

# Three-Phase Undervoltage Protection

## Low-Set Stage (UV3Low)

## High-Set Stage (UV3High)

Data subject to change without notice

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# 1. Introduction

## 1.1 Features

- Single-phase, two-phase and three-phase undervoltage protection
- Definite-time (DT) operation
- UV3Low: one inverse-time (IDMT) characteristic
- Voltage measurement with conventional voltage transformers or voltage dividers
- Two alternative measuring principles: the average value of consecutive instantaneous peak-to-peak values of voltages or the numerically calculated fundamental frequency voltages
- Virtual phase-to-phase voltage measurement channels can be used instead of the corresponding analogue measurement channels

## 1.2 Application

This document specifies the functions of the three-phase undervoltage function blocks UV3Low and UV3High used in products based on the RED 500 Platform. The inverse-time operation is only included in the UV3Low function block.

Faults in the network or a faulty tap changer or voltage regulator of a power transformer may cause abnormal busbar voltages. The function blocks UV3Low and UV3High are designed for the single-phase, two-phase and three-phase undervoltage protection whenever the DT characteristic or, as concerns the low-set stage, the IDMT (Inverse Definite Minimum Time) characteristic is appropriate. Suppression of harmonics is possible.

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

<b>ABB</b>	<b>IEC</b>	<b>ANSI</b>
<b>UV3Low</b>	<b>3U&lt;</b>	<b>27-1</b>
<b>UV3High</b>	<b>3U&lt;&lt;</b>	<b>27-2</b>

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

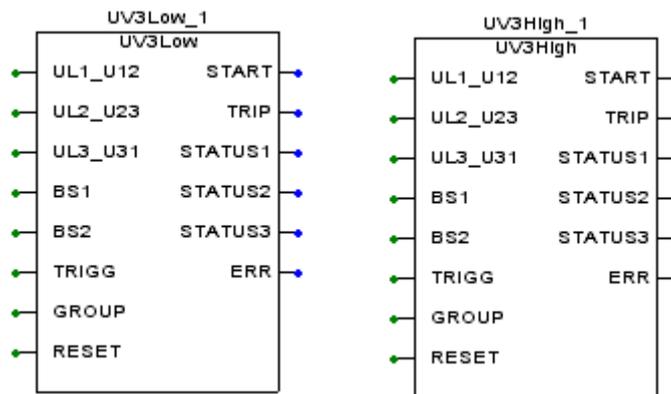


Figure 1. Function block symbols of UV3Low and UV3High

### 1.3

#### Input description

Name	Type	Description
UL1_U12	Analogue signal (SINT)	Input for measuring the phase-to-phase voltage $U_{12}$ or the phase-to-earth voltage $U_{L1}$
UL2_U23	Analogue signal (SINT)	Input for measuring the phase-to-phase voltage $U_{23}$ or the phase-to-earth voltage $U_{L2}$
UL3_U31	Analogue signal (SINT)	Input for measuring the phase-to-phase voltage $U_{31}$ or the phase-to-earth voltage $U_{L3}$
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 the setting groups 1 and 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 UV3Low or UV3High

## 1.4

**Output description**

<b>Name</b>	<b>Type</b>	<b>Description</b>
START	Digital signal (BOOL, active high)	Start signal
STATUS1	Digital signal (BOOL, active high)	Status of UL1_U12
STATUS2	Digital signal (BOOL, active high)	Status of UL2_U23
STATUS3	Digital signal (BOOL, active high)	Status of UL3_U31
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

Voltages can be measured with conventional voltage transformers or voltage dividers. 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. Digital inputs are connected to the boolean inputs of the function block and in the same way, the outputs of the function block are connected to the output signals.

