TOL3Cab
Three-Phase Thermal Overload Protection for Cables

Contents

1. Introduction

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- Adjustable percentual temperature limits for tripping, prior alarm and reclose inhibit
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- Ambient temperature compensation by external temperature sensor(s) or by parameter setting
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- The thermal model applied uses one time constant and the TRUE RMS current measuring principle

1.2 Application

This document specifies the function of the three-phase thermal overload protection function block TOL3Cab used in products based on the RED 500 Platform.

TOL3Cab is designed for the thermal protection of three-phase power cables and overhead lines.

Table 1 . Protection diagram symbols used in the relay terminal

ABB	IEC	ANSI
TOL3Cab	**3Ith>**	**49F**

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

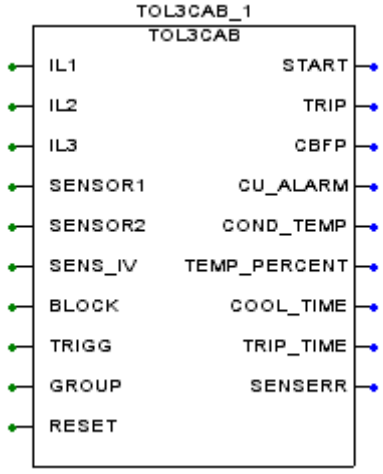

Figure 1. Function block symbol of TOL3Cab, the three-phase thermal overload protection for cables

1.3 Input description

Name	Type	Description
IL1	Analogue signal (SINT)	Input for measuring the RMS-value of the phase current I_{L1}
IL2	Analogue signal (SINT)	Input for measuring the RMS-value of the phase current I_{L2}
IL3	Analogue signal (SINT)	Input for measuring the RMS-value of the phase current I_{L3}
SENSOR1	Analogue signal (REAL)	External temperature sensor 1 for ambient temp. measurement
SENSOR2	Analogue signal (REAL)	External temperature sensor 2 for ambient temp. measurement
SENS_IV	Digital signal (BOOL, active high)	Signal indicating a sensor fault i.e. an invalidity input for sensor measurement
BLOCK	Digital signal (BOOL, active high)	Signal for blocking the tripping of the function block
TRIGG	Digital signal (BOOL, pos. edge)	External 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.
RESET	Digital signal (BOOL, pos. edge)	Input signal for resetting the trip signal, sensor error signal and registers of TOL3Cab

1.4 Output description

Name	Type	Description
START	Digital signal (BOOL, active high)	Prior alarm signal
TRIP	Digital signal (BOOL, active high)	Tripping signal
CBFP	Digital signal (BOOL, active high)	Delayed trip signal for circuit-breaker failure protection (CBFP)
CU_ALARM	Digital signal (BOOL, active high)	Warning signal for overload current
COND_TEMP	Analogue signal (REAL)	Calculated temperature of the conductor
TEMP_PERCENT	Analogue signal (REAL)	Calculated temperature of the conductor, per cent value
COOL_TIME	Analogue signal (DINT)	Time which should be waited before reclosuring is possible
TRIP_TIME	Analogue signal (DINT)	Predicted time to the trip
SENSERR	Digital signal (BOOL, active high)	Signal for indicating a sensor error

2. Description of operation

2.1 Configuration

Phase currents can be measured via conventional current transformers or Rogowski coils. 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. TOL3Cab requires that the Thermal Overload Protection or True RMS Current measurement is activated for all the phase current analogue channels connected to this function block. Digital inputs are configured in the same programming environment (the number of 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 configuration tool. The phase currents I_{L1}, I_{L2} and I_{L3} are connected to the corresponding IL1, IL2 and IL3 inputs of the function block. TOL3Cab can also be used with one or two phase current channels, the rest of the analogue channel inputs shall be left unconnected.

If RTD-measurements are used for compensating the ambient temperature, the RTD-variables are connected to the SENSOR1, SENSOR2 and SENS_IV inputs as presented in the figure 3 below. If only one measurement input is used, corresponding RTD-variables are connected to the SENSOR1 and SENS_IV inputs. Provided the external sensor measurement is not used at all, the SENS_IV, SENSOR1 and SENSOR2 inputs can be left unconnected. Refer to the section 2.3.8 for choosing correct settings.

