ARCTEQ®
RELAYABLE POWER

AQ-110x

Arc sensor unit with overcurrent

Instruction manual

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1 Document information

Table. 1 - 1. History of Revision 1.

Revision	1.00
Date	October 2010
Changes	- The first revision of the manual.
Revision	1.01
Date	July 2011
Changes	- Sensor chapter revised (fiber pictures and point sensor connections). - Standard Arc Scheme chapter revised (e.g. scheme 0a added). - DIP switch definition updated (e.g. HSO latch/non-latch). - LED description revised (current channels LEDs will not blink during the auto-configuration). - Partly AQ-110F information added. - Dimensions and installation chapter, the depth of the unit is changed from 170 mm to 175 mm. - Casing and dimensions section, the unit size and the size with package have been added.
Revision	1.02
Date	April 2012
Changes	- The AQ-SAS^{TM} chapter removed from the manual.
Revision	1.03
Date	July 2012
Changes	- Scheme select DIP switch settings chapter added. - The point sensor max. wiring length is up to 200 meters. - System self-supervision chapter revised.
Revision	1.04
Date	May 2019
Changes	- Moved the scheme selection content to DIP switch settings, refer to Chapter 3.5. - Technical data updated. - Added an application example, refer to Chapter 6.
Revision	1.05
Date	November 2019
Changes	- Added information to the "Technical data" chapter.

Table. 1 - 2. History of Revision 2.

Revision	2.00
Date	October 2020
Changes	- Content completely rewritten to improve grammar and readability. - The "Available logic schemes" chapter updated. - The AQ-02 point sensor chapter added to the "Arc sensors" chapter, and AQ-02's technical data added to the "Technical data" chapter. - The sensor-unit type dependency list updated. - The original "Connecting sensors" chapter moved to the AQ-0x instruction booklet, and replaced with a summary of how to connect point sensors. A summary of connecting fiber sensors also added to the chapter. - All technical data checked and updated where necessary. - Ordering information updated. - Images updated where necessary.

Revision	2.01
Date	November 2021
Changes	- Panel cut-out installation image added. - Dimension measurements updated. - Replaced "one fifths" with "1 A or 5 A secondary nominal can be selected" in the "Unit features" chapter. - Wiring diagram, simplified block diagram, DIP switch diagram & application image(s) updated. - Push button image added. - End covering description added to AQ-07, removed from AQ-08. - Cut-and-slice text removed all fiber descriptions. - Connections image updated. - The test plan example updated. - The Main-Tie-Main application example image updated. - The HSO chapter updated. - All table layouts unified in "Technical data". - The IP classification of point sensors updated. - The AWG value updated. - "Disturbance tests" table reformatted. - Order code images updated (separated the codes for AQ-110P and AQ-110F). - The number for Arcteq's technical support added to the reference information.

2 Abbreviations

BI – binary input

BO – binary output

CB – circuit breaker

CBFP – circuit breaker failure protection

CT – current transformer

EPROM – erasable, programmable read-only memory

HSO – high-speed output

LED – light emitting diode

LV – low-voltage

MV – medium-voltage

NC – normally closed

NO – normally open

PCB – printed circuit board

QD – quenching device

RF – radio frequency

Rx – receiver

SAS – standard arc scheme

SF – system failure

Tx – transceiver

µP - microprocessor

3 General

The AQ-110x (both AQ-110P and AQ-110F) device is a sophisticated microprocessor-based arc flash protection unit. It has a combined current and arc sensing which provides more criteria for tripping. The device is designed to minimize the damage caused by an arcing fault (arc flash) by tripping the circuit breaker which supplies current to the fault. The complete system self-supervision functionality of AQ-110x provides the highest level of dependability as it continuously monitors all internal system functions as well as all external connections.

The AQ-110x device is designed according to the latest protection relay standards and is therefore suitable for installations in rough environments. These include utilities and power plants (both traditional and renewable), various heavy industry applications (off-shore, marine, oil, gas, mining, steel, etc.) as well as commercial and institutional electrical systems. Both AQ-110x variants are suitable for MV and LV switchgears as well as for motor control center applications in both new and retrofitted installations.

3.1 Unit features

AQ-110x is a multipurpose arc flash protection unit and can be applied to a variety of applications. It can be used on its own as a stand-alone unit, or it can be a part of a more complex arc protection system through the binary bus.

AQ-110x comes in two variants. The AQ-110P variant supports four (4) point sensor channels as well as one (1) optional fiber sensor channel. The AQ-110F variant supports three (3) fiber sensor channels. All other features are the same in both variants.

The following list presents the main features of the 110P unit:

- 92…265 V AC/DC auxiliary power supply or 18…72 V DC auxiliary power supply (optional)
- three (3) phase current inputs; 1 A or 5 A secondary nominal can be selected
- one (1) residual current inputs; 1 A or 5 A secondary nominal can be selected
- four (4) arc point sensor channels
- one (1) fiber loop sensor channel (optional)
- two (2) binary inputs with nominal operation voltage of 24 V DC
- two (2) high-speed semiconductor trip outputs
- three (3) normally open trip relay outputs
- one (1) normally open trip relay output or one (1) normally closed trip relay output (electronic lock-out)
- one (1) binary output (24 V DC)
- one (1) system failure output
- twenty (20) indication LEDs
- one (1) push button.

The following list presents the main features of the 110F unit:

- 92…265 V AC/DC auxiliary power supply or 18…72 V DC auxiliary power supply (optional)
- three (3) phase current inputs; 1 A or 5 A secondary nominal can be selected
- one (1) residual current inputs; 1 A or 5 A secondary nominal can be selected
- three (3) fiber loop sensor channels
- two (2) binary inputs with nominal operation voltage of 24 V DC
- two (2) high-speed semiconductor trip outputs
- three (3) normally open trip relay outputs
- one (1) normally open trip relay output or one (1) normally closed trip relay output (electronic lock-out)
- one (1) binary output (24 V DC)
- one (1) system failure output

- nineteen (19) indication LEDs
- one (1) push button.

Figure. 3.1 - 1. Arc protection unit AQ-110P.

Figure. 3.1 - 2. Arc protection unit AQ-110F.