Voltage measurement channels are connected to the UL1\_U12, UL2\_U23 and UL3\_U31 inputs of the function block. The following voltages can be connected to each input:

Input name	Measured voltage
UL1_U12	UL1, UL1b, U12, U12b, U12s or U12bs
UL2_U23	UL2, UL2b, U23, U23b, U23s or U23bs
UL3_U31	UL3, UL3b, U31, U31b, U31s or U31bs

All analogue inputs has to be connected. If single or two-phase protection is required, one of the voltage channels must be connected to multiple inputs of the function block. This can be done only with phase-to-phase voltage channels.

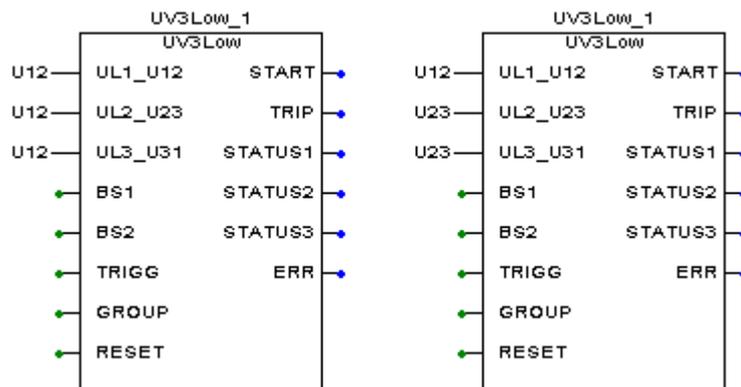


Figure 2 Connection examples when only one or two phase-to-phase voltages are available

If phase voltages are connected to the function block, the control parameter "Measuring mode" has to be in position Mode 3. Phase-to-phase voltages are derived from phase voltages within the function block as follows:

$$U_{12} = U_{L1} - U_{L2}$$

$$U_{23} = U_{L2} - U_{L3}$$

$$U_{31} = U_{L3} - U_{L1}$$

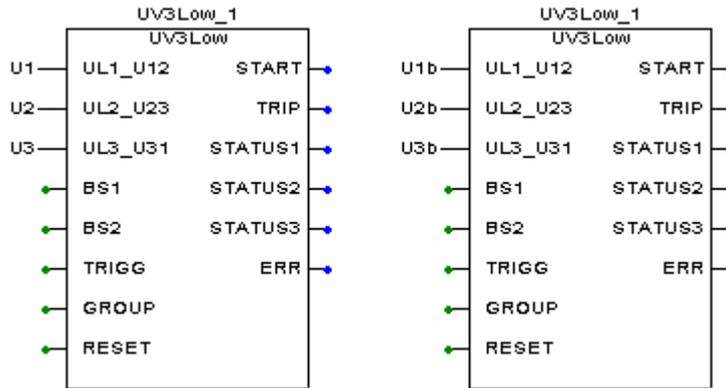


Figure 3 Connections when phase voltages are connected directly to the function block

Note that when phase-to-phase voltages are derived numerically in the function block, only the fundamental frequency measurement can be used: peak-to-peak measurement is not available (see section 2.2 Measuring mode).

Numerical formulation of phase-to-phase voltages can be done outside the function block as well. In this case virtual phase-to-phase voltage channels are connected to the function block. Both measuring modes 1 or 2 can now be used. Single or two-phase protection can be achieved similarly as in Figure 2.