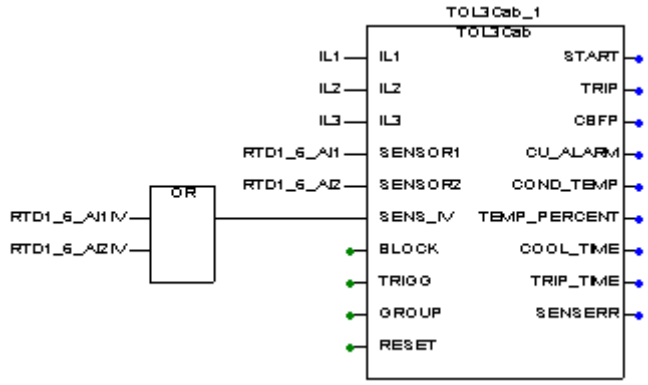

Figure 2. Example for the connection of the SENS_IV input that indicates the invalidity of sensor measurement when two RTD-sensors are used

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.

2.2 Measuring mode

The calculation of the thermal model is based on the TRUE RMS measuring principle. The thermal load is calculated by means of the highest phase current value.

2.3 Operation criteria

2.3.1 Principle of the thermal model applied

TOL3Cab applies the thermal model of one time constant for temperature measurement, which means that both the temperature rise and the cooling follow an exponential curve. The formula applied in calculating the cable temperature is presented below.

$$\Theta = [\left(\frac{I}{I_{CABLE}}\right)^2 * (\Theta_{MAX} - \Theta_{REF})] * (1 - e^{-t/\tau}) + \Theta_{AMB}$$

where

Symbol	Parameter	Description
Θ	Output COND_TEMP	Calculated conductor temperature (°C)
I	Current Ilx	The measured phase current with the highest TRUE RMS value
I_{CABLE}	Rated current	Maximum sustained load current value allowed for the cable
Θ_{MAX}	Maximum temp	Maximum temperature allowed for a cable under sustained load. The value depends on the insulation material used; for example, the maximum temperature for cables with PEX insulation is +90 °C and for those with PVC insulation +65 °C
Θ_{REF}	Reference temp	Temperature in which the rated current has been defined; for example, +15 °C for underground cables and +25 °C for overhead cables
τ	Time constant	Time constant for the temperature rise and cooling of a cable
Θ_{AMB}	Ambient temp	Ambient temperature, which can be either a set value or a one measured by sensors

In the initializing stage, i.e. when the auxiliary voltage is connected to the relay, the function block assumes that the cable temperature has risen to 50% of the difference between the parameter values “Maximum temp” and “Ambient temp”. For example, if the maximum temperature has been set to + 90 °C (cable with PEX insulation) and the ambient temperature is + 20 °C, the relay assumes a temperature of + 55 °C for the cable. The same temperature rise of 50% is also assumed for the cable when the operation mode is set into use i.e. the parameter is set as follows:

1 = ON: no sensors,

2 = ON: Sensor 1 or

3 = ON: Sensors 1&2.

2.3.2 TRIP output

The TRIP output is activated if TEMP_PERCENT i.e. the conductor temperature-rise measured in per cent exceeds the value of the “Trip temperature” parameter that can be set in the range 80% to 120%.

The so-called delayed trip is set into use by giving the “Trip temperature” parameter a value higher than 100% and the “Trip delay” parameter one higher than 0. For example, the trip temperature can be set to 120% and the trip delay to 60 min, in which case the function block trips when the cable load remains above 100% for 60 minutes but does not exceed 120%. If the temperature exceeds 120% during trip delay, the function trips immediately.

If the TRIP output is chosen not to be used, the parameter is set as follows: ...\Control setting\Trip & Start = Disabled.

2.3.3 START output

The START output becomes active when the calculated conductor temperature exceeds the setting of the “Prior alarm” parameter that can be given a value in the range 40% to 100%. If the START output is chosen not to be used, the parameter is set as follows: ...\Control setting\Trip & Start = Disabled.

