

SIEMENS



Voltage and Frequency Protection 7RW80 SIPROTEC Compact

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You will find a detailed overview of the technical data (extract of the manual) under:
<http://www.siemens.com/siprotec>

Description

The SIPROTEC 7RW80 is a numerical, multi-function relay for connection to voltage transformers. It can be used in distribution systems, on transformers and for electrical machines. If the SIPROTEC Compact 7RW80 detects any deviation from the permitted voltage, frequency or overexcitation values, it will respond according to the values set. The relay can also be applied for the purposes of system decoupling and for load shedding if ever there is a risk of a system collapse as a result of inadmissibly large frequency drops. An integrated load restoration function allows the re-establishment of the power system after recovery of the system frequency.

The SIPROTEC 7RW80 features “flexible protection functions”. Up to 20 additional protection functions can be created by the user. For example, a rate of change of frequency function or a reverse power function can be created.

The relay provides circuit-breaker control, additional primary switching devices (grounding switches, transfer switches and isolating switches) can also be controlled from the relay. Automation or PLC logic functionality is also implemented in the relay.

The integrated programmable logic (CFC) allows the user to add own functions, e.g. for the automation of switchgear (including: interlocking, transfer and load shedding schemes). The user is also allowed to generate user-defined messages. The communication module is independent from the protection. It can easily be exchanged or upgraded to future communication protocols.

Highlights

- Pluggable current and voltage terminals
- Binary input thresholds settable using DIGSI (3 stages)
- 9 programmable function keys
- 6-line display
- Buffer battery exchangeable from the front
- USB front port
- 2 additional communication ports
- Integrated switch for low-cost and redundant optical Ethernet rings
- Ethernet redundancy protocols RSTP, PRP and HSR for highest availability
- Relay-to-relay communication through Ethernet with IEC 61850 GOOSE
- Millisecond-accurate time synchronization through Ethernet with SNTP.



Fig. 8/1 SIPROTEC 7RW80 front view



Fig.8/2 SIPROTEC 7RW80 rear view

Voltage and Frequency Protection SIPROTEC 7RW80

Function overview

Protection functions	IEC	ANSI
Undervoltage/overvoltage protection	$V<, V>$	27/59
Rate-of-voltage-change protection	$V_E, V_{0>}$	59N ¹⁾
Overfrequency/underfrequency protection	$f<, f>$	81O/U
Load restoration		81LR
Jump of voltage vector	$\Delta\varphi>$	
Overexcitation protection	V/f	24
Phase-sequence-voltage supervision	$V_{2>}$, phase sequence	47
Synchrocheck		25
Rate-of-frequency-change protection	df/dt	81R
Rate-of-voltage-change protection	dV/dt	27R/59R
Trip circuit supervision	AKU	74TC
Lockout		86

Table 8/1 Function overview

Control functions/programmable logic

- Commands for the ctrl. of CB, disconnect switches (isolators/isolating switches)
- Control through keyboard, binary inputs, DIGSI 4 or SCADA system
- User-defined PLC logic with CFC (e.g. interlocking).

Monitoring functions

- Operational measured values V, f
- Minimum and maximum values
- Trip circuit supervision
- Fuse failure monitor
- 8 oscillographic fault records.

Communication interfaces

- System/service interface
 - IEC 61850 Edition 1 and 2
 - IEC 60870-5-103
 - PROFIBUS-DP
 - DNP 3.0
 - MODBUS RTU
 - Ethernet redundancy protocols RSTP, PRP and HSR
- Ethernet interface for DIGSI 4
- USB front interface for DIGSI 4.

Hardware

- 3 voltage transformers
- 3/7 binary inputs (thresholds configurable using software)
- 5/8 binary outputs (2 changeover)
- 1 life contact
- Pluggable terminal blocks.

1) Not available if function package "Q" or "E" (synchrocheck) is selected.

The SIPROTEC 7RW80 unit is a numerical protection device that can perform control and monitoring functions and therefore provide the user with a cost-effective platform for power system management, that ensures reliable supply of electrical power to the customers. The ergonomic design makes control easy from the relay front panel. A large, easy-to-read display was a key design factor.

