module is suitable for circuit breakers with one tripping coil

Operating voltage	110 VDC or 220 VDC (changed by jumper), 220 VAC
Latching current of closing/tripping circuit	0.3~4 A adaptive
Input	Manual opening signal
	Protection tripping signal
	Manual closing signal
	Protection closing signal
Output	Closed position signal HWJ
	Trip position signal TWJ
	Post-closing signal HHJ (only for DC operation module)
	Abnormal operating module (internal signal)
	Fault signal (internal signal)

Input and output

Communication interface

Front panel configuration interface	
Interface type	Front, non-isolated, USB2.0 Type A port
Connection mode	PC or USB flash disk with DIGSI installed
Maximum transmission distance	<5m

Rear GPS interface	
Interface type	Port A, RJ45 port, IRIG-B
Interface level	RS485 or TTL (adjusted by jumper/RS485 when delivery)
Insulation and voltage resistance	500VAC, 50Hz

Rear system interface	
RS485	
Support protocol	IEC60870-5-103 Modbus DIGSI
Interface type	Port B, RJ45 port Port C, RJ45 port
Insulation and voltage resistance	500VAC, 50Hz
Maximum transmission distance	1km
transfer speed	Minimum 300Bd, maximum 57.6kBd; Factory setting 19,200Bd
Ethernet	
Protocols	IEC 60870-5-103 IEC61850 MMS & GOOSE Modbus DIGSI
Electrical module	Port B, RJ45 port Port C, RJ45 port Port D, RJ45 port 100BaseT meets IEEE802.3
Insulation and voltage resistance	500VAC, 50Hz
Maximum distance	100 m
Optical module	Port B, LC interface Port C, LC interface Port D, RJ45 interface
Typical optical wavelength	1310nm
Fiber optical cable	Multi-mode G50/125 µm or G62.5/125 µm
Maximum distance	2 km
Maximum transmission distance	100m
Baud rate	100 MBit/s

Tolerance	
Ia, Ib, Ic (measurement CT):	0.2% of measured value, or 0.2%·IN
Va, Vb, Vc:	0.2% of measured value, or 0.2%·VN
P, Q, S (calculated via measurement CT)	0.5%
cosφ, PF (calculated via measurement CT)	1% or 0.01
Frequency	20mHz

Safety and EMC

Standards	GB/T 14598 (IEC 60255) DLT 478

Insulation test	(Routine test)
Standard	GB/T 14598.27
>100MΩ 500V DC	All circuits

Dielectric strength test	(Routine test)
Standard	GB/T 14598.27
2.0kV AC (RMS), 50Hz, 1min	Input, output, VT, CT, power supply and operation circuit
2.8kV DC, 1min	Input, output, VT, CT, power supply and operation circuit
2.0kV AC (RMS), 50Hz, 1min	Test voltage between power supply and weak current
500V AC (RMS), 50Hz, 1min	Isolated communication interface, GPS interface, analog input and analog output

Impulse voltage test	(Type test)
Standard	GB/T14598.27
5kV，1.2/50µs	Input, output, VT, CT, power supply and operating loop Test voltage between power supply and weak current
1.0kV，1.2/50µs	Isolated communication interface, GPS interface, analog input and output

Radiated emission test of enclosure port (type test)	
Standard	CISPR 11
40dB (µV/m)	30MHz~230MHz, quasi-peak (at 10m)
50dB (µV/m)	30MHz~230MHz, quasi-peak (at 3m)
47dB (µV/m)	230MHz~1,000MHz, quasi-peak (at 10m)
57dB (µV/m)	230MHz~1,000MHz, quasi-peak (at 3m)

Emission test of auxiliary power port (type test)	
Standard	CISPR 22
79dB (µV/m)	0.15MHz~0.50MHz, quasi-peak
66dB (µV/m)	0.15MHz~0.50MHz, average
73dB (µV/m)	0.5MHz~30MHz, quasi-peak
60dB (µV/m)	0.5MHz~30MHz, average

Radiated RF electromagnetic field immunity test (type test)	
Standard	GB/T 17626.3 (IEC 61000-4-3)
Sweep frequency	Sweep frequency range: 80-1,000MHz, 1,400~2,700MHz; Amplitude modulation: 80% AM (1kHz); Step: ≤1%
10V/m (Level 3)	Enclosure port
Frequency point	Frequency point range: 80MHz, 160MHz, 380MHz, 450MHz, 900MHz, 1850MHz, 2150MHz; Amplitude modulation: 80% AM (1 kHz); Duty ratio: 100%
10V/m(Level 3)	Enclosure port

Electrostatic discharge immunity test (enclosure port) (type test)	
Standard	GB/T 17626.2(IEC 61000-4-2)
8kV (level 4)	Contact
15kV (level 4)	Air

Rated frequency magnetic field immunity test (enclosure port) (type test)	
Standard	GB/T 17626.8(IEC 61000-4-8)
Continuous (Level 5)	100A/m
1s~3s (Level 5)	1000A/m

Technical Data

Safety and EMC

Impulse magnetic field immunity test (enclosure port) (type test)		
Standard		GB/T 17626.9 (IEC 61000-4-9)
1000A/m	(Level 5)	tr/th:8/20 μs

Damped oscillating magnetic field immunity test (enclosure port) (type test)		
Standard		GB/T17626.10(IEC61000-4-10)
100A/m	(Level 5)	1MHz/0.1MHz

Conducted disturbance immunity test (type test) induced by radio frequency fields		
Standard		GB/T17626.6(IEC61000-4-6)
Sweep frequency		Sweep frequency range: 0.15 - 80 MHz; Impedance: 150Ω; Amplitude modulation: 80% AM; Amplitude modulation: 80% AM; Step: <=1%
10V	(Level 3)	Auxiliary power supply, communication port, input, output and functional ground port
Dot frequency		Dot frequency range: 27MHz, 68MHz; Source impedance: 150Ω; Amplitude modulation: 80%AM; Duty ratio: 100%
10V	(Level 3)	Auxiliary power supply, communication port, input, output and functional ground port

Fast transient immunity test (type test)		
Standard		GB/T17626.4(IEC61000-4-4) tr/td: 5/50ns Repetition frequency: 5kHz
4kV	(level 4)	Power supply, input, output, VT, CT, operating loop, analog input and output loop
2kV	(level 4)	Communication port

Slow damped oscillation wave immunity test (type test)		
Standard		GB/T 17626.18 (IEC 61000-4-18) Voltage oscillation frequency: 1MHz, 100kHz Voltage rise time: 75ns Repetition frequency: 1MHz/400Hz; 100kHz/40Hz Output impedance: 200Ω
Differential mode: 1kV, common mode: 2.5kV (level 3)		Power supply, input, output, VT, CT, operating loop, analog input and output loop
Differential mode: 0kV, common mode: 1kV		Communication port

Surge immunity test (type test)		
Standard		GB/T 17626.5 (IEC 61000-4-5) Wavefront/half-peak time: 1.2/50 (8/20) μs Voltage(current); Source impedance: 2Ω
Wire to wire: 2kV	(level 4)	Auxiliary power supply, coupling resistance: 0Ω; Coupling capacitance: 18μF Input, output, VT, CT, operating loop, analog input and output loop, Coupling resistance: 40Ω; Coupling capacitance: 0.5μF
Wire to ground: 4kV	(level 4)	Auxiliary power supply, coupling resistance: 10Ω; Coupling capacitance: 9μF Input, output, VT, CT, operating loop, analog input and output loop, Coupling resistance: 40Ω; Coupling capacitance: 0.5μF
Wire to ground: 4kV	(level 4)	Communication port, coupling resistance: 0Ω; Coupling capacitance: 0MF

Binary input rated frequency disturbance test	
Standard	GB/T 14598.26
Differential mode voltage: 150V	Coupling resistance: 100Ω; Coupling capacitance: 0.1μF
Common mode voltage: 300V	Coupling resistance: 220Ω; Coupling capacitance: 0.47μF

Safety and EMC

Vibration and shock during operation (type test)	
Standard	IEC60255-21 IEC60068
Vibration IEC60255-21-1, level II IEC60068-2-6	Sinusoid Vibration response: Vibration frequency range: 10Hz~150Hz, crossover frequency: 60Hz, scanning rate: 1x frequency/min; the displacement amplitude below the crossover frequency is 0.075mm; The displacement amplitude above the crossover frequency is 1g acceleration; 20 cycles for 3 orthogonal triads Vibration endurance: Vibration frequency range: 10~150Hz, scanning rate: 1x frequency/min, 2g acceleration; 20 cycles for 3 orthogonal triads
Shock IEC 60255-21-1, level I IEC 60068-2-27	Half-sinusoid Shock response: 5g acceleration, pulse duration 11ms; Three shocks for each of the three orthogonal triads Shock endurance: 15g acceleration, pulse duration 11ms; Three shocks for each of the three orthogonal triads

DC voltage sag test	
Standard	GB/T 17626.11 (IEC 61000-4-11)
1/3 base device 100ms/ 110VDC, 300ms/220VDC,	100% residual voltage
1/2 base device 50ms/ 110VDC, 200ms/220VDC,	

Vibration and shock during transportation	
Standards	IEC 60255-21 IEC 60068
Vibration IEC 60255-21-1, level II IEC 60068-2-6	Sinusoid 5Hz to 8Hz: ±7.5mm amplitude; 8Hz to 150Hz: 2g acceleration; Frequency refresh rate: 1x frequency/min, 20 cycles for 3 orthogonal triads
Shock IEC 60255-21-1, level I IEC 60068-2-27	Half-sinusoid 15g acceleration, 11ms interval Three shocks for each of the three orthogonal triads
Continuous shock (collision) IEC 60255-21-2, level I IEC 60068-2-29	Half-sinusoid 10g acceleration, duration 16ms 1000 vibrations for each of the 3 orthogonal triads

Temperature and humidity (type test)	
Standards	Low temperature IEC 60068-2-1:2007 High temperature IEC 60068-2-2:2007 Constant damp heat IEC 60068-2-78:2001
Normal operating temperature range	-40°C - +70°C
Storage temperature range	-40°C - +85°C
Constant damp heat performance test	Test temperature: +40°C, relative humidity: 93% Test for 10 days, insulation resistance>10MΩ, dielectric strength >75% of normal value
Alternating damp heat performance test	High temperature cycle: +40°C, humidity: 93%; Low temperature cycle: +25°C, humidity: 97%; 24h (12h+12h) cycle, 6 times
Allowable normal operating humidity range	Allowable humidity average per year: ≤75% Relative humidity; No more than 56 days in a year Relative humidity 93%; Condensation must be avoided!

Mechanical data

Device type	7SJ686	
Housing	Flush mounting rack, 7XP20	
Width	1/3*19"	1/2*19"
Weight	6kg	8kg
Protection grade	Front/side IP51, Rear IP20	
Protection bond impedance	≤0.1Ω (apply 10A AC)	

Overcurrent protection

Basic

Measuring inputs	Ia, Ib, Ic,
Definite time stage	Phase overcurrent stage 1,2,3 With forward direction or without direction With compound voltage release and undervoltage release
Inverse time stage	IEC inverse characteristics of Normal/Very/ Extremely/Long With forward direction or without direction

Measurands

All current and voltage	Fundamental component

Setting range/increment

Definite time characteristics

Stage 1 Stage 2 Stage 3	With In=1A	0.03A to 40.00A or ∞ (disabled)	Step 0.01A
	With In=5A	0.15A to 200.00A or ∞ (disabled)	
Stage 1 delay Stage 2 delay Stage 3 delay		0.00s to 100.00s or ∞ (disabled) Time delay: from pickup to operate	Step 0.01s
Negative-sequence voltage (Refer to Vph)		1.00V to 57.00V or ∞ (disabled)	Step 0.01V
Undervoltage (Refer to Vpp)		1.00V to 100.00V or ∞ (disabled)	Step 0.01V

Inverse time characteristics

Pickup value Ip (phase)	With In=1A	0.05A to 25.00A or ∞ (disabled)	Step 0.01A
	With In=5A	0.25A to 125.00A or ∞ (disabled)	
Time constant T		0.05s to 10.00s or ∞ (disabled)	Step 0.01s
Dropout time delay		0.00s	

Mode(settable)

Def.-T Stage 1 (settable & controllable)	On/off (1/0)
Def.-T Stage 2 (settable & controllable)	On/off (1/0)
Def.-T Stage 3 (settable & controllable)	On/off (1/0)
Inv.-T Stage (settable & controllable)	On/off (1/0)
Def.-T Stage 1 with compound voltage release	Yes/no (1/0)
Def.-T Stage 2 with compound voltage release	Yes/no (1/0)
Def.-T Stage 3 with compound voltage release	Yes/no (1/0)
Def.-T Stage 1 with direction release	Forward/no (1/0)
Def.-T Stage 2 with direction release	Forward/no (1/0)
Def.-T Stage 3 with direction release	Forward/no (1/0)
Inv.-T Stage with direction release	Forward/no (1/0)
Direction criteria against measuring voltage failure	Block OC/release OC (1/0)
Voltage criteria against measuring voltage failure	Block OC/release OC (1/0)

Definite time overcurrent protection – data

Pickup time		
-2x threshold -10x threshold		Approx. 35ms Approx.- 20ms
Dropout time		Approx. 30ms
Dropout factor		0.95 with I/In≥0.2; 0.01*In with I/In<0.2
Directional criteria	Polarization	Cross polarization voltage: When the measured voltage is too low, the memorized voltage is used (for 2s)
	Forward direction	Vref.rot+45°(inductive)
	Sensitivity	Unlimited for 1-ph and 2-ph faults Unlimited for transient state of 3-ph fault Under steady state, approx. 7V (Vpp)

Tolerance	Pickup current	2% of setting value or 10mA with IN=1A or 50mA with IN=5A
	Time delay	1% or 10ms
	Direction phase angle	1°
	Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15	1%
	Influence of temperature -25°C to 55°C	0.5%/10K
	Influence of frequency 0.9≤f/fn≤1.1	1%
	Harmonics influence	
	-Maximum 10% third harmonics	1%
	-Maximum 10% fifth harmonics	1%
	Transient overreach during fundamental measurement τ>100ms (completely asymmetrical)	<5%

Inverse time overcurrent protection – data

Pickup threshold		Approx. $1.10I_p$
Dropout		Approx. 1.05x setting value I_p with $I_p/I_N \geq 0.2$; Approx. equivalent to 0.95x pickup threshold; 0.01*In with I/In<0.2
Directional criteria	Polarization	Cross polarization voltage: When the measured voltage is too low, the memorized voltage is used (for 2s)
	Forward direction	$V_{ref.rot}$+45°(inductive)
	Sensitivity	Unlimited for 1-ph and 2-ph faults Unlimited for transient state of 3-ph fault Under steady state, approx. 7V (Vpp)

