

zenon manual

Automatic Line Coloring (ALC) - Topology





© 2012 Ing. Punzenberger COPA-DATA GmbH

All rights reserved.

Distribution and/or reproduction of this document or parts thereof in any form are permitted solely with the written permission of the company COPA-DATA. The technical data contained herein has been provided solely for informational purposes and is not legally binding. Subject to change, technical or otherwise.



Contents

1.	1. Welcome to COPA-DATA help			
2.	Auto	matic Li	ine Coloring (ALC) - Topology	5
3.	ALC 6	element	ts	7
	3.1	Proced	dural elements	8
		3.1.1	Example Switch - Color from ALC	11
		3.1.2	Connection points for procedural elements	15
		3.1.3	Switch input/output	17
	3.2	Lines		18
		3.2.1	Example	22
		3.2.2	Connection points of lines	23
	3.3	Checki	ng the project	25
4.	Confi	iguratio	on	26
	4.1	Mode o	of coloring for UNDEFINED	26
	4.2	Configu	uration of the sources	28
	4.3	Configu	uration of topological interlockings	30
		4.3.1	Disconnector under load - interlocking conditions	32
5.	Chan	ge ALC	source color	33
6.	Deta	il screer	ns	35
7.	Error	detecti	ion in electrical grids	38
	7.1	Ground	d fault search	40
		7.1.1	Short circuit search mode	41
		7.1.2	Earth Fault Identification Type	41
		7.1.3	Ground fault display	42
		7.1.4	Earth fault triggering	43
		7.1.5	Start ground fault search	44
		7.1.6	Acknowledge ground fault message	45
		7.1.7	End ground fault search	46
	7 2	Chart a	circuit coarch	47



7.2.1	Short circuit identification type	48
7.2.2	Short circuit display	49
7.2.3	Short circuit identification triggering	49
7.2.4	Acknowledge short circuit message	50



1. Welcome to COPA-DATA help

GENERAL HELP

If you miss any information in this help chapter or have any suggestions for additions, please feel free to contact us via e-mail: documentation@copadata.com (mailto:documentation@copadata.com).

PROJECT SUPPORT

If you have concrete questions relating to your project, please feel free to contact the support team via e-mail: support@copadata.com (mailto:support@copadata.com)

LICENSES AND MODULES

If you realize that you need additional licenses or modules, please feel free to contact the sales team via e-mail: sales@copadata.com (mailto:sales@copadata.com)

2. Automatic Line Coloring (ALC) - Topology

The topologic coloring of lines allows easy automatic dynamizing of tubes in technology (for media) as well as in the energy distribution (for electricity). So process controlled coloring of topological nets can easily be realized.

Because the tube structure is designed in the screen with all its technological elements (e.g. tanks and valves, or generators, switches and consumers), it is internally emulated as a model and the media flow is displayed in the Runtime.



In order to allow screen-overlapping models the entire design and configuration is always project-wide. You therefore have one entire topological model per project, which is used for the calculation of the tube statuses and ultimately for the coloring of the tubes.

The whole topology is created automatically from the graphic design. No other engineering actions are necessary.



Info

The ALC algorithm only runs through once from a source starting from each switch.

DETAIL SCREENS

To display individual screens, a partial area can be taken from the topological network and displayed individually by means of alias. A detail screen (on page 35) can be displayed with the data from different equipment parts, for instance outputs or partial networks.

LICENSING

Must be licensed for Editor and Runtime (single-user, server, standby). No need to be licensed for Runtime client. Licensing is carried out using the zenon Energy Edition.

- ALC: Included in the license for Energy Edition; provides basic properties for line coloring.
- Topology package: Requires additional licensing on the server (not on the client) and expands ALC by:
 - Multiple supplies
 - Secured supply
 - Topological interlockings
 - Transformer and separator topological elements
 - Error detection (version 6.50 and above)



3. ALC elements

Automatic Line Coloring (ALC) makes it possible to color lines regardless of the process status. The combined element is used as the process element. Automatic line coloring allows easy automatic dynamizing of tubes in technology (for media) as well as in the topological networks (for electricity).

CONFIGURATION

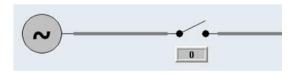
For the design two types of screen elements with different functions are distinguished. On the one hand these are procedural elements (on page 8) (source, switch/disconnector, drain, transformer or link) and on the other hand lines (on page 18).

In doing so, the technical elements have a function and a color (source and transformer). If the procedural elements are active, the connected lines take on the color of these elements at the source and transformer or they take on the color of the element's input line for the switch and the link. If the procedural elements are inactive, the color of the lines is taken from the definition in the editor.

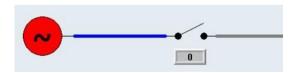
The different functions of the elements are assigned in the properties of the combined element.

EXAMPLE

A source has a connected line. A switch is connected to the line. And a second line is connected there. If the source is active, the first line is colored with the color of the Automatic Line Coloring defined in the source up to the valve. The other line is not colored before the switch is closed.



Source inactive



Source active





Switch closed



Undefined or invalid



If the procedural element status is undefined or malfunction, this is automatically detected. All connected lines and all further elements are displayed in the color of the predefined source undefined for both states.

3.1 Procedural elements

Procedural elements are created in zenon with a combined Element. Their state determines the coloring of the connected line.

