SIEMENS

SIPROTEC

Multi-Functional Protective Relay with Local Control 7SJ689

V4.60

User Manual

C53000-G1176-C346-1

Note

For safety purposes, please note instructions and warnings in the Preface.

Release: V04.00.00

Date: 02.2012

Preface

Purpose of this Manual

This manual describes the functions, operation, installation, and commissioning of the device 7SJ689.

In particular, one will find:

Information on the Device Configuration and a description of the device functions and setting options → Chapter 2;

Instructions for mounting and commissioning → Chapter 3;

For general information on operation and configuration of SIPROTEC® 4 devices, please refer to the SIPROTEC® System Description /1/.

Target Audience

Protection engineers, commissioning engineers, personnel concerned with adjustment, checking, and service of selective protective equipment, automatic and control facilities, and personnel of electrical facilities and power plants.

Applicability of this Manual

This manual is valid for：SIPROTEC 4 Remote Trip Release Device 7SJ689; firmware version V4.6.

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 89/336/EEC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 73/23 EEC). This conformity is proved by tests conducted by Siemens AG in accordance with Article 10 of 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 60255-6 for the low-voltage directive. This device is designed and produced for industrial use. The product conforms with the international standards of the series IEC 60255 and the German standard VDE 0435.

Further Standards IEEE 37.90(Detailed find in Chpater 4)

Additional Support

Should further information on the System SIPROTEC® 4 be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the local Siemens representative.

Our Customer Care Center provides 24-hours service:

Hotline: 8008289887, 4008289887

Fax: +86-025-52114978

e-mail: ea_support.cn@siemens.com

Training Courses

For detail training courses, please refer to our training center:

Siemens Power Automation Ltd.,(SPA)
Building 4, Hua Rui Industry Park,
88 Cheng Xin Avenue,
Jiangning Economic & Technological Development Zone

Tele:+86-025-52120188

Fax:+86-025-52114982

Website: http://www.siemens.com.cn/ea

Instructions and Warnings

The warnings and notes contained in this manual serve for your own safety and for an appropriate lifetime of the device. Please observe them!

The following indicators and standard definitions are used:

DANGER!

indicates that death, severe personal injury or substantial property damage will result if proper precautions are not taken.

Warnings!

indicates that death, severe personal injury or substantial property damage can result if proper precautions are not taken.

Caution!

indicates that minor personal injury or property damage can result if proper precautions are not taken. This particularly applies to damage on or in the device itself and consequential damage thereof.

Note

indicates information about the device or respective part of the instruction manual which is essential to highlight.

WARNING!

Qualified Personnel

Commissioning and operation of the equipment (module, device) as set out in this manual may only be carried out by qualified personnel. Qualified personnel in terms of the technical safety information as set out in this manual are persons who are authorized to commission, activate, to ground and to designate devices, systems and electrical circuits in accordance with the safety standards.

Use as prescribed

The operational equipment (device, module) may only be used for such applications as set out in the catalogue and the technical description, and only in combination with third-party equipment recommended or approved by Siemens.

The successful and safe operation of the device is dependent on proper handling, storage, installation, operation, and maintenance.

When operating an electrical equipment, certain parts of the device are inevitably subject to dangerous voltage. Severe personal injury or property damage may result if the device is not handled properly.

Before any connections are made, the device must be grounded to the ground terminal.

All circuit components connected to the voltage supply may be subject to dangerous voltage.

Dangerous voltage may be present in the device even after the power supply voltage has been removed (capacitors can still be charged).

Operational equipment with exposed current transformer circuits may not be operated.

The limit values as specified in this manual or in the operating instructions may not be exceeded. This aspect must also be observed during testing and commissioning.

Typographic and Symbol Convention

The following text formats are used when literal information from the device or to the device appear in the text flow:

Parameter Names

Designators of configuration or function parameters which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are marked in bold letters in monospace type style. The same applies to the titles of menus.

1234A

Parameter addresses have the same character style as parameter names. Parameter addresses contain the suffix **A** in the overview tables if the parameter can only be set in DIGSI via the option **Display additional settings**.

Parameter Options

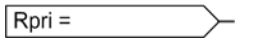
Possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are additionally written in italics. The same applies to the options of the menus.

„Messages“

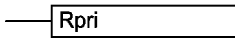
Designators for information, which may be output by the relay or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

Deviations may be permitted in drawings and tables when the type of designator can be obviously derived from the illustration.

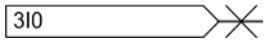
The following symbols are used in drawings:



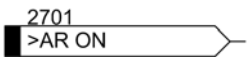
Device-internal logical input signal



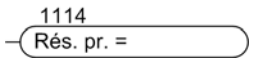
Device-internal logical output signal



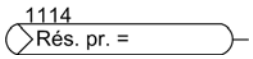
Internal input signal of an analog quantity



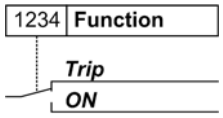
External binary input signal with number (binary input, input indication)



External binary input signal with number (example of a value indication)

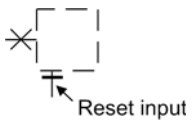


External binary output signal with number (device indication) used as input signal

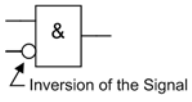


Example of a parameter switch designated **FUNCTION** with address 1234 and the possible settings ON and OFF

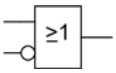
Besides these, graphical symbols are used in accordance with IEC 60617-12 and IEC 60617-13 or similar. Some of the most frequently used are listed below:



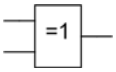
Input signal of analog quantity



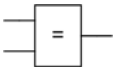
AND-gate operation of input values



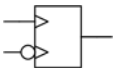
OR-gate operation of input values



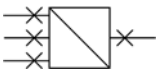
Exklusive OR-gate (antivalence): output is active, if only **one** of the inputs is active



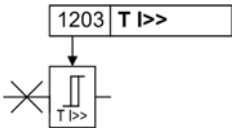
Coincidence gate (equivalence): output is active, if **both** inputs are active or inactive at the same time



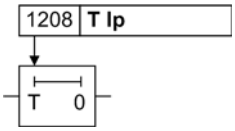
Dynamic inputs (edge-triggered) above with positive, below with negative edge



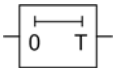
Formation of one analog output signal from a number of analog input signals



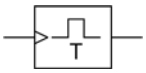
Limit stage with setting address and parameter designator (name)



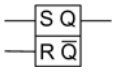
Timer (pickup delay T, example adjustable) with setting address and parameter designator (name)



Timer (dropout delay T, example non-adjustable)



Dynamic triggered pulse timer T (monoflop)



Static memory (RS-flipflop) with setting input (S), resetting input (R), output (Q) and inverted output ($\overline{Q}$)

Technical Terminology and Symbol

I_N	Normal Current
U_N	Normal Voltage
U_{Nprim}	Primary Normal Voltage
U_{Nsec}	Secondary Normal Voltage
Ia	Phase-A Current
Ib	Phase-B Current
Ic	Phase-C Current
In	Zero-Sequence Current （Measred value from common CT）
Ins	Zero-Sequence Current （Measred value from sensitive CT）
3I0	Zero-Sequence Current （Calculated value from internal programming）
Ua	Phase-A voltage
Ub	Phase-B voltage
Uc	Phase-C voltage
Uab	Line AB voltage
Ubc	Line BC voltage
Uca	Line CA voltage
3U0	Zero-sequence voltge （calculated value from internal programming

Un	Zero-sequence voltge （Meaured value from PT）
Ux	Isolated Voltage
Usyn	Synchronization Voltage
Udelta	Open-delta voltage
Uphph	Phase-phase voltage
Uph	Phase voltage
P	Active Power
Q	Reactive Power
S	apparent power
PF	Power Factor
PT	Voltage Transformer
CT	Current Transformer

■

Contents

Introduction

1

The device SIPROTEC 7SJ689 is introduced in the view of the applications, the characteristics and the functional scopes in this chapter.

1.1 Application Scope

The device is a digital overvoltage and remote tripping protection, which can be used as a local discriminating device for overvoltage and remote tripping of 220kV and above voltage long-distance transmission lines.

Protection Functions

Local criterions including zero-sequence and negative-sequence currents and voltages, Fault component current, low currents, phase low power factors and phase low active power are provided, which can reflect the fault and abnormal operating conditions of the primary system. After different local criterions are applied according to the operation requirements, the safety of protection is improved without reducing the reliability thereof.

When the local overvoltage protection detects the system fault, the tripping operation of the local circuit breaker is executed, and at the same time the signal transferred to the other side enables the remote trip.

Device Information and Measured Values, Events and Fault Records

The operation information provides the state information of the power system and the device. The measured values and the calculated values can be directly displayed on the screen of a local device, and further remotely displayed through communication via a serial interface.

The information of the device can be displayed through a light-emitting diode (LED) mounted on a panel of the device (the LED is user-defined), which can be externally processed through an output connection point, and also associated through the user-defined logic (CFC) or transmitted through the serial interface.

If a fault (system fault) occurs, the important event and the state change may be recorded in the fault records (event records or trip records). The device also records the value of a transient fault for subsequent analysis.

Communications

The service port C can be selected as a cable data line or an optical fibre, or can carry out communication through MODEM. Therefore, remote access to the device can be realized through a PC installed with operationing software, for example, a centre PC is capable of operating a plurality of devices.

The system port B guarantees the communication between the device and a remote control centre, and the transmission medium can be the cable wire or the optical fibre. Data transmission can be in accordance with the redundant IEC 60870 870-5-103 transmission protocol by which the protection device accesses to SInAUT LSA and SICAM automatic systems and other systems. IEC61850 protocol also can be realized for the data transmission through the EN100 module; the protection device provides an access to the 100M Ethernet of the substation automation system; and simultaneously, the port is also capable of realizing DIGSI communication and communication based on GOOSE mechanism.

1.2 Characteristics

General Characteristics

- A powerful 32-bit microprocessor is employed.
- The whole process from the acqusition and input of analog quantities to the output of binary is realized through digital processing.
- Due to binary input/output and the use of a direct-current or alternating-current converter, the internal data processing module of the device and an external sensor, and a controller and a direct-current power source can be electrically isolated from each other completely.

- The device is simple and convinient to operate, which can be operated through the panel of the device or by using DIGSI software.
- The measured and metered data is continuously calculated, and displayed on the front panel.
- Event information and fault data are recorded, the real-time information of eight system faults (power grid faults) and instantaneous fault values can be recorded, and the longest recording time is 10 seconds.
- The measured values are continuously monitored, and the software and hardware of the device can be self-checked continuously.
- Communication can be performed by means of the serial port and SCADA or the station control unit of the substation via a data cable, a modem or an optical cable.
- The clock power supply of the device is provided by a battery,and the device can keep time synchronization with IRIG-B (through a satellite) or DCF77 signals through binary input signals or system interface time setting commands.
- Statistics: the number of trip signals sent by the equipment is recorded; and the last breaking current record and the accumulation of the short circuit currents of all phases of the circuit breaker are recorded.
- Operating time accumulation: the statistic of the operating hours of the protected equipment.
- A convenient commissioning environment is provided, for example, wire connection examination, direction determination input/output state examination, and fast examination of system interfaces and system interface information.

Overvoltage Protection

- Three-Phase AND or Three-Phase OR can be selected as a criterion for the Overvoltage Protection.
- The Overvoltage Protection may realize Local Trip and Remote Trip, respectively.
- The Remote Trip can be blocked via the three-phase trip position of the local side circuit breaker.

Remote Trip Protection

- A One-to-One via Local Criterion manner is adopted.
- The local criterions can be switched on or off in groups, respectively.
- The corresponding local criterions are automatically switched off after PT wire break or CT wire break.

Supervision Functions

- As the device can supervise the internal measurement circuits, hardware, software and power supply itself, the reliability of the equipment is greatly improved.
- The secondary circuits of the current transformer and the voltage transformer can be supervised through the summation and balance detection technologies.

User-defined Logic Functions

- The user can establish the user-defined logic functions by combining external and internal signals.
- Boolean operation (AND, OR, NOT, XOR and the like) can be used.
- The desired time delay and limit values can be set.
- Measured value processing, including zero point suppression, may increase the inflection points of the inputs by the sensors and the zero drift supervision.

■

Functions 2

This chapter describes the individual functions of the SIPROTEC 4 device 7SJ689. It shows the setting possibilities for each function in maximum configuration. Guidelines for establishing setting values are given. Where required, formulae may also be given.

Based on the following information, the user can get to know the specific application functions of the device.

2.1 General

The settings associated with the various device functions may be maintained and operated using the operating or service interface in DIGSI in conjunction with a personal computer. Some parameters may also be set using the control keys on the front panel of the device. The specific procedure is explained in detail in the SIPROTEC 4 System Description /1/.

2.1.1 Device

The protection requires some general information.

2.1.1.1 General

Spontaneous Fault Signal

After a fault occurs, the device may be spontaneous to display the most important fault data.

The indication of messages masked to local LEDs and the provision of spontaneous messages can be made dependent on whether the device has issued a trip signal. The information is then not output if during a system disturbance one or more protection functions have picked up but no stripping by the 7SJ689 resulted because the fault was cleared by a different device (e.g. on another line). These messages are then limited to faults in the line to be protected.

When the device trips to drop out, stationary conditions (Fault Display/Trip Display, Trip/No Trip) decide whether the new fault information is stored or the record information is reset.

Spontaneous Fault Signal Reset

A new pickup of a protection function may reset any previously stored LED/relay, so that only the information of the latest fault is displayed.

2.1.1.2 Soft Linking Piece and Control Word

When the remote trip protection function or the overvoltage protection function needs to be ON/OFF, it can be operated through the soft linking piece; if quick setting of the protection functions is required, it can be operated through the control word. DIGSI configuration, the human-machine interface of the device and the communication protocols all can be used for the configuration or operation of the soft linking piece and the control word.

Soft Linking Piece

A soft linking piece control page, under the control page of **Power System Data1**, comprises the settings of the following three functions: 0045 **Remote Trip**, 0050 **Overvoltage Protection**, and 0650 **Remote Access Enable**. The control options of the soft linking piece can not be changed by the setting group . The following figure is the Digsi interface of soft linking piece:

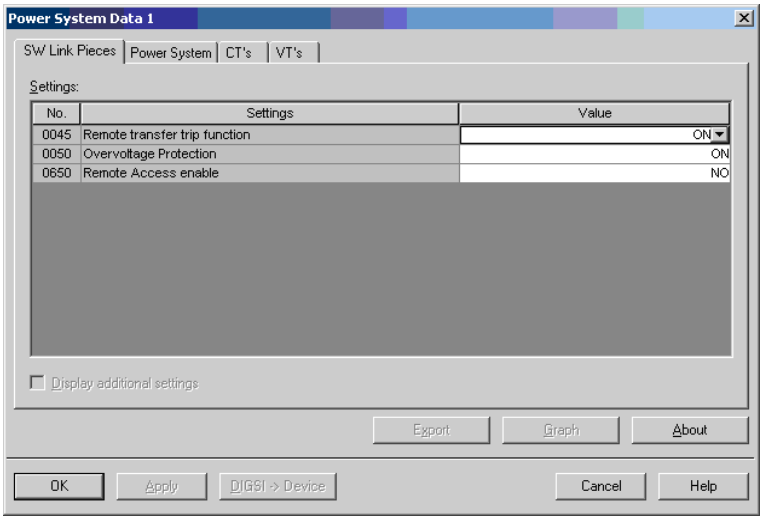


Figure 2-1 DIGSI Soft Linking Piece Control Interface

Control Word

Control Word page is under a **Setting Group** page. A control word dialog box lists all the criterion options and the overvoltage protection function-dependent settings of the Remote Trip Protection functions of the 7SJ689 device according to the control range of each function. The ON and OFF of the options will correspond to the ON and OFF of the corresponding functions included in the **Setting Group** . For example, the changes of such options as 4500 **Remote trip without local criterion,** 4501 **PT switch off LC with voltage**, 4510 **Fault current/voltage criterion**, 4530 **Low current/low active power criterion**, 4540 **Low power factor criterion** all may simultaneously appear under the parameter setting page of **Remote Trip Protection**; and the left four items are the settings of **Overvoltage Protection**. The following figure is a DIGSI control word configuration interface:

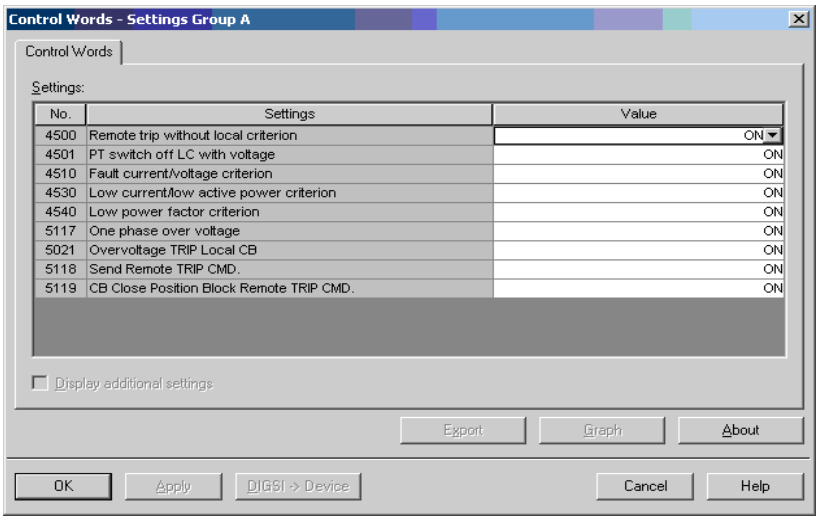


Figure 2-2 DIGSI Control Word Interface

The setup ranges of the control word and the soft linking piece are correspondingly as follows:

Type	Protection Function	Setting Name
Control Word	Remote Trip Protection	Failure Current Voltage Pickup
		Low Current Low Active Power Pickup
		Low Power Factor Pickup
		Remote Trip not via Fault Criterion
		PT Broken Wire OFF Voltage Dependence Local Criterion
	Overvoltage Protection	Overvoltage One-Out-Of-Three Mode
		Local Side Circuit Breaker Trip upon Overvoltage
		Overvoltage Pickup Remote Trip
		Overvoltage Remote Trip is blocked via Trip Position
Soft Linking Piece	Remote Trip Protection	Remote Trip Protection
	Overvoltage Protection	Overvoltage Protection
	Remote Setting Modification	Remote Setting Modification

2.1.1.3 Information List

No.	Information	Type of Information	Comments
-	>Back Light on	SP	>Back Light on
-	>Reset LED	IntSP	>Reset LED
-	>DataStop	IntSP	>Stop data transmission
-	Test mode	IntSP	Test mode
-	Feeder gnd	IntSP	Feeder GROUNDED
-	Brk OPENED	IntSP	Breaker OPENED
-	HWTestMod	IntSP	Hardware Test Mode
-	SynchClock	IntSP_Ev	Clock Synchronization
-	Distur.CFC	OUT	Disturbance CFC
1	Not configured	SP	No Function configured
2	Non Existent	SP	Function Not Available
3	>Time Synch	SP_Ev	>Synchronize Internal Real Time Clock
5	>Reset LED	SP	>Reset LED
15	>Test mode	SP	>Test mode
16	>DataStop	SP	>Stop data transmission
51	Device OK	OUT	Device is Operational and Protecting
52	ProtActive	IntSP	At Least 1 Protection Funct. is Active
55	Device Reset	OUT	Device Reset
56	Initial Start	OUT	Initial Start of Device
67	Resume	OUT	Resume
68	Clock Synch. Error	OUT	Clock Synchronization Error
69	DayLightSavTime	OUT	Daylight Saving Time
70	Settings Calc.	OUT	Setting calculation is running
71	Settings Check	OUT	Settings Check
72	Level-2 change	OUT	Level-2 change
110	Event Lost	OUT_Ev	Event lost
113	Flag Lost	OUT	Flag Lost
125	Chatter ON	OUT	Chatter ON

No.	Information	Type of Information	Comments
140	Error Sum Alarm	OUT	Error with a summary alarm
144	Error 5V	OUT	Error 5V
145	Error 0V	OUT	Error 0V
146	Error -5V	OUT	Error -5V
147	Error PwrSupply	OUT	Error Power Supply
160	Alarm Sum Event	OUT	Alarm Summary Event
177	Fail Battery	OUT	Failure: Battery empty
178	I/O-Board error	OUT	I/O-Board Error
181	Error A/D-conv.	OUT	Error: A/D converter
183	Error Board 1	OUT	Error Board 1
191	Error Offset	OUT	Error: Offset
192	Error1A/5Awrong	OUT	Error:1A/5Ajumper different from setting
193	Alarm adjustm.	OUT	Alarm: Analog input adjustment invalid
194	Error neutralCT	OUT	Error: Neutral CT different from MLFB
220	CT Ph wrong	OUT	Error: Range CT Ph wrong
301	Pow.Sys.Flt.	OUT	Power System fault
302	Fault event	OUT	Fault event
303	sens Gnd flt	OUT	sensitive Ground fault
320	Warn Mem. Data	OUT	Warn: Limit of Memory Data exceeded
321	Warn Mem. Para.	OUT	Warn: Limit of Memory Parameter exceeded
322	Warn Mem. Oper.	OUT	Warn: Limit of Memory Operation exceeded
323	Warn Mem. New	OUT	Warn: Limit of Memory New exceeded
502	Relay Drop Out	SP	Relay Drop Out
510	Relay CLOSE	SP	General CLOSE of relay
545	PU Time	VI	Time from Pickup to drop out
546	TRIP Time	VI	Time from Pickup to TRIP

2.1.2 Power System Data 1

2.1.2.1 General

The protection device requires certain basic parameters regarding the protected equipment so that the device can adapt to its desired application. These may be, for instance, the rated value parameters of the power system and the transformer etc. There are also some parameters that are common to all functions, i.e. not associated with a specific protection, control or monitoring function. The following section discusses these parameters.

2.1.2.2 Setting Notes

General

The data can be entered at a panel embedded in the protection device or an external user operating panel connected to the protection device. Press the MENU key to open the Main Menu. Apply ◀ to select ETTINGS , and then press the▶to navigate to the SETTINGS display. To enter the Power System Data, select the P.System Data 1 in the SETTINGS menu.

In DIGSI, doubleclick SETTINGS to display relevant selection. A dialog box with tabs Power System, CT Parameters, PT Parameters and Soft Linking Piece will open under P.System Data 1 in which you can configure the individual parameters. The following descriptions are therefore structured accordingly.

Rated Values of Current Transformer (CT)

At addresses 204 **CT Rated Primary Current** and address 205 **CT Rated Secondary Current**, information can be entered regarding the transformation ratio of the current transformer. It must be ensured that the secondary current rated value of the transformer matches the set current rated value, otherwise an offset of the primary current value calculated in protection may occur. At addresses 217 **IE-CT rated primary current** and 218 **IE-CT rated secondary current,** information is entered regarding the primary and secondary current ratio of the current transformer. In case of a normal connection (polar end connected to In of the transformer), address 217 **IE-CT rated primary current** and address 204 **CT Rated Primary Current** must be set to the same value.

Rated Values of Voltage Transformer (PT)

At addresses 202 **Rated Primary Voltage**, information can be entered regarding the primary rated voltage of the connected voltage transformer. The Secondary Rated Voltage (phase-to-phase voltage) is set to 100V in default.

Soft Linking Piece

When the Remote Trip Protection function or the Overvoltage Protection function needs to be switched on/off, the operation can be performed through the soft linking piece, including settings of the following three functions: 0045 **Remote transfer trip function**, 0050 **Overvoltage Protection**, and 0650 **Remote Access enable**. The control options of the soft linking piece cannot be changed by the setting group . Please refer to 2.1.1.2.

2.1.2.3 Settings

The table indicates region-specific presettings. The configuration column indicates the corresponding secondary rated current of the current transformer.

Addr.	Parameter	Configuration	Setting Options	Default Setting	Comments
0045	Remote Trip		ON, OFF	ON	Remote Transfer Trip Function
0050	FCT 59		ON, OFF	ON	59 Overvoltage Protection
0650	Remote Access		YES/NO	NO	Remote Access enable
202	Vnom PRIMARY		1.0 .. 1200.00 kV	220.0 kV	Rated Primary Voltage
204	CT PRIMARY		1 .. 9999A	1200 A	CT Rated Primary Current
205	CT PRIMARY		1A ,5A	1A	CT Rated Primary Current
217	Ignd-CT PRIM		1 .. 9999 A	1200 A	Ignd-CT rated primary current
218	Ignd-CT SEC		1A ,5A	1A	Ignd-CT rated secondary current

2.1.3 Fault Recording

The Multi-Functional Protection Device 7SJ689 is equipped with a fault record memory, which records, in addition to measured instantaneous values ia, ib, ic, in and ua, ub, uc, 3· u0, Negative Sequence Current I2, Negative Sequence Voltage U2, Three-Phase Power Factor Phase Angle PF, Three-Phase Active Power P and Remote Trip Signal. These parameters are acquired at intervals of 1.25 ms(50 Hz) and stored in a buffer region (16 sample points per cycle). The storage time of the information of a fault is adjustable within 5 seconds. The supportable maximum storage time is 10 s, and the longest storage time of a single record signal is 1s in default. Up to 8 fault records can be recorded in the buffer region. The fault record memory is automatically updated with every new fault, so that there is no acknowledgment for previously recorded faults required. In addition to protection pickup, the fault record can also be started via the input and the serial port.

2.1.3.1 General

The record data can be connected to a personal computer via the serial ports, read through the protection data processing software DIGSI and analyzed by the graphic analysis software SIGRA 4. The latter may graphically represent the data recorded during the fault and also calculate a lot of additional information from the measured values. Signals can be additionally recorded as binary marks, e.g. "pickup", "trip".

A device having a serial system interface is capable of transmitting the recorded fault data to a control centre via the port. The data can be processed by application programs in a central device. The current values and the voltage values are referred to their maximum values, scaled to their rated values and prepared for graphic representations. The binary signal mark, e.g. "fault detection", "trip", of a special event also can be graphically displayed.

Transfer to the central device can be polled automatically, either after each fault detection, or only after a trip.

Note

The signals used for binary tracks can be configured in DIGSI.

The fault recording (waveform capture) is started upon the pickup of the protection function. The relevant parameters of the recording waveform are referred to the following:

Parameter	Default
WAVEFORMTRIGGER	Protection Pickup Trigger and Storage of Records
WAVEFORM DATA	Power System fault
MAX. LENGTH	1.00 sec
PRE. TRIG. TIME	0.25 sec
POST REC. TIME	0.10 sec
BinIn CAPT.TIME	0.50 sec

2.1.3.2 Information List

No.	Information	Type of Information	Comments
-	FltRecSta	IntSP	Fault Recording Start
4	>Trig.Wave.Cap.	SP	>Trigger Waveform Capture
203	Wave. deleted	OUT_Ev	Waveform data deleted
30053	Fault rec. run.	OUT	Fault recording is running

2.1.4 Setting Goups

Up to four independent setting groups can be created for establishing the device's function settings.