Tolerance	Pickup/dropout current	2% of setting value or 10mA with I_N=1A or 50mA with I_N=5A
	Tripping time: with $2 \leq I/I_p \leq 20$	5% of calculated value or 30ms
	Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15	1%
	Influence of temperature -25°C to 55°C	0.5%/10K
	Influence of frequency 0.9≤f/fn≤1.1	1%
	Harmonics influence - Maximum 10% third harmonics	1%
	- Maximum 10% fifth harmonics	1%
	Transient overreach during fundamental measurement τ>100ms (completely asymmetrical)	<5%
Inverse time characteristics	Normal inverse time	$t = \frac{0.14}{(I/I_p)^{0.02}-1} \bullet T_p[s]$
	Very inverse time	$t = \frac{13.5}{(I/I_p)^{1}-1} \bullet T_p[s]$
	Extremely inverse time	$t = \frac{80}{(I/I_p)^{2}-1} \bullet T_p[s]$
	Long inverse time	$t = \frac{120}{(I/I_p)^{1}-1} \bullet T_p[s]$

Ground overcurrent protection

Basic

Measuring input	In (settable measured or calculated value)
Definite time stage	Ground overcurrent stage 1, 2, 3 With forward direction or without direction (zero-sequence voltage is adapted to measured value or calculated value according to voltage connection) Settable setting value of In or 3I0
Inverse time stage	IEC inverse characteristics of Normal/Very/Extremely/Long With forward direction or without direction (zero-sequence voltage is adapted to measured value or calculated value according to voltage connection)

Measurands

All current and voltage	Fundamental component

Setting range/increment

Definite time ground overcurrent protection

Stage 1 Stage 2 Stage 3	With In=1A	0.0NA to 40.00A or ∞ (disabled)	Step 0.01A
	With In=5A	0.15A to 200.00A or ∞ (disabled)	
Stage 1 delay Stage 2 delay Stage 3 delay		0.00s-100.00s or ∞ (disabled)	Step 0.01s

Inverse time ground overcurrent protection

Pickup value Ip	With In=1A	0.05A to 20.00A or ∞ (disabled)	Step 0.01A
	With In=5A	0.25A to 100.00A or ∞ (disabled)	
Time constant T		0.05s to 10.00s or ∞ (disabled)	Step 0.01s
Dropout time delay		0.00s	

Mode(settable)

Def.-T Stage 1 (settable & controllable)	On/off (1/0)
Def.-T Stage 2 (settable & controllable)	On/off (1/0)
Def.-T Stage 3 (settable & controllable)	On/off (1/0)
Inv.-T Stage (settable & controllable)	On/off (1/0)
Def.-T Stage 1 with direction release	Forward/no (1/0)
Def.-T Stage 2 with direction release	Forward/no (1/0)
Def.-T Stage 3 with direction release	Forward/no (1/0)
Inv.-T Stage with direction release	Forward/no (1/0)
Direction criteria against measuring voltage failure	Block gnd. OC/ release gnd. OC (1/0)

Definite time ground overcurrent protection – data

Pickup time			
-2x threshold -10x threshold		Approx. 35ms Approx. 20ms	
Dropout time		Approx. 30ms	
Dropout factor		0.95 with I/In ≥0.2; 0.01*In with I/In <0.2	
Direction criteria	Polarization	3V0, 3I0. When the measured voltage is too low, the memorized voltage is used (for 2s)	
	Forward direction	$V_{ref.rot}$ -45°(inductive)	
	Sensitivity	3U0, 3I0	Measured zero-sequence voltage ≈ 2.5V Calculated zero-sequence voltage ≈ 5V
Tolerance	Pickup current		2% of setting value or 10mA with In=1A or 50mA with In=5A
	Time delay		1% or 10ms
	Direction phase angle		3°
	Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15		1%
	Influence of temperature -25°C to 55°C		0.5%/10K
	Influence of frequency 0.9≤f/fn≤1.1		1%
	Harmonics influence		
	-Maximum 10% third harmonics		1%
	-Maximum 10% fifth harmonics		1%

Inverse time ground overcurrent protection – data

Pickup threshold		Approx. 1.10 Ip	
Dropout factor		Approx. 1.05x setting value Ip with Ip/IN≥0.3; Approx. equivalent to 0.95x pickup threshold	
Dropout factor		0.95 with I/In ≥0.2; 0.01*In with I/In <0.2	
Direction criteria	Polarization	3U0, 3I0 polarized voltage When the measured voltage is too low, the memorized voltage is used (for 2s)	
	Forward direction	Vref.rot -45°(inductive)	
	Sensitivity	3U0, 3I0	Measured zero-sequence voltage ≈ 2.5V Calculated zero-sequence voltage ≈ 5V
Tolerance	Pickup/dropout current		2% of setting value or 10mA when In=1A or 50mA when In=5A
	Tripping time: with 2≤I/Ip≤20		5% of calculated value or 30ms
	Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15		1%
	Influence of temperature -25°C to 55°C		0.5%/10K
	Influence of frequency 0.9≤f/f_n≤1.1		1%
	Harmonics influence		
	-Maximum 10% third harmonics		1%
	-Maximum 10% fifth harmonics		1%

For inverse time characteristics, please refer to the data of inverse time overcurrent protection

Arc protection

Basic

Measuring inputs	Ia, Ib, Ic Arc probe 1 Arc probe 2 Arc probe 3 Arc external trip 1 Arc external trip 2

Setting range/increment

Current	0.1 to 20.0 I/In, step 0.1I/In
Time delay	0.08s to 0.50s, step 0.01s
Arc sensor type	Visible light point sensor/visible light line sensor
Current jump	On/off
Channel 1 operate with	Not configured/Only arc/Arc and current
Channel 2 operate with	Not configured/Only arc/Arc and current
Channel 3 operate with	Not configured/Only arc/Arc and current
External trip 1 operate with	Not configured/Only arc/Arc and current
External trip 1 operate with	Not configured/Only arc/Arc and current
Channel 1 trip	yes/no
Channel 2 trip	yes/no
Channel 3 trip	yes/no
External trip 1 trip	yes/no
External trip 2 trip	yes/no
Mode(settable)	
Arc protection	On/off
Mode(controllable)	
Arc protection	On/off

Arc protection - data

Pickup time		
Only arc		≤4ms
Arc and current jump		≤6ms
-2x setting value (arc and current jump)		≤15ms
Dropout time		≤15ms
Arc dropout factor		0.5
Current dropout factor		0.95 with I>=0.2I/In; 0.01*In with I< 0.2I/In
Tolerance	Arc	20% of setting value
	Current	5% of setting value or 0.01 In
	Time delay	1% of setting value or 10ms

Overload protection

Setting range/increment

Stage 1	With I_N=1A	0.03A to 2.00A or ∞ (disabled)	Step 0.01A
Stage 2	With I_N=5A	0.15A to 10.00A or ∞ (disabled)	
Stage 1 delay	0.00s to 9000.00s, ∞		Step 0.01s
Stage 2 delay			
Stage 1 behavior	Trip/alarm (1/0)		
Stage 2 behavior			
Mode(settable)			
Stage 1	On/off (1/0)		
Stage 2	On/off (1/0)		
Mode(controllable)			
Overload protection	On/off (1/0)		

Overload protection – data

Pickup time		
-2x threshold	Approx. 30ms	
-10x threshold	Approx. 20ms	
Dropout time	Approx. 30ms	
Dropout factor	0.95 with I/In ≥0.2; 0.01*In with I/In <0.2	
Tolerance	Pickup current	2% of setting value or 10mA with I_N=1A or 50mA with I_N=5A
	Time delay	1% or 10ms
	Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15	1%
	Influence of temperature -25°C to 55°C	0.5%/10K
	Influence of frequency 0.9≤f/fn≤1.1	1%
	Harmonics influence -Maximum 10% third harmonics	1%
	-Maximum 10% fifth harmonics	1%
	Transient overreach during fundamental measurement τ>100ms (completely asymmetrical)	<5%

Low frequency load-shedding

Setting range/increment

Stage number	4 stages; Individual on/off for each stage	
Minimum Vpp (referred to 1.732x V1)	10 to 120V	Step 1V
Pickup threshold	45.00 to 50.00Hz	Step 0.01Hz
Load-shedding threshold	45.00 to 49.90Hz	Step 0.01Hz
Time delay	0.20s to 100.00s	Step 0.01s
df/dt threshold	0.10s to 20.00Hz/s	Step 0.01Hz/s
Blocked by frequency up	Yes/no (1/0)	
Mode(settable)		
Stage 1	On/off (1/0)	
Stage 2	On/off (1/0)	
Stage 3	On/off (1/0)	
Stage 4	On/off (1/0)	
Mode(controllable)		
Low frequency load-shedding	On/off (1/0)	

Low frequency load-shedding – data

Times		
Pickup time	Approx. 100ms	
Dropout time	Approx. 90ms	
Pickup time, df/dt	Approx. 230ms	
Dropout time, df/dt	Approx. 110ms	
Dropout factor, voltage	Approx. 1.05	
Dropout difference, df/dt	0.05Hz/s	
Tolerance	Frequency	10mHz (with U=Un, f=f_N) 15mHz (f_N-5Hz to f_N+5Hz, except for f_N) 25mHz (f_N-10Hz to f_N-5Hz, f_N+5Hz to f_N+10Hz)
	Time delay	1% or 10ms
	Voltage	3% of setting value or 1V
	df/dt	5% of setting value or 0.05 Hz/s
	Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15	1%
	Influence of temperature -25°C to 55°C	0.5%/10K
	Harmonics influence -Maximum 10% third harmonics	1%
	-Maximum 10% fifth harmonics	1%
	Influence of frequency 0.9≤f/fn≤1.1	1%
	Transient overreach τ>100ms (completely asymmetric)	<5%

Low voltage load-shedding

Setting range/increment

Stage number	4 stages; Individual on/off for each stage	
Minimum Vpp (referred to 1.732x V1)	20 to 120V	Step 1V
Time delay	0.10s to 100.00s	Step 0.01s
-dv/dt threshold	4 to 100V/s	Step 1V/s
Blocked by voltage up	On/off (1/0)	
Mode(settable)		
Stage 1	On/off (1/0)	
Stage 2	On/off (1/0)	
Stage 3	On/off (1/0)	
Stage 4	On/off (1/0)	
Mode(controllable)		
Low voltage load-shedding	On/off (1/0)	

Low voltage load-shedding - data

PTimes		
Pickup time	Approx. 70ms	
Dropout time	Approx. 30ms	
Pickup time, dv/dt	Approx. 220ms	
Dropout time, dv/dt	Approx. 150ms	
Dropout factor, voltage	Approx. 1.05	
Dropout difference, dv/dt	0.05V/s	
Tolerance	Time delay	1% or 10ms
	Voltage	3% of setting value or 1V
	dv/dt	3V/s
	Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15	1%
	Influence of temperature -25°C to 55°C	0.5%/10K
	Harmonics influence -Maximum 10% third harmonics -Maximum 10% fifth harmonics	1% 1%
	Influence of frequency 0.9≤f/fn≤1.1	1%
	Transient overreach τ>100ms (completely asymmetric)	<5%

Instantaneous tripping at SOTF

Setting range/increment

Overcurrent threshold	With I_N=1A	0.03A to 40.00A or ∞ (disabled)	Step 0.01A
	With I_N=5A	0.15A to 200.00A or ∞ (disabled)	
Overcurrent time delay		0.00s to 100.00s or ∞	Step 0.01s
Undervoltage threshold		1.00 to 100.00V, 0 (disabled)	Step 0.01V
Negative-seq. volt. threshold		1.00 to 57.00V, ∞ (disabled)	Step 0.01V
Ground overcurrent threshold	With I_N=1A	0.03A to 40.00A or ∞ (disabled)	Step 0.01A
	With I_N=5A	0.15A to 200.00A or ∞ (disabled)	
Ground OC time delay		0.00s to 100.00s	Step 0.01s

Mode(settable)	
Overcurrent protection	On/off (1/0)
OC with compound voltage release	On/off (1/0)
Voltage criteria against meas. voltage failure	Block OC/release OC (1/0)
Ground overcurrent protection	On/off (1/0)
Behaviors AR	Pre-closing/post-closing (0/1)
AR pre-closing with direction release	Forward/without direction (1/0)
Voltage criteria against measur. voltage failure	Block gnd. OC/release gnd. OC (1/0)
Mode(controllable)	
Overcurrent protection	On/off (1/0)
Ground overcurrent protection	On/off (1/0)

Synchro-check

Setting range/increment

Object	None/Breaker1/Breaker2/...	Default Breaker1
Minimum voltage	20 to 125V	Step 1V
Maximum voltage	20 to 140V	Step 1V
V1, V2 dead voltage threshold	1 to 60V	Step 1V
V1, V2 live voltage threshold	20 to 140V	Step 1V
V1</V2>	On/off (1/0)	The default is input/1
V1>/V2<	On/off (1/0)	The default is input/1
V1</U2<	On/off (1/0)	The default is input/1
Maximum permitted duration	0.01 to 1200.00s	Step 0.01s
CB closing time	0.01 to 0.60s	Step 0.01s
Vsyn connection with	Va, Vb, Vc, Vab, Vbc, Vca,	Default Vab
Asynchronous condition dV	0.5 to 50.0V	Step 0.1V
Asynchronous condition df	0.01-2.00Hz	Step 0.01Hz
Synchronous condition	On/off (1/0)	Default 1
Synchronous condition dV	0.5 to 50.0V	Step 0.1V
Synchronous condition dPhi	2 to 80°	Step 1°
Mode(settable)		
Synchro-check	On/off (1/0)	
Tolerance		
Time	1% of setting value or 10ms	
Voltage	≤% of measured value, or 0.5% of U_N	
Frequency	20mHz, with fNom±5Hz	
Phase angle	0.5°	

Automatic reclosing

Setting range/increment		
Ready time	0.50 to 320.00s	Step 0.01s
Cycle	1, 2	Default 1
Dead time, 1st cycle	0.01 to 320.00s	Step 0.01s
Dead time, 2nd cycle	0.01 to 320.00s	Step 0.01s
Interval between two cycles	0.01 to 320.00s	Step 0.01s
Synchro-check	On/off (1/0)	Default 0
dPhi	2 to 80°	Step 1°
Extended maximum AR time	0.50 to 1,800.00s or oo	Step 0.01s
Vsyn connection with	Va, Vb, Vc, Vab, Vbc, Vca	Default Va
Dead voltage check	On/off (1/0)	Default 0
Discrepancy start AR	On/off (1/0)	Default 0
Time delay for discrepancy start AR	0.01 to 320.00s	Step 0.01s
BI start AR	On/off (1/0)	Default 0
Mode (settable & controllable)		
Automatic reclosing	On/off (1/0)	
Tolerance		
Time	1% of setting value or 10ms	
Voltage	≤% of measured value, or 0.5% of Un	
Frequency	20mHz, with fNom±5Hz	
Phase angle	0.5°	