The following settings are available:

Property		Description
Fur	nction type	Defines the technological type of the Combined element.
•	Conclusion	For bus bar ends. Blocks the error message "Line only connected on one side" when being compiled in the Editor.
•	Source	Passes on its color. If the source is active (value: 1), all connected lines that have Color from ALC option set in the element properties are allocated the color of the source. The color is defined in the project properties as the source color. (e.g. tanks or generators). A source is a single pole with a static source number assigned to it. The source is switchable over the state of its main variable. Generally, sources are considered as net-synchronous and detachable.
•	Generator	A generator generally behaves like a source, but it is considered as independent an not net-synchronous.
•	Switch	With this lines can be split. If the switch is closed/active (value: 1), then the connection between the two lines is closed and the line is colored with the defined source color up to the next switch. In this case a switch forwards the source color



	of the input line to the output line
	of the input line to the output line.
	If the status of the switch is malfunction, undefined or INVALID, the color of the line turns into the color undefined from the ALC configuration in the project properties. A switch thus delivers source number 0 (undefined) to its output (connection 2) instead of the incoming source number.
	Example: See Switch example - colors from ALC (on page 11) section.
Disconnect or	A disconnector generally behaves like a switch. Nevertheless, a disconnector may not be connected in the topological model. A status (on, off, intermediate position, malfunction) is determined via its main variable.
▶ Valve	A valve acts in a similar manner to a switch, but it is used for water and gas lines.
	Value of the main variable:
	Switch OFF: Value 0 -> valve closed-> No water flow
	Switch ON: Value 1 -> valve closed completely-> No water flow
	Switch DIF: Value 2 -> valve partially open-> Water flow
	Switch STO: Value 3 -> valve malfunction
▶ Drain	This defines the end of the line. The drain does not influence the coloring; it is only used so that the model can be displayed in full. If an external program (e.g. VBA) should access the model, then the drain probably is needed for further calculations, and so has to be inserted. In Energy projects, the drain is used for representing consumers. These customers are considered for the calculation of the ALC interlockings (command groups) 'Consumer is undersupplied'.
▶ Transforme	A transformer is a drain and a source at the same time. SO with a transformer the
r	input color (input source) can be transformed to a new output color (transformer source color). The output connection is only active, if the transformer is switched active. But the output line does not get the color of the input line as with a switch, but the source color of the transformer. So a source has to be defined for each transformer. A transformer cannot be switched active or inactive, it always is active.
	Transformer capable of reverse feed:
	To have a transformer capable of reverse feed, you must select, for Source for reverse feed, a different source than UNDEFINED [0]. This means that the transformer behaves the same for both directions - from the input to the output (forward) and also from the output to the input (backward). The only difference is that the Source for reverse



	feed property and not the Source property is used for further distribution of the source number . Note:Defective network statuses or missing configurations, such as a feed from the input and output at the same time or a short circuit from input and output are not specially colored. This means that the transformer capable of taking a reverse feed behaves like two transformers switched to run antiparallel that are not capable of taking a reverse feed.
▶ Link	With a link a line can be continued on some other place. If a link is supplied by a line, all other links with the same link number also are supplied by this line. Here it does not matter, whether the links are in the same screen or on different screens in the project. So screen independent lines can be defined. It is possible to have more than two links with the same link number in one project. Links can be supplied by several lines at the same time or can themselves supply several lines. In principle there is no difference between inputs and outputs. The source information is passed on to all connected lines. Attention: Two link elements cannot be connected directly to one line. In between, there has to be at least one other procedural element (switch/disconnector or transformer).
	A link cannot be switched active or inactive, it always is active.
Link number	Only the link number is entered for a link function. All identical link numbers in a project correlate with each other. Detailed description in the function type Link. This property is only active, if the function type link has been selected.
Source	Here a source is assigned to an element. In this selection box all sources defined in the ALC configuration (in the project properties) are available. All source names are listed. This property is only active if the function type 'source', 'transformer' or 'generator' has been selected.

A variable of the IEC type BOOL or integer has to be linked to the element as the main variable, so that the switch can get the status (open, closed, invalid). In the same way, the source gets its status (active/inactive) from the linked main variable.

For the function types source and transformer the defined source number is forwarded to the consumers (drains) over open/closed switches. The statuses and colors of all connected lines are calculated from the superposed sum of the supplying source numbers and procedural elements.





Info

Only the first two bits are considered for the switching. The first bit stands for the actual switching. 0 equals off and 1 equals 1.

The second bit is the error bit. There is no error only if it is 0.

STATES

- ▶ A switch and a source are switched on if the value of the linked variable is 1.
- ▶ A switch is invalid if the value of the linked variable is >1 or has an INVALID status. An invalid switch provides the source number 0 (undefined) at its exit (connection 2) instead of the source number entering. In the direction towards the input the switch behaves as normal.

Note: if the (acknowledgement) variable has the status INVALID, the whole subsequent network is INVALID, because the status of the network is not known. The status INVALID is forwarded (routed) using subsequent closed switches.



Attention

If in the single status the color and the filling color from the ALC is activated, also the procedural elements are colored by the status of the connected lines in the Runtime.

3.1.1 Example Switch - Color from ALC

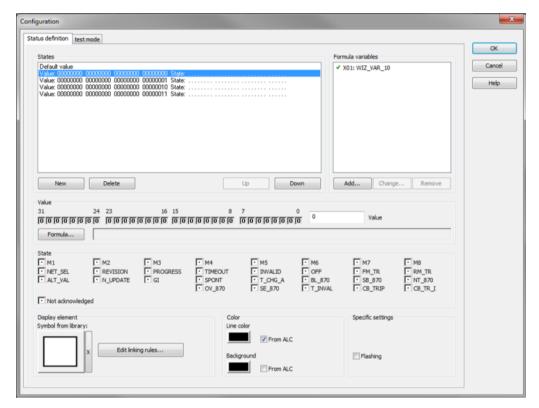
EXAMPLE 1

Combined element with value status 00 and line color from ALC:

- 1. Configuration in the Editor:
 - Combined element with value status 00







2. Results in the following in Runtime:

• Source color: Green

· Color without voltage: White

• Switch status: off/open (value 0)



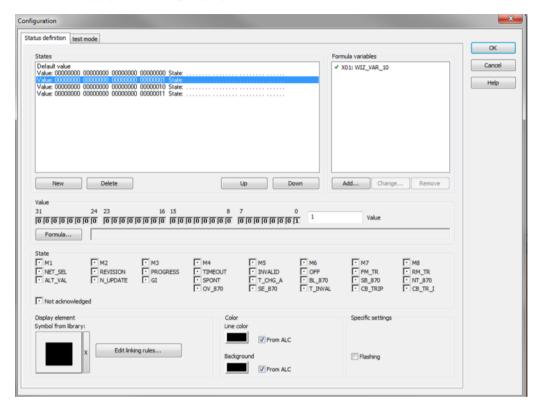
EXAMPLE 2

Combined element with value status 01 and colors from ALC:

- 1. Engineering in the Editor
 - Combined element with value status 01
 - Line color from ALC active



• Fill color from ALC active



2. Results in the following in Runtime:

• Source color: Green

Color without voltage: White

• Switch status: on/closed (value1)



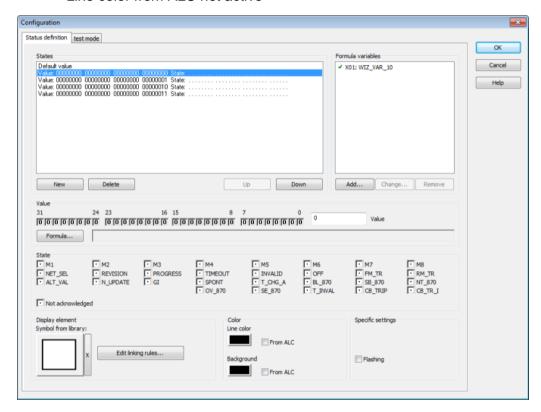
EXAMPLE 3

Combined element with value status 00 without colors from ALC:

- 1. Configuration in the Editor:
 - Combined element with value status 00







- 2. Results in the following in Runtime:
 - Source color: Green
 - Color not energized and construction color of the line: White
 - Defined line and fill color of the combined element: black
 - Switch status: off/open (value 0)

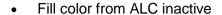


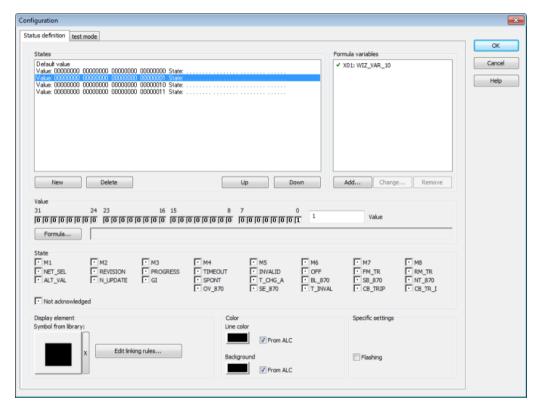
EXAMPLE 4

Combined element with value status 01 without colors from ALC:

- 1. Engineering in the Editor
 - Combined element with value status 01
 - Line color from ALC inactive







- 2. Results in the following in Runtime:
 - Source color = green
 - Color not energized and construction color of the line: White
 - Defined line and fill color of the combined element: black
 - Switch status: on/closed (value1)



3.1.2 Connection points for procedural elements

When configuring, a line is connected to a procedural element (combined element) by overlapping drawings in the screen at connection points of the combined element. Only one line can be connected to the same connection point at the same time. All lines that start within the area defined below, are connected (Topology from the graphic).

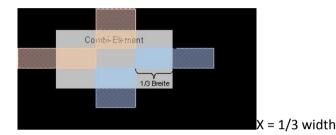


Attention

Use ALC elements only in un-rotated state because:

The calculation for the topological model for the ALC in the Editor is based on the position of the elements in un-rotated state and without considering any dynamics.

All possible connection points are shown in detail in the following illustration:



Y = 1/3 width (max. 10 pixels)

Z = 1/3 height

W = 1/3 height (max. 10 pixels)



Info

If a line is outside the area shown above, there is no connection and thus no coloring. So there will also be no coloring for further lines.

With sources, drains and links, all described connection points can be generally used.



Attention

With sources and drains only one connection point must be used at the same time. It does not matter which connection point. If different connection points are used at the same time, undefined states can occur.

Elements of the type link can also use several connection points at the same time. The incoming color information is passed on to all lines.

In switches/disconnectors/valves and transformers, the connection 1 (input) is on the left or on the top and connection 2 (outputs) are on the right or on the bottom. This background color can be changed with the Switch input/output property.





Info

At switches and transformers it has to be cared, that only one input connection and one output connection is used. The simultaneous use of several input or output connection points results in inconsistencies and is therefore not reliable.



Info

For all procedural elements the following is true: Only one line can be connected to a connection point. Junctions cannot be realized directly on an element but must be drawn with lines.

Switch input/output 3.1.3

If a transformer, disconnector or switch is configured, the input and output can be switched. To do this:

- 1. Select either transformer, disconnector or switch as a Function type
- 2. activate the Switch input/output check box

The input is then placed at the right or at the bottom and the output is placed left or at the top.

OVERVIEW

Configuration device	Input	Output
normal	Left	Right
normal	top	below
swapped	Right	Left
swapped	below	top

3.2 Lines

Lines are represented by vector elements Line, Polyline and Tube.

If the option <code>Color from ALC</code> is activated for a line, the coloring is defined by the ALC configuration. Lines are automatically colored by the system depending on the status of the procedural elements and the ALC settings.

Here the color usually comes from the highest priority source number of the media flowing through the line, or stays "empty/not energized" just as defined in the screen with static or dynamic colors.

You define the display type by means of drop-down lists:

- Priority for display
- ▶ Display multiple supply
- Display secured supply

The following options are available in the properties of the lines:



Parameters	Description
Color from ALC	Activates the automatic line coloring for these vector elements. That means: If the source for the line is active and all switches/valves leading from the source to the line are closed/open, the line is accordingly colored. If the line is fed by a single source, the defined source color is used for coloring the line. The line width is not changed.
Priority for display	Defines if multiple supply, secured supply or both are displayed. Default: Multiple supplies
Secured supply	The element is displayed according to the rules of the secured supply. A line is then considered to have a secure supply if it is supplied by at least two different switches or transformers with a non-system source. System sources do not contribute to secured supply, but do not exclude it.
Multiple supplies	The element is displayed according to the rules of the multiple supply. A line is considered to have multiple supplies if it is supplied by at least two different sources. In doing do, it does not matter if they are system or user sources and from which side the line is supplied by the sources.
No priority	The coloring rules for multiple supply and for secured supply are applied at the same time if both criteria are met. That means: If a line has multiple supplies and a secured supply, The priority is set to No priority,
	 The display for multiple supply is set to two sources with highest priority, The display for secured supply is set to double width, then the line is twice as wide and displayed as a dashed line in two colors.



