REU 523
Combined Overvoltage and Undervoltage Relay

Technical Reference Manual

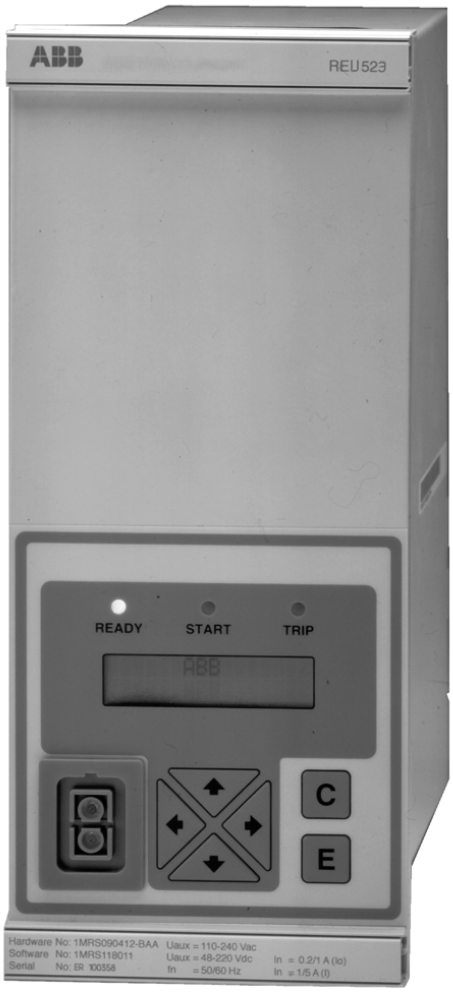

ABB Automation

Contents

1. Introduction

1.1. About this manual

This manual is intended to provide the user with thorough information on the relay REU 523 and its applications. The focus in the manual is on technical description of the relay.

Instructions for using the Man-Machine Interface (MMI) are found in separate “Operator’s Manual” and for installation in “Installation Manual”.

1.2. The use of the relay

The three-phase voltage relay REU 523 is intended to be used for overvoltage and undervoltage protection and supervision in distribution substations. It can also be used for protection of generators, motors and transformers.

The relay features two over- and two undervoltage protection functions that evaluate the fundamental wave of the three phase-to-phase voltages but can also be programmed to evaluate single phase-to-phase voltage. One of the undervoltage stages can alternatively be set to evaluate the positive-phase-sequence voltage.

The protection relay REU 523 is based on a microprocessor environment. A self-supervision system monitors continuously the operation of the relay.

The MMI includes an LCD display which makes the local use of the relay safe and easy.

Local control of the protection relay can be carried out with a portable computer connected to the front connector and remote control via the rear connector connected to the distribution automation system through the serial interface and fibre-optic bus.

1.3. Features

- Overvoltage and undervoltage protection
- Single- or three-phase operation
- High-set overvoltage stage with definite-time or inverse definite minimum time (IDMT) characteristic
- Low-set overvoltage stage with definite-time or IDMT characteristic
- High-set undervoltage stage with definite-time or IDMT characteristic
- Low-set undervoltage stage with definite-time or IDMT characteristic
- Positive-phase-sequence protection
- Settable drop-off/pick-up ratio for low-set overvoltage and low-set undervoltage stages
- Circuit-breaker failure protection unit (CBFP)
- Disturbance recorder
- All settings can be modified with a personal computer
- Settings are stored in a non-volatile memory and remain even in case of power supply failure
- MMI with an alphanumeric LCD and manoeuvring buttons

- Two normally open power output contacts
- Two change-over type signal output contacts
- Output contact functions freely configurable for desired operation
- Three accurate voltage inputs
- Galvanically isolated binary input with a wide input voltage range
- Optical PC-connector for two-way SPA-bus data communication (front)
- RS-485 connector (rear), for system communication
- Continuous self-supervision of hardware and software. At a permanent fault all stages and outputs are blocked.
- Rated frequency user-selectable 50/60 Hz
- Nominal voltage user-selectable 100/110/115/120 V
- User-selectable password protection for MMI
- Display of primary voltage values

1.4. Guarantee

Please inquire the guarantee of your nearest ABB representative.

2. Safety Information

	Dangerous voltages can occur on the connectors, even though the auxiliary voltage is disconnected.
	National and local electrical safety regulations must always be followed.
	The frame of the protection relay has to be carefully earthed.
	Only a competent electrician is allowed to carry out the electrical installation.

3. Instructions

3.1. Application

The overvoltage and undervoltage relay REU 523 is a secondary relay that is connected to the voltage transformers of an object to be protected. It is designed for overvoltage and undervoltage protection and supervision in distribution substations. Other application areas are overvoltage and undervoltage protection of generators, motors and transformers.

The three-phase overvoltage and undervoltage stages continuously measure the phase-to-phase voltages of the system. On detection of a fault the relay starts, trips the circuit breaker, provides alarms, records fault data etc., in accordance with the application and the configured relay functions.

Both the overvoltage and the undervoltage units include two protection stages: low-set stages U> and U<, and high-set stages U>> and U<<. Each protection stage can be given a definite-time or an inverse definite minimum time (IDMT) characteristic.

The start and operation of the high-set and low-set undervoltage stages can be blocked when the measured voltages are under 0.2 x U_n. Further, the operation of all protection stages can be blocked separately by means of an external binary input signal.

The high-set undervoltage stage can be set to operate either based on conventional undervoltage measurement or on the calculated positive-phase-sequence voltage U1s. Selecting the positive-phase-sequence operation automatically deselects the conventional high-set undervoltage stage operation, and vice versa.

The operation of the stage U< can be blocked by the start of the stage U<<. The high-set stages of the overvoltage and undervoltage units can be deselected from operation separately.

The protection functions are independent of each other unless configured to be dependent, and they have their own setting groups as well as data recording. The over- and undervoltage functions use conventional voltage transformer measurement.

Output contact matrix allows any start or trip signal from the protection stages to be routed to the desired output contact.

3.2. Requirements

When the protection relay is operating under conditions specified below (see also “Technical data” beginning from page 47), the relay is practically maintenance-free. The relay includes no parts or components subject to abnormal physical or electrical wear under normal operating conditions.

Environmental conditions

• Specified ambient service temperature range	-10...+55 °C
• Temperature influence on the operating values of the relay within the specified ambient service temperature range	0.1% / °C
• Transport and storage temperature range	-40...+70 °C

3.3. Configuration

Setting and connection example

The appropriate configuration of the output contact matrix enables using the trip signals from the over- and undervoltage stages for operating two different circuit breakers. The start signals can be used for blocking co-operating protection relays, for signalling and for initiating autoreclosing.

Figure 3.3.-1 represents the relay with the default configuration.

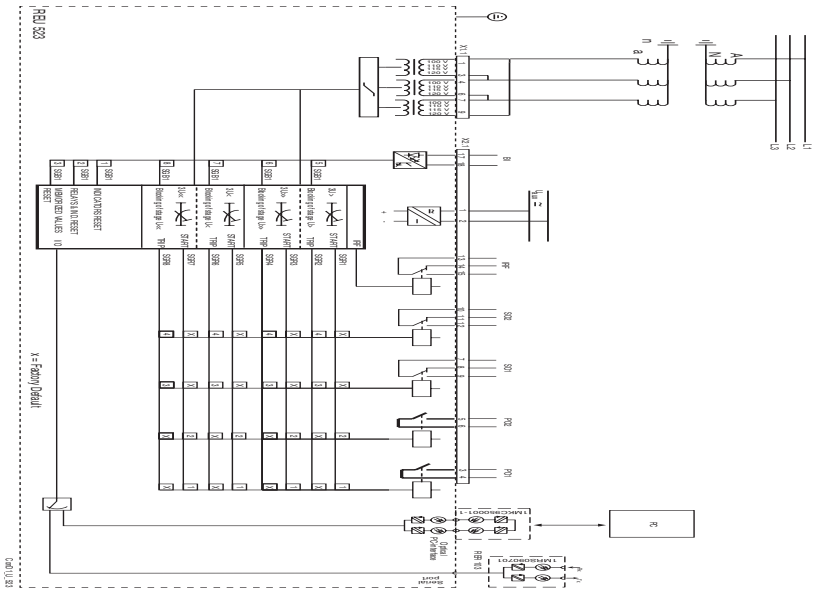

Fig. 3.3.-1 Connection diagram of the overvoltage and undervoltage relay

4. Technical Description

4.1. Functional description

4.1.1. Product functions

4.1.1.1. Schema of product functions

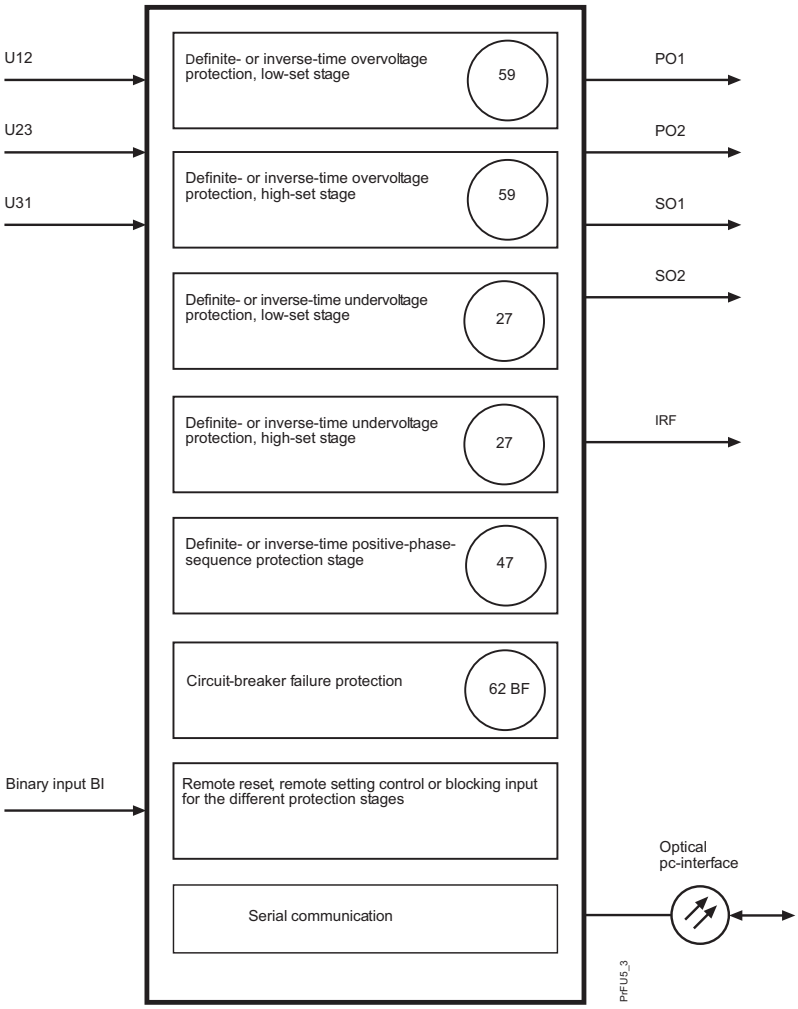

Fig. 4.1.1.1.-1 Product functions

4.1.1.2. Overvoltage, undervoltage and positive-phase-sequence

Refer to sections:

- 4.1.3.2. Overvoltage unit
- 4.1.3.3. Undervoltage unit
- 4.1.3.4. Positive-phase-sequence protection

4.1.1.3. Inputs

The relay includes three energizing inputs and one external binary input controlled by an external voltage. The function of the binary input is determined with selector switches of the protection relay.

For more details of the inputs, refer to section 4.2.1. Input / output connections and tables 4.1.3.6-6, 4.2.1-1 and 4.2.1-5.

4.1.1.4. Outputs

The relay is provided with two power outputs (PO1 and PO2) and two signal outputs (SO1 and SO2). Switchgroups SGR1...8 are used for routing the start and trip signals of any protection stage to the desired signal or power output.