Sensitive ground fault detection

Setting range/increment			
Mode	On/off/alarm		Default: off
Operate with	Vn or Ins Vn & Ins		Default: Vn or Ins
50ns-1 threshold	Sensitive CT	0.001 to 2.000A,	Step 0.001A
50ns-1 direction	None/forward/backward		Default: None
50ns-1 delay	0.0 to 320.00s, ∞		Step 0.01s
50ns-2 threshold	Sensitive CT	0.001-2.000A, ∞	Step 0.001A
50ns-2 direction	None/forward/backward		Default: None
50ns-2 delay	0.0 to 320.00s, ∞		Step 0.01s
Zero-seq. overvoltage threshold	1.8 to 200.0V, ∞		Step 0.1 °
Zero-seq. overvoltage delay	0.10 to 40000.00s, ∞		Step 0.01s
Sensitive ground fault detection - data			
Pickup time	Approx. 50ms		
Voltage dropout factor	0.95 or 0.6V		
Voltage tolerance			
Vn> (measured value)	1% of setting value or 0.3V		
3V0> (calculated value)	1% of setting value or 3V		
Time tolerance	1% of setting value or 10ms		
Current dropout factor	0.95. with 50ns>20mA		
Current tolerance	2% of setting value or 1mA		

External trip

Setting range/increment		
Number: 5		
Mode	On/off/alarm	
Time delay	0.00 to 100.00s (default 0.01s)	Step 0.01s
External trip - data		
Pickup time	Typical value approx. 20ms	
Dropout time	Approx. 12ms	
Time tolerance	1% of setting value or 10ms	

FC circuit operate blocking

Basic			
Measuring input	Ia, Ib, Ic, fundamental		
Setting range/increment			
Pickup threshold	With I_N=1A	0.10A to 20.00A or ∞ (disabled)	Step 0.01A
	With I_N=5A	0.5A to 100.00A or ∞ (disabled)	

Current comparison protection

Setting range/increment			
Threshold			
Dynamic threshold	With I_N=1A	0.10A to 20.00A	Step 0.01A
	With I_N=5A	0.50A to 100.00A	
Dynamic threshold, closing	With I_N=1A	0.10A to 20.00A	Step 0.01A
	With I_N=5A	0.50A to 100.00A	
Static threshold	With I_N=1A	0.50A to 20.00A	Step 0.01A
	With I_N=5A	2.50A to 100.00A	

Mode	
Current comparison protection (settable & controllable)	On/off
Inter-trip	Yes/no
Inter-trip behavior	Trip/alarm

Support split-phase CT broken-wire blocking differential protection function

Current comparison protection - data		
Pickup time	2x threshold, <35ms	
Permitted frequency range	45Hz to 55Hz	
Tolerance	With I_N=1A	20mA or 50%
	With I_N=5A	100mA or 50%

Optical fiber remote signal	
Number of remote signal	32
Transmission delay	<10ms

Restricted earth fault protection, transformer

Setting range/increment			
Differential current	$I_{REF}>/I_{Nobj}$	0.5 to 2.00	Step 0.1
Angle limit	j_{REF}	110° (fixed)	
Current tolerance		5% with I<5·I_N	
Time delay	T_{REF}	0.00s to 60.00s or ∞ (disable)	Step 0.01s
Time tolerance		1% of setting value or 10ms	

Setting time is an additional delay

Pickup time	
Rated frequency	50Hz
Approx.	40ms
Dropout time, approx.	40ms
Dropout factor, approx.	0.7

Switch onto fault

Basic

Measuring inputs	Ia, Ib, Ic, In (settable measured or calculated zero sequence current)
Definite time overcurrent	2 stages Additionally provides compound voltage and undervoltage release
Definite time ground OC	2 stages Zero-sequence voltage release

Measurands

All current and voltage	Fundamental

Setting range/increment

Valid duration	0.00s to 100.00s	Step 0.01s
Overcurrent stage 1 threshold	With IN=1A, 0.03A to 40.00A or ∞ (disabled)	Step 0.01A
Overcurrent stage 2 threshold	With IN=5A, 0.15A to 200.00A or ∞ (disabled)	
Overcurrent stage 1 delay Overcurrent stage 2 delay	0.00s to 100.00s	Step 0.01s
Negative-sequence voltage threshold (referred to Vph)	1.0V to 57.0V or ∞ (disabled)	Step 0.1V
Undervoltage threshold (referred to Vpp)	1.0V to 100.0V or 0 (disabled)	Step 0.1V
Ground OC stage 1 threshold	With IN=1A, 0.03A to 40.00A or ∞ (disabled)	Step 0.01A
Ground OC stage 2 threshold	With IN=5A, 0.15A to 200.00A or ∞ (disabled)	
Ground OC stage 1 delay Ground OC stage 2 delay	0.00s to 100.00s	Step 0.01s
Zero-sequence voltage threshold	1.0V to 200.0V or ∞ (disabled)	Step 0.1V

Mode(settable)

Overcurrent stage 1	On/off (1/0)
Overcurrent stage 2	On/off (1/0)
Overcurrent stage 1 with compound voltage release	On/off (1/0)
Overcurrent stage 2 with compound voltage release	On/off (1/0)
Ground OC stage 1	On/off (1/0)
Ground OC stage 2	On/off (1/0)
Ground OC stage 1 with zero-seq. voltage release	On/off (1/0)
Ground OC stage 2 with zero-seq. voltage release	On/off (1/0)
Voltage criteria against measuring voltage failure	Blocked/release (1/0)

Switch onto fault - data

Pickup time	
2x threshold	Approx. 30ms
10x threshold	Approx. 20ms
Dropout time	Approx. 30ms
Dropout factor	Approx. 0.95 with $I/I_N \geq 0.3$

Tolerance	Pickup current	2% of setting value or 10mA with IN=1A or 50mA with IN=5A
	Time delay	1% or 10ms
	Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15	1%
	Influence of temperature -25°C to 55°C	0.5%/10K
	Influence of frequency 0.9≤f/fn≤1.1	1%
	Harmonics influence -Maximum 10% third harmonics -Maximum 10% fifth harmonics	 1% 1%
	Transient overreach during fundamental wave measurement τ>100ms (completely asymmetrical)	<5%

Reverse power protection

Setting range/increment

Mode	On/off		
Total power	With I_N=1A	0.8W to 10,000.0W or ∞ (disabled)	Step 0.1W
	With I_N=5A	2.5W to 50,000.0W or ∞ (disabled)	
Power direction	Forward/backward		
Time delay	0.0 to 3,600.0s		Step 0.1s

Reverse power protection - data

Pickup time	
-Typical value	Approx. 120ms
-Maximum	Approx. 350ms
Tolerance	1% of setting value or 0.3W with P>1/3Pn

Negative-sequence protection

Setting range/increment

Negative-sequence def.-T OC	With I_N=1A	0.03 to 2.00A	Step 0.01A
	With I_N=5A	0.15 to 10.00A	
Negative-sequence def.-T OC delay		0.00s to 60.00s or ∞ (disable)	Step 0.01s
Pickup time	Approx. 35ms		
Dropout time	Approx. 35ms		
Dropout factor	Approx. 0.95 with $I2/I_N \geq 0.3$		
Time tolerance	1% or 10ms		
Negative-sequence def.-T OC pickup current tolerance	With I_N=1A	3% of setting value or 10mA	
	With I_N=5A	3% of setting value or 50mA	

Negative-sequence inv.-T OC	With I_N=1A	0.03 to 2.00A	Step 0.01A
	With I_N=5A	0.15 to 10.00A	
Negative-sequence inv.-T OC time constant		0.05s to 3.20s or ∞ (disable)	Step 0.01s
Inverse time curve (IEC)	Normal inverse time		
	Very inverse time		
	Extremely inverse time		
	Long inverse time		
Inverse time pickup current	1.10x setting value I2p		
Inverse time dropout current	0.95x pickup current		
Negative-sequence inv.-T OC pickup current tolerance	With I_N=1A	3% of setting value or 10mA	
	With I_N=5A	3% of setting value or 50mA	
Negative-sequence inv.-T OC time tolerance	With 2≤ I/I2p≤20	5% calculated value, or 30ms	

Over-/undervoltage protection

Basic		
Measurands	Uab, Ubc, Uac	
Setting range/increment		
Overvoltage protection	On/off	
Overvoltage protection stage 1 Overvoltage protection stage 2	20 to 260V, or ∞ (disabled)	Step 1V
Overvoltage protection stage 1 delay Overvoltage protection stage 2 delay	0.0 to 100.0s or ∞ (disabled)	Step 0.1s
Undervoltage protection	On/off	
Undervoltage protection stage 1 Undervoltage protection stage 2	10 to 150V, or ∞ (disabled)	Step 1V
Undervoltage protection stage 1 delay Undervoltage protection stage 2 delay	0.0 to 100.0s or ∞ (disabled)	Step 0.1s

Over-/undervoltage protection - data	
Pickup time	
-Typical value	Approx. 50ms
Pickup voltage tolerance	2% of setting value or 0.5V
Time tolerance	1% of setting value or 10ms
Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15	1%
Influence of temperature -25°C to 55°C	0.5%/10K
Influence of frequency 0.9≤f/fn≤1.1	1%
Harmonics influence	
-Maximum 10% third harmonics	1%
-Maximum 10% fifth harmonics	1%

Circuit breaker failure protection

Basic			
Measurands	Ia, Ib, Ic		
Setting range/increment			
Mode	On/off		
Pickup current	With I_N=1A	0.05 to 20.00A	Step 0.01A
	With I_N=5A	0.25 to 100.00A	Step 0.01A
Time delay 1 Time delay 2	0.06 to 60.0s or ∞ (disabled)		Step 0.1s

Circuit breaker failure protection - data	
Dropout time	Approx. 25ms
Pickup current tolerance	2% of setting value or 10mA with IN=1A or 50mA with IN=5A
Time tolerance	1% of setting value or 10ms
Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15	1%
Influence of temperature -25°C to 55°C	0.5%/10K
Influence of frequency 0.9≤f/fn≤1.1	1%
Harmonics influence	
-Maximum 10% third harmonics	1%
-Maximum 10% fifth harmonics	1%

User-defined protection

Measurands/mode			
3-ph	I, In, Ins, 3I0, I1, I2, I2/I1, V, Vn, 3V0, V1, V2, P, Q, cosφ, dv/dt		
1-ph	I, In, Ins, V, Vn, P, Q, cosφ		
Others	f, df/dt, BI		
I, V	Fundamental component, RMS, Positive-sequence component, Negative-sequence component		
Pickup	Overshoot or undershoot		
Setting range/increment			
Pickup threshold:			
Current I, I1, I2, 3I0, I_n	With I_N=1A	0.03 to 40.00	Step 0.01A
	With I_N=5A	0.15 to 200.0	
Ratio I_2/I_1		15% to 100%	Step 1%
Sensitive ground current Ins		0.001 to 1.500A	Step 0.001A
Voltage V, V_1, V_2, $3V_0$		2.0 to 150.0V	Step 0.1V
Displacement voltage V_n		2.0 to 200.0V	Step 0.1V
Power P, Q	With I_N=1A	0.5 to 10,000W	Step 0.1W
	With I_N=5A	2.5 to 50,000W	
Power factor COSφ		-0.99 to +0.99	Step 0.01
Frequency	With f_N=50Hz	40.00 to 60.00	Step 0.01Hz
df/dt		0.10 to 20.00Hz/s	Step 0.01Hz/s
dv/dt		4 to 100V/s	Step 1V/s
Dropout factor, overshoot		1.01 to 3.00	Step 0.01
Dropout factor, undershoot		0.70 to 0.99	Step 0.01
Dropout difference, f		0.02 to 1.00Hz	Step 0.01Hz
Pickup delay		0.00 to 60.00s	Step 0.01s
Operate delay		0.00 to 3,600.00s	Step 0.01s
Dropout delay		0.00 to 60.00s	Step 0.01s

Functional limitation		
3-ph power measurement	IN=1A	I>0.03A
	IN=5A	I>0.15A
1-ph power measurement	IN=1A	I>0.03A
	IN=5A	I>0.15A

Time	
Pickup time	
I, V	
2x threshold	Approx. 30ms
10x threshold	Approx. 20ms
I, V (symmetrical component)	
2x threshold	Approx. 40ms
10x threshold	Approx. 30ms
P, Q	
With typical value	Approx. 120ms
Maximum	Approx. 350ms
PF	300 to 600ms
f	Approx. 100ms
df/dt	
With typical value	Approx. 220ms
Maximum	1s
BI	Approx. 20ms

Dropout time:		
I, V		<20ms
I, V (symmetrical component)		<30ms
P, Q		
At typical value		<50ms
Maximum		<350ms
PF		<300ms
f		<100ms
df/dt		<200ms
dv/dt		Approx. 200ms
BI		<10ms
Allowable tolerance		
Pickup threshold:		
I	When IN=1A	1% of setting value or 10mA
	When IN=5A	1% of setting value or 50mA
I (symmetric. component)	When IN=1A	2% of setting value or 20mA
	When IN=5A	2% of setting value or 100mA
I (I2/I1)		2% of setting value
V		2% of setting value or 0.5V
V (symmetrical component)		2% of setting value or 0.2V
P, Q		1% of setting value or 0.3W with P>1/3Pn
PF		2°
f		±15mHz
df/dt		5% of setting value or 0.05Hz/s
dv/dt		5% of setting value or 2V/s
Time delay		1% of setting value or 10ms
Influencing factor		
Influence of DC auxiliary voltage 0.8≤V/Vn≤1.15		1%
Influence of temperature -25°C to 55°C		0.5%/10K
Frequency range fn± 5Hz		1%
Harmonics influence -Maximum 10% third harmonics -Maximum 10% fifth harmonics		1%

Transformer differential protection (87T, 4 sides)

Pickup value			
I-DIFF>>	I/INobj	0.5 to 35.0 or ∞ (disabled)	Step 0.1
I-DIF >	I/INobj	0.05 to 2.00	Step 0.01
Factor increasing character. (motor, reactor)		1.0 to 2.0	Step 0.1
I-DIFF> delay		0.00s to 60.00s or ∞ (disable)	Step 0.01s
I-DIFF>> delay		0.00s to 60.00s or ∞ (disable)	Step 0.01s
2nd harmonic content		0.00s to 60.00s or ∞ (disable)	Step 1%
nth harmonic content		10% to 80%	Step 1%
(3rd harmonic or 5th harmonic)		10% to 80%	
Crosse blocking		On/off	Step 1 cycle
Cross blocking time		2 to 1,000 cycles or 0 (disabled) or ∞ (valid until dropout)	
Pickup time			
I-DIFF>		33ms	
I-DIFF>>		1.5x threshold	26ms
Dropout time		>2x threshold	16ms
Dropout factor		Approx. 20ms	
		Approx. 0.7	

