SIEMENS

Numerical Machine Protection

7UM515 V3.1

Instruction Manual Order No. C53000–G1176–C111–3

– Overflux protection	U/f>
– Voltage protection	U><
– Stator earth fault 100 % protection	$R_{E<}$
– Earth fault protection	$U_0>$
– Frequency protection	f><
– Interturn fault protection	$U_{IT}>$
– Rotor earth fault protection	$R_E<$

Figure 1 Illustration of the numerical machine protection 7UM515 (in housing for surface mounting)

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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 50081–2 and EN 50082–2 (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).

Contents

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 7UM515 is a numerical machine protection unit from the “Numerical Machine Protection series 7UM51” and provides a practical combination of protection functions for electrical machines or power station blocks.

The unit supplements the protection and supervisory functions of the 7UM511 and 7UM512 relays and, together, they provide a complete protection system for large generators which are block connected with a unit transformer to the power system. It is, however, completely autonomous and can, with all its functions, be operated completely independent of other protection equipment.

Further units of its series offer additional functions which satisfy the requirements for up to the largest machines. A survey of this machine protection series is shown in Figure 1.1.

A large number of alarm relays and LED‘s on the front panel of the unit provide information about the detected faults, the monitored operating conditions of the protected machine and about the unit itself. Five trip relays are available for direct tripping of circuit breakers and other control devices.

Space-saving construction and sensible mounting and connection techniques permit easy exchange with conventional protection equipment in existing plants. Comprehensive internal monitoring of hardware and software reduces the time required for testing and provides an extremely high availability of the protection system.

Serial interfaces allow comprehensive communication with other digital control and storage devices. For data transmission a standardized protocol according VDEW/ZVEI and IEC 60870–5–103 is used, as well as in accordance with DIN 19244. The device can therefore be incorporated in Localized Substation Automation networks (LSA). The system interface is suited to communication via a modem link.

1.2 Features

- Processor system with powerful 16–bit–microprocessor;
- complete digital measured value processing and control from data acquisition and digitizing of the measured values up to the trip decision for the circuit breakers;
- complete galvanic and reliable separation of the internal processing circuits from the measurement, control and supply circuits of the system, with screened analog input transducers, binary input and output modules and d.c/d.c converter;
- insensitive to v.t. and c.t. errors, transient conditions and interferences;
- large frequency range (part functions operate above 11 Hz): therefore also operative during run-up and shutting down of the generator;
- continuous calculation of operational measured values and indication on the front display;
- 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;
- communication with central control and storage devices via serial interfaces is possible, optionally with 2 kV insulation or for connection of optical fibre;
- continuous monitoring of the measured values and the hardware and software of the relay.

7UM511

- Underexcitation protection
- Overvoltage protection, two-stage
- Undervoltage protection
- Stator earth fault protection U_0>
- Frequency protection, four-stage
- Forward power supervision
- Reverse power protection
- Unbalanced load protection
- Overcurrent time protection, two-stage
- High-sensitivity earth current protection
- Thermal stator overload protection
- Four external trip signals can be processed
- Two trip circuit supervision channels

7UM512

- Overvoltage protection and frequency dependent undervoltage protection
- Earth fault protection U_0>, I_0> directional
- Frequency protection, two-stage
- Single-phase power protection
- Unbalanced load protection
- Overcurrent time protection with undervoltage seal-in
- Overcurrent/undercurrent supervision
- Rotor earth fault protection, two-stage
- D.C. voltage time protection
- Four external trip signals can be processed
- Two trip circuit supervision channels

7UM515

- Overflux protection U/f
- Undervoltage protection, inverse time
- Overvoltage protection, two-stage
- Stator earth fault 100 % protection
- Earth fault protection U_0>
- Frequency protection, four-stage
- Interturn fault protection
- Rotor earth fault protection, two-stage
- Four external trip signals can be processed
- Two trip circuit supervision channels

7UM516

- Impedance protection
- Power swing blocking
- Stator earth fault protection U_0>
- Out-of-step protection
- Forward power supervision
- Reverse power protection
- Unbalanced load protection
- Four external trip signals can be processed
- Two trip circuit supervision channels

7UT512

- Differential protection for generators and motors
- or
- Differential protection for two-winding transformers or units
- Overcurrent time protection
- Thermal overload protection
- Two external trip signals can be processed
- (2 trip relays, small size: $^1/_3$ case)

7UT513

- Differential protection for generators and motors
- or
- Differential protection for three-winding transformers or units
- Restricted earth fault protection or
- Tank leakage protection
- Overcurrent time protection
- Thermal overload protection
- Two external trip signals can be processed
- (5 trip relays, large size: $^1/_2$ case)

Figure 1.1 Survey of the numerical machine protection series

1.3 Implemented functions

The protective and supervisory functions of the numerical machine protection unit can be individually switched to be operative or inoperative. The unit comprises the following functions:

Overflux protection

– calculation of the ratio U/f,

– calculation of the thermal stress,

– standard characteristics or either optional characteristic selectable,

– adjustable warning and tripping stage.

Overvoltage and undervoltage protection

– two-stage overvoltage detection,

– separate undervoltage detection,

– undervoltage protection with settable voltage-time characteristic.

Stator earth fault 100 % protection

– protection of the entire stator winding (protective range 100 %),

– stator winding is biased with a very small voltage (approx. 1 % of rated voltage),

– operating frequency 20 Hz, machine voltage has therefore insignificant influence on the measurement,

– warning and tripping stage are adjusted directly in ohms of the stator earth resistance, related to the terminals of the relay.

Earth fault protection U_0

– connection to a line connected earthing transformer or neutral earthing transformer,

– protective range 90 % to 95 % of the stator windings,

– measurement of the displacement voltage with fundamental wave filters, for machines in block connection.

Frequency protection

– supervision of underfrequency (f<) and/or overfrequency (f>) with four individually adjustable frequency limits,

– insensitive against harmonic content and phase jumps in the measured quantities,

– adjustable undervoltage blocking,

– adjustable number of measurement repetitions.

Interturn fault protection

– highly sensitive measurement of the displacement voltage caused by interturn faults,

– suppression of harmonic content in the measuring quantity.

Rotor earth fault protection

– protection range of the entire excitation circuit (100 % protection range),

– excitation circuit is biased by a small d.c. voltage which is reversed by a automatic control circuit,

– insignificant influence of rotor earth capacitance,

– insignificant influence of a.c. voltages contained in the excitation circuit,

– calculation of very high-ohmic earth resistances is possible,

– warning and tripping stage are adjusted directly in ohms of the rotor earth resistance,

– measurement circuit supervision and alarm in case of disturbances,

– processing of the measured quantities of an external rotating protection is possible.

Coupling of external binary signals

– for processing or re-transmitting of external signals or commands,

– connection to signal relays, LEDs, and via serial interface to localized substation control and monitoring facility (e.g. LSA).

Coupling of external trip signals

– combining up to 4 externals signal into the annunciation processing,

– tripping by up to 4 external signals via the integrated trip matrix,

– time delay possible.

Integrated tripping matrix

– with 5 trip relays (each with 2 NO contacts) for up to 20 protection commands.

Integrated trip test

– initiation of live tripping by the operator panel or via the operating interface.

Integrated trip circuit supervision

– detection of interruptions, short-circuits and voltage failure for two tripping circuits.

2 Design

2.1 Arrangements

All protection functions including dc/dc converter are accommodated on two plug-in modules of Double Europa Format. These modules are installed in a housing 7XP20. Two different types of housings can be delivered:

– **7UM515★–★B★★★–** in housing 7XP2040–1 for **panel surface mounting**

  The housing has full sheet-metal covers, as well as a removable front cover with transparent plastic window.

  Plastic guide rails are built in for the support of plug-in modules. Next to the guide rail at the bottom on the left-hand side of each module, a contact area which is electrically connected to the housing is installed to mate with the earthing spring of the module. Connection to earth is made before the plugs make contact. Earthing screws have been provided on the left hand side of the housing. Additionally, terminal 26 is connected to the case.

  All external signals are connected to 100 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.

  The heavy duty current plug connectors provide automatic shorting of the c.t. circuits whenever the module is withdrawn. This does not release from the care to be taken when c.t. secondary circuits are concerned.

  For the isolated interface to a central control and storage unit, an additional coupling facility has been provided. For the hard-wired V.24 (RS232C) serial interface (model 7UM515★–★★★★★–★**B**), 4 screwed terminals are provided. For the interface for optical fibre connection (model 7UM515★–★★★★★–★**C**), two F–SMA connectors have been provided.

  The degree of protection for the housing is IP51, for the terminals IP21. For dimensions please refer to Figure 2.2.

– **7UM515★–★C★★★–** in housing 7XP2040–2 for **panel flush mounting** or **7UM515★–★E★★★** for **cubicle installation**

  The housing has full sheet-metal covers, as well as a removable front cover with transparent plastic window.

  Plastic guide rails are built in for the support of plug-in modules. Next to the guide rail at the bottom on the left-hand side of each module, a contact area which is electrically connected to the housing is installed to mate with the earthing spring of the module. Connection to earth is made before the plugs make contact. Earthing screws have been provided on the rear wall of the housing.

  All external signals are connected to connector modules which are mounted on the rear cover over cutouts. For each electrical connection, one screwed terminal 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.

  The heavy duty current plug connectors provide automatic shorting of the c.t. circuits whenever the module is withdrawn. This does not release from the care to be taken when c.t. secondary circuits are concerned.

  The plug modules are labelled according to their mounting position by means of a grid system (e.g. **1A**2). The individual connections within a module are numbered consecutively from left to right (when viewed from the rear), (e.g. 1A**2**); refer to Figure 2.1.

  The isolated interface to a central control and storage unit (7UM515★–★★★★★–★**B**) is led to a 4-pole connection module. In the interface for optical fibre connection (7UM515★–★★★★★– ★**C**), a module with 2 F–SMA connectors is provided instead.

  Degree of protection for the housing is IP51 (for cubicle installation IP 30), for the terminals IP21. For dimensions please refer to Figure 2.3.

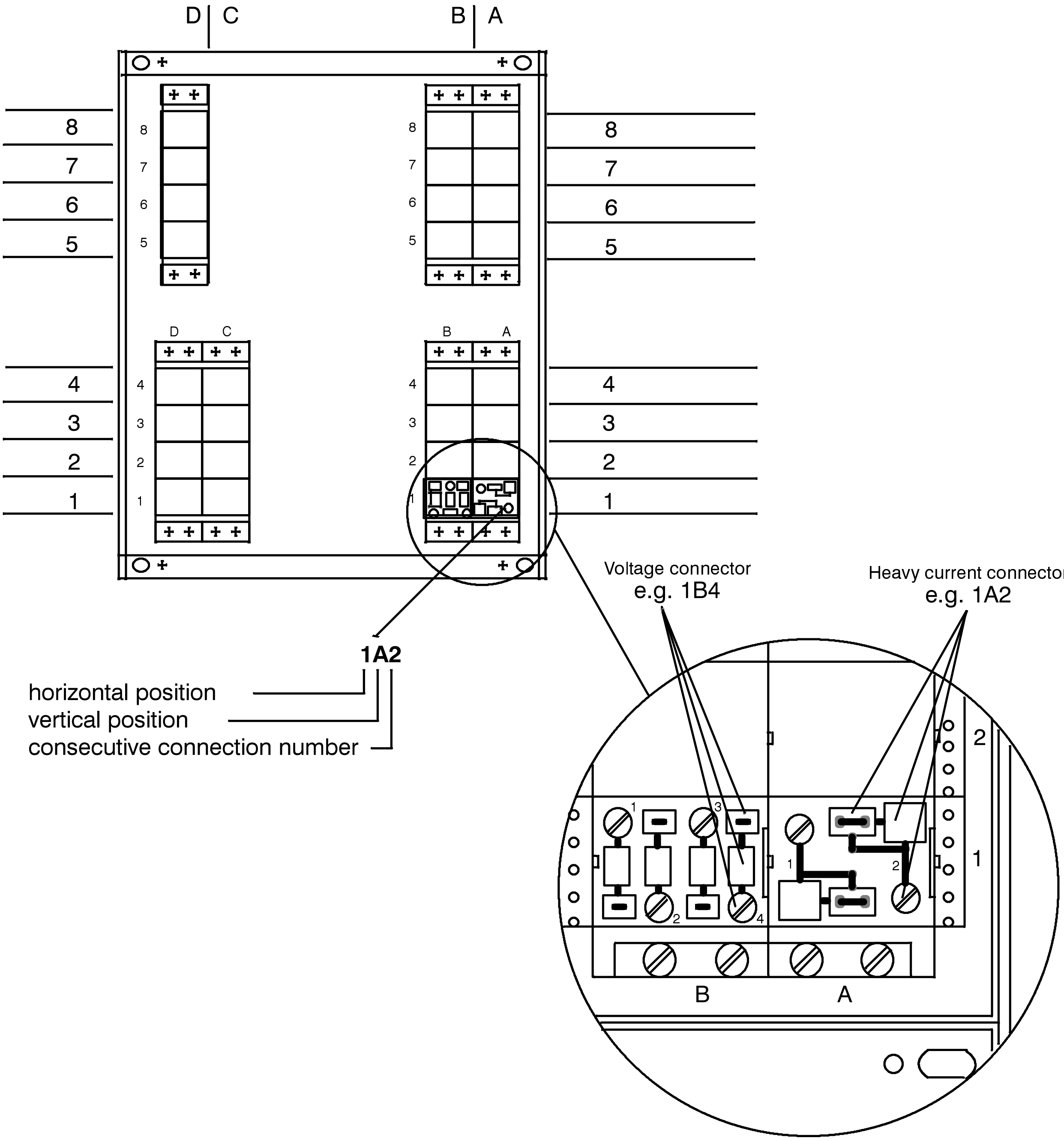
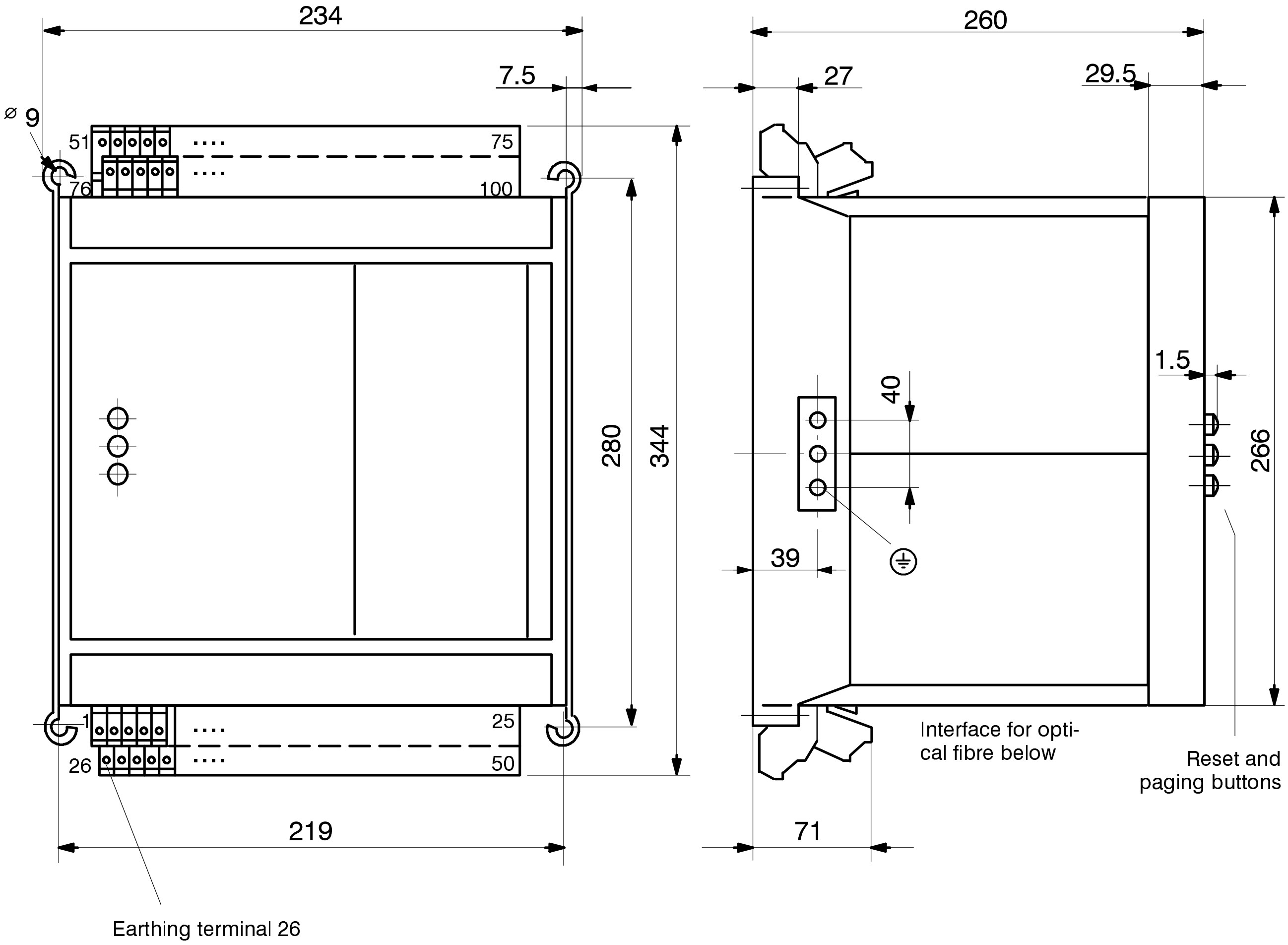


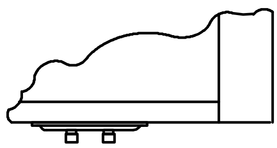
Figure 2.1 Connection plugs (rear view) – housing for flush mounting – example

2.2 Dimensions

Figures 2.2 and 2.3 show the dimensions of the various types of housings available.

7UM515 Housing for **panel surface mounting** 7XP2040 − 1





Optical fibre connectors:
integrated F−SMA connector
with ceramic post,
e.g for glass fibre 62.5/125 μm

Max. 100 terminals for cross-section max. 5 mm^2
Max. torque value 1.7 Nm or 15 in-lb

Dimensions in mm

Figure 2.2 Dimensions for housing 7XP2040 − 1 for panel surface mounting

7UM515 Housing for **panel flush mounting** or **cubicle installation** 7XP2040−2

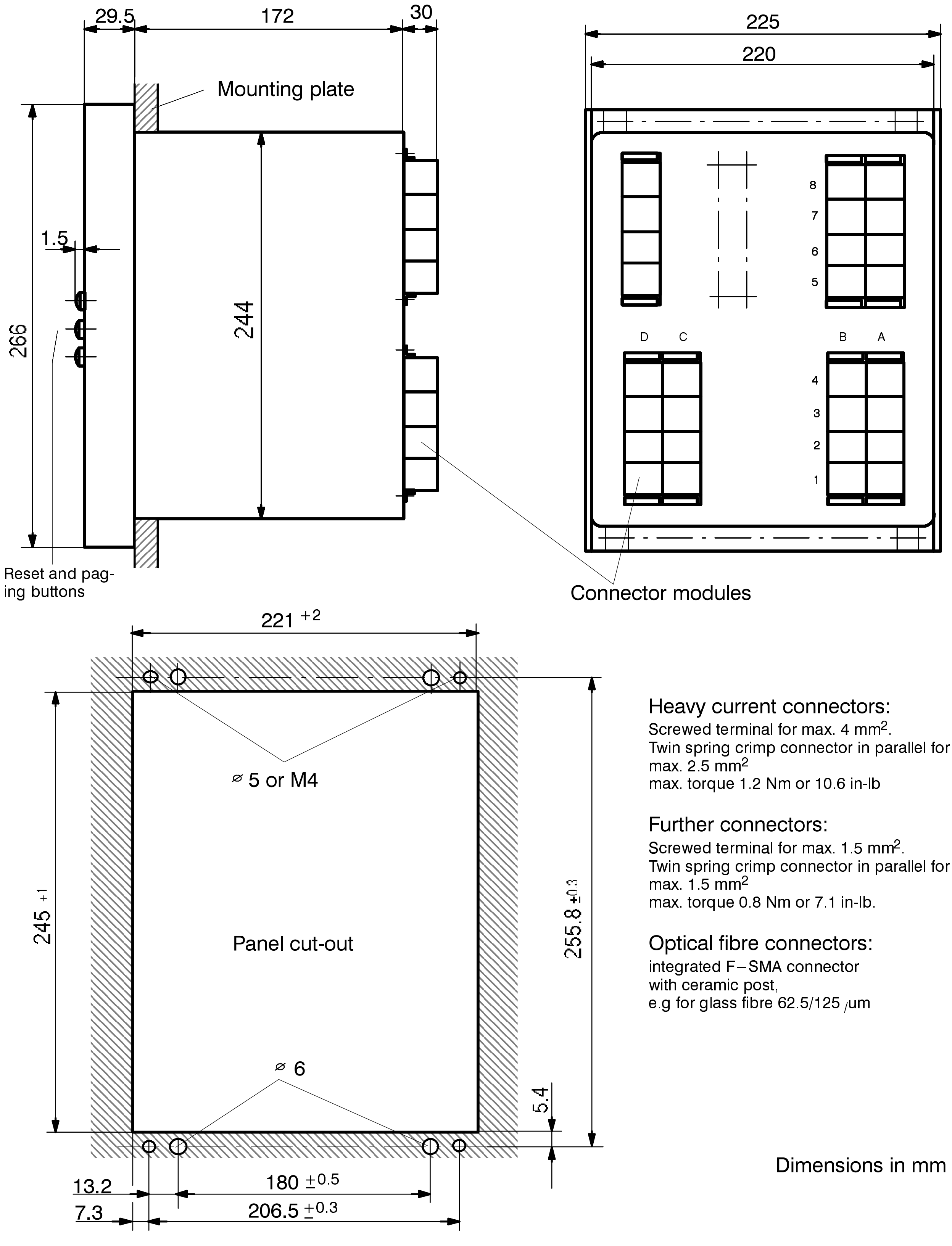


Figure 2.3 Dimensions for housing 7XP2040−2 for panel flush mounting or cubicle installation

2.3 Ordering data

Numerical Machine Protection

			8.	9.	10.	11.	12.		13.	14.	15.	16.
7 U M 5 1 5	0	–			B	0	1	–	0		A	0

Auxiliary voltage (position 8)

24/48 V dc 2

60/110/125 V dc 4

220/250 V dc 5

Construction (position 9)

in housing 7XP20 for panel surface mounting . . . . B

in housing 7XP20 for panel flush mounting
or cubicle installation C

in housing 7XP20 for cubicle installation
(without glass front) . . . . E

Serial interface for coupling to a control centre (position 14)

isolated serial interface (similar V.24 or RS 232 C) . . . . B

serial interface for optical fibre connection C

2.4 Accessories

The measurement input for the neutral displacement voltage measurement of the earth fault protection U_0 is dimensioned for a rated voltage of 100 V. A voltage divider 500 V/100 V is used when connecting to a neutral earthing transformer or a line connected earthing transformer with a secondary voltage of 500 V. The **voltage divider 500 V/100 V** type **3PP1336--1CZ–013001** is suitable and also includes a test resistor. Refer to Figure 2.4 for schematic circuit diagram and to Figure 2.10 for dimensions.

The measurement input for the displacement voltage measurement of the stator earth fault 100 % protection is dimensioned for a rated voltage of 200 V. A voltage divider 500 V/200 V is used when connecting to a neutral earthing transformer or a line connected earthing transformer with a secondary voltage of 500 V. The **voltage divider** type **3PP1336--1CZ–013001** is suitable, too. It contains different tappings, one for **500 V/200 V**. Refer to Figure 2.4 for schematic circuit diagram and to Figure 2.10 for dimensions.

The bias voltage of the stator earth fault 100 % protection is produced by the **20 Hz generator 7XT3300**. Refer to Figure 2.5 for schematic circuit diagram and to Figure 2.11 for dimensions.

The **band–pass filter 7XT3400** is tuned to 20 Hz and must be located in the circuitry between the 20 Hz generator and the load resistor. Refer to Figure 2.6 for schematic circuit diagram and to Figure 2.12 for dimensions.

The 20 Hz measurement current for stator earth fault 100 % protection is transformed by an **intermediate current transformer**, e.g **400 A/5 A**, type **4NC1225–2CK20**. Refer to Figure 2.13 for dimensions.

The excitation circuit is biased by a voltage generated in the **controller unit 7XT7000--0B** (Refer to Figure 2.7 for schematic circuit diagram and to Figure 2.14 for dimensions) or in the **controller unit 7XT7100--0*A00** (Refer to Figure 2.8 for schematic circuit diagram and to Figure 2.15 for dimensions for panel surface mounting or to Figure 2.16 for dimensions for panel flush mounting.

The bias voltage is coupled into the rotor circuit by the **coupling unit 2 x 40 kΩ**. Two types are available: Type **7XR6002** with test voltage 4.5 kV or type **7XR6003** with test voltage 6 kV. Schematic circuit diagram (refer to Figure 2.9) and dimensions (refer to Figure 2.10) are equal for both types.

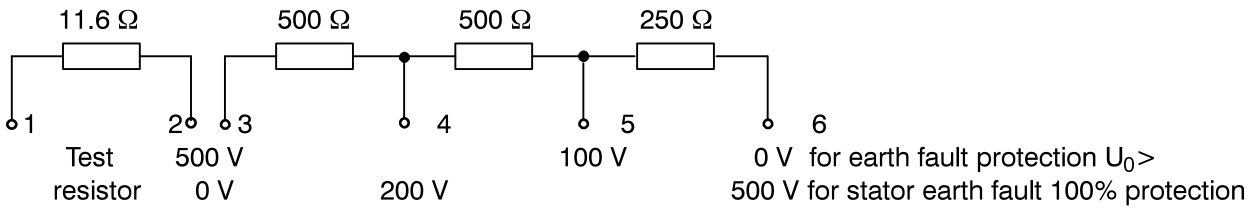


Figure 2.4 Schematic diagram of voltage divider 500 V/100 V or 500 V/200 V, type 3PP1336–1CZ–013001

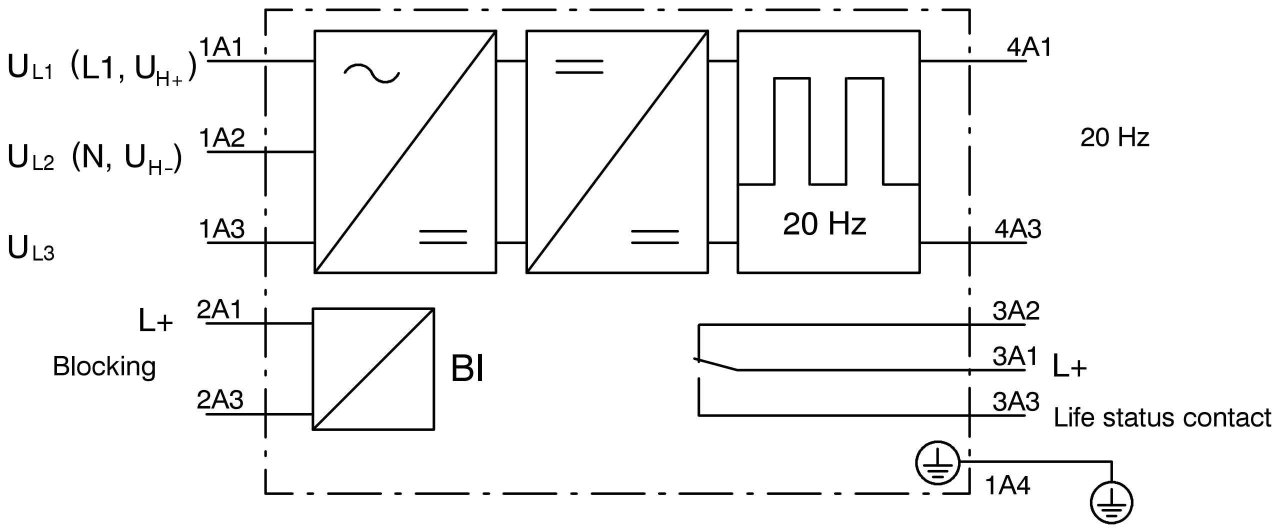


Figure 2.5 Schematic diagram of 20 Hz generator, type 7XT3300–0*A00

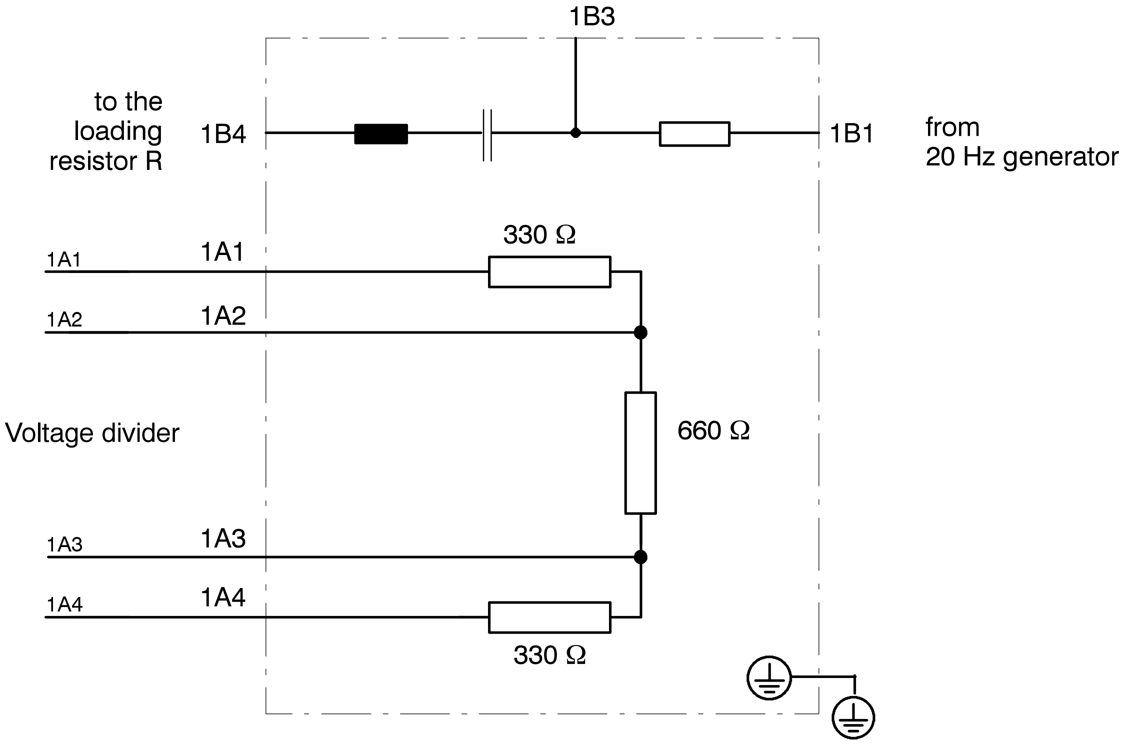


Figure 2.6 Schematic diagram of 20 Hz band-pass filter, type 7XT3400−0*A00

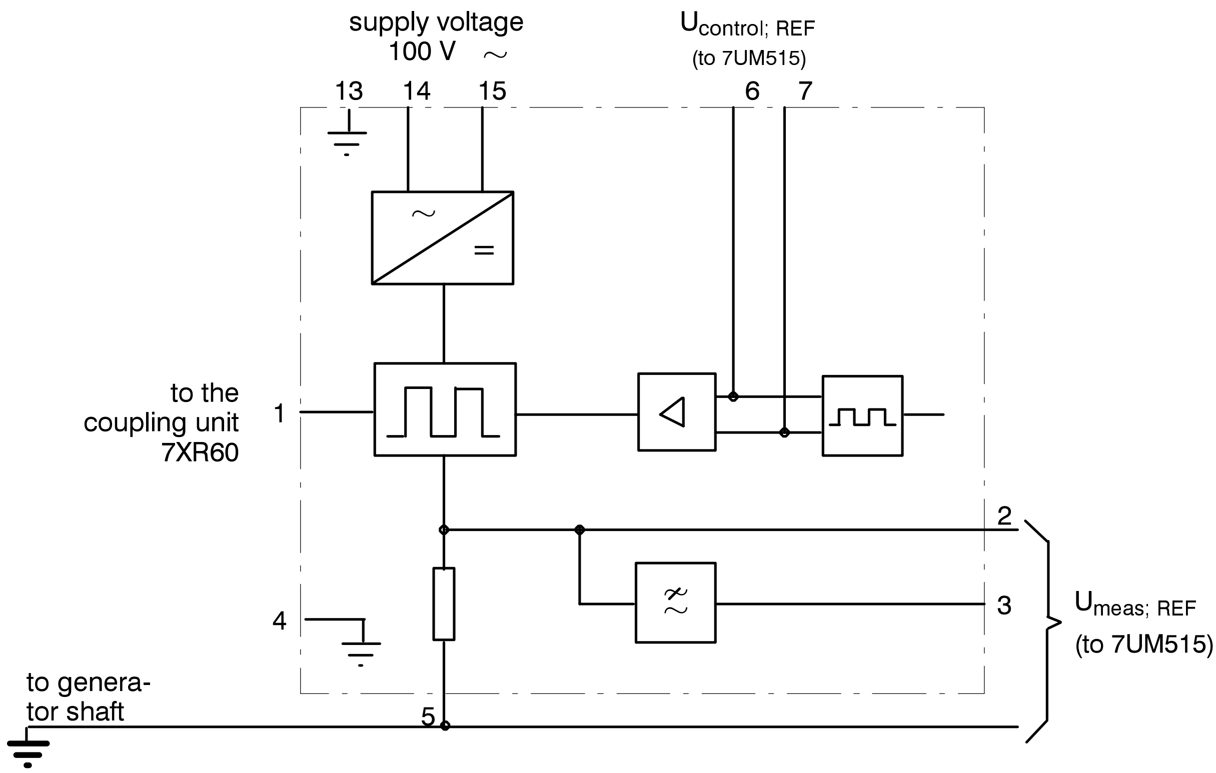


Figure 2.7 Schematic diagram of controller unit, type 7XT7000−0B

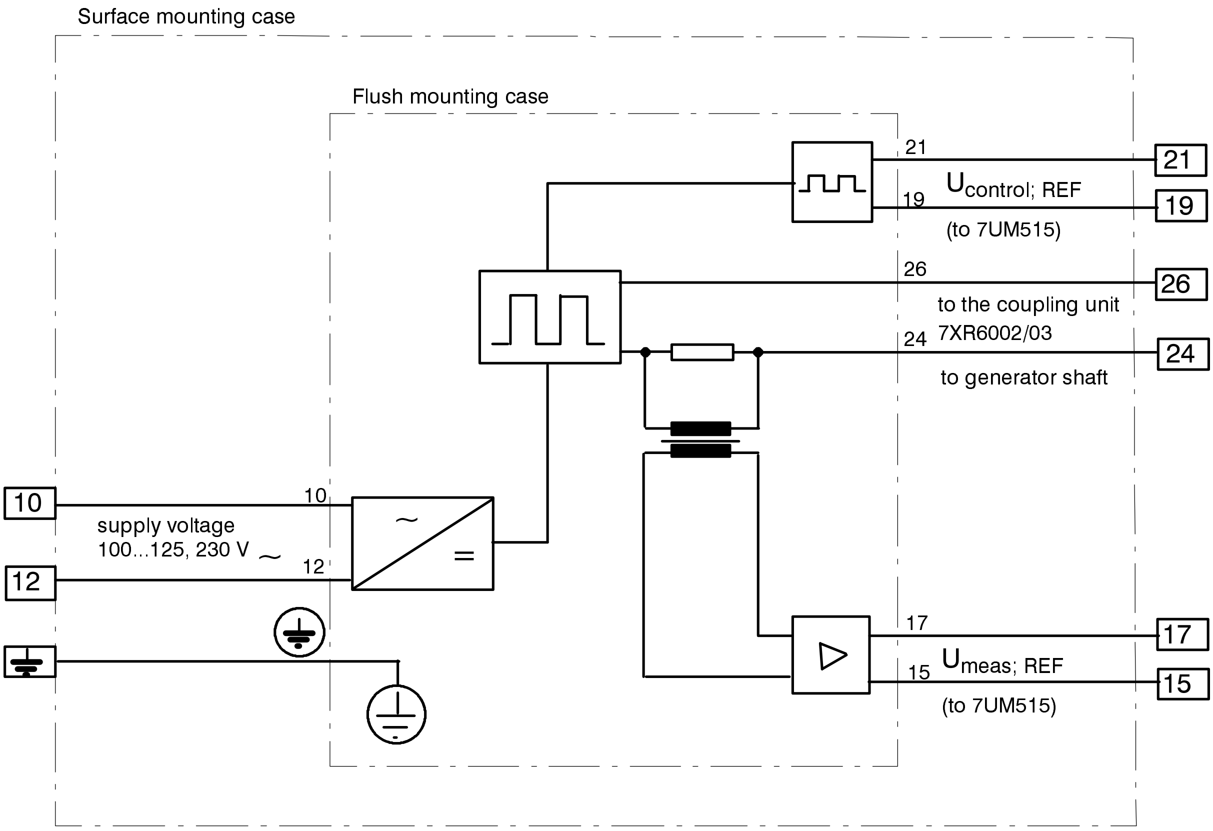


Figure 2.8 Schematic diagram of controller unit 7XT7100–0*A00

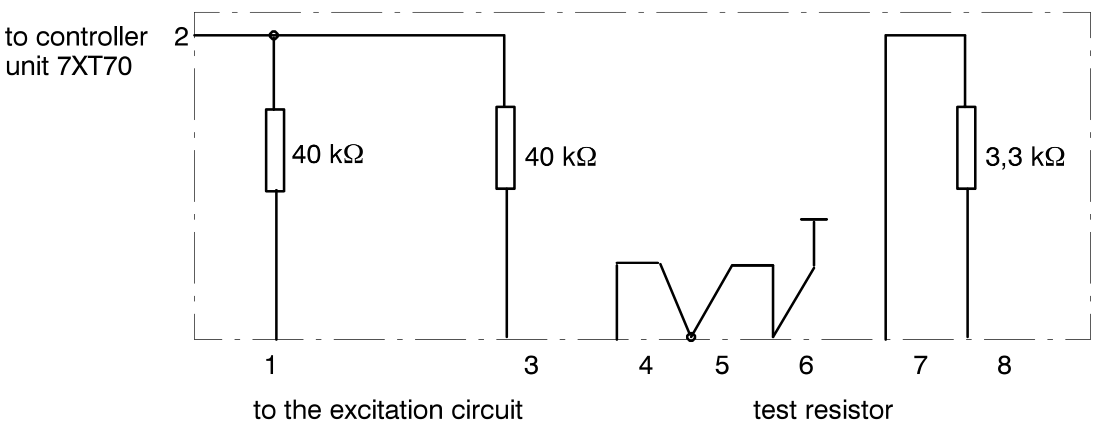
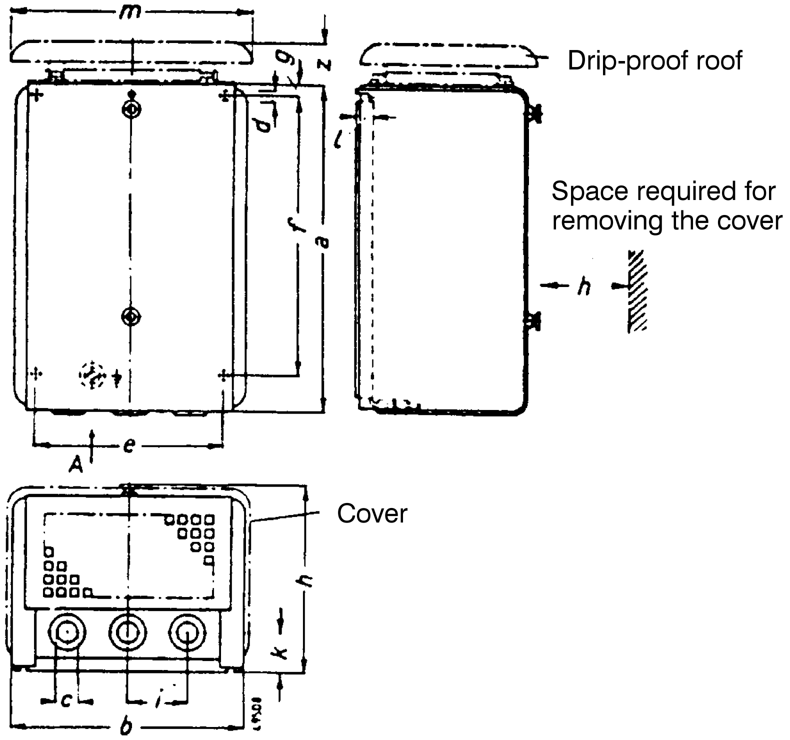


Figure 2.9 Schematic diagram of coupling unit, type 7XR6002 and 7XR6003



3PP1 with degree of protection IP 20 (IP 23 with drip-proof roof) Dimensions in mm

Type	a	b	c	d	e	f	g	h	i	k	l	m	z
3PP1 33	267	187	3 x 16	7	160	230	10	146	50	30	10	196	33
3PP1 34	267	237	4 x 20	7	180	230	12	198	50	32	10	– –	– –

Figure 2.10 Dimensions of 3PP13

3PP133 for voltage divider 3PP1336−1CZ−013001 (500 V/100 V and 500 V/200 V)
for coupling unit 7XR6002 and 7XR6003

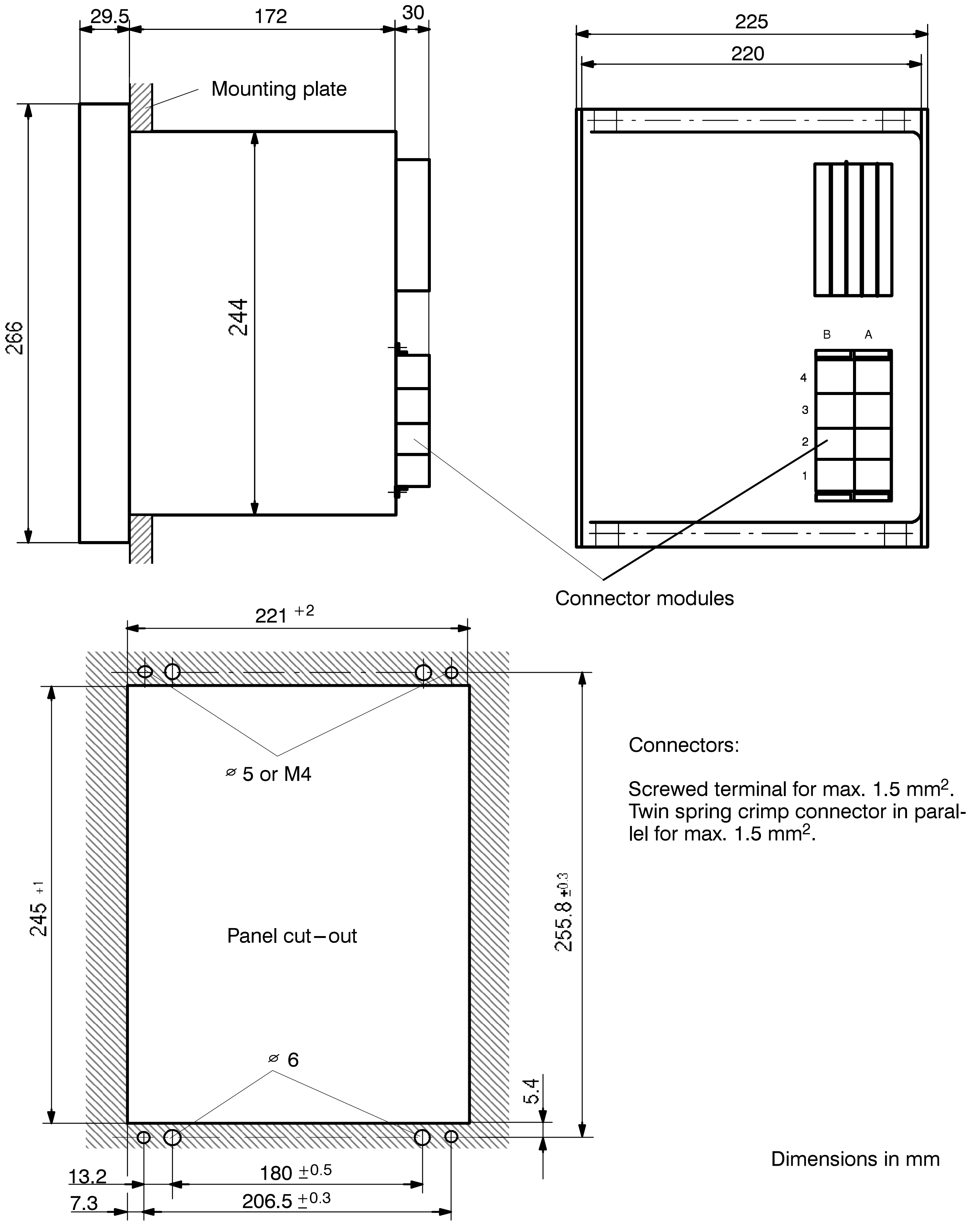
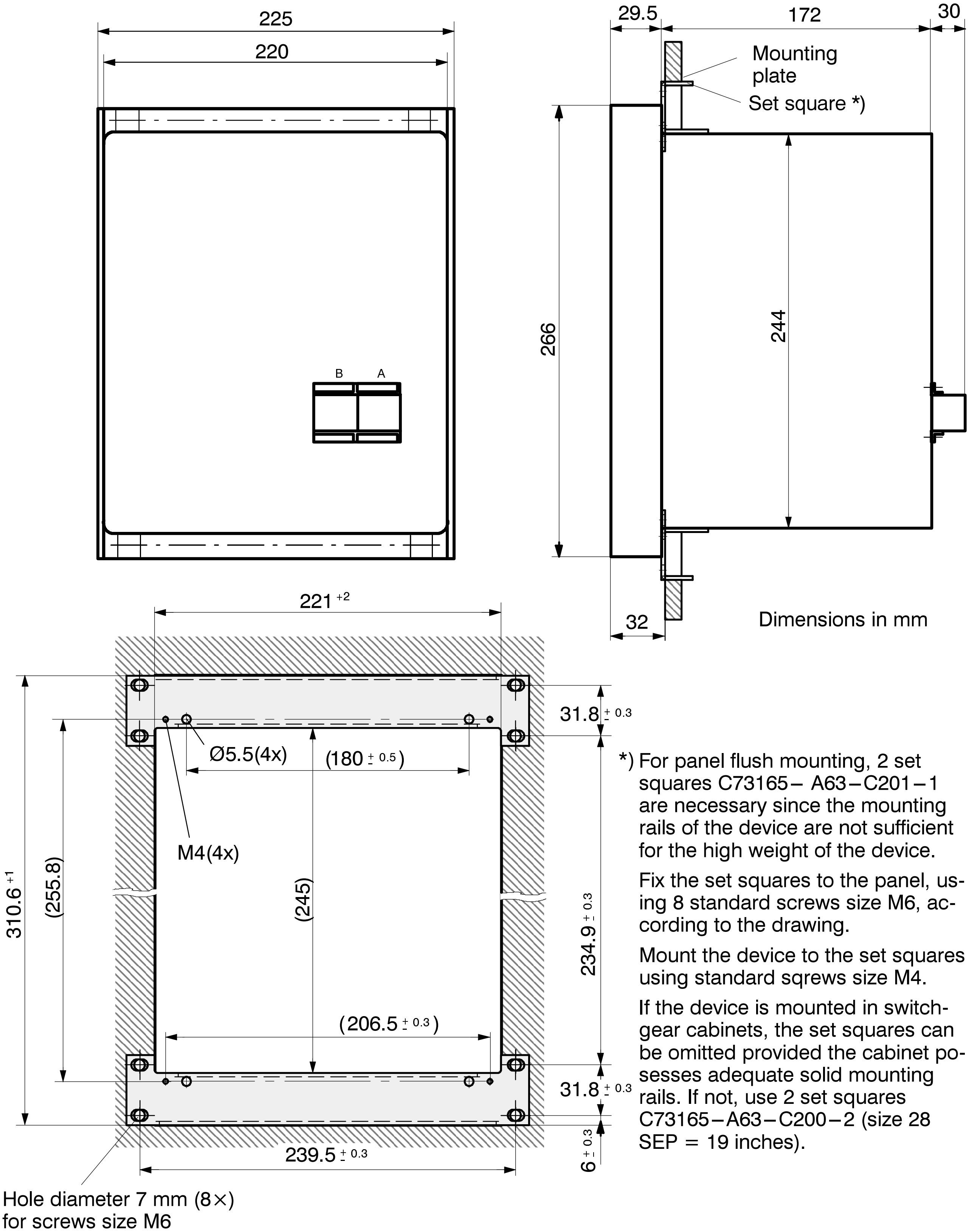


Figure 2.11 Dimensions of 20 Hz generator, type 7XT3300−0*A00 for panel flush mounting or cubicle installation



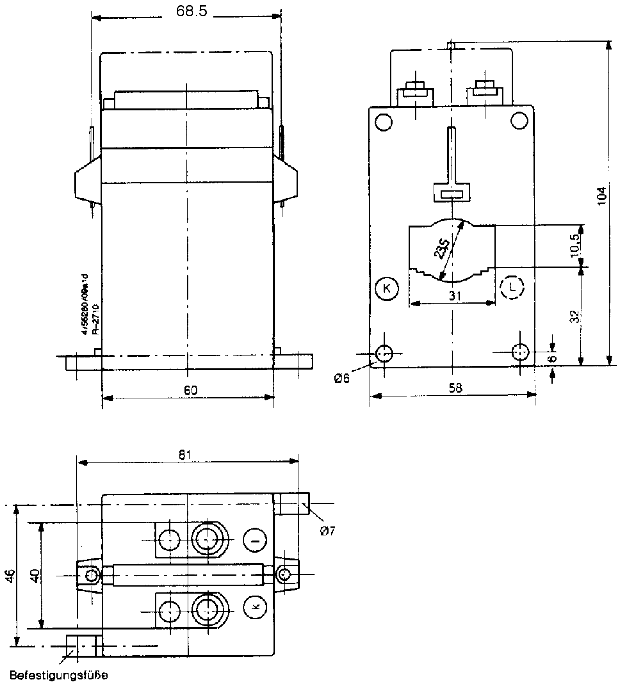
*) For panel flush mounting, 2 set squares C73165− A63−C201−1 are necessary since the mounting rails of the device are not sufficient for the high weight of the device.

Fix the set squares to the panel, using 8 standard screws size M6, according to the drawing.

Mount the device to the set squares using standard sqrews size M4.

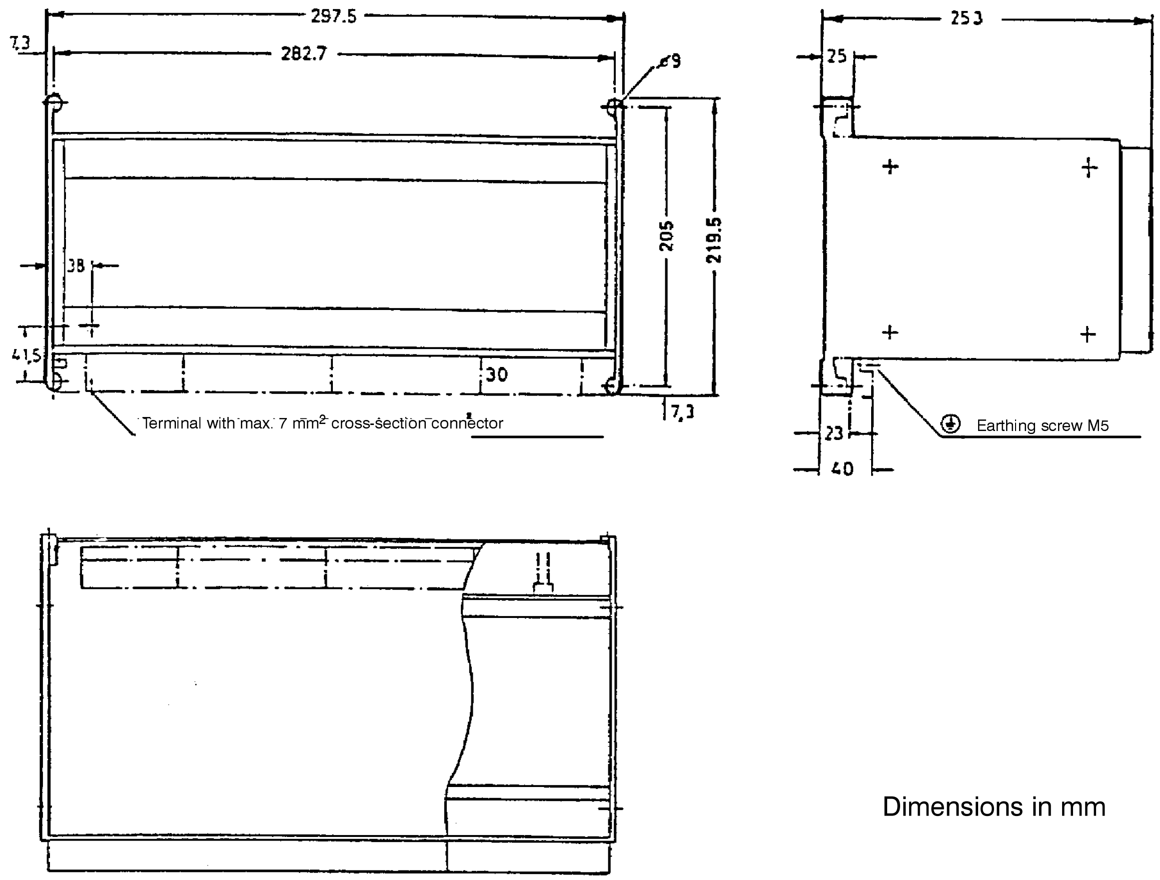
If the device is mounted in switchgear cabinets, the set squares can be omitted provided the cabinet posesses adequate solid mounting rails. If not, use 2 set squares C73165−A63−C200−2 (size 28 SEP = 19 inches).

Figure 2.12 Dimensions of 20 Hz band-pass filter, type 7XT3400−0*A00 for panel flush mounting or cubicle installation



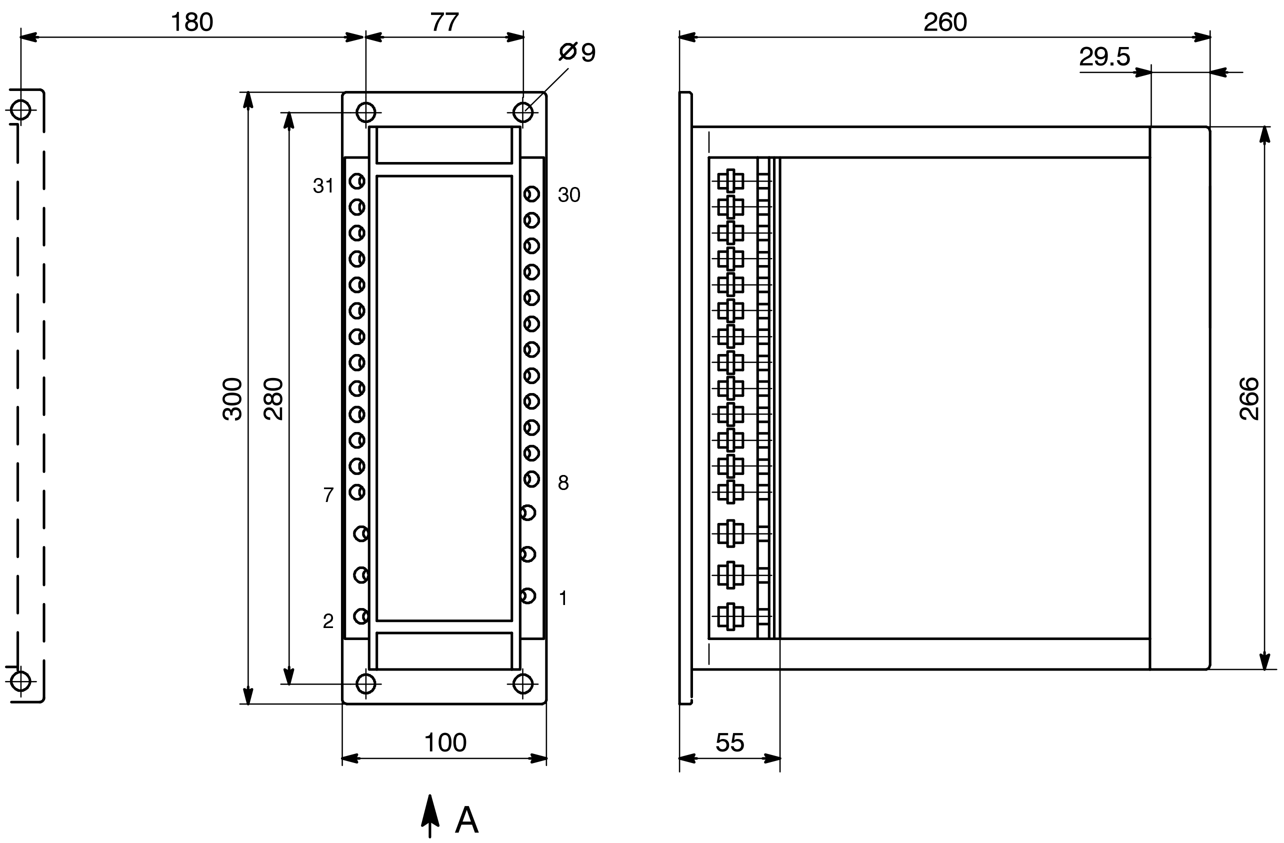
Dimensions in mm

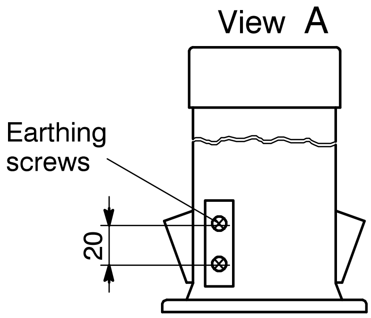
Figure 2.13 Dimensions of intermediate current transformer, type 4NC1225



Dimensions in mm

Figure 2.14 Dimensions of controller unit, type 7XT7000−0B





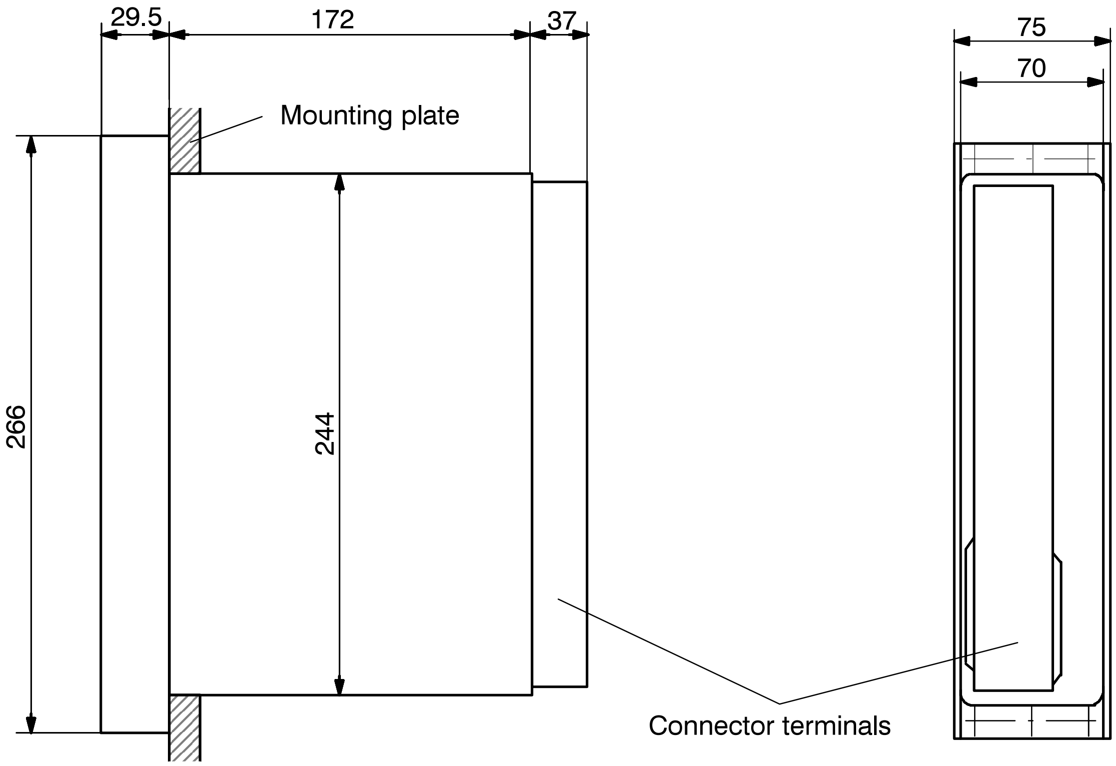
Heavy current connectors (terminals 1 to 6):
not used in 7XT71

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 Messrs AMP for copper wires with cross–section 1.0 mm^2 to 2.6 mm^2 AWG 17 to 13
solid bare copper wire directly:	cross–section 0.5 mm^2 to 2.6 mm^2 AWG 20 to 13 flexible wire requires end sleeves
max. torque value	1.8 Nm or 16 in-lbs

Dimensions in mm

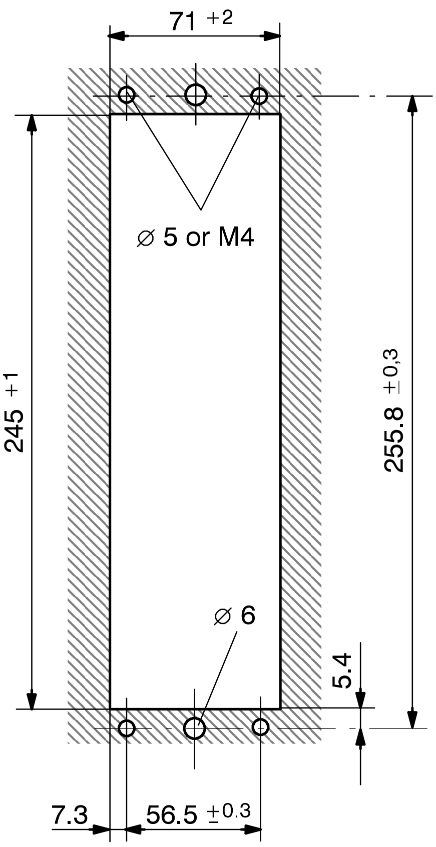
Figure 2.15 Dimensions of controller unit, type 7XT7100−0**B**A00 for panel surface mounting with terminals at both sides



Heavy current connectors (terminals 1 to 6):
not used in 7XT71

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 Messrs AMP for copper wires with cross–section 1.0 mm^2 to 2.6 mm^2 AWG 17 to 13
Snap-in terminal:	for copper wires with cross–section 0.5 mm^2 to 2.5 mm^2 AWG 20 to 13
max. torque value	1.8 Nm or 16 in-lbs



Panel cut-out

Dimensions in mm

Figure 2.16 Dimensions of controller unit, type 7XT7100−0**E**A00 for panel flush mounting or cubicle installation

3 Technical data

3.1 General data

3.1.1 Inputs/outputs

Measuring circuits

Rated voltage U_N		100 V to 125 V (settable)
Rated frequency f_N		50 Hz/60 Hz (settable)
Power consumption	voltage path at 100 V	< 0.3 VA per phase
Power consumption	current path I_{SEF}	< 1 VA at 5 A, 50 Hz < 0.05 VA at 0.5A, 20 Hz
Input resistance d.c. input for rotor earth fault protection		approx 1 MΩ
Overload capability – thermal (rms)	current path I_{SEF}	100 A for ≤1 s 20 A for ≤10 s 4 A continuous
– dynamic (pulse current)		250 A one half cycle
Overload capability – thermal (rms)	voltage path	140 Vac continuous
Overload capability – thermal (rms)	residual voltage path (U_0)	140 Vac continuous 300 Vac for ≤30 s
Overload capability – thermal (rms)	d.c. input for rotor earth fault protection	60 V continuous 200 V for ≤30 s

Auxiliary voltage

Power supply via integrated dc/dc converter

Rated auxiliary voltage U_H	24/48 Vdc	60/110/125 Vdc	220/250 Vdc
Permissible variations	19 to 56 Vdc	48 to 144 Vdc	176 to 288 Vdc

Superimposed ac voltage, peak-to-peak		≤ 12 % at rated voltage ≤ 6 % at limits of admissible voltage
Power consumption	quiescent energized	approx 11 W approx 20 W
Bridging time during failure/short-circuit of auxiliary voltage		≥ 50 ms at U_{dc} ≥ 110 Vdc

Heavy duty (command) contacts

Command (trip) relays, number		5
Contacts per relays		3 x 2 NO and 2 x 1 NO
Switching capacity	MAKE	1000 W/VA
	BREAK	30 W/VA
Switching voltage		250 V
Permissible current		5 A continuous
		30 A for 0.5 s

Signal contacts

Signal/alarm relays		12/1
Contact per relays		4 CO and 8 NO and 1 NC
Switching capacity	MAKE/BREAK	20 W/VA
Switching voltage		250 V
Permissible current		1 A

Binary inputs, number 8

Voltage range: 24 to 250 V dc (as delivered)
Pick-up value reconnectable: by solder bridges in 2 ranges:

for rated control voltage	24/48/60 Vdc	110/125/220/250 Vdc
Pick-up value, approx.	16 Vdc	80 Vdc

Current consumption: approx 1.7 mA independent of operating voltage

Serial interfaces

Operator terminal interface	non-isolated
– Connection	at the front, 25-pole subminiature connector according ISO 2110 for connection of a personal computer or similar
– Transmission speed	as delivered 9600 Baud min 1200 Baud, max 19200 Baud
Interface for data transfer to a control centre	
– Standards	similar V.24/V.28 to CCITT; RS 232 C to EIA, protocol to VDEW/ZVEI and IEC 60870–5–103 or according to DIN 19244
– Transmission speed	as delivered 9600 Baud min 1200 Baud, max 19200 Baud
– Transmission security	Hamming distance d = 4
– Connection directly	data cable at housing terminals 2 core pairs, with individual and common screening, e.g. LI YCY–CY/2 x 2 x 0.25 mm^2
Transmission distance	max 1000 m
Test voltage	2 kV; 50 Hz
– Connection optical fibre	integrated F–SMA connector for direct optical fibre connection, with ceramic post e.g. glass fibre 62.5/125 µm for flush mounted housing: at the rear for surface mounted housing: on the bottom cover
Optical wave length	820 nm
Permissible line attenuation	max 8 dB
Transmission distance	max 1.5 km
Normal signal position	reconnectable; factory setting: “light off”

3.1.2 Electrical tests

Insulation tests	
Standards:	IEC 60255–5
– High voltage test (routine test) except d.c. voltage supply input	2 kV (rms); 50 Hz
– High voltage test (routine test) only d.c. voltage supply input	2.8 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; τ =15 µs; 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 Ω
– 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 Ω; 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; R_i = 150 Ω
– Power frequency magnetic field IEC 61000–4–8, class IV IEC 60255–6	 30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz

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

Standards:	IEC 60255−21 and IEC 60068−2
− Vibration IEC 60255−21−1, class 1 IEC 60068−2−6	sinusoidal 10 Hz to 60 Hz: ± 0.035 mm amplitude; 60 Hz to 150 Hz: 0.5 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
− Shock IEC 60255−21−2, class 1	half sine acceleration 5 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
− Seismic vibration IEC 60255−21−3, class 1 IEC 60068−3−3	sinusoidal 1 Hz to 8 Hz: ± 3.5 mm amplitude (hor. axis) 1 Hz to 8 Hz: ± 1.5 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

Vibration and shock during transport

Standards:	IEC 60255−21 and IEC 60068−2
− Vibration IEC 60255−21−1, class 2 IEC 60068−2−6	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
− Shock IEC 60255−21−2, class 1 IEC 60068−2−27	half sine acceleration 15 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
− Continuous shock IEC 60255−21−2, class 1 IEC 60068−2−29	half sine acceleration 10 g, duration 16 ms, 1000 shocks each direction of 3 orthogonal axes

3.1.4 Climatic stress tests

− recommended temperature during service	−5 °C to +55 °C	(> 55 °C decreased display contrast)
− permissible temperature during service	−20 °C to +70 °C	
permissible temperature during storage	−25 °C to +55 °C	
permissible temperature during transport	−25 °C to +70 °C	

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.