4.1.1.5. Circuit-breaker failure protection

The relay features a circuit-breaker failure protection (CBFP) unit. The CBFP unit generates a trip signal via output PO2 after the set operate time 0.10 s...1.00 s if the fault has not been cleared by that time.

The CBFP unit can be used for tripping via redundant trip circuits of the same circuit breaker if the circuit breaker is provided with two trip coils. The circuit-breaker failure protection unit is activated with a switch of switchgroup SGF.

4.1.1.6. Disturbance recorder

The relay includes an internal disturbance recorder, which records momentary measured values, external BI signal and states of the internal protection stages. The disturbance recorder can be set to be triggered on operation of stages or on an external BI signal, either on the falling or rising trigger edge.

4.1.1.7. MMI module

The MMI of the relay is equipped with six push-buttons and an alphanumeric LCD for 2 x 16 characters. The push-buttons are used for navigating in the menu structure and for adjusting set values.

An MMI password protects all user-changeable values from being changed by an unauthorised person. The default value for the MMI password is “999”. With the default value the password is not active and it is not required for altering parameter values. For further information, refer to “Operator’s Manual”.

4.1.1.8. Self-supervision

The self-supervision system of the relay handles run-time fault situations and informs the user about an existing fault. When the self-supervision system detects a permanent internal relay fault, the ready indication LED starts blinking. At the same time the self-supervision alarm relay that is normally picked up drops off and a fault code appears on the display. This code is a number that identifies the fault type. For fault codes, refer to section “Internal fault” in “Operator’s Manual”.

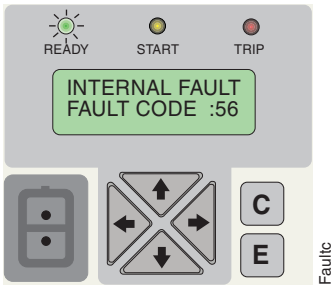

Fig. 4.1.1.8.-1 Internal fault

Fault codes can indicate:

- No response on output contact test.
- Faulty program memory, work memory or parameter memory.
- Too high or too low a reference voltage value.

4.1.2. Configuration

The figure below illustrates how the start, trip and binary input signals can be configured so that the required protection functions are obtained.

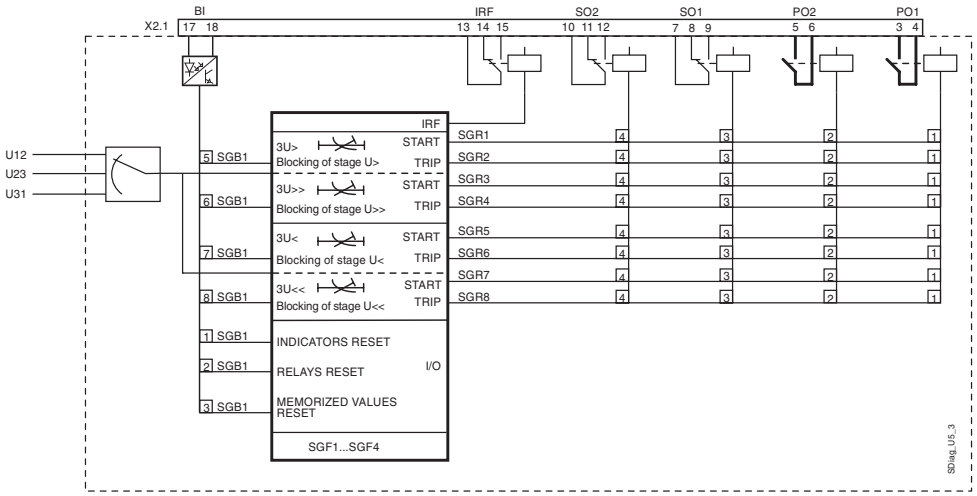

Fig. 4.1.2.-1 Signal diagram of the overvoltage and undervoltage relay

A certain functionality can be achieved with the configuration of the start, trip and binary input signals. The operation of the protection functions and indications can be configured as well. The functionality is selected with the switches of switchgroups SGF (Functions), SGB (Binary Input/Blockings) and SGR (Relays). The functions of these switches are explained in detail in the corresponding SG_-tables.

4.1.3. Protection

4.1.3.1. Block diagram

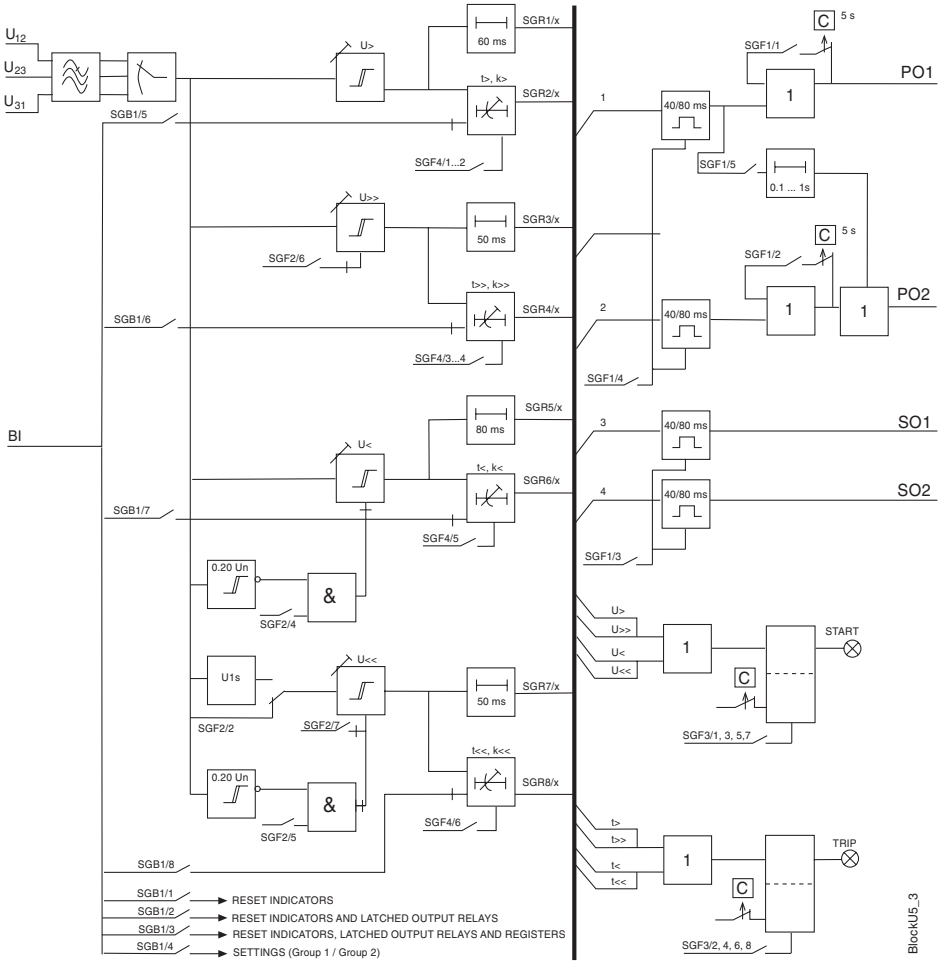

Fig. 4.1.3.1.-1 Block diagram of the combined overvoltage and undervoltage relay REU 523

4.1.3.2. Overvoltage unit

When one or several of the measured voltages exceed the set start value of the low-set stage U> and the preset start time of ~ 60 ms elapses, the overvoltage unit begins delivering a start signal. Further, when the set operate time for the low-set stage at definite-time operation or the calculated operate time at inverse-time operation passes, the overvoltage unit operates.

In the same way as the low-set stage, the high-set stage U>> of the overvoltage unit begins delivering a start signal after a preset ~ 50 ms start time when the set start value is exceeded. When the set operate time for the high-set stage at definite-time operation or the calculated operate time at inverse-time operation elapses, the overvoltage unit operates.

The low-set and high-set stages of the overvoltage unit may be given a definite-time or an inverse definite minimum time (IDMT) characteristic. When the IDMT characteristic is chosen, two time/current curve groups called A and B are available.

The high-set stage can be deselected from operation by setting a bit in one of the software switchgroups. When the stage is disabled, "---" is shown on the LCD and "999" in communication via the SPA bus indicating deselection of the protection stage.

4.1.3.3. Undervoltage unit

When one or several of the measured voltages fall below the set start value of the low-set stage U< and the preset start time of ~ 80 ms elapses, the undervoltage unit begins delivering a start signal. Further, when the set operate time for the low-set stage at definite-time operation or the calculated operate time at inverse-time operation passes, the undervoltage unit operates.

When the conventional operation mode is selected for the high-set undervoltage stage and one or all of the measured voltages, depending on the set operation criteria, fall below the set start value of the high-set stage U<<, the undervoltage unit begins delivering a start signal after a preset ~ 50 ms start time.

When the positive-phase-sequence protection mode is selected for the high-set undervoltage stage and the calculated positive-phase-sequence voltage U1s falls below the set start value of the high-set stage U<<, the undervoltage unit begins delivering a start signal after a preset ~ 50 ms start time. When the set operate time at definite-time operation or the calculated operate time at inverse-time operation for the high-set stage elapses, the undervoltage unit operates.

The low-set and high-set stages of the undervoltage unit may be given a definite-time or an inverse definite minimum time (IDMT) characteristic. When the IDMT characteristic is chosen, one time/current curve group called C is available.

Starting and operation of the low-set and high-set undervoltage stages can be internally blocked when the measured value falls below 0.2 x U_n. This function is selected in one of the software switchgroups.

The high-set stage can be deselected from operation by setting a bit in one of the software switchgroups. When the stage is disabled, "---" is shown on the LCD and "999" in communication via the SPA bus indicating deselection of the protection stage.

The operation of stage U< can be blocked by the start of the stage U<<. The selection is made with a switch in one of the software switchgroups.

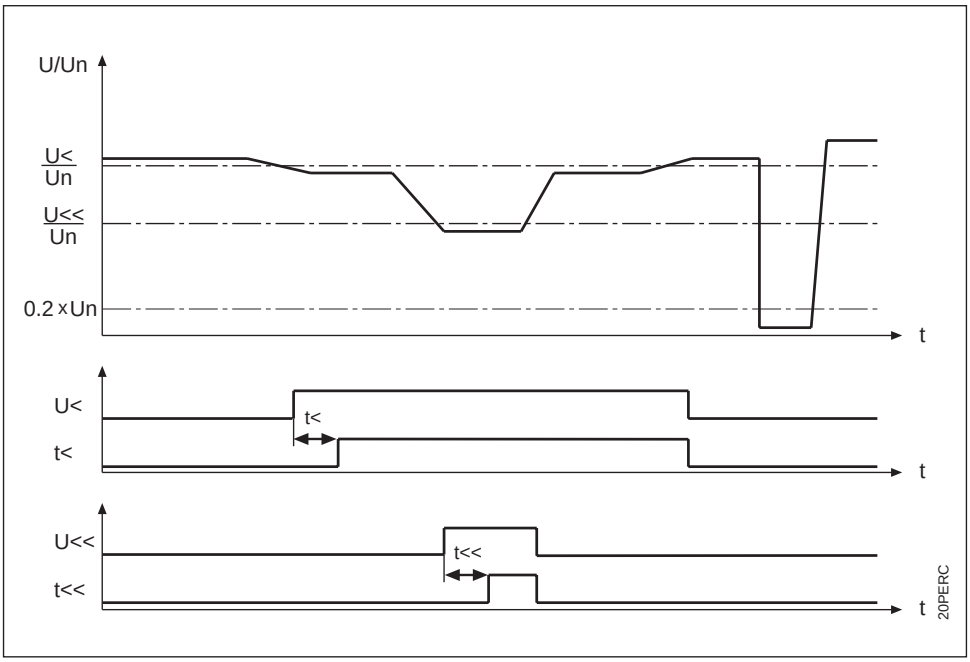

Fig. 4.1.3.3.-1 Operation of the undervoltage unit when the function of the high-set and low-set undervoltage stages is internally blocked in case the voltage falls below 0.2 x U_n

4.1.3.4. Positive-phase-sequence protection

Instead of the phase-to-phase voltage measurement the high-set undervoltage stage can be set to be based on the positive-phase-sequence voltage. The relay calculates the voltage on the basis of the two phase-to-phase voltages U_{12} and U_{23}.