Tolerance (default setting value, 2-sided, one measuring point per side)	
I-DIFF>	5% of setting value
I-DIFF>>	5% of setting value
Time tolerance (setting time is additional delay)	1% of setting value or 10ms

Analog input and output

Analog output (optional function)	
Number	Up to 2
Possible measurands	All measurands available in DIGSI tool
Scale	0.0 to 24.0mA, maximum allowable 100mA
Accuracy	0.2%*20mA
Analog input (optional function)	
Number	Up to 4
Possible measurands	Temperature, taps, all measurands in DIGSI tool
Scale	0.0mA - 22.0mA
Accuracy	0.2%*20mA

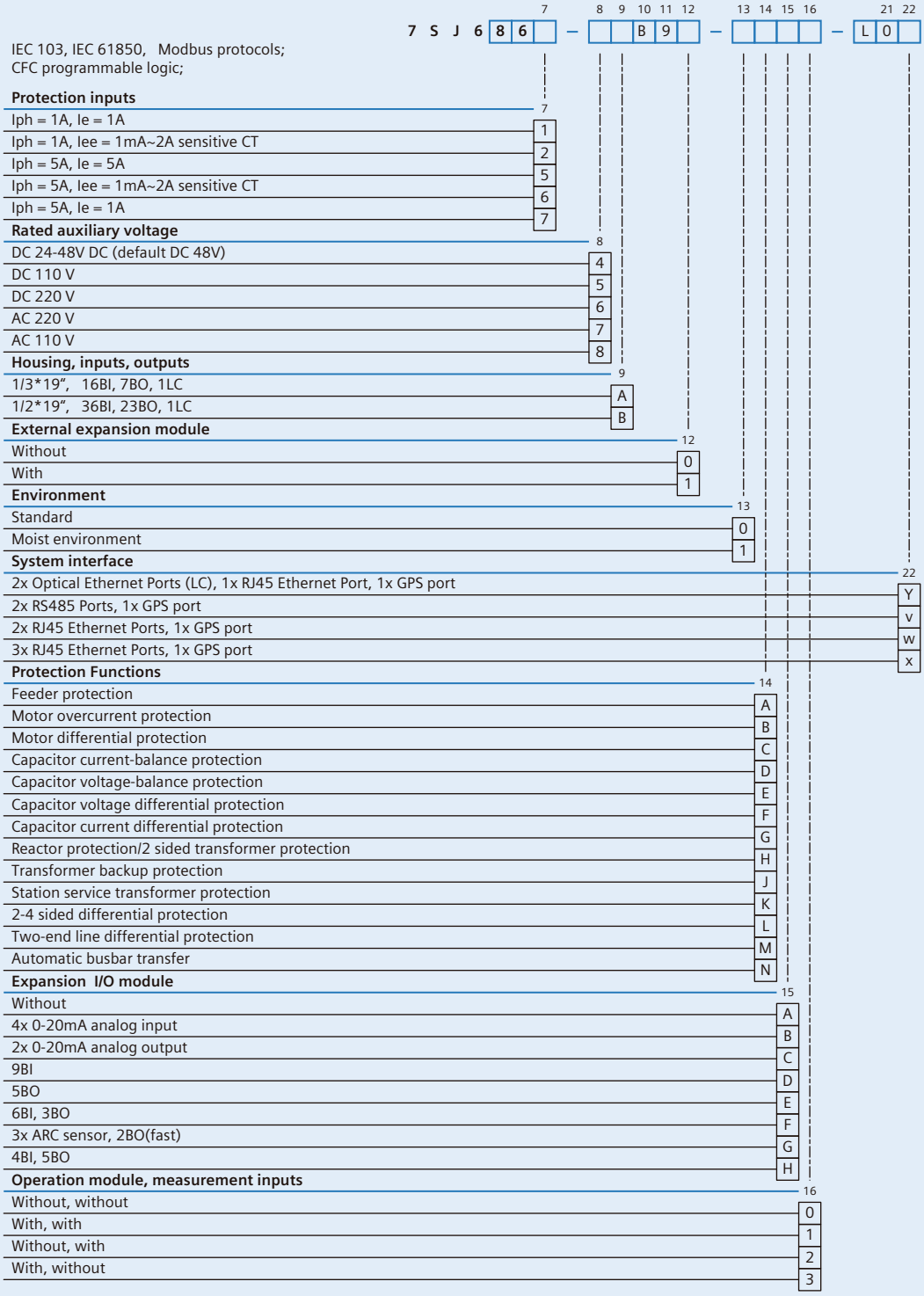
Other functions

Record	
Memorized storage by buffer battery in the event of power loss	
Latest 16 trip logs	
Latest 20 fault records with total 20s, 32 samples per cycle	
Latest 8 ground fault logs	
Latest 512 event logs	
Electrical energy	
Measured Wp, Wq (active energy and reactive energy)	in kWh (MWh or GWh) and in kVARh (MVARh or GVARh)
Scale	28 bits, 0 to 2 68 435 455 decimal number according to IEC 608705-103 31 bits, 0 to 2 147 483 647 decimal number according to other protocols
Tolerance (at rated frequency)	≤ 1% with I > 0.1 IN, U > 0.1 UN and |cos φ| ≥ 0.707
Time synchronization	
Time synchronization	IRIG-B (format IRIG-B000) BI Communication SNTP

Time tracking operating mode		
No.	Operating mode	
1	Internal	Internal synchronization with RTC (preset)
2	Time signal IRIG-B	External synchronization with IRIG-B
3	BI pulses	External synchronization by BI pulses
4	Fieldbus (Modbus, IEC 60870-5-103, IEC 61850)	External synchronization with system interface
5	SNTP	Simple network time protocol

Change of setting group	
Number of available setting group	4 (setting groups A, B, C and D)
Change by	Device keypad Front DIGSI port Communication protocol of system interface BI

Selection and ordering data



Notes: If position 8th = 7 and 16th = 1 or 3, AC operation module is installed; If position 8th = 5 or 6 and 16th = 1 or 3, DC operation module is installed.
If position 8th = 8, that optionally position 16th = 0 or 2
If position 8th = 4, that exclusively position 9th = A, 14th = N and 16th = 0
If position 9th = B, that optionally position 14th = A, H or M
If position 14th = J, that optionally position 7th = 1, 5 or 7
If position 14th = L, that optionally position 7th = 1 or 5 and exclusively 16th = 0
If position 14th = N, that optionally position 7th = 1, 5 or 7, exclusively 15th = E, optionally 16th = 0 or 3
If position 14th = M, that exclusively position 15th = A
If position 15th = G, that optionally position 14th = A, B, C, D, E, F, G, H, J or K
If position 9th = B and 14th = H, that position 15th must not be G
If the wireless temperature measurement or Adam module is selected, that position 12th must be 1
If IRIG-B with factory TTL is required, please place additional code Y21.
If PT with factory AC 220V is required, please place additional code Y23.

Selection and ordering data

Description	Order code
DIGSI 4 V4.92 and above	
DIGSI 4 V4.92 and above Software for configuration and operation of Siemens protection device Includes license for 10 computers Software media: DVD Authorization method: Serial No.	
Function • Protection configuration • SIGRA (fault record analysis) • CFC (programmable logic) • Graphic editor (for diagram display and control display) • DIGSI 4 remote access (remote configuration) • IEC 61850 system configurator	7XS5403-0AA00

Arc probe order code

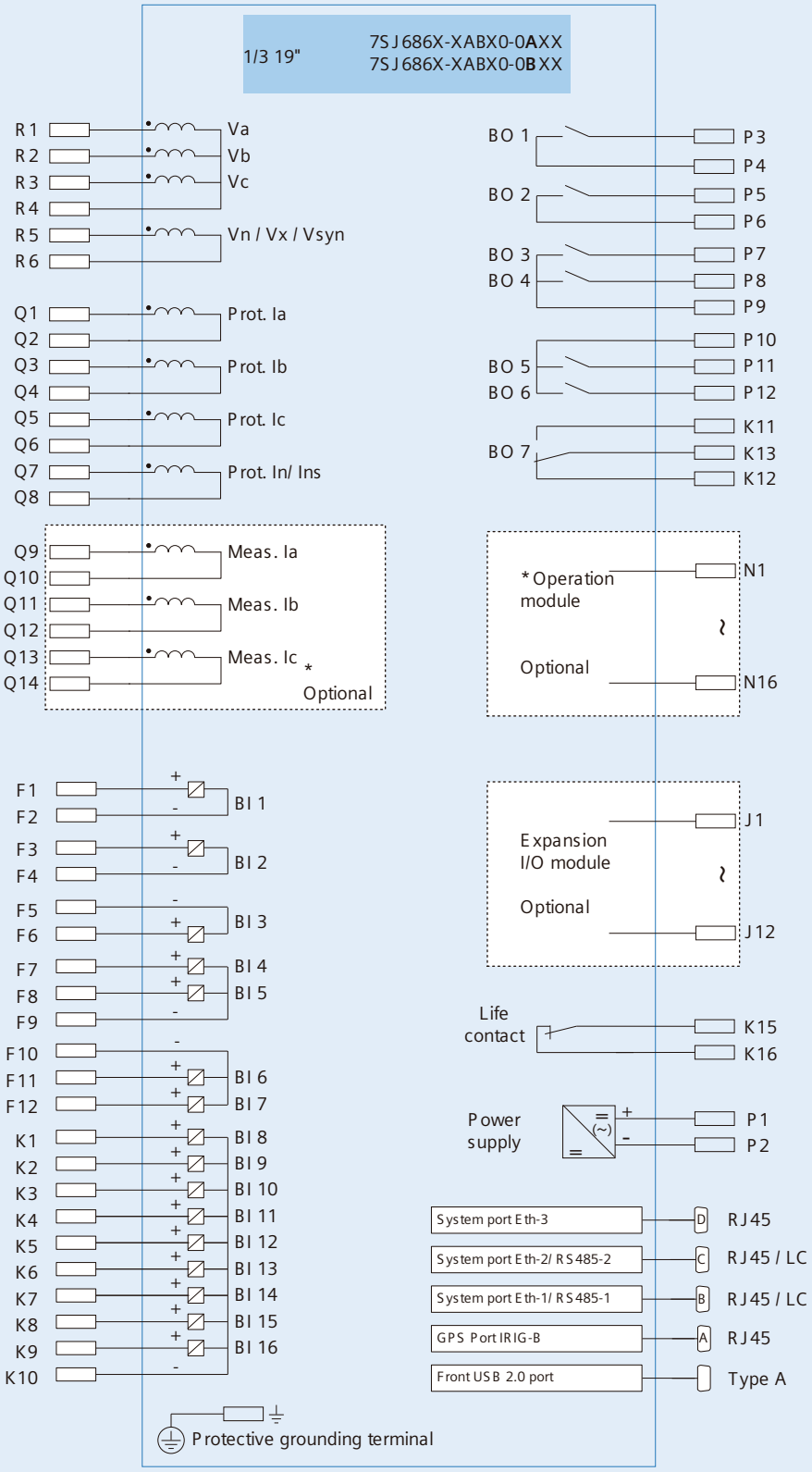
Sensor type	Order number	Remark
Point optical cable 3m	P1X19	For normal air switchgear: It is generally recommended to order 7m cable or order them according to the actual size of switchgear.
Point optical cable 4m	P1X28	
Point optical cable 5m	P1X37	
Point optical cable 7m	P1X277	
Point optical cable 10m	P1X46	
Point optical cable 15m	P1X55	
Point optical cable 20m	P1X64	
Point optical cable 35m	P1X82	
Line optical cable 5m	P1X107	he line optical cable is installed along the busbar, the length must be greater than 2 times the length of busbar, and a line coupling optical cable must be provided.
Line optical cable 10m	P1X116	
Line optical cable 20m	P1X125	
Line optical cable 30m	P1X134	
Line optical cable 40m	P1X143	
Line coupling optical cable 3m	P1X152	The line coupling optical cable is used to connect 7SJ686 protection device and line optical cable.
Line coupling optical cable 5m	P1X161	
Line coupling optical cable 10m	P1X170	

Order code of wireless temperature measurement accessories

Equipment type	Ordering code	Remark
Wireless receiver	7XV1952-0CA00	Built-in with magnet and attached to the interior wall of switchgear LV compartment.
Wireless temperature sensor	7XV1952-0BA00	Includes 540mm metal cable ties and mounting accessories
Wireless ambient temperature and humidity sensor	7XV1952-0DA00	Built-in with replaceable 3.6V 14250 lithium battery
High gain antenna	7XV1952-0EA00	This antenna is to be ordered when the centralized bus solution is used

To install the temperature sensor, the 2.5mm socket head wrench, 5-inch nipper plier and iron scissors are required.

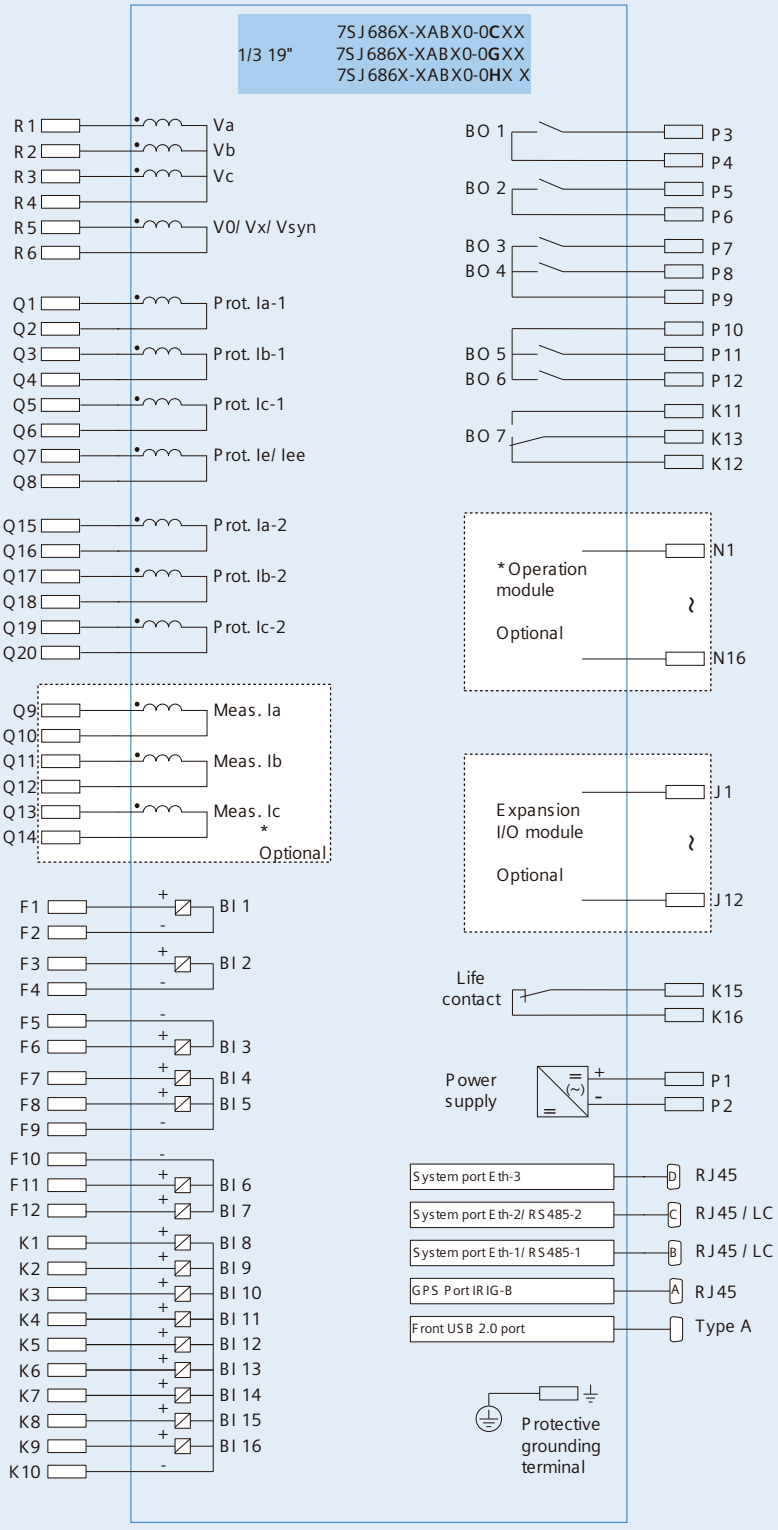
Connection Diagram for Feeder Overcurrent Protection and Motor Overcurrent Protection



*BI, BO, LED and LCD display can be freely user-defined.

