**POWER**FACTORY

# PowerFactory 2021

## Technical Reference

### Under-/Overvoltage

RelUlim, TypUlim

PF2021

**POWER SYSTEM SOLUTIONS**

MADE IN GERMANY

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# Contents

# 1 General Description

The *Under-/Overvoltage* “RelUlim” block implements one of the following protection functions:

- an over voltage definite time element
- an under voltage definite time element
- a vector jump detection element

The block defines a voltage trip threshold and a constant time delay or, only if set as vector jump detection element, an angular difference; no graphical representation of the trip characteristic is available.

The *Under-/Overvoltage* “RelUlim” block is operational during short circuit, load flow and RMS/EMT simulations.

# 2 Features & User interface

## 2.1 Under-/Overvoltage (RelUlim )

The user can change the block settings using the “Under-/Overvoltage” dialogue (“RelUlim” class). The dialogue consists of two tab pages: *Basic data*, and *Description*. The main settings are located in the *Basic data* tab page.

### 2.1.1 Basic data

The “Under-/Overvoltage” dialogue provides a *presentation* area where the red text shows some info regarding:

- The international symbols used to represent the block protective function.
- The active functionality (*Undervoltage* or *Overvoltage* or *Vector Shift*)
- Which voltages are measured by the block.

The block can be disabled using the “Out of service” check box (“outserv” parameter). If the element is an *Under voltage* or an *Over voltage* element, the voltage threshold and the time delay can be set using the “Voltage” (“Uset” parameter), and the “Time Delay” control (“Tdel” parameter). If the the element is a *Vector Shift*, the angular threshold can be set using the “Delta Angle” (“Uang” parameter) control. The controls are combo boxes for ranges of discrete values otherwise edit boxes. The blue text on the right of the graphical controls provides additional info regarding the voltage threshold in terms of primary voltage.

### 2.1.2 Description

The *Description* tab page can be used to insert some information to identify the Ioc protective element (both with a generic string and with an unique textual string similar to the *Foreign Key* approach used in the relational databases) and to identify the source of the data used to create it.

## 2.2 Under-/Overvoltage Type(TypUlim )

The *Under-/Overvoltage* block main characteristics must be configured in the "Under-/Overvoltage Type" dialogue (*TypUlim* class). The dialogue doesn't contain any tab page, all parameters are showed in the dialogue unique page.

The "IEC Symbol" ("sfiec" parameter) and the "ANSI Symbol" ("sfansi" parameter) combobox allow to insert for documentation purpose the European and the US standard symbols representing the block functionality. A list of possible symbols is available in the combo boxes but any other symbol can be typed.

The "Function" ("ifunc" parameter) combo box defines if the block is one of the following

- an *Undervoltage* element
- an *Overvoltage* element
- a *Vector shift* element

The number and the type of the input quantities processed by the block can be configured using the "Type" combo box ("itype" parameter) as:

- 3 phase element ("Voltage (3ph)")
- single phase element ("Voltage (1ph)")
- earth element ("Earth Voltage (3*U0)")
- negative sequence element ("Negative Sequence (U2)")
- positive sequence element ("Positive Sequence (U1)" )

Many of the types listed above are provided for documentation only purpose. The underlying types are:

- a 3 phase block (for the "Voltage (3ph)" "Type")
- a single phase block (for the "Voltage (1ph)", "Earth Voltage (3*U0)", "Negative Sequence (U2)", "Positive Sequence (U1)" "Type")
- a *Vector Shift* block

If the element is an *Under voltage* or an *Over voltage* element the voltage threshold and the time delay ranges can be set inserting a range definition string in the "Voltage" ("rUset" parameter), and the "Time Delay" ("rTdel" parameter) edit boxes.
If the the element is a *Vector Shift*, the angular threshold range can be set inserting a range definition string in the "Delta Angle" ("rUang" parameter) edit box.

### 2.2.1 Vector shift

When in the “Function” (“ifunc” parameter) combo box the *Vector shift* item has been set, the block monitors the angle of the phase voltages and trips when the variation of the angle of all phases is greater than the “Delta Angle” (“rUang” parameter) value.
It can be used to reproduce the F78 and F78V ANSI function.

This PowerFactory functionality has been conceived to be used running an EMT simulation , due to the better accuracy achieved by an EMT simulation in the phase voltage angles calculation, but it can be also used running a RMS simulation or a SHC calculation.

The algorithm is also slightly different in the SHC calculation, which is a static calculation and in the RMS/EMT simulations.

