Numerical Voltage, Frequency, and Overflux Protection Relay

SIPROTEC 7RW600 V1.0

Instruction Manual

Order No: C53000–G1176–C117–3

Figure 1  Illustration of the numerical voltage, frequency, and overflux protection relay 7RW600 (in flush mounting case)
Conformity

This product is in conformity 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 application within specified voltage limits (Low-voltage directive 73/23 EEC).

Conformity is proved by tests that had been performed according to article 10 of the Council Directive in accordance with the generic standards EN 50081 and EN 50082 (for EMC directive) and the standards EN 60255—6 (for low-voltage directive) by Siemens AG.

The device is designed and manufactured for application in industrial environment.

The device is designed in accordance with the international standards of IEC 60255 and the German standards DIN 57435 part 303 (corresponding to VDE 0435 part 303).

Further applicable standards: ANSI/IEEE C37.90.0 and C37.90.1.
Matching the rated frequency

When the relay is delivered from factory, it is preset to operate with a rated frequency of 50 Hz. If the rated system frequency is 60 Hz, this must be matched accordingly. Switch-over to 60 Hz is explained in detail in the operation instructions in Section 6.3.3, first item. In the following, switch-over to 60 Hz is described in an abbreviated form.

The operating interface is built up by a hierarchically structured menu tree, which can be passed through by means of the scrolling keys ↓, ↑, Δ, and ↘. Thus, each operation object can be reached as illustrated in the example below for change-over of the rated frequency.

After the relay has been switched on, the green LED (“Service”) illuminates and the red LED (“Blocked”) lights up until the processor system has started up. The display shows the type identification of the relay (“7RW600”) and the version of the implemented firmware (“V1.**”).

Pressing the key ↘ leads to the main menu item “PARAM.” (parameters). Switch over to the second operation level with key ↑. The first address block is “00 CONF.” (configuration). Key ↘ leads to the second address block “01 POWER SYST.DAT” (power system data). On the third operation level, which is obtained with ↑, the first item is “01 FREQ” (frequency).

Press the following keys in sequence: ↑↑↑↑. The display shows the new rated frequency 60 Hz. Confirm again with ↓. Press twice the key ↓ to return to the first operation level.

![Diagram](attachment:image)

Press ↘ key
press ↑ key
press ↘ key
press ↑ key
press ↘ key
press ↓ key
press ↓ key
press ↓ key
press ↓ key
press ↓ key
press ↓ key
press + key
press – key
press + key
press + key
press + key
press E key
press E key
press E key
press E key
press E key
rated frequency is now 60 Hz

return to 1st operation level
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NOTE:

This instruction manual does not purport to cover all details in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information 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 sales office.

The contents of this instruction manual shall not become part nor modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligations of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein do not create new warranties nor modify the existing warranty.
1 Introduction

1.1 Application

The functions contained in the relay SIPROTEC 7RW600 can be used for various protection and supervision tasks.

Typical application is the use as a network disconnecting relay, which maintains the in-plant generation after a network fault. Furthermore, it can be used as load shedding relay, when impermissible voltage or frequency fluctuations may give rise to network black-out. In conjunction with the overcurrent time protection relay SIPROTEC 7SJ600, protection for electrical machines can be established.

As machine protection relay, the voltage, frequency, and overflux protection guard generators and transformers against faulty operation of the voltage and/or speed regulator, after full load rejection, or in island operation of power stations.

Throughout a fault in the network or power station the magnitudes of the instantaneous measured and calculated values are stored for a period of max. 5 seconds and are available for subsequent fault analysis. Alternatively, the r.m.s. values can be stored over max. 50 s. In order to transmit these data, the relay is equipped with a serial RS485 interface. Thus, comfortable and clear evaluation of the fault history including fault recording is possible as well as comfortable operation of the relay, by means of a personal computer with appropriate programs. This interface is suited to communication via a modem link.

Continuous monitoring of the hardware and software of the relay permits rapid annunciation of internal faults. This ensures the high reliability and availability of the device.

1.2 Features

- Processor system with powerful 16-bit microcontroller;
- complete digital measured value processing and control from data acquisition and digitizing of the measured values up to the trip decisions for the circuit breaker;
- complete galvanic and reliable separation of the internal processing circuits from the measurement, control and supply circuits of the system, with analog input transducers, binary input and output modules, and d.c./d.c. converter;
- insensitive against current transformer errors, transient phenomena and interferences;
- different combinations of the protective and supervision functions can be ordered;
- the two measured input voltages may be connected phase-to-phase (V-connection) or single-phase to different voltage transformers;
- circuit breaker operation test facility by test trip of the breaker;
- trip circuit supervision for the tripping coil including the circuitry possible;
- simple setting and operation using the integrated operation panel or a connected personal computer with menu-guided software;
- storage of fault data, storage of instantaneous or r.m.s. values during a fault for fault recording.
1.3 Implemented functions

The available protective and supervisory functions of the numerical voltage, frequency, and overflux relay SIPROTEC 7RW600 depend on the ordered version, refer also to Section 2.3 Ordering data. They can be switched effective or ineffective. The total possible scope of functions is the following:

**Undervoltage protection**

- single-stage undervoltage detection:
- two different voltages can be processed with single-phase voltage connection,
- the positive sequence voltage is processed with two-phase voltage connection (V-connection).

**Overvoltage protection**

- two-stage overvoltage detection with separately adjustable setting values,
- two voltages can be processed with single-phase voltage connection, two-stage each,
- both the phase-to-phase voltages are processed with two-phase voltage connection (V-connection), two-stage.

**Frequency protection**

- four individually adjustable frequency stages can be set as overfrequency protection \( f > \) or underfrequency protection \( f < \),
- high-accuracy measurement procedure,
- insensitive against harmonics and phase shifts,
- adjustable minimum operating voltage threshold,
- each stage with individually settable time delay.

**Rate-of-frequency-change protection**

- four individually adjustable rate-of-change stages can be set as drop-of-frequency protection \( | -df/dt | > \),
- adjustable minimum operating voltage threshold,
- each stage with individually settable time delay,
- all stages are released when \( f < f_N \), or can be combined with the corresponding underfrequency stage.

**Overflux protection**

- calculation of the ratio \( U/f \) (proportional to induction \( B \)),
- calculation of the thermal stress,
- standard characteristic or either optional characteristic selectable,
- adjustable warning and tripping stage.
2 Design

2.1 Arrangements

All protection functions including dc/dc converter are accommodated on a printed circuit board of Double Europa Format. This p.c.b. forms, complemented by a guide plate, a multi-pin connector module and a front unit, a plug-in module which is installed in a housing 7XP20.

The guide plate cams in conjunction with distance pieces on the p.c.b. and the shaping of the connector modules ensure proper mounting and fixing of the module. The inner part of the housing is free from enamel and thus functions as a large contact plane and shield with solid electrical conductivity and mates with the earthing blades of the module. Connection to earth is made before the plugs make contact. An earthing area has been provided at the housing to which grounding strips can be connected in order to ensure solid low-impedance earthing.

The degree of protection for the housing is IP51, for the terminals IP21.

Three different types of housings can be delivered:

- **7RW600x--xB+++** in housing 7XP20 with terminals at both sides for panel surface mounting

  The housing is built of a metal tube and carries a terminal block with four holes for fixing the relay to the panel.

  All external signals are connected to the terminal block which is mounted without screws at the rear of the housing. For each electrical connection, one screwed terminal for the use of up to two ring cable lugs is provided. Alternatively, up to two solid bare wires (even with different diameter) can be connected directly. Use copper conductors only! Use copper conductors only!

  For dimensions please refer to Figure 2.1.

- **7RW600x--xD+++** in housing 7XP20 with terminal top and bottom for panel surface mounting

  The housing is built of a metal tube and carries fixing angles for mounting on the panel.

  All external signals are connected to screwed terminals which are arranged over cut-outs on the top and bottom covers. The terminals are numbered consecutively from left to right at the bottom and top. Use copper conductors only!

  For dimensions please refer to Figure 2.2.

- **7RW600x--xE+++** in housing 7XP20 for panel flush mounting or cubic installation

  The housing is built of a metal tube and carries fixing angles for mounting into the panel cut-out or into the cubic rack.

  All external signals are connected to a connector block which is mounted without screws at the rear of the housing. For each electrical connection, one screwed terminal for the use of up to two ring cable lugs and one parallel snap-in terminal are provided. For field wiring, the use of the screwed terminals is recommended; snap-in connection requires special tools. Use copper conductors only!

  For dimensions please refer to Figure 2.3.
2.2 Dimensions

Figures 2.1 to 2.3 show the dimensions of the various types of housings available.

**7RW600**××××**B**×××× Housing for panel surface mounting 7XP20 with terminals at both sides

<table>
<thead>
<tr>
<th>Recommended space</th>
<th>Dimensions in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>77</td>
</tr>
<tr>
<td>Ø9</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td></td>
</tr>
<tr>
<td>260</td>
<td></td>
</tr>
<tr>
<td>260</td>
<td></td>
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<tr>
<td>29.5</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td></td>
</tr>
</tbody>
</table>

**Heavy current connectors (terminals 1 to 6, not used in 7RW600):**

- **isolated ring cable lug:** for bolts 6 mm diameter
- **max. major diameter 13 mm**
- **type:** e.g. PIDG of Messer AMP
- **for copper wires with cross section:** 2.7 mm² to 8.6 mm²
- **AWG 12 to 10**

- **solid bare copper wire directly:** cross section 2.5 mm² to 4.0 mm²
- **AWG 13 to 11**
- **flexible wire requires end sleeves**
- **max. torque value:** 3.5 Nm or 34 in-lbs

**Voltage connectors (terminals 7 to 31):**

- **isolated ring cable lug:** for bolts 4 mm diameter
- **max. major diameter 9 mm**
- **type:** e.g. PIDG of Messer AMP
- **for copper wires with cross section:** 1.0 mm² to 2.6 mm²
- **AWG 17 to 13**

- **solid bare copper wire directly:** cross section 0.5 mm² to 2.6 mm²
- **AWG 20 to 13**
- **flexible wire requires end sleeves**
- **max. torque value:** 1.8 Nm or 16 in-lbs

Figure 2.1 Dimensions for housing 7XP20 for panel surface mounting with terminals at both sides
7RW600\*--\*D*** in housing for **panel surface mounting** 7XP20 with terminals top and bottom

Max. 32 terminals for cross-section max. 7 mm²
Max. torque value 3.5 Nm or 34 in-lbs

Installation on the panel shall be carried out with studs or screws size M6.
If the relay is to be mounted on (e.g. existing) bolts size M8, then slot nuts acc. DIN 546 shall be used.

**Dimensions in mm**

Figure 2.2 . Dimensions for housing 7XP20 for panel surface mounting with terminals top and bottom
**7RW600** Housing for **panel flush mounting** or cubicle installation 7XP20

---

**Heavy current connectors (terminals 1 to 6, not used in 7RW600):**

- **Screwed terminal (ring cable lug):** for bolts 6 mm diameter  
  max. major diameter 13 mm  
  type: e.g. PIDG of Messei AMP  
  for copper wires with cross section  
  2.7 mm² to 6.6 mm²  
  AWG 12 to 10

- **Snap-in terminal:** for copper wires with cross-section  
  2.5 mm² to 4.0 mm²  
  AWG 13 to 11

**max. torque value** 3.5 Nm or 34 in-lbs

---

**Voltage connectors (terminals 7 to 31):**

- **Screwed terminal (ring cable lug):** for bolts 4 mm diameter  
  max. major diameter 9 mm  
  type: e.g. PIDG of Messei AMP  
  for copper wires with cross section  
  1.0 mm² to 2.6 mm²  
  AWG 17 to 13

- **Snap-in terminal:** for copper wires with cross-section  
  0.5 mm² to 2.5 mm²  
  AWG 20 to 13

**max. torque value** 1.8 Nm or 16 in-lbs

---

**Dimensions in mm**

---

**Figure 2.3** Dimensions for housing 7XP20 for panel flush mounting or cubicle installation
### 2.3 Ordering data

**Numerical Frequency, Voltage, and Overflux Protection**

<table>
<thead>
<tr>
<th>7 R W 6 0 0</th>
<th>0</th>
<th>A</th>
<th>0</th>
<th>D</th>
<th>A</th>
<th>0</th>
</tr>
</thead>
</table>

**Auxiliary voltage**
- 24/48 V dc ........................................... 2
- 60/110/125 V dc ..................................... 4
- 220/250 V dc / 115 V ac, 50/60 Hz ..................... 5

**Construction**
- in housing for panel surface mounting with terminals at both sides ........................................... B
- in housing for panel surface mounting with terminals top and bottom ........................................... D
- in housing for panel flush mounting/cubicle installation ...................................................... E

**Preset operating language**
- English ......................................................... 0
- German .......................................................... 1
- Spanish .......................................................... 2
- French ............................................................ 3

**Scope of functions**
- Voltage and frequency protection ................................. 0
- Voltage, frequency, rate-of-frequency-change protection ................................. 1
- Voltage and overflux protection ................................. 2
2.4 Accessories

A connecting cable of 1 m length is attached to the converter V.24—to—RS485. This is used to connect the terminals of the relay with the 25-pole socket at the converter which is designated with “RS422”.

The copper connecting cable 7XV5100 is to connect the 25-pole connector at the converter which is designated with “RS232”, with the personal computer or laptop.

A copper connecting cable, a converter V.24—to—RS485, and an operating program DIGSI are necessary for communication between the protection relay and a personal computer or laptop.

A fibre-optic converter is necessary when the relay is to be connected via an optical fibre cable to a central station.

Copper connecting cable
between PC (9pin socket) and converter V.24 — RS485 .............................. 7XV5100—2
between PC (25pin socket) and converter V.24 — RS485 .............................. 7XV5100—0

Converter V.24 — RS485
with connecting cable 1 m, PC adapter with connector 230 Vac, 50 Hz ............. 7XV5700—0AA00
with connecting cable 1 m, PC adapter with connector 110 Vac, 60 Hz ............. 7XV5700—1AA00

Converter full-duplex fibre-optic cable — RS485
with aux. supply 24—250 Vdc and 110/230 Vac ................................. 7XV5600—0AA00

Operating software DIGSI
DIGSI—LIGHT V3 (expansion level 1)
parameterization and operating software (English) ............................... 7XS5120—1AA00
DIGSI V3 extended version
parameterization and operating software (English) ............................... 7XS5020—1AA00
requirement: MS—WINDOWS V3.1 or higher

Graphic evaluation program DIGRA¹)
for visualization of fault recordings, together with DIGSI V3 (English) .......... 7XS5130—1AA00
requirement: MS—WINDOWS V3.1 or higher and DIGSI

¹) is included in the extended version of operating software program DIGSI V3
3 Technical data

3.1 General data

3.1.1 Inputs/outputs

### Measuring circuits

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<th>Specification</th>
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<td>Rated voltage $U_N$</td>
<td>100 V to 125 V (selectable)</td>
</tr>
<tr>
<td>Rated frequency $f_N$</td>
<td>50 Hz/60 Hz (selectable)</td>
</tr>
<tr>
<td>Power consumption voltage path at 100 V</td>
<td>$\leq 0.2$ VA per input</td>
</tr>
<tr>
<td>Linearity range voltage path</td>
<td>170 Vac</td>
</tr>
<tr>
<td>Overload capability voltage path – thermal (r.m.s.)</td>
<td>200 V continuous 230 V for $\leq 10$ s</td>
</tr>
</tbody>
</table>

### Auxiliary voltage

Power supply via integrated dc/dc converter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated auxiliary voltage $U_r$ dc</td>
<td>$24/48$ Vdc, $60/110/125$ Vdc, $220/250$ Vdc</td>
</tr>
<tr>
<td>Permissible variations</td>
<td>$19$ to $58$ Vdc, $48$ to $150$ Vdc, $176$ to $300$ Vdc</td>
</tr>
<tr>
<td>Superimposed a.c. voltage, peak–peak</td>
<td>$\leq 12$ %</td>
</tr>
<tr>
<td>Power consumption quiescent</td>
<td>approx. 2 W</td>
</tr>
<tr>
<td>Power consumption energized</td>
<td>approx. 4 W</td>
</tr>
<tr>
<td>Bridging time during failure/short-circuit of auxiliary voltage</td>
<td>$\geq 50$ ms at $U_{\text{rated}}$</td>
</tr>
<tr>
<td>Rated auxiliary voltage $U_r$ ac</td>
<td>$115$ Vac, $50/60$ Hz</td>
</tr>
<tr>
<td>Permissible variations</td>
<td>$92$ to $133$ Vac</td>
</tr>
</tbody>
</table>

### Output contacts

Output relays, number, total 6 (can be marshalled)
two-channel controlled and monitored command relays (K1 and K2) 2 (can be marshalled)
Contacts per relay K1 to K5 1 NO
K6 1 NC or 1 NO (reconnectable)
Switching capacity MAKE 1000 W/VA
BREAK 30 W/VA
Switching voltage 250 V
Permissible current 5 A continuous
30 A for 0.2 s
### Binary inputs, number

3 (can be marshalled)

### Rated operating voltages

**Current consumption**

24 to 250 Vdc

approx. 2.5 mA, independent of operating voltage

### Pick-up threshold

- **rated aux. voltage 24/48/60 Vdc**
  \[
  U_{\text{pick-up}} \geq 17 \text{ Vdc} \\
  U_{\text{drop-off}} < 8 \text{ Vdc}
  \]

- **rated aux. voltage 110/125/220/250 Vdc**
  \[
  U_{\text{pick-up}} \geq 75 \text{ Vdc} \\
  U_{\text{drop-off}} < 45 \text{ Vdc}
  \]

- **pick-up/drop-off time**
  approx. 7 ms

### Serial Interface

- **Standard**
  RS485

- **Test voltage**
  2.8 kV d.c.

- **Connection**
  data cable at housing terminals, two data wires, one frame reference, for connection of a personal computer or converter RS485/optical fibre; core pairs with individual and common screening, screen must be earthed at both sides;
  characteristic impedance 120 Ω (>100 kHz)
  capacitance per unit length <60 nF/km
  loop resistance per unit length <160 Ω/km
  major diameter > 0.53 mm

- **Transmission speed**
  as delivered 9600 Baud
  min. 1200 Baud; max. 19200 Baud

- **Protocol**
  according to IEC 60870–5–103

### 3.1.2 Electrical tests

#### Insulation tests

**Standards:**

IEC 60255–5; ANSI/IEEE C37.90.0

- **High voltage test (routine test)**
  except d.c. voltage supply input and RS485
  2 kV (r.m.s.), 50 Hz

- **High voltage test (routine test)**
  only d.c. voltage supply input and RS485
  2.8 kV dc

- **High voltage test (type test)**
  between open contacts
  1.5 kV dc

- **Impulse voltage test (type test)**
  all circuits, class III
  5 kV (peak); 1.2/50 μs; 0.5 J; 3 positive and 3 negative shots at intervals of 5 s
**EMC tests; immunity** (type tests)

**Standards:**
- IEC 60255–6, IEC 60255–22 (product standards)
- EN 50082–2 (generic standard)
- VDE 0435 part 303

- High frequency
  - IEC 60255–22–1, class III
    - 2.5 kV (peak); 1 MHz; \( \tau = 15 \mu s \); 400 shots/s; duration 2 s

- Electrostatic discharge
  - IEC 60255–22–2 class III
  - and IEC 61000–4–2, class III
    - 4 kV/6 kV contact discharge; 8 kV air discharge; both polarities; 150 pF; \( R_i = 330 \Omega \)

- Radio-frequency electromagnetic field, non-modulated; IEC 60255–22–3 (report) class III
  - 10 V/m; 27 MHz to 500 MHz

- Radio-frequency electromagnetic field, amplitude modulated; IEC 61000–4–3, class III
  - 10 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz

- Radio-frequency electromagnetic field, pulse modulated; IEC 61000–4–3/ENV 50204, class III
  - 10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 %

- Fast transients
  - IEC 60255–22–4 and IEC 61000–4–4, class III
    - 2 kV; 5/50 ns; 5 kHz; burst length 15 ms; repetition rate 300 ms; both polarities; \( R_i = 50 \Omega \); duration 1 min

- Conducted disturbances induced by radio-frequency fields, amplitude modulated
  - IEC 61000–4–6, class III
    - 10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz

- Power frequency magnetic field
  - IEC 61000–4–8, class IV
    - 30 A/m continuous; 300 A/m for 3 s; 50 Hz
  - IEC 60255–6
    - 0.5 mT; 50 Hz

**Further EMC tests; immunity** (type tests)

- Oscillatory surge withstand capability
  - ANSI/IEEE C37.90.1
    - 2.5 kV to 3 kV (peak); 1 MHz to 1.5 MHz, decaying oscillation; 50 shots per s; duration 2 s; \( R_i = 150 \Omega \) to 200 \( \Omega \)

- Fast transient surge withstand capability
  - ANSI/IEEE C37.90.1
    - 4 kV to 5 kV; 10/150 ns; 50 shots per s; both polarities; duration 2 s; \( R_i = 80 \Omega \)

- Radiated electromagnetic interference
  - ANSI/IEEE C37.90.2
    - 10 V/m to 20 V/m; 25 MHz to 1000 MHz; amplitude and pulse modulated

- High frequency test
  - document 17C (SEC) 102
    - 2.5 kV (peak, alternating polarity); 100 kHz, 1 MHz, 10 MHz and 50 MHz, decaying oscillation; \( R_i = 50 \Omega \)

**EMC tests; emission** (type tests)

**Standard:**
- EN 50081–★ (generic standard)

- Conducted interference voltage, aux. voltage
  - CISPR 22, EN 55022, class B
    - 150 kHz to 30 MHz

- Interference field strength
  - CISPR 11, EN 55011, class A
    - 30 MHz to 1000 MHz
### 3.1.3 Mechanical stress tests

**Vibration and shock during operation**

<table>
<thead>
<tr>
<th>Standards:</th>
<th>IEC 60255–21 and IEC 60068–2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vibration</strong></td>
<td>sinusoidal</td>
</tr>
<tr>
<td>IEC 60255–21–1, class 2</td>
<td>10 Hz to 60 Hz: ± 0.075 mm amplitude; 60 Hz to 150 Hz: 1.0 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes</td>
</tr>
<tr>
<td>IEC 60068–2–6</td>
<td></td>
</tr>
<tr>
<td><strong>Shock</strong></td>
<td>half sine acceleration 5 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes</td>
</tr>
<tr>
<td>IEC 60255–21–2, class 1</td>
<td></td>
</tr>
<tr>
<td>IEC 60068–2–27</td>
<td></td>
</tr>
<tr>
<td><strong>Seismic vibration</strong></td>
<td>sinusoidal 1 Hz to 8 Hz: ± 4 mm amplitude (hor. axis) 1 Hz to 8 Hz: ± 2 mm amplitude (vert. axis) 8 Hz to 35 Hz: 1 g acceleration (hor. axis) 8 Hz to 35 Hz: 0.5 g acceleration (vert. axis) sweep rate 1 octave/min 1 cycle in 3 orthogonal axes</td>
</tr>
<tr>
<td>IEC 60255–21–3, class 1</td>
<td></td>
</tr>
<tr>
<td>IEC 60068–2–59</td>
<td></td>
</tr>
</tbody>
</table>

**Vibration and shock during transport**

<table>
<thead>
<tr>
<th>Standards:</th>
<th>IEC 60255–21 and IEC 60068–2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vibration</strong></td>
<td>sinusoidal 5 Hz to 8 Hz: ± 7.5 mm amplitude; 8 Hz to 150 Hz: 2 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes</td>
</tr>
<tr>
<td>IEC 60255–21–1, class 2</td>
<td></td>
</tr>
<tr>
<td>IEC 60068–2–6</td>
<td></td>
</tr>
<tr>
<td><strong>Shock</strong></td>
<td>half sine acceleration 15 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes</td>
</tr>
<tr>
<td>IEC 60255–21–2, class 1</td>
<td></td>
</tr>
<tr>
<td>IEC 60068–2–27</td>
<td></td>
</tr>
<tr>
<td><strong>Continuous shock</strong></td>
<td>half sine acceleration 10 g, duration 16 ms, 1000 shocks each direction of 3 orthogonal axes</td>
</tr>
<tr>
<td>IEC 60255–21–2, class 1</td>
<td></td>
</tr>
<tr>
<td>IEC 60068–2–29</td>
<td></td>
</tr>
</tbody>
</table>
3.1.4 Climatic stress tests

- recommended temperature during service
  
  
- permissible temperature during service
  
  
- permissible temperature during storage
  
  
- permissible temperature during transport
  
  Storage and transport with standard works packaging!

- Permissible humidity
  mean value per year \( \leq 75\% \) relative humidity;
  on 30 days per year 95\% relative humidity;
  condensation not permissible!

We recommend that all units are installed such that they are not subjected to direct sunlight, nor to large temperature fluctuations which may give rise to condensation.

3.1.5 Service conditions

The relay is designed for use in industrial environment, for installation in standard relay rooms and compartments so that with proper installation **electro-magnetic compatibility (EMC)** is ensured. The following should also be heeded:

- All contactors and relays which operate in the same cubicle or on the same relay panel as the digital protection equipment should, as a rule, be fitted with suitable spike quenching elements.

- All external connection leads in sub-stations from 100 kV upwards should be screened with a screen capable of carrying power currents and earthed at both sides. No special measures are normally necessary for sub-stations of lower voltages.

  - The screen of the RS485 cable must be earthed.

  - It is not permissible to withdraw or insert individual modules under voltage. In the withdrawn condition, some components are electrostatically endangered; during handling the standards for electrostatically endangered components must be observed. The modules are not endangered when plugged in.

  **WARNING!** The relay is not designed for use in residential, commercial or light-industrial environment as defined in EN 50081.

