ARCTEQ
RELAYABLE POWER

AQ-S254

Alarm and Indication IED

Instruction manual

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1. Manual revision notes

1.1. Version 2 revision notes

Revision	2.00
Date	6.6.2019
Changes	- New more consistent look. - Improved descriptions generally in many chapters. - Improved readability of a lot of drawings and images. - Updated protection functions included in every IED manual. - Every protection IED type now has connection drawing, application example drawing with function block diagram and application example with wiring. - Added General-menu description.
Revision	2.01
Date	6.11.2019
Changes	- Added description for LED test and button test. - Added display sleep timer description. - Complete rewrite of every chapter. - Improvements to many drawings and formula images. - Order codes revised. - Added double ST 100 Mbps Ethernet communication module and Double RJ45 10/100 Mbps Ethernet communication module descriptions

1.2. Version 1 revision notes

Revision	1.00
Date	15.1.2018
Changes	- The first revision for AQ-S254
Revision	1.01
Date	18.1.2019
Changes	- Added HMI display technical data

2. Abbreviations

CB – Circuit breaker

CBFP – Circuit breaker failure protection

CT – Current transformer

CPU – Central processing unit

EMC – Electromagnetic compatibility

HMI – Human machine interface

HW – Hardware

IED – Intelligent electronic device

IO – Input output

LED – Light emitting diode

LV – Low voltage

MV – Medium voltage

NC – Normally closed

NO – Normally open

RMS – Root mean square

SF – System failure

TMS – Time multiplier setting

TRMS – True root mean square

VAC – Voltage alternating current

VDC – Voltage direct current

SW – Software

uP - Microprocessor

3. General

The AQ-S254 alarm and indication IED is a member of the AQ-200 product line. The hardware and software are modular: the hardware modules are assembled and configured according to the application's I/O requirements and the software determines the available functions. This manual describes the specific application of the AQ-S254 alarm and indication IED. For other AQ-200 series products please consult the respective device manuals.

AQ-S214 may be applied as a substation alarm sounder, a substation general I/O extension unit or in any other application that requires extended I/O capabilities. The local indications are visualized conveniently through the freely programmable alarm LED display and event list. AQ-S214 can be connected to a substation automation system by using various standard communication protocols, including the IEC 61850 substation communication standard.

The AQ-S214 IED can be programmed through the easy-to-use AQtivate 200 setting and configuration software.

4. IED user interface

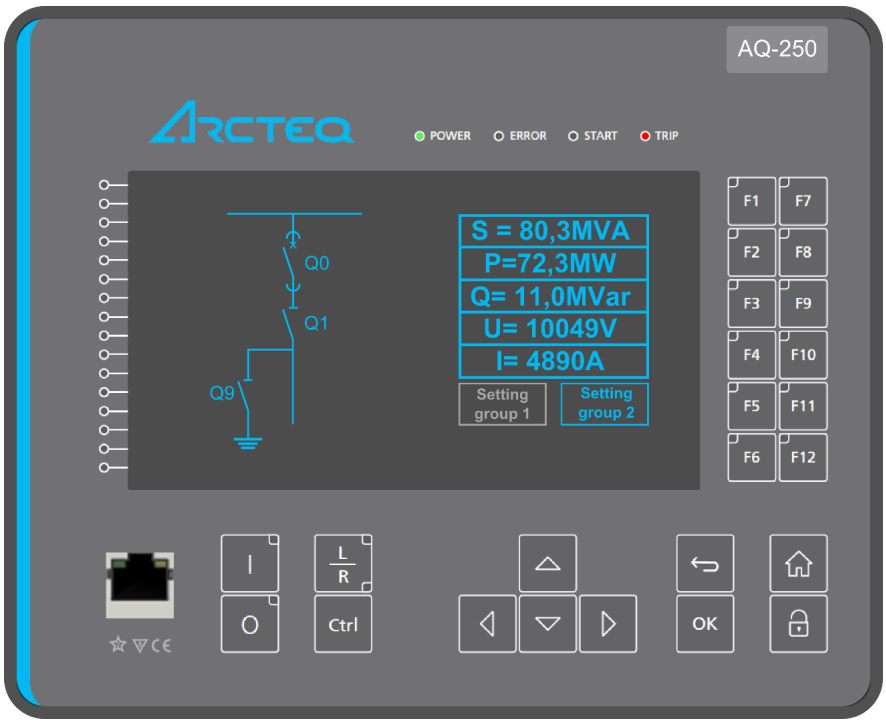
4.1. Panel structure

The user interface section of an AQ-200 series device is divided into two user interface sections: one for the hardware and the other for the software. You can access the software interface either through the front panel or through the AQtivate freeware software suite.

4.1.1. Local panel structure

The front panel of AQ-250 series devices have multiple LEDs, control buttons and a local RJ-45 Ethernet port for configuration. Each unit is also equipped with an RS-485 serial interface and an RJ-45 Ethernet interface on the back of the device. See the image and list below.

Figure. 4.1.1. - 1. Local panel structure.



- Four (4) freely configurable LEDs: "Power", "Error", "Start" and "Trip".
- Sixteen (16) freely configurable LEDs with programmable legend texts.
- Three (3) object control buttons: Choose the controllable object with the Ctrl button and the control breaker with the I and the O buttons.
- The L/R button switches between the local and the remote control modes.
- Eight (8) buttons for IED local programming: the four navigation arrows, the Back and the OK buttons, the Home and the password activation buttons).
- Twelve (12) freely configurable function buttons (F1…F12).
- One (1) RJ-45 Ethernet port for IED configuration.

The view in the screen is freely configurable with the buttons: you can change the setting groups or control the relay's general logic. The status of the object (circuit breaker, disconnector) can be displayed on the screen. All measured and calculated values regardless of the magnitude catecory (current, voltage, power, energy, frequency, etc.) can be shown on the screen.

Holding the I (object control) button down for five seconds brings up the button test menu. It displays all the physical buttons on the front panel. Pressing any of the listed buttons marks them as tested. When all buttons are marked as having been tested, you can press the Back button to close the button test menu.

4.2. Configuring user levels and their passwords

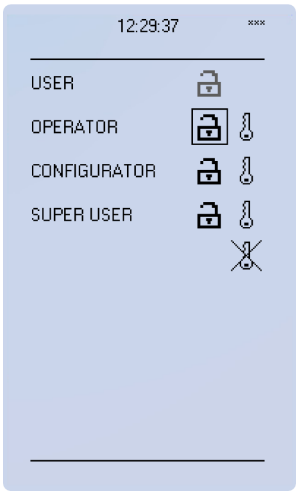
As a factory default, no user level is locked with a password in an IED. In order to activate the different user levels, click the **Lock** button in the device's HMI and set the desired passwords for the different user levels.

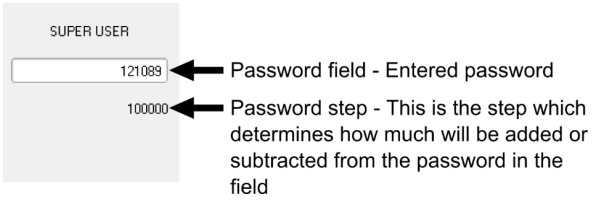
NOTE!

Passwords can only be set locally in an HMI.

A number of stars are displayed in the upper right corner of the HMI; these indicate the current user level. The different user levels and their star indicators are as follows (also, see the image below for the HMI view):

- Super user (***)
- Configurator (**)
- Operator (*)
- User (-)





You can set a new password for a user level by selecting the key icon next to the user level's name. After this you can lock the user level by pressing the **Return** key while the lock is selected. If you need to change the password, you can select the key icon again and give a new password. Please note that in order to do this the user level whose password is being changed must be unlocked.

As mentioned above, the access level of the different user levels is indicated by the number of stars. The required access level to change a parameter is indicated with a star (*) symbol if such is required. As a general rule the access levels are divided as follows:

- *User:* Can view any menus and settings but cannot change any settings, nor operate breakers or other equipment.
- *Operator:* Can view any menus and settings but cannot change any settings BUT can operate breakers and other equipment.
- *Configurator:* Can change most settings such as basic protection pick-up levels or time delays, breaker control functions, signal descriptions etc. and can operate breakers and other equipment.

- *Super user:* Can change any setting and can operate breakers and other equipment.

NOTE!

Any user level with a password automatically locks itself after half an hour (30 minutes) of inactivity.

5. Functions

5.1. General menu

The *General* menu consists of basic settings and indications of the device. Additionally, the all activated functions and their status are displayed in the *Protection*, *Control* and *Monitor* profiles.

Table. 5.1. - 1. Parameters and indications in the *General* menu.

Name	Description	Range	Step	Default
Device name	The file name uses these fields when loading the aqs configuration file from the AQ-200 unit.	-	-	Unitname
Device location		-	-	Unitlocation
Timesync. source	If an external clock time synchronization source is available, the type is defined with this parameter. In the internal mode there is no external Timesync source. IRIG-B requires a serial fiber communication option card.	0: Internal 1: External NTP 2: External Serial 3: IRIG-B	-	0: Internal
Enable stage forcing	When this parameter is enabled it is possible for the user to force the protection, control and monitoring functions to different statuses like START and TRIP. This is done in the function's *Info* page with the *Status force to* parameter.	0: Disabled 1: Enabled	-	0: Disabled
System phase rotating order	Allows the user to switch the expected order in which the phase measurements are wired to the unit.	0: A-B-C 1: A-C-B	-	0: A-B-C
Language	Changes the parameter description languages in the HMI.	0: User defined 1: English 2: Suomi 3: Svenska 4: Español 5: Français	-	1: English
Clear events	Clears the event history recorded in the AQ-200 device.	0: - 1: Clear	-	0: -
Display brightness	Changes the display brightness. Brightness level 0 turns the display off.	0…8	1	4
Display sleep timeout	If no buttons are pressed after a set time, the display will change the brightness to whatever is set on the *Display sleep brigthness* parameter. If set to 0, this feature is not in use.	0...3600 s	1 s	0 s
Display sleep brightness	Defines the brightness of the display when *Display sleep timeout* has elapsed. Brightness level 0 turns the display off.	0...8	1	0
Return to default view	If the user navigates to a menu and gives no input after a period of time defined with this parameter, the unit will return to the default view automatically. If time is set to 0 s, this feature is not in use.	0…3600 s	10 s	0 s
LED test	When activated, all LEDs are lit up. LEDs with multiple possible colors blink each color.	0: - 1: Activated	-	0: -
Reset latches	Resets the latched signals in the logic and the matrix. When a reset command is given the parameter will return back to "-" automatically.	0: - 1: Reset	-	0: -
Measurement recorder	Enables the *Measurement recorder* tool. The Measurement recorder is configured in *Tools → Misc → Measurement recorder*.	0: Disabled 1: Enabled	-	0: Disabled
Mimic reconfigure	Reload the mimic to the unit.	0: - 1: Reconfigure	-	0: -

Table. 5.1. - 2. The *General* menu indications

Name	Description

Serial number	The unique serial number identification of the unit.
SW version	The firmware software version of the unit.
HW conf.	The order code identification of the unit.
UTC time	The UTC time value which the device's clock uses.

5.2. Alarming function

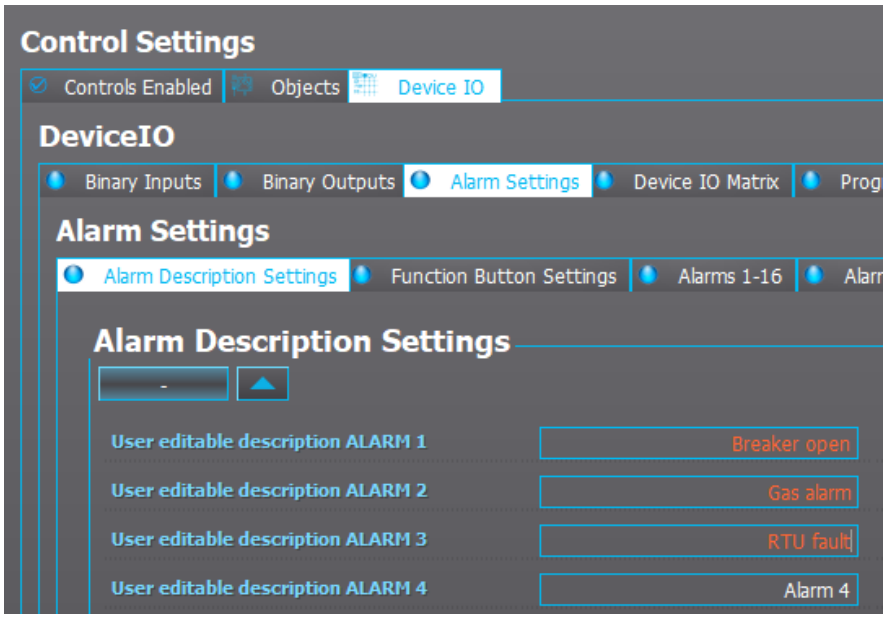
Figure. 5.2. - 2. Front panel view

Signal alarming is the main feature of AQ-S254 Alarming IEDs. The alarming unit has 128 alarms the user can set. The user defines each alarm description and activating signal. These settings are done in the *Alarm settings* menu (*Control → Device IO → Alarm settings*).

The alarming unit generates events with time stamps into the event history and the alarm statuses are shown on the IED's display. The alarm statuses can also be read in the remote terminal unit (RTU).

Alarm descriptions

Figure. 5.2. - 3. User-edited alarm descriptions.



The user-edited alarm text is displayed in the *Alarm* view in the HMI when the alarm has been activated. The user can update the descriptions in the settings (*Commands → Write to relay → Parameters or Commands → Write changes*).

Assigning alarm activation signals

Alarm activation signals are divided into eight tabs in groups of 16. The user can assign a digital input, a logic signal or a GOOSE message into each of the alarms. When any of the alarms have been activated by the assigned signal, the alarm appears in the *Alarms* view in the relay's HMI.

Figure. 5.2. - 4. Assigning alarms.

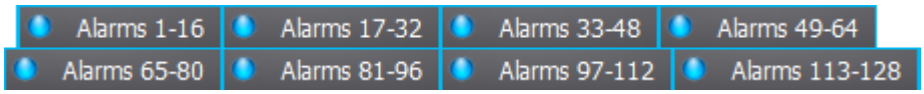
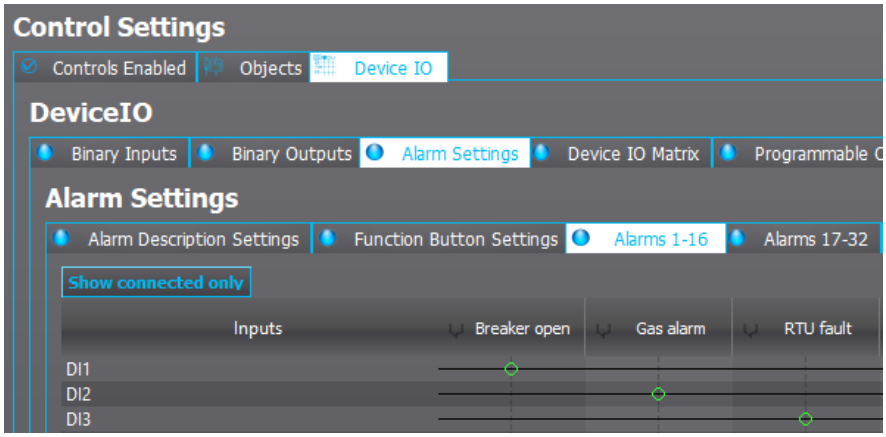


Figure. 5.2. - 5. Digital inputs assigned as alarm activating signals.



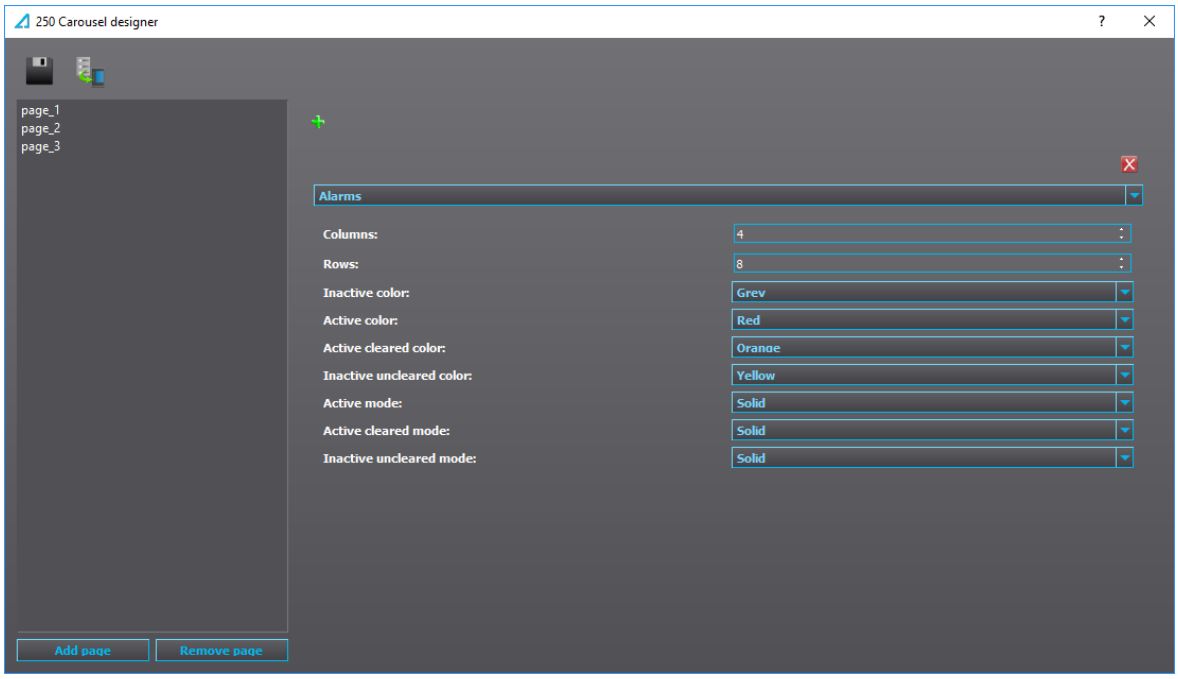
The user can assign signals into alarms by clicking on the matrix. When the matrix is done, it must be sent to the relay for the changes to take effect (*Commands → Write to relay → Logic*).

When the signal assigned into an alarm activates, the color changes in the *Alarms* view in the relay's HMI. Active alarms are displayed in the *Alarms* view with a red color in the text box. When the signal that activated the alarm is deactivated, the alarm box color becomes yellow until the alarm has been reset. Once an alarm has been reset the color changes back to gray.

If the alarm signal's ON state has been checked in the *Event Mask*, an ALARM ON event is recorded with a time stamp into the event history. These alarms are also reported in the communication protocol if one is in use.

Changing the look of the *Alarms* view

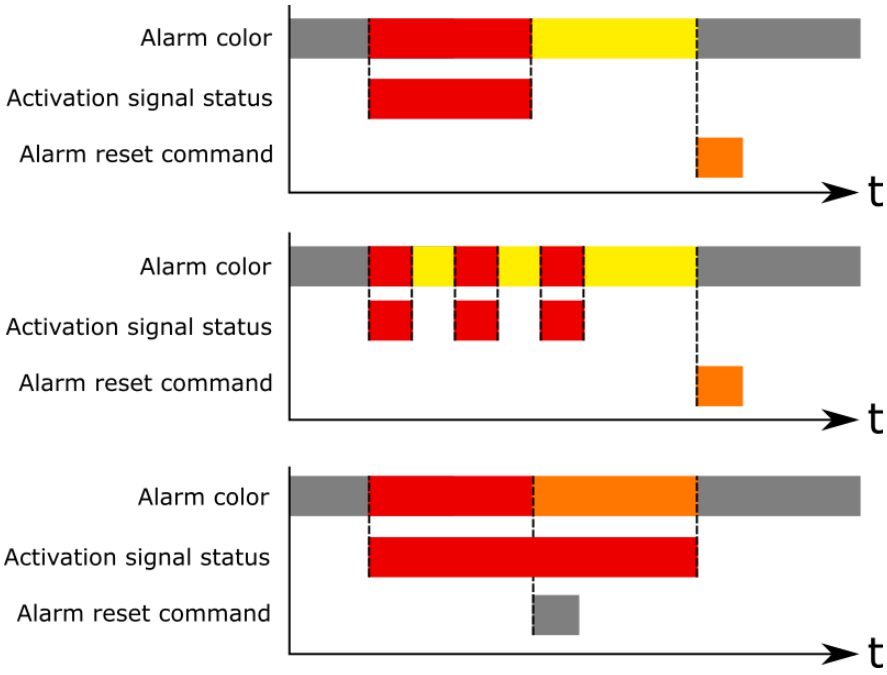
Figure. 5.2. - 6. Carousel designer view of the *Alarms* view settings.



Changing the look of the *Alarms* viewis done in Carousel designer. Carousel designer is found in *Tools → Carousel designer*.

The column and row settings allow the user to define the size, shape and number of alarms displayed in the *Alarms* view. Any number of alarms between 1 and 128 can be displayed. The color displayed in different states of the alarm can be gray, red, green, yellow, orange, or blue. With the color settings displayed above the following cases can occur:

Figure. 5.2. - 7. Examples of alarm color behaviours.



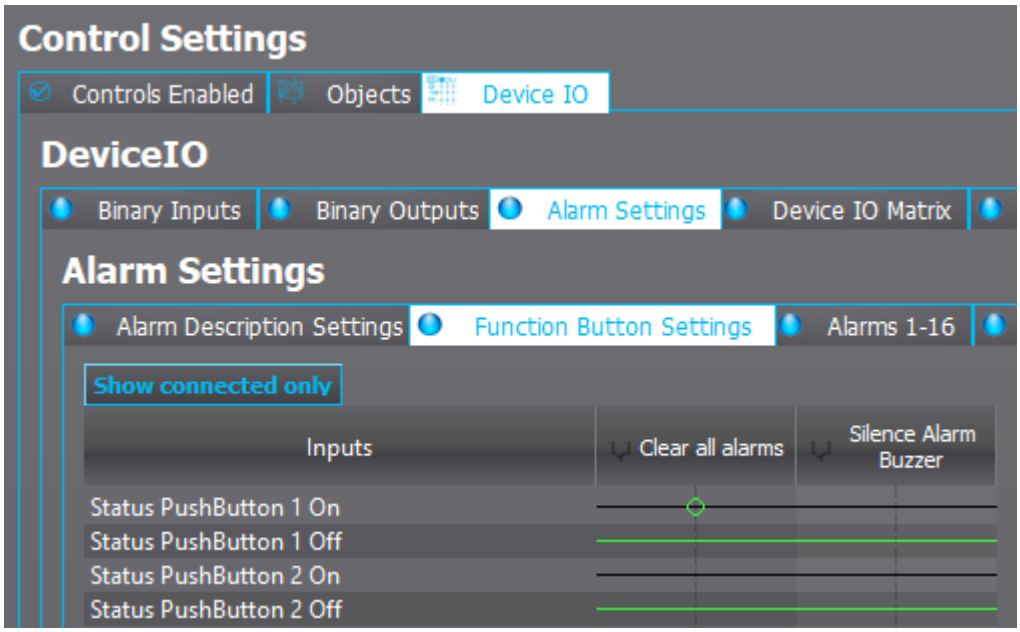
In the first case the activation signal changes the color from grey (inactive) to red (active). The activation signal drops off and the alarm color changes to yellow (inactive uncleared). The reset command clears the yellow color back to grey (inactive).

The second case shows a similar sequence. The only difference is that the activation signal pulses three times which results in the color going back and forth between red and yellow.

In the third case the alarm is red (active) and a reset command is given. This results in the orange color (active cleared) and the light will stay orange until the activation signal drops off.

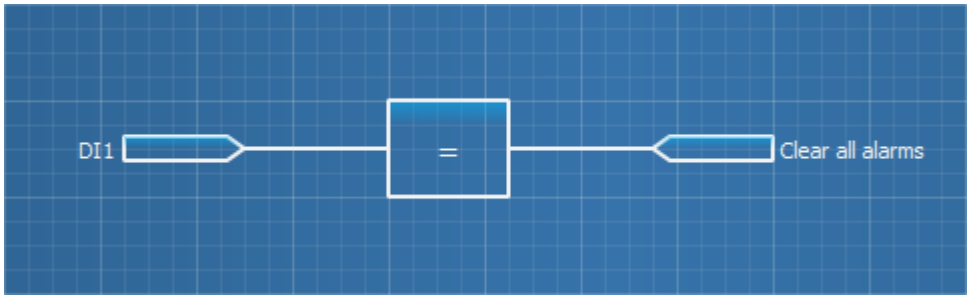
Clearing activated alarms

Figure. 5.2. - 8. Setting up the button for clearing alarms.



The button used for clearing alarms is defined in *Control → Device IO → Alarm settings → Function Button Settings*. Please notice that the function button mode should be set to PRESS RELEASE mode in *Control → Device IO → User-button settings*.

Alarms can be also cleared by using the CLEAR ALL ALARMS signal in the logic editor. In the example below, a physical push button activates Digital Input 1 which is connected to CLEAR ALL ALARMS.



After doing this in the logic editor, click *Save* and then update logic (*Commands → Write to relay → Logic*).

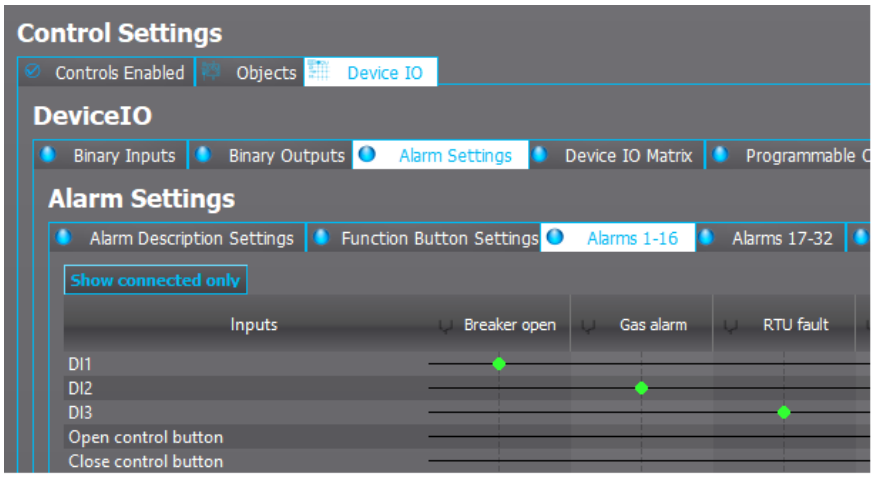
Buzzer activation and deactivation

AQ-S214 and AQ-S254 Alarming IEDs do not have an integrated buzzer. However, if an alarming buzzer is needed it is possible to connect an external buzzer. I is activated by one of the output relays of the IED. The user can set up the buzzer control by connecting the ALARM BUZZER signal to an output (*Control → Device IO → Device IO Matrix*). Whenever an alarm is activated the ALARM BUZZER signal will also activate and the output contact can be controlled.

The user can silence the alarm buzzer by pressing the **Back** button located in the IED panel, or by connecting a digital input or some other binary signal in the logic to SILENCE ALARM BUZZER.

Clearing latched alarms

Figure. 5.2. - 9. Latched signals as dots.



Latched signals are represented by filled markers in the matrix.

If a latched signals is connected to an alarm, the alarm unit requires the user to push the **Back** button in the unit's front panel before the latched signal can be cleared. Using latched signals is generally not advised in order to keep alarm clearing simple.

Events

The alarm function generates events from the status changes in the monitored signals. The user can select the status ON or OFF for messages in the main event buffer.

Table. 5.2. - 3. Event codes.