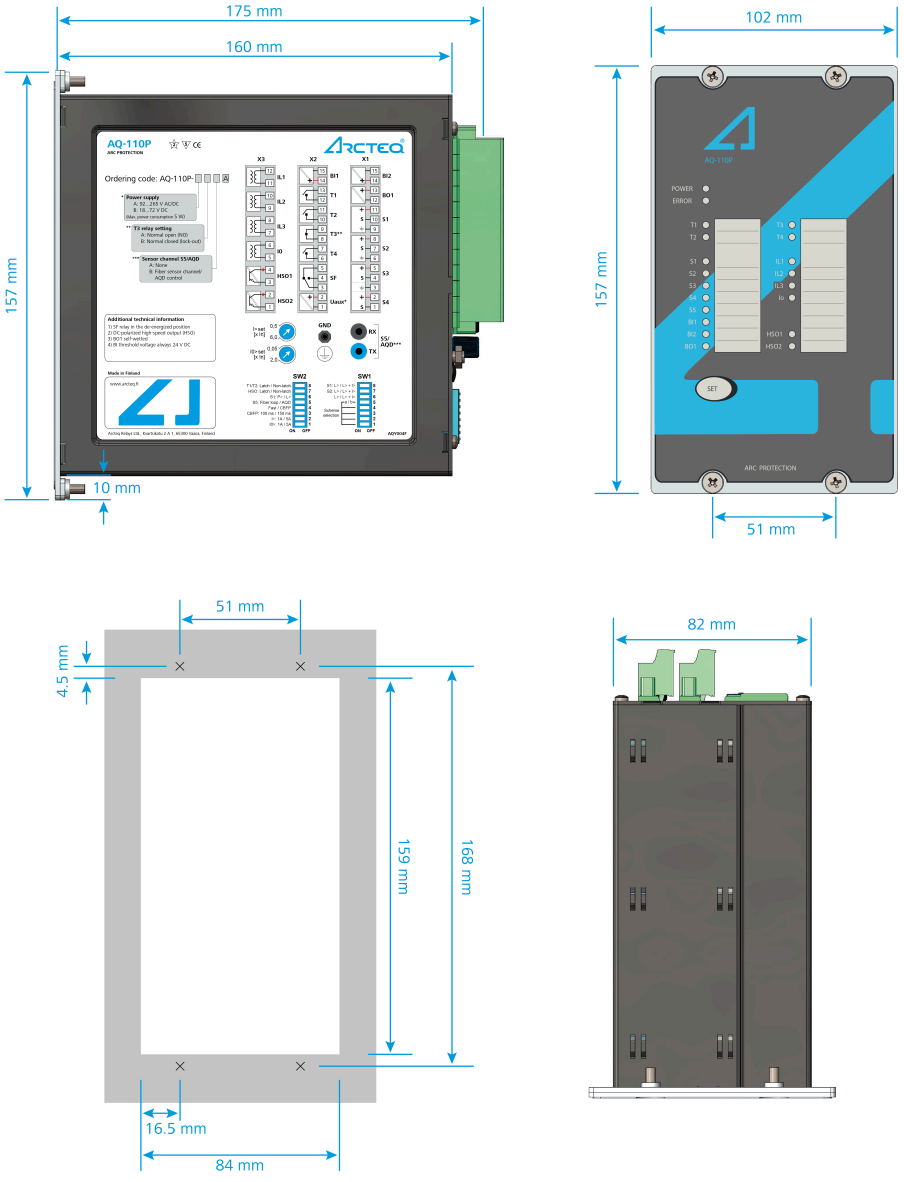
3.2 Dimensions and installation

AQ-110x can be either door-mounted or panel-mounted in a standard 19 inch rack. The unit's dimensions (without cards) are as follows:

- Height: 157 mm (6.18 in)
- Width: 102 mm (4.02 in)
- Depth: 160 mm (6.30 in).

The figure below presents the dimension of the unit visually. It also shows the dimensions of the cut-out (bottom-left) required when mounting the unit on a panel. While the image is of the AQ-110P device, the measurements are the same for AQ-110F as well.

Figure. 3.2 - 3. Dimensions of the device.



The following figure presents how to install an AQ-110x unit into a cut-out.

Figure. 3.2 - 4. Installing a unit into a cut-out.

3.3 Simplified block diagram

The figures below presents the main components that can be found in the AQ-110x units (AQ-110P and AQ-110F).

Figure. 3.3 - 5. Simplified block diagram of AQ-110P.