– 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

Housing	7XP20; refer to Section 2.1
Dimensions	refer to Section 2.2
Weight (mass)	
– in housing for surface mounting	approx 12.5 kg
– in housing for flush mounting	approx 10.5 kg
Degree of protection acc. to EN 60529	
– Housing	IP 51 *)
– Terminals	IP 21

*) IP30 for cubicle installation; the degree of protection required for the point of installation must be ensured by the cubicle.

3.2 Overflux protection U/f>

Setting ranges/steps

Overflux (ratio $\frac{U/U_N}{f/f_N}$ >)		1.00 to 1.50	(steps 0.01)
Time delay T_{Warn} (warning stage)		0.00 s to 32.00 s	(steps 0.01 s)
Time delay T (stepped characteristic)		0.00 s to 32.00 s or ∞	(steps 0.01 s)
Reset delay T_r		0.00 s to 32.00 s	(steps 0.01 s)
Pair of values for characteristic of thermal replica	U/f T	1.02 to 1.60 1 s to 98 s or ∞	(steps 0.01) (steps 1 s)
Time multiplier		1 to 8	(steps 1)
U/f − basis value (limit value for overflux detection)		0.00 to 1.00	(steps 0.01)
Thermal warning stage		70 % to 99 %	(steps 1 %)

Times (stepped characteristic)

− at 1.1 times setting value		≤ 250 ms
Reset times		approx 60 ms
Reset ratio	pick-up on U/f thermal warning stage	approx 0.98 approx 0.99

Tripping time characteristics
thermal replica according presettings — refer Figure 3.1

Tolerances

− pick-up on U/f	3 % of set value
− time delays T (stepped charact., warning stage)	1 % but min. 10 ms
− thermal replica	5 % related to U/f ± 0.4 s

Influence variables

− Auxiliary d.c. voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	≤ 1%
− Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$	≤ 0.5 %/10 K
− Frequency in range 0.9 f_N to 1.1 f_N	≤ 1 %

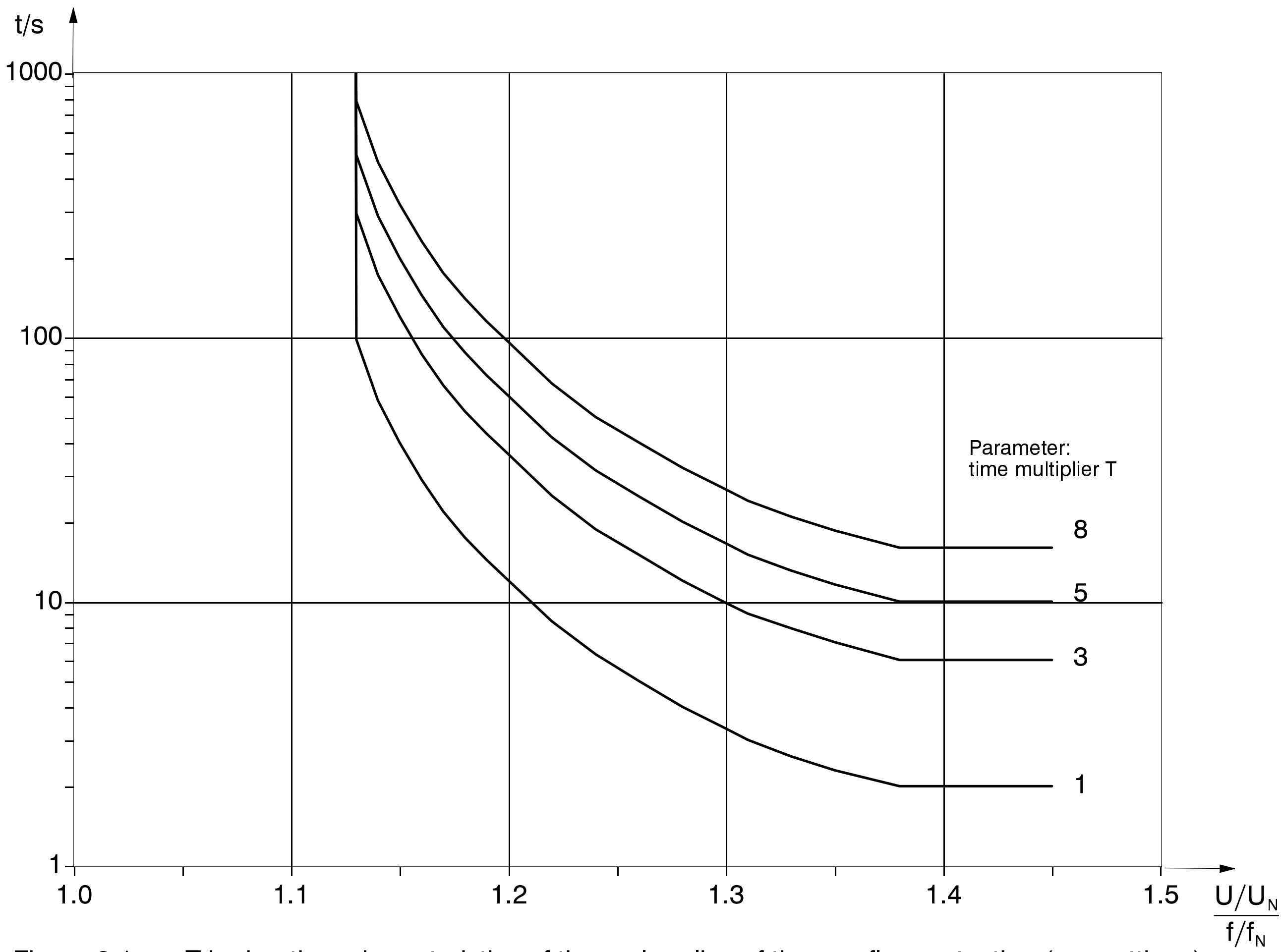


Figure 3.1 Tripping time characteristics of thermal replica of the overflux protection (pre-settings)

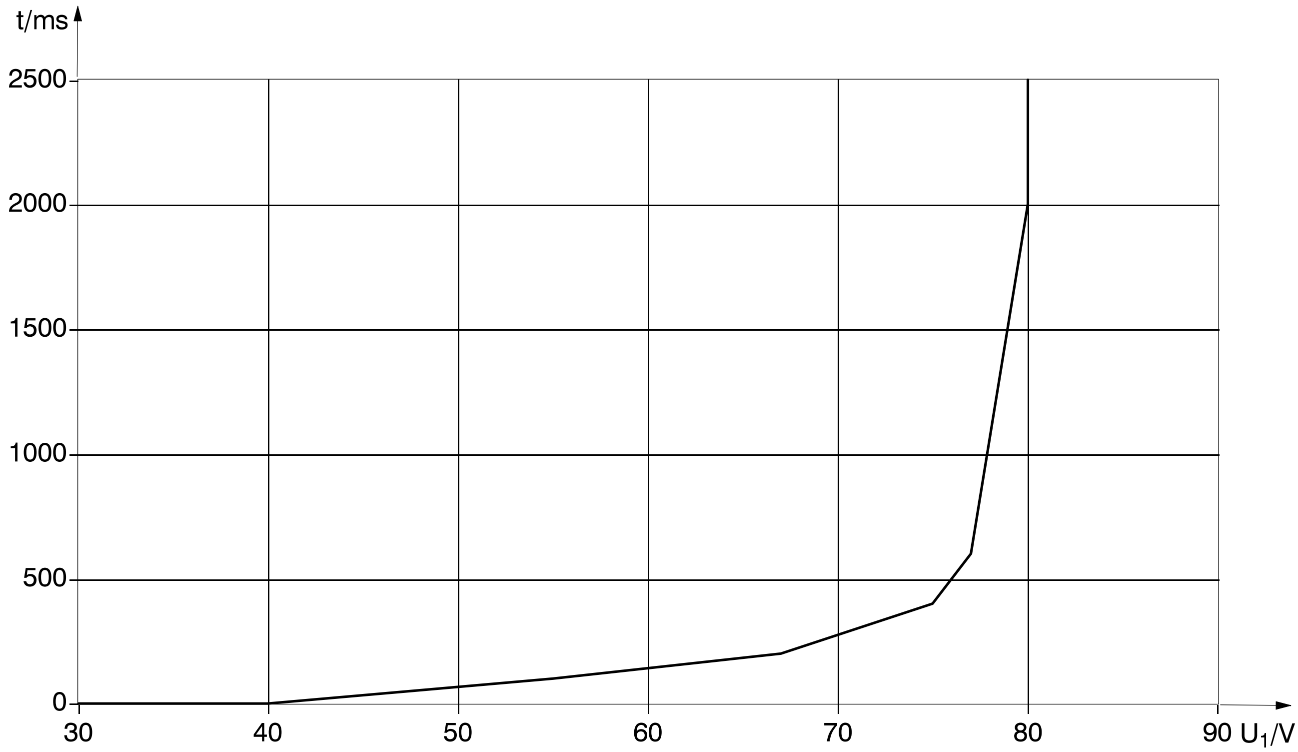


Figure 3.2 Tripping time characteristic of the undervoltage protection (pre-settings)

3.3 Undervoltage protection U<

Setting ranges/steps

Inverse time undervoltage	U< T(U<)	20 V to 100 V 0.00 s to 32.00 s or ∞	(steps 1 V) (steps 0.01 s)
Reset delays	T_r	0.00 s to 32.00 s	(steps 0.01 s)

Pick-up time – undervoltage	U<	approx 50 ms
– reset time		approx 50 ms
Reset ratio undervoltage	U<	approx 1.05
Tripping characteristics	t = f(U)	
– pre-settings		refer to Figure 3.2

Tolerances

– voltage limit values	U<	3 % of set value or 1 V
– voltage time characteristic		3 % referred to U

Influence variables

– Auxiliary d.c. voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	$\leq$ 1%
– Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$	$\leq$ 0.5 %/10 K
– Frequency in range 0.9 f_N to 1.1 f_N	$\leq$ 1 % referred to U

3.4 Overvoltage protection U>, U>>

Setting ranges/steps

Overvoltage U>, U>>	30 V to 180 V	(steps 1 V)
Time delays T(U>), T(U≫)	0.00 s to 32.00 s or ∞	(steps 0.01 s)
Reset delays T_r	0.00 s to 32.00 s	(steps 0.01 s)

Pick-up times – overvoltage U>, U≫	$\leq$ 50 ms
Reset times – overvoltage U>, U≫	approx 50 ms
Reset ratios – overvoltage U>, U≫	approx 0.98

Tolerances

– voltage limit values U>, U≫	3 % of set value or 1 V
– time delays T	1 % but min. 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 $-5\ ^\circ C \leq \vartheta_{amb} \leq +40\ ^\circ C$	$\leq$ 0.5 %/10 K
– Frequency in range 0.9 f_N to 1.1 f_N	$\leq$ 1 %

3.5 Stator earth fault 100 % protection R_E<

Setting ranges/steps

Warning stage R<		20 Ω to 500 Ω	(steps 1 Ω)
Tripping stage R<<		10 Ω to 300 Ω	(steps 1 Ω)
Current stage I>>		0.02 A to 0.80 A	(steps 0.01 A)
20 Hz voltage failure supervision	BLOCK U_{20}<	0.3 V to 15.0 V	(steps 0.1 V)
	BLOCK I_{20}<	5 mA to 40 mA	(steps 1 mA)
transformer angle error correction	CT ANG. W1	−30° to +30°	(steps 1°)
transformation factor	S/E/F−FACT	1.0 to 200.0	(steps 0.1)
Time delays T		0.00 s to 32.00 s or ∞	(steps 0.01 s)
Transformation factor for primary earth resistance		1.0 to 200.0	(steps 0.01)
Reset times Tr		0.00 s to 32.00 s	(steps 0.01 s)

20 Hz generator
Input circuit

– rated input voltage	100 V/110 V ac, three-phase
– rated frequency	50 Hz / 60 Hz
– operating range	80 V to 130 V ac (phase-phase)
– power consumption at 110 V∼	110 VA with solid earth fault; without earth faul dependent on the load resistance R_B: approx 45 VA at R_B = 10 Ω

Output circuit

– rated output voltage	25 V (square wave)
– rated output frequency	20 Hz ± 0.4 Hz

Pick-up times	
– warning stage R<, tripping stage R<<	≤ 1.3 s
– current tripping stage I>>	≤ 250 ms
Reset times	
– warning stage R<, tripping stage R<<	≤ 0.8 s
– current tripping stage I>>	≤ 120 ms
Reset ratios	approx 1.2 to 1.7

Tolerances	
– warning stage R<, tripping stage R<<	5 % of set value but min. 2 Ω
– current tripping stage I>>	3 % of set value but min. 3 mA
– time delays T	1 % but min. 10 ms

Influence variables	
– Auxiliary d.c. voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	≤ 1%
– Auxiliary a.c. voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	≤ 1%
– Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$	≤ 0.5 %/10 K
– Frequency in range 40 Hz to 69 Hz	≤ 1 %

3.6 Earth fault protection U_0>

Setting ranges/steps

Displacement voltage U_E>	5.0 V to 100.0 V	(steps 0.1 V)
Time delay T	0.00 s to 32.00 s or ∞	(steps 0.01 s)
Reset time Tr	0.00 s to 32.00 s	(steps 0.01 s)

Pick-up time

– displacement voltage U_E>	$\leq$ 50 ms
– Reset time	$\leq$ 40 ms
– Reset ratio	approx 0.7

Tolerances

– displacement voltage U_E>	3 % of set value
– time delays T	1 % but min. 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 $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$	$\leq$ 0.5 %/10 K
– Frequency in range 0.9 f_N to 1.1 f_N	$\leq$ 1 %

3.7 Frequency protection f><

Setting ranges/steps

Number of frequency stages	4; adjustable f> or f<	
Pick-up value f> or f<	40.00 Hz to 65.00 Hz	(steps 0.01 Hz)
Number of repeated measurement for f>, f<	2 to 10000 (3 a.c. periods per measurement)	(steps 1)
Undervoltage lock-out for f>, f<	40 V to 100 V	(steps 1 V)

Pick-up times

– Frequency f>, f<	dependent on frequency and number of repeated measurements: approx 100 ms plus 3 a.c. periods per measurement (e.g. 400 ms with 5 measurements at 50 Hz)
Reset times	dependent on frequency and number of repeated measurements: approx 100 ms plus 3 a.c. periods per measurement (e.g. 400 ms with 5 measurements at 50 Hz)
Reset hysteresis Δf	approx. 20 mHz
Reset ratio undervoltage lock-out $U_1<$	approx. 1.05

Tolerances

– frequency f>, f<	10 mHz at $f_N = 50$ Hz
– undervoltage lock-out $U_1<$	3 % of set value

Influence variables

– Auxiliary d.c. voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	$\leq$ 0.1%
– Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$	$\leq$ 0.1 %/10 K
– Frequency in range 40 Hz to 65 Hz	$\leq$ 0.05 %

3.8 Interturn fault protection $U_{IT}>$

Setting ranges/steps		
Displacement voltage $U_{IT}>$	0.3 V to 130.0 V	(steps 0.1 V)
Time delay T	0.00 s to 32.00 s or ∞	(steps 0.01 s)
Reset time T_r	0.00 s to 32.00 s	(steps 0.01 s)

Pick-up time

– displacement voltage $U_{IT}>$	$\leq$ 50 ms
– Reset time	$\leq$ 40 ms
– Reset ratio	approx 0.6

Tolerances

– displacement voltage $U_{IT}>$	3 % of set value but min. 0.1 V
– time delays T	1 % but min. 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 $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$	$\leq$ 0.5 %/10 K
– Frequency in range 0.9 f_N to 1.1 f_N	$\leq$ 1 %

3.9 Rotor earth fault protection R_E<

3.9.1 Internal measurement procedure

Setting ranges/steps

Warning stages RE< WARN and RE< TEST	5.0 kΩ to 80.0 kΩ	(steps 0.1 kΩ)
Tripping stages RE≪ TRIP and RE≪ TEST	1.0 kΩ to 10.0 kΩ	(steps 0.1 kΩ)
Pick-up value of meas. circuit supervision Qc<	0.01 mAs to 1.00 mAs or 0 (supervision ineffective)	(steps 0.01 mAs)
Time delays T	0.00 s to 32.00 s or ∞	(steps 0.01 s)
Reset delays T_r	0.00 s to 32.00 s	(steps 0.01 s)

Permissible **rotor earth capacitance** C_E (with respect to specified tolerances and detection of measuring circuit fault)	$0.15\ \mu F \leq C_E \leq 4.0\ \mu F$
Auxiliary voltage supply	
– permissible operating range	80 V ac to 110 V ac
– power consumption at 100 V ac	approx 25 VA

Pick-up times

– Warning stage, tripping stage, test stages (with 7XT70)	$\leq$ 1.0 s at $0.15\ \mu F \leq C_E \leq 1.0\ \mu F$ $\leq$ 1.5 s at $1\ \mu F < C_E \leq 4.0\ \mu F$
Reset times	
– Warning stage, tripping stage, test stages (with 7XT70)	$\leq$ 1 s at $0.15\ \mu F \leq C_E \leq 1.0\ \mu F$ $\leq$ 1.5 s at $1\ \mu F < C_E \leq 4.0\ \mu F$

Reset ratios	RE< WARN, RE< TEST	approx 1.25
	RE≪ TRIP, RE≪ TEST	approx 1.25
	Qc<	approx 1.20 but min. +0.01 mAs

Tolerances

– Warning stage, tripping stage, test stages	5 % of set value but min. 0.5 kΩ at $0.15\ \mu F \leq C_E \leq 1.0\ \mu F$ 10 % of set value but min. 0.5 kΩ at $1\ \mu F < C_E \leq 4.0\ \mu F$
– Time delays T	1 % but min. 10 ms
– Circuit supervision Q_C	5 % of set value but min. 0.005 mAs

Influence variables

– Auxiliary d.c. voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	$\leq$ 1%
– Temperature in range $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$	$\leq$ 0.5 %/10 K
– Frequency in range 40 Hz to 69 Hz	$\leq$ 1 %

3.9.2 Processing of measured signals of an external (rotating) rotor earth fault protection

Setting ranges/steps

Warning stages RE< WARN and RE< TEST	5.0 kΩ to 80.0 kΩ	(steps 0.1 kΩ)
Tripping stages RE≪ TRIP and RE≪ TEST	1.0 kΩ to 10.0 kΩ	(steps 0.1 kΩ)
Time delays T	0.00 s to 32.00 s or ∞	(steps 0.01 s)
Reset delays T_r	0.00 s to 32.00 s	(steps 0.01 s)

Interface

Input level (shunt voltage)	2 Vdc to 10 Vdc (4 mAdc to 20 mAdc at 500 Ω shunt)
Assignment between input level and earth resistance R_E	refer to Figure 3.3
Interrupted wire detection	input voltage less than 1 Vdc (2 mAdc)
Reset of interrupted wire detection	input voltage higher than 1.5 Vdc (3 mAdc)

Pick-up times

– Warning stage, tripping stage, test stages	≤ 0.4 s
Reset times – Warning stage, tripping stage, test stages	≤ 0.4 s
Reset ratios	approx 1.25

Tolerances

– Warning stage, tripping stage, test stages	2 % of set value but min. 0.5 kΩ
– Time delays T	1 % but min. 10 ms

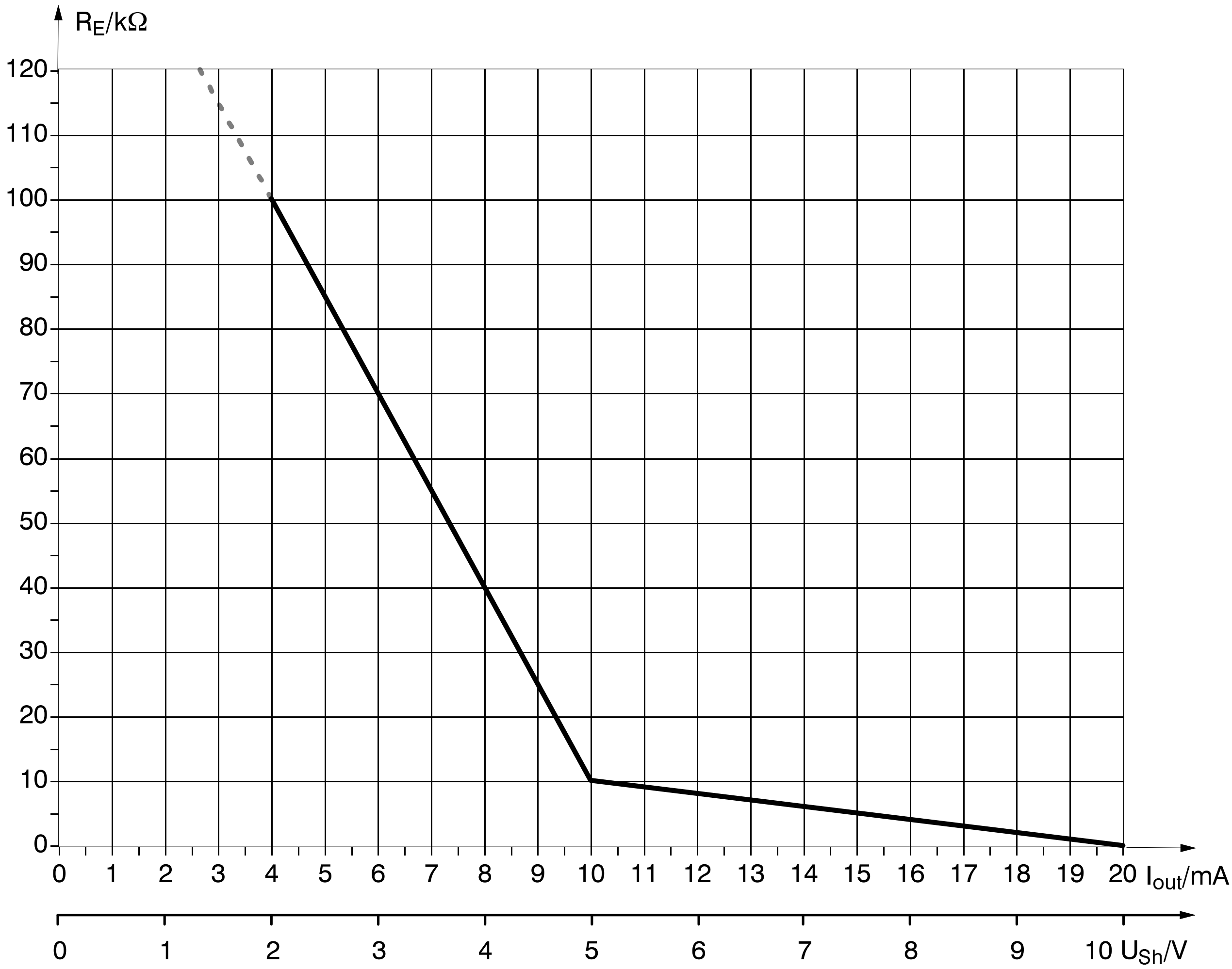


Figure 3.3 Assignment between input level and rotor earth resistance R_E

3.10 Ancillary functions

External trip commands via binary input

Setting ranges/steps

Time delays T	0.00 s to 32.00 s or ∞	(steps 0.01 s)
Drop-off delay T_r	0.00 s to 32.00 s	(steps 0.01 s)

Times

operating time	(dependent on frequency)	approx 12 ms at 50 Hz/60 Hz
Drop-off times	(dependent on frequency)	approx 8 ms at 50 Hz/60 Hz

Tolerance

– Time delays T, T_r	1 % but min. 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 $-5\ °C \leq \vartheta_{amb} \leq +40\ °C$	$\leq$ 0.5 %/10 K
– Frequency in range 40 Hz to 69 Hz	$\leq$ 15 ms

Operational measured values (measurement transformation)

– Operational voltage values	U_{L1-N}; U_{L2-N}; U_{L3-N} in kV primary and in V secondary
Measurement range	0 V to 140 V
Tolerance	$\leq$ 2 V
– Maximum voltage value (phase-to-phase)	$U_{max\ L-L}$
Measurement range	10 V to 240 V
Tolerance	$\leq$ 2 % of measured value or 2 V
– Positive sequence voltage	U_{pos}
Measurement range	6 V to 240 V
Tolerance	$\leq$ 2 % of measured value or 2 V
– Frequency	f
Measurement range	40 Hz to 69 Hz
Tolerance	$\leq$ 0.05 Hz
– Displacement voltage	U_0
Measurement range	0 V to 140 V
Tolerance	$\leq$ 2 V
– Displacement voltage	$U_{I/T}$
Measurement range	0 V to 130 V
Tolerance	2 % or 0.25 V
– Bias voltage of stator circuit	U_{SEF}
Measurement range	0 V to 16 V
Tolerance	$\leq$ 0.5 V
– Residual current	I_{SEF}
Measurement range	0 A to 1.2 A
Tolerance	$\leq$ 3 % of measured value or 0.01 A
– Stator earth resistance (secondary) R_{SEF}	
Measurement range	0 Ω to 999 Ω
Tolerance	$\leq$ 5 % or 2 Ω
– Stator earth resistance (primary)	$R_{se\ p}$
Measurement range	0 kΩ to (0.999 kΩ $\times$ transformation factor)
Tolerance (at the relay terminal)	$\leq$ 5 % or (0.005 Ω $\times$ transformation factor)
– Period of rotor bias voltage	T_g
Measurement range	0.2 s to 5.0 s
Tolerance	$\leq$ 5 % or 0.05 s
– Amplitude of rotor bias voltage	U_g (with controller unit 7XT71)
Measurement range	0 V to 60 V
Tolerance	$\leq$ 1 V
– Measured rotor earth fault current (active component) of internal measurement or input current of external (rotating) protection	I_g
Measurement range	0.0 mA to 20.0 mA
Tolerance	$\leq$ 0.05 mA

– Charge on polarity reversal	Qc
Measurement range	0.00 mAs to 1.00 mAs
Tolerance	$\leq$ 0.005 mAs
– Rotor earth resistance	R_{REF}
Measurement range	0.0 kΩ to 199.0 kΩ
Tolerance	$\leq$ 3 % or 0.5 kΩ for $R_E \leq$ 80 kΩ and $C_E \leq$ 1 µF $\leq$ 10 % or 0.5 kΩ for $R_E \leq$ 80 kΩ and $C_E \leq$ 4 µF
– Overflux	U/f referred to rated flux U_N/f_N
Measurement range	0 to 2.4
Tolerance	$\leq$ 5 %
– Temperature rise calculated from overflux	U/f th
Measurement range	0 % to 240 % (thermal replica)
Tolerance	$\leq$ 5 % of set value of U/f
– Referred thermal losses calcul. from overflux	Th.loss.
Measurement range	0 % to 240 %
Tolerance	$\leq$ 3 % ± 1 digit

all indications ±1 digit display tolerance

Steady-state measured value supervision

Voltage unbalance	U_{max}/U_{min} > symmetry factor as long as U > U_{limit}
Phase sequence	clockwise phase rotation

Fault event data storage

Storage of annunciations of the four last fault events, three of which can be read out locally

Real time clock

Resolution for operational annunciations	1 min
Resolution for fault event annunciations	1 ms
Max time deviation	0.01 %
Buffer battery	Lithium–Battery 3 V/1 Ah, Type CR 1/2 AA Self-discharge time > 5 years

Data storage for fault recording optionally instantaneous values or r.m.s. values

Instantaneous values:

Storage period (pick-up or trip command = 0 ms) max. 5 s, selectable pre-trigger and post-fault time

Sampling rate	1 instantaneous value per 1.67 ms at 50 Hz 1 instantaneous value per 1.39 ms at 60 Hz	
	phase voltage	u_{L1-N}
	phase voltage	u_{L2-N}
	phase voltage	u_{L3-N}
	earth fault displacement voltage	u_0
	interturn fault displacement voltage	u_{IT}
	bias voltage for stator circuit	u_{SEF}
	earth current of stator circuit	i_{SEF}
	measured current for rotor circuit	i_{REF}

rms values:

Storage period	max. 60 s, selectable pre-trigger and post-fault time	
Sampling rate	1 r.m.s. value per 20 ms at 50 Hz 1 r.m.s. value per $16^2/_3$ ms at 60 Hz	
	positive sequence component of phase voltages	$\sqrt{3} \cdot U_{pos}$
	max. phase-to-phase voltage	U_{L-L}
	Displacement voltage (earth fault)	U_0
	Displacement voltage (interturn fault)	U_{IT}
	bias voltage for stator circuit	U_{SEF}
	earth current of stator circuit	I_{SEF}
	rotor earth resistance	R_{REF}
	frequency deviation	$f - f_N$

3.11 Operating ranges of the protection functions

	Operat. cond. 0	Operating condition 1		Operat. cond. 0
Protection function	f ≤ 10 Hz	11≤f/Hz≤40	40≤f/Hz≤70	f ≥ 70 Hz
Overflux protection, definite time	inactive	**active**	**active**	inactive
Overflux protection, thermal stage	inactive[1)]	**active**	**active**	inactive[1)]
Undervoltage protection	inactive	**active**[2)]	**active**	inactive
Overvoltage protection	inactive	**active**[2)]	**active**	inactive
Stator earth fault 100 % protection – resistance calculation – current stage I>>	 **active** **active**	 inactive **active**	 **active** **active**	 **active** **active**
Stator earth fault protection U_0>	inactive	**active**[2)]	**active**	inactive
Underfrequency protection	inactive	**active**[3)]	**active**	inactive[4)]
Overfrequency protection	inactive	**active**[5)]	**active**	inactive[6)]
Interturn fault protection	inactive	**active**[2)]	**active**	inactive
Rotor earth fault protection	**active**	inactive	**active**	**active**
External trip commands	**active**	**active**	**active**	**active**

1) thermal replica registers cooling-down
2) voltages are measured too small below 25 Hz (input saturation)
3) no frequency measurement possible, but pick-up is ensured due to underfrequency
4) no frequency measurement possible, but pick-up (when present) is reset
5) no frequency measurement possible, but pick-up (when present) is reset
6) no frequency measurement possible, but pick-up is ensured due to overfrequency

Figure 3.4 Operating ranges of the protection functions

4 Method of operation

4.1 Operation of complete unit

The numerical machine protection 7UM515 is equipped with a powerful and proven 16–bit micro-processor. This provides fully digital processing of all functions from data acquisition of measured values to the trip signals for the circuit breakers.

Figure 4.1 shows the base structure of the unit.

The transducers of the measured value input section ME transform the currents and 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

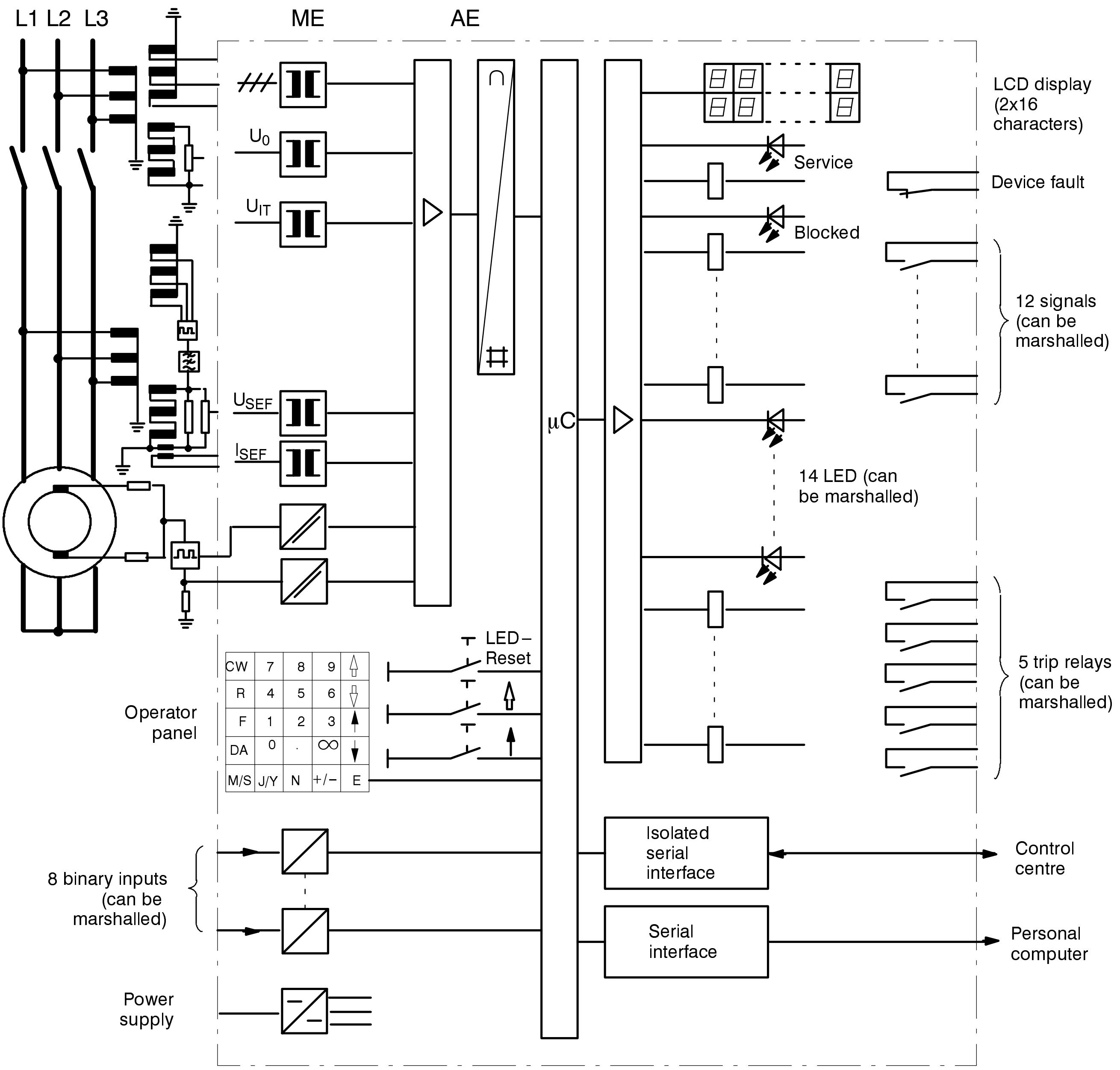


Figure 4.1 Hardware–structure of machine protection relay 7UM515

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.

Measured voltages and control voltages for the rotor earth fault protection are fed to the unit via inbuilt d.c. voltage transformers, thus performing galvanic isolation between switch gear potential and the internal electronic circuitry. The matched voltages are then also passed to the analog input section.

The analog input section AE contains input amplifiers, sample and hold elements for each input, analog-to-digital converters and memory circuits for the data transfer to the microprocessor.

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

– filtering and formation of the measured quantities,
– calculation of the positive sequence component of the measured voltages,
– scanning of values for the thermal replica of losses caused by overflux,
– calculation of the insulation resistance of the stator circuit as well as of the rotor circuit,
– calculation of the frequency,
– scanning of limit values and time sequences,
– decision about trip commands,
– storage of measured quantities during a fault for analysis.

The frequency of the measured quantities is continuously measured and used in an integrated follow-up circuit; this ensures that the protection functions are always processed with algorithms matched to the actual frequency. Thus, a wide frequency range from 40 Hz to 69 Hz is specified with small frequency influence. In general, processing is even possible from approx 11 Hz on but with respectively slower speed.

However, frequency measurement requires that an a.c. measurement value be present (at least 10 % of rated a.c. quantity) at either a.c. input so that the frequency follow-up can operate. The unit indicates this as “Operating condition 1”.

If none of the a.c. inputs is fed by a sufficient measurement quantity, or if the frequency is out of the range of 11 Hz to 70 Hz, the unit indicates this as “Operating condition 0”. Processing of measured values is not possible during this time.

Binary inputs and outputs to and from the processor are channelled via the input/output elements. From these the processor receives information from the switch-gear (e.g. remote resetting) or from other equipment (e.g. blocking signals). Outputs include, in particular, trip commands to the circuit breakers, signals for remote signalling of important events and conditions as well as visual indicators (LEDs), and an alphanumerical 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. are entered into the protection from this panel (refer 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 Section 6.4). The dialog with the relay can be carried out alternatively via the serial interface in the front plate by means of an operator panel or a personal computer.

Via a second serial interface, fault data can be transmitted to a central evaluation unit. During healthy operation, measured values can also be transmitted, e.g. the measured voltage at the point of installation. This second interface is isolated and thus satisfies the requirements for external signals, i.e. isolation and interference suppression comply with the requirements according to IEC 60255 and VDE 0435, part 303.

Communication via this interface is alternatively possible by means of fibre optic links, provided this interface is accordingly ordered (refer to Section 2.3 Ordering data).

A power supply unit provides the auxiliary supply on the various voltage levels to the described functional units. + 24 V is used for the relay outputs. The analog input requires ±15 V whereas the processor and its immediate peripherals are supplied with +5 V. Transient failures in the supply voltage, up to 50 ms, which may occur during short-circuits in the dc supply system of the plant are bridged by a dc voltage storage element (rated auxiliary voltage ≥ 110 Vdc).

The protective functions are described in detail in the following sections. Each function can be individually activated or rendered inoperative. As each function is realized by its own autonomous firmware, mutual interference is excluded.

4.2 Overflux protection U/f>

The overflux protection is used to detect impermissible overflux conditions which can endanger transformers. Such conditions are caused by an increase in voltage and/or reduction in 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 overflux protection is fitted with a definite time stage and a thermal replica which calculates the temperature rise of the iron caused by the overflux, according to a thermal single-body model.

The referred temperature rise is computed by means of the differential equation

$$\frac{d\Theta}{dt} + \frac{1}{\tau} \cdot \Theta = \frac{1}{\tau} \cdot Q$$

whereby

- Θ – actual temperature rise referred to the steady-state temperature rise at maximum permissible overflux U/f
- τ – thermal iron time constant of the protected object
- Q – referred thermal losses, correspond to the temperature rise after thermal equilibrium

When the temperature rise reaches the first set threshold, a warning alarm is given. If the second temperature threshold is reached, trip command is given.

If the value of the continuously permissible induction is exceeded, an alarm is initiated (refer to Figure 4.2). After the time corresponding to the actual induction and the time constant has elapsed, the protected object is disconnected.

An adjustable, definite-time, overflux time stage is superimposed on the thermal characteristic (refer to Figure 4.2).

When delivered from factory, a standard tripping time characteristic is set in the relay. This can be changed by entering 6 pairs of values U/f and T, from which the relay calculates a user defined tripping time characteristic. The intermediate values are interpolated.

The logic diagram of the overflux protection is illustrated in Figure 4.3.

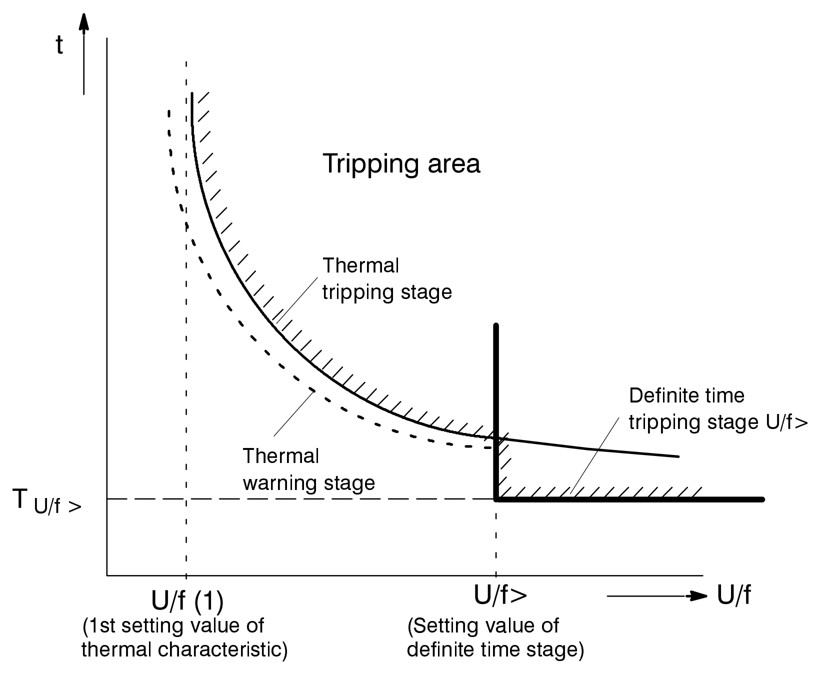


Figure 4.2 Tripping time characteristic of the overflux protection – pre-settings

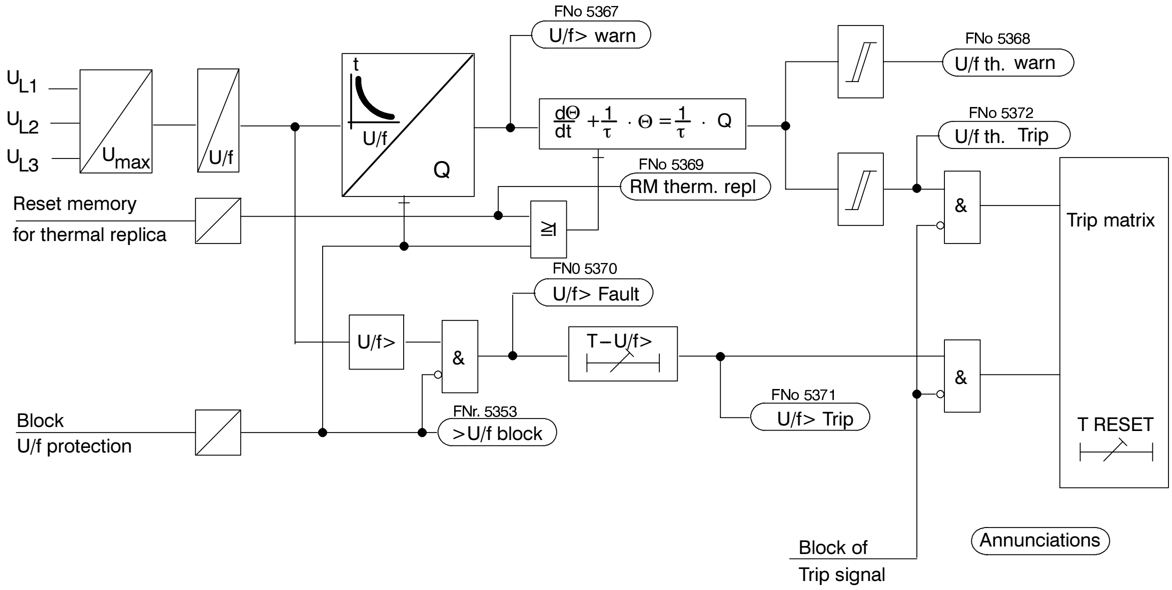


Figure 4.3 Logic diagram of the overflux protection

4.3 Undervoltage protection U<

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.

For this, the fundamental wave of the positive sequence system is paramount. The phase voltages are filtered by the protection (Fourier analysis) and only the fundamental waves are evaluated. Of these, the protection only detects the positive sequence system.

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

The undervoltage protection provides a voltage dependent tripping time characteristic. This is composed of six pairs of voltage values with associated time delays. Figure 4.4 illustrates the tripping time characteristic. The delay times for voltages between these pairs of values are gained from linear interpolation.

If the measured voltage drops below the smallest voltage value U_1 but grows then in to the range of the hysteresis, the protection will trip after the delay time T_1 (see also Figure 4.4).

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 a voltage transformer m.c.b.

Figure 4.5 shows the logic diagram of the undervoltage protection.

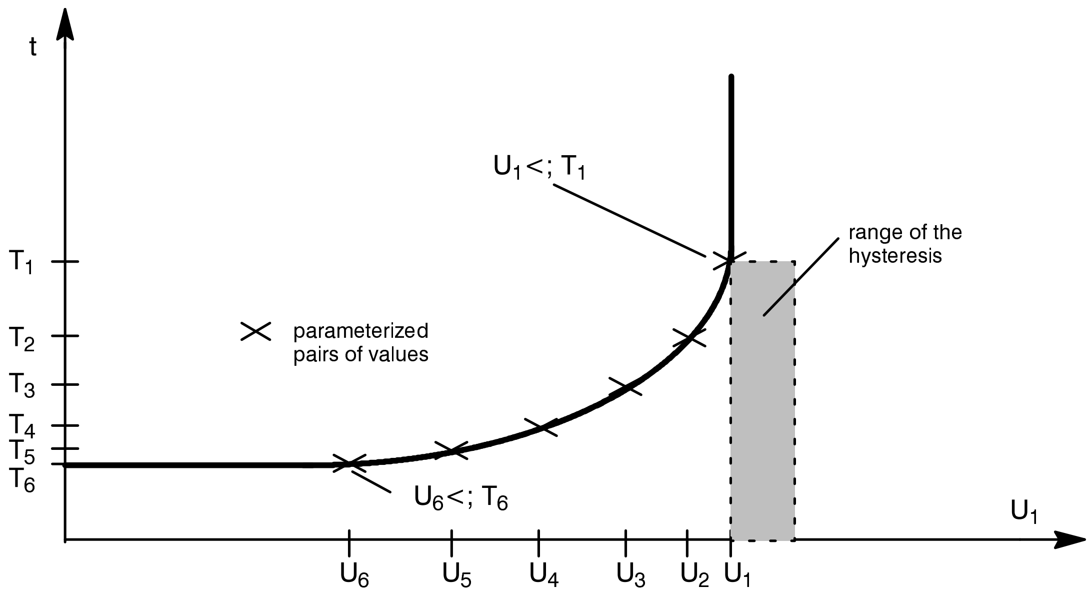


Figure 4.4 Tripping time characteristic of undervoltage protection – example

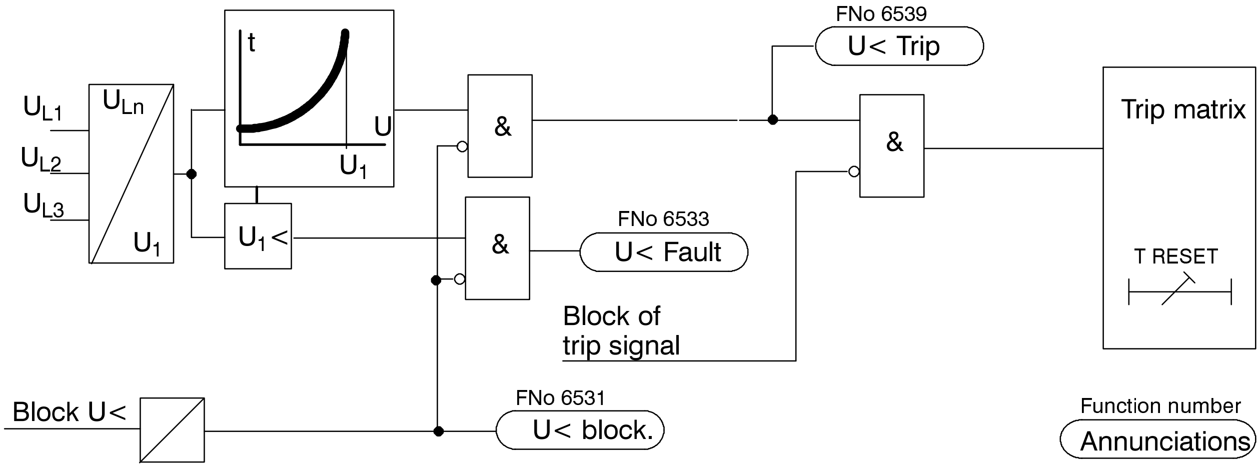


Figure 4.5 Logic diagram of undervoltage protection

4.3 Overvoltage protection U>, U>>

Overvoltage protection has the task of protecting the electrical machine, 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 protection is fed by the three phase-to-earth voltages. Numerical filters ensure that only the fundamental waves are processed and harmonics are suppressed. The overvoltage protection evaluates the highest of the three phase-to-phase voltages (calculated from the phase-to-earth voltages). Time stages are provided to bridge out short voltage rises. A large overvoltage initiates a fast trip by the U>> stage; a small overvoltage initiates a long-time trip by the 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 a binary input.

Figure 4.6 shows the logic diagram of the overvoltage protection.

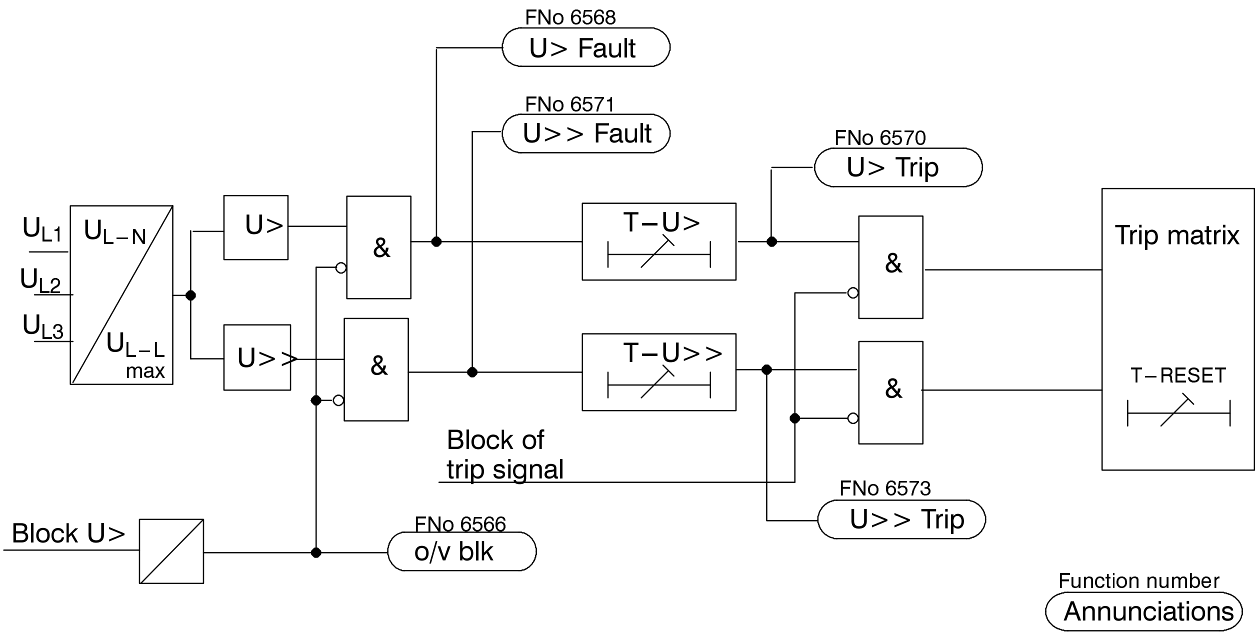


Figure 4.6 Logic diagram of the two-stage overvoltage protection

4.5 Stator earth fault 100 % protection R_E<

The stator earth fault 100 % protection detects earth faults in the stator windings of three-phase machines which are connected via a block unit transformer to the system.

The protection operates with a 20 Hz bias voltage and is independent of the occurrence of a system frequency displacement voltage. Thus, the protection detects earth fault in the entire winding zone including the machine star-point.

The bias voltage amounts to approximately 1 % of the rated phase voltage; the winding insulation is thus not additionally stressed. During earth faults, the 20 Hz voltage source drives a very small earth current through the earth fault point.

The protection can be coupled to the system via a line connected earthing transformer with open delta secondary windings, in parallel to the load resistor R (refer to Figure 4.7). Alternatively, connection to a neutral earthing transformer is possible; this is connected between the star-point of the machine and earth (Figure 4.8).

The 20 Hz bias voltage, produced by an external 20 Hz generator (G), is filtered (F) and causes a voltage drop across the loading resistor R. It is connected via the voltage divider VD to the relay input U_{SEF}. This voltage is transformed to the stator circuit by the earthing transformer and produces a displacement of the stator star-point voltage. Thus, a small current will flow through the stator earth capacitances.

This current is transformed by an intermediate current transformer ICT and fed to the protection relay input I_{SEF}.

The measured quantities U_{SEF} and I_{SEF} are processed by numerical filters and form the 20 Hz measuring quantities, the phasors U_{20} and I_{20}. Different frequencies, particularly the system frequency, are eliminated. The stator earth resistance is calculated from U_{20} and I_{20}.

Calculation is averaged over several 20 Hz periods. That is why the measuring time is relatively long.

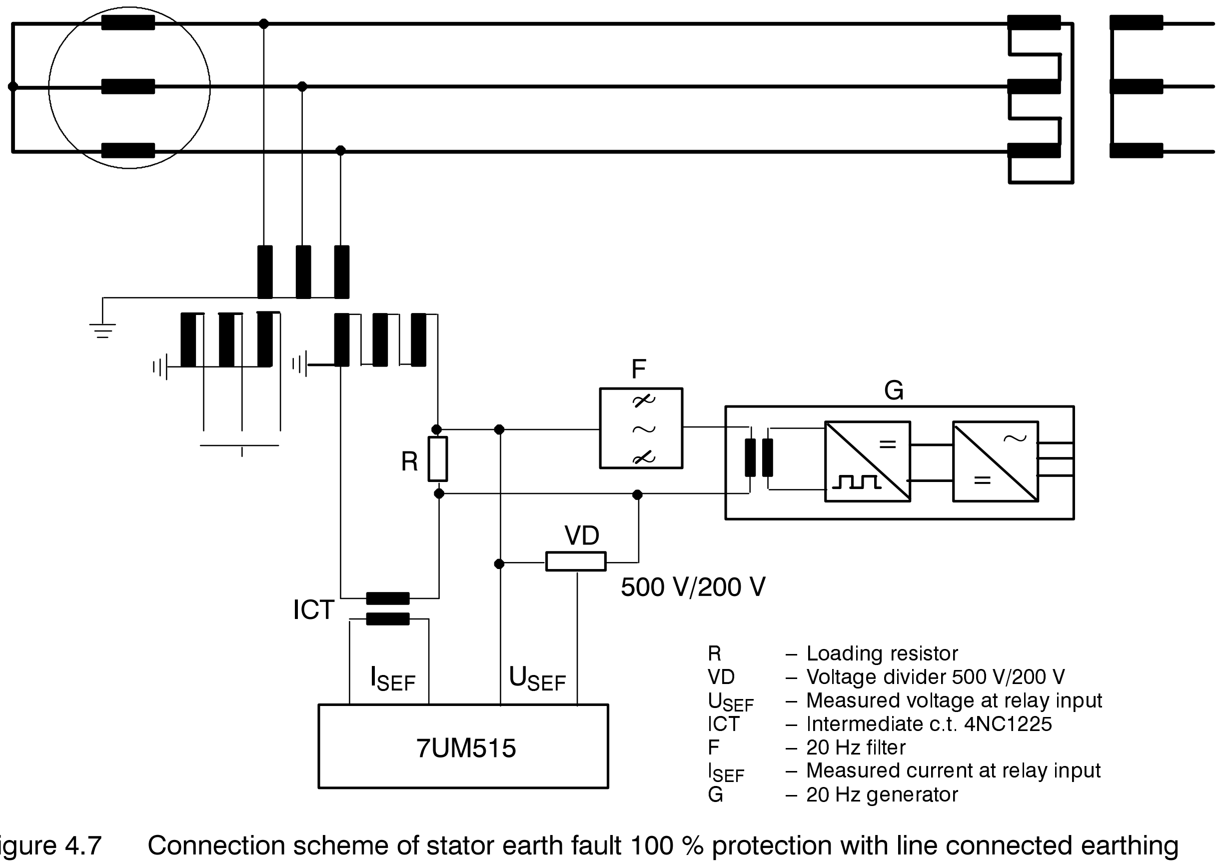


Figure 4.7 Connection scheme of stator earth fault 100 % protection with line connected earthing transformer

Measurement accuracy can be improved by internal compensation of the phase angle error of the measuring transformers, i.e. the earthing transformer, intermediate c.t. as well as the input transformers within the relay.

The earth resistance is calculated in the frequency range of 40 Hz to 70 Hz. For lower frequencies, calculation with 20 Hz is not useful because the generator frequency could interfere with the 20 Hz quantities. This would be the case during run-up or shutdown of the machine.

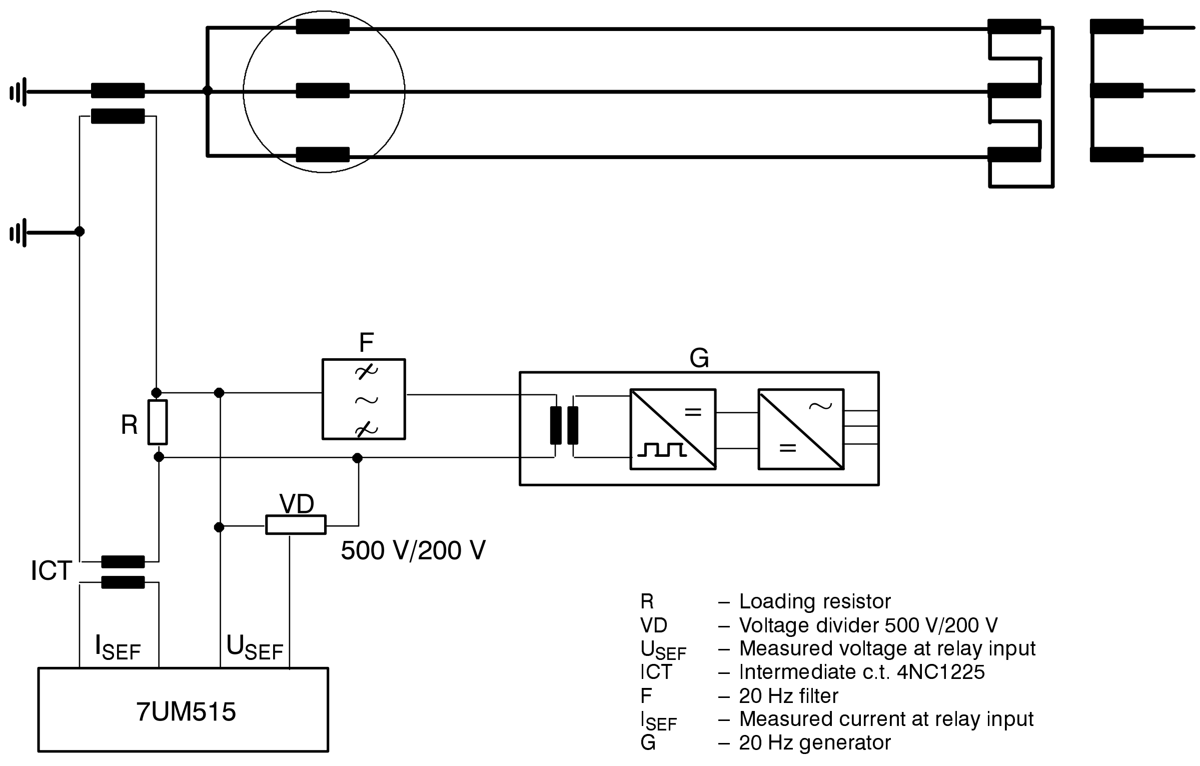
The stator earth fault 100 % protection is operative also when no other measured quantities are present at the measuring inputs of 7UM515. For commissioning, e.g., the stator earth resistance can thus be measured by means of the 20 Hz quantities even when "Operating condition" is not indicated, i.e. even when the frequency is 0.

The measured current I_{SEF} is, additionally, monitored by a current stage (S/E/F I>>). This stage is independent of the resistance measurement and processes the total earth current, i.e. unfiltered. If, with an earth fault near the machine terminals, the earth fault current exceeds the limit of this current stage, earth fault is detected even without resistance measurement. This is useful because the high system-frequency-voltage in this case produces a high system-frequency-current whereas the 20 Hz current is small; the earth fault can be detected immediately.

The displacement voltage from the earthing transformer is normally 500 V with a machine terminal earth fault. It is transformed to a lower value of 200 V by a voltage divider 500 V/200 V.

When the 20 Hz bias voltage fails, earth resistance measurement is no more possible and resistance calculation is blocked. Nevertheless, the earth current monitor remains operative! When the set value S/E/F I>> is exceeded, tripping is thus ensured.

Figure 4.9 shows the logic diagram of the stator earth fault 100 % protection.



R – Loading resistor
VD – Voltage divider 500 V/200 V
U_{SEF} – Measured voltage at relay input
ICT – Intermediate c.t. 4NC1225
F – 20 Hz filter
I_{SEF} – Measured current at relay input
G – 20 Hz generator

Figure 4.8 Connection scheme of stator earth fault 100 % protection with neutral earthing transformer

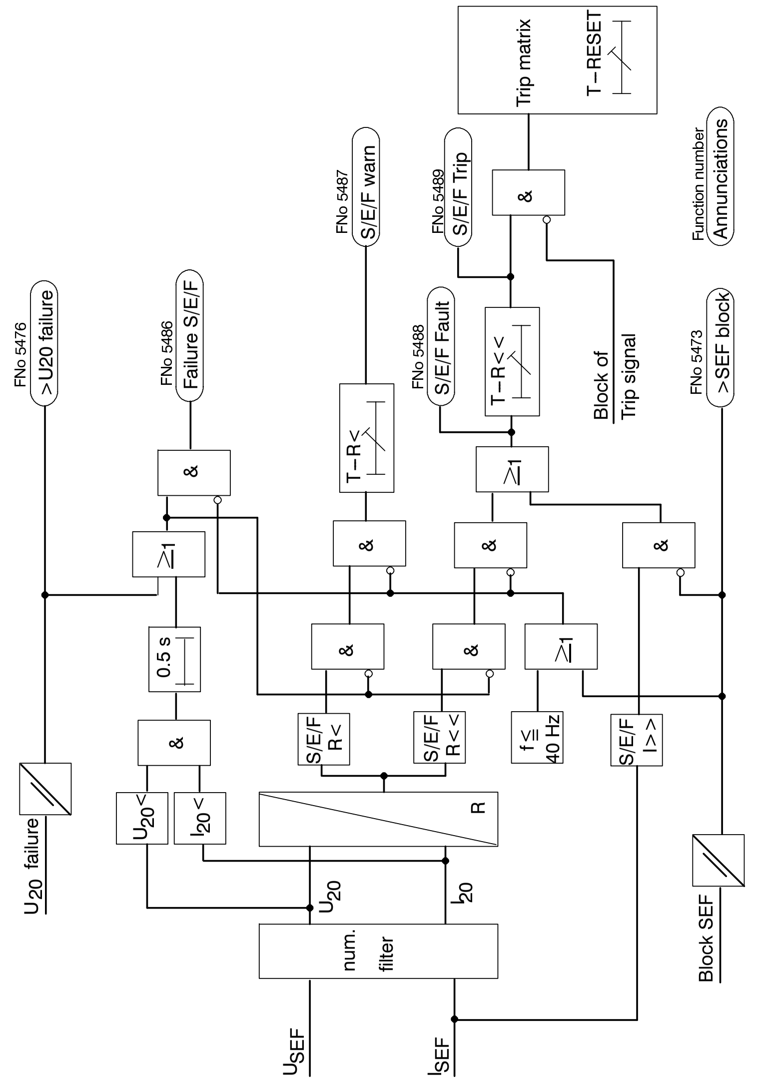


Figure 4.9 Logic diagram of the stator earth fault 100 % protection

4.6 Earth fault protection U_0>

The earth fault protection measures the displacement voltage which occurs in case of an earth fault. The earth fault protection in 7UM515 is also suitable to detect earth faults between generator isolator and other isolators, particularly on the stub or busbar, e.g. for power station unit transformer and power station auxiliary transformer (refer figure B.1 in appendix B).

