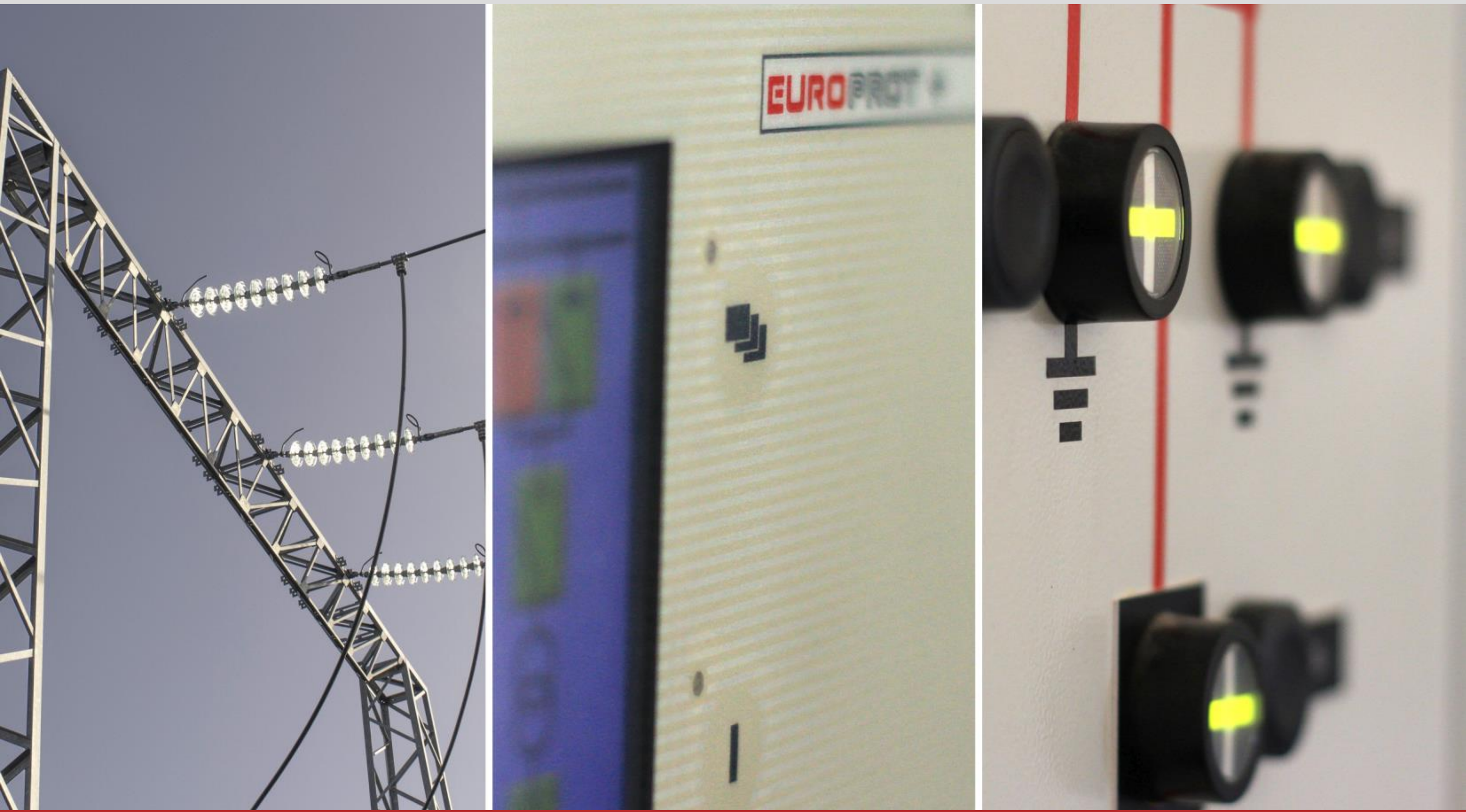

FUNCTION BLOCK DESCRIPTION

Broken conductor protection

ANSI 46BC

PROTECTA HUNGARY

DOCUMENT ID: PP-13-22162
VERSION: 1.1
2020-06-25, BUDAPEST

PROTECTION, AUTOMATION AND CONTROL FOR POWER INDUSTRY

VERSION INFORMATION

VERSION	DATE	MODIFICATION	COMPILED BY
1.0	2020-06-25	First edition	Tóth
1.1	2020-06-30	Function renamed to PBC46 instead of PBR46	Erdős

CONTENTS

1 Application

The broken conductor protection function can be applied to detect a power lines and cables broken conductor condition or a single-pole breaker malfunction condition.