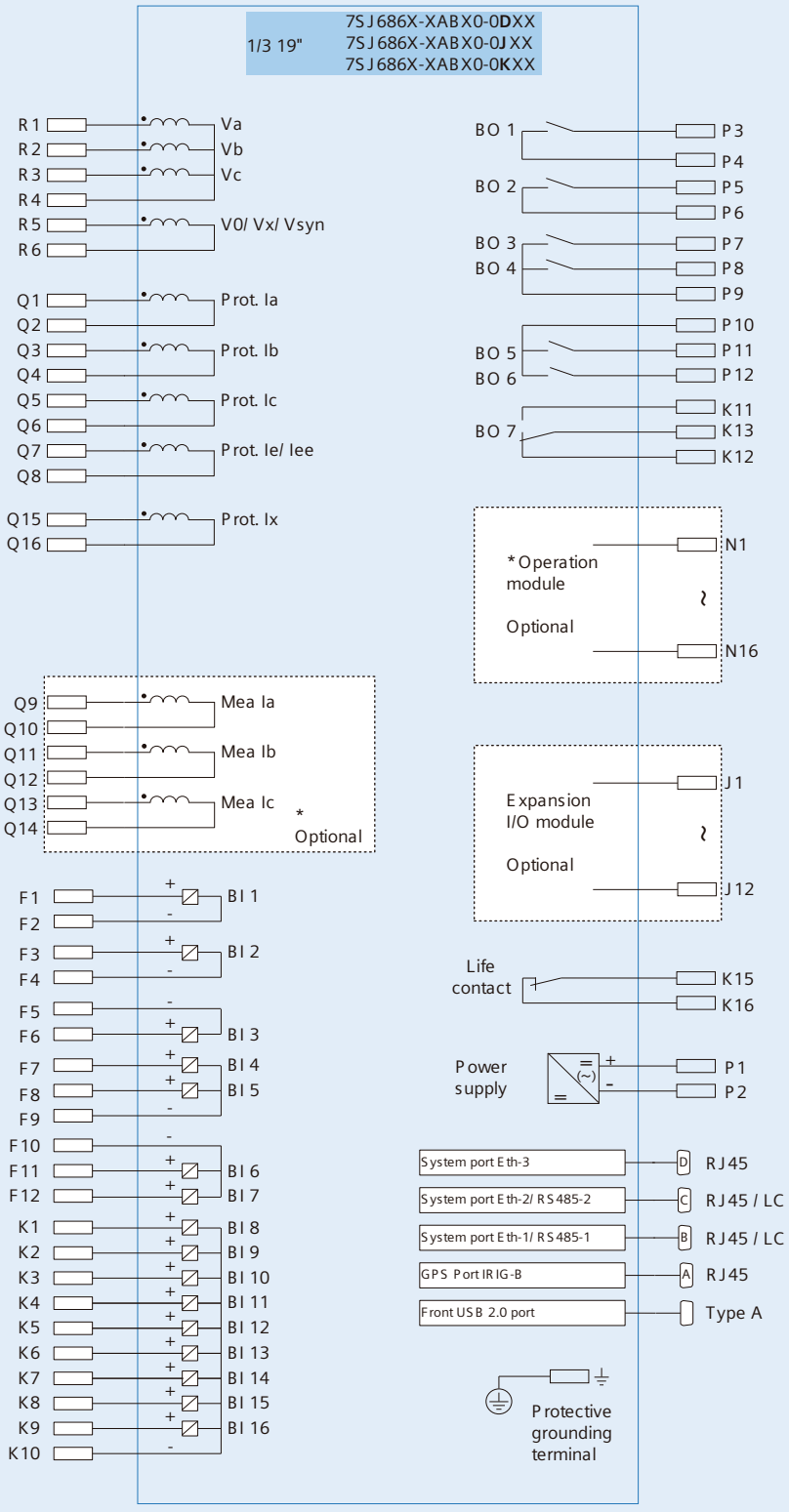
Connection Diagram

Connection Diagram for Motor Differential Protection, Two-winding Transformer Differential Protection, Capacitor Current Differential Protection and Reactor Differential Protection



*BI, BO, LED and LCD display can be freely user-defined.

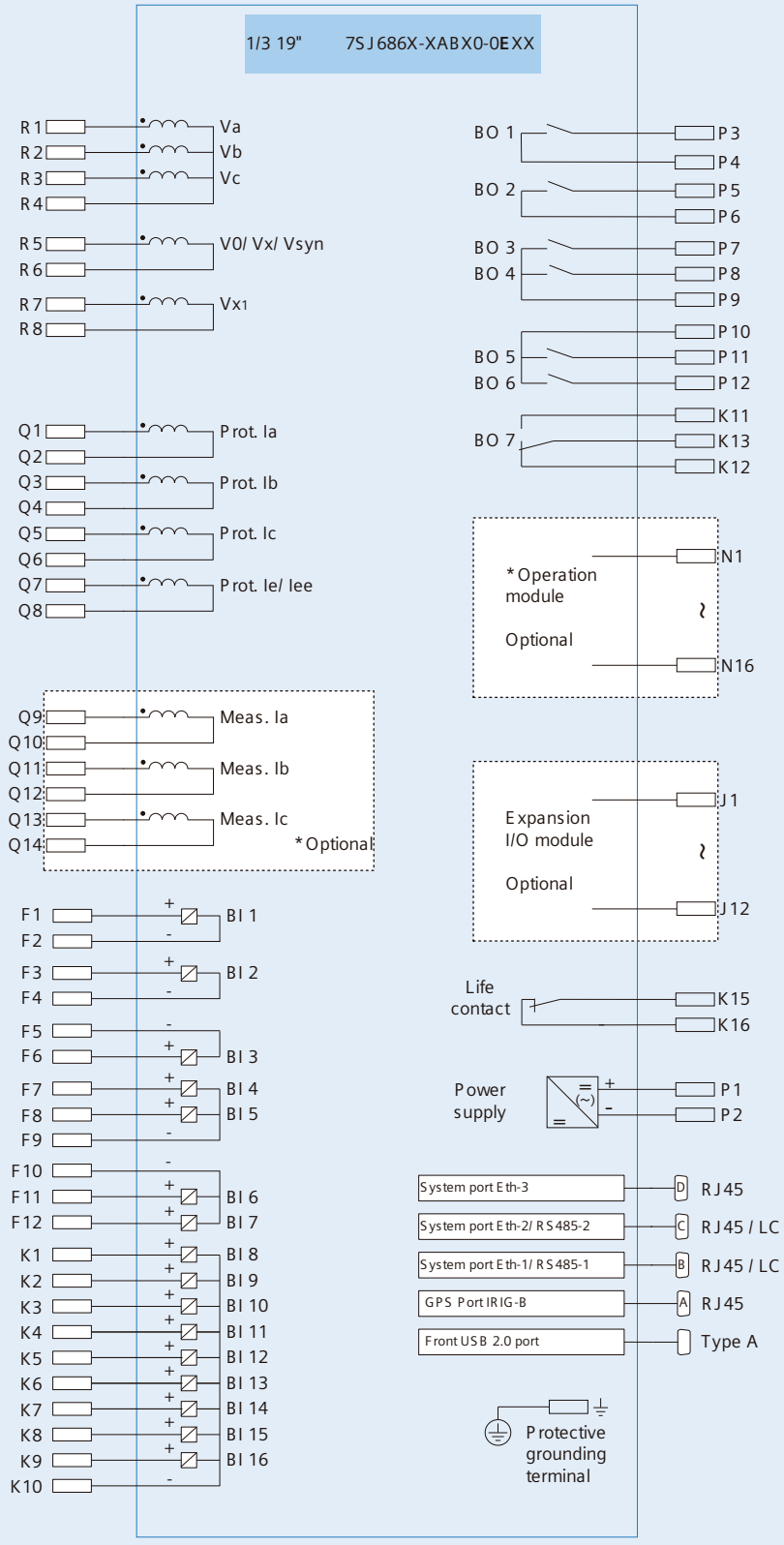
Connection Diagram for Capacitor Current-unbalance Protection, Transformer Backup Protection and Station Service Transformer Protection



*BI, BO, LED and LCD display can be freely user-defined.
*Sensitive CT must not be selected.

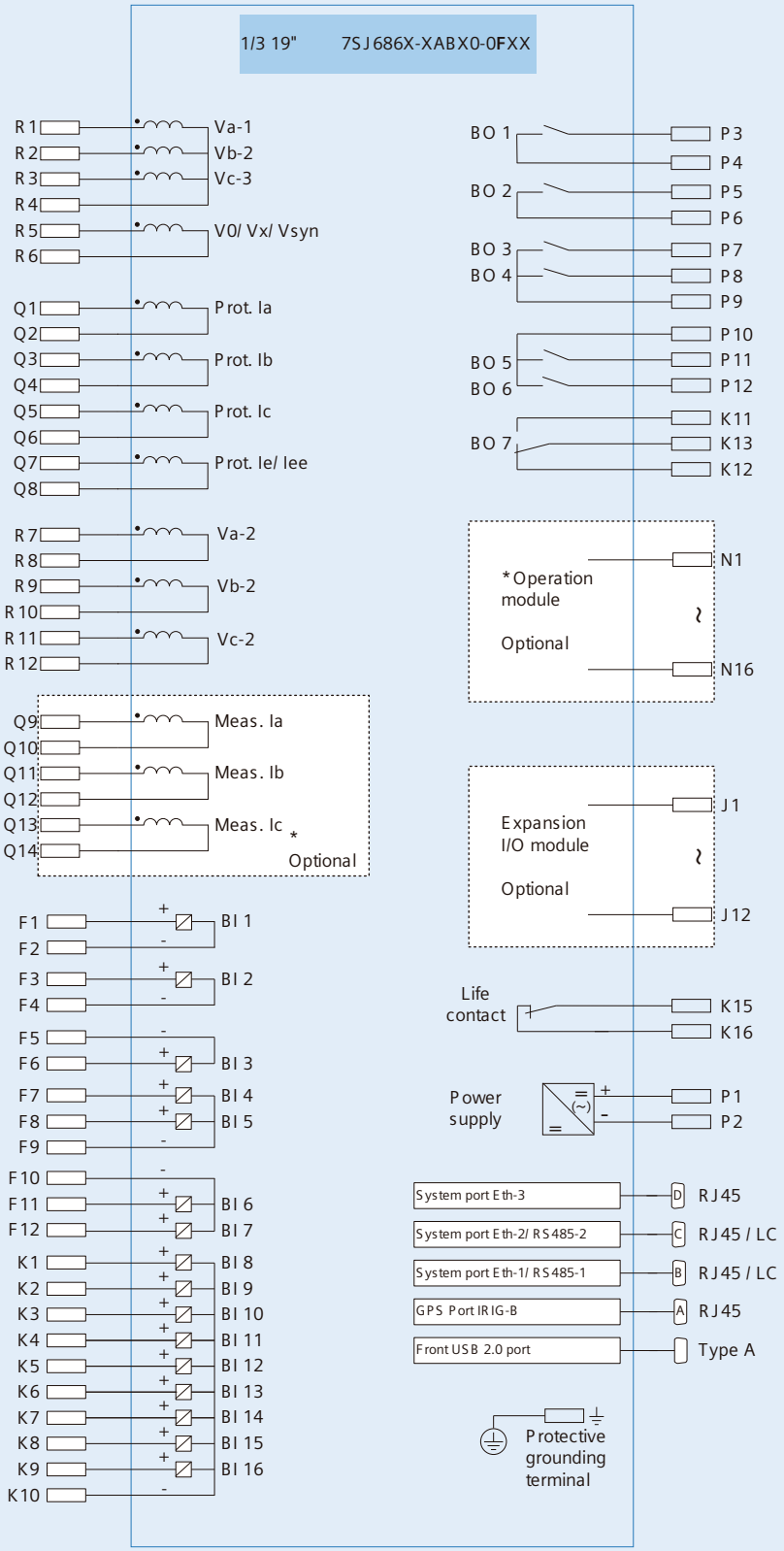
Connection Diagram

Connection Diagram for Capacitor Voltage-unbalance Protection



*BI, BO, LED and LCD display can be freely user-defined.