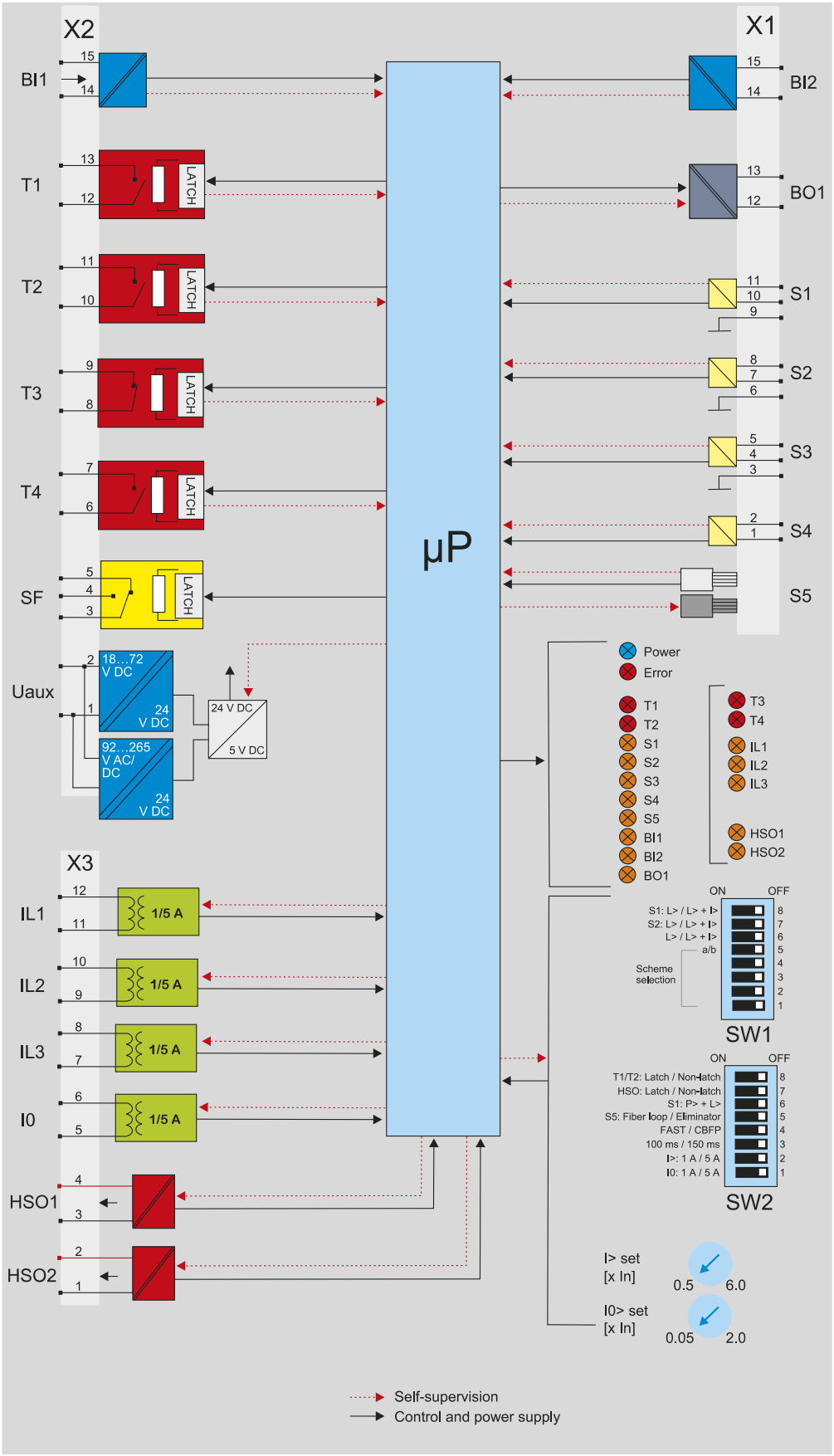
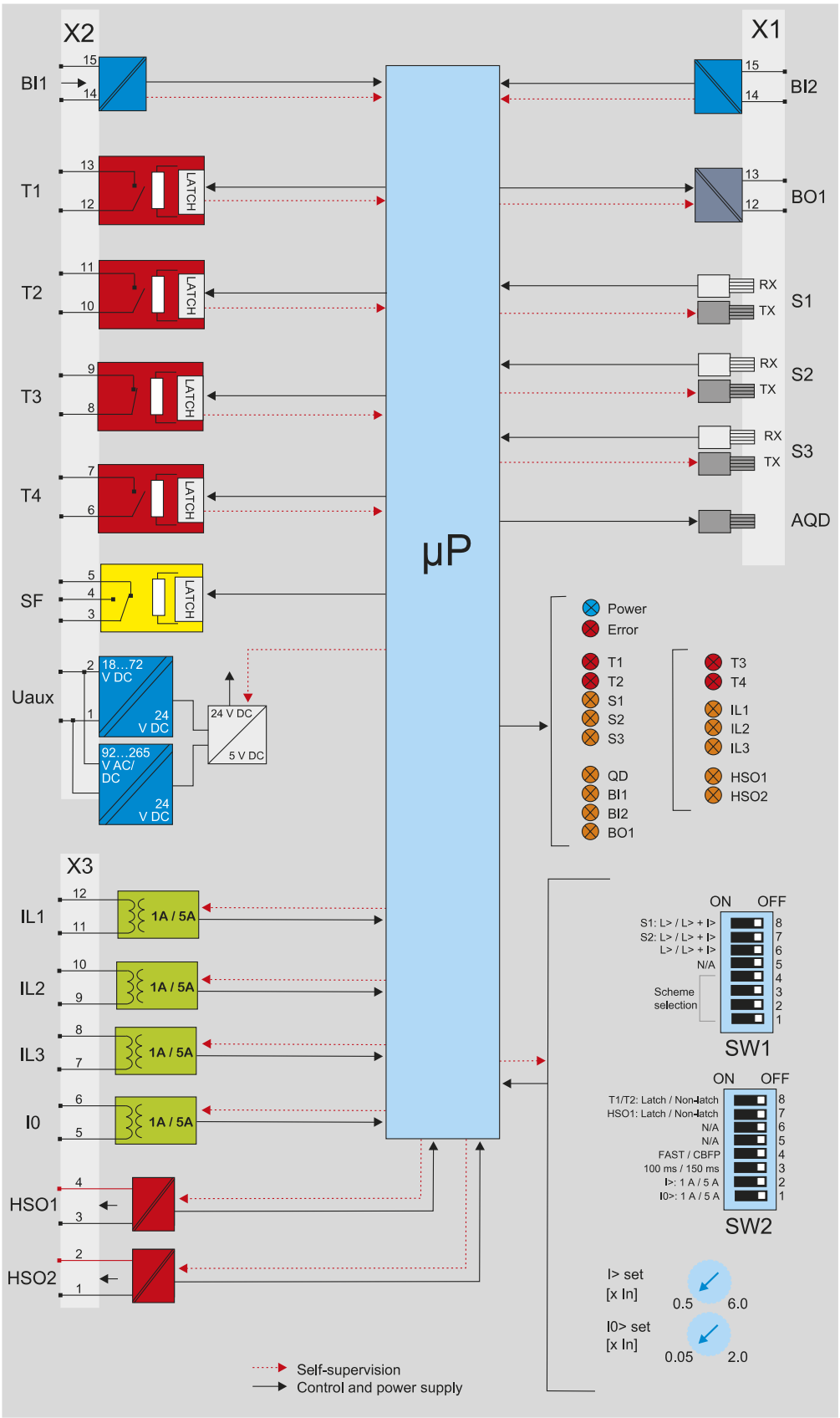


Figure. 3.3 - 6. Simplified block diagram of AQ-110F.



NOTE!

Please note that the latching (or non-latching) of trip relays T1 and T2 is determined with the DIP switch (SW1:6). The trip relays T3 and T4 are always latched. The binary output BO1 is always non-latched!

3.4 Wiring

Figure. 3.4 - 7. Wiring diagram for AQ-110P.