1.1 Mode of operation

By measuring the phase current input signals and compares the ratio of negative phase sequence current (I2) to positive phase sequence current (I1).

If the I2/I1 ratio is above the setting limit, the function generates a start signal. It is a necessary precondition of start signal generation that the *positive phase sequence current (I1) must be between **6.67%** and **100%** of the rated current*.

The function can be disabled by parameter setting, and by an input signal programmed by the user with the graphic programming tool.

The trip command is generated after the defined time delay if trip command is enabled by parameter setting.

1.2 Operation principles

Figure *1-1* shows the structure of the broken conductor protection algorithm.

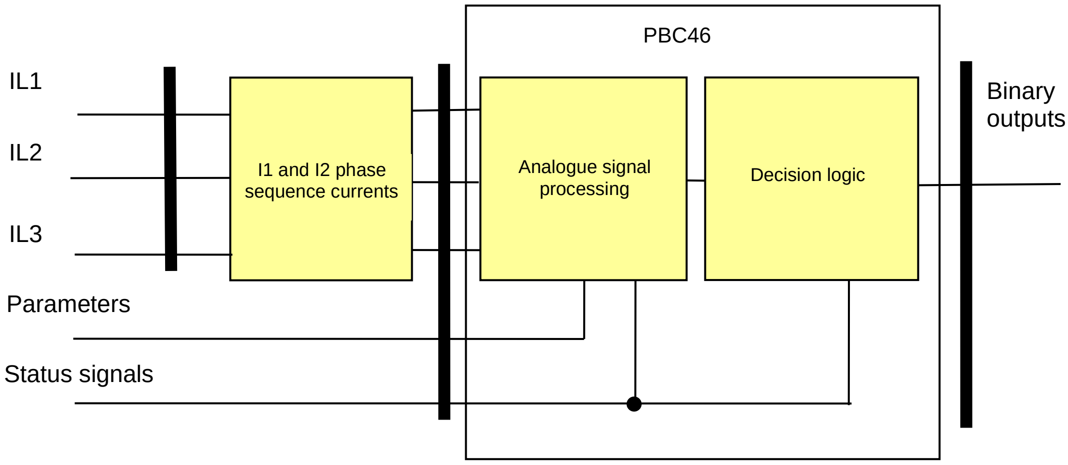

Figure 1-1 Structure of the broken conductor protection algorithm

The **inputs** of the preparatory phase are
- the three phase currents,

The **outputs** of the preparatory phase are
- positive phase sequence current (I1) and negative phase sequence current (I2) values of the fundamental Fourier component of three phase currents.
- the RMS value of the fundamental Fourier components of positive phase sequence current (I1) and negative phase sequence current (I2).

The **inputs** of the broken conductor function are
- the RMS value of the fundamental Fourier component of the positive phase sequence current (I1) and negative phase sequence current (I2),
- parameters,
- status signals.

The **outputs** are
- the binary output status signals.

The **software modules** of the broken conductor function:

Fourier calculations

These modules calculate the RMS values of the basic Fourier current components of the phase currents individually (not part of the PBC46 function).

Positive and negative sequence

This module calculates the basic Fourier current components of the positive and negative sequence currents, based on the Fourier components of the phase currents (not part of the PBC46 function).

Analogue signal processing

This module processes the positive and negative phase sequence current components to prepare the signals for the decision.

Decision logic

The decision logic module combines the status signals to generate the starting signal and the trip command of the function.

The following description explains the details of the individual components.

1.3 The Fourier calculation (Fourier)

These modules calculate the RMS values of the fundamental Fourier components of the phase currents individually. They are not part of the PBC46 function; they belong to the preparatory phase.