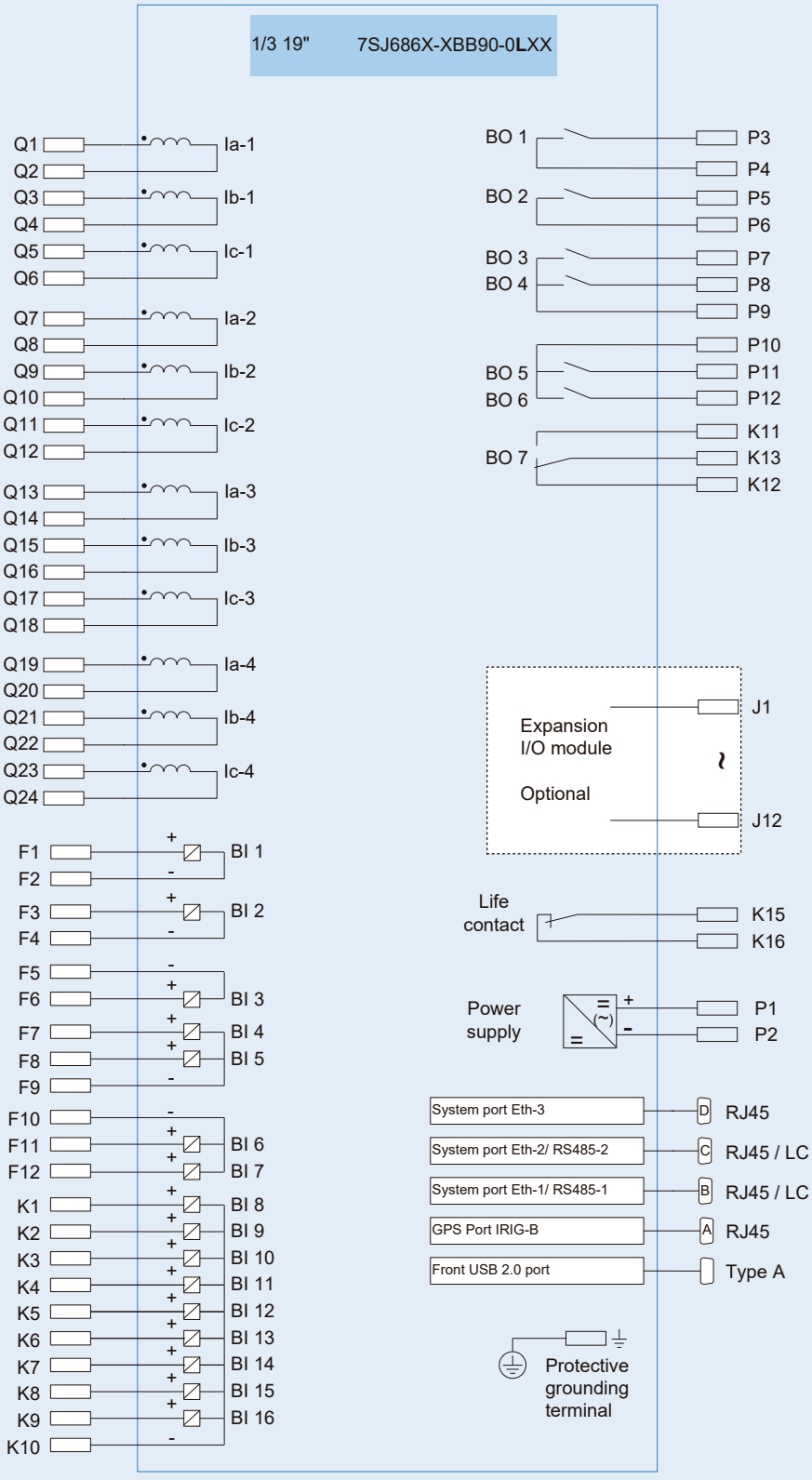
Connection Diagram for Capacitor Voltage Differential Protection



*BI, BO, LED and LCD display can be freely user-defined.

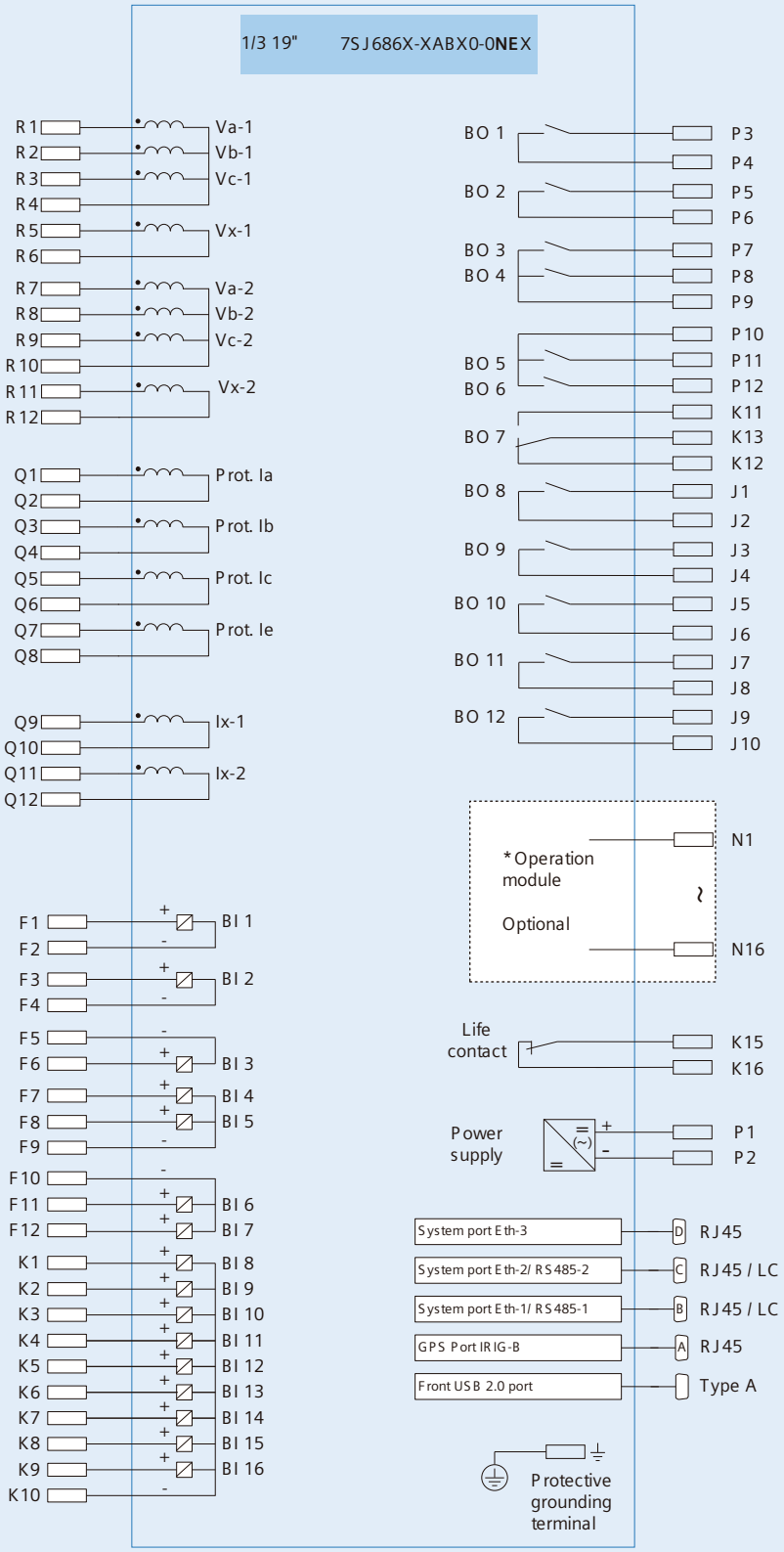
Connection Diagram

Connection Diagram of 2~4-sided Transformer Differential Protection



* BI, BO, LED and LCD display can be freely user-defined.

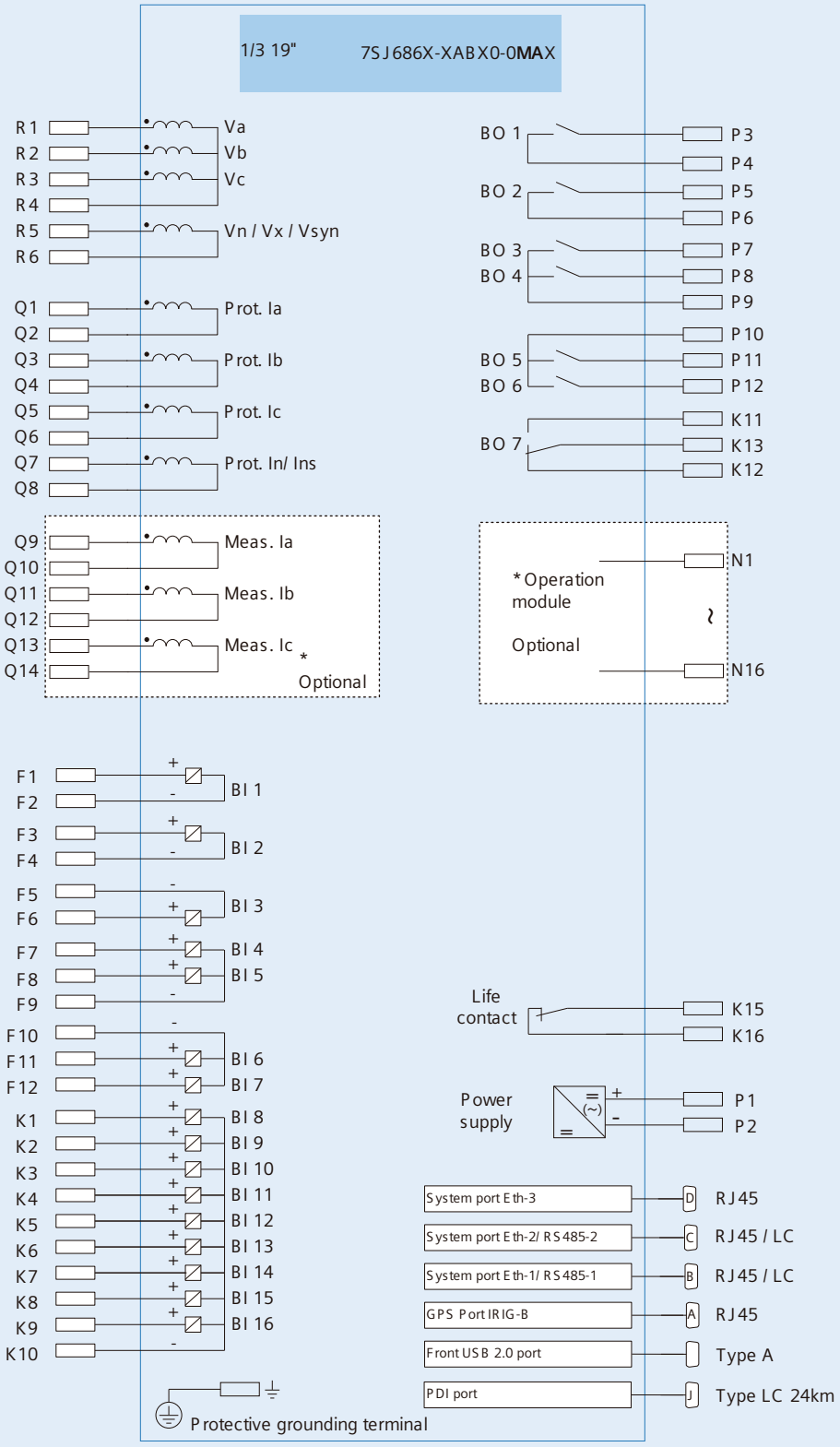
Connection Diagram for Automatic Busbar Transfer



*BI, BO, LED and LCD display can be freely user-defined.

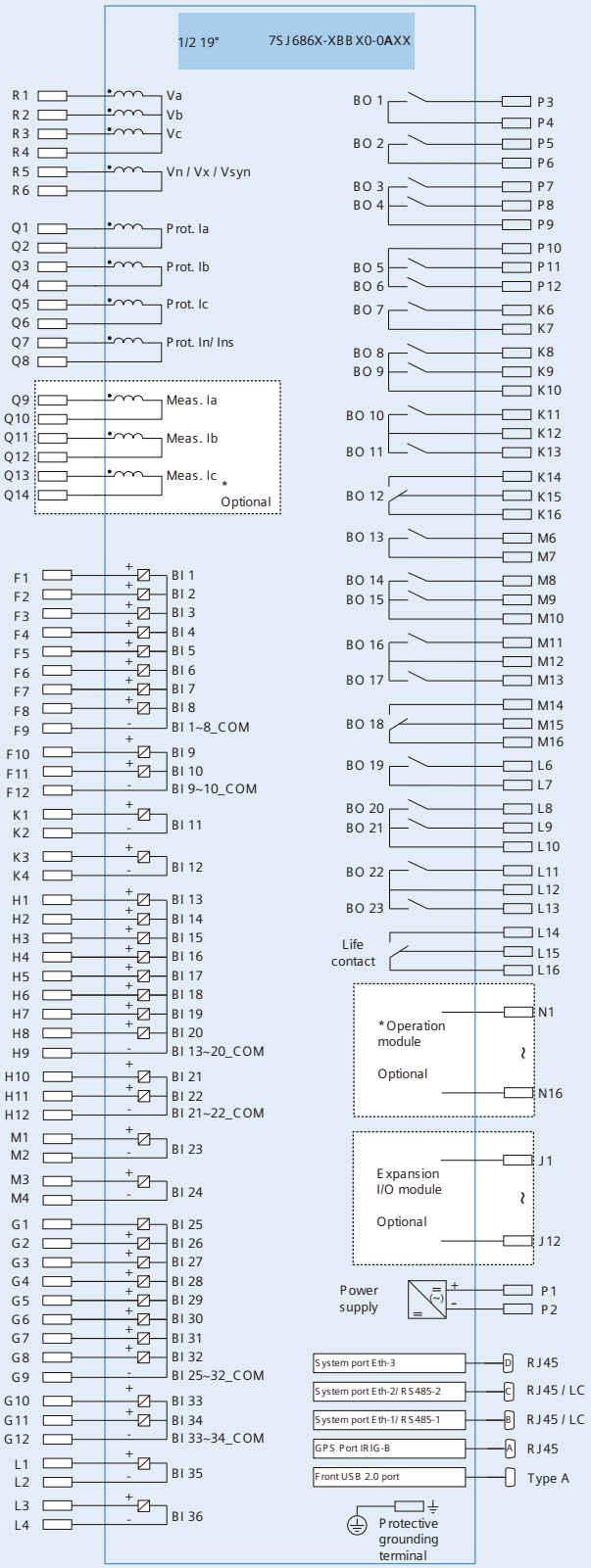
Connection Diagram

Connection Diagram for Line Differential Protection with 1/3*19" Housing



*BI, BO, LED and LCD display can be freely user-defined.

