FuseFail
Fuse Failure Supervision

Contents

1 Introduction

1.1 Features

- Detection of failures in a voltage measurement circuitry
- A failure is detected in a voltage measurement circuitry when the negative-sequence voltage rises to a significant level while the negative-sequence current does not rise correspondingly
- If only one phase-to-phase voltage is measured, detection is based on the amplitude of the measured voltage and the absence of high negative-sequence current
- If all the measured voltages are lost while the currents remain at a normal level, a failure is recognised in the voltage measurement circuit
- The output BSOUT indicating a failure in the voltage measurement circuitry is disabled if a high current value is detected in any phase (=> fault current). This is particularly important in the case of three-phase short-circuit close to the measuring point.
- The output BSOUT indicating a failure in the voltage measurement circuitry is disabled also if the current ceases to zero
- The function block includes an input for position information of a miniature circuit breaker (MCB). The opening of the MCB generates an event even if the function block is in the “Not in use” mode.

1.2 Application

This document specifies the functions of the fuse failure supervision function block FuseFail used in products based on the RED 500 Platform.

Some voltage based protection functions may maloperate if a voltage measurement circuitry is damaged or if the miniature circuit breaker (MCB) of the measurement circuitry has opened for example due to an operation of the short circuit protection.

Such protection functions, e.g. UI6Low, are therefore blocked by FuseFail to avoid a wrong operation of the protection during the absence of the correct voltage measurement.

A failure in the voltage measurement circuitry should, however, be repaired as soon as possible to restore the blocked protection functions into use.

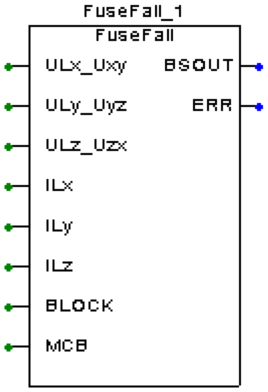

Figure 1. Function block symbol of FuseFail

1.3 Input description

Name	Type	Description
ULx_Uxy	Analogue signal (SINT)	Input for measuring phase-to-earth voltage or phase-to-phase voltage
ULy_Uyz	Analogue signal (SINT)	Input for measuring phase-to-earth voltage or phase-to-phase voltage
ULz_Uzx	Analogue signal (SINT)	Input for measuring phase-to-earth voltage or phase-to-phase voltage
ILx	Analogue signal (SINT)	Input for measuring phase current
ILy	Analogue signal (SINT)	Input for measuring phase current
ILz	Analogue signal (SINT))	Input for measuring phase current
BLOCK	Digital signal (BOOL, active high)	Signal for blocking the function block
MCB	Digital signal (BOOL, active high)	Position indication of a miniature circuit breaker (TRUE = closed)

1.4 Output description

Name	Type	Description
BSOUT	Digital signal (BOOL, active high)	Blocking signal for protection functions
ERR	Digital signal (BOOL, active high)	Signal for indicating a configuration error

2 Description of operation

2.1 Configuration

If the relay is not yet configured, the measuring devices and signal types for the 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 the selectable analogue inputs, digital inputs and digital outputs depends on the hardware used).

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 Relay Configuration Tool. The phase-to-earth voltages or phase-to-phase voltages (e.g. U_{L1}, U_{L2} and U_{L3} or U_{12}, U_{23} and U_{31}) are connected to the corresponding inputs, ULx_Uxy, ULy_Uyz and ULz_Uzx, of the function block. The phase currents (e.g. I_{L1}, I_{L2} and I_{L3} or I_{L1b}, I_{L2b} and I_{L3b}) are connected to the corresponding inputs ILx, ILy and ILz of the function block. Note that all the currents and voltages need not be available when using the function block.