Control

The integrated control function permits control of disconnect devices, grounding switches or circuit-breakers through the integrated operator panel, binary inputs, DIGSI 4 or the control or automation system (e.g. SICAM)

Programmable logic

The integrated logic characteristics (CFC) allow the user to add own functions for automation of switchgear (e.g. interlocking) or switching sequence. The user can also generate user-defined messages. This functionality can form the base to create extremely flexible transfer schemes.

Operational measured value

Extensive measured values (e.g. I , V), metered values (e.g. W_p , W_q) and limit values (e.g. for voltage, frequency) provide improved system management.

Operational indication

Event logs, trip logs, fault records and statistics documents are stored in the relay to provide the user or operator with all the key data required to operate modern substations.

Line protection

For the enhancement of the feeder protection the 7RW80 provides several stages for voltage and frequency protection.

Generator and transformer protection

Through implemented voltage, frequency and overexcitation protection the SIPROTEC 7RW80 can be used for generators and transformers in case of defective voltage or frequency control, full load rejection or operation in islanding generation systems.

System decoupling and load shedding

For system decoupling and load shedding the SIPROTEC 7RW80 provides voltage, frequency, rate-of-frequency-change and rate-of-voltage-change protection.

Load restoration

For power system recovery, frequency protection and load restoration are available in SIPROTEC 7RW80.

Switchgear cubicles for high/medium voltage

All units are designed specifically to meet the requirements of high/medium-voltage applications. In general, no separate measuring instruments (e.g., for current, voltage, frequency, ...) or additional control components are necessary.