3.1.6 Design

<table>
<thead>
<tr>
<th>Housing</th>
<th>7XP20; refer to Section 2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>refer to Section 2.2</td>
</tr>
<tr>
<td>Weight</td>
<td>approx. 4.5 kg</td>
</tr>
<tr>
<td>Degree of protection acc. to EN 60529</td>
<td>approx. 4.0 kg</td>
</tr>
<tr>
<td>Housing</td>
<td>IP 51</td>
</tr>
<tr>
<td>Terminals</td>
<td>IP 21</td>
</tr>
</tbody>
</table>
3.2 Undervoltage protection $U< (U_x<, U_1<^1)$

**Setting ranges/steps**

<table>
<thead>
<tr>
<th>Undervoltage</th>
<th>$U&lt; (U_x&lt;, U_1&lt;^1)$</th>
<th>20 V to 120 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time delay</td>
<td>$T(U&lt;, U_x&lt;, U_1&lt;^1)$</td>
<td>0.00 s to 60.00 s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or $\infty$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(steps 1 V)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(steps 0.01 s)</td>
</tr>
</tbody>
</table>

**Operating times**

- pick-up time: approx. 50 ms
- drop-off time: approx. 50 ms

**Reset ratio**

- undervoltage $U< (U_x<, U_1<^1)$: approx. 1.05

**Tolerances**

- voltage limit values $U< (U_x<, U_1<^1)$: 3 % of set value or 1 V
- delay times: 1 % of set value or 10 ms

**Influence variables**

- Auxiliary d.c. voltage  
  in range $0.8 \leq U_h/U_{HN} \leq 1.15$  
  $\leq 1\%$
- Temperature  
  in range $-5 \, ^\circ C \leq \theta_{amb} \leq +40 \, ^\circ C$  
  $\leq 0.5 \, %/10 \, K$
- Frequency  
  in range $0.95 \, f_N$ to $1.05 \, f_N$  
  $\leq 1 \, %$ referred to $U$

$^1$) positive sequence voltage $U_1$ only with two-phase connection
3.3 Overvoltage protection U>, U>> (U_x>, U_x>>\textsuperscript{1})

**Setting ranges/steps**

<table>
<thead>
<tr>
<th>Overvoltage</th>
<th>U&gt;, U&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>U_x&gt;, U_x&gt;&gt;\textsuperscript{1}</td>
<td>20 V to 170 V</td>
</tr>
<tr>
<td>Time delays</td>
<td>T(U&gt;, U&gt;&gt;, U_x&gt;, U_x&gt;&gt;\textsuperscript{1})</td>
</tr>
<tr>
<td>T(0.00 s to 60.00 s or (\infty))</td>
<td>(steps 0.01 s)</td>
</tr>
</tbody>
</table>

**Operating times**

- **pick-up times**
  - overvoltage U>, U>> (U_x>, U_x>>\textsuperscript{1}) approx. 50 ms

- **drop-off times**
  - overvoltage U>, U>> (U_x>, U_x>>\textsuperscript{1}) approx. 50 ms

**Reset ratios**

- overvoltage U>, U>> (U_x>, U_x>>\textsuperscript{1}) approx. 0.95

**Tolerances**

- voltage limit values U>, U>> (U_x>, U_x>>\textsuperscript{1}) 3 % of set value or 1 V
- time delays T 1 % of set value or 10 ms

**Influence variables**

- Auxiliary d.c. voltage in range 0.8 \(\leq\) U_i/UHN \(\leq\) 1.15 \(\leq\) 1%
- Temperature in range -5°C \(\leq\) \(\theta_a\text{mb}\) \(\leq\) +40°C \(\leq\) 0.5 %/10 K
- Frequency in range 0.95 \(f_N\) to 1.05 \(f_N\) \(\leq\) 1 % referred to U

\textsuperscript{1}) separate voltage U_x only with connection of two single-phase voltages
### 3.4 Rate-of-frequency-change protection $df/dt$\> 

**Setting ranges/steps**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting/Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of rate-of-change stages</td>
<td>4</td>
</tr>
<tr>
<td>Rate-of-change values $df/dt$</td>
<td>1.0 Hz/s to 10.0 Hz/s or $\infty$ (ineffective) (steps 0.1 Hz/s)</td>
</tr>
<tr>
<td>Time delays $T$</td>
<td>0.00 s to 60.00 s or $\infty$ (ineffective) (steps 0.01 s)</td>
</tr>
<tr>
<td>Undervoltage blocking $U &lt;$</td>
<td>20 V to 100 V or $\infty$ (ineffective) (steps 1 V)</td>
</tr>
</tbody>
</table>

**Operating times**

- **pick-up times $df/dt$\>** approx. 200 ms

**reset ratio** of undervoltage blocking approx. 1.05

**Tolerances**

- **rate-of-change $df/dt$**
  - in range 45 Hz to 50 Hz 100 mH/s at $f_N = 50$ Hz and $U = U_N$
  - in range 54 Hz to 60 Hz 150 mH/s at $f_N = 60$ Hz and $U = U_N$
- **time delays $T$** 1 % of set value or 10 ms
- **undervoltage blocking $U <$** 3 % of set value or 1 V

**Influence variables** rate-of-change

- **Auxiliary d.c. voltage** in range $0.8 \leq U_h/U_{HN} \leq 1.15$ $\leq 0.1 \%$
- **Temperature** in range $-5 ^\circ C \leq t_{amb} \leq +40 ^\circ C$ $\leq 0.1 \%/10 K$
- **Frequency** in range 40 Hz to 65 Hz $\leq 0.05 \%$
3.5 Frequency protection f> <

Setting ranges/steps

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of frequency stages</td>
<td>4; adjustable f&gt; or f&lt;</td>
</tr>
<tr>
<td>Pick-up value f&gt; or f&lt;</td>
<td>40.00 Hz to 68.00 Hz (steps 0.01 Hz)</td>
</tr>
<tr>
<td>Delay times T(f&gt;, f&lt;)</td>
<td>0.00 s to 60.00 s or ∞ (ineffective)</td>
</tr>
<tr>
<td>Undervoltage blocking U&lt; for f&gt;, f&lt;</td>
<td>20 V to 100 V or ∞ (ineffective)</td>
</tr>
</tbody>
</table>

Operating times

- pick-up times f>, f<                         | approx. 100 ms                            |
- drop-off times f>, f<                        | approx. 100 ms                            |

Reset hysteresis Δf                            | approx. 20 mHz                            |

Reset ratio undervoltage blocking U<          | approx. 1.05                              |

Tolerances

- frequency f>, f<                             | 10 mHz at f = f_N                         |
  typical 5 mHz at f = f_N and U = U_N         |
- undervoltage blocking U<                     | 3 % of set value or 1 V                   |
- time delays T(f>, f<)                        | 1 % of set value or 10 ms                 |

Influence variables

- Auxiliary d.c. voltage                       | in range 0.8 ≤ U_R/URN ≤ 1.15 ≤ 0.1 %    |
- Temperature                                 | in range −5 °C ≤ t_amb ≤ +40 °C ≤ 0.1 %/10 K |
- Frequency                                   | in range 40 Hz to 65 Hz                  |
### 3.6 Overflux protection U/f >

**Setting ranges/steps**

- **Overflux warning stage** (ratio $\frac{U}{U_N} >$) = limit for preload processing $1.00$ to $1.20$ (steps 0.01)
- **Time delay** $T_{\text{warn}}$ (warning stage) $0.00$ s to $60.00$ s or $\infty$ (ineffective) (steps 0.01 s)
- **Overflux tripping stage** (ratio $\frac{U}{U_N} >>$) $1.00$ to $1.40$ (steps 0.01)
- **Time delay** $T(U/f >>)$ (stepped characteristic) $0.00$ s to $60.00$ s or $\infty$ (ineffective) (steps 0.01 s)
- **Characteristic values** $U/f$
- **Associated time delays** $T$
- **Cooling-down time** $0$ s to $20000$ s (steps 1 s)
- **Voltage transformer matching factor** $0.50$ to $2.00$ (steps 0.01)

**Operating times** (stepped characteristic)

- **Pick-up time** at $1.1$ times setting value $\leq 50$ ms
- **Drop-off time** approx $60$ ms

**Reset ratio**

- **Pick-up on U/f** approx $0.95$

**Tripping time characteristics**

- **Thermal replica according to pre-setting** refer to Figure 3.1

**Tolerances**

- **Pick-up on U/f** $3\%$ of set value
- **Time delays** $T$ (stepped characteristic, warning stage) $1\%$ but min. $10$ ms
- **Thermal stage** $5\%$ referred to $U/f \pm 0.5$ s

**Influence variables**

- **Auxiliary direct current voltage**
  - in range $0.8 \leq \frac{U}{U_{\text{ref}}} \leq 1.15$ $\leq 1\%$
- **Temperature**
  - in range $-5$ °C $\leq \theta_{\text{amb}} \leq +40$ °C $\leq 0.5$ %/10 K
- **Frequency**
  - in range $0.9 f_N$ to $1.1 f_N$ $\leq 1$ %
Figure 3.1  Trip characteristic resulting from the thermal stage and the stepped stage of the overflux protection (presettings)
3.7 Ancillary functions

**Operational value measurements**

- operational voltage values
  - measurement range: \( U \); \( U_x \)\(^{1)} \) in V secondary
  - tolerance: 0 V to 170 V
  - 3 % or 2 V

- operational meas. value positive sequence voltage
  - measurement range: \( U_1 \)\(^{2)} \) in V secondary
  - tolerance: 0 V to 170 V
  - 3 % or 2 V

- Frequency
  - Measurement range: \( f \)
  - Tolerance: 25 Hz to 70 Hz
  - \( \leq 0.05 \) Hz

- Overflux
  - Measurement range: \( U/f \) referred to rated flux \( U_N/f_N \)
  - Tolerance: 0 to 2.4
  - \( \leq 5 \) %

\(^{1)} \) separate voltage \( U_x \) only with connection of two single-phase voltages
\(^{2)} \) positive sequence voltage \( U_1 \) only with two-phase connection

**Fault event data storage**

storage of annunciations of the last eight faults

**Time assignment**

- resolution for operational annunciations: 1 s
- resolution for fault event annunciations: 1 ms
- max time deviation: 0.01 %

**Data storage for fault recording**

- max. 8 fault events
  - alternatively instantaneous or r.m.s. values

**Instantaneous values:**

- total storage time (fault detection or trip command = 0 ms)
  - max. 5 s, selectable pre-trigger and post-fault time

  - max. storage period per fault event: \( T_{\text{max}} \) = 0.30 to 5.00 s (steps 0.01 s)
  - pre-trigger time: \( T_{\text{pre}} \) = 0.05 to 0.50 s (steps 0.01 s)
  - post-fault time: \( T_{\text{post}} \) = 0.05 to 0.50 s (steps 0.01 s)

- sampling rate: 1 instantaneous value per ms at 50 Hz
  - 1 instantaneous value per 0.83 ms at 60 Hz
r.m.s. values

total storage time (fault detection or trip command = 0 ms) \[\text{max. 50 s, selectable pre-trigger and post-fault time}\]

max. storage period per fault event \[T_{\text{max}}\] 0.30 to 50.00 s (steps 0.01 s)
pre-trigger time \[T_{\text{pre}}\] 0.05 to 5.00 s (steps 0.01 s)
post-fault time \[T_{\text{post}}\] 0.05 to 5.00 s (steps 0.01 s)
sampling rate 1 r.m.s. value per 10 ms at 50 Hz
1 r.m.s. value per 8.33 ms at 60 Hz

Trip circuit supervision with one or two binary inputs

Circuit breaker trip test with live trip

### 3.8 Performance outside of the operation ranges

<table>
<thead>
<tr>
<th>Operating ranges</th>
<th>(U &gt; 10 \text{ V}; ; 25 &lt; f/\text{Hz} &lt; 70)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Function</th>
<th>(U &lt; 10 \text{ V})</th>
<th>(f &lt; 25 \text{ Hz or } f &gt; 70 \text{ Hz})</th>
</tr>
</thead>
</table>
| Undervoltage protection \(U<, U_x<\) \(U_1<\) | no blocking | no blocking
| | pick-up and trip will occur when the voltage has been in the operating range before | measured values seem smaller; thus, over-function is possible |
| Overvoltage protection \(U>, U_x>\) | no blocking | no blocking
| | no pick-up since the measured value lies below the setting value; no trip | measured values seem smaller; thus, no over-function |
| Rate-of-frequency-change protection \(df/dt>\) | blocking*) | blocking
| | undervoltage blocking of this protection is effective | no pick-up; protection resets when already picked up |
| Frequency protection \(f<\) | blocking*) | blocking
| | undervoltage blocking of this protection is effective | no pick-up; protection resets when already picked up |
| Overflux protection \(U/f>\) | blocking | blocking
| | no pick-up; protection resets when already picked up | no pick-up; protection resets when already picked up |

*) unless undervoltage blocking is set ineffective (\(\infty\))

Table 3.1 Performance of the functions outside of the operating ranges
4 Method of operation

4.1 Operation of complete unit

The numerical voltage, frequency, and overflux protection relay Siprotec 7RW600 is equipped with a powerful and proven 16-bit microcontroller. This provides fully digital processing of all functions from data acquisition of measured values to the trip signals to the circuit breaker.

Figure 4.1 shows the base structure of the unit.

The transducers of the measured value input section ME transform the voltages from the measurement transformers of the switch-gear and match them to the internal processing level of the unit.

Apart from the galvanic and low-capacitive isolation provided by the input transformers, filters are provided for the suppression of interference. The filters have been optimized with regard to bandwidth and processing speed to suit the measured value processing. The matched analog values are then passed to the analog input section AE.

The voltage inputs are independent from each other. They can be connected either to two different voltage sources (as illustrated) or to two voltages of a voltage transformer set, e.g. phase-to-phase in V-connection.

---

Figure 4.1 Hardware structure of the numerical frequency, voltage, and overflux protection relay 7RW600 – example for connection to two independent single-phase voltages U and U_X
The analog input section AE contains input amplifiers for each input, analog-to-digital converters and memory circuits for the data transfer to the microcontroller.

Apart from control and supervision of the measured values, the microcontroller processes the actual protective functions. These include in particular:

- filtering and formation of the measured quantities,
- scanning of limit values and time sequences,
- calculation of the frequency and the rate-of-change in frequency,
- calculation of the positive sequence voltage in case of two-phase voltage connection (V-connection),
- calculation of the ratio U/f which is proportional to the flux or induction,
- calculation of the tripping time in accordance with the selected characteristics and delay times,
- decision about trip commands,
- storage of measured quantities during a fault for analysis.

Binary inputs and outputs to and from the microcontroller are channelled via the input/output elements.

From these the controller receives information from the switch-gear (e.g. remote resetting) or from other equipment (e.g. blocking signals). Outputs include, in particular, the trip commands to the circuit breakers, signals for remote signalling of important events and conditions as well as visual indicators (LEDs), and an alphanumeric display on the front.

An integrated membrane keyboard in connection with a built-in alphanumerical LCD display enables communication with the unit. All operational data such as setting values, plant data, etc. can be entered into the protection from this panel (refer to Section 6.3). Using this panel the parameters can be recalled and the relevant data for the evaluation of a fault can be read out after a fault has occurred (refer to Section 6.4). The dialog with the relay can be carried out alternatively via the serial interface by means of personal computer.

A power supply unit provides the auxiliary supply to the described functional units with +/-5 V. Transient failures in the supply voltage, up to 50 ms, which may occur during short-circuits in the d.c. supply system of the plant are bridged by a d.c. voltage storage element.

The following clarification explain all possible protection functions of the relay. In the actual case, only the functions in accordance with the ordering code are available (see Section 2.3 Ordering data).
4.2 Undervoltage protection $U < (U_x, U_1)$

The undervoltage protection mainly protects consumers (induction machines) from the consequences of dangerous voltage drops in island networks and prevents impermissible operating conditions and possible loss of stability. It can also be used as a criterion for load shedding in interconnected networks.

The relay provides two measured voltage inputs $U$ and $U_x$. Thus, it is possible either to process two independent voltages and monitor them for undervoltage or to process the positive sequence voltage $U_1$ of a three-phase system. In the latter case, two phase-to-phase voltages must be connected to the relay in V-connection.

The positive sequence component is not influenced by asymmetrical occurrences in the system. It is decisive for the torque of an induction machine and has an advantage in particular when evaluating stability problems. In the event of two-phase short-circuits or earth faults, asymmetrical voltage drops will occur. In contrast to single-phase measuring systems, the measurement of the positive sequence system is not influenced by these events.

An adjustable time delay is provided to bridge out permissible short-term voltage drops. In order to avoid malfunction of the protection in the event of secondary voltage failure, it can be blocked via a binary input, e.g. by the auxiliary contact of a voltage transformer miniature circuit breaker or from the position of the main circuit breaker when the machine is at stand-still.

The measured voltages are filtered by numerical filter algorithms; the fundamental wave is paramount. The frequency error of the filters is compensated internally within the operating range. When the frequency goes beyond the operating range of the protection, i.e. below 25 Hz or above 70 Hz, the undervoltage protection remains operative. But, since frequency compensation is no more possible, increased measurement error is expected so that the protection will become more sensitive and tends to overfunction. Therefore, when used as machine protection, the undervoltage protection must be blocked via a binary input during run-up and shutdown of the machine.

When the relay is switched on and no measured voltage is present, the undervoltage does not operate. First, when a measured voltage is connected within the operation range, i.e. above 10 V and within 25 Hz and 70 Hz, the protection is activated. This prevents from pick-up and tripping immediately after the relay has been connected to its supply voltage.

Figure 4.2 shows the logic diagram of the undervoltage protection with two independent voltages, Figure 4.3 with two phase-to-phase voltages in V-connection.
Figure 4.2 Logic diagram of the undervoltage protection with two independent single-phase voltages

Figure 4.3 Logic diagram of the undervoltage protection with two-phase connection (V-connection) and processing of the positive sequence voltage component $U_1$
4.3 Overvoltage protection U>, U>> (Ux>, Ux>>)

Overvoltage protection has the task of protecting electrical machines, and the associated electrical plant connected to it, from the effects of impermissible voltage increases. Overvoltages can be caused by incorrect manual operation of the excitation system, faulty operation of the automatic voltage regulator, (full) load shedding of a generator, separation of the generator from the system or during island operation.

The relay provides two measured voltage inputs U and Ux. Thus, it is possible either to process two independent voltages and monitor them for overvoltage or to process the voltages of a three-phase system. In the first case, separate threshold values U> and Ux> can be set. In the latter case, two phase-to-phase voltages must be connected to the relay in V−connection; the setting values U> and T U> are then valid for both voltages, and the setting values Ux> and T Ux> are irrelevant, but annunciations are generated for each voltage which has exceeded the threshold.

The overvoltage protection is of two-stage design. Numerical filters ensure that only the fundamental waves are processed and harmonics are suppressed. Time stages are provided to bridge out short voltage rises. A large overvoltage initiates a fast trip by the assigned U>> stage; a small overvoltage initiates a long-time trip by the assigned U> stage. Voltage limit values and time delays can be set individually for each stage.

Tripping of the overvoltage protection can be blocked by an external criterion via binary inputs.

Figure 4.4 shows the logic diagram of the overvoltage protection with two independent voltages, Figure 4.5 with two phase-to-phase voltages in V−connection.
Figure 4.4  Logic diagram of the two-stage overvoltage protection with two independent **single-phase** voltages: separate setting values and separate blocking facilities for the two measured voltages U and Uₓ.
Figure 4.5  Logic diagram of the two-stage overvoltage protection with two-phase connection (V−connection) and processing of the maximum voltage: common setting values and common blocking facility for the two measured voltages, but separate annunciations and outputs
4.4 Rate-of-frequency-change protection df/dt

When the power equilibrium between the power generation and the power demand is distorted, e.g. by failure of an important power station, disconnecting or load shedding measures must be taken immediately in order to prevent black-out of the entire power system. These measures are the more effective the earlier they are taken after the disturbance is detected.

The rate-of-frequency-change protection detects changes in the direction of decreasing frequency fast and reliably. Load shedding measures can thus be initiated before the permissible underfrequency limit (which can be detected by the frequency protection, see Section 4.5) is reached.

The rate-of-frequency-change protection of 7RW600 is of four-stage design. The stages can be set individually and independently, and can initiate different control functions. Thus, variable matching to the system conditions is possible.

The frequency is derived from the voltage input U, which is normally supplied by a phase-to-phase voltage (e.g. \( U_{L1-L2} \)). The voltage input \( U_k \) is irrelevant for frequency measurement. The fundamental wave is filtered out. The rate-of-change is evaluated from the calculated frequency in 100 ms intervals. The result is stabilized by a sufficient number of repeated measurement.

The frequency, and thus its rate-of-change, can be processed as long as the input voltage \( U \) is of sufficient magnitude and the frequency lies within the operating range of the protection. When the voltage is too small for evaluation, the rate-of-change protection is blocked as is the frequency protection.

The trip commands can be delayed by timer stages. Additionally, each rate-of-change stage can be logically AND—combined with the corresponding frequency stage. Each rate-of-change stage can be blocked via binary inputs from external sources, and the rate-of-change protection can be blocked in total.

The logic diagram of the rate-of-frequency-change protection is illustrated in Figure 4.6.
Figure 4.6  Logic diagram of the rate-of-frequency-change protection
4.5 Frequency protection f\(>\)\(<

Frequency protection is used to detect overfrequency or underfrequency in electrical networks or power stations. When the frequency increases above or decreases below the permissible limits, control commands are output, e.g. to divide the network, to shed consumers, or to disconnect the power station.

The cause of underfrequency is either an excessive demand of active power from the network, or faulty operation of the governor or of the frequency regulator. Underfrequency protection is also applied on generators which operate (temporarily) in an island network. In island operation the reverse power protection cannot operate should the prime mover fail. The underfrequency protection can be used to separate the generator from the network.

Overfrequency is caused, for example, by load shedding (island operation) or by faulty operation of the frequency regulator. The danger in this case is that machines connected to long unloaded lines may commence to self-excite.

The frequency protection includes four frequency stages. Each stage can be set individually as an underfrequency or overfrequency stage and is independent from the other stages and can initiate different control functions. Thus, variable matching to the system conditions is possible. The set frequency threshold determines whether a stage operates as an overfrequency protection (when set above the rated frequency) or as an underfrequency protection (when set below the rated frequency).

Numerical filters are provided to exclude influences by harmonics and phase shifts. Ripple control frequencies are irrelevant (attenuation >65 dB at twice rated frequency). The result is stabilized by a sufficient number of repeated measurement.

The frequency is derived from the voltage input \(U\), which is normally supplied by a phase-to-phase voltage (e.g. \(U_{L1-L2}\)). The voltage input \(U_x\) is irrelevant for frequency measurement.

The frequency can be processed as long as the input voltage \(U\) is of sufficient magnitude and the frequency lies within the operating range of the protection. When the voltage is too small for evaluation, the frequency protection is blocked.

The trip commands can be delayed by timer stages. Additionally, each frequency stage can be blocked via binary inputs from external sources, and the frequency protection can be blocked in total.

The logic diagram of the frequency protection is illustrated in Figure 4.7.
Figure 4.7 Logic diagram of the frequency protection
4.6 Overflux protection U/f>

The overflux protection is used to detect impermissible overflux conditions in electrical equipment which can endanger e.g. generators or transformers. Such conditions are caused by an increase in voltage and/or reduction in frequency.

The induction which is proportional to the flux is

\[ B = \frac{\phi}{A} = \frac{1}{4.44 \cdot N \cdot A} \cdot \frac{U}{f} \]

where
- \( B \) = induction
- \( \phi \) = flux
- \( N \) = number of turns
- \( A \) = iron cross-section
- \( U \) = induced voltage
- \( f \) = frequency

An increase in induction above the rated values leads very quickly to saturation of the iron core and to large eddy current losses. Power station unit transformers which are separated from the system and connected only to the generator are particularly endangered.

The overflux protection measures the ratio voltage/frequency which is proportional to the induction \( B \).

The measured voltage for overflux protection depends on the connection mode (single-phase or two-phase). With single-phase connection, the voltage \( U \) is taken for overflux detection, the voltage \( U_X \) is then irrelevant. With two-phase connection the maximum of the two voltages \( U \) and \( U_X \) is decisive for overflux detection. The frequency is assumed to be the same, it is always measured from the voltage \( U \).

The overflux protection is fitted with a definite time stage \( U/f> \) and a thermal stage which approximates the heating-up of the iron caused by the overflux, according to a thermal single-body model.

A counter is released when a settable pick-up value \( U/f> \) is exceeded. This counter is incremented according to the excess in \( U/f \). When the trip limit is reached trip command is issued.

When the measured quantity falls below the pick-up value, trip command is cancelled and the counter is decremented according to the set cooling-down time. The counter is set to zero when the reset input is energized or when the overflux protection is blocked.

The thermal characteristic is defined by 7 pairs of values \( U/f \) (referred to rated values) and \( T \) (see Figure 4.8). The preset values are adequate in most cases; it corresponds to a standard power transformer.

The preset values can be changed if necessary by entering different time values during setting. The protection calculates then a user defined tripping time characteristic. The intermediate values are interpolated.

The preset values suppose that the pick-up value \( U/f> \) and the first setting value of the thermal stage are identical (1.1 times rated flux, see Figure 3.1). If these values differ from each other, the relay will react as shown in Figure 4.8.

An adjustable correction factor allows matching of the voltage magnitude in case the rated voltage of the voltage transformers differs from the rated voltage of the protected object.

The logic diagram of the overflux protection is illustrated in Figure 4.9.
**Figure 4.8** Tripping time characteristics of the overflux protection

**Figure 4.9** Logic diagram of the overflux protection
4.7 Trip circuit supervision

The device includes a trip circuit supervision for one trip circuit. Dependent on the number of binary inputs which are available for this purpose, supervision can be effected with one or two binary inputs. When two binary inputs are used, disturbances in the trip circuit can be detected for every switching condition; when one binary input is used, those disturbances which occur during closed trip contacts cannot be detected.

Figure 4.12 shows the logic diagram of the announcements generated by the trip circuit supervision.

4.7.1 Supervision using two binary inputs

When two binary inputs are used, they are connected according to Figure 4.10: one input in parallel to the trip relay the circuit of which is to be supervised, the other in parallel to the circuit breaker auxiliary contact.

Note: In 7RW600, the two binary inputs BI2 and BI3 have a common negative pole. This combination is, therefore, not suitable for trip circuit supervision. Use the binary inputs BI1 and BI2 instead.

The binary inputs are energized (logical “H”) or short-circuited (logical “L”) depending on the status of the trip relay and the circuit breaker (see Figure 4.10).

During normal operation it is not possible that both the binary inputs are de-energized (logical “L”) at the same time unless for the short time where the trip relay has already closed but the breaker is not yet open.

If both the binary inputs are de-energized continuously, this indicates that either the trip circuit is interrupted, or the trip circuit is short-circuited, or the control voltage for tripping is absent, or the breaker has not properly operated. Thus, this status indicates a fault in the trip circuit.

The status of the two binary inputs is checked approximately in 200 ms intervals. An intentional time delay for alarm is produced by three repeated status checks before an alarm is given. This prevents from faulty alarms due to short transient occurrences.

4.7.2 Supervision using one binary input

When one binary input is used, this is connected according to Figure 4.11: in parallel to the trip relay the circuit of which is to be supervised.

The binary input is energized (logical “H”) as long as the trip relay is not energized and the trip circuit is healthy.

When the binary input is not energized (logical “L”), this indicates that either the trip contact is closed or the trip circuit is interrupted, or the trip circuit is short-circuited, or the control voltage for tripping is absent. As the trip contacts may be closed during healthy trip circuit condition, the status of the binary input is checked in relatively long periods (30 s). Furthermore, an intentional time delay for alarm is produced by three repeated status checks before an alarm is given. This prevents from faulty alarms during closed trip contacts.

Since the second binary input is not available in this mode, it must be replaced by a resistor R which is connected to the breaker auxiliary contact Aux2 (refer to Figure 4.11, compare with Figure 4.10). This allows to detect disturbance in the trip circuit even when the breaker auxiliary contact Aux1 is open and the trip contact is reset. The resistance of R is dimensioned such that the trip coil TC must not be energized when the circuit breaker is open (auxiliary contact Aux1 open, Aux 2 closed); on the other hand the binary input must be safely energized when the trip contact is open.

Information on how to dimension the resistor are contained in Section 5.2.3.2.
Figure 4.10  Principle of trip circuit supervision with two binary inputs
Figure 4.11   Principle of trip circuit supervision with one binary input
Figure 4.12 Logic diagram of trip circuit supervision
4.8 Ancillary functions

The ancillary functions of the numerical voltage, frequency, and overflux protection 7RW600 include:

- processing of annunciations,
- storage of fault data for fault recording,
- operational measurements,
- test routines,
- monitoring functions.

4.8.1 Processing of annunciations

After a fault in the protected object, information concerning the response of the protective device and knowledge of the measured values are of importance for an exact analysis of the history of the fault. For this purpose the device provides annunciation processing which is effective in three directions.

4.8.1.1 Indicators and binary outputs (output relays)

Important events and conditions are indicated by optical indicators (LED) on the front plate. The relay also contains output relays for remote signalling and trip commands. All of the signals can be marshalled, i.e. they can be allocated meanings other than the factory settings. In Section 5.5 the delivered condition and the marshalling facilities are described in detail.

The output relays are not latched and automatically reset as soon as the originating signal disappears. The LEDs can be arranged to latch or to be self-resetting.

The memories of the LEDs can be reset:

- locally, by operation of the reset button ("N") on the relay,
- remotely by energization of the remote reset input,
- via the operating interface,
- automatically, on occurrence of a new general pick-up signal.

Some indicators and relays indicate conditions; it is not appropriate that these should be stored. Equally they cannot be reset until the originating criterion has been removed. This mainly concerns fault indications such as "Trip circuit interrupted", etc.

A green LED indicates readiness for operation ("Service"). This LED cannot be reset and remains illuminated when the microcontroller is working correctly and the unit is not faulty. The LED extinguishes when the self-checking function of the microcontroller detects a fault or when the auxiliary voltage is absent.

With the auxiliary voltage present but with an existing internal fault in the unit, a red LED illuminates ("Blocked") and blocks the unit.

4.8.1.2 Information on the display panel or to a personal computer

Events and conditions can be read off in the display on the front plate of the device. Additionally, a personal computer, for example, can be connected via the operation interface, and all the informations can then be sent to it. The interface is suited to be operated directly or via a modem link.

In the quiescent state, i.e. as long as no system faults are present, the display outputs the operational measured values of the frequency and voltage at voltage input U. In the event of a network fault, information on the fault appears instead of the operating information. The first line of the display indicates fault detection messages; the second line displays the trip annunciation of the protection. The quiescent information is displayed again once these fault annunciations have been acknowledged. The acknowledgement is identical to resetting of the stored LED displays as in Section 4.8.1.1.

The device also contains several event buffers, e.g. for operating messages or fault annunciations (refer to Section 6.4). These messages, as well as the available operating values, can be transferred into the front display at any time using the keyboard or to the personal computer via the operating interface.
After a fault, for example, important information concerning its history, such as pick-up and tripping, can be called up on the display of the device. The fault inception is indicated with the absolute time of the operating system. The sequence of the events is tagged with the relative time referred to the moment at which the fault detector has picked up. Thus, the elapsed time until tripping is initiated and until the trip signal is reset can be read out. The resolution is 1 ms.

The events can also be read out with a personal computer by means of the appropriate program DIGSI®. This provides the comfort of a CRT screen and menu-guided operation. Additionally, the data can be documented on a printer or stored on a floppy disc for evaluation elsewhere.

The protection device stores the data of the last eight network faults; if a ninth fault occurs the oldest fault is overwritten in the fault memory.

A network fault begins with recognition of the fault by pick-up of any fault detector and ends with the latest fault detector reset.

4.8.2 Data storage and transmission for fault recording

The instantaneous values of the measured values $u$ and $u_x$

are sampled at 1 ms intervals (for 50 Hz) or 0.83 ms intervals (for 60 Hz) and stored in a circulating shift register. In case of a fault, the data are stored over a selectable time period, but max. over 5 seconds. The maximum number of fault records within this time period is 8. These data are then available for fault analysis. For each renewed fault event, the actual new fault data are stored without acknowledgement of the old data.

The r.m.s. values of the measured values $U$, $U_x$, and $f - f_N$
can alternatively be sampled at intervals of one half a.c. period and stored in a circulating shift register. In case of a fault, the data are stored over a selectable time period, but max. over 50 seconds. The maximum number of fault records within this time period is 8. These data are then available for fault analysis. For each renewed fault event, the actual new fault data are stored without acknowledgement of the old data.

The data can be transferred to a connected personal computer via the operation interface and evaluated by the protection data evaluation program DIGSI®. The voltages are referred to their maximum values, normalized to their rated values and prepared for graphic visualization. In addition, signals are marked as binary traces, e.g. “Pick-up” and “Trip”.

4.8.3 Operating measurements and conversion

For local recall or transmission of data, the true r.m.s. values of the voltages $U$ and $U_x$ (if connected) as well as the frequency $f$ are available as long as the relay is not dealing with a fault. When the overflux protection is available (model 7RW600×−×××××−×××), the calculated quotient $U/f$ can be read out.

The following is valid:

- $U$ and $U_x$ 1) voltages in V secondary,
- $U_1$ 2) positive sequence voltage in V secondary (if available),
- $f$ frequency in Hz,
- $U/f$ flux proportional to $U/f$, referred to rated conditions $U_N/f_N$ (if available).

1) separate voltage $U_x$ only with connection of two single-phase voltages
2) positive sequence voltage $U_1$ only with two-phase connection
4.8.4 Test facilities

7RW600 allows simple checking of the tripping circuit and the circuit breaker as well as interrogation of the state of the binary inputs. Initiation of the test can be given from the operator keyboard or via the operator interface (refer to Section 6.6.3 and 6.6.4).