The earth fault protection provides, additionally, back-up protection for earth fault in the stator circuit of the generator, as long as the generator isolator is closed. With displacement voltage pick-up at 10 % to 15 % of the full displacement voltage, the protected zone of the generator windings is 85 % to 90 %.

The achieved sensitivity of the protection is only limited by power frequency interference voltages during an earth fault in the network. These interference voltages are transferred to the machine side via the coupling capacitances of the block transformer. If necessary, a loading resistor can be provided to reduce these interference voltages. The protection initiates disconnection of the machine when an earth fault in the protected zone has been present for a set time.

The displacement voltage can be measured via the e–n winding (open delta winding) of a voltage transformer set or the measurement winding of a line connected earthing transformer (refer to Section 5.2.5). If it is used for stator earth fault protection only, the displacement voltage can also be measured at the machine starpoint via voltage transformers or neutral earthing transformers. Since the neutral earthing transformer or the line connected earthing transformer usually supply a displacement voltage of 500 V (with full displacement), a voltage divider 500 V/100 V is to be connected in such cases.

In all kinds of displacement voltage formation, the components of the third harmonic in each phase are summed since they are in phase in the three-phase system. In order to obtain reliable measured quantities, only the fundamental of the displacement voltage is evaluated in the earth fault protection. Harmonics are filtered out by numerical filter algorithms.

Figure 4.10 shows the logic diagram of the earth fault protection.

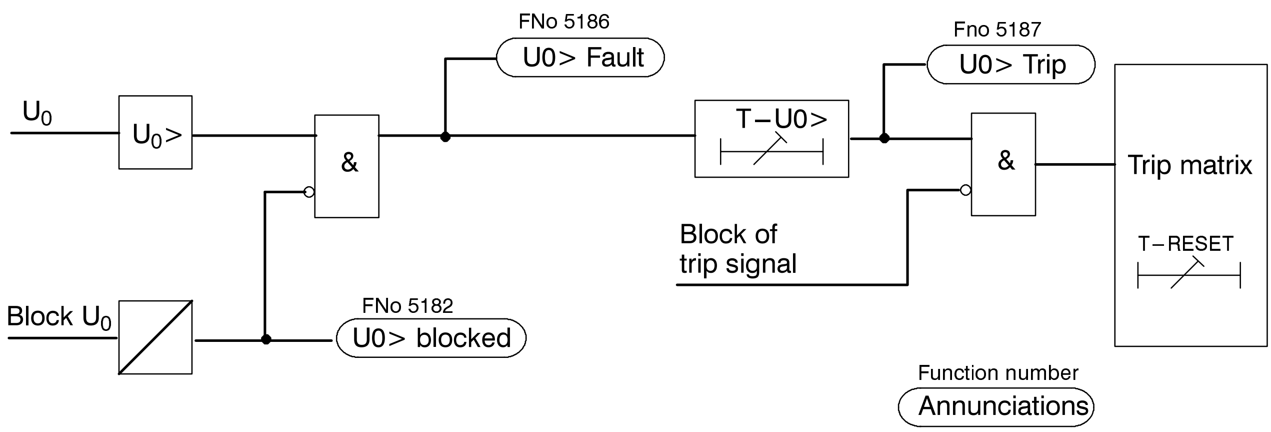


Figure 4.10 Logic diagram of the earth fault protection U_0>

4.7 Frequency protection

Frequency protection is used to disconnect electrical machines from the network in the event of an impermissible underfrequency or overfrequency condition.

The cause of **under**frequency 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 machine protection 7UM515 includes four high-accuracy 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.

The unit uses two operating steps to determine the frequency from the positive sequence system of the voltages:

Firstly, the frequency is roughly ascertained from the measurement of the period duration, i.e. from the distance between two zero passes. This results in the “base frequency” f_b.

In order to accurately determine the frequency, the angular speed of the measured voltage vector (with actual frequency) referred to the base frequency is measured, i.e. the difference between actual frequency and base frequency f_b. This is done by measuring the phase angle between measured frequency vector and base frequency vector over 36 sample values, i.e. in the time interval of 3 a.c. periods.

Since the frequency is not derived directly from the sine of the voltage, but from the change in angle of two sinusoidal signals with small frequency difference, a high accuracy can be achieved.

Trip signal is initiated when the frequency has exceeded the set threshold value (for each stage separately) for a number which can be set as “measurement repetitions”. By this way, trip delay is determined by the set number of measurement repetitions. Each measurement takes three a.c. periods. Thus, the trip delay can be derived from the formula:

$$t_{trip} = 3 \cdot \frac{n}{f_{system}} + 100\text{ ms}$$

where: f_{system} actual system frequency
n number of repeated measurements, as set by the operator

A “frequency fault” signal is given after half the number of measurement repetitions, individually for each stage. Note that this fault signal represents the start instant for fault detection: The trip time as indicated in the fault annunciations shows the time from fault detection to trip, i.e. in case of frequency protection only half the total time from under/overfrequency to trip.

The unit continuously supervises the measurement voltage. If the positive sequence component of the voltages drops below a certain value, the measurement repetition counters are decremented. If “frequency fault” had been detected, this signal resets when the counter is 0.

Blocking of frequency measurement and tripping can also be initiated by connecting external signals via binary inputs. In this case also the counter of the blocked stage is decremented until 0, as above.

If the frequency reverts to less than 39 Hz, high-accuracy measurement is not possible, but underfrequency is detected: The counters of **under**frequency protection are **in**cremented, until “underfrequency fault” and finally trip signal are given. The **over**frequency protection counter is **de**cremented until 0 should it has been greater than 0.

If the frequency is below 11 Hz or higher than 69 Hz or, if the measured voltage is too small for frequency determination, “operating condition 1” is not fulfilled, i.e. no suitable measured quantities are present:

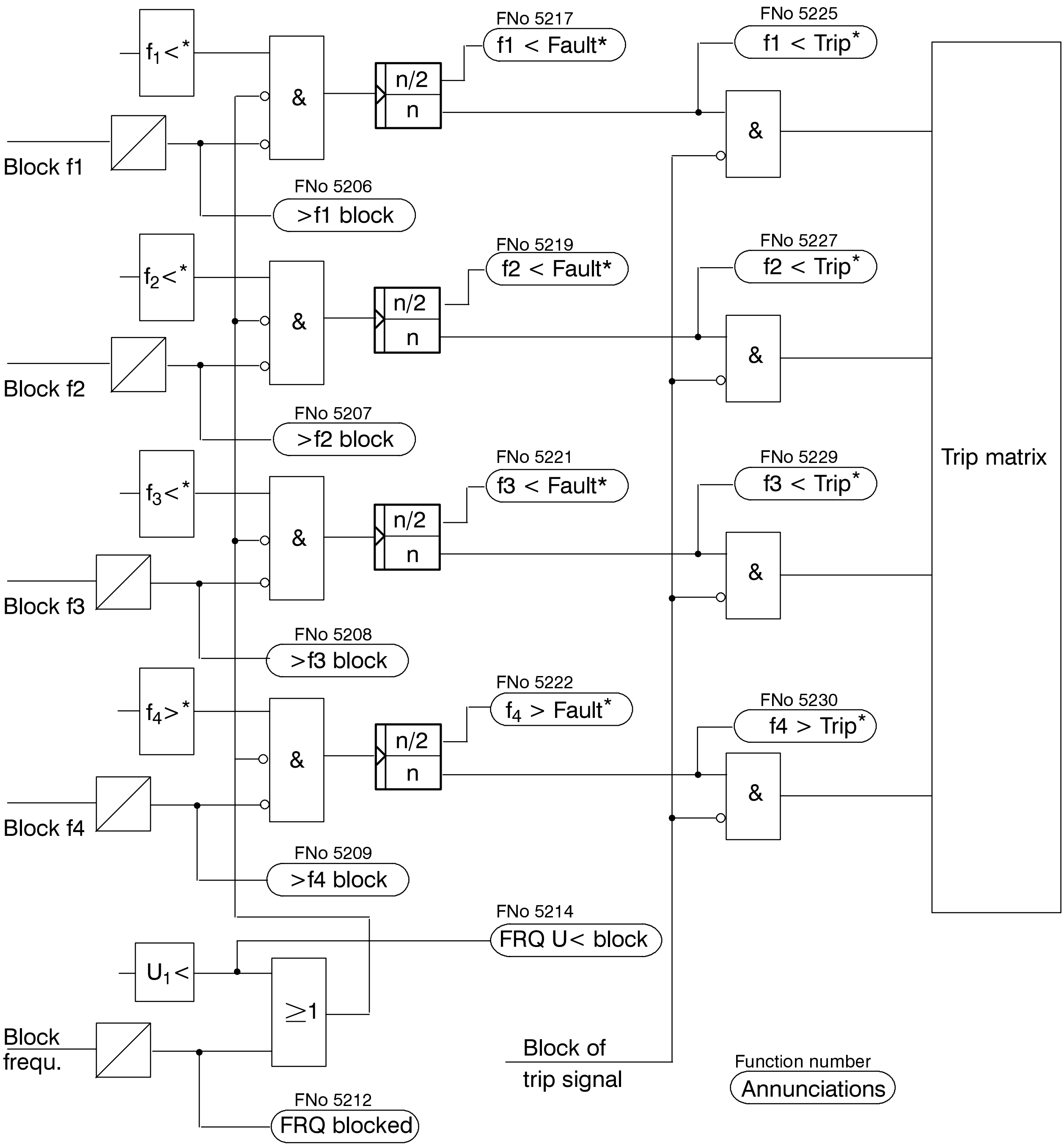
The counter of the **under**frequency stages are **de**cremented until 0. If “frequency fault” had been detected, this signal resets when the counter is 0.

If the **over**frequency protection counter has already counted to 1 or higher and the frequency has been higher than 66 Hz, when “operating condition 1” disappears, the counter is **in**cremented every three a.c. periods until the set number of measurement repetitions has been reached. This ensures overfrequency tripping even in case the frequency rise higher than 69 Hz. For application as overspeed protection of small hydro-electric machines or gas-turbine sets with possibly high rate-of-change in frequency $^{df}/_{dt}$, it must be ensured that overfrequency has been detected before the frequency leaves the operating range of the frequency protection , i.e. the frequency rises above 69 Hz. This is fulfilled when the rate-of-change in frequency is below 8 Hz/s.

If overfrequency is not detected before the “operating condition 1” has disappeared, or if none of the three voltages is present of sufficient magnitude, the counter is decremented until zero is reached: the protection drops off.

When a trip command has been issued before the upper operating limit of 69 Hz has been exceeded, trip is sealed in until the frequency protection stage is blocked or until suitable measured quantities (i.e. within the permissible operating range) are present again.

Figure 4.11 shows the logic diagram of the frequency protection.



* The pick-up symbols and the annunciations are illustrated for the preset configuration of the frequency protection. If the configuration is changed, the symbols < and > may appear interchanged.

Figure 4.11 Logic diagram of the frequency protection

4.8 Interturn fault protection U_{IT}>

The interturn fault in an electrical machine is detected by measuring the displacement voltage $U_{I/T}$ occurring with this kind of fault.

Three two-phase-insulated voltage transformers are used. The primary windings of the voltage transformers are star-connected; the star-point of these is connected to the machine star-point by a high voltage cable. The star-point of the voltage transformer set must not be earthed since this would earth the machine star-point: each earth fault would lead to a single-phase short-circuit. The secondary windings of the voltage transformer set are open delta connected and led to the relay (refer to connection scheme in Figure 4.12).

If an interturn short-circuit occurs, the centre point of the voltage triangle is displaced by a displacement voltage which should be called $U_{I/T}$. This displacement voltage is detected by the interturn fault protection. In order to obtain reliable measured quantities, only the fundamental of the displacement voltage is evaluated. Harmonics are filtered out by numerical filter algorithms.

As long as the machine is without interturn fault, no fundamental of the open delta voltage is measured.

This protection may, alternatively, be used as single-phase overvoltage protection, due to its large setting range.

Figure 4.13 shows the logic diagram of the interturn fault protection.

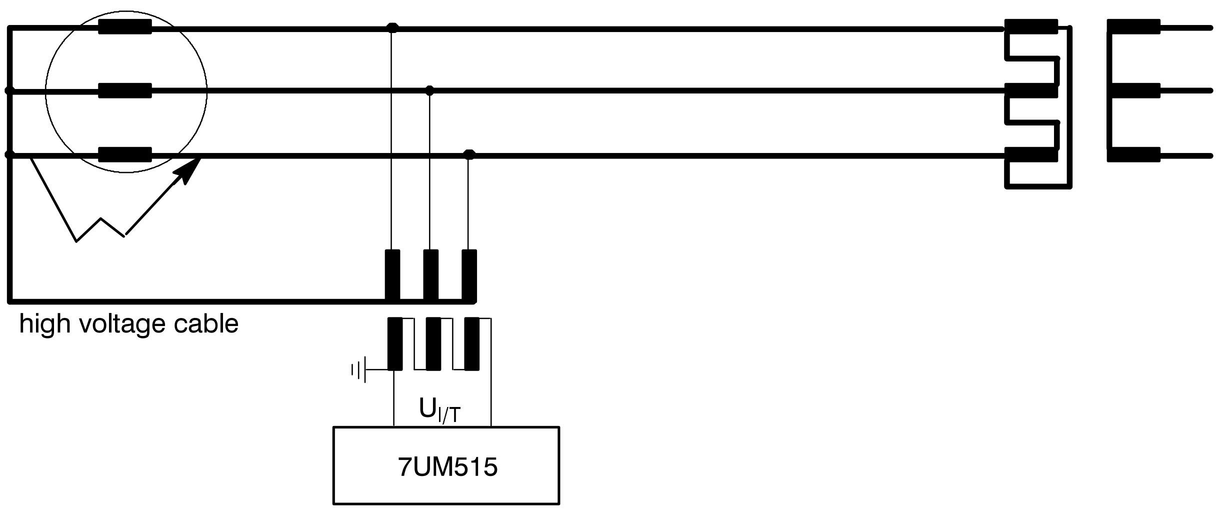


Figure 4.12 Connection scheme of interturn fault protection

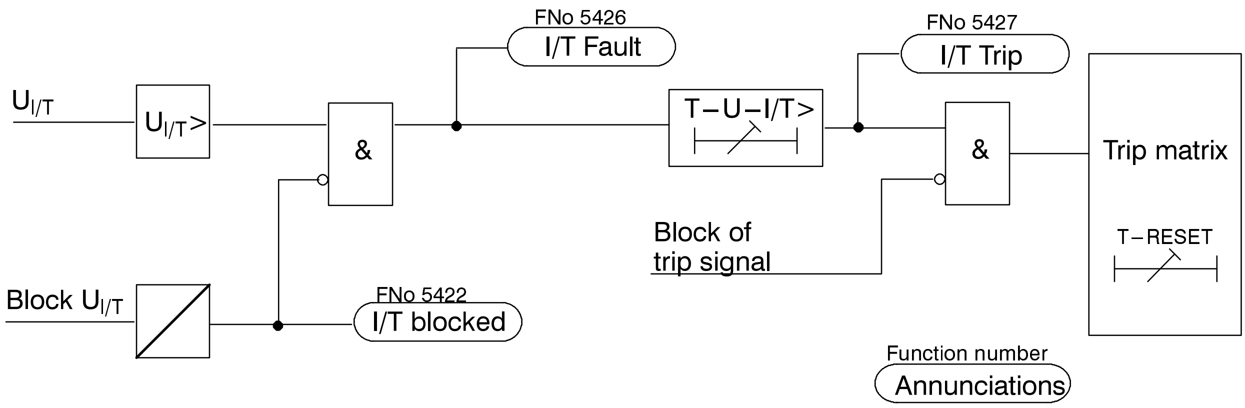


Figure 4.13 Logic diagram of the interturn fault protection

4.9 Rotor earth fault protection R_E<

Rotor earth fault protection is used to detect high- and low-ohmic earth faults in the excitation circuit of synchronous machines. One earth fault in the excitation winding does not cause immediate damage; however, if a second earth fault occurs, then this represents a winding short-circuit of the excitation circuit. Magnetic unbalances can occur resulting in extreme mechanical forces which can lead to the destruction of the machine.

4.9.1 Internal measurement procedure

The rotor earth fault protection in the 7UM515 uses a 50 V d.c. bias voltage U_g the polarity of which is reversed approximately 1 to 8 times per second. The voltage is generated in an external controller unit 7XT7⋆. The voltage U_g is symmetrically coupled to the excitation circuit via a coupling unit 7XR6002 or 7XR6003 with high-ohmic coupling resistors and simultaneously connected via a low-ohmic measurement shunt R_M to earth (Figure 4.14).

At each polarity reversal, this bias d.c. voltage U_g drives a small charging current I_g through the coupling unit and the capacitances of the excitation circuit to earth. The current causes a proportional voltage drop across the measuring shunt R_M. This voltage U_M is connected to the protection relay input for further processing.

The use of a d.c. bias voltage eliminates the influence of the earth capacitances of the excitation circuit on the resistance measurement. For this reason, after each described polarity reversal, resistance calculation is only carried out after the shunt voltage U_M has stabilized to the steady-state value, i.e. the rate of change in U_M is practically 0. Thus, measurement is independent of the magnitude and fluctuations in the capacitance of the excitation circuit and even high-ohmic earth resistances can be detected.

However, the measurement could be falsified by two interference quantities: Firstly, depending on the location of the earth fault within the rotor winding, a d.c. voltage from the excitation voltage occurs in the measurement circuit. Secondly, high a.c. voltages can be superimposed upon the excitation d.c. voltage.

In order to prevent resistance calculation from the influences of a.c. voltages (particularly in case of static excitation devices with thyristors or rotating rectifiers), the measured voltage is filtered by numerical algorithms.

The d.c. interference is eliminated by the following method: The polarity of the bias d.c. voltage U_g is consecutively reversed and repeated measurements are taken. Reversing the polarity is effected in the controller unit 7XT70 automatically by a control pulse U_C from the protection unit after it has recognized the steady-state condition in the measured voltage U_M and stored it for calculation. The time periods between the bias voltage reversals depend on the earth capacitance and the earth resistance of the excitation circuit. In the controller unit 7XT71, bias voltage reversals are executed with fixed periods that are detrmined during commissioning.

The difference is formed between two successive measurements, I_{g1} and I_{g2} (refer to Figure 4.15). Thus, the d.c. components from the excitation circuit cancel each other whereas the d.c. components of the measured current I_g (produced by the bias voltage U_g) are added.

The value thus derived is directly a measure for the earth conductance of the excitation circuit. It is used for the protection function as well as for indication of the earth resistance, e.g. in the display of the unit.

The earth resistance supervision is of two-stage design. Usually an alarm is initiated if the earth resistance falls below an initial high-ohmic stage (e.g. 40 kΩ). If the value falls below the second low-ohmic stage (e.g. 5 kΩ), then tripping will be initiated after a short time delay.

The rotor earth fault protection can be switched over to test mode by energization of a binary input. A simulated earth fault does not cause trip, in this mode, but produces a separate test annunciation. Switching to test mode is not possible as long as pick-up of the protection has already occurred before.

Since a current flows even during healthy operation, i.e. the capacitive charging current at each polarity reversal, the protection can recognize and alarm an interruption in the measurement circuit, provided the capacitance to earth is at least 0.15 μF. Additionally, failure of the controller unit (7XT7⋆) is recognized and signalled.

The rotor earth fault protection of the 7UM515 can be combined – with certain restrictions – with rotor earth fault protection relays which operate with a system frequency bias voltage, since it operates with a d.c. bias voltage.

Figure 4.16 shows the logic diagram of the rotor earth fault protection.

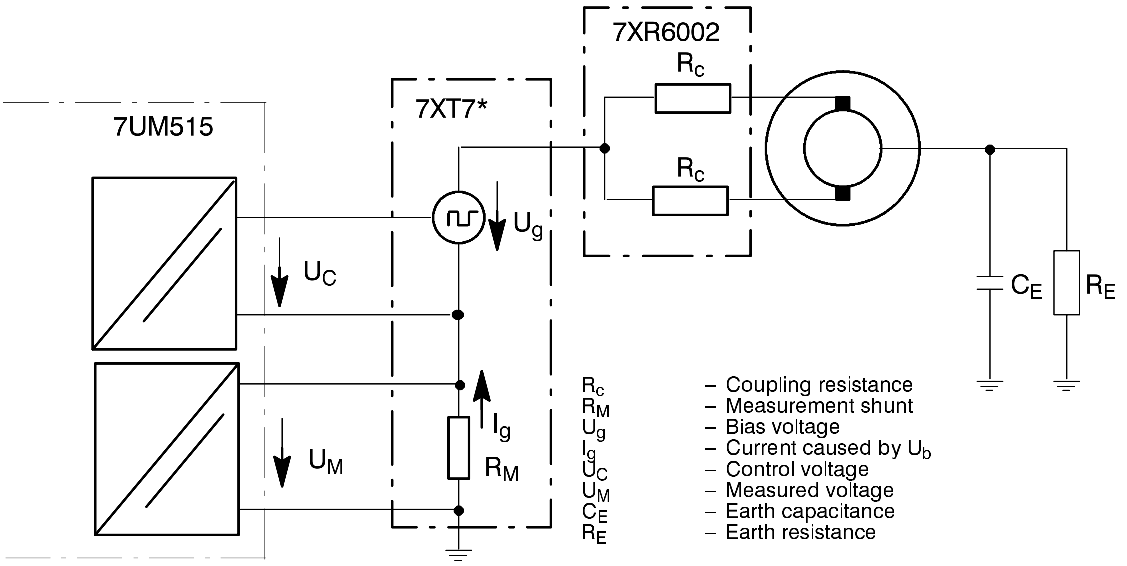


Figure 4.14 Connection scheme of rotor earth fault protection

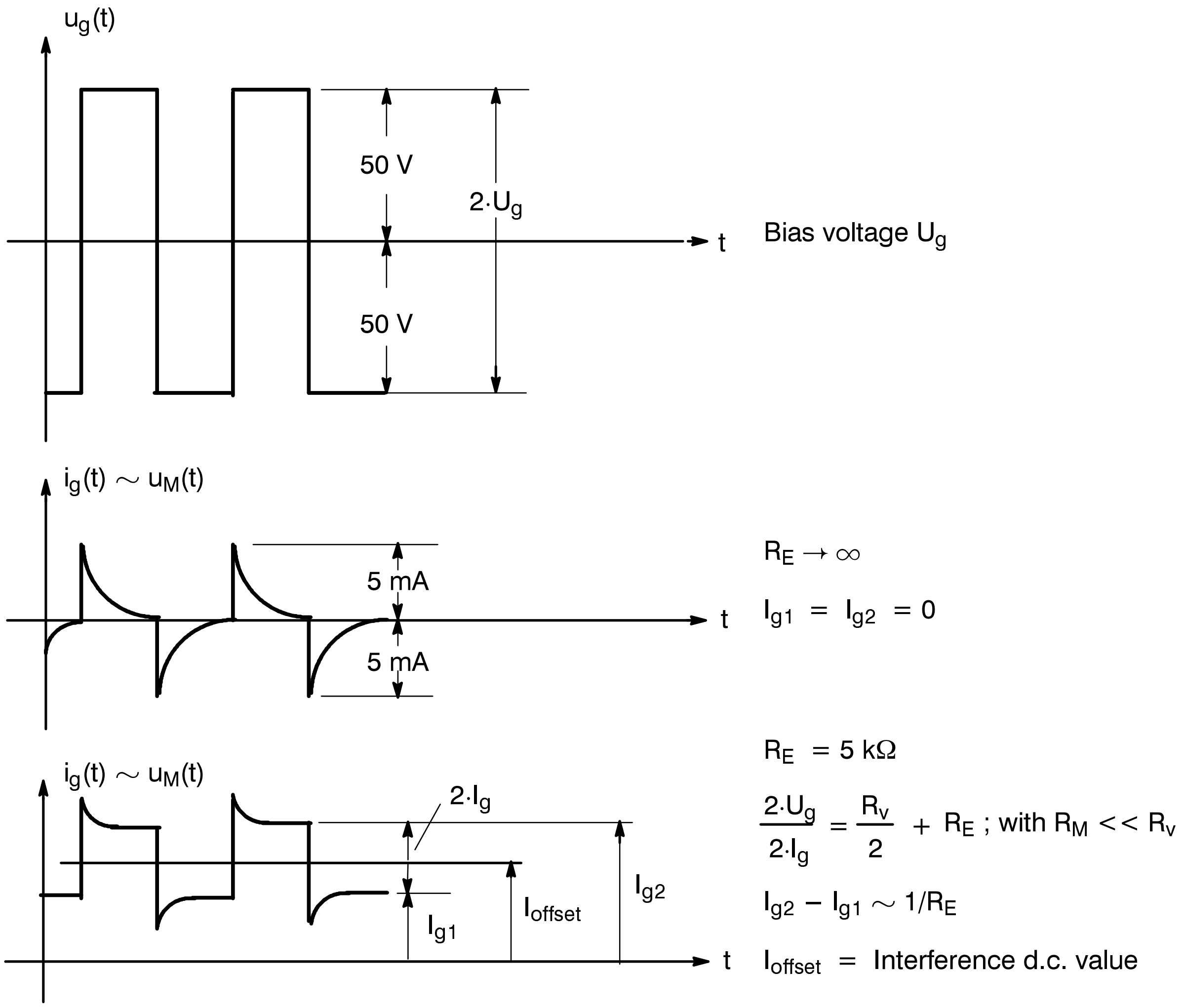


Figure 4.15 Time diagram of measured values, examples for measured value formation

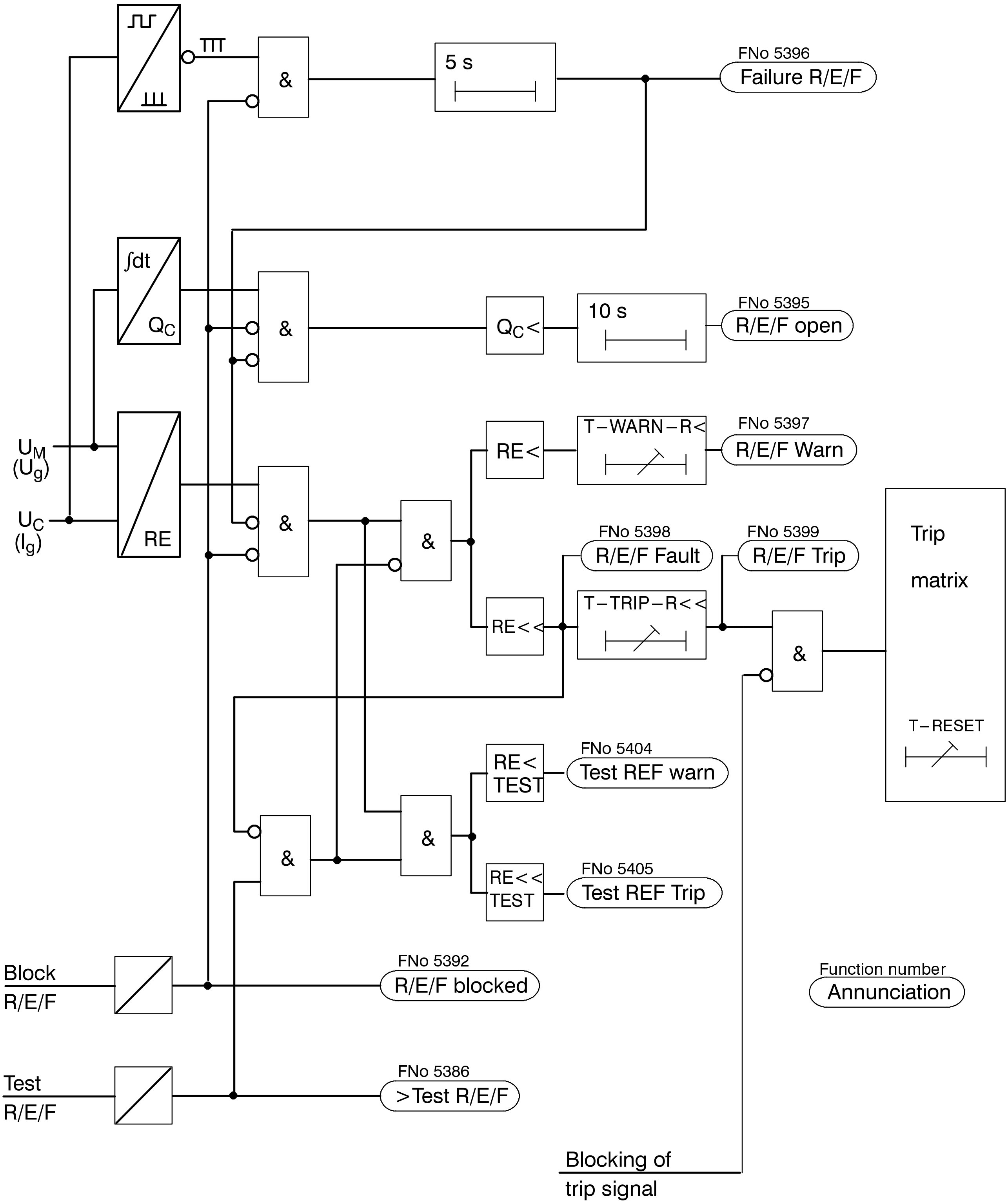


Figure 4.16 Logic diagram of the rotor earth fault protection

4.9.2 External rotor earth fault protection (RMT)

7UM515 can process the measured values of an external rotor earth fault protection device which, for example, rotates on the rotor shaft (**r**otating **m**easured value **t**ransmission, RMT). The measured value 4 to 20 mA d.c., which is transmitted from the rotating earth fault protection relay, is fed to a measuring shunt (500 Ω), which converts it into a d.c. voltage of 2 to 10 V; this voltage is adequate for the d.c. input (isolating amplifier) of 7UM515. The relay calculates the rotor earth resistance according to a conversion curve (refer also to Figure 3.3, Section 3.9.2). The result is used for the indication of the rotor earth resistance as well as for comparison with the protection threshold values of the warning and tripping stage in the same way as it is done with the internal measurement procedure.

The operating range 4 to 20 mA (transmitter output) or 2 to 10 V (relay input) allows continuous monitoring of the transmission link: values smaller than 2 V indicate a disturbance of the transmission.

A function test can be carried out without trip command: The binary input "`Test SEF`" is energized whilst a measured signal is applied to the d.c. input. Thus, the normal warning and tripping stages are blocked. Special test annunciations are generated instead: "`Test REF warn`" and/or "`Test REF Trip`". Switching to test mode is not possible as long as pick-up has already occurred before.

Figure 4.17 shows the logic diagram of the rotor earth fault protection with rotating measured value transmission.

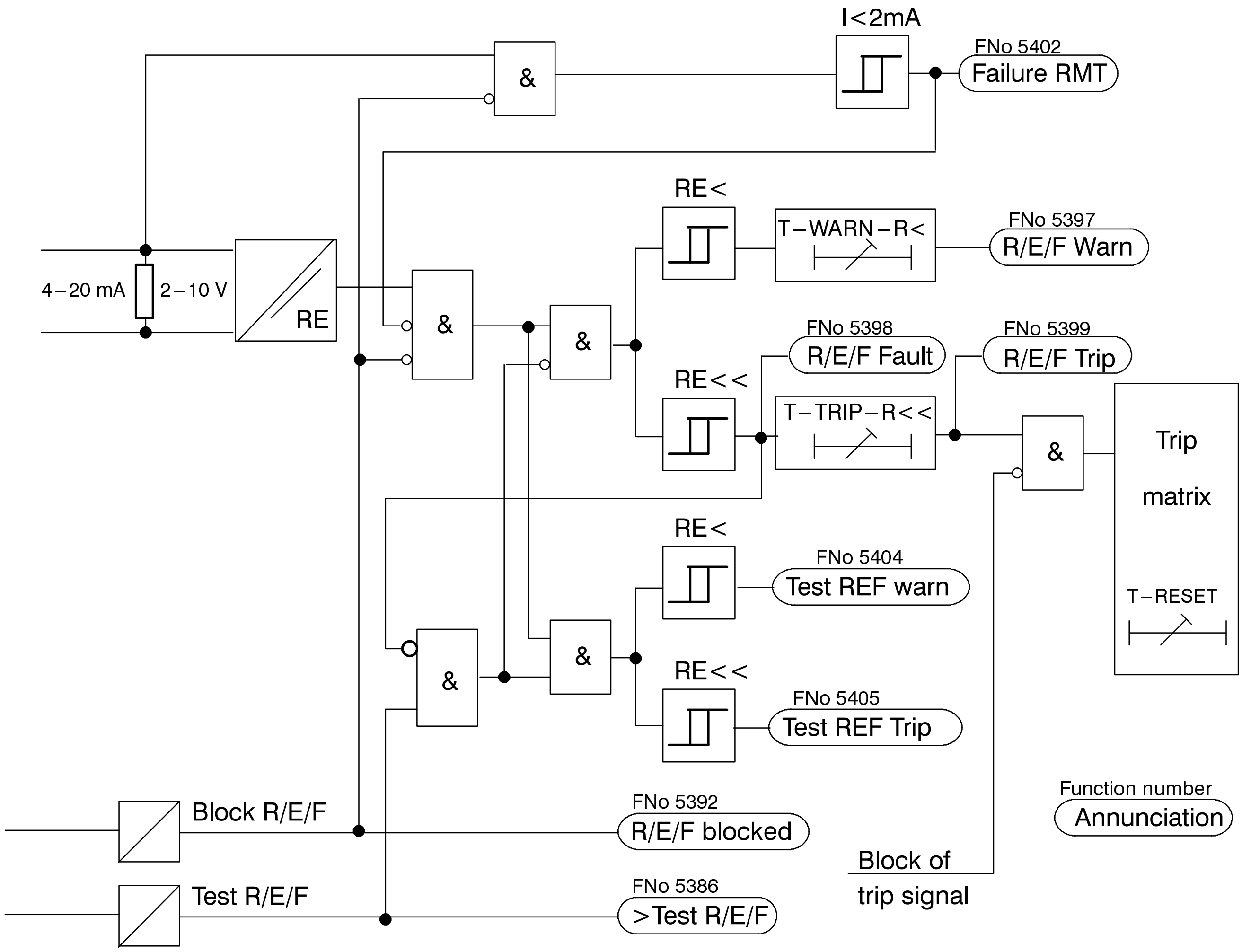


Figure 4.17 Logic diagram of rotor earth fault protection with rotating measured value transmission

4.10 External trip commands via binary inputs

Up to four desired signal from external protection or supervision units can be incorporated into the processing of 7UM515. The signals are coupled as "External signal" via binary inputs. Like the internal protection and supervision signals, they can be annunciated, time delayed, transmitted to the trip matrix, and blocked. By means of these signals it is possible to include external protection commands, e.g. from Buchholz protection or shaft current supervision, into the processing of annunciations and trip commands of 7UM515. Furthermore, an interaction of protection functions of different numerical machine protection relays of the series 7UM51 can be performed.

The status of the assigned inputs is checked in cyclic intervals. Alteration of the input status is considered only after two subsequent status checks with equal result. An additional time delay T−DELAY is available for each of the external trip command channels, a drop-off delay T−RESET can equally be set.

The logic diagram of one external trip command channel is illustrated in Figure 4.18. In total, the relay incorporates four such channels, i.e. four times this logic. The illustrated function numbers are valid for the first external trip command channel.

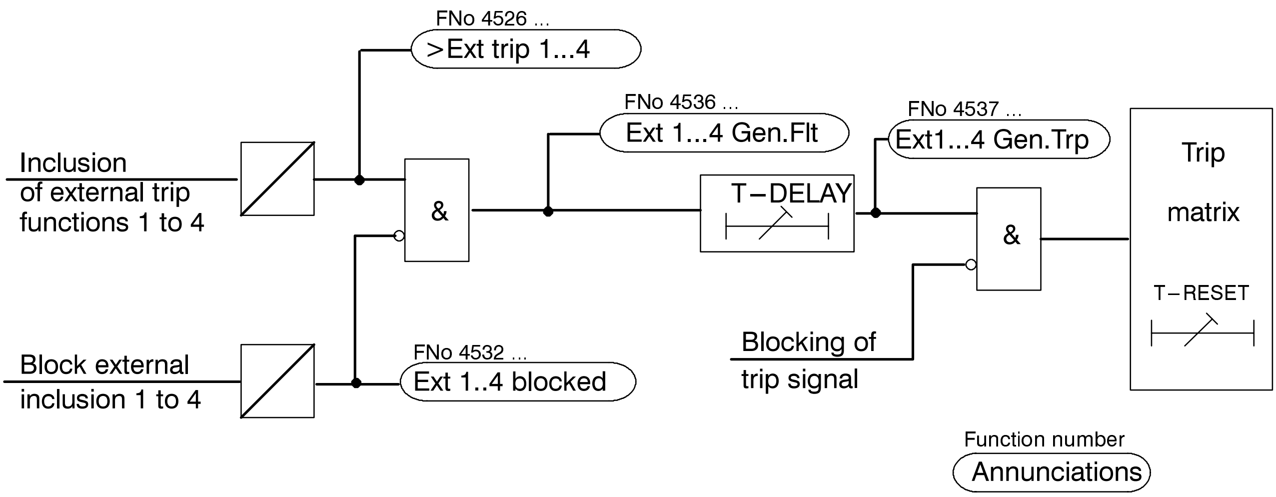


Figure 4.18 Logic diagram of one external trip command channel

4.11 Switch-over of the phase rotation

The relay provides the facility to change the phase rotation via energization of a binary input. This allows to use all protection functions in case the phase rotation is counter-clockwise without interchanging of phases. This is useful, for example, when the relay is used for the protection of generator-motors in a pumped-storage power station, where the rotation is reversed during pumping operation of the turbo-set. When the assigned binary input is energized, all protection functions which operate dependent on the phase sequence are internally switched over to counter-clockwise phase rotation.

Switch-over of the phase rotation is registered by the relay only while its state is “operating condition 0” (no suitable measured quantities present). Furthermore, the switch-over signal must be present for at least 200 ms. After this, the phase quantities of the phases L2 and L3 are swapped. But this is relevant only for the internal calculation of the symmetrical components; the phase dedicated annunciations, fault recordings, and measured values are not affected.

During “operating condition 0” the phase rotation is determined by the state of the assigned binary input for phase rotation provided the status change of the binary input lasts 200 ms or longer. When the status change is shorter than 200 ms, it is not registered. The status change is neither registered, when the “operating condition 0” is left before the 200 ms have elapsed. During “operating condition 1” (suitable measured quantities are present), switch-over of the phase rotation is not possible. An applied signal to the binary input – once having been registered – may be removed during “operating condition 1”.

But it is recommended that the reversed phase rotation signal be applied continuously, for safety reasons: Maloperation could occur when the processor system is reset, for example after alteration of the configuration parameters of the relay.

Figure 4.19 shows the logic diagram of the switch-over function of the phase rotation.

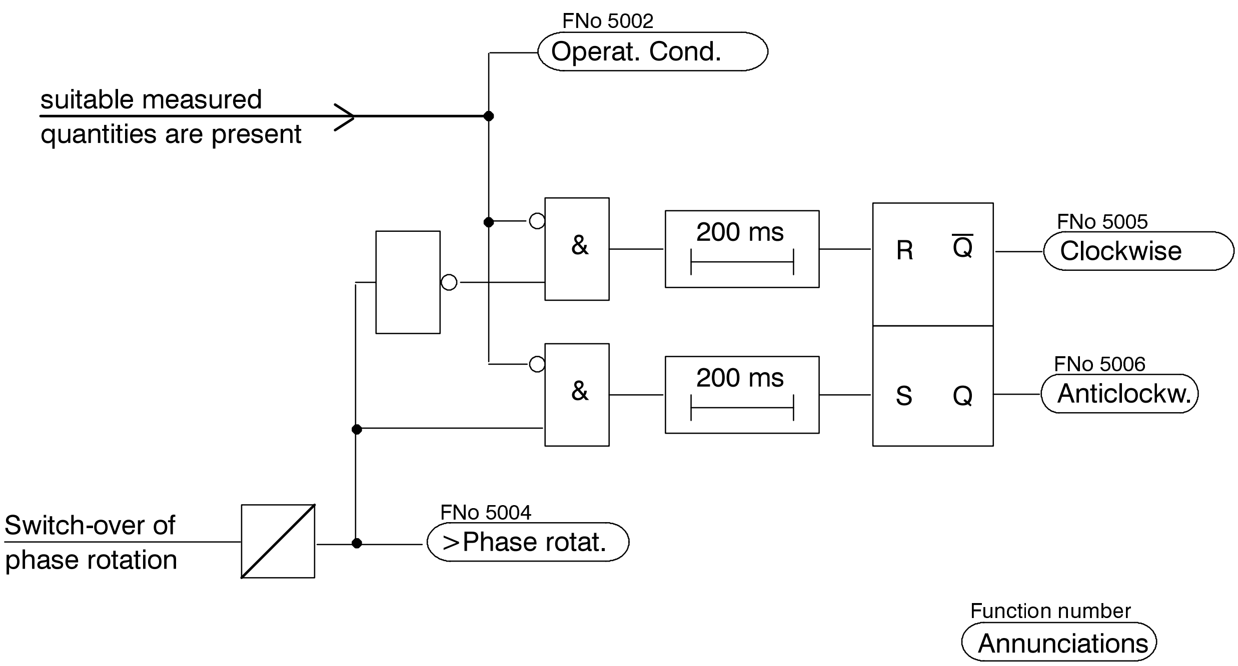


Figure 4.19 Logic diagram of the switch-over of the phase rotation

4.12 Trip matrix

The numerical machine protection 7UM51 includes an integrated trip matrix. The trip matrix represents the switching centre of the protection: The cross-bar distributor between the protection trip signals and the switching elements in the plant.

The command signals output by the different protective functions, as described in Sections 4.2 to 4.10, can be marshalled to the 5 trip relays of the unit as required. External signals such as, for example, from the Buchholz protection, pressure or temperature supervision, shaft vibration measurement, etc., can be coupled into the 7UM51 via a binary input and marshalled to the trip relays via the trip matrix. Each trip relay can be assigned to a switching element, such as a circuit breaker, de-excitation circuit-breaker, trip valve, or other control gear. Alternatively, five different tripping programs can be realized by using external master trip relays.

The procedure for programming the trip matrix and also the marshalling condition as delivered from factory are described in detail in Section 5.5.5.

4.13 Circuit breaker trip test

Numerical machine protection relay 7UM51 allows simple checking of the tripping circuits and the circuit breakers.

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

Initiation of the test cycle can be given from the operator keyboard or via the front operator interface (as described in Section 6.7.8).

4.14 Trip circuit supervision

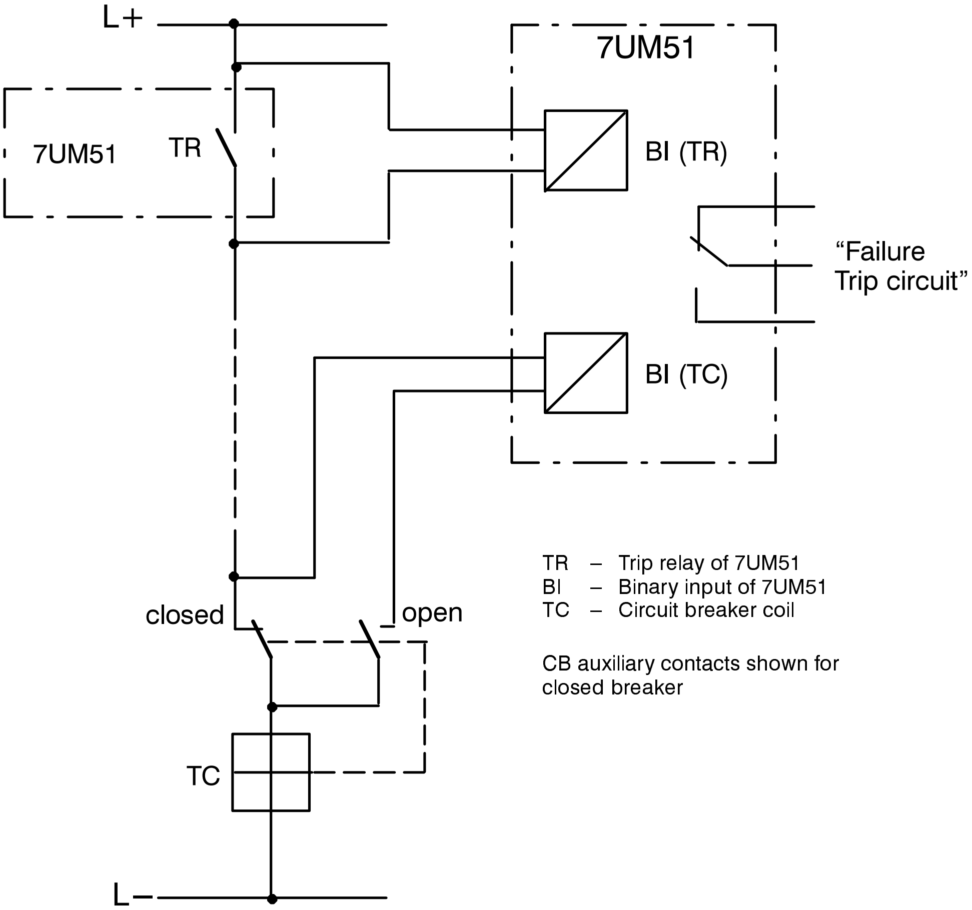
The numerical machine protection 7UM51 includes two trip circuit supervision functions. Two trip circuits can be supervised. Two binary inputs must be reserved for each trip circuit supervision. They have to be connected as shown in Figure 4.20. One input is connected in parallel to the trip relay the circuit of which is to be supervised; the other input is connected in parallel to the circuit beaker auxiliary contact or over the NO and NC auxiliary contacts as Figure 4.20 shows.

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

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 twice to three times per second. An intentional time delay for alarm can be produced by setting the number of repeated status checks before an alarm is given.



No	Trip relay	CB position	BI (TR)	BI (TC)
1	open	CLOSED	H	L
2	open	OPEN	H	H
3	closed	CLOSED	L	L
4	closed	OPEN	L	H

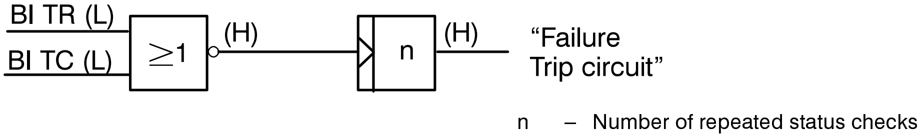


Figure 4.20 Principle of trip circuit supervision (one supervision channel)

4.15 Ancillary functions

The ancillary functions of the numerical machine protection 7UM515 include:

– Processing of annunciations,

– Storage of short circuit data for fault recording,

– Operational measurements and testing routines,

– Monitoring functions.

4.15.1 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.

4.15.1.1 Indicators and binary outputs (signal relays)

Important events and conditions are indicated by optical indicators (LED) on the front plates. The modules also contain signal relays for remote signalling. Most of the signals and indications 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 signal 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 on the relay,
– remotely by energization of the remote reset input.
– remotely via one of the interfaces.

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 “auxiliary voltage fault”, etc.

A green LED indicates readiness for operation. This LED cannot be reset and remains illuminated when the microprocessor is working correctly and the unit is not faulty. The LED extinguishes when the self-checking function of the microprocessor 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.

4.15.1.2 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.

In the quiescent state, i.e. as long as no faults are present, the display outputs selectable operating information (usually an operational measured value) in each of the two lines. In the event of a fault, selectable information on the fault appears instead of the operating information, e.g. detected phase(s) and elapsed time from fault detection to trip command. 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 4.15.1.1.

The device also has several event buffers, e.g. for operating messages etc. (see Section 6.4) which are saved against supply voltage failure by a buffer battery. These messages, as well as all 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 provided the real time clock is available. 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 four faults; if a fifth fault occurs the oldest fault is overwritten in the fault memory. The local display allows the messages of the last three faults to be read out.

A fault begins with recognition of the fault by pick-up of any protection function and ends with the latest reset of a protection function.

4.15.1.3 Information to a central unit

In addition, all stored information can be transmitted via an optical fibre connector or the isolated second interface (system interface) to a control centre, for example, the SIEMENS Localized Substation Automation System LSA 678. Transmission uses a standardized transmission protocol according to VDEW/ZVEI and IEC 60870 – 5 – 103 or (selectable) according to DIN 19244.

4.15.2 Data storage and transmission for fault recording

The device incorporates a data store which can optionally store the instantaneous values or the r.m.s. values of various measured quantities.

The instantaneous values of the measured values

u_{L1-N} , u_{L2-N} , u_{L3-N} , u_0 , $u_{I/T}$, u_{SEF} , i_{SEF} , i_{ref}

can be sampled at intervals of 12 values per 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 5 seconds.

The r.m.s. values of the quantities

$U_{pos\ seq}$, U_{L-Lmax} , U_0 , $U_{I/T}$, U_{SEF} , I_{SEF} , R_{SEF} , $f-f_N$

can alternatively be sampled in intervals of 1 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 60 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 at the front and evaluated by the protection data evaluation program DIGSI®. The currents and voltages are referred to their maximum values, normalized to their rated values and prepared for graphic visualization. In addition, signals can be marked as binary traces, e.g. “Pick-up” and “Trip”.

Additionally, the fault record data can be transmitted to a control centre via the serial system interface. Evaluation of the data is made in the control centre, using appropriate software programs. The currents and voltages are referred to their maximum values, normalized to their rated values and prepared for graphic visualization. In addition, signals can be marked as binary traces, e.g. “Pick-up” and “Trip”.

When the data are transferred to a central unit, read-out can proceed automatically, optionally after each pick-up of the relay or only after a trip. The following then applies:

– The relay signals the availability of fault record data,

– The data remain available for recall until commencement of the next fault event.

– A transmission in progress can be aborted by the central unit.

4.15.3 Operating measurements and conversion

For local recall or transmission of data, the true r.m.s. values of the voltages, the positive sequence component of the voltages, the maximum phase-to-phase voltage as well as the displacement voltages of earth fault and interturn fault protection are always available.

The following is valid:

- U_{L1E}, U_{L2E}, U_{L3E} voltages (phase-earth) in kilovolts primary and in V secondary,
- U_0 displacement voltage (earth fault),
- $\sqrt{3} \cdot U_{pos}$ positive sequence voltage,
- $U_{LL\,max}$ maximum phase-to-phase voltage,
- $U_{I/T}$ displacement voltage (interturn fault).

Additionally, the frequency, the bias voltage of the stator earth fault 100 % protection and the current produced by it, the calculated stator earth resistance, the calculated rotor earth resistance as well as the measured values of rotor earth fault protection, unbalanced load and the calculated rotor temperature rise can be read out:

- f [Hz] frequency in Hz,
- U_{SEF} bias voltage of stator earth fault protection (secondary at the relay terminals),
- I_{SEF} stator earth current in A (secondary at the relay terminals),
- R_{SEF} calculated stator earth resistance (secondary),
- R_{SEp} calculated stator earth resistance (primary),
- T_g period of bias voltage for rotor earth fault protection,
- U_g amplitude of bias voltage for rotor earth fault protection (with 7XT71),
- I_g active rotor current,
- Q_c charge of rotor voltage reversal,
- R_{REf} calculated rotor earth resistance.

Additionally, the overflux proportional value U/f (referred to U_N/f_N) and the calculated temperature rise can be read off from the display panel:

- U/f overflux $\frac{U/U_N}{f/f_N}$,
- U/f th. the calculated temperature rise of overflux protection in % of the trip temperature rise
- th.loss. referred thermal losses caused by overflux in %

4.15.4 Monitoring functions

7UM515 incorporates comprehensive monitoring functions which cover both hardware and software; furthermore, the measured values are continuously checked for plausibility so that the voltage transformer circuits are also included in the monitoring system.

4.15.4.1 Hardware monitoring

The complete hardware is monitored for faults and inadmissible functions, from the measured value inputs to the output relays. In detail this is accomplished by monitoring:

- Auxiliary and reference voltages

  The processor monitors the offset and reference voltage of the ADC (analog/digital converter). The protection is blocked as soon as impermissible deviations occur. Permanent faults are annunciated.

  Failure or switch-off of the auxiliary voltage automatically puts the system out of operation; this status is indicated by a fail-safe contact. Transient dips in supply voltage of less than 50 ms will not disturb the function of the relay (rated auxiliary voltage $\geqq$ 110 V).

- Measured value acquisition

  The complete chain, from the input transformers up to and including the analog/digital converters are monitored by the plausibility check of the measured values.

In the **voltage path**, there are four input converters: three connected to each phase-earth voltage, one further can be connected to the displacement voltage U_{EN}. A fault in the voltage circuits will be recognized when

$|u_{L1} + u_{L2} + u_{L3} + k_U \cdot u_{EN}| >$

SUM.Uthres + SUM.Fact. U x U_{max}

Factor k_U (parameter Uph/Udelta) can be set to correct different ratios of phase and open delta voltage transformer windings. SUM.Uthres and SUM.Fact. U are setting parameters (Section 6.3.10). The component SUM.Fact.U x U_{max} takes into account permissible voltage proportional transformation errors in the input converters (Figure 4.21).

Note: Voltage sum (phase-earth) monitoring can operate properly only when an externally formed open delta voltage U_{EN} is connected to the residual voltage input of the relay.

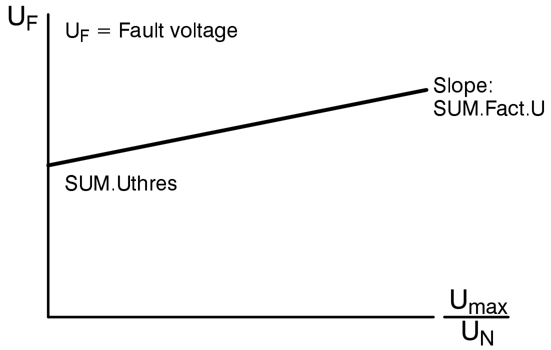


Figure 4.21 Voltage sum monitoring (voltage plausibility check)

– Command output channels:

The trip relays are controlled by two command channels and one additional release channel. Discontinuities and short-circuits in the relay control circuits are monitored.

– Memory modules:

The memory modules are periodically checked for fault by:

- Writing a data bit pattern for the working memory (RAM) and reading it,
- 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.

4.15.4.2 Software monitoring

For continuous monitoring of the program sequences, a watchdog timer is provided which will reset the processor in the event of processor 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 processor.

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 relay, thus indicating “equipment fault” and simultaneously the LED “Blocked” comes on.

4.15.4.3 Monitoring of external measuring transformer circuits

To detect interruptions or short circuits in the external measuring transformer circuits or faults in the connections (an important commissioning aid) the measured values are checked at cyclic intervals, as long as no pick-up condition exists:

– Voltage symmetry

In healthy operation it can be expected that the voltages will be approximately symmetrical. Therefore, the device checks the three phase-to-phase voltages for symmetry. Monitoring of the symmetry of the phase-to-phase voltages is not influenced by earth faults.

The following applies:

$$|U_{min}|/|U_{max}| < \text{SYM.Fact.U}$$
if
$$|U_{max}| > \text{SYM.Uthres}$$

whereby U_{max} is the largest of the three voltages and U_{min} the smallest. The symmetry factor SYM.Fact.U represents the magnitude of the asymmetry of the voltages. The threshold SYM.Uthres is the lower limit of the processing area of this monitoring function (see Figure 4.22). Both parameters can be set (see Section 6.3.10).

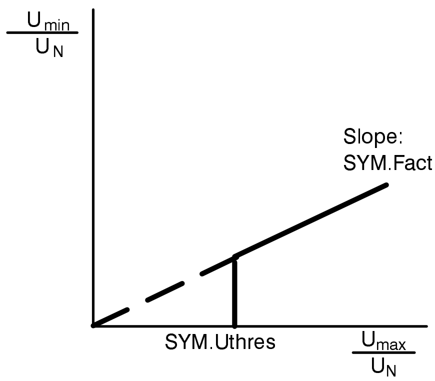


Figure 4.22 Voltage symmetry monitoring

– Phase rotation

Since correct functioning of the protection functions relies upon a clockwise sequence of the phase voltages (symmetrical components), the direction of rotation is monitored:

U_{L1} before U_{L2} before U_{L3}

This check is carried out when the measured voltages as described in 4.15.4.1 are plausible and have a minimum value of at least

$$|U_{L1}|, |U_{L2}|, |U_{L3}| > 40\ \text{V}/\sqrt{3}$$

Counter-clockwise rotation will cause an alarm.

In those cases where counter-clockwise phase rotation can occur during operation, e.g. in pumped-storage power stations, the relay must be informed about the reversal of the phase sequence via a appropriately assigned binary input. When this input is energized, the phases L2 and L3 are internally swapped in order to ensure correct symmetrical component calculation (see also Section 4.11). The phase dedicated annunciations, fault recordings, and measured values are not affected.

Table 4.1 gives a survey of all the functions of the measured value monitoring system, together with the possible causes and the associated annunciations. It is possible that more than one monitoring function operates during a certain disturbance. Blocking of any protection function does not take place.

Monitoring	Failure covered, reaction
1. Plausibility check of voltages phase – earth $\lvert u_{L1} + u_{L2} + u_{L3} +$ **Uph/Udelta** x $u_{EN} \rvert >$ **SUM.Uthres** + **SUM.Fact. U** x U_{max}	Relay failures in the signal acquisition circuits u_{L1}, u_{L2}, u_{L3}, u_E delayed alarm “`Failure ΣUp-e`”
2. Voltage unbalance (phase – phase) $\frac{\lvert U_{min} \rvert}{\lvert U_{max} \rvert} <$ **SYM.Fact.U** and $\lvert U_{max} \rvert >$ **SYM.Uthres**	Short-circuit or interruption (1-phase, 2-phase) in v.t. secondary circuits or unbalanced voltage on the system delayed alarm “`Failure Usymm`”
3. Phase rotation L1 before L2 before L3, as long as $\lvert U_{L1} \rvert, \lvert U_{L2} \rvert, \lvert U_{L3} \rvert > 40\ V/\sqrt{3}$ (Operating condition 1) and counter-clockwise rotation is not indicated via a binary input	Swapped voltage connections or reverse rotation sequence delayed alarm “`Fail.PhaseSeq`”

Bolted figures are setting values.

Table 4.1 Summary of measuring circuit monitoring

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 **e**lectrostatically **e**ndangered **c**omponents (EEC) must be observed. In installed conditions, the modules are in no danger.

5.2.1 Mounting and connections

5.2.1.1 Model 7UM515★–★B★★★ for panel surface mounting

– Secure the unit with four screws to the panel. For dimensions refer to Figure 2.2.

– Connect earthing terminal (Terminal 26) of the unit to the protective earth of the panel.

– Make a solid low-ohmic and low-inductive operational earth connection between the earthing surface at the side 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 Druseidt, Remscheid, Germany.

– Make connections via screwed terminals. Observe labelling of the individual connectors and the max. permissible conductor cross-sections.

5.2.1.2 Model 7UM515★–★C★★★ for panel flush mounting or 7UM515★–★E★★★ for cubicle installation

– Lift up both labelling strips on the lid of the unit and remove cover to gain access to four holes for the fixing screws.

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

– Connect earthing screw on the rear of the unit to the protective earth of the panel or cubicle.

– 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 Druseidt, Remscheid, Germany.

– Make connections via the screwed or snap-in terminals of the sockets 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.

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.

5.2.2.1 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 288 V. The pick-up threshold lies near 16 V. In order to optimize the operation of the inputs, they should be matched to the real control voltage to increase stability against stray voltages in the d.c. circuits.

In order to fit a higher pick-up threshold of approximately 80 V to a binary input a solder bridge must be removed. Figure 5.1 shows the assignment of these solder bridges for the inputs BI 1 to BI 4, and their location on the basic p.c.b. of the basic input/output module GEA–1. Figure 5.2 shows the assignment of these solder bridges for the inputs BI 5 to BI 8 and their location on the additional input/output module ZEA–1.

– Open housing cover.

– Loosen the basic module using the pulling aids provided at the top and bottom.

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.

– Pull out basic module and place onto a conductive surface.

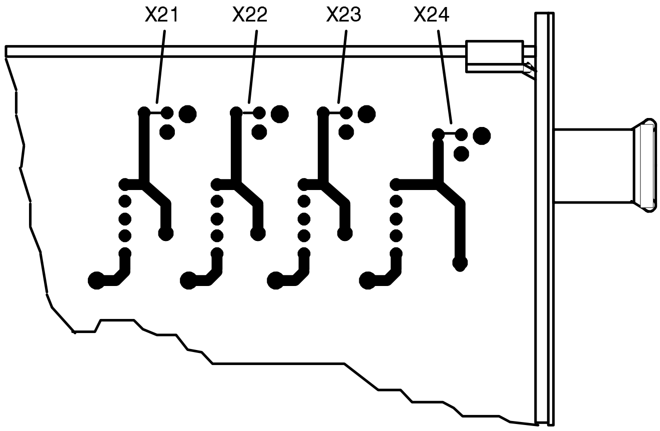
– Check the solder bridges according to Figure 5.1, remove bridges where necessary.

– Insert basic module into the housing; ensure that the releasing lever is pushed fully to the left before the module is pressed in.

– Firmly push in the module using the releasing lever.

– Similarly check on the additional input/output module ZEA–1 according to Figure 5.2. (This smaller module has pulling handles instead of the releasing lever).

– Close housing cover.



Binary input 1 : Solder bridge X21

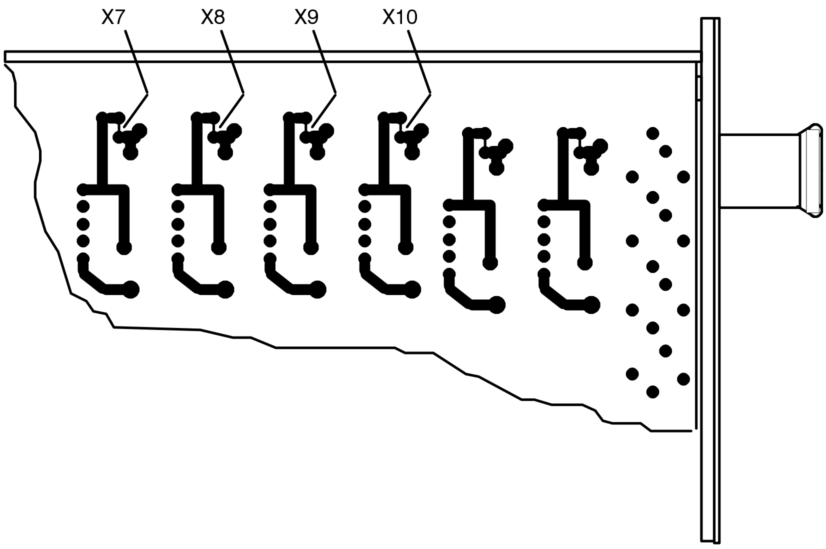
Binary input 2 : Solder bridge X22

Binary input 3 : Solder bridge X23

Binary input 4 : Solder bridge X24

For rated voltages 24/48/60 V– :	Solder bridges must be fitted! Pick-up threshold approx. 16 V
For rated voltages 110/125/220/250 V– :	Solder bridges may be removed: Cut and bend aside. Pick-up threshold approx. 80 V

Figure 5.1 Checking for control voltages for binary inputs 1 to 4 on basic module GEA–1



Binary input 5 : Solder bridge X7

Binary input 6 : Solder bridge X8

Binary input 7 : Solder bridge X9

Binary input 8 : Solder bridge X10

For rated voltages 24/48/60 V– :	Solder bridges must be fitted! Pick-up threshold approx. 16 V
For rated voltages 110/125/220/250 V– :	Solder bridges may be removed: Cut and bend aside. Pick-up threshold approx. 80 V

Figure 5.2 Checking for control voltages for binary inputs 5 to 8 on additional module ZEA–1

5.2.3 Inserting the back-up battery

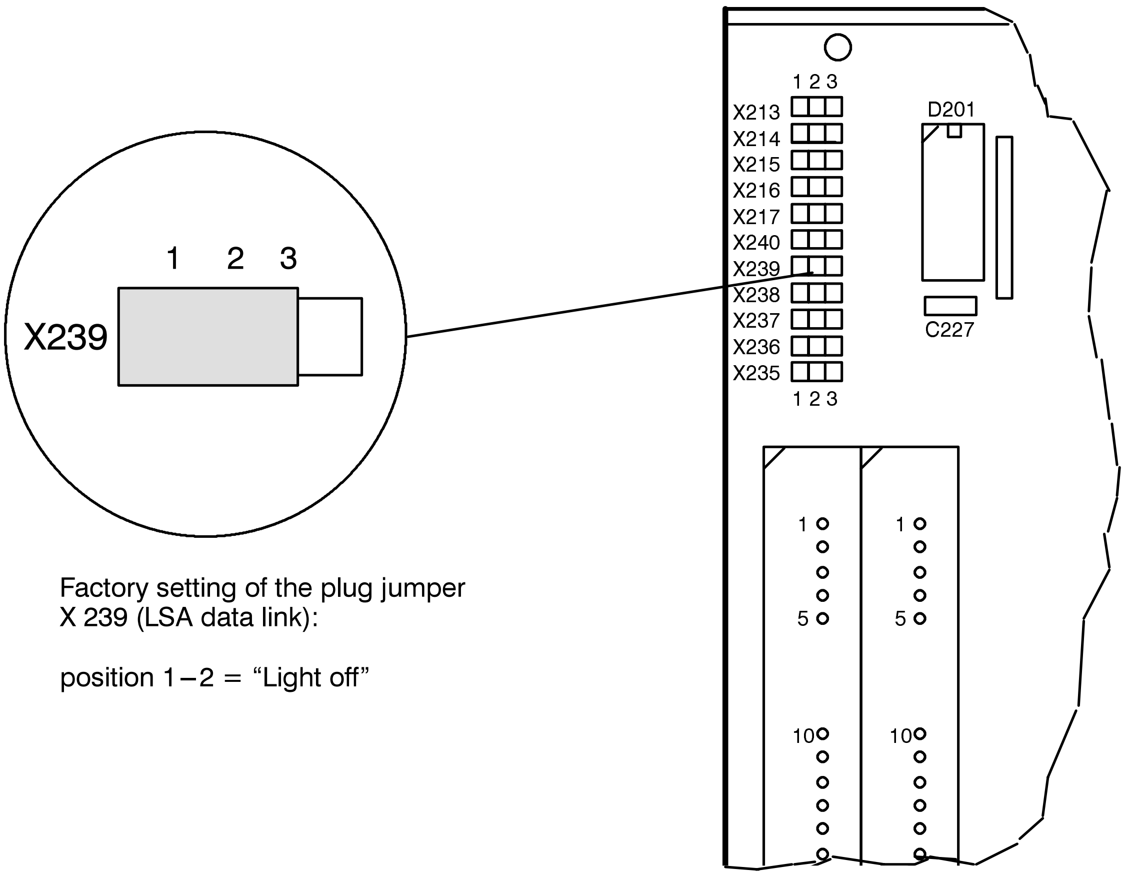
The device annunciations are stored in NV–RAMs. A back-up battery is available so that they are retained even with a longer failure of the d.c. supply voltage. The back-up battery is also required for the internal system clock with calender to continue in the event of a power supply failure.