display multiple supplies	Multiple supply means that a line is supplied by multiple sources at the same time. Here you can define how lines with multiple supply are displayed. Default: highest priority source
highest priority source	The line gets the color of the source with the highest priority. Note: Priorities correspond to the sequence chosen in the ALC configuration.
two highest priority sources	Applies for lines fed by two or more different sources. The two sources with the highest priorities define the coloring. The line is displayed with the these two colors (dashed). The dash length can be changed using the Dashing length supplied multiple times property.
	System sources apply fir multiple supplies just as with genuine sources and color lines in two colors it they are configured accordingly.
Alternative color	The color defined in the Alternative color property is used.
Dashing length supplied multiple times	Defines the dash length (in pixels) of lines, polylines or tubes for the dashed ALC coloring for two sources with the highest priority for display multiple supplies.
	▶ Minimal: 0 (automatic dash length)
	▶ Maximal: 32767
	▶ Default: 0
Alternative color	Alternative color for the ALC coloring of lines, polylines or tubes with multiple supplies.
display secured supply	Secured supply means that a line gets multiple supply from one source (parallel). Here you can define how 'secured supply' is displayed.
	A line is always displayed as having a secure supply if it is supplied by at least two switches with a genuine source (not system source).



	Default: normal	
double width	Relevant for lines fed in parallel by the same source. If this is the case, the line is displayed with double the configured width. (Example: A line with line width 5 pixels is displayed with 10 pixels if secure-fed.) If this line is fed by two or more different sources (multi-supply), the line width does not change! The color is always defined by the source with the highest priority!	
double brightness	Relevant for lines fed in parallel by the same source. The line is displayed with double the original brightness. If this line is fed by two or more different sources (multi-supply), the line color does not change! If this line is multi-fed from one source (secure supply), the line is displayed with double the original brightness. Formula for the calculation of the double brightness: 1. The defined RGB color is transformed to the HLS system. 2. L (luminance = brightness) is recalculated with NewLuminance = 240*3/4 + L/4 3. The color value is recalculated to the RGB system with the new brightness. The color is always defined by the source with the highest priority!	
normal	The element is displayed in the color of the source and with the configured width.	
Use alias	Active: Alias is used.	
Alias	Opens the dialog (on page 35) for selecting a model.	



Info

The source color and the priorities of the sources are defined in the project properties.

User-defined sources must have a higher ID than 9. IDs up to 9 are reserved for system sources.





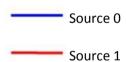
Info

The calculation of the color of a line in the Runtime is done with the following priority list:

- 1. Automatic Line Coloring (highest priority, overrules all other settings)
- 2. Dynamic colors
- 3. Static colors

Example 3.2.1

In the following example Source 0 has the color blue and Source 1 has the color red. And Source 0 is the source with the highest priority.



This results in the following displays for the different options:



	Line / Polyline	Tube
highest priority source		Combi
two highest priority sources		
double width		
double brightness	-	

3.2.2 Connection points of lines

The connection of one line (line, polyline or tube) to another line is done with overlapping drawing in the screen at connection points. The connection points - either connection areas - are at the start and the end of each line and are around 3 pixels large.

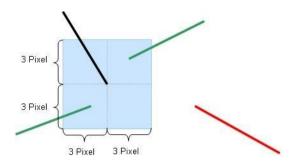


The start point of a line has the coordinates (start point x/start point y): 150/100 pixels. This results in a connection area (x/y): 147 - 153 / 97 - 103 pixels.

If the line start or end of this line and that of one or more other lines is within this area, the lines are automatically connected without any further engineering. A mere overlapping of the connection areas of the single lines is not sufficient!



In the following illustration the connection area is displayed graphically (the green lines are connected to the black one, the red line not.



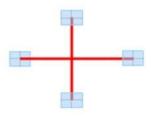
Info

Any number of lines can be connected in a connection area.

Attention

If a line is outside the connection area (e.g. the red line in the illustration), no connection is established and there is no coloring of the line. So there will also be no coloring for further lines.

Line crossings can easily be realized, if the ends of the lines are not in the connection area.



Attention

Use ALC elements only in un-rotated state because:

The calculation for the topological model for the ALC in the Editor is based on the position of the elements in un-rotated state and without considering any dynamics.



3.3 **Checking the project**

Engineer the desired procedural elements and lines in one or more screens and save these screens. Then you can check via Create all Runtime files Or Create changed Runtime files Whether there are any errors or conflicts in the screens. If error and/or conflicts should exist, corresponding error messages or warnings are displayed in the output window.



💡 Info

Double click the corresponding line in the output window. The screen with the erroneous screen element will be opened automatically. If the erroneous screen element is part of a symbol, the corresponding symbol is automatically selected.

The following error message can be displayed.

- ALC: Screen '%s' Two Link elements with different Link number are connected to line '%s'. (Double click opens the screen and selects the line.)
- ▶ ALC: Screen '%s' More than two connection points are used at element '%s'. For each element only one input and one output may be used. (Double click opens the screen and selects the element.)

The following warnings can be displayed.

- ▶ ALC: Screen '%s' Alias line '%s' is connected to a no-alias line. (Double click opens the screen and selects the line.)
- ▶ ALC: Screen '%s' Alias element '%s' is connected to a no-alias line. (Double click opens the screen and selects the element)
- ▶ ALC: Screen '%s' No-alias element '%s' is connected to an alias line. (Double click opens the screen and selects the element)
- ▶ ALC: Screen '%s' Line '%s' is only connected on one side. (Double click opens the screen and selects the line.)
- ALC: Screen '%s' Element '%s' is not connected. (Double click opens the screen and selects the element)
- ▶ ALC: Screen '%s' Element '%s' is only connected on one side. (Double click opens the screen and selects the element)



In the error messages or warnings the corresponding elements are identified using the element reference. This reference also serves as the link key for ALC aliases.