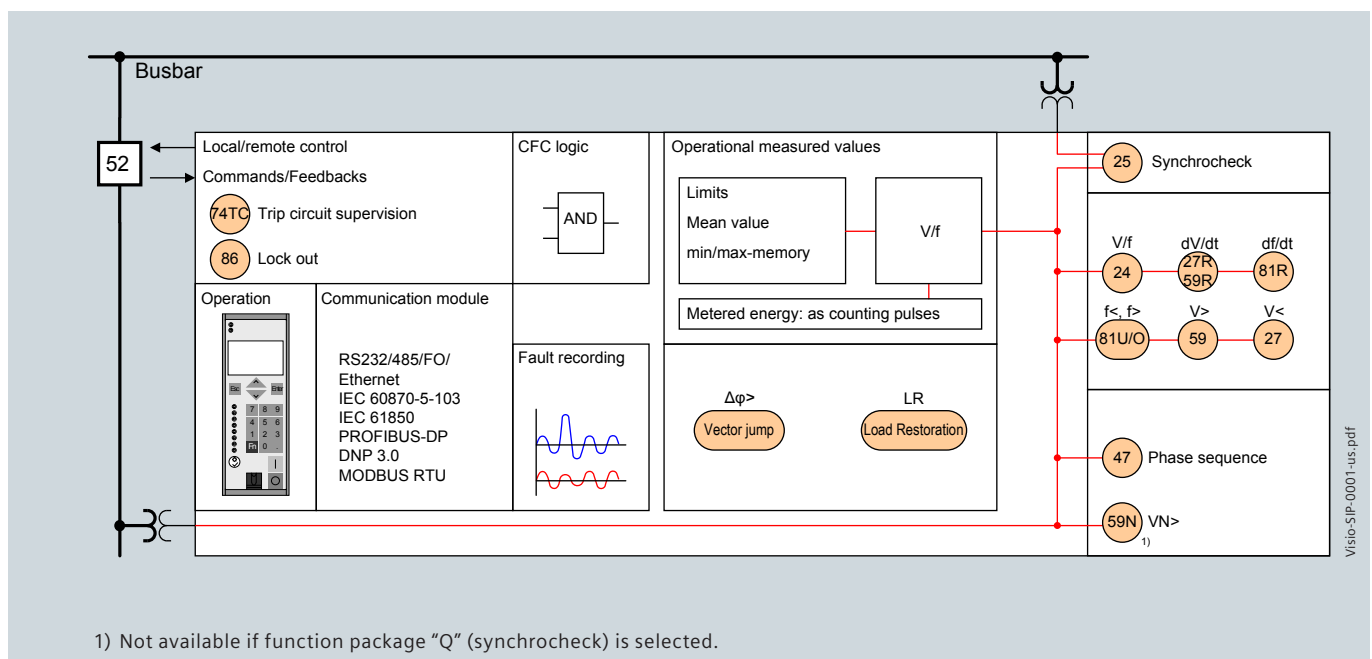


Fig. 8/3 Function diagram

Protection functions

Undervoltage protection (ANSI 27)

The two-element undervoltage protection provides protection against dangerous voltage drops (especially for electric machines). Applications include the isolation of generators or motors from the network to avoid undesired operating conditions and a possible loss of stability. Proper operating conditions of electrical machines are best evaluated with the positive-sequence quantities. The protection function is active over a wide frequency range of 25 to 70 Hz. The function can operate either with phase-to-phase, phase-to-ground or positive phase-sequence voltage. Three-phase and single-phase connections are possible. In addition a user definable curve with up to 20 value pairs is available.

Overvoltage protection (ANSI 59)

The two-element overvoltage protection detects unwanted network and machine overvoltage conditions. The function can operate either with phase-to-phase, phase-to-ground, positive phase-sequence or negative phase-sequence voltage. Three-phase and single-phase connections are possible. In addition, a user definable curve with up to 20 value pairs is available.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for overfrequency and underfrequency protection. Electric machines and parts of the system are protected from unwanted frequency deviations. Unwanted frequency changes in the network can be detected and the load can be removed at a specified frequency setting. Frequency protection can be used over a wide frequency range of 25 to 70 Hz. There are four elements (individually set as overfrequency, underfrequency or OFF) and each element can be delayed separately. Blocking of the frequency protection can be performed by activating a binary input or by using an undervoltage element.

Load restoration

The load restoration function provides an automatic reconnection of power system parts when the system frequency has recovered after load shedding. Four load restoration stages are available. They can be switched on and off separately. If the frequency conditions allow the assumption of sufficient generation resources, the load restoration function will consecutively reconnect small load parts at specified time intervals.

Overexcitation protection (ANSI 24)

The overexcitation protection serves for detection of an un-permissible high induction (proportional to V/f) in generators or transformers, which leads to thermal overloading. This may occur when starting up, shutting down under full load, with weak systems or under isolated operation. The inverse characteristic can be set via eight points derived from the manufacturer data. In addition, a definite-time alarm stage and an instantaneous stage can be used. For calculation of the V/f ratio, frequency and also the highest of the three line-to-line voltages are used. The frequency range that can be monitored comprises 25 to 70 Hz.

Jump of voltage vector

Monitoring the phase angle in the voltage is a criterion for identifying an interrupted infeed. If the incoming line should fail, the abrupt current discontinuity leads to a phase angle jump in the voltage. This is measured by means of a delta process. The command for opening the generator or coupler circuit-breaker will be issued if the set threshold is exceeded.

Flexible protection functions

SIPROTEC 7RW80 enables the user to easily add up to 20 additional protection functions. Parameter definitions are used to link standard protection logic with any chosen characteristic quantity (measured or calculated quantity). The standard logic consists of the usual protection elements such as the pickup set point, the set delay time, the TRIP command, a block function, etc.

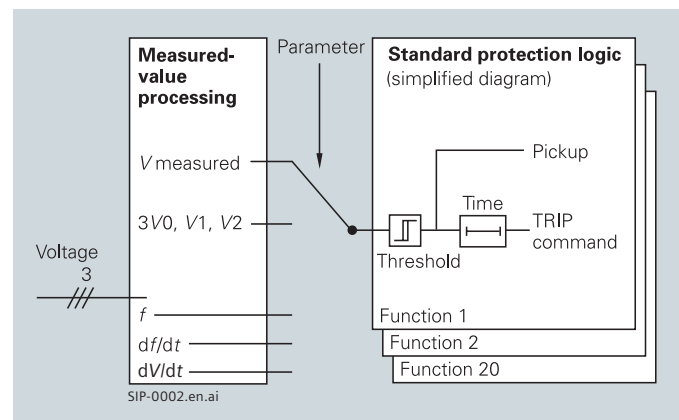


Fig. 8/4 Flexible protection functions

The mode of operation for voltage quantities can be three-phase or single-phase. Almost all quantities can be operated with ascending or descending pickup stages (e.g. under and overvoltage). All stages operate with protection priority or speed.