The battery is normally supplied separately with relays of production series up to /EE. It should be inserted before the relay is installed. Section 7.2 explains in detail how to replace the back-up battery. Join this section accordingly when inserting the battery for the first time.

The battery is already installed at delivery in newer models. It should be checked according to Section 7.2 that the battery is correctly in place.

5.2.4 Checking the transmission link to LSA

If the relay is intended to operate with a central data processing station (e.g. LSA) these connections must also be checked. It is important to visually check the allocation of the transmitter and receiver channels. Since each connection is used for one transmission direction, the transmit connection of the relay must be connected to the receive connection of the central unit and vice versa.



Factory setting of the plug jumper X 239 (LSA data link):

position 1 – 2 = "Light off"

Figure 5.3 Position of the jumper X239 on the power supply board

If data cables are used, the connections are marked in sympathy with ISO 2110 and DIN 66020:

TXD Transmit line of the respective unit
MT Frame reference for the transmit line

RXD Receive line of the respective unit
MR Frame reference for the receive line

The conductor screen and the common overall screen must be earthed at one line end only. This prevents circulating currents from flowing via the screen in case of potential differences.

Transmission via optical fibre is recommended. It is particularly insensitive against disturbances and automatically provides galvanic isolation. Transmit and receive connector are designated with the symbols —●—> for transmit output and ——>● for receive input.

The normal signal position for the data transmission is factory preset as "light off". This can be changed by means of a plug jumper X239 which is accessible when the plug-in module is removed from the case. The jumper is situated in the upper rear area of the center board (power supply p.c.b.) (Figure 5.3).

Jumper	Position	Normal signal position
X239	1 – 2	"Light off"
X239	2 – 3	"Light on"

5.2.5 Connections

General and connection diagrams are shown in Appendix B. The scope of connections between machine and 7UM515 depends on how the different protection functions are used. The connections are generally executed as follows:

Voltage, **frequency** and **overflux protection** are connected to phase voltages L1, L2, L3 against earth of the voltage transformers.

For **earth fault protection** the neutral displacement voltage is supplied from a line connected earthing transformer or a neutral earthing transformer. Since the secondary windings of these transformers usually supply a voltage of 500 V (with full displacement voltage) the voltage must be connected to the unit via a voltage divider 500 V/100 V (e.g. 3PP1336–1CZ–013001).

A connection example is shown in Figure 5.4 (line connected earthing transformer). The illustrations also show the load resistor R_B which provides a sufficiently high signal-to-noise ratio for the measured value. Further instructions are contained in the pamphlet "Planning Machine Protection Systems", Order No. E50400–U0089–U412–A1–7600.

In the case of **stator earth fault 100 % protection**, interconnections between 7UM515 and the accessory devices are arranged as in Figure B.1 (Appendix B); Figure 5.5 shows a schematic example.

The connections between the intermediate current transformer and the protection relay and between the voltage divider and the protection relay shall be laid closely together in order to prevent interference in this leads. The secondary winding of the intermediate c.t. must be connected to earth at one end. The loop resistance between the intermediate c.t. and the protection relay must not exceed 0.5 Ω. The same applies for the conductor loop between the 20 Hz generator and the band-pass filter as well as between the band-pass filter and the load resistor. The last mentioned connections should be screened. Provided the previous conditions are fulfilled, a longer distance is admitted between protection relay and the accessories, e.g. the accessories may be located in the earthing transformer field.

The neutral displacement voltage is supplied from an earthing transformer or a neutral earthing transformer.

The a.c. power supply for the 20 Hz generator is normally taken from a set of voltage transformers connected to the generator terminals; this ensures that no stray voltages are present on the machine during generator stand-still.

Since the 20 Hz bias voltage may be superimposed by a high 50 Hz voltage during an earth fault close to the machine terminals, the voltage must be connected to the unit via a voltage divider 500 V/200 V (e.g. 3PP1336–1CZ–013001). A connection example is shown in Figure 5.5.

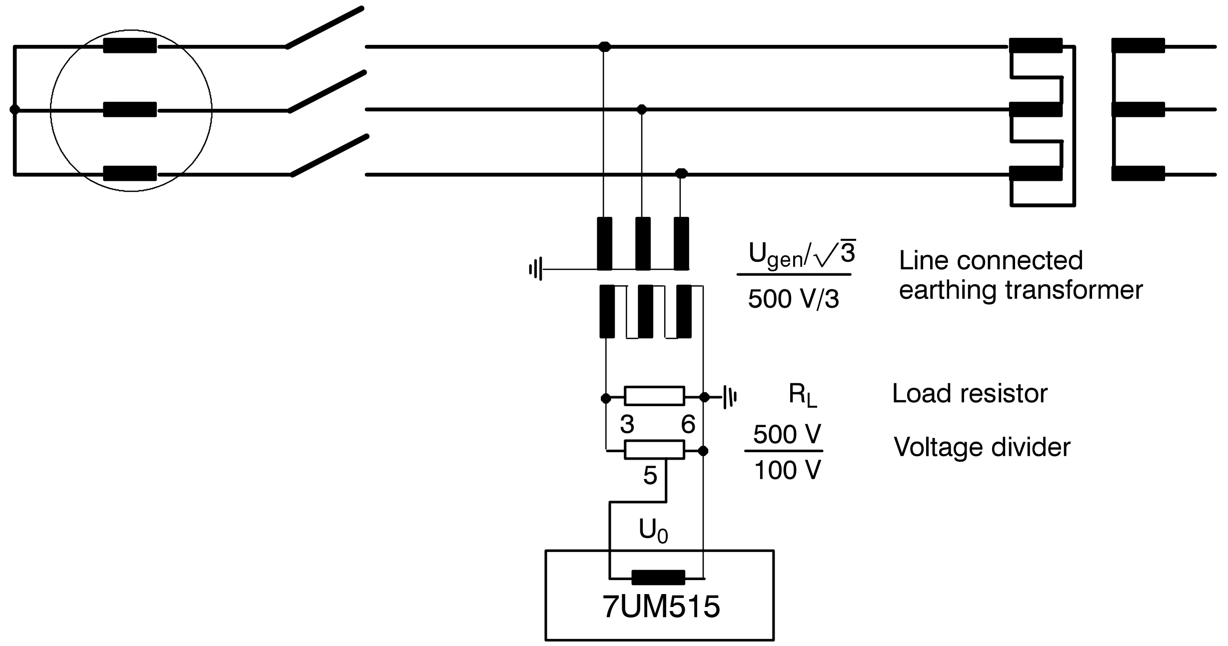


Figure 5.4 Connections for earth fault protection U_0 – example

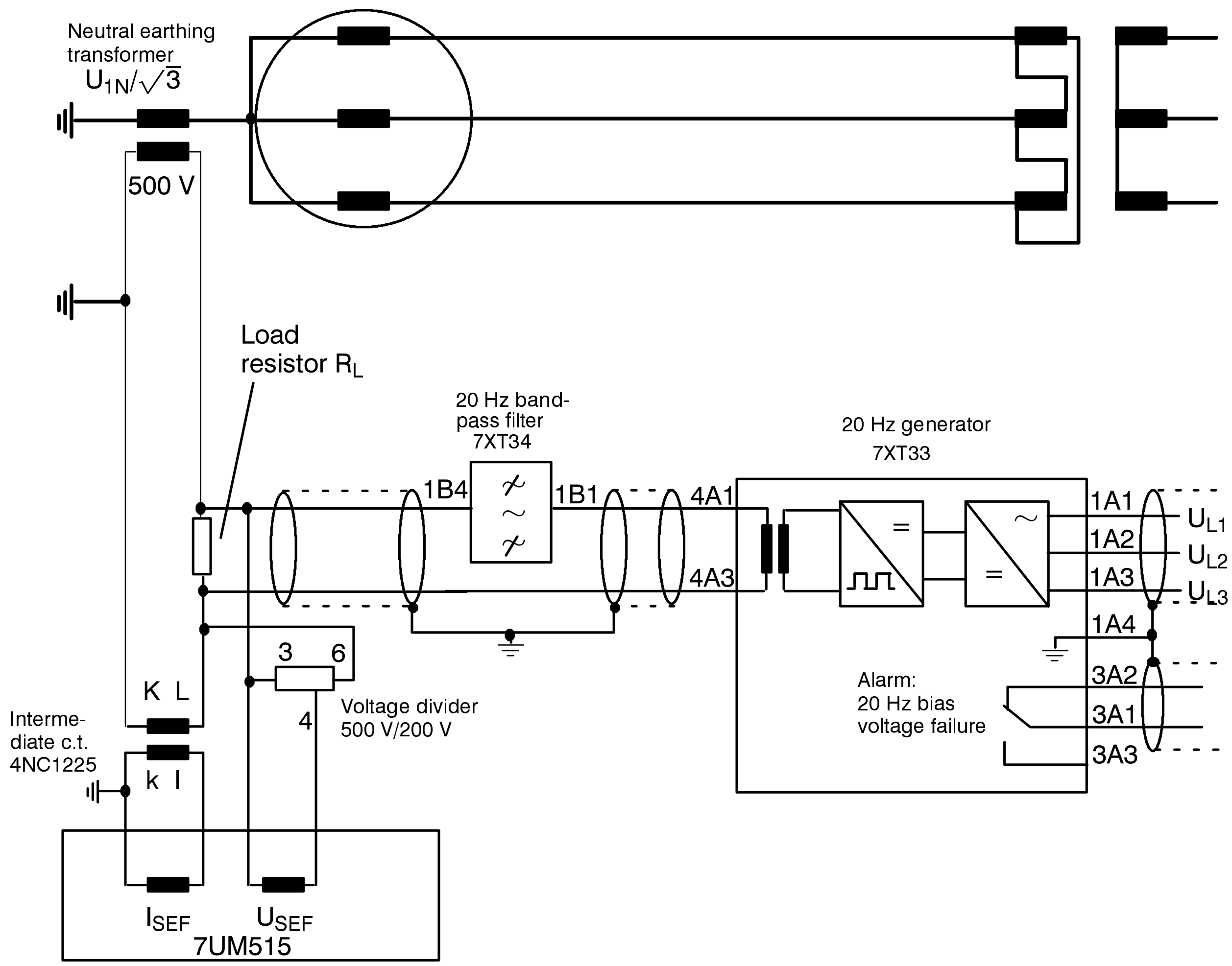


Figure 5.5 Connections for stator earth fault 100 % protection with neutral earthing transformer

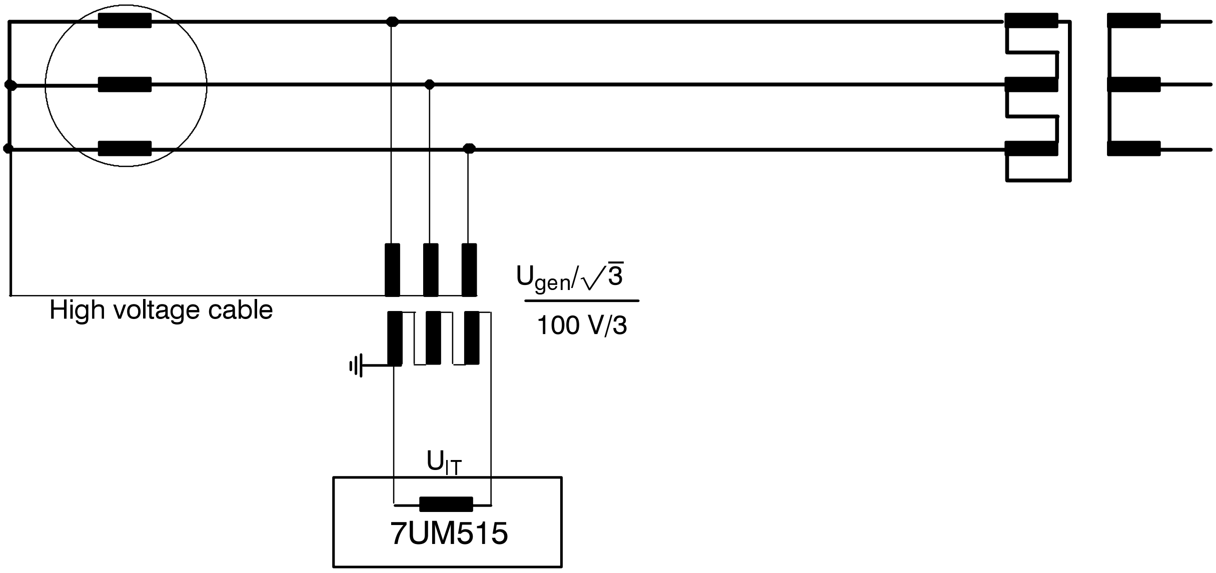


Figure 5.6 Connections for interturn fault protection

Three two-phase-insulated voltage transformers must be used for the **interturn protection**. The primary windings of the v.t.s are star connected and the secondary windings are open-delta connected. The voltage transformer primary star point is connected to the generator star point by a high voltage cable. The v.t. star point **must not** be earthed since this would earth the machine star point. A connection example is shown in Figure 5.6.

Two possibilities exist in the case of **rotor earth fault protection**:

If rotating measured value transmission (RMT) is used, i.e. a measured value acquisition device is installed on the rotor shaft, the output signal of this is converted to a proportional voltage by means of a shunt resistor. This voltage is fed to the assigned input of 7UM515 (see Figure 5.7).

If the integrated rotor earth fault protection is used, interconnections between 7UM515 and the accessory devices must be arranged. Figure B.1 (Appendix B) shows the interconnections when 7XT70 is used. Figure 5.8 shows a schematic example with controller unit 7XT70, Figure 5.9 with 7XT71.

The a.c. power supply for the controller unit 7XT7★ is supplied from the voltage transformers, e.g. U_{L2-L3}. It produces the control signals and the measured voltage for rotor earth resistance determination.

The measured voltage is coupled to the excitation circuit via the coupling unit 7XR6002 or 7XR6003 or 7XR6004. Three models are available: Model 7XR6002 is designed for test voltage 4.5 kV. If a higher test voltage is required, model 7XR6003 is suitable with a test voltage of 6 kV, or model 7XR6004 is suitable with a test voltage of 5 kV.

Controller unit, coupling unit and the protection relay should be installed closely together, e.g. on the same relay panel or in the same relay cubicle.

The connections between the controller unit and the protection relay shall be laid closely together and twisted in order to prevent interference in this leads. *Note* that these measuring circuits will be galvanically connected to the excitation circuit of the machine and therefore stressed by higher potentials against earth! The connections between the rotor circuit to the coupling unit and to the protection relay should be screened as well as the a.c. auxiliary voltage leads (see Figures 5.8 or 5.9). The controller unit provides terminals for the connection of the screens.

Refer to Appendix B for overall connection examples.

Most of the binary inputs and outputs of the unit can be marshalled at liberty. Marshalling possibilities are described in detail in Section 5.5.

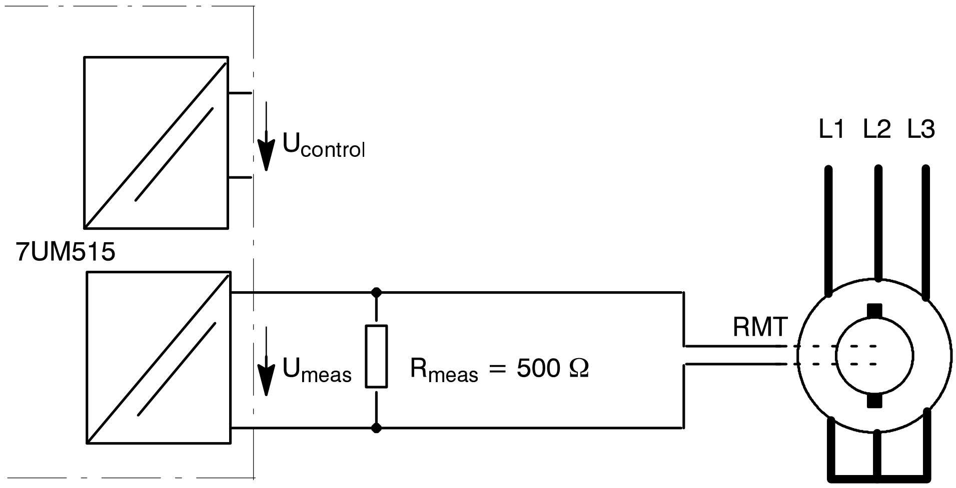


Figure 5.7 Connection of an external rotor earth fault protection (RMT)

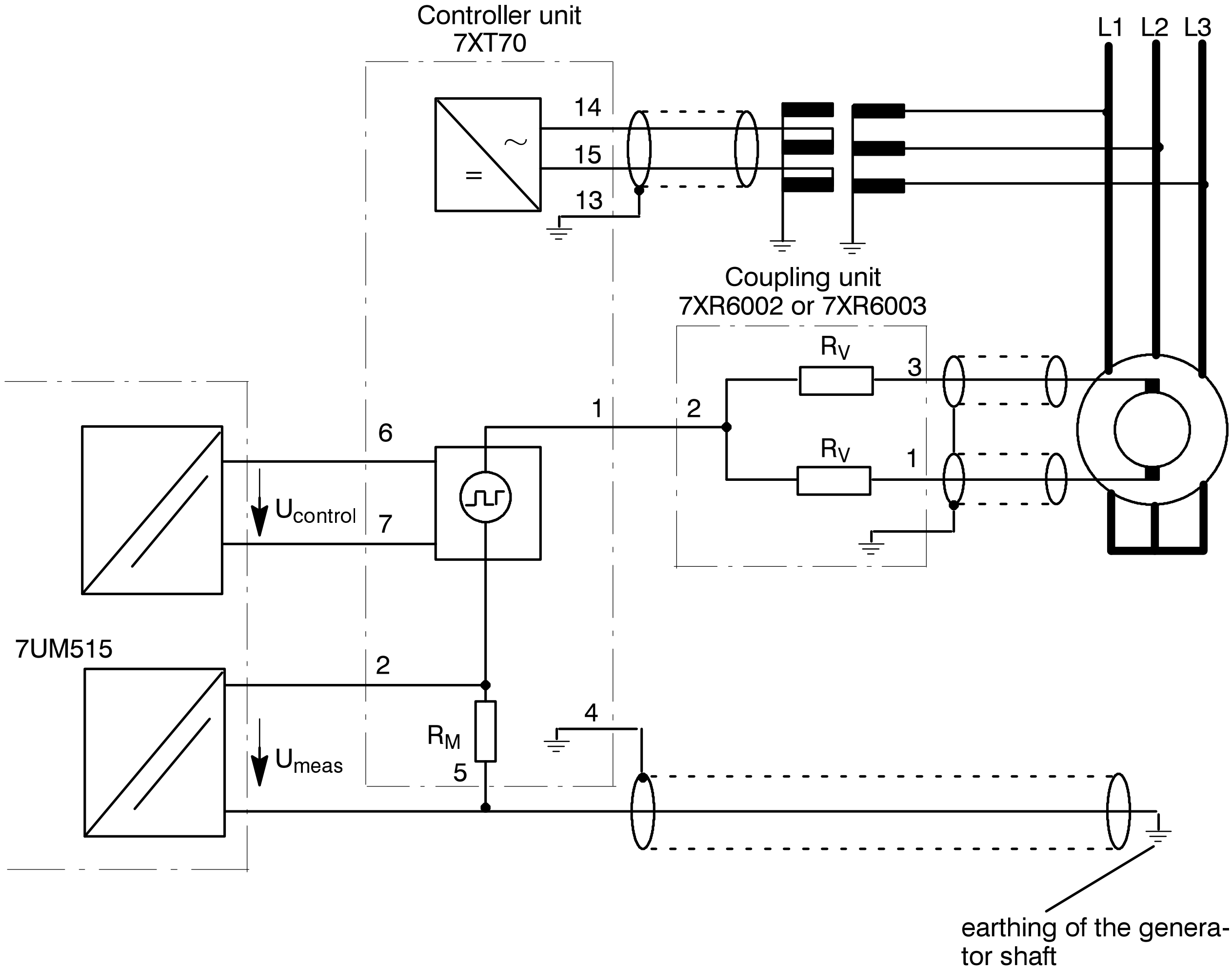


Figure 5.8 Connections for rotor earth fault protection (with controller unit 7XT7000−0B)

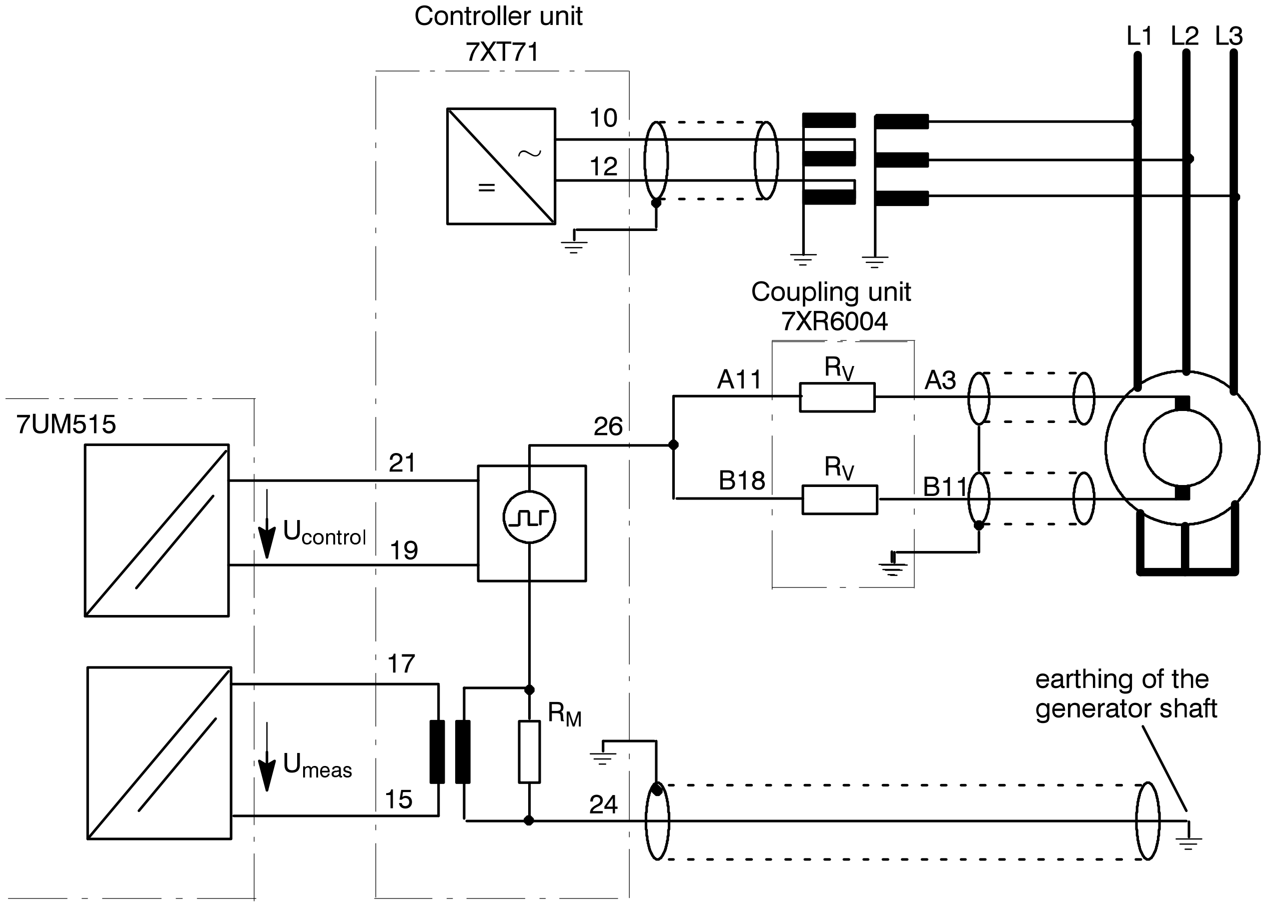


Figure 5.9 Connections for rotor earth fault protection (with controller unit 7XT7100−0*A00

5.2.6 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 dc supply and the voltage transformer circuits!

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

- Are the voltage transformers correctly earthed?
- Are the polarities of the voltage transformer circuits correct?
- Is the phase relationship of the voltage transformers correct?
- Are connections and ratios of the earthing transformer and voltage divider from displacement voltage for earth fault protection U_0 correct (interconnection example Figure 5.4)?
- Are connections and ratio of the earthing transformer and voltage divider from displacement voltage for 100 % earth fault protection correct?
- Are the connections of the 20 Hz bias voltage circuit for stator earth fault 100 % protection correct and screened (interconnection example Figure 5.5 or B.1)?
- Are the connection leads between the intermediate current transformer and the protection relay and between the voltage divider and the protection relay laid closely together?
- Is the high voltage cable between machine star point and voltage transformers correctly isolated and **not** earthed?
- Are the connections of the displacement voltage for interturn fault protection U_{IT} correct (refer to Figure 5.6)?
- Are the connections between controller unit, coupling unit and protection relay for rotor earth fault protection correct (interconnection example Figure 5.7, Figure 5.8 or Figure 5.9)?
- Are the connections between coupling unit for integrated rotor earth fault protection and the excitation circuit correct and screened?
- Are the a.c. voltages for supply of the 20 Hz generator and for supply of the controller unit correct and screened?

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

– Ensure that the miniature slide switch on the front plate is in the “OFF” ◯· position. (refer Figure 6.1).

– Fit a dc ammeter in the auxiliary power circuit; range approx. 1.5 A to 3 A.

– Close the battery 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 be insignificant. Transient movement of the ammeter pointer only indicates the charging current of the storage capacitors.

– Put the miniature slide switch of the front plate in the “ON” position ⊙ . 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 last 7 sec.

– Open the circuit breaker for the dc power supply.

– Remove dc ammeter; reconnect the auxiliary voltage leads.

– Check through the tripping circuits to the circuit breakers.

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

– Check the signal circuits.

– Reclose the protective m.c.b.’s.

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. This applies for all entries via the membrane keyboard or front 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, trip commands,

– setting of functional parameters (thresholds, functions).

– 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 7UM515 disposes of four different code levels, i.e. different authorization levels. **Code level 1** releases the setting of the time clock, creating of a measuring record and switch-over of the active parameter set. That means with a codeword the operator can carry out specific settings, which are typical for normal operation conditions.

For operations of special importance, like the parameterization of functions and pick-up values, the start of test routines, reset of annunciation buffers, etc. **code level 2** is required. The codeword for this level comprises the items from code level 1, too.

For the configuration, i.e. the marshalling and configuration of the relay, **code level 3** is applicable.

The codewords pre-set upon delivery of the relay can be substituted by self-selected codewords. Changing of the codewords is done under addresses 7151 to 7154. These addresses are visible only when **code level 4** is fulfilled. The procedure is described in Section 5.3.3.

To indicate authorized operator use, press key **CW**, enter the codeword and confirm with **E**. The code“word” is a number of up to 6 digits. Upon delivery of the relay the number “0” is pre-set for all code levels. Codeword entry can also be made retrospectively after paging or direct addressing to any setting address.

```
E N T E R   C O D E W O R D :
@ @ @ @ @ @
```

```
C W   A C C E P T E D
```

```
C O D E W O R D   W R O N G
```

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 ACCEPTED**. Press the entry key **E** again.

If the codeword is not correct the display shows **CODEWORD WRONG**. Pressing the **CW** key allows another attempt at codeword entry.

Address blocks 70 to 79 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 interfaces, and the interaction of the device functions.

The simplest way of arriving at the beginning of this configuration blocks is to use key **DA**, followed by the address number **7 0 0 0** and ENTER, key **E**. The address 7000 appears, which forms the heading of the configuration blocks.

```
⇑ 7 0 0 0█ O P .   S Y S T E M
⇓ C O N F I G U R A T I O N
```

Beginning of the block “Operating system configuration”

The double arrow key ⇑ switches over to the first configuration block (see below). Use the key ↑ to find the address 7101. The display shows the four-digit address number, i.e. block and sequence number. The title of the requested parameter appears behind the bar (see below). The second line of the display shows the text applicable to the parameter. The present text can be rejected by the "No"–key **N**. The next text choice then appears, as shown in the boxes below. The chosen alternative **must be confirmed with enter key E!**

The setting procedure can be ended at any time by the key combination **F E**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS?". Confirm with the "Yes"–key **Y** that the new settings shall become valid now. If you press the "No"–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

If one tries to leave the setting range for the configuration blocks (i.e. address blocks 60 to 79) with keys ⇑ ⇓, the display shows the question "END OF CODEWORD OPERATION ?". Press the "No"–key **N** to continue configuration. If you press the "Yes"–key **J/Y** instead, another question appears: "SAVE NEW SETTINGS ?". Now you can confirm with **J/Y** or abort with **N**, as above.

When one exits the setting program, the altered parameters, which until then have been stored in buffer stores, are permanently secured in EEPROMs and protected against power outage. If configuration parameters have been changed the processor system will reset and re-start. During re-start the device is not operational.

5.3.2 Settings for the integrated operation – address block 71

Operating parameters can be set in address block 71. This block allows the operator language to be changed. The date format can be selected. Messages on the front display can be selected here for the quiescent state of the unit or after a fault event. To change any of these parameters, codeword entry is necessary (code level 3).

When the relay is delivered from the factory, the device is programmed to give function names and outputs in the German language. This can be changed under address 7101. The operator languages available at present are shown in the boxes below. The date is displayed in the European format when the relay is delivered.

```
⇑ 7100█ INTEGRATED
⇓ OPERATION
```

Beginning of the block "Integrated operation"

```
↑ 7101█ LANGUAGE
↓ DEUTSCH

ENGLISH
```

The available languages can be called up by repeatedly pressing the "No"–key **N**. Each language is spelled in the corresponding country's language. If you don't understand a language, you should find your own language.

The required language is chosen with the enter key **E**.

```
7102 DATE FORMAT
DD.MM.YYYY
```
```
MM/DD/YYYY
```

The date in the display is preset to the European format Day.Month.Year. Switch-over to the American format Month/Day/Year is achieved by depressing the "No"–key **N**; then confirm with the entry key **E**.

DD two figures for the day
MM two figures for the month
YYYY four figures for the year (incl. century)

```
7105 OPER. 1st L
not allocated
```
```
UL1E =
```
```
UL2E =
```
```
etc.
```

Message to be displayed in the **1st** display line during operation. Any of the operational measured values according to Section 6.4.4 can be selected as messages in the the quiescent state of the relay by repeatedly depressing the "No"–key **N**; The value selected by the entry key **E** under address 7105 will appear in the **first** line of the display.

```
7106 OPER. 2nd L
not allocated
```
```
etc.
```

Message to be displayed in the **2nd** display line during operation. The value selected by the entry key **E** under address 7106 will appear in the **second** line of the display.

Fault event annunciations can be displayed after a fault on the front. These can be chosen under addresses 7107 and 7108. The possible messages can be selected by repeatedly pressing the "No"–key **N**. The desired message is confirmed with the enter key **E**. These spontaneous messages are acknowledged during operation with the RESET key or via the remote reset input of the device or via the serial interfaces. After acknowledgement, the operational messages of the quiescent state will be displayed again as chosen under addresses 7105 and 7106.

```
7107 FAULT 1st L
Prot.Pick-up
```

After a fault event, the **first** line of the display shows:

the first protection function which has picked up,

```
Prot.Trip
```

the latest protection function, which has tripped,

```
T-Fault
```

the elapsed time from pick-up to drop-off,

```
T-Trip
```

the elapsed time from pick-up to trip command.

```
7108 FAULT 2nd L
Prot.Trip
```

After a fault event, the **second** line of the display shows:

the possibilities are the same as under address 7107.

```
etc.
```

5.3.3 Changing the codewords − address block 71

The codewords can be changed in addresses 7151 to 7154 for all four available code levels. This allows a downgrading of the operating authorization.

These four addresses are visible and changeable only when codeword level 4 (highest authorization stage) is fulfilled. This requires entry of the level 4 codeword.

It applies for all code levels that the higher level always includes the operation facilities of the lower code levels.

Codewords can be abbreviated to less than six digits. Then they have to be entered with exactly the same number of digits for each code word entry.

If the user does not change the codewords, then the pre-set code words remain valid. They are “0” for all four code levels. Entry of the previously used pre-set code word “000000” is accepted, too.

Attention! Do not forget the codewords! Forgetting a codeword is like loosing a key. Access to the relay is not possible without knowledge of the corresponding codeword. Without knowledge of the codeword of level 4, you never will have the chance to set new codewords.

```
7151  CW-LEVEL 1
0
```

Code level 1: this authorization level allows operations for the normal operating procedures (starting fault recording, setting the clock, selecting the active parameter set).

Smallest setting value: **0**
Largest setting value: **999999**

```
7152  CW-LEVEL 2
0
```

Code level 2: this authorization level allows operations of specific importance: functional parameters (address blocks 11 to 39), test routines (address blocks 44 to 49), reset of annunciation buffers (address block 82), and process parameter sets (address block 85).

Smallest setting value: **0**
Largest setting value: **999999**

```
7153  CW-LEVEL 3
0
```

Code level 3: this authorization level allows the configuration: marshalling (address blocks 61 to 64), interfaces (address blocks 71 to 72), fault recording (address block 74), scope of functions (address block 78), configuration of the relay (address block 79)

Smallest setting value: **0**
Largest setting value: **999999**

```
7154  CW-LEVEL 4
0
```

Code level 4: this is the highest authorization level for the user and allows alteration of the code words (addresses 7151 to 7154)

Smallest setting value: **0**
Largest setting value: **999999**

5.3.4 Configuration of the serial interfaces – address block 72

The device provides two serial interfaces: one PC interface for operation by means of a operator terminal or personal computer in the front and a further system interface for connection of a central control and storage unit, e.g. Siemens LSA 678. Communication via these interfaces 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 of code level 3 is necessary (refer to Section 5.3.1). The data must be coordinated with the connected devices.

All annunciations which can be processed by the LSA are stored within the device in a separate table. This is listed in Appendix C.

```
7200█ PC/SYSTEM
INTERFACES
```

Beginning of the block "Interfaces for personal computer and central computer system"

```
7201█ DEVICE ADD.
1
```

Identification number of the relay within the station or substation; valid for both the interfaces (operating and system interface). 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█ FEEDER ADD.
1
```

Number of the feeder within the station or substation; valid for both the interfaces (operating and system interface)
Smallest permissible number: **1**
Largest permissible number: **254**

```
7203█ SUBST. ADD.
1
```

Identification number of the station or substation, in case more than one station or substation can be connected to a central device
Smallest permissible number: **1**
Largest permissible number: **254**

```
7208█ FUNCT. TYPE
70
```

Function type in accordance with IEC 60870–5–103 and VDEW/ZVEI; for 7UM515 no. 70.
This address is mainly for information, it should not be changed.

```
7209█ DEVICE TYPE
16
```

Device type for identification of the device in Siemens LSA 678 and DIGSI®. For 7UM515 V3 no. 16.
This address is only for information, it cannot be changed.

Addresses 7211 to 7216 are valid for the operating (PC) interface on the front of the relay.

Note: For operator panel 7XR5, the PC–interface format (address 7211) must be *ASCII*, the PC Baud-rate (address 7215) must be *1200 BAUD*, the PC parity (address 7216) must be *NO 2 STOP*.

The setting of the PC GAPS (address 7214 for the operating interface) or the SYS GAPS (address 7224 for the system interface) is relevant only when the relay is intended to communicate via a modem. The settings are 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.

```
7211 PC INTERF.
DIGSI V3
```

```
ASCII
```

Data format for the PC (operating) interface:

format for Siemens protection data processing program *DIGSI*® Version *V3*

ASCII format

```
7214 PC GAPS
0.0 s
```

Maximum time period of data gaps within telegrams which may occur during data transmission via modem on the operating (PC) interface

Smallest setting value:	**0.0** s
Largest setting value:	**5.0** s

```
7215 PC BAUDRATE
 9600 BAUD
```

```
19200 BAUD
```

```
 1200 BAUD
```

```
 2400 BAUD
```

```
 4800 BAUD
```

The transmission Baud-rate for communication via the PC (operating) interface at the front can be adapted to the operator’s communication interface, e.g. personal computer, if necessary. The available possibilities can be displayed by repeatedly depression of the “No”–key **N**. Confirm the desired Baud-rate with the entry key **E**.

```
7216 PC PARITY
DIGSI V3
```

```
NO 2 STOP
```

```
NO 1 STOP
```

Parity and stop-bits for the PC (operating) interface:

format for Siemens protection data processing program *DIGSI*® Version *V3* with odd parity and 1 stop-bit

NO parity, *2 STOP*–bits

NO parity, *1 STOP*–bit, e.g. modem

Addresses 7221 to 7235 are valid for the system (LSA) interface.

```
7221█ SYS INTERF.
VDEW EXTENDED
```

Data format for the system (LSA) interface:

data in accordance with IEC 60870−5−103 and *VDEW*, *EXTENDED* by Siemens specified data

```
DIGSI V3
```

format for Siemens protection data processing program *DIGSI*® Version *V3*

```
LSA
```

format of the former Siemens *LSA* version

```
7222█ SYS MEASUR.
VDEW EXTENDED
```

Format of measured values for the system (LSA) interface:

data in accordance with IEC 60870−5−103 and *VDEW*/ZVEI, *EXTENDED* by Siemens specified data

```
7224█ SYS GAPS
0.0 s
```

Maximum time period of data gaps within telegrams which may occur during data transmission via modem on the system (LSA) interface

Smallest setting value: **0.0** s
Largest setting value: **5.0** s

```
7225█ SYS BAUDR.
 9600 BAUD
```

```
19200 BAUD
```

```
 1200 BAUD
```

```
 2400 BAUD
```

```
 4800 BAUD
```

The transmission Baud-rate for communication via the system interface can be adapted to the system interface, e.g. LSA, if necessary. The available possibilities can be displayed by repeatedly depression of the "No"−key **N**. Confirm the desired Baud-rate with the entry key **E**.

```
7226█ SYS PARITY
VDEW/DIGSIV3/LSA
```

Parity and stop-bits for the system (LSA) interface:

format for *VDEW*−protocol (IEC 60870−5−103) or Siemens protection data processing program *DIGSI*® *V*ersion *3* and former LSA

```
NO 2 STOP
```

NO parity, *2 STOP*−bits

```
NO 1 STOP
```

NO parity, *1 STOP*−bit, e.g. modem

Address 7235 is relevant only in case the system interface is connected with a hardware that operates with the protection data processing program DIGSI® (address 7221 SYS INTERF. = *DIGSI V3*). this address determines whether it shall be permitted to change parameters via this interface.

```
7235█ SYS PARAMET
NO
```

Remote parameterizing via the system interface

NO – is not permitted

```
YES
```

YES – is permitted

5.3.5 Settings for fault recording – address block 74

The machine protection relay is equipped with a fault data store (see Section 4.18.2). Distinction must be made between the reference instant and the storage criterion (address 7402). Normally, the general fault detection signal of the protection is the reference instant. The storage criterion can be the general fault detection, too (*STORAGE BY FD*), or the trip command (*STORAGE BY TRIP*). Alternatively, the trip command can be selected as reference instant (*START WITH TRIP*), in this case, the trip command is the storage criterion, too.

The actual recording time starts with the pre-trigger time T–PRE (address 7411) before the reference instant and ends with the post-fault time T–POST (address 7412) after the recording criterion has disappeared. The permissible recording time for each record is set under address 7410. Altogether 5 s are available for fault recording of instantaneous values, 60 s for recording of r.m.s. values (cf. address 7420). In this time range up to 8 fault records can be stored.

Note: The set times are related on a system frequency of 50 Hz. They are to be matched, accordingly, for different frequencies.

Note: In the illustration below, the time values are displayed for storage of instantaneous values. When r.m.s. values are stored, the times appear as 12 times the illustrated values.

Data storage can also be initiated via a binary input or by operator action from the membrane keyboard on the front of the relay or via the operating interface. The storage is triggered dynamically, in these cases. The length of the data storage is determined by the settings in addresses 7431 and 7432, but max. T–MAX, address 7410. Pre-trigger time and post-fault time are additive to the set values. If the storage time for start via binary input is set to ∞, then the storage time ends after de-energization of the binary input (statically), but not after T–MAX (address 7410).

```
7400█
FAULT RECORDINGS
```

Beginning of block “Fault recordings”

```
7402█ INITIATION
STORAGE BY FD.
```
```
STORAGE BY TRIP
```
```
START WITH TRIP
```

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█ T-MAX
1.00 s
```

Maximum time period of a fault record
Smallest setting value: **0.30** s
Largest setting value: **5.00** s
The times are **multiplied by 12** in case of storage of **r.m.s. values** (cf. address 7420)

```
7411█ T-PRE
0.10 s
```

Pre-trigger time before the reference instant
Smallest setting value: **0.05** s
Largest setting value: **4.00** s
The times are **multiplied by 12** in case of storage of **r.m.s. values** (cf. address 7420)

```
7412 T-POST
0.10 s
```

Post-fault time after the storage criterion disappears
Smallest setting value: **0.05** s
Largest setting value: **1.00** s
The times are **multiplied by 12** in case of storage of **r.m.s. values** (cf. address 7420)

```
7420 FAULT VALUE
INSTANTANEOUS
```

```
RMS VALUES
```

The stored fault values should be:

INSTANTANEOUS values with 12 values per a.c. cycle

RMS VALUES with one value per cycle

```
7431 T-BINARY IN
0.50 s
```

Storage time when fault recording is initiated via a binary input, pre-trigger and post-fault times are additive
Smallest setting value: **0.10** s
Largest setting value: **5.00** s
or ∞, i.e. as long as the binary input is energized (but not longer than T−MAX)
The times are **multiplied by 12** in case of storage of **r.m.s. values** (cf. address 7420)

```
7432 T-KEYBOARD
0.50 s
```

Storage time when fault recording is initiated via the membrane keyboard, pre-trigger and post-fault times are additive
Smallest setting value: **0.10** s
Largest setting value: **5.00** s
The times are **multiplied by 12** in case of storage of **r.m.s. values** (cf. address 7420)

Address 7490 is not relevant in case that the relay is connected to a control and storage processing system which operates with the protocol according to IEC 60870−5−103 and VDEW/ZVEI. But, if the relay is connected to a former LSA system, the relay must be informed how long a transmitted fault record must be, so that the former LSA system receives the correct number of fault record values.

Only for communication with a former LSA system:

```
7490 SYS LENGTH
660 VALUES FIX
```

```
<=3000 VAL. VAR
```

Length of a fault record which is transmitted via the serial system interface:

660 values fix or

variable length with a maximum of 3000 values

5.4 Configuration of the protective functions

5.4.1 Introduction

The device 7UM515 is capable of providing a series of protection and supplementary functions. The scope of the hard- and firm-ware is matched to these functions. Furthermore, individual functions can be set (configured) to be effective or non-effective. Additionally, the relay can be adapted to the system frequency.

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 this front-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 of code level 3 (see Section 5.3.1). Without codeword, the setting can be read out but not altered.

For the purpose of configuration, address blocks 78 and 79 are provided. One can access the beginning of the configuration blocks either by direct dial

– press direct address key **DA**,
– type in address **7 8 0 0**,
– press execute key **E** ;

or by paging with the keys ⇑ (forwards) or ⇓ (backwards), until address 7800 appears.

Within the block 78 one can page forward with ↑ or back with ↓. Each paging action leads to a further address for the input of a configuration parameter. In the following sections, each address is shown in a box and explained. In the upper line of the display, behind the number and the bar, stands the associated device function. In the second line is the associated text (e.g. "*EXIST*"). If this text is appropriate the arrow keys ↑ or ↓ can be used to page the next address. If the text should be altered press the "No"–key **N**; an alternative text then appears (e.g. "*NON–EXIST*"). There may be other alternatives which can then be displayed by repeated depression of the "No"–key **N**. The required alternative **must be confirmed with the key E!**

Use of the double arrow key ⇑ brings one to the next address block, in this case 79. There one finds further setting parameters which can equally be confirmed or altered.

The configuration procedure can be ended at any time by the key combination **F E**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS ?". Confirm with the "Yes"–key **J/Y** that the new settings shall become valid now. If you press the "No"–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

If one tries to leave the setting range for the configuration blocks (i.e. address blocks 60 to 79) with keys ⇑ ⇓, the display shows the question "END OF CODEWORD OPERATION ?". Press the "No"–key **N** to continue configuration. If you press the "Yes"–key **J/Y** instead, another question appears: "SAVE NEW SETTINGS ?". Now you can confirm with **J/Y** or abort with **N**, as described above.

When one exits the setting program, the altered parameters, which until then have been stored in volatile memories, are then permanently secured in EEPROMs and protected against power outage. The processor system will reset and re-start. During restart the device is not operational.

5.4.2 Programming the scope of functions – address block 78

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 *NON EXIST* will not be processed in 7UM515: There will be no annunciations 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.

```
7800 SCOPE OF
FUNCTIONS
```

Beginning of the block "Scope of functions"

Overflux protection:

```
7813 U/f PROT.
EXIST
```

```
NON-EXIST
```

Stator earth fault protection 100 %:

```
7818 STATOR E/F
EXIST
```

```
NON-EXIST
```

Undervoltage protection:

```
7816 UNDERVOLT.
EXIST
```

```
NON-EXIST
```

Stator earth fault protection:

```
7819 SEF PROT.
EXIST
```

```
NON-EXIST
```

Overvoltage protection:

```
7817 OVERVOLT.
EXIST
```

```
NON-EXIST
```

Frequency protection:

```
7821 FREQUENCY
EXIST
```

```
NON-EXIST
```

External trip facilities via binary input:

```
7830 EXT. TRIP 1
EXIST

NON-EXIST
```

```
7831 EXT. TRIP 2
EXIST

NON-EXIST
```

```
7832 EXT. TRIP 3
EXIST

NON-EXIST
```

```
7833 EXT. TRIP 4
EXIST

NON-EXIST
```

Interturn fault protection:

```
7834 I/T PROT.
EXIST

NON-EXIST
```

Rotor earth fault protection:

```
7835 ROTOR E/F
EXIST

NON-EXIST
```

Trip circuit supervision:

```
7839 TRP SUPERV
EXIST

NON-EXIST
```

Parameter change-over:

```
7885 PARAM. C/O
NON-EXIST

EXIST
```

The rated system frequency must comply with the setting under address 7899. If the system frequency is not 50 Hz, address 7899 must be changed.

```
7899 FREQUENCY
fN 50 Hz

fN 60 Hz
```

Rated system frequency *50 Hz* or *60 Hz*

5.4.3 Setting the device configuration – address block 79

The configuration affects the interaction of the protective and additional functions, for 7UM515, especially the processing method of the rotor earth fault protection.

```
7900 DEVICE
CONFIGURATION
```

Beginning of the block “Device configuration”

```
7901 COUPL. REF
7XT70
```

```
7XT71
```

```
RMT
```

Measuring method of rotor earth fault protection:

- internal processing of the measured values produced by the controller unit 7XT70
- internal processing of the measured values produced by the controller unit 7XT71
- external processing of the measured values by rotating measured value transmission (RMT) via measurement transducer

---

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 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 in the front. The operation of the operator panel is described in detail in Section 6.2. Marshalling begins at the parameter address 6000.

The input of the codeword is required for marshalling (refer Section 5.3.1). Without codeword entry, parameters can be read out but not be changed. During codeword operation, i.e. from codeword entry until the termination of the marshalling procedure, the solid bar in the display flashes.

When the 7UM515 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 trip command "`U> Trip`" is registered. 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) signal relay, e.g. to the signal relay 5, the processor must be advised that the logical signal "`U> Trip`" should be transmitted to the signal relay 5. 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) signal relay? Up to **20** logical annunciations can trigger one (physical) signal relay.

A similar situation applies to binary inputs. In this case external information (e.g. voltage transformer m.c.b. tripped) 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 trip relays can also be assigned different functions. Each trip relay can be controlled by each command function or combination of up to **20** command functions.

The logical annunciation functions can be used in multiple manner. E.g. one annunciation function can trigger several signal relays, several trip relays, additionally be indicated by LEDs, and be controlled by a binary input unit. The restriction is, that the total of all physical input/output units (binary inputs plus signal relays plus LEDs plus trip relays) which are to be associated with one logical function must not exceed a number of **10**. If this number is tried to be exceeded, the display will show a corresponding message.

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) function should be allocated.

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

The beginning of the marshalling parameter blocks is reached by directly selecting the address 6000, i.e.

– press direct address key **DA**,
– enter address **6 0 0 0**,
– press enter key **E**

or by paging with keys ⇑ (forwards) or ⇓ (backwards) until address 6000 has been reached. The beginning of the marshalling blocks then appears:

```
⇑  6 0 0 0 █
⇓  M A R S H A L L I N G
```

Beginning of marshalling blocks

One can proceed through the marshalling blocks with the key ⇑ or go back with the key ⇓ . Within a block, one goes forwards with ↑ or backwards with ↓ . Each forward or backward step leads to display of the next input, output or LED position. In the display, behind the address and the solid bar, the physical input/output unit forms the heading.

The key combination **F** ↑, i.e. depressing the function key **F** followed by the arrow key ↑, switches over to the selection level for the logical functions to be allocated. During this change-over (i.e. from pressing the **F** key until pressing the ↑ key) the bar behind the address number is replaced by a "F". The display shows, in the upper line, the physical input/output unit, this time with a three 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 by pressing the "No"–key **N**. By repeated use of the key **N** all marshallable functions can be paged through the display. Back-paging is possible with the backspace key **R**. 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) 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 allocated`".

You can leave the selection level by pressing the key combination **F** ↑ (i.e. depressing the function key **F** followed by the arrow key ↑). The display shows again the four digit address number of the physical input/output module. Now you can page with key ↑ to the next input/output module or with ↓ to the previous to repeat selection procedure, as above.

The logical functions are also provided with function numbers which are equally listed in the tables. If the function number is known, this can be input directly on the selection level. Paging through the possible functions is then superfluous. With direct input of the function number, leading zeros need not be entered. After input of the function number, use **the enter key E**. Immediately the associated identification of the function appears for checking purposes. This can be altered either by entering a different function number or by paging through the possible functions, forwards with the "No"–key **N** or backwards with the backspace key **R**. If the function has been changed, another confirmation is necessary with **the enter key E**.

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 block to block, within the block or on the selection level. The character F before the arrow indicates that the function key **F** must be pressed before pushing the arrow key ↑.

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

The marshalling procedure can be ended at any time by the key combination **F E**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS?". Confirm with the "Yes"–key **J/Y** that the new allocations shall become valid now. If you press the "No"–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

If one tries to leave the setting range for the configuration blocks (i.e. address blocks 60 to 79) with keys ⇑ ⇓, the display shows the question "END OF CODEWORD OPERATION ?". Press the "No"–key **N** to continue marshalling. If you press the "Yes"–key **J/Y** instead, another question appears: "SAVE NEW SETTINGS ?". Now you can confirm with **J/Y** or abort with **N**, as above.

When one exits the marshalling program, the altered parameters, which until then have been stored in volatile memory, are then permanently secured in EEPROMs and protected against power outage. The processor system will reset and re-start. During re-start the device is not operational.

5.5.2 Marshalling of the binary inputs – address block 61

The unit contains 8 binary inputs which are designated INPUT 1 to INPUT 8. They can be marshalled in address block 61. The address block is reached by paging in blocks ⇑ ⇓ or by direct addressing with **DA 6 1 0 0 E**. 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` – “normally open” mode: the input acts as a NO contact, i.e. the control voltage at the input terminals activates the function;

`NC` – “normally closed” mode: the input acts as a NC contact, i.e. control voltage present at the terminals turns off the function, control voltage absent activates the function.

When paging through the display, each input function is displayed with the index “`NO`” or “`NC`” when proceeding with the “No”–key **N**.

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 Section 5.4.2).

With direct input of the function number, leading zeros need not be used. To indicate the contact mode the function number can be extended by a decimal point followed by **0** or **1**, whereby

.0 means “normally open” mode, corresponds to “`NO`” as above.

.1 means “normally closed” mode, corresponds to “`NC`” as above.

If the extension with .0 or .1 is omitted the display first indicates the function designation in “normally open” mode `NO`. By pressing the “No”–key **N** the mode is changed to `NC`. After direct input other functions can be selected by paging through the functions forwards with the “No”–key **N** or backwards with the backspace key **R**. The changed function then must be re-confirmed by the entry key **E**.

Note: One logical function must not be marshalled to several binary inputs, because an OR–logic of the signals can not be guaranteed!

The assignment of the binary inputs as delivered from factory is shown in the general diagrams in Appendix A and B. 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.

⇑⇓
```
6100█ MARSHALLING
BINARY INPUTS
```
Beginning of block “Marshalling binary inputs”

The first binary input is reached with the key ↑:

F↑ ↓
```
6101█ BINARY
INPUT 1
```
Allocations for binary input 1

Change over to the selection level with **F** ↑:

↑↓
```
001█ INPUT 1
>LED reset      NO
```
Reset of stored LED indications, FNo 5;
“normally open” operation:
LEDs are reset when control voltage present

```
0 0 2█ I N P U T   1
n o t   a l l o c a t e d
```

No further functions are initiated by binary input 1

Leave the selection level with key combination **F** ↑. You can go then to the next binary input with the arrow key ↑.

FNo	Abbreviation	Description
1	`not allocated`	Binary input is not allocated to any input function
3	`>Time Synchro`	Synchronize internal real time clock
4	`>Start FltRec`	Start fault recording from external command via binary input
5	`>LED reset`	Reset stored LED indicators
7	`>ParamSelec.1`	Parameter set selection 1 (in conjunction with 8)
8	`>ParamSelec.2`	Parameter set selection 2 (in conjunction with 7)
11	`>Annunc. 1`	User definable annunciation 1
12	`>Annunc. 2`	User definable annunciation 2
13	`>Annunc. 3`	User definable annunciation 3
14	`>Annunc. 4`	User definable annunciation 4
15	`>Sys-Test`	System interface messages/values are marked with "Test operation"
16	`>Sys-MM-block`	System interface messages and measured values are blocked
4523	`>Ext 1 block`	Block external trip command 1
4526	`>Ext trip 1`	External trip signal 1[1)]
4543	`>Ext 2 block`	Block external trip command 2
4546	`>Ext trip 2`	External trip signal 2[1)]
4563	`>Ext 3 block`	Block external trip command 3
4566	`>Ext trip 3`	External trip signal 3[1)]
4583	`>Ext 4 block`	Block external trip command 4
4586	`>Ext trip 4`	External trip signal 4[1)]
5004	`>Phase rotat.`	Phase rotation is reversed to counter-clockwise
5173	`>U0> block`	Block stator earth fault protection U_0>
5203	`>Frq. block`	Block frequency protection
5206	`>f1 block`	Block frequency protection stage f1
5207	`>f2 block`	Block frequency protection stage f2
5208	`>f3 block`	Block frequency protection stage f3
5209	`>f4 block`	Block frequency protection stage f4
5353	`>U/f block`	Block overexcitation protection
5356	`>RM th.repl.`	Reset memory of thermal replica U/f
5383	`>R/E/F block`	Block rotor earth fault protection
5386	`>Test R/E/F`	Activate test operation for rotor earth fault protection via binary input
5413	`>I/T block`	Block interturn fault protection
5473	`>SEF block`	Block stator earth fault protection
5476	`>U20 failure`	Failure 20 Hz bias voltage of stator earth fault protection
6506	`>U< block`	Block undervoltage protection
6513	`>o/v block`	Block overvoltage protection
6872	`>Trip rel 1`	Trip circuit supervision 1: input in parallel to trip relay
6873	`>CBaux 1`	Trip circuit supervision 1: input in parallel to CB auxiliary contact
6892	`>Trip rel 2`	Trip circuit supervision 2: input in parallel to trip relay
6893	`>CBaux 2`	Trip circuit supervision 2: input in parallel to CB auxiliary contact

1) recommended contact mode: NO operation

Table 5.1 Marshalling possibilities for binary inputs

Addr	1st display line	2nd display line	FNo	Remarks
6100	MARSHALLING	BINARY INPUTS		Heading of the address block
6101	BINARY INPUT 1	INPUT 1 >LED reset NO	5	Acknowledge and reset of stored LED and display indications, LED−test
6102	BINARY INPUT 2	INPUT 2 >RM th.repl. NO	5356	Reset memory of thermal replica U/f
6103	BINARY INPUT 3	INPUT 3 >Frq. block NO	5203	Block frequency protection
6104	BINARY INPUT 4	INPUT 4 >u< block NO	6506	Block undervoltage protection
6105	BINARY INPUT 5	INPUT 5 >SEF block NO	5473	Block stator earth fault protection 100 %
6106	BINARY INPUT 6	INPUT 6 >U0> block NO	5173	Block stator earth fault protection U_0>
6107	BINARY INPUT 7	INPUT 7 >R/E/F block NO	5383	Block rotor earth fault protection
6108	BINARY INPUT 8	INPUT 8 not allocated	1	Not marshalled when delivered

Table 5.2 Preset binary inputs

5.5.3 Marshalling of the signal output relays – address block 62

The unit contains 13 signal outputs (alarm relays). One signal relay is permanently assigned and annunciates the readiness for operation of the unit.The other signal relays are designated SIGNAL RELAY 1 to SIGNAL RELAY 12 and can be marshalled in address block 62. The block is reached by paging in blocks with ⇑ ⇓ or by directly addressing **DA 6 2 0 0 E**. 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 given to several physical signal relays (see also Section 5.5.1).

Table 5.3 gives a listing of all annunciation functions with the associated function numbers **FNo**. Annunciation functions are naturally not effective when the corresponding protection function has been programmed out ("de-configured" – refer to Section 5.4.2).