4.8.4.1 Circuit breaker trip test

Prerequisite for the start of a circuit breaker trip test is that no protective function has picked up.

The relay issues a trip command. Before start of the procedure and during the test procedure, the relay indicates the test sequence in the display.

4.8.4.2 Interrogation of binary states

The momentary condition of the binary inputs can be displayed on request by the operator as well as the LED indicators.

4.8.5 Monitoring functions

The device incorporates comprehensive monitoring functions which cover both hardware and software.

4.8.5.1 Hardware monitoring

The hardware is monitored for faults and inadmissible functions. In detail this is accomplished by monitoring:

- Auxiliary and reference voltages

Failure or switch-off of the auxiliary voltage automatically puts the system out of operation; this status is indicated by the breaking contact of an availability relay provided it is accordingly allocated. Transient dips in supply voltage of less than 50 ms will not disturb the function of the relay.

- Command output channels:

Two of the six output relays are controlled by two command channels (K1 and K2); they are, therefore, particularly suited for tripping. As long as no pick-up condition exists, the central controller makes a cyclic check of these command output channels for availability, by exciting each channels one after the other and checking for change in the output signal level. Change of the feed-back signal to low level indicates a fault in one of the control channels or in the relay coil. Such a condition leads automatically to alarm and blocking of the command output.

- Memory modules:

After the relay has been connected to the auxiliary supply voltage, the working memory (RAM) is checked by writing a data bit pattern and reading it.

The further memory modules are periodically checked for fault by:

- formation of the modulus for the program memory (EPROM) and comparison of it with a reference program modulus stored there,

- Formation of the modulus of the values stored in the parameter store (EEPROM) then comparing it with the newly determined modulus after each parameter assignment process.

4.8.5.2 Software monitoring

For continuous monitoring of the program sequences, watchdog timers are provided which will reset the controller in the event of controller failure or if a program falls out of step. Further, internal plausibility checks ensure that any fault in processing of the programs, caused by interference, will be recognized. Such faults lead to reset and restart of the controller.

If such a fault is not eliminated by restarting, further restarts are initiated. If the fault is still present after three restart attempts the protective system will switch itself out of service and indicate this condition by drop-off of the availability signal, thus indicating “equipment fault” and simultaneously the LED “Blocked” comes on.
5 Installation instructions

⚠️ Warning

The successful and safe operation of this device is dependent on proper handling and installation by qualified personnel under observance of all warnings and hints contained in this manual.

In particular the general erection and safety regulations (e.g. IEC, DIN, VDE, or national standards) regarding the correct use of hoisting gear must be observed. Non-observance can result in death, personal injury or substantial property damage.

5.1 Unpacking and repacking

When dispatched from the factory, the equipment is packed in accordance with the guidelines laid down in IEC 60255–21, which specifies the impact resistance of packaging.

This packing shall be removed with care, without force and without the use of inappropriate tools. The equipment should be visually checked to ensure that there are no external traces of damage.

The transport packing can be re-used for further transport when applied in the same way. The storage packing of the individual relays is not suited to transport. If alternative packing is used, this must also provide the same degree of protection against mechanical shock, as laid down in IEC 60255–21–1 class 2 and IEC 60255–21–2 class 1.

Before initial energization with supply voltage, the relay shall be situated in the operating area for at least two hours in order to ensure temperature equalization and to avoid humidity influences and condensation.

5.2 Preparations

The operating conditions must accord with VDE 0100/5.73 and VDE 0105 part 1/7.83, or corresponding national standards for electrical power installations.

⚠️ Caution!

The modules of digital relays contain CMOS circuits. These shall not be withdrawn or inserted under live conditions! The modules must be so handled that any possibility of damage due to static electrical charges is excluded. During any necessary handling of individual modules the recommendations relating to the handling of electrostatically endangered components (EEC) must be observed.

In installed conditions, the modules are in no danger.
5.2.1 Mounting and connections

5.2.1.1 Model 7RW600\*–\*B*** or –\*D*** for panel surface mounting

- Secure the unit with four screws to the panel. Verify sufficient space to adjacent relays in case of model –\*B***. For dimensions refer to Figure 2.1 or 2.2.

- Make a solid low-ohmic and low-inductive operational earth connection between the earthing surface at the bottom of the unit using at least one standard screw M4, and the earthing continuity system of the panel; recommended grounding strap DIN 72333 form A, e.g. Order-No. 15284 of Messrs Druseitd, Remscheid, Germany.

- Make connections via screwed terminals; observe labelling of the individual terminals; observe the maximum permissible cross sections.

- If the RS485 interface is used, the cable screen must be earthed.

5.2.1.2 Model 7RW600\*–\*E*** for panel flush mounting or cubicle installation

- Slip away the covers at top and bottom of the housing in order to gain access to the four holes in the fixing angle.

- Insert the unit into the panel cut-out or the cubicle rack and secure it with four fixing screws. For dimensions refer to Figure 2.3.

- Make a solid low-ohmic and low-inductive operational earth connection between the earthing surface at the rear of the unit using at least one standard screw M4, and the earthing continuity system of the panel or cubicle; recommended grounding strap DIN 72333 form A, e.g. Order-No. 15284 of Messrs Druseitd, Remscheid, Germany.

- Make connections via the screwed or snap-in terminals of the connectors of the housing. Observe labelling of the individual connector modules to ensure correct location; observe the max. permissible conductor cross-sections. The use of the screwed terminals is recommended; snap-in connection requires special tools and must not be used for field wiring unless proper strain relief and the permissible bending radius are observed.

- If the RS485 interface is used, the cable screen must be earthed.

5.2.2 Checking the rated data

The rated data of the unit must be checked against the plant data. This applies in particular to the auxiliary voltage of the unit.

5.2.2.1 Auxiliary voltage

Four different ranges of auxiliary voltage can be delivered (cf. Section 2.3 and 3.1.1). If, for exceptional reason, the rated voltage of the supply input is to be changed, it must be taken into account that the models for rated auxiliary voltage 60/110/125 Vdc and 220/250 Vdc differ from each other by different plug jumpers. The assignment of these jumpers and their location on the p.c.b. are shown in Figure 5.1. The model for 220/250 Vdc is suitable for 115 Vac, too. When the relay is delivered, all these pluses are correctly located and matched to the specification given on the name plate of the relay, so that, normally, none of the jumpers need be altered.

5.2.2.2 Control d.c. voltage of binary inputs

When delivered from factory, the binary inputs are designed to operate in the total control voltage range from 19 V to 300 V d.c. If the rated control voltage for binary inputs is 110 V or higher, it is advisable to fit a higher pick-up threshold to these inputs in order to increase stability against stray voltages in the d.c. circuits.

To fit a higher pick-up threshold of approximately 75 V to a binary input a jumper must be removed. Figure 5.2 shows the assignment of these jumpers and their location on the p.c.b.

Note: If binary inputs are used for trip circuit supervision, it must be considered that two binary inputs (or one input and a replacement resistor) are connected in series. Therefore, the pick-up threshold must be clearly smaller than half the control voltage.

5.2.2.3 Relay K6: NO or NC operation

The output relay K6 is equipped with a change-over contact but only one contact circuit can be connected to the terminals. A jumper on the p.c.b. determines whether the normally open contact or the normally closed contact is effective. When delivered the NC contact is effective and signals “equipment fault”. The allocation of this jumper is illustrated in Figure 5.1.
For all alteration of jumpers, proceed as follows:
- Slip away the covers at top and bottom of the housing in order to gain access to the two fixing screws of the module. Unscrew these screws.
- Pull out the module by taking it at the front cover and place it on a surface which is suited to electrostatically endangered components (EEC);

⚠ Caution!
Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface.

- Check the jumpers according to Figures 5.1 and 5.2.
- Insert module into the housing;
- Fix the module into the housing by tightening the two fixing screws.
- Re-insert covers.

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Output relay K6</th>
</tr>
</thead>
<tbody>
<tr>
<td>X3 – X4</td>
<td>NO contact</td>
</tr>
<tr>
<td>X4 – X5</td>
<td>NC contact (as delivered)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Jumpers</th>
<th>Rated auxiliary voltage</th>
</tr>
</thead>
<tbody>
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<td>24 Vdc</td>
</tr>
<tr>
<td>X1.1–X1.2</td>
<td>X</td>
</tr>
<tr>
<td>X1.2–X1.3</td>
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</tr>
<tr>
<td>X1.2.1–X1.2.2</td>
<td>X</td>
</tr>
<tr>
<td>X1.2.2–X1.2.3</td>
<td></td>
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<td>X22 – X23</td>
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<td>X23 – X25</td>
<td>X</td>
</tr>
<tr>
<td>X12.2 – X12.3</td>
<td>X</td>
</tr>
<tr>
<td>X27 – X28</td>
<td>X</td>
</tr>
</tbody>
</table>

Figure 5.1  Checking for auxiliary voltage of the integrated dc-dc-converter and contact mode K6
For rated voltages 24/48/60 V-: Jumper X*-2 – X*-3 must be inserted! (pick-up threshold approx. 17 Vdc)
For rated voltages 110/125/220/250 V-: Jumper X*.1 – X*.2 may be inserted. (pick-up threshold approx. 75 Vdc)

where * = 6, 7 and 8

Figure 5.2 Checking for control voltages for binary inputs
5.2.3 Checking the communication link (if used)

If the relay is intended to communicate with a central data evaluation device or with a personal computer, the data link must be checked. It is important to visually check the allocation of the transmission wires to the terminals. Depending on the used converter 7XV56 or 7XV57, the following assignment must be obtained:

<table>
<thead>
<tr>
<th>Converter RS485/ optic fibre</th>
<th>Designation</th>
<th>7RW6000 –</th>
<th>A**** –</th>
<th>D**** –</th>
</tr>
</thead>
<tbody>
<tr>
<td>7XV57</td>
<td>7XV56</td>
<td>GND</td>
<td>Term. 27</td>
<td>Term. 10</td>
</tr>
<tr>
<td>A</td>
<td>Terminal 3</td>
<td>A</td>
<td>Term. 29</td>
<td>Term. 12</td>
</tr>
<tr>
<td>B</td>
<td>Terminal 2</td>
<td>B</td>
<td>Term. 28</td>
<td>Term. 11</td>
</tr>
</tbody>
</table>

Check that the necessary auxiliary voltage for supply of the converter is connected correctly. The cable shield is grounded at both ends of the cable.

The standard cable has only two conductors. The two inner conductors are connected to A and B. GND is not usually connected.

If the cable used provides a third inner conductor it is connected to GND. Where communication is subject to heavy interference or a potential difference of more than 7 V exists between the units connected to one cable, the GND connection may be connected to the shielding, and both grounded to the shield connection of the housing.

To ensure reliable data transmission the RS485 bus must be terminated at the last unit on the bus (connect terminating resistor). The unit 7RW600 is not already terminated. To activate the termination, open the unit (see Section 5.2.2) and set jumpers X20 and X21 to position 2 – 3 (see Figure 5.3). If the bus is extended, the termination must be deactivated on the units that are connected in the middle of the bus. To do this, set jumpers X20 and X21 to position 1 – 2.

<table>
<thead>
<tr>
<th>Terminating resistor</th>
<th>jumper X20</th>
<th>jumper X21</th>
</tr>
</thead>
<tbody>
<tr>
<td>effective</td>
<td>2 – 3</td>
<td>2 – 3</td>
</tr>
<tr>
<td>not effective (as delivered)</td>
<td>1 – 2</td>
<td>1 – 2</td>
</tr>
</tbody>
</table>

Figure 5.3 Terminating resistor

The optical interface of the 7XV56 converter works with positive logic. The normal character position for the fiber-optic connection is therefore “Light off”. If the normal character position has to be changed you can do this with a switch that is accessible when you open the housing of the 7XV56.
### 5.2.4 Connections

General and connection diagrams are shown in Appendix A and B. The marshalling possibilities of the binary inputs and outputs are described in Section 5.5. Observe the following particularities:

#### 5.2.4.1 Measured voltage inputs

The relay contains two measured voltage inputs, designated with U and $U_x$. Frequency, rate-of-frequency-change, and overflux determination are derived from the main input U (terminals 7 and 8).

The second voltage input $U_x$ (terminals 9 and 10 for versions 7RW6000—*B*** and —*E*** resp. terminals 13 and 14 for version 7RW6000—*D*** can be used for a separate and independent measured voltage (see Figure 5.4). Alternatively, the two inputs can be connected phase-to-phase to a three-phase system in V—connection (see Figure 5.5).

In the first case, two different voltages U and $U_x$ can be processed and individually monitored for overvoltage and/or undervoltage by the voltage protection functions.

In the latter case, two phase-to-phase voltages of the three-phase system are connected in V—connection. The overvoltage protection processes then both of these two voltages, the undervoltage protection processes the positive sequence component of the voltages.

![Figure 5.4 Connection example for two independent single-phase voltages](image)

![Figure 5.5 Connection example for two phase-to-phase voltages in V—connection](image)

#### 5.2.4.2 Trip circuit supervision

If the trip circuit supervision is used, decision must be made whether two binary inputs or only one is available for this purpose. The function is explained in detail in Section 4.7, where also the principle connections are given.

**Note:** It must be considered that two binary inputs (or one input and a replacement resistor) are connected in series. Therefore, the pick-up threshold of the binary input(s) (Section 5.2.2.2) must be clearly smaller than half the control voltage.

**Note:** In 7RW600, the two binary inputs B12 and B13 have a common negative pole. This combination is, therefore, not suitable for trip circuit supervision. Use the binary inputs B11 and B12 instead.

If one single binary input is available (Figure 5.6), an external resistor $R$ must be connected in the circuit of the breaker auxiliary contact (Aux2), which replaces the missing second binary input (refer also to Section 4.7.2). Thus, a fault is also detected when the NO auxiliary contact is open and the trip relay contact has reset. This resistor must be dimensioned such that the trip coil (TC) of the breaker cannot operate when the breaker is open (Aux1 open and Aux2 closed), but that the binary input (B11) can operate when the trip contact of the device has opened, at the same time (Figure 5.6).
This results in an upper limit \( R_{\text{max}} \) and a lower limit \( R_{\text{min}} \) of the resistance, from which the arithmetical mean value is taken:

\[
R = \frac{R_{\text{max}} + R_{\text{min}}}{2}
\]

The maximum resistance \( R_{\text{max}} \) is derived from the minimum control voltage of the binary input:

\[
R_{\text{max}} = \left( \frac{U_{\text{CV}} - U_{\text{Bl min (High)}}}{I_{\text{Bl (High)}}} \right) - R_{\text{TC}}
\]

The minimum resistance \( R_{\text{min}} \) is derived from the maximum control voltage which does not operate the circuit breaker trip coil:

\[
R_{\text{min}} = R_{\text{TC}} \cdot \left( \frac{U_{\text{CV}} - U_{\text{TC (LOW)}}}{U_{\text{TC (LOW)}}} \right)
\]

If this calculation results in \( R_{\text{max}} \) being smaller than \( R_{\text{min}} \), it must be repeated with a lower control voltage \( U_{\text{Bl min}} \). The jumpers of the binary input must be set according Section 5.2.2.2 corresponding to this smaller voltage.

The power demand of the resistor is

\[
P_R = I^2 \cdot R = \left( \frac{U_{\text{CV}}}{R + R_{\text{TC}}} \right)^2 \cdot R
\]

---

**Figure 5.6** Dimensioning the external resistor \( R \) when one single binary input is used
Example:

\[
R = \frac{R_{\text{max}} + R_{\text{min}}}{2} = 36.5 \, \Omega
\]

The nearest standard value is selected: 33 \, \Omega.

The power consumption of the resistor is

\[
P_R = \left( \frac{110 \, \text{V}}{33 + 0.5 \, \text{k}\Omega} \right)^2, \quad 33 \, \Omega
\]

\[
P_R = 0.36 \, \text{W}
\]

A safety factor of at least 2 should be observed:

\[
P_R = 0.75 \, \text{W}
\]

5.2.5 Checking the connections

⚠️ Warning

Some of the following test steps are carried out in presence of hazardous voltages. They shall be performed by qualified personnel only which is thoroughly familiar with all safety regulations and precautionary measures and pay due attention to them. Non-observance can result in severe personal injury.

Before initial energization with supply voltage, the relay shall be situated in the operating area for at least two hours in order to ensure temperature equalization and to avoid humidity influences and condensation.

– Switch off the circuit breakers for the d.c. supply!

– Check the continuity of all the voltage transformer circuits against the plant and connection diagrams:

  – Are the polarities of the voltage transformer connections consistent (if applicable)?
  – Fit an ammeter in the auxiliary power circuit; range approx. 1.5 A to 3 A.
  – Close the power supply circuit breaker; check polarity and magnitude of voltage at the terminals of the unit or at the connector module.
  – The measured current consumption should correspond to the quiescent power consumption of approximately 2 W/VA. Transient movement of the ammeter pointer only indicates the charging current of the storage capacitors.
  – Open the circuit breaker for the power supply.
  – Remove the ammeter; reconnect the auxiliary voltage leads.

If test switches have been fitted in the secondary circuits, check their function.

– Close the power supply circuit breaker. The unit starts up and, on completion of the run-up period, the green LED on the front comes on, the red LED gets off after at most 7 sec.

– Open the circuit breaker for the power supply.

– Check through the tripping circuits to the circuit breaker.

– Check through the control wiring to and from other devices.

– Check the signal circuits.
5.3 Configuration of operation and memory functions

5.3.1 Operational preconditions and general

For most operational functions, the input of a codeword is necessary. The "codeword" is a predefined key sequence which must be entered via the membrane keyboard or operating interface which concern the operation on the relay, for example

- configuration parameters for operation language, interface configuration, and device configuration,
- allocation or marshalling of annunciation signals, binary inputs, optical indications,
- setting of functional parameters (thresholds, functions).
- starting of test procedures.

In order to indicate authorized operation and to prevent from unintended alteration, the codeword must be entered before any alteration can be performed.

When an operation object is selected which requires codeword input, press one of the keys 1 or 2 in order to inform the relay about the intended alteration. The display then shows the line “CW :” which indicates that the codeword is required. The ‘codeword’ itself consists of the key sequence 1 and . Press these keys in the indicated sequence and confirm with the enter key E. If the codeword is correct the display shows “CW OK.”. By pressing the enter key E one more time the operation item is displayed again. Use the keys 1 or 2 in order to change the presented text or numerical value. A flashing cursor indicates that the relay operates now in alteration mode, starting with the first alteration and ending after confirmation of the altered item with the enter key E. The alteration mode is equally ended when the setting menu is left or after an internal waiting time.

The codeword is not required for the read-out of annunciations, operating data or fault data, or for the read-out of setting parameters.

![Codeword Interface Example]

The entered characters do not appear in the display, instead only a symbol @ appears. After confirmation of the correct input with E the display responds with CW OK_. Press the entry key E again.

If the codeword is not correct the display shows CW WRONG. Pressing the keys 1 or 2 allows another attempt at codeword entry.

The operating interface is built up by a hierarchically structured menu tree, which can be passed through by means of the scrolling keys , , , , and . Thus, each operation object can be reached. A complete overview is listed in Appendix C. Figure 5.7 illustrates the way to get to the configuration items.

After the relay has been switched on, the display shows the type designation and the version of the implemented firmware. Pressing the key leads to the first main menu item “PARAME.5” (parameters) in the first operation level of the menu tree.

---

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Figure 5.7  Menu tree (sheet 1): Selection and settings of protection functions (continued next page)
Figure 5.7   Menu tree (sheet 2): Annunciations and ancillary functions
The menu tree can be passed through by means of the scrolling keys \( \downarrow \), \( \uparrow \), \( \Delta \), and \( \nabla \). Thus, each operation object can be reached. A complete overview is listed in Appendix C. Figure 5.8 illustrates the way to get to the configuration items.

After the relay has been switched on, the display shows the type designation and the version of the implemented firmware. Pressing the key \( \nabla \) leads to the first main menu item “PARAME.” (parameters) in the first operation level of the menu tree. Press key \( \uparrow \) to reach the second operation menu level, which starts with the first parameter block “00 CONF.” (configuration). Press the key \( \nabla \) repeatedly until address block 71 appears. You may scroll back with the key \( \Delta \) or page to the previous operation menu level with \( \downarrow \).

Address blocks 71 to 74 are provided for configuration of the software operating system. These settings concern the operation of the relay, communication with external operating and processing devices via the serial interface, and the interaction of the device functions.

Figure 5.8 Extract from the operation structure and illustration of selection of the configuration blocks
You may, for example, change with the key ▶ to the third operation menu level, then with key ◄ back to the second operation menu level, as shown in Figure 5.8. Press the key ▶ to change to address block 72, etc.

The display shows the two-figure address block number and the meaning of the requested parameter (Figure 5.8). In the second display line follows the text or number which is presently applicable. The preset text or number can be altered by pressing the keys ◄ or ▶.

When the relay is operated from a personal computer by means of the protection data processing program DigiS,[5] each configuration parameter is identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

For text parameters, an alternative text appears which is illustrated in the explanations below. Multiple alternatives may be possible. The alternative which is chosen, is confirmed with the enter key E.

When the last possible alternative is reached, no further changing with the key ◄ is possible. The same is valid when one tries to change the first alternative with the key ▶.

If a numerical value of the parameter is required, the preset number can equally be changed with the keys ◄ or ▶ in order to get a higher or lower number. The desired value must be confirmed with the enter key E!

When one of the keys ◄ or ▶ is pressed continuously, the numbers will change with an accelerating sequence. Thus, a fast and fine adjustment is possible within a wide setting range.

If one tries to leave an operating item or operating level by pressing one of the arrow keys without having confirmed an alteration with the enter key E, the display will show the question “SAVE NEW SETTING?” Confirm with the “Yes”—key Y/J that the new settings shall become valid now. If you press the “No”—key N instead, codeword operation will be aborted, and the alteration which has been changed since the last entry is lost. Thus, erroneous alterations can be made ineffective. Press the arrow key once again in order to change really the operating item or level.

When the configuration or setting process is terminated by pressing the enter key E, the altered parameters are permanently secured in EEPROMs and protected against power outage.

### 5.3.2 Settings for the integrated operation – address block 71

Operating parameters can be set in address block 71. This block allows the operating language to be selected.

When the relay is delivered from the factory, the device is programmed to give function names and outputs in the English language. This can be changed under address block 71. This item is reached from the second operation level, address block 71 (as described above) by changing with the key ▶ to the third operation level where the operation language may be changed. The operator languages available at present are shown in the boxes below.

![Language Selection Menu]

The available languages can be called up by repeatedly pressing the key ◄ or ▶. Each language is spelled in the corresponding national language. If you don’t understand a language, you should find your own language, nevertheless. The required language is chosen with the enter key E.
5.3.3 Configuration of the serial interface – address block 72

The device provides one serial interface (operating or PC interface). Communication via this interface requires some data prearrangements: identification of the relay, transmission format, transmission speed.

These data are entered to the relay in address block 72. Codeword input is necessary (refer to Section 5.3.1). The data must be coordinated with the connected devices.

The setting of the GAPS is relevant only when the relay is intended to communicate via a modem. The setting is the maximum time period which is tolerated by the relay when gaps occur during transmission of a telegram. Gaps may occur, when modems are used, by compression of data, error correction, and differences of the Baud-rate. With good transmission quality, 1.0 s is adequate. The value should be increased when transmission quality is not so good. It must be noted that GAPS must be smaller than the setting of “reaction time protection relay” in the protection software DIGSI® V3. Recommended value:

\[ \text{GAPS} \approx \frac{\text{"reaction time protection relay"}}{2} \]

Higher values for “reaction time protection relay” reduce the transmission speed in case of transmission errors. If the relay interface is connected directly to a personal computer, then GAPS may be set to 0.0 s.

---

[7200] Beginning of the block “Interface for personal computer”

[7201] Identification number of the relay within the substation; The number can be chosen at liberty, but must be used only once within the plant system
- Smallest permissible number: 1
- Largest permissible number: 254

[7202] Number of the feeder within the substation;
- Smallest permissible number: 1
- Largest permissible number: 254

[7203] Identification number of the substation, in case more than one substation will be processed
- Smallest permissible number: 1
- Largest permissible number: 254

[7208] Function type in accordance with VDEW/ZVEI and IEC 60870– 5–103; for voltage and frequency protection no. 78.
This address is mainly for information, it should not be changed.
5.3.4 Settings for fault recording – address block 74

The protection relay is equipped with a fault data store (see Section 4.8.2). Distinction must be made between the reference instant and the storage criterion. Normally, the general fault detection signal of the protection is the reference instant. The storage criterion can be the general fault detection, too (RECby/FT), or the trip command (RECby/TP). Alternatively, the trip command can be selected as reference instant (SRT with TP), in this case, the trip command is the storage criterion, too.

A fault event begins with the fault detection of any protection function and ends with drop-off of the latest fault detection. The scope of a fault record is normally this fault event.
The actual recording time starts with the pre-trigger time $T\text{-PRE}$ before the reference instant and ends with the post-fault time $T\text{-POS}$ after the recording criterion has disappeared. The permissible recording time for each record is set as $T\text{-MAX}$. Altogether 5 s are available for fault recording of instantaneous values, 50 s for recording of r.m.s. values. In this time range up to 8 fault records can be stored.

**Note:** The pre-settings illustrated in the following boxes relate to storage of instantaneous values. If r.m.s. values are to be stored, set an adequately longer period (e.g. 10 times).

**Note:** The setting ranges include both instantaneous and r.m.s. value ranges. If excessively long times are set for instantaneous values, the relay will limit them to the highest permissible value.

---

**[7400]**
Beginning of block “Fault recordings”

**[7402]**
Data storage is initiated:
- fault detection is reference instant
- fault detection is storage criterion
- fault detection is reference instant
- trip command is storage criterion
- trip command is reference instant
- trip command is storage criterion

**[7410]**
Maximum time period of one fault record
Smallest setting value: 0.30 s
Largest setting value (instant. values): 5.00 s
Largest setting value (r.m.s. values): 50.00 s

**[7411]**
Pre-trigger time before the reference instant
Smallest setting value: 0.05 s
Largest setting value (instant. values): 0.50 s
Largest setting value (r.m.s. values): 5.00 s

**[7412]**
Post-fault time after the storage criterion disappears
Smallest setting value: 0.05 s
Largest setting value (instant. values): 0.50 s
Largest setting value (r.m.s. values): 5.00 s

**[7420]**
Data storage of
- instantaneous values (20 samples per a.c. period)
- r.m.s. values (2 samples per a.c. period)
5.4 Configuration of the protective functions

5.4.1 Introduction

The device 7RW600 provides a series of protection and additional functions. The scope of the hard- and firmware is matched to these functions, dependent on the ordered version (refer to Section 2.3 Ordering data). Furthermore, individual functions can be set (configured) to be effective or non-effective by configuration parameters.

The configuration parameters are input through the integrated operation keyboard at the front of the device or by means of a personal computer, connected to the operation interface. The use of the integrated operating keyboard is described in detail in Section 6.2. Alteration of the programmed parameters requires the input of the codeword (see Section 5.3.1). Without codeword, the setting can be read out but not altered.

For the purpose of configuration, address block 00 is provided. This block is reached from the initial display in operation level 1 with the key \( \downarrow \) ("PARAME.") and changing with key \( \uparrow \) to the second operation level. Address block 00 CONFiguration appears (Figure 5.9).

![Diagram](image)

**Figure 5.9** Extract from the operation structure and illustration of selection of the configuration block

Within the block 00 one can page with key \( \uparrow \) to the third operation level and scroll on with key \( \downarrow \) or scroll back with key \( \Delta \). Each paging action leads to a further operation object for the input of a configuration parameter. In the following sections, each operating object is shown in a box and explained. In the upper line of the display, behind the block number, stands the associated device function. In the second line is the associated text (e.g. "EXIST"). If this text is appropriate the arrow keys \( \uparrow \) or \( \Delta \) can be used to page the
next or previous operating item. If the text should be altered, press the keys 
 or 
 after having input the codeword; an alternative text then appears (e.g. “nonEXIST”). There may be other alternatives which can then be displayed by repeated depression of the keys 
 or 
. When the last possible alternative is reached, no further changing with the key 
 is possible. The same is valid when one tries to change the first alternative with the key 
. The required alternative must be confirmed with the key 
!

When the relay is operated from a personal computer by means of the protection data processing program DIGI[5], each configuration parameter is identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

If one tries to leave an operating item or operating level by pressing one of the arrow keys without having confirmed an alteration with the enter key 
, the display will show the question “SAVE NEW SETTING?”. Confirm with the “Yes” – key 
 that the new settings shall become valid now. If you press the “No” – key 
 instead, codeword operation will be aborted, and the alteration which has been changed since the last entry is lost. Thus, erroneous alterations can be made ineffective. Press the arrow key once again in order to change really the operating item or level.

When the configuration or setting process is terminated by pressing the enter key 
, the altered parameters are permanently secured in EEPROMs and protected against power outage.

With the arrow key 
 (one level back), the second operation level can be reached where you may scroll with key 
 to the next address block. If you press the arrow key 
 once again, the first operation level is reached.

### 5.4.2 Programming the scope of functions and the connection mode – address block 00

The available protective and additional functions can be programmed as existing or not existing. For some functions it may also be possible to select between multiple alternatives.

Functions which are configured as nonEXIST will not be processed in 7RW600: There will be no announcements and the associated setting parameters (functions, limit values) will not be requested during setting (Section 6.3). In contrast, switch-off of a function means that the function will be processed, that indication will appear (e.g. “… switched off”) but that the function will have no effect on the result of the protective process (e.g. no tripping command).

The following boxes show the possibilities for the maximum scope of the device. In an actual case, functions which are not available will not appear in the display.