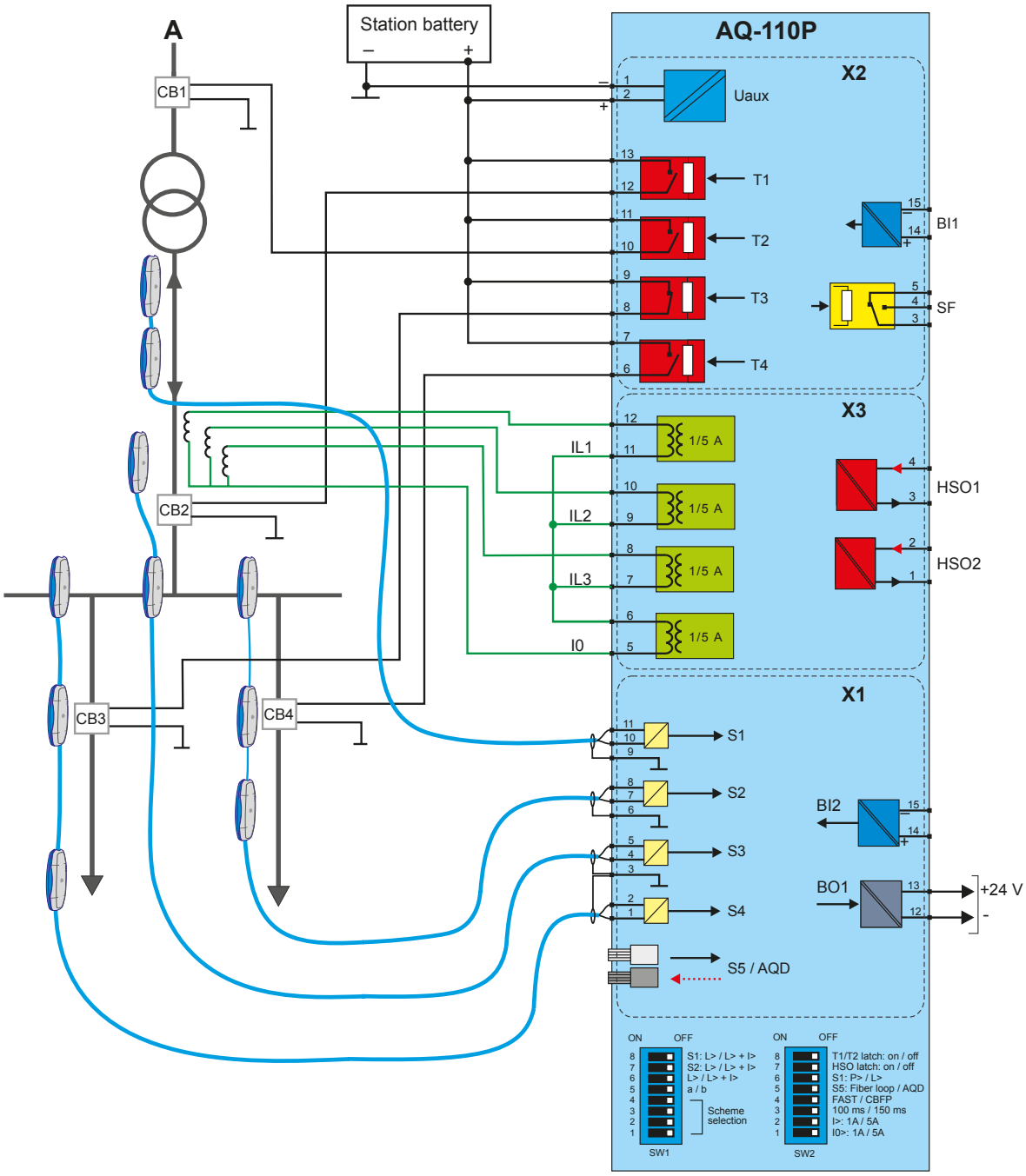
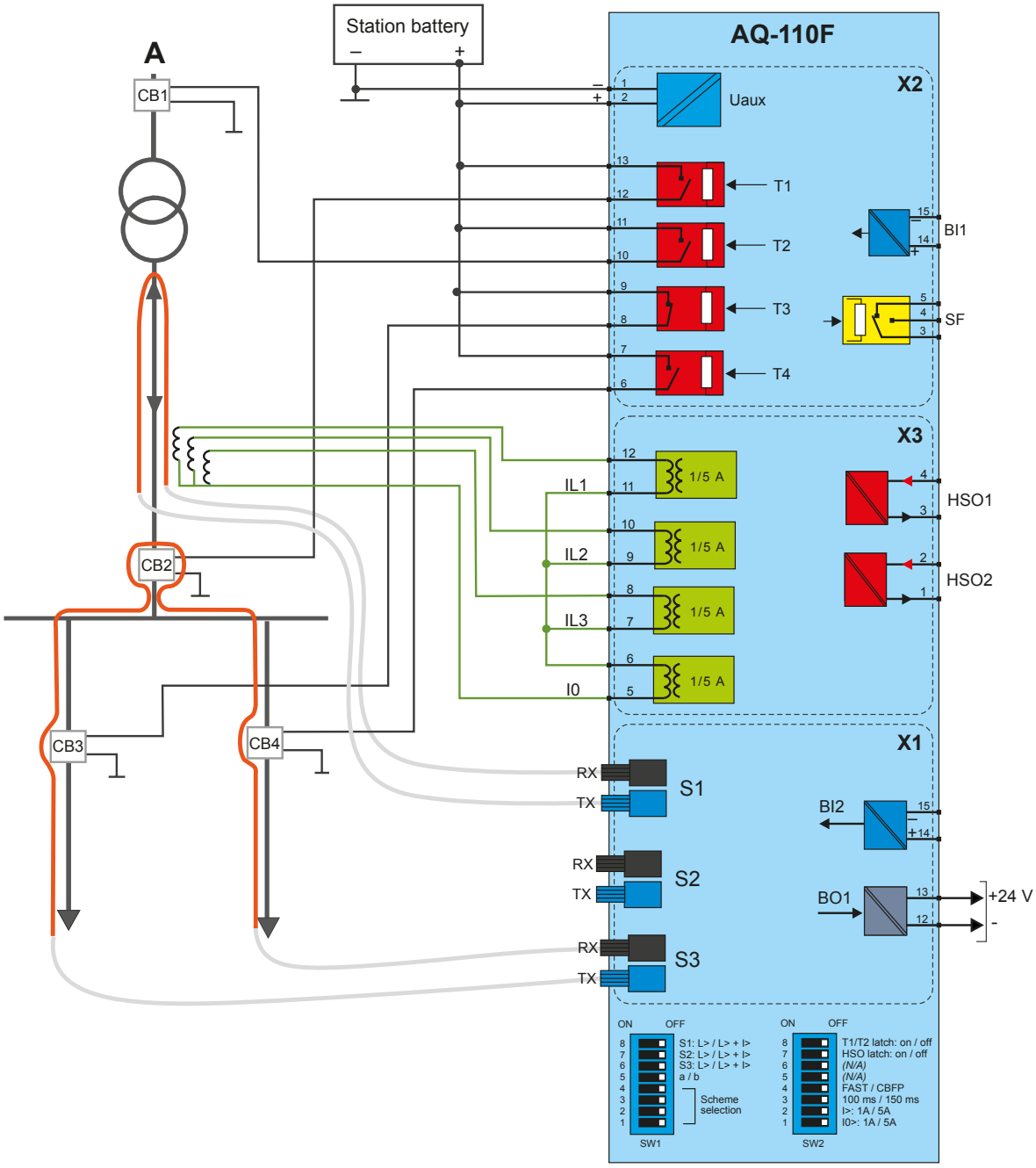


Figure. 3.4 - 8. Wiring diagram for AQ-110F.



4 Operation and configuration

4.1 LED indicator functions

The AQ-110P unit has twenty (20) indication LEDs and the AQ-110F unit has nineteen (19) indication LEDs. Apart from the "Power" and "Error" LEDs, the user can write their own identifications for each of the remaining LEDs on the text insert located in the transparent pocket next to the LEDs. The LEDs are on the unit's front panel to allow for a clear view without a separate need to open doors.

When the unit is powered up, it performs an LED test. All LEDs turn on for two (2) seconds and then turn off; only the blue "Power" LED stays on.

When the unit operates normally, only the blue "Power" LED is lit.

All current measuring channels (that is, IL1, IL2, IL3 and I0) have their own indication LEDs. When any channel measurement exceeds the set threshold value for longer than 1.5 ms, its corresponding LED turns on. In an open CT condition both the corresponding current channel indicator LED and the "Error" LED are blinking.

The LEDs of inactive sensors are off. If an arc sensor is activated for longer than 1.5 ms, its corresponding LED turns on. The activation function of the sensor LEDs is latched when the LED's light is not blinking.

If there is a loose sensor wire or if the self-supervision function detects a configuration mismatch (that is, a new sensor has been attached but the auto-configuration system setup has not been run), the corresponding LED starts flashing and the "Error" LED activates.

The binary I/O LEDs indicate the status of the input and output lines. If any of the lines become active for longer than 1.5 ms, the corresponding LED turns on (that is, they become latched). This also happens when a trip situation occurs. The trip outputs are controlled with DIP switch settings. All activation and trip indication LEDs are latched, even if the DIP switch settings are in the non-latched mode.

