

**Contents**

<b>1. Introduction .....</b>	<b>2</b>
1.1 Features.....	2
1.2 Application .....	2
1.3 Input description .....	3
1.4 Output description.....	3
<b>2. Description of operation.....</b>	<b>4</b>
2.1 Configuration .....	4
2.2 Measuring mode .....	4
2.3 Operation criteria .....	4
2.4 Setting groups.....	5
2.5 Test mode.....	5
2.6 START and TRIP outputs .....	5
2.7 Resetting.....	6
<b>3. Parameters and events .....</b>	<b>7</b>
3.1 General .....	7
3.2 Setting values .....	8
3.2.1 Actual settings .....	8
3.2.2 Setting group 1 .....	8
3.2.3 Setting group 2 .....	8
3.2.4 Control settings.....	9
3.3 Measurement values.....	10
3.3.1 Input data.....	10
3.3.2 Output data .....	10
3.3.3 Recorded data .....	10
3.3.4 Events.....	13
<b>4. Technical data .....</b>	<b>14</b>

# 1. Introduction

## 1.1 Features

- Residual overvoltage protection
- Definite-time (DT) operation
- Residual voltage measurement with open-delta connected voltage transformers or by digital addition of phase voltage signals
- Two alternative measuring principles: the average value of consecutive instantaneous peak-to-peak values of voltage or the numerically calculated fundamental frequency voltage
- Virtual residual voltage measurement channels can be used instead of the corresponding analogue measurement channels

## 1.2 Application

This document specifies the functions of the residual overvoltage protection function blocks ROV1Low, ROV1High and ROV1Inst used in products based on the RED 500 Platform. The three stages are identical in operation.

The residual overvoltage protection function blocks are designed for sensitive earth-fault protection. Suppression of harmonics is possible.

*Table 1. Protection diagram symbols used in the relay terminal*

ABB	IEC	ANSI
ROV1Low	Uo>	59N-1
ROV1High	Uo>>	59N-2
ROV1Inst	Uo>>>	59N-3

For IEC symbols used in single line diagrams, refer to the manual “Technical Descriptions of Functions, Introduction”, 1MRS750528-MUM.

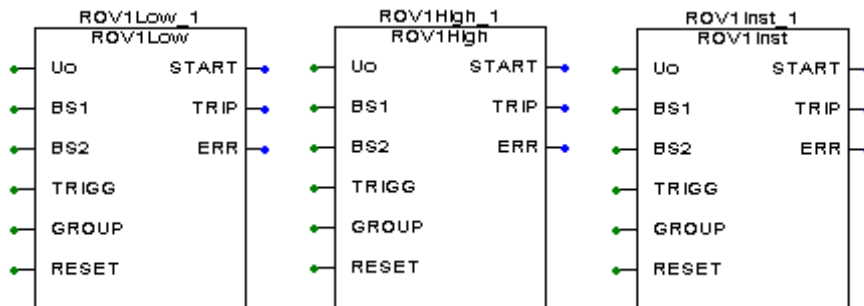


Figure 1. Function block symbols of ROV1Low, ROV1High and ROV1Inst

### 1.3

#### Input description

Name	Type	Description
Uo	Analogue signal (SINT)	Input for measuring residual voltage $U_o$ .
BS1	Digital signal (BOOL, active high)	Blocking signal 1
BS2	Digital signal (BOOL, active high)	Blocking signal 2
TRIGG	Digital signal (BOOL, pos. edge)	Control signal for triggering the registers
GROUP	Digital signal (BOOL, active high)	Control input for switching between setting group 1 and group 2. When GROUP is FALSE, group 1 is active. When GROUP is TRUE, group 2 is active.
RESET	Reset signal (BOOL, pos. edge)	Input signal for resetting the trip signal and registers of ROV1Low, ROV1High or ROV1Inst

### 1.4

#### Output description

Name	Type	Description
START	Digital signal (BOOL, active high)	Start signal
TRIP	Digital signal (BOOL, active high)	Trip signal
ERR	Digital signal (BOOL, active high)	Signal for indicating a configuration error

## 2. Description of operation

### 2.1 Configuration

Residual voltage  $U_o$  can be measured using an open delta connection of conventional voltage transformers. The measuring devices and signal types for analogue channels are selected and configured in a special dialogue box of the Relay Configuration Tool included in the CAP 505 Tool Box. Digital inputs are configured in the same programming environment (the number of selectable analogue inputs, digital inputs and digital outputs depends on the hardware variant).