---

**Block 00 Configuration**

- **[7800]** Beginning of block “Configuration of the scope of functions”

  - **[7816]** Undervoltage protection:
    
    - **[00 U < EXIST]**
    - **[00 U < nonEXIST]**

  - **[7817]** Overvoltage protection:
    
    - **[00 U > EXIST]**
    - **[00 U > nonEXIST]**

---

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The relay must be informed how the voltage inputs are connected. The inputs U and Uₓ can be connected to two independent voltages, e.g. according to Figure 5.10, or to two phase-to-phase voltages of a three-phase system in V-connection, according to Figure 5.11. Refer also to Section 5.2.4.1.

The first possibility is also valid if only one single measured voltage is connected to the relay.

---

**Figure 5.10** Connection of two independent single-phase voltages

**Figure 5.11** Connection of two phase-to-phase voltages in V-connection

---

Connection of the voltage inputs to two independent voltages, according to figure 5.10.
Connection of the voltage inputs to two phase-to-phase voltages in V-connection, according to figure 5.11.
5.5 Marshalling of binary inputs, binary outputs and LED indicators

5.5.1 Introduction

The functions of the binary inputs and outputs represented in the general diagrams (Appendix A) relate to the factory settings. The assignment of the inputs and outputs of most of the internal functions can be rearranged and thus adapted to the on-site conditions.

Marshalling of the inputs, outputs and LEDs is performed by means of the integrated operator panel or via the operating interface. The operation of the operator panel is described in detail in Section 6.2. Marshalling begins at the address block 60.

The input of the codeword is required for marshalling (refer to Section 5.3.1). Without codeword entry, parameters can be read out but not be changed. A flashing cursor indicates that the relay operates now in alteration mode, starting with the first alteration and ending after confirmation of the altered item with the enter key E. The alteration mode is equally ended when the setting menu is left or after an internal waiting time.

When the firmware programs are running the specific logic functions will be allocated to the physical input and output modules or LEDs in accordance with the selection.

Example: A fault is registered from any of the integrated protection functions. This event is generated in the device as an “annunciation” (logical function) and should be available at certain terminals of the unit as a N.O. contact. Since specific unit terminals are hard-wired to a specific (physical) output relay, e.g. to the output relay 2, the processor must be advised that the logical signal “Fault detected” (fault detected) should be transmitted to the output relay 2. Thus, when marshalling is performed two statements of the operator are important: Which (logical) annunciation generated in the protection unit program should trigger which (physical) output relay?

Up to 20 logical annunciations can trigger one (physical) output relay.

A similar situation applies to binary inputs. In this case external information (e.g. blocking of the undervoltage protection) is connected to the unit via a (physical) input module and should initiate a (logical) function, namely blocking. The corresponding question to the operator is then: Which signal from a (physical) input relay should initiate which reaction in the device? One physical input signal can initiate up to 10 logical functions.

The logical annunciation functions can be used in multiple manner. E.g. one annunciation function can trigger several output relays, additionally be indicated by LEDs, and be controlled by a binary input unit.

The marshalling procedure is set up such that for each (physical) binary input, each output relay, and for each marshallable LED, the operator will be asked which (logical) functions should be allocated.

The offered logical functions are tabulated for the binary inputs, outputs and LEDs in the following sections.

The marshalling block is reached with the keys \( \nabla \) (scrolling forwards) or \( \Delta \) (scrolling backwards), \( \triangleright \) (next operation level) or \( \downarrow \) (previous operation level), i.e. from the initial display (Figure 5.12):

- key \( \nabla \) (forwards),
- key \( \triangleright \) (second operation level),
- key \( \nabla \) (forwards) until address block 60 appears in the display.

\[ \begin{array}{c}
60 \\
\text{M A R S H} \\
\end{array} \]

Beginning of marshalling blocks
You may, for example, change with the key △ to the next operation menu level, then with key ○ back to the previous operation menu level, as shown in Figure 5.12. Within a menu level, key ↙ is used to scroll forwards or △ to scroll backwards. Each forward or backward step in the fourth operation level leads to display of the next input, output or LED position. In the display the physical input/output unit forms the heading.

Key △ leads to the selection level of an individual input/output module. The display shows, in the upper line, the physical input/output unit, this time with a one to two digit index number. The second display line shows the logical function which is presently allocated.

On this selection level the allocated function can be changed after codeword input by pressing the key ◀. By repeated use of the key ◀ allmarshallable functions can be paged through the display. Back-paging is possible with the key △. When the required function appears press the execute key E. After this, further functions can be assigned to the same physical input or output module (with further index numbers) by using the key ↙. Each selection

must be confirmed by pressing the key E! If a selection place shall not be assigned to a function, selection is made with the function “not all.” (not allocated).

You can leave the selection level by pressing the key ○. The display shows again the previous selection level. Now you can page with key ↙ to the next input output module or with △ to the previous to repeat selection procedure, as above.
In the following paragraphs, allocation possibilities for binary inputs, binary outputs and LED indicators are given. The arrows ▼ △ or ◄ ◄ at the left hand side of the display box indicate paging from operation level to another operation level, within the operation level or selection level. Those arrows which lead to the next operating step in a logical sequence are indicated in bold figures.

The function numbers and designations are listed completely in Appendix C.

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, each configuration parameter is identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

If one tries to leave an item or operating level by pressing one of the arrow keys without having confirmed the allocation with the enter key E, the display will show the question “SAVE NEW SETTING?”. Confirm with the “Yes” — key Y/J that the new settings shall become valid now. The new text is displayed now. If you press the “No” — key N instead, all alterations which has been changed since the last entry of the key E are lost and the old text is displayed. Thus, erroneous alterations can be made ineffective. Press the arrow key once again in order to change really the operating item or level.

When the marshalling process is terminated by pressing the enter key E, the allocations are permanently secured in EEPROMs and protected against power outage.

### 5.5.2 Marshalling of the binary inputs — address block 61

The unit contains 3 binary inputs which are designated INPUT 1 to INPUT 3. They can be marshalled in address block 61. The block is reached from the initial display by pressing the key ▼ to the first main menu item “PARAME.” (parameters) in the first operation level of the menu tree. Press key △ to reach the second operation menu level, which starts with the first parameter block “00 CONF.” (configuration). Press the key ▼ repeatedly until address block “60 MARSH” (marshalling) appears. Key △ leads to operation level 3 with address block “61 MARSH BIN. INP” (marshalling of binary inputs) (refer also to Figure 5.12).

The selection procedure is carried out as described in Section 5.5.1.

A choice can be made for each individual input function as to whether the desired function should become operative in the “normally open” mode or in the “normally closed” mode, whereby:

- (no index) “normally open” mode: the input acts as a NO contact, i.e. control voltage present at the terminals turns off the function, control voltage absent activates the function;

- n “normally closed” mode: the input acts as a NC contact, i.e. control voltage present at the terminals turns on the function;

When paging through the display with ◄ or ◄, each input function is displayed without any index which indicates the “normally open” mode and with the index “n” which indicates the “normally closed” mode, as above. The changed function then must be re-confirmed by the entry key E.

Table 5.1 shows a complete list of all the binary input functions with their associated function number FNo. Input functions naturally have no effect if the corresponding protection function has been programmed out (“de-configured”, refer to Section 5.4.2).

The assignment of the binary inputs as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show, as an example, the allocation for binary input 1. Table 5.2 shows all binary inputs as preset from the factory for versions 7RW600×———0*** and —1***, table 5.3 for version 7RW600×———2***.
Change over to the selection level with △:

[6101] Allocations for binary input 1

[6102] Reset of stored LED indications, FNo 5;
"normally open" operation:
LEDs are reset when control voltage present

[6103] No further functions are initiated by binary input 1

Following codeword input, all marshallable functions can be paged through the display by repeated use of the key △. Back-paging is possible with the key ▽. When the required function appears press the execute key E. After this, further functions can be allocated to the same physical input or output module (with further index numbers 1 to 10) by using the key ▽. Each selection must be confirmed by pressing the key E! If a selection place shall not be assigned to a function, selection is made with the function “not all.” (not allocated).

Leave the selection level with key ▽. You can then to the next binary input with the arrow key △.

<table>
<thead>
<tr>
<th>FNo</th>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>not all.</td>
<td>Binary input is not allocated to any input function</td>
</tr>
<tr>
<td>3</td>
<td>&gt;Ti.syn</td>
<td>Time synchronization of internal time clock</td>
</tr>
<tr>
<td>5</td>
<td>&gt;LED r.</td>
<td>Reset LED indicators</td>
</tr>
<tr>
<td>1157</td>
<td>&gt;CBClo</td>
<td>Circuit breaker is manually closed (from discrepancy switch)</td>
</tr>
<tr>
<td>5203</td>
<td>&gt;Frg bl</td>
<td>Block frequency protection</td>
</tr>
<tr>
<td>5206</td>
<td>&gt;f1 blk</td>
<td>Block frequency protection f1 stage</td>
</tr>
<tr>
<td>5207</td>
<td>&gt;f2 blk</td>
<td>Block frequency protection f2 stage</td>
</tr>
<tr>
<td>5208</td>
<td>&gt;f3 blk</td>
<td>Block frequency protection f3 stage</td>
</tr>
<tr>
<td>5209</td>
<td>&gt;f4 blk</td>
<td>Block frequency protection f4 stage</td>
</tr>
<tr>
<td>5353</td>
<td>&gt;U/f bl</td>
<td>Block overexcitation protection</td>
</tr>
<tr>
<td>5357</td>
<td>&gt;RM U/f</td>
<td>Reset memory of thermal replica U/f</td>
</tr>
<tr>
<td>5503</td>
<td>&gt;df blk</td>
<td>Block rate-of-frequency-change protection</td>
</tr>
<tr>
<td>5504</td>
<td>&gt;df1 bl</td>
<td>Block rate-of-change stage df1/dt</td>
</tr>
<tr>
<td>5505</td>
<td>&gt;df2 bl</td>
<td>Block rate-of-change stage df2/dt</td>
</tr>
<tr>
<td>5506</td>
<td>&gt;df3 bl</td>
<td>Block rate-of-change stage df3/dt</td>
</tr>
<tr>
<td>5507</td>
<td>&gt;df4 bl</td>
<td>Block rate-of-change stage df4/dt</td>
</tr>
<tr>
<td>6506</td>
<td>&gt;U&lt; bl</td>
<td>Block undervoltage protection U&lt; stage</td>
</tr>
<tr>
<td>6513</td>
<td>&gt;U&gt; bl</td>
<td>Block overvoltage protection U&gt; stage</td>
</tr>
<tr>
<td>6518</td>
<td>&gt;Ux&lt; bl</td>
<td>Block undervoltage protection Ux&lt; stage</td>
</tr>
<tr>
<td>6519</td>
<td>&gt;Ux&gt; bl</td>
<td>Block overvoltage protection Ux&gt; stage</td>
</tr>
<tr>
<td>6851</td>
<td>&gt;SUP bk</td>
<td>Blocking trip circuit supervision</td>
</tr>
<tr>
<td>6852</td>
<td>&gt;TrpRel</td>
<td>Trip circuit supervision: Trip relay</td>
</tr>
<tr>
<td>6853</td>
<td>&gt;CBaux</td>
<td>Trip circuit supervision: CB auxiliary</td>
</tr>
</tbody>
</table>

Table 5.1 Marshalling possibilities for binary inputs
The complete pre-settings are listed in Tables 5.2 and 5.3.

<table>
<thead>
<tr>
<th>4th selection level</th>
<th>5th selection level</th>
<th>FNo</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARSHALLING</td>
<td>BINARY INPUTS</td>
<td></td>
<td>Heading of the address block</td>
</tr>
<tr>
<td>61 M A R S H B I 1</td>
<td>61 B I 1 1</td>
<td>5</td>
<td>Acknowledge and reset of stored LED and displayed fault indications, LED—test</td>
</tr>
<tr>
<td></td>
<td>&gt; L E D r .</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61 M A R S H B I 2</td>
<td>61 B I 2 1</td>
<td>5203</td>
<td>Block frequency protection</td>
</tr>
<tr>
<td></td>
<td>&gt; F q r b l</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61 M A R S H B I 3</td>
<td>61 B I 3 1</td>
<td>6506</td>
<td>Block undervoltage protection</td>
</tr>
<tr>
<td>61 M A R S H B I 3</td>
<td>61 B I 3 1</td>
<td>6518</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; U &lt; b l</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; U x &lt; b l</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.2  Preset binary inputs for versions 7RW600—*****—0*** and —1*** (voltage, frequency, rate-of-frequency-change protection)

<table>
<thead>
<tr>
<th>4th selection level</th>
<th>5th selection level</th>
<th>FNo</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARSHALLING</td>
<td>BINARY INPUTS</td>
<td></td>
<td>Heading of the address block</td>
</tr>
<tr>
<td>61 M A R S H B I 1</td>
<td>61 B E 1 1</td>
<td>5</td>
<td>Acknowledge and reset of stored LED and displayed fault indications, LED—test</td>
</tr>
<tr>
<td></td>
<td>&gt; L E D Q .</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61 M A R S H B I 2</td>
<td>61 B E 2 1</td>
<td>5353</td>
<td>Block overexcitation protection</td>
</tr>
<tr>
<td></td>
<td>&gt; U / f b l</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61 M A R S H B I 3</td>
<td>61 B E 3 1</td>
<td>6513</td>
<td>Block overvoltage protection</td>
</tr>
<tr>
<td>61 M A R S H B I 3</td>
<td>61 B E 3 1</td>
<td>6519</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; U &lt; b l</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; U x &gt; b l</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.3  Preset binary inputs for version 7RW600—*****—2*** (voltage and overflux protection)

5.5.3  Marshalling of the output relays — address block 62

The unit contains 6 output relays (K1 to K6). These are of equal type and, thus, of equal switching capacity and capable to trip circuit breaker coils. Nevertheless, the output relays K1 and K2 are dual channel controlled, i.e. they are energized via two different control channels and continuously supervised. Therefore, they are particularly suited for trip relays. They are marshalled according to Section 5.5.5.

The remaining output relays K3 to K6 can be marshalled in address block 62. The output relays K4 and K5 have a common plus connection. Output relay K6 can optionally operate with its make or break contact. Refer to Section 5.2.2.3 for selection of this contact mode. The break contact is suitable for internal fault alarm.

The block 62 is reached from the initial display by pressing the key \( \Downarrow \) to the first main menu item “PARAME.” (parameters) in the first operation level of the menu tree. Press key \( \Uparrow \) to reach the second operation menu level, which starts with the first parameter block “00 CONF.” (configuration). Press the key \( \Downarrow \) repeatedly until address block “60 MARSH” (marshalling) appears. Key \( \Uparrow \) leads to operation level 3 with address block “61 MARSH BIN INP” (marshalling of binary inputs); key \( \Downarrow \) leads to address block “62 MARSH RELAY” (marshalling relays) (refer also to Figure 5.12).
The selection procedure is carried out as described in Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciation function can be routed to several physical output relays (see also Section 5.5.1).

Table 5.4 gives a listing of all annunciation functions with the associated function numbers FNo. Annunciation functions are naturally not effective when the corresponding protection function is not available or has been programmed out (“de-configured” – refer to Section 5.4.2).

Note: Besides the annunciation functions listed in Table 5.4, further functions may appear in the display which are not meaningful for marshalling (e.g. annunciations of measured values). Therefore, it is strongly advised to use only the annunciations listed in Table 5.4 for marshalling of output functions.

The assignment of the output relays as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show an example for marshalling of the output relay 3. Table 5.5 shows all relays as preset from the factory for versions 7RW600•••••••••0••• and –1•••, Table 5.6 for version 7RW600•••••••••2•••.

Note as to Table 5.4: Annunciations which are indicated by a leading “>” sign, represent the direct confirmation of the binary inputs and are available as long as the corresponding binary input is energized.

Further information about annunciations see Section 6.4.

---

The first output relay is reached with the key ▲:

[6200] Beginning of the block “Marshalling of the output relays”

Change over to the selection level with ▲:

[6201] Allocations for relay 3

[6202] Relay 3 has been preset for:
Frequency protection: Trip stage f2, FNo 5237;

[6203] no further functions are preset for output relay 3

Following codeword input, all marshallable functions can be paged through the display by repeated use of the key ▲. At first, all direct confirmation annunciations of binary inputs will appear, then the further annunciations. Back-paging is possible with the key ▲. When the required function appears press the execute key E. After this, further functions can be allocated to the same output relay (with further index numbers 1 to 20) by using the key ▼. Each selection must be confirmed by pressing the key E! If a selection place shall not be assigned to a function, selection is made with the function “not all.” (not allocated).

Leave the selection level with key ▼. You can go then to the next output relay with the arrow key ▼.
<table>
<thead>
<tr>
<th>FNo</th>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>not all.</td>
<td>No annunciation allocated</td>
</tr>
<tr>
<td>3</td>
<td>&gt;Ti.syn</td>
<td>Time synchronization of the internal real time clock</td>
</tr>
<tr>
<td>5</td>
<td>&gt;LED r.</td>
<td>Reset LED indicators</td>
</tr>
<tr>
<td>52</td>
<td>operat.</td>
<td>At least one protection function is operative</td>
</tr>
<tr>
<td>60</td>
<td>LED res</td>
<td>Stored annunciations are reset</td>
</tr>
<tr>
<td>110</td>
<td>ANNlost</td>
<td>Annunciations lost (buffer overflow)</td>
</tr>
<tr>
<td>111</td>
<td>PCanLT</td>
<td>Annunciations for personal computer interface lost</td>
</tr>
<tr>
<td>113</td>
<td>TAGlost</td>
<td>Fault tag lost</td>
</tr>
<tr>
<td>115</td>
<td>ANNovf1</td>
<td>Fault annunciation buffer overflow</td>
</tr>
<tr>
<td>203</td>
<td>REC del</td>
<td>Fault recording data deleted</td>
</tr>
<tr>
<td>501</td>
<td>FT det</td>
<td>General fault detection of the device</td>
</tr>
<tr>
<td>511</td>
<td>DEV.Trp</td>
<td>General trip command of the device</td>
</tr>
<tr>
<td>1157</td>
<td>&gt;CBCclo</td>
<td>Circuit breaker is closed (from discrepancy switch)</td>
</tr>
<tr>
<td>1174</td>
<td>CBtest</td>
<td>Circuit breaker test in progress</td>
</tr>
<tr>
<td>1185</td>
<td>CBptTST</td>
<td>Circuit breaker test: Trip 3pole</td>
</tr>
<tr>
<td>5203</td>
<td>Frq bl</td>
<td>Block frequency protection complete</td>
</tr>
<tr>
<td>5206</td>
<td>&gt;f1 blk</td>
<td>Block frequency protection f1 stage</td>
</tr>
<tr>
<td>5207</td>
<td>&gt;f2 blk</td>
<td>Block frequency protection f2 stage</td>
</tr>
<tr>
<td>5208</td>
<td>&gt;f3 blk</td>
<td>Block frequency protection f3 stage</td>
</tr>
<tr>
<td>5209</td>
<td>&gt;f4 blk</td>
<td>Block frequency protection f4 stage</td>
</tr>
<tr>
<td>5211</td>
<td>Frq off</td>
<td>Frequency protection is switched off</td>
</tr>
<tr>
<td>5212</td>
<td>Frq bl</td>
<td>Frequency protection is blocked</td>
</tr>
<tr>
<td>5213</td>
<td>Frq act</td>
<td>Frequency protection is active</td>
</tr>
<tr>
<td>5214</td>
<td>Uf&lt; bl</td>
<td>Frequency protection is blocked by undervoltage</td>
</tr>
<tr>
<td>5232</td>
<td>f1 Flt.</td>
<td>Frequency protection: f1 stage fault detection</td>
</tr>
<tr>
<td>5233</td>
<td>f2 Flt.</td>
<td>Frequency protection: f2 stage fault detection</td>
</tr>
<tr>
<td>5234</td>
<td>f3 Flt.</td>
<td>Frequency protection: f3 stage fault detection</td>
</tr>
<tr>
<td>5235</td>
<td>f4 Flt.</td>
<td>Frequency protection: f4 stage fault detection</td>
</tr>
<tr>
<td>5236</td>
<td>f1 Trip</td>
<td>Frequency protection: Trip by f1 stage</td>
</tr>
<tr>
<td>5237</td>
<td>f2 Trip</td>
<td>Frequency protection: Trip by f2 stage</td>
</tr>
<tr>
<td>5238</td>
<td>f3 Trip</td>
<td>Frequency protection: Trip by f3 stage</td>
</tr>
<tr>
<td>5239</td>
<td>f4 Trip</td>
<td>Frequency protection: Trip by f4 stage</td>
</tr>
<tr>
<td>5353</td>
<td>&gt;U/f bl</td>
<td>Block overflux protection</td>
</tr>
<tr>
<td>5357</td>
<td>&gt;RM U/f</td>
<td>Reset memory of thermal replica U/f</td>
</tr>
<tr>
<td>5361</td>
<td>U/f off</td>
<td>Overflux protection is switched off</td>
</tr>
<tr>
<td>5362</td>
<td>U/f blk</td>
<td>Overflux protection is blocked</td>
</tr>
<tr>
<td>5363</td>
<td>U/f act</td>
<td>Overflux protection is active</td>
</tr>
<tr>
<td>5367</td>
<td>U/f&gt;wrn</td>
<td>Overflux protection: U/f warning stage</td>
</tr>
<tr>
<td>5370</td>
<td>U/f&gt;Plt</td>
<td>Overflux protection: Fault detection U/f&gt;</td>
</tr>
<tr>
<td>5371</td>
<td>U/f&gt;Trp</td>
<td>Overflux protection: Trip of U/f&gt; stage</td>
</tr>
<tr>
<td>5372</td>
<td>U/ftTrp</td>
<td>Overflux protection: Trip of the thermal stage</td>
</tr>
<tr>
<td>5503</td>
<td>&gt;df blk</td>
<td>Block rate-of-frequency-change protection</td>
</tr>
<tr>
<td>5504</td>
<td>&gt;df1 bl</td>
<td>Block rate-of-change stage df1/dt</td>
</tr>
<tr>
<td>5505</td>
<td>&gt;df2 bl</td>
<td>Block rate-of-change stage df2/dt</td>
</tr>
<tr>
<td>5506</td>
<td>&gt;df3 bl</td>
<td>Block rate-of-change stage df3/dt</td>
</tr>
<tr>
<td>5507</td>
<td>&gt;df4 bl</td>
<td>Block rate-of-change stage df4/dt</td>
</tr>
<tr>
<td>5511</td>
<td>df off</td>
<td>Rate-of-frequency-change protection is switched off</td>
</tr>
<tr>
<td>5512</td>
<td>df blk</td>
<td>Rate-of-frequency-change protection is blocked</td>
</tr>
<tr>
<td>5513</td>
<td>df act</td>
<td>Rate-of-frequency-change protection is active</td>
</tr>
<tr>
<td>5514</td>
<td>Udf&lt; bl</td>
<td>df/dt protection is blocked by undervoltage</td>
</tr>
<tr>
<td>5516</td>
<td>df1 Flt</td>
<td>df1/dt stage: Fault detection</td>
</tr>
<tr>
<td>5517</td>
<td>df2 Flt</td>
<td>df2/dt stage: Fault detection</td>
</tr>
<tr>
<td>5518</td>
<td>df3 Flt</td>
<td>df3/dt stage: Fault detection</td>
</tr>
<tr>
<td>5519</td>
<td>df4 Flt</td>
<td>df4/dt stage: Fault detection</td>
</tr>
</tbody>
</table>

Table 5.4  Marshalling possibilities for output relays and LEDs (continued next page)
<table>
<thead>
<tr>
<th>FNo</th>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5520</td>
<td>df1 Trp</td>
<td>df1/dt stage trip</td>
</tr>
<tr>
<td>5521</td>
<td>df2 Trp</td>
<td>df2/dt stage trip</td>
</tr>
<tr>
<td>5522</td>
<td>df3 Trp</td>
<td>df3/dt stage trip</td>
</tr>
<tr>
<td>5523</td>
<td>df4 Trp</td>
<td>df4/dt stage trip</td>
</tr>
<tr>
<td>6506</td>
<td>&gt;U&lt; bl</td>
<td>Block undervoltage protection U&lt;</td>
</tr>
<tr>
<td>6513</td>
<td>&gt;U&gt; bl</td>
<td>Block overvoltage protection U&gt;</td>
</tr>
<tr>
<td>6518</td>
<td>&gt;Ux&lt; bl</td>
<td>Block undervoltage protection Ux&lt;</td>
</tr>
<tr>
<td>6519</td>
<td>&gt;Ux&gt; bl</td>
<td>Block overvoltage protection Ux&gt;</td>
</tr>
<tr>
<td>6530</td>
<td>U&lt; off</td>
<td>Undervoltage protection U&lt; is switched off</td>
</tr>
<tr>
<td>6531</td>
<td>U&lt; blk</td>
<td>Undervoltage protection U&lt; is blocked</td>
</tr>
<tr>
<td>6532</td>
<td>U&lt; act</td>
<td>Undervoltage protection U&lt; is active</td>
</tr>
<tr>
<td>6533</td>
<td>U&lt; Flt</td>
<td>Undervoltage fault detection U&lt;</td>
</tr>
<tr>
<td>6539</td>
<td>U&lt; Trp</td>
<td>Undervoltage protection, U&lt; trip</td>
</tr>
<tr>
<td>6565</td>
<td>U&gt; off</td>
<td>Overvoltage protection U&gt; is switched off</td>
</tr>
<tr>
<td>6566</td>
<td>U&gt; blk</td>
<td>Overvoltage protection U&lt; is blocked</td>
</tr>
<tr>
<td>6567</td>
<td>U&gt; act</td>
<td>Overvoltage protection U&gt; is active</td>
</tr>
<tr>
<td>6568</td>
<td>U&gt; Flt</td>
<td>Overvoltage fault detection U&gt;</td>
</tr>
<tr>
<td>6570</td>
<td>U&gt; Trp</td>
<td>Overvoltage protection, U&gt; trip</td>
</tr>
<tr>
<td>6571</td>
<td>U&gt;&gt; Flt</td>
<td>Overvoltage fault detection U&gt;&gt;</td>
</tr>
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<td>6573</td>
<td>U&gt;&gt; Trp</td>
<td>Overvoltage protection U&gt;&gt; trip</td>
</tr>
<tr>
<td>6576</td>
<td>Ux&lt; off</td>
<td>Undervoltage protection Ux&lt; is switched off</td>
</tr>
<tr>
<td>6577</td>
<td>Ux&lt; blk</td>
<td>Undervoltage protection Ux&lt; is blocked</td>
</tr>
<tr>
<td>6578</td>
<td>Ux&lt; act</td>
<td>Undervoltage protection Ux&lt; is active</td>
</tr>
<tr>
<td>6579</td>
<td>Ux&lt; Flt</td>
<td>Undervoltage fault detection Ux&lt;</td>
</tr>
<tr>
<td>6580</td>
<td>Ux&lt; Trp</td>
<td>Undervoltage protection, Ux&lt; trip</td>
</tr>
<tr>
<td>6584</td>
<td>Ux&gt; off</td>
<td>Overvoltage protection Ux&gt; is switched off</td>
</tr>
<tr>
<td>6585</td>
<td>Ux&gt; blk</td>
<td>Overvoltage protection Ux&lt; is blocked</td>
</tr>
<tr>
<td>6586</td>
<td>Ux&gt; act</td>
<td>Overvoltage protection Ux&gt; is active</td>
</tr>
<tr>
<td>6587</td>
<td>Ux&gt; Flt</td>
<td>Overvoltage fault detection Ux&gt;</td>
</tr>
<tr>
<td>6588</td>
<td>Ux&gt;&gt;Flt</td>
<td>Overvoltage protection, Ux&gt; trip</td>
</tr>
<tr>
<td>6589</td>
<td>Ux&gt;&gt; Trp</td>
<td>Overvoltage fault detection Ux&gt;</td>
</tr>
<tr>
<td>6590</td>
<td>Ux&gt;&gt;Trp</td>
<td>Overvoltage protection Ux&gt;&gt; trip</td>
</tr>
<tr>
<td>6851</td>
<td>&gt;SUP bk</td>
<td>Blocking trip circuit supervision</td>
</tr>
<tr>
<td>6852</td>
<td>&gt;TrpRel</td>
<td>Trip circuit supervision: Trip relay</td>
</tr>
<tr>
<td>6853</td>
<td>&gt;CB aux.</td>
<td>Trip circuit supervision: Circuit breaker auxiliary</td>
</tr>
<tr>
<td>6860</td>
<td>SUP off</td>
<td>Trip circuit supervision is switched off</td>
</tr>
<tr>
<td>6862</td>
<td>SUP blk</td>
<td>Trip circuit supervision is blocked</td>
</tr>
<tr>
<td>6863</td>
<td>SUP act</td>
<td>Trip circuit supervision is active</td>
</tr>
<tr>
<td>6864</td>
<td>SUPNoBI</td>
<td>Trip circuit supervision is blocked: Binary input not marshalled</td>
</tr>
<tr>
<td>6865</td>
<td>CIR int</td>
<td>Trip circuit interrupted</td>
</tr>
</tbody>
</table>