The function based on the positive-phase-sequence voltage can be applied to disconnecting a smaller power plant from the outside network. This may be necessary in case a fault somewhere else in the network causes a condition, critical for the power plant. An example of this kind of a fault is a short circuit either on the transmission or distribution network level.

The situation may be critical for the power plant for different reasons. For example, due to the relay operation caused by a fault situation, the power plant may be left to feed an isolated network. In this case, there is a risk that the isolated network, in an asynchronous state compared to the rest of the network, is reconnected to the network, e.g. as a result of an autoreclosure. Another hazardous situation would be that the power plant falls into an asynchronous state during the fault condition. Both of these hazards may be prevented if the power plant is disconnected from the network quickly enough by opening the connecting circuit breaker.

The benefit of the disconnecting relay assembly based on the positive-phase-sequence voltage is that the voltage value during the network fault or after it measures well the criticalness of the fault for a smaller power plant. When the positive-phase-sequence voltage falls below the critical limit, the power plant has to be disconnected from the network.

The voltage relay measuring the positive-phase-sequence voltage complements other methods, based on frequency relay and overcurrent relay, for disconnecting a smaller power plant.

The positive-phase-sequence function can also be used instead of the conventional high-set three-phase undervoltage protection based on phase-to-phase voltages. For example, this kind of undervoltage protection function can be used for disconnecting motors in case of voltage interruption so that the motors are prevented from starting simultaneously when the voltage becomes available again.

The relay has to be set to three-phase use, not to single-phase use, when the positive-phase-sequence operation criteria is selected.

4.1.3.5. Time/voltage characteristics

At the IDMT characteristic, the operate time of the stage is a function of the voltage: the greater the deviation from the setting value, the shorter the operate time. Three time/voltage curve groups called A, B and C are available.

The overvoltage and undervoltage units can be given a definite-time or an inverse definite minimum time operation characteristic. The settings of switches SGF4/1...2 determine the operation mode of stage U>, SGF4/3...4 that of stage U>>, switch SGF4/5 determines the operation mode of stage U< and SGF4/6 that of stage U<<. Refer to section “Settings” beginning from page 19.

Recording of the operate time does not start until the deviation between the measured voltage and the setting value is 6 %. The operate time accuracy stated in the technical data applies when the deviation is 10 % or greater.

Characteristics for overvoltage stages

The IDMT characteristic curve groups A and B are designed for overvoltage stages U> and U>>. The stages U> and U>> can be configured to use different characteristics. The relationship between time and voltage at inverse-time characteristic can be expressed as follows:

$$t[s] = \frac{k \times a}{\left(b \times \frac{U - U>}{U>} - 0.5 \right)^{p}} + c$$

where

t = operate time [s]

k = time multiplier k> or k>>

U = measured voltage [V]

U> = set start voltage [V] for U> or U>>

a = constant 480

b = constant 32

c = constant 0.035

p = constant (see table 4.1.3.5-1)

The A- and B-type characteristics are illustrated in Fig. 4.1.3.5.-1 and Fig. 4.1.3.5.-2.

Characteristic for undervoltage stages

The IDMT characteristic curve group C is designed for undervoltage stages U< and U<<. The stages U< and U<< can be configured to use different characteristics. The relationship between time and voltage at inverse-time characteristic can be expressed as follows:

$$t[s] = \frac{k \times a}{\left(b \times \frac{U< - U}{U<} - 0.5\right)^{p}} + c$$

where

t = operate time [s]

k = time multiplier k< or k<<

U = measured voltage [V]

U< = set start voltage [V] for U< or U<<

a = constant 480

b = constant 32

c = constant 0.055

p = constant (see table 4.1.3.5-1)

The C-type characteristic is illustrated in Fig. 4.1.3.5.-3.

Table 4.1.3.5-1 Values of constant p

Time/current characteristic	**A**	**B**	**C**
p	2	3	2

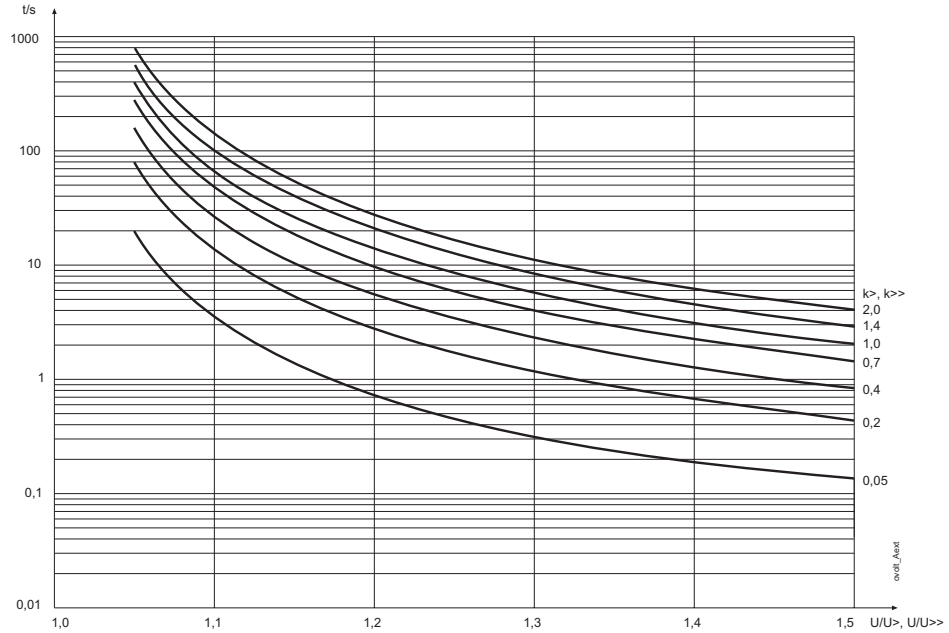

Fig. 4.1.3.5.-1 Type A characteristics

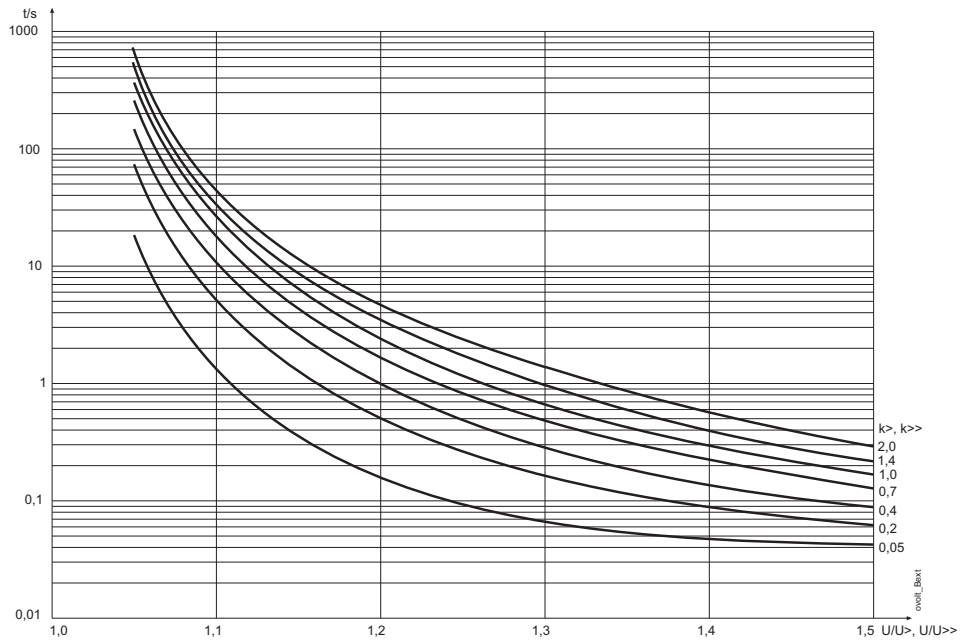

Fig. 4.1.3.5.-2 Type B characteristics

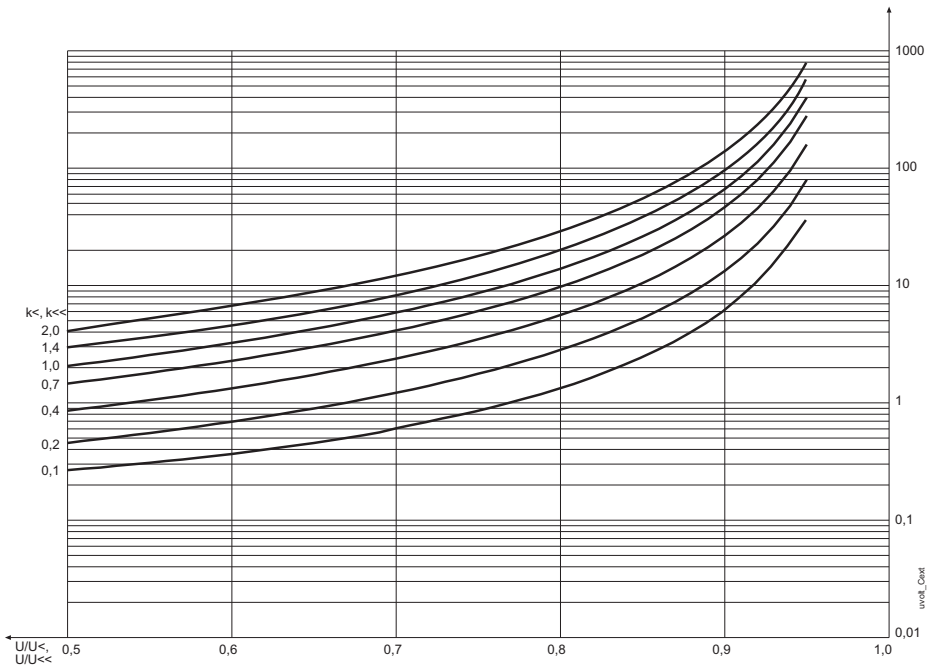

Fig. 4.1.3.5.-3 Type C characteristics

4.1.3.6. Settings

Two alternative setting groups, 1 and 2, are available for the relay. Either of these setting groups can be used as the actual settings, one group at a time. Both the groups have their related registers. Switching between the setting groups 1 and 2 enables changing a whole group of settings at the same time. This can be done in any of the following ways:

1. Via the MMI
2. With parameter V150 via serial communication
3. By means of an external binary input BI

Values of the settings are altered via the MMI or with a personal computer provided with the Relay Setting Tool.

Before the relay is connected to a system, one must assure that the relay has been given correct settings. If there is any doubt about the settings, the setting values should be read with the relay trip circuits disconnected or tested by applying an adjustable voltage to the matching transformers of the relay. Refer to chapter “Check Lists” beginning from page 55.