When the analogue channels and digital inputs have been selected and configured in the dialogue box, the inputs and outputs of the function block can be configured on a graphic worksheet of the configuration tool. The residual voltage  $U_o$  can be connected to the  $U_o$  input of the function block. Furthermore, digital inputs are connected to the boolean inputs of the function block and the outputs of the function block are connected to the output signals.

### 2.2 Measuring mode

The function block operates on two alternative measuring principles: the average value of consecutive instantaneous peak-to-peak values or the numerically calculated fundamental frequency component of the residual voltage. An MMI parameter or a serial communication parameter can be used for selecting the measuring mode.

With both the measuring principles, the operation is insensitive to the DC component and the operation accuracy is defined in the frequency range  $f/f_n=0.95...1.05$ . In peak-to-peak measurement, the harmonics of the residual voltage are not suppressed, whereas in fundamental frequency measurement the harmonics suppression is at least -50 dB at  $f = n \times f_n$ , where  $n = 2, 3, 4, 5, \dots$

### 2.3 Operation criteria

The function block starts when the residual voltage of the busbar system exceeds the set start voltage. When the function block starts, the signal START is set to TRUE. Should the duration of the earth-fault exceed the set definite operate time, the function block operates. The delay of the heavy-duty output relay is included in the total operate time. When the function block operates, the signal TRIP is set to TRUE.

The DT timer will be allowed to run only if the signal BS1 is inactive, i.e. its value is FALSE. When the blocking signal BS1 becomes active, i.e. its value turns to TRUE, the timer will be stopped (frozen).

When the blocking signal BS2 is active, the TRIP signal cannot be activated. The TRIP signal can be blocked by activating the signal BS2 until the function block drops off.

## 2.4 Setting groups

Two different groups of setting values, group 1 and group 2, are available for the function block. Switching between the two groups can be done in the following three ways:

- 1 Locally via the control parameter “Group selection”<sup>1)</sup> of the MMI
- 2 Over the communication bus by writing the parameter V2<sup>1)</sup>
- 3 By means of the input signal GROUP when allowed via the parameter “Group selection” (i.e. when V2 = 2<sup>1)</sup>).

<sup>1)</sup> Group selection (V2): 0 = Group 1; 1 = Group 2; 2 = GROUP input

The control parameter “Active group” indicates the setting group valid at a given time.

## 2.5 Test mode

The digital outputs of the function block can be activated with separate control parameters for each output either locally via the MMI or externally via the serial communication. When an output is activated with the test parameter, an event indicating the test is generated.

The protection functions operate normally while the outputs are tested.

## 2.6 START and TRIP outputs

The output signal START is always pulse-shaped. The minimum pulse width of the corresponding output signal is set via a separate parameter on the MMI or the serial communication. If the start situation is longer than the set pulse width, the START signal remains active until the start situation is over. The output signal TRIP may be non-latching or latching. When the latching mode has been selected, the TRIP signal remains active until the output is reset even if the operation criteria have reset.

## 2.7

**Resetting**

The TRIP output signal and the registers can be reset either via the RESET input, or over the serial bus or the local MMI.

The operation indicators, latched trip signal and recorded data can be reset as follows:

	<b>Operation indicators</b>	<b>Latched trip signal</b>	<b>Recorded data</b>
RESET input of the function block <sup>1)</sup>		X	X
Parameter F044V013 <sup>1)</sup>		X	X
Parameter F045V013 <sup>1)</sup>		X	X
Parameter F046V013 <sup>1)</sup>		X	X
General parameter F001V011 <sup>2)</sup>	X		
General parameter F001V012 <sup>2)</sup>	X	X	
General parameter F001V013 <sup>2)</sup>	X	X	X
Push-button C <sup>2)</sup>	X		
Push-buttons C + E (2 s) <sup>2)</sup>	X	X	
Push-buttons C + E (5 s) <sup>2)</sup>	X	X	X

<sup>1)</sup> Resets the latched trip signal and recorded data of the particular function block.