2.3.4 CU_ALARM output

The CU_ALARM output is activated when one of the three phase currents becomes so high that even if it remains the same, the cable temperature will exceed the maximum temperature set for the cable.

2.3.5 COND_TEMP & TEMP_PERCENT outputs

The calculated conductor temperature (°C) COND_TEMP as well as the percentual temperature rise TEMP_PERCENT can be monitored in the following three ways:

1 Via the MMI of the relay, in the view MAIN MENU / Protection lib. / TOL3Cab / Output data

2 Via serial communication provided the event E10 has not been excluded via the "Event mask" control parameter of TOL3Cab. Note that only the percentual temperature rise TEMP_PERCENT is sent with the event.

3 Via the MIMIC view of the relay provided the connection presented in Figure 4 below has been configured with the Relay Configuration Tool

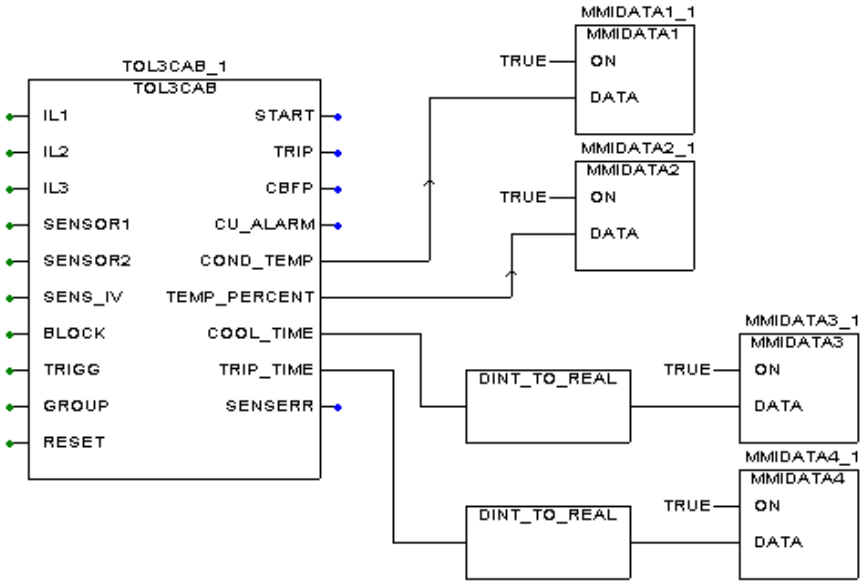

Figure 3. Graphic representation of the COND_TEMP and TEMP_PERCENT outputs in the MIMIC view of the relay

TOL3Cab sends an event containing the percentual temperature rise of the conductor to serial communication once a minute at the most frequent. However, if the change in the conductor temperature is less than 0,5% of the previous value sent, no event is sent to serial communication even though one minute has passed since the previous event.

2.3.6 COOL_TIME output

The COOL_TIME output indicates in full minutes the time required for the cable to cool below the set temperature limit i.e. value of the “Reclosure temp.” parameter. The cooling time left (min) can be monitored in the following three ways:

1 Via the MMI of the relay, in the view MAIN MENU / Protection lib. / TOL3Cab / Output data

2 Via serial communication provided the event E11 has not been excluded via the “Event mask” control parameter of TOL3Cab

3 Via the MIMIC view of the relay provided the connection has been configured with the Relay Configuration Tool. For an exemplary connection, see Figure 4 above.

The COOL_TIME output will show value 99999 if TRIP output is not active or the cable is still loaded and thus not be expected to cool below the set temperature limit, i.e. the value of the Reclosure temp. parameter.

2.3.7 TRIP_TIME output

The TRIP_TIME output indicates the operate time of the function block when the current remains at the present level. The time estimate can be monitored in the following three ways:

1 Via the MMI of the relay, in the view MAIN MENU / Protection lib. / TOL3Cab / Output data

2 Via serial communication provided the event E16 has not been excluded via the “Event mask” control parameter of TOL3Cab

3 Via the MIMIC view of the relay provided the connection has been configured with the Relay Configuration Tool. For an exemplary connection, see Figure 4 above.