All LED indications are stored in the non-volatile memory (EPROM) to help identify the necessary trip information if auxiliary power is lost. When the unit is re-powered after a power supply loss, the front panel shows the status of all LEDs.

You can clear the LEDs by pushing the SET button.

4.2 LED operations guide

The table below describes the function of each indicator LED in detail. Please note that the use of sensor channels differs between the two variants: the S4 and S5 sensor channels are not in use in the AQ-110F variant.

Table. 4.2 - 3. LED operations of AQ-110P and AQ-110F.

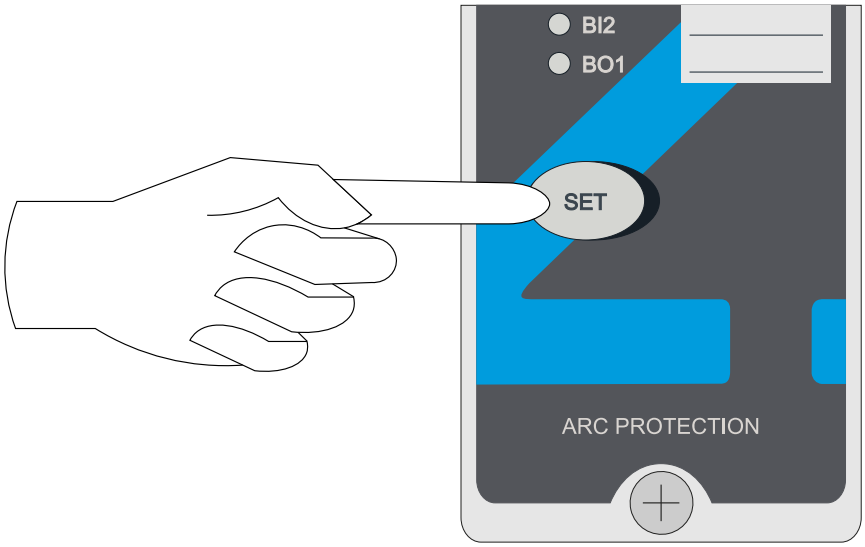
LED name (color)	Light off	Steady light	Blinking light	Action if abnormal
POWER (blue)	The auxiliary power supply is disconnected.	The auxiliary power supply is connected.	*(N/A)*	Check the power supply.
ERROR (red)	The system is healthy.	A system failure has occured.	A configuration mismatch has been detected. Protection is partially operational.	Verify the system condition (see the "System self-supervision" and "Troubleshooting" chapters).

T1–T4 (red)	Normal status.	The trip relay has activated.	*(N/A)*	Check what caused the trip, clear the fault and reset the indicator LEDs with the push button.
S1–S3 (amber)	Normal status.	Light information has activated the sensor channel.	There is a sensor channel discontinuity or a system setup has not been performed; or, pressure information has activated the sensor channel (when using an AQ-02 point sensor).	Check the sensor continuity or perform a system setup (see the "System setup" chapter); or, check what activated the sensor.
S4 (amber) NB! Only in AQ-110P!	Normal status.	Light information has activated the sensor channel.	There is a sensor channel discontinuity or a system setup has not been performed; or, pressure information has activated the sensor channel (when using an AQ-02 point sensor).	Check the sensor continuity or perform a system setup (see the "System setup" chapter); or, check what activated the sensor.
S5 (amber) NB! Only in AQ-110P!	Normal status.	The fiber sensor channel has been activated.	There is a fiber sensor discontinuity or a system setup has not been performed.	Check the sensor continuity or perform a system setup (see the "System setup" chapter); or, check what activated the sensor.
S5 (amber) NB! Only in AQ-110F!	Normal status.	The QD channel has been activated.	The fiber connection to the quenching system has dropped off or a system setup has not been performed.	Check the fiber connection and/or the system configuration.
BI1–BI2 (amber)	Normal status.	The binary input has been activated.	The binary input has a loose connection.	Check the binary input wiring.
BO1 (amber)	Normal status.	The binary output has been activated.	*(N/A)*	—
IL1–IL3 (amber)	Normal status (the actual current is below the set threshold).	The measured current is above the set threshold.	There is an open CT connection in the channel.	Check the set current thresholds, or check the CT wiring.
I0 (amber)	Normal status (the actual current is below the set threshold).	The measured residual current is above the set threshold.	*(N/A)*	Check the threshold set for residual current.
HSO1–HSO2 (red)	Normal status.	The high-speed output has been activated.	*(N/A)*	Check what activated the output, clear the fault and reset the indicator LEDs with the push button.

4.3 Push button (SET)

The unit contains one push button, SET, and it can be used for all operational functions. The push button is used for setting up the system (also known as auto-configuration), for resetting the indicator LEDs and the latched output relays, as well as for checking the input connection.

Figure. 4.3 - 9. The "SET" push button on the device's front panel.



4.3.1 System setup (auto-configuration)

After all sensors and binary lines have been connected, a system setup procedure (also known as auto-configuration) must be performed. The sequence is initialized by pressing the SET push button for two seconds. This causes the sensor and binary LEDs to start blinking. The unit scans these inputs to see if they are connected; when an input is detected, the corresponding LED lights up to mark that a connection was found. All inputs that are not connected continue to blink for three more seconds. Then, all LEDs are turned off. Additionally, the DIP switch setting are stored in the non-volatile memory during this sequence.

All sensor inputs remain operational even when they have not been auto-configured. System setup is only used for self-supervision purposes.

Please note that to reconfigure a unit with fewer connections (BI/BO or sensors) than in the previously memorized setup, one of the DIP switches must be moved back and forth once before the system setup procedure is carried out. After this, you must wait one minute before you begin the new auto-configuration sequence.

You can reconfigure a unit with more connections at any time without the wait and without having to move one of the DIP switches.

4.3.2 Reset

All LED indications and latched trip relays can be reset by pressing the SET push button for one second.

Unless the button is pressed, the latched trip relays remain active until the auxiliary power is disconnected. All LED indications also remain active even when the auxiliary power supply is disconnected unless the button is pressed. Please refer to the "Non-volatile memory" chapter for more information.

4.3.3 Input connection check

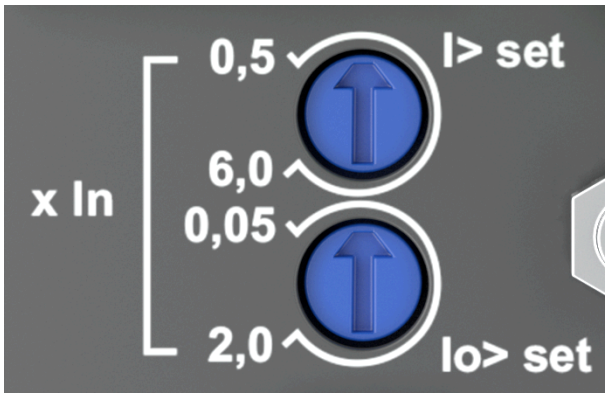
After the system setup (auto-configuration) procedure is completed, you can verify the connectivity of all sensors and binary input channels by pressing the SET push button three (3) times within two (2) seconds. The LEDs of the corresponding sensors and binary input channels start blinking while the "Power" LED is already blinking. The LEDs blink as many times as there are connected sensors and binary output channels from other units.