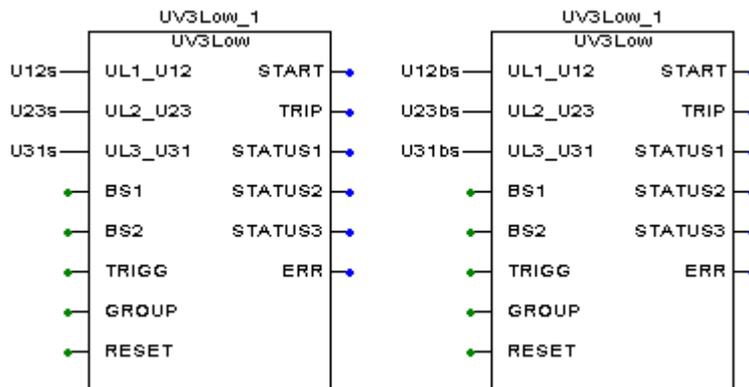


Figure 4 Connection examples when virtual phase-to-phase voltages are used

## 2.2

### Measuring mode

When phase-to-phase voltages are measured, the function block operates on two alternative measuring principles: the average value of consecutive instantaneous peak-to-peak values of voltages or the numerically calculated fundamental frequency voltage. The measuring mode is selected with either an MMI parameter or a serial communication parameter as follows:

Measuring mode	Voltage types measured	Measuring principle
Mode 1	Phase-to-phase voltages	Peak-to-peak measurement
Mode 2	Phase-to-phase voltages	Fundamental frequency measurement
Mode 3	Phase-to-earth voltages	Fundamental frequency measurement

With both the measuring principles, the operation is insensitive to the DC component and the operation accuracy is defined in the frequency range  $f/f_n=0.95\dots1.05$ . In peak-to-peak measurement, the harmonics of the voltages 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 phase-to-phase voltages used for undervoltage protection are selected with the setting parameter "Voltage select". If at least one phase-to-phase voltage of the selected voltages falls below the set start voltage, the module delivers the START signal. When the function block starts, the START signal and the STATUS\_ output signal of the specific phase-to-earth or phase-to-phase voltage are set to TRUE. Should the undervoltage situation exceed the preset definite operate time or, at the inverse-time operation of UV3Low, the time determined by the level of the measured voltage, the function block operates. At the inverse-time operation, the voltage/time curve C is available. The delay of the heavy-duty output relay is included in the total operate time. When the function block operates, the TRIP signal is set to TRUE.

To avoid unwanted operations, e.g. during an auto-reclose sequence, starting and tripping of the undervoltage function block can be blocked. The internal blocking function is activated if at least one of the used voltage signals falls below the fixed value  $0.2 \times U_n$ . The setting parameter "Intern. blocking" is used for enabling the internal undervoltage blocking.

The DT or IDMT timer is allowed to run only if the external blocking signal BS1 and the internal undervoltage blocking are inactive. When the blocking signal or the undervoltage blocking becomes active (TRUE), the timer will be stopped (frozen).

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

### 2.3.1

#### Operation hysteresis and reset ratio

The “Oper. hysteresis” control parameter can be set to adjust the level of a comparator. The operation hysteresis affects the reset ratio. If the hysteresis is set to 3%, for example, the reset ratio of an overvoltage function block (OV3\_) will be 0.97. On the other hand, the same setting for an undervoltage function block (UV3\_) will lead to the reset ratio of 1.03. Furthermore, an absolute operation hysteresis of 0.005 per unit is included. The absolute hysteresis affects the reset ratio when a low start voltage setting is used. For example, if the start voltage setting is  $0.2 \times U_n$  and the operation hysteresis is set to 2%, the reset ratio would normally be 0.98 (OV\_) or 1.02 (UV\_). Due to the absolute hysteresis, however, the reset ratio will be 0.975 (OV\_) or 1.025 (UV\_).

The default setting of the parameter, which is 4%, is recommended. A lower hysteresis setting may lead to repetitive starting of protection. Therefore, the deviation from the nominal frequency and the total harmonic distortion (THD) of the network should be carefully studied when using a setting lower than the default value, since these factors affect the measurement accuracy. If a low hysteresis setting is used, the following is recommended:

Network condition	Recommended action
Low deviation from the nominal frequency	Use fundamental frequency measurement (Mode 2&3)
High deviation from the nominal frequency but low THD	Use peak-to-peak measurement (Mode 1)
High deviation from the nominal frequency and high THD	Increase the operation hysteresis setting

Figure 5 below clarifies the effect of the “Oper. hysteresis” parameter. The start voltage of overvoltage protection is set to  $1.1 \times U_n$  and that of undervoltage protection to  $0.9 \times U_n$ . Both protection functions have the same setting of 4% for the “Oper. hysteresis” parameter.