**SHC calculation** : In the SHC calculation, except the angular differences calculated at the SHC time, the only other data available are the LDF data. For this reason the angle variation is calculated as the difference between the angles calculated running the LDF and the angles calculated running the SHC. If the angle variation of all phases is greater than the “Delta Angle” (“rUang” parameter) value then a *Vector shift* is detected and the block trips

**RMS/EMT simulation** : The RMS/EMT algorithm calculates the angular difference between the actual voltage angles and the angles measured a cycle and an half cycle before the actual simulation time. If at least 5 of these 6 angular differences are greater than the “Delta Angle” (“rUang” parameter) value then a *Vector shift* is detected and the block trips.

# 3 Integration in the relay scheme

The *Under-/Overvoltage*“RelUlim” type class name is *TypUlim*. The *Under-/Overvoltage* dialogue class name is *RelUlim*. As already shown, there are three main versions of the block: a single phase, a three phase version and the Vector Shift. The number and the name of the input signals depends only upon which of these versions is used.
The typical connection of a single phase *Under-/Overvoltage*“RelUlim” block is showed in Figure 3.1.

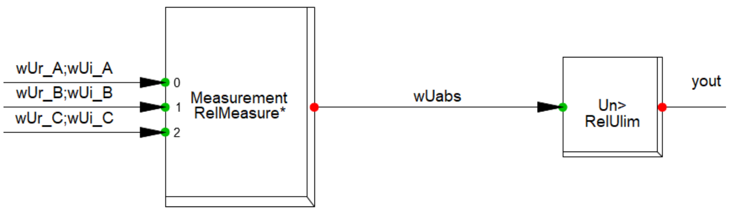



Figure 3.1: Connection scheme of a *DIgSILENT* single phase *Under-/Overvoltage*“RelUlim” block.

The connections associated with a three phase *Under-/Overvoltage*“RelUlim” block are quite similar.
The typical connection of a three phase *Under-/Overvoltage*“RelUlim” block is showed in Figure 3.2.

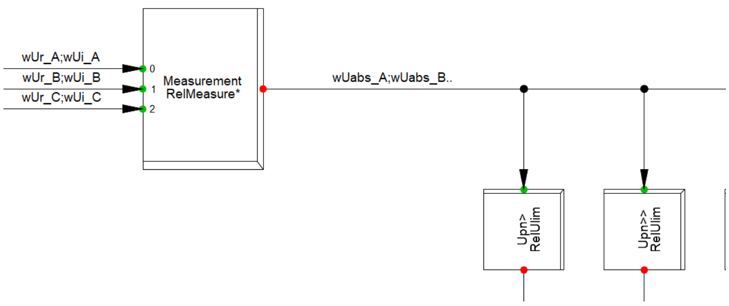



Figure 3.2: Connection scheme of a *DIgSILENT* three phase *Under-/Overvoltage*“RelUlim” block.

The connections associated with a *Vector Shift*“RelUlim” block are different, the phase voltage vector components and the clock signal must be provided.
The typical connection of a Phase Shift *Under-/Overvoltage*“RelUlim” block is showed in Figure 3.3.

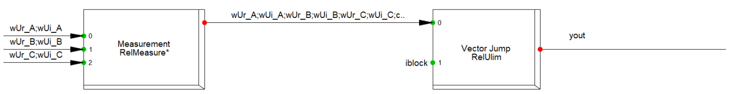



Figure 3.3: Connection scheme of a *DIgSILENT* three phase Vector Shift *Under-/Overvoltage*“RelUlim” block.