4.4 Current threshold settings

The AQ-110x units have four (4) current measurement inputs: three (3) measure phase currents and one (1) measures the residual current. Both the phase and residual current measurements are used as secondary trip criteria in an arc protection system to avoid trips caused by natural light sources.

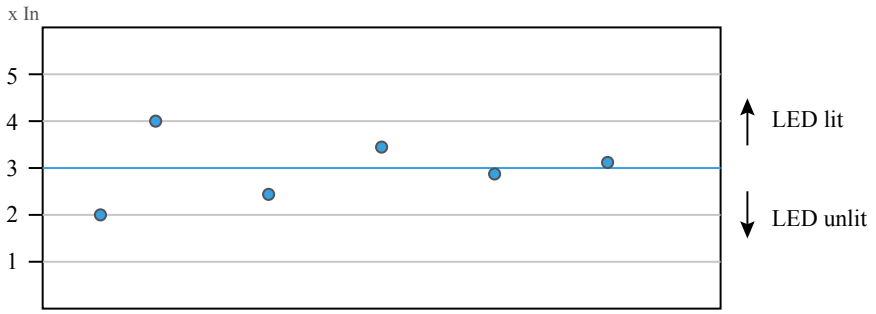
The threshold for phase overcurrent is typically set to 50 % above the highest load current. The residual overcurrent is set to very sensitive. The set points are set by using the trimmers (see the image below). You can get an accurate setting by injecting the desired set current into the phase and residual current inputs of the unit and by simultaneously adjusting the trimmers until the phase and residual current indicator LEDs are lit.

Figure. 4.4 - 10. Overcurrent setting trimmers.



You can also fine-tune the current threshold setting by adjusting the trimmers and switching between lit and unlit LEDs (see the diagram below).

Figure. 4.4 - 11. Fine-tuning the current threshold setting.



The setting range for the phase overcurrent stage is 0.5…6 × I_n. The setting range for the residual overcurrent stage is 0.05…2 × I_n.

4.5 DIP switch settings

The DIP switches are used to configure the unit's tripping logic and other functionalities. The various trip schemes can be programmed easily by selecting the appropriate DIP switch positions. However, the most convenient way to set the AQ-110 unit or a more complex arc protection system is to use Standard Arc Schemes (SAS).

Tripping can be based on arc light only, or on both arc light and current thresholds, or on other tripping criteria (such as undervoltage, etc.). You can also enable the CBFP (circuit breaker failure protection) scheme with the DIP switches. Current threshold and other tripping criteria can also be applied to BI1 to block tripping caused by natural light sources.

Both AQ-110 variants contain two switch groups, SW1 and SW2. They are located at the back of the unit for easy access. The scheme selection number is based on binary arithmetic. The figure below presents the numbering of the two switch groups, and the tables below that give a detailed description of the settings for both switch groups.

Figure. 4.5 - 12. DIP switch diagram for AQ-110P (above) and AQ-110F (below).

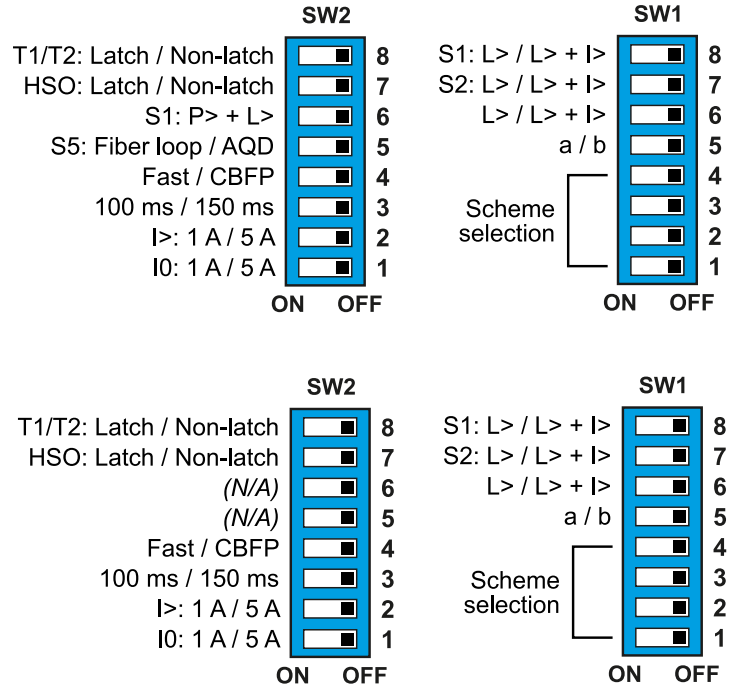


Table. 4.5 - 4. DIP switch settings for SW1.

Pin number (name)	Function selection	ON (left position)	OFF (right position)
8 (S1: L> or L> + I>)	The tripping criterion for the S1 sensor channel.	Tripping on light only (L>).	Tripping on light and overcurrent (L> + I>), both of which are required to occur simultaneously to trigger tripping.
7 (S2: L> or L> + I>)	The tripping criterion for the S2 sensor channel.	Tripping on light only (L>).	Tripping on light and overcurrent (L> + I>), both of which are required to occur simultaneously to trigger tripping.

6 (S3: L> or L> + I>) (AQ-110F) (L> or L> + I>) (AQ-110P)	The tripping criterion for the S3 sensor channel. (AQ-110F) The tripping criterion for the S3, S4 and S5 sensor channels. (AQ-110P)	Tripping on light only (L>).	Tripping on light and overcurrent (L> + I>), both of which are required to occur simultaneously to trigger tripping.
5 (a or b)	The selection of a standard arc scheme.	SAS type a.	SAS type b.
4 (scheme selection)	The selection of a standard arc scheme.	Please refer to the "Scheme selection" and "Application example" chapters.	Please refer to the "Scheme selection" and "Application example" chapters.
3 (scheme selection)	The selection of a standard arc scheme.	Please refer to the "Scheme selection" and "Application example" chapters.	Please refer to the "Scheme selection" and "Application example" chapters.
2 (scheme selection)	The selection of a standard arc scheme.	Please refer to the "Scheme selection" and "Application example" chapters.	Please refer to the "Scheme selection" and "Application example" chapters.
1 (scheme selection)	The selection of a standard arc scheme.	Please refer to the "Scheme selection" and "Application example" chapters.	Please refer to the "Scheme selection" and "Application example" chapters.

Table. 4.5 - 5. DIP switch settings for SW2.