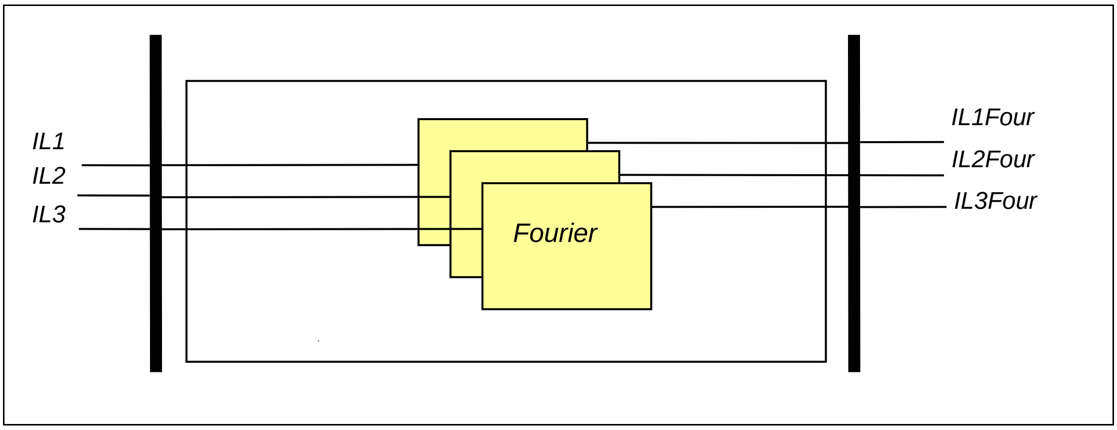

Figure 1-2 Principal scheme of the Fourier calculation

The **inputs** are the sampled values of the three phase currents (IL1, IL2, IL3)

The **outputs** are the RMS values of the fundamental Fourier components of the phase currents (IL1Four, IL2Four, IL3Four).

1.4 The positive and negative phase sequence calculation (Positive and negative sequence)

This module calculates the positive and negative phase sequence components based on the Fourier components of the phase currents. This module belongs to the preparatory phase.

The **inputs** are the basic Fourier components of the phase currents (IL1Four, IL2Four, IL3Four).

The **outputs** are the basic Fourier components of the positive (IPosFour) and negative sequence current component (INegFour).

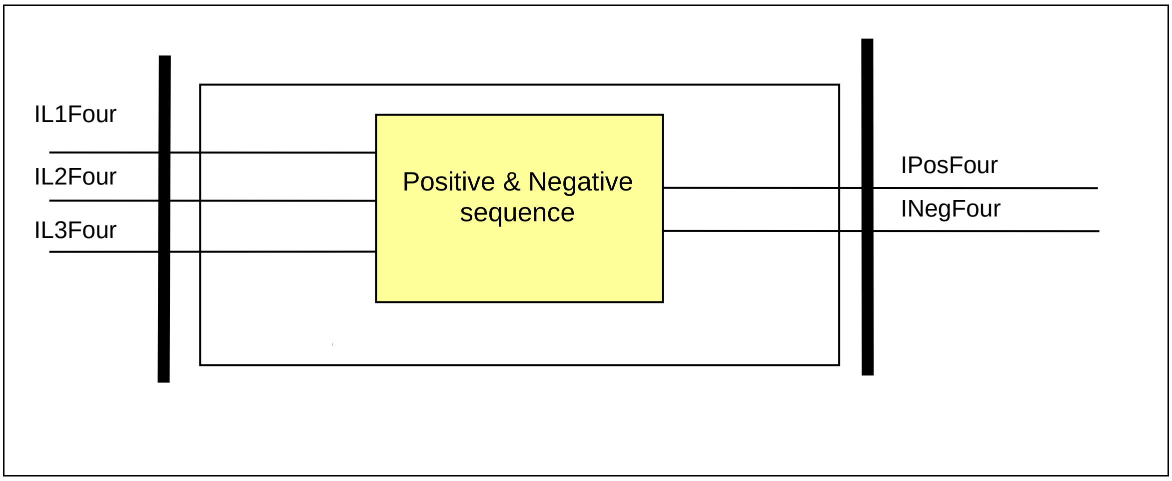

Figure 1-3 Schema of the sequence component calculation

1.5 The Analogue signal processing

This module processes the Fourier components of the phase currents to prepare the signals for the decision.