Table 4.1.3.6-1 Setting values

Setting	Description	Setting range	Default setting
$U>/U_n$	Start voltage of stage U> as a multiple of the rated voltage of the energizing input. • definite and inverse time	0.60...1.40 x U_n	1.20 x U_n
t>	Operate time of stage U> in seconds at definite-time characteristic.	0.06...600 s	0.06 s
k>	Time multiplier k> of stage U> at inverse-time characteristic.	0.05...2.00	0.05
D/P>	Drop-off/pick-up ratio for U>	0.95...0.99	0.97
$U>>/U_n$	Start voltage of stage U>> as a multiple of the rated voltage of the energizing input. • definite and inverse time	0.80...1.60 x U_n and ∞ [1]	1.20 x U_n
t>>	Operate time of stage U>> in seconds.	0.05...600 s	0.05 s
k>>	Time multiplier k>> of stage U>> at inverse-time characteristic.	0.05...2.00	0.05
$U</U_n$	Start voltage of stage U< as a multiple of the rated voltage of the energizing input. • definite and inverse time	0.30...1.20 x U_n	0.30 x U_n
t<	Operate time of stage U< in seconds at definite-time characteristic.	0.10...600 s	0.10 s
k<	Time multiplier k< of stage U< at inverse-time characteristic.	0.10...2.00	0.10
D/P<	Drop-off/pick-up ratio for U<	1.01...1.05	1.03
$U<</U_n$	Start voltage of stage U<< as a multiple of the rated voltage of the energizing input. • definite and inverse time	0.30...1.20 x U_n and ∞ [1]	0.30 x U_n
t<<	Operate time of stage U<< in seconds at definite-time characteristic.	0.10...600 s	0.10 s
k<<	Time multiplier k<< of stage U<< at inverse-time characteristic.	0.10...2.00	0.10
CBFP	Circuit-breaker failure protection	0.10...1.00 s	0.10 s

[1] The stage can be set out of operation with SGF switches. This state is indicated by “---” on the LCD and by “999” when parameters are read via the SPA bus.

Selector switchgroups SGF, SGB and SGR

Part of the settings and the selections of the operation characteristics of the relay in various applications is made with selector switchgroups SG_. The switchgroups are software based and thus not physical switches to be found in the hardware of the relay. The switches can be set one by one.

A checksum is used for verifying that the switches have been properly set. The figure below shows an example of manual checksum calculation.

Switch No	Position		Weighting factor		Value
1	1	x	1	=	1
2	0	x	2	=	0
3	1	x	4	=	4
4	0	x	8	=	0
5	1	x	16	=	16
6	0	x	32	=	0
7	1	x	64	=	64
8	0	x	128	=	0
	Checksum		SG_ Σ	=	85

*Fig. 4.1.3.6.-1 An example of calculating the checksum of a selector switchgroup SG_*

When the checksum, calculated according to the example above, equals the checksum read from the relay, the switches in the concerned switchgroup are properly set.

The following tables indicate the factory default settings of the switches and the corresponding checksums.

SGF1...SGF4

Switchgroups SGF1...SGF4 are used for configuring the desired functions as follows.

Table 4.1.3.6-2 SGF1

Switch	Function	Default setting
SGF1/1	Selection of the latching feature for output PO1	0
SGF1/2	Selection of the latching feature for output PO2 • 0 = The output contact opens when the unit that activated an operation is deactivated. • 1 = The output contact remains closed even if the unit that activated an operation is deactivated. The latching feature selected, the output contact is reset with the push-button on the front panel, via the external binary input or the serial bus.	0
SGF1/3	Minimum pulse length for signal outputs SO1 and SO2 • 0 = 80 ms • 1 = 40 ms	0
SGF1/4	Minimum pulse length for power outputs PO1 and PO2 • 0 = 80 ms • 1 = 40 ms Note! The latching function of PO1 and PO2 will overrun this function.	0
SGF1/5	Circuit-breaker failure protection (CBFP) • 0 = The circuit-breaker failure protection is out of operation. • 1 = The signal on output PO1 starts a timer which will generate a delayed signal to the output PO2 if the fault is not cleared before the operate time elapses.	0
SGF1/6	Not in use	0
SGF1/7	Not in use	0
SGF1/8	Not in use	0
Σ SGF1		0

Table 4.1.3.6-3 SGF2

Switch	Function	Default setting
SGF2/1	Single- or three-phase operation • 0 = three-phase operation • 1 = single-phase operation In single-phase use, the measured voltage has to be connected to inputs X1.1/1 and X1.1/3 for proper function, and the start voltage of stage U<< is to be set 0.1 x U_n below the start voltage of stage U<.	0
SGF2/2	Selection between conventional undervoltage measurement and positive-phase-sequence protection for stage U<< • 0 = conventional undervoltage measurement in use • 1 = positive-phase-sequence U1s in use	0

Table 4.1.3.6-3 SGF2

Switch	Function	Default setting
SGF2/3	Operation condition for stage U<< when the conventional undervoltage measurement is selected • 0 = Normal use for detecting loss of voltage when all voltages fall below the set value. • 1 = More sensitive operation: the stage starts when even one of the phases falls momentarily below the set value. In this case, to avoid unnecessary start situations, the start voltage of stage U<< is to be set to 0.6 x U_n or below.	0
SGF2/4	Internal blocking of stage U< when the measured voltage falls below 0.2 x U_n • 0 = internal blocking of U< • 1 = no internal blocking of U<	0
SGF2/5	Internal blocking of stage U<< when the measured voltage falls below 0.2 x U_n • 0 = internal blocking of U<< • 1 = no internal blocking of U<<	0
SGF2/6	Inhibition of the operation of stage U>> • 0 = The operation of the stage U>> is not inhibited. • 1 = The operation of the stage U>> is inhibited.	0
SGF2/7	Inhibition of the operation of stage U<< • 0 = The operation of the stage U<< is not inhibited. • 1 = The operation of the stage U<< is inhibited.	0
SGF2/8	Blocking of operation of stage U< by starting of stage U<< • 0 = The operation of the stage U< is not blocked. • 1 = The operation of the stage U< is blocked.	0
Σ SGF2		0

Table 4.1.3.6-4 SGF3

Switch	Function	Default setting
SGF3/1	The operation mode for the start indicator of stage U> • 0 = The start indicator automatically resets once the fault disappears. • 1 = The start indication remains even if the fault disappears.	0
SGF3/2	The operation mode for the trip indicator of stage U> • 0 = The trip indicator automatically resets once the fault disappears. • 1 = The trip indication remains even if the fault disappears.	1
SGF3/3	The operation mode for the start indicator of stage U>> • 0 = The start indicator automatically resets once the fault disappears. • 1 = The start indication remains even if the fault disappears.	0
SGF3/4	The operation mode for the trip indicator of stage U>> • 0 = The trip indicator automatically resets once the fault disappears. • 1 = The trip indication remains even if the fault disappears.	1
SGF3/5	The operation mode for the start indicator of stage U< • 0 = The start indicator automatically resets once the fault disappears. • 1 = The start indication remains even if the fault disappears.	0

Table 4.1.3.6-4 SGF3

Switch	Function	Default setting
SGF3/6	The operation mode for the trip indicator of stage U< • 0 = The trip indicator automatically resets once the fault disappears. • 1 = The trip indication remains even if the fault disappears.	1
SGF3/7	The operation mode for the start indicator of stage U< • 0 = The start indicator automatically resets once the fault disappears. • 1 = The start indication remains even if the fault disappears.	0
SGF3/8	The operation mode for the trip indicator of stage U< • 0 = The trip indicator automatically resets once the fault disappears. • 1 = The trip indication remains even if the fault disappears.	1
Σ SGF3		170

Note!

Only the indication for the latest start or trip situation remains active as defined in settings. Each indication is overridden by a newer indication of higher priority.

Table 4.1.3.6-5 SGF4

SGF4/1	SGF4/2	SGF4/3	SGF4/4	SGF4/5	SGF4/6	SGF4/7	SGF4/8	Operation
0	0	0	0	0	0	0	0	Definite time[1)]
1	0	-	-	-	-	-	-	U> A Curve
0	1	-	-	-	-	-	-	U> B Curve
-	-	1	0	-	-	-	-	U>> A Curve
-	-	0	1	-	-	-	-	U>> B Curve
-	-	-	-	1	-	-	-	U< C Curve
-	-	-	-	-	1	-	-	U<< C Curve

[1)] Default setting

Note!

For each stage, only one type of characteristic can be selected at a time! If more than one switch is set active for a stage, the characteristic with the lowest weighting factor of the selected switches will be activated. This only concerns the overvoltage stages.

SGB1

Table 4.1.3.6-6 SGB1 Resetting / blocking with BI

Switch	Function	Default setting
SGB1/1	• 0 = Indicators are not reset by the binary input signal. • 1 = Indicators are reset by the binary input signal.	0
SGB1/2	• 0 = Indicators and latched output contacts are not reset by the binary input signal. • 1 = Indicators and latched output contacts are reset by the binary input signal.	0
SGB1/3	• 0 = Indicators, latched output contacts and memorized values are not reset by the binary input signal. • 1 = Indicators, latched output contacts and memorized values are reset by the binary input signal.	0
SGB1/4	Switching between the setting groups 1 and 2, either via the serial bus with command V150, or using the external binary input. • 0 = The setting group cannot be changed with an external binary input. • 1 = The currently used setting group is determined exclusively by the state of the binary input. Note! When SGB1/4 is set to 1, it is important that the switch has the same setting in both the setting groups.	0
SGB1/5	Blocking of stage U> by binary input	0
SGB1/6	Blocking of stage U>> by binary input	0
SGB1/7	Blocking of stage U< by binary input	0
SGB1/8	Blocking of stage U<< by binary input • When SGB1/5...8 = 0, tripping of the concerned stage is not blocked by an external binary input signal. • When SGB1/5...8 = 1, tripping of the concerned stage is blocked by an external binary input signal.	0
Σ SGB1		0

SGR1...SGR8

The start and operate signals of the protection stages are connected to the output contacts with switches SGR1...SGR8.

The matrix below can be used for help in making the desired selections. The start and operate signals of the different protection stages are combined with the output contacts by encircling the desired intersection point. Each intersection point is marked with a switch number, and the corresponding weighting factor of the switch is shown on the bottom row of the matrix. The switchgroup checksum is obtained by adding together horizontally the weighting factors of all the selected switches of the switchgroup.

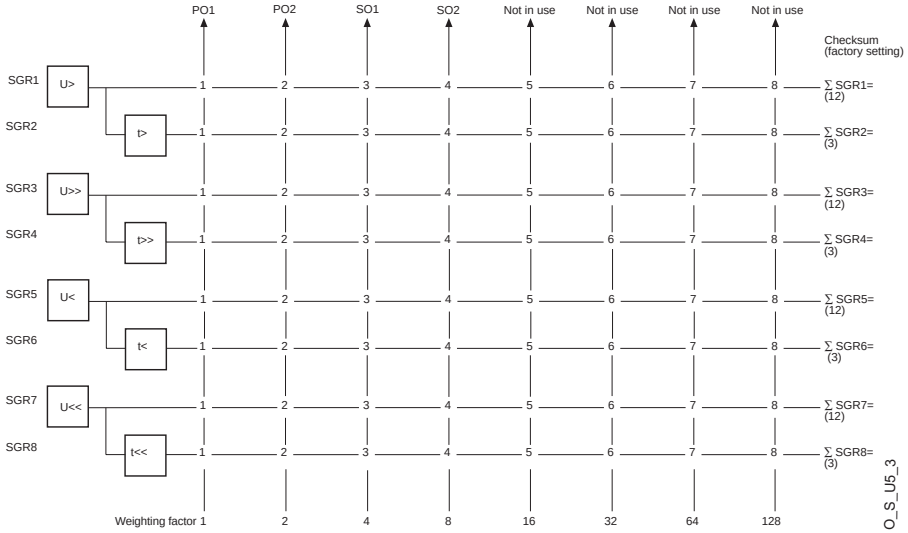

Fig. 4.1.3.6.-2 Output signal matrix of the overvoltage and undervoltage relay

Table 4.1.3.6-7 SGR1...SGR8

Switch	Function	Default setting
SGR1/1...4	U> signal to output contacts PO1, PO2, SO1 and SO2	12
SGR2/1...4	t> signal to output contacts PO1, PO2, SO1 and SO2	3
SGR3/1...4	U>> signal to output contacts PO1, PO2, SO1 and SO2	12
SGR4/1...4	t>> signal to output contacts PO1, PO2, SO1 and SO2	3
SGR5/1...4	U< signal to output contacts PO1, PO2, SO1 and SO2	12
SGR6/1...4	t< signal to output contacts PO1, PO2, SO1 and SO2	3
SGR7/1...4	U<< signal to output contacts PO1, PO2, SO1 and SO2	12
SGR8/1...4	t<< signal to output contacts PO1, PO2, SO1 and SO2	3