Note as to Table 5.3: 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 assignment of the output signal relays as delivered from factory is shown in the general diagrams in Appendix A and B. The following boxes show an example for marshalling signal relay 1. Table 5.4 shows all signal relays as preset from the factory.

```
⇑  6 2 0 0█ M A R S H A L L I N G
⇓  S I G N A L   R E L A Y S
```

Beginning of the block "Marshalling of the output signal relays"

The first signal relay is reached with the key ↑:

```
F↑ 6 2 0 1█ S I G N A L
 ↓ R E L A Y   1
```

Allocations for signal relay 1

Change over to the selection level with **F** ↑:

```
↑  0 0 1█ R E L A Y   1
↓  S / E / F   T r i p
```

Signal relay 1 has been preset for:
1st: Stator earth fault 100 % protection trip,
FNo 5489;

```
↑  0 0 2█ R E L A Y   1
↓  n o t   a l l o c a t e d
```

no further functions are preset for signal relay 1

Leave the selection level with key combination **F** ↑. You can go then to the next signal output relay with the arrow key ↑.

```
↑  6 2 0 1█ S I G N A L
↓  R E L A Y   1
```

Allocations for signal relay 1

FNo	Abbreviation	Description
1	not allocated	No annunciation allocated
3	>Time Synchro	Synchronize internal real time clock
4	>Start FltRec	Start fault recording from external command via binary input
5	>Reset LED	Reset LED indicators
7	>ParamSelec.1	Parameter set selection 1 (in connection with 8)
8	>ParamSelec.2	Parameter set selection 2 (in connection with 7)
11	>Annunc. 1	User definable annunciation 1
12	>Annunc. 2	User definable annunciation 2
13	>Annunc. 3	User definable annunciation 3
14	>Annunc. 4	User definable annunciation 4
15	>Sys-Test	System interface messages/values are marked with “Test operation”
16	>Sys-MM-block	System interface messages and measured values are blocked
51	Dev.operative	Protection relay operative
52	Prot. operat.	At least one protection function operative
60	Reset LED	Stored LED are reset
95	Param.running	Parameters are being set
96	Param. Set A	Parameter Set A is activated
97	Param. Set B	Parameter Set B is activated
98	Param. Set C	Parameter Set C is activated
99	Param. Set D	Parameter Set D is activated
141	Failure 24V	Failure 24 V internal dc supply
143	Failure 15V	Failure 15 V internal dc supply
144	Failure 5V	Failure 5 V internal dc supply
145	Failure 0V	Failure 0 V A/D converter
161	I supervision	Failure current supervision, general
165	Failure ΣUp-e	Failure voltage sum supervision
167	Failure Usymm	Failure supervision symmetry U
171	Fail.PhaseSeq	Failure supervision phase sequence
502	Dev. Drop-off	General drop-off of device
4523	>Ext 1 block	Block external trip command 1
4526	>Ext trip 1	External trip signal 1
4531	Ext 1 off	External trip signal 1 is switched off
4532	Ext 1 blocked	External trip signal 1 is blocked
4533	Ext 1 active	External trip signal 1 is active
4536	Ext 1 Gen.Flt	External trip signal 1: general fault detection signal
4537	Ext 1 Gen.Trp	External trip signal 1: general trip command issued
4543	>Ext 2 block	Block external trip command 2
4546	>Ext trip 2	External trip signal 2
4551	Ext 2 off	External trip signal 2 is switched off
4552	Ext 2 blocked	External trip signal 2 is blocked
4553	Ext 2 active	External trip signal 2 is active
4556	Ext 2 Gen.Flt	External trip signal 2: general fault detection signal
4557	Ext 2 Gen.Trp	External trip signal 2: general trip command issued
4563	>Ext 3 block	Block external trip command 3
4566	>Ext trip 3	External trip signal 3
4571	Ext 3 off	External trip signal 3 is switched off
4572	Ext 3 blocked	External trip signal 3 is blocked
4573	Ext 3 active	External trip signal 3 is active
4576	Ext 3 Gen.Flt	External trip signal 3: general fault detection signal
4577	Ext 3 Gen.Trp	External trip signal 3: general trip command issued
4583	>Ext 4 block	Block external trip command 4
4586	>Ext trip 4	External trip signal 4
4591	Ext 4 off	External trip signal 4 is switched off
4592	Ext 4 blocked	External trip signal 4 is blocked
4593	Ext 4 active	External trip signal 4 is active
4596	Ext 4 Gen.Flt	External trip signal 4: general fault detection signal
4597	Ext 4 Gen.Trp	External trip signal 4: general trip command issued

Table 5.3 Marshalling possibilities for signal relays and LEDs (continued next page)

FNo	Abbreviation	Description
5002	Operat. Cond.	Operating condition 1: suitable measured values are present
5004	>Phase rotat.	Phase rotation is reversed to counter-clockwise
5005	Clockwise	Clockwise phase rotation
5006	Counter-clock	Counter-clockwise phase rotation
5173	>U0> block	Block stator earth fault protection U_0>
5181	U0> off	Stator earth fault protection U_0> is switched off
5182	U0> blocked	Stator earth fault protection U_0> is blocked
5183	U0> active	Stator earth fault protection U_0> is active
5186	U0> Fault	Stator earth fault protection: fault detection
5187	U0> Trip	Stator earth fault protection: trip command issued
5203	>Frq. block	Block frequency protection
5206	>f1 block	Block frequency protection stage f1
5207	>f2 block	Block frequency protection stage f2
5208	>f3 block	Block frequency protection stage f3
5209	>f4 block	Block frequency protection stage f4
5211	FRQ off	Frequency protection is switched off
5212	FRQ blocked	Frequency protection is blocked
5213	FRQ active	Frequency protection is active
5214	FRQ U< block	Frequency protection is blocked due to unsuitable voltage
5216	f1> Fault	Frequency protection: fault detection of f1>–stage
5217	f1< Fault	Frequency protection: fault detection of f1<–stage
5218	f2> Fault	Frequency protection: fault detection of f2>–stage
5219	f2< Fault	Frequency protection: fault detection of f2<–stage
5220	f3> Fault	Frequency protection: fault detection of f3>–stage
5221	f3< Fault	Frequency protection: fault detection of f3<–stage
5222	f4> Fault	Frequency protection: fault detection of f4>–stage
5223	f4< Fault	Frequency protection: fault detection of f4<–stage
5224	f1> Trip	Trip by overfrequency protection stage f1>
5225	f1< Trip	Trip by underfrequency protection stage f1<
5226	f2> Trip	Trip by overfrequency protection stage f2>
5227	f2< Trip	Trip by underfrequency protection stage f2<
5228	f3> Trip	Trip by overfrequency protection stage f3>
5229	f3< Trip	Trip by underfrequency protection stage f3<
5230	f4> Trip	Trip by overfrequency protection stage f4>
5231	f4< Trip	Trip by underfrequency protection stage f4<
5353	>U/f block	Block overexcitation protection
5356	>RM th.repl.	Reset memory of of thermal replica U/f
5361	U/f> off	Overexcitation protection is switched off
5362	U/f> blocked	Overexcitation protection is blocked
5363	U/f> active	Overexcitation protection is active
5367	U/f> warn	Overexcitation protection: U/f warning stage
5368	U/f> th.warn	Overexcitation protection: thermal warning stage
5369	RM th. repl.	Reset memory of thermal replica U/f
5370	U/f> Fault	Overexcitation protection: Fault detection U/f>
5371	U/f> Trip	Overexcitation protection: Trip of U/f> stage
5372	U/f> th.Trip	Overexcitation protection: Trip of thermal stage
5383	>R/E/F block	Block rotor earth fault protection
5386	>Test R/E/F	Activate test operation of rotor earth fault protection via binary input
5391	R/E/F off	Rotor earth fault protection is switched off
5392	R/E/F blocked	Rotor earth fault protection is blocked
5393	R/E/F active	Rotor earth fault protection is active
5395	R/E/F open	Measuring circuit of rotor earth fault protection is open
5396	Failure R/E/F	Failure in measuring circuit of rotor earth fault protection
5397	R/E/F Warn	Rotor earth fault protection: Warning stage

Table 5.3 Marshalling possibilities for signal relays and LEDs (continued next page)

FNo	Abbreviation	Description
5398	R/E/F Fault	Rotor earth fault protection: Fault detection
5399	R/E/F Trip	Rotor earth fault protection: Trip
5402	Failure RMT	Failure rotating measuring value transmission
5404	Test REF warn	Rotor earth fault protection: Warning stage during test operation
5405	Test REF Trip	Rotor earth fault protection: Trip during test operation
5413	>I/T block	Block interturn fault protection
5421	I/T off	Interturn fault protection is switched off
5422	I/T blocked	Interturn fault protection is blocked
5423	I/T active	Interturn fault protection is active
5426	I/T Fault	Interturn fault protection: Fault detection
5427	I/T Trip	Interturn fault protection: Trip
5473	>SEF block	Block stator earth fault protection
5476	>U20 failure	Failure 20Hz bias voltage for stator earth fault protection
5481	S/E/F off	Stator earth fault protection is switched off
5482	S/E/F blocked	Stator earth fault protection is blocked
5483	S/E/F active	Stator earth fault protection is active
5486	Failure S/E/F	Failure stator earth fault protection
5487	S/E/F warn	Stator earth fault protection warning stage
5488	S/E/F Fault	Stator earth fault protection: Fault detection
5489	S/E/F Trip	Stator earth fault protection: Trip
6506	>U< block	Block undervoltage protection U<
6513	>o/v block	Block overvoltage protection U>/U>>
6530	U< off	Undervoltage protection is switched off
6531	U< block	Undervoltage protection is blocked
6532	U< active	Undervoltage protection is active
6533	U< fault	Undervoltage protection fault detection U<
6539	U< trip	Undervoltage protection trip U<
6565	o/v off	Overvoltage protection is switched off
6566	o/v blk	Overvoltage protection is blocked
6567	o/v active	Overvoltage protection is active
6568	U> Fault	Overvoltage protection fault detection U>
6570	U> Trip	Overvoltage protection U> trip U>
6568	U>> Fault	Overvoltage protection fault detection U>>
6573	U>> Trip	Overvoltage protection U>> trip U>>
6872	>Trip rel 1	Trip circuit supervision 1: input in parallel to trip relay
6873	>CBaux 1	Trip circuit supervision 1: input in parallel to CB auxiliary contact
6879	Failure Trip1	Failure detected in trip circuit 1
6892	>Trip rel 2	Trip circuit supervision 2: input in parallel to trip relay
6893	>CBaux 2	Trip circuit supervision 2: input in parallel to CB auxiliary contact
6899	Failure Trip2	Failure detected in trip circuit 2

Table 5.3 Marshalling possibilities for signal relays and LEDs

Addr	1st display line	2nd display line	FNo	Remarks
6200	MARSHALLING	SIGNAL RELAYS		Heading of the address block
6201	SIGNAL RELAY 1	RELAY 1 S/E/F Trip	 5489	 Trip by stator earth fault protection
6202	SIGNAL RELAY 2	RELAY 2 R/E/F Trip	 5399	 Trip by rotor earth fault protection
6203	SIGNAL RELAY 3 RELAY 3	RELAY 3 U/f> Trip U/f> th.Trip	 5371 5372	 Trip by overexcitation protection (U/f> stage and thermal stage)
6204	SIGNAL RELAY 4	RELAY 4 U0> Trip	 5187	 Trip by stator earth fault protection U_0>
6205	SIGNAL RELAY 5	RELAY 5 U> Trip	 6570	 Trip by overvoltage protection, stage U>
6206	SIGNAL RELAY 6	RELAY 6 U>> Trip	 6573	 Trip by overvoltage protection, stage U>>
6207	SIGNAL RELAY 7	RELAY 7 U< Trip	 6539	 Trip by undervoltage protection
6208	SIGNAL RELAY 8 RELAY 8	RELAY 8 f1< Trip f2< Trip	 5225 5227	 Trip by frequency protection: stages f1< and f2<
6209	SIGNAL RELAY 9	RELAY 9 f4> Trip	 5230	 Trip by frequency protection: stage f4>
6210	SIGNAL RELAY 10	RELAY 10 U/f> warn	 5367	Overexcitation protection: Thermal warning stage
6211	SIGNAL RELAY 11 RELAY 11 RELAY 11 RELAY 11 RELAY 11 RELAY 11 RELAY 11 RELAY 11 RELAY 11 RELAY 11 RELAY 11	RELAY 11 U0> Trip f1> Trip f2> Trip f4> Trip U/f> Trip U/f> th.Trip R/E/F Trip S/E/F Trip U< Trip U> Trip U>> Trip	 5187 5225 5227 5230 5371 5372 5399 5489 6539 6570 6573	General annunciation of all pre-selected trip signals
6212	SIGNAL RELAY 12	RELAY 12 R/E/F Warn	 5397	Rotor earth fault protection: Warning stage
6213	SIGNAL RELAY 13	RELAY 13*) Dev.operative	 51	Device operative*); the NC contact can be used for “Device faulty” annunciation

*)permanently assigned, cannot be altered

Table 5.4 Preset annunciations for signal relays

5.5.4 Marshalling of the LED indicators – address block 63

The unit contains 16 LEDs for optical indications, 14 of which can be marshalled. They are designated LED 1 to LED 14 and can be marshalled in address block 63. The block is reached by paging in blocks with ⇑ ⇓ or by directly addressing with **DA 6 3 0 0 E**. 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 given 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 (`m` for **m**emorized) or unstored mode (`nm` for "**n**ot **m**emorized"). Each annunciation function is displayed with the index `m` or `nm` when proceeding with the **N**–key.

The marshallable annunciation functions are the same as those listed in Table 5.3. Annunciation functions are, of course, not effective when the corresponding protection function has been programmed out (de-configured).

With direct input of the function number it is not necessary to input the leading zeros. To indicate whether the stored or unstored mode shall be effective the function number can be extended by a decimal point followed by 0 or 1, whereby

.0 unstored indication (not memorized) corresponds to "`nm`" as above,

.1 stored indication (memorized) corresponds to "`m`" as above.

If the extension with .0 or .1 is omitted the display shows first the function designation in unstored mode with "`nm`". Press the "No"–key **N** to change to stored mode "`m`". After direct input other functions can be selected by paging through the functions forwards with the "No"–key **N** or backwards with the backspace key **R.** The changed function then must be re-confirmed by the enter-key **E**.

The assignment of the LEDs as preset by the factory is shown in the front of the unit (Figure 6.1). The following boxes show, as an example, the assignment for LED 14. Table 5.5 shows all LED indicators as they are preset from the factory.

```
⇑ 6300█ MARSHALLING
⇓ LED  INDICATORS
```

Beginning of the block "Marshalling of the LED indicators"

The desired marshallable LED is reached with the key ↑:

```
6314█ LED  14
```

Allocations for LED 14

Change over to the selection level with **F** ↑:

```
001█ LED  14
Failure  5V    nm
```

LED 14 has been preset for:
1st: Failure of internal 5 Vdc power supply,
FNo `144`

```
002█ LED  14
Failure  15V   nm
```

LED 14 has been preset for:
2nd: Failure of internal 15 Vdc power supply,
FNo `143`

```
003█ LED  14
Failure  24V   nm
```

LED 14 has been preset for:
3rd: Failure of internal 24 Vdc power supply,
FNo `141`

```
004█ LED  14
Failure  0V    nm
```

LED 14 has been preset for:
4th: Failure of internal 0 Vdc power supply,
FNo `145`

```
005█ LED  14
not allocated
```

no further allocation for LED 14

After input of all annunciation functions for LED 14, change-back to the marshalling level is carried out with **F** ↑:

```
6 3 1 4█ L E D   1 4
```

Allocations for LED 14, Meaning: “Failure in one of the internal d.c. supply circuits”.

Addr	1st display line	2nd display line	FNo	Remarks
6300	MARSHALLING	LEDs		Heading of the address block
6301	LED 1 LED 1	 S/E/F Trip m	 5489	Trip by stator earth fault 100 % protection
6302	LED 2 LED 2	 R/E/F Warn nm	 5397	Rotor earth fault protection: Warning stage
6303	LED 3 LED 3	 R/E/F Trip m	 5399	Trip by rotor earth fault protection
6304	LED 4 LED 4	 U/f> warn nm	 5367	Overexcitation protection: U/f warning stage
6305	LED 5 LED 5 LED 5	 U/f> Trip m U/f> th.Trip m	 5371 5372	Trip by overexcitation protection (U/f> stage and thermal stage)
6306	LED 6 LED 6	 U0> Trip m	 5187	Trip by stator earth fault U_0>
6307	LED 7 LED 7	 U> Trip m	 6570	Trip by overvoltage protection U> stage
6308	LED 8 LED 8	 U>> Trip m	 6573	Trip by overvoltage protection U>> stage
6309	LED 9 LED 9	 U< Trip m	 6539	Trip by undervoltage protection
6310	LED 10 LED 10 LED 10	 f1< Trip m f2< Trip m	 5225 5227	Trip by frequency protection: stages f1< and f2<
6311	LED 11 LED 11	 f4> Trip m	 5230	Trip by frequency protection stage f4>
6312	LED 12 LED 12	 U< blocked nm	 6531	Undervoltage protection is blocked
6313	LED 13 LED 13	 S/E/F blocked nm	 5482	Stator earth fault 100 % protection is blocked
6314	LED 14 LED 14 LED 14 LED 14 LED 14	 Failure 5V nm Failure 15V nm Failure 24V nm Failure 0V nm	 144 143 141 145	Failure in one of the internal d.c. supply circuits

Table 5.5 Preset LED indicators

5.5.5 Marshalling of the command (trip) relays − address block 64

The unit contains 5 trip relays which are designated TRIP RELAY 1 to TRIP RELAY 5. The trip relays can be marshalled in the address block 64. The block is reached by paging in blocks with ⇑ ⇓ or by directly addressing with **DA**, input of the address number **6 4 0 0** and pressing the enter key **E**. 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 given to several trip relays (see also Section 5.5.1).

Table 5.6 shows the list of all the command 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 Section 5.4.2).

The following boxes show an example for marshalling of trip relays 3. Table 5.7 shows all trip relays as preset from the factory. Figure 5.10, at the end of this section, illustrates the preset assignment as a tripping matrix.

```
6 4 0 0█ M A R S H A L L I N G
T R I P   R E L A Y S
```

Beginning of the block “Marshalling of the trip relays”

The desired trip relay is reached with the key ↑:

```
6 4 0 1█ T R I P
R E L A Y   1
```

Allocations for trip relay 1

Change over to the selection level with **F** ↑:

```
0 0 1█ T R I P   R E L .   1
T e s t   T r i p   1
```

Trip relay 1 has been preset for:
1st: Trip by test trip function for trip relay 1, FNo 1175; this function is **fix allocated and cannot be changed!**

```
0 0 2█ T R I P   R E L .   1
S / E / F   T r i p
```

Trip relay 1 has been preset for:
2nd: Trip by stator earth fault 100 % protection, FNo 5489

```
0 0 3█ T R I P   R E L .   1
U / f >   T r i p
```

Trip relay 1 has been preset for:
3rd: Trip by overexcitation protection stage U/f>, FNo 5371

```
0 0 4█ T R I P   R E L .   1
U / f >   t h . T r i p
```

Trip relay 1 has been preset for:
4th: Trip by overexcitation protection thermal stage, FNo 5372

```
0 0 5█ T R I P   R E L .   1
f 2 <   T r i p
```

Trip relay 1 has been preset for:
5th: Trip by frequency protection stage f_2<, FNo 5227

```
0 0 6█ T R I P   R E L .   1
U 0 >   T r i p
```

Trip relay 1 has been preset for:
6th: Trip by stator earth fault protection U_0>,
FNo 5187

```
0 0 7█ T R I P   R E L .   1
U <   T r i p
```

Trip relay 1 has been preset for:
7th: Trip by undervoltage protection,
FNo 6539

```
0 0 8█ T R I P   R E L .   1
f 1 <   T r i p
```

Trip relay 1 has been preset for:
8th: Trip by frequency protection, stage f1<,
FNo 5225

```
0 0 9█ T R I P   R E L .   1
n o t   a l l o c a t e d
```

Trip relay 1 has been preset for:
9th: no function allocated

Leave the selection level with key combination **F** ↑. You can go then to the next trip relay with the arrow key ↑.

FNo	Abbreviation	Logical command function
1	not allocated	no command function allocated
11	>Annunc. 1	User definable annunciation 1
12	>Annunc. 2	User definable annunciation 2
13	>Annunc. 3	User definable annunciation 3
14	>Annunc. 4	User definable annunciation 4
4537	Ext 1 Gen.Trp	Trip by external trip signal 1 via binary input
4557	Ext 2 Gen.Trp	Trip by external trip signal 2 via binary input
4577	Ext 3 Gen.Trp	Trip by external trip signal 3 via binary input
4597	Ext 4 Gen.Trp	Trip by external trip signal 4 via binary input
5187	U0> Trip	Trip by stator earth fault protection U_0>
5224	f1> Trip	Trip by frequency protection, stage f1>
5225	f1< Trip	Trip by frequency protection, stage f1<
5226	f2> Trip	Trip by frequency protection, stage f2>
5227	f2< Trip	Trip by frequency protection, stage f2<
5228	f3> Trip	Trip by frequency protection, stage f3>
5229	f3< Trip	Trip by frequency protection, stage f3<
5230	f4> Trip	Trip by frequency protection, stage f4>
5231	f4< Trip	Trip by frequency protection, stage f4<
5371	U/f> Trip	Trip by overexcitation protection, stage U/f>
5372	U/f> th.Trip	Trip by overexcitation protection, thermal stage
5399	R/E/F Trip	Trip by rotor earth fault protection
5427	I/T Trip	Trip by interturn fault protection
5489	S/E/F Trip	Trip by stator earth fault 100 % protection
6539	U< trip	Trip by undervoltage protection U<
6570	U> trip	Trip by overvoltage protection U>
6573	U>> Trip	Trip by overvoltage protection U>>

Table 5.6 Marshalling possibilities for command functions

Addr	1st display line	2nd display line	FNo	Remarks
6400	MARSHALLING	TRIP RELAYS		Heading of the address block
6401	TRIP TRIP REL. 1 TRIP REL. 1 TRIP REL. 1 TRIP REL. 1 TRIP REL. 1 TRIP REL. 1 TRIP REL. 1 TRIP REL. 1	RELAY 1 Test Trip 1 1) S/E/F Trip U/f> Trip U/f> th.Trip f2< Trip U0> Trip U< Trip f1< Trip	 1175 5489 5371 5372 5227 5187 6539 5225	e.g. trip for network circuit breaker
6402	TRIP TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2	RELAY 2 Test Trip 2 1) S/E/F Trip U/f> Trip U/f> th.Trip f2< Trip f4> Trip R/E/F/Trip U> Trip U>> Trip	 1176 5489 5371 5372 5227 5230 5399 6570 6573	e.g. trip for generator circuit breaker
6403	TRIP TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3	RELAY 3 Test Trip 3 1) S/E/F Trip U/f> Trip U/f> th.Trip f2< Trip f4> Trip R/E/F/Trip U> Trip U>> Trip	 1177 5489 5371 5372 5227 5230 5399 6570 6573	e.g. trip for stop valve
6404	TRIP TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4	RELAY 4 Test Trip 4 1) S/E/F Trip U/f> Trip U/f> th.Trip f2< Trip f4> Trip R/E/F/Trip U> Trip U>> Trip	 1178 5489 5371 5372 5227 5230 5399 6570 6573	e.g. trip for de-excitation
6405	TRIP TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5	RELAY 5 Test Trip 5 1) S/E/F Trip U/f> Trip U/f> th.Trip f2< Trip f4> Trip U0> Trip	 1179 5489 5371 5372 5227 5230 5187	e.g. trip for station auxiliary supply change-over

1) Trip test for each trip relay is fix allocated and cannot be altered

Table 5.7 Preset command functions for trip relays

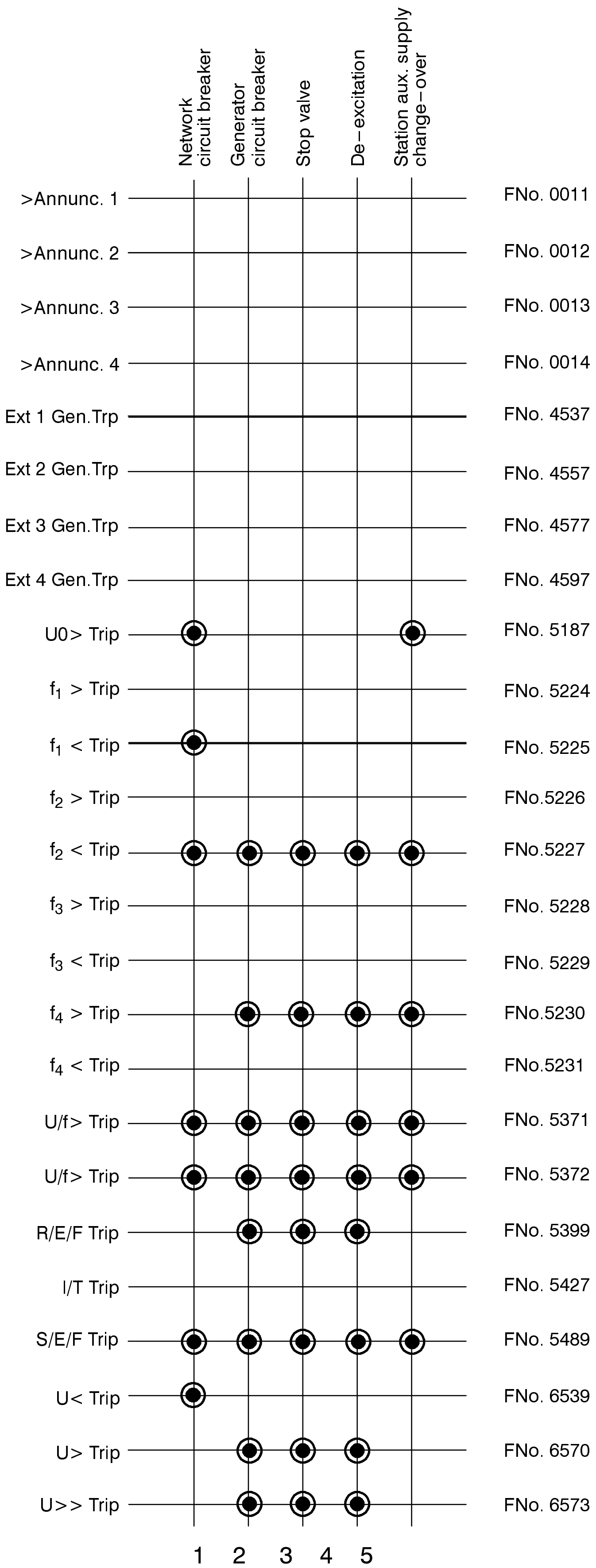


Figure 5.10 Tripping matrix − pre-settings

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.

6.2 Dialog with the relay

Setting, operation and interrogation of digital protection 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

The membrane keyboard and display panel is externally arranged similar to a pocket calculator. Figure 6.1 illustrates the front view.

A two-line, each 16 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 four figure number, followed by a bar. This number presents the **setting address**. The first two digits indicate the address **block**, then follows the two-digit **sequence number**. In models with parameter change-over facility, the identifier of the parameter set is shown before the setting address.

The keyboard comprises 28 keys with numbers, Yes/No and control buttons. The significance of the keys is explained in detail in the following.

Numerical keys for the input of numerals:

0 to 9	Digits 0 to 9 for numerical input
•	Decimal point
∞	Infinity symbol
+/−	Change of sign (input of negative numbers)

Yes/No keys for text parameters:

J/Y	Yes key: operator affirms the displayed question
N	No key: operator denies the displayed question or rejects a suggestion and requests for alternative

Keys for paging through the display:

↑	Paging forwards: the next address is displayed
↓	Paging backwards: the previous address is displayed
⇧	Block paging forwards: the beginning of the next address block is displayed
⇩	Block paging backwards: the beginning of previous address block is displayed

Confirmation key:

E	Enter or confirmation key: each numerical input or change via the Yes/No 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.

Control and special keys:

CW	Codeword: prevents unauthorized access to setting programs (not necessary for call-up of annunciations or messages)
R	Backspace erasure of incorrect entries
F	Function key; explained when used
DA	Direct addressing: if the address number is known, this key allows direct call-up of the address
M/S	Messages/Signals: interrogation of annunciations of fault and operating data (refer Section 6.4)

The three keys ↑ ; ⇑ ; RESET which are somewhat separated from the rest of the keys, can be accessed when the front cover is closed. The arrows have the same function as the keys with identical symbols in the main field and enable paging in forward direction. Thus all setting values and event data can be displayed with the front cover closed. Furthermore, stored LED indications on the front can be erased via the RESET key without opening the front cover. During reset operation all 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. The display is switched over to operating mode as soon as one of the keys **DA**, **M/S**, **CW** or ⇑ is pressed.

6.2.2 Operation with a personal computer

A personal computer 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.

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. It is also possible, by connecting a plotter, to print out the fault history traces.

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. Note that the operating interface in the front of the relay is not galvanically isolated and that only adequate connection cables are applied (e.g. 7XV5100−2). Further information about facilities on request.

6.2.3 Operational preconditions

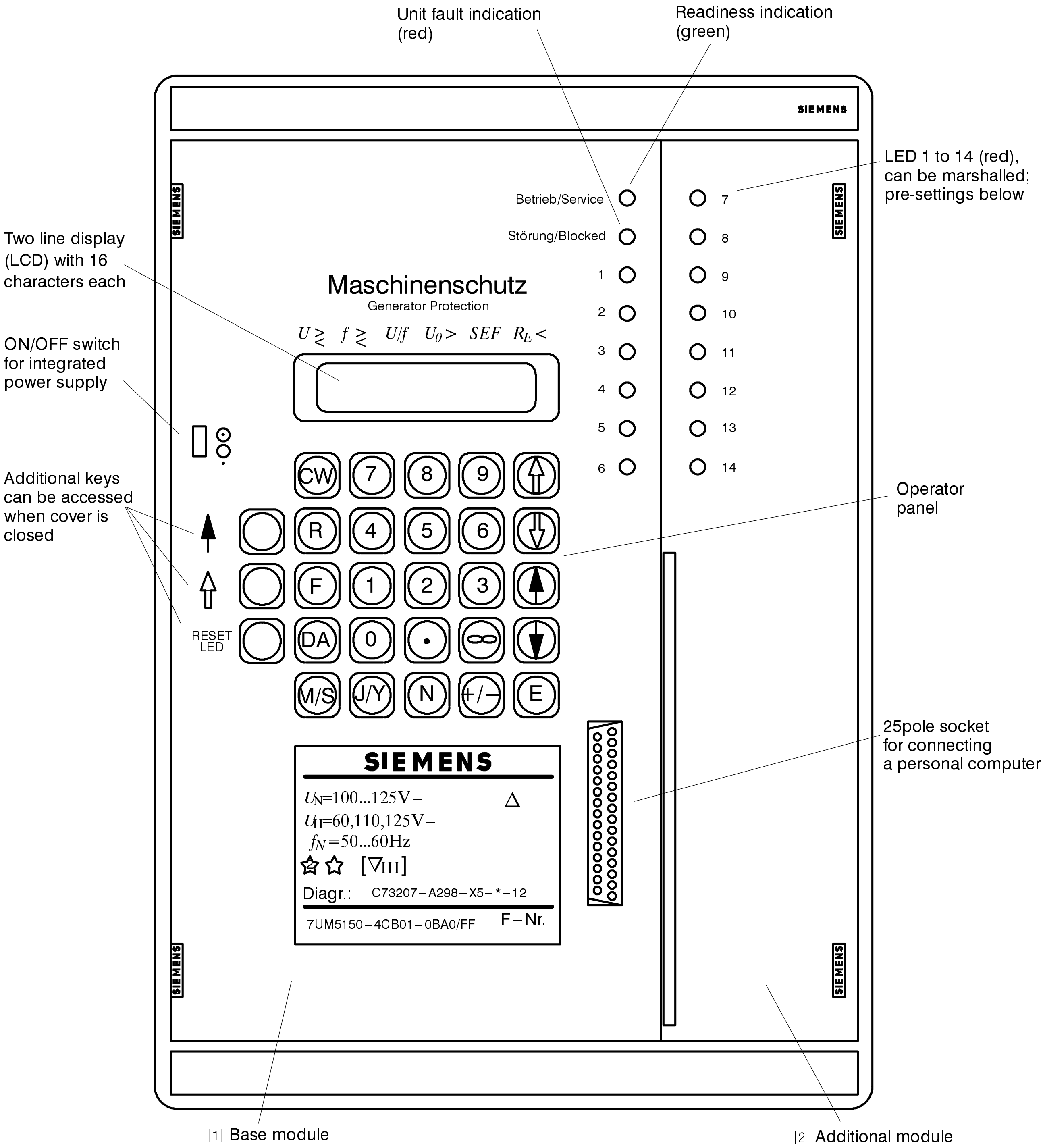
For most operational functions, the input of a codeword is necessary. This applies for all entries via the membrane keyboard or front interface which concern the operation on the relay, for example

- setting of functional parameters (thresholds, functions),
- allocation or marshalling of signals, binary inputs, LED indicators, trip relays,
- configuration parameters for operating 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.

6.2.4 Representation of the relay (front view)



Factory presetting LEDs:

1	S/E/F Trip	6	U0> Trip	11	f4> Trip
2	R/E/F Warn	7	U> Trip	12	U< block
3	R/E/F Trip	8	U>> Trip	13	S/E/F block
4	U/f Warn	9	U< Trip	14	Device fault (hardware fault)
5	U/f Trip	10	f1<, f2< Trip		

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

For setting the functional parameters it is necessary to enter the codeword of code level 2 (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

  The address is identified by the block number followed by 00 as sequence number (e.g. **11**00 for block **11**). Displayed text forms the heading of this block. No input is expected. By using keys ⇑ or ⇓ the next or the previous block can be selected. By using the keys ↑ or ↓ the first or last address within the block can be selected and paged.

– Addresses which require numerical input

  The display shows the four-digit address, i.e. block and sequence number (e.g. **1202** for block **12**, sequence number **2**). Behind the bar appears the meaning of the required parameter, 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) block. If the value needs to be altered, it can be overwritten using the numerical keys and, if required, the decimal point and/or change sign (**+/–**) or, where appropriate, infinity sign ∞. The permissible setting range is given in the following text, next to the associated box. Entered values beyond this range will be rejected. The setting steps correspond to the last decimal place as shown in the setting box. Inputs with more decimal places than permitted will be truncated down to the permissible number. **The value must be confirmed with the entry key E!** The display then confirms the accepted value. The changed parameters are only saved after termination of parameterizing (refer below).

– Addresses which require text input

  The display shows the four-digit address, i.e. block and sequence number (e.g. **1301** for block **13**, sequence number **1**). Behind the bar appears the meaning of the required parameter, 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) block. If the text needs to be altered, press the "No"–key **N**. The next alternative text, also printed in the display boxes illustrated in the following sections, then appears. If the alternative text is not desired, the **N** key is pressed again, etc. The alternative which is chosen, **is confirmed with the entry key E.** The changed parameters are only saved after termination of parameterizing (refer below).

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 ⇑ ⇓ or ↑↓ at the left hand side of the illustrated display boxes indicate the method of moving from block to block or within the block. Unused addresses are automatically passed over.

If the parameter address is known, then direct addressing is possible. This is achieved by depressing key **DA** followed by the four-digit address and subsequently pressing the enter key **E**. After direct addressing, paging by means of keys ⇑ ⇓ and keys ↑ ↓ is possible.

The setting procedure can be ended at any time by the key combination **F E**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS?". Confirm with the "Yes"–key **Y** that the new settings shall become valid now. If you press the "No"–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

If one tries to leave the setting range for the functional parameter blocks (i.e. address blocks 10 to 39) with keys ⇑ ⇓, the display shows the question “END OF CODEWORD OPERATION ?”. Press the “No”–key **N** to continue parameterizing. If you press the “Yes”–key **J/Y** instead, another question appears: “SAVE NEW SETTINGS ?”. Now you can confirm with **J/Y** or abort with **N**, as above.

After completion of the parameterizing process, the changed parameters which so far have only been stored in volatile memory, are then permanently stored in EEPROMs. The display confirms “NEW SETTINGS SAVED”. After pressing the key **M/S** followed by RESET LED, the indications of the quiescent state appear in the display.

6.3.1.2 Selectable parameter sets

Up to 4 different sets of parameters can be selected for the functional parameters, i.e. the addresses above 1000 and below 4000. These parameter sets can be switched over during operation, locally using the operator panel or via the operating interface using a personal computer, or also remotely using binary inputs.

If this facility is not used then it is sufficient to set the parameters for the preselected set. The rest of this section is of no importance. Otherwise, the parameter change-over facility must be configured as *EXIST* under address 7885 (refer Section 5.4.2). The first parameter set is identified as set A, the other sets are B, C and D. Each of these sets is adjusted one after the other.

If the switch-over facility is to be used, first set all parameters for the normal status of parameter set A. Then switch over to parameter set B:

– Fist complete the parameterizing procedure for set A as described in Section 6.3.1.1.

– Press key combination **F 2**, i.e. first the function key **F** and then the number key **2**. All following inputs then refer to parameter set B.

All parameter sets can be accessed in a similar manner:

- Key combination **F 1**:
  access to parameter set **A**

- Key combination **F 2**:
  access to parameter set **B**

- Key combination **F 3**:
  access to parameter set **C**

- Key combination **F 4**:
  access to parameter set **D**

Input of the codeword is again necessary for the setting of a new selected parameter set. Without input of the codeword, the settings can only be read but not modified.

Since only a few parameters will be different in most applications, it is possible to copy previously stored parameter sets into another parameter set.

It is additionally possible to select the original settings, i.e. the settings preset on delivery, for a modified and stored parameter set. This is done by copying the “ORIG.SET” to the desired parameter set.

It is finally still possible to define the active parameter set, i.e. the parameter set which is valid for the functions and threshold values of the unit. See Section 6.5.3 for more details.

The parameter sets are processed in address block 85. The most simple manner to come to this block is using direct addressing:

– press direct address key **DA**,
– enter address, e.g. **8 5 0 0**,
– press enter key **E**.

The heading of the block for processing the parameter sets then appears.

It is possible to scroll through the individual addresses using the ↑ key. The copying facilities are summarized in Table 6.1.

⇑ ⇓ 8500 █ PARAMETER CHANGE-OVER	Beginning of the block “Parameter change-over”; processing of parameter sets

Addr.	Copy from	to
8510	ORIG.SET	SET A
8511	ORIG.SET	SET B
8512	ORIG.SET	SET C
8513	ORIG.SET	SET D
8514	SET A	SET B
8515	SET A	SET C
8516	SET A	SET D
8517	SET B	SET A
8518	SET B	SET C
8519	SET B	SET D
8520	SET C	SET A
8521	SET C	SET B
8522	SET C	SET D
8523	SET D	SET A
8524	SET D	SET B
8525	SET D	SET C

Table 6.1 Copying parameter sets

Following copying, only such parameters need be changed which are to be different from the source parameter set.

Parameterizing must be terminated for each parameter set as described in Section 6.3.1.1.

6.3.1.3 Setting of date and time

The date and time can be set if the the real time clock is available. Setting is carried out in block 81 which is reached by direct addressing **DA 8 1 0 0 E** or by paging with ⇑ and ⇓. Input of the codeword is required to change the data.

Selection of the individual addresses is by further scrolling using ↑ ↓ as shown below. Each modification must be confirmed with the enter key **E**.

The date and time are entered with dots as separator signs since the keyboard does not have a colon or slash (for American date).

The clock is synchronized at the moment when the enter key **E** is pressed following input of the complete time. The difference time facility (address 8104) enables exact setting of the time since the difference can be calculated prior to the input, and the synchronization of the clock does not depend on the moment when the enter key **E** is pressed.

⇑⇓
```
8100█ SETTING
REAL TIME CLOCK
```
Beginning of the block “Setting the real time clock”
Continue with ↑.

↑↓
```
25.05.1996
15:58:26
```
At first, the actual date and time are displayed.
Continue with ↑.

↑↓
```
8102█ DATE
```
Enter the new date: 2 digits for day, 2 digits for month and 4 digits for year (including century); use the order as configured under address 7102 (Section 5.3.2), but always use a dot for separator:
DD.MM.YYYY or **MM.DD.YYYY**

↑↓
```
8103█ TIME
```
Enter the new time: hours, minutes, seconds, each with 2 digits, separated by a dot:
HH.MM.SS

↑↓
```
8104█ DIFF. TIME
```
Using the difference time, the clock is set forwards by the entered time, or backwards using the **+/−** key.
The format is the same as with the time setting above.

6.3.2 Initial displays − address blocks 0 and 10

When the relay is switched on, firstly the address 0 and the type identification of the relay appears. All Siemens relays have an MLFB (machine readable type number). When the device is operative and displays a quiescent message, any desired address can be reached e.g. by pressing the direct address key **DA** followed by the address number.

```
0█ 7UM515    V3.**B
7UM5150*********
```

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

After address 1000, the functional parameters begin. If switch-over of parameter sets is used, the identifier of the parameter set is indicated as a leading character. Further address possibilities are listed under “Annunciations” and “Tests”.

```
A1000█
PARAMETERS
```

Commencement of functional parameter blocks (example illustrated for parameter set A)

6.3.3 Machine and power system data − address blocks 11 and 12

The relay requests basic data of the power system and of the protected machine. They are not absolutely necessary for the actual protection functions, however, they are used for the determination of operational data.

```
 1100█ MACHINE  &
POWERSYSTEM  DATA
```

Beginning of the block “Machine and power system data”

```
 1103█ POWER
20.0  MVA
```

Rated apparent power of machine
Setting range: **0.1** MVA to **2000.0** MVA

```
 1104█ COS  PHI
0.850
```

Rated power factor cos φ
Setting range: **0.000** to **1.000**

```
 1105█ In
1.099  kA
```

Rated current of machine
Setting range: **0.050** kA to **50.000** kA

```
 1106█ Un
10.50  kV
```

Rated voltage of machine (phase-to-phase)
Setting range: **0.30** kV to **100.00** kV

The instrument transformer data are entered in block 12.

```
 1200█ INSTRUMENT
TRANSFORMER DATA
```

Beginning of block
"Instrument transformer data"

```
 1202█ Un PRIMARY
10.00 kV
```

Primary rated voltage of voltage transformers (phase-to-phase)
Setting range: **0.30** kV to **50.00** kV

```
 1204█ UN SECOND
100 V
```

Secondary rated voltage of voltage transformers (phase-to-phase)
Setting range: **100** V to **125** V

With addresses 1205 and 1206, the device is instructed as to how the residual path of the voltage transformers is connected. This information is important for the monitoring of measured values.

If the voltage transformer set or earthing transformer has e–n (open delta) windings, and if these are connected to the device, then this has to be recorded in address 1205. Since the ratio of the voltage transformers is normally

$$\frac{U_{Nprim}}{\sqrt{3}} : \frac{U_{Nsec}}{\sqrt{3}} : \frac{U_{Nsec}}{3}$$

the factor Uph/Udelta (secondary values, address 1206) shall be set as $3/\sqrt{3} = \sqrt{3} \approx 1.73$ when the delta windings are connected. If the ratio is different, e.g. when the displacement voltage is formed by intermediate transformers, the factor has to be selected accordingly.

```
 1205█ VT DELTA
CONNECTED

NOT CONNECTED
```

The measured displacement voltage input Udelta of the device is
CONNECTED to the e–n (open delta) windings of the voltage transformer set or
NOT CONNECTED

```
 1206█ Uph/Udelta
1.73
```

Matching factor for residual voltage:

$$\frac{\text{rated secondary voltage of v.t. phase winding}}{\text{rated secondary voltage of open delta winding}}$$

normally 1.73

Setting range: **–9.99** to **9.99**

6.3.4 Settings for overflux protection − address block 13

```
1300 OVERFLUX
PROTECTION U/f
```

Beginning of the block “Overflux protection function U/f”

```
1301 U/f PROT.
OFF
```

Switch *OFF* of overflux protection U/f

```
ON
```

Switch *ON* of overflux protection U/f

```
BLOCK TRIP REL
```

Overflux protection U/f operates but *TRIP REL*ay is *BLOCK*ed.

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

If the value U/f, as set under address 1302, is exceeded, pick-up occurs. After the time delay address 1303, trip command of the definite time stage is issued.

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

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 replica. If a warning temperature rise is exceeded (address 1305, set in % of the trip temperature rise), an alarm is given by the protection. If the trip temperature rise is exceeded, trip signal appears.

The continuously permissible induction value as stated by the manufacturer determines the setting. This related value (B/B_N) is the base value and is to be set under address 1308.

If this limit value is exceeded continuously, alarm is given (address 1305). Tripping occurs when the time according the set thermal characteristic is reached.

```
1302 U/f>
1.40
```

Pick-up value of the definite time stage
Setting range: **1.00** to **1.50**

```
1303 T-U/f>
1.00 s
```

Delay time for definite time stage
Setting range: **0.00** s to **32.00** s
and ∞ (no trip with definite time stage)

```
  1 3 0 4█ T - R E S E T
1 . 0 0   s
```

Reset delay after trip signal has been initiated
Setting range: **0.00** s to **32.00** s

```
  1 3 0 5█ W A R N   T H E R M
8 5   %
```

Thermal warning temperature rise in % of tripping temperature rise of the thermal stage
Setting range: **70** % to **99** %

The dependency between overflux and trip time is determined by the selected tripping time characteristic. If no statement of the manufacturer is available, it is useful to keep the preset standard characteristic unchanged.

If the overflux (or B/B_N) time characteristic of the protected object is available, 6 value pairs are entered to the relay. Start with the value for continuous overflux under addresses 1308/1309. Continue with 5 further value pairs. Thus, each user defined characteristic can be achieved.

The time multiplier (address 1307) can shift the characteristic in the direction of the time axis. Thus, a time prolongation or time reduction can be achieved without changing the shape of the curve.

The U/f base value (address 1320) is the lowest limit below which no temperature rise is calculated. That means, that values below this setting are not processed. If, for example, the U/f BASE value is set to 1, no thermal processing takes place for induction below rated induction; if the U/f BASE value is set to 0 then each induction leads to a simulated temperature rise. Tripping times for a certain overflux (or overinduction) are accordingly shorter, in the latter case.

```
  1 3 0 6█ T - W A R N
2 0 . 0 0   s
```

Delay time for warning stage
Setting range: **0.00** s to **32.00** s

```
  1 3 0 7█ T I M E   M U L T .
1
```

Time multiplier for U/f time characteristic
Setting range: **1** to **8**

```
  1 3 0 8█ U / f       ( 1 )
1 . 1 0
```

1st characteristic value of overflux = continuously permissible limit value U/f
Setting range: **1.02** to **1.60**

```
  1 3 0 9█ T - U / f   ( 1 )
∞   s
```

Time delay T of 1st characteristic value
Setting range: **1** s to **98** s
and ∞

```
  1 3 1 0█ U / f       ( 2 )
1 . 1 3
```

2nd characteristic value of overflux U/f
Setting range: **1.02** to **1.60**

```
1311 T-U/f  (2)
98 s
```

Time delay T of 2nd characteristic value
Setting range: **1** s to **98** s

```
1312 U/f    (3)
1.15
```

3rd characteristic value of overflux U/f
Setting range: **1.02** to **1.60**

```
1313 T-U/f  (3)
40 s
```

Time delay T of 3rd characteristic value
Setting range: **1** s to **98** s

```
1314 U/f    (4)
1.20
```

4th characteristic value of overflux U/f
Setting range: **1.02** to **1.60**

```
1315 T-U/f  (4)
12 s
```

Time delay T of 4th characteristic value
Setting range: **1** s to **98** s

```
1316 U/f    (5)
1.31
```

5th characteristic value of overflux U/f
Setting range: **1.02** to **1.60**

```
1317 T-U/f  (5)
3 s
```

Time delay T of 5th characteristic value
Setting range: **1** s to **98** s

```
1318 U/f    (6)
1.38
```

6th characteristic value of overflux U/f
Setting range: **1.02** to **1.60**

```
1319 T-U/f  (6)
2 s
```

Time delay T of 6th characteristic value
Setting range: **1** s to **98** s

```
1320 U/f BASE
1.00
```

Base value of thermal overflux U/f
Setting range: **0.00** to **1.00**

6.3.5 Settings for undervoltage protection – address block 16

Display	Description
1600 UNDERVOLTAGE	Beginning of the block "Undervoltage protection"
1601 UNDERVOLT. OFF	Switch *OFF* of the undervoltage protection
ON	Switch *ON* of the undervoltage protection
BLOCK TRIP REL	Undervoltage protection operates but *TRIP REL*ay is *BLOCK*ed.

The undervoltage protection has a voltage dependent time characteristic. The undervoltage protection mainly protects consumers (induction machines) from the consequences of voltage drops in island networks. Also in interconnected networks, it can be used as a load shedding criterion.

Depending on the type of the machine and the network, different points need to be considered when setting the parameters:

In the case of asynchronous machines, the pull-out torque is normally 2 to 2.5 times the rated torque. It decreases with the square of the voltage. This means that the machine will stall at 60 % to 70 % rated voltage. However, asynchronous motors can run up again after recovery of a sufficiently high voltage, albeit with increased starting current.

The setting for the voltage limit value should, therefore, lie slightly (approx. 5 %) above the ratio

$$\sqrt{\frac{\text{rated torque}}{\text{pull – out torque}}} \cdot U_N$$

Since the above considerations assume rated frequency, power values can be inserted in place of torques.

In synchronous machines, the torque decreases linearly with the voltage. However, synchronous machines are more sensitive with regard to voltage decreases since they – contrary to asynchronous machines – fall out-of-step if the pull-out torque has been reached. Therefore the safety margin should be slightly higher. Also in this case, the voltage should not drop below 60 % to 70 % of rated voltage.

For the setting of the voltage limit value, a value equal to 10 % above the ratio

$$\frac{\text{rated torque}}{\text{pull-out torque}} \cdot U_N$$

is recommended. Power values can be inserted instead of torques.

If the permissible voltage time characteristic of the machine is stated by the manufacturer, this should be taken as the base for the settings.

The characteristic can be entered to the protection by setting 6 pairs of the voltage time characteristic. Thus, each sort of curve can be achieved. The 6 pairs of values can be read out from the voltage time characteristic of the machine and parameterized under the addresses 1602 to 1613.

Start with the value for the highest voltage under address 1602; the associated time is set under address 1603. Continue with 5 further value pairs which must be decreasing voltage values and decreasing associated times. Thus, each user defined characteristic can be achieved. Time delays between the set voltage values will be linearly interpolated by the protection.

Note, that all setting times are additional delay times, which do not include the normal operating times (measuring time, reset time) of the protection function itself. This should also be considered when setting the times.

Note: If all delay times should be equal, i.e. the delay should be definite time, nevertheless, six different voltage values must be entered, in an decreasing order.

```
1602█ U<        (1)
80 V
```

1st characteristic value U< of undervoltage dependent time characteristic
Setting range: **20** V to **100** V

```
1603█ T-U<      (1)
2.00 s
```

Time delay T of 1st characteristic value
Setting range: **0.00** s to **32.00** s
and ∞

```
1604█ U<        (2)
77 V
```

2nd characteristic value U< of undervoltage dependent time characteristic
Setting range: **20** V to **100** V

```
1605█ T-U<      (2)
0.60 s
```

Time delay T of 2nd characteristic value
Setting range: **0.00** s to **32.00** s
and ∞

```
1606█ U<        (3)
75 V
```

3rd characteristic value U< of undervoltage dependent time characteristic
Setting range: **20** V to **100** V

```
1607█ T-U<      (3)
0.40 s
```

Time delay T of 3rd characteristic value
Setting range: **0.00** s to **32.00** s
and ∞

```
1608█ U<        (4)
67 V
```

4th characteristic value U< of undervoltage dependent time characteristic
Setting range: **20** V to **100** V

```
1609█ T-U<      (4)
0.20 s
```

Time delay T of 4th characteristic value
Setting range: **0.00** s to **32.00** s
and ∞

```
1610█ U<        (5)
55 V
```

5th characteristic value U< of undervoltage dependent time characteristic
Setting range: **20** V to **100** V

```
1611█ T-U<      (5)
0.10 s
```

Time delay T of 5th characteristic value
Setting range: **0.00** s to **32.00** s
and ∞

```
1612█ U<        (6)
40 V
```

6th characteristic value U< of undervoltage dependent time characteristic
Setting range: **20** V to **100** V

```
1613█ T-U<      (6)
0.00 s
```

Time delay T of 6th characteristic value
Setting range: **0.00** s to **32.00** s
and ∞

```
1614█ T-RESET
1.00 s
```

Reset delay after trip command has been initiated
Setting range: **0.00** s to **32.00** s

6.3.6 Settings for overvoltage protection – address block 17

Display	Description
1700 OVER VOLTAGE	Beginning of the block "Overvoltage protection"
1701 OVERVOLT. OFF	Switch *OFF* of the overvoltage protection
ON	Switch *ON* of the overvoltage protection
BLOCK TRIP REL	Overvoltage protection operates but *TRIP REL*ay is *BLOCK*ed.

Setting of the overvoltage protection depends on the speed with which the voltage regulator can regulate voltage fluctuations. The protection must not interfere with the operation of a correctly operating voltage regulator. Its characteristic must, therefore, always lie above the voltage/time characteristic of the voltage regulator.

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

If the generator sheds full load, the voltage initially increases 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.

Display	Description
1702 U> 110 V	Pick-up value of U> stage of overvoltage protection Setting range: **30** V to **180** V
1703 U>> 130 V	Pick-up value of U>> stage of overvoltage protection Setting range: **30** V to **180** V
1704 T-U> 1.50 s	Trip delay of overvoltage protection stage U> (long time stage) Setting range: **0.00** s to **32.00** s and ∞ (no trip with overvoltage U>)
1705 T-U>> 0.00 s	Trip delay of overvoltage protection stage U>> (short time stage) Setting range: **0.00** s to **32.00** s and ∞ (no trip with overvoltage U>>)
1706 T-RESET 1.00 s	Reset delay after trip command has been initiated Setting range: **0.00** s to **32.00** s

6.3.7 Settings for stator earth fault 100 % protection – address block 18

```
  1 8 0 0 █ S T A T O R   E / F
1 0 0   %   P R O T E C T I O N
```

Beginning of the block
"Stator earth fault 100 % protection"

```
  1 8 0 1 █ S T A T O R   E / F
O F F
```

Switch *OFF* of stator earth 100 % fault protection

```
O N
```

Switch *ON* of stator earth fault 100 % protection

```
B L O C K   T R I P   R E L
```

Stator earth fault 100 % protection operates but *TRIP RELay* is *BLOCKed*.

The final setting is performed during commissioning using primary tests, refer Section 6.7.3 and 6.7.6.

The protection calculates the stator earth resistance from the values U_{SES} and I_{SES} as they are available at the relay terminals (secondary values). The actual (primary) stator earth resistance is transformed to the relay values by the earthing transformer (neutral or line connected), the voltage divider and the intermediate current transformer. The protection is set in secondary values (address 1802 and 1804). The secondary value of the stator earth resistance can be calculated according the following formula:

$$R_{E\ sec} = \frac{9}{TR^2_{E\ Tr}} \cdot \frac{TR_{ICT}}{TR_{VD}} \cdot R_{E\ prim}$$

where

$R_{E\ sec}$	stator earth resistance related to the unit terminals = setting value
$TR_{E\ Tr}$	transformation ratio of the earthing transformer
TR_{ICT}	transformation ratio of the intermediate current transformer
TR_{VD}	transformation ratio of the voltage divider
$R_{E\ prim}$	stator earth resistance of the primary stator circuit

The factor R_{prim}/R_{sec} is the overall transformation ratio and should be entered as S/E/F–FACT under address 1811:

$$S/E/F-FACT = \frac{TR^2_{E\ Tr}}{9} \cdot \frac{TR_{VD}}{TR_{ICT}}$$

This factor is not relevant for any protection function but allows the calculation and display of the actual (primary) stator earth resistance.

The operation of the 20 Hz generator is monitored by supervision of the 20 Hz voltage and 20 Hz current. If both fall below the values set under addresses 1808 (voltage U_{20}) and 1809 (current I_{20}), earth resistance calculation is blocked but the earth current stage continues operation; an alarm is given. In order to achieve maximum operation range these values should be set as low as possible (e.g. 1 V and 10 mA). The final setting is determined during commissioning using primary tests, refer Section 6.7.3.

The setting value of the earth current stage is finally determined during commissioning. Remember that the current stage uses the total earth current, i.e. 20 Hz plus system frequency component. Thus, this stage is particularly effective at earth fault near the machine terminals with relatively high system frequency component. The setting value (address 1806) should be chosen such that this stage covers approximately 80 % of the stator winding. This results in the following suggestion:

$$S/E/F\ I>> = \frac{0{,}2 \cdot 500\ V}{R} \cdot \frac{1}{TR_{ICT}}$$

where:

S/E/F I>>	setting value of the earth current stage address 1806
R	loading resistor at the earthing transformer
TR_{ICT}	transformation ratio of the intermediate current transformer

Exact calculation of the stator earth resistance takes a relatively long inherent operation time of the earth fault 100 % protection because of the integration over a long time period. This should be taken into account when setting the time delays (addresses 1803 and 1805). Remember that these times are pure delay time which do not include the operating times (measuring time, reset time) of the protection functions.

The transformer angle error correction (address 1810) allows optimization of the accuracy of the stator earth resistance measurement. Optimum setting value can be determined during commissioning using primary tests (refer to Section 6.7.3). However, in most cases this correction is not necessary.

Example:

Earthing transformer	$\frac{10\ \text{kV}}{\sqrt{3}} \Big/ \frac{500\ \text{V}}{3}$
Loading resistor	10 Ω 10 A continuous 50 A for 20 s
Voltage divider	500 V/200 V
Intermediate c.t.	200 A/5 A

It is assumed that the transformation ratio of the intermediate current transformer (400/5) has been reduced to 200/5 by feeding the primary lead twice through the transformer window.

With full displacement voltage, earth current produced by the earthing transformer would be

$$\frac{500\ \text{V}}{10\ \Omega} = 50\ \text{A}$$

The secondary current at the relay terminals is thus

$$I_{S/E/F} = \frac{500\ \text{V}}{10\ \Omega} \cdot \frac{5\ \text{A}}{200\ \text{A}} = 1.25\ \text{A}$$

With a desired protection range of 80 % of the stator windings for the earth current stage, this stage must pick up at $^2/_{10}$ of the full displacement voltage; the earth current is then also $^2/_{10}$. The setting value (address 1806) is then:

$$\text{S/E/F I>>} = 0.2 \cdot 1.25\ \text{A} = 0.25\ \text{A}$$

The delay time T−R<< (address 1805) is also valid for the earth current stage; it must be set shorter than the short-time capability of the loading resistor, in this case less than 20 s. If the current capability of the earthing transformer is less than that of the loading resistor, then this capability is decisive for the time delay.

The overall transformation factor (address 1811) is in this example

$$\text{S/E/F} - \text{Fact} = \frac{\left(\frac{10000\ \text{V}}{\sqrt{3}} \cdot \frac{3}{500\ \text{V}}\right)^2}{9} \cdot \frac{500/200}{200/5}$$

$$= 8.33$$

The factor is set to 8.3. Thus, the primary resistance is calculated as 8 times the secondary value as calculated by the protection.

The setting values S/E/F R< (address 1802) and S/E/F R<< (address 1804) can be determined by inversion of the above formula, i.e.

$$\text{S/E/F R<} = \frac{9}{\left(\frac{10000\ \text{V}}{\sqrt{3}} \cdot \frac{3}{500\ \text{V}}\right)^2} \cdot \frac{200/5}{500/200} \quad R_{E\ prim}$$

$$\text{S/E/F R<} = \frac{1}{8.33} \cdot R_{E\ prim} = 0.12 \cdot R_{E\ prim}$$

If, for example, the earth resistance tripping stage should operate at stator earth resistance of 1000 Ω, the setting value S/E/F R<< (address 1804) is set to 0.12 · 1000 Ω = 120 Ω.

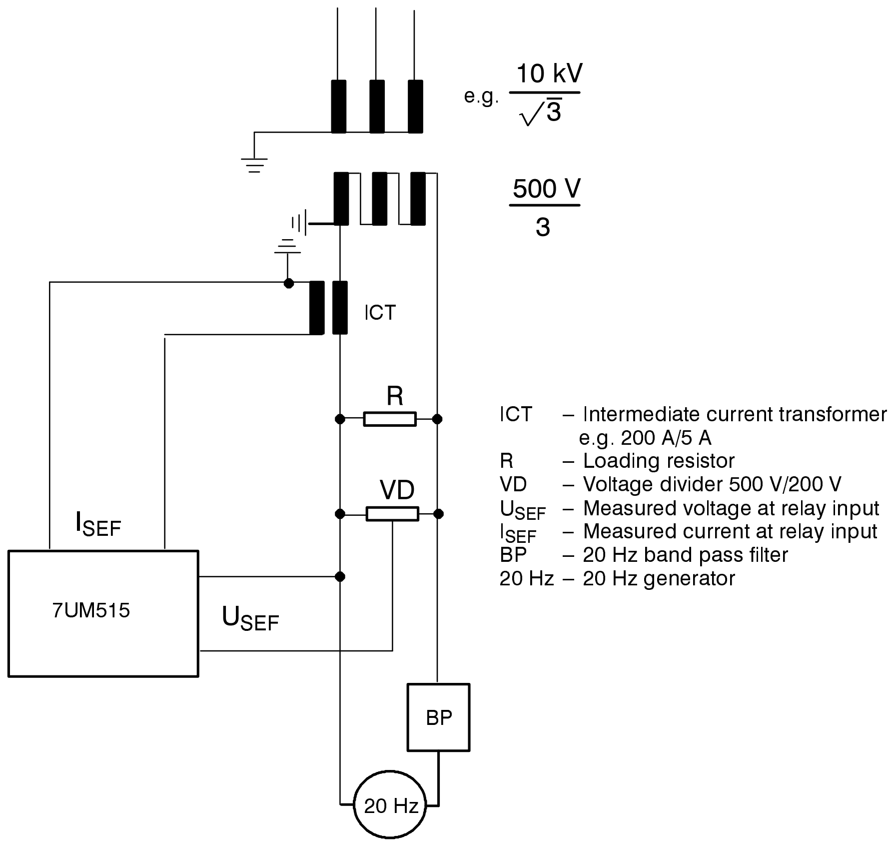


Figure 6.2 Connection scheme of the stator earth fault 100 % protection

```
1802█ S/E/F  R<
100  Ω
```

Pick-up value of the warning stage of stator earth fault protection
Setting range (at the relay terminals): **20** Ω to **500** Ω

```
1803█ T-R<
10.00  s
```

Time delay of the warning stage
Setting range: **0.00** s to **32.00** s
and ∞ (no warning annunciation)

```
1804█ S/E/F  R<<
20  Ω
```

Pick-up value of the tripping stage of stator earth fault protection
Setting range (at the relay terminals: **10** Ω to **300** Ω

```
1805█ T-R<<
1.00  s
```

Time delay of the tripping stage
Setting range: **0.00** s to **32.00** s
and ∞ (no trip)

```
 1806 S/E/F  I>>
0.40  A
```

Pick-up value of current tripping stage
Setting range: **0.02** A to **0.80** A

```
 1807 T-RESET
1.00  s
```

Reset delay after trip signal has been initiated
Setting range: **0.00** s to **32.00** s

```
 1808 BLOCK  U20
1.0  V
```

Pick-up threshold of 20 Hz undervoltage blocking
Setting range: **0.3** V to **15** V

```
 1809 BLOCK  I20
 10  mA
```

Pick-up threshold of 20 Hz undercurrent blocking
Setting range: **5** mA to **40** mA

```
 1810 CT  ANG.  W1
0  °
```

Angle error compensation of earthing c.t. and intermediate c.t.
Setting range: **−30**° to **+30**°

```
 1811 S/E/F-FACT
37.0
```

Transformation factor for primary earth resistance
Setting range: **1.0** to **200.0**

6.3.8 Settings for stator earth fault protection $U_0>$ – address block 19

```
1900█
EARTH FAULT U0>
```

Beginning of the block
“Earth fault protection $U_0>$”

```
1901█ SEF PROT.
OFF
```

Switch *OFF* of earth fault protection $U_0>$

```
ON
```

Switch *ON* of earth fault protection $U_0>$

```
BLOCK TRIP REL
```

Earth fault protection operates but *TRIP REL*ay is *BLOCK*ed

---

The criterion for the inception of an earth fault in the stator circuit is the occurrence of a neutral displacement voltage. Exceeding the setting value $U_0>$ (address 1902) therefore represents the pick-up for this protection.

The setting must be chosen such that the protection does not pick-up during operational asymmetries. The pick-up value should be at least twice the value of the operational asymmetry. A value of 10 % to 15 % of the full displacement value is normal. The full displacement voltage corresponds to the rated secondary voltage of the voltage transformers.

Additionally, the pick-up value has to be chosen such that displacements during network earth faults which are transferred via the coupling capacitances of the unit transformer to the stator circuit, do not lead to pick-up. The damping effect of the load resistor must also be considered in this case.

The setting value is twice the displacement value which is coupled in at full network displacement. Final determination of the setting value occurs during commissioning with primary values according to Section 6.7.6.

The earth fault trip is delayed by the time set under address 1903.

All set times are additional delay times and do not include operating times (measurement times, reset times) of the protection function itself.

```
1902█ U0>
10.0 V
```

Pick-up value of earth fault detection
Setting range: **5.0** V to **100.0** V

```
1903█ T-U0>
0.30 s
```

Time delay for trip
Setting range: **0.00** s to **32.00** s
and ∞ (no trip with $U_0>$)

```
1904█ T-RESET
1.00 s
```

Reset delay after trip signal has been initiated
Setting range: **0.00** s to **32.00** s

6.3.9 Settings for frequency protection – address block 21

```
  2 1 0 0█ O V E R / U N D E R
F R E Q U E N C Y
```

Beginning of the block
"Overfrequency and underfrequency protection"

```
  2 1 0 1█ f >  /  f <
O F F
```

Switch *OFF* of the frequency protection

```
O N
```

Switch *ON* of the frequency protection

```
B L O C K   T R I P   R E L
```

Frequency protection operates but *TRIP REL*ay is *BLOCK*ed

Four high-accuracy frequency stages are available. Each stage can be set as overfrequency stage or underfrequency stage. This is determined by the rated frequency as configured under address 7899 (refer to Section 5.4.2) 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**.

As a matter of principle, the setting values for frequency and delay times depend on the values supplied by the power station operator.

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.

The operating time of the frequency protection stages depends on the set number of repeated measurements n, where the time period of the actual cycle must be considered. High-accuracy frequency calculation takes 3 a.c. cycles; thus, the operating time corresponds to 3 · n · cycle period. 2 to 10000 repeated measurements can be set for each frequency stage; this corresponds to approximately the following time delays:

at f = 50 Hz : 0.12 s to 600 s
at f = 60 Hz : 0.10 s to 500 s

```
  2 1 0 2█ f   S T A G E   1
4 9 . 5 0   H z
```

Pick-up value of the frequency stage f_1
Setting range: **40.00** Hz to **65.00** Hz
The preset value results in an underfrequency stage

```
 2103█MEA.REP.f1
10
```

Number of measurement repetitions (3 a.c. periods each) for frequency stage f_1
Setting range: **2** to **10000**

```
 2104█f STAGE 2
49.00 Hz
```

Pick-up value of the frequency stage f_2
Setting range: **40.00** Hz to **65.00** Hz
The preset value results in an underfrequency stage

```
 2105█MEA.REP.f2
10
```

Number of measurement repetitions (3 a.c. periods each) for frequency stage f_2
Setting range: **2** to **10000**

```
 2106█f STAGE 3
48.00 Hz
```

Pick-up value of the frequency stage f_3
Setting range: **40.00** Hz to **65.00** Hz
The preset value results in an underfrequency stage

```
 2107█MEA.REP.f3
10
```

Number of measurement repetitions (3 a.c. periods each) for frequency stage f_3
Setting range: **2** to **10000**

```
 2108█f STAGE 4
51.00 Hz
```

Pick-up value of the frequency stage f_3
Setting range: **40.00** Hz to **65.00** Hz
The preset value results with rated frequency f_N = 50 Hz in an overfrequency stage

```
 2109█MEA.REP.f4
10
```

Number of measurement repetitions (3 a.c. periods each) for frequency stage f_3
Setting range: **2** to **10000**

```
 2110█BLOCK. U<
65 V
```

Minimum operating voltage (positive sequence voltage), below which frequency measurement f>< is blocked
Setting range: **40** V to **100** V

6.3.10 Settings for measured value monitoring – address block 29

The different monitoring functions of the protective relay are described in Section 4.15.4. They partly monitor the relay itself, partly the steady-state measured values of the transformer circuits.

The sensitivity of the measured value monitoring can be changed in block 29. The factory settings are sufficient in most cases. If particularly high operational asymmetries of the voltages are expected, or if, during operation, one or more monitoring functions react sporadically, then the sensitivity should be reduced.

```
2900█ MEAS.VALUE
SUPERVISION
```

Beginning of block
“Measured value supervision”

```
2901█ M.V.SUPERV
OFF
```
```
ON
```

Measured value monitoring is

OFF switched off

ON switched on

```
2902█ SYM.Uthres
50 V
```

Voltage threshold (phase-phase) above which the symmetry monitoring is effective (refer to Figure 4.22)
Smallest setting value: **10** V
Largest setting value: **100** V

```
2903█ SYM.Fact.
U 0.75
```

Symmetry factor for the voltage symmetry = slope of the symmetry characteristic (refer Figure 4.22)
Smallest setting value: **0.58**
Largest setting value: **0.95**

```
2904█ SUM.Uthres
10 V
```

Voltage threshold above which the summation monitoring (refer to Figure 4.21) reacts (absolute content)
Smallest setting value: **10** V
Largest setting value: **200** V

```
2905█ SUM.Fact.U
0.75
```

Relative content (related to the maximum phase-to-phase voltage) for operation of the current summation monitoring (refer to Figure 4.21)
Smallest setting value: **0.60**
Largest setting value: **0.95**
and 0

6.3.11 Coupling external trip signals – address blocks 30 to 33

Up to four desired signals from external protection or supervision units can be included into the processing of 7UM515. The signals are coupled as "External signals" via binary inputs. Like the internal protection and supervision signals, they can be annunciated as "External trip", time delayed and transmitted to the trip matrix.