Event number	Event channel	Event block name	Event code	Description
768	12	ALARM1	0	Alarm 1 On
769	12	ALARM1	1	Alarm 1 Off
770	12	ALARM1	2	Alarm 2 On
771	12	ALARM1	3	Alarm 2 Off
772	12	ALARM1	4	Alarm 3 On
773	12	ALARM1	5	Alarm 3 Off
774	12	ALARM1	6	Alarm 4 On
775	12	ALARM1	7	Alarm 4 Off
776	12	ALARM1	8	Alarm 5 On
777	12	ALARM1	9	Alarm 5 Off
778	12	ALARM1	10	Alarm 6 On
779	12	ALARM1	11	Alarm 6 Off
780	12	ALARM1	12	Alarm 7 On
781	12	ALARM1	13	Alarm 7 Off
782	12	ALARM1	14	Alarm 8 On
783	12	ALARM1	15	Alarm 8 Off

784	12	ALARM1	16	Alarm 9 On
785	12	ALARM1	17	Alarm 9 Off
786	12	ALARM1	18	Alarm 10 On
787	12	ALARM1	19	Alarm 10 Off
788	12	ALARM1	20	Alarm 11 On
789	12	ALARM1	21	Alarm 11 Off
790	12	ALARM1	22	Alarm 12 On
791	12	ALARM1	23	Alarm 12 Off
792	12	ALARM1	24	Alarm 13 On
793	12	ALARM1	25	Alarm 13 Off
794	12	ALARM1	26	Alarm 14 On
795	12	ALARM1	27	Alarm 14 Off
796	12	ALARM1	28	Alarm 15 On
797	12	ALARM1	29	Alarm 15 Off
798	12	ALARM1	30	Alarm 16 On
799	12	ALARM1	31	Alarm 16 Off
800	12	ALARM1	32	Alarm 17 On
801	12	ALARM1	33	Alarm 17 Off
802	12	ALARM1	34	Alarm 18 On
803	12	ALARM1	35	Alarm 18 Off
804	12	ALARM1	36	Alarm 19 On
805	12	ALARM1	37	Alarm 19 Off
806	12	ALARM1	38	Alarm 20 On
807	12	ALARM1	39	Alarm 20 Off
808	12	ALARM1	40	Alarm 21 On
809	12	ALARM1	41	Alarm 21 Off
810	12	ALARM1	42	Alarm 22 On
811	12	ALARM1	43	Alarm 22 Off
812	12	ALARM1	44	Alarm 23 On
813	12	ALARM1	45	Alarm 23 Off
814	12	ALARM1	46	Alarm 24 On
815	12	ALARM1	47	Alarm 24 Off
816	12	ALARM1	48	Alarm 25 On
817	12	ALARM1	49	Alarm 25 Off
818	12	ALARM1	50	Alarm 26 On
819	12	ALARM1	51	Alarm 26 Off
820	12	ALARM1	52	Alarm 27 On
821	12	ALARM1	53	Alarm 27 Off
822	12	ALARM1	54	Alarm 28 On
823	12	ALARM1	55	Alarm 28 Off
824	12	ALARM1	56	Alarm 29 On

825	12	ALARM1	57	Alarm 29 Off
826	12	ALARM1	58	Alarm 30 On
827	12	ALARM1	59	Alarm 30 Off
828	12	ALARM1	60	Alarm 31 On
829	12	ALARM1	61	Alarm 31 Off
830	12	ALARM1	62	Alarm 32 On
831	12	ALARM1	63	Alarm 32 Off
832	13	ALARM2	0	Alarm 33 On
833	13	ALARM2	1	Alarm 33 Off
834	13	ALARM2	2	Alarm 34 On
835	13	ALARM2	3	Alarm 34 Off
836	13	ALARM2	4	Alarm 35 On
837	13	ALARM2	5	Alarm 35 Off
838	13	ALARM2	6	Alarm 36 On
839	13	ALARM2	7	Alarm 36 Off
840	13	ALARM2	8	Alarm 37 On
841	13	ALARM2	9	Alarm 37 Off
842	13	ALARM2	10	Alarm 38 On
843	13	ALARM2	11	Alarm 38 Off
844	13	ALARM2	12	Alarm 39 On
845	13	ALARM2	13	Alarm 39 Off
846	13	ALARM2	14	Alarm 40 On
847	13	ALARM2	15	Alarm 40 Off
848	13	ALARM2	16	Alarm 41 On
849	13	ALARM2	17	Alarm 41 Off
850	13	ALARM2	18	Alarm 42 On
851	13	ALARM2	19	Alarm 42 Off
852	13	ALARM2	20	Alarm 43 On
853	13	ALARM2	21	Alarm 43 Off
854	13	ALARM2	22	Alarm 44 On
855	13	ALARM2	23	Alarm 44 Off
856	13	ALARM2	24	Alarm 45 On
857	13	ALARM2	25	Alarm 45 Off
858	13	ALARM2	26	Alarm 46 On
859	13	ALARM2	27	Alarm 46 Off
860	13	ALARM2	28	Alarm 47 On
861	13	ALARM2	29	Alarm 47 Off
862	13	ALARM2	30	Alarm 48 On
863	13	ALARM2	31	Alarm 48 Off
864	13	ALARM2	32	Alarm 49 On
865	13	ALARM2	33	Alarm 49 Off

866	13	ALARM2	34	Alarm 50 On
867	13	ALARM2	35	Alarm 50 Off
868	13	ALARM2	36	Alarm 51 On
869	13	ALARM2	37	Alarm 51 Off
870	13	ALARM2	38	Alarm 52 On
871	13	ALARM2	39	Alarm 52 Off
872	13	ALARM2	40	Alarm 53 On
873	13	ALARM2	41	Alarm 53 Off
874	13	ALARM2	42	Alarm 54 On
875	13	ALARM2	43	Alarm 54 Off
876	13	ALARM2	44	Alarm 55 On
877	13	ALARM2	45	Alarm 55 Off
878	13	ALARM2	46	Alarm 56 On
879	13	ALARM2	47	Alarm 56 Off
880	13	ALARM2	48	Alarm 57 On
881	13	ALARM2	49	Alarm 57 Off
882	13	ALARM2	50	Alarm 58 On
883	13	ALARM2	51	Alarm 58 Off
884	13	ALARM2	52	Alarm 59 On
885	13	ALARM2	53	Alarm 59 Off
886	13	ALARM2	54	Alarm 60 On
887	13	ALARM2	55	Alarm 60 Off
888	13	ALARM2	56	Alarm 61 On
889	13	ALARM2	57	Alarm 61 Off
890	13	ALARM2	58	Alarm 62 On
891	13	ALARM2	59	Alarm 62 Off
892	13	ALARM2	60	Alarm 63 On
893	13	ALARM2	61	Alarm 63 Off
894	13	ALARM2	62	Alarm 64 On
895	13	ALARM2	63	Alarm 64 Off
11776	184	ALARM3	0	Alarm 65 On
11777	184	ALARM3	1	Alarm 65 Off
11778	184	ALARM3	2	Alarm 66 On
11779	184	ALARM3	3	Alarm 66 Off
11780	184	ALARM3	4	Alarm 67 On
11781	184	ALARM3	5	Alarm 67 Off
11782	184	ALARM3	6	Alarm 68 On
11783	184	ALARM3	7	Alarm 68 Off
11784	184	ALARM3	8	Alarm 69 On
11785	184	ALARM3	9	Alarm 69 Off
11786	184	ALARM3	10	Alarm 70 On

11787	184	ALARM3	11	Alarm 70 Off
11788	184	ALARM3	12	Alarm 71 On
11789	184	ALARM3	13	Alarm 71 Off
11790	184	ALARM3	14	Alarm 72 On
11791	184	ALARM3	15	Alarm 72 Off
11792	184	ALARM3	16	Alarm 73 On
11793	184	ALARM3	17	Alarm 73 Off
11794	184	ALARM3	18	Alarm 74 On
11795	184	ALARM3	19	Alarm 74 Off
11796	184	ALARM3	20	Alarm 75 On
11797	184	ALARM3	21	Alarm 75 Off
11798	184	ALARM3	22	Alarm 76 On
11799	184	ALARM3	23	Alarm 76 Off
11800	184	ALARM3	24	Alarm 77 On
11801	184	ALARM3	25	Alarm 77 Off
11802	184	ALARM3	26	Alarm 78 On
11803	184	ALARM3	27	Alarm 78 Off
11804	184	ALARM3	28	Alarm 79 On
11805	184	ALARM3	29	Alarm 79 Off
11806	184	ALARM3	30	Alarm 80 On
11807	184	ALARM3	31	Alarm 80 Off
11808	184	ALARM3	32	Alarm 81 On
11809	184	ALARM3	33	Alarm 81 Off
11810	184	ALARM3	34	Alarm 82 On
11811	184	ALARM3	35	Alarm 82 Off
11812	184	ALARM3	36	Alarm 83 On
11813	184	ALARM3	37	Alarm 83 Off
11814	184	ALARM3	38	Alarm 84 On
11815	184	ALARM3	39	Alarm 84 Off
11816	184	ALARM3	40	Alarm 85 On
11817	184	ALARM3	41	Alarm 85 Off
11818	184	ALARM3	42	Alarm 86 On
11819	184	ALARM3	43	Alarm 86 Off
11820	184	ALARM3	44	Alarm 87 On
11821	184	ALARM3	45	Alarm 87 Off
11822	184	ALARM3	46	Alarm 88 On
11823	184	ALARM3	47	Alarm 88 Off
11824	184	ALARM3	48	Alarm 89 On
11825	184	ALARM3	49	Alarm 89 Off
11826	184	ALARM3	50	Alarm 90 On
11827	184	ALARM3	51	Alarm 90 Off

11828	184	ALARM3	52	Alarm 91 On
11829	184	ALARM3	53	Alarm 91 Off
11830	184	ALARM3	54	Alarm 92 On
11831	184	ALARM3	55	Alarm 92 Off
11832	184	ALARM3	56	Alarm 93 On
11833	184	ALARM3	57	Alarm 93 Off
11834	184	ALARM3	58	Alarm 94 On
11835	184	ALARM3	59	Alarm 94 Off
11836	184	ALARM3	60	Alarm 95 On
11837	184	ALARM3	61	Alarm 95 Off
11838	184	ALARM3	62	Alarm 96 On
11839	184	ALARM3	63	Alarm 96 Off
11840	185	ALARM4	0	Alarm 97 On
11841	185	ALARM4	1	Alarm 97 Off
11842	185	ALARM4	2	Alarm 98 On
11843	185	ALARM4	3	Alarm 98 Off
11844	185	ALARM4	4	Alarm 99 On
11845	185	ALARM4	5	Alarm 99 Off
11846	185	ALARM4	6	Alarm 100 On
11847	185	ALARM4	7	Alarm 100 Off
11848	185	ALARM4	8	Alarm 101 On
11849	185	ALARM4	9	Alarm 101 Off
11850	185	ALARM4	10	Alarm 102 On
11851	185	ALARM4	11	Alarm 102 Off
11852	185	ALARM4	12	Alarm 103 On
11853	185	ALARM4	13	Alarm 103 Off
11854	185	ALARM4	14	Alarm 104 On
11855	185	ALARM4	15	Alarm 104 Off
11856	185	ALARM4	16	Alarm 105 On
11857	185	ALARM4	17	Alarm 105 Off
11858	185	ALARM4	18	Alarm 106 On
11859	185	ALARM4	19	Alarm 106 Off
11860	185	ALARM4	20	Alarm 107 On
11861	185	ALARM4	21	Alarm 107 Off
11862	185	ALARM4	22	Alarm 108 On
11863	185	ALARM4	23	Alarm 108 Off
11864	185	ALARM4	24	Alarm 109 On
11865	185	ALARM4	25	Alarm 109 Off
11866	185	ALARM4	26	Alarm 110 On
11867	185	ALARM4	27	Alarm 110 Off
11868	185	ALARM4	28	Alarm 111 On

11869	185	ALARM4	29	Alarm 111 Off
11870	185	ALARM4	30	Alarm 112 On
11871	185	ALARM4	31	Alarm 112 Off
11872	185	ALARM4	32	Alarm 113 On
11873	185	ALARM4	33	Alarm 113 Off
11874	185	ALARM4	34	Alarm 114 On
11875	185	ALARM4	35	Alarm 114 Off
11876	185	ALARM4	36	Alarm 115 On
11877	185	ALARM4	37	Alarm 115 Off
11878	185	ALARM4	38	Alarm 116 On
11879	185	ALARM4	39	Alarm 116 Off
11880	185	ALARM4	40	Alarm 117 On
11881	185	ALARM4	41	Alarm 117 Off
11882	185	ALARM4	42	Alarm 118 On
11883	185	ALARM4	43	Alarm 118 Off
11884	185	ALARM4	44	Alarm 119 On
11885	185	ALARM4	45	Alarm 119 Off
11886	185	ALARM4	46	Alarm 120 On
11887	185	ALARM4	47	Alarm 120 Off
11888	185	ALARM4	48	Alarm 121 On
11889	185	ALARM4	49	Alarm 121 Off
11890	185	ALARM4	50	Alarm 122 On
11891	185	ALARM4	51	Alarm 122 Off
11892	185	ALARM4	52	Alarm 123 On
11893	185	ALARM4	53	Alarm 123 Off
11894	185	ALARM4	54	Alarm 124 On
11895	185	ALARM4	55	Alarm 124 Off
11896	185	ALARM4	56	Alarm 125 On
11897	185	ALARM4	57	Alarm 125 Off
11898	185	ALARM4	58	Alarm 126 On
11899	185	ALARM4	59	Alarm 126 Off
11900	185	ALARM4	60	Alarm 127 On
11901	185	ALARM4	61	Alarm 127 Off
11902	185	ALARM4	62	Alarm 128 On
11903	185	ALARM4	63	Alarm 128 Off

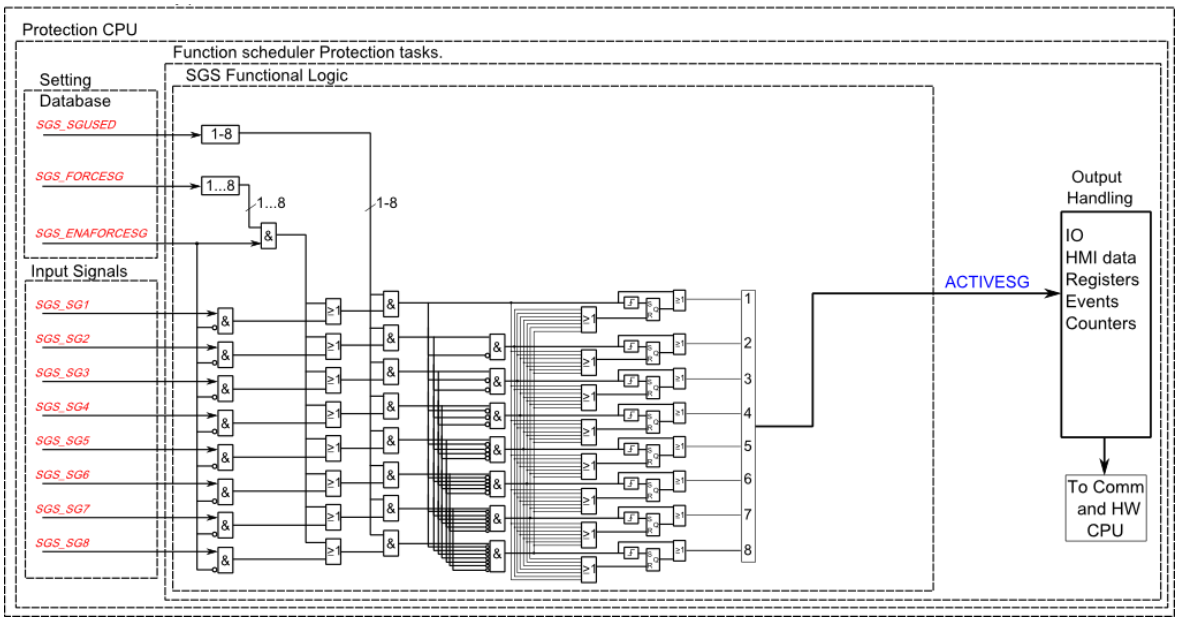
5.3. Control functions

5.3.1. Setting group selection

All relay types support up to eight (8) separate setting groups. The Setting group selection function block controls the availability and selection of the setting groups. By default, only Setting group 1 (SG1) is active and therefore the selection logic is idle. When more than one setting group is enabled, the setting group selector logic take control of the setting group activations based on the logic and conditions the user has programmed.

The following figure presents a simplified function block diagram of the setting group selection function.

Figure. 5.3.1. - 10. Simplified function block diagram of the setting group selection function.

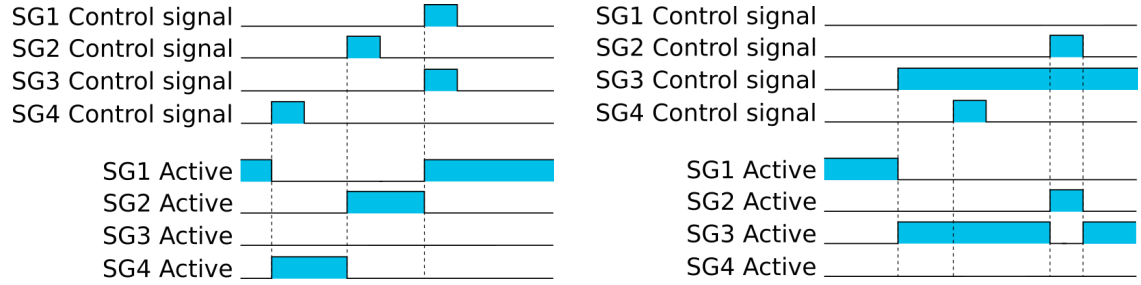


Setting group selection can be applied to each of the setting groups individually by activating one of the various internal logic inputs and connected digital inputs. The user can also force any of the setting groups on when the "Force SG change" setting is enabled by giving the wanted quantity of setting groups as a number in the communication bus or in the local HMI, or by selecting the wanted setting group from *Control → Setting groups*. When the forcing parameter is enabled, the automatic control of the local device is overridden and the full control of the setting groups is given to the user until the "Force SG change" is disabled again.

The switch and selection of application-controlled setting groups can be controlled either by pulses or by signal levels. The setting group controller block gives setting groups priority values for situations when more than one setting group is controlled at the same time: the request from a higher-priority setting group is taken into use.

If static signals are used for control, lower priority setting group requests are not applied. If pulse control is used, control of the setting group has to be applied to all setting groups. For example, if Setting group 2 is selected with a signal and then released, Setting group 1 is not automatically selected as the active setting group; instead, it needs to be specifically set as such.

Figure. 5.3.1. - 11. Example sequences of group changing (control with pulse only, or with both pulses and static signals).



Settings and signals

The settings of the setting group control function include the active setting group selection, the forced setting group selection, the enabling (or disabling) of the forced change, the selection of the number of active setting groups in the application, as well as the selection of the setting group changed remotely. If the setting group is forced to change, the corresponding setting group must be enabled and the force change must be enabled. Then, the setting group can be set from communications or from HMI to any available group. If the setting group control is applied with static signals right after the "Force SG" parameter is released, the application takes control of the setting group selection.

Table. 5.3.1. - 4. Settings of the setting group selection function.

Name	Range	Step	Default	Description
Active setting group			SG1	Displays which setting group is active.
Force SG	0: None 1: SG1 2: SG2 3: SG3 4: SG4 5: SG5 6: SG6 7: SG7 8: SG8	-	0: None	The selection of the overriding setting group. After "Force SG change" is enabled, any of the configured setting groups in the relay can be overriden. This control is always based on the pulse operating mode. It also requires that the selected setting group is specifically controlled to ON after "Force SG" is disabled. If there are no other controls, the last set setting group remains active.
Force SG change	0: Disabled 1: Enabled	-	0: Disabled	The selection of whether the setting group forcing is enabled or disabled. This setting has to be active before the setting group can be changed remotely or from a local HMI. This parameter overrides the local control of the setting groups and it remains on until the user disables it.
Used setting groups	0: SG1 1: SG1...2 2: SG1...3 3: SG1...4 4: SG1...5 5: SG1...6 6: SG1...7 7: SG1...8	-	0: SG1	The selection of the activated setting groups in the application. If a setting group is enabled, it cannot be controlled to "Active". Newly-enabled setting groups copy their values from Setting group 1.

Remote SG change	0: None 1: SG1 2: SG2 3: SG3 4: SG4 5: SG5 6: SG6 7: SG7 8: SG8	-	0: None	This parameter can be controlled through SCADA to change the setting group remotely. Please note that if a higher priority setting group is being controlled by a signal, a lower priority setting group cannot be activated with this parameter.

Table. 5.3.1. - 5. Signals of the setting group selection function.

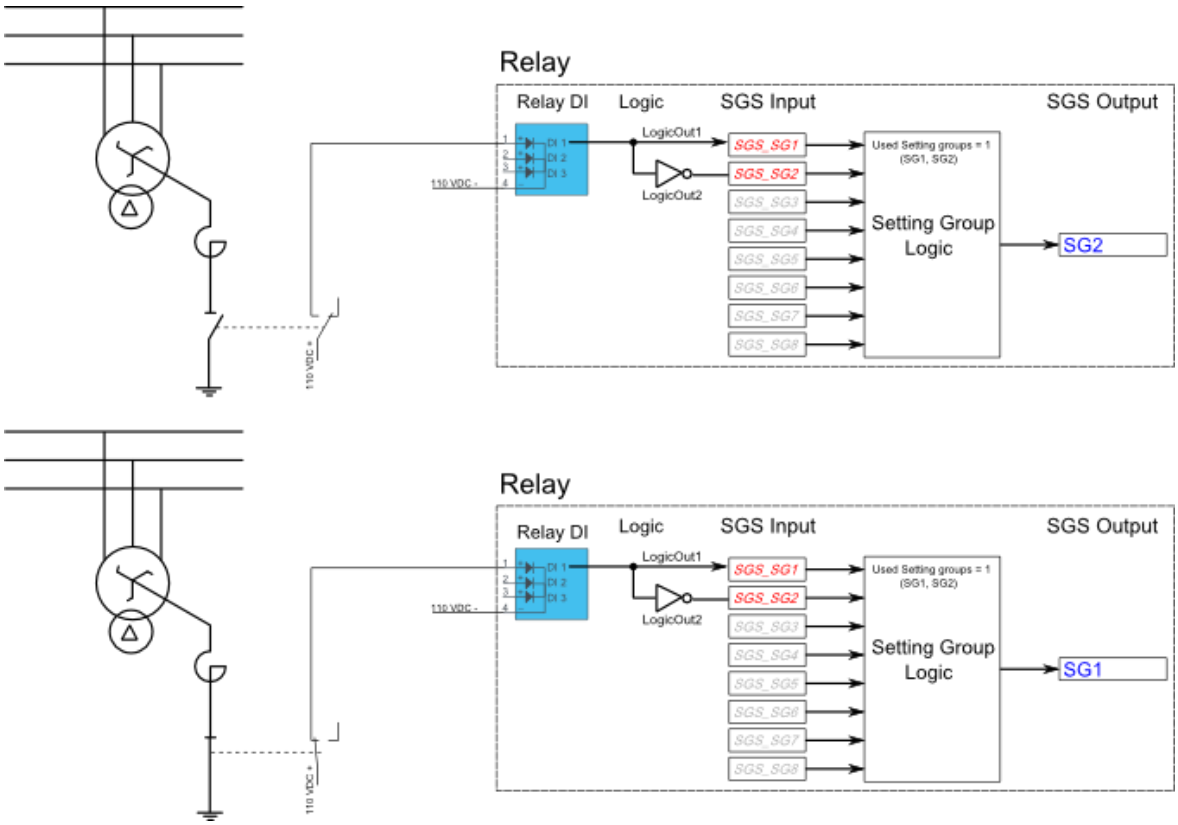
Name	Range	Step	Default	Description
Setting group 1	0: Not active 1: Active	-	0: Not active	The selection of Setting group 1 ("SG1"). Has the highest priority input in setting group control. Can be controlled with pulses or static signals. If static signal control is applied, no other SG requests will be processed.
Setting group 2	0: Not active 1: Active	-	0: Not active	The selection of Setting group 2 ("SG2"). Has the second highest priority input in setting group control. Can be controlled with pulses or static signals. If static signal control is applied, no requests with a lower priority than SG1 will be processed.
Setting group 3	0: Not active 1: Active	-	0: Not active	The selection of Setting group 3 ("SG3"). Has the third highest priority input in setting group control. Can be controlled with pulses or static signals. If static signal control is applied, no requests with a lower priority than SG1 and SG2 will be processed.
Setting group 4	0: Not active 1: Active	-	0: Not active	The selection of Setting group 4 ("SG4"). Has the fourth highest priority input in setting group control. Can be controlled with pulses or static signals. If static signal control is applied, no requests with a lower priority than SG1, SG2 and SG3 will be processed.
Setting group 5	0: Not active 1: Active	-	0: Not active	The selection of Setting group 5 ("SG5"). Has the fourth lowest priority input in setting group control. Can be controlled with pulses or static signals. If static signal control is applied, SG6, SG7 and SG8 requests will not be processed.
Setting group 6	0:Not active 1:Active	-	0:Not active	The selection of Setting group 6 ("SG6"). Has the third lowest priority input in setting group control. Can be controlled with pulses or static signals. If static signal control is applied, SG7 and SG8 requests will not be processed.
Setting group 7	0: Not active 1: Active	-	0: Not active	The selection of Setting group 7 ("SG7"). Has the second lowest priority input in setting group control. Can be controlled with pulses or static signals. If static signal control is applied, only SG8 requests will not be processed.
Setting group 8	0: Not active 1: Active	-	0: Not active	The selection of Setting group 8 ("SG8"). Has the lowest priority input in setting group control. Can be controlled with pulses or static signals. If static signal control is applied, all other SG requests will be processed regardless of the signal status of this setting group.

Example applications for setting group control

This chapter presents some of the most common applications for setting group changing requirements.

A Petersen coil compensated network usually uses directional sensitive earth fault protection. The user needs to control its characteristics between varmetric and wattmetric; the selection is based on whether the Petersen coil is connected when the network is compensated, or whether it is open when the network is unearthed.

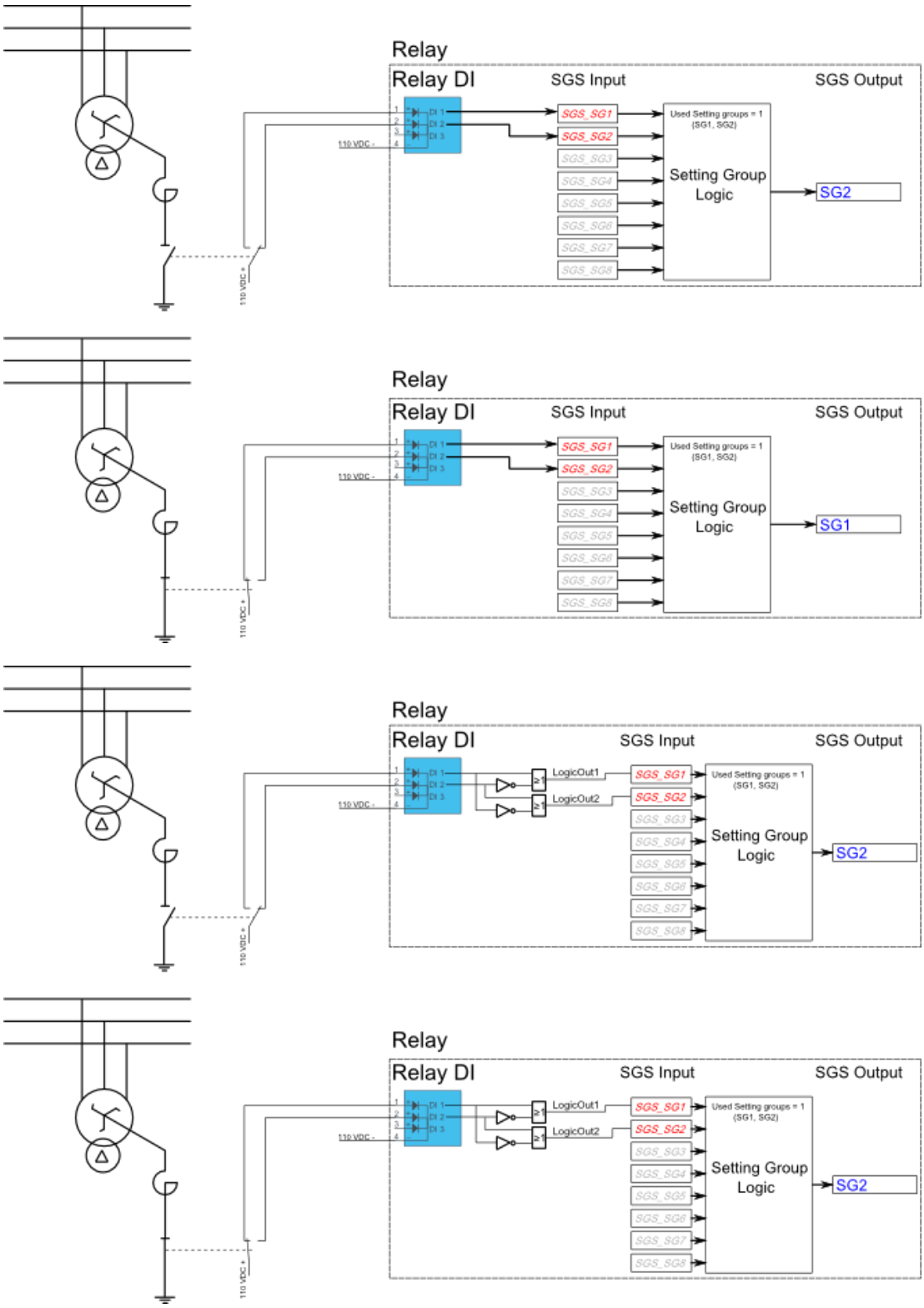
Figure. 5.3.1. - 12. Setting group control – one wire connection from Petersen coil status.