4.1.3.7. Technical data of protection functions

Table 4.1.3.7-1 Stages U> and U>>

Feature	**Stage U>**	**Stage U>>**
Start voltage • at definite-time and inverse-time characteristics	0.60...1.40 x U_n	0.80...1.60 x U_n and ∞
Start time, typical	60 ms	50 ms
Time/voltage characteristic • definite time • operate times t> and t>> • inverse-time characteristic • time multipliers k> and k>>	 0.06...600 s A-curve B-curve 0.05...2.00	 0.05...600 s A-curve B-curve 0.05...2.00
Reset time	70 ms[1)]	70 ms[1)]
Drop-off/pick-up ratio	0.95...0.99	0.97
Operate time accuracy at definite-time mode	±2 % of set value or ±25 ms	±2 % of set value or ±25 ms
Operate time accuracy at inverse-time mode	±25 ms or the accuracy appearing when the measured voltage varies ±3 %	±25 ms or the accuracy appearing when the measured voltage varies ±3 %
Operation accuracy • definite-time and inverse-time characteristics	 ±1.5 % of set value	 ±1.5 % of set value

Table 4.1.3.7-2 Stages U< and U<<

Feature	Stage U<	Stage U<<
Start voltage • at definite-time and inverse-time characteristics	0.30...1.20 x U_n	0.30...1.20 x U_n and ∞
Start time, typical	80 ms	50 ms
Time/voltage characteristic • definite time • operate times t< and t<< • inverse-time characteristic • time multipliers k< and k<<	 0.10...600 s C-curve 0.10...2.00	 0.10...600 s C-curve 0.10...2.00
Reset time	70 ms[1)]	70 ms[1)]
Drop-off/pick-up ratio	1.01...1.05	1.03
Operate time accuracy at definite-time mode	±2 % of set value or ±25 ms	±2 % of set value or ±25 ms
Operate time accuracy at inverse-time mode	±25 ms or the accuracy appearing when the measured voltage varies ±3 %	±25 ms or the accuracy appearing when the measured voltage varies ±3 %
Operation accuracy • definite-time and inverse-time characteristic • positive-phase-sequence with definite-time and inverse-time characteristic	 ±1.5% of set value	 ±1.5 % of set value ±5% of set value

[1)] Note!
The reset time is normally 70 ms. In case the measured voltage that caused the activation of the output relay falls below the set start voltage value within less than the start time of the protection function stage added with the set minimum pulse length for the activated relay, the reset time depends on the selected minimum pulse length.

4.1.4. Monitoring

The function of the relay can be monitored with the help of three indicators on the relay front panel: a green READY LED, a yellow START LED and a red TRIP LED.

In addition, in case of an internal fault or an alarm from the protection stages, a text message appears on the display.

The messages on the LCD have a certain priority order. If different types of indications are activated simultaneously, the message with the highest priority appears on the display.

The priority order of the messages:

1. Internal fault
2. Trip, CBFP
3. Start

4.1.5. Self-supervision (IRF)

The relay is provided with an extensive self-supervision system that continuously supervises the software and the electronics of the relay. It handles run-time fault situations and informs the user about an existing fault via a LED on the MMI.

When a fault is detected, the relay first tries to eliminate it by restarting. Only after the fault is found to be permanent, the green READY indicator starts to blink and the protection relay delivers a fault signal to the self-supervision output contact. Additionally, a fault indication text appears on the LCD.

The fault indication has the highest priority on the MMI. None of the other MMI indications can override the IRF indication. When the display panel has received a fault indication, the indication text remains on the LCD. As long as the green LED is blinking, the fault indication or the green LED can not be turned off. In case an internal fault disappears, the fault indication text remains on the display. The green READY indicator stops blinking and the alarm output IRF is released to normal service state.

The IRF code is the code of the latest internal fault detected by the self-supervision system. It describes the type of the fault. When a fault appears, the code is to be recorded and given to an authorised repair shop when overhaul is ordered. For fault codes, refer to section “Internal fault” in “Operator’s Manual”.

4.1.6. I/O test

The I/O test is used for testing the configuration as well as the connections to and from the relay. Running this test enables monitoring the state of the binary input as well as activating and testing the eight internal signals from the protection stages and the IRF output one by one. Provided that the internal signals from the protection stages have been set to be routed to the output contacts (PO1, PO2, SO1 and SO2) with the switches of SGR1...8, the output contacts are activated and the corresponding event codes generated when the I/O test is run. The test mode is entered via “Function test/BI” in MMI menu; refer to “Operator’s Manual”.

4.1.7. Disturbance recorder

4.1.7.1. Function

The relay features an integrated disturbance recorder for recording monitored quantities. The recorder captures continuously curve forms of the voltages as well as the external binary input signal and states of the internal protection stages, and stores these in the volatile memory.

When the recorder is triggered, the post-triggering recording starts. If the post-triggering recording length has been defined to be less than the total recording length of 40 cycles, a part of the history recording, preceding the triggering, also remains in the memory to fill the total recording length. When the post-triggering recording has finished, a complete recording has been created and stored in the memory.

As soon as the recorder has been triggered and the recording finished, the recording can be unloaded and verified by means of a personal computer with a special program.

4.1.7.2. Recorder data

One recording contains the information of three analogue channels and eight digital channels for a period of 40 cycles. The analogue channels are the momentary voltages measured by the relay, and the digital channels are the operating signals of the protection stages and the external binary input signal linked to the relay. The sampling frequency is 16 times the rated frequency, resulting in 800 Hz at 50 Hz rated frequency and in 960 Hz at 60 Hz rated frequency. At a power reset or reset of recorded values (WV102:1) the contents of the recorder memory are lost.

4.1.7.3. Control and indication of recorder status

It is possible to control and monitor the indicated status of the disturbance recorder by writing to and reading the parameter V246. Reading the parameter returns either the value 0 or 1, indicating whether the recorder is not triggered, or triggered and ready to be unloaded.

Writing the value 0 to the parameter clears the recorder memory, restarts storing of new data in the memory and enables triggering of the recorder. Writing the value 2 to the parameter restarts the unloading process in the recorder by setting the time stamp and first data ready to be read. Writing the value 4 to the parameter triggers the recorder.

4.1.7.4. Triggering

Triggering the disturbance recorder for start of a new recording sequence is only possible if the recorder is not already triggered (V246=0).

The recorder can be triggered either manually by writing the value 4 to parameter V246 or it can be triggered by the rising or falling edge of the signals from the internal protection stages and/or the binary input signal. Triggering on the rising edge means that the recording sequence starts when the signal is activated. Correspondingly, triggering on the falling edge means that the recording sequence starts when the active signal resets.

Serial parameters V241...V244 define the triggering conditions and parameter V246 is for manual triggering. When the recorder has been triggered and a recording stored in the memory, the value of parameter V246 changes from 0 to 1.

The default triggering condition is the operation of protection stages.

4.1.7.5. Settings and unloading

Setting parameters for the disturbance recorder are V parameters V241...V246 and M parameters M18, M20 and M80.

Parameter	Description
V241	Specifies the signal(s) to be used for triggering: signal(s) from the internal protection stages and/or the binary input signal
V242	Defines whether the recorder is to be triggered on the falling or rising edge of the signal(s) specified by parameter V241
V243	Defines the external binary input signal to be used for triggering
V244	Defines whether the rising or falling edge of the binary input signal is to trigger the recorder

Parameter	Description
V245	Length of recording after triggering. The total recording length is 40 cycles.
V246	Status of the recorder
M18	Used for giving the disturbance recorder a unique identification number
M20	Used for designating the disturbance recorder the name of the station where the relay is located. The maximum length of a name is 15 characters.
M80	Used for designating the rated voltage and unit of the primary voltage transformer(s). The format of the parameter is XXXX,YY; where XXXX is the voltage value ranging between 0.00...600, and YY is the unit, e.g. 20.0,kV. The rated voltage and unit are used for calculating the primary values for the analogue channels in a special PC program used for unloading the disturbance recorder. Setting the parameter M80 also enables display of the primary values on the LCD.

4.1.7.6. Event code

It is possible to set the disturbance recorder to generate an event code into the event register when the recorder is triggered. To enable the event code to be generated, set the event mask in serial parameter V158. The event code generated is E31.

4.1.8. Recorded data

When one of the overvoltage stages starts, recording of the highest measured voltage value as well as the start duration, measured as a percentage of the set operate time, begins. If the started protection stage resets before the operate time has elapsed, the highest voltage value captured during the starting and the start duration are stored in the event register at the moment of reset.

On the other hand, if either of the overvoltage stages trips, both the values at the moment of tripping and the values captured during the starting are memorized.

The same principle applies to the undervoltage stages: if a stage only starts, the lowest voltage value as well as the lowest calculated positive-phase-sequence value and the start duration are stored in the event register. In case the starting is followed by a trip, the values at the moment of tripping as well as the values captured during the starting are memorized.

The event register takes the latest five events. The recording of a new sequence is only possible after all the stages that caused the previous event have reset.

How many times (range: 0...255) a protection function has started can be read via the MMI submenu “Number of starts” under “Recorded data” or via the parameters V5...V8.

Table 4.1.8-1 Recorded data

REGISTER	Recorded data
EVENT1	The highest voltage value measured during the start sequence of an overvoltage stage as a multiple of the rated voltage U_n. The lowest voltage value measured during the start sequence of an undervoltage stage as a multiple of the rated voltage U_n. The voltage measured at the moment of tripping. The lowest value of the positive-phase-sequence voltage at start of stage U< or U<<. Duration of the latest start situation of stages t>, t>>, t< or t<< expressed as a percentage of the set operate time or, at IDMT mode of operation, of the calculated operate time. Time stamp for the event; date and time. The previous recorded values are pushed forward one step in the event register while the oldest values are lost. The last five recorded events are memorized so that the most recent values are stored in register EVENT 1 and the other four recorded values in registers EVENT 2...EVENT 5. When one of the stages operates, the duration reading (t>, t>>, t< or t<<) for the stage is 100%.
EVENT 2	The operation principle is the same as that of EVENT 1.
EVENT 3	The operation principle is the same as that of EVENT 1.
EVENT 4	The operation principle is the same as that of EVENT 1.
EVENT 5	The operation principle is the same as that of EVENT 1.

4.1.9. External serial communication

4.1.9.1. Communication ports

The relay is provided with two serial communication ports: an optical PC-connection on the front panel and an RS-485 connection on the rear panel.

The 9-pole RS-485 connection connects the relay to the distribution automation system via a SPA bus. A fibre-optic interface module of type RER 103 is used to connect the relay to the fibre-optic communication bus. Note that the auxiliary voltage must always be disconneced while connecting the RER 103 to the relay.

Although the module RER 103 supports both SPA bus and LON bus communication, the relay only allows the use of SPA bus. LON communication is possible with a separate LSG module.

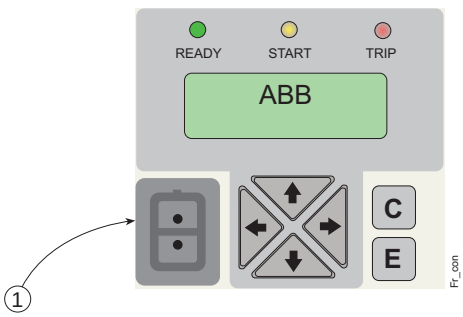

Fig. 4.1.9.1.-1 Front connector (1) for remote communication

Via the optical PC-connector on the front panel the relay is connected to a PC for setting. The front interface uses SPA-bus protocol.

The optical PC-connector isolates the PC from the relay galvanically. The connection consists of a transmitter stage and a receiver stage. The front connector is standardized for ABB relay products and requires a specific opto-cable (ABB art. no 1MKC950001-1). The cable is connected to the serial RS-232C port of the PC and it is powered by RS-232C control signals. The cable works correctly with baud rates 4.8 and 9.6 kbps.