Table 5.4 Marshalling possibilities for output relays and LEDs
<table>
<thead>
<tr>
<th>4th selection level</th>
<th>5th selection level</th>
<th>FNo</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARSHALLING</td>
<td>SIGNAL RELAYS</td>
<td></td>
<td>Heading of the address block</td>
</tr>
<tr>
<td>6 2 M A R S H</td>
<td>6 2 R E L 3 1</td>
<td>5237</td>
<td>Frequency protection: Trip by stage f₂</td>
</tr>
<tr>
<td>R E L 3</td>
<td>f 2 T r i p</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 2 M A R S H</td>
<td>6 2 R E L 4 1</td>
<td>5238</td>
<td>Frequency protection: Trip by stage f₃</td>
</tr>
<tr>
<td>R E L 4</td>
<td>f 3 T r i p</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 2 M A R S H</td>
<td>6 2 R E L 5 1</td>
<td>5232</td>
<td>Frequency protection: fault detec. stage f₁</td>
</tr>
<tr>
<td>R E L 5</td>
<td>f 1 F l t.</td>
<td></td>
<td>Frequency protection: fault detec. stage f₂</td>
</tr>
<tr>
<td>R E L 5</td>
<td>f 2 F l t.</td>
<td>5233</td>
<td>Frequency protection: fault detec. stage f₃</td>
</tr>
<tr>
<td>R E L 5</td>
<td>f 3 F l t.</td>
<td>5234</td>
<td></td>
</tr>
<tr>
<td>R E L 5</td>
<td>U &lt; F l t</td>
<td>6533</td>
<td>Undervoltage fault detection U&lt;</td>
</tr>
<tr>
<td>R E L 5</td>
<td>U x &lt; F l t</td>
<td>6579</td>
<td>Undervoltage fault detection Uₓ&lt;</td>
</tr>
<tr>
<td>6 2 M A R S H</td>
<td>6 2 R E L 6 1</td>
<td>52</td>
<td>At least one protection function is active;</td>
</tr>
<tr>
<td>R E L 6</td>
<td>o p e r a t.</td>
<td></td>
<td>device operative; NC contact indicates &quot;device fault&quot;</td>
</tr>
</tbody>
</table>

Table 5.5 Marshalling possibilities for output relays and LEDs for versions 7RW600*-****-0** and -1** (voltage, frequency, rate-of-frequency-change protection)

<table>
<thead>
<tr>
<th>4th selection level</th>
<th>5th selection level</th>
<th>FNo</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARSHALLING</td>
<td>SIGNAL RELAYS</td>
<td></td>
<td>Heading of the address block</td>
</tr>
<tr>
<td>6 2 M A R S H</td>
<td>6 2 R E L 3 1</td>
<td>6573</td>
<td>Overvoltage protection U&gt;&gt; trip</td>
</tr>
<tr>
<td>R E L 3</td>
<td>U &gt;&gt; T r p</td>
<td></td>
<td>Overvoltage protection Uₓ&gt;&gt; trip</td>
</tr>
<tr>
<td>R E L 3</td>
<td>U x &gt;&gt; T r p</td>
<td>6590</td>
<td></td>
</tr>
<tr>
<td>6 2 M A R S H</td>
<td>6 2 R E L 4 1</td>
<td>5367</td>
<td>Overflux protection: U/f&gt; warning stage</td>
</tr>
<tr>
<td>R E L 4</td>
<td>U / f &gt; w r n</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 2 M A R S H</td>
<td>6 2 R E L 5 1</td>
<td>6568</td>
<td>Overvoltage fault detection U&gt;</td>
</tr>
<tr>
<td>R E L 5</td>
<td>U &gt; F l t</td>
<td></td>
<td>Overvoltage fault detection U&gt;&gt;</td>
</tr>
<tr>
<td>R E L 5</td>
<td>U &gt;&gt; F l t</td>
<td>6571</td>
<td>Overvoltage fault detection Uₓ&gt;</td>
</tr>
<tr>
<td>R E L 5</td>
<td>U x &gt; F l t</td>
<td>6587</td>
<td>Overvoltage fault detection Uₓ&gt;&gt;</td>
</tr>
<tr>
<td>R E L 5</td>
<td>U x &gt; &gt; F l t</td>
<td>6588</td>
<td></td>
</tr>
<tr>
<td>6 2 M A R S H</td>
<td>6 2 R E L 6 1</td>
<td>52</td>
<td>At least one protection function is active;</td>
</tr>
<tr>
<td>R E L 6</td>
<td>o p e r a t.</td>
<td></td>
<td>device operative; NC contact indicates &quot;device fault&quot;</td>
</tr>
</tbody>
</table>

Table 5.6 Marshalling possibilities for output relays and LEDs for version 7RW600*-****-2** 7RW600*-****-2** (voltage and overflux protection)
5.5.4 Marshalling of the LED indicators — address block 63

The unit contains 6 LEDs for optical indications, 4 of which can be marshalled. They are designated LED 1 to LED 4 and can be marshalled in address block 63. The block is reached from the initial display by pressing the key \( \mathcal{V} \) to the first main menu item “PARAME.” (parameters) in the first operation level of the menu tree. Press key \( \mathcal{E} \) to reach the second operation menu level, which starts with the first parameter block “00 CONF.” (configuration). Press the key \( \mathcal{V} \) repeatedly until address block “60 MARSH” (marshalling) appears. Key \( \mathcal{E} \) leads to operation level 3 with address block “61 MARSH BIN INP” (marshalling of binary inputs); key \( \mathcal{V} \) (twice) leads to address block “63 MARSH LED IND” (marshalling LED indicators) (refer also to Figure 5.12).

The selection procedure is carried out as described in Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciations function can be routed to several LEDs (see also Section 5.5.1).

Apart from the logical function, each LED can be marshalled to operate either in the stored mode or unstored mode. Each annunciations function is displayed with the index \( \mathcal{X} \) (for memorized) or without index (for not memorized) when proceeding with the key \( \mathcal{E} \).

The marshalled annunciations functions are the same as those listed in Table 5.4. Annunciations functions are, of course, not effective when the corresponding protection function has been programmed out (de-configured).

The changed function must be re-confirmed by the enter—key \( \mathcal{E} \).

The assignment of the LEDs as preset by the factory for both versions is shown in the front of the unit (Fig 6.1). The following boxes show, as an example, the assignment for LED 2. Table 5.7 shows all LED indicators as they are preset from the factory for versions \( 7RW600x-*****-0*** \) and \( -1*** \), Table 5.8 for version \( 7RW600x-*****-2*** \).

The first marshalled LED is reached with the key \( \mathcal{E} \), the second with \( \mathcal{V} \):

\[
\begin{array}{c|c}
\mathcal{V} & \mathcal{E} \\
63 & \text{MARSH} \\
\text{LED} & \text{IND} \\
\end{array}
\]

Beginning of the block “Marshalling of the LED indicators”

Change over to the selection level with \( \mathcal{E} \):

\[
\begin{array}{c|c}
\mathcal{V} & \mathcal{E} \\
63 & \text{LED} \\
2 & \text{1} \\
\end{array}
\]

[6323] LED 2 has been preset for:  
1st: Frequency protection: Trip stage \( f_2 \), memorized,  
FNo 5237

[6324] No further functions are preset for LED 2

Following codeword input, all marshalled functions can be paged through the display by repeated use of the key \( \mathcal{E} \). Back-paging is possible with the key \( \mathcal{V} \). When the required function appears press the execute key \( \mathcal{E} \). After this, further functions can be allocated to the same LED indicator (with further index numbers 1 to 20) by using the key \( \mathcal{V} \). Each selection must be confirmed by pressing the key \( \mathcal{E} \)! If a selection place shall not be assigned to a function, selection is made with the function “not all.” (not allocated).
Leave the selection level with key ↓. You can go then to the next LED indicator with the arrow key ↑; key Δ is used to scroll backwards.

<table>
<thead>
<tr>
<th>4th selection level</th>
<th>5th selection level</th>
<th>FNo</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARSHALLING</td>
<td>LEDs</td>
<td></td>
<td>Heading of the address block</td>
</tr>
<tr>
<td>6 3 M A R S H</td>
<td>6 3 L E D 1 1</td>
<td>5236</td>
<td>Frequency protection: Trip stage $f_1$; memorized</td>
</tr>
<tr>
<td>L E D 1</td>
<td>f 1 T r i p M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 3 M A R S H</td>
<td>6 3 L E D 2 1</td>
<td>5237</td>
<td>Frequency protection: Trip stage $f_2$; memorized</td>
</tr>
<tr>
<td>L E D 2</td>
<td>f 2 T r i p M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 3 M A R S H</td>
<td>6 3 L E D 3 1</td>
<td>5238</td>
<td>Frequency protection: Trip stage $f_3$; memorized</td>
</tr>
<tr>
<td>L E D 3</td>
<td>f 3 T r i p M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 3 M A R S H</td>
<td>6 3 L E D 4 1</td>
<td>6539</td>
<td>Trip by undervoltage protection ($U&lt;, U_x&lt;$); memorized</td>
</tr>
<tr>
<td>L E D 4</td>
<td>U &lt; T r p M</td>
<td>6580</td>
<td></td>
</tr>
<tr>
<td>L E D 4</td>
<td>U x &lt; T r p M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.7 Preset LED indicators for versions 7RW600$-*****-0***$ and $-1***$ (voltage, frequency, rate-of-frequency-change protection)

<table>
<thead>
<tr>
<th>4th selection level</th>
<th>5th selection level</th>
<th>FNo</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARSHALLING</td>
<td>LEDs</td>
<td></td>
<td>Heading of the address block</td>
</tr>
<tr>
<td>6 3 M A R S H</td>
<td>6 3 L E D 1 1</td>
<td>5367</td>
<td>Overflux protection: U/f warning stage; memorized</td>
</tr>
<tr>
<td>L E D 1</td>
<td>U / f &gt; w r n M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 3 M A R S H</td>
<td>6 3 L E D 2 1</td>
<td>5372</td>
<td>Trip by overflux protection; memorized</td>
</tr>
<tr>
<td>L E D 2</td>
<td>U / f T r p M</td>
<td>5371</td>
<td></td>
</tr>
<tr>
<td>L E D 3</td>
<td>U / f &gt; T r p M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 3 M A R S H</td>
<td>6 3 L E D 3 1</td>
<td>6570</td>
<td>Trip by overvoltage protection ($U&gt;, U_x&gt;$); memorized</td>
</tr>
<tr>
<td>L E D 3</td>
<td>U &gt; T r p M</td>
<td>6589</td>
<td></td>
</tr>
<tr>
<td>L E D 3</td>
<td>U x &gt; T r p M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 3 M A R S H</td>
<td>6 3 L E D 4 1</td>
<td>6573</td>
<td>Trip by overvoltage protection ($U&gt;&gt;, U_x&gt;&gt;$); memorized</td>
</tr>
<tr>
<td>L E D 4</td>
<td>U &gt;&gt; T r p M</td>
<td>6590</td>
<td></td>
</tr>
<tr>
<td>L E D 4</td>
<td>U x &gt;&gt; T r p M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.8 Preset LED indicators for version 7RW600$-*****-2***$ (voltage and overflux protection)
5.5.5 Marshalling of the command (trip) relays — address block 64

The unit contains 6 output relays (K1 to K6). These are of equal type and, thus, of equal switching capacity and capable to trip circuit breaker coils. Nevertheless, the output relays K1 and K2 are dual channel controlled, i.e. they are energized via two different control channels and continuously supervised. Therefore, they are particularly suited for trip relays. These trip relays can be marshalled in the address block 64.

Address block 64 is reached from the initial display by pressing the key \(\downarrow\) to the first main menu item “PARAME.” (parameters) in the first operation level of the menu tree. Press key \(\uparrow\) to reach the second operation menu level, which starts with the first parameter block “00 CONFF.” (configuration). Press the key \(\downarrow\) repeatedly until address block “60 MARSH” (marshalling) appears. Key \(\uparrow\) leads to operation level 3 with address block “61 MARSH BIN. INP” (marshalling of binary inputs); repeated pressing of the key \(\downarrow\) leads to address block “64 MARSH CMD.REL” (marshalling command relays).

The selection procedure is carried out as described in Section 5.5.1. Multiple commands are possible, i.e. one logical command function can be routed to several trip relays (see also Section 5.5.1).

All of the annunciation functions in accordance with Table 5.4, can be marshalled to output command relays. But those listed in Table 5.9 are particularly suitable for trip relay output. Regard the table as a recommended pre-selection. Command functions are naturally not effective when the corresponding protection function is not available in the relay or has been programmed out (de-configured).

The assignment of the trip relays as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show examples for marshalling of trip relays 1. Table 5.10 shows all trip relays as preset from the factory for versions 7RW600x—*****—0*** and —1***, Table 5.11 for version 7RW600x—*****—2***.

If further protection functions shall trip the same breaker, the assigned trip relay must be triggered by the corresponding command functions.
Following codeword input, all marshellable functions can be paged through the display by repeated use of the key \( \text{\textbullet} \). Back-paging is possible with the key \( \text{\textbullet} \). When the required function appears press the execute key \( \text{\textbullet} \). After this, further functions can be allocated to the same trip relay (with further index numbers 1 to 20) by using the key \( \text{\textbullet} \). Each selection must be confirmed by pressing the key \( \text{\textbullet} \) If a selection place shall not be assigned to a function, selection is made with the function “not all.” (not allocated).

Leave the selection level with key \( \text{\textbullet} \). You can go then to the next command relay with the arrow key \( \text{\textbullet} \).

<table>
<thead>
<tr>
<th>FNo</th>
<th>Abbreviation</th>
<th>Logical command function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>not all.</td>
<td>No function allocated</td>
</tr>
<tr>
<td>501</td>
<td>FT det</td>
<td>General fault detection of the device</td>
</tr>
<tr>
<td>511</td>
<td>DEV.Trp</td>
<td>General trip command of the device</td>
</tr>
<tr>
<td>1185</td>
<td>CBtpTST</td>
<td>Circuit breaker test: live trip</td>
</tr>
<tr>
<td>5236</td>
<td>f1 Trip</td>
<td>Frequency protection: trip by ( f_1 ) stage</td>
</tr>
<tr>
<td>5237</td>
<td>f2 Trip</td>
<td>Frequency protection: trip by ( f_2 ) stage</td>
</tr>
<tr>
<td>5238</td>
<td>f3 Trip</td>
<td>Frequency protection: trip by ( f_3 ) stage</td>
</tr>
<tr>
<td>5239</td>
<td>f4 Trip</td>
<td>Frequency protection: trip by ( f_4 ) stage</td>
</tr>
<tr>
<td>5371</td>
<td>U/f&gt;Trp</td>
<td>Overflux protection: trip by U/f stage</td>
</tr>
<tr>
<td>5372</td>
<td>U/ftTrp</td>
<td>Overflux protection: trip by thermal stage</td>
</tr>
<tr>
<td>5520</td>
<td>df1 Trp</td>
<td>Rate-of-frequency-change protection: trip by df1/dt stage</td>
</tr>
<tr>
<td>5521</td>
<td>df2 Trp</td>
<td>Rate-of-frequency-change protection: trip by df2/dt stage</td>
</tr>
<tr>
<td>5522</td>
<td>df3 Trp</td>
<td>Rate-of-frequency-change protection: trip by df3/dt stage</td>
</tr>
<tr>
<td>5523</td>
<td>df4 Trp</td>
<td>Rate-of-frequency-change protection: trip by df4/dt stage</td>
</tr>
<tr>
<td>6539</td>
<td>U&lt; Trp</td>
<td>Undervoltage protection: trip by ( U_\text{&lt;} ) stage</td>
</tr>
<tr>
<td>6570</td>
<td>U&gt; Trp</td>
<td>Overvoltage protection: trip by ( U_\text{&gt;} ) stage</td>
</tr>
<tr>
<td>6573</td>
<td>U&gt;&gt; Trp</td>
<td>Overvoltage protection: trip by ( U_\text{&gt;&gt;} ) stage</td>
</tr>
<tr>
<td>6580</td>
<td>Ux&lt; Trp</td>
<td>Undervoltage protection: trip by ( U_x_\text{&lt;} ) stage</td>
</tr>
<tr>
<td>6589</td>
<td>Ux&gt; Trp</td>
<td>Overvoltage protection: trip by ( U_x_\text{&gt;} ) stage</td>
</tr>
<tr>
<td>6590</td>
<td>Ux&gt;&gt;Trp</td>
<td>Overvoltage protection: trip by ( U_x_\text{&gt;&gt;} ) stage</td>
</tr>
</tbody>
</table>

Table 5.9  Command functions

<table>
<thead>
<tr>
<th>4th selection level</th>
<th>5th selection level</th>
<th>FNo</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARSHALLING</td>
<td>TRIP RELAYS</td>
<td></td>
<td>Heading of the address block</td>
</tr>
<tr>
<td>6 4 M A R S H C M D . R E 1</td>
<td>6 4 C M D 1 1</td>
<td>6539</td>
<td>Trip by ( U_\text{&lt;} ) stage of undervoltage protection</td>
</tr>
<tr>
<td></td>
<td>U &lt; T r p</td>
<td>6580</td>
<td>Trip by ( U_x_\text{&lt;} ) stage of undervoltage protection</td>
</tr>
<tr>
<td>6 4 M A R S H C M D . R E 2</td>
<td>6 4 C M D 2 1</td>
<td>5236</td>
<td>Trip by ( f_1 ) stage of frequency protection</td>
</tr>
</tbody>
</table>

Table 5.10  Preset command functions for trip relays for versions 7RW600*-*****-0** and -1** (voltage, frequency, rate-of-frequency-change protection)
<table>
<thead>
<tr>
<th>4th selection level</th>
<th>5th selection level</th>
<th>FNo</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARSHALLING</td>
<td>TRIP RELAYS</td>
<td></td>
<td>Heading of the address block</td>
</tr>
<tr>
<td>6 CMD . RE 1</td>
<td>6 CMD 1 1</td>
<td>5372</td>
<td>Trip by overflux protection</td>
</tr>
<tr>
<td>CMD . RE 1</td>
<td>U / f t Trp</td>
<td>5371</td>
<td></td>
</tr>
<tr>
<td>CMD . RE 1</td>
<td>U / f &gt; Trp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 CMD . RE 2</td>
<td>6 CMD 2 1</td>
<td>6570</td>
<td>Trip by overvoltage protection</td>
</tr>
<tr>
<td>CMD . RE 2</td>
<td>U &gt; Trp</td>
<td>6589</td>
<td></td>
</tr>
<tr>
<td>CMD . RE 2</td>
<td>U x &gt; &gt; Trp</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.11  Preset command functions for trip relays for version 7RW600-*****-2*** (voltage and overflux protection)
6 Operating instructions

6.1 Safety precautions

⚠️ Warning

All safety precautions which apply for work in electrical installations are to be observed during tests and commissioning.

⚠️ Caution!

Connection of the device to a battery charger without connected battery may cause impermissibly high voltages which damage the device. See also Section 3.1.1 under Technical data for limits.

The keyboard comprises 9 keys with paging, Yes/No and control buttons. The significance of the keys is explained in detail in the following:

Keys for alteration of numerical values and alternative texts:

- increasing a value or text item
- decreasing a value or text item

Yes/No keys:

Y/J Yes key: operator affirms the displayed question
N No key: operator denies the displayed question; this key serves either as reset key for stored LED indicators and fault announcements

Keys for scrolling and paging:

Scrolling forwards: the next display line or menu item is displayed
Scrolling backwards: the previous display line or menu item is displayed
Paging to the next operation level: the operation object of the next operating level is displayed
Paging to the previous operation level: the operation object of the previous operating level is displayed

6.2 Dialog with the relay

Setting, operation and interrogation of digital protection and automation systems can be carried out via the integrated membrane keyboard and display panel located on the front plate. All the necessary operating parameters can be entered and all the information can be read out from here. Operation is, additionally, possible via the interface socket by means of a personal computer or similar.

6.2.1 Membrane keyboard and display panel

Figure 6.1 illustrates the front view.

A two-line, each 8 character, liquid crystal display presents the information. Each character comprises a 5 x 8 dot matrix. Numbers, letters and a series of special symbols can be displayed.

During dialog, the upper line gives a two-figure number. This number presents the setting address block.
Confirmation key:

Enter or confirmation key: each change via the “Yes”/“No” – keys or the or keys must be confirmed by the enter key; only then does the device accept the change. The enter key can also be used to acknowledge and clear a fault prompt in this display; a new input and repeated use of the enter key is then necessary.

Stored LED indications on the front and the fault annunciation buffer can be erased via the “No” – key N. During reset operation the assigned LEDs on the front will be illuminated thus performing a LED test. With this reset, additionally, the fault event indications in the display on the front panel of the device are acknowledged; the display shows then the operational values of the quiescent state.

6.2.2 Operation with a personal computer

A personal computer (with operating system MS WINDOWS) allows, just as the operator panel, all the appropriate settings, initiation of test routines and read-out of data, but with the added comfort of screen-based visualization and a menu-guided procedure. The PC program DIGSI® is available for setting and processing of all digital protection data.

All data can be read in from, or copied onto, magnetic data carrier (floppy disc) (e.g. for settings and configuration).

Additionally, all the data can be documented on a connected printer.

For operation of the personal computer, the instruction manuals of this device are to be observed. The PC program DIGSI® is available for setting and processing of all digital protection data. A survey of the suitable operating programs and further accessories is shown in Section 2.4.

6.2.3 Operational preconditions

For most operational functions, the input of a code-word is necessary. This applies for all entries via the membrane keyboard or interface which concern the operation on the relay, for example

- setting of functional parameters (thresholds, functions),
- allocation or marshalling of trip relays, signals, binary inputs, LED indicators,
- configuration parameters for operation language, interface and device configuration,
- initiation of test procedures.

The codeword is not required for the read-out of annunciations, operating data or fault data, or for the read-out of setting parameters.

The method of entry of the codeword is explained in detail in the installation instructions under Section 5.3.1.
6.2.4 Representation of the relay (front view)

**Diagram:**
- Readiness indication (green)
- Unit faulty indication (red)
- Two line display (LCD) with 8 characters each
- LED 1 to 4 (red) can be marshalled; presetting below
- Operator panel with control and function keys

**Table:**

<table>
<thead>
<tr>
<th>Version</th>
<th>Factory presetting LEDs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>7RW600*–0*** and –1***</td>
<td>1 Trip by frequency protection: f1 stage</td>
</tr>
<tr>
<td></td>
<td>2 Trip by frequency protection: f2 stage</td>
</tr>
<tr>
<td></td>
<td>3 Trip by frequency protection: f3 stage</td>
</tr>
<tr>
<td></td>
<td>4 Trip by undervoltage protection: U&lt;, U&lt;</td>
</tr>
<tr>
<td></td>
<td>5 Overvoltage protection: Uf warning stage</td>
</tr>
<tr>
<td></td>
<td>6 Trip by overvoltage protection</td>
</tr>
<tr>
<td></td>
<td>7 Trip by undervoltage protection: U&gt;&gt;, U&gt;&gt;</td>
</tr>
</tbody>
</table>

Figure 6.1 Front view of operating key board and display panel
6.3 Setting the functional parameters

6.3.1 Introduction

6.3.1.1 Parameterizing procedure

The operating surface is built up by a hierarchically structured menu tree, which can be passed through by means of the scrolling keys ‡, △, ▽, and ▼. Thus, each operation object can be reached. Figure 6.2 shows the principle, a complete overview is listed in Appendix C.

From the initial display, the key ▽ is used to switch to the first operation item “PARAME.” (parameters) which contains all setting and configuration blocks of the device (see Figure 6.2). Key ‡ is pressed to change to the next operation level. The display shows the first item “CONF.” (configuration), which is described in Section 5.3 and 5.4.

Pressing the key ▽ leads to the first parameter block “01 POWER SYST.DAT” (power system data). Further parameter blocks can be called up with the scrolling keys ▽ or ▼, for those functions which are available in the relay and configured as EXISTing.

The key ‡ changes to the third operation level where the individual functions and values are set; refer to Figure 6.2. They are explained in detail in the following sections.

![Diagram showing the selection of the power system data](image-url)

Figure 6.2 Selection of the power system data
For setting the functional parameters it is necessary to enter the codeword (see Section 5.3.1). Without codeword entry, parameters can be read out but not be changed.

If the codeword is accepted, parameterizing can begin. In the following sections each address is illustrated in a box and is explained. There are three forms of display:

— Addresses without request for operator input

Displayed text forms the heading of this address block. The address block is identified by the block number (two digit number). No input is expected. By using keys \( \triangledown \) or \( \Delta \) the next or the previous block can be selected. By using the key \( \downarrow \) the next operation level can be reached.

— Addresses which require numerical input

The display shows the two-digit block number in the first line. Behind the block number appears the meaning of the required parameter in abbreviated form, in the second display line, the value of the parameter. When the relay is delivered a value has been preset. In the following sections, this value is shown. If this value is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) operation level. If the value needs to be altered, it can — after codeword input — be increased with the keys \( \leftrightarrow \) or decreased with the key \( \uparrow \). When one of the keys, \( \leftrightarrow \) or \( \uparrow \), is pressed continuously, the numbers will change with an accelerating sequence. Thus, a fast and fine adjustment is possible within a wide setting range. The permissible setting range is given in the following text, next to the associated box. When the highest possible value is reached, no further changing with the key \( \leftrightarrow \) is possible. The same is valid when one tries to change the lowest value with the key \( \uparrow \). The selected value must be confirmed with the entry key E! The display then confirms the accepted value. The changed parameter is effective after this confirmation.

— Addresses which require text input

The display shows the two-digit block number and the meaning of the required parameter and in the second display line, the applicable text. When the relay is delivered, a text has been preset. In the following sections, this text is shown. If it is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) operation level. If the text needs to be altered, press — after codeword input — the key \( \leftrightarrow \) (or \( \uparrow \)). The next (or previous) alternative text, also printed in the display boxes illustrated in the following sections, then appears. If the alternative text is not desired, then the key \( \leftrightarrow \) (or \( \uparrow \)) is pressed again, etc. The alternative which is chosen, is confirmed with the entry key E. When the last possible alternative is reached, no further changing with the key \( \leftrightarrow \) is possible. The same is valid when one tries to change the first alternative with the key \( \uparrow \).

For each of the addresses, the possible parameters and text are given in the following sections. If the meaning of a parameter is not clear, it is usually best to leave it at the factory setting. The arrows \( \triangledown \), \( \Delta \) besides the illustrated display boxes indicate the method of moving from block to block or within the block. Unused addresses are automatically passed over.

When the relay is operated from a personal computer by means of the protection data processing program DIGSi\textsuperscript{®}, each functional parameter is identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

If one tries to leave an operating item or operating level by pressing one of the arrow keys without having confirmed an alteration with the enter key E, the display will show the question “SAVE NEW SETTING?”. Confirm with the “Yes”–key Y/J that the new settings shall become valid now. If you press the “No”–key N instead, codeword operation will be aborted, and the alteration which has been changed since the last entry is lost. Thus, erroneous alterations can be made ineffective. Press the arrow key once again in order to change really the operating item or level.

When the setting process is terminated by pressing the enter key E, the altered parameters are permanently secured in EEPROMs and protected against power outage.
6.3.1.2 Setting of date and time

The date and time should be set when the relay is finally installed and connected to the supply voltage.

From the initial display, the key \( \triangledown \) is pressed (three times) until the menu item “ADDITION FUNCTION” (“additional functions”) is displayed. Key \( \triangleright \) is pressed to change to the next operation level. The display shows the first item “TIME SETTING”. Change to the third operation level with key \( \triangleright \). The actual date and time is displayed now. Scroll on with key \( \triangledown \) to find the setting items for date and time, as illustrated below.

The next two addresses allow to set date and time. Codeword entry is not required. Day, month, and year can be altered using the keys \( \triangleright \) and \( \triangleleft \). Each time a value is changed, the enter key \( E \) must be pressed, before the next number can be changed. Proceed in analog manner to change the time.

Note: When the day is changed, the display firstly allows 31 days. Only when the month and year is changed, the relay can check plausibility of the complete date. After confirmation with the enter key \( E \), the day may be reduced to an existing number. After the relay has been switched on, first the date “01.07.97” appears and the time since the start-up of the processor system.

\[
\begin{align*}
\text{DATE} & \quad 27.07.97 \\
\text{TIME SETTING} & \quad 01:07:00 \\
\text{ADDITION FUNCTION} & \quad [9000]
\end{align*}
\]

Beginning of the block “Additional functions”

At first, the “actual” date (DD.MM.YY) and the “actual” time (HH.MM.SS) are displayed. Continue with \( \triangledown \).

Enter the new date: 2 digits for day, 2 digits for month and 2 digits for year: DD MM YY

Use key \( \triangleright \) to increase the day or \( \triangleleft \) to decrease; use key \( \triangleright \) to change over to the month; use key \( \triangleright \) to increase the month or \( \triangleleft \) to decrease; use key \( \triangleright \) to change over to the year; use key \( \triangleright \) to increase the year or \( \triangleleft \) to decrease; confirm with enter key \( E \).
6.3.2 Initial display

When the relay is switched on, firstly the type identification of the relay and the version of the implemented firmware appears. All Siemens relays have an MLFB (machine readable order number). Approximately 30 s after the relay has been switched on, the display shows the quiescent messages (frequency and voltage U). When the keys ▼ and subsequently △ is pressed, the initial display is shown again.

The relay introduces itself by giving its type number. The second display line shows the version of firmware with which it is equipped.

The setting parameters start at address block 01. This block is reached by pressing the key ▼ (refer also to Figure 6.2), with △ to the second operation level (“00 CONFIG.”), with ▼ to block “01 POWER SYST.DAT” (power system data). Further address possibilities are listed under “Annunciations” and “Tests”.

6.3.3 Power system data – address block 01

The relay requests basic data of the power system and the switchgear.

Firstly, the rated system frequency can be changed. It must comply with the setting. If the system frequency is not 50 Hz, the address must be changed.

Key ▼ is used to come to the time setting. Enter the new time: 2 digits for hour, 2 digits for minute: HH △ MM

Use key △ to increase the hour or ▼ to decrease; use key △ to change over to the minute; use key ▼ to increase the minute or △ to decrease;

the seconds are not changed. They are automatically set to “00” when the enter key E is pressed.
Next, the secondary rated voltage is entered; it should comply with the voltage transformers’ rated secondary voltage:

\[
\begin{array}{c}
0 \text{ L} \\
1 \text{ 0} \\
0 \text{ V}
\end{array}
\]

[1102]
Rated secondary voltage of voltage transformers (phase-to-phase)
Smallest setting value: 100 V
Largest setting value: 125 V

The minimum trip command duration T—TRP can be set. This is then valid for all protection functions of the device which can issue a trip signal.

\[
\begin{array}{c}
0 \text{ L} \\
1 \text{ T—TRP} \\
0 \text{ . 1} \\
5 \text{ s}
\end{array}
\]

[1134]
Minimum duration of the trip command
Smallest setting value: 0.01 s
Largest setting value: 60.00 s

In order to come to the next address block, key \( \downarrow \) is pressed to return to the previous operation level, and subsequently \( \uparrow \) is pressed which will lead to the next address block 15. The individual parameters are listed in the next operation level.