The TRIP_TIME output will show value 99999 if the current is so low that the tripping temperature is not expected to be exceeded. Value 99999 is also shown if the BLOCK input is activated or the parameter "Trip & Start" is set to "Disabled". After a trip command, the TRIP_TIME will remain zero as long as the TRIP output is active.

2.3.8 Compensation of ambient temperature

In the thermal model (see the formula above in section “Principle of the thermal model applied”) the influence of ambient temperature is compensated by the parameter “Ambient temp” which can be either a set value or one measured by temperature sensors. Compensating the ambient temperature is crucial for the correct function of the thermal model since the environmental conditions of cables to be protected vary considerably.

The principle of ambient temperature compensation is defined via the control setting parameter “Operation mode”. When no external sensors are used to measure the ambient temperature, the “Operation mode” parameter is given the value 1 (=ON: no sensors). In this case the temperature value applied in the thermal model is the one set for the “Ambient temp” parameter. On the other hand, when external sensors are used, the “Operation mode” parameter is given the value 2 or 3. When the value 2 (=ON: Sensor 1) is set for the parameter, one temperature sensor is used which is connected to the SENSOR1 input of the function block. The value 3 (=ON: Sensors 1&2) means that two sensors are used for measuring the ambient temperature, in which case the function applies the higher of the two temperature values in the thermal model for compensating the ambient temperature.

At any time, the ambient temperature value used for calculating the conductor temperature can be checked via the MMI or via serial communication in the menu ... / TOL3Cab / Control setting / Ambient temp.

2.3.9 Reclose inhibit

After TOL3Cab has tripped, reclosing is not possible until the conductor temperature calculated by the formula above (see section “Principle of the thermal model applied”) falls below the value set for the “Reclosure temp” parameter, because the function block holds the TRIP output active. If the reclosing inhibit is chosen not to be used, the parameter is set to 100%.

2.3.10 Temperature sensor supervision

If the measured ambient temperature is not within the allowable range from -40 to +70 degrees, the function block sends a "Sensor error" event (E15) and activates the SENSERR output. The same is done if TOL3Cab detects a rapid change of more than 5 degrees in the measured temperature or if the input SENS_IV is activated. The SENSERR output is always latched and must be reset as presented in the chapter 2.7.

When TOL3Cab detects an error in a sensor measurement, it applies the set temperature value for compensating the ambient temperature.

2.3.11 BLOCK input

If the BLOCK input is active, the TRIP output cannot be activated, but TOL3Cab still continues measuring the conductor temperature. Thus, activating the BLOCK signal prevents neither temperature measurement nor activation of the START or CU_ALARM outputs.

2.4 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”[1)] of the MMI

2 Over the communication bus by writing the parameter V3[1)]

3 By means of the input signal GROUP, when allowed via the parameter “Group selection” (i.e. when V3 = 2[1)])

[1)] 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.

2.5 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.

2.6 START, TRIP and CBFP outputs

The output signal START is always pulse-shaped. The minimum pulse width of the START and TRIP output signals is set via a separate parameter on the HMI or on the 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 have a non-latching or latching feature. If the start situation is longer than the set pulse width and the non-latching mode has been selected, the TRIP signal remains active until the start situation is over. When the latching mode has been selected, the TRIP signal remains active until the output is reset even if the operation criteria have reset.

The circuit-breaker failure protection function provides a delayed trip signal, CBFP, after the TRIP signal unless the fault has disappeared during the set CBFP time delay. The CBFP output can be used to operate a circuit breaker in front of the circuit breaker of the feeder.

Note! The control parameter "Trip pulse" also sets the pulse width of the CBFP output signal. The CBFP signal resets when the set pulse width elapses, even if the start

situation is still active. Therefore, if the CBFP function is used, a setting value of 200ms or longer for the control parameter "Trip pulse" is recommended.

The default value for the control parameter “CBFP time” is 0.00 s, which means that the circuit-breaker failure protection is not in use.

2.7 Resetting

The TRIP output signal, SENSERR output signal and registers can be reset either via the RESET input or over the serial bus or the local MMI.