Applications

- Setting groups enable the user to save the corresponding settings for each application so that the settings can be quickly called up when required. All setting groups are stored in the device. Only one setting group may be active at a specific time.

2.1.4.1 General

Changing Setting Groups

During operation the user can switch the setting groups, via the human-machine interface of the device, inputs (if so configured), the service interface of a personal computer or the system interface. For reasons of the safety, it is not possible to change between the setting groups during a power system fault.

A setting group includes the setting values for all functions. While setting values may vary, the selected functions of any setting group remain the same.

2.1.4.2 Setting Notes

General

In the 7SJ689 device, there are four setting groups (from A to D). The function parameters of the setting groups from A to D can be set one by one. At most four groups can be set.The SIPROTEC 4 System Description gives further information on how to copy the setting groups or reset them to their status at delivery and also how to change from one setting group to another.

Subsection 3.1 of the manual3.1 tells you how to change between the setting groups via inputs.

2.1.4.3 Setting Groups

Addr.	Parameter	Setting Options	Default Setting	Comments
302	CHANGE	Setting Group A	Setting Group A	Change to Another Setting Group
		Setting Group B		
		Setting Group C		
		Setting Group D		
		Inputs		
		Protocol		

2.1.4.4 Information List

No.	Information	Type of Information	Comments
-	P-GrpA act	IntSP	Setting Group A is active
-	P-GrpB act	IntSP	Setting Group B is active
-	P-GrpC act	IntSP	Setting Group C is active
-	P-GrpD act	IntSP	Setting Group D is active
7	>Set Group Bit0	SP	>Setting Group Select Bit 0
8	>Set Group Bit1	SP	>Setting Group Select Bit 1

2.1.5 Power System Data 2

2.1.5.1 General

The system data (Power System Data 2) includes all function settings. In contrast to the Power System Data 1 as discussed before, the settings can be changed with the setting group.

2.1.5.2 Setting Notes

Definition of Rated Values

Address1101 **Measurement: Full Scale Voltage (100%)** and 1102 **Measurement: Full Scale Current (100%)**, the primary reference voltage (Phase-to-Phase) and reference current (phase) of the protected equipment can be entered. If these reference values match the primary rated values of the PT and CT, the values correspond to the settings in address 202 and 204 (referring to Subsection 2.1.2.2). The values are generally displayed in the form of actual values.

2.1.5.3 Settings

The table indicates region-specific presettings. The configuration column indicates the corresponding secondary rated current of the current transformer.

Addr.	Parameter	Configuration	Setting Options	Default Setting	Comments
1101	FullScaleCurr.		1.0 .. 1200.0 kV	220.0 kV	Measurem:FullScaleCurrent(Equipm.rating)
1102	FullScaleVolt.		1 ..9999A	1200 A	Measurem:FullScaleVoltage(Equipm.rating)

2.1.5.4 Information List

No.	Information	Type of Information	Comments
126	Protection ON/OFF	IntSP	Protection ON/OFF (via system port)
356	>Manual Close Signal	SP	>Manual close signal
501	Protection Pickup	OUT	Relay PICKUP
511	Protection General Trip Command	OUT	Relay GENERAL TRIP command
533	Ia :	VI	Primary fault current Ia
534	Ib :	VI	Primary fault current Ib
535	Ic :	VI	Primary fault current Ic
561	Manual Close Signal Detected	OUT	Manual close signal detected
4601	>Brk Aux NO	SP	>Breaker contact (OPEN, if bkr is open)
4602	>Brk Aux NC	SP	>Breaker contact(OPEN, if bkr is closed)

2.2 Remote Trip Protection

2.2.1 Application

In case of an overvoltage of the opposite side of the line, a failure of the circuit breaker or a fault of a reactor without independent circuit breaker, a remote Tripping signal can be always sent out through a remote protection system, so that the functions in local device trip the local circuit breaker according to the settings after receiving the remote trip signal.

2.2.2 Remote Tripping Local Criterions

The remote tripping function of the device includes three local criterion groups: Fault Current Voltage Criterions, Low Current Low Active Criterions and Low Power Factor Criterions, and each criterion group can be decided to be ***ON*** or ***OFF*** through the setting of the control word.

The Fault Current Voltage Criterions include elements, e.g. delta current, Zero Sequence Current, Negative Sequence Current, Zero Sequence Overvoltage And Negative Sequence Overvoltage, etc.;

The Low Current Low Active Criterions include a Low Current element and a Low Active Power element.

The Low Power Factor Criterions includes a Low Power Factor element.

2.2.2.1 Zero Sequence Current

When the Zero Sequence Current 3I0(calculated value, 3I0=Ia+Ib+Ic) is greater than the **4512 3I0 pickup**, The annunciation ***17466 3I0 picked up*** is issued in 40 ms, and the Zero Sequence Current Criterion will be automatically OFF after CT wire break.

2.2.2.2 Negative Sequence Current

When the negative sequence current I_2 is greater than the **4513 I2 pickup**,the annunciation ***17467 I2 picked up*** is issued in 40 ms and the Negative Sequence Current Criterion will be automatically OFF after CT wire break.

2.2.2.3 Zero Sequence Voltage

When the Zero Sequence Voltage $\mathbf{3U_0}$ (calculated value, $\mathbf{3U_0=U_a+U_b+U_c}$) is greater than the **4514 3U0 pickup**, the annunciation ***17468 3U0 picked up*** is issued in 40 ms and the Zero Sequence Voltage Criterion is automatically OFF after PT wire break.

2.2.2.4 Negative Sequence Voltage

When the negative sequence voltage $\mathbf{U_2}$ is greater than the **4515 U2 pickup**, the annunciation ***17469 U2 picked up*** is issued in 40 ms and the Negative Sequence Voltage Criterion will be automatically OFF after PT wire break.

2.2.2.5 Delta Current

A delta current element measures the amplitude of a phase-to-phase current variation according to the following criterions:

$\Delta I_{\Phi\Phi} > 1.25\Delta I_T + \Delta I_{SET}$

$\Delta I_{\Phi\Phi}$ is the calculated phase-to-phase current change,
it is a half-wave integral of $\Delta i_{\Phi\Phi}(t) = i_{\Phi\Phi}(t) - i_{\Phi\Phi}(t - 2T)$

ΔI_T is the floating threshold,

$\Delta I_T = \Delta I_{\Phi\Phi}(t - T/2) - \Delta I_{\Phi\Phi}(t - T)$

ΔI_{SET} is the setting value of the parameter **4511 Delta I pickup**

T is a cycle period

$_{\Phi\Phi}$ Phase-to-phase AB,BC or CA

The Delta Current criterion works on three phase-phase currents respectively.

When the criterion is fulfilled on a phase-phase current, the related pickup signal will be released. The pickup signals include ***17470 Delta IAB PU***, ***17471 Delta IBC PU*** and ***17472 Delta ICA PU***. And the released pickup signal(s) will be latched for 5S automatically. The details of the pickup logics are shown in below figure.

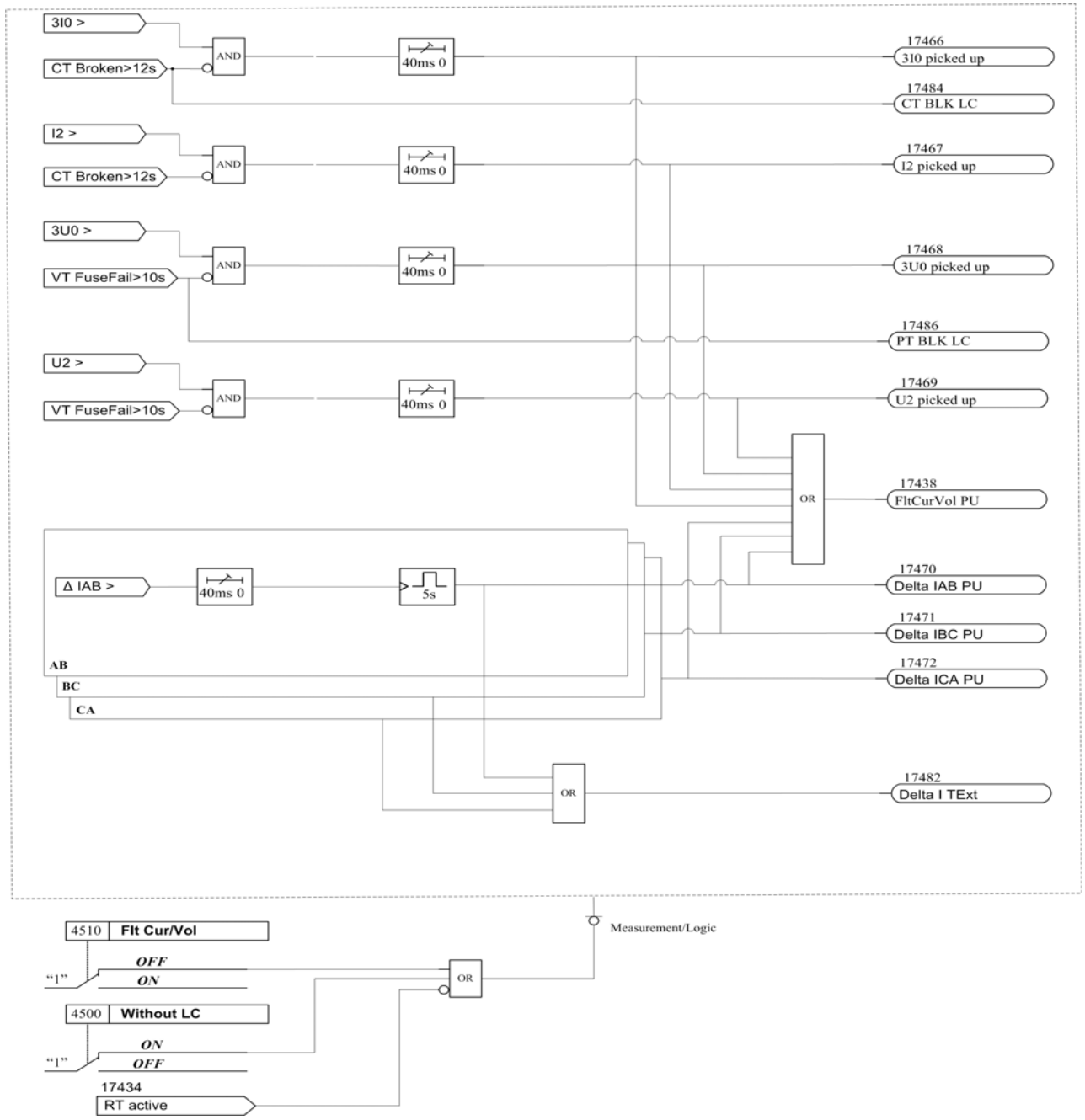


Figure 2-3 Fault Current Voltage Criterions

2.2.2.6 Low Current

When the current of any phase is lower than the **4531 Low current pickup**, the annunciation ***17473 IA picked up***, ***17474 IB picked up*** and ***17475 IC picked up*** are issued in **40 ms.** When the **4531 Low current pickup** is set to 0, the Low Current element is switched off, and the Low Current Criterion will be *OFF* after the CT wire break.

2.2.2.7 Low Active Power

When the active power of any phase is satisfied $|UI\cos\Phi| < P_{SET}$

, (P_{SET} is **4532 Low active power pickup**), the annunciation ***17476 PA picked up***, ***17477 PB picked up*** and ***17478 PC picked up*** are issued in **40 ms**. When the **4532 Low active power pickup** is set to 0, the Low Active Power element is switched off.

When the current of a phase is lower than $\mathbf{0.03I_N}$ or the voltage of the phase is lower than $\mathbf{0.3U_N}$, the Low Active Power element of the phase will be switched off. The Low Active Power Criterions of three phases will be OFF after the PT wire break.

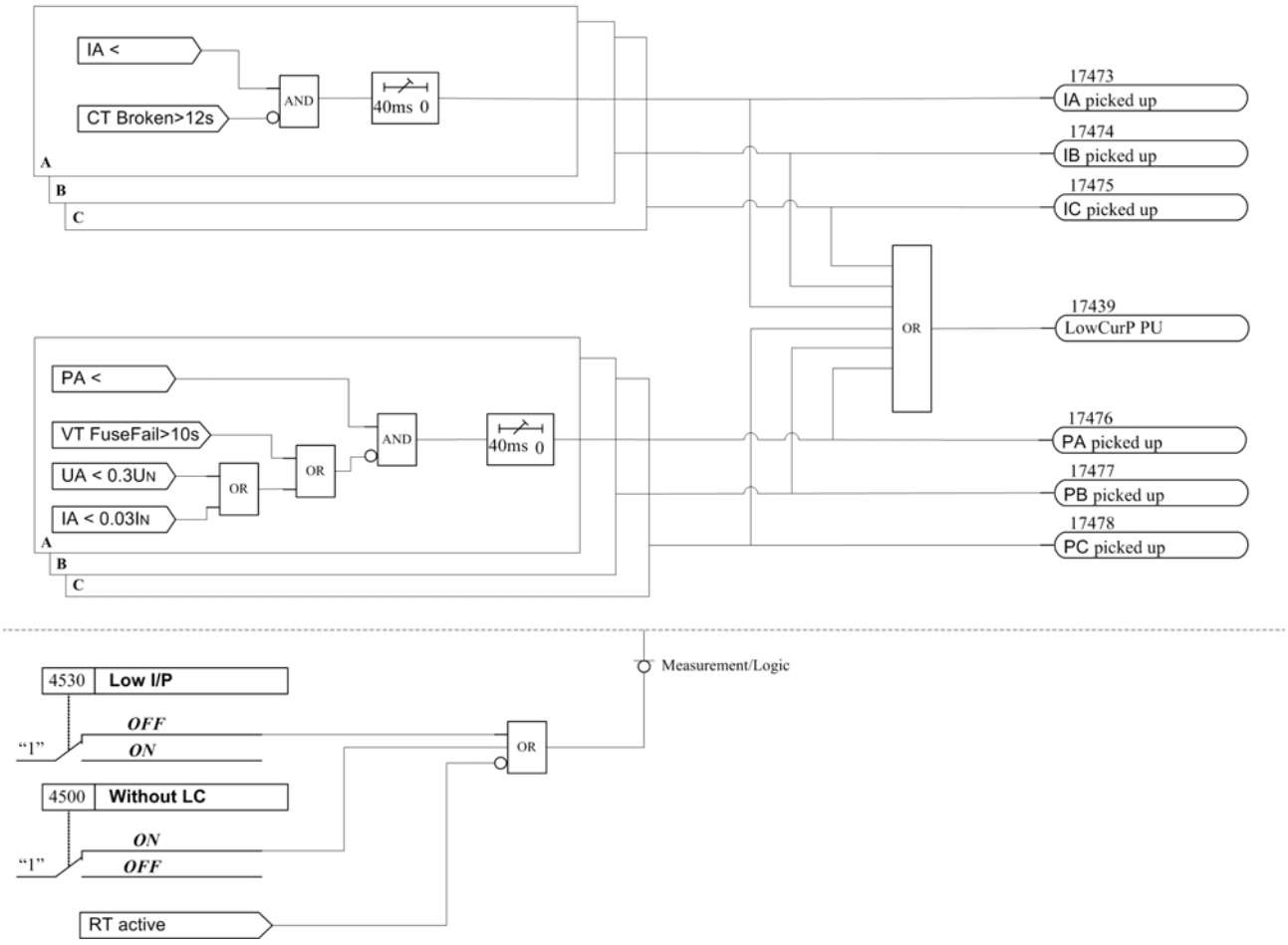


Figure 2-4 Low Current Low Active Power Criterions

2.2.2.8 Low Power Factor

When the power factor of any phase is satisfied

$$|\cos\Phi| < \cos\Phi_{SET}$$

Provided that φ_{SET} is the **4541 Low power factor pickup**, the annunciation ***17479 PFA picked up*** , ***17480 PFB picked up*** and ***17481 PFC picked up*** are issued in **40 ms**. When the ***4541 Low power factor pickup*** is set to **90** degrees, the Low Power Factor element is switched off.

During normal operation, when the voltages of three phases are all lower than $\mathbf{0.3U_N}$ or the currents are lower than $\mathbf{0.05I_N}$, the Low Power Factor element of the corresponding phase is switched on. The Low Power Factor Criterions will be OFF after the PT wire break.

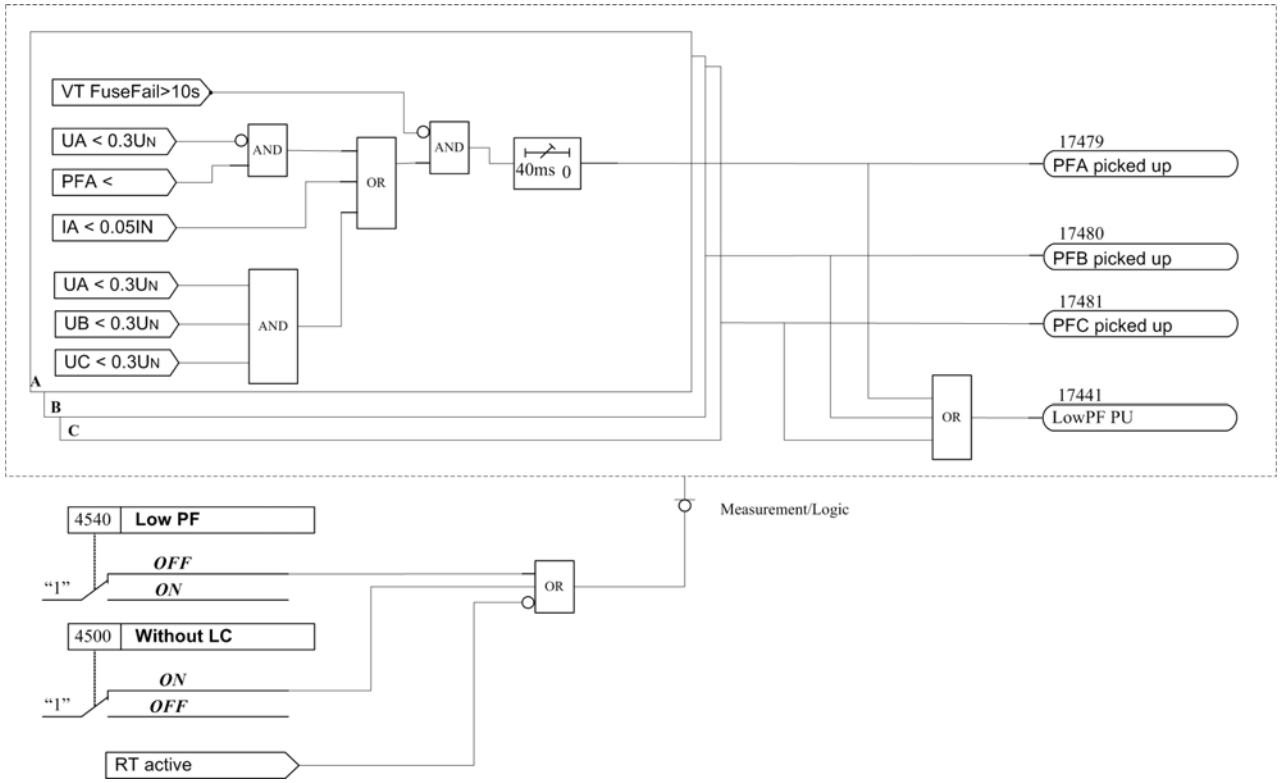


Figure 2-5 Low Power Factor Criterions

2.2.3 Remote Tripping Logic

2.2.3.1 Remote Tripping Signal

In case of an overvoltage of the opposite side of the line, a failure of the circuit breaker or a fault of a reactor without independent circuit breaker, a remote tripping signal can be always sent out through a remote protection system, so that the device trips the local circuit breaker according to the corresponding local criterion action relay after receiving the remote tripping signal ***17431 >RT signal***.

If the device receives a channel fault signal ***17504 >FAIL:RMT.Sig***, Channel Receiving is blocked and an alarm signal ***17503 Error RMT.Sig*** is sent out; The Channel Receiving is restarted through a time delay of **200 ms** after the channel fault signal disappears.

When the receiving channel continues receiving for more than **10.1 s**, it is considered that the receiving channel is abnormal, and then an alarm signal is sent out while the channel receiving is blocked. The channel receiving is restarted through a time delay of **200ms** after the channel signal disappears.

2.2.3.2 Remote Tripping Logic

When **4500 Remote trip without local criterion** is set to ***OFF***, the Local Criterion is active. When any local criterion pickup signal ***17438 FltCurVol PU***, ***17439 LowCurP PU***, or ***17441 LowPF PU*** acts, and the remote Tripping signal ***17431 >RT signal*** is received, the Remote Tripping Protection is tripped via a **4502 Remote trip with criterion time delay** relay. If a PT broken wire fault occurs, and when the **4501 PT switch off LC with voltage** is set to ***ON***, The Remote Tripping Protection is switched OFF from the Zero Sequence Voltage, Negative Sequence Voltage, Low Active Power and Low Power Factor Criterions and turned to No Local Criterion Operating mode, and at this moment, if the ***17431 >RT signal*** is received, tripping is performed via a **4503 Remote trip without criterion time delay** relay. When the **4500 Remote trip without local criterion** is

set to ***ON***, and if the ***17431 >RT signal*** is received, tripping is performed via a **4503 Remote Trip nit via Fault Criterion Time** relay.

Trip Command Dropout Conditions:
1) Shortest Trip Command Holding Time(**0.15s**) to
2) **17431 *>RT signal*** disappears
3) the currents of three phases are all lower than the Breaker Close Current Criterion **($0.04I_N$)**
When the above conditions are satisfied simultaneously, the Trip Command is dropped out.

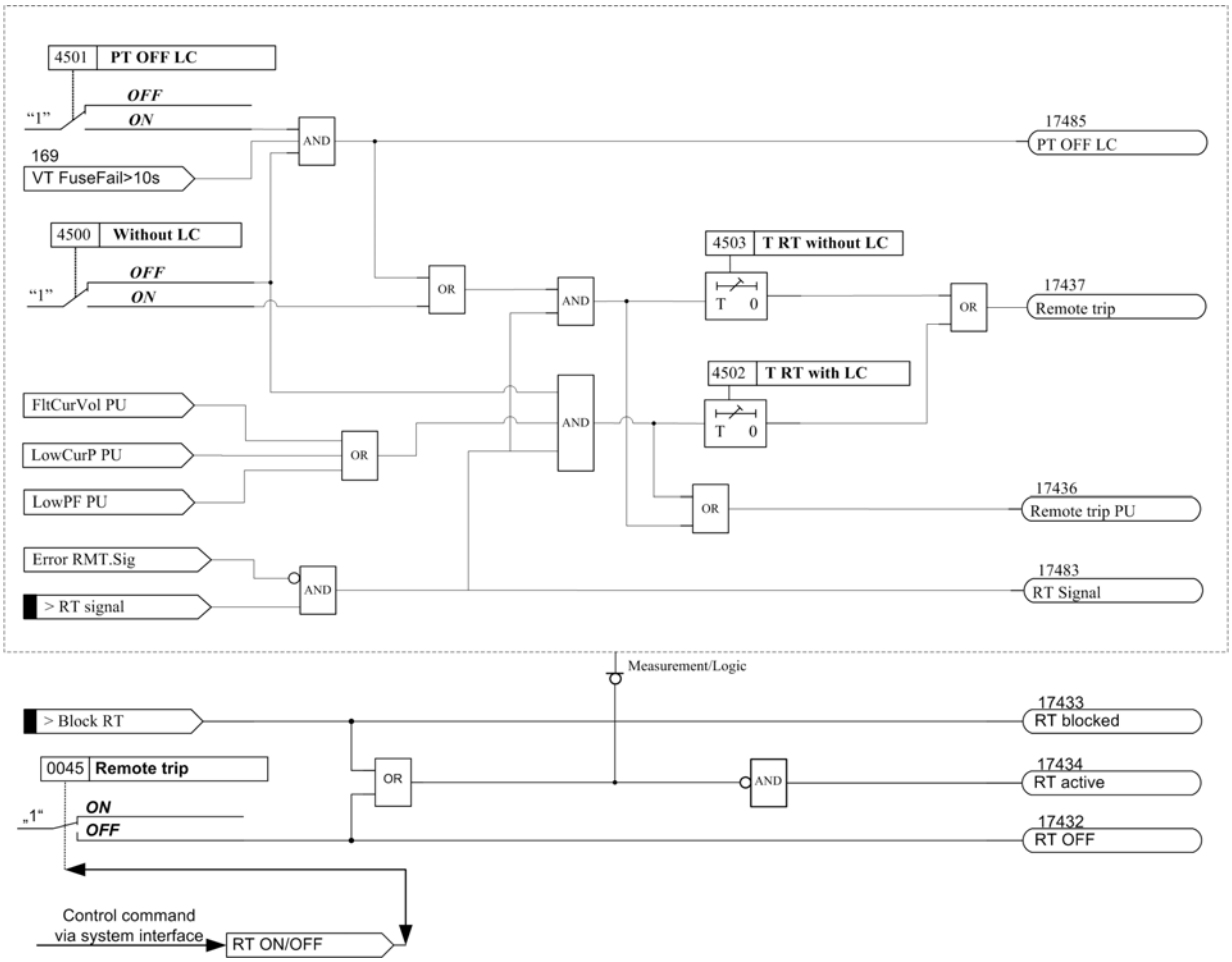


Figure 2-6 Remote Trip Logic

2.2.4 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
0045	Remote Trip	ON/OFF	ON	Remote Transfer Trip Function
4500	Without LC	ON/OFF	ON	Remote trip without local criterion
4501	PT OFF LC	ON/OFF	OFF	PT switch off LC with voltage

Addr.	Parameter	Setting Options	Default Setting	Comments
4510	Flt Cur/Vol	ON/OFF	OFF	Fault current/voltage criterion
4530	Low I/P	ON/OFF	OFF	Low current/low active power criterion
4540	Low PF	ON/OFF	OFF	Low power factor criterion
4511	Delta I pickup	0.05 - 0.50 A, ∞	0.20 A	Delta I pickup
4512	3I0 pickup	0.05 - 20.00 A, ∞	1.00 A	3I0 pickup
4513	I2 pickup	0.05 - 20.00 A, ∞	1.00 A	I2 pickup
4514	3U0 pickup	2.0 - 57.7 V, ∞	10.0 V	3U0 pickup
4515	U2 pickup	2.0 - 57.7 V, ∞	10.0 V	U2 pickup
4531	I pickup	0 , 0.05 - 0.50 A	0.05 A	Low current pickup
4532	P pickup	0 , 2.0 - 200.0 W	8.0 W	Low active power pickup
4541	PF pickup	30 ~ 90°	45°	Low power factor pickup
4502	T RT with LC	0.01 - 10.00 s	0.10 s	Remote trip with criterion time delay
4503	T RT without LC	0.01 - 10.00 s	0.20 s	Remote trip without criterion time delay

2.2.5 Information List

No.	Information	Type of Information	Comments
17430	>Block RT	SP	>Block remote trip
17431	>RT signal	SP	>Remote trip signal
17432	RT OFF	OUT	Remote trip is switched OFF
17433	RT blocked	OUT	Remote trip is blocked
17434	RT active	OUT	Remote trip is active
17440	Remote Trip	IntSP	Remote Transfer Trip Function
17442	wtLC ON/OFF	IntSP	Without local criterion ON/OFF
17444	FltIU ON/OFF	IntSP	Fault cur/vol ON/OFF
17446	LowCurPON/OFF	IntSP	Low current/P ON/OFF
17448	PF pickup	IntSP	Low power factor pickup
17466	3I0 picked up	OUT	3I0 picked up
17467	I2 picked up	OUT	I2 picked up
17468	3U0 picked up	OUT	3U0 picked up
17469	U2 picked up	OUT	U2 picked up
17470	Delta IAB PU	OUT	Delta IAB picked up
17471	Delta IBC PU	OUT	Delta IBC picked up
17472	Delta ICA PU	OUT	Delta ICA picked up
17473	IA picked up	OUT	Low current phase A picked up
17474	IB picked up	OUT	Low current phase B picked up

No.	Information	Type of Information	Comments
17475	IC picked up	OUT	Low current phase C picked up
17476	PA picked up	OUT	Low active power phase A picked up
17477	PB picked up	OUT	Low active power phase B picked up
17478	PC picked up	OUT	Low active power phase C picked up
17479	PFA picked up	OUT	Low power factor phase A picked up
17480	PFB picked up	OUT	Low power factor phase B picked up
17481	PFC picked up	OUT	Low power factor phase C picked up
17482	Delta I TExt	OUT	ExtTime of current change in progress
17483	RT Signal	OUT	Remote trip signal
17484	CT BLK LC	OUT	I0/I2/I/P/PF blocked after CT broken
17485	PT OFF LC	OUT	U0/U2/P/PF switched off after PT broken
17486	PT BLK LC	OUT	U0/U2/P/PF blocked after PT broken
17487	RT Sig. N. Cfg.	OUT	RT Signal not configured
17488	PTwtLC ON/OFF	IntSP	PT switched off LC ON/OFF
17436	Remote trip PU	OUT	Remote trip picked up
17437	Remote trip	OUT	Remote trip
17438	FltCurVol PU	OUT	Fault current/voltage picked up
17439	LowCurP PU	OUT	Low current/active power picked up
17441	LowPF PU	OUT	Low power factor picked up
17503	Error RMT.Sig	OUT	Error: remote signal command
17504	>FAIL:RMT.Sig	SP	>Failure: remote signal trip

2.3 Overvoltage Protection

2.3.1 Application

Abnormally high voltages often occur e.g. in low loaded, long distance transmission lines, in islanded systems when generator voltage regulation fails, or after full load shutdown of a generator from the system.