4. Configuration

4.1 Mode of coloring for UNDEFINED

Coloring in the network can be implemented in two modes with the status as UNDEFINED:

- ▶ Standard
- ▶ Input takes priority

This setting is made using the Automatic Line Coloring/Mode for coloring project property.

STANDARD

The graph search starts with a source and goes through the whole network, so that each closed switch (switch variable has the value 1) per direction is only gone through once, so no cycles occur. In doing so, each node visited (=line segment) is colored with the source color. The directly-related lines are marked as a node.

If the search finds a switch that has a switch variable with the following status, the UNDEFINED color is used for coloring from this point onwards:

- INVALID [values: any desired],
- ▶ is invalid [value: 3]
- ▶ is in intermediate position [value: 2])

The graph search is now continued in the same form. Each switch is gone through just once per direction with the UNDEFINED color. Therefore each switch can be gone through a maximum of four times per source:

1. with source number in forwards direction,



- 2. with source number in backwards direction,
- 3. with UNDEFNED in forwards direction,
- 4. with UNDEFNED in backwards direction,

INPUT TAKES PRIORITY

With the Supply takes priority setting, only lines that have a supply from at least one source but not clearly from any one source are colored as UNDEFINED. If a line is supplied with at least one source, it can no longer receive an UNDEFINED color from another source.

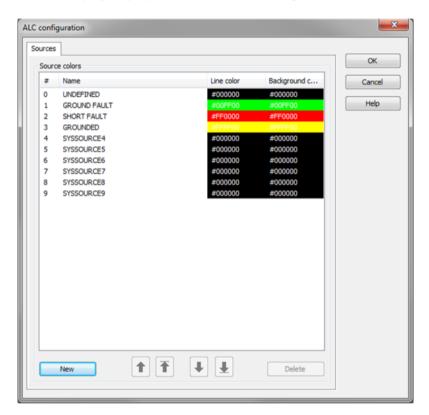
This search is a two-stage search:

- ▶ In the first stage, as with Standard, the source color is distributed in the network from each switched source, as long as the next switch is closed. The search is ended if the switch is open or invalid/undefined.
- In the second stage, the search is started at each invalid/undefined switch that receives a supply from one side and the UNDEFINED color is distributed to the unsupplied side. This search also considers the switches that are invalid/undefined as closed and thus distributes the UNDEFINED color in the network until it meets a clearly open switch. In addition, a search is ended if a line element is reached that is already supplied.



4.2 Configuration of the sources

The sources, e.g. their names and colors (sequence and priority), are configured project-specifically within the project properties under 'ALC configuration'.



The following parameters can be defined for each single source:



Parameters	Description
Number	Internal unique consecutive number, so that the source can be identified. This number is given by the system automatically and cannot be changed.
	Attention: IDs 0 to 9 are reserved for the system sources and must not be used userspecific.
Name	Logical name for the source (e.g.: 'water' or 'grounded'). This name is also used when selecting the source number for Combined elements. You can change the name by clicking it with the left mouse button. With this edit mode is switched on. The changes are accepted with Enter or by selecting another source.
	Note: The labels are not language switchable.
Foreground	Foreground color of the source. This color is used for coloring lines, polylines and as the outside color of tubes.
Background	Background color of the source. This is used as the background color for tubes and procedural elements (Combined element).

The definition of the colors can directly be done with entering the according hexadecimal code. To do this click the color with the left mouse button, so that the edit mode is activated. The changes are accepted with Enter or by selecting another source.

Alternatively the color can also be selected from a dialog. When activating the hexadecimal code, a . . . button appears in the columnClicking it opens the color selection.

The hexadecimal code describes the RGB color value and consists of the following. #RRGGBB.

Element	Meaning	
#	Identifier to indicate that a hexadecimal color code is used.	
RR	2 digits are the red value of the color in hexadecimal system. 0-255 is 0-FF	
GG	2 digits are the green value of the color in hexadecimal system. 0-255 is 0-FF	
ВВ	2 digits are the blue value of the color in hexadecimal system. 0-255 is 0-FF	

New sources are created or existing sources are deleted by means of the 'New' and 'Delete' buttons.



Attention

Limitations for deleting sources:

The sources 0 to 9 are reserved for system sources and cannot be deleted.

Only the source with the highest ID can be deleted.



💡 Info

The sequence in this list represents the priority of the sources, with the first element having the highest priority.

To change the priorities of the single sources, they can be moved upwards or downwards using the arrow buttons

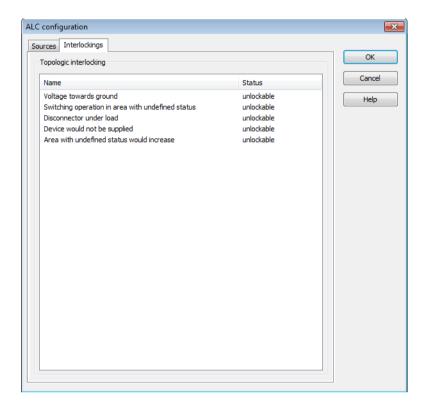
Configuration of topological interlockings 4.3

topological interlockings from the ALC for commands can be configured here.



This dialog is only available when both the "Energy Edition" and the "Automatic Line Coloring" modules are licensed.





The following conditions are available: The settings made here apply globally, for the whole Topological Model:

Parameters	Description	
Voltage towards ground	Interlocking is active if a switch/disconnector is to be closed and a grounded potential is connected to its first connector and its other connector is connected or undefined.	
Switching action in an area with an undefined status	Interlocking is active if a switch disconnector is to be closed and both of its connectors are 'undefined' or 'disturbed'.	
Disconnector under load	Interlocking is active if certain conditions have been met for switching on or off. Conditions: See "Disconnector under load - interlocking conditions (on page 32)" section.	
Device would no longer be supplied	Interlocking is active, when a consumer, which was supplied before, would be unsupplied after the switching action (by switch or disconnector).	
Area with undefined status would increase	Interlocking is active if a switch disconnector is to be closed and one connector is 'undefined' or 'disturbed' and the other not.	