<sup>2)</sup> Affects all function blocks.

## 3. Parameters and events

### 3.1 General

- Each function block has a specific channel number for serial communication parameters and events. The channel for ROV1Low is 44, that for ROV1High 45 and that for ROV1Inst 46.
- The data direction of the parameters defines the use of each parameter as follows:

Data direction	Description
R, R/M	Read only
W	Write only
R/W	Read and write

- The different event mask parameters (see section “Control settings”) affect the visibility of events on the MMI or on serial communication (LON or SPA) as follows:

Event mask 1 (FxxxV101/102)	SPA / MMI (LON)
Event mask 2 (FxxxV103/104)	LON
Event mask 3 (FxxxV105/106)	LON
Event mask 4 (FxxxV107/108)	LON

For example, if only the events E3, E4 and E5 are to be seen on the MMI of the relay terminal, the event mask value 56 (8 + 16 + 32) is written to the “Event mask 1” parameter (FxxxV101).

In case a function block includes more than 32 events, there are two parameters instead of e.g. the “Event mask 1” parameter: the parameter “Event mask 1A” (FxxxV101) covers the events 0...31 and “Event mask 1B”(FxxxV102) the events 32...63.

## 3.2 Setting values

### 3.2.1 Actual settings

#### ROV1Low, ROV1High and ROV1Inst

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Operation mode	S1	0 or 1 <sup>1)</sup>	-	1	R/M	Selection of operation mode
Start voltage	S2	2.0...100.0	% Un	2.0	R/M	Start voltage
Operate time	S3	0.05...300.00	s	0.05	R/M	Operate time in DT mode

<sup>1)</sup> Operation mode 0 = Not in use; 1 = Definite time

### 3.2.2 Setting group 1

#### ROV1Low, ROV1High and ROV1Inst

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Operation mode	S41	0 or 1 <sup>1)</sup>	-	1	R/W	Selection of operation mode
Start voltage	S42	2.0...100.0	% Un	2.0	R/W	Start voltage
Operate time	S43	0.05...300.00	s	0.05	R/W	Operate time in DT mode

<sup>1)</sup> Operation mode 0 = Not in use; 1 = Definite time

### 3.2.3 Setting group 2

#### ROV1Low, ROV1High and ROV1Inst

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Operation mode	S71	0 or 1 <sup>1)</sup>	-	1	R/W	Selection of operation mode
Start voltage	S72	2.0...100.0	% Un	2.0	R/W	Start voltage
Operate time	S73	0.05...300.00	s	0.05	R/W	Operate time in DT mode

<sup>1)</sup> Operation mode 0 = Not in use; 1 = Definite time



## 3.2.4

## Control settings

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Measuring mode	V1	0 or 1 <sup>1)</sup>	-	1	R/W	Selection of measuring mode
Group selection	V2	0 ... 2 <sup>2)</sup>	-	0	R/W	Selection of the active setting group
Active group	V3	0 or 1 <sup>3)</sup>	-	0	R/M	Active setting group
Start pulse	V4	0...1000	ms	0	R/W	Minimum pulse width of START signal
Trip signal	V5	0 or 1 <sup>4)</sup>	-	0	R/W	Selection of latching feature for TRIP output
Trip pulse	V6	40...1000	ms	40	R/W	Minimum pulse width of TRIP
Reset registers	V13	1=Reset	-	0	W	Resetting of latched trip signal and registers
Test START	V31	0 or 1 <sup>5)</sup>	-	0	R/W	Testing of START
Test TRIP	V32	0 or 1 <sup>5)</sup>	-	0	R/W	Testing of TRIP
Event mask 1	V101	0...1023	-	15	R/W	Event mask 1 for event transmission (E0 ... E9)
Event mask 2	V103	0...1023	-	15	R/W	Event mask 2 for event transmission (E0 ... E9)
Event mask 3	V105	0...1023	-	15	R/W	Event mask 3 for event transmission (E0 ... E9)
Event mask 4	V107	0...1023	-	15	R/W	Event mask 4 for event transmission (E0 ... E9)

<sup>1)</sup> Measuring mode 0 = Peak-to-peak; 1 = Fundam. freq.