2.3.2 Overvoltage Logic

When the **5117 One phase over voltage** is ON, the Overvoltage Protection responds to any phase overvoltage; and when the **5117 One phase over voltage** is OFF, the Overvoltage Protection responds to the three phases of overvoltages. The dropout ratio of the overvoltage protection voltage element is **0.98**.

The 7SJ689 device responds to the overvoltage of the local end of the line. The protection sends out an alarm message or trips the local side circuit breaker via **5023 59 Time Delay.** Setting is established via the control word **5021 Overvoltage TRIP Local CB**. Besides, the Overvoltage Pickup Remote Trip function can be blocked via the position of the local side circuit breaker.

Logic Diagram

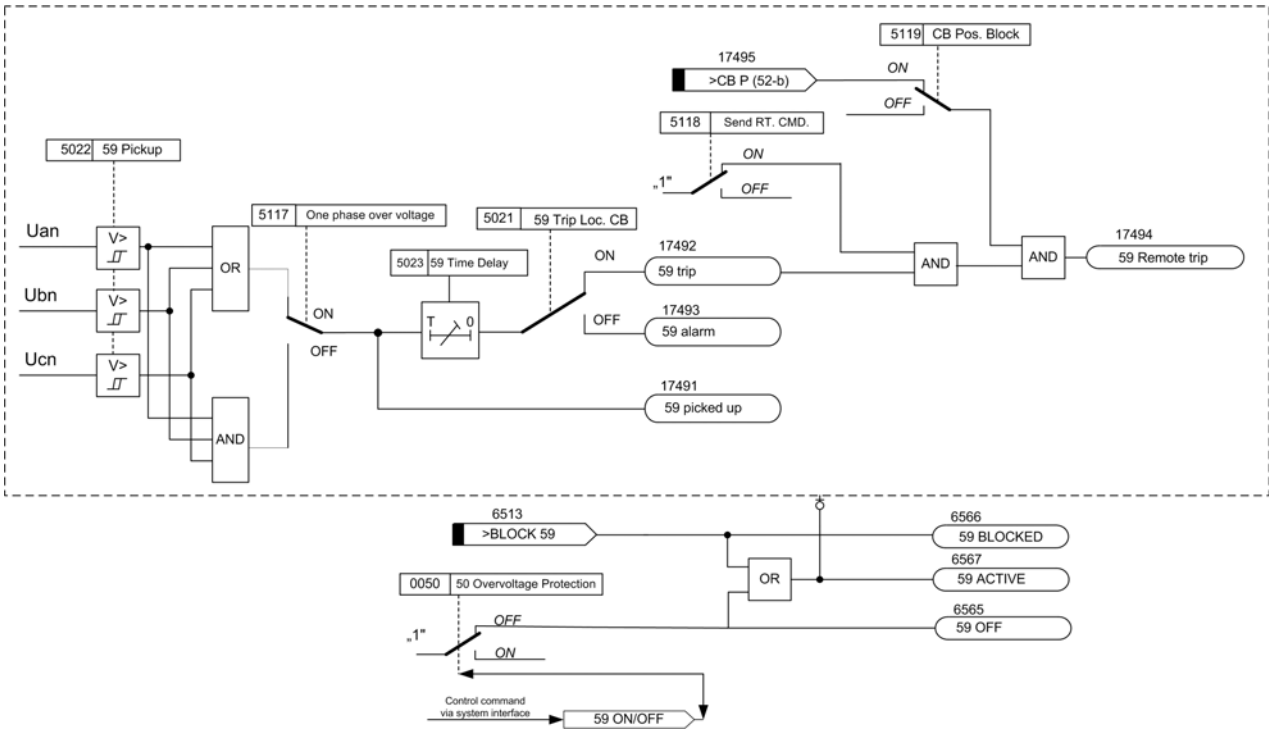


Figure 2-7 Overvoltage Protection Logic Diagram

After the Overvoltage Local Trip or Remote Trip of 7SJ689 device is triggered.

1, the minimum trip time is satisfied

2, there is no current in three phases

3, the overvoltage protection element is dropped out,
The trip command is dropped out.

The Overvoltage Pickup Remote Trip function can be blocked via the position of the local side circuit breaker. When the local side overvoltage element starts to trip the local circuit breaker, and **5118 Send Remote TRIP CMD** is set to ***ON***, Remote Trip is picked up if one of the following conditions is satisfied:

1, the local circuit breaker **TWJ** is closed, and the line has no current

2, **5119 CB Close Position Block Remote TRIP CMD** is set to ***OFF***

The **TWJ** auxiliary contacts of three phases are connected in series and then connected to the input contact of the ***17495 >CB P (52-b)*** of the device, see figure **2-8(A)**. For a half-switch wire connection, the respective TWJ auxiliary contacts of three phases of a side switch and a middle switch are connected in series with each other and then connected to the input of the ***17495 >CB P (52-b)*** of the device in a wire connection manner in accordance with figure **2-8(B)**.

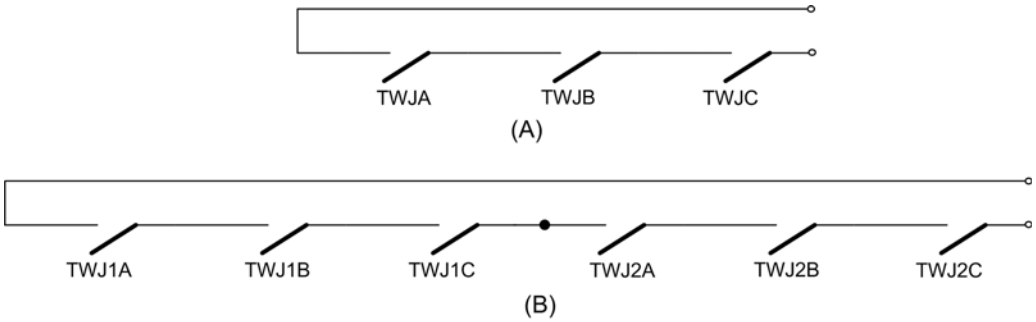


Figure 2-8 Logic Diagram of Tripping the Local Side Circuit Breaker in Overvoltage Protection

2.3.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
5021	59 Trip Loc. CB	ON OFF	ON	Overvoltage TRIP Local CB
5022	59 PICKUP	57.7 - 100.0 V	60 V	59 Pickup
5023	59 DELAY	0.01 - 10.00 sec	0.50 sec	59 Time Delay
5117	1pOV ON/OFF	ON OFF	ON	One phase over voltage ON/OFF
5118	Send RT. CMD.	ON OFF	ON	Send Remote TRIP CMD.
5119	CB Pos. Block	ON OFF	ON	CB Close Position Block Remote TRIP CMD.

2.3.4 Information List

No.	Information	Type of Information	Comments
6565	59 OFF	OUT	59-Overvoltage protection switched OFF
6566	59 BLOCKED	OUT	59-Overvoltage protection is BLOCKED
6567	59 ACTIVE	OUT	59-Overvoltage protection is ACTIVE
6513	>BLOCK 59	SP	>BLOCK 59 overvoltage protection
17435	1pOV ON/OFF	IntSP	One phase over voltage ON/OFF
17491	59 picked up	OUT	59 picked up

No.	Information	Type of Information	Comments
17492	59 trip	OUT	59 trip
17493	59 alarm	OUT	59 alarm
17494	59 Remote trip	OUT	59 Remote trip
17495	>CB P (52-b)	SP	>CB P (52-b) (OPEN, if bkr is closed)
17496	FCT 59	IntSP	59 Overvoltage Protection
17497	59trip ON/OFF	IntSP	59 trip local CB ON/OFF
17498	59RT ON/OFF	IntSP	Send remote trip CMD ON/OFF
17499	CBBLK ON/OFF	IntSP	CB block remote trip ON/OFF

2.4 Supervision Functions

2.4.1 Hardware Monitoring

Auxiliary and Reference Voltages

The processor voltage of 5 V DC is monitored by the hardware since the processor will no longer be functional if the voltage falls below the minimum value. In that case, the device is put out of operation. When the supply voltage returns, the processor system is restarted.

Failure of or switching off the supply voltage removes the device from operation and a message is immediately generated by a normally closed contact. Brief auxiliary voltage interruptions of less than 50 ms do not disturb the readiness of the device (for nominal auxiliary voltage > 110 VDC).

The processor monitors the offset and reference voltage of the ADC (analog-digital converter). The protection is suspended if the voltages deviate outside an allowable range, and lengthy deviations are reported.

Buffer Battery

The buffer battery, which ensures operation of the internal clock and storage of counters and messages if the auxiliary voltage fails, is periodically checked for charge status. If it is less than an allowed minimum voltage, then the „Fail:Battery“ message is issued.

Memory Components

All working memories (RAMs) are checked during startup. If a malfunction occurs then, the starting sequence is interrupted and an LED blinks. During operation the memories are checked with the help of their checksum. For the program memory, the cross sum is formed cyclically and compared to the stored program cross sum.

For the settings memory, the cross sum is formed cyclically and compared to the cross sum that is freshly generated each time a setting process takes place.

If a fault occurs the processor system is restarted.

Scanning

Scanning and the synchronization between the internal buffer components are constantly monitored. If any deviations cannot be removed by renewed synchronization, then the processor system is restarted.

AD Transformer Monitoring

The digitized sampled values are being monitored in respect of their plausibility. If the result is not plausible, message 181 „Error A/D -conv.“ is issued. The protection is blocked, thus preventing unwanted operation. Furthermore, a fault record is generated for recording of the internal fault.

Monitoring of the Hardware Modules

The device is able to recognize location and malfunctions of hardware modules during operation. In the event of a fault, messages "Error Board 1“ (FNo. 183) is initiated.

2.4.2 Software Monitoring

Watchdog

For continuous monitoring of the program sequences, a time monitor is provided in the hardware (hardware watchdog) that expires upon failure of the processor or an internal program, and causes a complete restart of the processor system.

An additional software watchdog ensures that malfunctions during the processing of programs are discovered. This also initiates a restart of the processor system.

If such a malfunction is not cleared by the restart, an additional restart attempt is begun. After three unsuccessful restarts within a 30 second window of time, the device automatically removes itself from service and the red „Error“ LED lights up. The readiness relay drops out and indicates „device malfunction“ with its normally closed contact.

Offset Monitoring

This monitoring function checks all ring buffer data channels for corrupt offset replication of the analog/digital transformers and the analog input paths using offset filters. Any possible offset errors are detected using DC voltage filters and the associated samples are corrected up to a specific limit. If this limit is exceeded, an annunciation is issued (191 ***Error Offset***) that is part of the warn group annunciation (annunciation 160). As increased offset values affect the reliability of measurements taken, we recommend to send the device to the OEM plant for corrective action if this annunciation continuously occurs.

2.4.3 PT Broken wire supervision

The device 7SJ689 has two PT broken wire associated signals: ***170 VT FuseFail*** and ***169 VT FuseFail>10s***. Their determination logic is as follows:

1) a failure voltage (zero sequence voltage 30V) appears while no failure current (zero sequence current 0.06A(In=1 A), 0.3 A(In=5 A)) is present, the ***170 VT FuseFail*** will be present instantaneously.

2) the voltages of three phases are all lower than 5 V while no failure current is present, the ***1170 VT FuseFail*** will be present instantaneously.

3)***170 VT FuseFail*** is present continously for 10 s, and after that the ***169 VT FuseFail>10s*** signal will be present.

4) ***170 VT FuseFail*** is instantaneously reset.

5) the signal ***169 VT FuseFail>10s*** is not reset instantaneously; and it disappears only after the signal ***170 VT FuseFail*** has disappeared for 10 s.

After the ***169 VT FuseFail>10s*** signal is present, the Zero Sequence Voltage, Negative Sequence Voltage, Low Active Power and Low Power Factor Local Criterions will be OFF.

2.4.4 CT Broken Wire Supervision

CT Broken Wire Detection

When the CT broken wire supervision function is active, and it is detected that the zero sequence current is greater than $0.1I_N$ and the current of any phase is lower than $0.06I_N$, **CT Broken** is switched ON. **CT**

Broken>12s is switched ON if the alarm is still present after 12S. The negative sequence current, zero sequence current and low current local criterions are switched off after CT wire break.

2.4.5 Information List

No.	Information	Type of Information	Comments
00169	VT FuseFail>10s	OUT	VT Fuse Failure (alarm >10s)
00170	VT FuseFail	OUT	VT Fuse Failure (alarm instantaneous)
17501	CT Broken>12s	OUT	CT Broken alarm >12s
17502	CT Broken	OUT	CT Broken(alarm instantaneous)
161	Fail I Superv.	OUT	Failure: General Current Supervision
6509	>FAIL:FEEDER VT	SP	>Failure: Feeder VT
6510	>FAIL: BUS VT	SP	>Failure: Busbar VT
162	Failure Σ I	OUT	Failure: Current Summation
163	Fail I balance	OUT	Failure: Current Balance
167	Fail V balance	OUT	Failure: Voltage Balance
197	MeasSup OFF	OUT	Measurement Supervision is switched OFF
255	Fail VT circuit	OUT	Failure VT circuit
259	VTsup. inactive	OUT	VT circuit supervision inactive

2.5 Device Logic

The function logic is used for adjusting the running of the protection function and auxiliary functions, which is further used for processing results and information sent out from the system. This mainly includes:

-Fault Check/Pickup Logic

-Processing Tripping Logic

2.5.1 Pickup Logic of the Whole Device

General Pickup

The general pickup signals of all protection functions of the device are connected by a logic or gate, which trigger the general pickup of the device. The general pickup is triggered upon the pickup of the first protection function and dropped out upon the dropout of the last protection function. At the general pickup of the device, information "Protection Pickup" will be displayed in Addr.501.

The general pickup of the device is the precondition of the pickup of most internal and external relevant functions. The general pickup may control the following internal functions:

- Pickup Tripping Logic: all fault information participates in the Tripping logic from the general pickup of the device to the general dropout thereof.
- Fault Recording Initialization: the storage and mountainous of fault recording also are the same dependent on the general pickup of the device.

Exception: apart from being set to ***ON*** or ***OFF***, some protection functions also can be set to ***Alarm Only***. If being set to ***Alarm Only***, neither Tripping command or Tripping logic is present, so that the fault recording is inactive and no fault record is displayed.

The general pickup of the device can also control the external functions with an output contact, for example:

- Automatic Reclose Device,
- Pickup Auxiliary Device, or similar devices.

2.5.2 Tripping Logic of the Whole Device

General Trip

The general pickup signals of all protection functions are connected by a logic or gate and information "Protection Trip" is generated in Addr.511.

The information can be defined on the LED indications or the binary output, which is the same as the trip information of other individual protections.

Termination of Trip Signal

Once the protection function outputs a trip command, "Protection General Trip Command" information will be present (see figure2-9). Meanwhile, the Shortest Trip Command Holding Time **and the Shortest Trip Command Duration Time** are picked up. The Shortest Trip Command Holding Time can ensure that there is enough time to transmit a tripping signal to a circuit breaker even though a function trigging the tripping signal is quickly dropped out. The tripping command can be terminated only when all protection functions are dropped out (no function is in the pickup mode) and after the Shortest Trip Command Holding Time expires.

Finally, the tripping signal can be held until manual reset (holding function). The circuit breaker thereby is allowed to be locked without coincidence until a fault reason is found out and the signal is manually reset. The manual reset can be realized through a Reset LED key or by activating a specific binary input (">Reset Indication Lamp"). Of course, the precondition is that the closing coil of the circuit breaker is as usual in an interlocking state during the presence of the tripping signal and that the current of its trip coil is blocked by the auxiliary contact of the circuit breaker.

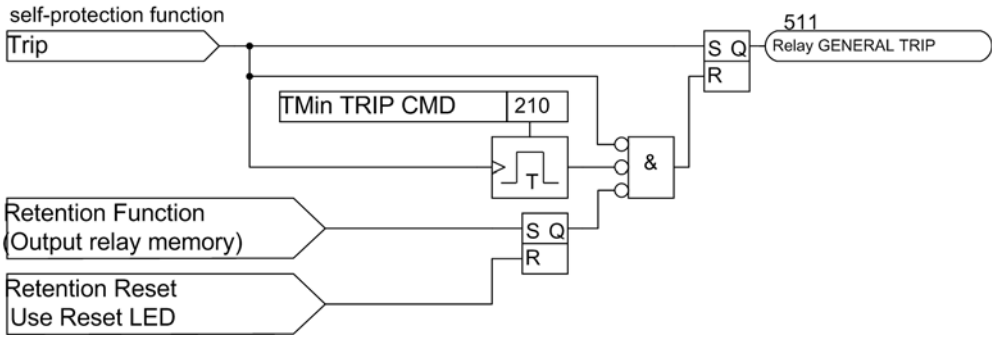


Figure 2-9 Termination of Tripping Signal

2.5.3 Setting Notes

Tripping Signal Duration Time

The settings of the Shortest Tripping Duration Time **and the Trip Command Duration Time** are suitable for all protection functions capable of picking up trip. For the 7SJ689 device, the default of the Shortest Trip Duration Time is 0.15s.

2.6 Auxiliary Functions

The chapter of Auxiliary Functions describes the common functions of the device.

2.6.1 Message Processing

After a system fault occurs, the response data and the measured data of the protection device will be stored for analysis in the future. For this reason, the device needs to perform Information Processing.

Applications

- LED Indication Display and binary Output (output device)
- Information Displayed through Display Panel or Personal Computer
- Information Transmitted to Control Centre

Preconditions

SIPROTEC 4 system description document gives the detailed description of the configuration process (see/1/).

2.6.1.1 LED Displays and Binary Output (Output Relays)

Important events and states can be displayed by means of the LED indications on the front panel of the device. In addition, the device also provides a relay device for remote information. All LED indications and binary outputs can be freely set for indicating certain explicit information. The device has a default setting at delivery. The appendix of the manual describes the delivery conditions and the configuration options in detail.

The operating modes of the relay device and the LED indications include two modes of self-holding and non-self-holding (each mode can be set independently).

Signal loss can be avoided at the lost of an auxiliary power supply in the self-holding state. The reset can be performed by the following method:

- Press the LED key on the device,
- Perform remote reset by means of a binary input,
- Perform reset via a serial port,
- Pick up automatic reset by a new pickup (if Addr.625A **LED Minimum Holding Time**is set to 0). If the Addr.625A is set to 0, regardless of pickup, the LED indication is always active.

The state indication information is not self-held. As the same, the reset can be activated after a criterion report is reset. This is suitable for the information of the supervision function and similar functions.

Green LED indication ("operating") shows that the device is in normal operation, and the LED indication cannot be reset. The indication is OFF if the microprocessor fails in self-check or an auxiliary voltage disappears.

When the auxiliary voltage is normal, but an internal fault of the device occurs, the red indication ("fault") is ON and the microprocessor may block the device.

2.6.1.2 Information on the Integrated Display (LCD) or Personal Computer

Time and state information can be read out from the display on the front panel of the device. A personal computer can be connected to the device via a PC interface on the front or a service interface on the rear, thereby reading information.

The device provides several event buffer regions for storing the operation information and the circuit breaker states. These buffer regions are supplied with power by a battery, in order to prevent the information from being lost along with the loss of the auxiliary voltage. The information can be displayed on LCD at any time through a key, or transmitted to the personal computer through a serial interface or a PC interface. The operation specification of reading information during operation is described in detail in System Description SIPROTEC 4.

Information Classification

Information Classification:

- Operating Information (event records); Information generated during the operation of the device: Information related to the states of the device functions, Measurement Data, Power System Data, Control Command Records and the like.
- Fault Information (trip records): the protection device is capable of storing the inforamtion of the last 8 network faults.

- "Statistic" Information: including a device pickup trip command counter, reclose command times and the values of BLOCK current and accumulated failure currents.

The device is capable of generating a complete list containing all information and relay functions. The maximum function scope can be found out in the appendix. All functions are associated with an information No.. Each transmissible information also has a piece of corresponding indication information.

Operating Information(Buffer: Event Records)

The operating information comprises the information related to the operating condition of the device during operation. About 200 pieces of information can be recorded in the device in a time order. The latest information is displayed at the end of the list. In case of memory overflow, the old information in the list may be covered with new information.

Fault Information(Buffer: Trip Records)

After a system fault occurs, important information related to the fault evolution process can be stored and played back, e.g. the pickup of the protection element or the trigger of the trip signal. The fault start time is marked by the absolute time of a system internal clock. A disturbance process is output with the relative time at the moment of the fault occurring, so that the fault duration time before Trip and time until the Trip Command Reset can be determined. Time Information Resolution is set to 1ms.

Stored Information

The information of the latest eight network faults can be retrieved and read. The nominal definition of the network fault refers to that the whole process from the detection of a fault to the final elimination of interference is a network fault. If the automatic reclose takes place, the network fault is ended by the last reclose trial. Therefore, the whole elimination process comprises a plurality of reclose trials, which only take up one trip record buffer region. In a network fault, the information of a plurality of faults may be generated (from the pickup of the first protection function to the dropout of the last protection function). Each fault event without automatic reclose represents a network fault.

A buffer is capable of recording 600 pieces of information in all. In case of the memory overflow of the buffer, the oldest data will be covered with the latest data.

General Interrogation

The current state of the SIPROTEC. 4 protection device can be read through the general interrogation retrieved by DIGSI. The general interrogation displays the current values of all information.

Spontaneous Information

The current state of the introduced information can be reflected through the spontaneous information displayed by DIGSI. Each new introduced information may be displayed immediately, that is to say, the user has no need to wait its update and pickup.

2.6.1.3 Information to Control Center

If the device is provided with a serial interface, the stored information can be transmitted to a central control and storage device through the interface. The transmission can be achieved via different transmission protocols.

2.6.2 Statistics

The statistics include the trip times of the pickup of the 7SJ689 protection device and the number of its on-load operation hours. In addition, a further counter is provided which is capable of measure the number of hours of the circuit breaker being in the "OPEN" state. More statistical data can be obtained by taking full advantage of the time interval of the maintenance of the circuit breaker.

The counter and the memory can still operate reliably after losing the auxiliary power supply.

During the first pickup of the protection device, the statistical data is preset to zero.

2.6.2.1 General

Number of Trips

In order to count the number of trips of the 7SJ689 protection device, the position of the circuit breaker must be monitored through the auxiliary contact of the breaker and by means of the binary input of the 7SJ689 protection device. Therefore, the internal pulse counter must be assigned to the binary input under the control of the open state of the circuit breaker in a matrix. If only the option "Measured and Metered Values Only" is active in the configuration matrix, the pulse count value "Total Number of Trip" can be found out in the "statistic table".

Total Number of Operating Hours

The total number of operating hours under the on-load condition is also stored (when the current value of at least one phase is greater than the Circuit Breaker Close Current Criterion set in the Addr.212 , the default of the close current in the 7SJ689 device is 0.04IN).

"Circuit Breaker Open" Hour Number Statistics

A CFC application program is capable of performing counting of statistic similar to the number of operating hours, thus counting the number of hours of the "Ciruict Breaker Open" state. A general hour number counter is connected to a corresponding binary input. Counting is started if the corresponding binary input is activated. Meanwhile, the counter is selected to be picked up while being lower than the current threshold defined in the parameter **212 BkrClosed I MIN**. The counter can be set and reset. An application example for this type of counter can be obtained on the Internet (SIPROTEX Download Zone).

2.6.2.2 Setting Notes

Read/Setting/Reset Counter

he SIPROTEC 4 system specification describes how to read the statistical counter through the front panel of the device or DIGSI. In the menu option **Record > Statistics**, the statistical counter is set and reset through a counter value which is rewritten and displayed.

2.6.2.3 Information List

No.	Information	Type of Information	Comments
-	#of TRIPs=	PMV	Number of TRIPs=
409	>BLOCK Op Count	SP	>BLOCK Op Counter
1020	Op.Hours=	VI	Counter of operating hours
1021	Σ Ia =	VI	Accumulation of interrupted current Ph A
1022	Σ Ib =	VI	Accumulation of interrupted current Ph B
1023	Σ Ic =	VI	Accumulation of interrupted current Ph C

2.6.3 Measurement

A series of measured values and the derived quantities thereof can be used for field interrogation or data remote transmission.

Applications

- Information of System Actual Condition
- A secondary value is converted into a primary value and a percent

Preconditions

The protection device is further capable of displaying the primary values and the percents of the measured values in addition to the secondary values thereof.

