FUNCTION BLOCK DESCRIPTION

Directional under-power protection

ANSI 37, IEC P <

PROTECTA HUNGARY

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PROTECTION, AUTOMATION AND CONTROL FOR POWER INDUSTRY

VERSION INFORMATION

VERSION	DATE	MODIFICATION	COMPILED BY
Preliminary	2009-11-24	Preliminary version, without technical information	Petri
	2010-10-05	Naming revision	Csipke
1.0	2010-11-11	First edition	Petri
1.1	2020-02-06	Update technical data	Zsarnai
2.0	2020-01-06	New document design, new chapters added	Tóth F.
3.0	2024-08-28	Graphical analogue inputs added Figures updated IEC61850 info added Reset ratio updated	Ádám, Erdős

CONTENTS

1 Directional under-power protection function

1.1 Application

The directional under-power protection function can be applied mainly to protect any elements of the electric power system, mainly generators, if the active and/or reactive power has to be limited in respect of the allowed minimum power.

1.2 Mode of operation

The inputs of the function are the Fourier basic harmonic components of the three phase currents and those of the three phase voltages.

Based on the measured voltages and currents, the block calculates the three-phase active and reactive power (point S in Figure 1-1) and compares the P-Q coordinates with the defined characteristics on the power plane. The characteristic is defined as a line laying on the point S_S and perpendicular to the direction of S_S. The S_S point is defined by the “Start power” magnitude and the “Direction angle”. The under-power function operates if the angle of the S-S_S vector related to the directional line is above 90 degrees or below -90 degrees, i.e. if the point S is on the “Operate” side of the P-Q plane.

At operation, the “Start power” value is increased by a hysteresis value.

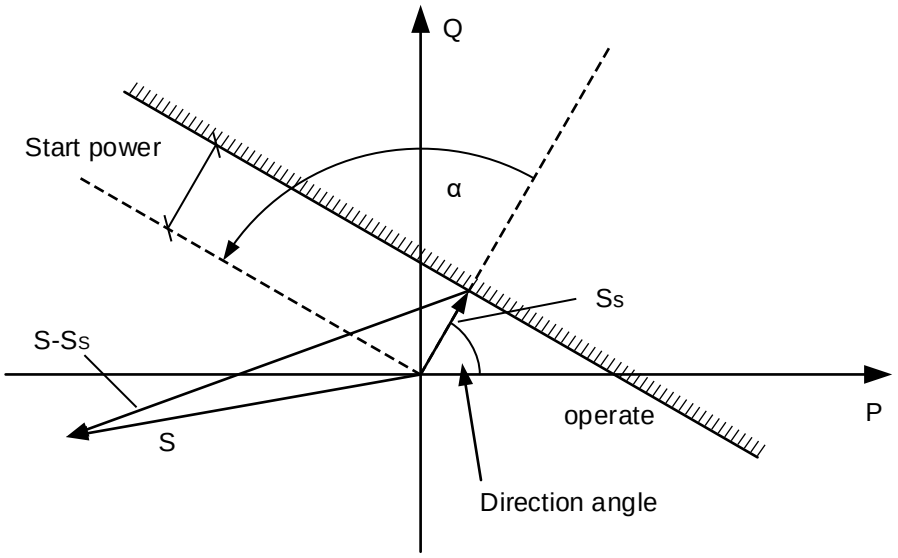

Figure 1-1 The directional under-power decision

1.3 Structure of the directional under-power protection algorithm

Figure 1-2 shows the structure of the directional under-power protection (DUP32) algorithm.