Pin number (name)	Function selection	ON (left position)	OFF (right position)
8 (T1/T2: latch or non-latch)	Latches or non-latches the T1 and T2 trip relays.	T1 and T2 operate as latched.	T1 and T2 operate as non-latched.
7 (HSO: latch or non-latch)	Latches or non-latches the HSO1 and HSO2 high-speed outputs.	HSO1 and HSO2 operate as latched.	HSO1 and HSO2 operate as non-latched.
6 (S1: P> or L>) Only in AQ-110P!	The tripping criterion for the S1 sensor channel.	Tripping on pressure only (P>).	Tripping on light only (L>).
5 (S5: Fiber loop or AQD) Only in AQ-110P!	The selection between the fiber loop function and the arc quenching system (AQD) control.	The S5 fiber sensor channel operates as the fiber loop sensor function.	The S5 fiber sensor channel operates as the arc quenching system (AQD) control. The Tx terminal of S5 sends a test pulse signal to the quenching system.
4 (fast or CBFP)	The selection for the function of the T2 trip relay.	The trip time of the T2 trip relay is 7 ms.	The T2 trip relay operates as a CBFP relay. If any sensor or L> input (BI2) is activated for longer than the set CBFP time (that is, 100 or 150 ms), the CBFP function activates the T2 trip relay and the BO1 binary output. Please note that the master trip command (BI2) will not activate T2 when this dipswitch is set to the CBFP mode.
3 (100 ms or 150 ms)	The setting for the CBFP time.	The CBFP time is set to 100 ms.	The CBFP time is set to 150 ms.
2 (I>: 1 A or 5 A)	The nominal current selection for the phase currents IL1, IL2 and IL3.	The nominal current is 1 A.	The nominal current is 5 A.

1 (I0>: 1 A or 5 A)	The nominal current selection for the residual current I0.	The nominal current is 1 A.	The nominal current is 5 A.

4.5.1 Scheme selection

This chapter describes the schemes available for both variants of the unit. The schemes are configured using the first DIP switch (SW1) and its pins numbered 1…4 ("Scheme selection") and 5 ("a or b"). For detailed instructions on each of the available schemes please refer to the AQ-SAS™ booklet (can be found at arcteq.fi/downloads/). Please note that there are four booklets: two are for schemes based on IEC standards (MV and LV versions) and the other two for schemes based on ANSI standards (MV and LV versions).

4.5.2 Available logic schemes

The schemes described below are the most important ones for this unit. However, additional schemes are also available; please contact your nearest Arcteq representative for more information on those schemes.

SS:0a

The logic scheme SS:0a is designed for arc protection solutions by a stand-alone unit. An arc fault that is detected from any of the four sensor channels trips all trip contacts. At the same time, this also sends a master trip (MT) signal and an overcurrent signal to the outgoing feeder of all connected AQ-101 units (if these are used).

You can find a more detailed description of this scheme in the AQ-SAS™ booklet.

Figure. 4.5.2 - 13. The logic diagram of SS:0a.

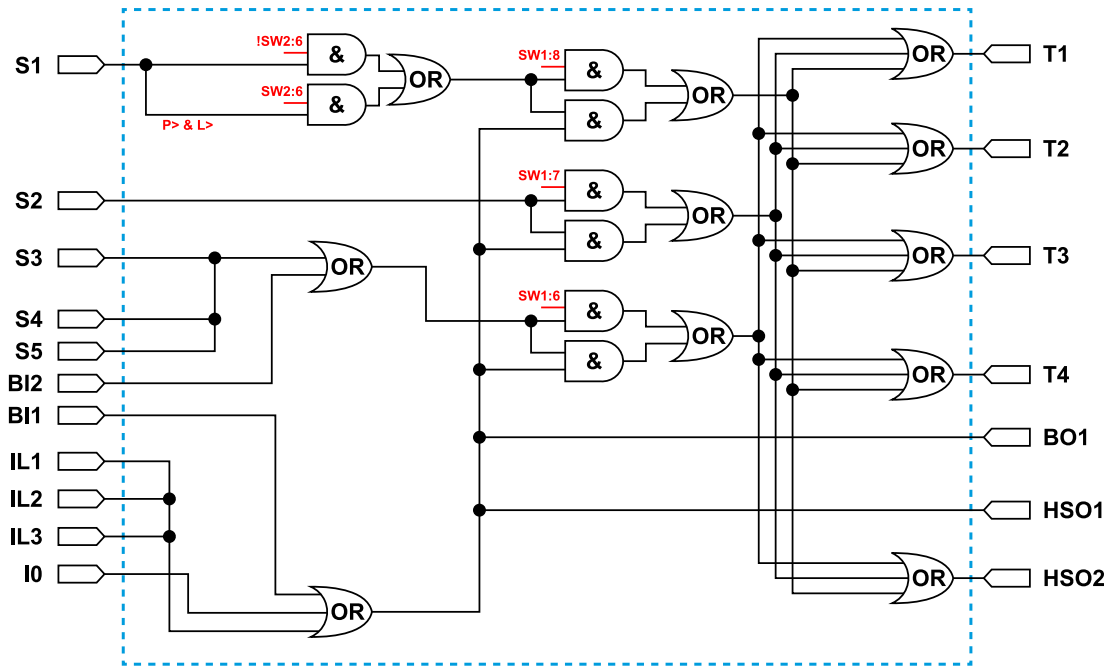


Figure. 4.5.2 - 14. The DIP switch settings for SS:0a.

Figure. 4.5.2 - 15. The trip logic matrix of SS:0a.

SS:0a		OUTPUTS					
		T1	T2	T3	BO1	HSO1	HSO2
INPUTS	S1	x	x	x	x	x (I>)	x
	S2	x	x	x	x	x (I>)	x
	S3	x	x	x	x	x (I>)	x
	S4	x	x	x	x	x (I>)	x

SS:1a

The logic scheme SS:1a typically used for selective arc protection solutions with one incoming feeder and one busbar. The sensor S1 monitors the incoming cable compartment, while S2 monitors the incoming feeder circuit breaker compartment. The sensors S3, S4 and S5 (the fiber loop sensor) monitor the busbar compartment. The trip contact T1 is responsible for tripping the incoming feeder circuit breaker. The trip contact T2 is used for tripping the upstream circuit breaker, while T3 is used for tripping the busbar section's circuit breaker. The trip contact T4 acts as the trip alarm. The overcurrent signal is sent to the outgoing feeder units within 2 ms in order to trip the outgoing feeder circuit breakers. If an arc fault is detected either in the incoming circuit breaker compartment or in the busbar compartment, a master trip (MT) signal is sent to all outgoing feeder AQ-101 units (if these are used).

You can find a more detailed description of this scheme in the AQ-SAS™ booklet.

Figure. 4.5.2 - 16. The logic diagram of SS:1a.