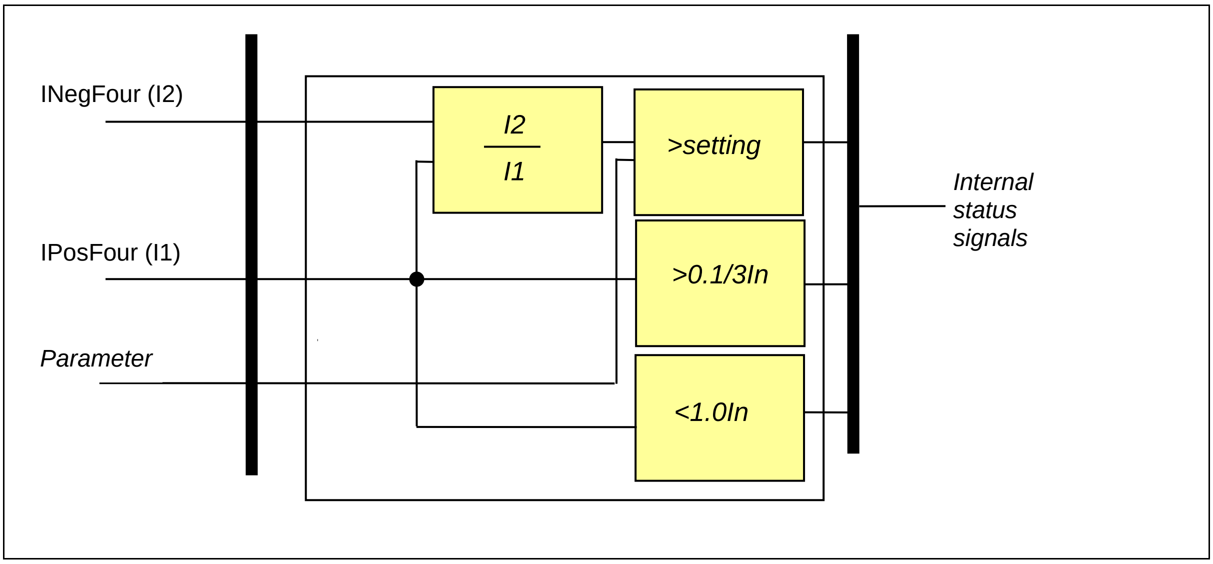

Figure 1-4 Principal scheme of the analogue signal processing

The **inputs** are the basic Fourier component of the positive (IPosFour) and negative sequence currents (INegFour) and parameters.

The **outputs** are internal binary signals:

- I2/I1> the ratio of negative sequence current (I2) to positive sequence current (I1) as a percentage is above the limit defined by the preset parameter PBC46_StCurr_IPar_ (Start current);
- I1>0.1/3In the positive phase sequence current (I1) value of the fundamental Fourier components of the phase currents is sufficient for evaluation;
- I1<1.0In the positive phase sequence current (I1) value of the fundamental Fourier components of the phase currents is sufficient for evaluation.

1.6 The decision logic (Decision logic)

The decision logic module combines the status signals, binary and enumerated parameters to generate the trip command of the function.