Display	Description
3000 EXTERNAL TRIP FUNCTION 1	Beginning of the block "Including of an external trip function 1"
3001 EXT.TRIP 1 OFF	Switch *OFF* of external trip function 1
ON	Switch *ON* of external trip function 1
BLOCK TRIP REL	external trip function operates but *TRIP REL*ay is *BLOCK*ed
3002 T-DELAY 1.00 s	Time delay for external trip function 1 Setting range: **0.00** s to **32.00** s and ∞ (no trip)
3003 T-RESET 0.10 s	Reset delay after trip signal has been initiated Setting range: **0.00** s to **32.00** s

---

Display	Description
3100 EXTERNAL TRIP FUNCTION 2	Beginning of the block "Including of an external trip function 2"
3101 EXT.TRIP 2 OFF	Switch *OFF* of external trip function 2
ON	Switch *ON* of external trip function 2
BLOCK TRIP REL	external trip function operates but *TRIP REL*ay is *BLOCK*ed
3102 T-DELAY 1.00 s	Time delay for external trip function 2 Setting range: **0.00** s to **32.00** s and ∞ (no trip)
3103 T-RESET 0.10 s	Reset delay after trip signal has been initiated Setting range: **0.00** s to **32.00** s

Display	Description
3200 ▮ EXTERNAL TRIP FUNCTION 3	Beginning of the block “Including of an external trip function 3”
3201 ▮ EXT.TRIP 3 OFF	Switch *OFF* of external trip function 3
ON	Switch *ON* of external trip function 3
BLOCK TRIP REL	external trip function operates but *TRIP REL*ay is *BLOCK*ed
3202 ▮ T-DELAY 1.00 s	Time delay for external trip function 3 Setting range: **0.00** s to **32.00** s and ∞ (no trip)
3203 ▮ T-RESET 0.10 s	Reset delay after trip signal has been initiated Setting range: **0.00** s to **32.00** s

Display	Description
3300 ▮ EXTERNAL TRIP FUNCTION 4	Beginning of the block “Including of an external trip function 4”
3301 ▮ EXT.TRIP 4 OFF	Switch *OFF* of external trip function 4
ON	Switch *ON* of external trip function 4
BLOCK TRIP REL	external trip function operates but *TRIP REL*ay is *BLOCK*ed
3302 ▮ T-DELAY 1.00 s	Time delay for external trip function 4 Setting range: **0.00** s to **32.00** s and ∞ (no trip)
3303 ▮ T-RESET 0.10 s	Reset delay after trip signal has been initiated Setting range: **0.00** s to **32.00** s

6.3.12 Settings for interturn fault protection − address block 34

```
3400 INTERTURN
FAULT PROTECTION
```

Beginning of the block "Interturn fault protection"

```
3401 INTERTURN
OFF
```

Switch *OFF* of interturn fault protection

```
ON
```

Switch *ON* of interturn fault protection

```
BLOCK TRIP REL
```

Interturn fault protection operates but *TRIP RELay* is *BLOCKed*.

The final setting is performed during commissioning using primary tests, refer Section 6.7.4. It is essential that the protection does not pick up during fault free operation. This is valid also when interference influences occur. Interferences are caused by stator winding asymmetries, particularly during two-phase short-circuits. The asymmetries then produce a displacement voltage which must not lead to pick-up of the interturn protection.

The interference displacement voltage is measured during commissioning when performing the short-circuit tests (Section 6.7.4). Thereafter, the setting value U−I/T> (address 3402) will be determined and the protected winding zone can be calculated. Optimum would be that the protection will even detect a short-circuit of *one* turn.

Tripping can be delayed under address 3403. Note, that all setting times are additional delay times, which do not include the normal operating times (measuring time, reset time) of the protection function itself.

The large setting range of the voltage threshold (address 3402) of this protection function allows to use it, alternatively, as a single-phase single-stage overvoltage protection.

```
3402 U-I/T>
2.0 V
```

Pick-up value of interturn fault protection
Setting range: **0.3** V to **130.0** V

```
3403 T-U-I/T>
1.50 s
```

Time delay for trip
Setting range: **0.00** s to **32.00** s
and ∞ (no trip)

```
3404 T-RESET
1.00 s
```

Reset delay after trip signal has been initiated
Setting range: **0.00** s to **32.00** s

6.3.13 Settings for rotor earth fault protection − address block 35

```
 3500▌ROTOR
EARTH FAULT
```

Beginning of the block
“Rotor earth fault protection”

```
 3501▌ROTOR E/F
OFF
```

Switch *OFF* of rotor earth fault protection

```
ON
```

Switch *ON* of rotor earth fault protection

```
BLOCK TRIP REL
```

Rotor earth fault protection operates but *TRIP REL*ay is *BLOCK*ed.

The measured value is derived, optionally, from an external measured value transmission from the rotor (rotating measured value transmission, RMT), or from the internal protection function. In the latter case, the bias voltage of the rotor circuit is optionally derived from the controller unit 7XT70 with variable polarity reversal frequency, or from 7XT71 with fix reversal frequency. The relay had been informed about the connected controller unit during configuration (Section 5.4.3) under address 7901.

Since the protection calculates the ohmic rotor-earth resistance directly in all three cases, the limit values of the warning stage (address 3502) and of the trip stage (address 3503) can be directly set as resistance values. The pre-set values are sufficient for most cases. These values can be different depending on the insulation resistance and the cooling medium. A sufficient margin between the setting value and the insulation resistance shall be observed.

The time delay for the warning stage (address 3504) is mostly set to approximately 10 s, and for the trip stage (address 3505) to approximately 0.5 s to 1 s. The set times are additional delay times which do not include the operating times (measurement time, reset time) of the protection function itself.

```
 3502▌RE< WARN
40.0 kΩ
```

Pick-up value of the warning stage $R_E<$
Setting range: **5.0** kΩ to **80.0** kΩ

```
 3503▌RE<< TRIP
5.0 kΩ
```

Pick-up value of the tripping stage $R_E<<$
Setting range: **1.0** kΩ to **10.0** kΩ

```
 3504▌T-WARN-R<
10.00 s
```

Time delay for warning stage $R_E<$
Setting range: **0.00** s to **32.00** s
and ∞ (no warning)

```
 3505▌T-TRIP-R<<
1.00 s
```

Time delay for tripping stage $R_E<<$
Setting range: **0.00** s to **32.00** s
and ∞ (no trip)

```
3506█ T-RESET
1.00 s
```

Reset time after trip signal has been initiated
Setting range: **0.00** s to **32.00** s

The rotor earth fault protection can be tested during operation. A binary input (“>Test R/E/F”, FNo 5386) is used to switch the protection function to test mode. When a rotor earth fault is now simulated from a test device, this is not annunciated as rotor earth fault alarm and does not lead to trip either, but a separate annunciation “Test REF warn”, (FNo 5404) is produced when the test threshold RE< TEST (address 3507) is reached, and the annunciation “Test REF Trip” (FNo 5405) is produced when the trip threshold (address 3508) has been reached. The threshold for test operation are normally set to the same value as the thresholds for normal operation (addresses 3502 and 3503).

```
3507█ RE<  TEST
40.0 kΩ
```

Pick-up value of warning stage during test operation
Setting range: **5.0** kΩ to **80.0** kΩ

```
3508█ RE<<  TEST
5.0 kΩ
```

Pick-up value of tripping stage during test operation
Setting range: **1.0** kΩ to **10.0** kΩ

The integrated measuring method (bias voltage produced by 7XT70 or 7XT71) uses the charging current of the rotor circuit capacitance, which occurs after polarity reversal, to verify that the measuring circuit is correctly closed. The integral of this charging current represents the charge Qc which is necessary for each polarity reversal. This charge is available under address 5808 in the operational measured values B (refer also to Section 6.4.4). During commissioning, the charge can be read out. Approximately half the charge should be set under address 3509 as pick-up value for open measuring circuit detection.

If the rotor earth capacitance is very small (smaller than approximately 0.15 µF), then the charge is equally very small so that a reasonable setting of address 3509, and therefore open circuit detection is not possible. In such case it is recommended to set address 3509 to 0, which make the measuring circuit supervision ineffective.

Assumed the rotor earth capacitance would be 0.1 µF. Then the charge at polarity reversal with 50 V is:

$$Q_C = 2 \cdot C_E \cdot U_b = 100\ \text{V} \cdot 0.1\ \mu\text{F} = 0.01\ \text{mAs}$$

```
3509█ Qc<
0.02 mAs
```

Charge Q_C during polarity reversal below which the measuring circuit is assumed to be open
Setting range: **0.01** mAs to **1.00** mAs
and 0 (no open circuit annunciation)

6.3.14 Settings for trip circuit supervision – address block 39

Binary inputs of the device can be used for the two trip circuit supervision functions (refer Section 4.15). Each trip circuit supervision needs two binary inputs.

The trip circuit is supervised for open-circuit, short-circuit and control voltage failure.

The trip circuits are checked approx. two to three times per second. Alarm delay is determined by the number of measurement repetitions (address 3903). Higher number of measurement repetitions corresponds to longer alarm delay and, of course, to increased safety against faulty alarm. Equally, the time delay can bridge out short interruptions during breaker operation.

```
3900█ TRIP CIR'T
SUPERVISION
```

Beginning of the block “Trip circuit supervision”

```
3901█ TRP SUPERV
OFF
```

```
ON
```

Trip circuit supervision is
OFF switched off
ON switched on

```
3902█ No.CIRCT.
1
```

Number of supervised trip circuits;
possible: **1** to **2**

```
3903█ MEA.REPET.
3
```

Number of measurement repetitions
Setting range: **2** to **6**
(corresponding to an alarm delay of approx. 0.6 s to 1.8 s)

6.4 Annunciations

6.4.1 Introduction

After a 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 plates 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,

– Transmission via the serial interface to local or remote control facilities.

Most of these annunciations can be relatively 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, the following possibilities exist:

– Block paging with the keys ⇑ forwards or ⇓ backwards up to address 5000,

– Direct selection with address code, using key **DA**, address **5 0 0 0** and execute with key **E**,

– Press key **M/S** (M stands for “messages”, S for “signals”); then the address 5000 appears automatically as the beginning of the annunciation blocks.

For configuration of the transfer of annunciations via the serial interfaces, the necessary data are entered in block 72 (see Section 5.3.4).

The annunciations are arranged as follows:

Block 51 Operational annunciations; these are messages which can appear during the operation of the relay: information about condition of relay functions, measurement data etc.

Block 52 Event annunciations for the last fault; pick-up, trip, expired times or similar. As defined, a fault begins with pick-up of any fault detector and ends after drop-off of the last fault detector.

Block 53 Event annunciations for the previous network fault, as block 52.

Block 54 Event annunciations for the last but two network fault, as block 52.

Block 57 Indication of operational measured values (voltages, frequency).

Block 58 Indication of measured values of earth fault and interturn fault protection.

Block 59 Indication of measured values of overflux protection.

```
⇑ 5 0 0 0 █
⇓ A N N U N C I A T I O N S
```

Commencement of “Annunciation blocks”

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.

6.4.2 Operational annunciations – address block 51

Operational and status annunciations contain information which the unit provides during operation and about the operation. They begin at address 5100. Important events and status changes are chronologically listed, starting with the most recent message. Time information is shown in hours and minutes. Up to 50 operational indications can be stored. If more occur, the oldest are erased in sequence.

Faults in the machine are only indicated as "`Fault`" together with the sequence number of the fault. Detailed information about the history of the fault is contained in blocks "Fault annunciations"; refer Section 6.4.3.

The input of the codeword is not required.

After selection of the address 5100 (by direct selection with **DA 5 1 0 0 E** and/or paging with ⇑ or ⇓ and further scrolling ↑ or ↓) the operational annunciations appear. The boxes below show all available operational annunciations. In each specific case, of course, only the associated annunciations 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** = "**C**oming") or a status is announced "**C**oming" and "**G**oing" (**C**/**G**).

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

```
⇑  5100█ OPERATIONAL
⇓  ANNUNCIATIONS
```

Beginning of the block "Operational annunciations"

```
↑  19.05.96   17:02
↓  R/E/F  blocked:C
```

1st line: Date and time of the event or status change

2nd line: Annunciation text, in the example **C**oming

If the real time clock is not available the date is replaced by ★★.★★.★★, the time is given as relative time from the last re-start of the processor system.

Direct response from binary inputs:

`>Start FltRec`	Fault recording started via binary input (C)
`>Annunc. 1`	User defined annunciation No 1 received via binary input (C/G)
`>Annunc. 2`	User defined annunciation No 2 received via binary input (C/G)
`>Annunc. 3`	User defined annunciation No 3 received via binary input (C/G)
`>Annunc. 4`	User defined annunciation No 4 received via binary input (C/G)
`>Ext trip 1`	External trip signal 1 via binary input (C/G)
`>Ext trip 2`	External trip signal 2 via binary input (C/G)
`>Ext trip 3`	External trip signal 3 via binary input (C/G)

>Ext trip 4	External trip signal 4 via binary input (C/G)
>Phase rotat.	Change-over to counter-clockwise phase rotation via binary input (K/G)
>f1 block	Block frequency protection stage f_1 via binary input (C/G)
>f2 block	Block frequency protection stage f_2 via binary input (C/G)
>f3 block	Block frequency protection stage f_3 via binary input (C/G)
>f4 block	Block frequency protection stage f_4 via binary input (C/G)
>U20 failure	Failure 20 Hz bias voltage for stator earth fault 100 % (C/G)
>Trip rel 1	Trip circuit supervision 1: input in parallel to trip relay (C/G)
>CBaux 1	Trip circuit supervision 1: input in parallel to CB auxiliary contact (C/G)
>Trip rel 2	Trip circuit supervision 2: input in parallel to trip relay (C/G)
>CBaux 2	Trip circuit supervision 2: input in parallel to CB auxiliary contact (C/G)

General operational annunciations of the protection device:

Dev.operative	Device operative / healthy (C/G)
Prot. operat.	Any protection function is operative (C/G)
Initial start	Initial start of the processor system (C)
LED reset	Stored LED indications reset (C)
LogMeasBlock	Messages and measured values via the system interface are blocked (C/G)
Test mode	Messages and measured value via the system interface are marked with “Test operation” (C/G)
Param.running	Parameters are being set (C/G)
Param. Set A	Parameter set A is active (C/G)
Param. Set B	Parameter set B is active (C/G)
Param. Set C	Parameter set C is active (C/G)
Param. Set D	Parameter set D is active (C/G)
System Flt	Power system fault (C/G), detailed information in the fault annunciations

Flt.RecDatDel	Fault recording data deleted (C)
Flt.Rec.viaBI	Fault recording triggered via binary input (C)
Flt.Rec.viaKB	Fault recording triggered via the front keyboard (C)
Flt.Rec.viaPC	Fault recording triggered via operating (PC) interface (C)
Operat. Cond.	Operating condition 1, i.e. suitable measured values are present (C/G)
Clockwise	Clockwise phase rotation (C)
Counter-clock	Counter-clockwise phase rotation (C)

Operational annunciations of monitoring functions:

Wrong SW-vers	Software version of the device is wrong (C)
Wrong dev. ID	Device identification number is wrong (C)
Annunc. lost	Annunciations lost (buffer overflow) (C)
Annu. PC lost	Annunciations for operating (PC) interface lost (C)
Oper.Ann.Inva	Operational annunciations invalid (C/G)
Flt.Ann.Inval	Fault annunciations invalid (C/G)
LED Buff.Inva	Buffer for stored LEDs invalid (C/G)
VDEW StateInv	VDEW state (IEC 60870–5–103 protocol) invalid (C/G)
Chs Error	Check-sum error detected (C/G)
Chs A Error	Check-sum error detected for parameter set A: no operation possible with this set (C/G)
Chs B Error	Check-sum error detected for parameter set B: no operation possible with this set (C/G)
Chs C Error	Check-sum error detected for parameter set C: no operation possible with this set (C/G)
Chs D Error	Check-sum error detected for parameter set D: no operation possible with this set (C/G)
Failure 24V	Failure in internal supply voltage 24 V (C/G))
Failure 15V	Failure in internal supply voltage 15 V (C/G))

`Failure 5V`	Failure in internal supply voltage 5 V (C/G))
`Failure 0V`	Failure in offset voltage 0 V (C/G)
`Fail.TripRel`	Failure on trip relay (C/G)
`LSA disrupted`	LSA–link disrupted (system interface) (C/G)
`Failure ΣUp-e`	Failure detected by voltage plausibility monitor ΣU (C/G)
`Failure Usymm`	Failure detected by voltage symmetry monitor (C/G)
`Fail.PhaseSeq`	Failure detected by phase sequence monitor (C/G)
`Failure Trip1`	Failure in trip circuit 1 (C/G)
`Failure Trip2`	Failure in trip circuit 2 (C/G)

Operational annunciations of overexcitation protection:

`U/f> off`	Overexcitation protection is switched off (C/G)
`U/f> blocked`	Overexcitation protection is blocked (C/G)
`U/f> active`	Underexcitation protection is active (C/G)
`U/f> warn`	Overexcitation protection: U/f warning stage (C/G)
`U/f> th.warn`	Overexcitation protection: thermal warning stage (C/G)
`RM th. repl.`	Reset memory of thermal replica U/f (C/G)

Operational annunciations of undervoltage protection:

`U< off`	Undervoltage protection is switched off (C/G)
`U< blocked`	Undervoltage protection is blocked (C/G)
`U< active`	Undervoltage protection is active (C/G)

Operational annunciations of overvoltage protection:

o/v off	Overvoltage protection is switched off (C/G)
o/v blk	Overvoltage protection is blocked (C/G)
o/v active	Overvoltage protection is active (C/G)

Operational annunciations of stator earth fault 100 % protection:

S/E/F off	Stator earth fault 100 % protection is switched off (C/G)
S/E/F blocked	Stator earth fault 100 % protection is blocked (C/G)
S/E/F active	Stator earth fault 100 % protection is active (C/G)
Failure S/E/F	Failure measurement circuit of stator earth fault 100 % protection (C/G)
S/E/F warn	Stator earth fault 100 %protection: Warning stage (C/G)

Operational annunciations of stator earth fault protection U_0>:

U0> off	Stator earth fault protection U_0> is switched off (C/G)
U0> blocked	Stator earth fault protection U_0> is blocked (C/G)
U0> active	Stator earth fault protection U_0> is active (C/G)

Operational annunciations of frequency protection:

FRQ off	Frequency protection is switched off (C/G)
FRQ blocked	Frequency protection is blocked (C/G)
FRQ active	Frequency protection is active (C/G)
FRQ U< block	Frequency protection is blocked due to insufficient positive sequence voltage magnitude (C/G)

Operational annunciations of interturn fault protection:

I/T off	Interturn fault protection is switched off (C/G)
I/T blocked	Interturn fault protection is blocked (C/G)
I/T active	Interturn fault protection is active (C/G)

Operational annunciations of rotor earth fault protection:

R/E/F off	Rotor earth fault protection is switched off (C/G)
R/E/F blocked	Rotor earth fault protection is blocked (C/G)
R/E/F active	Rotor earth fault protection is active (C/G)
R/E/F open	Measuring circuit of rotor earth fault protection is interrupted (C/G)
Failure R/E/F	Failure in measuring circuit of rotor earth fault protection (C/G)
R/E/F Warn	Rotor earth fault protection: warning stage operated (C/G)
Failure RMT	Failure in rotating measuring value transmission (C/G)
Test REF warn	Rotor earth fault warning stage during test (C/G)
Test REF Trip	Rotor earth fault Trip during test operation (C)

Operational annunciations of the external trip functions:

Ext 1 off	External trip function 1 is switched off (C/G)
Ext 1 blocked	External trip function 1 is blocked (C/G)
Ext 1 active	External trip function 1 is active (C/G)
Ext 2 off	External trip function 2 is switched off (C/G)
Ext 2 blocked	External trip function 2 is blocked (C/G)
Ext 2 active	External trip function 2 is active (C/G)

`Ext 3 off`	External trip function 3 is switched off (C/G)
`Ext 3 blocked`	External trip function 3 is blocked (C/G)
`Ext 3 active`	External trip function 3 is active (C/G)
`Ext 4 off`	External trip function 4 is switched off (C/G)
`Ext 4 blocked`	External trip function 4 is blocked (C/G)
`Ext 4 active`	External trip function 4 is active (C/G)

Operational annunciations of trip test functions:

`Test Trip 1`	Test trip relay 1 is in progress (C/G)
`Test Trip 2`	Test trip relay 2 is in progress (C/G)
`Test Trip 3`	Test trip relay 3 is in progress (C/G)
`Test Trip 4`	Test trip relay 4 is in progress (C/G)
`Test Trip 5`	Test trip relay 5 is in progress (C/G)

Operational annunciations of trip circuit supervision:

`Failure Trip1`	Failure in trip circuit 1 (C/G)
`Failure Trip2`	Failure in trip circuit 2 (C/G)

Further messages:

`Table overflow`	If more messages have been received the last valid message is *Table overflow*.
`End of table`	If not all memory places are used the last message is *End of table*.

6.4.3 Fault annunciations − address blocks 52 to 54

The annunciations which occurred during the last three 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 under addresses 5200, 5300 and 5400. When a further fault occurs, the data relating to the oldest are erased. Each fault data buffer can contain up to 80 annunciations.

Input of the codeword is not required.

To call up the **last** fault data, one goes to address 5200 either by direct address **DA 5 2 0 0 E** or by paging with the keys ⇑ or ⇓. With the keys ↑ or ↓ one can page the individual annunciations forwards or backwards. Each annunciation is assigned with a sequence item number.

For these purposes, the “fault” means the period from first pick-up of any protection function up to last drop-off of a protection function.

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.

```
5200█ LAST
FAULT
```

Beginning of the block “Fault annunciations of the last system fault”

```
001█ 15.06.96
System Flt 6
```

under item 1, the date of the system fault is indicated, in the second line the consecutive number of the system fault

```
002█ 12:41:33.587
Fault        :C
```

under item 2, the time of the beginning of the fault is given; time resolution is 1 ms

```
003█ 0 ms
U0> Fault    :C
```

The following items indicate all fault annunciations which have occurred from fault detection until drop-off of the device, in chronological sequence. These annunciations are tagged with the relative time in milliseconds, starting with the first fault detection.

```
004█ 108 ms
S/E/F Fault  :C
```

```
005█ 301 ms
U0> Trip     :C
```

```
006█ 1107 ms
S/E/F Trip   :C
```

```
007█ 2108 ms
Dev. Drop-off :C
```

General fault annunciations of the device:

`Flt.Buff.Over`	Fault annunciations lost (buffer overflow)
`System Flt`	System fault with consecutive number
`Fault`	Beginning of fault
`Device FltDet`	Fault detection of the device, general
`Device Trip`	Trip by the device, general
`Dev. Drop-off`	Drop-off of the device, general

Fault annunciations of overexcitation protection:

`U/f> Fault`	Fault detection of overexcitation protection
`U/f> Trip`	Trip by overexcitation protection (U/f> stage)
`U/f> th.Trip`	Trip by thermal stage of overexcitation protection

Fault annunciations of undervoltage protection:

`U< Fault`	Undervoltage fault detection U<
`U< Trip`	Trip by undervoltage protection U<

Fault annunciations of overvoltage protection:

`U> Fault`	Overvoltage fault detection U>
`U>> Fault`	Overvoltage fault detection U>>
`U> Trip`	Trip by overvoltage protection U>
`U>> Trip`	Trip by overvoltage protection U>>

Fault annunciations of stator earth fault 100 % protection:

`S/E/F Fault`	Fault detection of stator earth fault 100 % protection
`S/E/F Trip`	Trip by stator earth fault 100 % protection

Fault annunciations of stator earth fault protection U_0>:

`U0> Fault`	Fault detection of stator earth fault protection
`U0> Trip`	Trip by stator earth fault protection

Fault annunciations of frequency protection:

`f1> Fault`	Fault detection of frequency protection, stage $f_1>$
`f1< Fault`	Fault detection of frequency protection, stage $f_1<$
`f2> Fault`	Fault detection of frequency protection, stage $f_2>$
`f2< Fault`	Fault detection of frequency protection, stage $f_2<$
`f3> Fault`	Fault detection of frequency protection, stage $f_3>$
`f3< Fault`	Fault detection of frequency protection, stage $f_3<$
`f4> Fault`	Fault detection of frequency protection, stage $f_4>$
`f4< Fault`	Fault detection of frequency protection, stage $f_4<$
`f1> Trip`	Trip by frequency protection, stage $f_1>$
`f1< Trip`	Trip by frequency protection, stage $f_1<$
`f2> Trip`	Trip by frequency protection, stage $f_2>$
`f2< Trip`	Trip by frequency protection, stage $f_2<$
`f3> Trip`	Trip by frequency protection, stage $f_3>$
`f3< Trip`	Trip by frequency protection, stage $f_3<$
`f4> Trip`	Trip by frequency protection, stage $f_4>$
`f4< Trip`	Trip by frequency protection, stage $f_4<$

Fault annunciations of interturn fault protection:

`I/T Fault`	Fault detection of interturn fault protection
`I/T Trip`	Interturn fault protection: Trip

Fault annunciations of rotor earth fault protection:

`R/E/F Fault`	Fault detection of the rotor earth fault protection
`R/E/F Trip`	Trip by rotor earth fault protection

Fault annunciations for trip from external source via binary input:

`Ext 1 Gen.Flt`	External trip function 1 picked up
`Ext 1 Gen.Trp`	Trip by external trip function 1
`Ext 2 Gen.Flt`	External trip function 2 picked up
`Ext 2 Gen.Trp`	Trip by external trip function 2
`Ext 3 Gen.Flt`	External trip function 3 picked up
`Ext 3 Gen.Trp`	Trip by external trip function 3
`Ext 4 Gen.Flt`	External trip function 4 picked up
`Ext 4 Gen.Trp`	Trip by external trip function 4

Further messages:

`Table empty`	means that no fault event has been recorded
`Table overflow`	means that other fault data have occurred, however, memory is full
`Table superceded`	a new fault event has occurred during read-out: page on with ↑ or ↓; the display shows the first annunciation in the actualized order
`End of table`	If not all memory places are used the last message is `End of table`.

The data of the **second to last** fault can be found under address 5300. The available annunciations are the same as for the last fault.

```
⇧ 5300█ 2nd  TO  LAST
⇩ FAULT
        etc.
```

Beginning of the block "Fault annunciations of the second to last fault"

The data of the **third to last** fault can be found under address 5400. The available annunciations are the same as for the last fault.

```
⇧ 5400█ 3rd  TO  LAST
⇩ FAULT
        etc.
```

Beginning of the block "Fault annunciations of the third to last fault"

6.4.4 Read-out of operational measured values – address blocks 57 to 59

The steady state r.m.s. operating values can be read out at any time under the address blocks 57 to 59. The first address block can be called up directly using **DA 5 7 0 0 E** or by paging with ⇑ or ⇓. The individual measured values can be found by further paging with ↑ or ↓. Entry of the codeword is not necessary. The values will be updated in approximately 1 second intervals.

The data are displayed in absolute primary values and in percent of the rated device values. To ensure correct primary values, the rated data must be entered to the device under address block 12 as described in Section 6.3.3.

In the following example, some typical values have been inserted. In practice the actual values appear. The possible ranges are given in Section 3.10 . Values beyond the limits are shown as ★★★★.

Further measured or calculated values are displayed in address blocks 58 and 59.

```
⇑  5700█ OPERATIONAL
⇓  MEAS. VALUES A
```

Beginning of the block “Operational measured values A”

Use ↑ key to move to the next address with the next measured value.

```
↑  5701█ MEAS.VALUE
↓  UL1E=  6.09  kV
```

Page on with the ↑ key to read off the next address with the next measured value, or page back with ↓

```
↑  5702█ MEAS.VALUE
↓  UL2E=  6.08  kV
```

One address is available for each measured value. The values can be reached also by direct addressing using key **DA** followed by the address number and execute with **E**

```
↑  5703█ MEAS.VALUE
↓  UL3E=  6.08  kV
```

The primary values (addresses 5701 to 5703) are referred to the primary rated values as parameterized under address 1202 (refer Section 6.3.3)

```
↑  5704█ MEAS.VALUE
↓  UL1E  =  60.9  V
```

The secondary voltages (addresses 5704 to 5706) are referred to the voltages applied to the relay terminals. These values are not influenced by addresses 1202 and 1204

```
↑  5705█ MEAS.VALUE
↓  UL2E  =  60.8  V
```

```
↑  5706█ MEAS.VALUE
↓  UL3E  =  60.8  V
```

5707 MEAS.VALUE U0 = 0.2 V	Displacement voltage from earth fault protection
5708 MEAS.VALUE Upos.seq= 105 V	The percentage is referred to the phase-to-phase voltage, i.e. $\sqrt{3} \cdot U_{pos}$
5709 MEAS.VALUE UL-Lmax= 105 V	Maximum phase-to-phase voltage in Volt
5710 MEAS.VALUE Ui/t= 000 V	Displacement voltage from interturn fault protection
5711 MEAS.VALUE f[Hz]= 50.00	Frequency in Hz can only displayed when an a.c. measured quantity is present

The operational measured values B are particularly helpful during commissioning of the machine protection unit using primary tests (refer to Sections 6.7.2 and 6.7.3). From these measured values, the setting values for the stator earth fault protection and the rotor earth fault protection can be easily checked or derived.

5800 OPERATIONAL MEAS. VALUES B	Beginning of the block “Operational measured values B”
5801 MEAS.VALUE U-SEF= 0.0 V	Bias voltage (20 Hz) for stator circuit
5802 MEAS.VALUE I-SEF= 0.0 A	Stator earth current: total r.m.s. of current due to 20 Hz bias voltage and system frequency current
5803 MEAS.VALUE R-SEF= 625 Ω	Calculated stator earth resistance related to the relay terminals
5804 MEAS.VALUE Rse p= 23.13 kΩ	Calculated stator earth resistance, primary value converted by means of the S/E/F FACTor of address 1811

```
5805█ MEAS.VALUE
Tg=  0.8  s
```

Period of the pulsed bias voltage of rotor earth fault protection (internal measurement) , with external measurement (rotating measured value transmission), ★★★★ are displayed

```
5806█ MEAS.VALUE
Ug=  50  V
```

Amplitude of the pulsed bias voltage of rotor earth fault protection; when controller unit 7XT70 is used, or with external measurement (rotating measured value transmission RMT), then ★★★★ are displayed

```
5807█ MEAS.VALUE
Ig=  0.5  mA
```

Measured current through the resistance of the rotor earth circuit; when measurement by rotating measured value transmission (RMT) is used then the current of the measurement transducer is displayed

```
5808█ MEAS.VALUE
Qc=  2.03  mAs
```

The charged which is moved at each polarity reversal of the rotor bias voltage; when measurement by rotating measured value transmission (RMT) is used then ★★★★ is displayed

```
5809█ MEAS.VALUE
R-REF=  81.5  kΩ
```

Calculated rotor earth resistance; values beyond the highest value 199.9 kΩ are indicated as 199.9 kΩ

```
5900█ OPERATIONAL
MEAS. VALUES C
```

Beginning of the block “Operational measured values C”

```
5901█ MEAS.VALUE
U/f  =  1.05
```

Overflux, related on rated flux U_N/f_N

```
5902█ MEAS.VALUE
U/f th.  =  50  %
```

Calculated temperature rise of iron core derived from overflux as percentage of trip temperature rise. If overflux function is switched off, indication reads 000 %. If no suitable quantities are present (e.g. f < 10 Hz or f > 70 Hz) the relay continues to calculate the cooling-down process but temperature rise is no more possible.

```
5903█ MEAS.VALUE
Th.loss.=  50  %
```

Normalized thermal iron losses in %
100 % corresponds to thermal power when flux corresponds to the value parameterized under address 1308.

6.5 Operational control facilities

During operation of the protection relay it may be desired to intervene in functions or annunciations manually or from system criteria. 7UM515 comprises facilities, e.g. to re-adjust the real time clock, to erase stored informations, or to change over preselected sets of function parameters.

The functions can be controlled from the operating panel on the front of the device, via the operating interface in the front as well as via binary inputs.

In order to control functions via binary inputs it is necessary that the binary inputs have been marshalled to the corresponding switching functions during installation of the device and that they have been connected (refer Section 5.5.2 Marshalling of the binary inputs).

The control facilities begin with address block 8000. This address is reached

– by block paging with the keys ⇑ forwards or ⇓ backwards up to address 8000, or

– by direct selection with address code, using key **DA**, address **8 0 0 0** and execute with key **E.**

```
⇑  8000█ DEVICE
⇓  CONTROL
```

Beginning of the block “Device control”

6.5.1 Adjusting and synchronizing the real time clock – address block 81

The date and time can be adjusted at any time during operation as long as the real time clock is operative. Setting is carried out in block 81 which is reached by direct addressing **DA 8 1 0 0 E** or by paging with ⇑ and ⇓.

Input of the codeword is required to change the data. Selection of the individual addresses is by further scrolling using ↑ ↓ as shown below. Each modification must be confirmed with the enter key **E**.

```
⇑  8100█ SETTING
⇓  REAL TIME CLOCK
```

Beginning of the block “Setting the real time clock”. Continue with ↑.

```
↑  15.02.1996
↓  17:04:55
```

At first, the actual date and time are displayed. Continue with ↑.

```
↑  8102█ DATE
↓
```

Enter the new date: 2 digits for day, 2 digits for month and 4 digits for year (including century); use the order as configured under address 7102 (Section 5.3.2), but always use a dot for separator:
DD.MM.YYYY or **MM.DD.YYYY**

```
↑  8103█ TIME
↓
```

Enter the new time: hours, minutes, seconds, each with 2 digits, separated by a dot:
HH.MM.SS

```
↑  8104█ DIFF. TIME
↓
```

Using the difference time, the clock is set forwards by the entered time, or backwards using the **+/--** key. The format is the same as with the time setting above.

6.5.2 Erasing stored annunciations – address block 82

The annunciations and the status of the LED memories are stored in NV–RAMs and thus saved provided the back-up battery is installed. These stores can be cleared in block 82. Block 82 is called up by paging with the keys ⇑ or ⇓ or directly by keying in the code **DA 8 2 0 0 E**. With the exception of resetting the LED indications (address 8201), codeword entry is necessary (code level 2) to erase the stored items. Reset is separate for the different groups of memories and annunciations. One reaches the individual items by paging ↑ ↓. Erasure requires confirmation with the key **J/Y**. The display then confirms the erasure. If erasure is not required, press key **N** or simply page on.

⇑⇓
```
8200█
RESET
```
Beginning of block “Reset”

↑↓
```
8201█ RESET
LED  ?
```
Request whether the LED memories should be reset

↑↓
```
8202█ RESET
OPERAT.ANNUNC. ?
```
Request whether the operational annunciation buffer store should be erased

↑↓
```
8203█ RESET
FAULT ANNUNC. ?
```
Request whether the fault annunciation buffer and fault recording stores should be erased

During erasure of the stores (which may take some time) the display shows TASK IN PROGRESS. After erasure the relay acknowledges erasure, e.g.

```
8202█ RESET
SUCCESSFUL
```

6.5.3 Information to LSA during test operation − address block 83

When the relay is connected to a central storage device or localized substation automation system and the protocol according IEC 60870−5−103 or VDEW/ZVEI is used, then the informations which are transmitted to the central computing system can be influenced.

The standardized protocol allows all annunciations, messages, and measured values to be tagged with the origin "test operation", which occur while the relay is tested. Thus, these messages can be distinguished from those which occur during real operation. Additionally, it is possible to block all annunciations, messages and measured values to LSA during test operation.

This features can be accomplished via binary inputs or using the integrated operating keyboard or via the operating (PC) interface.

In order to accomplish switch-over via binary inputs, the respective inputs must have been assigned during marshalling (refer to Section 5.5.2). The following input functions are suitable:

FNo 15 `>Sys-Test` for tagging the messages and measured values with the origin "Test operation",

FNo 16 `>Sys-MM-block` for blocking all messages and measured values.

In order to carry out switch-over by the operator, entry of the codeword (code level 1) is necessary (refer to Section 5.3.1). For this purpose, address block 83 is available provided the protocol according IEC 60870−5−103 or VDEW/ZVEI has been chosen during configuration of the serial system interface (Section 5.3.4, address 7221 and/or 7222 *VDEW EXTENDED*). The block is called up by paging with the keys ⇑ or ⇓ or directly by keying in the code **DA 8 3 0 0 E**. Use key ↑ to scroll to address 8301. By pressing the "No"−key **N** the positions of this switch are changed. The desired position must be confirmed with the enter key **E**.

As with every settings of the device for which codeword input is necessary, codeword operation must be terminated. This is done by using the key combination **F E**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS?". Confirm with the "Yes"−key **J/Y** that the new settings shall become valid now. If you press the "No"−key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

```
⇑ 8300 SYS-VDEW
⇓ ANNUNC.-MEAS.VAL
```

Beginning of block "Annunciations and measured values for the system interface with IEC 60870−5−103 or VDEW/ZVEI compatible protocol"

```
↑ 8301 SYS TEST
↓ OFF
  ON
```

Only for IEC 60870−5−103 or VDEW/ZVEI compatible protocol:

in *ON* position, the IEC 60870−5−103 or VDEW/ZVEI-compatible annunciations are assigned with the origin "test operation"

```
↑ 8302 SYS BLOCK
↓ OFF
  ON
```

Only for IEC 60870−5−103 or VDEW/ZVEI compatible protocol:

in *ON* position, no annunciations and measured values are transmitted to the system interface

---

Do not forget to switch the addresses back to *OFF* after having finished test operations!

6.5.4 Selection of parameter sets – address block 85

Up to 4 different sets of parameters can be selected for the functional parameters, i.e. the addresses above 1000 and below 4000. These parameter sets can be switched over during operation, locally using the operator panel or via the operating interface using a personal computer, or also remotely using binary inputs.

The first parameter set is identified as set A, the other sets are B, C and D. Each of these sets has been set during parameterizing (Section 6.3.1.2) provided the switch-over facility is used.

6.5.4.1 Read-out of settings of a parameter set

In order to **look up** the settings of a parameter set **in the display** it is sufficient to go to any address of the function parameters (i.e. addresses above 1000 and below 4000), either by direct addressing using key **DA**, entering the four-figure address code and terminating with enter key **E**, or by paging through the display with ⇑ or ⇓. You can switch-over to look up a different parameter set, e.g.

– Press key combination **F 2**, i.e. first the function key **F** and then the number key **2**. All displayed parameters now refer to parameter set B.

The parameter set is indicated in the display by a leading character (A to D) before the address number indicating the parameter set identification.

The corresponding procedure is used for the other parameter sets:

- Key combination **F 1**:
  access to parameter set **A**
- Key combination **F 2**:
  access to parameter set **B**
- Key combination **F 3**:
  access to parameter set **C**
- Key combination **F 4**:
  access to parameter set **D**

The relay operates always with the active parameter set even during read-out of the parameters of any desired parameter set. The change-over procedure described here is, therefore, only valid for **read-out** of parameters **in the display**.

6.5.4.2 Change-over of the active parameter set from the operating panel

For **change over to a different parameter set**, i.e. if a different set shall be activated, the address block 85 is to be used. For this, codeword entry (code level 1) is required.

The block for processing parameter sets is reached by pressing the direct address key **DA** followed by the address **8 5 0 0** and enter key **E** or by paging through the display with ⇑ or ⇓. The heading of the block will appear:

```
⇑  8 5 0 0█ P A R A M E T E R
⇓  C H A N G E - O V E R
```

Beginning of the block “Parameter change-over”: processing of parameter sets

It is possible to scroll through the individual addresses using the ↑ key or to scroll backwards with ↓.

Address 8501 shows the actually active parameter set with which the relay operates.

In order to switch-over to a different parameter set scroll on with ↑ to address 8503. Using the “No”–key **N** you can change to any desired parameter set; alternatively, you can decide that the parameter sets are to be switched over from binary inputs or via the system interface. If the desired set or possibility appears in the display, press the enter key **E**.

As with every settings of the device for which codeword input is necessary, codeword operation must be terminated. This is done by using the key combination **F E**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question “SAVE NEW SETTINGS?”. Confirm with the “Yes”–key **Y** that the new settings shall become valid now. If you press the “No”–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

```
8501 ACTIV PARAM
SET A
```

Address 8501 shows the actually active parameter set

```
8503 ACTIVATING
SET A
```

```
SET B
```

```
SET C
```

```
SET D
```

```
SET BY BIN.INPUT
```

```
SET BY LSA CONTR
```

Use the “No”−key **N** to page through the alternative possibilities. The desired possibility is selected by pressing the enter key **E**.

If you select *SET BY BIN.INPUT*, then the parameter set can be changed over via binary inputs (see Section 6.5.4.3)
If you select *SET BY LSA CONTR*, then the parameter set can be changed over via the system interface

6.5.4.3 Change-over of the active parameter-set via binary inputs

If change-over of parameter sets is intended to be carried out via binary inputs, the following is to be heeded:

- Locally (i.e. from the operator panel or from PC via the operating interface), ACTIVATION must be switched to *SET BY BIN.INPUT* (refer Section 6.5.4.2).
- 2 logical binary inputs are available for control of the 4 parameter sets. These binary inputs are designated “`>ParamSelec.1`” and “`>Param Selec.2`” (FNo `7` and `8`).
- The logical binary inputs must be allocated to 2 physical input modules (refer Section 5.5.2) in order to allow control. An input is treated as not energized when it is not assigned to any physical input.
- The control input signals must be continuously present as long as the selected parameter set shall be active.

The active parameter sets are assigned to the logical binary inputs as shown in Table 6.2.

A simplified connection example is shown in Figure 6.3. Of course, the binary inputs must be declared in normally open (“`NO`”) mode.

Binary input		causes
ParamSelec.1	ParamSelec.2	active set
no	no	Set A
yes	no	Set B
no	yes	Set C
yes	yes	Set D

no = input not energized
yes = input energized

Table 6.2 Parameter selection via binary input

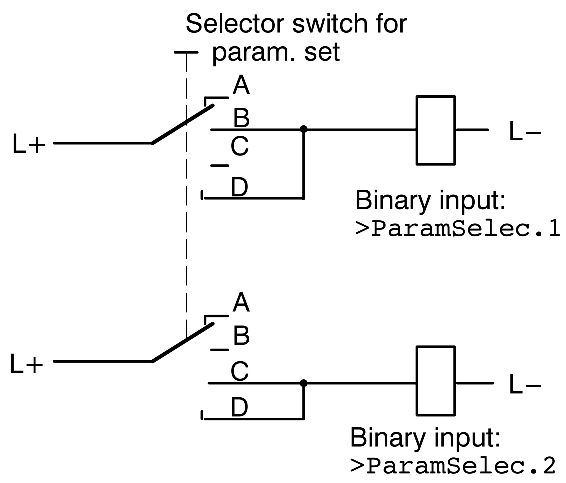


Figure 6.3 Connection scheme for parameter change-over via two binary inputs

6.6 Testing and commissioning

6.6.1 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 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.

DANGER!

Secondary connections of the current transformers must be short-circuited before the current leads to the relay are interrupted!
If a test switch is installed which automatically short-circuits the current transformer secondary leads, it is sufficient to set this switch to the “Test” position. The short-circuit switch must be checked beforehand (refer to Section 5.2.6).

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 unless otherwise noted; for different setting values formulae are given, where necessary.

The use of a three-phase test set which applies three phase voltage (0 to 100 V) is recommended for secondary testing. In the following test procedure descriptions the use of such a test set is assumed. For coarse function testing, a single-phase voltage source would be sufficient; however, pick-up values cannot be always obtained.

If unsymmetrical voltages occur during the tests it is likely that the asymmetry monitoring will frequently operate. This is of no concern because the condition of steady-state measured values is monitored and, under normal operating conditions, these are symmetrical; under short circuit conditions these monitoring systems are not effective.

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. In the testing hints the annunciations as set by the factory are stated. Additional annunciations which can be generated by other protection functions or part functions are not mentioned. If the relay is connected to a central memory device via the serial interface, correct communication between the relay and the master station must be checked.

After tests which cause LED indications to appear, these should be reset, at least once by each of the possible methods: the reset button on the front plate and via the remote reset relay (see connection diagrams, Appendix A).

NOTE:
The unit contains an integrated frequency follow-up circuit; this ensures that the protection functions are always processed with algorithms matched to the actual frequency. This explains the wide frequency range and the small frequency influence. However, it requires that measurement values be present before a dynamic test can take place, so that the frequency follow-up can operate. If a measurement value is switched from 0 to the unit without a different measurement value having been present beforehand, an additional time delay of approximately 120 ms is incurred since the unit must firstly calculate the frequency from the measurement value. In addition, no output signal is possible if no measurement value is connected. A trip signal, once issued, of course, is maintained for at least the duration of the parameterized reset time (refer also to Section 3.11).

NOTE:
When the unit is delivered from the factory, all protective functions have been switched off. This has the advantage that each function can be separately tested without being influenced by other functions. The required functions must be activated for testing and commissioning.

6.6.2 Testing the overflux protection U/f>

The function of the overflux protection can only be tested if this function is configured as *EXIST* in address 7813 (as delivered, refer to Section 5.4.2) and has been parameterized as operative (contrary to the condition as delivered from factory) (address 1301 U/f PROT. = *ON* or = *BLOCK TRIP REL*).

The overflux protection comprises a definite time stage and two thermal stages (warning stage and tripping stage).In addition, a delayed alarm is output when the continuously permissible limit value U/f(1) (address 1308) is exceeded.

Single-phase, two-phase, or three-phase testing can be performed without difficulty. The pick-up value corresponds to the maximum phase-to-phase voltage.

The simplest function check is a read-out of the frequency, overflux and maximum voltage U L–Lmax as measured and calculated by the unit. These values are found in the OPERATIONAL MEASURED VALUES A and C under addresses 5709, 5711 and 5901.

If a voltage source with adjustable frequency is available, then the limit for the definite U/f characteristic (in address 1302) 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 140 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 picks up.
- Annunciation “`U/f> Fault`” (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.

Note: During voltage testing a voltage of at least $0.2 \cdot U_N$ should be applied to any desired phase (refer also note in Section 6.6.1).

Connect voltage of 1.1 x pick-up value U/f> (address 1302).
- Annunciation "`U/f> Fault`" (not marshalled when delivered from factory).
- After T–U/f> (1 s, address 1303, annunciation "`U/f> Trip`" (LED 5 and signal relay 3 and signal relay 11 with factory pre-settings).
- Trip relays (1, 2, 3, 4 and 5).

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 BASE (address1320). Smaller overflux does not produce a simulated temperature rise, i.e. do not affect pre-load processing.

The setting value U/f (1) in address 1308 represents that overflux for which the tripping time is infinite. For this reason the time setting T–U/f (1) is ∞.

The shape of the tripping time characteristic is determined by the pairs of values as set under addresses 1310 to 1319.

The time factor TIME MULT. in address 1307 multiplies all time values of the characteristic. This corresponds to parallel shifting of the characteristic along the time axis.

The setting value WARN THERM (address 1305) determines the thermal warning stage in % of the thermal tripping stage.

With the preset values:

– U/f BASE = 1.00 (address 1320),
– U/f (1) = 1.10 (address 1308)

the thermal iron losses will be Q = 50 % provided the applied overflux is

$$\frac{U/U_N}{f/f_N} = 1,05$$

No warning, no tripping must occur.

The operational measured values C under address block 59 should show:

– the calculated overflux U/f which should amount to approx. 1.05 in this case,

– the normalized thermal iron losses Q which should amount to approx. 50 % in this case,

After an appropriate long time the thermal steady-state value *U/f th* should amount to approx. 50 % in this case.

Note: During dynamic testing, a voltage of at least $0.2 \cdot U_N$ should be applied to any desired phase (refer also to note in Section 6.6.1).

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 "`RM th.repl.`" (reset memory of thermal replica). This function is allocated to binary input INPUT 2 when the unit is delivered from factory. It is easier to de-activate and re-activate the overflux protection function (address 1301).

Switch voltage corresponding to U/f = 1.25.
- After delay time of the warning stage (20 s, address 1306) Annunciation "`U/f> warn`" (LED 4 and signal relay 10).
- After reaching the thermal warning stage (address 1305) annunciation "`U/f> th.warn`" (not marshalled when delivered from factory).
- On reaching the thermal trip stage after a time according to the trip time characteristic (5 s) annunciation "`U/f> th.Trip`" (LED 5 and signal relay 3).
- Trip relays (1 to 5).

Note: Depending on the set values for U/f and T–U/f (addresses1302 and 1303), the definite time stage may pick up and trip before the thermal stage.

If testing with pre-load is performed (i.e. the flux has exceeded the base value of address 1320 before starting of the test), it must be ensured that a thermal equilibrium has been established prior to the start of the time measurement. This is the case only when the pre-load has been continuously connected for a sufficiently long period.

6.6.3 Testing the undervoltage protection U<

The function of the undervoltage protection can only be tested if this function is configured as *EXIST*, in address 7816 (as delivered, refer to Section 5.4.2) and has been parameterized as operative (contrary to the condition as delivered from factory) (address 1601 UNDERVOLT. = *ON* or = *BLOCK TRIP REL*).

The positive sequence component of the voltages is used for the internal formation of the measured value. Measurement on the undervoltage protection function should therefore be performed with three-phase symmetrical measurement values. If asymmetrical values are used, deviations must be expected.

For testing the voltage time characteristic it is necessary to perform sudden voltage dips. They can be produced by switching off one phase or two phases after a three-phase symmetrical voltage has been applied. The positive sequence component of the voltages is thus reduced to $^2/_3$ or $^1/_3$ of the applied symmetrical voltage.

If, however, the voltage is reduced to less than the minimum operating voltage of the protection, i.e. the minimum permissible voltage to calculate the positive sequence component, then the operating condition is not fulfilled. Pick-up may occur but delayed trip is no more possible.

The time delay can be checked and compared with the set values (addresses 1602 to 1613).

It must be noted that the set times are pure delay times; operating times of the measurement functions are not included. Particularly, in case of tests with high voltage step changes (to small voltages), the total time delay is influenced by the inherent operating time of the relay.

Activate binary input “`>U< block`” (INPUT 4 when delivered from factory).
- Annunciation “`U< blocked`” (LED 12).
- No further annunciations relating to voltage protection.

Switch voltage to approximately rated voltage, but above set value U< (1) (address1602).

De-activate binary input “`>U< block`”. Block annunciation disappears.

Disconnect one or two (not all the three) phases of the voltage.
- Annunciation “`U< Fault`” (not marshalled when delivered from factory).
- After the time determined by the characteristic annunciation “`U< Trip`” (LED 9 and signal relays 7 and 11.
- Trip relay (1).

Further checks are performed with primary values during commissioning (Section 6.7.5).

6.6.4 Testing the overvoltage protection U>, U>>

The function of the overvoltage protection can only be tested if this function is configured as *EXIST*, in address 7817 (as delivered, refer to Section 5.4.2) and has been parameterized as operative (contrary to the condition as delivered from factory) (address 1701 OVERVOLT. = *ON* or = *BLOCK TRIP REL*).

The maximum phase-to-phase voltage is used for the internal formation of the measured value. Measurement on the overvoltage protection function can therefore be performed with single-, two-, or three-phase measurement values.

The set values (address 1702 and 1703) refer always to the phase-to-phase voltage.

Caution!

Test voltages larger than 140 V (phase-to-earth) may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability).

The time delays for overvoltage are checked with approximately 1.2 times pick-up value. It must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

Note: During dynamic voltage testing at least one voltage should be higher than 0.2 times rated voltage, before the test commences (refer also note in Section 6.6.1).

Connect voltage of 1.2 x pick-up value U> (address 1702).

- Annunciation “`U> Fault`” (not marshalled when delivered from factory).
- After T−U> (1.5 s; address 1704) annunciation “`U> Trip`” (LED 7 and signal relays 5 and 11).
- Trip relays (2, 3 and 4).

Disconnect voltage.

If blocking of the overvoltage protection shall be used, check as follows:

Activate binary input “`>U> block`” (not allocated when delivered from factory). Connect voltage.

- Annunciation “`o/v blk`” (not allocated when delivered).
- No further annunciations relating to overvoltage protection.

De-activate binary input. Disconnect voltage.

Connect voltage of 1.2 x pick-up value U>> (address 1703).

- Annunciation “`U>> Fault`” (not allocated when delivered from factory).
- After T−U>> (0 s; address 1705) annunciation “`U>> Trip`” (LED 8 and signal relays 6 and 11).
- Trip relays (2, 3 and 4).

Disconnect voltage.

Attention: If setting values have been changed for testing, reset to correct values (addresses 1702 and 1703)!

Further checks are performed with primary values during commissioning (Section 6.7.5).

6.6.5 Testing the stator earth fault 100 % protection

The function of the stator earth fault 100 % protection can only be tested if this function is configured as *EXIST*, in address 7818 (as delivered, refer to Section 5.4.2) and has been parameterized as operative (contrary to the condition as delivered from factory)(address 1801 STATOR E/F = *ON* or = *BLOCK TRIP REL*).

If an a.c. voltage source with adjustable frequency (20 Hz and rated frequency, approx. 5 V; 0.5 A) is available, simple checking of the stator earth fault 100 % protection is possible. This voltage is applied to the measured voltage input U_{SEF} for stator earth fault 100 % protection; a current derived from this voltage is applied to the current input I_{SEF} for stator earth fault 100 % protection (equal phase).

The a.c. source is adjusted to 20 Hz ($\pm$0,2 Hz). The protection calculates the stator earth resistance Rs/e/f from this voltage U_{SEF} and current I_{SEF}. These values can be read out in the OPERATIONAL MEASURED VALUES B under address block 58.

If, e.g., the applied voltage is U_{SEF} = 5 V and the current is I_{SEF} = 20 mA then the following values could be read out under address block 58:

– U−SEF approx. 5.0 V
– I−SEF approx. 0.02 A
– R−SEF approx. 250 Ω

The calculated resistance can be decreased by reducing the voltage and/or increasing the current, until the warning stage (address 1802) picks up:

- After T−R< (address 1803, 10 s when delivered) annunciation "`S/E/F warn`" (not allocated when delivered).

And after further reduction of the resistance:

- Annunciation "`S/E/F Fault`" (not allocated when delivered).
- After T−R<< (address 1805, 1 s when delivered) annunciation "`S/E/F Trip`" (LED 1 and signal relays 1 and 11).
- Trip relays (1, 2, 3, 4 and 5).

<u>*Note:*</u>
The applied 20 Hz voltage must be higher than the value which is set under address 1808 BLOCK U20; otherwise the resistance calculation would be blocked if, at the same time, the 20 Hz current is smaller then the values set in address 1809 BLOCK I20. During this blocking, only the current stage S/E/F I>> (address 1806) is effective, which cannot calculate the resistance. Equally, the resistance cannot be displayed in the operational measured values B under address block 58.

When checking the delay times it must be noted that the set times are pure delay times; operating times of the measurement function are not included. Different operating times are valid for the resistance measurement and the current stage.

Activate input "`>SEF block`" (INPUT 5 at delivery).

- Annunciation "`S/E/F blocked`" (LED 13 when delivered).
- Annunciations "`S/E/F Fault`", "`S/E/F Warn`" and "`S/E/F Trip`" disappear. Wait for resetting time (address 1807) if applicable.

De-activate binary input. Alarms disappear. The relay will pick-up and trip again.

Activate input "`>U20 failure`" (not allocated when delivered).

- Annunciations "`>U20 failure`" and "`Failure S/E/F`" (not allocated when delivered).
- Annunciations "`S/E/F Fault`", "`S/E/F Warn`" and "`S/E/F Trip`" disappear. Wait for resetting time if applicable. *Note:* If the <u>current</u> stage S/E/F I>> has picked up and tripped, only the warning stage will reset.

De-activate binary input. Disconnect test quantities.

Now test the <u>current</u> stage: This can be done by a 50 Hz or 60 Hz source.

Apply current I_{SES} = 500 mA but above the set value S/E/F I>> (address 1806). The measured current can be read out in the operational measured values B. Resistance measurement will not take place because of missing 20 Hz quantities.

- Annunciation "`Failure S/E/F`" (not allocated when delivered).
- Annunciation "`S/E/F Fault`" (not allocated when delivered).
- After T−R<< (address 1805, 1 s when delivered) annunciation "`S/E/F Trip`" (LED 1 and signal relays 1 and 11).
- Trip relays (1, 2, 3, 4 and 5).

Further tests, especially checks of the whole stator earth fault protection system including the 20 Hz generator and other accessories, are performed with primary values during commissioning. (refer to Sections 6.7.3 and 6.7.6).

6.6.6 Testing the earth fault protection U_0>

The functions of the earth fault protection can only be tested if this protection is configured as *EXIST* in address 7819 (as delivered, refer to Section 5.4.2) and has been parameterized as operative – contrary to the condition as delivered from factory (address 1901 SEF PROT. = *ON* or = *BLOCK TRIP REL*).

The earth fault protection processes the displacement voltage which is produced by the earth fault.

When checking the delay times it must be noted that the set times are pure delay times; operating times of the measurement function are not included.

Note: Rated voltage should be connected to at least one voltage measurement input for the dynamic testing of the neutral displacement voltage (refer also to note in Section 6.6.1).

Connect voltage of 1.2 times setting value Uo> (address 1902) to measurement input for the neutral displacement voltage .

- Annunciation "`U0> Fault`" (not marshalled when delivered from factory).
- After T–U0> (address 1903, 0.3 s when delivered from factory) annunciation "`U0> Trip`" (LED 6 and signal relays 4 and 11).
- Trip relays (1 and 5).

Disconnect voltage.

Activate binary input "`>U0> block`" (INPUT 6 when delivered from factory). Connect voltage.

- Annunciation "`U0> blocked`" (not allocated when delivered).
- No annunciations concerning earth fault protection.

Disconnect voltage. Deactivate binary input.

Further checks are performed with primary values during commissioning. (refer to Section 6.7.6).

6.6.7 Testing the frequency protection functions

The functions of the frequency protection 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> / f< = *ON* or = *BLOCK TRIP REL*).

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 A under address 5711.

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

When measuring times, it must be considered that the delay time of the frequency protection is determined by the number of repeated measurements. Each measurement takes 3 a.c. periods. Thus, the delay is 3/f times the set number of repeated measurements. Note that the tripping time as indicated in the fault annunciations starts with the fault detection signal which occurs after half the number of repeated measurements. Thus, the indicated tripping time corresponds to the other half of the number of repeated measurements.

Connect rated voltage, increase frequency until overfrequency protection (f_4) picks up.

- Annunciation "`f4> Fault`" (not marshalled when delivered from factory) after half the time for the set measurement repetitions (address 2109 MEA.REP.f4 = 10 at delivery).
- Annunciation "`f4> Trip`" after the full time for the set measurement repetitions (LED 11 and signal relay 9 when delivered from factory).
- Trip relays (2, 3, 4 and 5).

Reduce frequency until annunciation disappears; note that the number of repeated measurements is valid for reset delay, too.

Set to rated voltage, reduce frequency until the first underfrequency protection stage (f_1<) (address 2102) picks up.

- Annunciation "`f1< Fault`" (not marshalled when delivered from factory) after half the time for the st measurement repetitions (address 2103 MEA.REP.f1 = 10 at delivery).
- Annunciation "`f1< Trip`" after the full time for the set measurement repetitions (LED 10 and signal relays 8 and 11).
- Trip relay (1).

Further reduce frequency until the second underfrequency stage f_2< picks up.

- Annunciation "`f2< Fault`" (not marshalled when delivered from factory) after half the time for the set measurement repetitions (address 2105 MEA.REP.f2 = 10 at delivery).
- Annunciation "`f2< Trip`" after the full time for the set measurement repetitions (LED 10 and signal relay 8 and 11).
- Trip relays (1, 2, 3. 4 and 5).

Further reduce frequency until the third underfrequency stage f_3< picks up.

- Annunciation "`f3< Fault`" (not marshalled when delivered from factory) after half the time for the set measurement repetitions (address 2107 MEA.REP.f3 = 10 at delivery).
- Annunciation "`f3< Trip`" after the full time for the set measurement repetitions (not marshalled when delivered from factory).
- Trip relays (not marshalled when delivered from factory).

Activate binary input 3 ("`>Frq. block`").

- The blocking annunciations appear (not marshalled when delivered from factory).
- Annunciations "`f1< Fault`", "`f2< Fault`", "`f3< Fault`" and "`f1< Trip`", "`f2< Trip`" and "`f3< Trip`" disappear; note that the number of repeated measurements is valid for reset delay, too.

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

Further checks are performed with primary values during commissioning (Section 6.7.5).

6.6.8 Testing the interturn fault protection

The function of the interturn fault protection can only be tested if this protection is configured as *EXIST* in address 7834 (as delivered, refer to Section 5.4.2) and has been parameterized as operative – contrary to the condition as delivered from factory (address 3401 INTERTURN = *ON* or = *BLOCK TRIP REL*).

The interturn fault protection processes the asymmetry voltage which is produced by an interturn fault.

When checking the delay times it must be noted that the set times are pure delay times; operating times of the measurement function are not included.

Note: Rated voltage should be connected to at least one voltage measurement input for the dynamic testing of the neutral displacement voltage (refer also to note in Section 6.6.1).

Connect voltage of 1.2 times setting value U–I/T> (address 3402) to measurement input for the interturn fault displacement voltage .

- Annunciation "`I/T Fault`" (not marshalled when delivered from factory).
- After T–U–I/T> (address 3403, 1.5 s when delivered from factory) annunciation "`I/T Trip`" (not allocated when delivered from factory).
- Trip relays (not allocated when delivered from factory).

Disconnect voltage.

Activate binary input "`>I/T> block`" (not marshalled when delivered from factory). Connect voltage.

- Annunciation "`I/T blocked`" (not allocated when delivered).
- No annunciations concerning interturn fault protection.

Disconnect voltage. Deactivate binary input.

Further checks are performed with primary values during commissioning. (refer to Section 6.7.4).

6.6.9 Testing the rotor earth fault protection

The function of the rotor earth fault protection can only be tested if this protection is configured as *EXIST* in address 7835 (as delivered, refer to Section 5.4.2) and has been parameterized as operative – contrary to the condition as delivered from factory (address 3501 ROTOR E/F = *ON* or = *BLOCK TRIP REL*).

If an external rotor earth resistance measurement is provided (rotating measured value transmission), this must have been configured under address 7901 COUPL. REF = *RMT*. Only the measured d.c. voltage is to be applied to the relay input for testing. The resulting rotor earth resistance is checked according to Figure 3.3 in Section 3.9.2.

The integrated test function can be checked by energizing the binary input "`>Test R/E/F`". This input must be assigned to an input module of the relay. The trip command is blocked during this check:

Apply the measured d.c. voltage for rotor earth fault protection (≥4 V–) and increase it until the test threshold RE< TEST (address 3507, 40 kΩ when delivered) is reached:

- Annunciation "`Test REF warn`" (not allocated when delivered).

Further increase d.c. voltage (≥7,5 V–) until the test trip threshold RE<< TEST (address 3708, 5 kΩ) is reached:

- Annunciation "`Test REF Trip`" (not allocated when delivered).

Testing of the integrated rotor earth fault protection (address 7901 = *7XT70* or *7XT71*) is possible only together with the controller unit 7XT70 (controller unit with variable polarity reversal period) or 7XT71 (controller unit with fix polarity reversal period). Each of these units contains the source of the bias voltage for the rotor circuit and produces the control signals for the protection function. It must be supplied with an a.c. voltage (50 Hz to 60 Hz). Connections are arranged as in Figure 6.4 (7XT70) or Figure 6.5 (7XT71). The rotor earth resistance is simulated by the resistor R_E. An adjustable resistor R_E of 0 to 100 kΩ (≥0,5 W) is recommended.

The amplitude of the bias voltage produced by the controller unit 7XT70 is 50 V; it is not measured and displayed by the relay. When the controller unit type 7XT71 is used, the bias voltage is measured by the protection and can be read out in the operational measured values B under address 5806 Ug. The period T_g of the bias voltage is found in address 5805, and the current I_g which is produced by the bias voltage via the earth resistor R_E is displayed in address 5807.

The calculated earth resistance can be read out under address 5809 and compared with the resistance of R_E.

Reduce R_E until the warning stage (address 3502, 40 kΩ when delivered) is reached:
- After T−WARN (address 3504, 10 s when delivered) annunciation "`R/E/F Warn`" (LED 2 and signal relay 12).

After further reduction of R_E the trip stage will operate (address 3503):
- Annunciation "`R/E Fault`" (not allocated when delivered).
- After T−TRIP−R<< (address 3505, 1 s when delivered) annunciation "`R/E/F Trip`" (LED 3 and signal relays 2 and 11).
- Trip relays (2, 3 and 4).

When checking the delay times it must be noted that the set times are pure delay times; operating times of the measurement function are not included.

Activate input "`>R/E/F block`" (INPUT 7).
- Annunciation "`R/E/F blocked`" (not allocated when delivered).
- No further annunciations concerning rotor earth fault protection.

De-activate binary input. Alarm disappears.

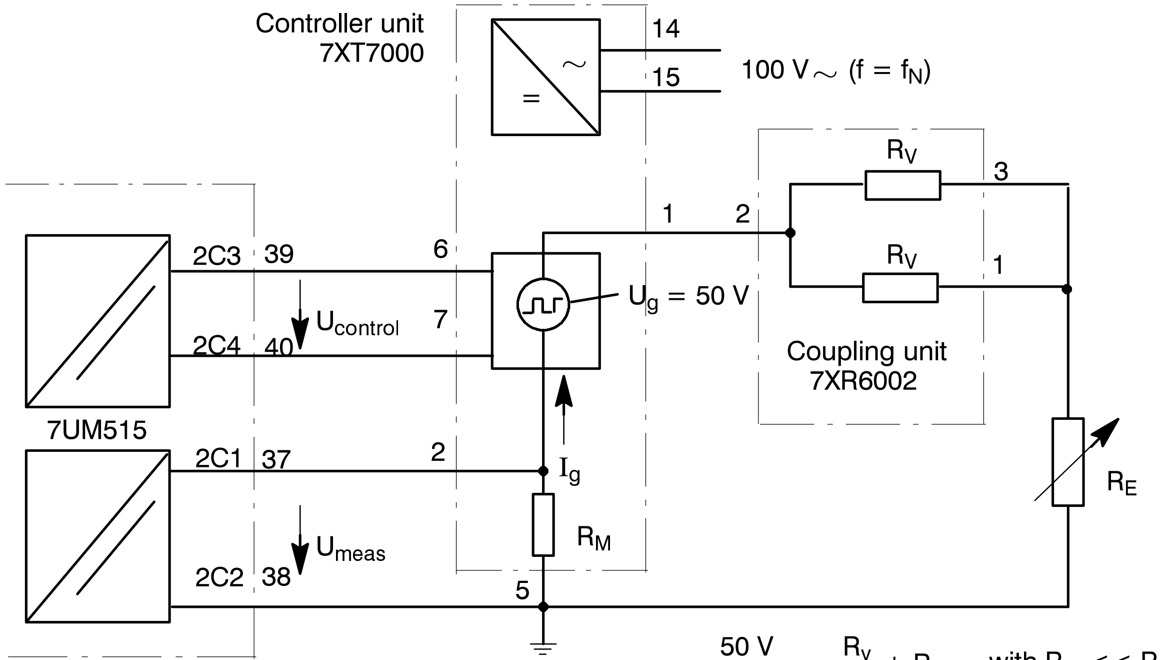
The integrated test function can be checked by energizing the binary input "`>Test R/E/F`". This input must be assigned to an input module of the relay. The trip command is blocked during this check.