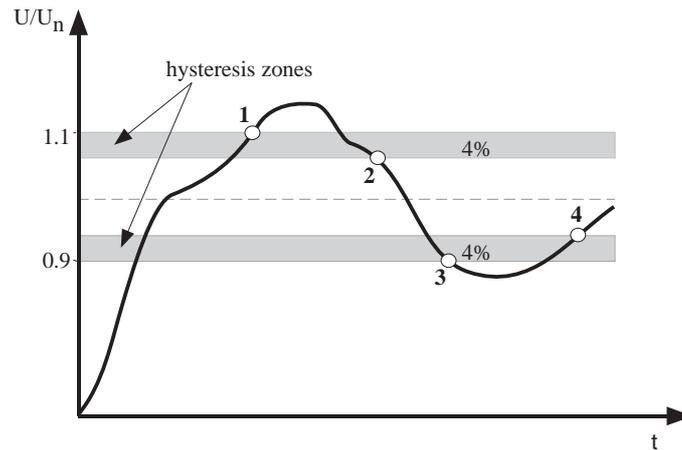


Figure 5. Principal of the operation hysteresis of voltage protection: 1) Overvoltage protection starts 2) The start of overvoltage protection is reset 3) Undervoltage protection starts 4) The start of undervoltage protection is reset

## 2.4

### IDMT type operation of UV3Low

At the inverse-time characteristic, the operate time will be the shorter, the more the voltage deviates from the set start voltage. The relationship between time and voltage can be expressed as follows:

$$t = \frac{ka}{\left(b \frac{U < - U}{U <} - 0.5\right)^p} + c$$

where

- t operate time in seconds
- k adjustable time multiplier
- U measured voltage
- U< set start voltage
- a constant 480
- b constant 32
- c constant 0.055
- p constant 2

This inverse-time characteristic is called the C curve. (For a graphical presentation of the curve, refer to the manual “Technical Descriptions of Functions, Introduction”.)

In the IDMT mode of operation, the integration of the operate time of the undervoltage function block will not start until the voltage falls to the level 6% below the set start value. The operate time accuracy stated in the technical data applies at voltage levels 10% below the set value.

The parameter “Operation mode” is used for selecting the definite-time or inverse-time operation for UV3Low.

## 2.5 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 V3<sup>1)</sup>
- 3 By means of the input signal GROUP when allowed via the parameter “Group selection” (i.e. when  $V3 = 2$ <sup>1)</sup>).

<sup>1)</sup>Group selection (V3): 0 = Group 1; 1 = Group 2; 2 = GROUP input

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

## 2.6 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.

## 2.7 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 on 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.

## 2.8

### Resetting

The TRIP output signal and the registers can be reset either with 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:

	Operation indicators	Latched trip signal	Recorded data
RESET input of the function block <sup>1)</sup>		X	X
Parameter F064V013 for UV3Low <sup>1)</sup>		X	X
Parameter F065V013 for UV3High <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 UV3Low is 64 and that for UV3High 65.
- 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

#### UV3Low

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Operation mode	S1	0 ... 2 <sup>1)</sup>	-	1	R/M	Selection of operation mode and inverse-time characteristic
Start voltage	S2	0.10...1.20	x Un	0.90	R/M	Start voltage
Operate time	S3	0.1...300.0	s	0.1	R/M	Operate time at DT mode
Time multiplier	S4	0.1...1.0	-	0.1	R/M	Time multiplier at IDMT mode

<sup>1)</sup>Operation mode 0 = Not in use; 1 = Definite time; 2 = C curve

#### UV3High

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	0.10...1.20	x Un	0.90	R/M	Start voltage
Operate time	S3	0.1...300.0	s	0.1	R/M	Operate time at DT mode