Depending on the application's requirements, the setting group control can be applied either with a one wire connection or with a two wire connection by monitoring the state of the Petersen coil connection.

When the connection is done with one wire, the setting group change logic can be applied as shown in the figure above. The status of the Petersen coil controls whether Setting group 1 is active. If the coil is disconnected, Setting group 2 is active. This way, if the wire is broken for some reason, the setting group is always controlled by SG2.

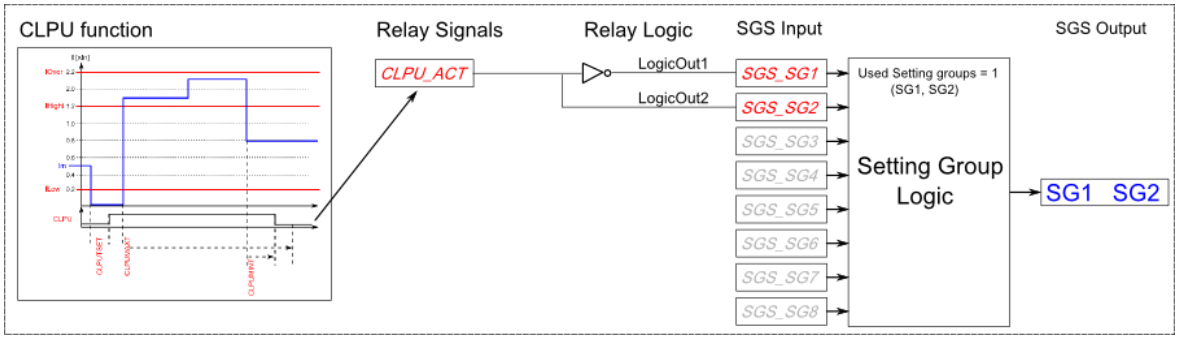
Figure. 5.3.1. - 13. Setting group control – two wire connection from Petersen coil status.



The images above depicts a two wire connection from the Petersen coil: the two images on the top depicts a direct connection, and the two image on the bottom includes additional logic. With a two wire connection the state of the Petersen coil can be monitored more securely. The additional logic ensures that a single wire loss will not affect the correct setting group selection.

The application-controlled setting group change can also be applied entirely from the relay's internal logics. For example, the setting group change can be based on the cold load pick-up function (see the image below).

Figure. 5.3.1. - 14. Entirely application-controlled setting group change with the cold load pick-up function.



In this example the cold load pick-up function's output is used for the automatic setting group change. Similarly to this application, any combination of the signals available in the relay's database can be programmed to be used in the setting group selection logic.

As all these examples show, setting group selection with application control has to be built fully before they can be used for setting group control. The setting group does not change back to SG1 unless it is controlled back to SG1 by this application; this explains the inverted signal NOT as well as the use of logics in setting group control. One could also have SG2 be the primary SG, while the ON signal would be controlled by the higher priority SG1; this way the setting group would automatically return to SG2 after the automatic control is over.

Events

The setting group selection function block (abbreviated "SGS" in event block names) generates events from its controlling status, its applied input signals, enabling and disabling of setting groups, as well as unsuccessful control changes. The function does not have a register.

Table. 5.3.1. - 6. Event codes.

Event number	Event channel	Event block name	Event code	Description
4160	65	SGS	0	SG2 Enabled
4161	65	SGS	1	SG2 Disabled
4162	65	SGS	2	SG3 Enabled
4163	65	SGS	3	SG3 Disabled
4164	65	SGS	4	SG4 Enabled
4165	65	SGS	5	SG4 Disabled
4166	65	SGS	6	SG5 Enabled
4167	65	SGS	7	SG5 Disabled
4168	65	SGS	8	SG6 Enabled
4169	65	SGS	9	SG6 Disabled
4170	65	SGS	10	SG7 Enabled
4171	65	SGS	11	SG7 Disabled
4172	65	SGS	12	SG8 Enabled
4173	65	SGS	13	SG8 Disabled
4174	65	SGS	14	SG1 Request ON

4175	65	SGS	15	SG1 Request OFF
4176	65	SGS	16	SG2 Request ON
4177	65	SGS	17	SG2 Request OFF
4178	65	SGS	18	SG3 Request ON
4179	65	SGS	19	SG3 Request OFF
4180	65	SGS	20	SG4 Request ON
4181	65	SGS	21	SG4 Request OFF
4182	65	SGS	22	SG5 Request ON
4183	65	SGS	23	SG5 Request OFF
4184	65	SGS	24	SG6 Request ON
4185	65	SGS	25	SG6 Request OFF
4186	65	SGS	26	SG7 Request ON
4187	65	SGS	27	SG7 Request OFF
4188	65	SGS	28	SG8 Request ON
4189	65	SGS	29	SG8 Request OFF
4190	65	SGS	30	Remote Change SG Reqeuest ON
4191	65	SGS	31	Remote Change SG Request OFF
4192	65	SGS	32	Local Change SG Request ON
4193	65	SGS	33	Local Change SG Request OFF
4194	65	SGS	34	Force Change SG ON
4195	65	SGS	35	Force Change SG OFF
4196	65	SGS	36	SG Request Fail Not configured SG ON
4197	65	SGS	37	SG Request Fail Not configured SG OFF
4198	65	SGS	38	Force Request Fail Force ON
4199	65	SGS	39	Force Request Fail Force OFF
4200	65	SGS	40	SG Req. Fail Lower priority Request ON
4201	65	SGS	41	SG Req. Fail Lower priority Request OFF
4202	65	SGS	42	SG1 Active ON
4203	65	SGS	43	SG1 Active OFF
4204	65	SGS	44	SG2 Active ON
4205	65	SGS	45	SG2 Active OFF
4206	65	SGS	46	SG3 Active ON
4207	65	SGS	47	SG3 Active OFF
4208	65	SGS	48	SG4 Active ON
4209	65	SGS	49	SG4 Active OFF
4210	65	SGS	50	SG5 Active ON
4211	65	SGS	51	SG5 Active OFF
4212	65	SGS	52	SG6 Active ON
4213	65	SGS	53	SG6 Active OFF
4214	65	SGS	54	SG7 Active ON
4215	65	SGS	55	SG7 Active OFF

4216	65	SGS	56	SG8 Active ON
4217	65	SGS	57	SG8 Active OFF

5.3.2. Object control and monitoring

The object control and monitoring function takes care of both for circuit breakers and disconnectors. The monitoring and controlling are based on the statuses of the relay's configured digital inputs and outputs. The number of controllable and monitored objects in each relay depends on the available inputs and outputs. One controllable object requires a minimum of two (2) output contacts. The status monitoring of one monitored object usually requires two (2) digital inputs. Alternatively, object status monitoring can be performed with a single digital input: the input's active state and its zero state (switched to 1 with a NOT gate in the Logic editor).

An object can be controlled by local control, by remote control, by an HMI mimic manually, or by a software function automatically. The function supports the modes "Direct control" and "Select before execute" while controlled remotely.

Object control consists of the following:

- control logic
- control monitor
- output handler.

In addition to these main parts, the user can add object-related circuit breaker failure protection (CBFP; 50BF) and object wear monitoring in the object control block. These additional functions are not included in the basic version of the object control block.

The outputs of the function are the OBJECT OPEN and OBJECT CLOSE control signals. Additionally, the function reports the monitored object's status and applied operations. The setting parameters are static inputs for the function, which can only be changed by the use in the function's setup phase.

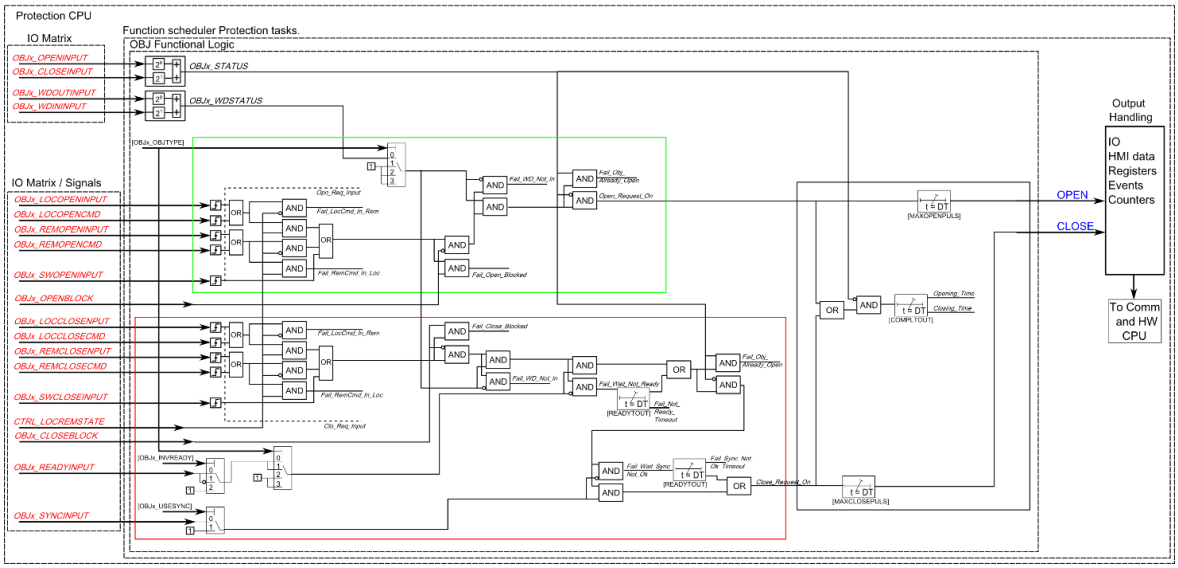
The inputs for the function are the following:

- digital input status indications (the OPEN and CLOSE status signals)
- blockings
- the OBJECT READY and SYNCHROCHECH monitor signals.
- Withdrawable cart IN and OUT status signals.

The function generates general time stamped ON/OFF events to the common event buffer from each of the two (2) output signals as well as several operational event signals. The time stamp resolution is 1 ms. The function also provides a resettable cumulative counter for OPEN, CLOSE, OPEN FAIL, and CLOSE FAIL events.

The following figure presents a simplified function block diagram of the object control and monitoring function.

Figure. 5.3.2. - 15. Simplified function block diagram of the object control and monitoring function.



Settings

The following parameters help the user to define the object. The operation of the function varies based on these settings and the selected object type. The selected object type determines how much control is needed and which setting parameters are required to meet those needs.

Table. 5.3.2. - 7. Object set and status.

Name	Range	Step	Default	Description
Local/Remote status	0: Local 1: Remote	-	1: Remote	Defines the status of the relay's local or remote switch. Control of the object has to be applied in the correct control location. The remote controls cannot override the open or close commands while in "Local" status.
Object name	-	-	Objectx	The user-set name of the object, at maximum 32 characters long.
Object type	0: Withdrawable circuit breaker 1: Circuit breaker 2: Disconnector (MC) 3: Disconnector (GND)	-	1: Circuit breaker	The selection of the object type. This selection defines the number of required digital inputs for the monitored object. This affects the HMI and the monitoring of the circuit breaker. It also affects whether the withdrawable cart is in or out. See the next table ("Object types") for a more detailed look at which functionalities each of the object types have.
Objectx Breaker status	0: Intermediate 1: Open 2: Closed 3: Bad	-	-	Displays the status of breaker. Intermediate is displayed when neither of the status signals (open or close) are active. Bad status is displayed when both status signals (open and close) are active.
Objectx Withdraw status	0: WDIntermediate 1: WDCartOut 2: WDCart In 3: WDBad 4: Not in use	-	-	Displays the status of circuit breaker cart. WDIntermediate is displayed when neither of the status signals (in or out) are active. WDBad status is displayed when both status signals (in and out) are active. If the selected object type is not set to "Withdrawable circuit breaker", this setting displays the "No in use" option.

Additional status information	0: Open Blocked 1: Open Allowed 2: Close Blocked 3: Close Allowed 4: Object Ready 5: Object Not Ready 6: Sync Ok 7: Sync Not Ok	-	-	Displays additional information about the status of the object.
Use Synchrocheck	0: Not in use 1: Synchrocheck in use	-	0: Not in use	Selects whether the "Synchrocheck" condition is in use for the circuit breaker close command.
Use Object ready	0: Ready High 1: Ready Low 2: Not in use	-	2: Not in use	Selects whether the "Object ready" condition is in use for the circuit breaker close command.
Open requests	0…4 294 967 295	1	-	Displayes the number of successful "Open" requests.
Close requests	0…4 294 967 295	1	-	Displays the number of successful "Close" requests.
Open requests failed	0…4 294 967 295	1	-	Displays the number of failed "Open" requests.
Close requests failed	0…4 294 967 295	1	-	Displays the number of failed "Close" requests.
Clear statistics	0: - 1: Clear	-	0: -	Clears the request statistics, setting them back to zero (0). Automatically returns to "-" after the clearing is finished.

Table. 5.3.2. - 8. Object types.

Name	Functionalities	Description
Withdrawable circuit breaker	WD cart position Position Control Object ready Use synchrocheck Interlocks	The monitor and control configuration of the withdrawable circuit breaker.
Circuit breaker	Position indication Control Object ready Use synchrocheck Interlocks	The monitor and control configuration of the circuit breaker.
Disconnector (MC)	Position indication Control	The position monitoring and control of the disconnector.
Disconnector (GND)	Position indication	The position indication of the earth switch.

Table. 5.3.2. - 9. I/O.

Signal	Range	Description
Objectx Open input ("Objectx Open Status In")	Digital input or other logical signal selected by the user (SWx)	A link to a physical digital input. The monitored object's OPEN status. "1" refers to the active open state of the monitored object. Position indication of digital inputs and protection stage signals can be done by using IEC 61850 signals, GOOSE signals or logical signals.

Objectx Close input ("Objectx Close Status In")	Digital input or other logical signal selected by the user (SWx)	A link to a physical digital input. The monitored object's CLOSE status. "1" refers to the active close state of the monitored object. Position indication of digital inputs and protection stage signals can be done by using IEC 61850 signals, GOOSE signals or logical signals.
WD Object In ("Withdrw.CartIn.Status In")	Digital input or other logical signal selected by the user (SWx)	A link to a physical digital input. The monitored withdrawable object's position is IN. "1" means that the withdrawable object cart is in. Position indication of digital inputs and protection stage signals can be done by using IEC 61850 signals, GOOSE signals or logical signals.
WD Object Out ("Withdrw.CartOut.Status In")	Digital input or other logical signal selected by the user (SWx)	A link to a physical digital input. The monitored withdrawable object's position is OUT. "1" means that the withdrawable object cart is pulled out. Position indication of digital inputs and protection stage signals can be done by using IEC 61850 signals, GOOSE signals or logical signals.
Object Ready (Objectx Ready status In")	Digital input or other logical signal selected by the user (SWx)	A link to a physical digital input. Indicates that status of the monitored object. "1" means that the object is ready and the spring is charged for a close command. Position indication of digital inputs and protection stage signals can be done by using IEC 61850 signals, GOOSE signals or logical signals. The application can set the ready status to be either "1" or "0".
Syncrocheck permission ("Sync.Check status In")	Digital input or other logical signal selected by the user (SWx)	A link to a physical digital input or a synchrocheck function. "1" means that the synchrocheck conditions are met and the object can be closed. Position indication of digital inputs and protection stage signals can be done by using IEC 61850 signals, GOOSE signals or logical signals.
Objectx Open command ("Objectx Open Command")	OUT1… OUTx	The physical "Open" command pulse to the device's output relay.
Objectx Close command ("Objectx Close Command")	OUT1… OUTx	The physical "Close" command pulse to the device's output relay.

Table. 5.3.2. - 10. Operation settings.

Name	Range	Step	Default	Description
Breaker traverse time	0.02… 500.00 s	0.02 s	0.2 s	Determines the maximum time between open and close statuses when the breaker switches. If this set time is exceeded and both open and closed status inputs are active, the status "Bad" is activated in the "Objectx Breaker status" setting. If neither of the status inputs are active after this delay, the status "Intermediate" is activated.
Maximum Close command pulse length	0.02… 500.00 s	0.02 s	0.2 s	Determines the maximum length for a Close pulse from the output relay to the controlled object. If the object operates faster than this set time, the control pulse is reset and a status change is detected.
Maximum Open command pulse length	0.02… 500.00 s	0.02 s	0.2 s	Determines the maximum length for a Open pulse from the output relay to the controlled object. If the object operates faster than this set time, the control pulse is reset and a status change is detected.

Control termination timeout	0.02… 500.00 s	0.02 s	10 s	Determines the control pulse termination timeout. If the object has not changed it status in this given time the function will issue error event and the control is ended. This parameter is common for both open and close commands.
Final trip pulse length	0.00… 500.00 s	0.02 s	0.2 s	Determines the length of the final trip pulse length. When the object has executed the final trip, this signal activates. If set to 0 s, the signal is continuous. This can be used in the matrix or in Logic editor.

Table. 5.3.2. - 11. Control settings (DI and Application).

Signal	Range	Description
Access level for MIMIC control	0: User 1: Operator 2: Configurator 3: Super user	Defines what level of access is required for MIMIC control. The default is the "Configurator" level.
Objectx LOCAL Close control input	Digital input or other logical signal selected by the user	The local Close command from a physical digital input (e.g. a push button).
Objectx LOCAL Open control input	Digital input or other logical signal selected by the user	The local Open command from a physical digital input (e.g. a push button).
Objectx REMOTE Close control input	Digital input or other logical signal selected by the user	The remote Close command from a physical digital input (e.g. RTU).
Objectx REMOTE Open control input	Digital input or other logical signal selected by the user	The remote Open command from a physical digital input (e.g. RTU).
Objectx Application Close	Digital input or other logical signal selected by the user	The Close command from the application. Can be any logical signal.
Objectx Application Open	Digital input or other logical signal selected by the user	The Close command from the application. Can be any logical signal.

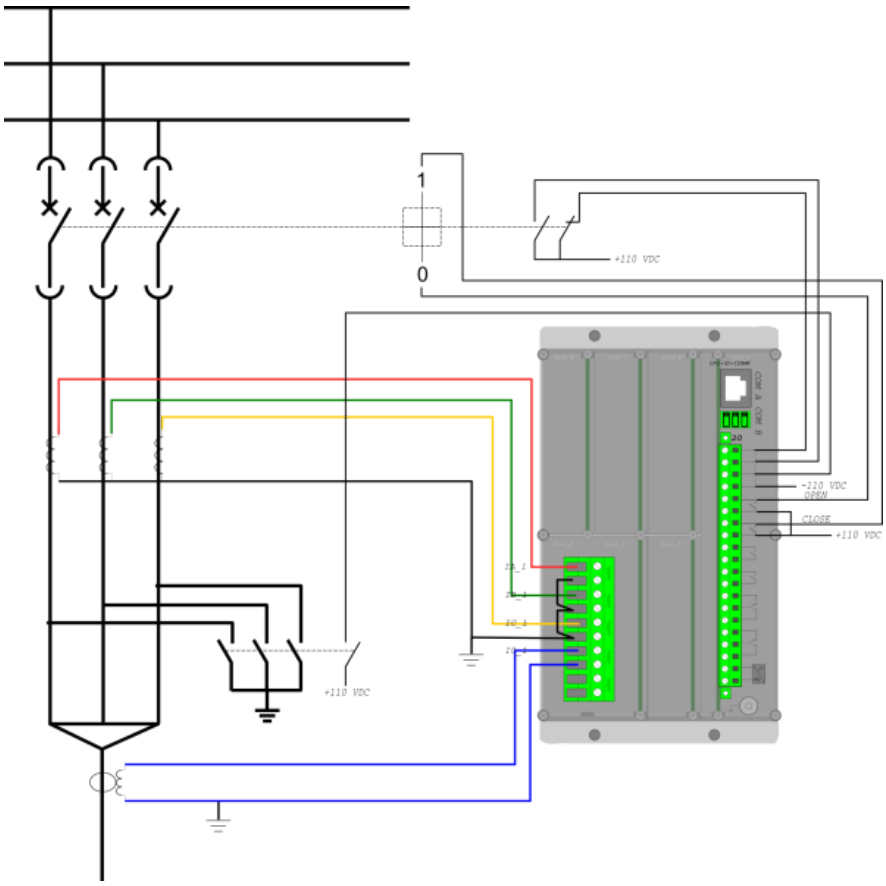
The pick-up activation of the function is not directly equal to the START signal generation of the function. The START signal is allowed if the blocking condition is not active.

Blocking and interlocking

The interlocking and blocking conditions can be set for each controllable object, with Open and Close set separately. Blocking and interlocking can be based on any of the following: other object statuses, a software function or a digital input.

The image below presents an example of an interlock application, where the closed earthing switch interlocks the circuit breaker close.

Figure. 5.3.2. - 16. Example of an interlock application.



In order for the blocking signal to be received on time, it has to reach the function 5 ms before the control command.

Events and registers

The object control and monitoring function (abbreviated "OBJ" in event block names) generates events and registers from the status changes in monitored signals as well as control command fails and operations. The user can select the status ON or OFF for messages in the main event buffer.

The function registers its operation into the last twelve (12) time-stamped registers. The triggering event of the function is recorded with a time stamp and with process data values.

Table. 5.3.2. - 12. Event codes of the OBJ function instances 1 – 10.

Event Number	Event channel	Event block name	Event Code	Description
2944	46	OBJ1	0	Object Intermediate
2945	46	OBJ1	1	Object Open
2946	46	OBJ1	2	Object Close
2947	46	OBJ1	3	Object Bad
2948	46	OBJ1	4	WD Intermediate
2949	46	OBJ1	5	WD Out
2950	46	OBJ1	6	WD In
2951	46	OBJ1	7	WD Bad
2952	46	OBJ1	8	Open Request ON

2953	46	OBJ1	9	Open Request OFF
2954	46	OBJ1	10	Open Command ON
2955	46	OBJ1	11	Open Command OFF
2956	46	OBJ1	12	Close Request ON
2957	46	OBJ1	13	Close Request OFF
2958	46	OBJ1	14	Close Command ON
2959	46	OBJ1	15	Close Command OFF
2960	46	OBJ1	16	Open Blocked ON
2961	46	OBJ1	17	Open Blocked OFF
2962	46	OBJ1	18	Close Blocked ON
2963	46	OBJ1	19	Close Blocked OFF
2964	46	OBJ1	20	Object Ready
2965	46	OBJ1	21	Object Not Ready
2966	46	OBJ1	22	Sync Ok
2967	46	OBJ1	23	Sync Not Ok
2968	46	OBJ1	24	Open Command Fail
2969	46	OBJ1	25	Close Command Fail
2970	46	OBJ1	26	Final trip ON
2971	46	OBJ1	27	Final trip OFF
3008	47	OBJ2	0	Object Intermediate
3009	47	OBJ2	1	Object Open
3010	47	OBJ2	2	Object Close
3011	47	OBJ2	3	Object Bad
3012	47	OBJ2	4	WD Intermediate
3013	47	OBJ2	5	WD Out
3014	47	OBJ2	6	WD In
3015	47	OBJ2	7	WD Bad
3016	47	OBJ2	8	Open Request ON
3017	47	OBJ2	9	Open Request OFF
3018	47	OBJ2	10	Open Command ON
3019	47	OBJ2	11	Open Command OFF
3020	47	OBJ2	12	Close Request ON
3021	47	OBJ2	13	Close Request OFF
3022	47	OBJ2	14	Close Command ON
3023	47	OBJ2	15	Close Command OFF
3024	47	OBJ2	16	Open Blocked ON
3025	47	OBJ2	17	Open Blocked OFF
3026	47	OBJ2	18	Close Blocked ON
3027	47	OBJ2	19	Close Blocked OFF
3028	47	OBJ2	20	Object Ready
3029	47	OBJ2	21	Object Not Ready

3030	47	OBJ2	22	Sync Ok
3031	47	OBJ2	23	Sync Not Ok
3032	47	OBJ2	24	Open Command Fail
3033	47	OBJ2	25	Close Command Fail
3034	47	OBJ2	26	Final trip ON
3035	47	OBJ2	27	Final trip OFF
3072	48	OBJ3	0	Object Intermediate
3073	48	OBJ3	1	Object Open
3074	48	OBJ3	2	Object Close
3075	48	OBJ3	3	Object Bad
3076	48	OBJ3	4	WD Intermediate
3077	48	OBJ3	5	WD Out
3078	48	OBJ3	6	WD In
3079	48	OBJ3	7	WD Bad
3080	48	OBJ3	8	Open Request ON
3081	48	OBJ3	9	Open Request OFF
3082	48	OBJ3	10	Open Command ON
3083	48	OBJ3	11	Open Command OFF
3084	48	OBJ3	12	Close Request ON
3085	48	OBJ3	13	Close Request OFF
3086	48	OBJ3	14	Close Command ON
3087	48	OBJ3	15	Close Command OFF
3088	48	OBJ3	16	Open Blocked ON
3089	48	OBJ3	17	Open Blocked OFF
3090	48	OBJ3	18	Close Blocked ON
3091	48	OBJ3	19	Close Blocked OFF
3092	48	OBJ3	20	Object Ready
3093	48	OBJ3	21	Object Not Ready
3094	48	OBJ3	22	Sync Ok
3095	48	OBJ3	23	Sync Not Ok
3096	48	OBJ3	24	Open Command Fail
3097	48	OBJ3	25	Close Command Fail
3098	48	OBJ3	26	Final trip ON
3099	48	OBJ3	27	Final trip OFF
3136	49	OBJ4	0	Object Intermediate
3137	49	OBJ4	1	Object Open
3138	49	OBJ4	2	Object Close
3139	49	OBJ4	3	Object Bad
3140	49	OBJ4	4	WD Intermediate
3141	49	OBJ4	5	WD Out
3142	49	OBJ4	6	WD In