The precondition of displaying the primary values and the percents correctly is complete and correct input of the rated values of the transformer. Moreover, the protection device further requires the transformation ratios of CT and PT during the configuration of the device. The following table shows a formula for converting a secondary value into a primary value and a percent.

2.6.3.1 Display of Measured Value

Table 2-1 Conversion Formula between Secondary Values and Primary Values/Percents

Measured Values	Secondary Values	Primary Values	%
I_a, I_b, I_c, I_1, I_2	I_{sec}	$\frac{\text{CT PRIMARY}}{\text{CT SECONDARY}} \cdot I_{sec}$	$\frac{I_{prim}}{\text{FullScaleCurr.}}$
$I_n = 3 \cdot I_0$ (calculated value)	$I_{n\,sec}$	$\frac{\text{CT PRIMARY}}{\text{CT SECONDARY}} \cdot I_{nsec}$	$\frac{I_{nprim}}{\text{FullScaleCurr.}}$
I_n (measured value)	$I_{n\,sec}$	$\frac{I_n\text{-CT PRIM}}{I_n\text{-CT SEC}} \cdot I_{n\,sec}$	$\frac{I_{nprim}}{\text{FullScaleCurr.}}$
I_{ns} (I_{nS} $I_{3I0real}$, $I_{3I0reactive}$,	$I_{nS\,sec.}$	$\frac{I_{ns}\text{-CT PRIM}}{I_{ns}\text{-CT SEC}} \cdot I_{ns\,sec}$	$\frac{I_{ns\,prim}}{\text{FullScaleCurr}}$
U_a, U_b, U_c, U_0, U_1, U_2, U_4	$U_{Ph\,sec.}$	$\frac{\text{Unom PRIM}}{\text{Unom SEC}} \cdot U_{ph\,sec}$	$\frac{U_{prim}}{\text{FullScaleVolt.}/(\sqrt{3})}$
U_{ab}, U_{bc}, U_{ca}	$U_{PhPh\,sec.}$	$\frac{\text{Unom PRIM}}{\text{Unom SEC}} \cdot U_{phph\,sec}$	$\frac{U_{prim}}{\text{FullScaleVolt.}}$
U_n	$U_{n\,sec.}$	$\text{Uph/Udelta} \cdot \frac{\text{Unom PRIM}}{\text{Unom SEC}} \cdot U_{n\,sec}$	$\frac{U_{prim}}{\sqrt{3} \cdot \text{FullScaleVolt.}}$
U_x	U_{xsec}	$\text{Uph/Udelta} \cdot \frac{\text{Unom PRIM}}{\text{Unom SEC}} \cdot U_{x\,sec}$	$\frac{U_{prim}}{\sqrt{3} \cdot \text{FullScaleVolt.}}$
P, Q, S (split phase)	No Secondary Measured Value		$\frac{\text{Power}_{prim}}{\sqrt{3} \cdot (\text{Full.Scal.Volt.}) \cdot (\text{Full.Scal.Curr.})}$
Power Factor (split phase)	cos φ	cos φ	cos φ · 100%
Frequency Protection	f Hz	f Hz	$\frac{f}{f_N} \cdot 100$

2.6.3.2 Transfer of Measured Values

The measured values can be transmitted to the control centre and a memory unit through a communication interface.

The measurement scopes of the values are transmitted according to protocols, and if necessary, subsequent additional settings are provided.

Protocol	Transmissible Measurement Scopes, Format
IEC 60870-5-103	Measured Values From 0 to 240 %
IEC 61850	The primary values measured are transmitted. The measured values and the format thereof are explained in PIXIT 7SJ manual. The measured values are transmitted in a "floating-point number" format. The measurement scopes transmitted are not affected by the measured values of the operation.

2.6.3.3 Information List

No.	Information	Type of Information	Comments
601	Ia	MV	Ia
602	Ib	MV	Ib
603	Ic	MV	Ic
604	In	MV	In
605	I1 =	MV	I1 (positive sequence)
606	I2 =	MV	I2 (negative sequence)
621	Va =	MV	Va
622	Vb =	MV	Vb
623	Vc =	MV	Vc
624	Va-b=	MV	Va-b
625	Vb-c=	MV	Vb-c
626	Vc-a=	MV	Vc-a
627	VN =	MV	VN
629	V1 =	MV	V1 (positive sequence)
630	V2 =	MV	V2 (negative sequence)
641	P =	MV	P (active power)
642	Q =	MV	Q (reactive power)
645	S =	MV	S (apparent power)
644	Freq=	MV	Frequency
831	3Io =	MV	3Io (zero sequence)
832	Vo =	MV	Vo (zero sequence)
901	Power factor	MV	Power Factor
30701	Pa =	MV	Pa (active power, phase A)
30702	Pb =	MV	Pb (active power, phase B)
30703	Pc =	MV	Pc (active power, phase C)
30704	Qa =	MV	Qa (reactive power, phase A)
30705	Qb =	MV	Qb (reactive power, phase B)
30706	Qc =	MV	Qc (reactive power, phase C)
30707	PFa =	MV	Power Factor, phase A
30708	PFb =	MV	Power Factor, phase B
30709	PFc =	MV	Power Factor, phase C

2.6.4 Set Points for Measured Values (statistic)

2.6.4.1 Description

A limit value can be set for a statistical counter, so that a piece of information is triggered immediately when the count of the counter reaches the limit value. The inform320ation is capable of driving the output of the device or displayed on LEDs.

2.6.4.2 Setting Notes

Limit Value Of Statistical Counter

The limit value of the statistical counter is performed in the submenu Threshold-Crossing Values (statistics) via the DIGSI. menu option Record → Statistics.The corresponding contents may be displayed in a new window

through doubleclicking. The preceding settings can be modified and covered (see SIPROTEC 4 System Specification).

2.6.4.3 Information List

No.	Information	Type of Information	Comments
-	Op Hours>	LV	Expiry of Total Number of Operating Hours
272	SP. Op Hours>	OUT	Set Point Operating Hours

2.6.5 Commissioning Tool

Data transmitted by the device to a master station computer system can be tested during testing or commissioning. A series of tools are used for testing the communication interface and the binary input/output interface of the device.

Applications

- Test Mode
- Commissioning

2.6.5.1 Description

Data transmitted to the SCADA system is tested in the test mode.

If the device is connected to a remote control master station through an SCADA communication interface, the information transmitted by the latter can be tested.

All information and measured values transmitted to the remote master station are attached with test mode flags if the device is tested in field (namely in the test mode) according to different transmission protocols. The flags are used for preventing the test information from being wrongly taken as the fault conditions of the actual system. A further optional operation is to block all information which is normally transmitted to the remote master station in the test mode.

Data Transmission Block also can be controlled by the binary inputs or set through the operating panel of the device, or set by a PC or the DIGSI software.

Detailed introductions on entering or quitting the test mode and blocking the data transmission are provided in the SIPROTEC 4 System Specification.

Check Communication Interface

If the device is equipped with a communication interface and is in communication with the remote master station, whether the information transmission is correct can be checked via the operation of DIGSI on the equipment.

All information transmitted to the communication interface via the configuration matrix may be displayed in a dialog box. In another column of the dialog box, the information can be set in a state expecting to be tested (e.g. ***ON***/***OFF***). A piece of information can be sent out by inputting command no.6 (according to a hardware test menu). The relevant information can be read through the event records of the SIPROTEC. 4 device, or read in the master station system.

The specific process is described in the chapter "Mounting and Commissioning".

Binary Input Output Check

The binary inputs and outputs and LED indications of the SIPROTEC. 4 device can be controlled by means of DIGSI. The function can be used for examining, for example, the connection condition of a cable between the device and substation equipment in the commissioning state.

The current states of all binary inputs and outputs and LE signals are displayed in a dialog box. Operating equipment, commands or information configured according to the hardware equipment are also displayed together. The state can be turned over in another column of the dialog box by inputting the command no.6. Therefore, each output device can be powered up to check the cable connection condition between the

protected equipment and the system without generating an alarm signal.

The specific process is described in the chapter "Mounting and Commissioning".

Generate Commissioning Recording Diagram

The equipment may be needed to be powered up during commissioning for testing the stability of protection in the close process. At this moment, the recording diagram or event records may provide detailed information of the protection actions and behaviors.

In the 7SJ689 device,recording and storage thereof can be triggered by an action of the protection element; and as the same, the same data can be recorded through a DIGSI command, the communication interface or the binary inputs. For a case where the recording is triggered by the binary inputs, the ">Trigger Recording event " must be associate with the binary inputs. At this moment, a trigger signal may be generated to trigger recording, for example, a binary is shifted to trigger recording when the protected equipment is powered up.

Recording further can be triggered through an external signal in stead of an internal protection element action. The processing process is the same as the internal trigger and has a sequential number. However, the record is not displayed in the fault records because the record is a system fault event.

The specific process is described in the chapter "Mounting and Commissioning".

■

Mounting and Commissioning 3

This chapter is intended for experienced commissioning staff. The related commissioning staff must be familiar with the commissioning of protection and control systems, the management of power systems and related safety rules and guidelines. Hardware configurations that may be required in specific cases are described in this chapter. Protected objects (lines, transformers, etc.) are required to carry load in tests on the primary side.

3.1 Mounting and Connections

General

Failure to observe these precautions can result in death, personal injury, or serious material damage.

Trouble-free and safe use of this device depends on proper transport, storage, installation, and assembly of the device according to the warnings in this device manual.

Of particular importance are the general installation and safety regulations for work in a high-voltage environment (for example, ANSI, IEC, EN, DIN, or other national and international regulations). These regulations must be observed.

3.1.1 Configuration Information

Preconditions

For mounting and connections, the following conditions must be satisfied:

The rated data of the device must be tested previously by a method recommended in SIPROTEC 4 System Description, and furthermore, the data should meet the requirements of power system parameters.

General Connection

Comprehensive diagrams for the protection device 7SJ689 are described in the appendix A.2. The corresponding connection examples of CT and PT circuits are shown in the appendix A.3 . The mounting configuration of the **power system parameter** 1(section2.1.3.2) will be checked to ensure the connection of the device is satisfied.

Voltage Connection Examples 7SJ689

The voltage connection examples are shown in the appendix A.3.

Binary Inputs and Outputs

The configuration options of the binary in- and outputs, i.e. the procedure for the individual adaptation to the plant conditions, are described in the SIPROTEC 4 System Description. The connections to the plant are dependent on this configuration. The presettings of the device are listed in Appendix [A.4]. Please also check that the labelling strips on the front panel correspond to the configured message functions.

Setting Group Change

If the setting groups are changed using binary inputs, please observe the following contents:

- Two binary inputs must be dedicated to the purpose of changing setting groups when four groups are to beswitched. One binary input must be set for ">Set Group Bit0", the other input for ">Set Group Bit1". If either of these input functions is not assigned, then it is considered as not controlled.

Setting Group Change

- For the control of 2 setting groups one binary input is sufficient, namely ">Set Group Bit0", since the non-assigned binary input ">Set Group Bit1" is then regarded as not connected.
- The control signals must be permanently active so that the selected setting group is and remains active.

The following table shows the allocation of the binary inputs to the setting groups A to D and a simplified connection diagram for the two binary inputs is illustrated in the following figure. The figure illustrates an example in which both Set Group Bits 0 and 1 are configured to be controlled (actuated) when the associated binary input is energized (high).

wherein:

NO = not energized or not connected

YES = energized

Table 3-1 Changing setting groups using binary inputs

Binary Input		Activated Group
>Setting Group 0	**>Setting Group 1**	
NO	NO	Setting Group A
YES	NO	Setting Group B
NO	YES	Setting Group C
YES	YES	Setting Group D

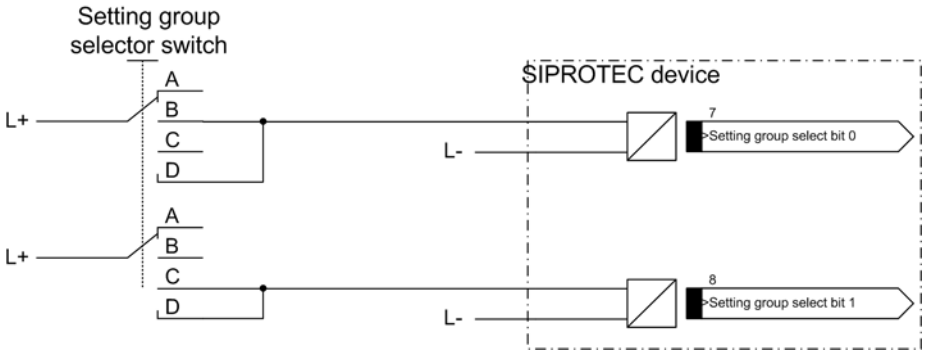


Figure 3-1 Connection Diagram (example) of changing setting groups using binary inputs

3.1.2 Hardware Modifications

3.1.2.1 General

Hardware modifications concerning, for instance, the control voltage for binary inputs or termination of serial interfaces might be necessary. Follow the procedure described in this section, whenever hardware modifications are carried out.

Auxiliary Voltage

The power supplies of the variants for DC 110 to 250 V, AC 115 to 230 V are largely interchangeable by modifying the position of the jumpers. The assignment of these jumpers to the nominal voltage ranges and their spatial arrangement on the PCB for the device 7SJ689 is described in the following sections. Location and ratings of the miniature fuse and the buffer battery are also shown. When the devices are delivered, these jumpers are set correctly according to the nameplate stickers and need not be altered.

Live Status Contact

The live contacts of devices 7SJ689 are changeover contacts.

Nominal Currents

The input transformers of the device are set to a nominal current of 1 A or 5 A by means of burden switching. The jumpers were positioned at the factory according to the specifications on the nameplate sticker. The assignment of the plug-in jumpers to the nominal current and the spatial arrangement of the jumpers are described in the following sections.

Jumpers X61, X62 and X63 must be set for the same nominal current, i.e. there must be one jumper for each input transformer, and the common jumper X 60.

With standard 1/5 A transformers, jumper X64 for the earth path is set to 1 A or 5 A irrespective of other jumper positions and depending on the ordered variant.

Note

If nominal current ratings are changed by way of exception, then the new ratings must be registered via the parameters 205 **CT SECONDARY** /218 **IN CT SEC** in the Power System Data (see Section 2.1.3.2).

Control Voltage for Binary Inputs

When the device is delivered from the factory, the binary inputs are set to operate with a voltage that corresponds to the rated DC voltage of the power supply. In general, to optimize the operation of the inputs, the pick-up voltage of the inputs should be set to most closely match the actual control voltage being used.

A jumper position must be changed to adjust the pickup voltage of a binary input. The assignment of the jumpers to the binary inputs and their spatial arrangement are described in the following sections.

Contact Mode for Binary Outputs

Input/output modules can have relays with changeover contacts which can be set as either NO or NC. To do so, the location of one jumper must be changed. To which relays of which modules this applies, is described in the following sections.

Exchanging Interfaces

The serial interface can only be replaced. The following section under margin heading „Rreplacing Interface Modules“ describes which interfaces can be exchanged, and how this is done.

Termination of Bus-capable Interfaces

If the device is equipped with a serial RS485 interface, they must be terminated with resistors at the last device on the bus to ensure reliable data transmission. For this purpose, terminating resistors are provided on the PCB of the CPU processor module and on the RS485 or PROFIBUS interface module which can be connected via jumpers. Here, only one option can be used. The physical arrangement of the jumpers on the PCB of the corresponding processor board CPU is described in the following sections under margin heading „Processor Board CPU“. The arrangement of the jumpers on the interface modules is described under margin heading „RS485/RS232“. Both jumpers must always be plugged identically.

The terminating resistors are disabled on delivery.

Spare Parts

Spare parts can be the buffer battery that provides for storage of the data in the battery-buffered RAM when the supply voltage fails, and the miniature fuse of the internal power supply. Their physical arrangement is shown in the figures of the processor boards. The ratings of the fuse are printed on the board next to the fuse. When exchanging the fuse, please observe the hints given in the SIPROTEC 4 System Description under „Maintenance“ and „Corrective Action / Repairs“.

3.1.2.2 Disassembly

Work on the Printed Circuit Boards

Note

Before carrying out the following steps, make sure that the device is not operative.

Caution!

Caution when changing jumper settings that affect nominal values of the device

As a consequence, the ordering number (MLFB) and the ratings that are stated on the nameplate do no longer match the actual device properties.

If such changes are necessary, the changes should be clearly and fully noted on the device. Self adhesive stickers are available that can be used as replacement nameplates.

To perform work on the printed circuit boards, such as checking or moving switching elements or exchanging modules, proceed as follows:

- Prepare working area. Provide a earthed mat for protecting components subject to damage from electrostatic discharges (ESD). The following equipment is needed:
  - screwdriver with a 5 to 6 mm wide tip,
  - a Philips screwdriver size 1,
  - 5 mm socket or nut driver.
- Unfasten the screw-posts of the D-subminiature connectors on the back panel at location „A“. This is not necessary if the device is designed for surface mounting.

- If the device has additional interfaces at locations „B“and „D“ apart from interfaces at locations „A“ and „D“, the screws located diagonally to the interfaces must be removed. This is not necessary if the device is designed for surface mounting.
- Remove the four or six caps on the front cover and loosen the screws that become accessible.
- Carefully take off the front cover. With device versions with a detached operator panel it is possible to remove the front cover of the device right after having unscrewed all screws.

Work on the Plug Connectors

Caution!

Mind electrostatic discharges

Non–observance can result in minor personal injury or material damage.

When working on plug connectors, electrostatic discharges must be avoided by previously touching a earthed metal part.

Do not plug or withdraw interface connections under power!

Here, the following must be observed:

- Disconnect the ribbon cable between the front cover and the CPU board (No. 1 in Figure 3-2) at the front cover side. Press the top latch of the plug connector up and the bottom latch down so that the plug connector of the ribbon cable is pressed out. This action does not apply to the device version with detached operator panel. However, on the central processor unit CPU (No. 1) the 7-pole plug connector X16 behind the D-sub-miniture connector and the plug connector of the ribbon cable (connected to the 68-pole plug connector on the rear side) must be removed.
- Disconnect the ribbon cables between the CPU unit (No. 1) and the input/output printed circuit board I/O (No. 2).
- Remove the boards and set them on the earthed mat to protect them from ESD damage.
- Check the jumpers according to figures to and the following information. Change or remove the jumpers if necessary.

The arrangement of modules for device types and housing sizes are shown in Figure 3-2.

Module Arrangement

The arrangement of modules for device 7SJ689 is illustrated in the following figure.

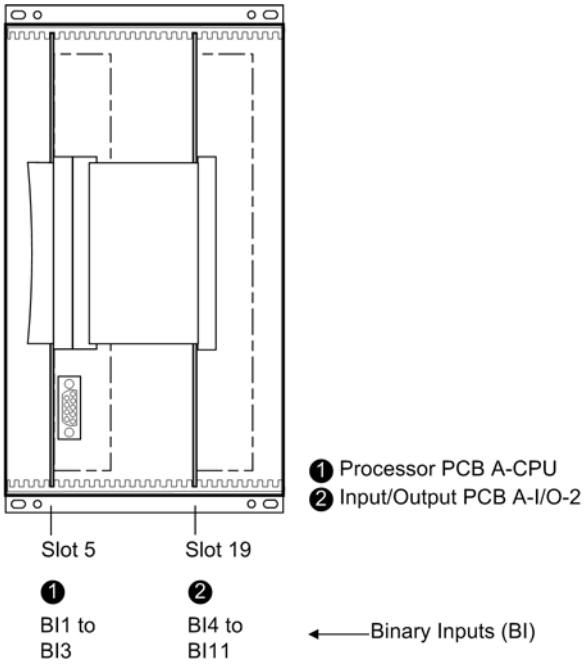


Figure 3-2 Front view of 7SJ689 after removal of the front cover (simplified and scaled down)

3.1.2.3 Switching Elements on the Printed Circuit Boards

Three different releases of the A–CPU board are available. They are shown in the following figures. The location of the miniature fuse (F1) and of the buffer battery (G1) are also shown in the following figures.

Processor Board A–CPU for 7SJ689

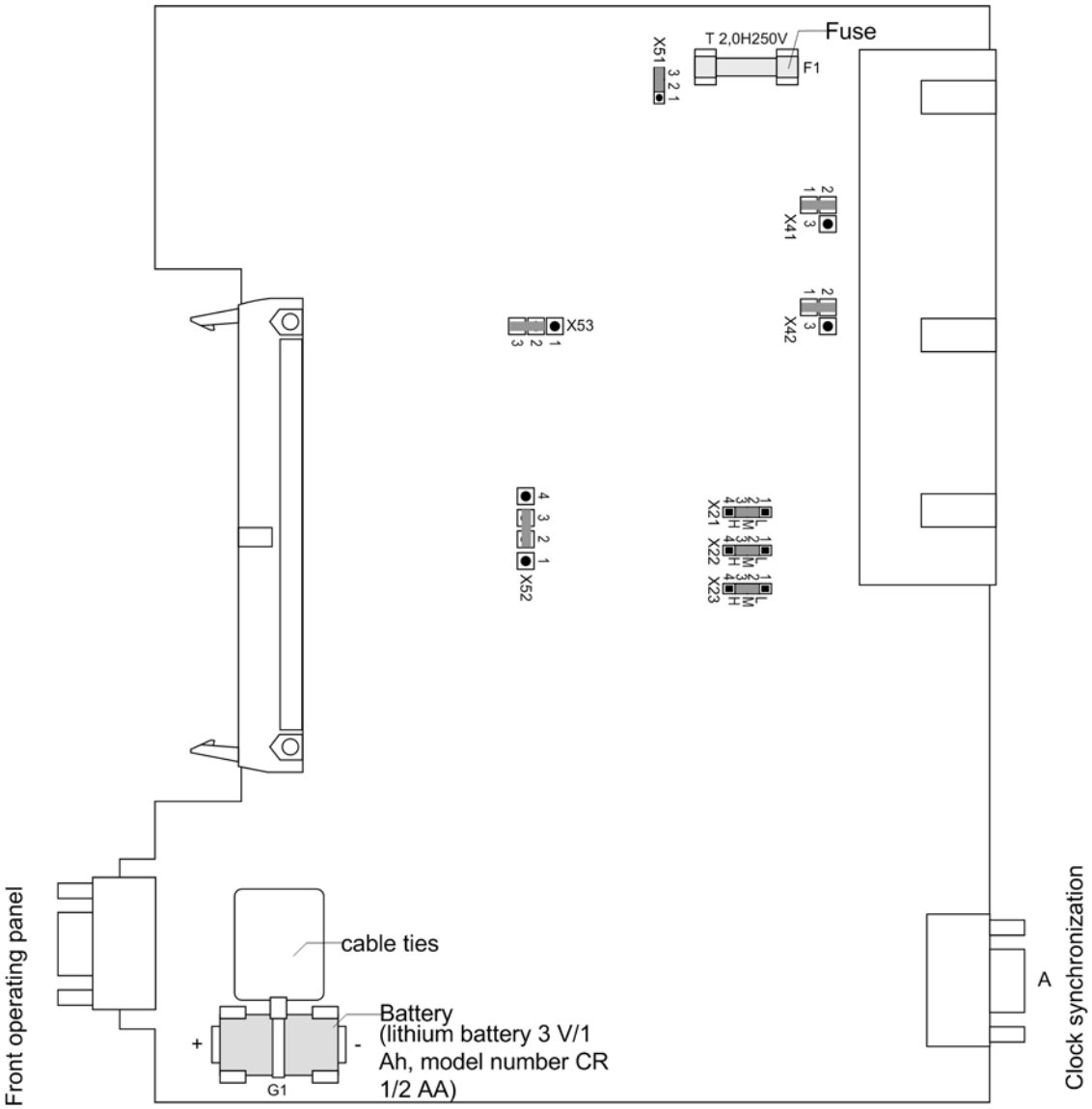


Figure 3-3 Processor printed circuit board A–CPU for 7SJ689 with jumpers settings required for the module configuration

Power Supply

Table 3-2 Jumper settings for the nominal voltage of the integrated **power supply** on the processor board A–CPU

Jumper	Rated Voltage
	110 to 250 VDC, **115 to 230 VAC**
X51	2-3
X52	2-3
X53	2-3

Pickup Voltages of BI1 to BI3

Table 3-3 Jumper settings for the **pickup voltages** of the binary inputs BI1 to BI3 on the processor board A–CPU

Binary inputs	Jumper	88 VDC threshold [1]	176 VDC threshold [2]
BI1	X21	M	H
BI2	X22	M	H
BI3	X23	M	H

[1] Factory settings for devices with power supply voltages of 110 VDC to 250 VDC, Binary input threshold 88V DC

[2] Factory settings for devices with power supply voltages of 110 VDC to 250 VDC, Binary input threshold 176 V DC

Contact Mode for Binary Outputs BO1 and BO2

Table 3-4 Jumper settings for the **contact mode** of relays BO1 and BO2 on the processor board A–CPU

for	Jumper	Open in quiescent state (NO)	Closed in quiescent state (NC)	Presetting
BO1	X41	1-2	2-3	1-2
BO2	X42	1-2	2-3	1-2

Input/Output Board A–I/O-2

The layout of the printed circuit board for the input/output board A–I/O-2 is illustrated in the following figure. The set nominal currents of the current input transformers and the selected operating voltage of binary inputs BI4 to BI11 are checked.