The function block will automatically adapt itself to the connected analogue inputs. Note that if only two voltages are to be connected to the function block, they are connected to the first and second voltage inputs (ULx_Uxy and ULy_Uyz) of the function block. If only one (phase-to-phase) voltage is to be connected, it is connected to the first voltage input. Similarly, if only two currents are to be connected they are connected to the first and second current inputs of the function block. It is important that the phase order is always 1-2-3, 2-3-1 or 3-1-2 (refer to section 2.2 “Configuration error checking”), regardless of the number of the connected voltages or currents. Refer to examples 1, 2 and 3 below.

Example 1. Connections of the currents

In this example, all phase-to-earth voltages are to be connected but only two phase currents are available. The possible connections for analogue inputs in this case are presented in Figure 2. Note that the connected voltages could also be as in example 2 or as in example 3. They are not dependent on the connected currents.

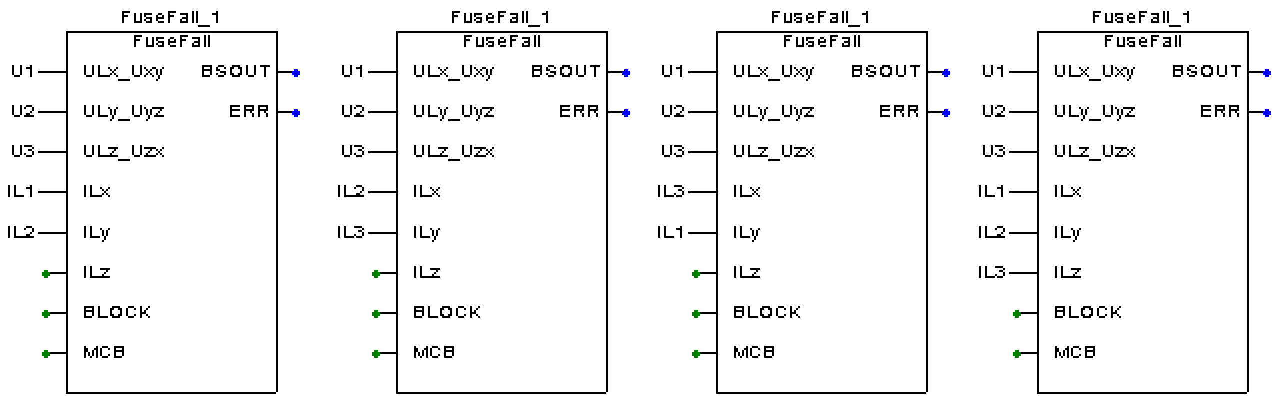

Figure 2. Analogue input connections when a), b), c) only two currents and d) all currents are used

Example 2. Connections of the voltages

In this example, two or three phase-to-phase voltages are measured. The possible connections for analogue inputs in this case are presented in Figure 3. Note that the connected currents could also be as in example 1. They are not dependent on the connected voltages.