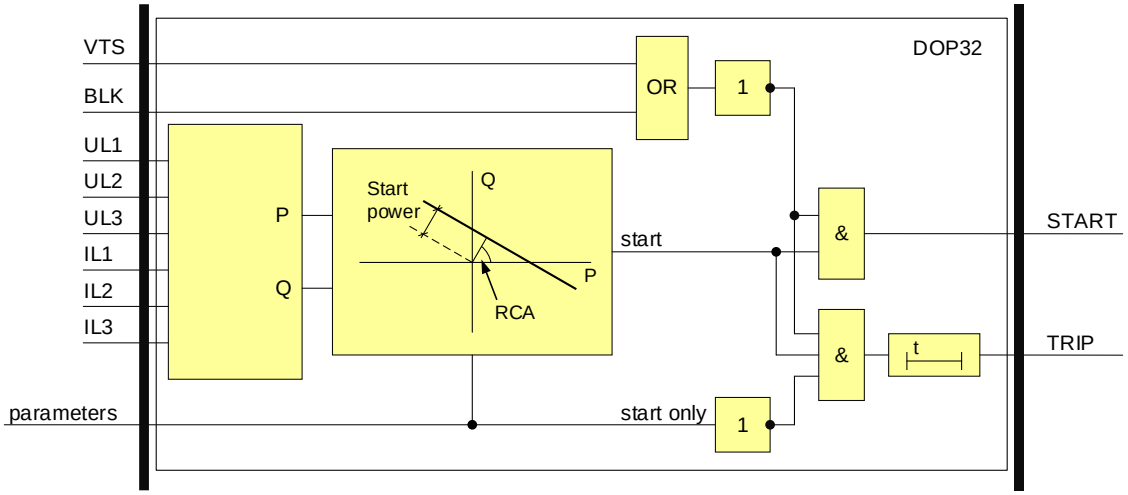

Figure 1-2 Structure of the directional under-power protection algorithm

The **inputs** are

- the RMS value of the fundamental Fourier component of the three phase currents (IL1, IL2, IL3),
- the RMS value of the fundamental Fourier component of the three phase voltages (UL1, UL2, UL3),
- parameters,
- status signals.

The function can be enabled or disabled (BLK input signal). The status signal of the VTS (voltage transformer supervision) function can also disable the directional operation.

The **outputs** are

- the binary output status signals.

The **software modules** of the directional under-power protection function are described in the following chapters.

1.3.1 P-Q calculation

Based on the RMS values of the fundamental Fourier component of the three phase currents and of the three phase voltages, this module calculates the three-phase active and reactive power values.

The **input signals are** the RMS values of the fundamental Fourier components of the three phase currents and three phase voltages.

The **internal output signals** are the calculated three-phase active and reactive power values.

1.3.2 Directional decision

This module decides if, on the power plane, the calculated complex power is closer to the origin than the corresponding point of the characteristic line, i.e. if the point S is on the “Operate” side of the P-Q plane. The operation of this function is explained in Figure 1-1.

The **internal input signals** are the calculated active and reactive power values.

The **internal output signal** is the start signal of the function.

1.3.3 The decision logic

This part of the function block combines status signals to make a decision to start. Additionally, to the directional decision, for the operation, the function must not be blocked by the general “Block” signal and may not be blocked by the signal “Block for VTS” of the voltage transformer supervision function.

If the parameter setting requires also a trip signal (Start Signal Only = 0), then the measurement of the definite time delay is started. The expiry of this timer results in a trip command.

2 Directional under-power protection function overview

The function block of the directional under-power protection function is shown on the figure below. This block shows all binary input and output status signals that are applicable in the graphic equation editor.

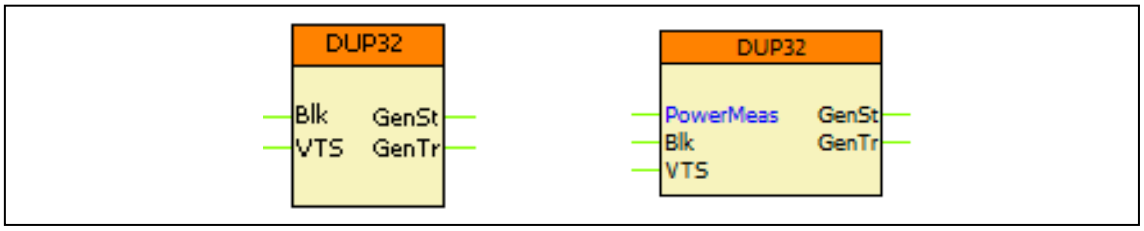

Figure 2-1 The function block of the directional under-power protection function

2.1 Settings

2.1.1 Parameters

Table 2-1 Parameters of the under-power protection function

TITLE	DIM	RANGE	STEP	DEFAULT	EXPLANATION
Operation	-	Off, On	-	Off	Enabling the function
Start Signal Only	-	FALSE, TRUE	-	FALSE	Selection: start signal only or both start signal and trip command
Direction Angle	deg	-179 – 180	1	0	Angle which belongs to Start power
Start Power	%	1.0 – 200.0	0.1	10.0	Start power of the function
Time Delay	msec	200 – 60000	1	200	Definite time delay of the trip command

2.2 Function I/O

This section describes briefly the analogue and digital inputs and outputs of the function block.