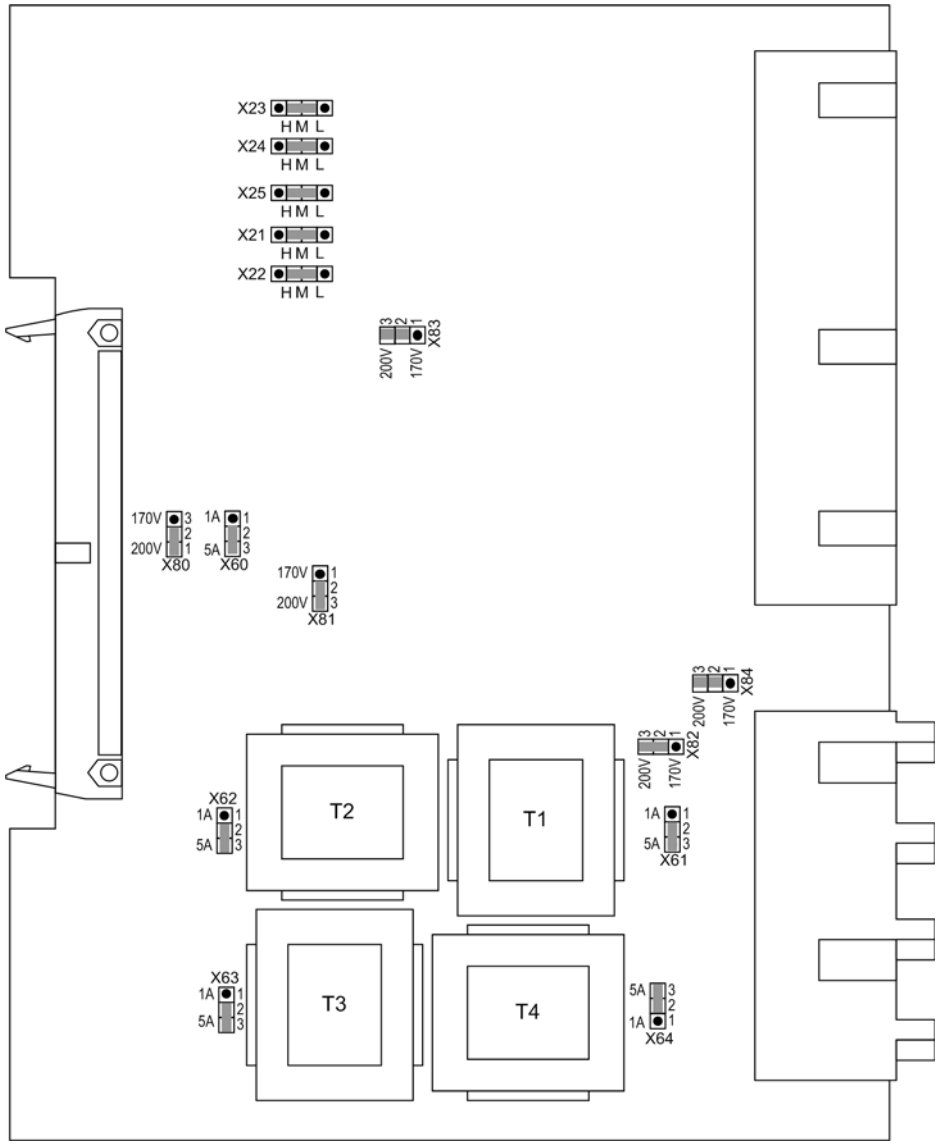


Figure 3-4 Input/output module A–I/O-2 for 7SJ689 with representation of the jumper settings required for the board configuration

The jumpers X60 to X63 must all be set to the same rated current, i.e. one jumper (X61 to X63) for each input transformer and in addition the common jumper X60. The jumper X64 determines the rated current for the input I_E and may thus have a setting that deviates from that of the phase currents.

The measuring range of the voltage inputs is defined via jumpers X80 to X85. For 7SJ689, the range 200 V must be set. The range may not be changed to 170 V.

Pickup Voltage of BI4 to BI11

Table 3-5 Jumper settings for **pickup voltages** of binary inputs BI4 to BI11 on the input/output board A–I/O-2

Binary inputs	Jumper	88 VDC threshold [1]	176 VDC threshold [2]
BI4	X21	M	H
BI5	X22	M	H
BI6	X23	M	H
BI7	X24	M	H
BI8	X25	M	H

[1] Factory settings for devices with power supply voltages of 110 VDC to 250 VDC, Binary input threshold 88V DC

[2] Factory settings for devices with power supply voltages of 110 VDC to 250 VDC, Binary input threshold 176 V DC

3.1.2.4 Reassembly

To reassemble the device, proceed as follows:

- Carefully insert the boards into the case. The mounting locations are shown in Figures 3-2 to . For the model of the device designed for surface mounting, use the metal lever to insert the processor circuit board CPU board. The installation is easier with the lever.
- First plug the plug connectors of the ribbon cable into the input/output boards I/O and then onto the processor module CPU. Do not bend any connector pins ! Do not use force !
- Insert the plug connector of the ribbon cable between the processor module CPU and the front cover into the socket of the front cover. This action does not apply to the device version with detached operator panel. Instead the plug connector of the ribbon cable connected to a 68pole plug connector on the rear side of the device must be plugged into the plug connector of the processor circuit board CPU. The 7pole X16 connector belonging to the ribbon cable must be plugged behind the D-subminiature female connector. The plugging position is not relevant in this context as the connection is protected against polarity reversal.
- Press the latches of the plug connectors together.
- Replace the front cover and secure to the housing with the screws.
- Put the covers back on.
- Re-fasten the interfaces on the rear of the device housing. This activity is not necessary if the device is designed for surface mounting.

3.2 Checking connection

3.2.1 Checking data connection of a serial port

Pin Assignment

The following tables illustrate the pin assignments of the various serial device interfaces, of the time synchronization interface and of the Ethernet interface. The position of the connections can be seen in the following figure.

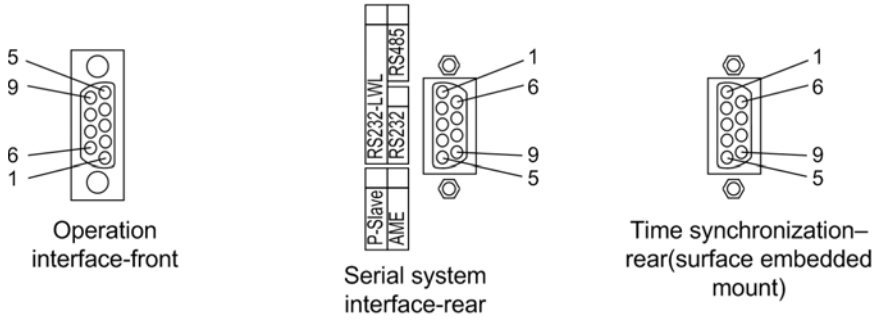


Figure 3-5 9-pin D-subminiature female connectors

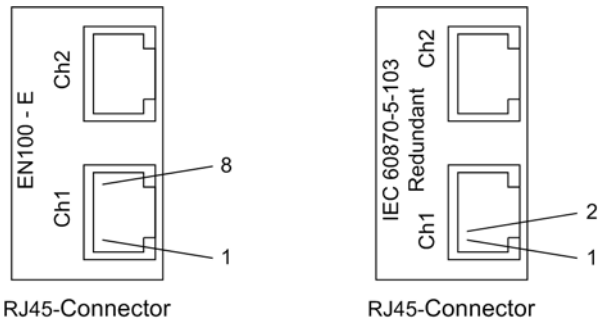


Figure 3-6 RJ45 Connector

Operation Interface

When the recommended communication cable is used (refer to the Appendix for the ordering number), correct connection between the SIPROTEC 4 device and the PC or laptop is automatically ensured.

Service Interface

If communications between devices are completed using services (port C) via a fixed wire or a modem, the data connections thereof need to be checked.

System Interface

When the serial port of a device is connected to a central substation control system, the data connection thereof must be checked. Visual check for a transmission channel and a receiving channel is very important. For

RS232 or a fibre optic interface, each connection corresponds to a transmission direction. Therefore, the output of one device must be connected to that of the other device, vice versa.

For a data cable, the connection manner thereof must refer to DIN 66020 and ISO2110:

- TxD = Data Outputs
- RxD = Data Inputs
- $\overline{\text{RTS}}$ = Request to Send
- $\overline{\text{CTS}}$ = Send Clear
- GND = Signal/Chasis Earthed

The cable shield is to be earthed at **both ends**. For extremely EMC-prone environments, the GND may be connected via a separate individually shielded wire pair to improve immunity to interference.

Termination

The RS485 interface can be applied to operating in a half-duplex mode with signals A/A' and B/B', which share a relative voltage pole C/C' (GND). After being checked, only the last device on the busbar is connected with a terminal resistor, while the other devices thereon are not. The jumper of the terminal resistor is on the interface module RS485. The terminal resistor can be also connected externally. In such a case, the terminal resistors on a module must be separated from the module.

If the busbar extends, please confirm again that only the last device on the busbar is connected with a terminal resistor, while the other devices thereon are not.

Time Synchronization Interface

It is optionally possible to process 5 V-, 12 V- or 24 V- time synchronization signals, provided that they are carried to the inputs named in the following table.

Table 3-6 D-SUB socket assignment of the time synchronization interface

Pin Number	Description	Signal Meaning
1	P24_TSIG	Input 24 V
2	P5_TSIG	Input 5 V
3	M_TSIG	Return Wire
4	– [1)]	– [1)]
5	SHIELD	Shield Potential
6	–	–
7	P12_TSIG	Input 12 V
8	P_TSYNC [1)]	Input 24 V[1)]
9	SHIELD	Shield Potential

[1)] distributed, but not used

Fiber-Optical Fibre

WARNING!

Laser Radiation!

Please do not directly look at the interior of an optical fibre component.

Signals transmitted via optical fibers are unaffected by interference. The fibers guarantee electrical isolation between the connections. Transmit and receive connections are represented by symbols.

The standard setting of the character idle state for the optical fiber interface is 鈍 ight off“. If the character idle state is to be changed, use the operating program DIGSI as described in the SIPROTEC 4 System Description.

3.2.2 Checking system connections

WARNING!

Warning of dangerous voltages

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Therefore, only qualified people who are familiar with and adhere to the safety procedures and precautionary measures should perform the inspection steps.

Caution!

Take care when operating the device without a battery on a battery charger.

Non-observance of the following measures can lead to unusually high voltages and consequently, the destruction of the device.

Do not operate the device on a battery charger without a connected battery. (For limit values see also Technical Data, Section 4.1).

If undervoltage protection is configured and enabled in the device and if, at the same time, the current criterion is disabled, the device picks up right after auxiliary voltage has been connected, since no measuring voltage is available. To make the device configurable, pickup is to be stopped, i.e. the measuring voltage is connected or voltage protection is blocked. This can be performed by operation.

Before the device is energized for the first time, it should be in the final operating environment for at least 2 hours to equalize the temperature, to minimize humidity and to avoid condensation. Connections are checked with the device at its final location. The plant must first be switched off and earthed.

Proceed as follows in order to check the system connections:

- Protective switches for the power supply and the measured voltages must be opened.
- Check the continuity of all current and voltage transformer connections against the system and connection diagrams:
  - Are the current transformers grounded properly?
  - Are the polarities of the current transformers the same?
  - Is the phase relationship of the current transformers correct?
  - Are the voltage transformers grounded properly?
  - Are the polarities of the voltage transformers correct?
  - Is the phase relationship of the voltage transformers correct?
  - Is the polarity for current input I4 correct (if used)?
  - Is the polarity for voltage input V4 correct (if used)?
- If check switches are used for secondary testing of the device, their functions also must be checked, in particular that in the “check“ setting the current transducer secondary lines are automatically shorted.
- The short-circuit feature of the current circuits of the device are to be checked. This may be performed with an ohmmeter or other test equipment for checking continuity. Make sure that terminal continuity is not wrongly simulated in reverse direction via current transformers or their short circuit links.
  - Remove the front panel of the device

  - Remove the ribbon cable connected to the I/O board with the measured current inputs (on the front side it is the right printed circuit board). Furthermore, remove the printed circuit board so that there is no more contact anymore with the plug-in terminal of the housing.
  - At the terminals of the device, check continuity for each pair of terminals that receives current from the CTs.
  - Firmly re-insert the board again. Carefully connect the ribbon cable. Do not bend any connector pins! Do not use force!
  - At the terminals of the device, again check continuity for each pair of terminals that receives current from the CTs.
  - Attach the front panel and tighten the screws.
- Connect an ammeter in the supply circuit of the power supply. A range of about 2.5 A to 5 A for the meter is appropriate.
- Switch on m.c.b. for auxiliary voltage (supply protection), check the voltage level and, if applicable, the polarity of the voltage at the device terminals or at the connection modules.
- The current consumption should correspond to the power input in neutral position of the device. The measured steady state current should be insignificant. Transient movement of the ammeter merely indicates the charging current of capacitors.
- Remove the voltage from the power supply by opening the supply circuit of the power supply.
- Disconnect the measuring test equipment; restore the normal power supply connections.
- Remove the voltage from the power supply by closing the supply circuit of the power supply.
- Close the protective switches for the voltage transformers.
- Verify that the voltage phase rotation at the device terminals is correct.
- Open the protective switches for the voltage transformers and the power supply.
- Check the trip and close circuits to the power system circuit breakers.
- Verify that the control wiring to and from other devices is correct.
- Check the signalling connections.
- Close the protective switches.

3.3 Commissioning

WARNING!

Warning of dangerous voltages when operating an electrical device

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Only qualified people shall work on and around this device. They must be thoroughly familiar with all warnings and safety notices in this instruction manual as well as with the applicable safety steps, safety regulations,and precautionary measures.

Before making any connections, the device must be earthed at the protective conductor terminal.

Hazardous voltages can exist in all switchgear components connected to the power supply and to measur ment and test circuits.

Hazardous voltages can be present in the device even after the power supply voltage has been removed (capacitors can still be charged).

After switching off the auxiliary voltage, wait a minimum of 10 seconds before reconnecting this voltage so that-steady conditions can be established.

The limit values given in Technical Data (Chapter 4) must not be exceeded, neither during testing nor during commissioning.

When testing the device with secondary test equipment, make sure that no other measurement quantities are connected and that the trip and close circuits to the circuit breakers and other primary switches are disco nected from the device.

Danger!

Hazardous voltages during interruptions in secondary circuits of current transformers

Non-observance of the following measure will result in death, severe personal injury or substantial property-damage.

Short-circuit the current transformer secondary circuits before current connections to the device are opened.

Switching operations have to be carried out during commissioning. A prerequisite for the prescribed tests is that these switching operations can be executed without danger. They are accordingly not intended for oper tional checks.

WARNING!

Warning of dangers evolving from improper primary tests.

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Primary tests are only allowed to be carried out by qualified personnel, who are familiar with the commissioing of protection systems, the operation of the plant and the safety rules and regulations (switching, earthing, etc.).

3.3.1 Test Mode and Transmission Block

Activated and Deactivation

If the device is connected to a central or main computer system via the SCADA interface, then the information that is transmitted can be influenced. This is only possible with some of the protocols available.

If the **test mode** is switched on, the messages sent by a SIPROTEC 4 device to the main system has an additional test bit. This bit allows the messages to be recognized as not resulting from actual faults. Furthermore,

it can be determined by activating the **transmission block** that no annunciations are transmitted via the system interface during test mode.

The SIPROTEC 4 System Manual describes in detail how to activate and deactivate the test mode and blocked data transmission. Please note that when DIGSI is being used for device editing, the program must be in the **online** operating mode for the test features to be used.

3.3.2 Checking System Interface (SCADA)

Preface Remarks

If the device features a system interface and this is used to communicate with the control center, the DIGSI device operation can be used to test if messages are transmitted correctly. This test option should however definitely not be used while the device is in"real" operation.

WARNING!

Danger evolving from operating the equipment (e.g.circuit breakers, disconnectors) by means of the test function

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the test function during real oper tion by transmitting or receiving messages via the system interface.

Note

After termination of the system interface test the device will reboot. Thereby, all annunciation buffers are erased. If required, these buffers should be extracted with DIGSI prior to the test.

The interface test is carried out using DIGSI in the Online operating mode:

- Open the online directory by double-clicking; the operating functions for the device appear.
- Click on Test; the function selection appears in the right half of the screen.
- Double-click on Generate Annunciations shown in the list view. The dialog box Generate Annunciations opens (refer to the following figure).

Structure of Test Dialog Box

In the column **Indication** the display texts of all indications are displayed which were allocated to the system interface in the matrix. In the column SETPOINT Status the user has to define the value for the messages to be tested. Depending on annunciation type, several input fields are offered (e.g. message "ON“ / message "OFF"). By clicking on one of the fields you can select the desired value from the pull-down menu.

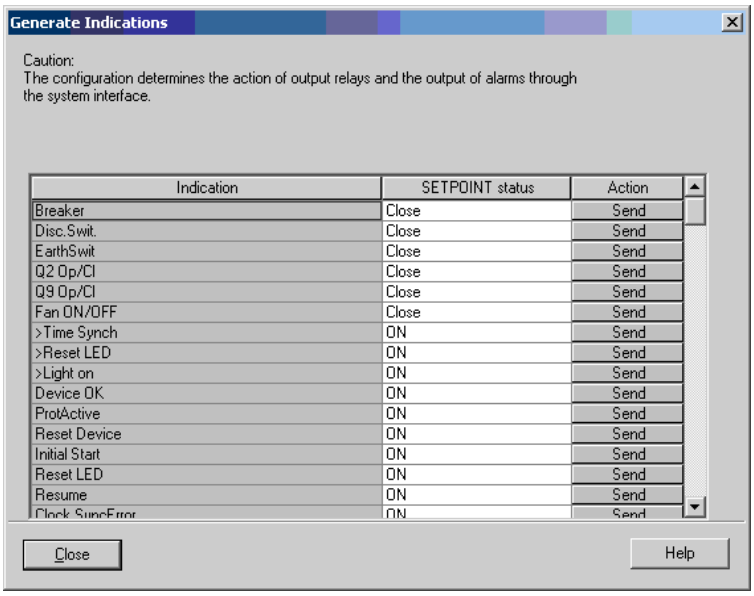


Figure 3-7 System Interface Tests with Dialog Box: generated information - examples

Changing Operating State

When clicking one of the buttons in the column **Action** for the first time, you will be prompted for the password-no. 6 (for hardware test menus). After correct entry of the password, individual annunciations can be initiated.To do so, click on the button **Send** on the corresponding line. The corresponding message is issued and can be read out either from the event log of the SIPROTEC 4 device or from the substation control system.

As long as the window is open, further tests can be performed.

Test In Message Direction

For all information that is transmitted to the central station, test the options in the list which appears in SETPOINT Status:

- Make sure that each checking process is carried out carefully without causing any danger (see above and refer to DANGER!)
- Click on Send in the function to be tested and check whether the transmitted information reaches the central station and shows the desired reaction. Data which are normally linked via binary inputs (first character ">") are likewise indicated to the central power system with this procedure. The function of the binary inputs itself is tested separately.

Exiting in Test Mode

To end the System Interface Test, click on Close. The device is briefly out of service while the start-up routine is executed. The dialog box closes.

Test in Command Direction

The information transmitted in command direction must be indicated by the central station. Check whether the reaction is correct.

3.3.3 Checking the Status of Binary Inputs and Outputs

Preface Remarks

The binary inputs, outputs, and LEDs of a SIPROTEC 4 device can be individually and precisely controlled in DIGSI. This feature is used to verify control wiring from the device to plant equipment (operational checks) during commissioning. This test option should however definitely not be used while the device is in "Real" operation.

DANGER!

Danger evolving from operating the equipment (e.g. circuit breakers, disconnectors) by means of the test function

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the test function during real operation by transmitting or receiving messages via the system interface.

Note

After finishing the hardware tests, the device will reboot. Thereby, all annunciation buffers are erased. If required, these buffers should be read out with DIGSI and saved prior to the test.

The hardware tests can be carried out in the online operating mode using the DIGSI:

- Open the **Online** directory by double-clicking; the operating functions for the device appear**.**
- Click on **Test**; the function selection appears in the right half of the screen.
- Double-click in the list view on **Hardware Test**. The dialog box of the same name opens (see the following figure).

Structure of Test Dialog Box

The dialog box is classified into three groups: **BI** for binary inputs, **REL** for output relays, and **LED** for lightemitting diodes. On the left of each of these groups is an accordingly labelled button. By double-clicking a button, information regarding the associated group can be shown or hidden.

In the column **Status** the present (physical) state of the hardware component is displayed. Indication is made by symbols. The physical actual states of the binary inputs and outputs are indicated by an open or closed switch symbol, the LEDs by a dark or illuminated LED symbol.

The opposite state of each element is displayed in the column **Scheduled**. The display is made in plain text.

The right-most column indicates the commands or messages that are configured (masked) to the hardware components.

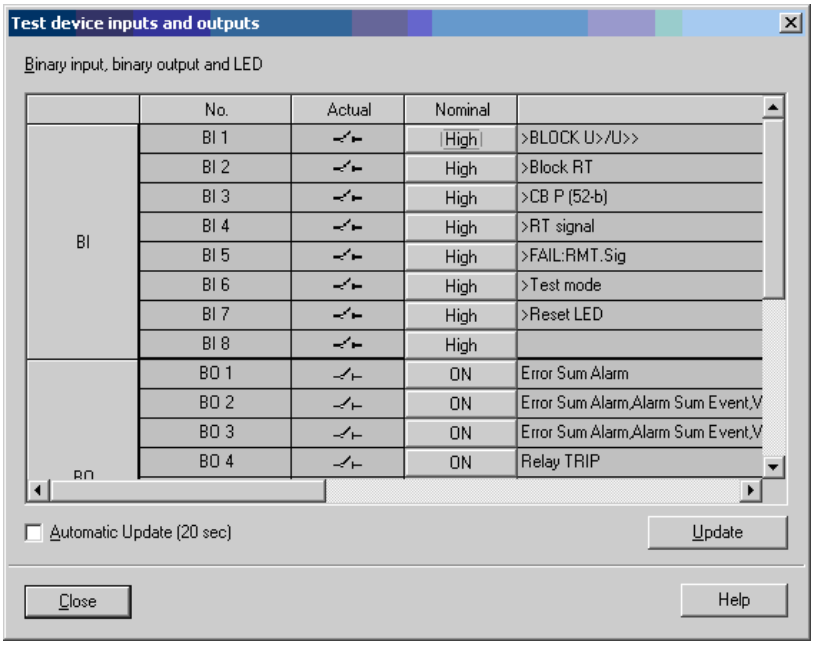


Figure 3-8 Test of the binary Inputs and Outputs — Examples

Changing the Operating State

To change the status of a hardware component, click on the associated button in the **Scheduled** column.

Password No. 6 (if activated during configuration) will be requested before the first hardware modification is allowed. After entry of the correct password a status change will be executed. Further status changes remain possible while the dialog box is open.

Test of the Output Relays

Each individual output relay can be energized allowing to check the wiring between the output relay of the 7SJ689 and the system, without having to generate the message that is assigned to the relay. As soon as the first status change for any one of the output relays is initiated, all output relays are separated from the internal device functions, and can only be operated by the hardware test function. This for example means that a switching command coming from a protection function or a control command from the operator panel to an output relay cannot be executed.

Proceed as follows in order to check the output relay :

- Ensure that the switching of the output relay can be executed without danger (see above under DANGER!).
- Each output relay must be tested via the corresponding Scheduled-cell in the dialog box.
- Finish the testing (see margin title below "Exiting the Test Mode"), so that during further testings no unwanted switchings are initiated.

Test of the Binary Inputs

To test the wiring between the plant and the binary inputs of the 7SJ689 the condition in the plant which initiates the binary input must be generated and the response of the device checked.

To do so, the dialog box **Hardware Test** must be opened again to view the physical state of the binary inputs. The password is not yet required.

Proceed as follows in order to check the binary inputs:

- Activate each of function in the system which causes a binary input to pick up.
- Check the reaction in the Status column of the dialog box. To do this, the dialog box must be updated. The options may be found below under the margin heading "updating the Display".
- Finish the testing (see margin heading below "Exiting the Test Mode").

If ,however, the effect of a binary input must be checked without carrying out any switching in the plant, it is possible to trigger individual binary inputs with the hardware test function. As soon as the first state change of any binary input is triggered and the password No. 6 has been entered, all binary inputs are separated from the plant and can only be activated via the hardware test function..

Test of the LEDs

The LEDs may be tested in a similar manner to the other input/output components. As soon as the first state change of any LED has been triggered, all LEDs are separated from the internal device functionality and can only be controlled via the hardware test function. This means e.g. that no LED is illuminated anymore by a protection function or by pressing the LED reset button.

Updating the Display

As the Hardware Test dialog opens, the operating states of the hardware components which are current at this time are read in and displayed.

An update is made:

- for each hardware component, if a command to change the condition is successfully performed,
- for all hardware components if the Update button is clicked,
- for all hardware components with cyclical updating (cycle time is 20 seconds) if the **Automatic Update (20sec)** field is marked.

Exiting the Test Mode

To end the hardware test, click on Close. The dialog box is closed. The device becomes unavailable for a brief start-up period immediately after this. Then all hardware components are returned to the operating conditions determined by the plant settings.

3.3.4 Test Fault Recording

General

In order to be able to test the stability of the protection during switchon procedures also, switchon trials can also be carried out at the end. Oscillographic records obtain the maximum information about the behaviour of the protection.

Requirements

Apart from the capability of storing fault recordings via pickup of the protection function, the 7SJ689 also has the capability of initiating a measured value recording via the operator program DIGSI, the serial interface or binary input. In the latter case, the information ">Trig.Wave.Cap." must be allocated to a binary input. Triggering for the oscillographic recording then occurs, for instance, via the binary input when the protection object is energized.

Those that are externally triggered (that is, without a protective stage pickup) are processed by the device as a normal oscillographic record. For each oscillographic record a fault record is created which is given its individual number to ensure that assignment can be made properly. However, these recordings are not displayed in the fault indication buffer, as they are not fault events..

Trigger Recording

To trigger test measurement recording with DIGSI, click on **Test** in the left part of the window. Double click the entry **Test Wave Form** in the list of the window.

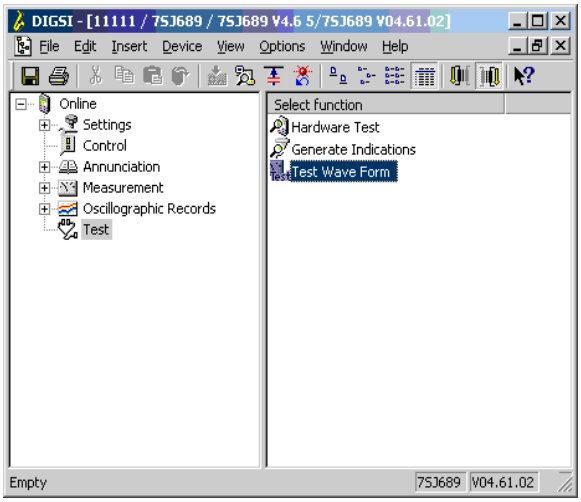


Figure 3-9 Triggering oscillographic recording with DIGSI

Oscillographic recording is started immediately. During recording, a report is given in the left part of the status bar. Bar segments additionally indicate the progress of the procedure.

SIGRA or COMTRRADE read program is needed to display and analyze the oscillographic data.

3.4 Final Preparation of Device

All screws are tightened firmly. All terminal strip screws are tightened, including those terminals not used.

Caution!

Inadmissable Tightening Torques.

Non -observance of the following measure can result in minor personal injury or property damage.

The tightening torques must not be exceeded as the threads and terminal chambers may otherwise be damaged!

The settings should be checked again, if they were changed during the tests. Check if all protection, control and auxiliary functions to be found with the configuration parameters are set correctly (Section 2.1.1, Functional Scope) and all desired functions are set to ***ON***. Keep a copy of all setting values on a PC.

Check the internal clock of the device. If necessary, set or synchronize the clock if it is not automatically synchronized. For assistance, refer to the SIPROTEC 4 System Description.

The annunciation buffers are deleted under **MAIN MENU → Annunciations → Set/Reset**, so that future information will only apply to actual events and states (see also SIPROTEC 4 System Description). The counters in the switching statistics should be reset to the values that were existing prior to the testing (see also SIPROTEC 4 System Description).

Reset the counter of the operational measured values (e.g. operation counter, if available) under **MAIN MENU → Measured Values → Reset** (also see SIPROTEC 4 System Description).

Press the ESC key (several times if necessary), to return to the default display. The default display appears in the display box (e.g. the display of operational measured values).