The following serial communication parameters shall be used for RS-232C:

- Number of data bits 7
- Number of stop bits 1
- Parity even
- Baud rate 9.6 kbps as default

Relay data, such as events, setting values, all input and recorded data, can be read via the optical PC-interface.

When setting values are altered via the optical PC-interface, the relay checks that the entered parameter values are within the permitted setting range. The relay refuses to accept too high or too low a setting value and keeps the former setting unchanged.

4.1.9.2. Event codes

Special codes have been determined to represent certain events, such as start and operation of protection stages and different states of output signals. The event codes can be transferred to higher system levels via the rear connector.

Events E1…E51 are stored in the event register of the relay. The maximum capacity of the register is 60 events. Under normal conditions the register is empty.

The content of the register can be read with L command 5 events at a time. Using the L command erases the read events from the register. (An exception to this are events E50 and E51 that have to be reset with C command.) Should a fault occur, for example in data communication, these events can be re-read with B command. If needed, the B command can also be repeated.

Events to be included in event reporting are marked with a multiplier 1. The event mask is formed by the sum of the weighting factors of all those events that are to be included in event reporting.

Table 4.1.9.2-1 Event masks

Event mask	Code	Setting range	Default setting
V155	E1...E8	0...255	85
V156	E9...E16	0...255	85
V157	E17...E24	0...255	3
V158	E31	0 or 1	1

Table 4.1.9.2-2 Event codes E1…E8

Code	Event	Weighting factor	Default value
E1	Starting of stage U>	1	1
E2	Starting of stage U> reset	2	0
E3	Tripping of stage U>	4	1
E4	Tripping of stage U> reset	8	0
E5	Starting of stage U>>	16	1
E6	Starting of stage U>> reset	32	0
E7	Tripping of stage U>>	64	1
E8	Tripping of stage U>> reset	128	0
	Default value of event mask V155		85

Table 4.1.9.2-3 Event codes E9…E16

Code	Event	Weighting factor	Default value
E9	Starting of stage U<	1	1
E10	Starting of stage U< reset	2	0
E11	Tripping of stage U<	4	1
E12	Tripping of stage U< reset	8	0
E13	Starting of stage U<<	16	1
E14	Starting of stage U<< reset	32	0
E15	Tripping of stage U<<	64	1
E16	Tripping of stage U<< reset	128	0
	Default value of event mask V156		85

Table 4.1.9.2-4 Event codes E17…E24

Code	Event	Weighting factor	Default value
E17	PO1 activated	1	1
E18	PO1 reset	2	1
E19	PO2 activated	4	0
E20	PO2 reset	8	0
E21	SO1 activated	16	0
E22	SO1 reset	32	0
E23	SO2 activated	64	0
E24	SO2 reset	128	0
	Default value of event mask V157		3

Table 4.1.9.2-5 Event code E31

Code	Event	Weighting factor	Default value
E31	Disturbance recorder triggered	1	1
	Default value of event mask V158		1

Explanations for default values:

0 = not included in event reporting

1 = included in event reporting

Table 4.1.9.2-6 Event codes E50 and E51

Code	Event
E50	Restart of relay
E51	Overflow of event register

Events E50 and E51 are always included in event reporting.

4.1.9.3. Remote transfer data

In some cases, altering parameter values via serial communication requires the use of the SPA password. The password is a number within the range 1...999. The default value for the SPA password is 1.

Password protection is removed by entering the password number in parameter V160 and reinstated by writing the same password to parameter V161. Loss of the auxiliary supply voltage also reinstates protection.

For example, to change a value of setting group 1, stage U> to 0.7 x U_n, proceed as follows:

- Enter the password, WV160:1
- Write a new value, WS41:0.7
- Reinstate password protection, WV161:1

The SPA password can be changed via the serial bus by entering first the current password in parameter V160, and writing then a new password to parameter V161.

The MMI password can be changed via parameter V162 but it is not possible to read the password from this parameter.

Abbreviations used in following tables:

- R = readable data
- W = writeable data
- P = password protected writeable data
- I = input data
- S = setting value
- V = recorded data/ parameter
- M = disturbance recorder parameter
- O = output data

Settings

Table 4.1.9.3-1 Settings

Variable	Actual settings (R)	Group 1 (R, W, P)	Group 2 (R, W, P)	Setting range
Start voltage of stage U>	S1	S41	S81	0.60...1.40 x U_n
Operate time of stage U>	S2	S42	S82	0.06...600 s
Time multiplier k>	S3	S43	S83	0.05...2.00
Drop-off/pick-up ratio D/P> of stage U>	S4	S44	S84	0.95...0.99
Start voltage of stage U>>	S5	S45	S85	0.80...1.60 x U_n
Operate time of stage U>>	S6	S46	S86	0.05...600 s
Time multiplier k>>	S7	S47	S87	0.05...2.00
Start voltage of stage U<	S8	S48	S88	0.30..1.20 x U_n
Operate time of stage U<	S9	S49	S89	0.10...600 s
Time multiplier k<	S10	S50	S90	0.10...2.00
Drop-off/pick-up ratio D/P< of stage U<	S11	S51	S91	1.01...1.05
Start voltage of stage U<<	S12	S52	S92	0.30..1.20 x U_n
Operate time of stage U<<	S13	S53	S93	0.10...600 s
Time multiplier k<<	S14	S54	S94	0.10...2.00
Checksum, SGF 1	S15	S55	S95	0...31
Checksum, SGF 2	S16	S56	S96	0...255
Checksum, SGF 3	S17	S57	S97	0...255
Checksum, SGF 4	S18	S58	S98	0...63
Checksum, SGB 1	S19	S59	S99	0...255
Checksum, SGR 1	S20	S60	S100	0...15
Checksum, SGR 2	S21	S61	S101	0...15
Checksum, SGR 3	S22	S62	S102	0...15
Checksum, SGR 4	S23	S63	S103	0...15
Checksum, SGR 5	S24	S64	S104	0...15
Checksum, SGR 6	S25	S65	S105	0...15
Checksum, SGR 7	S26	S66	S106	0...15
Checksum, SGR 8	S27	S67	S107	0...15
Operate time of circuit-breaker failure protection	S121	S121	S121	0.10...1.00 s
Time setting for disabling a new trip indication on LCD	S122	S122	S122	0...999 min

Recorded data

Parameter V1 indicates the highest and parameter V2 the lowest voltage value measured as multiples of the rated voltage U_n since the last reset. Parameter V3 shows the average voltage value during one minute's time, updated once a minute. The average voltage during a ten minutes' period is shown by parameter V4. The value is updated for the first time ten minutes after the relay start-up and after that once a minute. Parameters V5...V8 indicate the number of starts of the protection stages, parameter V9 shows the operation indication code and parameter V10 the stage that has tripped.

Table 4.1.9.3-2 Recorded data: Parameters V1…V10

Recorded data	**Para-meter**	**R/W**	**Value**
Maximum voltage measured after reset	V1	R	0...2 x U_n
Minimum voltage measured after reset	V2	R	0...2 x U_n
Average voltage during 1 minute	V3	R	0...2 x U_n
Average voltage during 10 minutes	V4	R	0...2 x U_n
Number of starts of stage U>	V5	R	0...255
Number of starts of stage U>>	V6	R	0...255
Number of starts of stage U<	V7	R	0...255
Number of starts of stage U<<	V8	R	0...255
Operation indication code	V9	R	0 = --- 1 = starting of stage U> 2 = tripping of stage t> 3 = starting of stage U>> 4 = tripping of stage t>> 5 = starting of stage U< 6 = tripping of stage t< 7 = starting of stage U<< 8 = tripping of stage t<< 9 = tripping of CBFP unit
Stage/voltage that caused tripping; the value may also be a combination of two or more of the individual values, e.g. 24 (= 8 + 16)	V10	R	1 = U_{12}> 2 = U_{23}> 4 = U_{31}> 8 = U_{12}>> 16 = U_{23}>> 32 = U_{31}>> 64 = U_{12}< 128 = U_{23}< 256 = U_{31}< 512 = U_{12}<< 1024 = U_{23}<< 2048 = U_{31}<< 4096 = U1s

The last five recorded values can be read with parameters V11...V100. Event n denotes the latest recorded value, n-1 the next one, and so forth.

Recorded data

Recorded data	Event (R)					Value
	n	n-1	n-2	n-3	n-4	
Maximum voltage measured at start of stage U> or U>>	V11	V31	V51	V71	V91	0...2 x U_n
Minimum voltage measured at start of stage U< or U<<	V12	V32	V52	V72	V92	0...2 x U_n
Voltage measured at the moment of tripping.	V13	V33	V53	V73	V93	0...2 x U_n
The lowest value of the positive-phase-sequence voltage at start of stage U< or U<<.	V14	V34	V54	V74	V94	0...2 x U_n
Start duration, stage U>	V15	V35	V55	V75	V95	0...100 %
Start duration, stage U>>	V16	V36	V56	V76	V96	0...100 %
Start duration, stage U<	V17	V37	V57	V77	V97	0...100 %
Start duration, stage U<<	V18	V38	V58	V78	V98	0...100 %
Time stamp of registered value, date	V19	V39	V59	V79	V99	YY-MM-DD
Time stamp of registered value, time	V20	V40	V60	V80	V100	HH.MM; SS.mss

Disturbance recorder

Table 4.1.9.3-3 M parameters for disturbance recorder

Description	Parameter	R/W	Value/Note
Analogue channels in use	M13	R	7 (=00000111B)
Digital channels in use	M14	R	255 (=11111111B)
Sampling rate	M15	R	800 or 960 Hz
Station identification/ unit number	M18	R/W	0…9999
Rated frequency	M19	R	50 or 60 Hz
Station name	M20	R/W	Max 15 characters
Digital channel texts	M40...47	R	
Analogue channel texts	M60...62	R	
Analogue channel(s): rated voltage and unit of primary voltage transformer(s)	M80[1)]	R/W	XXXX,YY; where XXXX: 0.00...600, YY: V or kV (e.g. 20.0,kV)

[1)] This parameter being set to the default value 0.00 causes that three dashes are shown instead of the primary value on the LCD.

Table 4.1.9.3-4 V parameters for disturbance recorder

Description	Parameter	R/W	Value
Internal trigger signals' checksum	V241	R,W	0...127, see table 4.1.9.3-5
Internal trigger signal's edge	V242	R,W	0...127, 0=rising, 1=falling
External trigger signal (BI signal)	V243	R,W	0 / 1, see table 4.1.9.3-6
External trigger signal's edge	V244	R,W	0 / 1, 0=rising, 1=falling
Post-triggering recording length	V245	R,W	0...40, amount of periods
Triggering state, clearing and restart	V246	R,W	R: 0=recorder not triggered 1=recorder triggered and recording stored in the memory W: 0=clear recorder memory 2=download restart; sets first information and time stamp for triggering ready to be read 4=manual triggering

Table 4.1.9.3-5 Disturbance recorder internal triggering

Event	Weighting factor	Default value of triggering mask, V241	Default value of triggering edge, V242
Starting of stage U>	1	0	0
Tripping of stage U>	2	1	0
Starting of stage U>>	4	0	0
Starting of stage U<	8	0	0
Tripping of stage U<	16	1	0
Starting of stage U<<	32	0	0
Tripping of stage U<<	64	1	0
Not in use	-	0	0
Checksum		82	0

Table 4.1.9.3-6 Disturbance recorder external triggering

Event	Weighting factor	Default value of triggering mask, V243	Default value of triggering edge, V244
External binary input BI	1	1	0
Not in use	-	0	0
Not in use	-	0	0
Not in use	-	0	0
Not in use	-	0	0
Not in use	-	0	0

Table 4.1.9.3-6 Disturbance recorder external triggering

Event	Weighting factor	Default value of triggering mask, V243	Default value of triggering edge, V244
Not in use	-	0	0
Not in use	-	0	0
Checksum		1	0