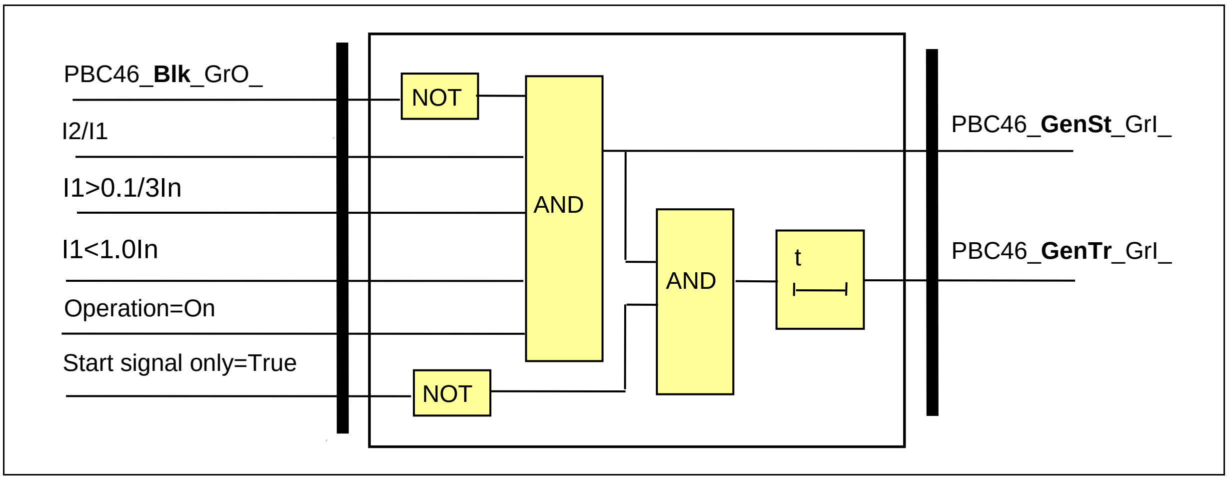

Figure 1-5 The logic scheme of the broken conductor function

The **inputs** are internal binary signals:

- I2/I1> — the ratio of positive phase sequence current (I1) to negative phase sequence current (I2) as a percentage is above the limit defined by the preset parameter “Start current”;
- I1>0.1/3In — the positive phase sequence current (I1) value of the fundamental Fourier components of the phase currents is sufficient for evaluation;
- I1<1.0In — the positive phase sequence current (I1) value of the fundamental Fourier components of the phase currents is sufficient for evaluation.

2 Broken conductor protection function overview

The graphic appearance of the function block of the broken conductor protection function is shown below. The block shows all binary input and output status signals which are applicable in the graphic equation editor.

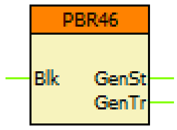

Figure 2-1 Graphic appearance of the function block of the broken conductor protection function

2.1 Settings

2.1.1 Parameters

The available parameters are listed below in order of their appearance in the *parameters* menu. If the setting range of a parameter should be extended, contact Protecta Support.

Table 2-1 Parameters of the broken conductor protection function

TITLE	DIM	RANGE	STEP	DEFAULT	EXPLANATION
Operation	-	Off, On	-	Off	Enabling the function
Start Signal Only	-	FALSE, TRUE	-	FALSE	When checked, the function provides start signal, but no trip signal.
Start Current	%	10 – 90	1	50	I2/I1 ratio setting
Time Delay	msec	100 – 60000	1	1000	Time delay (including the algorithm time, see Chapter 2.4 for more explanation)

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

The function uses the sampled values of a current input. This is defined in the configuration.

2.2.2 Binary input signals (graphed output statuses)

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

Table 2-2 The binary input signal of the broken conductor protection function

BINARY OUTPUT SIGNAL	EXPLANATION
PBC46_**Blk**_GrO_	Blocking input of the function

2.2.3 Binary output signals (graphed input statuses)

These signals can be used in EuroCAP to assign to LED, user LCD object etc. Parts written in **bold** are seen on the right side of the function block in the *Logic Editor*.

Table 2-3 The binary output signals of the broken conductor protection function

BINARY OUTPUT SIGNAL	SIGNAL TITLE	EXPLANATION
PBC46_**GenSt**_GrI_	General Start	General start signal of the function
PBC46_**GenTr**_GrI_	General Trip	General trip command of the function

2.2.4 Online data

Visible values on the *online data* page.

Table 2-4 Online displayed data of the broken conductor protection function

SIGNAL TITLE	DIMENSION	EXPLANATION
General Start	-	General start signal of the function
General Trip	-	General trip command of the function

2.2.5 Events

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

Table 2-5 Generated events of the broken conductor protection function

EVENT	VALUE	EXPLANATION
General Start	off, on	General start of the function
General Trip	off, on	General trip command of the function

2.3 Technical data

Table 2-6 Technical data of the broken conductor protection function

FUNCTION	VALUE	ACCURACY
Pick-up starting accuracy		< 2 %
Reset ratio	0,95	
Min. operate time	70 ms	

2.4 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 tests, otherwise there will be no physical trip on the relay.

Note that the time delay parameter incorporates the algorithm time as well, so the time delay *does **not** mean the time difference between the appearance of the start and trip signals* of the function. In other words: it is not the delay between the detection of the fault and the trip that follows it. This should be taken into consideration when checking the disturbance records.

Instead the time delay parameter defines the elapsed time from the appearance of the faulty state to the trip. Because of this, while testing, the delay measurement should start *from the moment of the fault injection* until the trip signal.