<sup>2)</sup> Group selection 0 = Group 1; 1 = Group 2; 2 = GROUP input

<sup>3)</sup> Active group 0 = Group 1; 1 = Group 2

<sup>4)</sup> Trip signal 0 = Non-latching; 1 = Latching

<sup>5)</sup> Testing 0 = Do not activate; 1 = Activate

### 3.3 Measurement values

#### 3.3.1 Input data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Voltage Uo	I1	0.0...120.0	% Un	0.0	R/M	Residual voltage Uo
Input BS1	I2	0 or 1 <sup>1)</sup>	-	0	R/M	Block signal BS1
Input BS2	I3	0 or 1 <sup>1)</sup>	-	0	R/M	Block signal BS2
Input TRIGG	I4	0 or 1 <sup>1)</sup>	-	0	R/M	Signal for triggering the registers
Input GROUP	I5	0 or 1 <sup>1)</sup>	-	0	R/M	Signal for switching between the groups 1 and 2
Input RESET	I6	0 or 1 <sup>1)</sup>	-	0	R/M	Signal for resetting the trip signal and registers of ROV1Low, ROV1High or ROV1Inst

<sup>1)</sup> Input 0 = Not active; 1 = Active

#### 3.3.2 Output data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Output START	O1	0 or 1 <sup>1)</sup>	-	0	R/M	Status of start signal
Output TRIP	O2	0 or 1 <sup>1)</sup>	-	0	R/M	Status of trip signal

<sup>1)</sup> Output 0 = Not active; 1 = Active

#### 3.3.3 Recorded data

The information required for later fault analysis is recorded when the function block starts, trips, or when the recording function is triggered via the external TRIGG input.

The data of three last operations (operation 1...3) are recorded and the values of the most recent operation always replace the data of the oldest operation. The registers are updated in the following order: Operation 1, Operation 2, Operation 3, Operation 1, Operation 2,...

##### 3.3.3.1 Date and time

The time stamp indicates the rising edge of the START, TRIP or TRIGG signal.

### 3.3.3.2 Duration

The duration of the start situation is recorded as a percentage of the set operate time.

### 3.3.3.3 Residual voltage

If the function block trips, the voltage value is updated at the moment of tripping i.e. on the rising edge of the TRIP signal. At external triggering, the voltage value is updated at the moment of triggering i.e. on the rising edge of the input signal TRIGG. If the function block starts but does not trip, the residual voltage value captured one fundamental cycle (20 ms at rated frequency 50 Hz) after the beginning of the start situation will be recorded. The value of the residual voltage  $U_o$  is recorded as a percentage value of the rated voltage  $U_n$ .

### 3.3.3.4 Status data

The status data of the input signals BS1 and BS2 as well as the “Active group” parameter are recorded at the moment of triggering. The “Active group” parameter indicates the setting group valid for the recorded data.

### 3.3.3.5 Priority

The priority of the recording function is the following:

- 1 Tripping
- 2 Starting
- 3 External triggering,

which means that if the function block has started, it will neglect an external triggering request.

## 3.3.3.6

## Recorded data 1

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Date	V201	YYYY-MM-DD	-	-	R/M	Recording date
Time	V202	hh:mm:ss.mss	-	-	R/M	Recording time
Duration	V203	0.0...100.0	%	0.0	R/M	Duration of start situation
Voltage Uo	V204	0.0...120.0	% Un	0.0	R/M	Filtered value of Uo
BS1	V205	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS1 input
BS2	V206	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS2 input
Active group	V207	0 or 1 <sup>2)</sup>	-	0	R/M	Active setting group

<sup>1)</sup> BS\_ 0 = Not active; 1 =Active

<sup>2)</sup> Active group 0 = Group 1; 1 = Group 2

## 3.3.3.7

## Recorded data 2

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Date	V301	YYYY-MM-DD	-	-	R/M	Recording date
Time	V302	hh:mm:ss.mss	-	-	R/M	Recording time
Duration	V303	0.0...100.0	%	0.0	R/M	Duration of start situation
Voltage Uo	V304	0.0...120.0	% Un	0.0	R/M	Filtered value of Uo
BS1	V305	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS1 input
BS2	V306	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS2 input
Active group	V307	0 or 1 <sup>2)</sup>	-	0	R/M	Active setting group