Clear the LEDs on the front panel of the device by pressing the LED key, so that they show only real events and states in the future. In this context, also output relays probably memorized are reset. Pressing the LED key also serves as a test for the LEDs on the front panel because they should all light when the button is pushed. Any LEDs that are lit after the clearing attempt are displaying actual conditions.

The green „RUN“ LED must light up, whereas the red „ERROR“ must not light up.

Close the protective switches. If test switches are available, then these must be in the operating position.

The device is now ready for operation.

■

Technical Data

4

This chapter provides the technical data of the device SIPROTEC 7SJ689 and the functions thereof, including the limit values that may not be exceeded under any circumstance. The mechanical data and the outline dimensional drawings of the protection device are introduced after the introduction of all electrical parameters and functional parameters thereof.

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4.1 General

4.1.1 Analog Inputs

Current Inputs

Rated Frequency	f_N	50 Hz or 60Hz
Rated Current	I_N	1 A or 5 A
Earth Return Load Per Phase - Inom = 1 A - INom = 5 A		 approx.0.05 VA approx.0.3 VA
Current Overload Capability - Thermal Stability (effective value) - Dynamic (peak value)		100 Inom 1 s 30 Inom 10 s 4 Inom Continuous 250 Inom (Half-Cycle)

Voltage Input

Rated Current	100 V to 225 B (adjustable)
Measurement Scope	0 V to 200 B (adjustable)
Burden	100V approx. 0.3 VA
AC Voltage Input Overload Capacity	
- Thermal (effective value)	230 V Continuous

4.1.2 Power Supply

DCVoltage

Voltage supply via an Integrated coverter	
Rated Auxiliary DC Voltage V_{Aux}	60/110/125 VDC
Permissible Voltage Ranges	48 to 150 VDC
Rated Auxiliary DC Voltage VAux	110/125/220/250 VDC
Permissible Voltage Range	88 to 300 VDC
AC Ripple Voltage Peak to Peak Value, IEC 60255-11	15 % of the auxiliary voltage

Power Input	Quiescent	Energized
7SJ689	approx. 4 W	approx. 7 W
Fault/Short Circuit Switching Time ‰, IEC 60255-11 (non-excited state)	⩾ 50 ms, at U ⩾ 110 VDC	
	⩾ 20 ms, at U ⩾ 24 VDC	

AC Voltage

Voltage supply via an Integrated coverter		
Rated Auxiliary Voltage V_{Aux}	115 VAC	230 VAC
Permissible Voltage Range	92 to 132 VAC	184 to 265 VAC

Power Input(115 VAC / 230 VAC)	Quiescent	Energized
7SJ689	approx. 3 VA	approx. 9 VA
Bridging Time for Failure/Short-Circuit (in not energized operation)	200 ms	

4.1.3 Binary Inputs and Outputs

Binary Inputs

Variant	Number	
7SJ689*-	8 (configurable)	
Rated Voltage Range	24 VDC to 250 VDC, bipolar	
Current Consumption (independent of the voltage)	approx. 1.8 mA	
Pickup Time	approx. 4 ms	
Secured Switching Threshold	Adjustable with jumpers	
for Rated Voltages	60/110/125 VDC	V high ≥ 19 VDC V low ≤ 10 VDC
for Rated Voltages	110/125/220/250 VDC	V high ≥ 88 VDC V low ≤ 44 VDC
for Rated Voltages (only for modules with 3 switching thresholds)	220/250 VDC and 115/230 VAC	V high ≥ 176 VDC V low ≤ 88 VDC
Maximum Permissible Voltage	300 VDC	
Input Pulse Filter	at 220 nF and 220 V, recovery time is >60 ms	

Binary Outputs

Output relay for commands/annunciations, alarm relay		
Number and Information	Determined according to the ordering variant (configurable)	
Order Version	normally open*)	normally open/normally closed, optional*)
7SJ689*-	8	2
Switching Capability MAKE	1000 W/VA	
Switching Capability BRAKE	30 VA 40 W resistive 25 W at L/R ≤ 50 ms	
Switching Voltage	250 VDC / VAC	
Admissible Current per Contact (continuous)	5 A	
Admissible Current per Contact (generate and hold)	30 A for 0.5 s (NO contact)	
Admissible Total Current on Common Line	5 A continuous, 30 A continuou 0.5 s	
AC Load (needing to take the dimensions of internal circuits into account)		
ANSI Capacitance Value $4.70 \cdot 10^{-9}$ F ± 20%	Frequency	Impedance
	50 Hz	$6.77 \cdot 10^{5}$ Ω ± 20%

4.1.4 Communication Interfaces

Operator Interface

Connection	Front side, non-isolated, RS232, 9-pin DSUB port for connecting a personal computer
Operation	With DIGSI
Transmission Speed	min. 4,800 Bd; max. 115,200 Bd; Factory Settings: 115,200 Bd; Parity: 8E1
Maximum Transmission Distance	49.2 feet (15 m)

Service/Modem

	Connection	Isolated Interface for Data Transmission
	Operation	With DIGSI
	Transmission Speed	min. 4 800 Bd, max. 115,200 Bd; Factory Settings: 38 400 Bd
RS232/RS485		RS232/RS485 according to the ordering variant
	Connection of Flush-Mounted Casing	Rear Panel, "C" Groove 9-Hole D-SUB Miniature Connecting Sheet
	Connection of Panel Surface-Mounted Casing	at the bottom of mounting of the casing; Shielded Data Cable
	Test Voltage	500 VAC
RS232		
	Maximum Transmission Distance	49.2 feet (15 m)
RS485		
	Maximum Transmission Distance	3,280 feet (1,000 m)

Fibre Optical Link (FO)		
	FO Connector Type	ST Connector
	Connection of Flush-Mounted Casing	Rear Panel, Mounting Position "C"
	Connection of Panel Surface-Mounted Casing	at the bottom of the casing of a console
	Optical Wavelength	λ= 820 nm
	Laser Group 1 according to EN 60825-1/-2	using glass fibre 50/125 μm or using glass fibre 62.5/125 μm
	Permissible Optical Link Signal Attenuation	max.8 dB, glass fibre ber 62.5/125 μm
	Maximum Transmission Distance	max. 0.93 miles (1.5 km)
	No Characteristic Position	Configurable; Factory Setting "Light off"

System Interface

Ethernet (EN 100) supporting IEC61850 and DIGSI		
	Connection of Flush-Mounted Casing	Rear Panel, Mounting Position "B" 2 x RJ45 Jack 100BaseT in accordance with IEEE802.3
	Connection of Panel Surface-Mounted Casing	Control Frame at the bottom of the casing
	Test Voltage (reg. socket)	500 V; 50 Hz
	Transmission Speed	100 MBit/s
	Bridging Distance	65.62 feet (20 m)
Ethernet (EN100) supporting IEC61850 andDIGSI		
	Connection of Flush-Mounted Casing	Rear Panel, Mounting Position "B", ST-Connector 100BaseT in accordance with IEEE802.3
	Connection of Panel Surface-Mounted Casing	(not applicable)
	Test Voltage (reg. socket)	100 MBit/s
	Transmission Speed	1300 nm
	Bridging Distance	max. 0.93 miles (1.5 km)

Time Synchronization Interface

Time Synchronization	DCF 77/IRIG B Signal (message format IRIG-B000)
Connection of Flush-Mounted Casing	Rear Panel, Mounting Position "A" 9-Pin D-SUB Busbar Connector
Connection of Panel Surface-Mounted Casing	Double-layer Terminal in the bottom of the casing
Signal Rated Voltage	optional 5 V, 12 V or 24 V
Test Voltage	500 V; 50 Hz

Signal Level and Load			
	Rated Signal Voltage		
	5 V	12 V	24 V
U_{IHigh}	6.0 V	15.8 V	31 V
U_{ILow}	1.0 V at I_{ILow} = 0.25 mA	1.4 V at I_{ILow} = 0.25 mA	1.9 V at I_{ILow} = 0.25 mA
I_{IHigh}	4.5 mA to 9.4 mA	4.5 mA to 9.3 mA	4.5 mA to 8.7 mA
R_I	890 at U_I = 4 V	1930 at U_I = 8.7 V	3780 at U_I = 17 V
	640 at U_I = 6 V	1700 at U_I = 15.8 V	3560 at U_I = 31 V

4.1.5 Electrical Tests

Standards

Standards:	IEC 60255 (product standards) ANSI/IEEE Std C37.90.0/.1/.2 UL 518 DIN 57435 Part 303 please see special function standards for more standards

Insulation Test

Standards:	IEC 60255-5 and IEC 60870-2-1
High Voltage Test (routine test): all circuits except the power supply, Inputs, Communication Interfaces and Time Synchronization Interfaces	2.5 kV (rms), 50 Hz
High Voltage Test (routine test): Auxiliary Voltages and Inputs	3.5 kV -
High Voltage Test (routine test): only Isolated Communication Interface and Time Synchronization Interfaces	500 kV (rms), 50 Hz
Pulse Voltage Test (type test): all circuits except Communication Interfaces and time Synchronization Interfaces as well as Circuit Class III	5 kV (peak value); 1.2/50 μs; 0.5 J; 3 positive and 3 negative pulses at intervals of 1 s

EMC Tests for Immunity (type test)

Standards:		IEC 60255-6 and -22 (product standards) EN 50082-2 (generic standards) DIN 57435 Part 303
High Frequency Test IEC 60255-22-1, Class III and VDE 0435 Part 303, Class III		2.5 kV (peak value); 1 MHz; τ= 15 μs; 400 Inrush Current per Second; Test Interval 2s; R_i = 200 Ω
Electrostatic Discharge IEC 60255-22-2, Class IV and IEC 61000-4-2, Class IV		8 kV Contact Discharge; 15 kV Exhaust Bipolarity; 150 pF; R_i = 330Ω
High Frequency Region Irradiation, Pulse Modulation C 60255-22-3 (report), Class III		10 V/m; 27 MHz to 500 MHz
High Frequency Region Irradiation, Pulse Amplitude Modulation IEC 61000-4-3, Class III		10 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz
High Frequency Region Irradiation, Pulse Modulation IEC 61000-4-3/EN V 50204, Class III		10 V/m; 900 MHz: Repetition Frequency 200 Hz: Duty cycle of 50 %
Fast Transient Disturbance Variants/Burst IEC 60255-22-4 and IEC 61000-4-4, Class IV		4 kV; 5/50 ns; 5 kHz; Burst time = 15 ms; cycle frequency 300 ms; bipolarity; R_i = 50 Ω; test duration 1 min
High Energy Surge Voltages (SURGE) IEC 61000-4-5 Installation Class 3		Pulse: 1.2/50 μs
	Auxiliary Voltages	Common Mode: 2 kV; 12 Ω; 9 μF Different Mode: 1 kV; 2 Ω; 18 μF
	Measurement Inputs, Inputs, Relay Outputs	Common Mode: 2 kV; 42 Ω; 0.5 μF Different Mode: 1 kV; 42 Ω; 0.5μF
High Frequency Online, Amplitude Modulation IEC 61000-4-6, Class III		10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Power System Frequency Magnetic Field IEC 61000-4-8, Class IV IEC 60255-6		30 A/m Continuous ; 300 A/m 3 s; 50 Hz 0.5 mT; 50 Hz

Oscillatory Surge Withstanding Capability IEEE Std C37.90.1	2.5 kV (peak value); 1 MHz; τ= 15 µs; 400 Inrush Current per Second; Test Interval 2s; R_i = 200 Ω
Fast Transient Surge Resistance IEEE Std C37.90.1	4 kV; 5/50 ns; Cycle Rate 300 ms; Bipolarity; Test Interval 1 mIn; R_i = 50 Ω
Electromagnetic Radiation Interference IEEE Std C37.90.2	35 V/m; 25 MHz to 1000 MHz
Oscillation Attenuation IEC 60694, IEC 61000-4-12	2.5 kV (peak value), Polarity Alternation 100 kHz, 1 MHz, 10 MHz and 50 MHz, R_i = 200 Ω

EMC Tests For Noise Emission (type test)

Standards:	EN 50081-* (generic technical standards)
Line Radio Noise Voltages, Auxiliary Voltages Only IEC-CISPR 22	150 kHz to 30 MHz Limited Group B
Interface Magnetic Intensity IEC-CISPR 22	30 MHz to 1000 MHz Limited Group B
Harmonic Current on the network at 230 VAC IEC 61000-3-2	Devices assigned to Group D (only for devices with> 50VA power consumption)
Voltage Fluctuation and Network Input Feeder Flickering at 230 VAC IEC 61000-3-3	Limits are observed

4.1.6 Mechanical Stress Tests

Vibration and Shock during Operation

Standards:	IEC 60255-21 and IEC 60068
Vibration IEC 60255-21-1, Class II; IEC 60068-2-6	Sinusoid 10 Hz to 60 Hz: ± 0.075 mm Vibration Amplitude; 60 Hz to 150 Hz: 1 g acceleration Frequency Sweep Rate: 1 octave/min 20 cycles in 3 vertical directions
Shock IEC 60255-21-2, Class I; IEC 60068-2-27	Semi-sinusoid 5 g acceleration, duration time 11 ms, 3 shocks in each of the three vertical directions
Seismic Vibration IEC 60255-21-3, Class I; IEC 60068-3-3	Sinusoid 1 Hz to 8 Hz: ± 3.5 mm vibration Amplitude (horizontal component) 1 Hz to 8 Hz: ± 1.5 mm vibration amplitude (vertical axis) 8 Hz to 35 Hz: 1 g acceleration (horizontal axis) 8 Hz to 35 Hz: 0.5 g acceleration (vertical axis) Frequency Sweep Rate: 1 octave/min, 1 cycle in 3 vertical directions

Vibration and Shock Stress during Transport

Standards:	IEC 60255-21 and IEC 60068
Vibration IEC 60255-21-1, Class II; IEC 60068-2-6	Sinusoid 5 Hz to 8 Hz: ± 0.075 mm vibration amplitude; 8 Hz to 150 Hz: 2 g acceleration Frequency Sweep Rate: 1 octave/min, 20 cycles in 3 vertical directions
Shock IEC 60255-21-2, Class I; IEC 60068-2-27	Semi-sinusoid 15 g acceleration, interval 11 ms 3 shocks in each of the three vertical directions
Continuous Shock IEC 60255-21-2, Class I; IEC 60068-2-29	Semi-sinusoid 10 g acceleration, duration time 16 ms, 1000 shocks in each of the three vertical directions

4.1.7 Climatic Stress Tests

Temperatures[1])

Standards:	IEC 60255-6
Type Test (according to IEC 60068 2 1 and -2 test duration 16 hours)	-25.00 °C to +85 °C or –13 °F to +185 °F
Permissible Temporary Operating Temperature (test lasting for 96 hours)	–20 °C to +70 °C or –4 °F to +158 °F (readable display is possibly restricted at +55 °C or +131 °F)
Permanent Operation Recommended Temperature (according to IEC 60255-6)	-5 °C to +55 °C or +23 °F to +131 °F
Temperature Limits for Storage	-25 °C to +55 °C or –13 °F to +131 °F
Temperature Limits for Transport	-25 °C to +70 °C or –13 °F to +158 °F
Using factory packaging to store and transport the device!	
1) UL-certified according to Standard 508 (industrial control equipment)	
Temperature Limits for Normal Operation (i.e. output device not energized)	-20 °C to +70 °C or –4 °F to +158 °F
Temperature Limits at Maximum Load (maximum permissible constant voltage of inputs and outputs)	–5 °C to +55 °C or+23 °F to +131 °F

Humidity

Permissible Humidity	Mean Value per Year =75 % Relative Humidity on 56 days of the year up to 93% Relative Humidity; and condensation must be avoided!
Siemens recommends that all devise be installed such that they are neither exposed to the direct sunlight, nor subject to large fluctuations in temperature that may cause condensation to occur.	

4.1.8 Service Conditions

The protection device is designed for use in an industrial environment and an electrical utility environment. Proper installation procedures should be followed to ensure electromagnetic compatibility (EMC).

In addition, the following is recommended:

- All contacts and relays that operate in the same cubicle, cabinet, or relay panel as the numerical protective device should, as a rule, be equipped with suitable surge suppression components.
- For substations with operating voltages of 100 kV and above, all external cables should be shielded with a conductive shield earthed at both ends. For substations with lower operating voltages, no special measures are normally required..
- Do not withdraw or insert individual modules or boards while the protective device is energized. In withdrawn condition, some components are electrostatically endangered; during handling the ESD standards (for **E**lectrostatic **S**ensitive **D**evices) must be observed. They are not endangered when inserted into the.

4.1.9 Design

Casing	7XP20
Dimensions	see dimensional drawings, see 4.5

Device Version	Casing	Dimensions	Weight
7SJ68*-*E	Flush-Mounted Frame	$^1/_3$	4 kg or 8.8 lb

Protection Level IEC 60529		
for Device with Surface-Mounted Casing		IP 51
in Flush-Mounted Casing and in mode with detachable console		
	Front	IP 51
	Rear	IP 50
Operating Personnel Protection		IP 2x with a cover cap

4.2 Overvoltage Protection

Setting Scope/Step Length

Operating Mode	3-Phase Overvoltage	
Criterion Manner	- Single-Phase Overvoltage - 3-Phase Overvoltage	
Trip Manner	- Local - Remote	
Pickup Current	57.7V to100.0V	Step Length 0.1 V
Action Delay	0.01s to 10.00s	Step Length 0.01s

Time

Pickup Time	2 times setting value, approx. 50ms
Dropout Time	approx. 50ms

Tolerances

Pickup Voltage Range	2% of the setting value or 1V
Action Delay	1% of the setting value or 10 ms

Influencing Variables for Pickup and Dropout

Direct-Current Power Voltage Range 0.8 ⩽ UPS/UPSN ⩽ 1.15	1%
Temperature Range -5 ℃ (23.00° F) ⩽ Θ amb ⩽ 55 ℃ (131.00° F)	0.5 %/ 10K
Frequency Range 0.95 ⩽ f/fN ⩽ 1.05	1%
Harmonics -10% third harmonic -10% fifth harmonic	 1% 1%

4.3 Remote Tripping Protection

Setting Ranges / Increments

Remote Trip Mode		- not via Fault Criterion - via Fault Criterion	
PT Broken Wire		OFF Voltage Dependence Local Criterion	
Local Criterion		Failure Current Voltage Low Current and Low Active Power Low Power Factor	
Remote Trip Protection			
Time of Remote Trip via Fault Criterion		0.01s to 10.00s	Step Length 0.01s
Time of Remote Trip not via Fault Criterion		0.01s to 10.00s	Step Length 0.01s
Failure Current Voltage Local Criterion			
Current variant setting	I_N = 1A	0.05A to 0.5A or ∞ (disabled)	Step Length 0.01A
	I_N = 5A	0.25A to 2.5A or ∞ (disabled)	
Zero Sequence Current Setting	I_N = 1A	0.05A to 20.00A or ∞ (disabled)	Step Length 0.01A
	I_N = 5A	0.25A to 100.00A or ∞ (disabled)	
Negative Sequence Current Setting	I_N = 1A	0.05A to 20.00A or oo(disabled)	Step Length 0.01A
	I_N = 5A	0.25A to 100.00A or oo(disabled)	
Zero Sequence Voltage Setting		2.0V to 57.7V or oo(disabled)	Step Length 0.1V
Negative Sequence Voltage Setting		2.0V to 57.7V or oo(disabled)	Step Length 0.1V
Low Current and Low Active Power Local Criterions			
Low Current Setting	I_N = 1A	0.05A to 0.5A or 0 (disabled)	Step Length 0.01A
	I_N = 5A	0.25A to 2.5A or 0 (disabled)	
Low Active Power	I_N = 1A	2.0W or 200.0W or 0 (disabled)	Step Length 0.1W
	I_N = 5A	10.0W or 1000.0.0W or 0 (disabled)	
Low Power Factor Local Criterion			
Low Power Factor Setting		30° to 89° or 90° (disabled)	Step Length 1°

Time

Pickup Time	delta current	2 times setting value	approx. 10ms
	Zero Sequence Current	2 times setting value	approx. 30ms
	Negative Sequence Current	2 times setting value	approx. 35ms
	Zero Sequence Voltage	2 times setting value	approx. 30ms
	Negative Sequence Voltage	2 times setting value	approx. 30ms
	Low Current	0.5 times setting value	approx. 30ms
	Low active power	0.5 times setting value	approx. 40ms
	Low Power Factor	0.5 times setting value	approx. 40ms
	Remote Trip Signal		
Dropout Time	delta current		approx. 10ms
	Zero Sequence Current		approx. 30ms
	Negative Sequence Current		approx. 35ms
	Zero Sequence Voltage		approx. 30ms
	Negative Sequence Voltage		approx. 30ms

	Low Current	approx. 30ms
	Low active power	approx. 20ms
	Low Power Factor	approx. 20ms
	Remote Trip Signal	approx. 10ms

Tolerances

Zero Sequence Current	5% or 10 mA at I_N=1 A or 50 mA at I_N=5 A
Negative Sequence Current	5% or 10 mA at I_N=1 A or 50 mA at I_N=5 A
Zero Sequence Voltage	5% or 1 V
Negative Sequence Voltage	5% or 1 V
Low Current	5% or 10 mA at I_N=1 A or 50 mA at I_N=5 A
Low active power	5% or 0.5 W
Low Power Factor	3°
Delay Time	1% or 10 ms

Influencing Variables for Pickup and Dropout

Direct-Current Power Voltage Range 0.8 ⩽ UPS/UPSN ⩽ 1.15	1%
Temperature Range -5 ℃ (23.00° F) ⩽ Θ amb ⩽ 55 ℃ (131.00° F)	0.5 %/ 10K
Frequency Range 0.95 ⩽ f/fN ⩽ 1.05	1%
Harmonics -10% third harmonic -10% fifth harmonic	 1% 1%

4.4 Additional Functions

Operation Measured Values

Current I_a; I_b; I_c Positive Sequence Component I_1 Negative Sequence Component I_2 Zero Sequence Component I_n/3I0	represented by A (kA) Primary or A Secondary or by % of IN
Scope Error [1)]	10 % - 200 % In_{om} 1% of the measured value or 0.5 % IN
Phase Voltage U_a, U_b, U_c Phase-to-Phase Voltage U_{ab}, U_{bc}, U_{ca}, U_{SYN} Un Positive Sequence Voltage U_1 Negative Sequence Voltage U_2	represented by kV Primary and V Secondary or by UN's %
Scope Error [1)]	10 % - 120 % of U_{Nom} 1% of the measured value, or 0.5% of U_N
S, apparent power	Primary side kVA (MVA or GVAR), represented by S_N's %
Scope Error [1)]	0 % to 120 % S_N S_N's 1 % for U/U_N and I/I_N = 50 to 120 %
P, Active Power	with Symbols, Sum/Split Phase, Primary Side KW (MW or GW) S_N%
Scope Error [1)]	0 % to 120 % S_N S_N's 1 % for U/U_N and I/I_N = 50 to 120 % and | cos φ | = 0.707 to 1 wherein S_N=°Ã3 · U_N · I_N
Q, Reactive Power	with Symbols, Sum/Split Phase, Primary Side KVAr (MVAr or GVAr) and % S_N
Scope Error [1)]	0 % to 120 % S_N S_N's 1 % For U/U_N and /I_N = 50 to 120 % and | sIn φ | = 0.707 to 1 wherein S_N=°Ã3 · U_N · I_N
cos φ, Power Factor	Sum and Phase Separation
Scope Error [1)]	1 to +1 1 % at | cos φ | ⩾ 0.707
Frequency	with Hz
Scope Error [1)]	f_N ± 5 Hz 20 mHz

[1)] at the Rated Frequency

PT Broken Wire Supervision

Operating Mode	- in an Earth System only for voltage connection to earth

Local Measured Value Supervision

Unbalanced Current	I_{max}/I_{mln} > balance factor, at I >I_{limit}, the delay time can be set
Unbalanced Voltage	U_{max}/U_{mln} > balance factor, at U > U_{limit}, the delay time can be set
Current Sum, Fast Supervision Function with Protection Block	$\| i_a + i_b + i_c + i_n \|$ >limit value

Fault Recording

The information of the latest 8 power system faults is recorded

Time Indication

Resolution of Event Log (operation alarm)	1 ms
Resolution of Trip Log (fault alarm)	1 ms
Maximum Time Offset (internal clock)	0.01 %
Battery	Lithium Battery 3 V/1 Ah, Type CR 1/2 AA Information" Alarm: Battery Fault " Low Battery

Fault Recording

At most 8 fault records are stored. The storage is maintained by a buffer battery at the loss of the power supply.	
Storage Time	10 s in all Records before and after Events and Adjustable Storage Time
Sampling Cycle	Each Cycle with 16 points (instantaneous values)

Statistics

Total Number of Trips	Max. 9 digits
Accumulated Breaking Current (split phase)	Max. 4 digits

Operating Time Calculation

Display Scope	Max. up to 7 digits
Standards	Exceeding Settable Current Setting (I> component, minimum breaker close current)

Clock

Clock Synchronization		DCF 77/IRIG Signal (telegram format IRIG-B000) Input Communications
Operating Mode of Time Tracking		
No.	Operating Mode	Explanation
1	Internal	Internal Synchronization with RTC (preset)
2	IEC 60870-5-103	External Synchronization with System Interfaces (IEC 60870-5-103)
3	Time Signal IRIG B	External Synchronization with IRIG B

4	Time Signal DCF77	External Synchronization with DCF 77
5	Time Signal sync.box	External Synchronization with Time Signal SIMEAS-Synch.Box
6	via Input Pulses	External Synchronization with Input Pulses
7	Field Busbar (Redundance 103)	External Synchronization via the Field Busbar
8	NTP (IEC 61850)	External Synchronization with System Interfaces (IEC 61850)

Setting Group Change of Parameters

Number of Available Setting Groups	4 (Setting Groups A, B, C and D)
Change Execution	with the keyboard of the device Device Pre-Service Port for DIGSI Protocols via System (SCADA) Interfaces Inputs

IEC 61850 GOOSE (internal device communication)

The GOOSE communication services of IEC 61850 can be used for interlocking of switchgears. The transmission time of the GOOSE information depends on the number of IEC 61850 clients and relay pickup conditions.
For the devices of versions V4.6 and above, the related desired action time must be checked in the application of the protection functions. In a particular case, necessary consultant must be performed to the manufactures in order to guarantee the application safety.