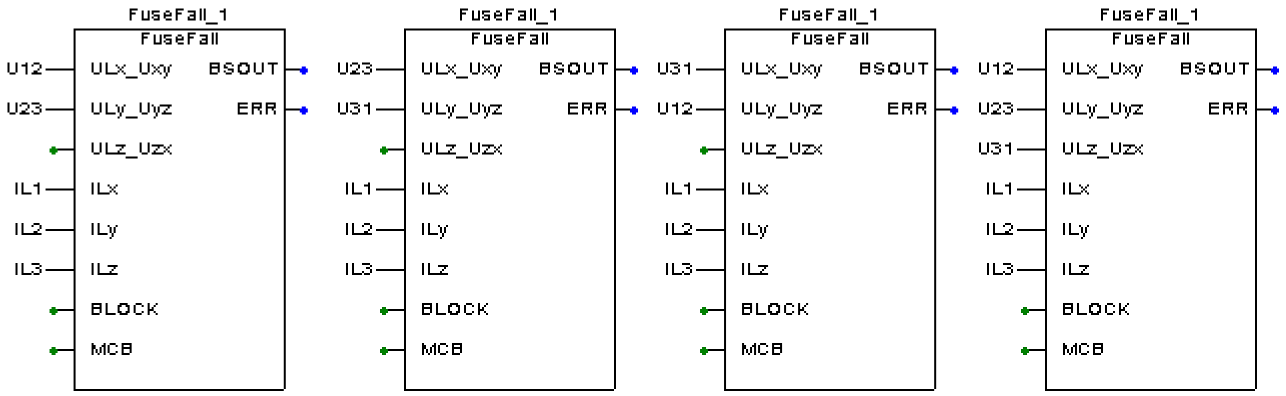

Figure 3. Analogue input connections when phase-to-phase voltages are used

Example 3. Connections of the voltages

In this example, only one phase-to-phase voltage is to be connected to the function block. The possible connections for analogue inputs in this case are presented in Figure 4. Note that the connected currents could also be as in example 1. They are not dependent on the connected voltages.

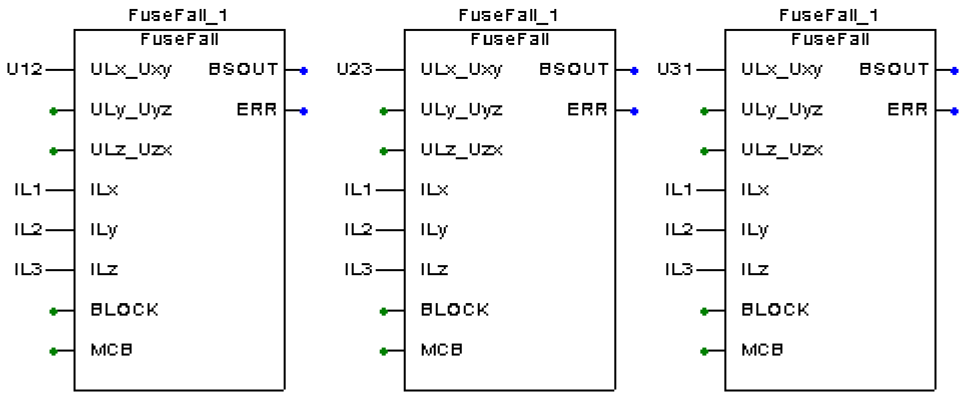

Figure 4. Analogue input connections when only one phase-to-phase voltage is used

Digital inputs are connected to the boolean inputs of the function block and the ERR output of the function block is connected to the output signal. The BSOUT output should be connected to the BLOCK input of the function block (or blocks) which is to be blocked in the case of a failure in the voltage measurement circuitry. If a digital signal indicating the state of the miniature circuit breaker (MCB) is available, it should be connected to the MCB input of the function block. Deactivation of the MCB input will activate BSOUT output and generate an event indicating an opened miniature circuit breaker.

If a digital signal indicating the state of the circuit breaker is available, it should be connected to a logical OR together with the BSOUT output of FuseFail and the output of the logical OR should then be connected to the BLOCK input of the function block to be blocked.

The function block should be instantiated within the same program as the fastest function block to be blocked with it. Thus, if there are for example three function blocks to be blocked, one is executed at 5-millisecond intervals, the other at 10-millisecond intervals and the third at 20-millisecond intervals, then the FuseFail function block has to be executed at 5-millisecond intervals. A global variable has to be used to transfer the status of the BSOUT output to the programs in other tasks. The fundamental frequency of 50 Hz is assumed in the previous example.

However, the execution interval of the FuseFail function block should not be greater than 20 milliseconds to ensure the right operation during three-phase short circuits in networks with a weak infeed.

When BSOUT output is used for blocking function blocks that are executed in a slower task interval than FuseFail, an additional delay has to be included in the block activation time and in the reset time. The delay is as long as the interval of the slower task. The following examples clarify the BSOUT activation time and the reset time. In these examples, a global variable v_BSOUT is used to deliver the BSOUT signal to other tasks.