<sup>1)</sup> BS\_ 0 = Not active; 1 =Active

<sup>2)</sup> Active group 0 = Group 1; 1 = Group 2

## 3.3.3.8

## Recorded data 3

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Date	V401	YYYY-MM-DD	-	-	R/M	Recording date
Time	V402	hh:mm:ss.mss	-	-	R/M	Recording time
Duration	V403	0.0...100.0	%	0.0	R/M	Duration of start situation
Voltage Uo	V404	0.0...120.0	% Un	0.0	R/M	Filtered value of Uo
BS1	V405	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS1 input
BS2	V406	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS2 input
Active group	V407	0 or 1 <sup>2)</sup>	-	0	R/M	Active setting group

<sup>1)</sup> BS\_ 0 = Not active; 1 =Active

<sup>2)</sup> Active group 0 = Group 1; 1 = Group 2

## 3.3.4

## Events

Code	Weighting coefficient	Default mask	Event reason	Event state
E0	1	1	START signal from Uo> Uo>> or Uo>>> stage	Reset
E1	2	1	START signal from Uo> Uo>> or Uo>>> stage	Activated
E2	4	1	TRIP signal from Uo> Uo>> or Uo>>> stage	Reset
E3	8	1	TRIP signal from Uo> Uo>> or Uo>>> stage	Activated
E4	16	0	BS1 signal of Uo> Uo>> or Uo>>> stage	Reset
E5	32	0	BS1 signal of Uo> Uo>> or Uo>>> stage	Activated
E6	64	0	BS2 signal of Uo> Uo>> or Uo>>> stage	Reset
E7	128	0	BS2 signal of Uo> Uo>> or Uo>>> stage	Activated
E8	256	0	Test mode of Uo> Uo>> or Uo>>> stage	Off
E9	512	0	Test mode of Uo> Uo>> or Uo>>> stage	On

## 4. Technical data

<b>Operation accuracies</b>	Depends on the frequency of the voltage measured: $f/f_n = 0.95...1.05: \pm 2.5\%$ of set value or $\pm 0.01 \times U_n$				
<b>Start time</b>	Injected voltages > 2 x start voltage: $f/f_n = 0.95...1.05$ <table style="width: 100%; border: none;"> <tr> <td style="text-align: center;">internal time</td> <td style="text-align: right;">&lt; 32 ms</td> </tr> <tr> <td style="text-align: center;">total time<sup>1)</sup></td> <td style="text-align: right;">&lt; 40 ms</td> </tr> </table>	internal time	< 32 ms	total time <sup>1)</sup>	< 40 ms
internal time	< 32 ms				
total time <sup>1)</sup>	< 40 ms				
<b>Reset time</b>	40...1000 ms (depends on the minimum pulse width set for the TRIP output)				
<b>Reset ratio</b>	Typ. 0.95 (range 0.95...0.98)				
<b>Retardation time</b>	Total retardation time for blocking <sup>2)</sup> < 25 ms Total retardation time when the voltage drops below the start value <sup>2)</sup> < 50 ms				
<b>Operate time accuracy</b>	Depends on the frequency of the voltage measured: $f/f_n = 0.95...1.05: \pm 2\%$ of set value or $\pm 20 \text{ ms}^2)$				
<b>Frequency dependence of the settings and operate times (see above)</b>	Measuring mode    Suppression of harmonics 0                      No suppression 1                      -50 dB at $f = n \times f_n$ , where $n = 2, 3, 4, 5, \dots$				
<b>Configuration data</b>	Task execution interval (Relay Configuration Tool): 10 ms at the rated frequency $f_n = 50 \text{ Hz}$				

<sup>1)</sup> Includes the delay of the signal relay

<sup>2)</sup> Includes the delay of the heavy-duty output relay

Technical revision history	
Technical revision	Change
B	-
C	-
D	Start voltage – the setting range extended