Reduce the earth resistance R_E until the test threshold RE< TEST (address 3507, 40 kΩ when delivered) is reached:
- Annunciation "`Test REF warn`" (not allocated when delivered).

Further decrease the earth resistance R_E until the test trip threshold RE<< TEST (address 3708, 5 kΩ) is reached:
- Annunciation "`Test REF Trip`" (not allocated when delivered).

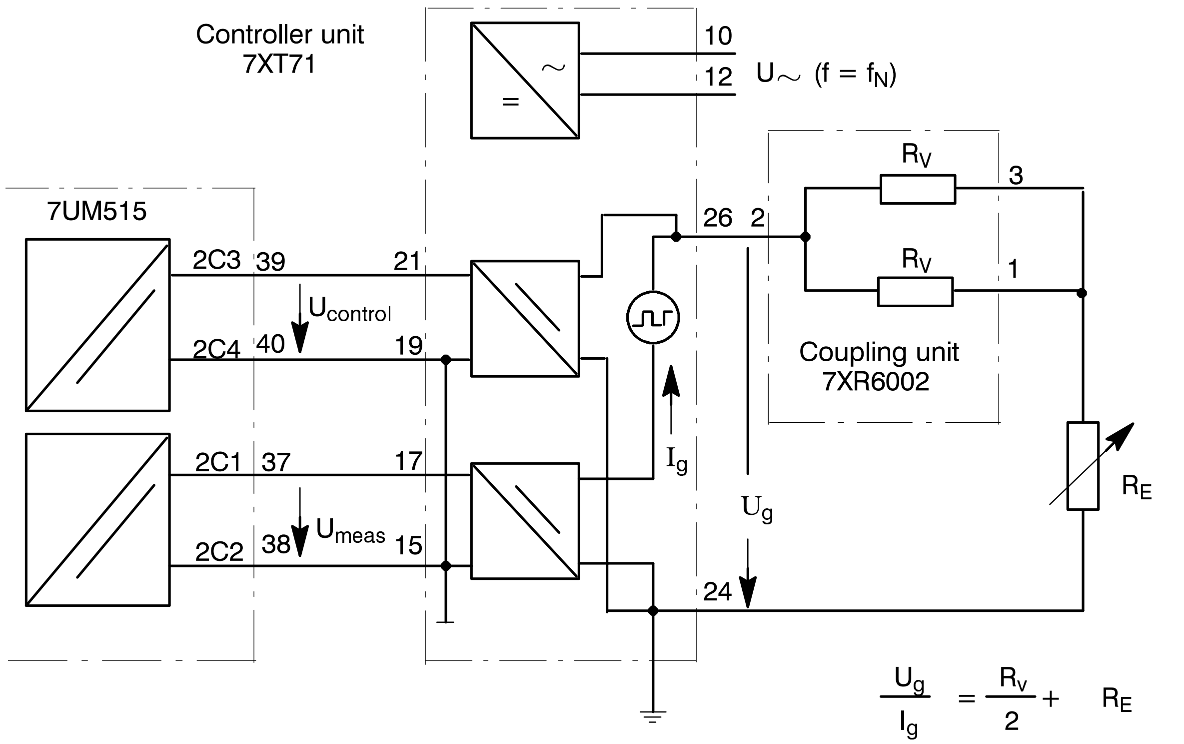
De-activate binary input. Disconnect test quantities.

Further tests are performed with primary values during commissioning. (refer to Section 6.7.2 and 6.7.7).



$$\frac{50\ V}{I_g} = \frac{R_V}{2} + R_E \quad \text{with } R_M << R_V$$

Figure 6.4 Testing the rotor earth fault protection with controller unit 7XT70, without generator



$$\frac{U_g}{I_g} = \frac{R_V}{2} + R_E$$

Figure 6.5 Testing the rotor earth fault protection with controller unit 7XT71, without generator

6.6.10 Testing the coupling of external trip functions

Four desired signals from external protection or supervisory units can be connected into the processing of the 7UM515 via binary inputs. Like the internal signals, they can be annunciated, delayed and transmitted to the trip matrix.

The external signals can be checked when they have been configured as EXT. TRIP = *EXIST* (addresses 7830, 7831, 7832, and/or 7833, refer to Section 5.4.2) and parameterized as operative (addresses 3001, 3101, 3201, and/or 3301), contrary to the condition as delivered from factory).

At the time of delivery, the external trip functions are not parameterized. The set times are pure delay times.

Activate binary input of the tested external trip function.

- Annunciation "`>Ext trip *`"; this is a straight acknowledgement message by the binary input as operational indication (not allocated when delivered from factory).
- Annunciation "`Ext * Gen.Flt`"; this is the actual fault event annunciation (not allocated when delivered from factory).
- After T−DELAY (address 3002 or 3102 or 3202 or 3302; 1 s when delivered from factory) annunciation "`Ext * Gen.Trp`" (not allocated when delivered from factory).
- Trip relays (not allocated when delivered from factory).

De-activate binary input.

6.6.11 Testing the trip circuit supervision

Two binary inputs can be used for one channel of the trip circuit supervision. Address 3902 (see Section 6.3.14) determines whether one or two such trip circuit supervision circuits shall be used.

The supervised trip circuit is detected as faulty if none of the inputs is energized at the same time (refer to Section 4.14). Alarm is given after a time delay which is specified by the set number of repeated measurements.

The trip circuit supervision can be checked if it has been configured as TRP SUPERV = *EXIST* (addresses 7839 set as delivered, refer to Section 5.4.2) and parameterized as operative (address 3901 TRP SUPERV = *ON*, Section 6.3.14), contrary to the position as delivered from factory.

Note: If, during marshalling, not two binary inputs are allocated to each desired trip circuit supervision, failure annunciation "`Failure Trip*`" will occur, as a warning.

Energize the two binary inputs which belong to the tested channel, individually one after the other by applying a d.c. voltage of >16 Vdc. But if a higher pick-up threshold has been set for the binary inputs (refer to Section 5.2.2.1), apply a voltage of >80 Vdc. As long as only one of the inputs is energized, no trip circuit alarm is given.

Energize both binary inputs which belong to the tested channel.

- No alarm annunciation concerning trip circuit supervision.

De-energize both binary inputs which belong to the tested channel.

- Annunciation "`Failure Trip*`" (not allocated when delivered) after a short delay which is specified by the number of repeated measurements. address 3903). Since the supervision operates 3 times to 4 times a second, one can expect a delay of approx. 0.75 s to 1 s per repeated measurement.

Test the second channel in the same way.

6.7 Commissioning using primary tests

6.7.1 General advices

All secondary test equipment must be removed. Connect measurement values. All installation preparations according to Section 5.2 must have been completed. It is presumed that the applied measuring method of the rotor earth fault protection is correctly configured under address 7901 (refer also to Section 5.4.2 and 6.6.9). Primary tests are performed with the machine.

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.)

Primary testing is usually performed in the following order:

– tests with the machine at stand-still,
– short-circuit tests,
– voltage tests,
– special tests.

The following hints are arranged in this order. All protection functions should be initially switched *OFF* (condition as delivered from factory) 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–EXIST*ing.

Switching on of a particular function can be performed in two different ways. The setting addresses concerned are shown in the respective sections.

– *BLOCK TRIP REL*: The protection function is operative and outputs annunciations and measured values. However, the trip command is blocked and it is not transmitted to the trip matrix.

– Protection function *ON:* The protection function is operative and outputs annunciations and measured values. The trip command activates the trip relays which have been marshalled to the protection function according to Section 5.5.5. If the protection command is not marshalled to any trip relay, tripping does not occur.

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 6.7.9.

6.7.2 Checking the rotor earth fault protection at stand-still

The rotor earth fault protection can be checked with the machine at stand-still. The controller unit (7XT70 or 7XT71), however, if used, must be supplied with an external a.c. voltage (50 Hz or 60 Hz). Please refer also to connection examples Figure 5.8 or 5.9 in Section 5.2.5).

Switch rotor earth fault protection (address 3501) to *BLOCK TRIP REL*.

Put the measurement brushes of the rotor circuit in place. If the controller unit 7XT71 is used, read out the applied bias voltage U_g in address 5806 under the operational measured values B. If the controller unit 7XT70 is used, U_g = 50 V (fix value, cannot be read out). In both cases, read out the earth current I_g (address 5807) produced by the bias voltage and the period T_g (address 5805) of polarity reversal and the charge Q_C (address 5808) at polarity reversal. Additionally, the calculated rotor earth resistance R–REF can be read out in address 5809. The display should show 199.9 kΩ, i.e. the highest recognizable value. The current I_g is determined only by the charging current at polarity reversal and should be negligible

The voltage step change at each polarity reversal is $2 \cdot U_g$. Thus, the charge is:

$$Q_c = 2 \cdot U_g \cdot C_E$$

Since this charge is present during healthy (earth-fault free) operation, it determines the value to be set for the measuring circuit supervision. The threshold for this supervision (address 3509) should be set to approximately half the measured charge value which is read out under address 5808 under the operational measured values B.

If the earth capacitance of the rotor-earth circuit is too small, i.e. if the charge is less than 0.02 mAs, supervision of the measurement circuit is not possible; supervision is made ineffective by setting Qc (address 3509) to 0.00 mAs.

If the controller unit 7XT71 is used, the polarity reversal period of this unit must be determined and set at this unit. The following paragraphs including the example do not apply for the controller unit type 7XT70.

The capacitance C_E of the rotor circuit and the time constant τ at polarity reversal can be roughly determined by the operational measured values as described above:

$$C_E = \frac{Qc}{2\ Ug}$$

$$\tau = R_g \cdot C_E$$

where R_g = the total resistance of the measuring circuit; this is mainly determined by the two parallel resistors of the coupling unit 7XR6002 and amounts to approx. 20 kΩ

The time constant τ determines the period of polarity reversal T_g. Assuming the time of decay of the capacitive charging current should be $10 \cdot \tau$, and the minimum system frequency should be 40 Hz (the minimum frequency for rotor earth fault protection), the half-period of polarity reversal and the reversal frequency can be derived as follows:

$$\frac{T_g}{2} \geq 10\tau + 5T_n = 10\tau + \frac{5}{f_n} = 10\tau + 0.125\ s$$

$$T_g \geq 20\tau + 0.250\ ms$$

$$\text{or:}\quad f_g \leq \frac{1}{T_g}$$

where
- τ = time constant of the charging current
- T_g = period of polarity reversal
- T_n = period of the system frequency
- fg = frequency of polarity reversal
- f_n = smallest system frequency under consideration (worst case 40 Hz)

The frequency f_g of polarity reversal must be set on the controller unit 7XT71.

Example:

operational measured values

Ug	=	50 V
Qc	=	0.06mAs
R−REF	=	199.9 kΩ

setting value (address 3509):

$$Qc< \ = \frac{1}{2} \cdot Qc = 0{,}03\ mAs$$

calculation of the frequency of polarity reversal:

$$C_E = \frac{Qc}{2\ Ug} = \frac{0.06\ mAs}{100\ V} = \underline{\underline{0.6\ \mu F}}$$

$$\tau = Rg \cdot C_E = 20 \cdot 10^3\ \Omega \cdot 0.6 \cdot 10^{-6}\ F = 12 \cdot 10^{-3}\ s$$

$$Tg \geq 20\ \tau + 0.250\ s = 0.24\ s + 0.25\ s \geq 0.49\ s$$

$$f_g \leq \frac{1}{Tg} = \frac{1}{0.49}\ Hz = 2.04\ Hz$$

setting value at 7XT71:

$$f_g = \underline{\underline{2.0\ Hz}}$$

After completion of the checks with earth-free rotor circuit, the next checks are those with simulated earth fault. In the case of machines with rotating rectifier excitation (Figure 6.6), an earth fault is installed between the two measurement slip rings with the measurement brushes in place. In case of machines with excitation via slip rings (Figure 6.7), the earth fault is installed between one slip ring and earth. The unit now measures the earth resistance. This value can be read out under the OPERATIONAL MEASURED VALUES B (address 5809):

R−REF = xxx.x kΩ

The earth resistor is now reduced to approximately 90 % of the trip resistance (RE<< TRIP, address 3503). The rotor earth fault protection initiates a pick-up signal and after T−TRIP−RE<< (address 3505, 1 s when delivered from factory) a trip annunciation (LED 3 and signal relays 2 and 11).

In the case of machines with excitation via slip rings, the above test is repeated for the other slip ring.

Remove earth fault resistor.

Lift measurement brushes or interrupt measurement circuit. Alarm “`R/E/F open`” appears after 10 s delay time(not allocated when delivered).

Close measurement circuit.

If the alarm “`R/E/F open`” is also present with the measurement circuit closed, then the rotor-earth-capacitance is less than 0.15 µF. In this case, a measurement circuit supervision is not possible; parameter Qc< (address 3509) should be set at 0.00 mAs (for 7XT71 already described above).

Switch off supply voltage of the controller unit 7XT7★. Annunciation “`Failure R/E/F`” is output after 5 s (not assigned when delivered).

After the completion of the test, check that all provisional measures for testing have been reversed:

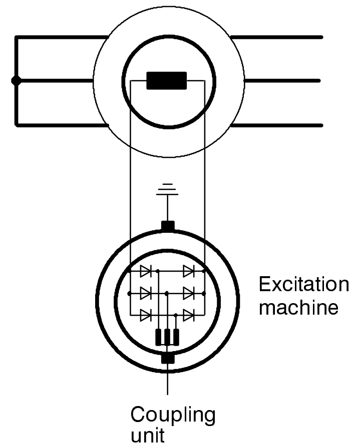


Figure 6.6 Excitation via rotating rectifiers with measurement brushes

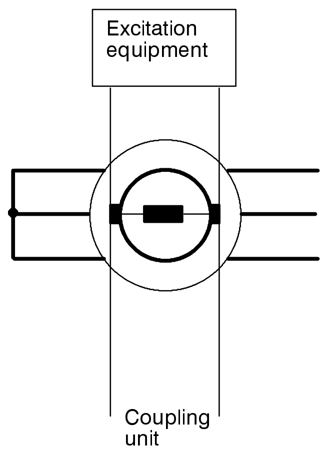


Figure 6.7 Excitation equipment fed via slip rings

– Earthing bridge or resistor has been removed,
– Measurement circuit has been closed,
– Controller unit connected to its operational supply a.c. voltage (refer also connection diagram in Figure 5.8 or 5.9 in Section 5.2.5).

Tests with the running machine are described later under Section 6.7.7.

6.7.3 Checking the stator earth fault 100 % protection at stand-still

The stator earth fault protection can be checked with the machine at stand-still; the measuring method is independent on whether the machine stands still, rotates, is excited or not. The 20 Hz generator, however, must be supplied with an external a.c. voltage (3 phase 100 V, 50 Hz or 60 Hz). Please refer also to connection example Figure 5.5 in Section 5.2.5).

Switch stator earth fault 100 % protection (address 1801) to *BLOCK TRIP REL*.

The 20 Hz measured quantities can be read out under the OPERATIONAL MEASURED VALUES B (address block 58):

U−SEF = xx.x V
I−SEF = y.yy A

The unit calculates from theses quantities the stator earth resistance related to the unit terminals. By means of the transformation factor S/E/F FACT according to address 1811, the primary earth resistance Rse p is calculated. Both values can be read out under address block 58:

R−SEF = xxx Ω
Rse p = x.xx kΩ

If the stator circuit is isolated from earth, the current I−SEF is determined by the stator earth capacitance and, therefore, very small. The calculated resistances are accordingly high. It must be noted that the maximum resistance value R−SEF that can be displayed is 999 Ω. The maximum primary value depends on the transformation factor S/E/F FACT (address 1811), i.e. 999 Ω x S/E/F−FACT).

Switch off the supply of the 20 Hz generator. Annunciation “`Failure S/E/F`” appears.

An earth fault is installed via a resistor between the machine star point and earth.

DANGER!

Hazardous voltages may occur on the machine even during stand-still. The 20 Hz generator, if switched on, can produce a voltage of 1 % to 3 % of the machine rated voltage in the machine starpoint!

Switch on power supply for 20 Hz generator.

The installed earth resistance must be transformed to the protection relay side; the following identity can be used:

$$R_{E\,sec} = \frac{9}{TR^2_{E\,Tr}} \cdot \frac{TR_{ICT}}{TR_{VD}} \cdot R_{E\,prim}$$

where

$R_{E\,sec}$	stator earth resistance related to the unit terminals; it is equal to the value Rs/e/f displayed in the operational measured values 2.
$TR_{E\,Tr}$	transformation ratio of the earthing transformer
TR_{ICT}	transformation ratio of the intermediate current transformer
TR_{VD}	transformation ratio of the voltage divider
$R_{E\,prim}$	stator earth resistance of the primary stator circuit

Note: When using a neutral earthing transformer, TR must be inserted as the voltage transformation ratio instead of TR/3. The result is the same since the neutral earthing transformer has only one winding.

The unit calculates the stator earth resistance related to the unit terminals, and the primary earth resistance by means of the transformation factor (address 1811). Both values can be read out under address block 58:

– R–SEF = xxx Ω
  Rse p = x.xx kΩ

Check that these values corresponds to the calculated value $R_{E\,sec}$ (as in above formula) and to the actual primary earth resistance. If the deviation is meaningful even though the parameters are correct, an angle error between the 20 Hz measuring current I–SEF and voltage U–SEF may be the cause. Check and adjust the angle error correction under address 1810 (CT ANG. W1). This angle can be optimized and then set to its final value. This correction angle is relevant only for stator earth fault protection and has no influence on other protection functions.

An earth fault is now fitted as described above via a resistor of approximately 90 % of the warning resistance (S/E/F R<, address 1802). The stator earth fault protection initiates a warning alarm after the delay time T–R< (address 1803, 10 s when delivered).

The resistance is now reduced to approx. 90 % of the trip resistance (S/E/F R<<, address 1804). The stator earth fault protection initiates a pick-up signal and after T–R<< (1 s when delivered from factory) a trip annunciation (LED 1 and signal relays 1 and 11).

Reduce the resistance to 0. Read out the 20 Hz voltage U–SEF under the OPERATIONAL MEASURED VALUES B (address block 58). Set the parameter BLOCK U20 under address 1808 to approx. 50 % to 80 % of this value. This should be the final setting.

Remove test resistor.

If the alarm from the 20 Hz generator is fed to a binary input of the unit (not allocated when delivered), then check:

The supply voltage of the 20 Hz generator must be switched off.

- Annunciation "`>U20 failure`" (not allocated when delivered).
- Annunciation "`Failure S/E/F`" (not allocated when delivered).

Switch on supply for 20 Hz generator.

If the stator earth fault 100 % protection shall be blocked via a binary input signal, this blocking must be checked:

Activate binary input "`>SEF block`" (INPUT 5 when delivered).

- Annunciation "`SEF blocked`" (LED 13).
- No further annunciation concerning the stator earth fault 100 % protection.

Tests with the running machine are described later under Section 6.7.6.

6.7.4 Checking the interturn fault protection – short-circuit tests

Switch interturn fault protection (address 3401) to *BLOCK TRIP REL*.

On the one hand, the interturn protection should detect an interturn fault even when the machine is working under no-load excitation, on the other hand, the protection must not malfunction on occurrence of interference conditions. Interferences can be caused by asymmetrical windings in the stator. This will result in appearance of a displacement voltage in particular during two-phase short-circuits. The interference voltage is determined by asymmetrical short-circuit tests.

Caution!

Since the rotor of the machine will already be thermally overloaded at small asymmetrical currents, the maximum permissible current for short-circuit tests must be calculated before these tests.

If the generator were excited up to rated current, then the unbalanced load would be

with a single-phase short-circuit

$$\frac{100}{3} \approx 33.3\ \%$$

with a two-phase short-circuit

$$\frac{100}{\sqrt{3}} \approx 57.7\ \%$$

If the continuously permissible unbalanced load is, for example, 12 %, then the single-phase short-circuit current must not be higher than

$$\frac{12\ \%}{33.3\%} \cdot I_N = 0.36\ I_N$$

The two-phase short-circuit current must not be higher than

$$\frac{12\ \%}{57.7\%} \cdot I_N = 0.207\ I_N$$

The same applies for the excitation current which also must not exceed 0.36 alt. 0.207 times the rated excitation current.

Install a two-phase short-circuit bridge at the machine terminals which is capable of carrying the applicable short-circuit currents.

DANGER!

Operations in primary area must only be performed with the machine at standstill and with plant sections voltage-free and earthed!

Switch excitation to “manual” mode.

Run up the machine and excite but at most to the current determined according to above short-circuit current calculation (for two-phase current).

Measure the excitation current.

Measure the displacement voltage at the relay terminals. It can be read out as Ui/t under address 5710.

Shut down the generator. Remove short-circuit bridge.

Extrapolate the measured displacement voltage to two-phase short-circuit current of the machine at rated excitation to gain the interference at two-phase current with rated excitation.

Check that the pick-up value of the interturn protection (address 3402) is approx. twice this interference voltage. Change the setting if necessary.

If the impulse excitation current is known, extrapolate to this excitation current and check that the pick-up value of the interturn fault protection is set to at least 1.5 times this interference voltage.

To check the sensitivity of the protection, the protected portion of the winding under no-load excitation is to be determined. This can be achieved as follows:

Install a single-phase short-circuit bridge between one machine terminal and the starpoint which is capable of carrying the applicable short-circuit currents.

DANGER!

Operations in primary area must only be performed with the machine at standstill and with plant sections voltage-free and earthed!

Switch excitation to “manual” mode.

Run up the machine and excite but at most to the current determined according to above short-circuit current calculation (for single-phase current).

Measure the excitation current.

Measure the displacement voltage at the relay terminals. It can be read out as Ui/t under address 5710.

Shut down the generator. Remove short-circuit bridge.

Extrapolate the measured displacement voltage to no-load excitation.

The protected winding portion can be determined:

$$\frac{U_{\text{at no-load excitation}} - U_{\text{setting}}}{U_{\text{at no-load excitation}}} \cdot 100\ \%$$

It is assumed in this formula that the displacement voltage be proportional to the short-circuited number of turns. In fact, the displacement voltage is much higher with a small number of turns so that the protection will be more sensitive than calculated. However, for easy calculation the above formula can be used.

If the interturn fault protection shall be used, switch it to be operative, i.e. address 3401 INTERTURN = *ON*, otherwise to *OFF*.

6.7.5 Checking the voltage circuits

Check in the unexcited condition of the machine with the help of remanent currents, that current transformer circuits are not open nor short-circuited and all short-circuit bridges are removed.

Switch overflux protection (address 1301), undervoltage protection (address 1601), overvoltage protection (address 1701) and frequency protection to *BLOCK TRIP REL*.

If the undervoltage protection is used, then blocking of this function on tripping of the VT 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< block" (INPUT 4 when delivered from factory).

– Switch voltage transformer m.c.b. to tripped position,
– Annunciation "U< blocked" (LED 12 when delivered).
– Slowly excite generator to rated voltage.

The undervoltage protection does not operate (no pick-up "U< Fault", no trip signal "U< Trip").

Switch on voltage transformer m.c.b.

Read out voltages in all three phases under address block 57. They can be compared with the actual voltages. At rated frequency and rated voltage, the value U/f should be near 1.00 (address 5901). The voltage of the positive sequence system (address 5716) must be approximately $\sqrt{3}$ times the indicated phase voltages (it is referred to the phase-to-phase voltage). If this is not, the voltage transformer connections are incorrect (crossovers).

The phase sequence at the relay must be clockwise. If not, the annunciation "Fail.PhaseSeq" appears in the operational annunciation (address block 51). If the machine has counter-clockwise rotation, two phases must be interchanged, or a binary input must be allocated to the input function ">Phase rotat" and energized at generator stand-still. If deviations occur, proceed as follows:

– Shut down turbo-set and de-excite generator,
– apply plant earths,
– check voltage transformer circuits and make corrections,
– repeat test.

Switch machine speed regulation to "manual " operation.

Increase machine speed, so that overfrequency protection just picks up (at delivery frequency stage f4, address 2108):

- Annunciation "f4> Fault" (not marshalled when delivered from factory)
- After a delay time determined by the number of repeated measurements (address 2109), annunciation "f4> Trip" (LED 11 and signal relays 9 and 11 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" (not marshalled when delivered from factory).
- After a delay time determined by the number of repeated measurements, annunciation "f1< Trip" and annunciation "f2< Trip" (LED 10 and signal relays 8 and 11 when delivered from factory) and "f3< Trip" (not marshalled when delivered from factory).

If a binary input is used for blocking the frequency stages (input 3 when delivered from factory), activate the block: Annunciations of the frequency protection disappear: if applicable wait for the reset delay for the trip command to elapse. De-activate binary input.

Adjust machine to rated speed and slowly de-excite the generator. When the generator voltage (positive sequence system) drops below the value set for U< (1) (address 1602): pick-up annunciation "`U< Fault`" appears (not marshalled when delivered from factory) and trip command "`U< Trip`" after delay according to the set characteristic (LED 9 and signal relays 7 and 11, 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< block`" (FNo 6506).

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 1301: U/f PROT. = *ON* or *OFF),*
(address 1601: UNDERVOLT = *ON* or *OFF),*
(address 1701: OVERVOLT = *ON* or *OFF*),
(address 2101: f> / f< = *ON* or *OFF).*

Partial functions can be switched to be inoperative by appropriate limit value settings (e.g. f* set to rated frequency).

6.7.6 Checking the earth fault protection

In order to ascertain the influence of the displacement voltage on the measurement circuits of the stator earth fault 100 % protection, to check interference suppression of the loading resistor, and in order to verify the protected zone of the earth fault protection functions, tests with running machine are suggested.

Switch stator earth fault 100 % protection (address 1801) to *BLOCK TRIP REL* (if not already done under Section 6.7.3), switch earth fault protection U_0 (address 1901) to *BLOCK TRIP REL*.

The accessories for earth fault 100 % protection shall be operative.

6.7.6.1 Calculation of protected zone

The loading resistor shall produce an earth current which operates the <u>current</u> stage of the stator earth fault 100 % protection in case of an earth fault at the limit of the protection zone. On the other hand, the loading resistor must not cause the earth fault protection to pick-up in case of a solid system earth fault. Finally, the earth fault current resulting from the loading resistor in the event of an earth fault at the machine terminals should not exceed 10 A.

In the event of an external (high-voltage side) short-circuit, an interference voltage is transmitted via the coupling capacitance C_K (Figure 6.8) which induces a neutral displacement voltage on the machine side. To ensure that this voltage is not interpreted by the protection as an earth fault within the machine, it is reduced by a suitable loading resistor to a value which corresponds to approximately one half the pick-up voltage of the earth fault protection $U_0>$ (address 1902). On the other hand, the earth fault current resulting from the loading resistor in the event of an earth fault at the machine terminals should not exceed 10 A.

Coupling capacitance C_K and loading resistor R_B represent a voltage divider (equivalent circuit diagram Figure 6.9); whereby R_B' is the resistance R_B referred to the machine terminal circuit. Since the reactance of the coupling capacitance is much larger than the referred resistance of the loading resistor R_B', U_C can be assumed to be $U_{NU}/\sqrt{3}$ (compare also vector diagram Figure 6.10), whereby $U_{NU}/\sqrt{3}$ is the neutral displacement voltage with a full displacement of the network (upper-voltage) neutral. The following applies:

$$R_B' : \frac{1}{\omega C_K} = U_R' : \frac{U_{NU}}{\sqrt{3}}$$

$$U_R' = R_B' \cdot \omega C_K \cdot U_{NU}/\sqrt{3}$$

Inserting the voltage transformation ratio TR of the earthing transformer:

$$U_R' = \frac{TR}{3} \cdot U_R \quad \text{and} \quad R_B' = \left(\frac{TR}{3}\right)^2 \cdot R_B$$

we obtain

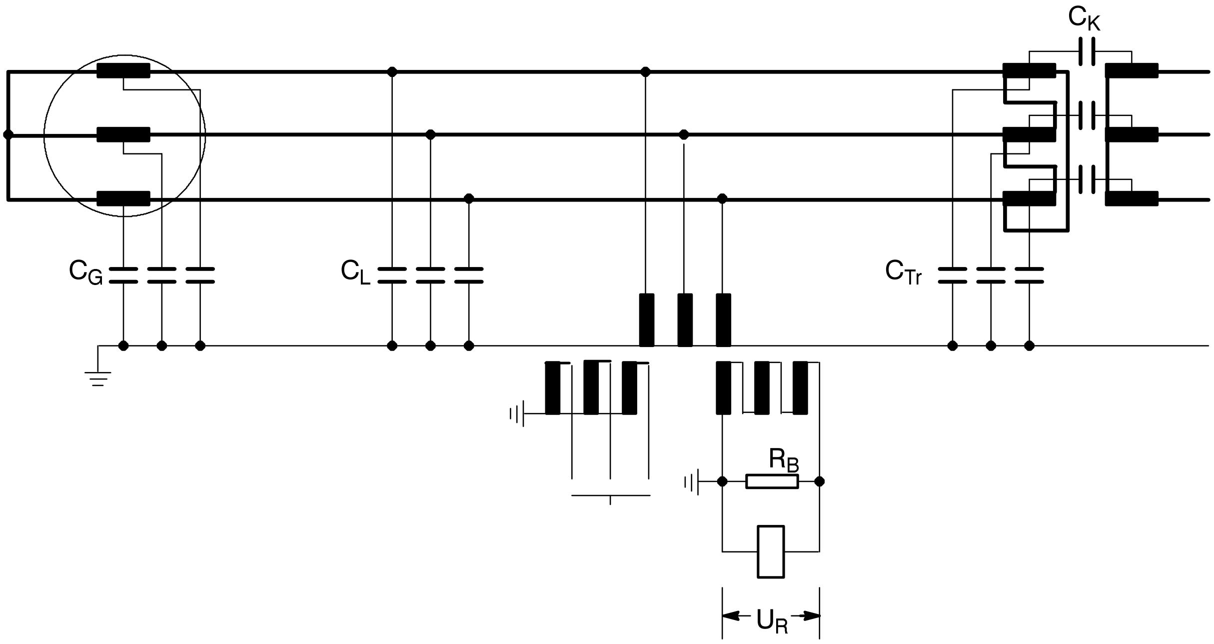
$$U_R = \frac{TR}{3} \cdot R_B \cdot \omega C_K \cdot U_{NU}/\sqrt{3}$$

Together with the voltage divider 500V/100V this corresponds to a displacement voltage of

$$U_E = \frac{1}{5} \cdot \frac{TR}{3} \cdot R_B \cdot \omega C_K \cdot U_{NU}/\sqrt{3}$$

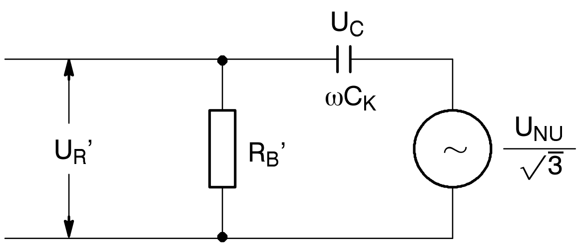
at the input of the unit.

The pick-up value for the neutral displacement voltage should amount to at least twice the value of this interference voltage.



R – Loading resistor
U_R – Neutral displacement voltage at protection relay
C_G – Generator–earth capacitance
C_L – Line–earth capacitance
C_{Tr} – Winding–earth capacitance of block transformer
C_K – Coupling capacitance of block transformer

Figure 6.8 Block diagram with earthing transformer



U_{NU} Rated voltage on upper-voltage side of block transformer
U_C Voltage at coupling capacitance C_K
C_K Total coupling capacitance between upper-voltage and lower-voltage windings.
U_R' Voltage across loading resistor
R_B' Loading resistor of earthing transformer, referred to machine circuit.

Figure 6.9 Equivalent diagram

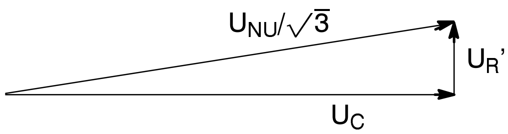


Figure 6.10 Vector diagram

<u>Example:</u>

Network: U_{NU} = 110 kV
f_N = 50 Hz
C_K = 0.01 µF

Earthing transformer:
TR = 36

Loading resistor:
R_B = 10 Ω

$$U_E = \frac{1}{5} \cdot \frac{TR}{3} \cdot R_B \cdot \omega C_K \cdot U_{NU}/\sqrt{3}$$

$$U_E = \frac{1}{5} \cdot \frac{36}{3} \cdot 10\ \Omega \cdot 314\ s^{-1} \cdot 0.01 \cdot 10^{-6}\ F \cdot \frac{110}{\sqrt{3}} \cdot 10^3\ V$$

$$= 4.8\ V$$

If, e.g., 10 V has been chosen as the setting value for Uo> in address 2002 then this corresponds to a protective zone of 90 %.

Note: When using a neutral earthing transformer, TR must be inserted as the voltage transformation ratio instead of TR/3. The result is the same since the neutral earthing transformer has one winding.

Similar calculation is valid for the protected zone of the current stage of the 100 % stator earth fault protection. In this case the current derived from the displacement voltage is measured by the protection. Note that the transformation ratio of the voltage divider normally is, in this case, 500 V/200 V.

6.7.6.2 Checking without earth fault

Run up machine and excite to rated voltage. No pick-up of any earth fault protection.

Read out the earth current I−SEF in OPERATIONAL MEASURED VALUES B (address block 58). Check that the pick-up value of the current stage of the earth fault 100 % protection is set at least to twice this 20 Hz interference current I−SEF (address 1808). Correct setting if necessary.

Shut down the machine.

6.7.6.3 Checking for machine earth fault

The 20 Hz generator must be supplied from an external source!

With the primary plant voltage-free and earthed, install a single-pole earth fault in the proximity of the machine terminals.

DANGER!

Operations in primary area must only be performed with the machine at standstill and with plant sections voltage-free and earthed!

Start up machine and slowly excite (however, not above $U_N/\sqrt{3}$) until the earth fault protection U_0> picks up (LED 6 when delivered from factory).

Read out U0 in OPERATIONAL MEASURED VALUES A (address 5707). If the connections are correct, this value corresponds with the machine terminal voltage in percent, referred to rated machine voltage (if applicable, deviating rated primary voltage of earthing transformer or neutral earthing transformer must be taken into account). This value also corresponds with the setting value U0> under address 1902 (see Figure 6.11).

The protection zone is 100 % − U0 [%], e.g.

Machine voltage at pick-up:	$0.1 \cdot U_N$
Measured value U0	10 %
Setting value U0>	10 V
Protected zone	90 %

Read out I−SEF in OPERATIONAL MEASURED VALUES B (address 5802). This value should be approximately equal to the setting of the current stage of the earth fault 100 % protection S/E/F I>> (address 1806). Thus, the protected zone of the current stage corresponds also to 100 % − U_0.

Shut down machine. Remove earth fault bridge.

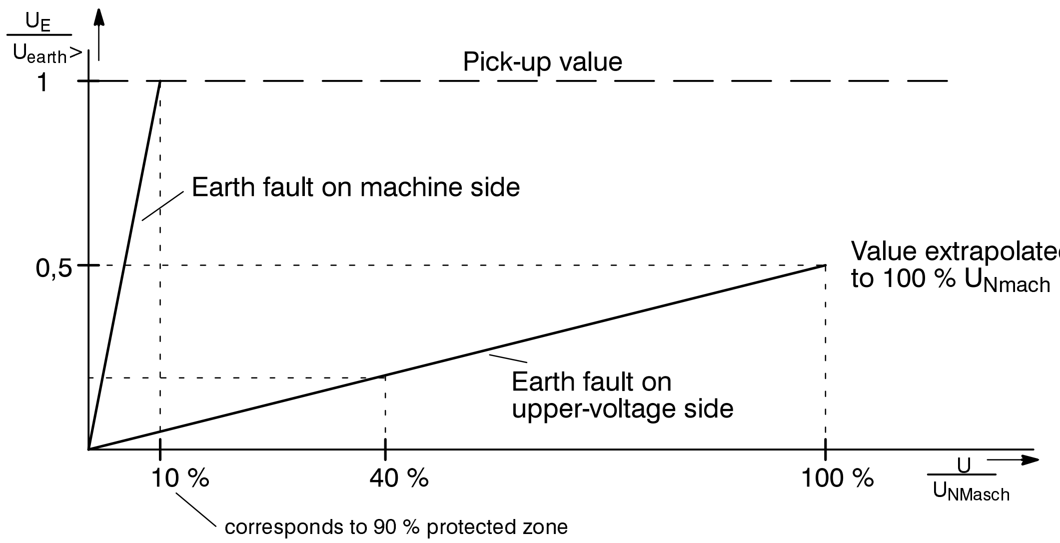


Figure 6.11 Neutral displacement voltage during earth faults

6.7.6.4 Check using network earth fault

With the primary plant voltage-free and earthed, install a single-pole earth fault bridge on the high-voltage side of the block transformer.

DANGER!

Operations in primary area must only be performed with the machine at standstill and with plant sections voltage-free and earthed!

Caution!

The star-points of the transformer must not be connected to earth during this test!

Start up machine and slowly excite to 40 % of rated machine voltage (max. 60 %). Earth fault protection does not pick-up.

Read out U0 and I–SEF in the OPERATIONAL MEASURED VALUES A (address 5707). Both values are extrapolated to rated machine voltage (Figure 6.11 as an example for the voltage). The voltage value thus calculated should correspond, at the most, to half the pick-up value U0> (address 1902), in order to achieve the desired safety margin of the U_0 earth fault protection. Read out the value of I–SEF under address 5802 and extrapolate to 1.3 times rated machine voltage. The current value thus calculated should correspond, at the most, to half the pick-up value S/E/F I>> (address 1806), in order to achieve the desired safety margin of the current stage of the stator earth fault 100 % earth fault protection.

Shut down machine. Remove earth fault bridge.

If the starpoint of the high-voltage side of the block transformer is to be earthed during normal operation, re-establish starpoint earthing.

The 20 Hz generator should now be supplied from the machine terminal voltage (if this supply mode is used).

Switch the desired earth fault protection functions to be operative: address 1801 STATOR E/F = *ON* or *OFF*, address 1901 SEF PROT. = *ON* or *OFF*.

6.7.7 Checking the rotor earth fault protection during operation

In Section 6.7.2, the rotor earth fault protection was checked with the machine at stand-still. In order to exclude possible interference on the measurement circuit by the running machine, an additional test during operation is recommended.

An earth fault is simulated via a resistor of approximately 90 % of the trip resistance (RE<< TRIP, address 3503). In machines with rotating rectifier excitation (Figure 6.6), the resistor is placed between the measurement slip rings; in machines with excitation via slip rings (Figure 6.7) between one slip ring and earth.

DANGER!

Operations in primary area must only be performed with the machine at standstill and with plant sections voltage-free and earthed!

Start up machine and excite to rated voltage. If applicable place measurement brushes into place.

The rotor earth fault protection initiates pick-up and, after T–TRIP–R<< (1 s when delivered), trip annunciation (LED 3 and signal relays 2 and 11).

The earth resistance R–REF as calculated by the unit can be read out in the OPERATIONAL MEASURED VALUES B (address 5809).

For machines with excitation via slip rings, the test is repeated for the other slip ring.

Shut down machine. Remove earth fault resistor.

Switch the rotor earth fault protection ROTOR E/F = *ON* under address 3501.

The controller unit should now be supplied from the machine terminal voltage (if this supply mode is used).

6.7.8 Checking the coupling of external trip signals

If the coupling of external functions for the alarm and/or trip processing is used, then these functions must be configured as *EXIST* in the addresses 7830 to 7833. The used function is, additionally, switched in address 3001, 3101, 3201, and/or 3301: EXT. TRIP ⋆ = *BLOCK TRIP REL*.

The function of the coupling is to be checked for one after another. For this, the source object of the coupled signal is operated and the effect checked.

Finally the used functions are switched *ON*.

6.7.9 Tripping test including circuit breaker – address block 44

Machine protection 7UM515 allows simple checking of the tripping circuit and each trip relay.

Initiation of the test can be given from the operator keyboard or from the front operator interface. The procedure is started with address 4400 which can be reached by paging with ⇑ or ⇓, or by direct dialling **DA 4 4 0 0 E**. Codeword input is necessary (code level 2).

By further paging with ↓ ↑ each of the trip relays can be selected for test.

After confirmation by the "Yes" – key **J/Y** the selected relay closes its contacts for 1 s.

⚠ **Warning**

After confirmation by the operator the switching device will be operated. Ensure before each test, that switching is permissible under the actual switchgear status. E.g. isolate circuit breaker by opening isolators at each side.

The test procedure can be ended or aborted by pressing the "No" – key **N** after the question "ENERGIZE TRIP RELAY n ? appears.

⇑⇓
```
4000█
TESTS
```
Commencement of the test blocks

⇑⇓
```
4400█ CB TEST
LIVE TRIP
```
Beginning of the block "Trip circuit breaker test: Live trip"

↑↓
```
4401█ ENERGIZE
TRIP RELAY 1 ?
```
Test trip circuit of trip relay 1?
Confirm with "**J/Y**" – key or abort with "**N**" – key

↑↓
```
4402█ ENERGIZE
TRIP RELAY 2 ?
```
Test trip circuit of trip relay 2?
Confirm with "**J/Y**" – key or abort with "**N**" – key

↑↓
```
4403█ ENERGIZE
TRIP RELAY 3 ?
```
Test trip circuit of trip relay 3?
Confirm with "**J/Y**" – key or abort with "**N**" – key

↑↓
```
4404█ ENERGIZE
TRIP RELAY 4 ?
```
Test trip circuit of trip relay 4?
Confirm with "**J/Y**" – key or abort with "**N**" – key

↑↓
```
4405█ ENERGIZE
TRIP RELAY 5
```
Test trip circuit of trip relay 5?
Confirm with "**J/Y**" – key or abort with "**N**" – key

6.7.10 Starting a test fault record – address block 49

A fault record storage can be started at any time using the operating panel or via the operating interface. Starting a test fault record is also possible via a binary input provided this is accordingly allocated (FNo 4 “>Start FltRec”).

The configuration parameters as set in address block 74 are decisive for this fault recording (refer to Section 5.3.5): Selection is made under address 7420 whether instantaneous values or r.m.s. values should be scanned; address 7431 concerns triggering via binary input, address 7432 triggering via the operating keyboard or via the operating interface. The pre-trigger time was set under address 7411.

If the fault record is triggered via a binary input, recording starts automatically with an external event, e.g. at the instant of a switching command.

Manual starting of a fault record can be carried out in address block 49, which can be reached by paging with ⇑ or ⇓, or by direct dialling with **DA 4 9 0 0 E**. The start address is reached with ↑:

```
⇑ 4900█ TEST
⇓ FAULT RECORDING
```

Beginning of block “Test fault recording” page on with ↑ to address 4901

```
↑ 4901█ FAULT REC.
  START ?
```

Start fault recording? Confirm with “**J/Y**” – key or abort with page-on key ↑

```
SUCCESSFUL
```

The relay acknowledges successful completion of the test recording

6.8 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 functions have been programmed in the configuration parameters (address blocks 78 and 79, refer to Section 5.4). Ensure that the trip times are not set to ∞ for those functions or stages which should trip and that all desired protection functions have been switched *ON*. Those functions which should only give information may be switched to *BLOCK TRIP REL*.

Push the key **M/S** on the front. The display shows the beginning of the annunciation blocks. Thus, it is possible that the measured values for the quiescent state of the relay can be displayed (see below). These values have been chosen during configuration (refer to Section 5.3.2) under the addresses 7105 and 7106.

Stored indications on the front plate should be reset by pressing the push-button "RESET LED" on the front so that from then on only real faults are indicated. From that moment the measured values of the quiescent state are displayed. 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 modules are properly inserted. The green LED must be on on the front; the red LED must not be on.

Close housing cover.

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.

If the device is equipped with a back-up battery for saving of stored annunciations and the internal time clock, the battery should be replaced after at most 10 years of operation (refer to Section 7.2). This recommendation is valid independent on whether the battery has been discharged by occasional supply voltage failures or not.

As the protection is almost completely self-monitored, from the measuring inputs to the command output relays, 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”. If there is a fault detected in the external measuring circuits, generally an alarm is given only.

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”.

The reaction to defects and indications given by the relay can be individually and in chronological sequence read off as operational annunciations under the address 5100, for defect diagnosis (refer to Section 6.4.2).

If the relay is connected to a local substation automation system (LSA), defect indications will also be transferred via the serial interface to the central control system.

⚠ Warning

Ensure that the connection modules are not damaged when removing or inserting the device modules! Hazardous voltages may occur when the heavy current plugs are damaged!

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 (address blocks 57 to 59) and comparison with the actual values for checking the analog interfaces.

– Simulation of an internal short-circuit with 4 x I_N for checking the analog input at high currents.

⚠ Warning

Hazardous voltages can be present on all circuits and components connected with the supply voltage or with the measuring and test quantities!

⚠ Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1 for overload capability). Observe a cooling down period!

– Circuit-breaker trip circuits are tested by actual live tripping. Respective notes are given in Section 6.7.9.

7.2 Replacing the back-up battery

The device annunciations are stored in NV–RAMs. A back-up battery is inserted so that they are retained even with a longer failure of the d.c. supply voltage. The back-up battery is also required for the internal system clock with calender to continue in the event of a power supply failure.

The back-up battery should be replaced at the latest after 10 years of operation. The way of displacement depends on the applied battery holder.

Recommended battery:

Lithium battery 3 V/1 Ah, type CR 1/2 AA, e.g.
- VARTA Order No. 6127 501 501 for relays with screwed terminal for the battery,
- VARTA Order No. 6127 101 501 for relays snap-on battery holder.

The battery is located at the rear edge of the processor board of the basic module GEA. The basic module must be removed from the housing in order to replace the battery.

- Prepare area of work: provide conductive surface for the basic module.

- Open housing cover.

- Read out device annunciations, i.e. all addresses which commence with 5 (5000 onwards). This is carried out most convenient using the front operating interface and a personal computer with the DIGSI® protection data processing program; the information is thus stored in the PC.

  Note: All configuration data and settings of the device are stored in EEPROMs protected against switching off of the power supply. They are stored independent of the back-up battery. They are, therefore, neither lost when the battery is replaced nor when the device is operated without a battery.

- **Only for relays with screwed terminal for the battery**: Prepare the battery as in Figure 7.1:

Caution!

Do not short-circuit battery! Do not reverse battery polarities! Do not charge battery!

Shorten the legs to 15 mm (6/10 inch) each and bend over at a length of 40 mm (16/10 inch).

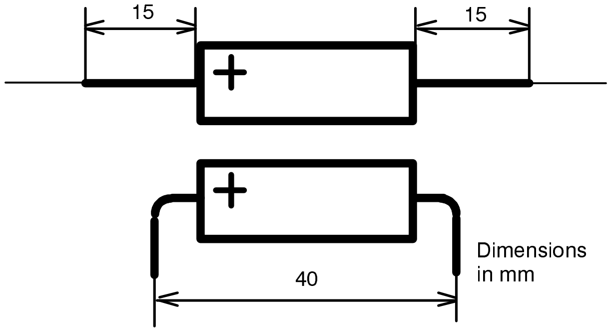


Figure 7.1 Bending the back-up battery for relays with screwed terminal for the battery

Later version do not have axial legs but are snapped on a battery holder.

- Loosen the basic module using the pulling aids provided at the top and bottom. (Figure 7.5).

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)!

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.

- Pull out basic module and place onto the conductive surface.

- Unscrew used battery from the terminals or remove it from the holder; **do not place on the conductive surface!**

- Insert the prepared battery into the terminals or holder as in Figure 7.2 and tighten the screws or as in Figure 7.3.

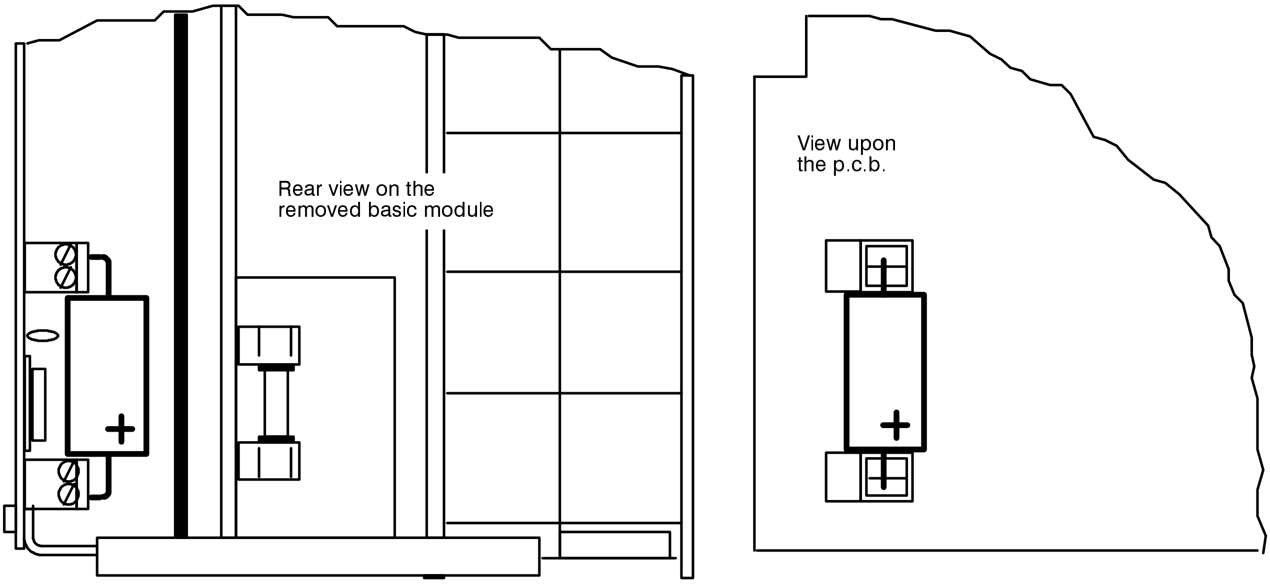


Figure 7.2 Installation of the back-up battery for relays with screwed battery teminals

– Insert basic module into the housing; ensure that the releasing lever is pushed fully to the left before the module is pressed in.

– Firmly push in the module using the releasing lever. (Figure 7.5).

Warning

The discharged battery contains Lithium. It must only be disposed off in line with the applicable regulations!

Do not reverse polarities! Do not recharge! Do not throw into fire! Danger of explosion!

– Provided the internal system clock is not automatically synchronized via the LSA interface, it can now be set or synchronized as described in Section 6.5.1

– Close housing cover.

The replacement of the back-up battery has thus been completed.

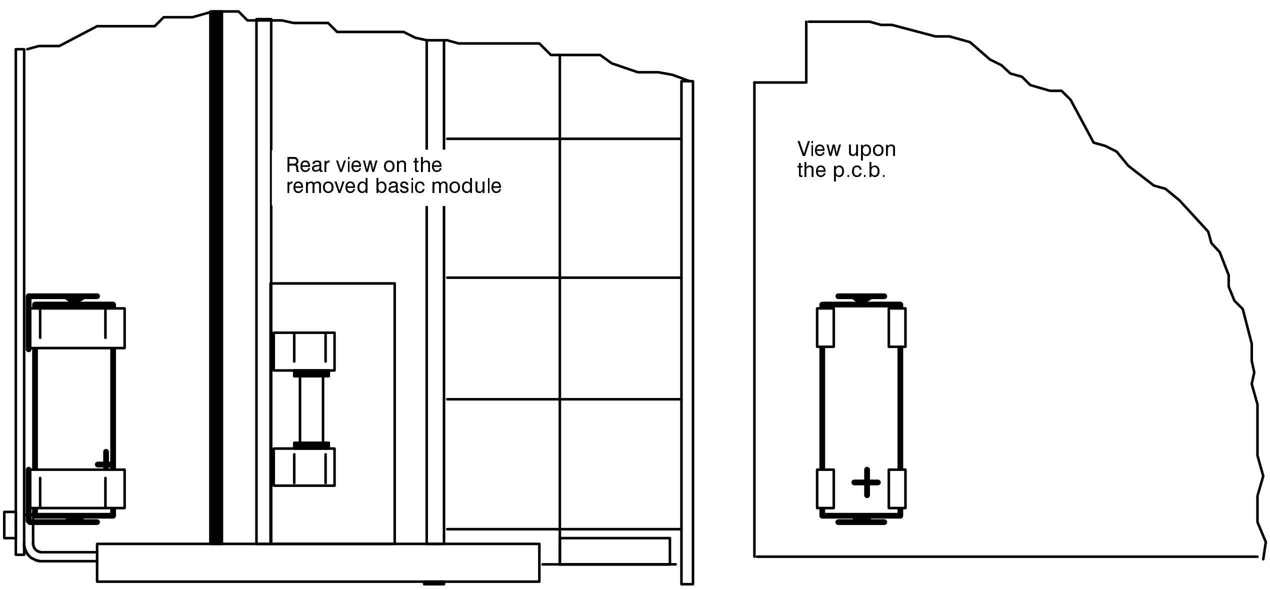


Figure 7.3 Installation of the back-up battery for relays with snap-on battery holder

7.3 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:

– Have the modules been properly pushed-in and locked?

– Is the ON/OFF switch on the front plate in the ON position ⊙ ?

– 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 7.4)? If appropriate, replace the fuse according to Section 7.3.1.

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 if the relay is not equipped with a buffer battery, and, if a parameterizing process has not yet been completed, the last parameters are not stored.

7.3.1 Replacing the mini-fuse

– Select a replacement fuse 5 × 20 mm. Ensure that the rated value, time lag (medium slow) and code letters are correct. (Figure 7.4).

– Prepare area of work: provide conductive surface for the basic module.

– Open housing cover.

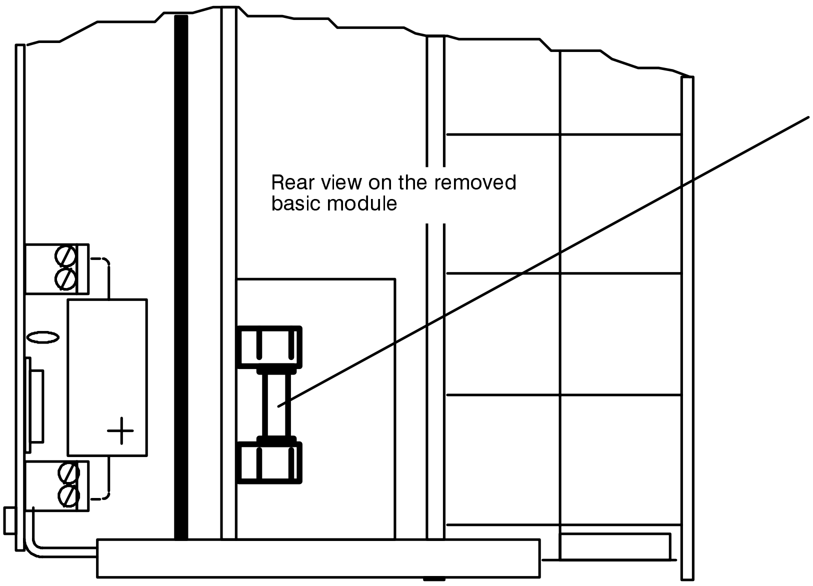
⚠ Warning

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)!

– Loosen the basic module using the pulling aids provided at the top and bottom. (Figure 7.5).

⚠ 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.



Mini-fuse of the power supply; medium slow (M)

at U_{HN}/V–	rated value
24/48	2 A/E
60/110/125	1,6 A/E
220/250	1 A/G

Figure 7.4 Mini-fuse of the power supply

– Pull out basic module and place onto the conductive surface.

– Remove blown fuse from the holder (Figure 7.4).

– Fit new fuse into the holder (Figure 7.4).

– Insert basic module into the housing; ensure that the releasing lever is pushed fully to the left before the module is pressed in (Figure 7.5).

– Firmly push in the module using the releasing lever. (Figure 7.5).

– Close housing cover.

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).