Protection functions/stages available are based on the available measured analog quantities:

Function	ANSI
$V<, V>, V_E>$	27, 59, 59N
$3V_0>, V_1><, V_2><$	59N, 47
$f><$	81O, 81U
$df/dt><$	81R
dV/dt	27R/59R

Table 8/2 Available flexible protection functions

For example, the following can be implemented:

- Rate-of-frequency-change protection (ANSI 81R)
- Rate-of-voltage-change protection (ANSI 27R/59R).

Synchrocheck, synchronizing function (ANSI 25)

When closing a circuit-breaker, the units can check whether two separate networks are synchronized. Voltage-, frequency- and phase-angle-differences are checked to determine whether synchronous conditions exist.

Lockout (ANSI 86)

All binary output statuses can be memorized. The LED reset key is used to reset the lockout state. The lockout state is also stored in the event of supply voltage failure. Reclosure can only occur after the lockout state is reset.

Trip circuit supervision (ANSI 74TC)

One or two binary inputs can be used for monitoring the circuit-breaker trip coil including its incoming cables. An alarm signal is generated whenever the circuit is interrupted.

Customized functions

Additional functions can be implemented using CFC or flexible protection functions.

Further functions

Measured values

The r.m.s. values are calculated from the acquired voltages along with the frequency. The following functions are available for measured value processing:

- Voltages $V_{L1}, V_{L2}, V_{L3}, V_{L1L2}, V_{L2L3}, V_{L3L1}$
- Symmetrical components V_1, V_2, V_0
- Frequency
- Mean as well as minimum and maximum voltage values
- Operating hours counter
- Limit value monitoring
Limit values can be monitored using programmable logic in the CFC. Commands can be derived from this limit value indication
- Zero suppression
In a certain range of very low measured values, the value is set to zero to suppress interference.

Commissioning

Commissioning could not be easier and is supported by DIGSI 4. The status of the binary inputs can be read individually and the state of the binary outputs can be set individually. The operation of switching elements (circuit-breakers, disconnect devices) can be checked using the switching functions of the relay. The analog measured values are represented as wide-ranging operational measured values. To prevent transmission of information to the control center during maintenance, the communications can be disabled to prevent unnecessary data from being transmitted. During commissioning, all indications with test tag for test purposes can be connected to a control and protection system.

Test operation

During commissioning, all indications with test tag can be passed to a control system for test purposes.

Voltage and Frequency Protection SIPROTEC 7RW80

Application examples

Line feeder with load shedding

In unstable power systems (e.g. solitary systems, emergency power supply in hospitals), it may be necessary to isolate selected consumers from the power system in order to protect the overall system.

The overcurrent protection functions are effective only in the case of a short-circuit.

Overloading of the generator can be measured as a frequency or voltage drop.