Example 1:

FuseFail	task interval 10 ms	BSOUT activation time <35 ms
Function block to be blocked	task interval 20 ms	activation time of the BLOCK input (via global variable v_BSOUT) < (35 ms + 20 ms) = 55 ms

Example 2:

FuseFail	task interval 10 ms	BSOUT reset time 20 ms
Function block to be blocked	task interval 20 ms	reset time of the BLOCK input (via global variable v_BSOUT) 20 ms + 20 ms = 40 ms

2.2 Configuration error checking

If the connected analogue inputs are not sufficient or not in the right order, the ERR output is activated and an error log notification is generated. Activation of the ERR output also automatically sets the function block to the “Not in use” mode, which means that it cannot operate.

2.3 Setting the rated values of the protected unit

A separate scaling factor can be set for each analogue channel. The factors enable differences between the ratings of the protected unit and those of the measuring device (CTs, VTs, etc.). A setting of 1.00 means that the rated value of the protected unit is exactly the same as that of the measuring device. For more information, refer to “Technical Reference Manual” for REM 54_.

2.4 Measuring mode

The function block has two different measuring modes.

1. If at least two voltages are connected, the operation is based on positive- and negative-sequence components of voltage and current.
2. In the case of only one connected phase-to-phase voltage the operation is based on the amplitude of the measured voltage and on positive- and negative-sequence currents.

The function block automatically selects the right measuring mode depending on the connected analogue signals.

Note!

When negative-sequence and positive-sequence components of voltage or current are calculated from only two phase variables, U_0 and correspondingly I_0 are assumed to be zero (i.e. $U_{L1}+U_{L2}+U_{L3} = 0$, $I_{L1}+I_{L2}+I_{L3} = 0$). When two phase-to-phase voltages are used, negative- and positive-sequence voltages can be calculated without additional assumptions.

2.5 Operation criteria

The operation criteria depend to some extent on the measuring mode. Operation on both measuring modes is described below.

2.5.1 Measuring mode 1

The BSOUT output is activated in the following situations:

- If the ratio of negative-sequence voltage to positive-sequence voltage exceeds the user-settable limit “Ratio U2/U1>” while the ratio of negative-sequence current to positive-sequence current does not exceed the user-settable limit “Ratio I2/I1<”.
- If all the voltage signals are lost and, at the same time, the ratio of negative-sequence current to positive-sequence current does not exceed the user-settable limit “Ratio I2/I1<”.

2.5.2 Measuring mode 2

The BSOUT output is activated in the following situation:

- If the only measured phase-to-phase voltage is lost and, at the same time, the ratio of negative-sequence current to positive-sequence current does not exceed the user-settable limit “Ratio I2/I1<”.

2.5.3 Additional criteria to the measuring modes

1. The activation of the BSOUT output is inhibited or BSOUT is reset (if already active) if the amplitude of any of the measured currents even temporarily exceeds 1.5 x I_n. The nominal current (I_n) is determined by the nominal current of the measuring device and the scaling factor of the analogue channel (see “Setting the

rated values of the protected unit”). This criterion affects also blocking based on the input MCB.

The inhibition described above is latched to ensure that the decrease of the fault current does not change the conditions so that the blocking signals would be activated falsely.

The inhibition is unlatched

- when the positive-sequence current has decreased to zero, that is, when the fault is cleared by opening the circuit breaker

  OR

- one second after its activation if the activation criteria for BSOUT are not met anymore

2. The activation of the BSOUT output is inhibited or BSOUT is reset (if already active) also during an undercurrent situation (positive-sequence current is very low).

2.5.4 Input MCB

The deactivation of the MCB input (position information of the miniature circuit breaker, closed when active) will activate the BSOUT output. It will also generate an additional event indicating the position of the miniature circuit breaker. The event is generated even if the function block is set to “Not in use” (control parameter “FuseFail”) and BSOUT output will not be activated.

If the first criterion described in the section “Additional criteria to the measuring modes” is fulfilled, the BSOUT output will not be activated when the input MCB is deactivated. The second criterion in that section does not affect blocking based on the input MCB.

Note!

The activation of the BSOUT output can take place only if the function block is set to “In use” (control parameter “FuseFail”) and is not blocked by an external blocking signal connected to the BLOCK input. The default setting for the parameter “FuseFail” is “Not in use”.