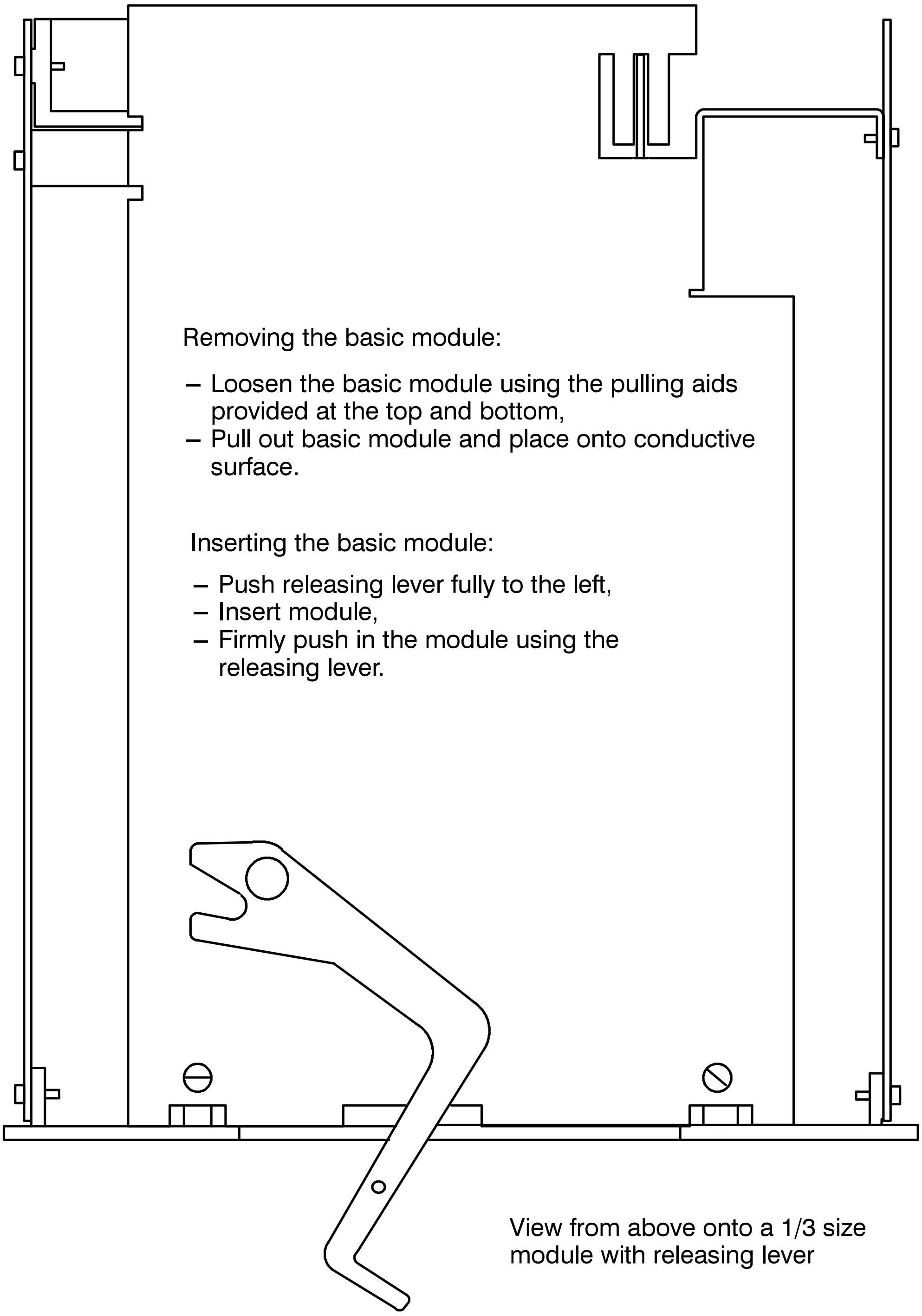


Figure 7.5 Aid for removing and inserting basic module

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 **E**lectrostatically **E**ndangered **C**omponents (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 transport 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 **E**lectrostatically **E**ndangered **C**omponents 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 Connection diagram

C Tables

A General diagrams

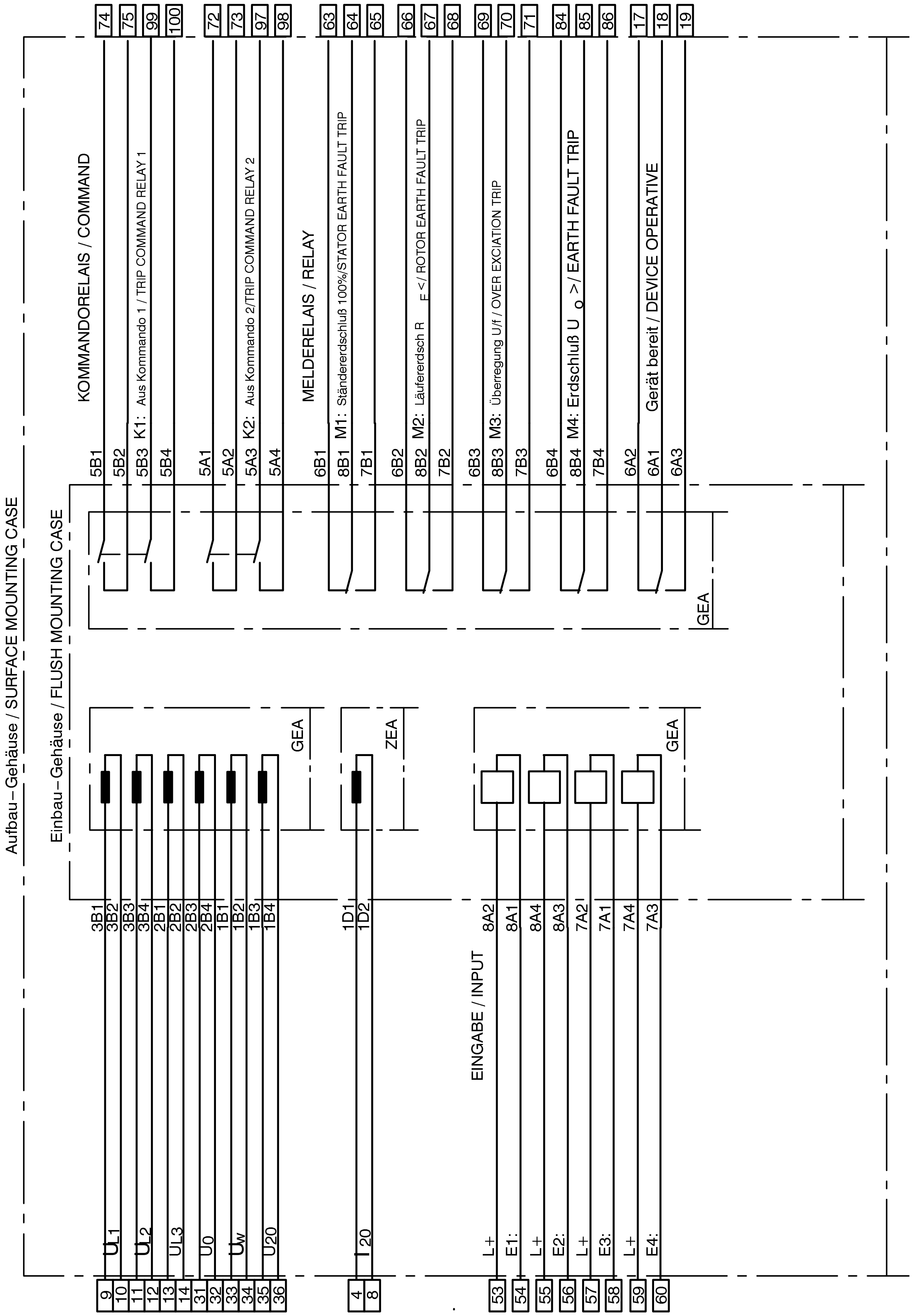


Figure A.1 7UM5150–★★B01–0★A0 (sheet 1)

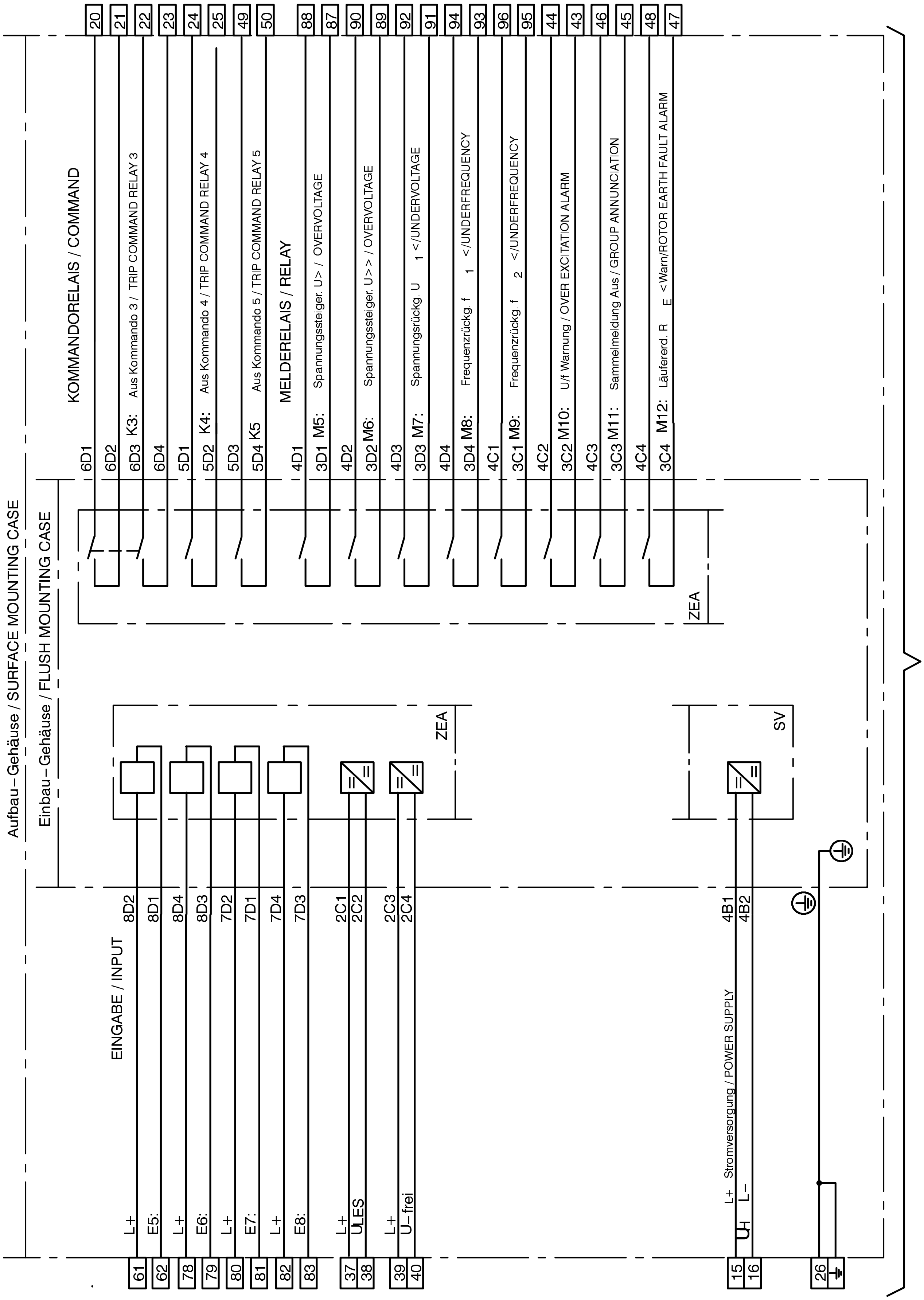
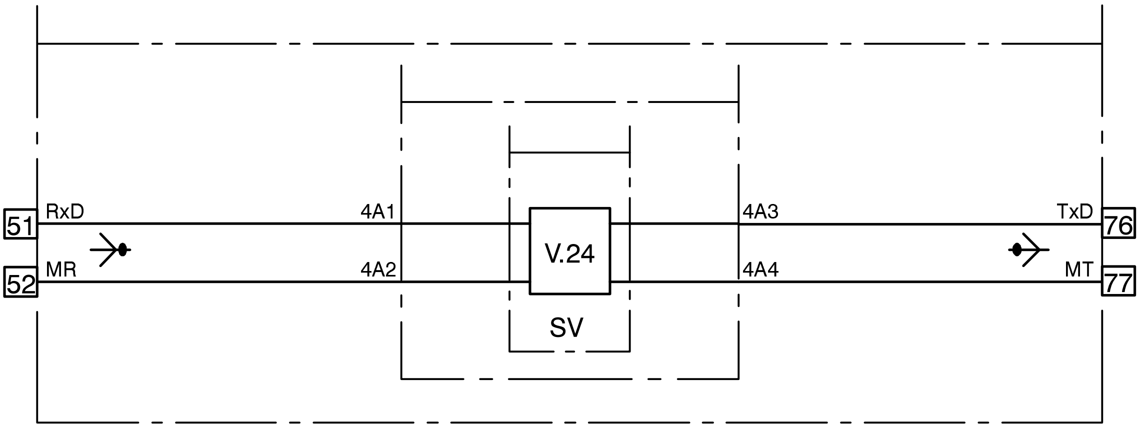
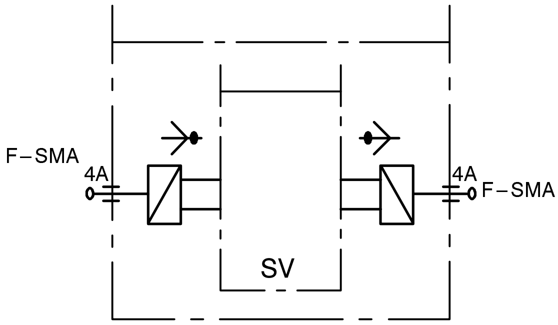


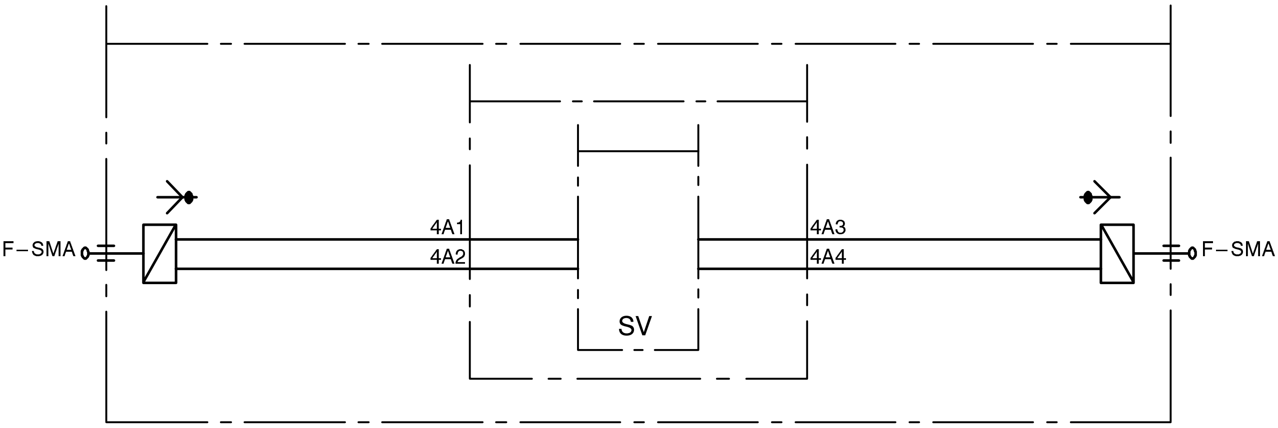
Figure A.2 7UM5150–★★B01–0★A0 (sheet 2)



Einbau- und Aufbaugehäuse mit V24–Schnittstelle
FLUSH AND SURFACE MOUNTING CASE WITH V24 DATA LINK
7UM5150–*BB01–0BA0 /
7UM5150–*CB01–0BA0 /
7UM5150–*EB01–0BA0 /



Einbau- Gehäuse mit LWL–Modul
FLUSH MOUNTING CASE WITH FIBER OPTIC INTERFACE
7UM5150–*CB01–0CA0 /
7UM5150–*EB01–0CA0 /



Aufbau- Gehäuse mit LWL–Modul
SURFACE MOUNTING CASE WITH FIBER OPTIC INTERFACE
7UM5150–*BB01–0CA0 /

Figure A.3 7UM5150–★★B01–0★A0 (sheet 3)

B Connection diagram

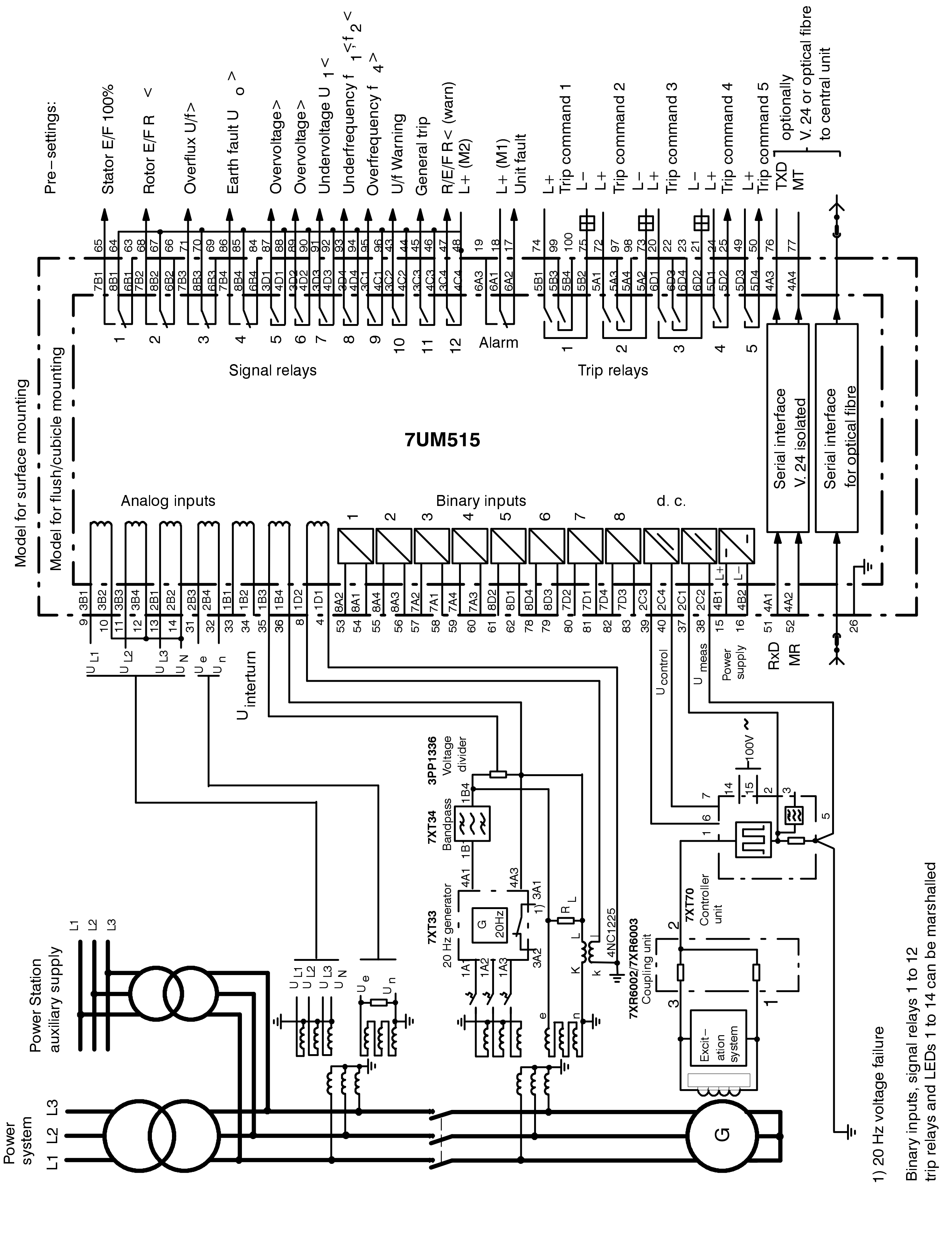


Figure B.1 Connection example 7UM515

C Tables

NOTE: The following tables list all data which are available in the maximum complement of the device. Dependent on the ordered model and configuration, only those data may be present which are valid for the individual version.

NOTE: The actual tables are attached to the purchased relay.

Annunciations 7UM515 for LSA (DIN 19244 and according VDEW/ZVEI)

```
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)
according to VDEW/ZVEI:
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
```

FNo.	Meaning	Ann. Op	Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
11	>User defined annunciation 1	CG		90	CA	GI	BT	p	27
12	>User defined annunciation 2	CG		91	CA	GI	BT	p	28
13	>User defined annunciation 3	CG		92	CA	GI	BT	p	29
14	>User defined annunciation 4	CG		93	CA	GI	BT	p	30
15	>Testing via system-interface	CG						135	53
16	>Block. of monitoring dir. via sys.-int	CG						135	54
51	Device operative / healthy	CG		1		GI		135	81
52	Any protection operative	CG			CA	GI		p	18
55	Re-start of processor system	C		193	CA			p	4
56	Initial start of processor system	C		3	CA			p	5
59	Real time response to LSA	C		192					
60	LED Reset	C		12	CA			p	19
61	Logging and measuring functions blocked	CG			CA	GI		p	20
62	Test mode	CG			CA	GI		p	21
63	PC operation via system interface	CG						135	83
95	Parameters are being set	CG		97	CA	GI		p	22
96	Parameter set A is active	CG		40	CA	GI		p	23
97	Parameter set B is active	CG		41	CA	GI		p	24
98	Parameter set C is active	CG		42	CA	GI		p	25
99	Parameter set D is active	CG		43	CA	GI		p	26
110	Annunciations lost (buffer overflow)	C		195				135	130
112	Annunciations for LSA lost	C		196				135	131
113	Fault tag lost						BT	135	136
140	General internal failure of device	CG			CA	GI		p	47
141	Failure of internal 24 VDC power supply	CG		88		GI		135	161
143	Failure of internal 15 VDC power supply	CG		83		GI		135	163
144	Failure of internal 5 VDC power supply	CG		89		GI		135	164
145	Failure of internal 0 VDC power supply	CG		84		GI		135	165
154	Supervision trip circuit	CG		100	CA	GI		p	36
160	Common alarm	CG			CA	GI		p	46
161	Measured value supervision of currents	CG			CA	GI		p	32
165	Failure: Voltage sum superv. (ph-e)	CG		105		GI		135	184
167	Failure: Voltage symmetry supervision	CG		108		GI		135	186
171	Failure: Phase sequence supervision	CG		111	CA	GI		p	35
204	Fault recording initiated via bin.input			59			BT	135	204
205	Fault recording initiated via keyboard			59			BT	135	205
206	Fault recording initiated via PC interf			59			BT	135	206
301	Fault in the power system		CG	2				135	231
302	Flt. event w. consecutive no.		C					135	232

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
501	General fault detection of device	C		5			BT	150	151
502	General drop-off of device	C		6				150	152
511	General trip of device	C		7			BT	150	161
694	Frequency f [Hz] =	M							
761	Rotor earth resistance	M							
763	Earth current in stator circuit	M							
764	Stator earth resistance	M							
769	Interturn displacement voltage	M							
770	Maximum Phase-Phase voltage	M							
774	Secondary earth voltage U0	M							
907	Positive sequence voltage	M							
933	Secondary voltage UL1E is	M						134	144
934	Secondary voltage UL2E is	M						134	144
935	Secondary voltage UL3E is	M						134	144
936	Secondary earth voltage U0 is	M						134	144
937	Frequency f [Hz] =	M						134	144
938	Positive sequence voltage	M						134	144
948	Operat. meas. temp. of catenary [%]	M						134	144
949	Displacement volt. o.interturn flt.prot	M						134	144
955	Bias voltage of stator circuit	M						134	144
956	Earth current in stator circuit	M						134	144
957	Stator earth resistance	M						134	144
958	Earth current in rotor circuit	M						134	144
959	Rotor earth resistance	M						134	144
960	Overflux referred to rated flux Un/fn	M						134	144
961	Overflux thermal replica	M						134	144
1175	Trip test for trip relay 1 in progress	CG		70		GI		151	90
1176	Trip test for trip relay 2 in progress	CG		71		GI		151	91
1177	Trip test for trip relay 3 in progress	CG		72		GI		151	92
1178	Trip test for trip relay 4 in progress	CG		73		GI		151	93
1179	Trip test for trip relay 5 in progress	CG		74		GI		151	94
4523	>Block external trip 1	CG				GI		51	123
4526	>Trigger external trip 1	CG		65		GI		51	126
4531	External trip 1 is switched off	CG		21		GI		51	131
4532	External trip 1 is blocked	CG		60		GI		51	132
4533	External trip 1 is active	CG		31		GI		51	133
4536	External trip 1: General fault det.		CG	200			BT	51	136
4537	External trip 1: General trip		C	244			BT	51	137
4543	>Block external trip 2	CG				GI		51	143
4546	>Trigger external trip 2	CG		66		GI		51	146
4551	External trip 2 is switched off	CG		22		GI		51	151
4552	External trip 2 is blocked	CG		61		GI		51	152
4553	External trip 2 is active	CG		32		GI		51	153
4556	External trip 2: General fault det.		CG	201			BT	51	156
4557	External trip 2: General trip		C	245			BT	51	157
4563	>Block external trip 3	CG				GI		51	163
4566	>Trigger external trip 3	CG		67		GI		51	166
4571	External trip 3 is switched off	CG		23		GI		51	171
4572	External trip 3 is blocked	CG		62		GI		51	172
4573	External trip 3 is active	CG		33		GI		51	173
4576	External trip 3: General fault det.		CG	202			BT	51	176
4577	External trip 3: General trip		C	246			BT	51	177
4583	>Block external trip 4	CG				GI		51	183
4586	>Trigger external trip 4	CG		68		GI		51	186
4591	External trip 4 is switched off	CG		24		GI		51	191
4592	External trip 4 is blocked	CG		63		GI		51	192
4593	External trip 4 is active	CG		34		GI		51	193

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
4596	External trip 4: General fault det.		CG	203			BT	51	196
4597	External trip 4: General trip		C	247			BT	51	197
5002	Suitable measured quantities present	CG		45		GI		71	2
5004	>Phase rotation counter-clockwise	CG				GI		71	4
5005	Phase rotation is clockwise	C						71	5
5006	Phase rotation is counter-clockwise	C						71	6
5173	>Block stator earth fault protection	CG				GI		70	151
5181	Stator earth fault prot. is switch off	CG		29		GI		70	156
5182	Stator earth fault protection is block.	CG		57		GI		70	157
5183	Stator earth fault protection is active	CG		39		GI		70	158
5186	Stator earth fault: Fault detection U0		CG	216			BT	70	159
5187	Stator earth fault: Trip U0 stage		C	237			BT	70	160
5203	>Block frequency protection	CG				GI		70	176
5206	>Block frequency prot. f1 stage	CG				GI		70	177
5207	>Block frequency prot. f2 stage	CG				GI		70	178
5208	>Block frequency prot. f3 stage	CG				GI		70	179
5209	>Block frequency prot. f4 stage	CG				GI		70	180
5211	Frequency protection is switched off	CG		119		GI		70	181
5212	Frequency protection is blocked	CG		139		GI		70	182
5213	Frequency protection is active	CG		129		GI		70	183
5214	Frequency protection blocked by U<	CG				GI		70	184
5216	Frequency protection: Fault stage f1>		CG	170			BT	70	185
5217	Frequency protection: Fault stage f1<		CG	171			BT	70	186
5218	Frequency protection: Fault stage f2>		CG	172			BT	70	187
5219	Frequency protection: Fault stage f2<		CG	173			BT	70	188
5220	Frequency protection: Fault stage f3>		CG	174			BT	70	189
5221	Frequency protection: Fault stage f3<		CG	175			BT	70	190
5222	Frequency protection: Fault stage f4>		CG	176			BT	70	191
5223	Frequency protection: Fault stage f4<		CG	177			BT	70	192
5224	Frequency protection: Trip stage f1>		C	180			BT	70	193
5225	Frequency protection: Trip stage f1<		C	181			BT	70	194
5226	Frequency protection: Trip stage f2>		C	182			BT	70	195
5227	Frequency protection: Trip stage f2<		C	183			BT	70	196
5228	Frequency protection: Trip stage f3>		C	184			BT	70	197
5229	Frequency protection: Trip stage f3<		C	185			BT	70	198
5230	Frequency protection: Trip stage f4>		C	186			BT	70	199
5231	Frequency protection: Trip stage f4<		C	187			BT	70	200
5353	>Block overexcitation protection	CG				GI		71	81
5356	>Reset memory of thermal replica U/f	CG				GI		71	82
5361	Overexcitation prot. is swiched off	CG		155		GI		71	83
5362	Overexcitation prot. is blocked	CG		143		GI		71	84
5363	Overexcitation prot. is active	CG		94		GI		71	85
5367	Overexc. prot.: U/f warning stage	CG		159		GI		71	86
5368	Overexc. prot.: th. warning stage	CG		160		GI		71	87
5369	Reset memory of thermal replica U/f	CG		56		GI		71	88
5370	Overexc. prot.: Fault detec. U/f>		CG	162			BT	71	89
5371	Overexc. prot.: Trip of U/f> stage		C	165			BT	71	90
5372	Overexc. prot.: Trip of th. stage		C	166			BT	71	91
5383	>Block rotor earth fault protection	CG				GI		71	113
5386	>Activate test operation via BI	CG				GI		71	116
5391	Rotor earth fault prot. is switched off	CG		144		GI		71	121
5392	Rotor earth fault prot. is blocked	CG		150		GI		71	122
5393	Rotor earth fault prot. is active	CG		147		GI		71	123
5395	Open circuit meas. circuit R/E/F	CG		98		GI		71	125
5396	Failure rotor earth fault protection	CG		99		GI		71	126
5397	Rotor earth fault prot.: Warning stage	CG		18		GI		71	127
5398	Rotor earth fault prot.: Fault detec.		CG	227			BT	71	128

		Ann.		LSA	VDEW/ZVEI				
FNo.	Meaning	Op	Ft	No.	CA	GI	BT	Typ	Inf
5399	Rotor earth fault prot.: Trip		C	229			BT	71	129
5402	Failure rotating meas. value transm.	CG		113		GI		71	132
5404	R/E/F warning stage during test	CG		69		GI		71	134
5405	R/E/F Trip during test operation	C		194			BT	71	135
5413	>Block interturn fault protection	CG				GI		71	141
5421	Interturn fault prot. is swiched off	CG		156		GI		71	142
5422	Interturn fault prot. is blocked	CG		64		GI		71	143
5423	Interturn fault prot. is active	CG		95		GI		71	144
5426	Interturn fault prot.: Fault detec.		CG	163			BT	71	145
5427	Interturn fault prot.: Trip		C	167			BT	71	146
5473	>Block Stator earth fault protection	CG				GI		71	226
5476	>Failure 20Hz bias voltage (S/E/F)	CG				GI		71	227
5481	S/E/F protection is switched off	CG		157		GI		71	228
5482	Stator earth fault prot. is blocked	CG		58		GI		71	229
5483	Stator earth fault prot. is active	CG		96		GI		71	230
5486	Failure stator earth fault protection	CG		103		GI		71	231
5487	Stator earth fault prot. warning stage	CG		161		GI		71	232
5488	Stator earth fault prot.: Fault detec.		CG	164			BT	71	233
5489	Stator earth fault prot.: Trip		C	168			BT	71	234
6506	>Block undervoltage protection U< stage	CG				GI		74	6
6513	>Block overvoltage protection	CG				GI		74	13
6530	Undervoltage protection is switched off	CG		121		GI		74	30
6531	Undervoltage protection is blocked	CG		141		GI		74	31
6532	Undervoltage protection is active	CG		131		GI		74	32
6533	Undervoltage fault detection U<		CG	219			BT	74	33
6539	Undervoltage protection, U< trip		C	241			BT	74	39
6565	Overvoltage protection is switched off	CG		122		GI		74	65
6566	Overvoltage protection is blocked	CG		142		GI		74	66
6567	Overvoltage protection is active	CG		132		GI		74	67
6568	Overvoltage fault detection U>		CG	217			BT	74	68
6570	Overvoltage protection U> trip		C	239			BT	74	70
6571	Overvoltage prot. fault detec. U>>		CG	218			BT	74	71
6573	Overvoltage protection U>> trip		C	240			BT	74	73
6872	>Trip circuit superv. trip relay 1	CG				GI		153	10
6873	>Trip circuit superv. CBaux 1	CG				GI		153	11
6879	Failure trip circuit 1	CG		101		GI		153	12
6892	>Trip circuit superv. trip relay 2	CG				GI		153	13
6893	>Trip circuit superv. CBaux 2	CG				GI		153	14
6899	Failure trip circuit 2	CG		102		GI		153	15

Annunciations 7UM515 for PC, LC-display and binary inputs/outputs

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FNo.   - Function number of annunciation
Op/Ft  - Operation/Fault annunciation
         C/CG: Coming/Coming and Going annunciation
         M   : Measurand
E      - Earth fault annunciation
IOT    - I: can be marshalled to binary input
         O: can be marshalled to binary output (LED, signal relay)
         T: can be marshalled to trip relay
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FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
3	>Time Synchro	>Time synchronization				IO
4	>Start FltRec	>Start fault recording	C			IO
5	>LED reset	>Reset LED indicators				IO
7	>ParamSelec.1	>Parameter set selection 1 (with No.8)				IO
8	>ParamSelec.2	>Parameter set selection 2 (with No.7)				IO
11	>Annunc. 1	>User defined annunciation 1	CG			IOT
12	>Annunc. 2	>User defined annunciation 2	CG			IOT
13	>Annunc. 3	>User defined annunciation 3	CG			IOT
14	>Annunc. 4	>User defined annunciation 4	CG			IOT
15	>Sys-Test	>Testing via system-interface	CG			IO
16	>Sys-MM-block	>Block. of monitoring dir. via sys.-int	CG			IO
51	Dev.operative	Device operative / healthy	CG			O
52	Prot. operat.	Any protection operative	CG			O
56	Initial start	Initial start of processor system	C			
60	LED reset	LED Reset	C			O
61	LogMeasBlock	Logging and measuring functions blocked	CG			
62	Test mode	Test mode	CG			
95	Param.running	Parameters are being set	CG			O
96	Param. Set A	Parameter set A is active	CG			O
97	Param. Set B	Parameter set B is active	CG			O
98	Param. Set C	Parameter set C is active	CG			O
99	Param. Set D	Parameter set D is active	CG			O
100	Wrong SW-vers	Wrong software-version	C			
101	Wrong dev. ID	Wrong device identification	C			
110	Annunc. lost	Annunciations lost (buffer overflow)	C			
111	Annu. PC lost	Annunciations for PC lost	C			
115	Flt.Buff.Over	Fault annunciation buffer overflow		C		
120	Oper.Ann.Inva	Operational annunciations invalid	CG			
121	Flt.Ann.Inval	Fault annunciations invalid	CG			
124	LED Buff.Inva	LED annunciation buffer invalid	CG			
129	VDEW-StateInv	VDEW state invalid	CG			
135	Chs Error	Error in check sum	CG			
136	Chs.A Error	Error in check sum for parameter set A	CG			
137	Chs.B Error	Error in check sum for parameter set B	CG			
138	Chs.C Error	Error in check sum for parameter set C	CG			
139	Chs.D Error	Error in check sum for parameter set D	CG			
141	Failure 24V	Failure of internal 24 VDC power supply	CG			O
143	Failure 15V	Failure of internal 15 VDC power supply	CG			O
144	Failure 5V	Failure of internal 5 VDC power supply	CG			O
145	Failure 0V	Failure of internal 0 VDC power supply	CG			O
154	Fail. TripRel	Supervision trip circuit	CG			
159	LSA disrupted	LSA (system interface) disrupted	CG			
161	I supervision	Measured value supervision of currents				O

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
165	Failure ∑Up-e	Failure: Voltage sum superv. (ph-e)	CG			O
167	Failure Usymm	Failure: Voltage symmetry supervision	CG			O
171	Fail.PhaseSeq	Failure: Phase sequence supervision	CG			O
203	Flt.RecDatDel	Fault recording data deleted	C			
204	Flt.Rec.viaBI	Fault recording initiated via bin.input	C			
205	Flt.Rec.viaKB	Fault recording initiated via keyboard	C			
206	Flt.Rec.viaPC	Fault recording initiated via PC interf	C			
244	D Time=	Diff. time of clock synchronism	M			
301	Syst.Flt	Fault in the power system	CG	C		
302	Fault	Flt. event w. consecutive no.		C		
501	Device FltDet	General fault detection of device		C		
502	Dev. Drop-off	General drop-off of device		C		O
511	Device Trip	General trip of device		C		
545	T-Drop	Time from fault detection to drop-off				
546	T-Trip	Time from fault detection to trip				
671	UL1E=	Voltage UL1E =	M			
672	UL2E=	Voltage UL2E =	M			
673	UL3E=	Voltage UL3E =	M			
694	f [Hz]=	Frequency f [Hz] =	M			
756	Tg=	Period of square-wave oscillator	M			
757	Ug=	Voltage of square-wave oscillator	M			
758	Ig=	Meas. current of rotor earth flt. prot.	M			
759	Qc=	Charge at polarity reversal	M			
760	Rse p=	Primary stator earth resistance	M			
761	R-REF=	Rotor earth resistance	M			
762	U-SEF=	Bias voltage for stator circuit	M			
763	I-SEF=	Earth current in stator circuit	M			
764	R-SEF=	Stator earth resistance	M			
765	U/f =	Overflux (U/Un) / (f/fn)	M			
766	U/f th=	Calculated temperature (U/f)	M			
767	Th.loss.=	Thermal losses	M			
769	Ui/t=	Interturn displacement voltage	M			
770	UL-Lmax=	Maximum Phase-Phase voltage	M			
771	UL1E =	Secondary voltage UL1E is	M			
772	UL2E =	Secondary voltage UL2E is	M			
773	UL3E =	Secondary voltage UL3E is	M			
774	U0 =	Secondary earth voltage U0	M			
907	Upos.seq=	Positive sequence voltage	M			
1175	Test Trip 1	Trip test for trip relay 1 in progress	CG			
1176	Test Trip 2	Trip test for trip relay 2 in progress	CG			
1177	Test Trip 3	Trip test for trip relay 3 in progress	CG			
1178	Test Trip 4	Trip test for trip relay 4 in progress	CG			
1179	Test Trip 5	Trip test for trip relay 5 in progress	CG			
4523	>Ext 1 block	>Block external trip 1				IO
4526	>Ext trip 1	>Trigger external trip 1	CG			IO
4531	Ext 1 off	External trip 1 is switched off	CG			O
4532	Ext 1 blocked	External trip 1 is blocked	CG			O
4533	Ext 1 active	External trip 1 is active	CG			O
4536	Ext 1 Gen.Flt	External trip 1: General fault det.		CG		O
4537	Ext 1 Gen.Trp	External trip 1: General trip		C		OT
4543	>Ext 2 block	>Block external trip 2				IO
4546	>Ext trip 2	>Trigger external trip 2	CG			IO
4551	Ext 2 off	External trip 2 is switched off	CG			O
4552	Ext 2 blocked	External trip 2 is blocked	CG			O
4553	Ext 2 active	External trip 2 is active	CG			O

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
4556	Ext 2 Gen.Flt	External trip 2: General fault det.		CG		O
4557	Ext 2 Gen.Trp	External trip 2: General trip		C		OT
4563	>Ext 3 block	>Block external trip 3				IO
4566	>Ext trip 3	>Trigger external trip 3	CG			IO
4571	Ext 3 off	External trip 3 is switched off	CG			O
4572	Ext 3 blocked	External trip 3 is blocked	CG			O
4573	Ext 3 active	External trip 3 is active	CG			O
4576	Ext 3 Gen.Flt	External trip 3: General fault det.		CG		O
4577	Ext 3 Gen.Trp	External trip 3: General trip		C		OT
4583	>Ext 4 block	>Block external trip 4				IO
4586	>Ext trip 4	>Trigger external trip 4	CG			IO
4591	Ext 4 off	External trip 4 is switched off	CG			O
4592	Ext 4 blocked	External trip 4 is blocked	CG			O
4593	Ext 4 active	External trip 4 is active	CG			O
4596	Ext 4 Gen.Flt	External trip 4: General fault det.		CG		O
4597	Ext 4 Gen.Trp	External trip 4: General trip		C		OT
5002	Operat. Cond.	Suitable measured quantities present	CG			O
5004	>Phase rotat.	>Phase rotation counter-clockwise	CG			IO
5005	Clockwise	Phase rotation is clockwise	C			O
5006	Counter-clock	Phase rotation is counter-clockwise	C			O
5173	>U0> block	>Block stator earth fault protection				IO
5181	U0> off	Stator earth fault prot. is switch off	CG			O
5182	U0> blocked	Stator earth fault protection is block.	CG			O
5183	U0> active	Stator earth fault protection is active	CG			O
5186	U0> Fault	Stator earth fault: Fault detection U0		CG		O
5187	U0> Trip	Stator earth fault: Trip U0 stage		C		OT
5203	>Frq. block	>Block frequency protection				IO
5206	>f1 block	>Block frequency prot. f1 stage	CG			IO
5207	>f2 block	>Block frequency prot. f2 stage	CG			IO
5208	>f3 block	>Block frequency prot. f3 stage	CG			IO
5209	>f4 block	>Block frequency prot. f4 stage	CG			IO
5211	FRQ off	Frequency protection is switched off	CG			O
5212	FRQ blocked	Frequency protection is blocked	CG			O
5213	FRQ active	Frequency protection is active	CG			O
5214	FRQ U< block	Frequency protection blocked by U<	CG			O
5216	f1> Fault	Frequency protection: Fault stage f1>		CG		O
5217	f1< Fault	Frequency protection: Fault stage f1<		CG		O
5218	f2> Fault	Frequency protection: Fault stage f2>		CG		O
5219	f2< Fault	Frequency protection: Fault stage f2<		CG		O
5220	f3> Fault	Frequency protection: Fault stage f3>		CG		O
5221	f3< Fault	Frequency protection: Fault stage f3<		CG		O
5222	f4> Fault	Frequency protection: Fault stage f4>		CG		O
5223	f4< Fault	Frequency protection: Fault stage f4<		CG		O
5224	f1> Trip	Frequency protection: Trip stage f1>		C		OT
5225	f1< Trip	Frequency protection: Trip stage f1<		C		OT
5226	f2> Trip	Frequency protection: Trip stage f2>		C		OT
5227	f2< Trip	Frequency protection: Trip stage f2<		C		OT
5228	f3> Trip	Frequency protection: Trip stage f3>		C		OT
5229	f3< Trip	Frequency protection: Trip stage f3<		C		OT
5230	f4> Trip	Frequency protection: Trip stage f4>		C		OT
5231	f4< Trip	Frequency protection: Trip stage f4<		C		OT
5353	>U/f block	>Block overexcitation protection				IO
5356	>RM th.repl.	>Reset memory of thermal replica U/f				IO
5361	U/f> off	Overexcitation prot. is swiched off	CG			O
5362	U/f> blocked	Overexcitation prot. is blocked	CG			O
5363	U/f> active	Overexcitation prot. is active	CG			O
5367	U/f> warn	Overexc. prot.: U/f warning stage	CG			O
5368	U/f> th.warn	Overexc. prot.: th. warning stage	CG			O

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
5369	RM th. repl.	Reset memory of thermal replica U/f	CG			O
5370	U/f> Fault	Overexc. prot.: Fault detec. U/f>		CG		O
5371	U/f> Trip	Overexc. prot.: Trip of U/f> stage		C		OT
5372	U/f> th.Trip	Overexc. prot.: Trip of th. stage		C		OT
5383	>R/E/F block	>Block rotor earth fault protection				IO
5386	>Test R/E/F	>Activate test operation via BI	CG			IO
5391	R/E/F off	Rotor earth fault prot. is switched off	CG			O
5392	R/E/F blocked	Rotor earth fault prot. is blocked	CG			O
5393	R/E/F active	Rotor earth fault prot. is active	CG			O
5395	R/E/F open	Open circuit meas. circuit R/E/F	CG			O
5396	Failure R/E/F	Failure rotor earth fault protection	CG			O
5397	R/E/F Warn	Rotor earth fault prot.: Warning stage	CG			O
5398	R/E/F Fault	Rotor earth fault prot.: Fault detec.		CG		O
5399	R/E/F Trip	Rotor earth fault prot.: Trip		C		OT
5402	Failure RMT	Failure rotating meas. value transm.	CG			O
5404	Test REF warn	R/E/F warning stage during test	CG			O
5405	Test REF Trip	R/E/F Trip during test operation	C			O
5413	>I/T block	>Block interturn fault protection				IO
5421	I/T off	Interturn fault prot. is swiched off	CG			O
5422	I/T blocked	Interturn fault prot. is blocked	CG			O
5423	I/T active	Interturn fault prot. is active	CG			O
5426	I/T Fault	Interturn fault prot.: Fault detec.		CG		O
5427	I/T Trip	Interturn fault prot.: Trip		C		OT
5473	>SEF block	>Block Stator earth fault protection				IO
5476	>U20 failure	>Failure 20Hz bias voltage (S/E/F)	CG			IO
5481	S/E/F off	S/E/F protection is switched off	CG			O
5482	S/E/F blocked	Stator earth fault prot. is blocked	CG			O
5483	S/E/F active	Stator earth fault prot. is active	CG			O
5486	Failure S/E/F	Failure stator earth fault protection	CG			O
5487	S/E/F warn	Stator earth fault prot. warning stage	CG			O
5488	S/E/F Fault	Stator earth fault prot.: Fault detec.		CG		O
5489	S/E/F Trip	Stator earth fault prot.: Trip		C		OT
6506	>U< block	>Block undervoltage protection U< stage				IO
6513	>o/v block	>Block overvoltage protection				IO
6530	U< off	Undervoltage protection is switched off	CG			O
6531	U< blocked	Undervoltage protection is blocked	CG			O
6532	U< active	Undervoltage protection is active	CG			O
6533	U< Fault	Undervoltage fault detection U<		CG		O
6539	U< Trip	Undervoltage protection, U< trip		C		OT
6565	o/v off	Overvoltage protection is switched off	CG			O
6566	o/v blk	Overvoltage protection is blocked	CG			O
6567	o/v active	Overvoltage protection is active	CG			O
6568	U> Fault	Overvoltage fault detection U>		CG		O
6570	U> Trip	Overvoltage protection U> trip		C		OT
6571	U>> Fault	Overvoltage prot. fault detec. U>>		CG		O
6573	U>> Trip	Overvoltage protection U>> trip		C		OT
6872	>Trip rel 1	>Trip circuit superv. trip relay 1				IO
6873	>CBaux 1	>Trip circuit superv. CBaux 1				IO
6879	Failure Trip1	Failure trip circuit 1	CG			O
6892	>Trip rel 2	>Trip circuit superv. trip relay 2				IO
6893	>CBaux 2	>Trip circuit superv. CBaux 2				IO
6899	Failure Trip2	Failure trip circuit 2	CG			O

Reference Table for Functional Parameters 7UM515

```
1000 PARAMETERS
_______________________________________________________________________

1100 MACHINE & POWERSYSTEM DATA

1103 POWER                   Rated apparent power of the machine
     min. 0.1                MVA
     max. 2000.0      ____

1104 COS PHI                 Rated power factor of the machine
     min. 0.000
     max. 1.000       ____

1105 In                      Rated current of the machine
     min. 0.050              kA
     max. 50.000      ____

1106 Un                      Rated voltage of the machine (phase-phase)
     min. 0.30               kV
     max. 100.00      ____
_______________________________________________________________________

1200 INSTRUMENT TRANSFORMER DATA

1202 UN VT PRIM              Primary rated VT current
     min. 0.30               kV
     max. 50.00       ____

1204 Un SECOND.              Secondary rated voltage
     min. 100                V
     max. 125         ____

1205 VT DELTA                VT for open delta winding connected
     CONNECTED           [ ] Connected
     NOT CONNECTED       [ ] Not connected

1206 Uph/Udelta              Matching factor for open delta voltage
     min. -9.99
     max. 9.99        ____
_______________________________________________________________________

1300 OVERFLUX PROTECTION U/f

1301 U/f PROT.               State of the overflux protection
     OFF                 [ ] off
     ON                  [ ] on
     BLOCK TRIP REL      [ ] Block trip relay

1302 U/f>                    Pick-up value of the definite time stage
     min. 1.00
     max. 1.50        ____

1303 T-U/f>                  Time delay of the definite time stage
     min. 0.00               s
     max. 32.00/∞     ____
```

```
1304 T-RESET                  Reset delay after trip (definite stage)
     min. 0.00                s
     max. 32.00         _____

1305 WARN THERM               Thermal warning stage in % of trip temperature
     min. 70                  %
     max. 99            _____

1306 T-WARN                   Delay time of the warning stage
     min. 0.00                s
     max. 32.00         _____

1307 TIME MULT.               Time multiplier for U/f time characteristic
     min. 1
     max. 8             _____

1308 U/f   (1)                1st characteristic value of overflux U/f
     min. 1.02
     max. 1.60          _____

1309 T-U/f (1)                Time delay T of 1st characteristic value
     min. 1                   s
     max. 98/∞          _____

1310 U/f   (2)                2nd characteristic value of overflux U/f
     min. 1.02
     max. 1.60          _____

1311 T-U/f (2)                Time delay T of 1st characteristic value
     min. 1                   s
     max. 98            _____

1312 U/f   (3)                3rd characteristic value of overflux U/f
     min. 1.02
     max. 1.60          _____

1313 T-U/f (3)                Time delay T of 1st characteristic value
     min. 1                   s
     max. 98            _____

1314 U/f   (4)                4th characteristic value of overflux U/f
     min. 1.02
     max. 1.60          _____

1315 T-U/f (4)                Time delay T of 1st characteristic value
     min. 1                   s
     max. 98            _____

1316 U/f   (5)                5th characteristic value of overflux U/f
     min. 1.02
     max. 1.60          _____

1317 T-U/f (5)                Time delay T of 1st characteristic value
     min. 1                   s
     max. 98            _____

1318 U/f   (6)                6th characteristic value of overflux U/f
     min. 1.02
     max. 1.60          _____
```

```
1319 T-U/f (6)              Time delay T of 1st characteristic value
     min. 1                 s
     max. 98          ____

1320 U/f BASE               Base value of thermal overflux U/f
     min. 0.00
     max. 1.00        ____
```

```
1600 UNDER VOLTAGE

1601 UNDERVOLT.             State of the undervoltage protection
     OFF               [ ] off
     ON                [ ] on
     BLOCK TRIP REL    [ ] Block trip relay

1602 U<   (1)               1st characteristic value of U<(t) char.
     min. 20                V
     max. 100         ____

1603 T-U< (1)               Time delay of 1st characteristic value
     min. 0.00              s
     max. 32.00/∞     ____

1604 U<   (2)               2nd characteristic value of U<(t) char.
     min. 20                V
     max. 100         ____

1605 T-U< (2)               Time delay of 2nd characteristic value
     min. 0.00              s
     max. 32.00/∞     ____

1606 U<   (3)               3rd characteristic value of U<(t) char.
     min. 20                V
     max. 100         ____

1607 T-U< (3)               Time delay of 3rd characteristic value
     min. 0.00              s
     max. 32.00/∞     ____

1608 U<   (4)               4th characteristic value of U<(t) char.
     min. 20                V
     max. 100         ____

1609 T-U< (4)               Time delay of 4th characteristic value
     min. 0.00              s
     max. 32.00/∞     ____

1610 U<   (5)               5th characteristic value of U<(t) char.
     min. 20                V
     max. 100         ____

1611 T-U< (5)               Time delay of 5th characteristic value
     min. 0.00              s
     max. 32.00/∞     ____

1612 U<   (6)               6th characteristic value of U<(t) char.
     min. 20                V
     max. 100         ____
```

```
1613 T-U< (6)              Time delay of 6th characteristic value
     min. 0.00             s
     max. 32.00/∞      ____

1614 T-RESET               Reset delay after trip
     min. 0.00             s
     max. 32.00        ____
```

```
1700 OVER VOLTAGE

1701 OVERVOLT.             State of the overvoltage protection
     OFF               [ ] off
     ON                [ ] on
     BLOCK TRIP REL    [ ] Block trip relay

1702 U>                    Pick-up value of the U> stage
     min. 30               V
     max. 180          ____

1703 U>>                   Pick-up value of the U>> stage
     min. 30               V
     max. 180          ____

1704 T-U>                  Time delay for trip U>
     min. 0.00             s
     max. 32.00/∞      ____

1705 T-U>>                 Time delay for trip U>>
     min. 0.00             s
     max. 32.00/∞      ____

1706 T-RESET               Reset delay after trip
     min. 0.00             s
     max. 32.00        ____
```

```
1800 STATOR E/F 100% PROTECTION

1801 STATOR E/F            State of the stator earth fault protection
     OFF               [ ] off
     ON                [ ] on
     BLOCK TRIP REL    [ ] Block trip relay

1802 S/E/F R<              Pick-up value of the warning stage S/E/F
     min. 20               Ω
     max. 500          ____

1803 T-R<                  Time delay of the warning stage
     min. 0.00             s
     max. 32.00/∞      ____

1804 S/E/F R<<             Pick-up value of the tripping stage S/E/F
     min. 10               Ω
     max. 300          ____

1805 T-R<<                 Time delay of the tripping stage S/E/F
     min. 0.00             s
     max. 32.00/∞      ____
```

```
1806 S/E/F I>>                Pick-up value of current tripping stage
     min. 0.02                A
     max. 0.80        ____

1807 T-RESET                  Reset delay after trip
     min. 0.00                s
     max. 32.00       ____

1808 BLOCK U20                Pick-up value of 20Hz undervolt. blocking
     min. 0.3                 V
     max. 15.0        ____

1809 BLOCK I20                Pick-up value of 20Hz undercurr. blocking
     min. 5                   mA
     max. 40          ____

1810 CT ANG. W1               Correction angle CT W1 (slope)
     min. -30                 °
     max. 30          ____

1811 S/E/F-FACT               Transformation factor for earthing resistance
     min. 1.0
     max. 200.0       ____
```

```
1900 EARTH FAULT U0>

1901 SEF PROT.                State of the stator earth fault prot. 90%
     OFF                  [ ] off
     ON                   [ ] on
     BLOCK TRIP REL       [ ] Block trip relay

1902 U0>                      Pick-up value of displacement voltage U0>
     min. 5.0                 V
     max. 100.0       ____

1903 T-U0>                    Time delay for trip
     min. 0.00                s
     max. 32.00/∞     ____

1904 T-RESET                  Reset delay after trip
     min. 0.00                s
     max. 32.00       ____
```

```
2100 OVER/UNDER FREQUENCY

2101 f> / f<                  State of the frequency protection
     OFF                  [ ] off
     ON                   [ ] on
     BLOCK TRIP REL       [ ] Block trip relay

2102 f STAGE 1                Pick-up value for stage f1
     min. 40.00               Hz
     max. 65.00       ____

2103 MEA.REP.f1               Number of meas. repetitions stage f1
     min. 2
     max. 10000       ____
```

```
2104 f STAGE 2              Pick-up value for stage f2
     min. 40.00             Hz
     max. 65.00       ____

2105 MEA.REP.f2             Number of meas. repetitions stage f2
     min. 2
     max. 10000       ____

2106 f STAGE 3              Pick-up value for stage f3
     min. 40.00             Hz
     max. 65.00       ____

2107 MEA.REP.f3             Number of meas. repetitions stage f3
     min. 2
     max. 10000       ____

2108 f STAGE 4              Pick-up value for stage f4
     min. 40.00             Hz
     max. 65.00       ____

2109 MEA.REP.f4             Number of meas. repetitions stage f4
     min. 2
     max. 10000       ____

2110 BLOCK. U<              Minimum operating voltage for frequency prot.
     min. 40                V
     max. 100         ____
```

```
2900 MEAS.VALUE SUPERVISION

2901 M.V.SUPERV             State of measured values supervision
     OFF                [ ] off
     ON                 [ ] on

2902 SYM.Uthres             Symmetry threshold for voltage monitoring
     min. 10                V
     max. 100         ____

2903 SYM.Fact.U             Symmetry factor for voltage monitoring
     min. 0.58
     max. 0.95        ____

2904 SUM.Uthres             Voltage threshold for voltage summation
     min. 10                V
     max. 200         ____

2905 SUM.Fact.U             Factor for voltage summation monitoring
     min. 0.60
     max. 0.95        ____
```

```
3000 EXTERNAL TRIP FUNCTION 1

3001 EXT.TRIP 1             State of external trip function 1
     OFF                [ ] off
     ON                 [ ] on
     BLOCK TRIP REL     [ ] Block trip relay
```

```
3002 T-DELAY              Time delay of external trip function 1
     min. 0.00            s
     max. 32.00/∞     ____

3003 T-RESET              Reset delay after trip
     min. 0.00            s
     max. 32.00       ____
```

```
3100 EXTERNAL TRIP FUNCTION 2

3101 EXT.TRIP 2           State of external trip function 2
     OFF              [ ] off
     ON               [ ] on
     BLOCK TRIP REL   [ ] Block trip relay

3102 T-DELAY              Time delay of external trip function 2
     min. 0.00            s
     max. 32.00/∞     ____

3103 T-RESET              Reset delay after trip
     min. 0.00            s
     max. 32.00       ____
```

```
3200 EXTERNAL TRIP FUNCTION 3

3201 EXT.TRIP 3           State of external trip function 3
     OFF              [ ] off
     ON               [ ] on
     BLOCK TRIP REL   [ ] Block trip relay

3202 T-DELAY              Time delay of external trip function 3
     min. 0.00            s
     max. 32.00/∞     ____

3203 T-RESET              Reset delay after trip
     min. 0.00            s
     max. 32.00       ____
```

```
3300 EXTERNAL TRIP FUNCTION 4

3301 EXT.TRIP 4           State of external trip function 4
     OFF              [ ] off
     ON               [ ] on
     BLOCK TRIP REL   [ ] Block trip relay

3302 T-DELAY              Time delay of external trip function 4
     min. 0.00            s
     max. 32.00/∞     ____

3303 T-RESET              Reset delay after trip
     min. 0.00            s
     max. 32.00       ____
```

```
3400 INTERTURN FAULT PROTECTION

3401 INTERTURN                 State of the interturn protection
     OFF                  [ ]  off
     ON                   [ ]  on
     BLOCK TRIP REL       [ ]  Block trip relay

3402 U-I/T>                    Pick-up value of interturn fault protection
     min. 0.3                  V
     max. 130.0           ____

3403 T-U-I/T>                  Time delay for trip
     min. 0.00                 s
     max. 32.00/∞         ____

3404 T-RESET                   Reset delay after trip
     min. 0.00                 s
     max. 32.00           ____
```

```
3500 ROTOR EARTH FAULT

3501 ROTOR E/F                 State of the rotor earth fault protection
     OFF                  [ ]  off
     ON                   [ ]  on
     BLOCK TRIP REL       [ ]  Block trip relay

3502 RE< WARN                  Pick-up value of the warning stage Re<
     min. 5.0                  kΩ
     max. 80.0            ____

3503 RE<< TRIP                 Pick-up value of the tripping stage Re<<
     min. 1.0                  kΩ
     max. 10.0            ____

3504 T-WARN-R<                 Time delay for warning stage Re<
     min. 0.00                 s
     max. 32.00/∞         ____

3505 T-TRIP-R<<                Time delay for trip Re<< stage
     min. 0.00                 s
     max. 32.00/∞         ____

3506 T-RESET                   Reset delay after trip
     min. 0.00                 s
     max. 32.00           ____

3507 RE< TEST                  Pick-up value during test (warning stage)
     min. 5.0                  kΩ
     max. 80.0            ____

3508 RE<< TEST                 Pick-up value during test (tripping stage)
     min. 1.0                  kΩ
     max. 10.0            ____

3509 Qc<                       Pick-up value of meas. circuit supervision
     min. 0.01                 mAs
     max. 1.00            ____
```

```
3900 TRIP CIR'T SUPERVISION

3901 TRP SUPERV              State of the trip circuit supervision
     OFF                 [ ] off
     ON                  [ ] on

3902 No.CIRCT.               Number of supervised circuits
     min. 1
     max. 2             ____

3903 MEA.REPET.              Number of meas. repetitions
     min. 2
     max. 6             ____
```

Tests and Commissioning Aids 7UM515

4000 TESTS

4400 CB TEST LIVE TRIP

4401 TRIP RELAY1	Trip of relay #1
4402 TRIP RELAY2	Trip of relay #2
4403 TRIP RELAY3	Trip of relay #3
4404 TRIP RELAY4	Trip of relay #4
4405 TRIP RELAY5	Trip of relay #5

4900 TEST FAULT RECORDING

4901 FAULT REC.	Initiation of fault recording

Annunciations, Measured Values etc. 7UM515

5000 ANNUNCIATIONS

5100 OPERATIONAL ANNUNCIATIONS

5200 LAST FAULT

5300 2nd TO LAST FAULT

5400 3rd TO LAST FAULT

5700 OPERATIONAL MEAS. VALUES A

5701 UL1E=	Voltage UL1E =
5702 UL2E=	Voltage UL2E =
5703 UL3E=	Voltage UL3E =
5704 UL1E =	Secondary voltage UL1E is
5705 UL2E =	Secondary voltage UL2E is
5706 UL3E =	Secondary voltage UL3E is
5707 U0 =	Secondary earth voltage U0
5708 Upos.seq=	Positive sequence voltage
5709 UL-Lmax=	Maximum Phase-Phase voltage
5710 Ui/t=	Interturn displacement voltage
5711 f [Hz]=	Frequency f [Hz] =

5800 OPERATIONAL MEAS. VALUES B

5801 U-SEF=	Bias voltage for stator circuit
5802 I-SEF=	Earth current in stator circuit
5803 R-SEF=	Stator earth resistance
5804 Rse p=	Primary stator earth resistance
5805 Tg=	Period of square-wave oscillator
5806 Ug=	Voltage of square-wave oscillator
5807 Ig=	Meas. current of rotor earth flt. prot.
5808 Qc=	Charge at polarity reversal
5809 R-REF=	Rotor earth resistance

5900 OPERATIONAL MEAS. VALUES C

5901 U/f =	Overflux (U/Un) / (f/fn)
5902 U/f th=	Calculated temperature (U/f)
5903 Th.loss.=	Thermal losses

Reference Table for Configuration Parameters 7UM515

6000 MARSHALLING

6100 MARSHALLING BINARY INPUTS

6101 BINARY INPUT 1 Binary input 1

6102 BINARY INPUT 2 Binary input 2

6103 BINARY INPUT 3 Binary input 3

6104 BINARY INPUT 4 Binary input 4

6105 BINARY INPUT 5 Binary input 5

6106 BINARY INPUT 6 Binary input 6

```
6107 BINARY INPUT 7       Binary input 7
     ______________       ______________       ______________
     ______________       ______________       ______________
     ______________       ______________       ______________

6108 BINARY INPUT 8       Binary input 8
     ______________       ______________       ______________
     ______________       ______________       ______________
     ______________       ______________       ______________
```

```
6200 MARSHALLING SIGNAL RELAYS

6201 SIGNAL RELAY 1       Signal relay 1
     ______________       ______________       ______________
     ______________       ______________       ______________
     ______________       ______________       ______________

6202 SIGNAL RELAY 2       Signal relay 2
     ______________       ______________       ______________
     ______________       ______________       ______________
     ______________       ______________       ______________

6203 SIGNAL RELAY 3       Signal relay 3
     ______________       ______________       ______________
     ______________       ______________       ______________
     ______________       ______________       ______________

6204 SIGNAL RELAY 4       Signal relay 4
     ______________       ______________       ______________
     ______________       ______________       ______________
     ______________       ______________       ______________

6205 SIGNAL RELAY 5       Signal relay 5
     ______________       ______________       ______________
     ______________       ______________       ______________
     ______________       ______________       ______________
```

6206 SIGNAL RELAY 6 Signal relay 6

6207 SIGNAL RELAY 7 Signal relay 7

6208 SIGNAL RELAY 8 Signal relay 8

6209 SIGNAL RELAY 9 Signal relay 9

6210 SIGNAL RELAY 10 Signal relay 10

6211 SIGNAL RELAY 11 Signal relay 11

6212 SIGNAL RELAY 12 Signal relay 12

6213 SIGNAL RELAY 13 Signal relay 13

______ ______ ______
______ ______ ______
______ ______ ______

6300 MARSHALLING LED INDICATORS

6301 LED 1 LED 1

______ ______ ______
______ ______ ______
______ ______ ______

6302 LED 2 LED 2

______ ______ ______
______ ______ ______
______ ______ ______

6303 LED 3 LED 3

______ ______ ______
______ ______ ______
______ ______ ______

6304 LED 4 LED 4

______ ______ ______
______ ______ ______
______ ______ ______

6305 LED 5 LED 5

______ ______ ______
______ ______ ______
______ ______ ______

6306 LED 6 LED 6

______ ______ ______
______ ______ ______
______ ______ ______

6307 LED 7 LED 7

6308 LED 8 LED 8

6309 LED 9 LED 9

6310 LED 10 LED 10

6311 LED 11 LED 11

6312 LED 12 LED 12

6313 LED 13 LED 13

6314 LED 14 LED 14

6400 MARSHALLING TRIP RELAYS

6401 TRIP RELAY 1 Trip relay 1

6402 TRIP RELAY 2 Trip relay 2

6403 TRIP RELAY 3 Trip relay 3

6404 TRIP RELAY 4 Trip relay 4

6405 TRIP RELAY 5 Trip relay 5

7000 OP. SYSTEM CONFIGURATION

```
7100 INTEGRATED OPERATION

7101 LANGUAGE                 Language
     DEUTSCH            [ ]  German
     ENGLISH            [ ]  English

7102 DATE FORMAT              Date format
     DD.MM.YYYY         [ ]  dd.mm.yyyy
     MM/DD/YYYY         [ ]  mm/dd/yyyy

7105 OPER. 1st L              Operational message for 1st display line

     _________________        _______________________________________

7106 OPER. 2nd L              Operational message for 2nd display line

     _________________        _______________________________________

7107 FAULT 1st L              Fault message for 1st display line

     _________________        _______________________________________

7108 FAULT 2nd L              Fault message for 2nd display line

     _________________        _______________________________________

7151 CW-LEVEL 1               Codeword for level 1
     min. 1
     max. 999999       ____

7152 CW-LEVEL 2               Codeword for level 2
     min. 1
     max. 999999       ____

7153 CW-LEVEL 3               Codeword for level 3
     min. 1
     max. 999999       ____

7154 CW-LEVEL 4               Codeword for level 4
     min. 1
     max. 999999       ____
```

```
7200 PC/SYSTEM INTERFACES

7201 DEVICE ADD.              Device address
     min. 1
     max. 254          ____

7202 FEEDER ADD.              Feeder address
     min. 1
     max. 254          ____

7203 SUBST. ADD.              Substation address
     min. 1
     max. 254          ____

7208 FUNCT. TYPE              Function type in accordance with VDEW/ZVEI
     min. 1
     max. 254          ____
```

```
7209 DEVICE TYPE            Device type
     min. 1
     max. 254         _____

7211 PC INTERF.             Data format for PC-interface
     DIGSI V3           [ ] DIGSI V3
     ASCII              [ ] ASCII

7215 PC BAUDRATE            Transmission baud rate for PC-interface
     9600 BAUD          [ ] 9600 Baud
     19200 BAUD         [ ] 19200 Baud
     1200 BAUD          [ ] 1200 Baud
     2400 BAUD          [ ] 2400 Baud
     4800 BAUD          [ ] 4800 Baud

7216 PC PARITY              Parity and stop-bits for PC-interface
     DIGSI V3           [ ] DIGSI V3
     NO 2 STOP          [ ] No parity,2 stopbits
     NO 1 STOP          [ ] No parity,1 stopbit

7221 SYS INTERF.            Data format for system-interface
     VDEW EXTENDED      [ ] VDEW extended
     DIGSI V3           [ ] DIGSI V3
     LSA                [ ] LSA

7222 SYS MEASUR.            Measurement format for system-interface
     VDEW EXTENDED      [ ] VDEW extended

7225 SYS BAUDR.             Transmission baud rate for system-interface
     9600 BAUD          [ ] 9600 Baud
     19200 BAUD         [ ] 19200 Baud
     1200 BAUD          [ ] 1200 Baud
     2400 BAUD          [ ] 2400 Baud
     4800 BAUD          [ ] 4800 Baud

7226 SYS PARITY             Parity and stop-bits for system-interface
     VDEW/DIGSIV3/LSA   [ ] VDEW/DIGSI V3/LSA
     NO 2 STOP          [ ] No parity,2 stopbits
     NO 1 STOP          [ ] No parity,1 stopbit

7235 SYS PARAMET            Parameterizing via system-interface
     NO                 [ ] no
     YES                [ ] yes
```

```
7400 FAULT RECORDINGS

7402 INITIATION             Initiation of data storage
     STORAGE BY FD.     [ ] Storage by fault det
     STORAGE BY TRIP    [ ] Storage by trip
     START WITH TRIP    [ ] Start with trip

7410 T-MAX                  Maximum time period of a fault recording
     min. 0.30              s
     max. 5.00        _____

7411 T-PRE                  Pre-trigger time for fault recording
     min. 0.05              s
     max. 4.00        _____
```

```
7412 T-POST                 Post-fault time for fault recording
     min. 0.05              s
     max. 1.00        ____

7420 FAULT VALUE            Fault values
     INSTANT. VALUES   [ ] Instantaneous values
     R.M.S. VALUES     [ ] R.M.S. values

7431 T-BINARY IN            Storage time by initiation via binary input
     min. 0.10              s
     max. 5.00/∞      ____

7432 T-KEYBOARD             Storage time by initiation via keyboard
     min. 0.10              s
     max. 5.00        ____

7490 SYS LENGTH             Length of fault record (former LSA)
     660 VALUES FIX    [ ] 660 values fix
     <=3000 VAL. VAR   [ ] <=3000 val. var
```

```
7800 SCOPE OF FUNCTIONS

7813 U/f PROT.              Overflux protection
     EXIST             [ ] Existent
     NON-EXIST         [ ] Non-existent

7816 UNDERVOLT.             Undervoltage protection
     EXIST             [ ] Existent
     NON-EXIST         [ ] Non-existent

7817 OVERVOLT.              Overvoltage protection
     EXIST             [ ] Existent
     NON-EXIST         [ ] Non-existent

7818 STATOR E/F             Stator earth fault protection 100%
     EXIST             [ ] Existent
     NON-EXIST         [ ] Non-existent

7819 SEF PROT.              Stator earth fault protection
     EXIST             [ ] Existent
     NON-EXIST         [ ] Non-existent

7821 FREQUENCY              Frequency protection
     EXIST             [ ] Existent
     NON-EXIST         [ ] Non-existent

7830 EXT. TRIP 1            External trip function 1
     EXIST             [ ] Existent
     NON-EXIST         [ ] Non-existent

7831 EXT. TRIP 2            External trip function 2
     EXIST             [ ] Existent
     NON-EXIST         [ ] Non-existent

7832 EXT. TRIP 3            External trip function 3
     EXIST             [ ] Existent
     NON-EXIST         [ ] Non-existent
```

```
7833 EXT. TRIP 4            External trip function 4
     EXIST              [ ] Existent
     NON-EXIST          [ ] Non-existent

7834 I/T PROT.              Interturn fault protection
     EXIST              [ ] Existent
     NON-EXIST          [ ] Non-existent

7835 ROTOR E/F              Rotor earth fault protection
     EXIST              [ ] Existent
     NON-EXIST          [ ] Non-existent

7885 PARAM. C/O             Parameter change-over
     NON-EXIST          [ ] Non-existent
     EXIST              [ ] Existent

7899 FREQUENCY              Rated system frequency
     fN 50 Hz           [ ] fN 50 Hz
     fN 60 Hz           [ ] fN 60 Hz
```

```
7900 DEVICE CONFIGURATION

7901 COUPL. REF             Mode of coupling the meas. signal R/E/F
     7XT70              [ ] R/E/F with 7XT70
     RMT                [ ] R/E/F with RMT
```

Operational Device Control Facilities 7UM515

8000 DEVICE CONTROL

8100 SETTING REAL TIME CLOCK

8101 DATE / TIME	Actual date and time
8102 DATE	Setting new date
8103 TIME	Setting new time
8104 DIFF. TIME	Setting difference time

8200 RESET

8201 RESET	Reset of LED memories
8202 RESET	Reset of operational annunciation buffer
8203 RESET	Reset of fault annunciation buffer

8300 SYS-VDEW ANNUNC.-MEAS.VAL

8301 SYS TEST		Testing via system-interface
OFF	[ ]	off
ON	[ ]	on
8302 SYS BLOCK		Blocking of monitoring direction via sys.-int.
OFF	[ ]	off
ON	[ ]	on

8500 PARAMETER CHANGE-OVER

8501 ACTIV PARAM		Actual active parameter set
8503 ACTIVATING		Activation of parameter set
SET A	[ ]	Set a
SET B	[ ]	Set b
SET C	[ ]	Set c
SET D	[ ]	Set d
SET BY BIN.INPUT	[ ]	Set via binary input
SET BY LSA CONTR	[ ]	Set by lsa control
8510 COPY		Copy original parameter set to set A
8511 COPY		Copy original parameter set to set B
8512 COPY		Copy original parameter set to set C
8513 COPY		Copy original parameter set to set D
8514 COPY		Copy parameter set A to set B

8515 COPY	Copy parameter set A to set C
8516 COPY	Copy parameter set A to set D
8517 COPY	Copy parameter set B to set A
8518 COPY	Copy parameter set B to set C
8519 COPY	Copy parameter set B to set D
8520 COPY	Copy parameter set C to set A
8521 COPY	Copy parameter set C to set B
8522 COPY	Copy parameter set C to set D
8523 COPY	Copy parameter set D to set A
8524 COPY	Copy parameter set D to set B
8525 COPY	Copy parameter set D to set C

9800 OPERATING SYSTEM CONTROL

9802 MONITOR	Monitor

To

SIEMENS AKTIENGESELLSCHAFT

Dept. EV S D PSN

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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.

Corrections/Suggestions

Substantial alterations against previous issue:

Accessory devices 7XT33 and 7XT34 for stator earth fault 100 % protection.

Subject to technical alteration

Siemens Aktiengesellschaft

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