If you click in the status column in one of these interlockings, a drop-down list opens with three choices:



Parameters	Description
do not check	The selected condition is not considered in this project (topological model).
unlockable	The selected condition is considered in this project. If the condition applies, the user can unlock it with a command (Command screen). This unlocking action is logged in the Chronological Event List.
not unlockable	The selected condition is considered in this project. The user cannot unlock it.

EXCEPTION TOPOLOGIC INTERLOCKING

The topologic interlocking is not carries out if:

- the variables of a switch ahs status Revision or
- the variable is manually corrects or set to Alternate value and with this is set to the same variable value as the initial value; in other words if the switch:
 - is set to OFF and then it is manually correted to OFF or replaced with Alternate value OFF.
 - is set to ON and then it is manually correted to ON or replaced with Alternate value ON.

4.3.1 Disconnector under load - interlocking conditions

For the disconnector under load topological interlocking, a disconnector can be switched if one of the following conditions is met:

WHEN BEING SWITCHED ON:

Before being switched:

- ▶ The left and the right line segment receive energy from the same source
- ▶ If the left line segment does not receive any voltage, the right line segment is grounded
- ▶ If the left line segment is grounded, the right line segment does not receive any voltage
- If the left line segment is not under load



▶ If the right line segment is not under load

WHEN BEING SWITCHED OFF:

After being switched:

- ▶ The left and the right line segment would receive energy from the same source
- ▶ If the left line segment does not receive any voltage and the right line segment is grounded
- ▶ If the left line segment were grounded, the right line segment would not receive any voltage
- ▶ If the left line segment were not under load
- If the right line segment were not under load



Meaning of "not under load"

All of the following conditions must be met for the status of not under load:

- All switches and disconnectors connected to the line segment are open.
- ▶ All sources and consuming devices connected to the line segment are switched off.
- No transformer may be connected to the line segment.
- It must not be a line that is only connected to this disconnector (open line).

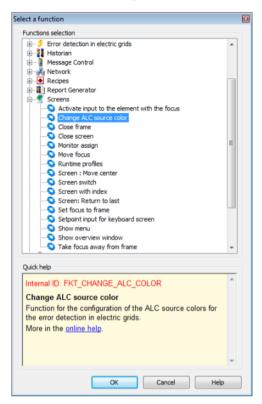
5. Change ALC source color

The foreground and background color of an ALC source can be temporarily changed for the coloring in Runtime using the Change ALC source color function. The change remains until Runtime is ended, reloaded or the function is executed again. To create the function:

- select New Function
- navigate to the screens node



▶ select Change ALC source color



- ▶ The dialog to define line colors and filling colors opens
- define the desired color



Property	Function
Source	Drop-down list to select the source and display the colors currently assigned. These colors cannot be changed here.
New color for source	Click on the color and a dialog opens to select a color.



6. Detail screens

To display individual screens, a partial area can be taken from the topological network and displayed individually by means of alias. The screen elements in the detail screen are not included in the topological model, but do however get their ALC colors from the model. They relate to an alias of the screen elements in the overall screen.

CREATE ALIAS

Aliases can be created for the elements:

- ▶ Line
- Polyline
- ► Tube
- ► Combined element

To create a source element as an alias:

- ► Activate it in the element's properties Use alias

 (to do this, ALC must be licensed and the Color from ALC property active)
- ▶ Click on the ... button in the Alias property



▶ the dialog to select elements opens





Parameters	Description
Screen	Click the button and a dialog opens to select a screen.
Available ALC elements	Shows the elements that belong to a screen with the element name, type of element and function type. Clicking on an element selects an alias.
	Filter
	The elements can be sorted according to all columns. When setting a filter, the options offered from all other filters are reduced to values that can be sensibly combined.
	Name: Input of a standard search term with wild cards (*). The last 12 search terms are offered in the list until the Editor is ended.
	▶ Element : Select from drop-down list.
	Function type: Select from drop-down list.
	Clicking on opens saved search or drop-down list.
	If a filter is active, clicking on the ${f x}$ deletes the filter.
Selected alias	Shows the selected element in the field of Available ALC elements.
No selection	Removes selected element.
ок	Saves selection and closes dialog.
Cancel	Discards changes and closes dialog.
Help	Opens online help.



Info

When selecting an element for a new alias, only elements and screens from the same project that the alias was defined in can be selected. Elements from subprojects or parallel projects are not available.

REPLACING ALIAS NAMES

Aliases can be be changed when switching screens with Replace link. A detail screen can therefore be displayed with the data from different equipment parts, for instance lines or partial networks. Alias names are replaced along the lines of variables and functions. It is also possible to replace in elements that are used in symbols. The same dialog as is opened for the target as the Alias property.



Note: Substitution using index variables is not possible.

7. Error detection in electrical grids

Error detection marks network parts that are subject to ground faults or short circuits by means of special colors in ALC. Sources for error detection are what are called ground fault or short circuit reporters that are assigned to a circuit breaker. Ground fault and short circuit reporters are always at the output of a circuit breaker element. Error messages are fixed in the screen and must be reset manually.



Info

This function is only available when both the "Energy Edition" and the "Automatic Line Coloring" modules are licensed.

ERROR DETECTION

Error detection runs locally. Each client in the network has its own independent model and can therefore search for ground faults and short circuits in different parts of the network.

Error detection in the electrical network is divided into:

- Ground fault search (on page 40)
- ▶ Short circuit search (on page 47)

To configure error detection

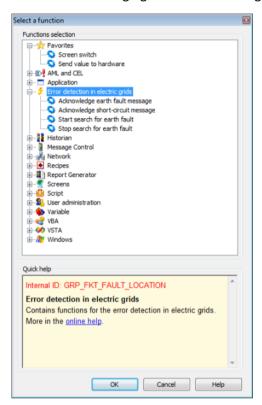
- You require a license for ALC and zenon Energy Edition
- configure the appropriate screens
- Configure (on page 8) ALC to the corresponding combined elements (switch, transformer, disconnector, valve)
- configure (on page 18) the lines so that they are colored by ALC

Special functions are available in Runtime for error detection:

Start ground fault search (on page 44)



- acknowledge (on page 45) ground fault message (on page 45)
- ► End ground fault search (on page 46)
- Acknowledge ground fault message (on page 50)



COLORINGS

Errors can be shown by a special coloring for the lines in ALC. In Runtime, the color assigned by ALC changes automatically as soon as the status of the line changes. The colorings configured can be changed in Runtime via the change ALC source color (on page 33) function.