2.6 Test mode

The BSOUT output of the function block can be activated with a separate control parameter 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 supervising functions operate normally while the BSOUT output is tested.

3 Parameters and events

3.1 General

- Each function block has a specific channel number for serial communication parameters and events. The channel for FuseFail is 118.
- 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 Settings

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Ratio U2/U1>	S41	10...50	%	25	R/W	Minimum ratio of negative-sequence voltage to positive-sequence voltage to allow blocking
Ratio I2/I1<	S42	10...50	%	20	R/W	Maximum ratio of negative-sequence current to positive-sequence current to allow blocking

3.2.2 Control settings

Parameter	Code	Values	Unit	Default	Data direction	Explanation
FuseFail	V1	0 or 1 [1)]	-	0	R/W	Function block in use or not in use
Test BSOUT	V2	0 or 1 [2)]	-	0	R/W	Testing BSOUT
Event mask 1	V101	0...255	-	15	R/W	Event mask 1 for event transmission (E0...E7)
Event mask 2	V103	0...255	-	15	R/W	Event mask 2 for event transmission (E0...E7)
Event mask 3	V105	0...255	-	15	R/W	Event mask 3 for event transmission (E0...E7)
Event mask 4	V107	0...255	-	15	R/W	Event mask 4 for event transmission (E0...E7)

[1)] Status 0=Not in use; 1=In use

[2)] Test 0=Do not activate; 1=Activate

3.3 Measurement values

3.3.1 Input data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Input BLOCK	I1	0 or 1 [1)]	-	0	R/M	Status of signal for blocking the function block
Input MCB	I2	0 or 1 [2)]	-	1	R/M	Position of the miniature circuit breaker contacts

[1)] Status 0=Not active; 1=Active

[2)] Position 0=Open; 1=Closed

3.3.2 Output data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Output BSOUT	O1	0 or 1 [1)]	-	0	R/M	Status of blocking signal for protection functions
Output ERR	O2	0 or 1 [1)]	-	0	R/M	Status of configuration error signal

[1)] Status 0=Not active; 1=Active

3.3.3 Events

Code	Weighting coefficient	Default mask	Event reason	Event state
E0	1	1	Fuse failure	Reset
E1	2	1	Fuse failure	Activated
E2	4	1	MCB position	Open
E3	8	1	MCB position	Closed
E4	16	0	FuseFail blocked	Reset
E5	32	0	FuseFail blocked	Activated
E6	64	0	Test mode of FuseFail	Off
E7	128	0	Test mode of FuseFail	On

4 Technical data

Operation accuracies	Depends on the frequency of the current and voltage measured: f/f_n=0.98...1.02: ±2.0 percentage units (of settings Ratio U2/U1> and Ratio I2/I1<) f/f_n=0.95...1.05: ±4.0 percentage units (of settings Ratio U2/U1> and Ratio I2/I1<)
BSOUT activation time (when the task interval is 10 ms) [1)]	Injected negative-sequence voltage = 2.00 x Ratio U2/U1>: f/f_n=0.98...1.02 < 35 ms (within the same task)
Reset time (when the task interval is 10 ms) [2)]	20 ms (within the same task)
Reset ratio	0.8...0.96 (for Ratio U2/U1>) 1.04...1.2 (for Ratio I2/I1<)
Configuration data	Task execution interval (Relay Configuration Tool): 5...20 ms, at the rated frequency f_n = 50 Hz

[1)] When BSOUT output is used for blocking function blocks that are executed in a slower task interval than FuseFail, an additional delay has to be included in the block activation time (refer to section 2.1 “Configuration”).

[2)] When BSOUT output is used for blocking function blocks that are executed in a slower task interval than FuseFail, an additional delay has to be included in the reset time (refer to section 2.1 “Configuration”).

Technical revision history	
Technical revision	**Change**
D	Function block specific configuration error event removed, event mask setting range is changed accordingly