3143	49	OBJ4	7	WD Bad
3144	49	OBJ4	8	Open Request ON
3145	49	OBJ4	9	Open Request OFF
3146	49	OBJ4	10	Open Command ON
3147	49	OBJ4	11	Open Command OFF
3148	49	OBJ4	12	Close Request ON
3149	49	OBJ4	13	Close Request OFF
3150	49	OBJ4	14	Close Command ON
3151	49	OBJ4	15	Close Command OFF
3152	49	OBJ4	16	Open Blocked ON
3153	49	OBJ4	17	Open Blocked OFF
3154	49	OBJ4	18	Close Blocked ON
3155	49	OBJ4	19	Close Blocked OFF
3156	49	OBJ4	20	Object Ready
3157	49	OBJ4	21	Object Not Ready
3158	49	OBJ4	22	Sync Ok
3159	49	OBJ4	23	Sync Not Ok
3160	49	OBJ4	24	Open Command Fail
3161	49	OBJ4	25	Close Command Fail
3162	49	OBJ4	26	Final trip ON
3163	49	OBJ4	27	Final trip OFF
3200	50	OBJ5	0	Object Intermediate
3201	50	OBJ5	1	Object Open
3202	50	OBJ5	2	Object Close
3203	50	OBJ5	3	Object Bad
3204	50	OBJ5	4	WD Intermediate
3205	50	OBJ5	5	WD Out
3206	50	OBJ5	6	WD In
3207	50	OBJ5	7	WD Bad
3208	50	OBJ5	8	Open Request ON
3209	50	OBJ5	9	Open Request OFF
3210	50	OBJ5	10	Open Command ON
3211	50	OBJ5	11	Open Command OFF
3212	50	OBJ5	12	Close Request ON
3213	50	OBJ5	13	Close Request OFF
3214	50	OBJ5	14	Close Command ON
3215	50	OBJ5	15	Close Command OFF
3216	50	OBJ5	16	Open Blocked ON
3217	50	OBJ5	17	Open Blocked OFF
3218	50	OBJ5	18	Close Blocked ON
3219	50	OBJ5	19	Close Blocked OFF

3220	50	OBJ5	20	Object Ready
3221	50	OBJ5	21	Object Not Ready
3222	50	OBJ5	22	Sync Ok
3223	50	OBJ5	23	Sync Not Ok
3224	50	OBJ5	24	Open Command Fail
3225	50	OBJ5	25	Close Command Fail
3226	50	OBJ5	26	Final trip ON
3227	50	OBJ5	27	Final trip OFF
9600	150	OBJ6	0	Object Intermediate
9601	150	OBJ6	1	Object Open
9602	150	OBJ6	2	Object Close
9603	150	OBJ6	3	Object Bad
9604	150	OBJ6	4	WD Intermediate
9605	150	OBJ6	5	WD Out
9606	150	OBJ6	6	WD In
9607	150	OBJ6	7	WD Bad
9608	150	OBJ6	8	Open Request ON
9609	150	OBJ6	9	Open Request OFF
9610	150	OBJ6	10	Open Command ON
9611	150	OBJ6	11	Open Command OFF
9612	150	OBJ6	12	Close Request ON
9613	150	OBJ6	13	Close Request OFF
9614	150	OBJ6	14	Close Command ON
9615	150	OBJ6	15	Close Command OFF
9616	150	OBJ6	16	Open Blocked ON
9617	150	OBJ6	17	Open Blocked OFF
9618	150	OBJ6	18	Close Blocked ON
9619	150	OBJ6	19	Close Blocked OFF
9620	150	OBJ6	20	Object Ready
9621	150	OBJ6	21	Object Not Ready
9622	150	OBJ6	22	Sync Ok
9623	150	OBJ6	23	Sync Not Ok
9624	150	OBJ6	24	Open Command Fail
9625	150	OBJ6	25	Close Command Fail
9626	150	OBJ6	26	Final trip ON
9627	150	OBJ6	27	Final trip OFF
9664	151	OBJ7	0	Object Intermediate
9665	151	OBJ7	1	Object Open
9666	151	OBJ7	2	Object Close
9667	151	OBJ7	3	Object Bad
9668	151	OBJ7	4	WD Intermediate

9669	151	OBJ7	5	WD Out
9670	151	OBJ7	6	WD In
9671	151	OBJ7	7	WD Bad
9672	151	OBJ7	8	Open Request ON
9673	151	OBJ7	9	Open Request OFF
9674	151	OBJ7	10	Open Command ON
9675	151	OBJ7	11	Open Command OFF
9676	151	OBJ7	12	Close Request ON
9677	151	OBJ7	13	Close Request OFF
9678	151	OBJ7	14	Close Command ON
9679	151	OBJ7	15	Close Command OFF
9680	151	OBJ7	16	Open Blocked ON
9681	151	OBJ7	17	Open Blocked OFF
9682	151	OBJ7	18	Close Blocked ON
9683	151	OBJ7	19	Close Blocked OFF
9684	151	OBJ7	20	Object Ready
9685	151	OBJ7	21	Object Not Ready
9686	151	OBJ7	22	Sync Ok
9687	151	OBJ7	23	Sync Not Ok
9688	151	OBJ7	24	Open Command Fail
9689	151	OBJ7	25	Close Command Fail
9690	151	OBJ7	26	Final trip ON
9691	151	OBJ7	27	Final trip OFF
9728	152	OBJ8	0	Object Intermediate
9729	152	OBJ8	1	Object Open
9730	152	OBJ8	2	Object Close
9731	152	OBJ8	3	Object Bad
9732	152	OBJ8	4	WD Intermediate
9733	152	OBJ8	5	WD Out
9734	152	OBJ8	6	WD In
9735	152	OBJ8	7	WD Bad
9736	152	OBJ8	8	Open Request ON
9737	152	OBJ8	9	Open Request OFF
9738	152	OBJ8	10	Open Command ON
9739	152	OBJ8	11	Open Command OFF
9740	152	OBJ8	12	Close Request ON
9741	152	OBJ8	13	Close Request OFF
9742	152	OBJ8	14	Close Command ON
9743	152	OBJ8	15	Close Command OFF
9744	152	OBJ8	16	Open Blocked ON
9745	152	OBJ8	17	Open Blocked OFF

9746	152	OBJ8	18	Close Blocked ON
9747	152	OBJ8	19	Close Blocked OFF
9748	152	OBJ8	20	Object Ready
9749	152	OBJ8	21	Object Not Ready
9750	152	OBJ8	22	Sync Ok
9751	152	OBJ8	23	Sync Not Ok
9752	152	OBJ8	24	Open Command Fail
9753	152	OBJ8	25	Close Command Fail
9754	152	OBJ8	26	Final trip ON
9755	152	OBJ8	27	Final trip OFF
9792	153	OBJ9	0	Object Intermediate
9793	153	OBJ9	1	Object Open
9794	153	OBJ9	2	Object Close
9795	153	OBJ9	3	Object Bad
9796	153	OBJ9	4	WD Intermediate
9797	153	OBJ9	5	WD Out
9798	153	OBJ9	6	WD In
9799	153	OBJ9	7	WD Bad
9800	153	OBJ9	8	Open Request ON
9801	153	OBJ9	9	Open Request OFF
9802	153	OBJ9	10	Open Command ON
9803	153	OBJ9	11	Open Command OFF
9804	153	OBJ9	12	Close Request ON
9805	153	OBJ9	13	Close Request OFF
9806	153	OBJ9	14	Close Command ON
9807	153	OBJ9	15	Close Command OFF
9808	153	OBJ9	16	Open Blocked ON
9809	153	OBJ9	17	Open Blocked OFF
9810	153	OBJ9	18	Close Blocked ON
9811	153	OBJ9	19	Close Blocked OFF
9812	153	OBJ9	20	Object Ready
9813	153	OBJ9	21	Object Not Ready
9814	153	OBJ9	22	Sync Ok
9815	153	OBJ9	23	Sync Not Ok
9816	153	OBJ9	24	Open Command Fail
9817	153	OBJ9	25	Close Command Fail
9818	153	OBJ9	26	Final trip ON
9819	153	OBJ9	27	Final trip OFF
9856	154	OBJ10	0	Object Intermediate
9857	154	OBJ10	1	Object Open
9858	154	OBJ10	2	Object Close

9859	154	OBJ10	3	Object Bad
9860	154	OBJ10	4	WD Intermediate
9861	154	OBJ10	5	WD Out
9862	154	OBJ10	6	WD In
9863	154	OBJ10	7	WD Bad
9864	154	OBJ10	8	Open Request ON
9865	154	OBJ10	9	Open Request OFF
9866	154	OBJ10	10	Open Command ON
9867	154	OBJ10	11	Open Command OFF
9868	154	OBJ10	12	Close Request ON
9869	154	OBJ10	13	Close Request OFF
9870	154	OBJ10	14	Close Command ON
9871	154	OBJ10	15	Close Command OFF
9872	154	OBJ10	16	Open Blocked ON
9873	154	OBJ10	17	Open Blocked OFF
9874	154	OBJ10	18	Close Blocked ON
9875	154	OBJ10	19	Close Blocked OFF
9876	154	OBJ10	20	Object Ready
9877	154	OBJ10	21	Object Not Ready
9878	154	OBJ10	22	Sync Ok
9879	154	OBJ10	23	Sync Not Ok
9880	154	OBJ10	24	Open Command Fail
9881	154	OBJ10	25	Close Command Fail
9882	154	OBJ10	26	Final trip ON
9883	154	OBJ10	27	Final trip OFF

Table. 5.3.2. - 13. Register content.

Name	Description
Date and time	dd.mm.yyyy hh:mm:ss.mss
Event code	2944-9883 Descr.
Recorded Object opening time	Time difference between the object receiving an "Open" command and the object receiving the "Open" status.
Recorded Object closing time	Time difference between the object receiving a "Close" command and object receiving the "Closed" status.
Object status	The status of the object.
WD status	The status of the withdrawable circuit breaker.
Open fail	The cause of an "Open" command's failure.
Close fail	The cause of a "Close" command's failure.
Open command	The source of an "Open" command.
Close command	The source of an "Open" command.
General status	The general status of the function.

5.3.3. Indicator object monitoring

The indicator object monitoring function takes care of the status monitoring of circuit breakers and disconnectors. The function's sole purpose is indication and does not therefore have any control functionality. To control circuit breakers and/or disconnectors, please use the Object control and monitoring function. The monitoring is based on the statuses of the configured relay's digital inputs. The number of monitored indicators in a relay depends on the available inputs and outputs. The status monitoring of one monitored object usually requires two (2) digital inputs. Alternatively, object status monitoring can be performed with a single digital input: the input's active state and its zero state (switched to 1 with a NOT gate in the Logic editor). The selection of the object type is done in Mimic editor.

The outputs of the function are the monitored indicator statuses (Open and Close). The setting parameters are static inputs for the function, which can only be changed by the use in the function's setup phase.

The inputs of the function are the binary status indications. The function generates general time stamped ON/OFF events to the common event buffer from each of the following signals: OPEN, CLOSE, BAD and INTERMEDIATE event signals. The time stamp resolution is 1 ms.

Settings

Function uses available hardware and software digital signal statuses. These input signals are also setting parameters for the function.

Table. 5.3.3. - 14. Indicator status.

Name	Range	Default	Description
Indicator name ("Ind. Name")	-	IndX	The user-set name of the object, at maximum 32 characters long.
IndicatorX Object status ("Ind.X Object Status")	0: Intermediate 1: Open 2: Closed 3: Bad	-	Displays the status of the indicator object. Intermediate status is displayed when neither of the status conditions (open or close) are active. Bad status is displayed when both of the status conditions (open and close) are active.

Table. 5.3.3. - 15. Indicator I/O.

Signal	Range	Description
IndicatorX Open input ("Ind.X Open Status In")	Digital input or other logical signal selected by the user (SWx)	A link to a physical digital input. The monitored indicator's OPEN status. "1" refers to the active "Open" state of the monitored indicator. Position indication of digital inputs and protection stage signals can be done by using IEC 61850 signals, GOOSE signals or logical signals.
IndicatorX Close input ("Ind.X Close Status In")	Digital input or other logical signal selected by the user (SWx)	A link to a physical digital input. The monitored indicator's CLOSE status. "1" refers to the active "Close" state of the monitored indicator. Position indication of digital inputs and protection stage signals can be done by using IEC 61850 signals, GOOSE signals or logical signals.

Events

The indicator object monitoring function (abbreviated "CIN" in event block names) generates events from the status changes in the monitored signals, including the continuous status indications. The user can select the status ON or OFF for messages in the main event buffer.

Table. 5.3.3. - 16. Event codes (instances 1-20).

Event Number	Event channel	Event block name	Event Code	Description
6656	104	CIN1	0	Intermediate
6657	104	CIN1	1	Open
6658	104	CIN1	2	Close
6659	104	CIN1	3	Bad
6720	105	CIN2	0	Intermediate
6721	105	CIN2	1	Open
6722	105	CIN2	2	Close
6723	105	CIN2	3	Bad
6784	106	CIN3	0	Intermediate
6785	106	CIN3	1	Open
6786	106	CIN3	2	Close
6787	106	CIN3	3	Bad
6848	107	CIN4	0	Intermediate
6849	107	CIN4	1	Open
6850	107	CIN4	2	Close
6851	107	CIN4	3	Bad
6912	108	CIN5	0	Intermediate
6913	108	CIN5	1	Open
6914	108	CIN5	2	Close
6915	108	CIN5	3	Bad
10752	168	CIN6	0	Intermediate
10753	168	CIN6	1	Open
10754	168	CIN6	2	Close
10755	168	CIN6	3	Bad
10816	169	CIN7	0	Intermediate
10817	169	CIN7	1	Open
10818	169	CIN7	2	Close
10819	169	CIN7	3	Bad
10880	170	CIN8	0	Intermediate
10881	170	CIN8	1	Open
10882	170	CIN8	2	Close
10883	170	CIN8	3	Bad
10944	171	CIN9	0	Intermediate
10945	171	CIN9	1	Open
10946	171	CIN9	2	Close
10947	171	CIN9	3	Bad
11008	172	CIN10	0	Intermediate
11009	172	CIN10	1	Open

11010	172	CIN10	2	Close
11011	172	CIN10	3	Bad
11072	173	CIN11	0	Intermediate
11073	173	CIN11	1	Open
11074	173	CIN11	2	Close
11075	173	CIN11	3	Bad
11136	174	CIN12	0	Intermediate
11137	174	CIN12	1	Open
11138	174	CIN12	2	Close
11139	174	CIN12	3	Bad
11200	175	CIN13	0	Intermediate
11201	175	CIN13	1	Open
11202	175	CIN13	2	Close
11203	175	CIN13	3	Bad
11264	176	CIN14	0	Intermediate
11265	176	CIN14	1	Open
11266	176	CIN14	2	Close
11267	176	CIN14	3	Bad
11328	177	CIN15	0	Intermediate
11329	177	CIN15	1	Open
11330	177	CIN15	2	Close
11331	177	CIN15	3	Bad
11392	178	CIN16	0	Intermediate
11393	178	CIN16	1	Open
11394	178	CIN16	2	Close
11395	178	CIN16	3	Bad
11456	179	CIN17	0	Intermediate
11457	179	CIN17	1	Open
11458	179	CIN17	2	Close
11459	179	CIN17	3	Bad
11520	180	CIN18	0	Intermediate
11521	180	CIN18	1	Open
11522	180	CIN18	2	Close
11523	180	CIN18	3	Bad
11584	181	CIN19	0	Intermediate
11585	181	CIN19	1	Open
11586	181	CIN19	2	Close
11587	181	CIN19	3	Bad
11648	182	CIN20	0	Intermediate
11649	182	CIN20	1	Open
11650	182	CIN20	2	Close

11651	182	CIN20	3	Bad

5.3.4. Milliampere outputs

The milliamp current loop is the prevailing process control signal in many industries. It is an ideal method of transferring process information because a current does not change as it travels from a transmitter to a receiver. It is also much more simple and cost-effective.

The benefits of 4...20 mA loops:

- the dominant standard in many industries
- the simplest option to connect and configure
- uses less wiring and connections than other signals, thus greatly reducing initial setup costs
- good for travelling long distances, as current does not degrade over long connections like voltage does
- less sensitive to background electrical noise
- detects a fault in the system incredibly easily since 4 mA is equal to 0 % output.

Milliampere (mA) outputs

Relays support up to two (2) independent mA option cards. Each card has four (4) mA output channels and one (1) mA input channel. If the device has an mA option card, enable mA outputs at *Control → Device IO → mA outputs*. The outputs are activated in groups of two: channels 1 and 2 are activated together, as are channels 3 and 4 (see the image below).

Figure. 5.3.4. - 17. Activating mA output channels.

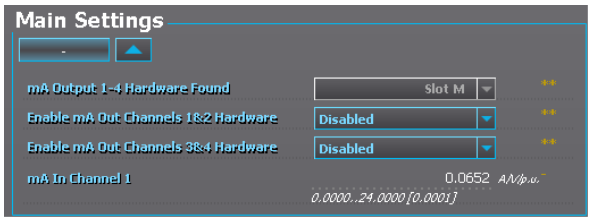


Table. 5.3.4. - 17. Main settings (output channels).

Name		Range	Default	Description
mA option card 1	Enable mA output channels 1 and 2	0: Disabled 1: Enabled	0: Disabled	Enables and disables the outputs of the mA output card 1.
	Enable mA output channels 3 and 4			
mA option card 2	Enable mA output channels 5 and 6	0: Disabled 1: Enabled	0: Disabled	Enables and disables the outputs of the mA output card 2.
	Enable mA output channels 7 and 8			

Table. 5.3.4. - 18. Settings for mA output channels.

Name	Range	Step	Default	Description
Enable mA output channel	0: Disabled 1: Enabled	-	0: Disabled	Enables and disables the selected mA output channel. If the channel is disabled, the channel settings are hidden.
Magnitude selection for mA output channel	0: Currents 1: Voltages 2: Powers 3: Impedance and admittance 4: Other	-	0: Currents	Defines the measurement category that is used for mA output control.

Magnitude of mA output channel	(dependent on the measurement category selection)	-	(dependent on the measurement category selection)	Defines the measurement magnitude used for mA output control. The available measurements depend on the selection of the "Magnitude selection for mA output channel" parameter.
Input value 1	$-10^7 \ldots 10^7$	0.001	0	The first input point in the mA output control curve.
Scaled mA output value 1	0.0000… 24.0000 mA	0.0001 mA	0 mA	The mA output value when the measured value is equal to or less than Input value 1.
Input value 2	$-10^7 \ldots 10^7$	0.001	1	The second input point in the mA output control curve.
Scaled mA output value 2	0.0000… 24.0000 mA	0.0001 mA	0 mA	The mA output value when the measured value is equal to or greater than Input value 2.

Figure. 5.3.4. - 18. Example of the effects of mA output channel settings.

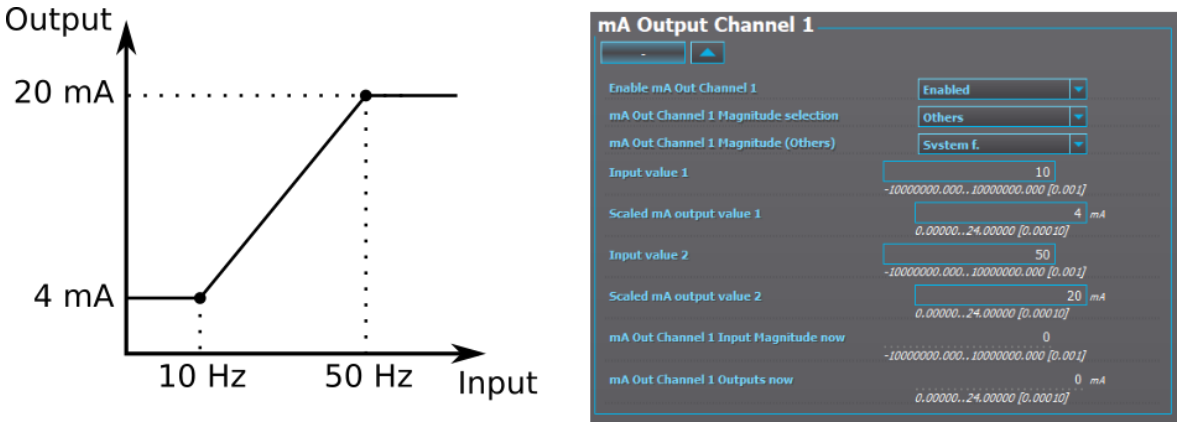


Table. 5.3.4. - 19. Hardware indications.

Name	Range	Step	Description
Hardware in mA output channels 1...4	0: None 1: Slot A 2: Slot B 3: Slot C 4: Slot D 5: Slot E 6: Slot F 7: Slot G 8: Slot H 9: Slot I 10: Slot J 11: Slot K 12: Slot L 13: Slot M 14: Slot N 15: Too many cards installed	-	Indicates the option card slot where the mA output card is located.
Hardware in mA output channels 5...8			

Table. 5.3.4. - 20. Measurement values reported by mA output cards.

Name	Range	Step	Description
mA in Channel 1	0.0000… 24.0000 mA	0.0001 mA	Displays the measured mA value of the selected input channel.
mA in Channel 2			
Input magnitude of the mA output channel	$-10^7 \ldots 10^7$	0.001	Displays the input value of the selected mA output channel at that moment.
Output magnitude of the mA output channel	0.0000… 24.0000 mA	0.0001 mA	Displays the output value of the selected mA output channel at that moment.

Milliampere input

Relays support up to two (2) independent mA option cards. Each card has four (4) mA output channels and one (1) mA input channel. If the device has an mA option card, enable the mA input at *Measurement → AI (mA, DI volt) scaling*. Activating "Analog input scaling" allows for the creation of a scaling curve (see the image below).

Figure. 5.3.4. - 19. Activating analog input scaling to create a scaling curve.

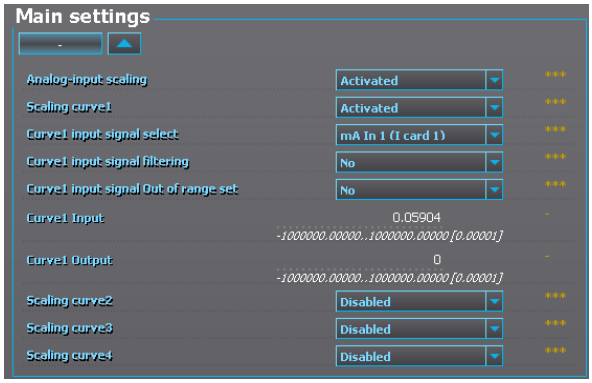


Table. 5.3.4. - 21. Main settings (input channel).

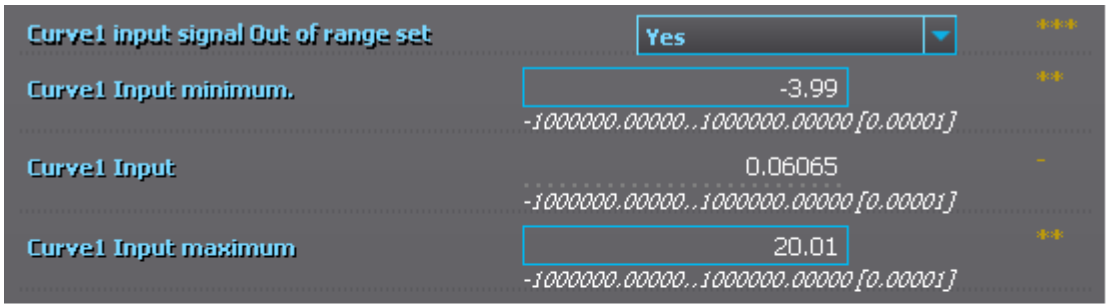
Name	Range	Default	Description
Analog input scaling	0: Disabled 1: Activated	0: Disabled	Enables and disables the mA input.
Scaling curve 1...4	0: Disabled 1: Activated	0: Disabled	Enables and disables the scaling curve and the mA input measurement.
Curve 1...4 input signal select	0: RTD S1 resistance … 15: RTD S16 resistance 16: mA in 1 (I card 1) 17: mA in 2 (I card 2)	0: RTD S1 resistance	Defines the measurement category used for mA input control.

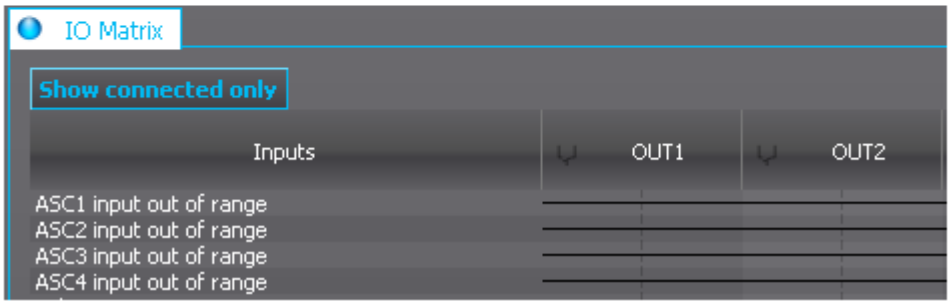
The input signal filter (see the image below) calculates the average of received mA signals according to the set time constant. This is why rapid changes and disturbances (such as fast spikes) are smothered.

The Nyquist rate states that the filter time constant must be at least double the period time of the disturbance process signal. For example, the value for the filter time constant is 2 seconds for a 1 second period time of a disturbance oscillation.

$$H(s) = \frac{Wc}{S+Wc} = \frac{1}{1+s/Wc}$$

When the curve signal is out of range, it activates the "Out of range" alarm, which can be used inside logic or with other relay functions. The signal can be assigned directly to an output relay or to an LED in the I/O matrix. The "Out of range" signal is activated, when the measured mA signal falls below the set input minimum limit, or when it exceeds the input maximum limit. The "Out of range" signal is very useful when e.g. a 4…20 mA input signal is used (see the image below).





If for some reason the mA input signal is lost, the value is fixed to the last actual measured cycle value. The value does not go down to the minimum if it has been something else at the time of the signal breaking.

Table. 5.3.4. - 22. Output settings and indications.

Name	Range	Step	Default	Description
Curve 1...4 update cycle	5...10 000 ms	5 ms	150 ms	Defines the length of the mA input measurement update cycle. If the user wants a fast operation, this setting should be fairly low.
Scaled value handling	0: Floating point 1: Integer out (Floor) 2: Integer (Ceiling) 3: Integer (Nearest)	-	0: Floating point	Rounds the milliampere signal output as selected.
Input value 1	0...4000	0.000 01	0	The measured milliampere input value at Curve Point 1.
Scaled output value 1	-10^7...10^7	0.000 01	0	Scales the measured milliampere signal at Point 1.
Input value 2	0...4000	0.000 01	1	The measured milliampere input value at Curve Point 2.
Scaled output value 1	-10^7...10^7	0.000 01	0	Scales the measured milliampere signal at Point 2.
Add curvepoint 3...20	0: Not used 1: Used	-	0: Not used	Allows the user to create their own curve with up to twenty (20) curve points, instead of using a linear curve between two points.

6. System integration

6.1. Communication protocols

6.1.1. NTP

When enabled, the NTP (Network Time Protocol) service can use external time sources to synchronize the device's system time. The NTP client service uses an Ethernet connection to connect to the NTP time server. NTP can be enabled by setting the primary time server and the secondary time server parameters to the address of the system's NTP time source(s).

Table. 6.1.1. - 23. Server settings.

Name	Range	Description
Primary time server address	0.0.0.0...255.255.255.255	Defines the address of the primary NTP server. Setting this parameter at "0.0.0.0" means that the server is not in use.
Secondary time server address	0.0.0.0...255.255.255.255	Defines the address of the secondary (or backup) NTP server. Setting this parameter at "0.0.0.0" means that the server is not in use.

Table. 6.1.1. - 24. Status.

Name	Range	Description
NTP quality for events	0: No sync 1: Synchronized	Displays the status of the NTP time synchronization at the moment. **NOTE:** This indication is not valid if another time synchronization method is used (external serial).
NTP-processed message count	0...2^{32}–1	Displays the number of messages processed by the NTP protocol.

Additionally, the time zone of the relay can be set by connecting to the relay and the selecting the time zone at *Commands → Set time zone* (AQtivate).

6.1.2. Modbus/TCP and Modbus/RTU

The device supports both Modbus/TCP and Modbus/RTU communication. Modbus/TCP uses the Ethernet connection to communicate with Modbus/TCP clients. Modbus/RTU is a serial protocol that can be selected for the available serial ports.

The following Modbus function types are supported:

- Read multiple holding registers (function code 3)
- Write single holding register (function code 6)
- Write multiple holding registers (function code 16)
- Read/Write multiple registers (function code 23)

The following data can be accessed using both Modbus/TCP and Modbus/RTU:

- Device measurements
- Device I/O
- Commands
- Events
- Time

Once the configuration file has been loaded, the user can access the Modbus map of the relay via the AQtivate software (*Tools → Communication → Modbusmap*). Please note that holding registers start from 1. Some masters might begin numbering holding register from 0 instead of 1; this will cause an offset of 1 between the relay and the master.