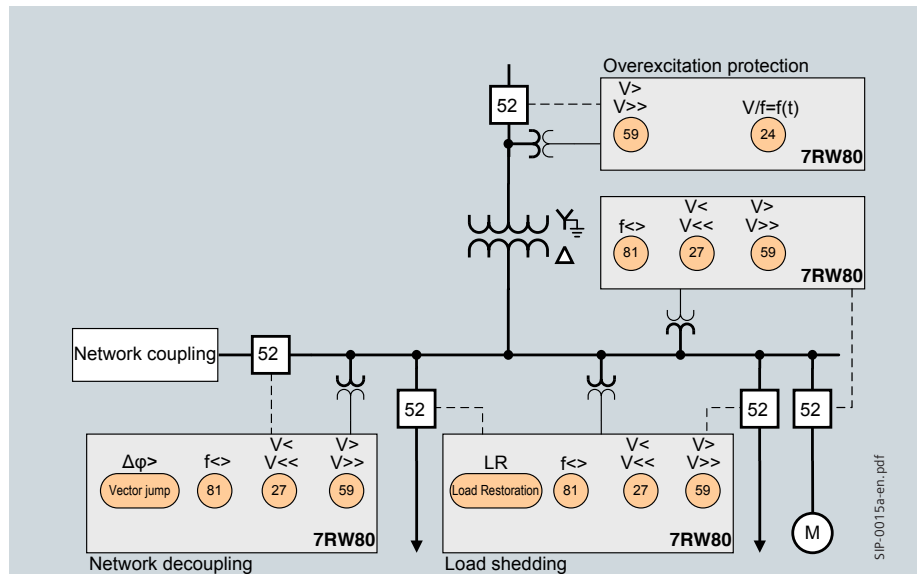


Fig. 8/5 Application example 7RW80

Load shedding with rate-of-frequency-change protection

From the measured frequency, the frequency difference is determined over a time interval. It corresponds to the momentary frequency change.

It is thus possible to quickly detect any major load drops in the power system, to disconnect certain consumers from the system, and to restore the system to stability. Unlike frequency protection, rate-of-frequency-change-protection already reacts before the pickup threshold of the frequency protection is reached.

The pickup value depends on the application, and follows the conditions of the power system. The rate-of-frequency-change protection function can also be used for the purposes of system decoupling.

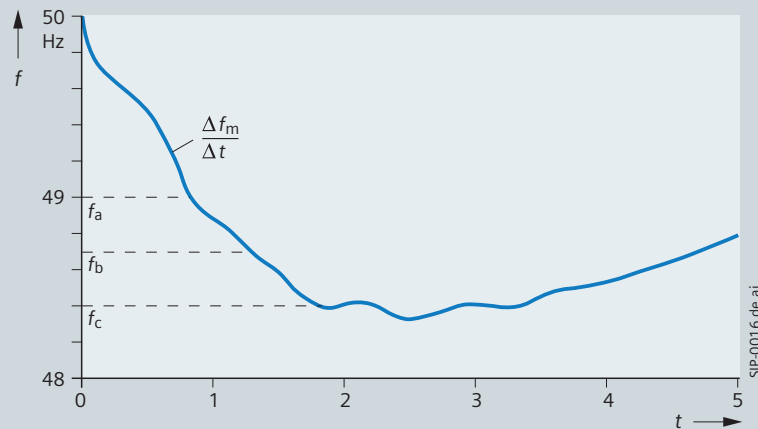


Fig. 8/6 Load shedding

Synchrocheck

Where two system sections are interconnected, the synchrocheck determines whether the connection is permissible without danger to the stability of the power system. In the example, load is supplied from a generator to a busbar through a transformer. The vector group of the transformer can be considered by means of a programmable angle adjustment, so that no external adjustment elements are necessary. Synchrocheck can be used for auto-reclosure, as well as for control functions (local or remote).