Messages are processed in the order in which they arrive. In the event of conflicts

- The colors for displaying errors take priority
- short circuit messages have priority over ground fault messages



7.1 Ground fault search

The ground fault search serves to highlight the network parts hat potentially have a ground fault by coloring these. The color is taken from the configuration of ALC source colors (on page 26) for the GROUND FAULT source.

Which network parts potentially have a ground fault can be deduced from the ground fault messages from ground fault identification devices (ground fault indicators, protective device with ground fault recording). The following applies for ground faults:

- ► Each device can have one to three ground fault messages.
- ► Ground faults are either dealt with by permanent message processing or by transient message processing.
- ► For directional ground fault devices, the direction can be lagging or leading in relation to triggering.
 - leading: First the message, then the transient bit.
 - lagging: First the transient bit, then the message.



💡 Info

A network component that potentially has a ground fault is then no longer considered to have a ground fault if this has been successfully connected.

CONFIGURATION

To configure the ground fault search:

- 1. assign the combined element that represents the switching element to the Function type switch (on page 41)
- 2. define the ground fault search mode (on page 41), fault display (on page 42) and ground fault indication triggering (on page 43)
- 3. set up the functions for start ground fault search (on page 44), acknowledge ground fault search (on page 45) and end ground fault search (on page 46)



Info

In order to also be able to set limits in intermeshed networks, only one area subject to a ground fault per path is searched for a fault.

7.1.1 Short circuit search mode

The short circuit search can either:

- color the network part potentially subject to a short circuit or
- the whole network where the short circuit is located

The coloring mode is defined via the Mode of the search for ground faults property.

To configure the property:

- ▶ navigate to the Automatic Line Coloring node in properties
- ▶ select the desired mode in the Mode of the search for ground faults property drop-down list
 - Color network part: colors only the network parts that are potentially subject to a short circuit
 - color whole network: colors in the whole linked network where the ground fault is

This setting can be changed in Runtime via the zenon API object model. In doing so, the short circuit search is recalculated once again.

7.1.2 Earth Fault Identification Type

The direction and type of information processing for the switch type combined element are determined by the Type setting. to configure:

- 1. navigate to the Automatic Line Coloring node in the combined element properties
- 2. open the Ground fault recognition node



- 3. select the desired type with the direction and type of alarm processing in the Type property
 - Direction: indicates if the raising edge of trip alarm or if the raising edge of a direction comes
 - leading: The current direction status is used for the raising edge of the trip alarm
 - lagging: after a raising edge of the trip alarm, the first raising edge of a direction is waited on; if this does not occur within 2 seconds, the earth fault device is considered non-directional
 - Information processing: states which information can be processed
 - none: normal switch; information is not processed
 - Permanent message processing: Newly received messages are considered a new ground fault trip
 - Transient message processing: Messages that are received during a current Search (on page 44) are suppressed

Note: The distinction between permanent message processing and transient message processing only relates to processing the message, not to the type. Transient bit message processing need not therefore relate to a transient bit.



Attention

To suppress intermittent ground faults, ground fault messages that are received in intervals shorter than 2 seconds are ignored.

7.1.3 Ground fault display

The variable linked at Display is an output variable for error detection and displays the recorded status of the ground fault identification device. This is necessary because all messages remain saved internally until they are acknowledged, i.e. they do not necessarily conform to the current status of the message variables.

Each time a recording is made, a set value is sent to this variable. In doing so, the values are as follows:



Value	Meaning
0	no ground fault
1	ground fault forwards
2	Ground fault backwards
3	non-directional ground fault
4	Error status - > both directions have activated



Info

To reduce problems in network operation, the variable linked here should be a linked variable.

7.1.4 Earth fault triggering

The alarm to report an earth fault is defined by the Triggering variable It can contain information on the presence of an earth fault and the direction of the earth fault from the point of view of the earth fault recognition device. In doing so, a distinction is made between:

- non-directional earth fault alarms
- Directional earth fault alarms with a trip alarm
- Directional earth fault alarms with a trip alarm

To configure the variable for the Triggering:

- 1. navigate to the Automatic Line Coloring node in the combined element properties
- 2. open the Ground fault recognition node
 - a) for non-directional earth fault alarms

Click on the ... button in the Triggering property

select the variable you wish to import in the dialog that opens

The properties for the direction remain empty



b) for directional earth fault alarms with a trip alarm

link the variable with Triggering and add the appropriate direction:

forwards: link a variable with the Forwards property

backwards: link a variable with the Backwards property

c) for directional earth fault alarms without a trip alarm

Link the variable with the corresponding direction:

forwards: link a variable with the Forwards property

backwards: link a variable with the Backwards property

The Triggering property remains empty

Note: If you address a directional identification device with Forwards in both directions, this is then considered erroneous and ignored.

7.1.5 Start ground fault search

The function Start search for ground fault serves to localize a ground fault and has two effects in Runtime:

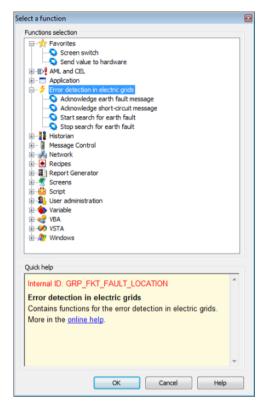
- 1. Messages from all ground fault identification devices that were configured with transient message processing are ignored.
- 2. The search algorithm is changed: Switch actions can only reduce the area subject to a ground fault further. Newly received messages do not therefore increase the area potentially subject to a ground fault.

To configure the Start search for ground fault function:

- create a new function
- navigate to the error detection node in the electrical network



▶ Select the Start search for ground fault function



▶ link the function to a button

7.1.6 Acknowledge ground fault message

With the Acknowledge ground fault message function, an internally recorded ground fault from a ground fault indication device can be acknowledged. In doing so, the internally-latched ground fault status is reset if the status is still pending, or highlighted as acknowledged. A recorded ground fault message is only deleted internally if this has been acknowledged and is no longer pending.