Table. 6.1.2. - 25. Modbus/TCP settings.

Parameter	Range	Description
Modbus/TCP Enable	0: Disabled 1: Enabled	Enables and disables the Modbus/TCP on the Ethernet port.
IP port	0…65 535	Defines the IP port used by Modbus/TCP. The standard port (and the default setting) is 502.

Table. 6.1.2. - 26. Modbus/RTU settings.

Parameter	Range	Description
Slave address	1…247	Defines the Modbus/RTU slave address for the unit.

Additionally, the user can adjust the measurement update interval with the following parameters (found at *Measurement → Measurement update*). These parameters do not affect the operating times of protection functions, only the frequency of measurement reporting to Modbus.

Table. 6.1.2. - 27. Settings for measurement update interval.

Name	Range	Step	Default	Description
Current measurement update interval	500…10 000 ms	5 ms	2 000 ms	Defines the measurement update interval of all current-related measurements.
Voltage measurement update interval	500…10 000 ms	5 ms	2 000 ms	Defines the measurement update interval of all voltage-related measurements.
Power measurement update interval	500…10 000 ms	5 ms	2 000 ms	Defines the measurement update interval of all power-related measurements.
Impedance measurement update interval	500…10 000 ms	5 ms	2 000 ms	Defines the measurement update interval of all impedance-related measurements.

6.1.3. Modbus I/O

The Modbus I/O protocol can be selected to communicate on the available serial ports. The Modbus I/O is actually a Modbus/RTU master implementation that is dedicated to communicating with serial Modbus/RTU slaves such as RTD input modules. Up to three (3) Modbus/RTU slaves can be connected to the same bus polled by the Modbus I/O implementation. These are named I/O Module A, I/O Module B and I/O Module C. Each of the modules can be configured using parameters in the following two tables.

Table. 6.1.3. - 28. Module settings.

Name	Range	Description
I/O module X address	0…247	Defines the Modbus unit address for the selected I/O Module (A, B, or C). If this setting is set to "0", the selected module is not in use.
Module x type	0: ADAM-4018+ 1: ADAM-4015	Selects the module type.
Channels in use	Channel 0… Channel 7 (or None)	Selects the number of channels to be used by the module.

Table. 6.1.3. - 29. Channel settings.

Name	Range	Step	Default	Description

T.C. type	0: +/- 20 mA 1: 4…20 mA 2: Type J 3: Type K 4: Type T 5: Type E 6: Type R 7: Type S	-	1: 4… 20 mA	Selects the thermocouple or the mA input connected to the I/O module. Types J, K, T and E are nickel-alloy thermocouples, while Types R and S are platinum/rhodium-alloy thermocouples.
Input value	-101.0…2 000.0	0.1	-	Displays the input value of the selected channel.
Input status	0: Invalid 1: OK	-	-	Displays the input status of the selected channel.

6.1.4. IEC 61850

The user can enable the IEC 61850 protocol in device models that support this protocol. The AQ-200 series devices use Edition 1 of IEC 61850. The following services are supported by IEC 61850 in Arcteq devices:

- Dataset (predefined data sets can be edited with the IEC 61850 tool in AQtivate)
- Report Control Blocks (both buffered and unbuffered reporting)
- Control ('direct operate with normal security' control sequences)
- Disturbance recording file transfer
- GOOSE
- Time synchronization

The device's current IEC 61850 setup can be viewed with the IEC61850 tool (*Tools → IEC 61850*). By browsing the 61850 tree one can see the full list of available logical nodes in the Arcteq implementation.

IEC 61850 main toolbar

Figure. 6.1.4. - 20. Main toolbar.

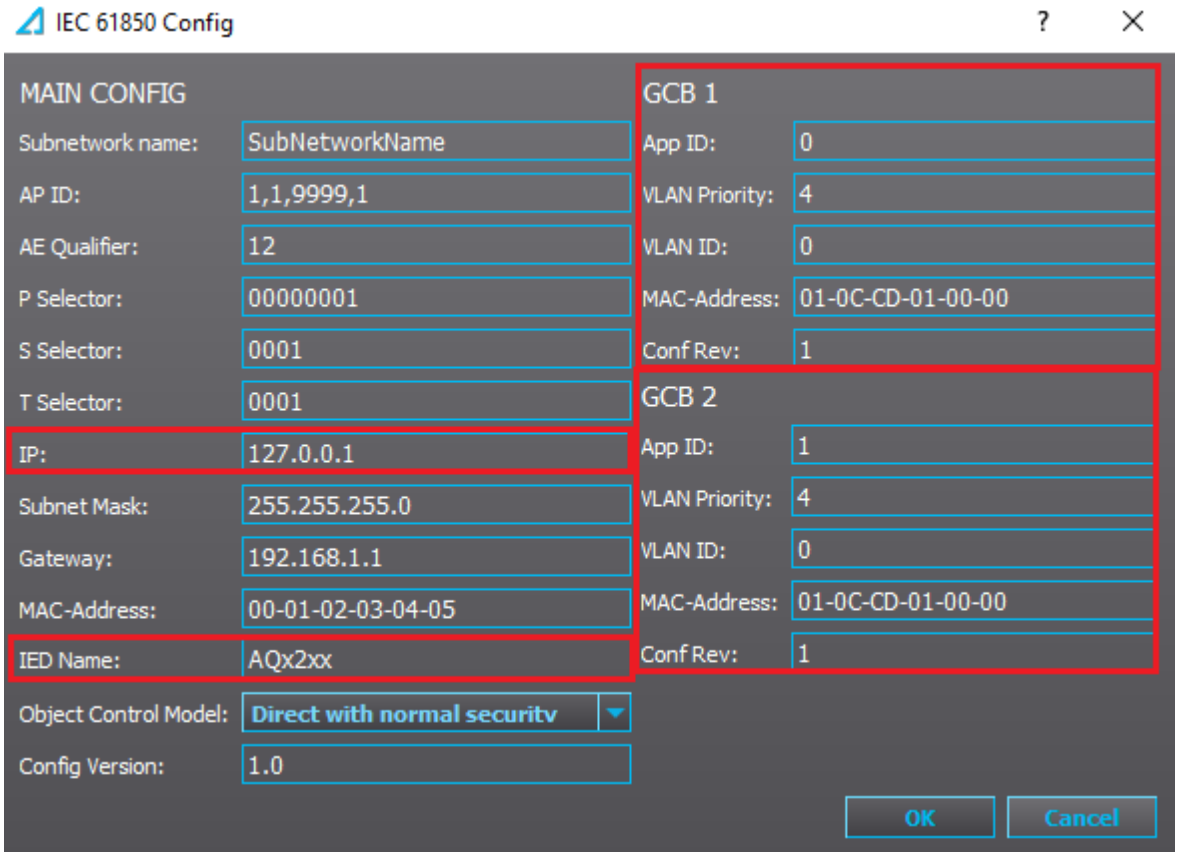
The buttons available in the main toolbar of the IEC 61850 tool are (as per image):

1. Open .CID/.ICD file
   Open an existing .CID or .ICD file from the PC's hard drive.
2. Save .CID/.ICD file
   If CID file was opened from PC's hard drive, saves all changes to that .CID or .ICD file.
3. Save to .aqs
   Saves the .CID or .ICD file into the .aqs currently open (remember to save the .aqs file as well [*File → Save*] to keep the changes!).
4. Save .CID/.ICD as...
   Saves the .CID or .ICD file on the PC's hard drive as a separate .CID or .ICD file.
5. Export dataset info
   Exports the dataset information into a .txt file which can then be viewed in table format with tools such as Excel.
6. Configurations
   Opens the main configurations pop-up window.
7. Edit datasets
   Opens the dataset editing window.
8. Send to relay
   Sends the .CID/.ICD configurations to the relay (requires a connection to the relay).
9. Import GOOSE settings
   Imports predefined GOOSE settings from another .CID/.ICD file.
10. Get default .CID/.ICD file from the relay
    Retrieves the default .CID/.ICD file from the relay.

Configurations

The main configurations dialog window is opened by pressing the sixth button ("Configurations") in the main toolbar. The most Important parameters here are the "IED name" and the "IP" settings. Additionally, if the intention is to use the GOOSE publisher service, the parameters for GCB1 and GCB2 should also be set. See the following image of the main configuration window for the basic settings and the settings for GOOSE publishing.

Figure. 6.1.4. - 21. Configurations window.

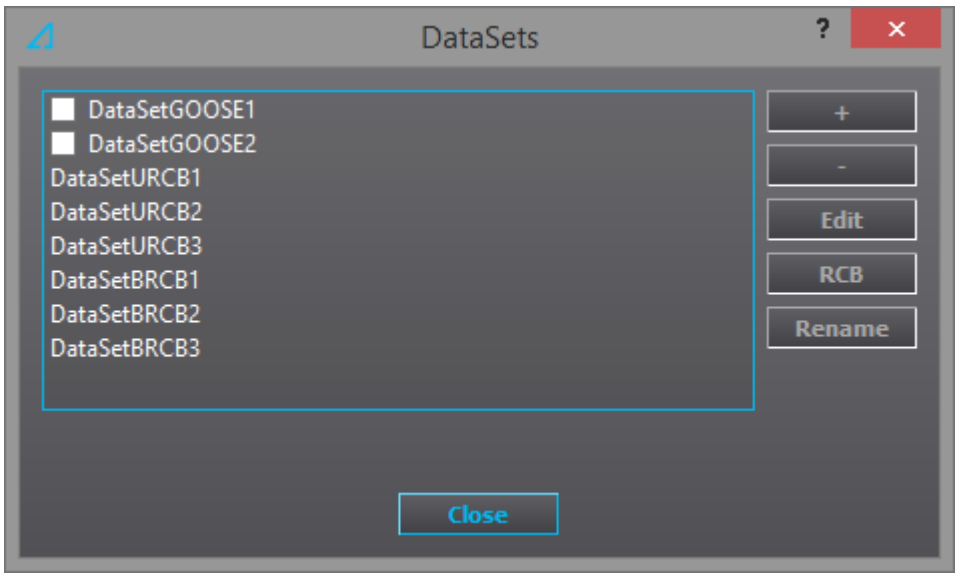


Data sets

The data set editing window is opened by pressing the seventh button on the main toolbar. Data sets can be added and removed by using the "+" and "-" buttons, respectively. When a data set has been added, it must be assigned to a Report Control Block with the "RCB" button. This opens a new pop-up window. The assigning can be either to unbuffered reporting (URCBs) or to buffered reporting (BRCBs).

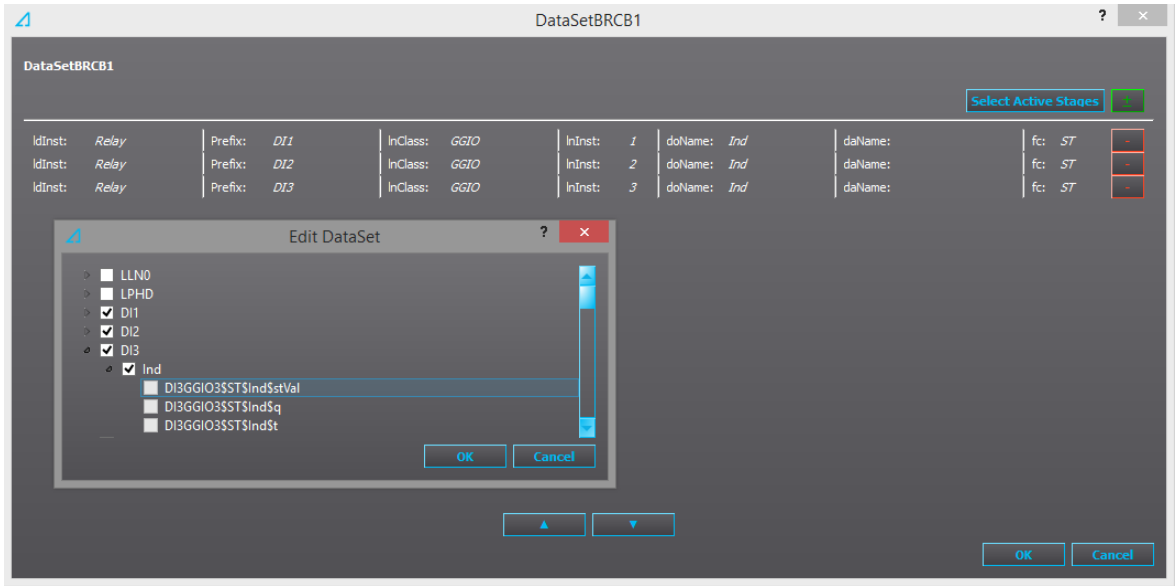
If both of the GOOSE publisher data sets are un-checked, the GOOSE publisher service is disabled (see the image below).

Figure. 6.1.4. - 22. Data set editing window.



All of these data sets can be edited. The data set editing dialog is opened by clicking on the selected data set to be edited and then clicking the "Edit" button. The editing dialog shows all currently configured entries of the data set. An entry can be removed from the data set by clicking the red "-" button located at the end of the entry's row. New entries can be added and old ones edited by clicking the green "+" button at the top right of the window. For URCB and BRCB data sets it is recommended that the data is selected on the doName (data object) level (see the image below). This way all available information (such as status, quality, and time) is always sent in the report. Data can also be selected on daName (data attribute) level, which selects each individual piece of data. This approach may be preferred for GOOSE data sets.

Figure. 6.1.4. - 23. Data selection on the data attribute level.



Settings.

The general setting parameters for the IEC 61850 protocol are visible both in AQtivate and in the local HMI. The settings are described in the table below.

Table. 6.1.4. - 30. General settings.

Name	Range	Step	Default	Description
IEC 61850 enable	0: Disabled 1: Enabled	-	0: Disabled	Enables and disables the IEC 61850 communication protocol.
IP port	0…65 535	1	102	Defines the IP port used by the IEC 61850 protocol. The standard (and default) port is 102.
General deadband	0.1…10.0 %	0.1 %	2 %	Determines the general data reporting deadband settings.
Active energy deadband	0.1… 1000.0 kWh	0.1 kWh	2 kWh	Determines the data reporting deadband settings for this measurement.
Reactive energy deadband	0.1… 1000.0 kVar	0.1 kVar	2 kVar	Determines the data reporting deadband settings for this measurement.
Active power deadband	0.1… 1000.0 kW	0.1 kW	2 kW	Determines the data reporting deadband settings for this measurement.
Reactive power deadband	0.1… 1000.0 kVar	0.1 kVar	2 kVar	Determines the data reporting deadband settings for this measurement.
Apparent power deadband	0.1… 1000.0 kVA	0.1 kVA	2 kVA	Determines the data reporting deadband settings for this measurement.
Power factor deadband	0.01…0.99	0.01	0.05	Determines the data reporting deadband settings for this measurement.
Frequency deadband	0.01…1.00 Hz	0.01 Hz	0.1 Hz	Determines the data reporting deadband settings for this measurement.
Current deadband	0.01… 50.00 A	0.01 A	5 A	Determines the data reporting deadband settings for this measurement.
Residual current deadband	0.01… 50.00 A	0.01 A	0.2 A	Determines the data reporting deadband settings for this measurement.
Voltage deadband	0.01… 5000.00 V	0.01 V	200 V	Determines the data reporting deadband settings for this measurement.
Residual voltage deadband	0.01… 5000.00 V	0.01 V	200 V	Determines the data reporting deadband settings for this measurement.
Angle measurement deadband	0.1…5.0 deg	0.1 deg	1 deg	Determines the data reporting deadband settings for this measurement.
Integration time	0…10 000 ms	1 ms	0 ms	Displays the integration time of the protocol. If this parameter is set to "0 ms", no integration time is in use.
GOOSE reconfigure	0: - 1: Reconfigure	-	0: -	Reconfigures the GOOSE.
GOOSE subscriber enable	0: Disabled 1: Enabled	-	0: Disabled	Enabled and disables the GOOSE subscriber.

For more information on the IEC 61850 communication protocol support, please refer to the conformance statement documents (www.arcteq.fi/downloads/ → AQ-200 series → Resources).

6.1.5. GOOSE

Arcteq relays support both GOOSE publisher and GOOSE subscriber. GOOSE subscriber is enabled with the "GOOSE subscriber enable" parameter at *Communication → Protocols → IEC 61850/GOOSE.* The GOOSE inputs are configured using either the local HMI or the AQtivate software.

There are up to 64 GOOSE inputs available for use. Each of the GOOSE inputs also has a corresponding input quality signal which can also be used in internal logic. The quality is good, when the input quality is low (that is, when the quality is marked as "0"). The value of the input quality can increase as a result of a GOOSE time-out or a configuration error, for example. The status and quality of the various logical input signals can be viewed at the *GOOSE IN status* and *GOOSE IN quality* tabs at *Control → Device I/O → Logical signals*.

GOOSE input settings

The table below presents the different settings available for all 64 GOOSE inputs.

Table. 6.1.5. - 31. GOOSE input settings.

Name	Range	Step	Default	Description
In use	0: No 1: Yes	-	0: No	Enables and disables the GOOSE input in question.
Application ID ("AppID")	0×0… 0×3FFF	0×1	0×0	Defines the application ID that will be matched with the publisher's GOOSE control block.
Configuration revision ("ConfRev")	1…2^{32}-1	1	1	Defines the configuration revision that will be matched with the publisher's GOOSE control block.
Data index ("DataIdx")	0…99	1	-	Defines the data index of the value in the matched published frame. It is the status of the GOOSE input.
NextIdx is quality	0: No 1: Yes	-	0: No	Selects whether or not the next received input is the quality bit of the GOOSE input.
Data type	0: Boolean 1: Integer 2: Unsigned 3: Floating point	-	0: Boolean	Selects the data type of the GOOSE input.

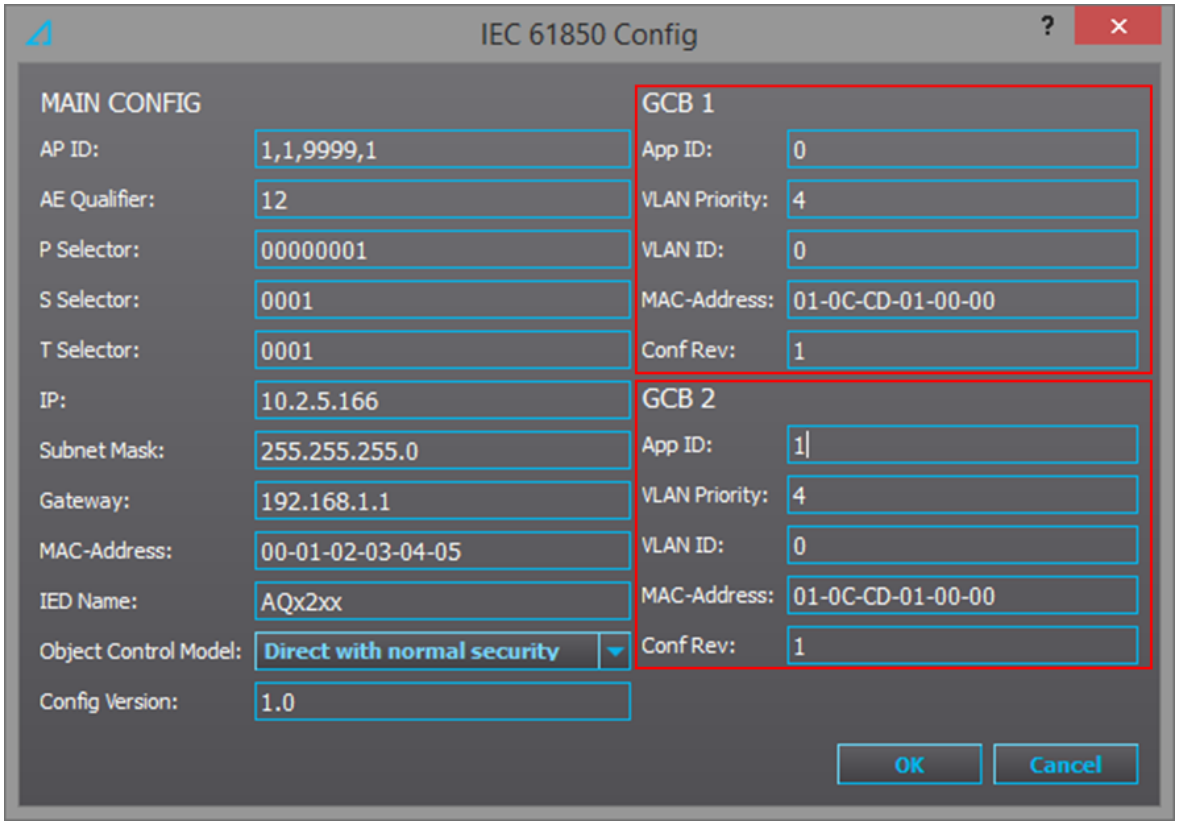
Setting the publisher

The configuration of the GOOSE publisher is done using the IEC 61850 tool in AQtivate (*Tools → Communication → IEC 61850*). In order for the GOOSE publishing service to be used, both of the GCBs and the GOOSE data sets must be set.

The GOOSE control blocks are accessed by clicking the sixth icon on the main toolbar, "Configurations" (see the image below).

The GOOSE control block settings are located on the right side of the Configurations pop-up window (see the image below). Both GCB1 and GCB 2 must be set. The important parameters are "App ID" (should be unique for the system) and "ConfRev" (checked by the subscriber). If VLAN switches have been used to build the sub-networks, both the "VLAN priority" and the "VLAN ID" parameters must be set to match the system specifications.

Figure. 6.1.5. - 24. Settings for both available GOOSE publishing data sets.



The GOOSE data sets define the data that is sent by the publisher. GOOSE publisher can only send binary data and quality information of the binary signals. The binary signal and the quality information for that binary singal are mapped together to the GOOSE input signals on the receiving side. In order for the quality information of each GOOSE input to be used in the relay logic, both the quality information and the GOOSE reception time-out supervision have to be of good quality, or else the quality signal activates.

6.1.6. IEC 103

IEC 103 is shortened form of the international standard IEC 60870-5-103. The AQ-200 series units are able to run as a secondary (slave) station. The IEC 103 protocol can be selected for the serial ports that are available in the device. A primary (master) station can then communicate with the Arcteq device and receive information by polling from the slave device. The transfer of disturbance recordings is not supported.

NOTE: Once the configuration file has been loaded, the IEC 103 map of the relay can be found in the AQtivate software (*Tools → IEC 103 map*).

The following table presents the setting parameters for the IEC 103 protocol.

Name	Range	Step	Default	Description
Slave address	1…254	1	1	Defines the IEC 103 slave address for the unit.
Measurement interval	0…60 000 ms	1 ms	2000 ms	Defines the interval for the measurements update.

6.1.7. DNP3

DNP3 is a protocol standard which is controlled by the DNP Users Group (www.dnp.org). The implementation of a DNP3 slave is compliant with the DNP3 subset (level) 2, but it also contains some functionalities of the higher levels. For detailed information please refer to the DNP3 Device Profile document (www.arcteq.fi/downloads/ → AQ-200 series → Resources).

Settings

The following table describes the DNP3 setting parameters.

Table. 6.1.7. - 32. Settings.

Name	Range	Step	Default	Description
DNP3 TCP enable	0: Disabled 1: Enabled	-	0: Disabled	Enables and disables the DNP3 TCP communication protocol when the Ethernet port is used for DNP3. If a serial port is used, the DNP3 protocol can be enabled from *Communication → DNP3*.
IP port	0…65 535	1	20 000	Defines the IP port used by the protocol.
Slave address	1…65 519	1	1	Defines the DNP3 slave address of the unit.
Master address	1…65 534	1	2	Defines the address for the allowed master.
Link layer time-out	0…60 000 ms	1 ms	0 ms	Defines the length of the time-out for the link layer.
Link layer retries	1…20	1	1	Defines the number of retries for the link layer.
Diagnostic - Error counter	$0…2^{32}-1$	1	-	Counts the total number of errors in received and sent messages.
Diagnostic - Transmitted messages	$0…2^{32}-1$	1	-	Counts the total number of transmitted messages.
Diagnostic - Received messages	$0…2^{32}-1$	1	-	Counts the total number of received messages.

Default variations

Table. 6.1.7. - 33. Default variations.

Name	Range	Default	Description
Group 1 variation (BI)	0: Var 1 1: Var 2	0: Var 1	Selects the variation of the binary signal.
Group 2 variation (BI change)	0: Var 1 1: Var 2	1: Var 2	Selects the variation of the binary signal change.
Group 3 variation (DBI)	0: Var 1 1: Var 2	0: Var 1	Selects the variation of the double point signal.
Group 4 variation (DBI change)	0: Var 1 1: Var 2	1: Var 2	Selects the variation of the double point signal.
Group 20 variation (CNTR)	0: Var 1 1: Var 2 2: Var 5 3: Var 6	0: Var 1	Selects the variation of the control signal.

Group 22 variation (CNTR change)	0: Var 1 1: Var 2 2: Var 5 3: Var 6	2: Var 5	Selects the variation of the control signal change.
Group 30 variation (AI)	0: Var 1 1: Var 2 2: Var 3 3: Var 4 4: Var 5	4: Var 5	Selects the variation of the analog signal.
Group 32 variation (AI change)	0: Var 1 1: Var 2 2: Var 3 3: Var 4 4: Var 5 5: Var 7	4: Var 5	Selects the variation of the analog signal change.

Setting the analog change deadbands

Table. 6.1.7. - 34. Analog change deadband settings.

Name	Range	Step	Default	Description
General deadband	0.1…10.0 %	0.1 %	2 %	Determines the general data reporting deadband settings.
Active energy deadband	0.1…1000.0 kWh	0.1 kWh	2 kWh	Determines the data reporting deadband settings for this measurement.
Reactive energy deadband	0.1…1000.0 kVar	0.1 kVar	2 kVar	Determines the data reporting deadband settings for this measurement.
Active power deadband	0.1…1000.0 kW	0.1 kW	2 kW	Determines the data reporting deadband settings for this measurement.
Reactive power deadband	0.1…1000.0 kVar	0.1 kVar	2 kVar	Determines the data reporting deadband settings for this measurement.
Apparent power deadband	0.1…1000.0 kVA	0.1 kVA	2 kVA	Determines the data reporting deadband settings for this measurement.
Power factor deadband	0.01…0.99	0.01	0.05	Determines the data reporting deadband settings for this measurement.
Frequency deadband	0.01…1.00 Hz	0.01 Hz	0.1 Hz	Determines the data reporting deadband settings for this measurement.
Current deadband	0.01…50.00 A	0.01 A	5 A	Determines the data reporting deadband settings for this measurement.
Residual current deadband	0.01…50.00 A	0.01 A	0.2 A	Determines the data reporting deadband settings for this measurement.
Voltage deadband	0.01… 5000.00 V	0.01 V	200 V	Determines the data reporting deadband settings for this measurement.
Residual voltage deadband	0.01… 5000.00 V	0.01 V	200 V	Determines the data reporting deadband settings for this measurement.
Angle measurement deadband	0.1…5.0 deg	0.1 deg	1 deg	Determines the data reporting deadband settings for this measurement.
Integration time	0…10 000 ms	1 ms	-	Displays the integration time of the protocol.

6.1.8. IEC 101/104

The standards IEC 60870-5-101 and IEC 60870-5-104 are closely related. Both are derived from the IEC 60870-5 standard. On the physical layer the IEC 101 protocol uses serial communication whereas the IEC 104 protocol uses Ethernet communication. The IEC 101/104 implementation works as a slave in the unbalanced mode.

For detailed information please refer to the IEC 101/104 interoperability document (www.arcteq.fi/downloads/ → AQ-200 series → Resources → "AQ-200 IEC101 & IEC104 interoperability").

IEC 101 settings

Table. 6.1.8. - 35. IEC 101 settings.