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

### 3.2.2 Setting group 1

#### UV3Low

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Operation mode	S41	0 ... 2 <sup>1)</sup>	-	1	R/W	Selection of operation mode and inverse-time characteristic
Start voltage	S42	0.10...1.20	x Un	0.90	R/W	Start voltage
Operate time	S43	0.1...300.0	s	0.1	R/W	Operate time at DT mode
Time multiplier	S44	0.1...1.0	-	0.1	R/W	Time multiplier at IDMT mode

<sup>1)</sup>Operation mode 0 = Not in use; 1 = Definite time; 2 = C curve

**UV3High**

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	0.10...1.20	x Un	0.90	R/W	Start voltage
Operate time	S43	0.1...300.0	s	0.1	R/W	Operate time at DT mode

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

**3.2.3****Setting group 2****UV3Low**

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Operation mode	S71	0 ... 2 <sup>1)</sup>	-	1	R/W	Selection of operation mode and inverse-time characteristic
Start voltage	S72	0.10...1.20	x Un	0.90	R/W	Start voltage
Operate time	S73	0.1...300.0	s	0.1	R/W	Operate time at DT mode
Time multiplier	S74	0.1...1.0	-	0.1	R/W	Time multiplier at IDMT mode

<sup>1)</sup>Operation mode      0 = Not in use; 1 = Definite time; 2 = C curve

**UV3High**

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	0.10...1.20	x Un	0.90	R/W	Start voltage
Operate time	S73	0.1...300.0	s	0.1	R/W	Operate time at 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...2 <sup>1)</sup>	-	0	R/W	Selection of measuring mode
Voltage select.	V2	1...7 <sup>2)</sup>	-	7	R/W	Selection of voltages
Group selection	V3	0...2 <sup>3)</sup>	-	0	R/W	Selection of the active setting group
Active group	V4	0 or 1 <sup>4)</sup>	-	0	R/M	Active setting group
Start pulse	V5	0...1000	ms	0	R/W	Minimum pulse width of START signal
Trip signal	V6	0 or 1 <sup>5)</sup>	-	0	R/W	Selection of latching feature for TRIP output
Trip pulse	V7	40...1000	ms	40	R/W	Minimum pulse width of TRIP
Intern. blocking	V8	0 or 1 <sup>6)</sup>	-	1	R/W	Enabling of internal undervoltage blocking
Oper. hysteresis	V9	1.0...5.0	%	4.0	R/W	Operation hysteresis
Reset registers	V13	1=Reset	-	0	W	Resetting of latched trip signal and registers
Test START	V31	0 or 1 <sup>7)</sup>	-	0	R/W	Testing of START
Test TRIP	V32	0 or 1 <sup>7)</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 = Mode 1; 1 = Mode 2; 2 = Mode 3

<sup>2)</sup>Voltage selection

1 = U12; 2 = U23; 3 = U12 &amp; U23; 4 = U31; 5 = U12 &amp; U31; 6 = U23 &amp; U31; 7 = U12 &amp; U23 &amp; U31