The operation indicators, output signals and recorded data can be reset as follows:

	Operation indicators	Latched trip & sensor err.	Recorded data
RESET input of the function block [1]		X	X
Parameter F047V013 [1]		X	X
General parameter F001V011 [2]	X		
General parameter F001V012 [2]	X	X	
General parameter F001V013 [2]	X	X	X
Push-button C [2]	X		
Push-buttons C + E (2 s) [2]	X	X	
Push-buttons C + E (5 s) [2]	X	X	X

[1] Resets the latched trip signal and recorded data of the particular function block.
[2] 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 TOL3Cab is 47.
- 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

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Time constant	S1	1...999	min	45	R	Heating / cooling time constant for the cable
Rated current	S2	1.0...5000.0	A	300.0	R	Maximum load current for the protected cable
Maximum temp	S3	40.0...150.0	°C	90.0	R	Maximum temperature permitted for the conductor
Reference temp	S4	-50.0...100.0	°C	20.0	R	Ambient temperature for determination of the maximum load current
Trip temperature	S5	80.0...120.0	%	100.0	R	Tripping temperature, per cent value
Prior alarm	S6	40.0...100.0	%	90.0	R	Prior alarm temperature, per cent value
Reclosure temp	S7	40.0...100.0	%	80.0	R	Temperature value which enables reclosing
Ambient temp	S8	-50.0...100.0	°C	40.0	R	Setting value for ambient temperature

3.2.2 Setting group 1

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Time constant	S41	1...999	min	45	R/W	Heating / cooling time constant for the cable
Rated current	S42	1.0...5000.0	A	300.0	R/W	Maximum load current for the protected cable
Maximum temp	S43	40.0...150.0	°C	90.0	R/W	Maximum temperature permitted for the conductor
Reference temp	S44	-50.0...100.0	°C	20.0	R/W	Ambient temperature for determination of the maximum load current
Trip temperature	S45	80.0...120.0	%	100.0	R/W	Tripping temperature, per cent value
Prior alarm	S46	40.0...100.0	%	90.0	R/W	Prior alarm temperature, per cent value
Reclosure temp	S47	40.0...100.0	%	80.0	R/W	Temperature value which enables reclosing
Ambient temp	S48	-50.0...100.0	°C	40.0	R/W	Setting value for ambient temperature

3.2.3 Setting group 2

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Time constant	S71	1...999	min	45	R/W	Heating / cooling time constant for the cable
Rated current	S72	1.0...5000.0	A	300.0	R/W	Maximum load current for the protected cable
Maximum temp	S73	40.0...150.0	°C	90.0	R/W	Maximum temperature permitted for the conductor
Reference temp	S74	-50.0...100.0	°C	20.0	R/W	Ambient temperature for determination of the maximum load current
Trip temperature	S75	80.0...120.0	%	100.0	R/W	Tripping temperature, per cent value
Prior alarm	S76	40.0...100.0	%	90.0	R/W	Prior alarm temperature, per cent value
Reclosure temp	S77	40.0...100.0	%	80.0	R/W	Temperature value which enables reclosing
Ambient temp	S78	-50.0...100.0	°C	40.0	R/W	Setting value for ambient temperature

3.2.4 Control settings

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Operation mode	V1	0...3 [1]	-	1	R/W	Selection of operation mode
Ambient temp	V2	-50.0...100.0	°C	0.0	R/M	Ambient temperature value
Group selection	V3	0...2 [2]	-	0	R/W	Selection of the active setting group
Active group	V4	0 or 1 [3]	-	0	R/M	Active setting group
Trip signal	V6	0 or 1 [4]	-	0	R/W	Selection of latching feature for TRIP output
Trip pulse	V7	100...1000	ms	100	R/W	Minimum pulse width of TRIP and CBFP
Trip delay	V8	0...60000	min	0	R/W	Operate time of the delayed trip
CBFP time	V9	0.00...100.00	s	0.00	R/W	Operate time of Circuit-Breaker Failure Protection
Trip & Start	V10	0 or 1 [5]	-	1	R/W	Enabling of START and TRIP outputs
Reset registers	V13	1=Reset	-	0	W	Resetting of latched trip signal, sensor error signal and registers
Test START	V31	0 or 1 [6]	-	0	R/W	Testing of START
Test TRIP	V32	0 or 1 [6]	-	0	R/W	Testing of TRIP
Test CBFP	V33	0 or 1 [6]	-	0	R/W	Testing of CBFP
Event mask 1	V101	0...131071	-	63	R/W	Event mask 1 for event transmission (E0 ... E16)
Event mask 2	V103	0...131071	-	63	R/W	Event mask 2 for event transmission (E0 ... E16)
Event mask 3	V105	0...131071	-	63	R/W	Event mask 3 for event transmission (E0 ... E16)
Event mask 4	V107	0...131071	-	63	R/W	Event mask 4 for event transmission (E0 ... E16)