Name	Range	Step	Default	Description
Common address of ASDU	0…65 534	1	1	Defines the common address of the application service data unit (ASDU) for the IEC 101 communication protocol.
Common address of ASDU size	1…2	1	2	Defines the size of the common address of ASDU.
Link layer address	0…65 534	1	1	Defines the address for the link layer.
Link layer address size	1…2	1	2	Defines the address size of the link layer.
Information object address size	2…3	1	3	Defines the address size of the information object.
Cause of transmission size	1…2	1	2	Defines the cause of transmission size

IEC 104 settings

Table. 6.1.8. - 36. IEC 104 settings.

Name	Range	Step	Default	Description
IEC 104 enable	0: Disabled 1: Enabled	-	0: Disabled	Enables and disables the IEC 104 communication protocol.
IP port	0…65 535	1	2404	Defines the IP port used by the protocol.
Common address of ASDU	0…65 534	1	1	Defines the common address of the application service data unit (ASDU) for the IEC 104 communication protocol.

Measurement scaling coefficients

The measurement scaling coefficients are available for the following measurements, in addition to the general measurement scaling coefficient:

- Active energy
- Reactive energy
- Active power
- Reactive power
- Apparent power
- Power factor
- Frequency
- Current
- Residual current
- Voltage
- Residual voltage
- Angle

The range is the same for all of the scaling coefficients. By default, there is no scaling.

- No scaling
- 1/10
- 1/100
- 1/1000
- 1/10 000
- 1/100 000
- 1/1 000 000
- 10
- 100
- 1000
- 10 000
- 100 000
- 1 000 000

Deadband settings.

Table. 6.1.8. - 37. Analog change deadband settings.

Name	Range	Step	Default	Description
General deadband	0.1…10.0 %	0.1 %	2 %	Determines the general data reporting deadband settings.
Active energy deadband	0.1…1000.0 kWh	0.1 kWh	2 kWh	Determines the data reporting deadband settings for this measurement.
Reactive energy deadband	0.1…1000.0 kVar	0.1 kVar	2 kVar	Determines the data reporting deadband settings for this measurement.
Active power deadband	0.1…1000.0 kW	0.1 kW	2 kW	Determines the data reporting deadband settings for this measurement.
Reactive power deadband	0.1…1000.0 kVar	0.1 kVar	2 kVar	Determines the data reporting deadband settings for this measurement.
Apparent power deadband	0.1…1000.0 kVA	0.1 kVA	2 kVA	Determines the data reporting deadband settings for this measurement.
Power factor deadband	0.01…0.99	0.01	0.05	Determines the data reporting deadband settings for this measurement.
Frequency deadband	0.01…1.00 Hz	0.01 Hz	0.1 Hz	Determines the data reporting deadband settings for this measurement.
Current deadband	0.01…50.00 A	0.01 A	5 A	Determines the data reporting deadband settings for this measurement.
Residual current deadband	0.01…50.00 A	0.01 A	0.2 A	Determines the data reporting deadband settings for this measurement.
Voltage deadband	0.01… 5000.00 V	0.01 V	200 V	Determines the data reporting deadband settings for this measurement.
Residual voltage deadband	0.01… 5000.00 V	0.01 V	200 V	Determines the data reporting deadband settings for this measurement.
Angle measurement deadband	0.1…5.0 deg	0.1 deg	1 deg	Determines the data reporting deadband settings for this measurement.
Integration time	0…10 000 ms	1 ms	-	Displays the integration time of the protocol.

6.1.9. SPA

The device can act as a SPA slave. SPA can be selected as the communication protocol for the COM B port (RS485 port in the CPU module). When the device includes a serial RS-232 card connector, the SPA protocol can also be selected as the communication protocol for the COM E and COM F ports. Please refer to the chapter "Construction and installation" in the device manual to see the connections for these modules.

The data transfer rate of SPA is 9600 bps, but it can also be set to 19 200 bps or 38 400 bps. As a slave the device sends data on demand or by sequenced polling. The available data can be measurements, circuit breaker states, function starts, function trips, etc. The full SPA signal map can be found in AQtivate (*Tools → SPA map*).

The SPA event addresses can be found at *Tools → Events and logs → Event list*.

NOTE!

To access SPA map and event list, an .aqs configuration file should be downloaded from the relay.

6.2. Analog fault registers

At *Communication → General I/O → Analog fault registers* the user can set up to twelve (12) channels to record the measured value when a protection function starts or trips. These values can be read in two ways: locally from this same menu, or through a communication protocol if one is in use.

The following table presents the setting parameters available for the 12 channels.

Table. 6.2. - 38. Fault register settings.

Name	Range	Step	Default	Description
Select record source	0: Not in use 1…12: I>, I>>, I>>>, I>>>> (IL1, IL2, IL3) 13…24: Id>, Id>>, Id>>>, Id>>>> (IL1, IL2, IL3) 25…28: I0>, I0>>, I0>>>, I0>>>> (I0) 29…32: I0d>, I0d>>, I0d>>>, I0d>>>> (I0) 33: FLX	-	0: Not in use	Selects the protection function and its stage to be used as the source for the fault register recording. The user can choose between non-directional overcurrent, directional overcurrent, non-directional earth fault, directional earth fault, and fault locator functions.
Select record trigger	0: TRIP signal 1: START signal 2: START and TRIP signals	-	0: TRIP signal	Selects what triggers the fault register recording: the selected function's TRIP signal, its START signal, or either one.
Recorded fault value	- 1000 000.00…1 000 000.00	0.01	-	Displays the recorded measurement value at the time of the selected fault register trigger.

6.3. Real time measurements to communication

With the *Real-time signals to communication* menu the user can report to SCADA measurements that are not normally available in the communication protocols mapping. Up to eight (8) magnitudes can be selected. The recorded value can be either a per-unit value or a primary value (set by the user).

Measurable values

Function block uses analog current and voltage measurement values. The relay uses these values as the basis when it calculates the primary and secondary values of currents, voltages, powers, impedances and other values.

Table. 6.3. - 39. Available measured values.

Signals	Description
Currents	
IL1 (ff), IL2 (ff), IL3 (ff), I01 (ff), I02 (ff)	Fundamental frequency current measurement values of phase currents and residual currents.
IL1 (TRMS), IL2 (TRMS), IL3 (TRMS), I01 (TRMS), I02 (TRMS)	TRMS current measurement values of phase currents and residual currents.
IL1, IL2, IL3, I01, I02 & 2^{nd} h., 3^{rd} h., 4^{th} h., 5^{th} h., 7^{th} h., 9^{th} h., 11^{th} h., 13^{th} h., 15^{th} h., 17^{th} h., 19^{th} h.	Magnitudes of the phase current components: 2^{nd} harmonic, 3^{rd} harmonic, 4^{th} harmonic, 5^{th} harmonic 7^{th}, harmonic 9^{th}, harmonic 11^{th}, harmonic 13^{th}, harmonic 15^{th}, harmonic 17^{th}, harmonic 19^{th} harmonic current.
I1, I2, I0Z	Positive sequence current, negative sequence current and zero sequence current.
I0CalcMag	Residual current calculated from phase currents.
IL1Ang, IL2Ang, IL3Ang, I01Ang, I02Ang, I0CalcAng I1Ang, I2Ang	Angles of each measured current.
Voltages	
UL1Mag, UL2Mag, UL3Mag, UL12Mag, UL23Mag, UL31Mag, U0Mag, U0CalcMag	Magnitudes of phase voltages, phase-to-phase voltages and residual voltages.
U1 Pos.seq V mag, U2 Neg.seq V mag	Positive and negative sequence voltages.
UL1Ang, UL2Ang, UL3Ang, UL12Ang, UL23Ang, UL31Ang, U0Ang, U0CalcAng	Angles of phase voltages, phase-to-phase voltages and residual voltages.
U1 Pos.seq V Ang, U2 Neg.seq V Ang	Positive and negative sequence angles.
Powers	
S3PH P3PH Q3PH	Three-phase apparent, active and reactive power.
SL1, SL2, SL3, PL1, PL2, PL3, QL1, QL2, QL3	Phase apparent, active and reactive powers.
tanfi3PH tanfiL1 tanfiL2 tanfiL3	Tan (φ) of three-phase powers and phase powers.
cosfi3PH cosfiL1 cosfiL2 cosfiL3	Cos (φ) of three-phase powers and phase powers.
Impedances and admittances	
RL12, RL23, RL31 XL12, XL23, XL31 RL1, RL2, RL3 XL1, XL2, XL3 Z12, Z23, Z31 ZL1, ZL2, ZL3	Phase-to-phase and phase-to-neutral resistances, reactances and impedances.
Z12Ang, Z23Ang, Z31Ang, ZL1Ang, ZL2Ang, ZL3Ang	Phase-to-phase and phase-to-neutral impedance angles.

Rseq, Xseq, Zseq RseqAng, XseqAng, ZseqAng	Positive sequence resistance, reactance and impedance values and angles.
GL1, GL2, GL3, G0 BL1, BL2, BL3, B0 YL1, YL2, YL3, Y0	Conductances, susceptances and admittances.
YL1angle, YL2angle, YL3angle, Y0angle	Admittance angles.
Others	
System f.	Used tracking frequency at the moment.
Ref f1	Reference frequency 1.
Ref f2	Reference frequency 2.
M thermal T	Motor thermal temperature.
F thermal T	Feeder thermal temperature.
T thermal T	Transformer thermal temperature.
RTD meas 1…16	RTD measurement channels 1…16.
Ext RTD meas 1…8	External RTD measurement channels 1…8 (ADAM module).

Settings

Table. 6.3. - 40. Settings.

Name	Range	Step	Default	Description
Measurement value recorder mode	0: Disabled 1: Activated	-	0: Disabled	Activates and disables the real-time signals to communication.
Scale current values to primary	0: No 1: Yes	-	0: No	Selects whether or not values are scaled to primary.
Slot X magnitude selection	0: Currents 1: Voltages 2: Powers 3: Impedance (ZRX) and admittance (YGB) 4: Others	-	0: Currents	Selects the measured magnitude catecory of the chosen slot.
Slot X magnitude	Described in table above ("Available measured values")	-	-	Selects the magnituge in the previously selected category.
Magnitude X	-10 000 000.000…10 000 000.000	0.001	-	Displays the measured value of the selected magnitude of the selected slot. The unit depends on the selected magnitude (either amperes, volts, or per-unit values).

7. Connections and application examples

7.1. Connections AQ-S254

Figure. 7.1. - 25. AQ-S254 variant without add-on modules.

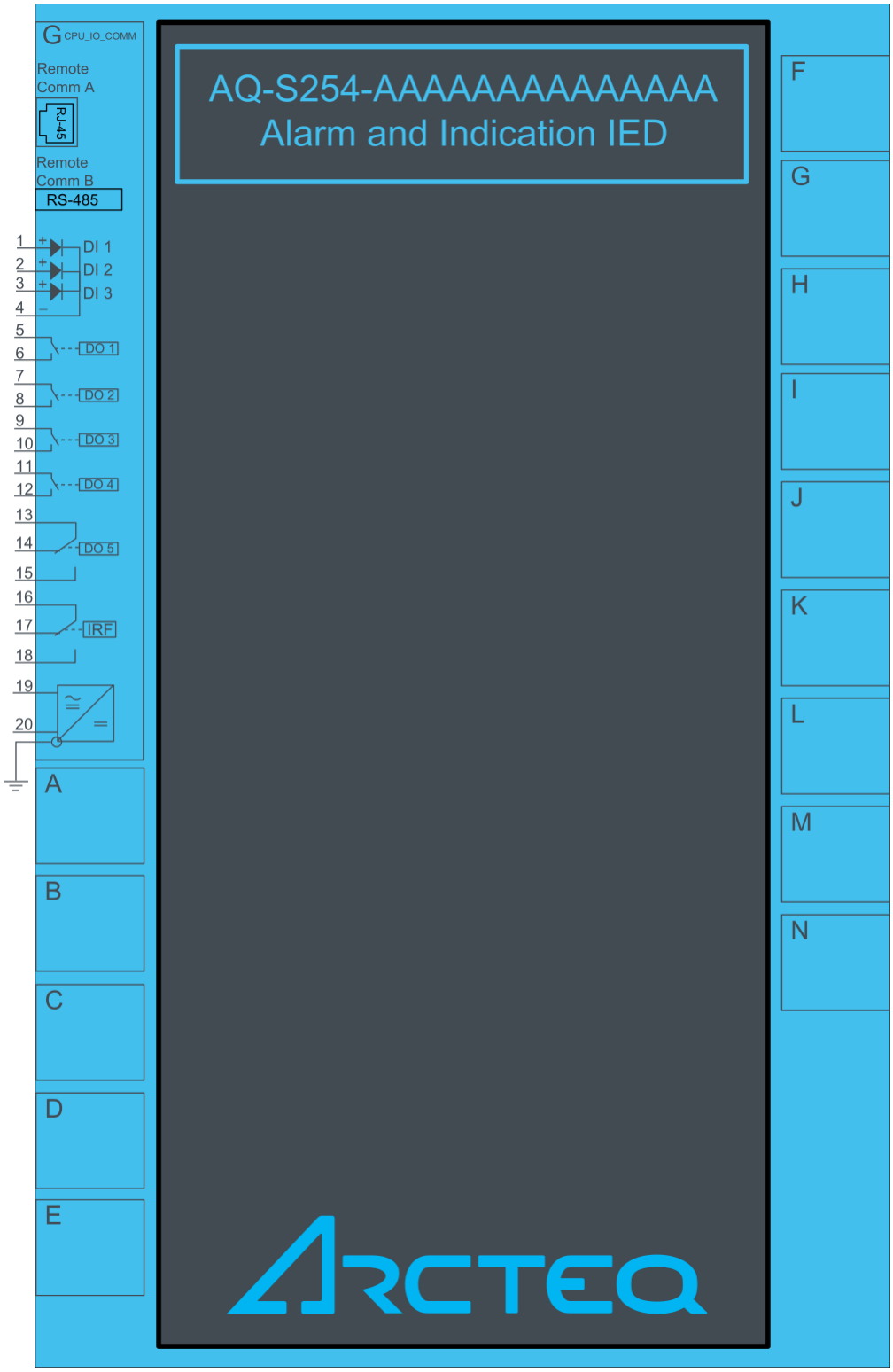


Figure. 7.1. - 26. AQ-S254 variant with digital input and output modules.

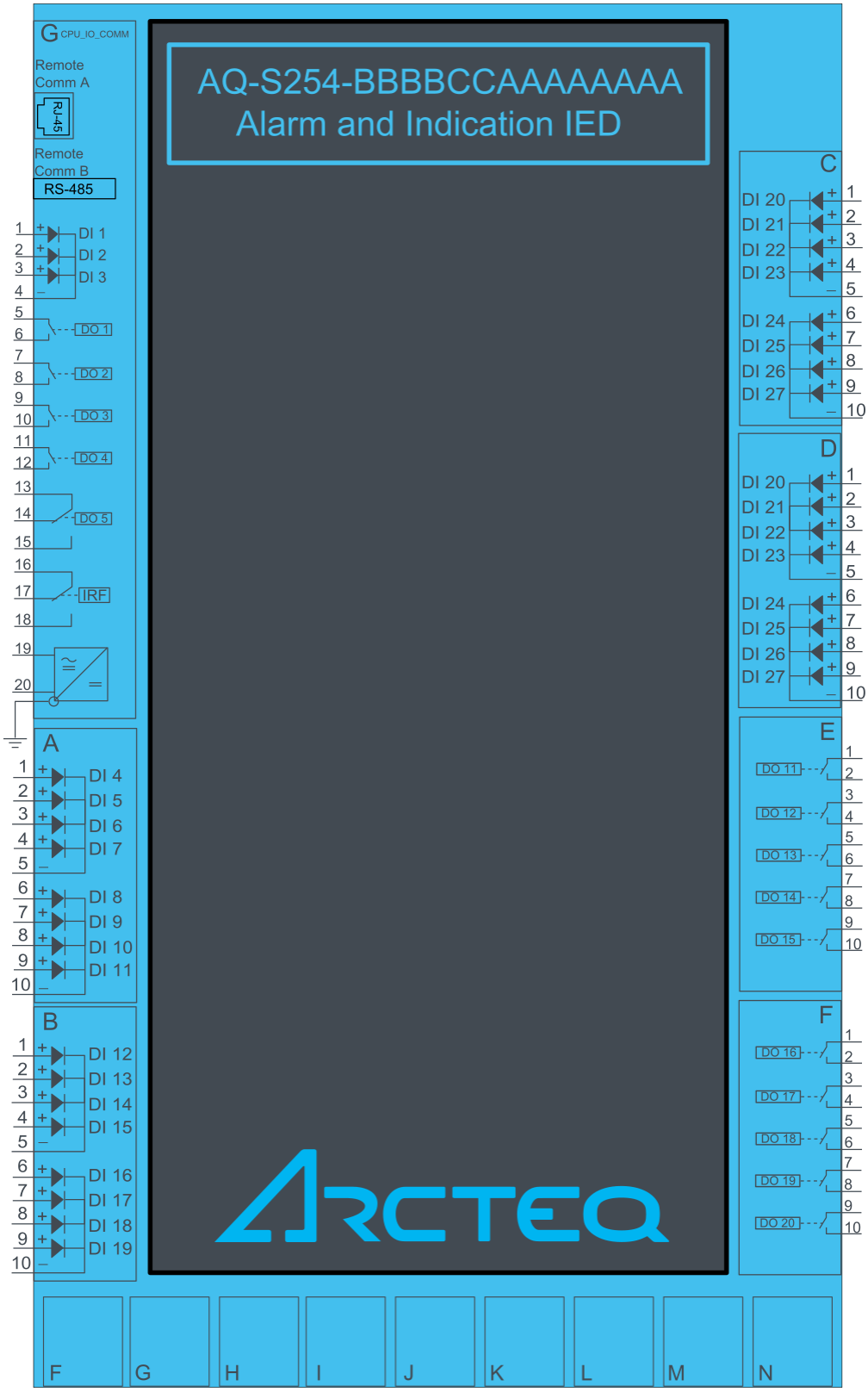
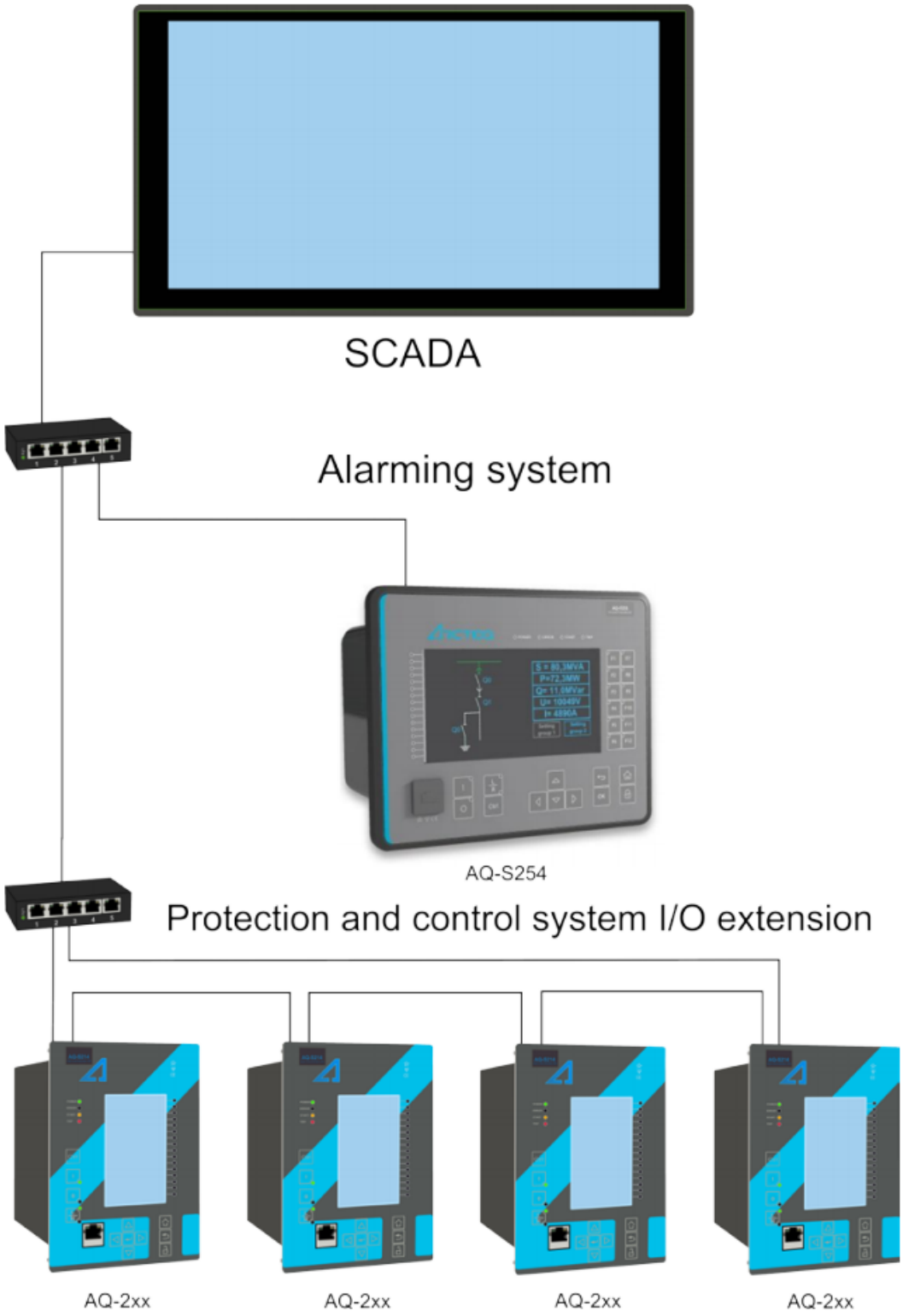


Figure. 7.1. - 27. AQ-S254 application example.



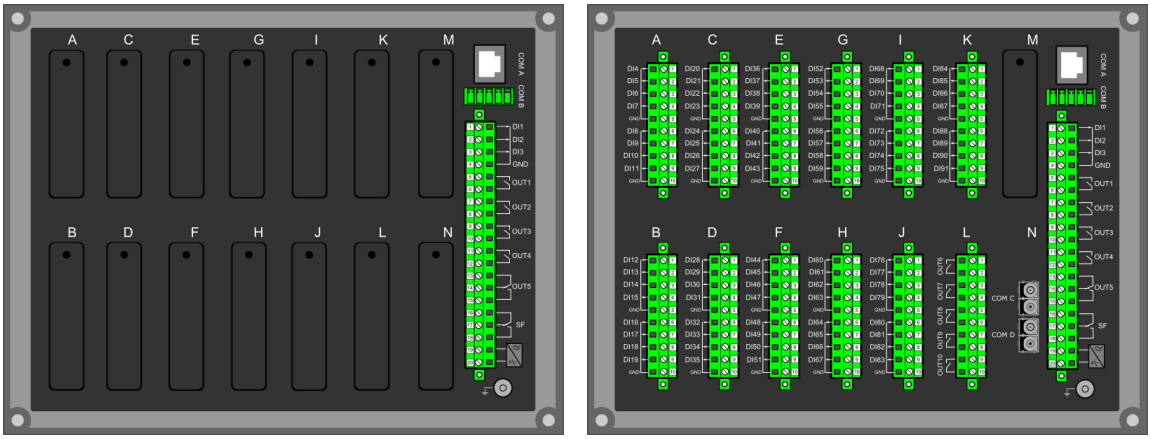
8. Construction and installation

8.1. Construction

AQ-X254 is a member of the modular and scalable AQ-200 series, and it includes 14 configurable and modular add-on card slots. As a standard configuration the device includes the CPU module (which consists of the CPU, a number of inputs and outputs, and the power supply).

The images below present the modules of both the non-optioned model (AQ-X254-XXXXXXX-**AAAAAAAAAAAAA**, on the left) and the almost fully optioned model (AQ-X254-XXXXXXX-**BBBBBBBBBBCAJ**, on the right).

Figure. 8.1. - 28. Modular construction of AQ-X254.



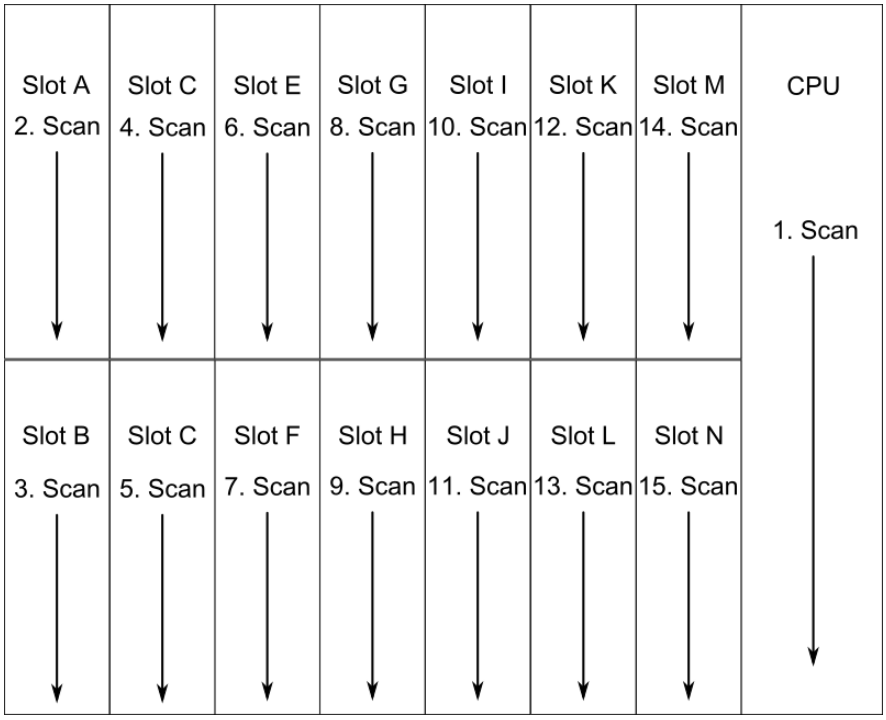
The modular structure of AQ-X254 allows for scalable solutions for different application requirements. In non-standard configurations Slots A to N accept all available add-on modules, such as digital I/O modules, integrated arc protection or another special module.The only difference between the slots affecting device scalability is that Slot N also supports communication options.

When an add-on module is inserted into the device, the start-up scan searches for modules according to their type designation code. If the module location or content is not what the device expects, the IED does not take additional modules into account and instead issues a configuration error message. In field upgrades, therefore, the add-on module must be ordered from Arcteq Relays Ltd. or its representative who can then provide the module with its corresponding unlocking code to allow the device to operate correctly once the hardware configuration has been upgraded. This also means that the module's location in the device cannot be changed without updating the device configuration data which, again, requires the unlocking code.

When an I/O module is inserted into the device, the module location affects the naming of the I/O. The I/O scanning order in the start-up sequence is as follows: the CPU module I/O, Slot A, Slot B, Slot C, and so on. This means that the digital input channels DI1, DI2 and DI3 as well as the digital output channels OUT1, OUT2, OUT3, OUT4 and OUT5 are always located in the CPU module. If additional I/O cards are installed, their location and card type affect the I/O naming.

The figure below presents the start-up hardware scan order of the device as well as the I/O naming principles.