6.3.4 Settings for undervoltage protection \( U_X < \) — address block 15

The parameters for \( U_X \) are only effective and available when the relay is connected to two single-phase voltages and when it is informed about (address 7901, MEAS = 1 phase). These parameters of address block 15 are decisive for the voltage \( U_X \) when it is fed to the terminals 9 and 10 (for model 7RW6000—\( \#B*** \) and \( \#E*** \)) or to the terminals 13 and 14 (for models 7RW6000—\( \#D*** \)).

This function can, furthermore, operate only when it is configured as EXIST in block address 00 (refer to Section 5.4.2).
For the settings no generally applicable values can be stated. Taking into account that the protection shall in the first place protect consumers from the consequences of voltage drops and prevent stability problems, the setting values will be between 60% and 75% of the rated voltage. The time delays have to be set such that voltage drops, which endanger the stability, are tripped. The time delays should, however, be long enough to avoid tripping for permissible short-time voltage drops.

All setting times are additional delay times, which do not include the normal operating delay times (measuring time, reset time) of the protection function itself.

### 6.3.5 Settings for undervoltage protection $U_<$ – address block 16

Address block 16 determines the parameters of the undervoltage protection $U_<$. When two single-phase voltages are connected and the relay is informed about (address 7901, MEAS = 1 phase) the voltage at the terminals 7 to 8 is decisive. With two-phase connection (V-connection) (address 7901, MESS = 2 phase), the positive sequence voltage of the three-phase system is decisive. This function can operate only when it is configured as EXIST in block address 00 (refer Section 5.4.2).

- **[1502]**
  - Pick-up value of $U_<$ stage of undervoltage protection
  - Setting range: 20 V to 120 V

- **[1503]**
  - Trip delay of undervoltage protection $U_<$
  - Setting range: 0.00 s to 60.00 s and $\infty$

### Operating instructions

- **[1600]**
  - Beginning of the block “Undervoltage protection $U_<$”

- **[1601]**
  - Switching OFF of the undervoltage protection $U_<$
  - Switching ON of the undervoltage protection $U_<$

For the settings, similar considerations apply as for address block 15, Section 6.3.4.
6.3.6 Settings for overvoltage protection U> – address block 17

Address block 17 determines the parameters of the overvoltage protection U>. When two single-phase voltages are connected and the relay is informed about (address 7901, MEAS = 1 phase) the voltage at the terminals 7 to 8 is decisive. With two-phase connection (V−connection) (address 7901, MESS = 2 phase), the parameter U> is valid for both voltages U and U>. This function can operate only when it is configured as EXIST in block address 00 (refer Section 5.4.2).

For the settings no generally applicable rules can be given. Taking into account that the protection shall in the first place prevent from excessive voltage stress of parts of the power system or station, setting values between 110 % and 115 % of the rated voltage are normal.

When the relay is used as generator protection, the setting of the overvoltage protection depends on the speed with which the voltage regulator can regulate voltage changes. The protection must not interfere in the operation of a correctly operating voltage regulator. The two-stage characteristic, therefore, must always lie above the voltage/time characteristic of the regulator.

The U> stage (long-time stage) should intervene in the event of steady-state overvoltages. It is set to approximately 110 % U_N and, depending on the regulating speed, to 1.5 s to 2 s.

If the generator sheds full load, the voltage initially increase depending on the transient voltage and is then reduced back to the rated value by the voltage regulator. The U>> stage as a short-time stage is usually set such that the transients after full-load rejection do not initiate tripping. A common setting is, e.g. 130 % U_N with a delay of 0.1 s.

All setting times are additional delay times, which do not include the normal operating times (measuring time, reset time) of the protection function itself.
6.3.7 Settings for overvoltage protection \( U_x > \) – address block 18

The parameters for \( U_x \) are only effective and available when the relay is connected to two single-phase voltages and when it is informed about (address 7901, MEAS = 1 phase). These parameters of address block 18 are decisive for the voltage \( U_x \) when it is fed to the terminals 9 and 10 (for model 7RW6000–\#B\#\# and –\#E\#\#) or to the terminals 13 and 14 (for models 7RW6000–\#D\#\#).

This function can, furthermore, operate only when it is configured as EXIST in block address 00 (refer to Section 5.4.2).

For the settings, similar considerations apply as for address block 17, Section 6.3.6. An alternative application of the \( U_x > \) protection function is as stator earth fault protection. For this case, smaller voltage thresholds are possible (smallest setting value 10 V).
6.3.8 Settings for rate-of-frequency-change protection – address block 20

This section is valid only for model 7RW6000-********-1***. This model includes a rate-of-frequency-change protection (refer also to Section 4.4). This can operate only when it is configured as EXIST in address block 00 (refer to Section 5.4.2).

[2000] Beginning of the block “Rate-of-frequency-change protection”

[2001] Switching OFF of the rate-of-frequency-change protection

Switching ON of the rate-of-frequency-change protection

When a certain underfrequency threshold \(f_{\text{static}}\) is decisive for the stability limit of a power system, a frequency relay would have to be set to a higher value in order to ensure that stability is not endangered under all circumstances. Such a setting would be too sensitive under conditions of steady-state underfrequency.

The rate-of-frequency-change protection can detect frequency drops already during their development. Thus, it can disconnect networks before the steady-state underfrequency limit is reached and prevent the system from loss of stability, without excessive sensitivity of the steady-state underfrequency limit.
Frequency protection and rate-of-frequency-change protection may complement each other such that the relay will trip on higher frequency reduction (at the steady-state limit) but on smaller frequency reduction with more severe rate-of-change in frequency. In this way, the network can be disconnected at smaller frequency reduction when, at the same time, the rate-of-change exceeds a certain amount.

The following considerations may apply: When the power system is split and part of the network works in island operation, the power equilibrium is distorted. This causes a frequency change. When the power demand is higher than the power generation, the difference must be produced by the kinetic energy of the remaining rotating machines. The following applies for the first second:

$$\frac{df}{dt} = -\frac{f_N}{2H} \cdot \frac{\Delta P}{S_N}$$

where

- $f_N$ rated system frequency
- $\Delta P$ step change in active power
- $H$ inertia constant
- $S_N$ rated apparent power of the machines

Typical value of the inertia constant $H$ are: 2 s to 10 s for cylindrical-rotor sets, and 1.5 s to 6 s for salient-pole machines.

The rate-of-change in frequency of an island network can be approximated with these data, as long as the frequency regulator has not yet interfered.

The rate-of-frequency-change protection of the relay 7RW600 generally operates only when the system frequency is below the rated frequency and the rate-of-change is negative. It is, furthermore, possible to combine a rate-of-change stage with the associated frequency stage by an AND-condition (parameter $df*lt* = ON$, where * is replaced by the number of the stage). In this latter case the protection will issue a trip command only when the frequency has fallen below the setting value $f*$ of address block 21 AND the negative rate-of-change exceeds the setting value of the associated rate-of-change stage (i.e. the stages with equal index).

The rate-of-frequency-change protection is blocked when the measured voltage $U$ has fallen below the release threshold $BL U <$.

---

[2002] Pick-up value for the first $df/dt$ stage
Setting range: $1.0$ Hz/s to $10.0$ Hz/s
and $\infty$ (no pick-up by rate-of-frequency-change stage $df1/dt$)

[2003] Time delay for the first $df/dt$ stage
Setting range: $0.00$ s to $20.00$ s
and $\infty$ (no trip by rate-of-frequency-change stage $df1/dt$)

[2004] AND—combination between rate-of-frequency-change stage $df1/dt$ and frequency protection stage $f1$
OFF or
ON

[2005] Pick-up value for the second $df/dt$ stage
Setting range: $1.0$ Hz/s to $10.0$ Hz/s
and $\infty$ (no pick-up by rate-of-frequency-change stage $df2/dt$)
20 T df2
0.25 s  [2006]
Time delay for the second df/dt stage
Setting range: 0.00 s to 20.00 s
and ∞ (no trip by rate-of-frequency-change stage df2/dt)

20 df2 & f
OFF
ON  [2007]
AND—combination between rate-of-frequency-change stage df2/dt and frequency protection stage f2
OFF or
ON

20 df3
6.0 Hz/s  [2008]
Pick-up value for the third df/dt stage
Setting range: 1.0 Hz/s to 10.0 Hz/s
and ∞ (no pick-up by rate-of-frequency-change stage df3/dt)

20 T df3
0.10 s  [2009]
Time delay for the third df/dt stage
Setting range: 0.00 s to 20.00 s
and ∞ (no trip by rate-of-frequency-change stage df3/dt)

20 df3 & f
OFF
ON  [2010]
AND—combination between rate-of-frequency-change stage df3/dt and frequency protection stage f3
OFF or
ON

20 df4
∞ Hz/s  [2011]
Pick-up value for the fourth df/dt stage
Setting range: 1.0 Hz/s to 10.0 Hz/s
and ∞ (no pick-up by rate-of-frequency-change stage df4/dt)

20 T df4
∞ s  [2012]
Time delay for the fourth df/dt stage
Setting range: 0.00 s to 20.00 s
and ∞ (no trip by rate-of-frequency-change stage df4/dt)

20 df4 & f
OFF
ON  [2013]
AND—combination between rate-of-frequency-change stage df4/dt and frequency protection stage f4
OFF or
ON

20 BLU
6.5 V  [2014]
Minimum operating voltage, below which rate-of-frequency-change measurement df/dt is blocked
Setting range: 20 V to 100 V
and ∞ (blocking is ineffective)
6.3.9 Settings for frequency protection — address block 21

Four frequency stages are available in models 7RW6000— and —. These functions can operate only when they are configured as EXIST in block address 00 (refer Section 5.4.2). Each stage can be set as overfrequency stage or underfrequency stage. This is determined by the rated frequency as configured under address 1101 (refer to Section 6.3.3) and the set limit value. When the limit value is set smaller than the rated frequency, the stage operates as underfrequency stage; when the limit value is set higher than the rated frequency, the stage operates as overfrequency stage. **When the limit value is set equal to the rated frequency, the concerned stage is ineffective.**

Frequency protection is used for network disconnection or load shedding. The setting values depend on the actual network conditions; general recommendations are, therefore, not possible.

Further application is in power stations. As a matter of principle, the setting values for frequency and delay times depend on the values supplied by the power station operator, in this case.

In power stations, the **underfrequency** protection usually has the task of maintaining the power station auxiliary supply by promptly disconnecting it from the network. The turbine regulator then regulates the generator set to rated speed so that the power station auxiliary supply can be maintained with rated frequency.

In general, turbine-generator sets can be continuously operated at down to 95% of rated frequency provided that the apparent power is reduced by the same amount. For the inductive consumers, however, the reduction in frequency does not only result in increased current intake but also endangers the operational stability. Therefore, only a short-time frequency reduction down to 48 Hz (at $f_N = 50$ Hz) or 58 Hz ($f_N = 60$ Hz) is usually permitted.

**Overfrequency** can occur, for example, during load shedding or faulty operation of the speed regulator (e.g. in island operation). Thus the overfrequency stage can be used e.g. as overspeed protection.

All setting times are additional delay times, which do not include the normal operating times (measuring time, reset time) of the protection function itself.

---

**[2100]**

Beginning of the block “Overfrequency and underfrequency protection”

**[2101]**

Switch OFF of the frequency protection

Switch ON of the frequency protection

**[2102]**

Pick-up value of the frequency stage $f_1$

Setting range: 40.00 Hz to 68.00 Hz

The preset value results in an **underfrequency** stage
[2103] Trip time delay of the frequency stage f₁
Setting range: 0.00 s to 60.00 s
and ∞ (no trip by frequency stage f₁)

[2104] Pick-up value of the frequency stage f₂
Setting range: 40.00 Hz to 68.00 Hz
The preset value results in an underfrequency stage

[2105] Trip time delay of the frequency stage f₂
Setting range: 0.00 s to 60.00 s
and ∞ (no trip by frequency stage f₂)

[2106] Pick-up value of the frequency stage f₃
Setting range: 40.00 Hz to 68.00 Hz
The preset value results in an underfrequency stage

[2107] Trip time delay of the frequency stage f₃
Setting range: 0.00 s to 60.00 s
and ∞ (no trip by frequency stage f₃)

[2108] Pick-up value of the frequency stage f₄
Setting range: 40.00 Hz to 68.00 Hz
The preset value results in an overfrequency stage when $f_N = 50$ Hz

[2109] Trip time delay of the frequency stage f₄
Setting range: 0.00 s to 60.00 s
and ∞ (no trip by frequency stage f₄)

[2110] Minimum operating voltage, below which frequency measurement $f > < f_N$ is blocked
Setting range: 20 V to 100 V
and ∞ (blocking is ineffective)
6.3.10 Settings for overflux protection – address block 29

Depending on the model ordered (refer to Section 2.3 Ordering data), SIPROTEC 7RW600 contains an overflux protection. This function is valid only for model 7RW600-4....-2.... It can operate only when it is configured as EXIST in block address 00 (refer to Section 5.4.2).

The overflux protection measures the ratio voltage/frequency which is proportional to the induction B and the flux \( \Phi \). The overflux protection must pick up when the induction admissible for the protected object (e.g. power station unit transformer) is exceeded. The transformer is endangered, for example, when a power station block is disconnected from the system from full-load, and the voltage regulator either does not operate or does not operate sufficiently fast to control the associated voltage rise.

Similarly, decrease in frequency (speed), e.g. in island systems, can endanger the transformer because of increased Induction.

Thus, the overflux protection supervises correct operation of the voltage regulator as well as the speed governor for all operational conditions.

The continuously permissible induction value as stated by the manufacturer determines the setting. This related value \( (B/B_0) \) is the base value and is to be set under address 2902.

If the value \( U/f \) (referred to \( U_{N}/f_{N} \), and thus proportional to the induction \( B/B_0 \) as set under address 2902, is exceeded, pick-up occurs. After expiry of the time delay address 2903, warning signal is given.

A stepped characteristic \( (U/f >>, TUf >> ) \) is provided in order to clear high overflux conditions rapidly.

The setting time is an additional delay time, which does not include the normal operating time (measuring time, reset time) of the protection function.

A thermal characteristic is superimposed on the definite time stage as described before. For this purpose, the temperature rise caused by the overflux or overinduction is simulated in a thermal approximation. When the pick-up (address 2902, see above) is exceeded, alarm is output, and a counter is released...
which accumulates the overflux and causes a trip command as soon as the time according to the setting has elapsed. The U/f base value is the lowest limit below which no temperature rise is calculated. That means, that values below this setting are not processed.

The preset values of the thermal characteristic correspond to a Siemens standard transformer. The values can be matched to the actual protected object with the aid of seven time delays which are assigned to seven overflux values, so that a characteristic of six straight lines results. If the data of the protected object are stated by the manufacturer, the seven time values should be entered for the overflux conditions U/f = 1.10, 1.15, 1.20, 1.25, 1.30, 1.35, and 1.40. If no data are available, the preset characteristic is adequate in most cases. Values between the parameterized points are interpolated by the protection function.

The trip command, once given, is reset as soon as the overflux has fallen below the pick-up value. But the counter is decremented with the time which is set for T RES under address 2913. This parameter determines the the counter time for counting from 100 % to 0 %.

The U/f–values can be matched to the rated v.t. voltage by means of the adaptation factor k ad under address 2914.

\[
k_{ad} = \frac{U_{N,\text{prim v.t.}}}{U_{N,\text{protected object}}}
\]

where

- \(U_{N,\text{protected object}}\) – rated voltage of the protected object
- \(U_{N,\text{prim v.t.}}\) – primary rated voltage of voltage transformers

---

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[2904]</td>
<td>29 U/f &gt;&gt;</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td>Pick-up value of the definite time stage</td>
<td>Setting range: 1.00 to 1.40</td>
</tr>
<tr>
<td>[2905]</td>
<td>29 T U f &gt;&gt;</td>
<td>1.00 s</td>
</tr>
<tr>
<td></td>
<td>Delay time for definite time stage</td>
<td>Setting range: 0.00 s to 60.00 s and (\infty)</td>
</tr>
<tr>
<td>[2906]</td>
<td>29 t 1.10</td>
<td>6000 s</td>
</tr>
<tr>
<td></td>
<td>Time delay of 1st characteristic value U/f = 1.10</td>
<td>Setting range: 0 s to 20000 s</td>
</tr>
<tr>
<td>[2907]</td>
<td>29 t 1.15</td>
<td>2400 s</td>
</tr>
<tr>
<td></td>
<td>Time delay of 2nd characteristic value U/f = 1.15</td>
<td>Setting range: 0 s to 20000 s</td>
</tr>
<tr>
<td>[2908]</td>
<td>29 t 1.20</td>
<td>60 s</td>
</tr>
<tr>
<td></td>
<td>Time delay of 3rd characteristic value U/f = 1.20</td>
<td>Setting range: 0 s to 20000 s</td>
</tr>
<tr>
<td>[2909]</td>
<td>29 t 1.25</td>
<td>30 s</td>
</tr>
<tr>
<td></td>
<td>Time delay of 4th characteristic value U/f = 1.25</td>
<td>Setting range: 0 s to 20000 s</td>
</tr>
</tbody>
</table>
6.3.11 Settings for trip circuit supervision — address block 39

The relay includes a trip circuit supervision function (refer to Section 4.7), which requires one or two binary inputs. This can operate only when it is configured (refer to Section 5.4.2) using one ("bypass – R") or two ("with 2 Bl") binary inputs. Furthermore, the adequate number of binary inputs must be allocated to this function and the external wiring must be correct.

If one binary input is used, trip circuit faults like interruption or control voltage failure can be detected but not trip circuit fault which occur during closed trip relay of the device. But if the trip command lasts more than 60 s to 90 s, then the trip circuit supervision will give alarm even without any other fault.

Details about the function of this supervision are given in Section 4.7. Section 5.2.3.2 contains information about connection and dimensioning hints as to the resistor in case of supervision with one single binary input.


6.4 Annunciations

6.4.1 Introduction

After a network fault, annunciations and messages provide a survey of important fault data and the function of the relay, and serve for checking sequences of functional steps during testing and commissioning. Further, they provide information about the condition of measured data and the relay itself during normal operation.

To read out recorded annunciations, no codeword input is necessary.

The annunciations generated in the relay are presented in various ways:

- LED indications in the front plate of the relay (Figure 6.1),
- Binary outputs (output relays) via the connections of the relay,
- Indications in the display on the front plate or on the screen of a personal computer, via the operating interface,

Most of these annunciations can be freely allocated to the LEDs and binary outputs (see Section 5.5). Also, within specific limitations, group and multiple indications can be formed.

To call up annunciations on the operator panel scroll with the key \( \bigtriangleup \) to the item “ANNUNC.” (annunciations), refer to Figure 6.3. The key \( \bigtriangledown \) changes over to the second operation level, where you can reach the different groups of annunciations with the scrolling keys \( \bigtriangleup \) and \( \bigtriangledown \).

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, the annunciation groups are identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

The annunciations are arranged as follows:

Block 81 Operational annunciations; these are messages which may appear during the operation of the relay: information about condition of relay functions, measurement data etc.

Block 82 Event annunciations for the last eight network faults: pick-up, trip, expired times, or similar. As defined, a network fault begins with pick-up of any fault detector and ends after drop-off of the last protection function. Within a network fault, several fault events can occur, from pick-up of any fault detection until drop-off of the latest protection function.

Block 84 Indication of operational measured values (voltage magnitudes, frequency).

The annunciations and measured values are arranged in lists. After paging to a certain annunciation block, an extract (two lines) of a list is shown in the display; the list can be scrolled by the keys \( \bigtriangleup \) and \( \bigtriangledown \), as illustrated in Figure 6.4.

A comprehensive list of the possible annunciations and output functions with the associated function number FNo is given in Appendix C. It is also indicated to which device each annunciation can be routed.
Figure 6.3 Selection of annunciation blocks

Figure 6.4 Display of an annunciation list – example
6.4.2 Operational announcements – address block 81

Operational and status announcements contain information which the unit provides during operation and about the operation. They begin at address block 81. Important events and status changes are chronologically listed, starting with the most recent message. Time information is shown in hours, minutes and seconds. Up to 30 operational indications can be stored. If more occur, the oldest are erased in sequence.

Faults in the network are only indicated as "FAULT" together with the sequence number of the fault. Detailed information about the history of the fault is contained in the block “Fault announcements”; refer to Section 6.4.3.

The input of the codeword is not required. The boxes below show all available operational announcements. In each specific case, of course, only the associated announcements appear in the display.

Next to the boxes below, the abbreviated forms are explained. It is indicated whether an event is announced on occurrence (c = “coming”) or a status is announced “coming” and “going” (c/g).

The first listed message is, as example, assigned with date and time in the first two lines; the third line shows the beginning of a condition with the character c to indicate that this condition occurred at the displayed time.

Use the arrow keys to scroll through the displayed announcement list.

When date and time have not yet been set (refer also to Section 6.3.1.2), the date is shown as 01.07.97, the time is given as relative time from the last re-start of the processor system.

**Direct response from binary inputs:**

- **> CB clo**  
  Circuit breaker closed (from CB auxiliary contact) (c/g)
- **> f1 blk**  
  Block frequency protection f1 stage (c/g)
- **> f2 blk**  
  Block frequency protection f2 stage (c/g)
- **> f3 blk**  
  Block frequency protection f3 stage (c/g)
- **> f4 blk**  
  Block frequency protection f4 stage (c/g)
- **> RM U/f**  
  Reset memory of thermal replica U/f (c/g)
> df1 bl
Block rate-of-frequency-change protection df1/dt stage (c/g)

> df2 bl
Block rate-of-frequency-change protection df2/dt stage (c/g)

> df3 bl
Block rate-of-frequency-change protection df3/dt stage (c/g)

> df4 bl
Block rate-of-frequency-change protection df4/dt stage (c/g)

> TrpRel
Trip circuit supervision: binary input in parallel to trip contact (c/g)

> CBaux
Trip circuit supervision: binary input in parallel to CB auxiliary contact (c/g)

General operational annunciations of the protection device:

operat.
At least one protection function operative (c/g)

LED res
Stored LED indications reset (c)

REC del
Fault recording data deleted (c)

Sys. Flt
Network system fault (c), detailed information in the fault annunciations

FAULT
Fault with associated sequence number (c)

Annunciations of monitoring functions:

ANN lost
Annunciations lost (buffer overflow) (c)

P Can nLT
Annunciations for operating (PC) interface lost (c)

Operational annunciations of the undervoltage protection:

U < off
Undervoltage protection U< is switched off (c/g)

U < blk
Undervoltage protection U< is blocked (c/g)

U < act
Undervoltage protection U< is active (c/g)
### Operational annunciations of the undervoltage protection:

- **$U_x < \text{ off}$**: Undervoltage protection $U_x <$ is switched off (c/g)
- **$U_x < \text{ blk}$**: Undervoltage protection $U_x <$ is blocked (c/g)
- **$U_x < \text{ act}$**: Undervoltage protection $U_x <$ is active (c/g)

### Operational annunciations of the overvoltage protection:

- **$U > \text{ off}$**: Overvoltage protection $U >$ is switched off (c/g)
- **$U > \text{ blk}$**: Overvoltage protection $U >$ is blocked (c/g)
- **$U > \text{ act}$**: Overvoltage protection $U >$ is active (c/g)
- **$U_x > \text{ off}$**: Overvoltage protection $U_x >$ is switched off (c/g)
- **$U_x > \text{ blk}$**: Overvoltage protection $U_x >$ is blocked (c/g)
- **$U_x > \text{ act}$**: Overvoltage protection $U_x >$ is active (c/g)

### Operational annunciations of the rate-of-frequency-change protection:

- **$df \text{ off}$**: Rate-of-frequency-change protection is switched off (c/g)
- **$df \text{ blk}$**: Rate-of-frequency-change protection is blocked (c/g)
- **$df \text{ act}$**: Rate-of-frequency-change protection is active (c/g)
- **$Udf < \text{ blk}$**: Rate-of-frequency-change protection is blocked by undervoltage (c/g)

### Operational annunciations of the frequency protection:

- **$Frq \text{ off}$**: Frequency protection is switched off (c/g)
- **$Frq \text{ blk}$**: Frequency protection is blocked (c/g)
- **$Frq \text{ act}$**: Frequency protection is active (c/g)
- **$Uf < \text{ blk}$**: Frequency protection is blocked by undervoltage (c/g)
Operational annunciations of the overflux protection:

- **U / f off**
  - Overflux protection is switched off (c/g)

- **U / f blk**
  - Overflux protection is blocked (c/g)

- **U / f act**
  - Overflux protection is active (c/g)

- **U / f > wrn**
  - Overflux protection: U/f warning stage (c/g)

- **U / f > Flt**
  - Overflux protection: Fault detection U/f> (c/g)

Operational annunciations of the trip circuit supervision:

- **SUP off**
  - Trip circuit supervision is switched off (c/g)

- **SUP blk**
  - Trip circuit supervision is blocked (c/g)

- **SUP act**
  - Trip circuit supervision is active (c/g)

- **SUP noB I**
  - Trip circuit supervision is blocked, because binary input is not marshalled (c/g)

- **CIR int**
  - Trip circuit is interrupted (c/g)

Operational annunciations of the circuit breaker test function:

- **CB test**
  - Circuit breaker test in progress (c/g)

- **CB t p Tst**
  - Trip by internal circuit breaker test function (c/g)
6.4.3 Fault annunciations – address block 82

The annunciations which occurred during the last eight network faults can be read off on the front panel or via the operating interface. The indications are recorded in the sequence from the youngest to the oldest. When a ninth fault occurs, the data relating to the oldest are erased. Each of the eight fault data buffers can contain up to 30 annunciations. When more occur, the last message signals “buffer overflow”.

Input of the codeword is not required.

When the relay is operative and the initial display or the quiescent messages are displayed, press the key \( \triangledown \) to reach the item “ANNUNC.” Key \( \triangledown \) is used to change over to the second operation level, where one can go with the key \( \triangledown \) to the address block 82 which forms the heading of the fault annunciations. The third operation level, with key \( \triangledown \) contains the eight system faults. The individual annunciations can be found in the fourth operation level (key \( \triangledown \)), see Figure 6.3. Use the keys \( \triangledown \) and \( \triangle \) to scroll through the annunciation list (Figure 6.4).

For these purposes, the term “system fault” means the period from fault inception up to final clearance. Within a network fault, several fault events can occur, from pick-up of any fault detection until drop-off of the latest protection function.

When date and time have not yet been set (refer also to Section 6.3.1.2), the date is shown as 01.07.97, the time is given as relative time from the last re-start of the processor system. Thereafter, the fault annunciations are listed in chronological sequence with the relative time referred to the first fault detection.

In the following clarification, all the available fault annunciations are indicated. In the case of a specific fault, of course, only the associated annunciations appear in the display. At first, an example is given for a system fault, and explained.

Use the arrow keys to scroll through the displayed annunciation list.