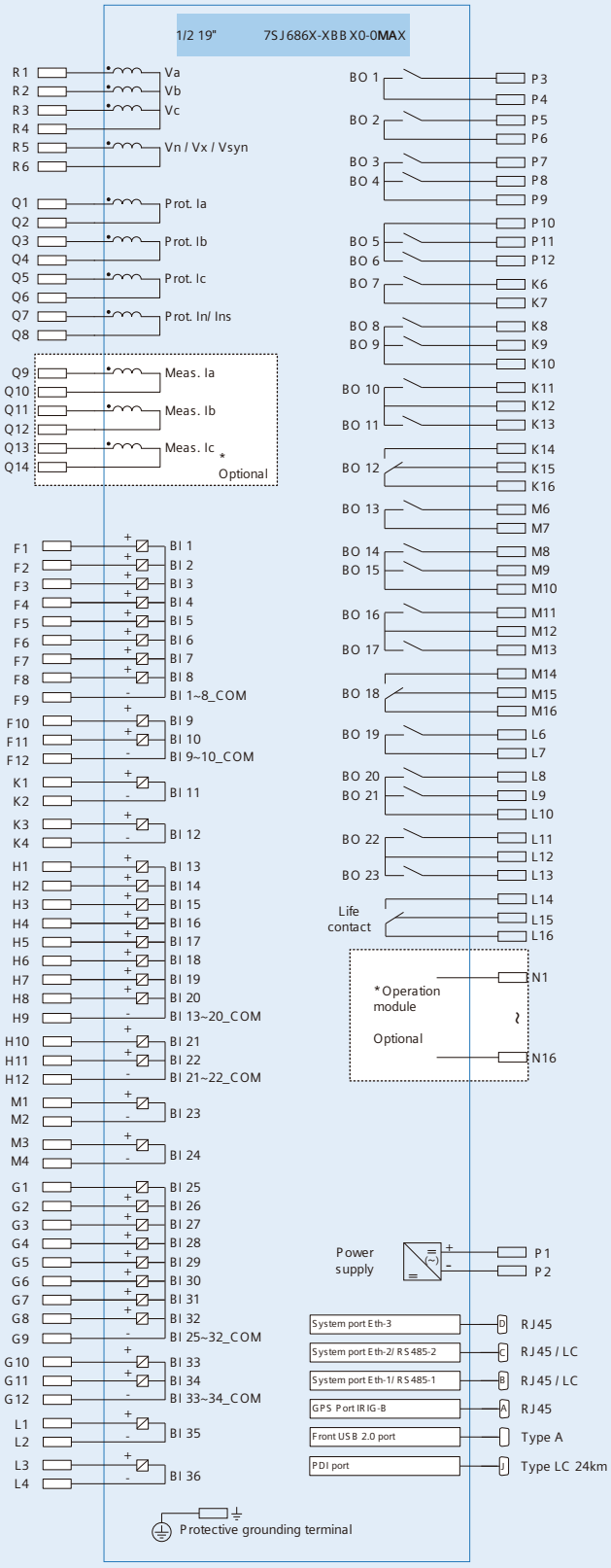
Connection Diagram for Feeder Protection with 1/2*19" Housing



*BI, BO, LED and LCD display can be freely user-defined.

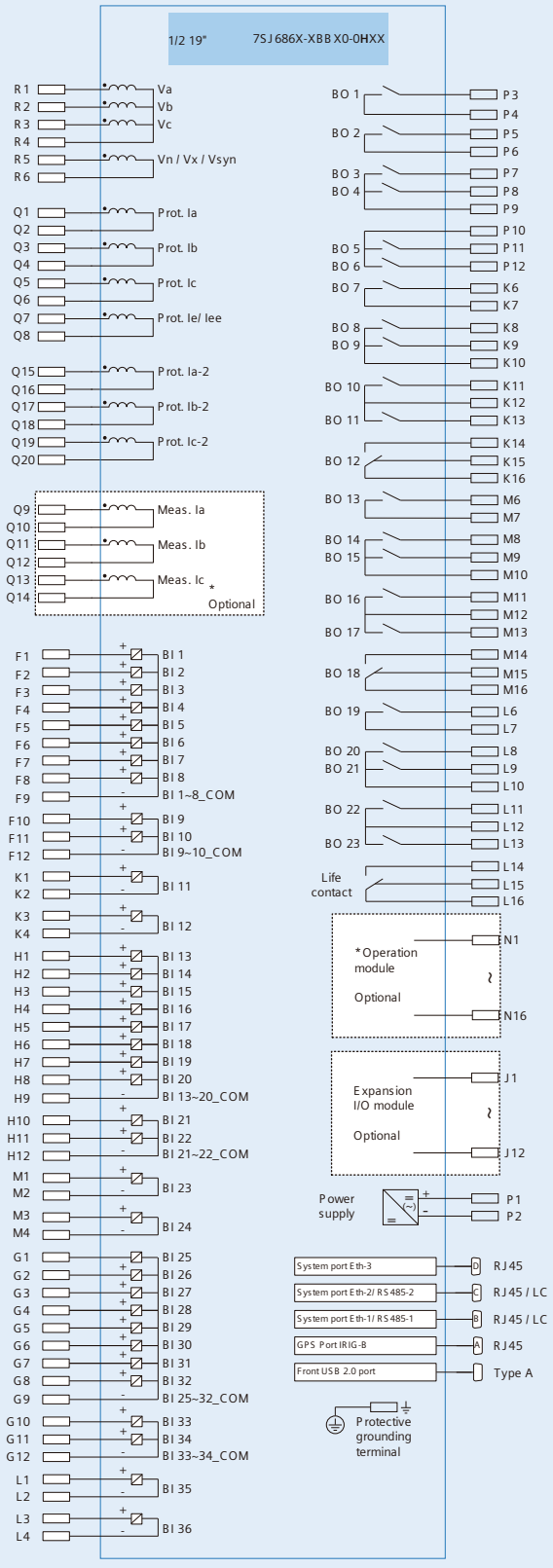
Connection Diagram

Connection Diagram for Line Differential Protection with 1/2*19" Housing



*BI, BO, LED and LCD display can be freely user-defined.

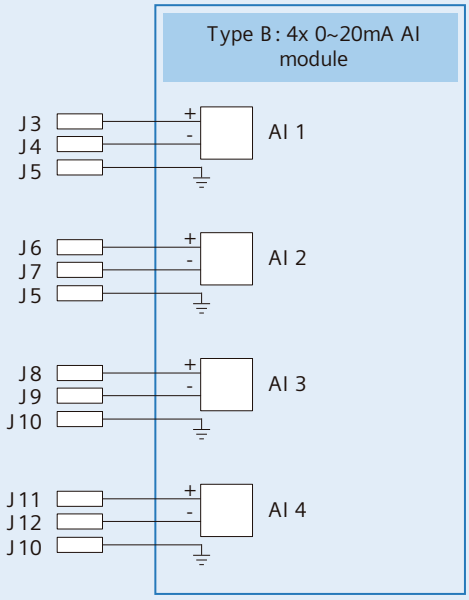
Connection Diagram for Two-winding Transformer Protection with 1/2*19" Housing

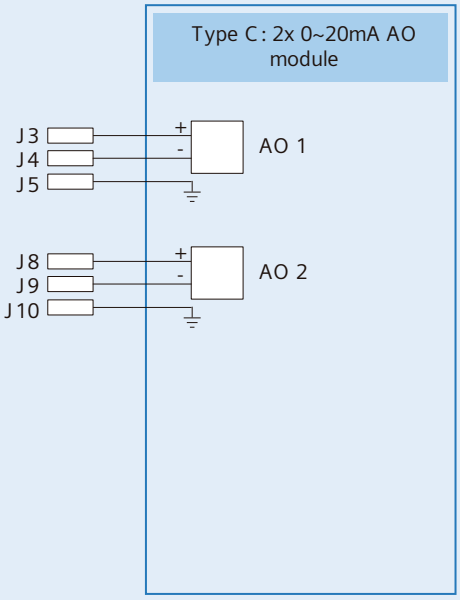


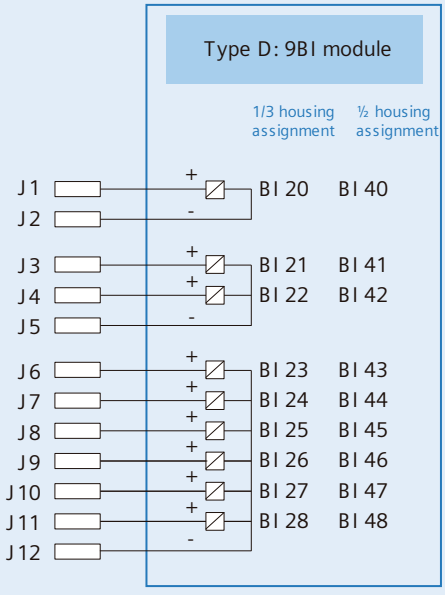
*BI, BO, LED and LCD display can be freely user-defined.