Figure. 8.1. - 29. Hardware scanning and IO naming principle in AQ-X254 IED



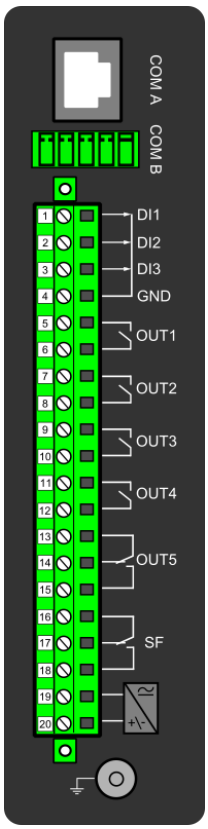
1. Scan
   The start-up system; detects and self-tests the CPU module, voltages, communication and the I/O; finds and assigns "DI1", "DI2", "DI3", "OUT1", "OUT2", "OUT3", "OUT4" and "OUT5".
2. Scan
   Scans Slot A, and moves to the next slot if Slot A is empty. If the scan finds an 8DI module (that is, a module with eight digital inputs), it reserves the designations "DI4", "DI5", "DI6", "DI7", "DI8", "DI9", "DI10" and "DI11" to this slot. If the scan finds a DO5 module (that is, a module with five digital outputs), it reserves the designations "OUT6", "OUT7", "OUT8", "OUT9" and "OUT10" to this slot. The I/O is then added if the type designation code (e.g. AQ-P215-PH0AAAA-BBC) matches with the existing modules in the device. If the code and the modules do not match, the device issues and alarm. An alarm is also issued if the device expects to find a module here but does not find one.
3. Scan
   Scans Slot B, and moves to the next slot if Slot B is empty. If the scan finds an 8DI module, it reserves the designations "DI4", "DI5", "DI6", "DI7", "DI8", "DI9", "DI10" and "DI11" to this slot. If Slot A also has an 8DI module (and therefore has already reserved these designations), the device reserves the designations "DI12", "DI13", "DI14", "DI15", "DI16", "DI17", "DI18" and "DI19" to this slot. If the scan finds a 5DO module, it reserves the designations "OUT6", "OUT7", "OUT8", "OUT9" and "OUT10" to this slot. Again, if Slot A also has a 5DO and has therefore already reserved these designations, the device reserves the designations "OUT11", "OUT12", "OUT13", "OUT14" and "OUT15" to this slot.
4. –15. Scan
   A similar operation to Scan 3 (checks which designations have been reserved by modules in previous slots and numbers the new ones accordingly).

Thus far this document has only explained the installation of I/O add-on cards to the option module slots. This is because all other module types are treated in a same way. For example, when an additional communication port is installed into the upper port of the communication module, its designation is Communication port 3 or higher, as Communication ports 1 and 2 already exist in the CPU module (which is scanned, and thus designated, first). After a communication port is detected, it is added into the device's communication space and its corresponding settings are enabled.

The almost fully optioned example case of AQ-X254-XXXXXXX-**BBBBBBBBBBBCAJ** (the first image pair, on the right) has a total of 91 digital input channels available: three (DI1…DI3) in the CPU module, and the rest in Slots A…K in groups of eight. It also has a total of 10 digital output channels available: five (DO1…DO5) in the CPU module, and five (DO6…DO10) in Slot L. These same principles apply to all non-standard configurations in the AQ-X254 IED family.

8.2. CPU module

Figure. 8.2. - 30. CPU module.



Connector	Description
COM A	Communication port A, or the RJ-45 port. Used for the AQtivate setting tool connection and for IEC 61850, Modbus/TCP, IEC 104, DNP3 and station bus communications.
COM B	Communication port B, or the RS-485 port. Used for the SCADA communications for the following protocols: Modbus/RTU, Modbus I/O, SPA, DNP3, IEC 101 and IEC 103. The pins have the following designations: Pin 1 = DATA +, Pin 2 = DATA –, Pin 3 = GND, Pins 4 & 5 = Terminator resistor enabled by shorting.
X1-1	Digital input 1, nominal threshold voltage 24 V, 110 V or 220 V.
X1-2	Digital input 2, nominal threshold voltage 24 V, 110 V or 220 V.
X1-3	Digital input 3, nominal threshold voltage 24 V, 110 V or 220 V.
X1-4	Common GND for digital inputs 1, 2 and 3.
X1-5:6	Output relay 1, with a normally open (NO) contact.
X1-7:8	Output relay 2, with a normally open (NO) contact.
X1-9:10	Output relay 3, with a normally open (NO) contact.
X1-11:12	Output relay 4, with a normally open (NO) contact.
X1-13:14:15	Output relay 5, with a changeover contact.
X1-16:17:18	System fault's output relay, with a changeover contact. Pins 16 and 17 are closed when the unit has a system fault or is powered OFF. Pins 16 and 18 are closed when the unit is powered ON and there is no system fault.

X1-19:20	Power supply IN. Either 85…265 VAC/DC (model A; order code "H") or 18…75 DC (model B; order code "L"). **Positive side** (+) **to Pin 20.**
GND	The relay's earthing connector.

By default, the CPU module (combining the CPU, the I/O and the power supply) includes two standard communication ports and the relay's basic digital I/O.

The current consumption of the digital inputs is 2 mA when activated, while the range of the operating voltage is 24 V/110 V/220 V depending on the ordered hardware. All digital inputs are scannced in 5 ms program cycles, and their pick-up and release delays as well as their NO/NC selection can be set with software. The digital output controls are also set by the user with software. By default, the digital outputs are controlled in 5 ms program cycles. All output contacts are mechanical. The rated voltage of the NO/NC outputs is 250 VAC/DC.

The auxiliary voltage is defined in the ordering code: the available power supply models available are A (85…265 VAC/DC) and B (18…75 DC). The power suppy's minimum allowed bridging time for all voltage levels is above 150 ms. The power supply's maximum power consumption is 15 W. The power supply allows a DC ripple of below 15 % and the start-up time of the power supply is below 5 ms. For further details, please refer to the "Auxiliary voltage" chapter in the "Technical data" section of this document.

Digital input settings

The settings described in the table below can be found at *Control → Device I/O → Digital input settings* in the relay settings.

Table. 8.2. - 41. Digital input settings.

Name	Range	Step	Default	Description
DIx Polarity	0: NO (Normally open) 1: NC (Normally closed)	-	0: NO	Selects whether the status of the digital input is 1 or 0 when the input is energized.
DIx Activation delay	0.000… 1800.000 s	0.001 s	0.000 s	Defines the delay for the status change from 0 to 1.
DIx AC drop-off time	0.000… 1800.000 s	0.001 s	0.000 s	Defines the delay for the status change from 1 to 0.
DIx AC mode	0: Disabled 1: Enabled	-	0: Disabled	Selects whether or not a 30-ms deactivation delay is added to account for alternating current.

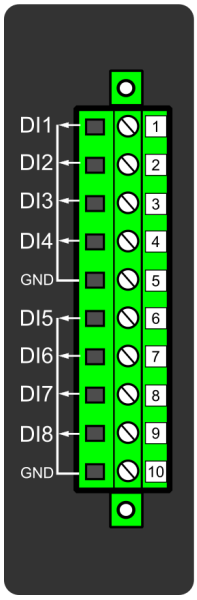
Scanning cycle

All digital inputs are scanned in a 5 ms cycle, meaning that the state of an input is updated every 0…5 milliseconds. When an input is used internally in the device (either in group change or logic), it takes additional 0…5 milliseconds to operate. Theoretically, therefore, it takes 0…10 milliseconds to change the group when a digital input is used for group control or a similar function. In practice, however, the delay is between 2…8 milliseconds about 95 % of the time. When a digital input is connected directly to a digital output (T1…Tx), it takes an additional 5 ms round. Therefore, when a digital input controls a digital output internally, it takes 0…15 milliseconds in theory and 2…13 milliseconds in practice.

Please note that the mechanical delay of the relay is **not** included in these approximations.

8.3. Digital input module (optional)

Figure. 8.3. - 31. Digital input module (DI8) with eight add-on digital inputs.



Connector	Description (x = the number of digital inputs in other modules that preceed this one in the configuration)
X 1	DIx + 1
X 2	DIx + 2
X 3	DIx + 3
X 4	DIx + 4
X 5	Common earthing for the first four digital inputs.
X 6	DIx + 5
X 7	DIx + 6
X 8	DIx + 7
X 9	DIx + 8
X 10	Common earthing for the other four digital inputs.

The DI8 module is an add-on module with eight (8) galvanically isolated digital inputs. This module can be ordered directly to be installed into the device in the factory, or it can be upgraded in the field after the device's original installation when required. The properties of the inputs in this module are the same as those of the inputs in the main processor module. The current consumption of the digital inputs is 2 mA when activated, while the range of the operating voltage is from 0…265 VAC/DC. The activation and release thresholds are set in the software and the resolution is 1 V. All digital inputs are scannced in 5 ms program cycles, and their pick-up and release delays as well as their NO/NC selection can be set with software.

For the naming convention of the digital inputs provided by this module please refer to the chapter titled "Construction and installation".

For technical details please refer to the chapter titled "Digital input module" in the "Technical data" section of this document.

Setting up the activation and release delays

The settings described in the table below can be found at *Control → Device I/O → Digital input settings* in the relay settings.

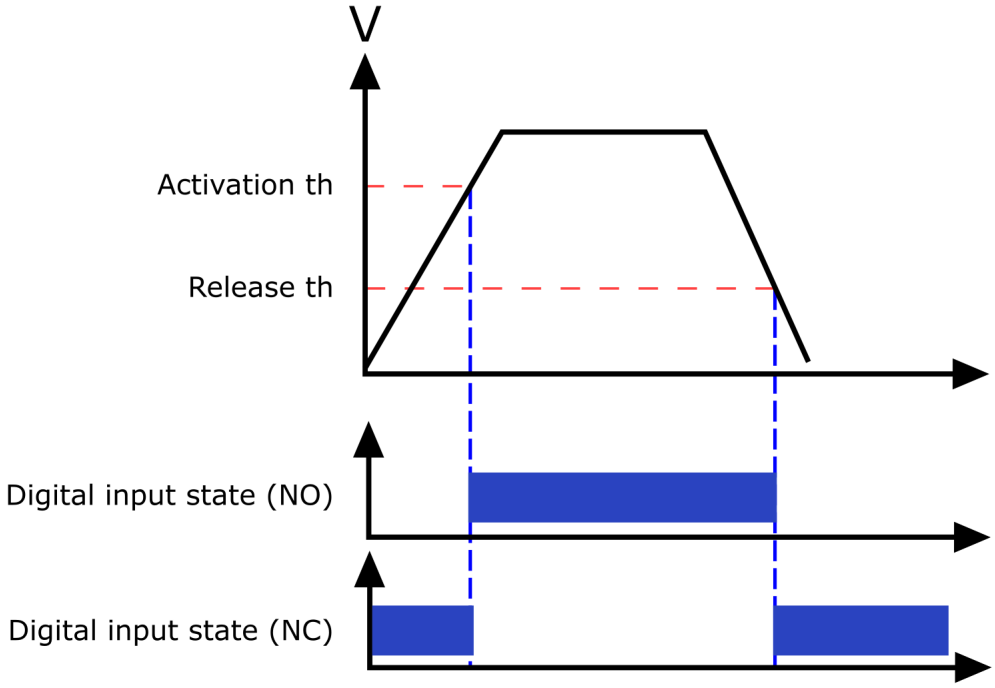
Table. 8.3. - 42. Digital input settings of DI8 module.

Name	Range	Step	Default	Description
DIx Polarity	0: NO (Normally open) 1: NC (Normally closed)	-	0: NO	Selects whether the status of the digital input is 1 or 0 when the input is energized.
DIx Activation threshold	16.0… 200.0 V	0.1 V	88 V	Defines the activation threshold for the digital input. When "NO" is the selected polarity, the measured voltage exceeding this setting activates the input. When "NC" is the selected polarity, the measured voltage exceeding this setting deactivates the input.
DIx Release threshold	10.0… 200.0 V	0.1 V	60V	Defines the release threshold for the digital input. When "NO" is the selected polarity, the measured voltage below this setting deactivates the input. When "NC" is the selected polarity, the measured voltage below this setting activates the input.
DIx Activation delay	0.000… 1800.000 s	0.001 s	0.000 s	Defines the delay when the status changes from 0 to 1.
DIx AC drop-off time	0.000… 1800.000 s	0.001 s	0.000 s	Defines the delay when the status changes from 1 to 0.
DIx AC Mode	0: Disabled 1: Enabled	-	0: Disabled	Selects whether or not a 30-ms deactivation delay is added to take the alternating current into account. The "DIx Release threshold" parameter is hidden and forced to 10 % of the set "DIx Activation threshold" parameter.
DIx Counter	0…2^{32}–1	1	0	Displays the number of times the digital input has changed its status from 0 to 1.
DIx Counter clear	0: - 1: Clear	-	0: -	Selects to clear the DIx counter.

The user can set the activation threshold individually for each digital input. When the activation and release thresholds have been set properly, they will result in the digital input states to be activated and released reliably. The selection of the normal state between normally open (NO) and normally closed (NC) defines whether or not the digital input is considered activated when the digital input channel is energized.

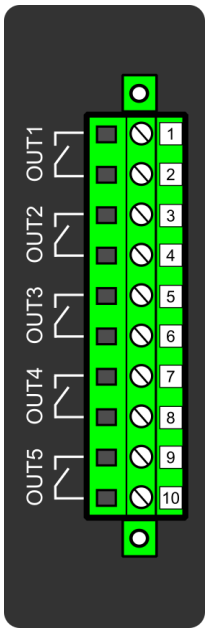
The diagram below depicts the digital input states when the input channels are energized and de-energized.

Figure. 8.3. - 32. Digital input state when energizing and de-energizing the digital input channels.



8.4. Digital output module (optional)

Figure. 8.4. - 33. Digital output module (DO5) with five add-on digital outputs.



Connector	Description
X 1–2	OUTx + 1 (1st and 2nd pole NO)
X 3–4	OUTx + 2 (1st and 2nd pole NO)
X 5–6	OUTx + 3 (1st and 2nd pole NO)
X 7–8	OUTx + 4 (1st and 2nd pole NO)
X 9–10	OUTx + 5 (1st and 2nd pole NO)

The DO5 module is an add-on module with five (5) digital outputs. This module can be ordered directly to be installed into the device in the factory, or it can be upgraded in the field after the device's original installation when required. The properties of the outputs in this module are the same as those of the outputs in the main processor module. The user can set the digital output controls with software. All digital outputs are scanned in 5 ms program cycles, and their contacts are mechanical in type. The rated voltage of the NO/NC outputs is 250 VAC/DC.

For the naming convention of the digital inputs provided by this module please refer to the chapter titled "Construction and installation".

For technical details please refer to the chapter titled "Digital output module" in the "Technical data" section of this document.

8.5. RTD & mA input module (optional)

Figure. 8.5. - 34. RTD & mA module connectors.

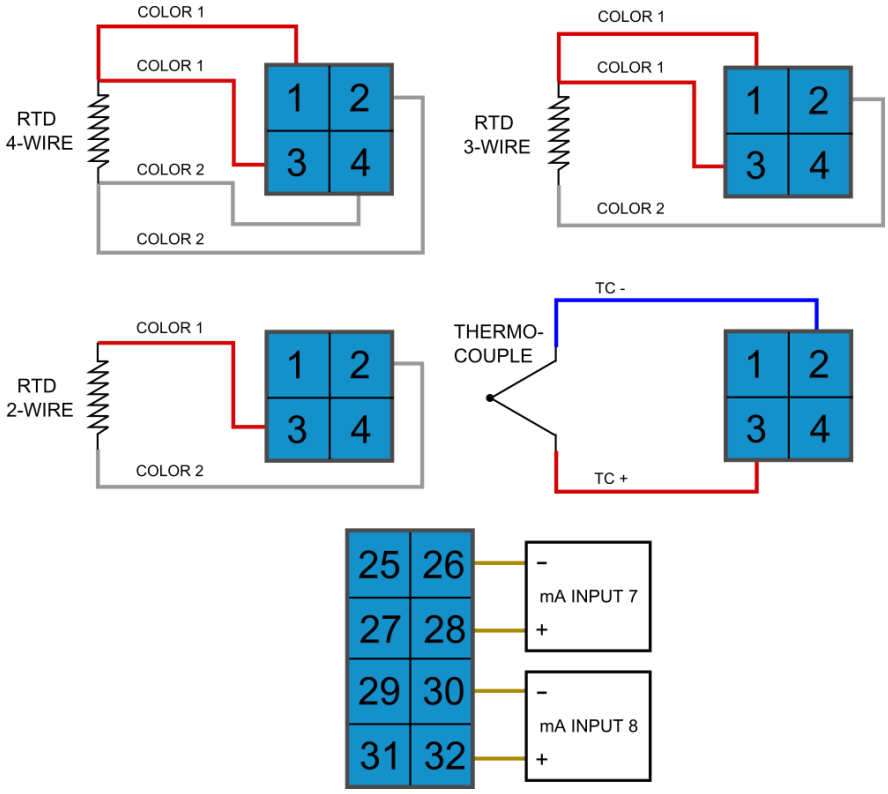
Channel	Connector			Connector
1	RTD1-1	1	2	RTD1-2/TC1-
	RTD1-3/TC1+	3	4	RTD1-4
2	RTD2-1	5	6	RTD2-2/TC2-
	RTD2-3/TC2+	7	8	RTD2-4
3	RTD3-1	9	10	RTD3-2/TC3-
	RTD3-3/TC3+	11	12	RTD3-4
4	RTD4-1	13	14	RTD4-2/TC4-
	RTD4-3/TC4+	15	16	RTD4-4
5	RTD5-1	17	18	RTD5-2/TC5-
	RTD5-3/TC5+	19	20	RTD5-4
6	RTD6-1	21	22	RTD6-2/TC6-
	RTD6-3/TC6+	23	24	RTD6-4
7	RTD7-1	25	26	RTD7-2/TC7-/mAin7-
	RTD7-3/TC7+	27	28	RTD7-4 / mAin7+
8	RTD8-1	29	30	RTD8-2/TC8/mAin8-
	RTD8-3/TC8+	31	32	RTD8-4/mAin8+

The RTD & mA module is an add-on module with eight (8) RTD input channels. Each input supports 2-wire, 3-wire and 4-wire RTD sensors as well as thermocouple (TC) sensors. The sensor type can be selected with software for two groups, four channels each. The supported sensor types are as follows:

- Supported RTD sensors: Pt100, Pt1000
- Supported thermocouple sensors: type K (NiCh/NiAl), type J (Fe/constantan), type T (Cu/constantan) and type S (Cu/CuNi compensating).

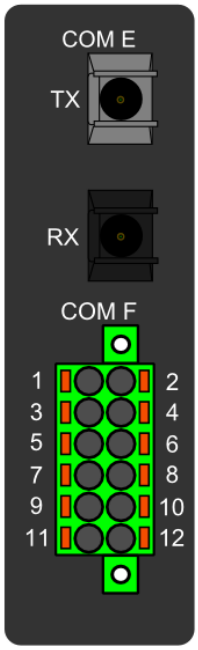
There are also two mA input channels available in the module. Please note that if the mA input channels are in use, only the first four channels are available for RTD and TC measurements.

Figure. 8.5. - 35. Different sensor types and their connections.



8.6. Serial RS-232 communication module (optional)

Figure. 8.6. - 36. Serial RS-232 module connectors.



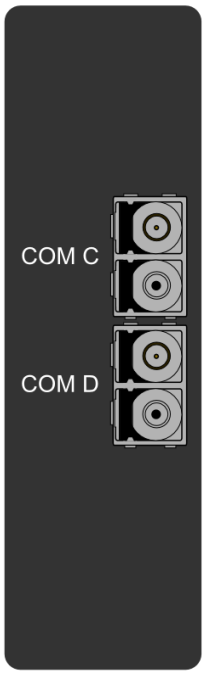
Connector	Name	Description

COM E	Serial fiber (GG/PP/GP/PG)	• Serial-based communications • Wavelength 660 nm • Compatible with 50/125 µm, 62.5/125 µm, 100/140 µm, and 200 µm Plastic-Clad Silica (PCS) fiber • Compatible with ST connectors
COM F – Pin 1	+24 V input	Optional external auxiliary voltage for serial fiber
COM F – Pin 2	GND	Optional external auxiliary voltage for serial fiber
COM F – Pin 3	-	-
COM F – Pin 4	-	-
COM F – Pin 5	RS-232 RTS	Serial based communications
COM F – Pin 6	RS-232 GND	Serial based communications
COM F – Pin 7	RS-232 TX	Serial based communications
COM F – Pin 8	RS-232 RX	Serial based communications
COM F – Pin 9	-	-
COM F – Pin 10	+3.3 V output (spare)	Spare power source for external equipment (45 mA)
COM F – Pin 11	-	-
COM F – Pin 12	-	-

The option card includes two serial communication interfaces: COM E is a serial fiber interface with glass/plastic option, COM F is an RS-232 interface.

8.7. LC 100 Mbps Ethernet communication module (optional)

Figure. 8.7. - 37. LC 100 Mbps Ethernet module connectors.

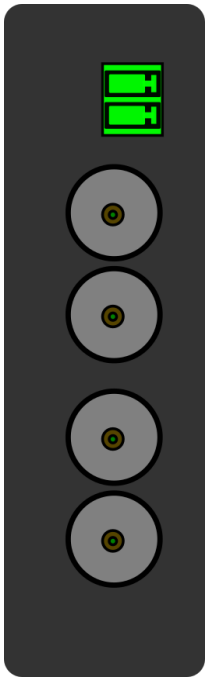


Connector	Description
COM C:	• Communication port C, LC fiber connector. • 62.5/125 µm or 50/125 µm multimode (glass). • Wavelength 1300 nm.
COM D:	• Communication port D, LC fiber connector. • 62.5/125 µm or 50/125 µm multimode (glass). • Wavelength 1300 nm.

The optional LC 100 Mbps Ethernet card supports both HSR and PRP protocols. The card has two PRP/HSR ports, which are 100 Mbps fiber ports.

8.8. Double ST 100 Mbps Ethernet communication module (optional)

Figure. 8.8. - 38. Double ST 100 Mbps Ethernet communication module connectors. Two pin connector is IRIG-B input.



Connector	Description
ST connectors:	• Duplex ST connectors • 62.5/125µm or 50/125µm multimode fiber • Transmitter wavelength 1260-1360 nm (nominal 1310 nm) • Receiver wavelength 1100-1600 nm • 100BASE-FX • Up to 2 km

This option cards supports redundant ring configuration and multidrop configurations. Redundant communication can be implemented by RSTP (Rapid Spanning Tree Protocol) supporting Ethernet switches. Each ring can only contain AQ-200 series devices. Any third party devices must be connected to separate ring.

For other redundancy options, see the 100LC option card.

Figure. 8.8. - 39. Ring connection example. Please note that third party devices should be connected in a separate ring.

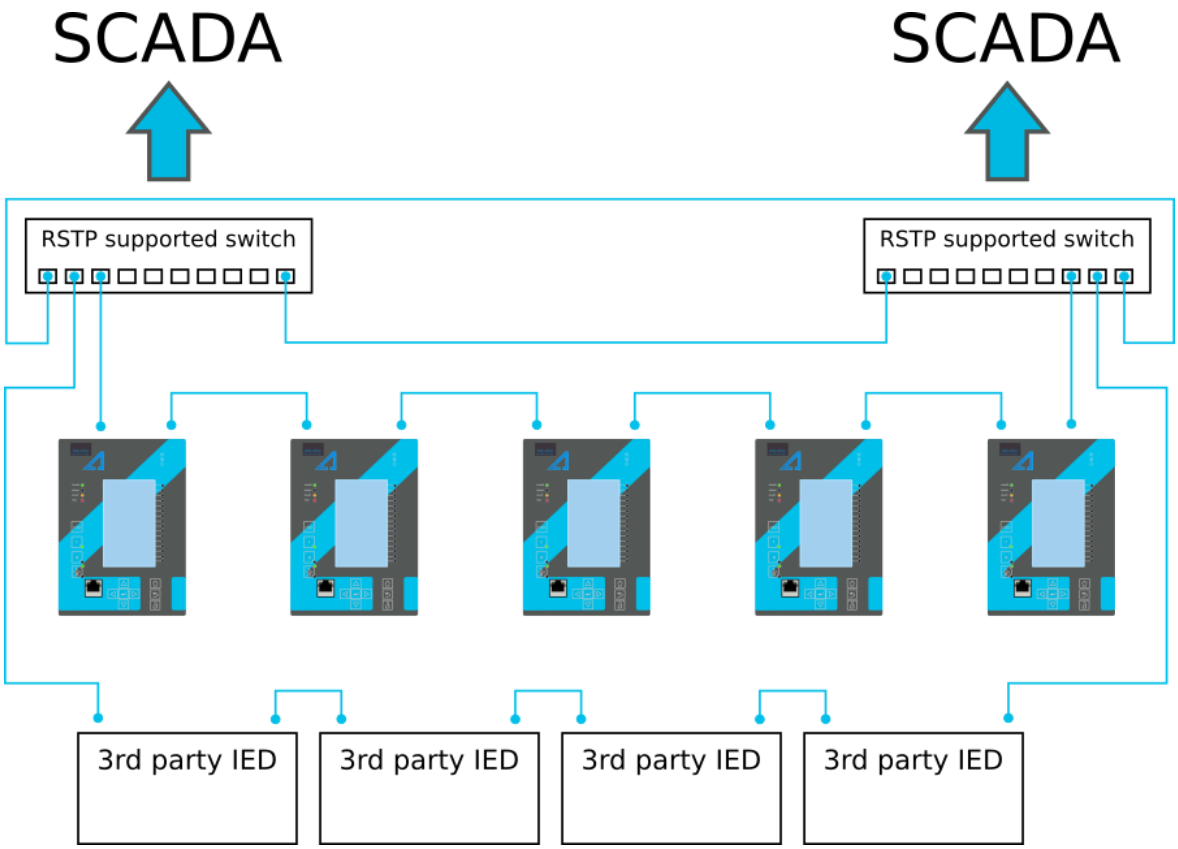
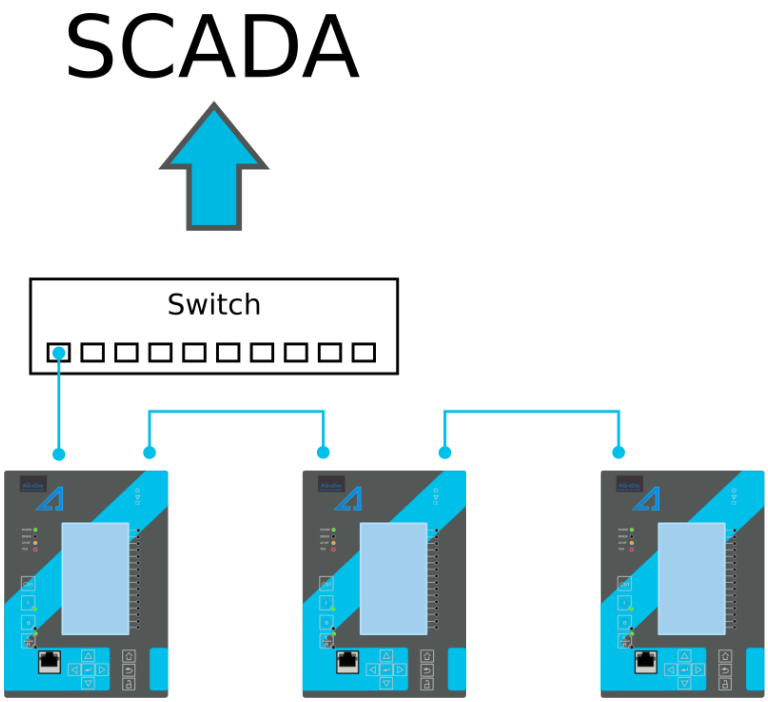
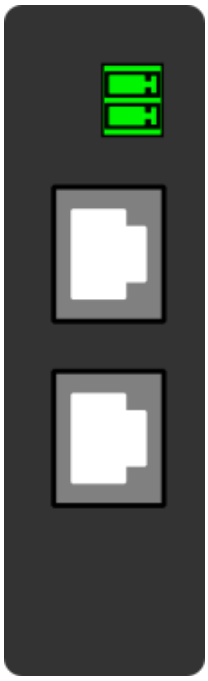


Figure. 8.8. - 40. Multidrop connection example.



8.9. Double RJ45 10/100 Mbps Ethernet communication module (optional)

Figure. 8.9. - 41. Double RJ45 10/100 Mbps Ethernet communication module (optional). Two pin connector is IRIG-B input.



Connector	Description
RJ45 connectors:	• Two Ethernet ports • RJ45 connectors • 10BASE-T and 100BASE-TX

This option cards supports redundant ring configuration and multidrop configurations. Redundant communication can be implemented by RSTP (Rapid Spanning Tree Protocol) supporting Ethernet switches. Each ring can only contain AQ-200 series devices. Any third party devices must be connected to separate ring.

For other redundancy options, see the 100LC option card.

Figure. 8.9. - 42. Ring connection example. Please note that third party devices should be connected in a separate ring.