Control parameters

Table 4.1.9.3-7 Control parameters

Description	Para-meter	R/W	Value
Resetting of output contacts with the latching feature	V101	W	1=reset
Resetting of registers and output contacts with the latching feature	V102	W	1=reset
Rated frequency	V133	R,W (P)	50=50 Hz 60=60 Hz
Nominal voltage	V134	R,W (P)	100, 110, 115, 120 (V)
Remote control of settings	V150	R,W	0=setting group 1 1=setting group 2
Event mask for U> and U>>	V155	R,W	0...255, see Event codes
Event mask for U< and U<<	V156	R,W	0...255, see Event codes
Event mask for output contacts' events	V157	R,W	0...255, see Event codes
Event mask for disturbance recorder	V158	R,W	0 / 1, see Event codes
Entering the password for settings	V160	W	1...999
Changing the password or reinstating password protection	V161	W (P)	1...999
Changing the password for MMI	V162	W	1...999 999=password disabled
Activating the self-supervision READY LED	V165	W	0=normal operation 1=self-supervision READY LED blinking
LED test for start and trip indicators	V166	W (P)	0=start and trip LEDs off 1=trip LED on, start LED off 2=start LED on, trip LED off 3=start and trip LEDs on
Default settings	V167	W (P)	2=Restore factory settings
Internal fault code	V169	R	0...255
SPA address of the relay	V200	R, W	1...254
Data transfer rate, kbps	V201	R, W	4.8 or 9.6
Rear communication	V202	W	1=communication to rear connector
Relay serial number	V230	R	ERxxxxxx
CPU serial number	V231	R	MRxxxxxx
Hardware number	V232	R	1MRS090409-BAA
Test date	V233	R	YYYYMMDD
Software number	V234	R	1MRS118017
Software revision	V235	R	A...Z
Date reading and setting (RED 500 format)	V250	R, W	YY-MM-DD
Time reading and setting (RED 500 format)	V251	R, W	HH.MM; SS.mss
Reading of event register	L	R	Time, channel number and event code
Re-reading of event register	B	R	Time, channel number and event code

Table 4.1.9.3-7 Control parameters

Description	Para-meter	R/W	Value
Type designation of the relay	F	R	REU 523
Reading of relay state data	C	R	0=normal state 1=relay been subject to automatic reset 2=overflow of event register 3=both events 1 and 2
Resetting of relay state data	C	W	0=resetting all events 1=reset only E50 2=reset only E51 4=reset all events including E51 but not E50
Time reading and setting	T	R, W	00.000...59.999 s
Date and time reading and setting	D	R, W	YY-MM-DD HH.MM;SS.mss

Input and output signals

The measured voltages and the status of the binary input signal can be read (R) with parameters I1...I4. When the value of parameter I4 is 1, the binary input is energized. The value of the calculated positive-phase-sequence voltage can be read via parameter I5.

Table 4.1.9.3-8 Inputs

Description	Parameters (R)	Value
Voltage U_{12}	I1	0...2 x U_n
Voltage U_{23}	I2	0...2 x U_n
Voltage U_{31}	I3	0...2 x U_n
Binary input signal BI	I4	0 or 1
Positive-phase-sequence voltage	I5	0...2 x U_n

Each protection stage has its internal output signal. These signals can be read (R) with parameters O1...O8. States of the output contacts can be read (R) or changed (W) with parameters O9...O12. When any of the values of parameters O1...O12 changes from 0 to 1, it is recorded in the corresponding parameter of O21...O32. The values recorded can be read via these parameters and they remain stored until reset.

Table 4.1.9.3-9 Output signals

Status of the protection stages	State of stage (R)	Recorded functions (R)	Value
Starting of stage U>	O1	O21	0 or 1
Tripping of stage U>	O2	O22	0 or 1
Starting of stage U>>	O3	O23	0 or 1
Tripping of stage U>>	O4	O24	0 or 1
Starting of stage U<	O5	O25	0 or 1
Tripping of stage U<	O6	O26	0 or 1
Starting of stage U<<	O7	O27	0 or 1
Tripping of stage U<<	O8	O28	0 or 1

Table 4.1.9.3-10 Outputs

Operation of output contacts	State of output (R,W,P)	Recorded functions (R)	Value
Output PO1	O9	O29	0 or 1
Output PO2	O10	O30	0 or 1
Output SO1	O11	O31	0 or 1
Output SO2	O12	O32	0 or 1
Enabling output contacts PO1, PO2, SO1 and SO2	O41	-	0 or 1

4.1.10. Relay parameterization

Local parameterization

The parameters of the relay can be set either locally via the MMI or externally via serial communication with the Relay Setting Tool. When the parameters are set locally the setting parameters can be chosen from the hierarchical menu structure. The desired language for parameter description can be selected. Refer to “Operator’s Manual”.

External parameterization

The Relay Setting Tool is used for parameterizing the relay units. The parameters can be set off-line in a PC and downloaded to the relay over a communication port. The views for parameterization included in the Relay Setting Tool menu structure are the same as the views on the technical level of the local MMI.

4.2. Design description

4.2.1. Input / output connections

The energizing voltages are connected to terminals X1.1/1-3, X1.1/4-6 and X1.1/7-9. The nominal voltage (100/ 110/ 115/ 120 V) of the matching transformers has to be selected with SPA parameter V134 or via the MMI. The relay can also be used in single-phase applications by setting switch 1 in switchgroup SGF2.

The binary input X2.1/17-18 can be used in three different ways: 1) as the binary input for an external blocking signal, 2) as the binary input for unlatching the trip relay, or 3) as the binary input for the remote control of relay settings. The requested function is selected with the switches of switchgroup SGB. The binary input can also be used as a trigger signal for the disturbance recorder; this function is selected with SPA parameter V243.

The auxiliary supply voltage of the relay is connected to terminals X2.1/1-2. At dc supply the positive lead is connected to terminal X2.1/1. For further details, see the description of the auxiliary voltage. The permitted auxiliary voltage range of the relay is marked on the front panel of the relay.

Output contacts PO1 and PO2 are heavy-duty trip contacts, capable of controlling most circuit breakers. The operate signals of different protection stages are routed to the relays with switches 1 and 2 of switchgroups SGR1...SGR8. On delivery from factory the trip signals of all the protection stages are routed to both the PO1 and PO2 contacts.

Output contacts SO1 and SO2 can be used for signalling on operation of the relay. The signals to be routed to the output contacts SO1 and SO2 are selected with switches 3 and 4 of switchgroups SGR1...SGR8. On delivery from factory the start signals of all the protection stages are routed to both the SO1 and SO2 contacts.

Output contact IRF functions as an output contact for the self-supervision system of the protection relay. The IRF relay is energized under normal operating conditions and contact gap X2.1/13-15 is closed. If a fault is detected by the self-supervision system, or on loss of the auxiliary supply, the output contact drops off and contact X2.1/13-14 closes.

In the following picture, a rear view of the relay, showing three connecting sockets: one for matching transformers, one for power supply and one for serial communication.

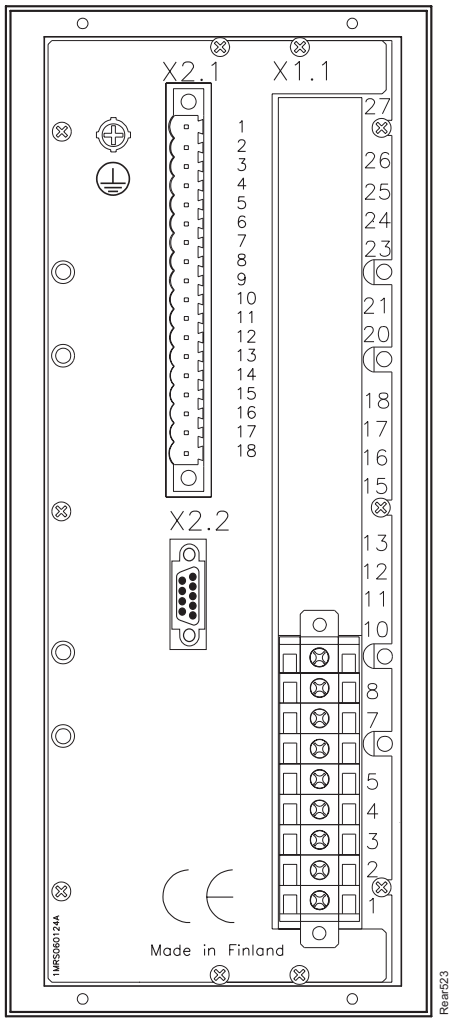

Fig. 4.2.1.-1 Rear view of the combined overvoltage and undervoltage relay

Table 4.2.1-1 Inputs for voltages

Terminal	Function
X1.1-1	U_{12} *
X1.1-3	U_{12}
X1.1-4	U_{23} *
X1.1-6	U_{23}
X1.1-7	U_{31} *
X1.1-9	U_{31}

*Note!
The wiring has to be done identically for each of the matching transformers used.

Table 4.2.1-2 Auxiliary supply voltage

Terminal	Function
X2.1-1	Input+
X2.1-2	Input-

Table 4.2.1-3 Output contacts

Terminal	Function
X2.1-3	PO1, closing contact
X2.1-4	
X2.1-5	PO2, closing contact
X2.1-6	
X2.1-7	SO1, common
X2.1-8	SO1, NC
X2.1-9	SO1, NO
X2.1-10	SO2, common
X2.1-11	SO2, NC
X2.1-12	SO2, NO

Table 4.2.1-4 Internal Relay Fault contact (IRF)

Terminal	Function
X2.1-13	Internal relay fault, common
X2.1-14	Closed; IRF, or U_{aux} disconnected
X2.1-15	Closed; no IRF, and U_{aux} connected

Table 4.2.1-5 Binary input BI

Terminal	Function
X2.1-17	Input+
X2.1-18	Input-

4.2.2. Serial communication connections

The relay is interfaced with a fibre-optic SPA bus by means of the bus connection module RER 103 via a 9-pole, D-type subminiature connector X2 located on the rear panel of the device. The terminals of the fibre-optic cables are connected to the counter terminals Rx (Receiver) and Tx (Transmitter) of the bus connection module. The fibre-optic cables are linked from one relay to another and to the substation level communication unit, for instance type SRIO 1000M.

The optical PC-connection on the relay front panel is used to connect the relay to a fibre-optic SPA bus via an opto-cable 1MKC950001-1.

Table 4.2.2-1 SPA logic/ RS-485 connection for RER 103

Terminal	**Function**
X.2.2-1	Data A (data signal +)
X.2.2-2	Data B (data signal -)
X.2.2-3	RTS A (request to send +)
X.2.2-4	RTS B (request to send -)
X.2.2-5	COL A (2.8 V on relay)
X.2.2-6	COL B (2.2 V on relay)
X.2.2-7	GND
X.2.2-8	NC
X.2.2-9	+5 Vdc, supply voltage (max. 200 mA)

4.2.3. Technical data

Table 4.2.3-1 Dimensions

Width 111.4 mm
Height, frame 265.9 mm (6U), box 255.8 mm
Depth 235 mm (245.1 mm with a protective rear cover, available as an option)
Enclosure size 1/4 (x 19”)
Weight of the relay ~3.2 kg

Table 4.2.3-2 Power supply

U_r =110/120/220/240 V ac U_r =48/60/110/125/220 V dc	
Operating range	80…265 V ac 38…265 V dc
Relay power start-up time, typical	300 ms
Burden of auxiliary supply under quiescent/operating condition	~ 4 W/~10 W
Ripple in dc auxiliary voltage	Max 12 % of the dc value
Interruption time in auxiliary dc voltage without resetting	< 30 ms at 48 V dc < 100 ms at 110 V dc < 500 ms at 220 V dc

Table 4.2.3-3 Energizing inputs

Rated frequency	50/60 Hz ±5 Hz
Rated voltage U_n	100/110/115/120 V
Maximum input voltage	
• continuously	2 x U_n
• for 10 s	3 x U_n
Power consumption at U_n	< 0.1 VA (typical 0.03 VA)

Table 4.2.3-4 Measuring range

Measured voltages on phases U_{12}, U_{23} and U_{31} as multiples of the rated voltages of the energizing inputs	0…2 x U_n
Measuring accuracy (f_n ±5 Hz) at 0.20...2.00 x U_n	±1.5 %

Table 4.2.3-5 Binary input

Operating range	18…265 V dc
Rated voltage	24/48/60/110/220 V dc
Current drain	~ 2…25 mA
Power consumption	< 0.8 W

Table 4.2.3-6 Signal outputs (SO1, SO2) and self-supervision output (IRF)

Rated voltage	250 V ac/dc
Continuous carry	5 A
Make and carry for 3.0 s	8 A
Make and carry for 0.5 s	10 A
Breaking capacity when the control circuit time-constant L/R < 40 ms, at 48/110/220 V dc	1 A / 0.25 A / 0.15 A
Minimum contact load	100 mA at 24 V ac/dc

Table 4.2.3-7 Power outputs (PO1, PO2)

Rated voltage	250 V ac/dc
Continuous carry	5 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control circuit time-constant L/R < 40 ms, at 48/110/220 V dc	5 A / 3 A / 1 A
Minimum contact load	100 mA at 24 V ac/dc

Table 4.2.3-8 Enclosure class

Front side	IP 54 (flush-mounted)
Rear side, connection terminals	IP20
Note! A rear protective cover (accessory part) can be used to protect and shield the rear of the case.	