4.5 Dimensions

4.5.1 Panel Flush and Cubicle Mounting(housing dimensions $^1/_3$)

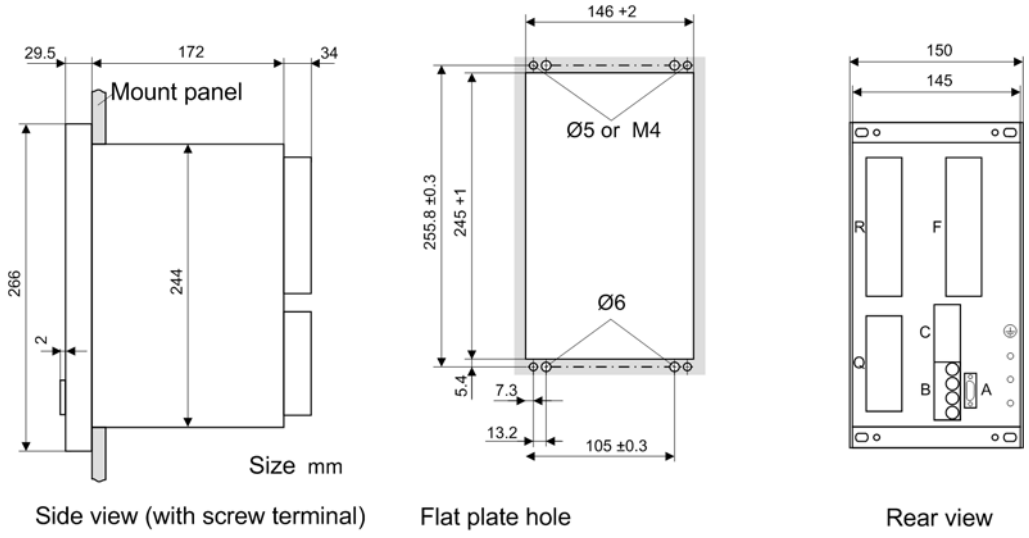

Figure 4-1 Dimensional Drawings of 7SJ689 for the Cubicle Mounting or the Flush Mounting of Switch Cubicle (casing dimensions $^1/_3$)

■

Appendix A

The appendix provides a basic reference for the experienced user. The appendix provides the ordering information of device modules. The appendix further comprises diagrams showing the terminal connection of the device modules. The following diagrams are the correct connection diagrams showing the connection between the device and primary equipment in some typical power system structures. Furthermore, all device arrangement selecting items further provide all setting tables and available information tables. Meanwhile, the appendix provides default setting values.

A.1 Ordering Information and Accessories

A.1.1 Ordering Information

A.1.1.1 7SJ689

Multi-Functional Protective Relay with Local Control	6	7		8	9	10	11	12		13	14	15	16		Supplementary
7 S J 6 8	**9**		–						–	**3**			**0**	+	

Housing, BinaryInput and Output,Measuring Transducer	Position 6
Frame$^{1}/_{3}$19" 8 BI,8 BO, 1 Life Contact,4CT/4PT	9

Measuring Inputs	Position 7
I_{Ph} = 1 A,I_N = 1 A	1
I_{Ph} = 5 A,I_N = 5 A	5

Auxiliary Voltage (Power Supply, Pickup Threshold of Binary Input)	Position 8
110 to 250 VDC, 115 to 230 VAC, Input threshold 88 VDC	5
110 to 250 VDC, 115 to 230 VAC, Input threshold 176 VDC	6

Construction:	Position 9
Flush Mounting Case Ring Lugs	E

Region-specific Default/Language Settings and Function Versions	Position 10
Region Worldwide, 50/60Hz, Language English	B
China, 50Hz, Language Chinese	W

System Interface (Rear Side, Port B)	Position 11
No system interface	0
Other interfaces L	9

Additional Information for Further System Interfaces (Rear side,Port B)	Supplementary
IEC60870-5-103, RS485 Double Network	+ L 0 P
IEC61850, EN100 Module RJ45 Port	+ L 0 R
IEC61850, EN100 Modular optical fibre double network	+ L 0 S

DIGSI/Modem Interface (Rear side,Port C)	Position12
No Interface	0
DIGSI4/Modem, RS232	1
DIGSI4/Modem, RS485	2

ANSI No.	Protection functions	Positions 14 and 15
59	Overvoltage protection	A A
	Local criterion	
	Remote trip protection	
	Fault recording	

A.1.2 Accessories

Exchangeable Interface Modules

Name	Order No.
RS232	C53207-A351-D641-1
RS485	C53207-A351-D642-1
FO 820 nm	C53207-A351-D643-1
Ethernet electrical (EN 100)	C53207-351-675-2
Ethernet Optical (EN 100)	C53207-351-676-1
IEC 60870-5-103 Protocol, Redundancy RS485	C53207-351-644-1

RS485/Fibre Optic Converter

RS485/Fibre Optic converter	Order No.
820 nm; FC-Connector	7XV5650-0AA00
820 nm; with ST-Connector	7XV5650-0BA00

Terminal Block Cover Plate

Terminal block cover plate type	Order No.
18-pin voltage terminal, 12-pin current terminal	C73334-A1-C31-1
12-pin voltage terminal, 8-pin current terminal	C73334-A1-C32-1

Link Bar

Terminal link bar type	Order No.
Voltage terminal, 18-terminal, or 12-terminal	C73334-A1-C34-1
Current terminal, 12-terminal, or 8-terminal	C73334-A1-C33-1

Female Plugs

Port type	Order No.
2-pin	C73334-A1-C35-1
3-pin	C73334-A1-C36-1

19"-Guide Rail for Subrack

Name	Order No.
Angle bead (Guide Rail)	C73165-A63-C200-4

Battery

Lithium battery 3 V/1 Ah, type CR 1/2 AA	Order No.
VARTA	6127 101 501

Interface Cable

Interface cable between PC and SIPROTEC device	Order No.
Cable with 9-pin male/female connections	7XV5100-4

RS485 Adapter Cable

Name	Order No.
Y-adapter cable for devices with IEC 60870-5-103 RS485 interface and sub-D connector on 2xRJ45 sub-miniature connector for a RS485 bus setup with network cables.2-core twisted, shielded, length 0.3 m; 1x RJ45 pin 9-pole on 2x RJ45 sub-miniature connector 8-pole	7XV5103-2BA00

IEC 60870-5-103 redundant, RS485 adapter cable

Name	Order No.
Y-shaped adapter cable of 2xRJ45 subminiature sub-D connector which is provided with IEC 60870-5-103 RS485 interface, is provided with network cable, and is used for setting RS485 bus.	7XV5103-2CA00

RS485 terminal resistor of RJ45 joint

Name	Order No.
Terminal resistor with RJ45 joint having the resistance of 120 (between pin 1 of 8-pin and pin	7XV5103-BA00 Terminal

A.2 Terminal Assignments

A.2.1 7SJ689-Housing for Panel Flush Mounting or Cubicle Mounting

7SJ689

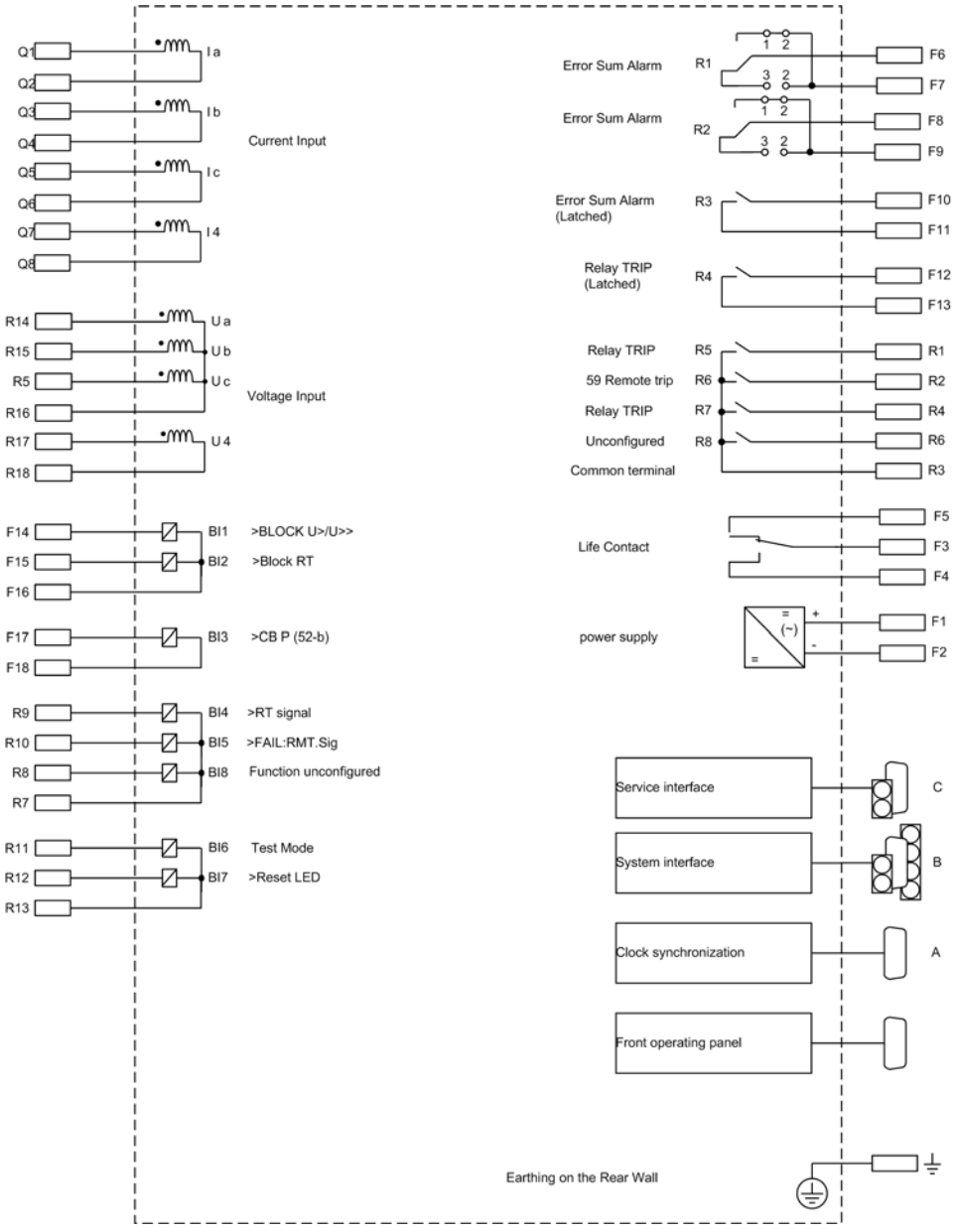

Figure A-1 7SJ689 Terminal Distributing Diagrams

A.2.2 7SJ689 - Housing for Panel Flush Mounting or Cubicle Mouting, Rear side

7SJ689

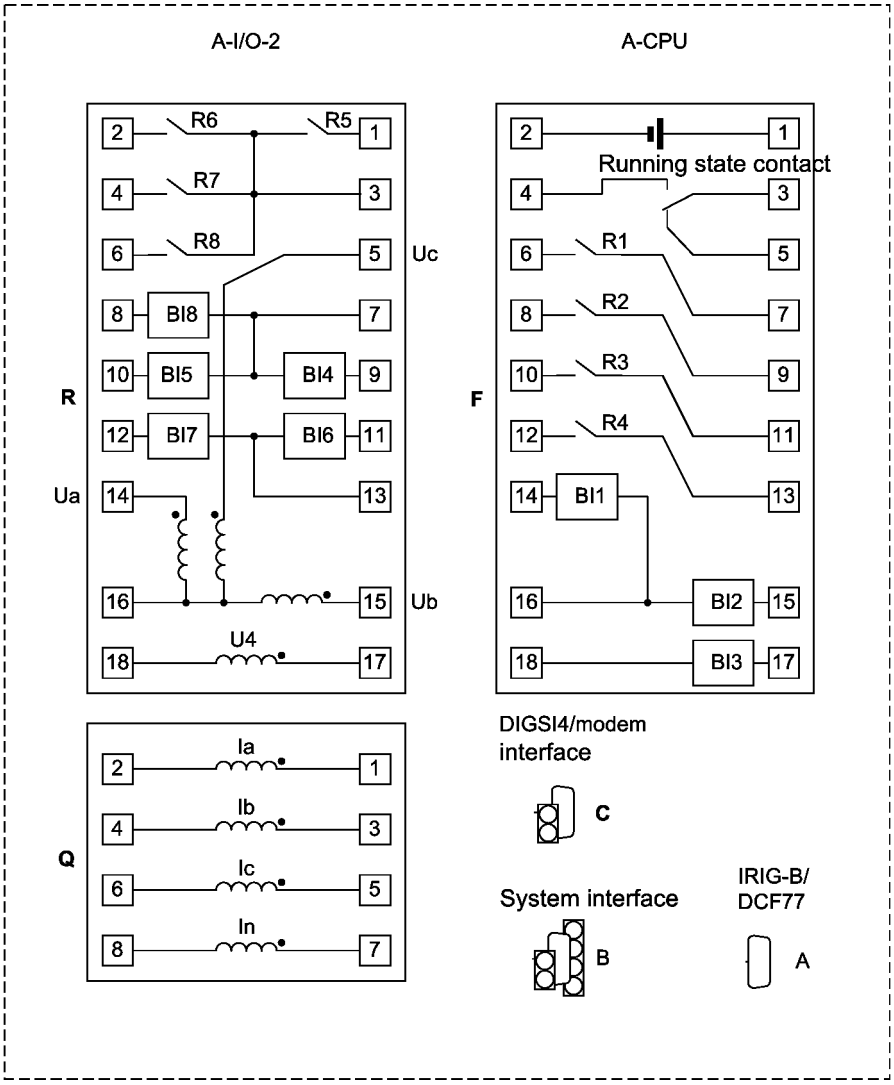

Figure A-2 Back view of 7SJ689

A.2.3 Connector Assignment

Serial Communication Port

	RS232	RS485	IEC 60870-5-103 Redundance RS485 (RJ45)
1	Shield (electrically connected with shield end)		B/B' (RxD/TxD-P)
2	RxD	—	A/A' (RxD/TxD-N)
3	TxD	A/A' (RxD/TxD-N)	—
4	—	—	—
5	GND	C/C' (GND)	—
6	—	—	—
7	RTS	—*)	—
8	CTS	B/B' (RxD/TxD-P)	—
9	—	—	—

*) Pin 7 also carries the RTS signal with RS232 level when operated as RS485 interface. Pin 7 must therefore not be connected!

Time Synchronization Port

Pin Number	Designation	Signal Meaning
1	P24_TSIG	Input 24 V
2	P5_TSIG	Input 5 V
3	M_TSIG	Loop line
4	—*)	—*)
5	Screen	Screen Potential
6	—	—
7	P12_TSIG	Input 12 V
8	P_TSYNC*)	Input 24 V*)
9	Screen	Screen Potential

*) assigned, but not available

A.3 Connection Examples

7SJ689

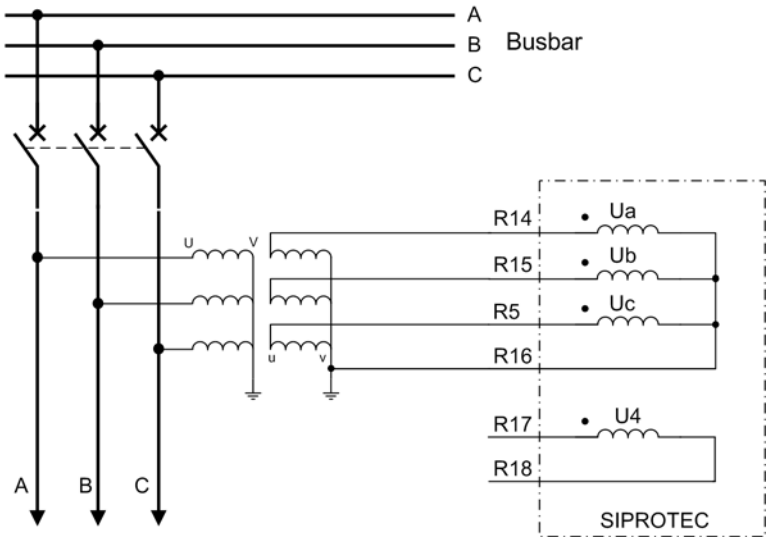

Figure A-3 Three Y-shaped PT voltage connection type (normal circuit layout)

A.4 Default Settings

A large number of LED indicating lamps, binary input and output and function keys are preset when the device is manufactured. The setting situation is illustrated as shown in the following tables.

A.4.1 LEDs

Table A-1 Display of Preset LED Lamps

LEDLamps	Allocated Function	Function No.	Description
LED1	Remote trip	17437	Latched
LED2	59 trip	17492	Latched
LED3	59 Remote trip	17494	Latched
LED4	CT Broken	17502	
	Fail I Superv.	161	
	Fail VT circuit	255	
	Error Sum Alarm	140	
	Alarm Sum Event	160	
LED5	RT Sig. N. Cfg.	17487	
	Error RMT.Sig	17503	
LED6	FltCurVol PU	17438	
	LowCurP PU	17439	
	LowPF PU	17441	
	Fail Ph. Seq. V	176	
LED7	Not configured	1	

A.4.2 Binary Input

Table A-2 Presetting of Input

Input	Allocated Function	Function No.	Description
BI1	>BLOCK 59	6513	Low level active
BI2	>Block RT	17430	Low level active
BI3	>CB P (52-b)	17495	
BI4	>RT signal	17431	
BI5	>FAIL:RMT.Sig	17504	
BI6	>Test mode	15	
BI7	>Reset LED	5	
BI8	Not configured	1	

A.4.3 Binary Output

Table A-3 Output device presettings for all devices and ordering variants

Output	Default Function	Function No.	Description
BO1	Error Sum Alarm	140	
BO2	Error Sum Alarm	140	
	Alarm Sum Event	160	
	CT Broken	17502	
	Fail I Superv.	161	
	Fail VT circuit	255	
BO3	Error Sum Alarm	140	Latched
	Alarm Sum Event	160	
	CT Broken	17502	
	Fail I Superv.	161	
	Fail VT circuit	255	
BO4	Relay TRIP	511	Latched
BO5	Relay TRIP	511	
BO6	59 Remote trip	17494	
BO7	Relay TRIP	511	
BO8	Not configured	1	

A.4.4 Default Display

7SJ689

The default display for the graphics performance characteristic of equipment 7SJ689 is the graphical solution of the current running state and/or the selected measured value. The displayed parameter can be selected during configuration.

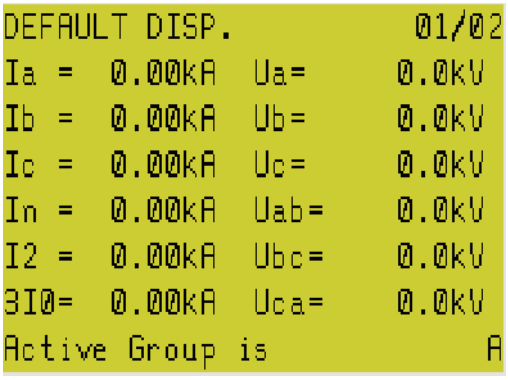

Figure A-4 Default display of the 7SJ689

A.5 Communication Protocol-dependent Functions

Protocal → / Function ↓	IEC 60870-5-103, redundant	IEC 61850 Ethernet (EN 100)	Additional service interface (optional)
Measured Values	Yes	Yes	Yes
Metered values	Yes	Yes	Yes
Fault recording	Yes	Yes	
Remote protection setting	—	Yes	/
User-defined signals and switching objects	Yes	Yes	Yes
Clock synchronization	Yes	Yes	—
Messages with time stampe	Yes	Yes	Yes
Commissioning aids			
Measured value signal module	Yes	Yes	Yes
Creating test messages	Yes	Yes	Yes
Physical mode	Asynchronous	Synchronous	—
Transmission Mode	Cyclically/Event	Cyclically/Event	—
Baud rate	2400 to 57600	Up to 100 MBaud	4800 to 115200
Type	-RS485	Ethernet TP Fiber-optic	-RS232 -RS485

A.6 Corresponding List between Writable Parameter and Message

Parameter			Message			Comments
Addresses	**Parameter Description**	**Function Group**	**No.**	**Message Description**	**Type of Information**	
0045	Remote Transfer Trip Function	System Parameter1	17440	Remote trip ON/OFF	IntSP	Flexible pressing plate
4500	Remote trip without local criterion	Remote trip protection	17442	Without local criterion ON/OFF	IntSP	Control Word
4501	PT switch off LC with voltage	Remote trip protection	17488	PT switched off LC ON/OFF	IntSP	Control Word
4510	Fault current/voltage criterion	Remote trip protection	17444	Fault cur/vol ON/OFF	IntSP	Control Word
4530	Low current/low active power criterion	Remote trip protection	17446	Low current/P ON/OFF	IntSP	Control Word
4540	Low power factor criterion	Remote trip protection	17448	Low power factor ON/OFF	IntSP	Control Word
0050	59 Overvoltage Protection	System Parameter1	17496	59 overvoltage ON/OFF	IntSP	Flexible pressing plate
5021	Overvoltage TRIP Local CB	Overvoltage protection	17497	59 trip local CB ON/OFF	IntSP	Control Word
5117	One phase over voltage ON/OFF	Overvoltage protection	17435	One phase over voltage ON/OFF	IntSP	Control Word
5118	Send Remote TRIP CMD.	Overvoltage protection	17498	Send remote trip CMD ON/OFF	IntSP	Control Word
5119	CB Close Position Block Remote TRIP CMD.	Overvoltage protection	17499	CB block remote trip ON/OFF	IntSP	Control Word

A.7 Settings

Addresses with suffixes ‘A’ only can be changed by DIGSI under `setting for displaying additional information`.

The following table shows region fault setting values. Column C (setting) shows secondary current rated values relevant to the current transformer.

Addresses.	Parameter	Function	C	Setting options	Default Setting	Comments
45	Remote Trip	Power system data1		ON OFF	ON	Remote Transfer Trip Function
50	FCT 59	Power system data1		ON OFF	ON	59 Overvoltage Protection
202	Vnom PRIMARY	Power system data1		1.0 .. 1200.0 kV	220.0 kV	Rated Primary Voltage
204	CT PRIMARY	Power system data1		1 .. 9999 A	1200 A	CT Rated Primary Current
205	CT PRIMARY	Power system data1	1A	1A 5A	1A	CT Rated Primary Current
			5A	1A 5A	5A	
217	Ignd-CT PRIM	Power system data1		1 .. 9999 A	1200 A	Ignd-CT rated primary current
218	Ignd-CT SEC	Power system data1	1A	1A 5A	1A	Ignd-CT rated secondary current
			5A	1A 5A	5A	
650	Remote Access	Power system data1		NO YES	NO	Remote Access enable
1101	FullScaleCurr.	Power system data2		1.0 .. 1200.0 kV	220.0 kV	Measurem:FullScaleCurrent(Equipm.rating)
1102	FullScaleVolt.	Power system data2		1 .. 9999 A	1200 A	Measurem:FullScaleVoltage(Equipm.rating)
4500	Without LC	Remote trip protection		ON OFF	ON	Remote trip without local criterion
4501	PT OFF LC	Remote trip protection		ON OFF	OFF	PT switch off LC with voltage
4502	T RT with LC	Remote trip protection		0.01.. 10.00 sec	0.10 sec	Remote trip with criterion time delay
4503	T RT without LC	Remote trip protection		0.01.. 10.00 sec	0.20 sec	Remote trip without criterion time delay
4510	Flt Cur/Vol	Remote trip protection		ON OFF	OFF	Fault current/voltage criterion
4511	Delta I pickup	Remote trip protection	1A	0.05 .. 0.50; ∞	0.20 A	Delta I pickup
			5A	0..25..2.5,A	1.00 A	
4512	3I0 pickup	Remote trip protection	1A	0.05 .. 20.00; ∞	1.00 A	3I0 pickup
			5A	0..25..100.00, ∞	5.00 A	
4513	I2 pickup	Remote trip protection	1A	0.05 .. 20.00; ∞	1.00 A	I2 pickup
			5A	0..25..100.00, ∞	5.00 A	
4514	3U0 pickup	Remote trip protection		2.0 .. 57.7 , ∞	10.0 V	3U0 pickup
4515	U2 pickup	Remote trip protection		2.0 .. 57.7 , ∞	10.0 V	U2 pickup
4530	Low I/P	Remote trip protection		ON OFF	OFF	Low current/low active power criterion
4531	I pickup	Remote trip protection		0.05 .. 0.50; 0	0.05 A	Low current pickup
				0..25..2.50, 0	0.25 A	
4532	P pickup	Remote trip protection	1A	2.0 .. 200.0, 0	8.0 W	Low active power pickup
			5A	10.0 .. 1000.0, 0	40.0 W	
4540	Low PF	Remote trip protection		ON OFF	OFF	Low power factor criterion

Addresses.	Parameter	Function	C	Setting options	Default Setting	Comments
4541	PF pickup	Remote trip protection		30 .. 90°	45°	Low power factor pickup
5117	1pOV ON/OFF	Overvoltage protection		ON OFF	ON	One phase over voltage ON/OFF
5118	Send RT. CMD.	Overvoltage protection		ON OFF	ON	Send Remote TRIP CMD.
5119	CB Pos. Block	Overvoltage protection		ON OFF	ON	CB Close Position Block Remote TRIP CMD.
5021	59 Trip Loc. CB	Overvoltage protection		ON OFF	ON	Overvoltage TRIP Local CB
5022	59 PICKUP	Overvoltage protection		57.7.. 100.0 V	60.0 V	59 Pickup
5023	59 DELAY	Overvoltage protection		0.01.. 10.00 sec	0.50 sec	59 Time Delay

A.8 Information List

The information of IEC 60 870-5-103 is reported as ON/OFF if the IEC 60 870-5-103 is general inquiry. The information of IEC 60 870-5-103 is reported as ON if the IEC 60 870-5-103 is not general inquiry.