[1] Operation mode 0=Not in use; 1=ON: no sensors; 2=ON: Sensor 1; 3=ON: Sensors 1&2
[2] Group selection 0=Group 1; 1=Group 2; 2=GROUP input
[3] Active group 0=Group 1; 1=Group 2
[4] Trip signal 0=Non-latching; 1=Latching
[5] Trip & Start 0=Disabled; 1= Enabled
[6] Testing 0=Do not activate; 1=Activate

3.3 Measurement values

3.3.1 Input data

Parameter	Code	Values	Unit	Default	Data direction	Explanation
Current IL1	I1	0.0...20000.0	A	0.0	R/M	Phase current IL1
Current IL2	I2	0.0...20000.0	A	0.0	R/M	Phase current IL2
Current IL3	I3	0.0...20000.0	A	0.0	R/M	Phase current IL3
IL1 (%)	I4	0.0...1000.0	% In	0.0	R/M	Phase current IL1 in percent
IL2 (%)	I5	0.0...1000.0	% In	0.0	R/M	Phase current IL2 in percent
IL3 (%)	I6	0.0...1000.0	% In	0.0	R/M	Phase current IL3 in percent
Temp SENSOR1	I7	-50.0...100.0	°C	0.0	R/M	Temperature value from sensor 1
Temp SENSOR2	I8	-50.0...100.0	°C	0.0	R/M	Temperature value from sensor 2
Input SENS_IV	I9	0 or 1 [1)]	-	0	R/M	Signal indicating sensor fault
Input BLOCK	I10	0 or 1 [2)]	-	0	R/M	Blocking signal
Input TRIGG	I11	0 or 1 [2)]	-	0	R/M	Signal for triggering the registers
Input GROUP	I12	0 or 1 [2)]	-	0	R/M	Signal for switching between group 1 and 2
Input RESET	I13	0 or 1 [2)]	-	0	R/M	Signal for resetting the output signals and registers of TOL3Cab

[1)] Input SENS_IV 0 = Valid;1 = Invalid
[2)] 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 [1)]	-	0	R/M	Status of start signal
Output TRIP	O2	0 or 1 [1)]	-	0	R/M	Status of trip signal
Output CU_ALARM	O3	0 or 1 [1)]	-	0	R/M	Status of CURRENT_ALARM signal
Output COND_TEMP	O4	-100.0...300.0	°C	0.0	R/M	Calculated temperature of the conductor
Output TEMP(%)	O5	0.0...1000.0	%	0.0	R/M	Calculated temperature of the conductor, per cent value from the maximum allowed temperature rise
Output COOL_TIME	O6	0...99999	min	0	R/M	Waiting time for the successful reclosure
Output TRIP_TIME	O7	0...99999	min	0	R/M	Predicted time for the trip in the overload situation
Output SENSERR	O8	0 or 1 [1)]	-	0	R/M	Status of sensor error signal

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

3.3.3 Recorded data

3.3.3.1 General

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 three last operations (operation 1...3) are recorded and the values of the most recent operation always replace the data of the oldest operation. The registers are updated in the following order: Operation 1, Operation 2, Operation 3, Operation 1, Operation 2,...

3.3.3.2 Parameter values

Date and time The time stamp indicates the rising edge of the START, TRIP or TRIGG signal.

Output TRIP Status of the TRIP signal.

Input TRIGG Signal for triggering the registers externally.

Trip delay The elapsed time is recorded as a percentage of the set trip delay. The time starts accumulating when the temperature rise exceeds 100%.

Primary current The measured primary current value (TRUE RMS) at the moment of recording.