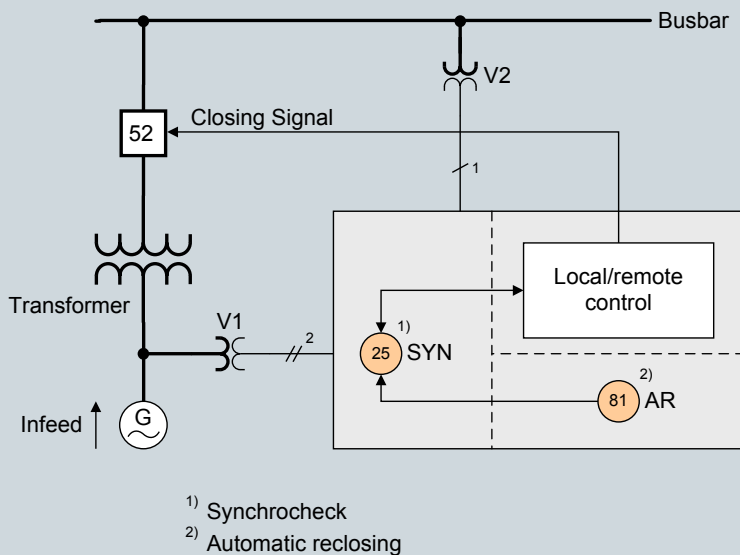


Fig. 8/7 Measurement of busbar and feeder voltage for synchronization

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Voltage and Frequency Protection SIPROTEC 7RW80

Selection and ordering data

Product description	Order No.										Short code									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	7RW80										0 - □ □ □ □ □ □ - □ □ □ □ □ □ + □ □ □ □ □ □									
Housing, binary inputs and outputs																				
Housing 1/6 19", 3x V, 3 BI, 5 BO ¹⁾ , 1 life contact		1																		
Housing 1/6 19", 3x V, 7 BI, 8 BO ¹⁾ , 1 life contact		2																		
Rated auxiliary voltage																				
DC 24 V/48 V																				
DC 60 V/110 V/125 V/220 V/250 V, AC 115 V, AC 230 V																				
Unit version																				
Surface mounting housing, screw-type terminal																				
Flush mounting housing, screw-type terminal																				
Region-specific default- and language settings																				
Region DE, IEC, language German ²⁾ , standard front																				
Region World, IEC/ANSI, language English ²⁾ , standard front																				
Region US, ANSI, language US-English ²⁾ , US front																				
Region FR, IEC/ANSI, language French ²⁾ , standard front																				
Region World, IEC/ANSI, language Spanish ²⁾ , standard front																				
Region World, IEC/ANSI, language Italian ²⁾ , standard front																				
Region RUS, IEC/ANSI, language Russian ²⁾ , standard front																				
Region CHN, IEC/ANSI, language Chinese ³⁾ , chinese front																				
Port B (at bottom of device, rear)																				
No port																				
IEC 60870-5-103 or DIGSI 4/modem, electrical RS232																				
IEC 60870-5-103 or DIGSI 4/modem, electrical RS485																				
IEC 60870-5-103 or DIGSI 4/modem, optical 820 nm, ST connector																				
PROFIBUS DP slave, electrical RS485																				
PROFIBUS DP slave, optical, double ring, ST connector																				
MODBUS, electrical RS485																				
MODBUS, optical 820 nm, ST connector																				
DNP 3.0, electrical RS485																				
DNP 3.0, optical 820 nm, ST connector																				
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector																				
IEC 61850, 100 Mbit Ethernet, optical, double, LC connector																				
Port A (at bottom of device, front)																				
No port																				
With Ethernet interface (DIGSI, not IEC 61850), RJ45 connector																				
Measuring / fault recording																				
With fault recording, average values, min/max values																				
Conformal Coating																				
for 7RW801																				
for 7RW802																				

see next page

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1) 2 changeover/Form C.
 2) Language selectable
 3) Language not changeable

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Voltage and Frequency Protection SIPROTEC 7RW80