The information which is user-defined by the new user or the information of the IEC 60 870-5-103 can be set as ON/OFF if information types are not from uploaded event types ('.._Ev'). The information types of more messages are described with reference to a SIPROTEC4 system, wherein Order No.: E50417-H1100-C151.

columns such as 'Event Log' 'Trip Log' and 'Ground Fault Log' are described according to the following rules:

UPPER CASE NOTATION ON/OFF:. definitely set, not allocatable

lower case notation On/off:. preset, allocatable

*: . not preset, allocatable

<blank>:. neither preset nor allocatable

Column I 'whether the faults recorder mark is available' uses the following rules:

UPPER CASE NOTATION 'M':. definitely set, not allocatable

lower case notation 'm':. preset, allocatable

*: . not preset, allocatable

<blank>:. neither preset nor allocatable

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					Comments
				Event Log ON/OFF	Trip (Fault)Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill.Rescord	LED	Input	Function Key	Device	Chatter Suppression	
-	>Back Light on	Device Universal	SP	on off	*		*	LED	BI		BO		
-	>Reset LED	Device Universal	IntSP	on	*		*	LED			BO		
-	>DataStop	Device Universal	IntSP	on off	*		*	LED			BO		
-	Test mode	Device Universal	IntSP	on off	*		*	LED			BO		
-	HWTestMod	Device Universal	IntSP	on off	*		*	LED			BO		
-	SynchClock	Device Universal	IntSP	*	*		*						
-	Distur.CFC	Device Universal	OUT	on off	*			LED			BO		
-	FltRecSta	Fault recording	IntSP	on off	*		m	LED			BO		
-	P-GrpA act	Setting changing	IntSP	on off	*		*	LED			BO		160
-	P-GrpB act	Setting changing	IntSP	on off	*		*	LED			BO		160
-	P-GrpC act	Setting changing	IntSP	on off	*		*	LED			BO		160
-	P-GrpD act	Setting changing	IntSP	on off	*		*	LED			BO		160
3	>Time Synch	Device Universal	SP_Ev	*	*			LED	BI		BO		
4	>Trig.Wave.Cap.	Fault recording	SP	*	*		m	LED	BI		BO		
5	>Reset LED	Device Universal	SP	*	*		*	LED	BI		BO		
7	>Set Group Bit0	Setting changing	SP	*	*		*	LED	BI		BO		
8	>Set Group Bit1	Setting changing	SP	*	*		*	LED	BI		BO		
15	>Test mode	Device Universal	SP	*	*		*	LED	BI		BO		
16	>DataStop	Device Universal	SP	*	*		*	LED	BI		BO		

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					Comments
				Event Log ON/OFF	Trip (Fault)Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill.Record	LED	Input	Function Key	Device	Chatter Suppression	
51	Device OK	Device Universal	OUT	on off	*		*	LED			BO		
52	ProtActive	Device Universal	IntSP	on off	*		*	LED			BO		
55	Reset Device	Device Universal	OUT	on	*		*	LED			BO		
56	Initial Start	Device Universal	OUT	on	*		*	LED			BO		
67	Resume	Device Universal	OUT	on	*		*	LED			BO		
68	Clock Synch. Error	Device Universal	OUT	on off	*		*	LED			BO		
69	DayLightSavTime	Device Universal	OUT	on off	*		*	LED			BO		
70	Settings Calc.	Device Universal	OUT	on off	*		*	LED			BO		
71	Settings Check	Device Universal	OUT	*	*		*	LED			BO		
72	Level-2 change	Device Universal	OUT	on off	*		*	LED			BO		
74	Remote Access	Device Universal	OUT	on off	*		*	LED			BO		
110	Event Lost	Device Universal	OUT_Ev	on	*			LED			BO		
113	Flag Lost	Device Universal	OUT	on	*		m	LED			BO		
125	Chatter ON	Device Universal	OUT	on off	*		*	LED			BO		
126	Protection ON/OFF	Power system data2	IntSP	on off	*		*	LED			BO		
140	Error Sum Alarm	Device Universal	OUT	on off	*		*	LED			BO		
144	Error 5V	Device Universal	OUT	on off	*		*	LED			BO		
145	Error 0V	Device Universal	OUT	on off	*		*	LED			BO		
146	Error -5V	Device Universal	OUT	on off	*		*	LED			BO		
147	Error PwrSupply	Device Universal	OUT	on off	*		*	LED			BO		
160	Alarm Sum Event	Device Universal	OUT	on off	*		*	LED			BO		
161	Fail I Superv.	Measurement Supervision	OUT	on off	*		*	LED			BO		
162	Failure Σ I	Measurement Supervision	OUT	on off	*		*	LED			BO		
163	Fail I balance	Measurement Supervision	OUT	on off	*		*	LED			BO		
167	Fail V balance	Measurement Supervision	OUT	on off	*		*	LED			BO		
169	VT FuseFail>10s	Measurement Supervision	OUT	on off	*		*	LED			BO		
170	VT FuseFail	Measurement Supervision	OUT	on off	*		*	LED			BO		
177	Fail Battery	Device Universal	OUT	on off	*		*	LED			BO		
183	Error Board 1	Device Universal	OUT	on off	*		*	LED			BO		
191	Error Offset	Device Universal	OUT	on off	*		*	LED			BO		
193	Alarm adjustm.	Device Universal	OUT	on off	*		*	LED			BO		
194	Error neutralCT	Device Universal	OUT	on off	*		*	LED			BO		

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					Comments
				Event Log ON/OFF	Trip (Fault)Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill.Record	LED	Input	Function Key	Device	Chatter Suppression	
197	MeasSup OFF	Measurement Supervision	OUT	on off	*		*	LED			BO		
203	Wave. deleted	Fault recording	OUT_Ev	on	*			LED			BO		
220	CT Ph wrong	Device Universal	OUT	on off	*		*	LED			BO		
255	Fail VT circuit	Measurement Supervision	OUT	on off	*		*	LED			BO		
259	VTsup. inactive	Measurement Supervision	OUT	on off	*		*	LED			BO		
272	SP. Op Hours>	Threshold-crossing value(statistic)	OUT	on off	*		*	LED			BO		
320	Warn Mem. Data	Device Universal	OUT	on off	*		*	LED			BO		
301	Pow.Sys.Flt.	Device Universal	OUT	on off	*		*	LED			BO		
320	Warn Mem. Data	Device Universal	OUT	on off	*		*	LED			BO		
321	Warn Mem. Para.	Device Universal	OUT	on off	*		*	LED			BO		
322	Warn Mem. Oper.	Device Universal	OUT	on off	*		*	LED			BO		
323	Warn Mem. New	Device Universal	OUT	on off	*		*	LED			BO		
356	>Manual Close	Power system data2	SP	*	*		*	LED	BI		BO		
409	>BLOCK Op Count	Statistic	SP	on off			*	LED	BI		BO		
501	Relay PICKUP	Power system data2	OUT		on		m	LED			BO		
511	Relay TRIP	Power system data2	OUT		on		m	LED			BO		
533	IL1:	Power system data2	VI		on off								
534	IL2:	Power system data2	VI		on off								
535	IL3:	Power system data2	VI		on off								
545	PU Time	Device Universal	VI										
546	TRIP Time	Device Universal	VI										
561	Man.Clos.Detect	Power system data2	OUT	on off	*		*	LED			BO		
1020	Op.Hours=	Statistic	VI										
1021	Σ Ia =	Statistic	VI										
1022	Σ Ib =	Statistic	VI										
1023	Σ Ic =	Statistic	VI										
4601	>Brk Aux NO	Power system data2											
4602	>Brk Aux NC	Power system data2											
6509	>FAIL:FEEDER VT	Measurement Supervision	SP	on off	*		*	LED	BI		BO		
6510	>FAIL: BUS VT	Measurement Supervision	SP	on off	*		*	LED	BI		BO		
6513	>BLOCK 59	Overvoltage	SP	on off	*		*	LED	BI		BO		
6565	59 OFF	Overvoltage	OUT	on off	*		*	LED			BO		
6566	59 BLOCKED	Overvoltage	OUT	on off	*		*	LED			BO		
6567	59 ACTIVE	Overvoltage	OUT	on off	*		*	LED			BO		
17430	>Block RT	Remote trip protection	SP	on off	*	*	*	LED	BI		BO		

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					Comments
				Event Log ON/OFF	Trip (Fault)Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill.Record	LED	Input	Function Key	Device	Chatter Suppression	
17431	>RT signal	Remote trip protection	SP	on off	*		*	LED	BI		BO		
17432	RT OFF	Remote trip protection	OUT	on off	*		*	LED			BO		
17433	RT blocked	Remote trip protection	OUT	on off	*		*	LED			BO		
17434	RT active	Remote trip protection	OUT	on off	*		*	LED			BO		
17440	Remote Trip	Remote trip protection	IntSP	on off	*		*	LED			BO		
17442	wtLC ON/OFF	Remote trip protection	IntSP	on off	*		*	LED			BO		
17444	FltIU ON/OFF	Remote trip protection	IntSP	on off	*		*	LED			BO		
17446	LowCurPON/OFF	Remote trip protection	IntSP	on off	*		*	LED			BO		
17448	PF pickup	Remote trip protection	IntSP	on off	*		*	LED			BO		
17466	3I0 picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17467	I2 picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17468	3U0 picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17469	U2 picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17470	Delta IAB PU	Remote trip protection	OUT	*	on off		*	LED			BO		
17471	Delta IBC PU	Remote trip protection	OUT	*	on off		*	LED			BO		
17472	Delta ICA PU	Remote trip protection	OUT	*	on off		*	LED			BO		
17473	IA picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17474	IB picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17475	IC picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17476	PA picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17477	PB picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17478	PC picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17479	PFA picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17480	PFB picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17481	PFC picked up	Remote trip protection	OUT	*	on off		*	LED			BO		
17482	Delta I TExt	Remote trip protection	OUT	*	on off		*	LED			BO		
17483	RT Signal	Remote trip protection	OUT	*	on off		*	LED			BO		
17484	CT BLK LC	Remote trip protection	OUT	*	on off		*	LED			BO		
17485	PT OFF LC	Remote trip protection	OUT	*	on off		*	LED			BO		
17486	PT BLK LC	Remote trip protection	OUT	*	on off		*	LED			BO		
17487	RT Sig. N. Cfg.	Remote trip protection	OUT	*	on off		*	LED			BO		
17488	PTwtLC ON/OFF	Remote trip protection	OUT	*	on off		*	LED			BO		
17491	59 picked up	Overvoltage	OUT	*	on off		*	LED			BO		
17492	59 trip	Overvoltage	OUT	*	on		*	LED			BO		
17493	59 alarm	Overvoltage	OUT	*	on off		*	LED			BO		
17494	59 Remote trip	Overvoltage	OUT	*	on		*	LED			BO		
17495	>CB P (52-b)	Overvoltage	OUT	*	on		*	LED			BO		
17496	FCT 59	Overvoltage	IntSP	on off	*		*	LED			BO		
17497	59trip ON/OFF	Overvoltage	IntSP	on off	*		*	LED			BO		
17498	59RT ON/OFF	Overvoltage	IntSP	on off	*		*	LED			BO		
17499	CBBLK ON/OFF	Overvoltage	IntSP	on off	*		*	LED			BO		

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					Comments
				Event Log ON/OFF	Trip (Fault)Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill.Rescord	LED	Input	Function Key	Device	Chatter Suppression	
17501	CT Broken>12s	Measurement Supervision	OUT	on off	on		*	LED			BO		
17502	CT Broken	Measurement Supervision		on off	on		*	LED			BO		
17503	Error RMT.Sig	Remote trip protection		on off	*		*	LED			BO		
17504	>FAIL:RMT.Sig	Remote trip protection		on off	*		*	LED			BO		
17435	1pOV ON/OFF	Overvoltage protection	IntSP	on off	*		*	LED			BO		
17436	Remote trip PU	Remote trip protection	OUT	on off	*		*	LED			BO		
17437	Remote trip	Remote trip protection	OUT	on off	*		*	LED			BO		
17438	FltCurVol PU	Remote trip protection	OUT	*	on off		*	LED			BO		
17439	LowCurP PU	Remote trip protection	OUT	*	on off		*	LED			BO		
17441	LowPF PU	Remote trip protection	OUT	*	on off		*	LED			BO		
30053	Fault rec. run.	Fault Recording											

A.9 Group Alarms

No.	Description	Function No.	Description
140	Failure alarm groups	144 145 146 147 177 178 183 191 193	5V Fault 0V Fault -5V Fault Power Supply Failure Alarm: Battery Input/Output Signal Panel Fault Plugin1 Faults Alarm: Offset Alarm: Analog Quantity Input Calibration Invalid
160	Event alarm groups	162 163 167	Current and supervision alarm Current Symmetric Supervision Alarm Voltage Symmetric Supervision Alarm
161	Current circuit supervision alarm	162 163	Current and supervision alarm Current Symmetric Supervision Alarm
255	PT Circuit Alarm	170	PT Broken Wire Instantaneous Alarm

A.10 Measured Values

Name	Description	Function	Type	Comments
	Total Number of Trips	Statistic	PMV	
601	Ia	Measurement	MV	
602	Ib	Measurement	MV	
603	Ic	Measurement	MV	
604	In	Measurement	MV	
605	I1(Positive Sequence)	Measurement	MV	
606	I2(Negative Sequence)	Measurement	MV	
621	Phase Voltage Ua	Measurement	MV	
622	Phase Voltage Ub	Measurement	MV	
623	Phase Voltage Uc	Measurement	MV	
624	Phase Voltage Ua-b	Measurement	MV	
625	Phase Voltage Ua-c	Measurement	MV	
626	Phase Voltage Ua-a	Measurement	MV	
627	Zero Sequence Voltage UN	Measurement	MV	
629	Positive Sequence Voltage U1	Measurement	MV	
630	Negative Sequence Voltage U2	Measurement	MV	
641	Active Power P	Measurement	MV	
642	Active Power Q	Measurement	MV	
645	S (apparent power)	Measurement	MV	
644	Frequencyf	Measurement	MV	
831	3Io(zero sequence)	Measurement	MV	
832	Uo(zero sequence)	Measurement	MV	
901	Power Factor	Measurement	MV	
30701	Pa (phase A active power)	Measurement	MV	*
30702	Pb (phase B active power)	Measurement	MV	
30703	Pc (phase C active power)	Measurement	MV	
30704	Qa (phase A reactive power)	Measurement	MV	
30705	Qb (phase B reactive power)	Measurement	MV	
30706	Qc (phase C reactive power)	Measurement	MV	
30707	A Phase Power Factor	Measurement	MV	*
30708	B Phase Power Factor	Measurement	MV	*
30709	C Phase Power Factor	Measurement	MV	*

*) If the measured values are needed to be sent via IEC 60 870-5-103, ‘scaling index’ of the information attribute is set to 7

■

Literature

/1/ SIPROTEC 4 System General; E50417-H1176-C151-B1

/2/ SIPROTEC DIGSI, Start UP; E50417-G1176-C152 -A3

/3/ DIGSI CFC, Manual; E50417-H1176-C098 -A9

/4/ SIPROTEC SIGRA 4, Manual; E50417-H1176-C070

Glossary

Battery

The buffer battery ensures that specified data areas, flags, timers and counters are retained retentively.

Bay controllers

Bay controllers are devices with control and monitoring functions without protective functions.

Bit pattern indication

Bit pattern indication is a processing function by means of which items of digital process information applying across several inputs can be detected together in parallel and processed further. The bit pattern length can be specified as 1, 2, 3 or 4 bytes.

BP_xx

Æ Bit pattern indication (Bitstring Of x Bit), x designates the length in bits (8, 16, 24 or 32 bits).

C_xx

Command without feedback

CF_xx

Command with feedback

CFC

Continuous Function Chart. CFC is a graphics editor with which a program can be created and configured by using ready-made blocks.

CFC blocks

Blocks are parts of the user program delimited by their function, their structure or their purpose.

Chatter blocking

A rapidly intermittent input (for example, due to a relay contact fault) is switched off after a configurable monitoring time and can thus not generate any further signal changes. The function prevents overloading of the system when a fault arises.

Combination devices

Combination devices are bay devices with protection functions and a control display.

Combination matrix

DIGSI V4.6 and higher allows up to 32 compatible SIPROTEC 4 devices to communicate with each other in an inter-relay communication network (IRC). The combination matrix defines which devices exchange which information.

Communication branch

A communications branch corresponds to the configuration of 1 to n users which communicate by means of a common bus.

Communication reference CR

The communication reference describes the type and version of a station in communication by PROFIBUS.

Component view

In addition to a topological view, SIMATIC Manager offers you a component view. The component view does not offer any overview of the hierarchy of a project. It does, however, provide an overview of all the SIPROTEC 4 devices within a project.

COMTRADE

Common Format for Transient Data Exchange, format for fault records.

Container

If an object can contain other objects, it is called a container. The object Folder is an example of such a container.

Control display

The image which is displayed on devices with a large (graphic) display after pressing the control key is called control display. It contains the switchgear that can be controlled in the feeder with status display. It is used to perform switching operations. Defining this diagram is part of the configuration.

Data pane

Æ The right-hand area of the project window displays the contents of the area selected in the Æ navigation window, for example indications, measured values, etc. of the information lists or the function selection for the device configuration.

DCF77

The extremely precise official time is determined in Germany by the "Physikalisch-Technischen-Bundesanstalt PTB" in Braunschweig. The atomic clock unit of the PTB transmits this time via the long-wave time-signal transmitter in Mainflingen near Frankfurt/Main. The emitted time signal can be received within a radius of approx. 1,500 km from Frankfurt/Main.

Device container

In the Component View, all SIPROTEC 4 devices are assigned to an object of type Device container. This object is a special object of DIGSI Manager. However, since there is no component view in DIGSI Manager, this object only becomes visible in conjunction with STEP 7.

Double command

Double commands are process outputs which indicate 4 process states at 2 outputs: 2 defined (for example ON/OFF) and 2 undefined states (for example intermediate positions)

Double-point indication

Double-point indications are items of process information which indicate 4 process states at 2 inputs: 2 defined (for example ON/OFF) and 2 undefined states (for example intermediate positions).

DP

Æ Double-point indication

DP_I

Æ Double point indication, intermediate position 00

Drag-and-drop

Copying, moving and linking function, used at graphics user interfaces. Objects are selected with the mouse, held and moved from one data area to another.

Electromagnetic compatibility

Electromagnetic compatibility (EMC) is the ability of an electrical apparatus to function fault-free in a specified environment without influencing the environment unduly.

EMC

Æ Electromagnetic compatibility

ESD protection

ESD protection is the total of all the means and measures used to protect electrostatic sensitive devices.

ExBPxx

External bit pattern indication via an ETHERNET connection, device-specific Æ Bit pattern indication

ExC

External command without feedback via an ETHERNET connection, device-specific

ExCF

External command with feedback via an ETHERNET connection, device-specific

ExDP

External double point indication via an ETHERNET connection, device-specific Æ Double-point indication

ExDP_I

External double-point indication via an ETHERNET connection, intermediate position 00, Æ Double-point indication

ExMV

External metered value via an ETHERNET connection, device-specific

ExSI

External single-point indication via an ETHERNET connection, device-specific Æ Single-point indication

ExSI_F

External single point indication via an ETHERNET connection, device-specific, Æ Fleeting indication, Æ Single-point indication

Field devices

Generic term for all devices assigned to the field level: Protection devices, combination devices, bay controllers.

Floating

Æ Without electrical connection to the Æ ground.

FMS communication branch

Within an FMS communication branch the users communicate on the basis of the PROFIBUS FMS protocol via a PROFIBUS FMS network.

Folder

This object type is used to create the hierarchical structure of a project.

General interrogation (GI)

During the system start-up the state of all the process inputs, of the status and of the fault image is sampled. This information is used to update the system-end process image. The current process state can also be sampled after a data loss by means of a GI.

GOOSE message

GOOSE-messages (Generic Object Oriented Substation Event) are data packets which will be transferred via the Ethernet-communication system in case of event-controlled. They serve to the direct information exchange of the device to each other. The cross-communication between the bay devices is implemented via this mechanism.

GPS

Global Positioning System. Satellites with atomic clocks on board orbit the earth twice a day in different parts in approx. 20,000 km. They transmit signals which also contain the GPS universal time. The GPS receiver determines its own position from the signals received. From its position it can derive the running time of a satellite and thus correct the transmitted GPS universal time.

Ground

The conductive ground whose electric potential can be set equal to zero in any point. In the area of ground electrodes the ground can have a potential deviating from zero. The term "Ground reference plane" is often used for this state.

Grounding

Grounding means that a conductive part is to connect via a grounding system to Æ ground.

Grounding

Grounding is the total of all means and measured used for grounding.

Hierarchy level

Within a structure with higher-level and lower-level objects a hierarchy level is a container of equivalent objects.

HV field description

The HV project description file contains details of fields which exist in a ModPara project. The actual field information of each field is memorized in a HV field description file. Within the HV project description file, each field is allocated such a HV field description file by a reference to the file name.

HV project description

All data are exported once the configuration and parameterization of PCUs and sub-modules using ModPara has been completed. This data is split up into several files. One file contains details about the fundamental project structure. This also includes, for example, information detailing which fields exist in this project. This file is called a HV project description file.

ID

Internal double-point indication Æ Double-point indication

ID_S

Internal double point indication intermediate position 00 Æ Double-point indication

IEC

International Electrotechnical Commission

IEC Address

Within an IEC bus a unique IEC address has to be assigned to each SIPROTEC 4 device. A total of 254 IEC addresses are available for each IEC bus.

IEC communication branch

Within an IEC communication branch the users communicate on the basis of the IEC60-870-5-103 protocol via an IEC bus.

IEC61850

Worldwide communication standard for communication in substations. This standard allows devices from different manufacturers to interoperate on the station bus. Data transfer is accomplished through an Ethernet network.

Initialization string

An initialization string comprises a range of modem-specific commands. These are transmitted to the modem within the framework of modem initialization. The commands can, for example, force specific settings for the modem.

Inter relay communication

Æ IRC combination

IRC combination

Inter Relay Communication, IRC, is used for directly exchanging process information between SIPROTEC 4 devices. You require an object of type IRC combination to configure an Inter Relay Communication. Each user of the combination and all the necessary communication parameters are defined in this object. The type and scope of the information exchanged among the users is also stored in this object.

IRIG-B

Time signal code of the Inter-Range Instrumentation Group

IS

Internal single-point indication Æ Single-point indication

IS_F

Internal indication fleeting Æ Fleeting indication, Æ Single-point indication

ISO 9001

The ISO 9000 ff range of standards defines measures used to ensure the quality of a product from the development to the manufacturing.

Link address

The link address gives the address of a V3/V2 device.

List view

The right pane of the project window displays the names and icons of objects which represent the contents of a container selected in the tree view. Because they are displayed in the form of a list, this area is called the list view.

LV

Limit value

LVU

Limit value, user-defined

Master

Masters may send data to other users and request data from other users. DIGSI operates as a master.

Metered value

Metered values are a processing function with which the total number of discrete similar events (counting pulses) is determined for a period, usually as an integrated value. In power supply companies the electrical work is usually recorded as a metered value (energy purchase/supply, energy transportation).

MLFB

MLFB is the acronym of "MaschinenLesbare FabrikateBezeichnung" (machine-readable product designation). It is equivalent to the order number. The type and version of a SIPROTEC 4 device are coded in the order number.

Modem connection

This object type contains information on both partners of a modem connection, the local modem and the remote modem.

Modem profile

A modem profile consists of the name of the profile, a modem driver and may also comprise several initialization commands and a user address. You can create several modem profiles for one physical modem. To do so you need to link various initialization commands or user addresses to a modem driver and its properties and save them under different names.

Modems

Modem profiles for a modem connection are saved in this object type.

MV

Measured value

MVMV

Metered value which is formed from the measured value

MVT

Measured value with time

MVU

Measured value, user-defined

Navigation pane

The left pane of the project window displays the names and symbols of all containers of a project in the form of a folder tree.

Object

Each element of a project structure is called an object in DIGSI.

Object properties

Each object has properties. These might be general properties that are common to several objects. An object can also have specific properties.

Off-line

In offline mode a link with the SIPROTEC 4 device is not necessary. You work with data which are stored in files.

OI_F

Output indication fleeting Æ Transient information

On-line

When working in online mode, there is a physical link to a SIPROTEC 4 device which can be implemented in various ways. This link can be implemented as a direct connection, as a modem connection or as a PROFIBUS FMS connection.

OUT

Output indication

Parameter set

The parameter set is the set of all parameters that can be set for a SIPROTEC 4 device.

Phone book

User addresses for a modem connection are saved in this object type.

PMV

Pulse metered value

Process bus

Devices featuring a process bus interface can communicate directly with the SICAM HV modules. The process bus interface is equipped with an Ethernet module.

PROFIBUS

PROcess FIeld BUS, the German process and field bus standard, as specified in the standard EN 50170, Volume 2, PROFIBUS. It defines the functional, electrical, and mechanical properties for a bit-serial field bus.

PROFIBUS Address

Within a PROFIBUS network a unique PROFIBUS address has to be assigned to each SIPROTEC 4 device. A total of 254 PROFIBUS addresses are available for each PROFIBUS network.

Project

Content-wise, a project is the image of a real power supply system. Graphically, a project is represented by a number of objects which are integrated in a hierarchical structure. Physically, a project consists of a series of folders and files containing project data.

Protection devices

All devices with a protective function and no control display.

Reorganizing

Frequent addition and deletion of objects creates memory areas that can no longer be used. By cleaning up projects, you can release these memory areas. However, a clean up also reassigns the VD addresses. As a consequence, all SIPROTEC 4 devices need to be reinitialized.

RIO file

Relay data Interchange format by Omicron.

RSxxx-interface

Serial interfaces RS232, RS422/485

SCADA Interface

Rear serial interface on the devices for connecting to a control system via IEC or PROFIBUS.

Service port

Rear serial interface on the devices for connecting DIGSI (for example, via modem).

Setting parameters

General term for all adjustments made to the device. Parameterization jobs are executed by means of DIGSI or, in some cases, directly on the device.

SI

Æ Single point indication

SI_F

Æ Single-point indication fleeting Æ Transient information, Æ Single-point indication

SICAM SAS

Modular substation automation system based on the substation controller Æ SICAM SC and the SICAM WinCC operator control and monitoring system.

SICAM SC

Substation Controller. Modularly substation control system, based on the SIMATIC M7 automation system.

SICAM WinCC

The SICAM WinCC operator control and monitoring system displays the condition of your network graphically, visualizes alarms and indications, archives the network data, allows to intervene manually in the process and manages the system rights of the individual employee.

Single command

Single commands are process outputs which indicate 2 process states (for example, ON/OFF) at one output.

Single point indication

Single indications are items of process information which indicate 2 process states (for example, ON/OFF) at one output.

SIPROTEC

The registered trademark SIPROTEC is used for devices implemented on system base V4.

SIPROTEC 4 device

This object type represents a real SIPROTEC 4 device with all the setting values and process data it contains.

SIPROTEC 4 variant

This object type represents a variant of an object of type SIPROTEC 4 device. The device data of this variant may well differ from the device data of the source object. However, all variants derived from the source object have the same VD address as the source object. For this reason, they always correspond to the same real SIPROTEC 4 device as the source object. Objects of type SIPROTEC 4 variant have a variety of uses, such as documenting different operating states when entering parameter settings of a SIPROTEC 4 device.

Slave

A slave may only exchange data with a master after being prompted to do so by the master. SIPROTEC 4 devices operate as slaves.

Time stamp

Time stamp is the assignment of the real time to a process event.

Topological view

DIGSI Manager always displays a project in the topological view. This shows the hierarchical structure of a project with all available objects.

Transformer Tap Indication

Transformer tap indication is a processing function on the DI by means of which the tap of the transformer tap changer can be detected together in parallel and processed further.

Transient information

A transient information is a brief transient Æ single-point indication at which only the coming of the process signal is detected and processed immediately.

Tree view

The left pane of the project window displays the names and symbols of all containers of a project in the form of a folder tree. This area is called the tree view.

TxTap

Æ Transformer Tap Indication

User address

A user address comprises the name of the station, the national code, the area code and the user-specific phone number.

Users

DIGSI V4.6 and higher allows up to 32 compatible SIPROTEC 4 devices to communicate with each other in an inter-relay communication network. The individual participating devices are called users.

VD

A VD (Virtual Device) includes all communication objects and their properties and states that are used by a communication user through services. A VD can be a physical device, a module of a device or a software module.

VD address

The VD address is assigned automatically by DIGSI Manager. It exists only once in the entire project and thus serves to identify unambiguously a real SIPROTEC 4 device. The VD address assigned by DIGSI Manager must be transferred to the SIPROTEC 4 device in order to allow communication with DIGSI Device Editor.

VFD

A VFD (Virtual Field Device) includes all communication objects and their properties and states that are used by a communication user through services.