# 4 Logic

## 4.1 Single phase

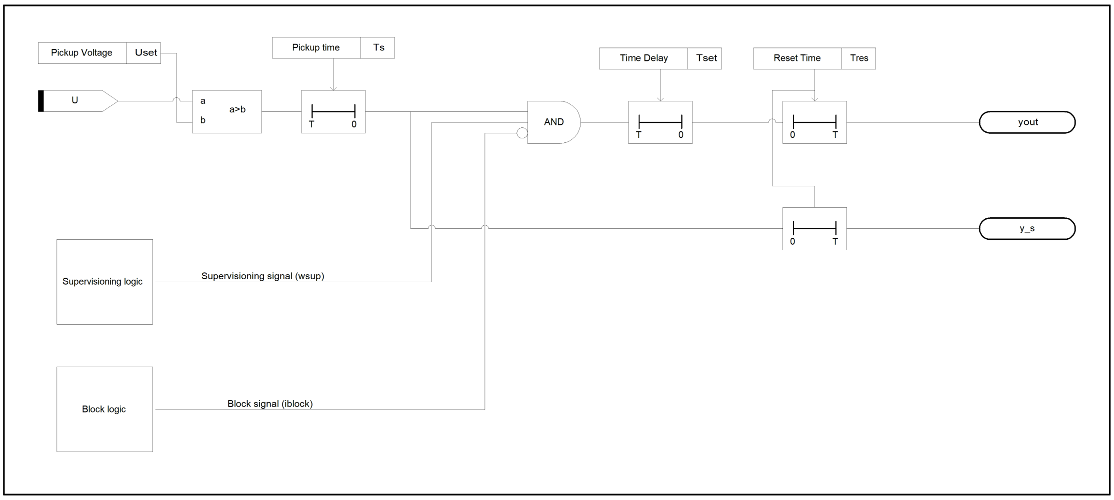
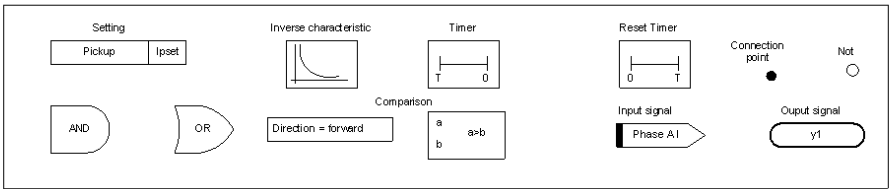



Figure 4.1: The Single Phase *Under-/Overvoltage (RelUlim)logic*



## 4.2 3 phase

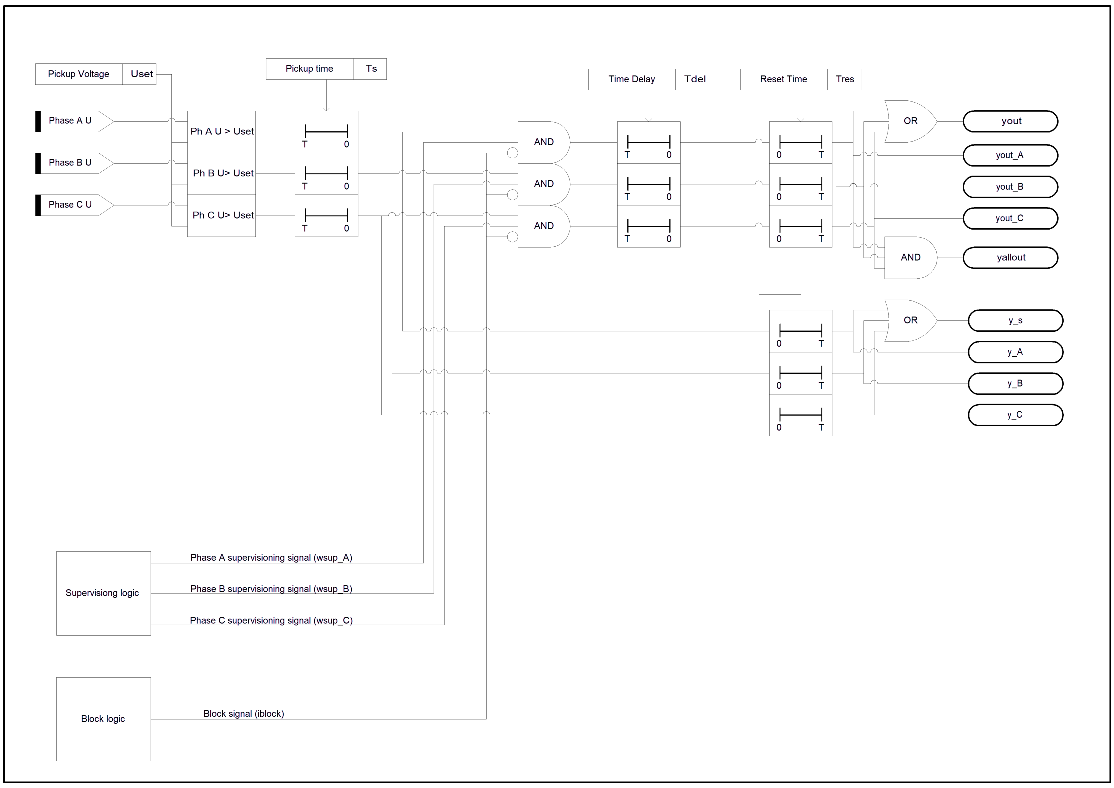
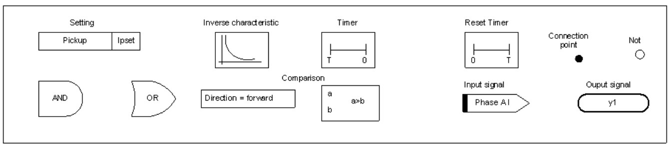