Selection and ordering data

ANSI No.	Product description	Order No.	Short code
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 7RW80 □ 0 - □ □ □ □ □ □ - □ D □ 0 + □ □ □ □ □	
	Voltage and frequency protection		A
27/59	Under/Overtoltage		
64/59N	Displacement voltage		
81U/O	Under/Overfrequency		
47	Phase rotation		
74TC	Trip circuit supervision		
86	Lockout		
	Parameter changeover		
	Monitoring functions		
	Control of circuit-breaker		
27R/59R/81R	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change		
	Voltage, frequency protection and load restoration		B
27/59	Under/Overtoltage		
64/59N	Displacement voltage		
81U/O	Under/Overfrequency		
	Load restoration		
47	Phase rotation		
74TC	Trip circuit supervision		
86	Lockout		
	Parameter changeover		
	Monitoring functions		
	Control of circuit-breaker		
27R/59R/81R	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change		
	Voltage, frequency protection and synchrocheck		C
27/59	Under/Overtoltage		
81U/O	Under/Overfrequency		
25	Synchrocheck		
47	Phase rotation		
74TC	Trip circuit supervision		
86	Lockout		
	Parameter changeover		
	Monitoring functions		
	Control of circuit-breaker		
27R/59R/81R	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change		
	Voltage, frequency, overexcitation protection and vector jump		D
27/59	Under/Overtoltage		
64/59N	Displacement voltage		
81U/O	Under/Overfrequency		
24	Overexcitation		
	Vector jump		
47	Phase rotation		
74TC	Trip circuit supervision		
86	Lockout		
	Parameter changeover		
	Monitoring functions		
	Control of circuit-breaker		
27R/59R/81R	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change		
	Voltage, frequency, overexcitation protection and vector jump, load restoration and synchrocheck		E
27/59	Under/Overtoltage		
81U/O	Under/Overfrequency		
24	Overexcitation		
	Vector jump		
	Load restoration		
25	Synchrocheck		
47	Phase rotation		
74TC	Trip circuit supervision		
86	Lockout		
	Parameter changeover		
	Monitoring functions		
	Control of circuit-breaker		
27R/59R/81R	Flexible protection functions (voltage parameters): Rate-of-frequency change, rate-of-voltage change		