- **[5200]** Beginning of the block “Fault annunciations”
- **[5210]** Beginning of the block “Fault annunciations of the last system fault”
- **[5211]**
  - 1st line: Date of the last system fault
  - 2nd line: Time of the last system fault
    - (hours, minutes, seconds ...)
    - ... and ms
  - System fault, coming
- **[5212]**
  - 1st line: Consecutive number of the system fault
  - 2nd line: Beginning of the relative time; time resolution is 1 ms
- **[5213]**
  - 1st line: Beginning of the relative time
  - 2nd line: Event that has started the relative time

---

etc.
General fault annunciations of the device:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sys. Flt</td>
<td>Network system fault</td>
</tr>
<tr>
<td>FAULT</td>
<td>Beginning of fault</td>
</tr>
<tr>
<td>ANN ov fl</td>
<td>Fault annunciations lost (buffer overflow)</td>
</tr>
<tr>
<td>FT det</td>
<td>General fault detection of device</td>
</tr>
<tr>
<td>DEV. Trp</td>
<td>General trip of device</td>
</tr>
<tr>
<td>f = Hz</td>
<td>Last frequency during fault in Hz</td>
</tr>
<tr>
<td>U = V</td>
<td>Last voltage U during fault in Volt</td>
</tr>
<tr>
<td>U x = V</td>
<td>Last voltage U_x during fault in Volt (if applicable)</td>
</tr>
</tbody>
</table>

Fault annunciations of the undervoltage protection functions:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>U &lt; Flt</td>
<td>Fault detection of undervoltage protection U&lt;</td>
</tr>
<tr>
<td>U &lt; Trp</td>
<td>Trip by undervoltage protection U&lt;</td>
</tr>
<tr>
<td>U x &lt; Flt</td>
<td>Fault detection of undervoltage protection U_x&lt;</td>
</tr>
<tr>
<td>U x &lt; Trp</td>
<td>Trip by undervoltage protection U_x&lt;</td>
</tr>
</tbody>
</table>

Fault annunciations of the overvoltage protection functions:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>U &gt; Flt</td>
<td>Fault detection of overvoltage protection U&gt;</td>
</tr>
<tr>
<td>U &gt; Trp</td>
<td>Trip by overvoltage protection U&gt;</td>
</tr>
<tr>
<td>U &gt;&gt; Flt</td>
<td>Fault detection of overvoltage protection U&gt;&gt;</td>
</tr>
<tr>
<td>U &gt;&gt; Trp</td>
<td>Trip by overvoltage protection U&gt;&gt;</td>
</tr>
<tr>
<td>U x &gt; Flt</td>
<td>Fault detection of overvoltage protection U_x&gt;</td>
</tr>
<tr>
<td>U x &gt; Trp</td>
<td>Trip by overvoltage protection U_x&gt;</td>
</tr>
<tr>
<td>U x &gt;&gt; Flt</td>
<td>Fault detection of overvoltage protection U_x&gt;&gt;</td>
</tr>
<tr>
<td>U x &gt;&gt; Trp</td>
<td>Trip by overvoltage protection U_x&gt;&gt;</td>
</tr>
</tbody>
</table>
### Fault annunciations of rate-of-frequency-change protection:

<table>
<thead>
<tr>
<th>df1 Flt</th>
<th>Fault detection of rate-of-frequency-change protection: df1/dt stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>df2 Flt</td>
<td>Fault detection of rate-of-frequency-change protection: df2/dt stage</td>
</tr>
<tr>
<td>df3 Flt</td>
<td>Fault detection of rate-of-frequency-change protection: df3/dt stage</td>
</tr>
<tr>
<td>df4 Flt</td>
<td>Fault detection of rate-of-frequency-change protection: df4/dt stage</td>
</tr>
<tr>
<td>df1 Trp</td>
<td>Trip by rate-of-frequency-change protection: df1/dt stage</td>
</tr>
<tr>
<td>df2 Trp</td>
<td>Trip by rate-of-frequency-change protection: df2/dt stage</td>
</tr>
<tr>
<td>df3 Trp</td>
<td>Trip by rate-of-frequency-change protection: df3/dt stage</td>
</tr>
<tr>
<td>df4 Trp</td>
<td>Trip by rate-of-frequency-change protection: df4/dt stage</td>
</tr>
</tbody>
</table>

### Fault annunciations of frequency protection:

<table>
<thead>
<tr>
<th>f1 Flt</th>
<th>Fault detection of frequency protection: f1 stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>f2 Flt</td>
<td>Fault detection of frequency protection: f2 stage</td>
</tr>
<tr>
<td>f3 Flt</td>
<td>Fault detection of frequency protection: f3 stage</td>
</tr>
<tr>
<td>f4 Flt</td>
<td>Fault detection of frequency protection: f4 stage</td>
</tr>
<tr>
<td>f1 Trp</td>
<td>Trip by frequency protection: f1 stage</td>
</tr>
<tr>
<td>f2 Trp</td>
<td>Trip by frequency protection: f2 stage</td>
</tr>
<tr>
<td>f3 Trp</td>
<td>Trip by frequency protection: f3 stage</td>
</tr>
<tr>
<td>f4 Trp</td>
<td>Trip by frequency protection: f4 stage</td>
</tr>
</tbody>
</table>

### Fault annunciation of overflux protection:

<table>
<thead>
<tr>
<th>U/f &gt; Flt</th>
<th>Fault detection of overflux protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>U/f Trp</td>
<td>Trip by thermal stage of overflux protection</td>
</tr>
<tr>
<td>U/f &gt; Trp</td>
<td>Trip by overflux protection (U/f&gt; stage)</td>
</tr>
</tbody>
</table>
Further messages:

- TAB empty
  - means that no fault event has been recorded
- TAB overfl
  - means that other fault data have occurred, however, memory is full
- TAB. END
  - If not all memory places are used the last message is TAB. END

Use key ↓ to go back to the third operation level. You can reach the second to last system fault by pressing the key ↓. The individual fault annunciations can be found with the key ▶ in the fourth operation level and scrolled through with the keys ↓ and △. The available annunciations are the same as for the last fault.

[5220] Beginning of the “Fault annunciations of the second to last system fault”

In corresponding way the annunciations of the third to last up to the eighth to last fault can be achieved.

[5230] Beginning of the “Fault annunciations of the third to last system fault”

[5280] Beginning of the “Fault annunciations of the eighth to last system fault”
6.4.4 Read-out of operational measured values – address block 84

Operating measured values can be read out at any time under the address block 84. When the relay is operative and the initial display or the quiescent messages are displayed, press the key \( \Uparrow \) to reach the item “ANNUNC.” Key \( \Uparrow \) is used to change over to the second operation level, where one can go with the key \( \Uparrow \) to the address block 84 which forms the heading of the operational measured values. The individual annunciations can be found in the third operation level (key \( \Uparrow \)), see Figure 6.3. Use the keys \( \Uparrow \) and \( \Delta \) to scroll through the individual measured values (Figure 6.4).

Entry of the codeword is not necessary.

During read-out, the values are not actualized, but after scrolling through the list with the keys \( \Uparrow \) and \( \Delta \), the actual values will be displayed.

In the following example, some example values have been inserted. In practice the actual values appear.

Use \( \Uparrow \) key to move to the next address with the next measured value.

Page on with the \( \Uparrow \) key to read off the next measured value, or page back with \( \Delta \)

The secondary voltages are referred to the voltages applied to the relay terminals. These values are not influenced by address 1102. The voltages \( U \) and \( U_x \) are displayed even outside of the operating range of the relay but with additional errors (because of missing frequency correction the displayed values are too small)

With two-phase connection (V-connection) and correct configuration of address 7901 (MEAS = 2 phase), the positive sequence voltage is displayed
### 6.5 Testing and commissioning

#### 6.5.1 General

Prerequisite for commissioning is the completion of the preparation procedures detailed in Chapter 5.

**Warning**

Hazardous voltages are present in this electrical equipment during operation. Non-observance of the safety rules can result in severe personal injury or property damage.

Only qualified personnel shall work on and around this equipment after becoming thoroughly familiar with all warnings and safety notices of this manual as well as with the applicable safety regulations.

Particular attention must be drawn to the following:

- The earthing screw of the device must be connected solidly to the protective earth conductor before any other connection is made.
- Hazardous voltages can be present on all circuits and components connected to the supply voltage or to the measuring and test quantities.
- Hazardous voltages can be present in the device even after disconnection of the supply voltage (storage capacitors!).
- The limit values given in the Technical data (Section 3.1) must not be exceeded at all, not even during testing and commissioning.

When the relay is intended to operate with two two-phase voltages of a three-phase system in V–connection, a three-phase symmetrical voltage source with individually adjustable voltages should be available. When the relay is intended to operate with one or two single-phase voltages, a single-phase voltage source is sufficient.

**NOTE**! The accuracy which can be achieved during testing depends on the accuracy of the testing equipment. The accuracy values specified in the Technical data can only be reproduced under the reference conditions set down in IEC 60255 resp. VDE 0435/part 303 and with the use of precision measuring instruments. The tests are therefore to be looked upon purely as functional tests.

During all the tests it is important to ensure that the correct command (trip) contacts close, that the proper indications appear at the LEDs and the output relays for remote signalling.

After tests which cause LED indications to appear, these should be reset, at least once by each of the possible methods: the reset button **N** on the front plate and via the remote reset relay (if marshalled, see connection diagrams, Appendix A). If the reset functions have been tested, resetting the stored indications is no more necessary as they are erased automatically with each new pick-up of the relay and replaced by the new annunciations.

**NOTE**: Three versions with different scope of function can be delivered. The 13th figure of the ordering code is decisive. The presettings of LEDs and binary inputs and outputs differ dependent on this scope of functions. In the following clarifications, the versions are considered where necessary:

- statements valid for versions 7RW600*−−−−−−0*** and −1*** are specified in brackets [],
- statements valid for versions 7RW600*−−−−−−2*** are specified in braces {}.
- statements valid for all versions are specified in parentheses ()

When testing the unit with a secondary injection test set, it must be ensured that no other measured values are connected and that the tripping leads to the circuit breaker trip-coils have been interrupted.

It is recommended that the actual settings for the relay be used for the testing procedure. If these values are not (yet) available, test the relay with the factory settings. In the following description of the test sequence the preset settings are assumed.

First, read out the operational measured values in order to verify that the test equipment is correctly connected.
6.5.2 Testing the undervoltage protection $U_\text{<}, U_\chi<$

The functions of undervoltage protection can only be tested if these functions have been configured as EXISt and parameterized as operative ($U_\chi = \text{ON}$ and/or $U_\chi = \text{ON}$).

The relay contains two measured voltage inputs, designated with $U$ (at terminals 7 and 8) and $U_\chi$ (at terminals 9 and 10 on models 7RW6000–$\star B\star \star \star$ and $\star E\star \star \star$, or terminals 13 and 14 on model 7RW6000–$\star D\star \star \star$). Possibility exists to connect either two different single-phase voltages to the inputs, or to connect two phase-to-phase voltages of a three-phase system in $V-$connection. The relay had been informed about this during configuration (refer to Section 5.4.2, address 7901). In the first case each voltage is monitored independently by the associated stage. In the latter case both voltages are monitored by the $U>$ and $U>>$ stages. Parameters $U_\chi>$ and $U_\chi>>$ are then ineffective and not available. Measurement on the overvoltage protection function can therefore be performed with single-phase test values. The stages can be tested individually one after another. The pick-up values relate to the connected phase-to-phase voltages.

Set voltage(s) to approximately rated voltage. Reduce voltage until it has fallen below the threshold value $U_\text{<}$, address 1602.
- Annunciation "$U_\text{<} \text{Flt}$" (not marshalled when delivered from factory).
- After $T U_\text{<} < 1.5$ s (address 1603) annunciation "$U_\text{<} \text{ Trp}$" [LED 4 and relay 1] {not marshalled when delivered from factory}.

Set voltage(s) to approximately rated voltage. Activate binary input "$U_\text{<} \text{ b1}$" [binary input 3] {not marshalled when delivered from factory}. Disconnect voltage(s)
- Annunciation "$U_\text{<} \text{ blk}$" (not marshalled when delivered from factory).
- No further alarms regarding undervoltage protection.

De-activate binary input.

For single-phase measurement with two different voltages (address 7901 = $1\text{phase}$), repeat the test for the voltage input $U_{\chi}$ with the parameters for $U_\chi<$ (addresses 1502 and 1503). When the relay is delivered, the same LEDs, binary inputs and outputs are valid as during test of voltage $U_\text{<}$.

**Attention!** If setting values have been changed for testing, reset to correct values (addresses 1602, 1603 and addresses 1502, 1503)!

Further checks are performed with primary values during commissioning (Section 6.6.2).

6.5.3 Testing the overvoltage protection $U>, U>>, U_\chi>, U_\chi>>$

The functions of overvoltage protection can only be tested if these functions have been configured as EXISt and parameterized as operative (in address 1701 $U>$ = ON and/or in address 1801 $U_\chi>$ = ON).

The relay contains two measured voltage inputs, designated with $U$ (at terminals 7 and 8) and $U_\chi$ (at terminals 9 and 10 on models 7RW6000–$\star B\star \star \star$ and $\star E\star \star \star$, or terminals 13 and 14 on model 7RW6000–$\star D\star \star \star$). Possibility exists to connect either two different single-phase voltages to the inputs, or to connect two phase-to-phase voltages of a three-phase system in $V-$connection. The relay had been informed about this during configuration (refer to Section 5.4.2, address 7901). In the first case each voltage is monitored independently by the associated stage. In the latter case both voltages are monitored by the $U>$ and $U>>$ stages. Parameters $U_\chi>$ and $U_\chi>>$ are then ineffective and not available. Measurement on the overvoltage protection function can therefore be performed with single-phase test values. The stages can be tested individually one after another. The pick-up values relate to the connected phase-to-phase voltages.

⚠️ **Caution!**

Test voltages larger than 200 V may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability).
The time delays for overvoltages are checked with approximately 1.2 x pick-up value. It must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

Connect voltage of 1.2 x pick-up value U> (address 1702) at terminals 7, 8.
- Annunciation "U> Flt" [in versions 7RW600*-****--0**** and -1**** not marshalled when delivered from factory] {in version 7RW600*-****--2**** relay 5}.
- After T–U> (1.5 s; address 1703), annunciation "U> Trp" [not marshalled when delivered from factory] (LED 3 and relay 2).

Disconnect voltage. Activate binary input ">U> blk" [not marshalled when delivered from factory] {binary input 3}. Connect voltage of 1.2 x pick-up value U> (address 1702) at terminals 7, 8.
- Annunciation "U> blk" (not marshalled when delivered from factory).
- No further alarms regarding overvoltage protection.

Disconnect voltage. De-activate binary input.
Connect voltage of 1.2 x pick-up value U>> (address 1704).
- Annunciation "U>> Flt" [not marshalled when delivered from factory] {relay 5}.
- After T–U>> (0 s; address 1705), annunciation "U>> Trp" [not marshalled when delivered from factory] (LED 4 and relay 3).

Disconnect voltage.

Repeat the tests accordingly for the voltage input Ux at the terminals 9 and 10 for model 7RW6000-*B**** and -*E**** or at the terminals 13 and 14 for model 7RW6000-*D****. When the relay is delivered, the same LEDs, binary inputs and outputs are valid as during test of voltage U>, U>>.

Attention! If setting values have been changed for testing, reset to correct values(addresses 1702 to 1705 and 1802 to 1805, if applicable)!

Further checks are performed with primary values during commissioning (Section 6.6.2).

6.5.4 Testing the frequency protection functions

- Frequency protection f<, f>

The functions of the frequency protection in versions 7RW600*-****--0**** and -1**** can only be tested if this protection is configured as EXIST in address 7821 (as delivered, refer to Section 5.4.2) and has been parameterized as operative – contrary to the condition as delivered from factory (address 2101 f< = ON).

The frequency is always measured from the voltage input U, i.e. at terminals 7 and 8. So it is sufficient to apply the test voltage only to these input terminals.

The simplest function check is a read-out of the frequency as measured by the unit. This value is found in the operational measured values under address 5701 (address block 84).

If a voltage source with adjustable frequency is available, then the limits of the overfrequency f> and of the underfrequency f< stages can be checked without difficulties.

When measuring times, it must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

Connect rated voltage, increase frequency until overfrequency protection (f4) picks up.
- Annunciation "f4 Flt." [not marshalled when delivered from factory].
- After T f4 (3 s; address 2109), annunciation "f4 Trip" [not marshalled when delivered from factory].

Activate binary input "f4 blk" [FNo 5209, not marshalled when delivered from factory].
- The blocking annunciations "f4 blk" appear (not marshalled when delivered from factory).
- Annunciations "f4 Flt." and "f4 Trip" disappear.

Reduce frequency to rated frequency; de-activate binary input.
Reduce frequency until the first underfrequency protection stage (f3) picks up.
Further reduce frequency until the second underfrequency stage f2 picks up.
- Annunciation “f2 Flt.” [relay 5].
- After T f2 (3 s; address 2105), annunciation “f2 Trip” [LED 2 and relay 3].

Further reduce frequency until the third underfrequency stage f3 picks up.
- Annunciation “f3 Flt.” [relay 5].
- After T f3 (10 s; address 2107), annunciation “f3 Trip” [LED 3 and relay 4].

Activate binary input (“>Freq blk”) [FNo 5203, binary input 2 when delivered from factory].
- The blocking annunciations “Freq bl” appear [not marshalled when delivered from factory].
- Annunciations “f1 Flt.”, “f2 Flt.”, “f3 Flt.” and “f1 Trip”, “f2 Trip” and “f3 Trip” disappear.

Bring frequency back to rated frequency. De-activate binary input. Switch off test quantity.

Further checks are performed with primary values during commissioning (Section 6.6.2).

**Rate-of-frequency-change protection df/dt**

The function of the rate-of-frequency-change protection in model 7RW600-series can only be tested if this protection is configured as EXIST in address 7820 (as delivered, refer to Section 5.4.2) and has been parameterized as operative – contrary to the condition as delivered from factory (address 2001, df/dt = ON).

The frequency, and thus the rate-of-change in frequency, is always measured from the voltage input U, i.e. at terminals 7 and 8. So it is sufficient to apply the test voltage only to these input terminals.

An exact check of the rate-of-frequency-change protection requires a voltage source with adjustable frequency and definable rate-of-change df/dt. The frequency change must be continuous, not in steps.

When measuring times, it must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

Connect rated voltage, set frequency to rated value. Increase the negative rate-of-change |−df/dt| until the first rate-of-change stage (df1/dt) picks up. Note that a rate-of-change stage will operate only when the frequency lies below the rated frequency.
- Annunciation “df1 Flt” [not marshalled when delivered from factory].
- After T df1 (0.5 s; address 2003), annunciation “df1 Trip” [not marshalled when delivered from factory].

Continue increasing |−df/dt| until the second stage (df2/dt) picks up.
- Annunciation “df2 Flt” [not marshalled when delivered from factory].
- After T df2 (0.25 s; address 2006), annunciation “df2 Trip” [not marshalled when delivered from factory].

Continue increasing |−df/dt| until the third stage (df3/dt) picks up.
- Annunciation “df3 Flt” [not marshalled when delivered from factory].
- After T df3 (0.1 s; address 2009), annunciation “df3 Trip” [not marshalled when delivered from factory].

Activate binary input (“>df blk”) [FNo 5503, not marshalled when delivered from factory].
- The blocking annunciations “df blk” appear [not marshalled when delivered from factory].
- Annunciations “df1 Flt”, “df2 Flt”, “df3 Flt” and “df1 Trip”, “df2 Trip” and “df3 Trip” disappear, or cannot be provoked by higher frequency change.

Bring frequency back to rated frequency. De-activate binary input. Switch off test quantity.

Further checks are performed with primary values during commissioning (Section 6.6.2).
6.5.5 Testing the overflux protection U/f>

The function of the overflux protection in version 7RW600x−xxxx−2xxx can only be tested if this protection is configured as EXIST in address 7829 (as delivered, refer to Section 5.4.2) and has been parameterized as operative – contrary to the condition as delivered from factory (address 2901, U/f = ON).

The overflux protection comprises a definite time stage and a thermal stage as a tripping stage. In addition, a delayed alarm is output when the continuously permissible limit value U/f> (address 2902) is exceeded.

The relay contains two measured voltage inputs, designated with U (at terminals 7 and 8) and Ux (at terminals 9 and 10 on models 7RW6000−ABxxx and −AExxx, or terminals 13 and 14 on model 7RW6000−ADxxx). Possibility exists to connect either two different single-phase voltages to the inputs, or to connect two phase-to-phase voltages of a three-phase system in V—connection. The relay had been informed about this during configuration (refer to Section 5.4.2, address 7901). In the first case, only the voltage U is decisive for flux evaluation. In the latter case, the higher of the voltages are decisive. In both cases, the frequency is always derived from the input U. Therefore, tests are performed with the voltage input U (terminals 7 and 8).

The simplest function check is a read-out of the frequency, overflux and maximum voltage U and Ux as measured and calculated by the unit. These values are found in the operational measured values under addresses 5701, 5702, 5703, 5704 and 5705 (block address 84).

If a voltage source with adjustable frequency is available, then the limit of the overflux definite time stage U/f> (address 2904) can be checked by slowly decreasing the frequency with constant voltage.

If the voltage source has only constant (system) frequency, the voltage can be increased until the protection picks up.

⚠️ Caution!

Test voltages larger than 200 V may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability).

Increase the test voltage until the definite U/f stage (address 2904) picks up.
- Annunciation “U/f>F1t” {not marshalled when delivered from factory}.
Switch off test voltage.

The delay times are checked with approximately 1.1 times the pick-up value. It must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

Connect voltage of 1.1 x pick-up value U/f> (address 2902).
- Annunciation “U/f>F1t” {not marshalled when delivered from factory}.
- After TU/f> (10 s, address 2903, annunciation “U/f>ωωωω” {LED 1 and relay 4 with factory pre-settings}).
Switch off test voltage.

The thermal stages can be tested at different points of the characteristic by applying different U/f quantities.

The basis value of the thermal characteristic is the set value U/f> (address2902). Smaller overflux does not produce a simulated temperature rise, i.e. do not affect pre-load processing.

The shape of the thermal characteristic is determined by the addresses 2906 to 2912.

With the preset value (U/f> = 1.10, address 2902) and an applied overflux of

\[
\frac{U/U_{N}}{f/f_{N}} = 1.05
\]

no warning, no tripping must occur.

The operational measured values under address block 84 should show the calculated overflux U/f which should amount to approx. 1.05 in this case.

Note: Before measuring the thermal trip time for different applied overflux, it must be ensured that the thermal memory is reset to 0. This is performed via the binary input “>RN 1 U/f” (reset memory of thermal replica) or by energizing briefly the blocking input “>U/f b1”, {allocated to binary input 2 when delivered}. It is either possible to de-activate and re-activate the overflux protection function (address 2901).
Switch voltage corresponding to \( \frac{U}{f} = 1.25 \).
- After delay time of the warning stage (10 s, address 2903) Annunciation "U/f>WIN" (LED 1 and relay 4).
- On reaching the thermal trip stage after a time according to the trip time characteristic (\( t = 30 \) s) annunciation "U/f>Trip" (LED 2 and relay 1).

**Note:** Depending on the set values for \( U/f >> \) and \( TUF >> \) (addresses 2904 and 2905), the definite time stage "U/f>Trip" may pick up and trip before the thermal stage.

### 6.5.6 Testing the trip circuit supervision

The trip circuit supervision function can only be tested if it has been configured in address block 00 (contrary to the state of delivery) with 2 BI (with 2 binary inputs) or bypass \( R \) (with one binary input, the second is by-passed by a resistor). Furthermore, it must be switched ON in address block 39 (CIRsup = ON), and the associated binary input(s) must be marshalled for this purpose (refer to Section 5.5.2).

#### 6.5.6.1 Trip circuit supervision using two binary inputs

In accordance with the task of this operation mode of the trip circuit supervision, the trip circuit is assumed to be disturbed when none of the two binary inputs is energized. (refer also to Section 4.7.1). This condition cannot occur steadily, i.e. over a certain time, as long as the trip circuit is operating correctly. It can only occur for a short time during the operation of the circuit breaker. Therefore, alarm is given, if this condition lasts for a time which corresponds to three measurement repetitions.

**Note:** In 7RW600, the two binary inputs BI2 and BI3 have a common negative pole. This combination is, therefore, not suitable for trip circuit supervision. Use the binary inputs BI1 and BI2 instead.

Energize the binary inputs one after the other: the fault indication disappears as long as one binary input is energized and reappears a short time after both inputs are de-energized.

When both control voltages are switched off, the annunciation "CIR int" (i.e. trip circuit interrupted, not allocated at delivery) appears after 400 ms to 700 ms.

#### 6.5.6.2 Trip circuit supervision using one binary input

In accordance with the task of this operation mode of the trip circuit supervision, the trip circuit is assumed to be disturbed when the binary input is not energized. (refer also to Section 4.7.2). This condition cannot occur steadily, i.e. over a certain time, as long as the trip circuit is operating correctly. It can only occur for a short time during which the trip relay of the protection device is closed. Therefore, alarm is given, if this condition lasts for a time which should be longer than the duration of a trip command of the device.

Energize the binary input: the fault indication disappears.

When the control voltage is switched off, the annunciation "CIR int" (not allocated at delivery) appears after 60 s to 90 s.
6.6 Commissioning using primary tests

6.6.1 General advices

All secondary testing sets and equipment must be removed. Connect measurement values. All installation preparations according to Section 5.2 must have been completed. For testing with primary values the protected object must be energized.

⚠️ Warning

Primary tests shall be performed only by qualified personnel which is trained in commissioning of protection systems and familiar with the operation of the protected object as well as the rules and regulations (switching, earthing, etc.)

All protection functions should be initially switched OFF so that they do not influence one another. During primary testing the functions are progressively switched to being operative. If a particular protection function is not required at all, it should be "de-configured" (refer to Section 5.4.2). It is then treated as non existing. If configuration parameters must be changed during commissioning, the measured quantities should have been switched off before.

Proper functioning of the trip circuits including the circuit breakers (or other control devices connected to the trip relays) should be checked at least once for each protection function by a live trip. Furthermore, live trip may be produced from the operating panel or via the operating interface according to Section 6.6.4.

6.6.2 Checking the voltage circuits

Switch on the voltage protection functions which shall be used and which are configured as EXIST (Section 5.4.2). If the undervoltage protection is used, then blocking of this function on tripping of the voltage transformer secondary m.c.b. should also be checked during voltage testing. It is assumed that the auxiliary contact of the m.c.b. is marshalled to the binary input “>U< b1” (in versions 7RW600*—*****—0*** and −1*** binary input 3 when delivered from factory).

Before energizing the protected object, ensure that no short-circuit bridges or earthing isolators are present.

With the voltage transformer m.c.b. closed, switch on the protected object.
- Read out voltage(s) under address block 75 (block 84). They can be compared with the actual voltage(s).

Switch voltage transformer m.c.b. to tripped position.
- Check that the message “U< b1” and “>U< b1” (if applicable) are indicated in the operational annunciations (address block 51, block 81) with the Комing index (both messages are not marshalled when delivered from factory).
- Check that the voltage(s) in address block 57 function block81) is (are) almost zero.
- Switch on voltage transformer m.c.b.
- check that the message “>U< b1” and “>U< b1” (if applicable) are indicated in the operational annunciations, but this time with the Going index.

Should the message not be given then check the connection of the voltage transformer secondary circuits, and check correct marshalling of the binary input from the auxiliary contact of the m.c.b. (refer to Section 5.5.2).

If the indices “C” for “Coming” and “G” for “Going” are interchanged, check and correct the contact mode of the binary input (“NO” or “NC” contact) in accordance with Section 5.5.2.

If the relay contains the overflux protection {model 7RW600*—*****—2***} and this shall be used, switch it on under address 2901, U/f = ON.

At rated frequency and rated voltage, the value U/f should be near 1.00 (address 5702, block 84). If deviation occurs, check the adaptation factor k_m in address 2914 (see Section 6.3.10) and correct if necessary.

In power station applications, switch machine speed regulation to “manual ” operation.

Reduce machine speed, so that the overflux warning stage U/f> (address 2902) picks up:
- Annunciation “U/f>P1t” {not marshalled when delivered from factory},
- After TU/f (address 2903, 10 s when delivered) annunciation “U/f>wrn” {LED1 and relay 4}.
If a binary input is used for blocking the overflux protection {input 2 when delivered from factory}, activate the block: Annunciations of the overflux protection disappear. De-activate binary input. Adjust machine to rated speed.

If the relay contains the frequency protection {model 7RW600×−×××××−0××× and −1××××2×××} and this shall be used, switch it on under address 2101, f> < = ON.

Increase machine speed, so that overfrequency protection just picks up (at delivery frequency stage f4, address 2108):
- Annunciation “f4> Flt.” (not marshalled when delivered from factory).
- After f4 Multiplication “f4 Trip” (not marshalled when delivered from factory).

Reduce machine speed, so that all underfrequency protection stages (at delivery frequency stages f1, f2, and f3) pick up (addresses 2102, 2104, and 2106):
- Annunciations “f< Fault” [relay 5].
- After f* annunciation “f1 Trip” [LED 1 and relay 2 when delivered from factory] and annunciation “f2 Trip” [LED 2 and relay 3 when delivered from factory] and “f3 Trip” [LED 3 and relay 4 when delivered from factory].

If a binary input is used for blocking the frequency stages [input 2 when delivered from factory], activate the block: Annunciations of the frequency protection disappear. De-activate binary input. Adjust machine to rated speed and slowly de-excite the generator. When the generator voltage drops below the value set for U< (address 1602) and/or Ux (address 1502): pick-up annunciation “U< Flt” resp. “Ux< Flt” appears (both are not marshalled when delivered from factory) and trip command “U< Trip” resp. “Ux< Trip” after delay according to the set characteristic [LED 4 and relays 1, when delivered from factory]. The annunciations remain after the machine has been completely de-excited. They can be reset by energizing the accordingly allocated binary input “>U< b1” (FNo 6506) resp. “>Ux< b1” (FNo 6518).

The voltage tests are completed after the generator has been shut down. The required voltage and frequency protection functions are switched to be operative:

(address 1501: Ux< = ON or OFF),
(address 1601: Ux< = ON or OFF),
(address 1701: U> = ON or OFF),
(address 1801: Ux> = ON or OFF),
(address 2001: dl/dt = ON or OFF),
(address 2101: f< = ON or OFF),
(address 2901: U/f = ON or OFF).

Partial functions can be switched to be inoperative by appropriate limit value settings (e.g. f* set to rated frequency).

6.6.3 Testing the switching conditions of binary inputs and LED indicators

The relay contains a test routine which interrogates the positions of the binary inputs and LEDs and indicates them on the display.

Tests can be performed in address block 40. This block is reached by pressing the key ▼ three times so that the block “ADDITION FUNCTION” (additional functions) is displayed. Change to the second operation level by the key ▽; “DATE/TIME” is displayed. Key ▼ is pressed to scroll to the test blocks.

When the relay is operated from a personal computer by means of the protection data processing program DIGIS®, the test items are identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

![TEST AIDS](image-url)

Beginning of the block “Tests and commissioning aids”

Change over with key ▽ to the next operation level which shows the heading of the input/output conditions. Page to the next operation level by the key ▽ to gain access to the individual tests.
Pressing the enter key $E$ causes the relay to display the question whether the states of the binary inputs shall be checked. Press the “Yes”—key $Y/J$ to confirm, or the “No”—key $N$ to abort. With the key $\downarrow$ the next test item can be selected.

Pressing the “Yes”—key $Y/J$ makes the relay display the states of the binary inputs (BI). Each energized input is marked by its number, inputs which are not energized are marked with a $-$:

1: BI 1 is energized (control voltage present)
2: BI 2 is energized (control voltage present)
3: BI 3 is energized (control voltage present)
$-$: BI is not energized (control voltage absent)

The illustrated example shows that the binary inputs BI 1 and BI 2 are energized, and binary input BI 3 is not energized.

Press the key $\downarrow$ to change to the conditions of the LEDs:

Pressing the enter key $E$ causes the relay to display the question whether the states of the LED indicators (LED) shall be checked. Press the “Yes”—key $Y/J$ to confirm, or the “No”—key $N$ to abort.