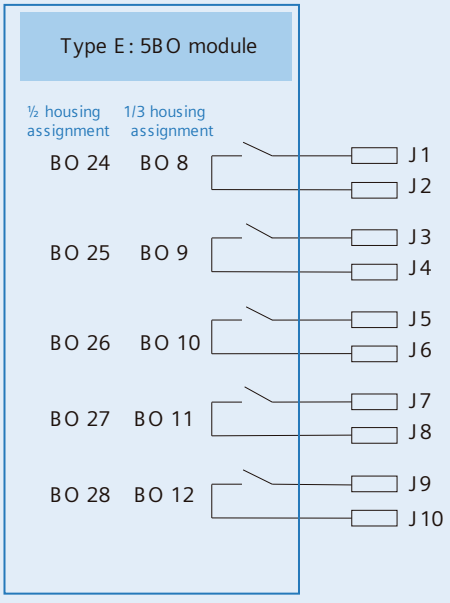
Connection Diagram

Connection Diagram for Expansion Module

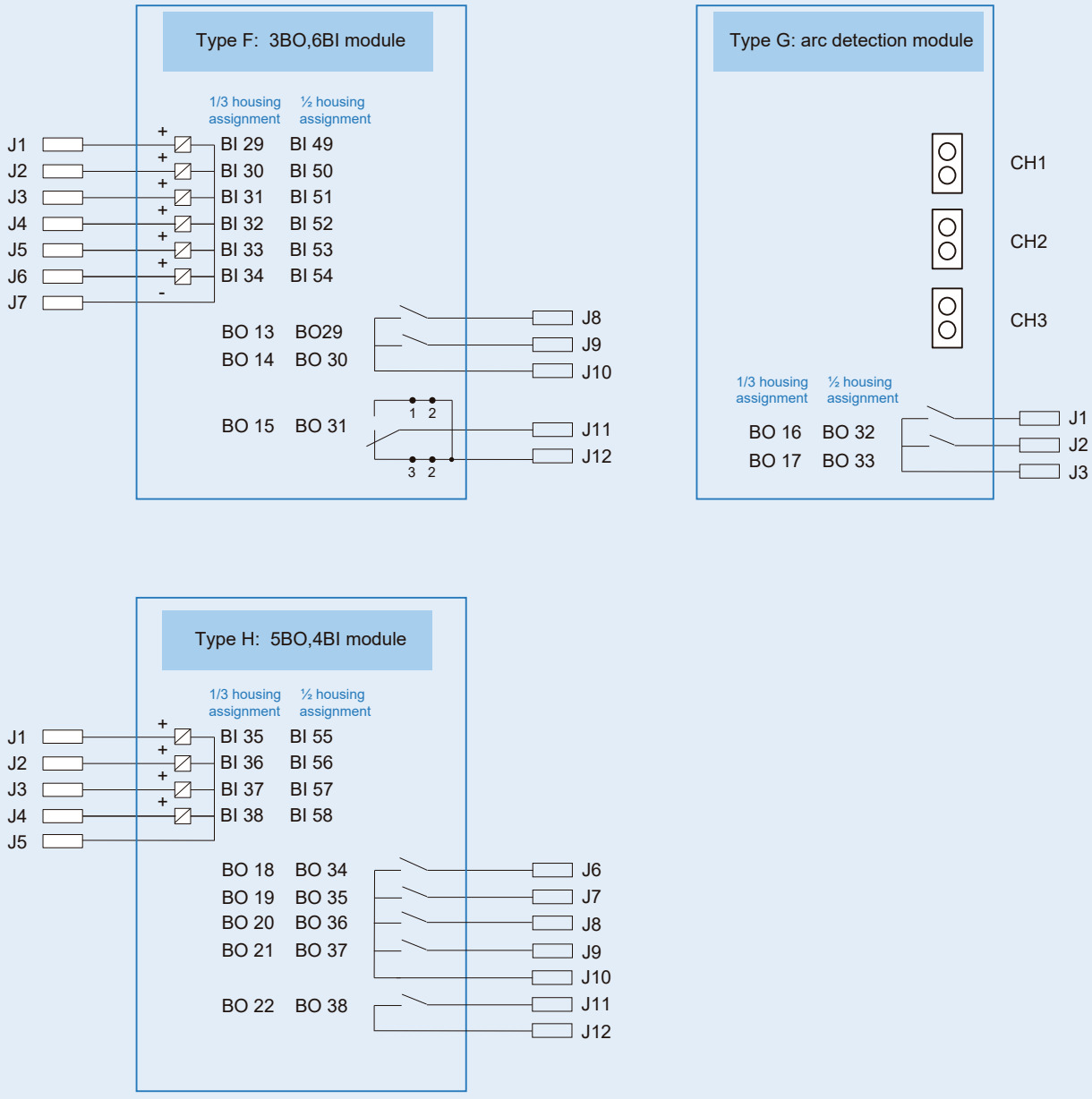






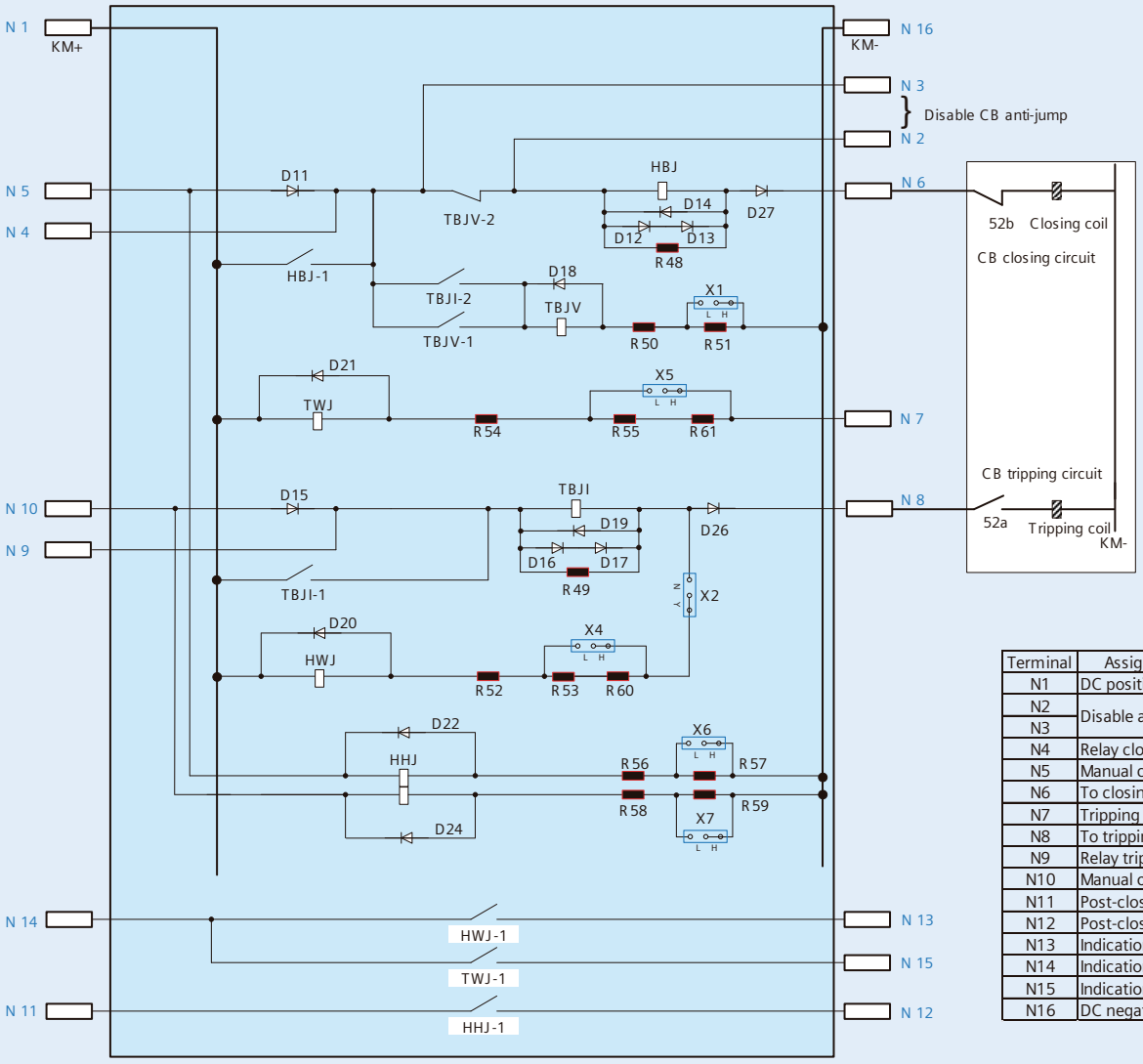


Connection Diagram for Expansion Module



Connection Diagram

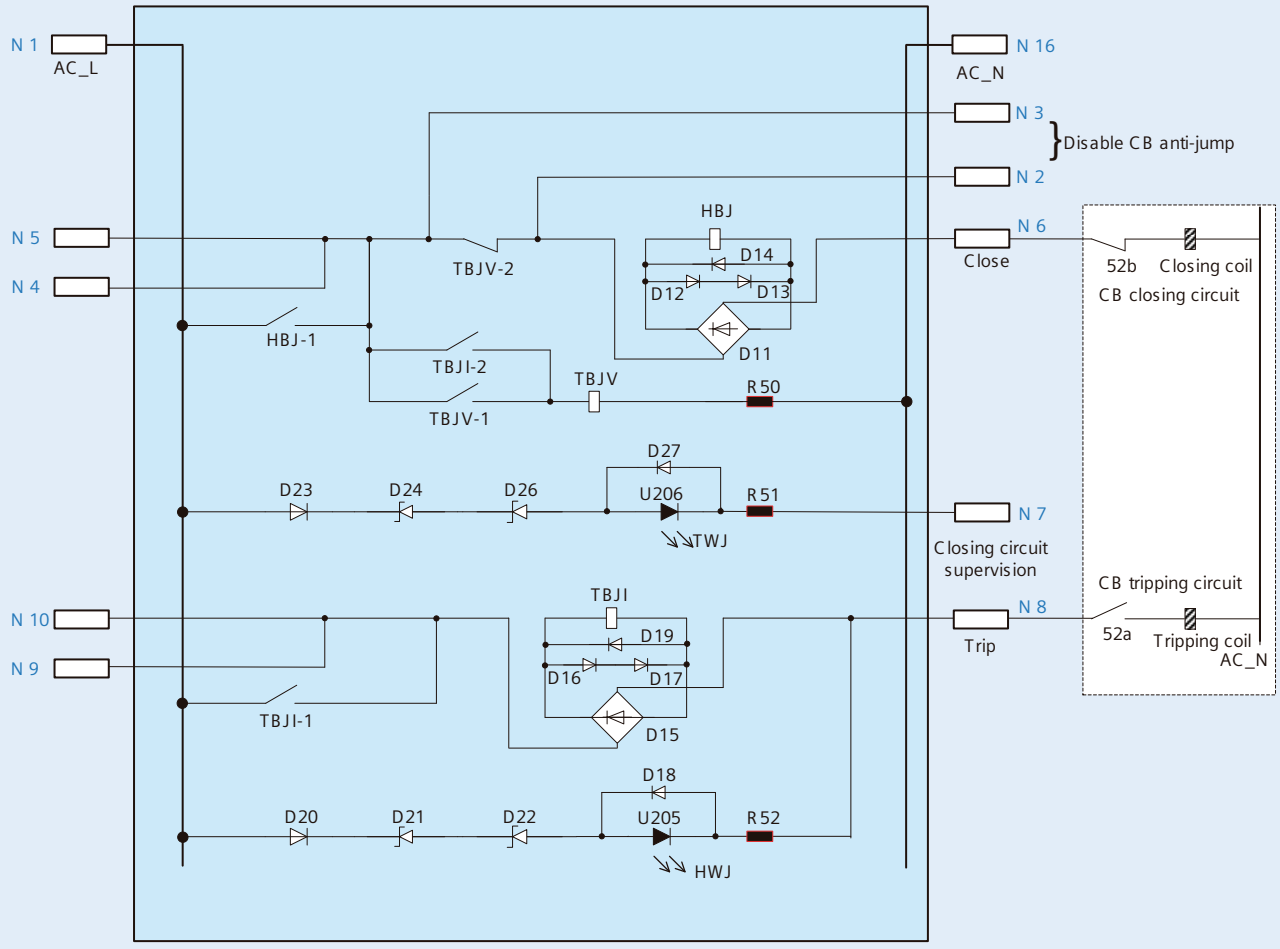
Circuit Diagram of DC Operation Module



Terminal	Assignment
N1	DC positive KM+
N2	Disable anti-jump
N3	
N4	Relay close
N5	Manual close
N6	To closing circuit
N7	Tripping pos. sup.
N8	To tripping circuit
N9	Relay trip
N10	Manual open
N11	Post-close 1
N12	Post-close 2
N13	Indication close
N14	Indication common
N15	Indication trip
N16	DC negative KM-

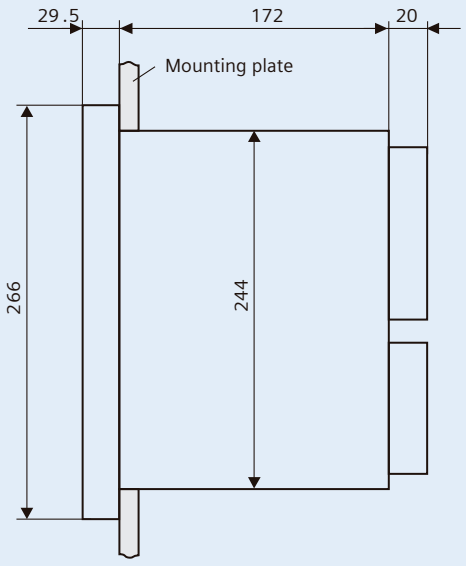
Note: If CB anti-jump is activated, the tripping/closing circuit can be supervised via BI.For details, please refer to page 5.

Connection Diagram for Expansion Module

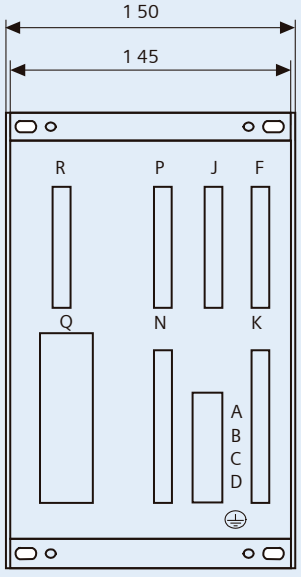


Dimensions

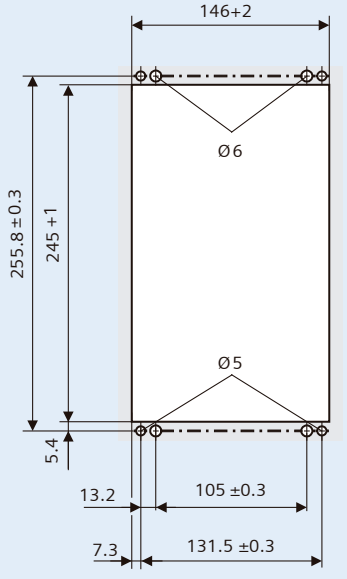
Dimensions for 1/3*19" device (in mm)



Side View

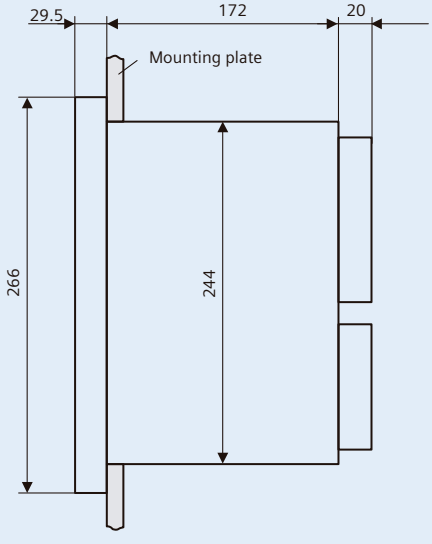


Rear View

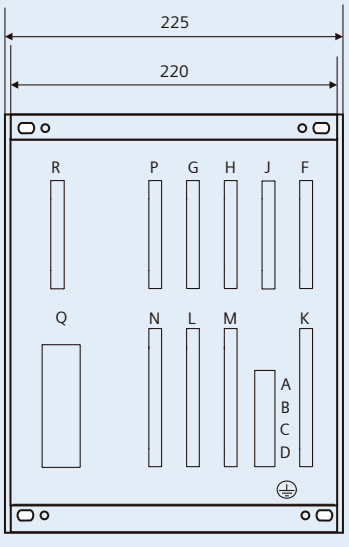


Cut-out (Front View)

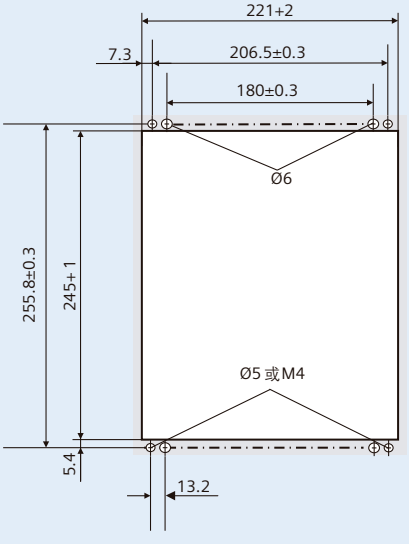
Dimensions for 1/2*19" device (in mm)



Side View



Rear View



Cut-out (Front View)

KETOP开普

№:JW111105

CNAS L0685

Test Report

Sample model	SIPROTEC 4 7SJ686
Sample name	Microcomputer Integrated Protection Measuring and Control Device
Client	Siemens Power Automation Ltd.
Manufacturer	Siemens Power Automation Ltd.
Agent/Dealer	/
Date of Issue	January 9, 2012

China KETOP Lab

National Relay Protection and Automation Equipment Quality Supervision and Test Center

KETOP开普

№:JW111105

Sample name: Microcomputer Integrated Protection Measuring and Control Device Model: SIPROTEC 4 7SJ686 Specification: Power supply DC110V/220VAC220V AC AC100V 1A50Hz Quantity: 2 Sample No.: KP111105 -1 KP111105 -2 Test place: KETOP Lab	Client: Siemens Power Automation Ltd. Client address: Building 4, Huarui Industrial Park, No. 88 Chengxin Avenue, Economic and Technical Development Zone, Jiangning District, Nanjing City, Jiangsu, PRC Manufacturer: Siemens Power Automation Ltd. Address: Building 4, Huarui Industrial Park, No. 88 Chengxin Avenue, Economic and Technical Development Zone, Jiangning District, Nanjing City, Jiangsu, PRC Agent/Dealer: / Agent/Dealer address: /
Test purpose: ☑ Entrusted test □ [illegible] □ National/industrial supervision □ Certification test □ Permit [illegible] □ Others	
Test conclusion: According to test results described in the report, our Lab hereby declares that the tested samples comply with test requirements.	
Issued by: Li Yaping	China KETOP Lab National Relay Protection and Automation Equipment Quality Supervision and Test Center January 9, 2012
Note: The report content in this electronic document is only for reference by the Client. The National Relay Protection and Automation Equipment Quality Supervision and Test Center is not responsible for the direct, indirect, inevitable or accidental damage caused by the use of the information or data in this electronic document.	

Ver 3.0

EUROPEAN INSPECTION AND CERTIFICATION COMPANY S.A.

CERTIFICATE OF CONFORMITY

FULLNESS EXAMINATION OF TECHNICAL FILE

This is to attest that, upon the relevant application of the above mentioned company, EUROCERT as Third Party Authority has reviewed the Technical Construction File of the described product which found to fulfill the basic health and safety prerequisites of above mentioned Directive(s).

Note:

On Behalf of EUROCERT

George Nikolopoulos
Technical Director

Third Party Authority Stamp

PRODUCT CERTIFICATE

No.: CQC15017129597

NAME AND ADDRESS OF THE APPLICANT

Siemens Power Automation Ltd.

NAME AND ADDRESS OF THE MANUFACTURER

Siemens Power Automation Ltd.

NAME AND ADDRESS OF THE FACTORY

Siemens Power Automation Ltd. (V02384T)

NAME, MODEL AND SPECIFICATION

Multifunctional protective device

THE STANDARDS AND TECHNICAL REQUIREMENTS FOR THE PRODUCTS

GB/T 14598.2-2011;GB/T 14598.20-2007

CERTIFICATION MODEL

Type Testing of Product + Initial Factory Inspection + Follow up Factory Inspection

President: Wang Kejiao

CHINA QUALITY CERTIFICATION CENTRE

IEC 61850 Certificate Level 8

KETOP开普

The product has not shown to be non-conforming to:

IEC 61850-7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems in substations

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All dimensions in this catalog are in millimeters unless otherwise stated.
We are entitled to modify the contents, especially the stated values, dimensions and weight.
They are subject to change without notice.
The information in this document contains a general description of available technology options, which may not apply in all cases. The required technology options need to be specifically noted in the contract.

Indication of Conformity

CE	This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage Directive 2006/95 EC). This conformity is proved by tests conducted by Siemens AG in accordance with the Council Directive in agreement with the generic standards EN 61000-6-2 and EN 61000-6-4 for EMC directive, and with the standard EN 60255-27 for the low-voltage directive. The device has been designed and produced for industrial use. The product conforms with the international standards of the series IEC 60255 and the German standard VDE 0435.

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