Figure 4.2: The three Phase *Under-/Overvoltage (RelUlim) logic*



## 4.3 Vector shift

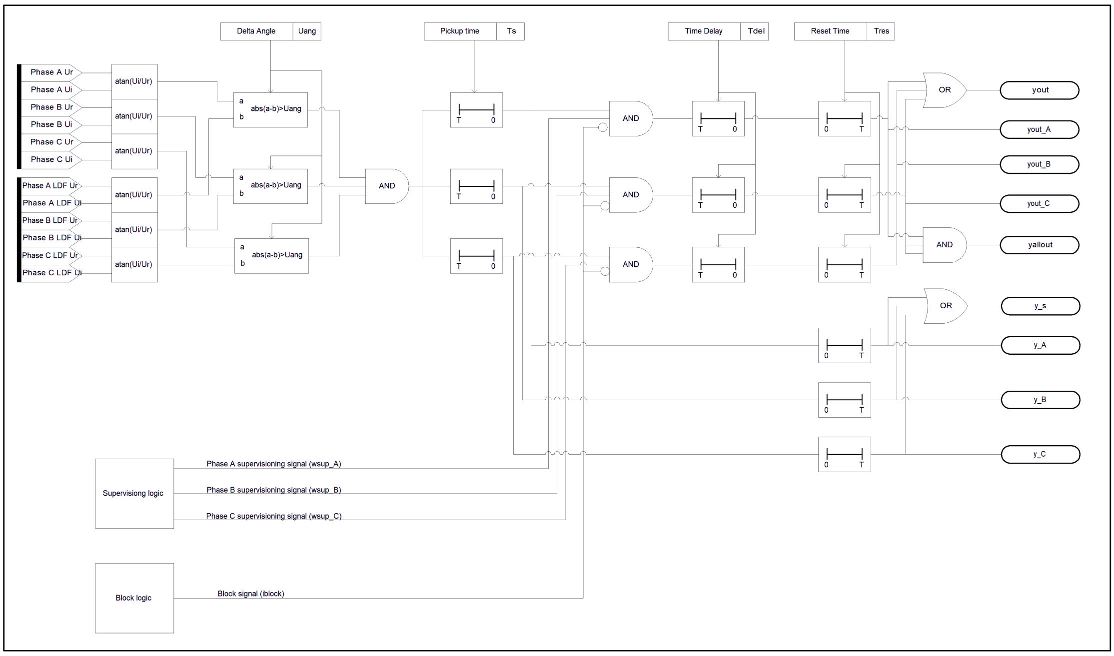
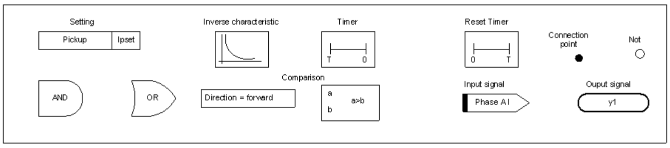



Figure 4.3: The Vector Shift *Under-/Overvoltage (RelUlim) simplified (SHC) logic*



# A Parameter Definitions

## A.1 Under-/Overvoltage Type (TypUlim )

Table A.1: Input parameters of Under-/Overvoltage type (*TypUlim* )

| Parameter | Description | Unit |
|---|---|---|
| loc_name | Name assigned by the user to the block type | Text |
| sfiec | IEC symbol (U<,U<<,U>,U>>) | Text |
| sfansi | ANSI symbol (*27,27N,59,78*) | Text |
| ifunc | Function (“Overvoltage”, “Undervoltage”, “Vector Shift”) | Integer |
| itype | Block Type (“Voltage (3ph)”, “Voltage (1ph)”, “Earth Voltage (3*U0)”, “Negative Sequence (U2)”, “Positive Sequence (U1)” | Integer |
| rUset | Range of the Voltage threshold | Text |
| rUang | Range of the delta angle threshold used by the *Vector Shift* detector | Text |
| iunitu | Voltage theshold unit (Sec. Amps, pu) | Integer |
| rTdel | Range of the trip time delay | Text |
| iunitt | Trip time delay unit (Sec, cycles) | Integer |
| Ts | Pick up time, it is the time spent measuring the voltage in the load flow and short circuit calculation and in the RMS simulation | Seconds |
| Tres | Reset time, it is the delay with which the block reset the trip outputs after that the voltage went below (or above if the *Undervoltage* function has been set) the trip threshold * Kr | Seconds |
| Kr | Reset ratio | Real |