Pressing the “Yes”—key $Y/J$ makes the relay display the states of the LEDs. Each energized LED is marked by its number, LEDs which are not energized are marked with a $-$:

1: LED 1 is energized
2: LED 2 is energized
3: LED 3 is energized
4: LED 4 is energized
$-$: LED is not energized

The illustrated example shows that the LED 1 is energized, LED 2 is not energized, LED 3 is not energized, LED 4 is energized.
6.6.4 Tripping test including circuit breaker

SIPROTEC 7RW600 allows simple checking of the tripping circuit and the circuit breaker.

Tests can be performed in address block 40. This block is reached by pressing the key ▼ three times so that the block “ADDITION FUNCTIONS” (additional functions) is displayed. Change to the next operation level by the key ▶; “I/O STAT” is displayed. Key ▼ is pressed until the display shows the test block “CB—TEST”.

When the relay is operated from a personal computer by means of the protection data processing program DIGSI®, the test items are identified by a four-digit address number. In the following clarifications, this number is indicated at the beginning of the explanations in brackets.

The individual test item is reached with the key ▶ in the next operation level.

If the circuit breaker auxiliary contacts advise the relay, through a binary input, of the circuit breaker position, the test can only be started when the circuit breaker is closed.

A prerequisite for starting the test is that no protection function of the relay be picked up. Codeword input is necessary. The circuit breaker test feature must have been allocated to the trip relay during marshalling.

The relay displays the test sequence in the second display line.

---

Block “Test of circuit breaker – Trip test”

After confirmation with the enter key E the relay requests for codeword input. After correct codeword input, repeat confirmation with the enter key E. The relay checks whether breaker test is permitted or one of the above mentioned obstacles is detected.

- a circuit breaker test is already running
- a system fault is in progress
- the breaker signals via a binary input that it is open

If none of the above mentioned reasons to refuse is present, the test is started. The following messages may occur during the test:

- circuit breaker test is aborted
- circuit breaker test has been unsuccessful; breaker has not opened
- circuit breaker test executed
6.7 Putting the relay into operation

All setting values should be checked again, in case they were altered during the tests. Particularly check that all desired protection and ancillary functions have been programmed in the configuration parameters (address blocks 00 and 01, refer to Section 5.4) and all desired protection functions have been switched ON. Ensure that the trip times are not set to \( \infty \) for those functions or stages which should trip.

Stored indications on the front plate should be reset by pressing the key “N” on the front so that from then on only real faults are indicated. During pushing the RESET button, the LEDs on the front will light up (except the “Blocked” – LED); thus, a LED test is performed at the same time.

Check that the module is properly inserted and fixed. The green LED must be on on the front; the red LED must not be on.

All terminal screws – even those not in use – must be tightened.

If a test switch is available, then this must be in the operating position.

The protection relay is now ready for operation.
7 Maintenance and fault tracing

Siemens digital protection relays are designed to require no special maintenance. All measurement and signal processing circuits are fully solid state and therefore completely maintenance free. Input modules are even static, relays are hermetically sealed or provided with protective covers.

As the protection is almost completely self-monitored, hardware and software faults are automatically annunciated. This ensures the high availability of the relay and allows a more corrective rather than preventive maintenance strategy. Tests at short intervals become, therefore, superfluous.

With detected hardware faults the relay blocks itself; drop-off of the availability relay signals “equipment fault” (when marshalled).

Recognized software faults cause the processor to reset and restart. If such a fault is not eliminated by restarting, further restarts are initiated. If the fault is still present after three restart attempts the protective system will switch itself out of service and indicate this condition by the red LED “Blocked” on the front plate. Drop-off of the availability relay signals “equipment fault”.

7.1 Routine checks

Routine checks of characteristics or pick-up values are not necessary as they form part of the continuously supervised firmware programs. The planned maintenance intervals for checking and maintenance of the plant can be used to perform operational testing of the protection equipment. This maintenance serves mainly for checking the interfaces of the unit, i.e. the coupling with the plant. The following procedure is recommended:

- Read-out of operational values (addresses 5701 to 5705, block 84) and comparison with the actual values for checking the analog interfaces.

7.2 Fault tracing

If the protective device indicates a defect, the following procedure is suggested:

If none of the LEDs on the front plate of the module is on, then check:

- Has the module been properly pushed in and locked?

- Is the auxiliary voltage available with the correct polarity and of adequate magnitude, connected to the correct terminals (General diagrams in Appendix A)?

- Has the mini-fuse in the power supply section blown (see Figure 7.1)? If appropriate, replace the fuse according to Section 7.2.1.

If the red fault indicator “Blocked” on the front is on and the green ready LED remains dark, the device has recognized an internal fault. Re-initialization of the protection system could be tried by switching the d.c. auxiliary voltage off and on again. This, however, results in loss of fault data and messages and, if a parameterizing process has not yet been completed, the last parameters are not stored. Additionally, date and time must be set again (refer to Section 6.3.1.2).

⚠️ Warning

Hazardous voltages can be present on all circuits and components connected with the supply voltage or with the measuring and test quantities!

- Circuit breaker trip circuits are tested by actual live tripping. Respective notes are given in Section 6.6.4.
7.2.1 Replacing the mini-fuse

- Select a replacement fuse 5 x 20 mm. Ensure that the rated value, time lag (slow) and code letters are correct. (Figure 7.1).
- Prepare area of work: provide conductive surface for the module.
- Slip away the covers at top and bottom of the housing in order to gain access to the two fixing screws of the module. Unscrew these screws.

⚠️ Warning

Hazardous voltages can be present in the device even after disconnection of the supply voltage or after removal of the modules from the housing (storage capacitors)!
- Pull out the module by taking it at the front cover and place it on a surface which is suited to electrostatically endangered components (EEC);

⚠️ Caution!

Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface.
- Remove blown fuse from the holder (Figure 7.1).
- Fit new fuse into the holder (Figure 7.1).
- Insert draw-out module into the housing;
- Fix the module into the housing by tightening the two fixing screws.

Switch on the device again. If a power supply failure is still signalled, a fault or short-circuit is present in the internal power supply. The device should be returned to the factory (see Chapter 8).

---

Figure 7.1 Mini-fuse of the power supply

<table>
<thead>
<tr>
<th>at $U_{HN}/V$</th>
<th>rated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>24/48 Vdc</td>
<td>1.6 / 250 G</td>
</tr>
<tr>
<td>60/110/125 Vdc</td>
<td>1.0 / 250 G</td>
</tr>
<tr>
<td>220/250 Vdc/115 Vac</td>
<td>1.0 / 250 G</td>
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8 Repairs

Repair of defective modules is not recommended at all because specially selected electronic components are used which must be handled in accordance with the procedures required for Electrostatically Endangered Components (EEC). Furthermore, special manufacturing techniques are necessary for any work on the printed circuit boards in order to do not damage the bath-soldered multilayer boards, the sensitive components and the protective finish.

Therefore, if a defect cannot be corrected by operator procedures such as described in Chapter 7, it is recommended that the complete relay should be returned to the manufacturer. Use the original packaging for return. If alternative packing is used, this must provide the degree of protection against mechanical shock, as laid down in IEC 60255–21–1 class 2 and IEC 60255–21–2 class 1.

If it is unavoidable to replace individual modules, it is imperative that the standards related to the handling of Electrostatically Endangered Components are observed.

⚠️ Warning

Hazardous voltages can be present in the device even after disconnection of the supply voltage or after removal of the module from the housing (storage capacitors)!

⚠️ Caution!

Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface. This applies equally for the replacement of removable components, such as EPROM or EEPROM chips. For transport and returning of individual modules electrostatic protective packing material must be used.

Components and modules are not endangered as long as they are installed within the relay.

Should it become necessary to exchange any device or module, the complete parameter assignment should be repeated. Respective notes are contained in Chapter 5 and 6.

9 Storage

Solid state protective relays shall be stored in dry and clean rooms. The limit temperature range for storage of the relays or associated spare parts is −25 °C to +55 °C (refer Section 3.1.4 under the Technical data), corresponding to −12 °F to 130 °F.

The relative humidity must be within limits such that neither condensation nor ice forms.

It is recommended to reduce the storage temperature to the range +10 °C to +35 °C (50 °F to 95 °F); this prevents from early ageing of the electrolytic capacitors which are contained in the power supply.

For very long storage periods, it is recommended that the relay should be connected to the auxiliary voltage source for one or two days every other year, in order to regenerate the electrolytic capacitors. The same is valid before the relay is finally installed. In extreme climatic conditions (tropics) pre-warming would thus be achieved and condensation avoided.

Before initial energization with supply voltage, the relay shall be situated in the operating area for at least two hours in order to ensure temperature equalization and to avoid humidity influences and condensation.
Appendix

A General diagrams

B Voltage transformer circuits – Connection examples

C Operation structure, Tables
B Voltage transformer circuits – Connection examples

Figure B.1 Connection of one phase-to-phase voltage U and a displacement voltage Ux – “1phase” under address 7901

Figure B.2 Connection of two phase-to-phase voltages of one three-phase voltage transformer set (V – connection at the relay) – “2phase” under address 7901
Figure B.3  Connection to two phase-to-phase voltages of a voltage transformer set in V-connection – “2phase” under address 7901
C  Operation structure, Tables

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Table C.2  Annunciations for LSA (IEC 60870−5−103) ................................. 141

Table C.3  Annunciations for PC, LC-display, and binary inputs/outputs ................ 142

Table C.4  Reference table for functional parameters ........................................ 144

Table C.5  Reference table for configuration parameters ..................................... 149

**NOTE**: The following tables list all data which are available in the maximum complement of the device. Dependent on the ordered model, only those data may be present which are valid for the individual version.

**NOTE**: The actual tables are attached to the purchased relay.
Menu Structure of 7RW600

- **7RW600 V1.00**
- **PARAME.**
  - **00 CONF.**
    - **00 U<**
      - **00 U>**
      - **df/dt**
      - **00 f?><**
      - **00 U/f**
      - **00CIRsup**
      - **00 MEAS**
    - **01 POWER SYST.DAT**
      - **01 FREQ**
        - **01 Un**
        - **01 T-TRP**
    - **Ux< PROT.**
      - **15 Ux<**
      - **15 Ux<**
      - **15 T Ux<**
    - **U< PROT.**
      - **16 U<**
      - **16 U<**
      - **16 T U<**
    - **U> PROT.**
      - **17 U>**
      - **17 U>**
Annunciations 7RW600 for LSA (IEC 60870-5-103)

**FNo.** - Function number of annunciation  
**Op/Ft** - Operation/Fault annunciation  
  C/CG: Coming/Coming and Going annunciation  
  V : Annunciation with Value  
  M : Measurand  
**LSA No.** - Number of annunciation for former LSA (DIN 19244) - not applicable according to IEC 60870-5-103:  
**CA** - Compatible Annunciation  
**GI** - Annunciation for General Interrogation  
**BT** - Binary Trace for fault recordings  
**Typ** - Function type (p: according to the configured "Function type")  
**Inf** - Information number

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<th>LSA</th>
<th>IEC 60870-5-103</th>
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<td>Ft</td>
<td>CA</td>
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<tr>
<td>511</td>
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<td></td>
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</tr>
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<td></td>
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<td>Voltage at input Ux [%] =</td>
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Annunciations 7RW600 for PC, LC-display and binary inputs/outputs

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## Reference Table for Functional Parameters 7RW600

### PARAME. - PARAMETER SETTINGS

<table>
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<tr>
<th>00 CONF. - SCOPE OF FUNCTIONS</th>
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<td>00 U&lt; Undervoltage protection</td>
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<td><strong>EXIST</strong> [ ] Existent</td>
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<td><strong>nonEXIST</strong> [ ] Non-existent</td>
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<td>00 U&gt; Overvoltage protection</td>
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<td><strong>EXIST</strong> [ ] Existent</td>
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<tr>
<td><strong>nonEXIST</strong> [ ] Non-existent</td>
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<td>df/dt Rate-of-frequency-change protection</td>
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<td><strong>EXIST</strong> [ ] Existent</td>
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<td><strong>nonEXIST</strong> [ ] Non-existent</td>
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<td>00 f&gt;&lt; Frequency protection</td>
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<td><strong>EXIST</strong> [ ] Existent</td>
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<td>00 U/f Overflux protection</td>
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<td><strong>EXIST</strong> [ ] Existent</td>
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<td><strong>nonEXIST</strong> [ ] Non-existent</td>
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<tr>
<td>00CIRsup Trip circuit supervision</td>
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<td><strong>nonEXIST</strong> [ ] Non-existent</td>
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<tr>
<td>with 2BI [ ] No resist., 2 BI</td>
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<tr>
<td>bypass-R [ ] bypass resistor, 1 BI</td>
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<tr>
<td>00 MEAS Measurement mode</td>
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<td>1phase [ ] single-phase</td>
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<td>2phase [ ] two-phase</td>
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### 01 POWER SYST.DAT - POWER SYSTEM DATA

<table>
<thead>
<tr>
<th>01 FREQ Rated system frequency</th>
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<tr>
<td>50 Hz [ ] fN 50 Hz</td>
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<td>60 Hz [ ] fN 60 Hz</td>
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<tr>
<td>01 Un Secondary rated voltage</td>
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<td>min. 100 [ ] V</td>
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<tr>
<td>max. 125 [ ] V</td>
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<td>01 T-TRP Minimum trip command duration</td>
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<tr>
<td>min. 0.01 [ ] s</td>
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<tr>
<td>max. 60.00 [ ] s</td>
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### 15 Ux< PROT. - UNDERVOLTAGE PROTECTION Ux<

<table>
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<tr>
<th>15 Ux&lt; State of the undervoltage protection Ux&lt;</th>
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</thead>
<tbody>
<tr>
<td>OFF [ ] off</td>
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<tr>
<td>ON [ ] on</td>
</tr>
<tr>
<td>15 Ux&lt; Pick-up value of the Ux&lt; stage</td>
</tr>
<tr>
<td>min. 20 [ ] V</td>
</tr>
<tr>
<td>max. 120 [ ] V</td>
</tr>
</tbody>
</table>
15 T Ux<  
Time delay for trip Ux<  
min. 0.00 s  
max. 60.00/∞

16 U< PROT. - UNDERVERVOLTAGE PROTECTION  
16 U<  
State of the undervoltage protection  
OFF [ ] off  
ON [ ] on  
16 U<  
Pick-up value of the U< protection  
min. 20 V  
max. 120  
16 T U<  
Time delay for trip U<  
min. 0.00 s  
max. 60.00/∞

17 U> PROT. - OVERVOLTAGE PROTECTION  
17 U>  
State of the overvoltage protection  
OFF [ ] off  
ON [ ] on  
17 U>  
Pick-up value of the U> stage  
min. 20 V  
max. 170  
17 T U>  
Time delay for trip U>  
min. 0.00 s  
max. 60.00/∞

18 Ux> PROT. - OVERVOLTAGE PROTECTION Ux>  
18 Ux>  
State of the overvoltage protection Ux>  
OFF [ ] off  
ON [ ] on  
18 Ux>  
Pick-up value of the Ux> stage  
min. 10 V  
max. 170  
18 T Ux>  
Time delay for trip Ux>  
min. 0.00 s  
max. 60.00/∞

18 Ux>>  
Pick-up value of the Ux>> stage  
min. 10 V  
max. 170  
18 T Ux>>  
Time delay for trip Ux>>  
min. 0.00 s  
max. 60.00/∞
20 df/dt PROT. - RATE-OF-FREQUENCY-CHANGE PROTECTION

20 df/dt
OFF [ ] off
ON [ ] on

20 df1
Pick-up value of the df1/dt stage
min. 1.0 Hz/s
max. 10.0 Hz/s

20 T df1
Time delay for trip df1/dt
min. 0.00 s
max. 20.00 s

20 df1&f
State of AND-combination with fault f1
OFF [ ] off
ON [ ] on

20 df2
Pick-up value of the df2/dt stage
min. 1.0 Hz/s
max. 10.0 Hz/s

20 T df2
Time delay for trip df2/dt
min. 0.00 s
max. 20.00 s

20 df2&f
State of AND-combination with fault f2
OFF [ ] off
ON [ ] on

20 df3
Pick-up value of the df3/dt stage
min. 1.0 Hz/s
max. 10.0 Hz/s

20 T df3
Time delay for trip df3/dt
min. 0.00 s
max. 20.00 s

20 df3&f
State of AND-combination with fault f3
OFF [ ] off
ON [ ] on

20 df4
Pick-up value of the df4/dt stage
min. 1.0 Hz/s
max. 10.0 Hz/s

20 T df4
Time delay for trip df4/dt
min. 0.00 s
max. 20.00 s

20 df4&f
State of AND-combination with fault f4
OFF [ ] off
ON [ ] on

20 BL U<
Min. voltage for rate-of-freq.-change prot.
min. 20 V
max. 100 V
21 f<> PROT. - OVER/UNDER-FREQUENCY PROTECTION

State of the frequency protection
- OFF [ ] off
- ON [ ] on

Pick-up value for stage f1
- min. 40.00 Hz
- max. 68.00

Time delay for trip f1 stage
- min. 0.00 s
- max. 60.00/

Pick-up value for stage f2
- min. 40.00 Hz
- max. 68.00

Time delay for trip f2 stage
- min. 0.00 s
- max. 60.00/

Pick-up value for stage f3
- min. 40.00 Hz
- max. 68.00

Time delay for trip f3 stage
- min. 0.00 s
- max. 60.00/

Pick-up value for stage f4
- min. 40.00 Hz
- max. 68.00

Time delay for trip f4 stage
- min. 0.00 s
- max. 60.00/

Minimum operating voltage for frequency prot.
- min. 20 V
- max. 100/

29 U/f PROT. - OVERFLUX PROTECTION U/f>

State of the overflux protection
- OFF [ ] off
- ON [ ] on

Pick-up value warning stage U/f>
- min. 1.00
- max. 1.20

Time delay for warning stage
- min. 0.00 s
- max. 60.00/

Pick-up value for trip U/f>>
- min. 1.00
- max. 1.40

Time delay for trip U/f>>
- min. 0.00 s
- max. 60.00/
29 t1.10  
min. 0  
max. 20000

Time delay for trip at (U/Un)/(f/fn)=1.10 s

29 t1.15  
min. 0  
max. 20000

Time delay for trip at (U/Un)/(f/fn)=1.15 s

29 t1.20  
min. 0  
max. 20000

Time delay for trip at (U/Un)/(f/fn)=1.20 s

29 t1.25  
min. 0  
max. 20000

Time delay for trip at (U/Un)/(f/fn)=1.25 s

29 t1.30  
min. 0  
max. 20000

Time delay for trip at (U/Un)/(f/fn)=1.30 s

29 t1.35  
min. 0  
max. 20000

Time delay for trip at (U/Un)/(f/fn)=1.35 s

29 t1.40  
min. 0  
max. 20000

Time delay for trip at (U/Un)/(f/fn)=1.40 s

29 T RES  
min. 0  
max. 20000

Time for cool down

29 k ad  
min. 0.50  
max. 2.00

Adaption factor

39 CIRsup - TRIP CIRCUIT SUPERVISION

39 CIRsup  
ON [ ] on  
OFF [ ] off

Trip circuit supervision
# Reference Table for Configuration Parameters 7RW600

## 60 MARSH - MARSHALLING

### 61 MARSH BIN.INP - MARSHALLING BINARY INPUTS

#### 61 MARSH BI 1 - MARSHALLING OF BINARY INPUT 1

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<th>Binary Input 1</th>
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<td>61BI1 5</td>
<td>5th Function</td>
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<td>6th Function</td>
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<td>61BI1 7</td>
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#### 61 MARSH BI 2 - MARSHALLING OF BINARY INPUT 2

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61BI2 4  BINARY INPUT 2 4th FUNCTION

61BI2 5  BINARY INPUT 2 5th FUNCTION

61BI2 6  BINARY INPUT 2 6th FUNCTION

61BI2 7  BINARY INPUT 2 7th FUNCTION

61BI2 8  BINARY INPUT 2 8th FUNCTION

61BI2 9  BINARY INPUT 2 9th FUNCTION

61BI2 10 BINARY INPUT 2 10th FUNCTION

61 MARSH BI 3 - MARSHALLING OF BINARY INPUT 3

61BI3 1  BINARY INPUT 3 1st FUNCTION

61BI3 2  BINARY INPUT 3 2nd FUNCTION

61BI3 3  BINARY INPUT 3 3rd FUNCTION

61BI3 4  BINARY INPUT 3 4th FUNCTION

61BI3 5  BINARY INPUT 3 5th FUNCTION

61BI3 6  BINARY INPUT 3 6th FUNCTION

61BI3 7  BINARY INPUT 3 7th FUNCTION

61BI3 8  BINARY INPUT 3 8th FUNCTION

61BI3 9  BINARY INPUT 3 9th FUNCTION
MARSH RELAY - MARSHALLING OF OUTPUT RELAYS

62 RELAY 3 - MARSHALLING OF OUTPUT RELAY 3

62REL3 1  RELAY 3 1st CONDITION

62REL3 2  RELAY 3 2nd CONDITION

62REL3 3  RELAY 3 3rd CONDITION

62REL3 4  RELAY 3 4th CONDITION

62REL3 5  RELAY 3 5th CONDITION

62REL3 6  RELAY 3 6th CONDITION

62REL3 7  RELAY 3 7th CONDITION

62REL3 8  RELAY 3 8th CONDITION

62REL3 9  RELAY 3 9th CONDITION

62REL310 RELAY 3 10th CONDITION

62REL311 RELAY 3 11th CONDITION

62REL312 RELAY 3 12th CONDITION

62REL313 RELAY 3 13th CONDITION

62REL314 RELAY 3 14th CONDITION

61BI3 10  BINARY INPUT 3 10th FUNCTION
62REL315 RELAY 3 15th CONDITION

62REL316 RELAY 3 16th CONDITION

62REL317 RELAY 3 17th CONDITION

62REL318 RELAY 3 18th CONDITION

62REL319 RELAY 3 19th CONDITION

62REL320 RELAY 3 20th CONDITION

62 MARSH REL 4 - MARSHALLING OF OUTPUT RELAY 4

62REL4 1 RELAY 4 1st CONDITION

62REL4 2 RELAY 4 2nd CONDITION

62REL4 3 RELAY 4 3rd CONDITION

62REL4 4 RELAY 4 4th CONDITION

62REL4 5 RELAY 4 5th CONDITION

62REL4 6 RELAY 4 6th CONDITION

62REL4 7 RELAY 4 7th CONDITION

62REL4 8 RELAY 4 8th CONDITION

62REL4 9 RELAY 4 9th CONDITION
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<thead>
<tr>
<th>63 MARSH LED 2 - MARSHALLING OF LED INDICATOR 2</th>
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<tr>
<td>63LED2 1</td>
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<td>----------</td>
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<tr>
<td>63LED2 2</td>
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<td>63LED2 3</td>
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<td>63LED2 6</td>
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<td>63LED2 7</td>
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</tbody>
</table>
63LED2 8  LED 2 8th CONDITION

63LED2 9  LED 2 9th CONDITION

63LED210  LED 2 10th CONDITION

63LED211  LED 2 11th CONDITION

63LED212  LED 2 12th CONDITION

63LED213  LED 2 13th CONDITION

63LED214  LED 2 14th CONDITION

63LED215  LED 2 15th CONDITION

63LED216  LED 2 16th CONDITION

63LED217  LED 2 17th CONDITION

63LED218  LED 2 18th CONDITION

63LED219  LED 2 19th CONDITION

63LED220  LED 2 20th CONDITION

63 LED 3 - MARSHALLING OF LED INDICATOR 3

63LED3 1  LED 3 1st CONDITION

63LED3 2  LED 3 2nd CONDITION
<table>
<thead>
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<tr>
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<td>LED 3 3rd CONDITION</td>
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<tr>
<td>63LED3 4</td>
<td>LED 3 4th CONDITION</td>
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<tr>
<td>63LED3 5</td>
<td>LED 3 5th CONDITION</td>
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<tr>
<td>63LED3 6</td>
<td>LED 3 6th CONDITION</td>
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<tr>
<td>63LED3 7</td>
<td>LED 3 7th CONDITION</td>
</tr>
<tr>
<td>63LED3 8</td>
<td>LED 3 8th CONDITION</td>
</tr>
<tr>
<td>63LED3 9</td>
<td>LED 3 9th CONDITION</td>
</tr>
<tr>
<td>63LED310</td>
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</tr>
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<td>63LED311</td>
<td>LED 3 11th CONDITION</td>
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<td>63LED312</td>
<td>LED 3 12th CONDITION</td>
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63 MARSH LED 4 - MARSHALLING OF LED INDICATOR 4

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63LED414  LED 4 14th CONDITION

63LED415  LED 4 15th CONDITION

63LED416  LED 4 16th CONDITION

63LED417  LED 4 17th CONDITION

63LED418  LED 4 18th CONDITION

63LED419  LED 4 19th CONDITION

63LED420  LED 4 20th CONDITION

64 MARSH CMD.REL - MARSHALLING TRIP RELAYS

64 MARSH CMD.RE 1 - MARSHALLING OF COMMAND RELAY 1

64CMD1 1  COMMAND RELAY 1 1st CONDITION

64CMD1 2  COMMAND RELAY 1 2nd CONDITION

64CMD1 3  COMMAND RELAY 1 3rd CONDITION

64CMD1 4  COMMAND RELAY 1 4th CONDITION

64CMD1 5  COMMAND RELAY 1 5th CONDITION

64CMD1 6  COMMAND RELAY 1 6th CONDITION

64CMD1 7  COMMAND RELAY 1 7th CONDITION

64CMD1 8  COMMAND RELAY 1 8th CONDITION
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<td>64CMD113</td>
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<td>64CMD118</td>
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### 71 INT.OP - INTEGRATED OPERATION

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<thead>
<tr>
<th>LANGUA</th>
<th>Language</th>
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<tbody>
<tr>
<td>ENGLISH</td>
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<td>DEUTSCH</td>
<td>[ ] German</td>
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<tr>
<td>FRANCAIS</td>
<td>[ ] French</td>
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<tr>
<td>ESPANOL</td>
<td>[ ] Spanish</td>
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### 72 INTERFACE - PC AND SYSTEM INTERFACES

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>Device address</th>
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<tr>
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<th>FEEDER</th>
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<table>
<thead>
<tr>
<th>F-TYPE</th>
<th>Function type in accordance with VDEW/ZVEI</th>
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<td>max. 254</td>
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<thead>
<tr>
<th>PC-INT</th>
<th>Data format for PC-interface</th>
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<td>DIGSI V3</td>
<td>[ ] DIGSI V3</td>
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<tr>
<td>ASCII</td>
<td>[ ] ASCII</td>
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<tr>
<td>VDEW ext</td>
<td>[ ] VDEW extended</td>
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<th>GAPS</th>
<th>Transmission gaps for PC-interface</th>
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<td>min. 0.0</td>
<td>max. 5.0</td>
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<table>
<thead>
<tr>
<th>PCBAUD</th>
<th>Transmission baud rate for PC-interface</th>
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<tr>
<td>9600 BAUD</td>
<td>[ ] 9600 Baud</td>
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<tr>
<td>19200 BD</td>
<td>[ ] 19200 Baud</td>
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<tr>
<td>1200 BAUD</td>
<td>[ ] 1200 Baud</td>
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<tr>
<td>2400 BAUD</td>
<td>[ ] 2400 Baud</td>
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<tr>
<td>4800 BAUD</td>
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</table>

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<thead>
<tr>
<th>PARITY</th>
<th>Parity and stop-bits for PC-interface</th>
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<td>DIGSI V3</td>
<td>[ ] DIGSI V3</td>
</tr>
<tr>
<td>8O1</td>
<td>[ ] Odd parity, 1 stopbit</td>
</tr>
<tr>
<td>8N1</td>
<td>[ ] No parity, 2 stopbits</td>
</tr>
<tr>
<td>8N1</td>
<td>[ ] No parity, 1 stopbit</td>
</tr>
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### 74 FAULT RECORDER - FAULT RECORDINGS

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<tr>
<th>RECini</th>
<th>Initiation of data storage</th>
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<tr>
<td>RECbyFT</td>
<td>[ ] Storage by fault det</td>
</tr>
<tr>
<td>RECbyTP</td>
<td>[ ] Storage by trip</td>
</tr>
<tr>
<td>SRTwitTP</td>
<td>[ ] Start with trip</td>
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<table>
<thead>
<tr>
<th>T-MAX</th>
<th>Maximum time period of a fault recording</th>
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</table>

<table>
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<tr>
<th>T-PRE</th>
<th>Pre-trigger time for fault recording</th>
</tr>
</thead>
<tbody>
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<td>min. 0.05</td>
<td>max. 5.00</td>
</tr>
</tbody>
</table>
### T-POS

- **Post-fault time for fault recording**
- **min.** 0.05 s
- **max.** 5.00 s

### VALUE

- **Fault values**
  - INST. [ ] Instantaneous values
  - R.M.S. [ ] R.M.S. values

### SYST SETTING - OPERATING SYSTEM SETTINGS

- **TEST**
  - Activating internal test
  - NONE [ ] none
  - withREPO [ ] With report
  - BUF-OVFL [ ] Err.buf.overfl=moni

- **MODUL**
  - Number of tested module
  - min. 0
  - max. 100
To

SIEMENS AKTIENGESELLSCHAFT
Dept. EV S SUP 21
D-13623 BERLIN
Germany

Dear reader,

printing errors can never be entirely eliminated: therefore, should you come across any when reading this manual, kindly enter them in this form together with any comments or suggestions for improvement that you may have.

From

Name

Company/Dept.

Address

Telephone no.
Substantial alterations against previous issue:

Errors corrected in section 3.1.2

Additional table C.2 in Appendix C