<sup>3)</sup>Group selection

0 = Group 1; 1 = Group 2; 2 = GROUP input

<sup>4)</sup>Active group

0 = Group 1; 1 = Group 2

<sup>5)</sup>Trip signal

0 = Non-latching; 1 = Latching

<sup>6)</sup>Intern. blocking

0 = Disabled; 1 = Enabled

<sup>7)</sup>Test START

0 = Do not activate; 1 = Activate

### 3.3 Measurement values

#### 3.3.1 Input data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Voltage UL1_U12	I1	0.00...2.00	x Un	0.00	R/M	Phase-to-phase voltage $U_{12}$ or phase-to earth voltage $U_{L1}$
Voltage UL2_U23	I2	0.00...2.00	x Un	0.00	R/M	Phase-to-phase voltage $U_{23}$ or phase-to earth voltage $U_{L2}$
Voltage UL3_U31	I3	0.00...2.00	x Un	0.00	R/M	Phase-to-phase voltage $U_{31}$ or phase-to earth voltage $U_{L3}$
Input BS1	I4	0 or 1 <sup>1)</sup>	-	0	R/M	Block signal BS1
Input BS2	I5	0 or 1 <sup>1)</sup>	-	0	R/M	Block signal BS2
Input TRIGG	I6	0 or 1 <sup>1)</sup>	-	0	R/M	Signal for triggering the registers
Input GROUP	I7	0 or 1 <sup>1)</sup>	-	0	R/M	Signal for switching between the groups 1 and 2
Input RESET	I8	0 or 1 <sup>1)</sup>	-	0	R/M	Signal for resetting the output signals and registers of UV3Low or UV3High

<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 or trips, or when the recording function is triggered via the external TRIGG input.

The data of the last three events are stored in Recorded data 1...3, beginning from Recorded data 1. These registers are updated in a cyclical manner, where the values of the most recent event overwrite the oldest recorded data. If the recorded data has been reset or the relay has been restarted, the first event is again stored in Recorded data 1.

### 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

At the DT mode of operation, the duration of the start situation is recorded as a percentage of the set operate time and, as concerns UV3Low, at the IDMT mode of operation as a percentage of the calculated operate time.

### 3.3.3.3 Voltages

If the function block trips, the voltage values are updated at the moment of tripping, i.e. on the rising edge of the TRIP signal. At external triggering, the voltage values are 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 voltage values captured one fundamental cycle (20 ms at rated frequency 50 Hz) after the beginning of the start situation will be recorded. So, the values of the phase-to-phase voltages  $U_{12}$ ,  $U_{23}$  and  $U_{31}$  are always recorded at the same moment, as multiples 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.000	-	-	R/M	Recording time
Duration	V203	0.0...100.0	%	0.0	R/M	Duration of start situation
Voltage UL1_U12	V204	0.00...2.00	x Un	0.00	R/M	Filtered value of $U_{12}$ or $U_{L1}$
Voltage UL2_U23	V205	0.00...2.00	x Un	0.00	R/M	Filtered value of $U_{23}$ or $U_{L2}$
Voltage UL3_U31	V206	0.00...2.00	x Un	0.00	R/M	Filtered value of $U_{31}$ or $U_{L3}$
BS1	V207	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS1 input
BS2	V208	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS2 input
Active group	V209	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

## 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.000	-	-	R/M	Recording time
Duration	V303	0.0...100.0	%	0.0	R/M	Duration of start situation
Voltage UL1_U12	V304	0.00...2.00	x Un	0.00	R/M	Filtered value of $U_{12}$ or $U_{L1}$
Voltage UL2_U23	V305	0.00...2.00	x Un	0.00	R/M	Filtered value of $U_{23}$ or $U_{L2}$
Voltage UL3_U31	V306	0.00...2.00	x Un	0.00	R/M	Filtered value of $U_{31}$ or $U_{L3}$
BS1	V307	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS1 input
BS2	V308	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS2 input
Active group	V309	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.000	-	-	R/M	Recording time
Duration	V403	0.0...100.0	%	0.0	R/M	Duration of start situation
Voltage UL1_U12	V404	0.00...2.00	x Un	0.00	R/M	Filtered value of $U_{12}$ or $U_{L1}$
Voltage UL2_U23	V405	0.00...2.00	x Un	0.00	R/M	Filtered value of $U_{23}$ or $U_{L2}$
Voltage UL3_U31	V406	0.00...2.00	x Un	0.00	R/M	Filtered value of $U_{31}$ or $U_{L3}$
BS1	V407	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS1 input
BS2	V408	0 or 1 <sup>1)</sup>	-	0	R/M	Status of BS2 input
Active group	V409	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 3U< or 3U<< stage	Reset
E1	2	1	START signal from 3U< or 3U<< stage	Activated
E2	4	1	TRIP signal from 3U< or 3U<< stage	Reset
E3	8	1	TRIP signal from 3U< or 3U<< stage	Activated
E4	16	0	BS1 signal of 3U< or 3U<< stage	Reset
E5	32	0	BS1 signal of 3U< or 3U<< stage	Activated
E6	64	0	BS2 signal of 3U< or 3U<< stage	Reset
E7	128	0	BS2 signal of 3U< or 3U<< stage	Activated
E8	256	0	Test mode of 3U< or 3U<< stage	Off
E9	512	0	Test mode of 3U< or 3U<< stage	On