2.2.1 Analogue inputs

Graphic Analogue inputs *(only from firmware version 2.10.2.3010 and up)*

The sources of the analogue inputs are defined by the user, applying the graphic equation editor (*Logic Editor*). Parts written in **bold** are seen on the left side of the function block in the Logic editor.

The function uses the following analogue signals as inputs:

Table 2-2 Analogue input signal of the directional under-power protection function

ANALOGUE INPUT SIGNAL	SIGNAL TITLE	EXPLANATION
DUP32_**PowerMeas**_AnIn_	Power Measurement	Input for 3ph power measurement signal (from the MXU – Line measurement function)

The applied analogue connectors must be identical to the analogue input type (i.e. voltage to voltage input etc.), Invalid connections are not allowed.

2.2.2 Analogue outputs (measurements)

The function has no analogue output signals.

2.2.3 Binary input signals (graphed output statuses)

The conditions of the inputs are defined by the user, applying the graphic equation editor (logic editor). The part written in **bold** is seen on the function block in the logic editor.

Table 2-3 The binary input status signals of the directional under-power protection function

BINARY STATUS SIGNAL	EXPLANATION
DUP32_**Blk**_GrO_	General blocking signal
DUP32_**VTS**_GrO_	Blocking signal from the voltage transformer supervision function

2.2.4 Binary output signals (graphed input statuses)

The binary output status signals of the under-power protection function, parts written in **bold** are seen on the function block in the logic editor.

Table 2-4 The binary output status signals of the directional under-power protection function

BINARY STATUS SIGNAL	TITLE	EXPLANATION
DUP32_**GenSt**_GrI_	General Start	General start signal of the function
DUP32_**GenTr**_GrI_	General Trip	Trip command of the function

2.2.5 On-line data

Visible values on the on-line data page:

Table 2-5 On-line data of the directional under-power protection function

SIGNAL TITLE	DIMENSION	EXPLANATION
General Start	-	General start of the function
General Trip	-	General trip command of the function
Power input assignment	-	*Status of the graphical analogue input (if exists) (Complete if OK, Missing if not connected)*

2.2.6 Events

The following events are generated in the event list, as well as sent to SCADA according to the configuration.

Table 2-6 Events of the directional under-power protection function

EVENT	VALUE	EXPLANATION	IEC61850 DATA ATTRIBUTES
General Start	off, on	General start of the function	PPDUP1STStr
General Trip	off, on	General trip command of the function	PPDUP1STOp

2.3 Technical data

Table 2-7 Technical data of the directional under-power protection function

FUNCTION	VALUE	ACCURACY
P,Q measurement	I > 10% In *	< 5%
P,Q meas with CT1500	I > 5% In *	< 5%
Direction angle	-179 - + 180º *	< 5%
	* = Angle btw. U&I: -70°- +70°	
Reset ratio according to Start Power setting*: • Over 40% • 10% – 40% • Below 10%	 1.05 (Setting + 2%)/Setting 1.2	
Reset time	< 100 ms	
Operating time	< 125 ms	
Time delay	0.2 – 60 s	1% or ± 25 ms

**The reason for different reset ratios is to avoid prilling in the low current range where the power measurement is less accurate, therefore the hysteresis for lower Start Power settings is increased.*

2.3.1 Notes for testing

Normally in the EuroProt+ devices the trip contacts are assigned to the Trip Logic function block, and not to the protection function blocks. Because of this, the testing personnel must make sure that the Trip Logic is switched on ('Operation' parameter is set to other than 'Off') before starting the testing, otherwise there will be no physical trip on the relay.

The function is based on the power measurement of the Line Measurement function block. This must be taken into consideration when the device has a separate CT for measurements, because with it, the under-power protection function will use that CT as well.

Additional notes for Graphic Analogue inputs *(only from firmware version 2.10.2.3010 and up):*

Starting from the firmware version **2.10.2.3010**, the majority of the function blocks can be updated to be equipped with graphic analogue inputs which **allow the user to assign the functions' analogue inputs by applying the graphic equation editor**.

The analogue connections of these functions can be checked by examining the source that is connected to their inputs (just like examining the source of a logic signal).

These functions must be placed in the Logic Editor and their graphic analogue inputs must be connected to make them operate. If a connection is intact, the online status of the corresponding analogue input will show "Complete". If it is missing, the status will be "Missing" and the function will not operate.

Note that these graphical inputs do not exist in the earlier firmware/function versions! Checking and modifying the analogue assignments in these cases are done by using the EuroCAP Software Configuration menu.