## A.2 Under-/Overvoltage Element (RelUlim )

Table A.2: Input parameters of the Under-/Overvoltage element (*RelUlim*))

| Parameter | Description | Unit |
|---|---|---|
| loc_name | Name assigned to the user to the block element | Text |
| Typ_id | Pointer to the relevant TypUlim object | Pointer |
| outserv | Flag to put out of service the block | Y/N |
| Uset | Voltage threshold in Volts | Sec Volts |
| Usetr | Voltage threshold in pu | pu |
| Uang | Delta angle threshold used by the *Vector Shift* detector | deg |
| Tdel | Trip time delay in seconds | Seconds |
| cTdel | Trip time delay in cycles | Cycles |
| CUpset | Voltage threshold in Volts | Primary Volts |

# B Signal Definitions

## B.1 Single phase

Table B.1: Input/output signals of the single phase Under-/Overvoltage element (*CalUlim1p*)

| Name | Description | Unit | Type | Model |
|---|---|---|---|---|
| wUabs | Input voltage | Sec Volts | IN | Any |
| iblock | Blocking signal | Seconds( or 1/0 RMS/EMT simulation) | IN | Any |
| wsup | Supervising signal | Seconds( or 1/0 RMS/EMT simulation) | IN | Any |
| yout | Trip signal | Seconds( or 1/0 RMS/EMT simulation) | OUT | Any |
| y_s | Start signal | Seconds( or 1/0 RMS/EMT simulation) | OUT | Any |

## B.2 3 phase

Table B.2: Input/output signals of 3 phase Under-/Overvoltage element (*CalUlim*)

| Name | Description | Unit | Type | Model |
|---|---|---|---|---|
| wUabs_A | Phase A input voltage | Sec Volts | IN | Any |
| wUabs_B | Phase B input voltage | Sec Volts | IN | Any |
| wUabs_C | Phase C input voltage | Sec Volts | IN | Any |
| iblock | Blocking signal | Seconds (or 1/0 RMS/EMT simulation) | IN | Any |
| wsup_A | Phase A supervising signal | Seconds( or 1/0 RMS/EMT simulation) | IN | Any |
| wsup_B | Phase B supervising signal | Seconds( or 1/0 RMS/EMT simulation) | IN | Any |
| wsup_C | Phase C supervising signal | Seconds( or 1/0 RMS/EMT simulation) | IN | Any |
| yout | Trip signal (any phase) | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yout_A | Phase A trip signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yout_B | Phase B trip signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yout_C | Phase C trip signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yallout | All phases trip signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| y_s | Start signal (any phase) | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| y_A | Phase A start signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| y_B | Phase B start signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| y_C | Phase C start signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |

## B.3 Vector Shift

Table B.3: Input/output signals of 3 phase Vector Shift element (*CalUvecshift*)

| Name | Description | Unit | Type | Model |
|---|---|---|---|---|
| wUabs_A | Phase A input voltage | Sec Volts | IN | Any |
| wUabs_B | Phase B input voltage | Sec Volts | IN | Any |
| wUabs_C | Phase C input voltage | Sec Volts | IN | Any |
| wUr_A | Phase A voltage real part | Secondary Volts | IN | Any |
| wUi_A | Phase A voltage imaginary part | Secondary Volts | IN | Any |
| wUr_B | Phase B voltage real part | Secondary Volts | IN | Any |
| wUi_B | Phase B voltage imaginary part | Secondary Volts | IN | Any |
| wUr_C | Phase C voltage real part | Secondary Volts | IN | Any |
| wUi_C | Phase C voltage imaginary part | Secondary Volts | IN | Any |
| iblock | Blocking signal | Seconds (or 1/0 RMS/EMT simulation) | IN | Any |
| wsup_A | Phase A supervising signal | Seconds( or 1/0 RMS/EMT simulation) | IN | Any |
| wsup_B | Phase B supervising signal | Seconds( or 1/0 RMS/EMT simulation) | IN | Any |
| wsup_C | Phase C supervising signal | Seconds( or 1/0 RMS/EMT simulation) | IN | Any |
| clock | Clock signal | 1/0 | IN | EMT only |
| yout | Trip signal (any phase) | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yout_A | Phase A trip signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yout_B | Phase B trip signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yout_C | Phase C trip signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yallout | All phases trip signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| y_s | Start signal (any phase) | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| y_A | Phase A start signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| y_B | Phase B start signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| y_C | Phase C start signal | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |

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