## 4. Technical data

<b>Operation accuracies</b>	<p>The operation accuracy is <math>\pm 2.5\%</math> of the set value when phase-to-earth voltages are connected to the terminal and phase-to-phase values are derived numerically in the terminal.</p> <p>The operation accuracy is <math>\pm 1\%</math> of the set value when phase-to-phase voltages are connected directly to the terminal.</p> <p>Above values apply when <math>f/f_n = 0.95\dots 1.05</math></p>						
<b>Start time</b>	<p>Injected voltages <math>&lt; 0.5 \times</math> start voltage:</p> <table> <tr> <td><math>f/f_n = 0.95\dots 1.05</math></td> <td>internal time</td> <td><math>&lt; 32</math> ms</td> </tr> <tr> <td></td> <td>total time <sup>1)</sup></td> <td><math>&lt; 40</math> ms</td> </tr> </table>	$f/f_n = 0.95\dots 1.05$	internal time	$< 32$ ms		total time <sup>1)</sup>	$< 40$ ms
$f/f_n = 0.95\dots 1.05$	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>	<p>Default 1.04 (range 1.01...1.05)</p> <p>Depends on the value of the "Oper. hysteresis" parameter</p>						
<b>Retardation time</b>	<p>Total retardation time when the voltage drops below the start value<sup>2)</sup></p> <p style="text-align: right;"><math>&lt; 60</math> ms</p>						
<b>Operate time accuracy at definite-time mode</b>	<p>Depends on the frequency of the voltage measured:</p> <p><math>f/f_n = 0.95\dots 1.05: \pm 2.5\%</math> of set value<sup>2)</sup></p>						
<b>Accuracy class index E at inverse-time mode (UV3Low)</b>	<p>Depends on the frequency of the voltage measured:</p> <p><math>f/f_n = 0.95\dots 1.05: \pm 35</math> ms<sup>2)</sup> or the accuracy appearing when the measured voltage varies <math>\pm 2.5\%</math></p>						
<b>Frequency dependence of the settings and operate times (see above)</b>	<table> <tr> <td>Measuring mode</td> <td>Suppression of harmonics</td> </tr> <tr> <td>Mode 1</td> <td>No suppression</td> </tr> <tr> <td>Mode 2&amp;3</td> <td>-50 dB at <math>f = n \times f_n</math>, where <math>n = 2, 3, 4, 5, \dots</math></td> </tr> </table>	Measuring mode	Suppression of harmonics	Mode 1	No suppression	Mode 2&3	-50 dB at $f = n \times f_n$ , where $n = 2, 3, 4, 5, \dots$
Measuring mode	Suppression of harmonics						
Mode 1	No suppression						
Mode 2&3	-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 $f_n = 50$ 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	<p>Input names changed: U12 → UL1_U12 U23 → UL2_U23 U31 → UL3_U31</p> <p>New outputs: STATUS1, STATUS2, STATUS3</p> <p>Control parameter "Oper. hysteresis" added</p> <p>Setting parameter values changed: Start voltage: 0.30...1.20 → 0.10...1.20 Operate time: 0.1...120.0 → 0.1...300.0</p> <p>Input data parameter names changed: Voltage U12 → Voltage UL1_U12 Voltage U23 → Voltage UL2_U23 Voltage U31 → Voltage UL3_U31</p>
D	-