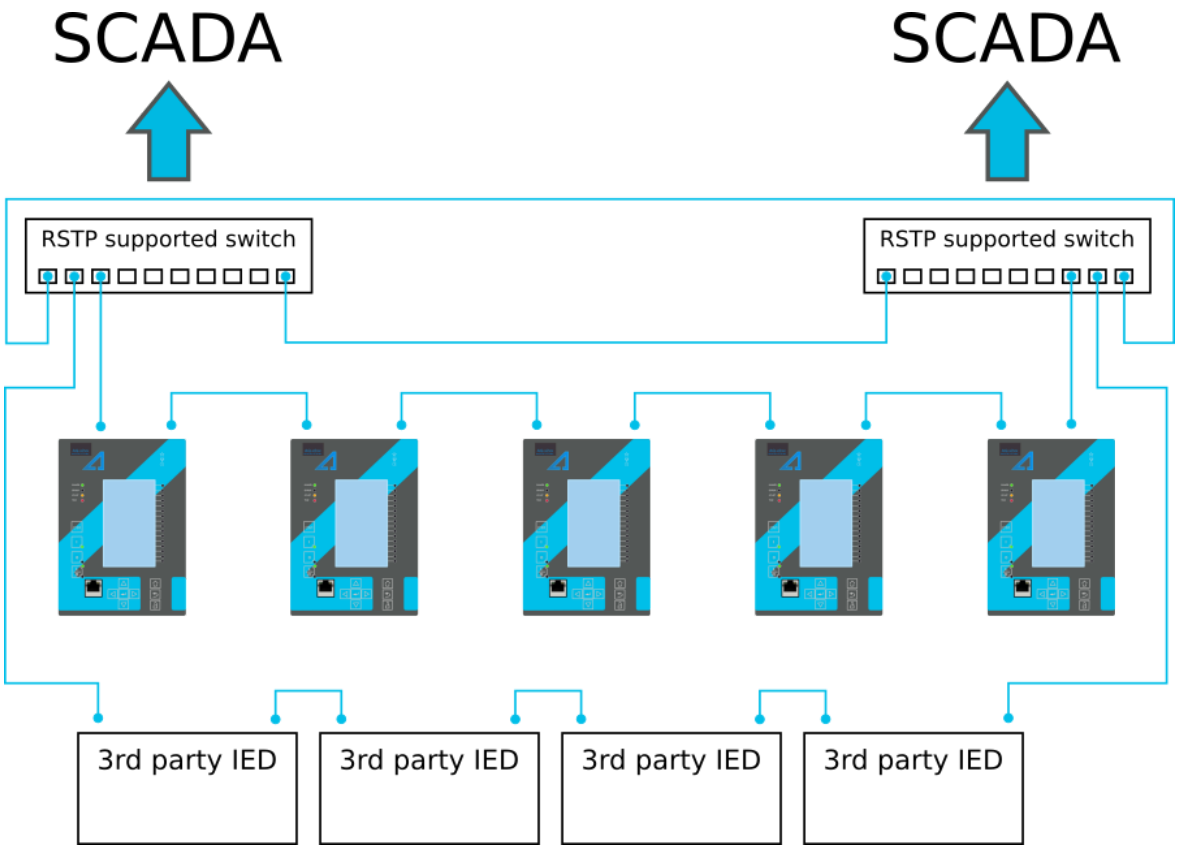
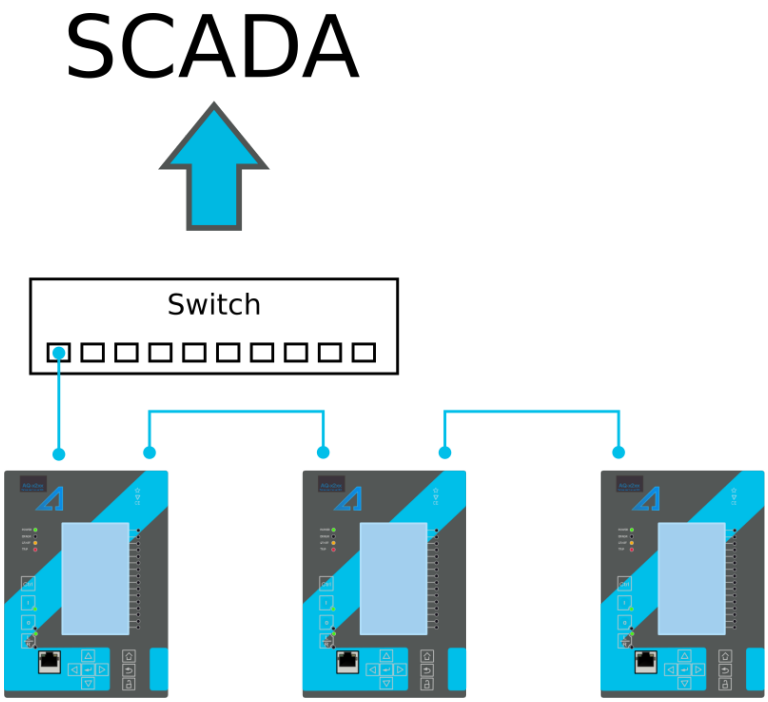


Figure. 8.9. - 43. Multidrop connection example.



8.10. Dimensions and installation

The device can be installed either to a standard 19” rack or to a switchgear panel with cutouts. The desired installation type is defined in the order code. When installing to a rack, the device takes a half (½) of the rack's width, meaning that a total of two devices can be installed to the same rack next to one another.

The figures below describe the device dimensions (first figure), the device installation (second), and the panel cutout dimensions and device spacing (third).

Figure. 8.10. - 44. Device dimensions.

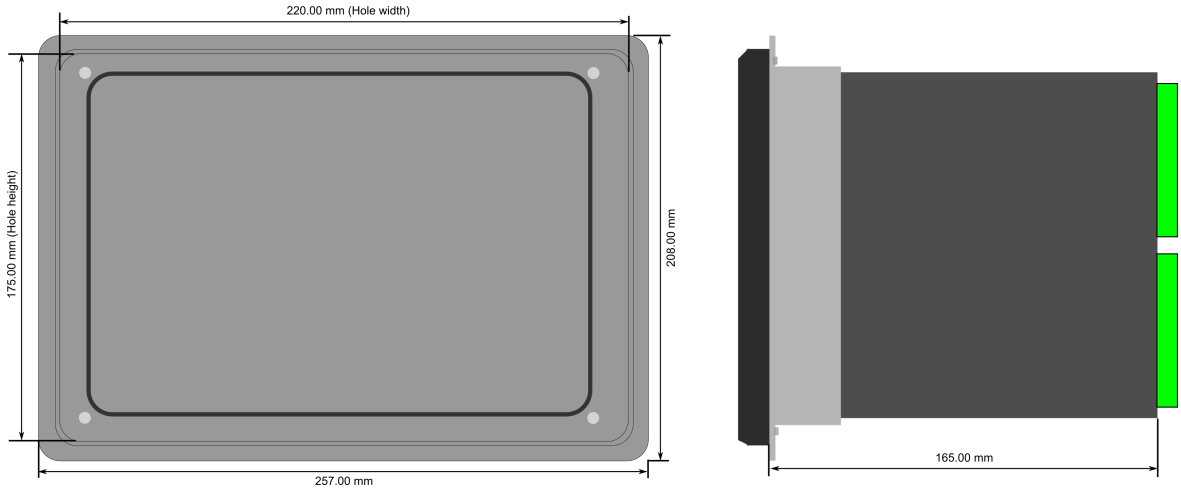


Figure. 8.10. - 45. Device installation.

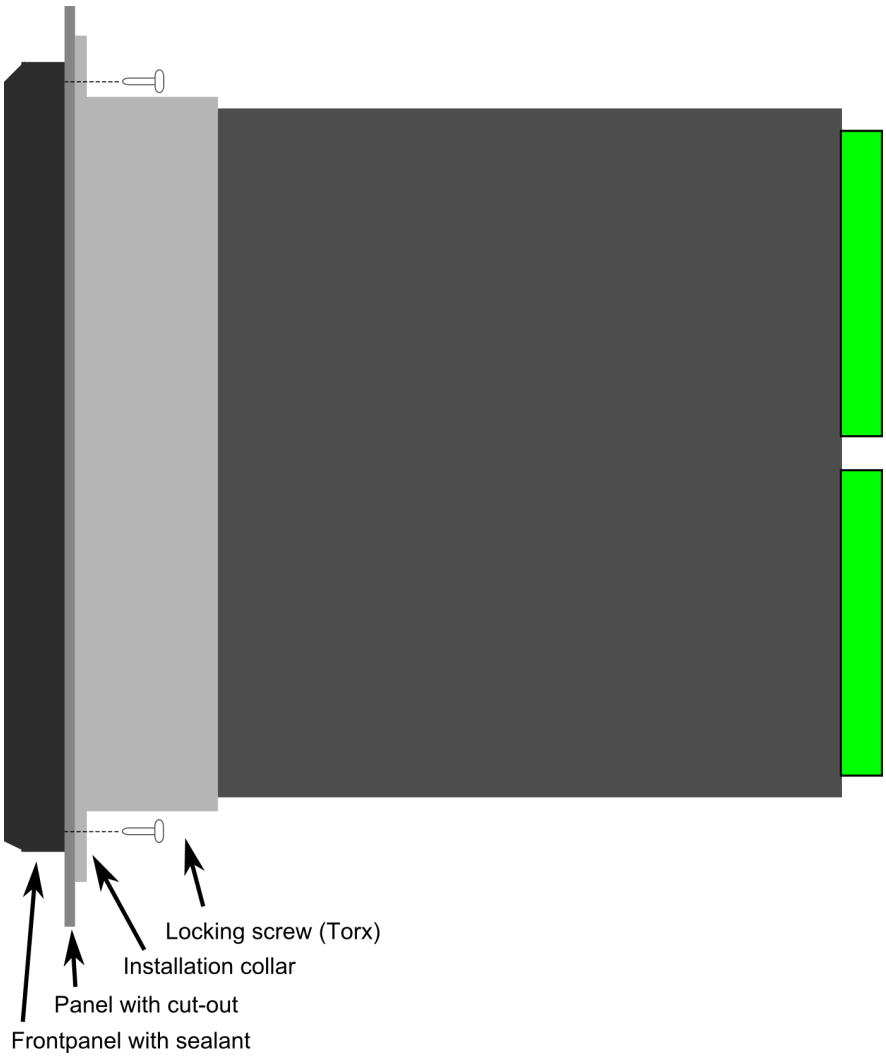
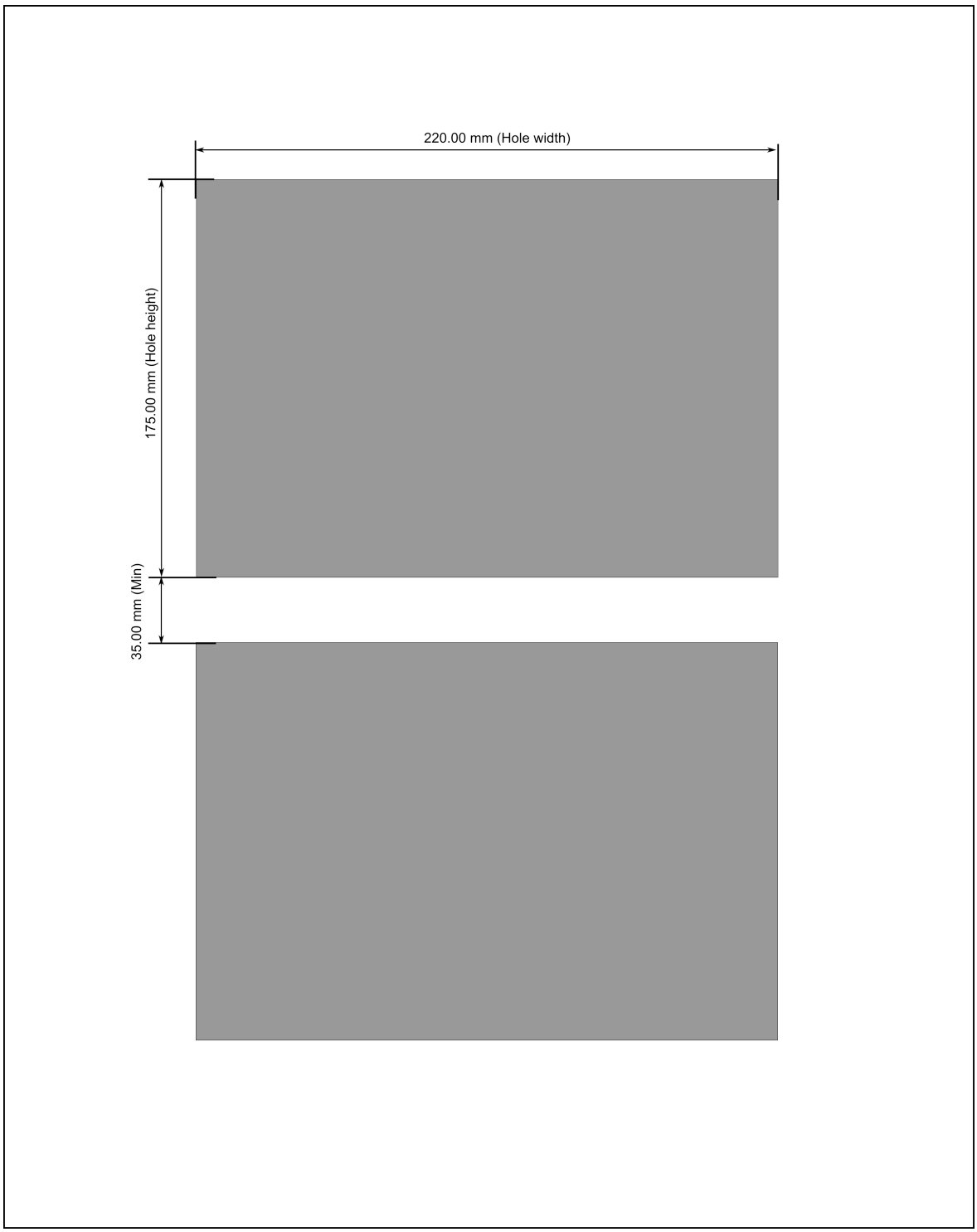


Figure. 8.10. - 46. Panel cut-out and spacing of the IED.



9. Technical data

9.1. Hardware

9.1.1. CPU & Power supply

9.1.1.1. Auxiliary voltage

Table. 9.1.1.1. - 43. Power supply model A

Rated values	
Rated auxiliary voltage	85…265 V (AC/DC)
Power consumption	< 20 W < 40 W
Maximum permitted interrupt time	< 40 ms with 110 VDC
DC ripple	< 15 %
Terminal block connection	
Terminal block	Phoenix Contact MSTB 2,5/5-ST-5,08
Solid or stranded wire Maximum wire diameter	2.5 mm^2

Table. 9.1.1.1. - 44. Power supply model B

Rated values	
Rated auxiliary voltage	18…72 VDC
Power consumption	< 20 W < 40 W
Maximum permitted interrupt time	< 40 ms with 24 VDC
DC ripple	< 15 %
Terminal block connection	
Terminal block	Phoenix Contact MSTB 2,5/5-ST-5,08
Solid or stranded wire Maximum wire diameter	2.5 mm^2

9.1.1.2. CPU communication ports

Table. 9.1.1.2. - 45. Front panel local communication port.

Port	
Port media	Copper Ethernet RJ-45
Number of ports	1
Port protocols	PC-protocols FTP Telnet
Features	
Data transfer rate	100 MB

System integration	Cannot be used for system protocols, only for local programming

Table. 9.1.1.2. - 46. Rear panel system communication port A.

Port	
Port media	Copper Ethernet RJ-45
Number of ports	1
Features	
Port protocols	IEC 61850 IEC 104 Modbus/TCP DNP3 FTP Telnet
Data transfer rate	100 MB
System integration	Can be used for system protocols and for local programming

Table. 9.1.1.2. - 47. Rear panel system communication port B.

Port	
Port media	Copper RS-485
Number of ports	1
Features	
Port protocols	Modbus/RTU IEC 103 IEC 101 DNP3 SPA
Data transfer rate	65 580 kB/s
System integration	Can be used for system protocols

9.1.1.3. CPU digital inputs

Table. 9.1.1.3. - 48. CPU model-isolated digital inputs, with thresholds defined by order code.

Rated values	
Rated auxiliary voltage	24, 110, 220 V (AC/DC)
Pick-up threshold Release threshold	Order code defined: 19, 90,170 V Order code defined: 14, 65, 132 V
Scanning rate	5 ms
Settings	
Pick-up delay	Software settable: 0…1800 s
Polarity	Software settable: Normally On/Normally Off
Current drain	2 mA
Terminal block connection	
Terminal block	Phoenix Contact MSTB 2,5/5-ST-5,08

Solid or stranded wire Maximum wire diameter	2.5 mm^2

9.1.1.4. CPU digital outputs

Table. 9.1.1.4. - 49. Digital outputs (Normal Open)

Rated values	
Rated auxiliary voltage	265 V (AC/DC)
Continuous carry	5 A
Make and carry 0.5 s Make and carry 3 s	30 A 15 A
Breaking capacity, DC (L/R = 40 ms) at 48 VDC at 110 VDC at 220 VDC	 1 A 0.4 A 0.2 A
Control rate	5 ms
Settings	
Polarity	Software settable: Normally On/Normally Off
Terminal block connection	
Terminal block	Phoenix Contact MSTB 2,5/5-ST-5,08
Solid or stranded wire Maximum wire diameter	 2.5 mm^2

Table. 9.1.1.4. - 50. Digital outputs (Change-Over)

Rated values	
Rated auxiliary voltage	265 V (AC/DC)
Continuous carry	5 A
Make and carry 0.5 s Make and carry 3 s	30 A 15 A
Breaking capacity, DC (L/R = 40 ms) at 48 VDC at 110 VDC at 220 VDC	 1 A 0.4 A 0.2 A
Control rate	5 ms
Settings	
Polarity	Software settable: Normally On/Normally Off
Terminal block connection	
Terminal block	Phoenix Contact MSTB 2,5/5-ST-5,08
Solid or stranded wire Maximum wire diameter	 2.5 mm^2

9.1.2. Option cards

9.1.2.1. Digital input module

Table. 9.1.2.1. - 51. Technical data for the digital input module.

Rated values	
Rated auxiliary voltage	5…265 V (AC/DC)

Current drain	2 mA
Scanning rate Activation/release delay	5 ms 5...11 ms
Settings	
Pick-up threshold Release threshold	Software settable: 16…200 V, setting step 1 V Software settable: 10…200 V, setting step 1 V
Pick-up delay	Software settable: 0…1800 s
Drop-off delay	Software settable: 0…1800 s
Polarity	Software settable: Normally On/Normally Off
Terminal block connection	
Terminal block	Phoenix Contact MSTB 2,5/5-ST-5,08
Solid or stranded wire Maximum wire diameter	2.5 mm^2

9.1.2.2. Digital output module

Table. 9.1.2.2. - 52. Technical data for the digital output module.

Rated values	
Rated auxiliary voltage	265 V (AC/DC)
Continuous carry	5 A
Make and carry 0.5 s Make and carry 3 s	30 A 15 A
Breaking capacity, DC (L/R = 40 ms) at 48 VDC at 110 VDC at 220 VDC	 1 A 0.4 A 0.2 A
Control rate	5 ms
Settings	
Polarity	Software settable: Normally On/Normally Off
Terminal block connection	
Terminal block	Phoenix Contact MSTB 2,5/5-ST-5,08
Solid or stranded wire Maximum wire diameter	 2.5 mm^2

9.1.2.3. RTD & mA input module

Table. 9.1.2.3. - 53. Technical data for the RTD & mA input module.

Channels 1-8	
2/3/4-wire RTD and thermocouple sensors	
Pt100 or Pt1000	
Type K, Type J, Type T and Type S	
Channels 7 & 8 support mA measurement	
Measurement range	
mA input range	0…33 mA

9.1.2.4. RS-232 & serial fiber communication module

Table. 9.1.2.4. - 54. Technical data for the RS-232 & serial fiber communication module.

Ports
RS-232
Serial fiber (GG/PP/GP/PG)
Serial port wavelength
660 nm
Cable type
1 mm plastic fiber

9.1.2.5. Double LC 100 Mbps Ethernet communication module

Table. 9.1.2.5. - 55. Technical data for the double LC 100 Mbps Ethernet communication module.

Protocols	
Protocols	HSR and PRP
Ports	
Quantity of fiber ports	2
Communication port C & D	LC fiber connector Wavelength 1300 nm
Fiber cable	50/125 µm or 62.5/125 µm multimode (glass)

9.1.3. Display

Table. 9.1.3. - 56. Technical data for the HMI TFT display.

Dimensions and resolution	
Number of dots/resolution	800 x 480
Size	84.78 × 49.90 mm (3.34 × 1.96 in)
Display	
Type of display	TFT
Color	RGB color

9.2. Functions

9.2.1. Control functions

9.2.1.1. Setting group selection

Table. 9.2.1.1. - 57. Technical data for the setting group selection function.

Settings and control modes	
Setting groups	8 independent, control-prioritized setting groups
Control scale	Common for all installed functions which support setting groups
Control mode	
Local	Any digital signal available in the device

Remote	Force change overrule of local controls either from the setting tool, HMI or SCADA
Operation time	
Reaction time	<5 ms from receiving the control signal

9.2.1.2. Object control and monitoring

Table. 9.2.1.2. - 58. Technical data for the object control and monitoring function.

Signals	
Input signals	Digital inputs Software signals
Output signals	Close command output Open command output
Operation time	
Breaker traverse time setting	0.02…500.00 s, setting step 0.02 s
Max. close/open command pulse length	0.02…500.00 s, setting step 0.02 s
Control termination time out setting	0.02…500.00 s, setting step 0.02 s
Inaccuracy: - Definite time operating time	±0.5 % or ±10 ms
Breaker control operation time	
External object control time	<75 ms
Object control during auto-reclosing	See the technical sheet for the auto-reclosing function.

9.2.2. Monitoring functions

9.3. Tests and environmental

Electrical environment compatibility

Table. 9.3. - 59. Disturbance tests.

All tests	CE-approved and tested according to EN 60255-26
Emissions	
Conducted emissions: EN 60255-26 Ch. 5.2, CISPR 22	150 kHz…30 MHz
Radiated emissions: EN 60255-26 Ch. 5.1, CISPR 11	30…1 000 MHz
Immunity	
Electrostatic discharge (ESD): EN 60255-26, IEC 61000-4-2	Air discharge 15 kV Contact discharge 8 kV
Electrical fast transients (EFT): EN 60255-26, IEC 61000-4-4	Power supply input 4 kV, 5/50 ns, 5 kHz Other inputs and outputs 4 kV, 5/50 ns, 5 kHz
Surge: EN 60255-26, IEC 61000-4-5	Between wires: 2 kV, 1.2/50 µs Between wire and earth: 4 kV, 1.2/50 µs
Radiated RF electromagnetic field: EN 60255-26, IEC 61000-4-3	f = 80…1 000 MHz, 10 V/m

Conducted RF field: EN 60255-26, IEC 61000-4-6	f = 150 kHz…80 MHz, 10 V (RMS)

Table. 9.3. - 60. Voltage tests.

Dielectric voltage test	
EN 60255-27, IEC 60255-5, EN 60255-1	2 kV, 50 Hz, 1 min
Impulse voltage test	
EN 60255-27, IEC 60255-5	5 kV, 1.2/50 µs, 0.5 J

Physical environment compatibility

Table. 9.3. - 61. Mechanical tests.

Vibration test	
EN 60255-1, EN 60255-27, IEC 60255-21-1	2…13.2 Hz, ± 3.5 mm 13.2…100 Hz, ± 1.0 g
Shock and bump test	
EN 60255-1, EN 60255-27, IEC 60255-21-2	20 g, 1 000 bumps/dir.

Table. 9.3. - 62. Environmental tests.

Damp heat (cyclic)	
EN 60255-1, IEC 60068-2-30	Operational: +25…+55 °C, 93…97 % (RH), 12+12h
Dry heat	
EN 60255-1, IEC 60068-2-2	Storage: +70 °C, 16 h Operational: +55 °C, 16 h
Cold test	
EN 60255-1, IEC 60068-2-1	Storage: –40 °C, 16 h Operational: –20 °C, 16 h

Table. 9.3. - 63. Environmental conditions.

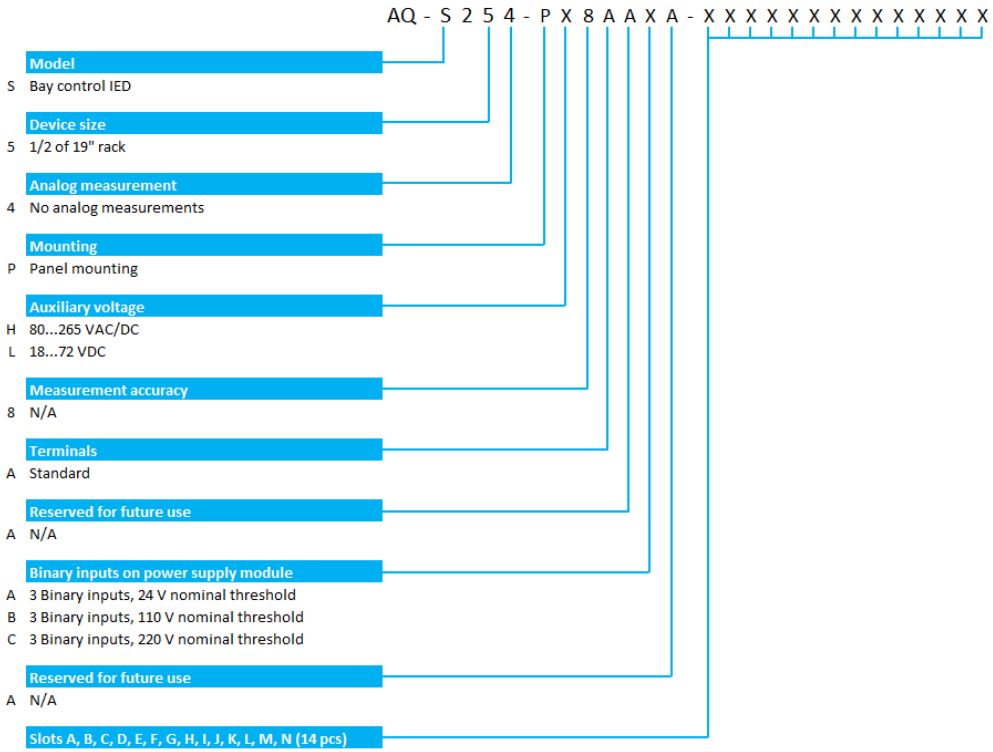
IP classes	
Casing protection class	IP54 (front) IP21 (rear)
Temperature ranges	
Ambient service temperature range	–35…+70 °C
Transport and storage temperature range	–40…+70 °C
Other	
Altitude	<2000 m
Overvoltage category	III
Pollution degree	2

Casing and package

Table. 9.3. - 64. Dimensions and weight.

Without packaging (net)	
Dimensions	Height: 208 mm Width: 257 mm (½ rack) Depth: 165 mm (no cards or connectors)
Weight	1.5 kg
With packaging (gross)	
Dimensions	Height: 250 mm Width: 343 mm Depth: 256 mm
Weight	2.0 kg

10. Ordering information



Accessories

Order code	Description	Note	Manufacturer
AQ-ACC-ADAM4016	ADAM-4016 RTD 6 ch RTD module with Modbus	Requires external	Advanced Co. Ltd.
	(Pt100/1000, Balco500, Ni)	power module	

11. Contact and reference information

Manufacturer

Arcteq Relays Ltd.

Visiting and postal address

Wolffintie 36 F 12

65200 Vaasa, Finland

Contacts

Phone:	+358 10 3221 370
Fax:	+358 10 3221 389
URL:	url: www.arcteq.fi
email sales:	sales@arcteq.fi
Technical support site:	https://arcteq.fi/support-landing/
Technical support:	+358 10 3221 388 (EET 8:00 – 16:00)