Output COND_TEMP Temperature value of the conductor at the moment of recording.

Ambient temp Ambient temperature value used in the thermal model.

3.3.3.3 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.

3.3.3.4 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.mss	-	-	R/M	Recording time
Output TRIP	V203	0 or 1 [1)]	-	0	R/M	Status of TRIP output
Input TRIGG	V204	0 or 1 [1)]	-	0	R/M	Status of TRIGG input
Trip delay	V205	0.0...100.0	%	0.0	R/M	Elapsed trip delay
Primary current	V206	0.0...20000.0	A	0.0	R/M	RMS current value (maximum of IL1,IL2 & IL3)
Output COND_TEMP	V207	-100.0...300.0	°C	0.0	R/M	Calculated temperature of the conductor
Ambient temp	V208	-50.0...100.0	°C	0.0	R/M	The ambient temperature used for the calculation of the thermal load

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

3.3.3.5 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.mss	-	-	R/M	Recording time
Output TRIP	V303	0 or 1 [1)]	-	0	R/M	Status of TRIP output
Input TRIGG	V304	0 or 1 [1)]	-	0	R/M	Status of TRIGG input
Trip delay	V305	0.0...100.0	%	0.0	R/M	Elapsed trip delay
Primary current	V306	0.0...20000.0	A	0.0	R/M	RMS current value (maximum of IL1,IL2 & IL3)
Output COND_TEMP	V307	-100.0...300.0	°C	0.0	R/M	Calculated temperature of the conductor
Ambient temp	V308	-50.0...100.0	°C	0.0	R/M	The ambient temperature used for the calculation of the thermal load

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

3.3.3.6 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.mss	-	-	R/M	Recording time
Output TRIP	V403	0 or 1 [1)]	-	0	R/M	Status of TRIP output
Input TRIGG	V404	0 or 1 [1)]	-	0	R/M	Status of TRIGG input
Trip delay	V405	0.0...100.0	%	0.0	R/M	Elapsed trip delay
Primary current	V406	0.0...20000.0	A	0.0	R/M	RMS current value (maximum of IL1,IL2 & IL3)
Output COND_TEMP	V407	-100.0...300.0	°C	0.0	R/M	Calculated temperature of the conductor
Ambient temp	V408	-50.0...100.0	°C	0.0	R/M	The ambient temperature used for the calculation of the thermal load

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

3.3.4 Events

Code	Weighting coefficient	Default mask	Event reason	Event state
E0	1	1	START signal from TOL3Cab	Reset
E1	2	1	START signal from TOL3Cab	Activated
E2	4	1	TRIP signal from TOL3Cab	Reset
E3	8	1	TRIP signal from TOL3Cab	Activated
E4	16	1	CBFP signal from TOL3Cab	Reset
E5	32	1	CBFP signal from TOL3Cab	Activated
E6	64	0	Current alarm from TOL3Cab	Reset
E7	128	0	Current alarm from TOL3Cab	Activated
E8	256	0	BLOCK signal of TOL3Cab	Reset
E9	512	0	BLOCK signal of TOL3Cab	Activated
E10	1024	0	Calculated temperature of the conductor	-
E11	2048	0	Cooling time for the successful reclosure	-
E12	4096	0	Test mode of TOL3Cab	Off
E13	8192	0	Test mode of TOL3Cab	On
E14	16384	0	Sensor error signal from TOL3Cab	Reset
E15	32768	0	Sensor error signal from TOL3Cab	Activated
E16	65536	0	Predicted trip time from TOL3Cab	-

4. Technical data

Operation accuracies	Current measurement: f/f_n = 0.95...1.05: ± 1.0%, I = 0.1...10.0 x I_n
Operate time accuracy	± 2% or ± 0.5 s
Reset ratio	TRIP: (TEMP_PERCENT - 0.1) / Trip temperature START: (TEMP_PERCENT - 0.1) / Prior alarm
Configuration data	Task execution interval (Relay Configuration Tool): 100 ms at the rated frequency f_n = 50 Hz

Technical revision history	
Technical revision	**Change**
C	-
D	-
E	Specification for the operate time accuracy added