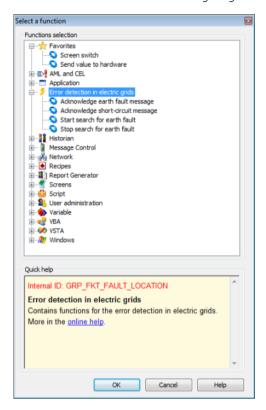
Rules when acknowledging:

- ▶ If a variable that corresponds to a triggering or direction variable of a ground fault recognition device is linked, this special ground fault message is acknowledged.
- ▶ If no variable has been linked, all ground fault messages are acknowledged.
- ► Acknowledgement can also take place via the zenon API object model.

To configure the Acknowledge ground fault message function:



- create a new function
- navigate to the error detection node in the electrical network
- ▶ Select the Acknowledge ground fault message function



- ▶ the dialog to select a variable opens
- ▶ link the desired variable to the function
- ▶ link the function to a button

7.1.7 End ground fault search

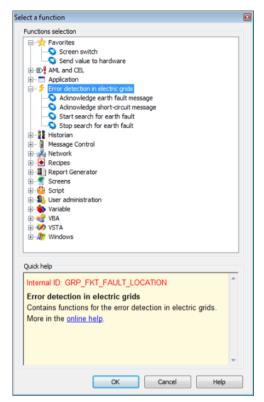
You end the ground fault search with the Stop search for ground fault function in Runtime.

To configure the function:

- create a new function
- navigate to the error detection node in the electrical network



▶ Select the Stop search for ground fault function



link the function to a button

7.2 Short circuit search

The short circuit search serves to highlight the network parts that potentially have a short circuit by coloring these. The color is taken from the configuration of ALC source colors for the SHORT FAULT source.

The network parts that are potentially subject to short circuits are deduced from short circuit reports. A short circuit identification device (short circuit indicator, protective device) can have one to three short circuit messages. For directional short circuit indication devices, the direction can be lagging or leading in relation to triggering. A network component that potentially has a short circuit is then no longer considered to have a ground fault if this has been successfully connected.

CONFIGURATION

To configure the short circuit search:



- 1. assign the combined element that represents the switching element to the Function type switch (on page 48)
- 2. define Short circuit display (on page 49) and Short circuit identification triggering (on page 49)
- 3. Set up the Acknowledge short circuit message (on page 50) function

7.2.1 Short circuit identification type

The direction and type of information processing for the switch type combined element are determined by the Type setting. to configure:

- 1. navigate to the Automatic Line Coloring node in the combined element properties
- 2. open the Short-circuit detection node
- 3. select the desired type at the Type property
 - Direction: indicates if the raising edge of trip alarm or if the raising edge of a direction comes before
 - leading:
 for the raising edge of the trip alarm, the current direction status is used
 - lagging:
 after a raising edge of the trip alarm, the first raising edge of a direction is waited on;
 if this does not occur within 2 seconds, the short circuit device is considered non directional
 - Information processing: states which information can be processed
 - none: normal switch; information is not processed
 - Permanent message processing:
 Newly received messages are considered a new ground fault trip



7.2.2 Short circuit display

The variable linked at <code>Display</code> is an output variable for error detection and displays the recorded status of the short circuit identification device. This is necessary because all messages remain saved internally until they are acknowledged, i.e. they do not necessarily conform to the current status of the message variables.

Each time a recording is made, a set value is sent to this variable. In doing so, the values are as follows:

Value	Meaning
0	no short circuit
1	Short circuit forwards
2	Short circuit backwards
3	Non-directional short circuit

7.2.3 Short circuit identification triggering

The variable for the message from the short circuit identification device is defined by the Triggering variable You can receive information about the presence of a short circuit and the direction of the short circuit from the point of view of the short circuit identification device. In doing so, a distinction is made between:

- non-directional short circuit reporters
- directional short circuit reporters with a trip alarm
- directional short circuit alarms with a trip alarm

To configure the variables for:

- 1. navigate to the Automatic Line Coloring node in the combined element properties
- 2. open the Short-circuit detection node
 - a) for non-directional short circuit reporters

Click on the ... button in the Triggering property

select the variable you wish to import in the dialog that opens



The properties for the direction remain empty

b) for directional short circuit reporters with a trip alarm

link the variable with Triggering and add the appropriate direction:

forwards: link a variable with the Forwards property

backwards: link a variable with the Backwards property

c) for directional short circuit reporters without a trip alarm

Link the variable with the corresponding direction:

forwards: link a variable with the Forwards property

backwards: link a variable with the Backwards property

The Triggering property remains empty

7.2.4 Acknowledge short circuit message

With the Acknowledge short-circuit message function, an internally recorded short circuit from a short circuit indication device can be acknowledged. In doing so, the internally-latched ground fault status is reset if the status is still pending, or highlighted as acknowledged. A recorded short circuit message is only deleted internally if this has been acknowledged and is no longer pending.

Rules when acknowledging:

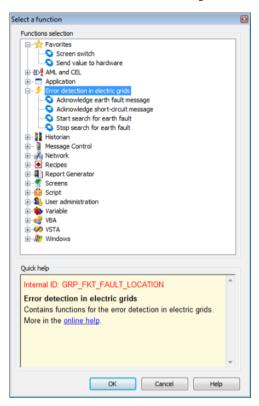
- ▶ If a variable that corresponds to a triggering or direction variable of a short circuit recognition device is linked, this special short circuit message is acknowledged.
- ▶ If no variable has been linked, all short circuit messages are acknowledged.
- ► Acknowledgement can also take place via the zenon API object model.

TO CONFIGURE THE ACKNOWLEDGE SHORT-CIRCUIT MESSAGE FUNCTION:

- create a new function
- navigate to the error detection node in the electrical network



▶ Select the Acknowledge short-circuit message function



- select the variable you wish to import in the dialog that opens
- ▶ link the function to a button