Voltage and Frequency Protection SIPROTEC 7RW80

Connection diagrams

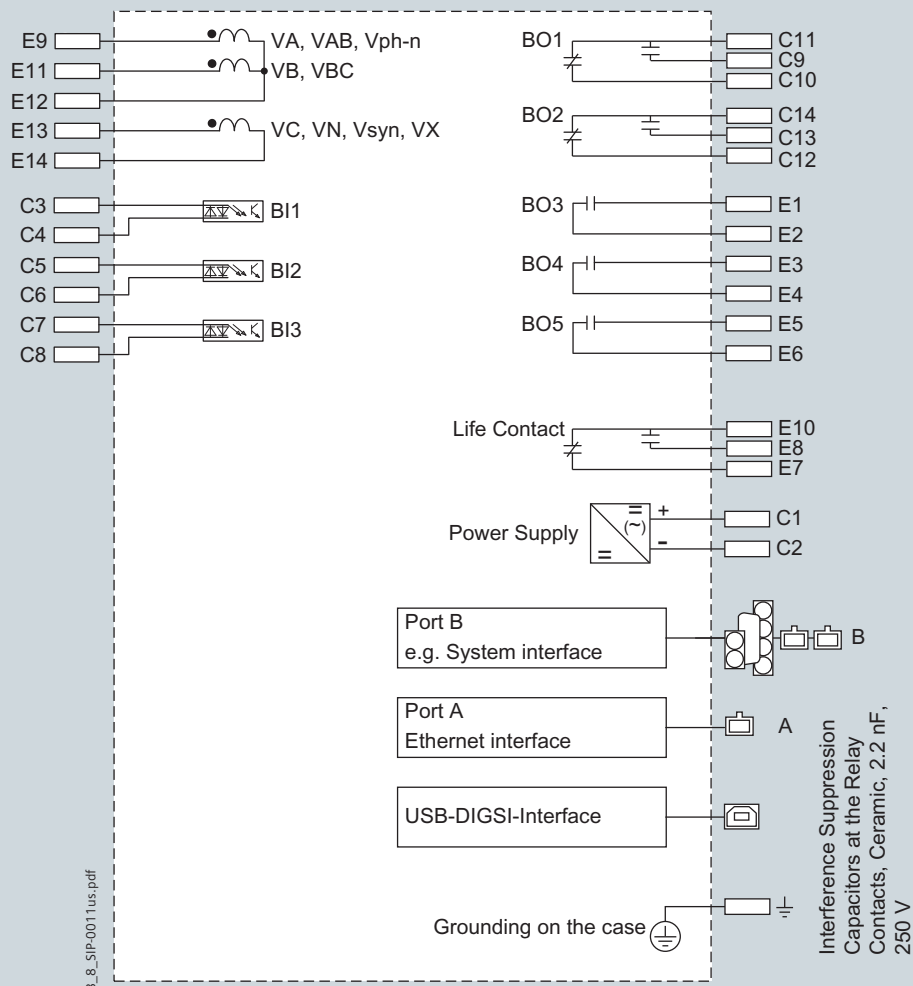


Fig. 8/8 Voltage and frequency protection SIPROTEC 7RW801

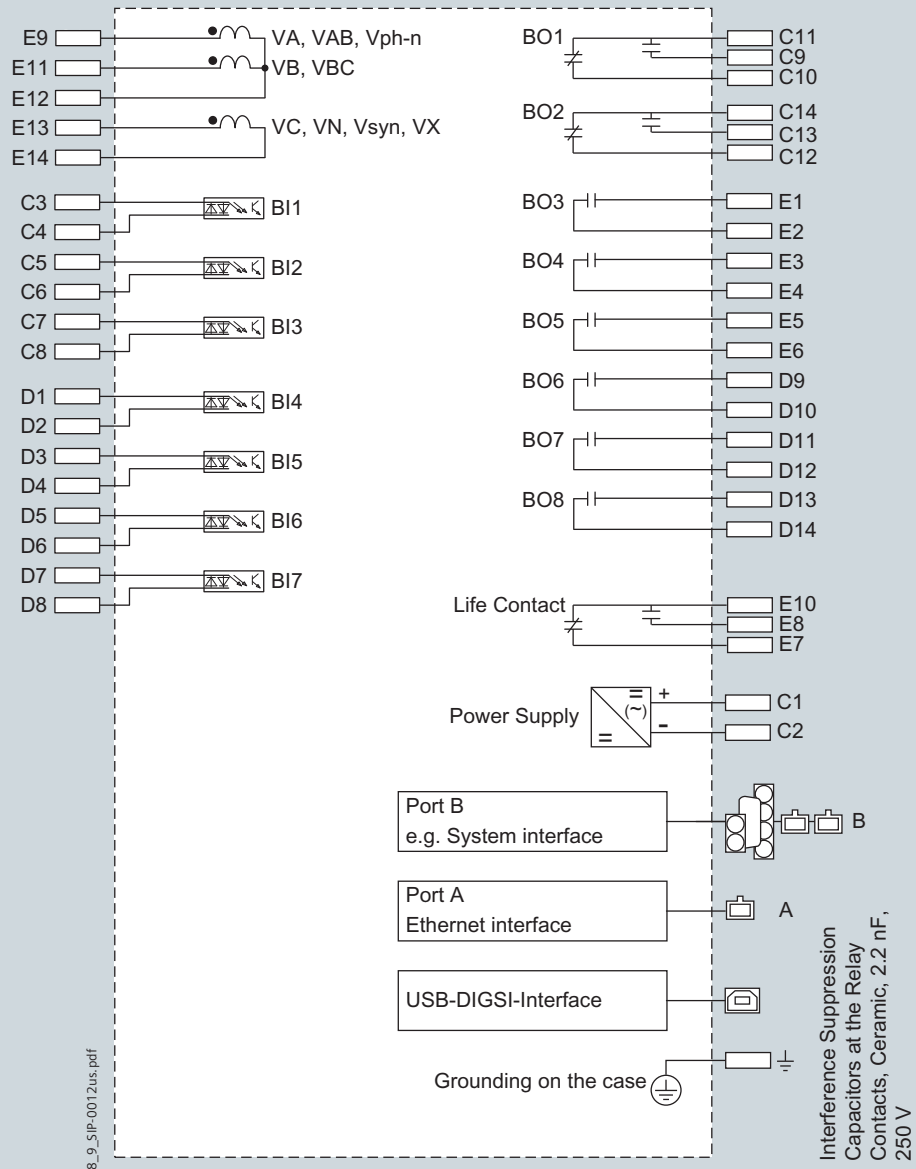


Fig. 8/9 Voltage and frequency protection SIPROTEC 7RW802