Table 4.2.3-9 Environmental tests

Specified service temperature range	-10...+55 °C
Transport and storage temperature range	-40...+70 °C
Dry heat test	according to IEC 60068-2-2
Dry cold test	according to IEC 60068-2-1
Damp heat test, cyclic	according to IEC 60068-2-30

Table 4.2.3-10 Electromagnetic compatibility tests

EMC immunity test level requirements consider the demands in the generic standard EN 50082-2	
1 MHz burst disturbance test, class III	According to IEC 60255-22-1
• Common mode	2.5 kV
• Differential mode	1.0 kV
Electrostatic discharge test, class III	According to IEC 61000-4-2
• For contact discharge	6 kV
• For air discharge	8 kV
Radio frequency interference tests	
• Conducted, common mode	According to IEC 61000-4-6 10 V (rms), f = 150 kHz…80 MHz
• Radiated, amplitude-modulated	According to IEC 61000-4-3 10 V/m (rms), f = 80…1000 MHz
• Radiated, pulse-modulated	According to ENV 50204 10 V/m, f = 900 MHz
• Radiated, test with a portable transmitter	According to IEC 60255-22-3, method C; f = 77.2 MHz, P = 6 W; f = 172.25 MHz, P = 5W
Fast transient disturbance tests	According to IEC 60255-22-4 and IEC 61000-4-4
• ac/dc ports	4 kV
• Binary input	2 kV
Surge immunity test	According to IEC 61000-4-5
• Power supply, ac/dc ports	4 kV, common mode 2 kV, differential mode
• I/O ports	2 kV, common mode 1 kV, differential mode
Power frequency (50 Hz) magnetic field IEC 61000-4-8	100 A/m
Voltage dips and short interruptions	According to IEC 61000-4-11 30 % / 10 ms 60 % / 100 ms >95 % / 5000 ms
Electromagnetic emission tests	According to EN 55011 and EN 50081-2
• Conducted, RF-emission (Mains terminal)	EN 55011, class A
• Radiated RF-emission	EN 55011, class A
CE approval	Complies with the EMC directive 89/336/EEC and the LV directive 73/23/EEC

Table 4.2.3-11 Standard tests

Insulation tests	
Dielectric tests • Test voltage	According to IEC 60255-5 2 kV, 50 Hz, 1 min
Impulse voltage test • Test voltage	According to IEC 60255-5 5 kV, unipolar impulses, waveform 1.2/50 µs, source energy 0.5 J
Insulation resistance measurements • Isolation resistance	According to IEC 60255-5 > 100 MΩ, 500 V dc
Mechanical tests	
Vibration tests (sinusoidal) Shock and bump test	According to IEC 60255-21-1 class I According to IEC 60255-21-2 class I

Table 4.2.3-12 Data communication

Rear interface, connector X2.2 • RS-485 connection for fibre-optic interface module RER 103 • SPA-bus protocol • 4.8 or 9.6 kbps
Front panel • Optical RS-232 connection for opto-cable • SPA-bus protocol • 4.8 or 9.6 kbps

Auxiliary voltage

For its operation the relay requires a secured auxiliary voltage supply. The internal power supply of the relay forms the voltages required by the relay electronics. The power supply is a galvanically isolated (flyback-type) DC/DC converter. A green READY LED on the front panel is lit when the power supply module is operating.

Input voltage ranges are:

- AC range 80...265 V ac, rated 110/120/220/240 V
- DC range 38...265 V dc, rated 48/60/110/125/220 V

The primary side of the power supply is protected with a fuse located on the PCB of the relay. The fuse size is 2.5 A (slow). In case the fuse is assumed to be blown, contact your relay supplier.

5. Ordering Information

Order number	REU523A 409-BAA
Protective cover for rear connectors	1MRS060132
Flush mounting kit	1MRS050209
Semi-flush mounting kit	1MRS050253
Wall mounting kit	1MRS050240
Side-by-side mounting kit	1MRS050241
19” Rack mounting kit	1MRS050257
Optic bus connection module	1MRS090701 (RER 103)
Opto-cable	1MKC950001-1

6. References

Other available manuals:

- Operator’s Manual, 1MRS751057-MUM
- Installation Manual, 1MRS750526-MUM

7. Index

Abbreviations

BI	Binary input
CBFP	Circuit-breaker failure protection
CPU	Central processing unit
IDMT	Inverse definite minimum time characteristic
IRF	Internal relay fault
LCD	Liquid Crystal Display
LED	Light-emitting diode
LSG	LON®/SPA Gateway, SPA-ZC 102
MMI	Man-Machine Interface
PCB	Printed Circuit Board
PO1, PO2	Power outputs
SGB	Switchgroups for binary input
SGF	Switchgroups for functions
SGR	Switchgroups for output contacts
SO1, SO2	Signal outputs
U_{12}, U_{23}, U_{31}	Phase-to-phase voltages
U1s	Positive-phase-sequence voltage

8. Check Lists

Table 8.-1 Setting group 1

Variable	Group 1 (R, W, P)	Setting range	Default setting	Customer's setting
Start voltage of stage U>	S41	0.60...1.40 x U_n	1.20 x U_n	
Operate time of stage U>	S42	0.06...600 s	0.06 s	
Time multiplier k>	S43	0.05...2.00	0.05	
Drop-off/pick-up ratio D/P> of stage U>	S44	0.95...0.99	0.97	
Start voltage of stage U>>	S45	0.80...1.60 x U_n	1.20 x U_n	
Operate time of stage U>>	S46	0.05...600 s	0.05 s	
Time multiplier k>>	S47	0.05...2.00	0.05	
Start voltage of stage U<	S48	0.30...1.20 x U_n	0.30 x U_n	
Operate time of stage U<	S49	0.10...600 s	0.10 s	
Time multiplier k<	S50	0.10...2.00	0.10	
Drop-off/pick-up ratio D/P< of stage U<	S51	1.01...1.05	1.03	
Start voltage of stage U<<	S52	0.30...1.20 x U_n	0.30 x U_n	
Operate time of stage U<<	S53	0.10...600 s	0.10 s	
Time multiplier k<<	S54	0.10...2.00	0.10	
Checksum, SGF 1	S55	0...31	0	
Checksum, SGF 2	S56	0...255	0	
Checksum, SGF 3	S57	0...255	170	
Checksum, SGF 4	S58	0...63	0	
Checksum, SGB 1	S59	0...255	0	
Checksum, SGR 1	S60	0...15	12	
Checksum, SGR 2	S61	0...15	3	
Checksum, SGR 3	S62	0...15	12	
Checksum, SGR 4	S63	0...15	3	
Checksum, SGR 5	S64	0...15	12	
Checksum, SGR 6	S65	0...15	3	
Checksum, SGR 7	S66	0...15	12	
Checksum, SGR 8	S67	0...15	3	

Table 8.-2 Setting group 2

Variable	Group 2 (R, W, P)	Setting range	Default setting	Customer's setting
Start voltage of stage U>	S81	0.60...1.40 x U_n	1.20 x U_n	
Operate time of stage U>	S82	0.06...600 s	0.06 s	
Time multiplier k>	S83	0.05...2.00	0.05	
Drop-off/pick-up ratio D/P> of stage U>	S84	0.95...0.99	0.97	
Start voltage of stage U>>	S85	0.80...1.60 x U_n	1.20 x U_n	
Operate time of stage U>>	S86	0.05...600 s	0.05 s	
Time multiplier k>>	S87	0.05...2.00	0.05	
Start voltage of stage U<	S88	0.30...1.20 x U_n	0.30 x U_n	

Table 8.-2 Setting group 2

Variable	Group 2 (R, W, P)	Setting range	Default setting	Customer's setting
Operate time of stage U<	S89	0.10...600 s	0.10 s	
Time multiplier k<	S90	0.10...2.00	0.10	
Drop-off/pick-up ratio D/P< of stage U<	S91	1.01...1.05	1.03	
Start voltage of stage U<<	S92	0.30...1.20 x U_n	0.30 x U_n	
Operate time of stage U<<	S93	0.10...600 s	0.10 s	
Time multiplier k<<	S94	0.10...2.00	0.10	
Checksum, SGF 1	S95	0...31	0	
Checksum, SGF 2	S96	0...255	0	
Checksum, SGF 3	S97	0...255	170	
Checksum, SGF 4	S98	0...63	0	
Checksum, SGB 1	S99	0...255	0	
Checksum, SGR 1	S100	0...15	12	
Checksum, SGR 2	S101	0...15	3	
Checksum, SGR 3	S102	0...15	12	
Checksum, SGR 4	S103	0...15	3	
Checksum, SGR 5	S104	0...15	12	
Checksum, SGR 6	S105	0...15	3	
Checksum, SGR 7	S106	0...15	12	
Checksum, SGR 8	S107	0...15	3	

Table 8.-3 Control parameters

Variable	Parameter	Setting range	Default setting	Customer's setting
Rated frequency	V133	50 / 60 Hz	50	
Rated Voltage	V134	100, 110, 115, 120 V	100	
Remote control of settings	V150	0 / 1	0	
Event mask for U> and U>>	V155	0...255	85	
Event mask for U< and U<<	V156	0...255	85	
Event mask for output contacts' events	V157	0...255	3	
SPA address of the relay	V200	1...254	1	
Data transfer rate	V201	4.8 or 9.6 kbps	9.6	
Operate time of circuit-breaker failure protection	S121	0.10...1.00 s	0.10	
Time setting for disabling new trip indication on LCD	S122	0...999 min	60	

Table 8.-4 Parameters for disturbance recorder

Information	Parameter	Setting range	Default setting	Customer's setting
Event mask for disturbance recorder	V158	0 / 1	1	
Internal trigger signals' checksum	V241	0...127	82	
Internal trigger signal's edge	V242	0...127	0	
External trigger signal (BI signal)	V243	0 / 1	1	
External trigger signal's edge	V244	0 / 1	0	
Post-triggering recording length	V245	0...40	20	
Station identification/unit number	M18	0…9999	0000	
Station name	M20	Max 15 characters	- ABB -	
Analogue channel(s): rated voltage and unit of primary voltage transformer(s)	M80	Rated voltage 0.00...600, unit V or kV	0.00, kV	

9. Customer Feedback

Date: _____ To fax: +358 10 224 1094

Category: _Comment __Query __Complaint

In case of feedback related to a specific product, please state the name of the product.

Product: _____

Description: _____

_____

_____

_____

_____

_____

Initiator: _____

Issuer: _____

Company: _____

Country: _____

Telefax no/
e-mail address: _____

If necessary, additional pages may be enclosed.

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