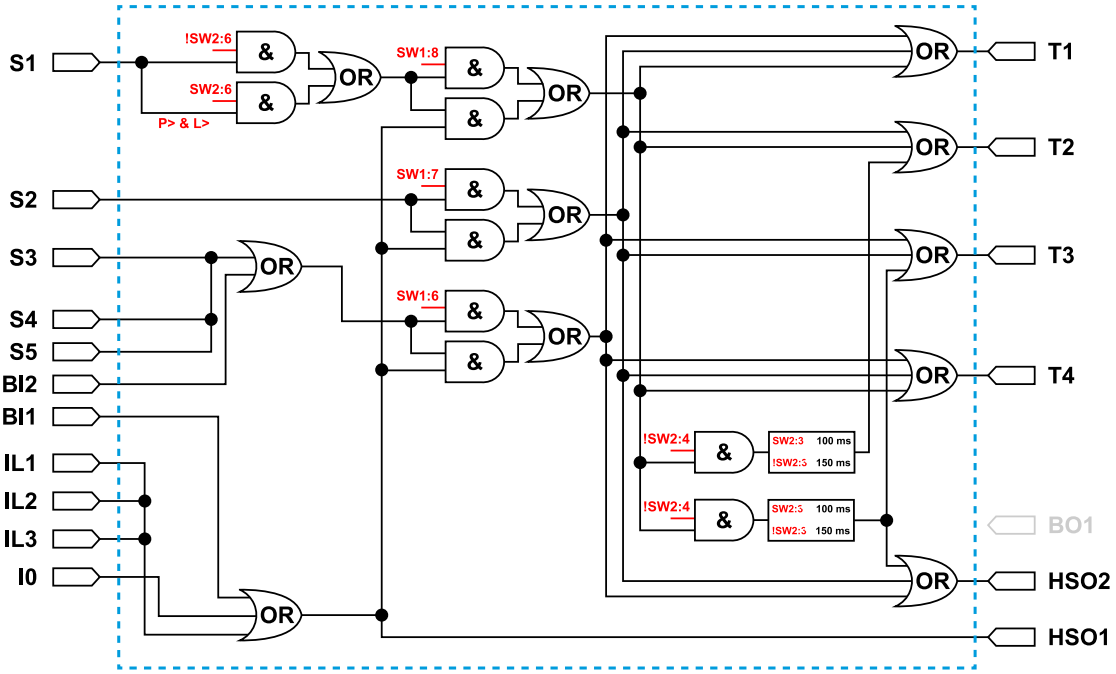


Figure. 4.5.2 - 17. The DIP switch settings for SS:1a.

Figure. 4.5.2 - 18. The trip logic matrix of SS:1a.

SS:1a		OUTPUTS						
		T1	T2	T3	T4	BO1	HSO1	HSO2
INPUTS	S1	x	x		x		x (I>)	
	S2	x	x	x	x		x (I>)	x
	S3	x		x	x		x (I>)	x
	S4	x		x	x		x (I>)	x

SS:1b

From the point of view of an AQ-110P, the design of the logic scheme SS:1b is very similar to the previous one (SS:1a). However, the high-speed output HSO1 acts as an additional trip contact in SS:1b. If an AQ-101 unit is applied to protect outgoing feeders, the main responsibility of AQ-110P is to send a master trip (MT) signal to trip all outgoing feeder circuit breakers.

You can find a more detailed description of this scheme in the AQ-SAS™ booklet.

Figure. 4.5.2 - 19. The logic diagram of SS:1b.

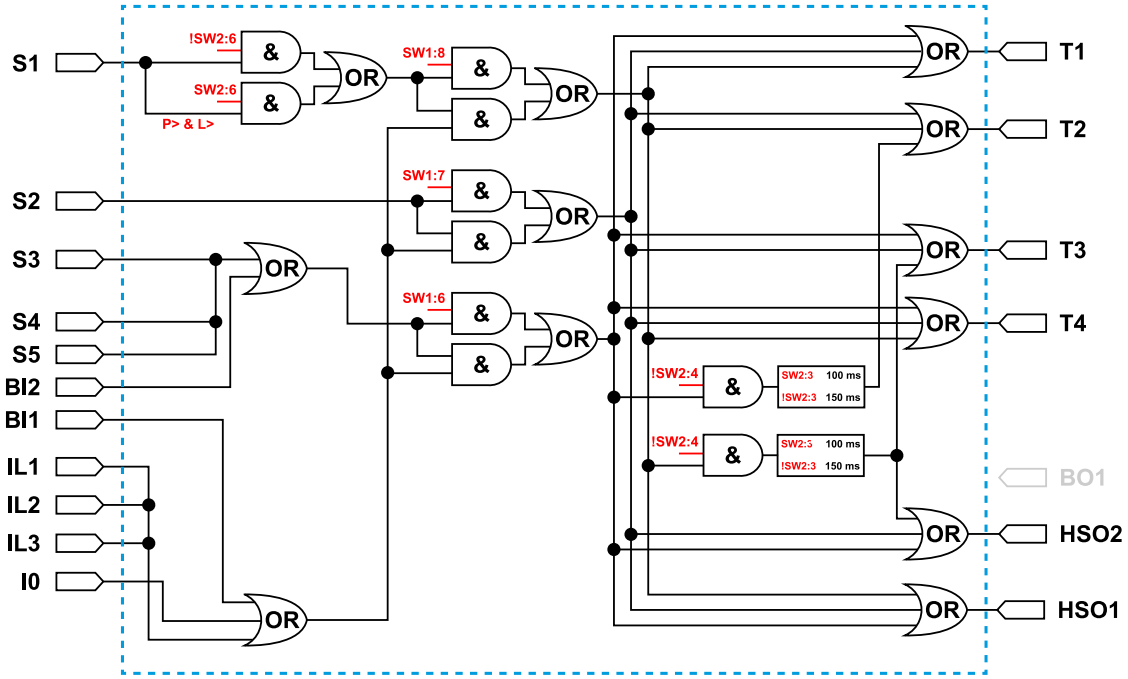


Figure. 4.5.2 - 20. The DIP switch settings for SS:1b.

Figure. 4.5.2 - 21. The trip logic matrix of SS:1b.

SS:1b		OUTPUTS						
		T1	T2	T3	T4	BO1	HSO1	HSO2
INPUTS	S1	x	x		x		x	
	S2	x	x	x	x		x	x
	S3	x		x	x		x	x
	S4	x		x	x		x	x

SS:2a

The logic scheme SS:2a is designed for selective arc protection solutions with two incoming feeders and one busbar. The sensor S1 monitors the incoming cable compartment, while S2 monitors the incoming feeder circuit breaker compartment. The sensors S3, S4 and S5 (the fiber loop sensor) monitor the busbar compartment. The trip contact T1 is responsible for tripping the incoming feeder circuit breaker. The trip contact T2 is used for tripping the upstream circuit breaker, while T3 is used for tripping the busbar section's circuit breaker. The trip contact T4 acts as the trip alarm. The overcurrent signal is sent to the outgoing feeder units within 2 ms in order to trip the outgoing feeder's circuit breakers. If an arc fault is detected either in the incoming circuit breaker compartment or in the busbar compartment, a master trip (MT) signal is sent to all outgoing feeder AQ-101 units (if these are used).

You can find a more detailed description of this scheme in the AQ-SAS^{TM} booklet.

Figure. 4.5.2 - 22. The logic diagram of SS:2a.

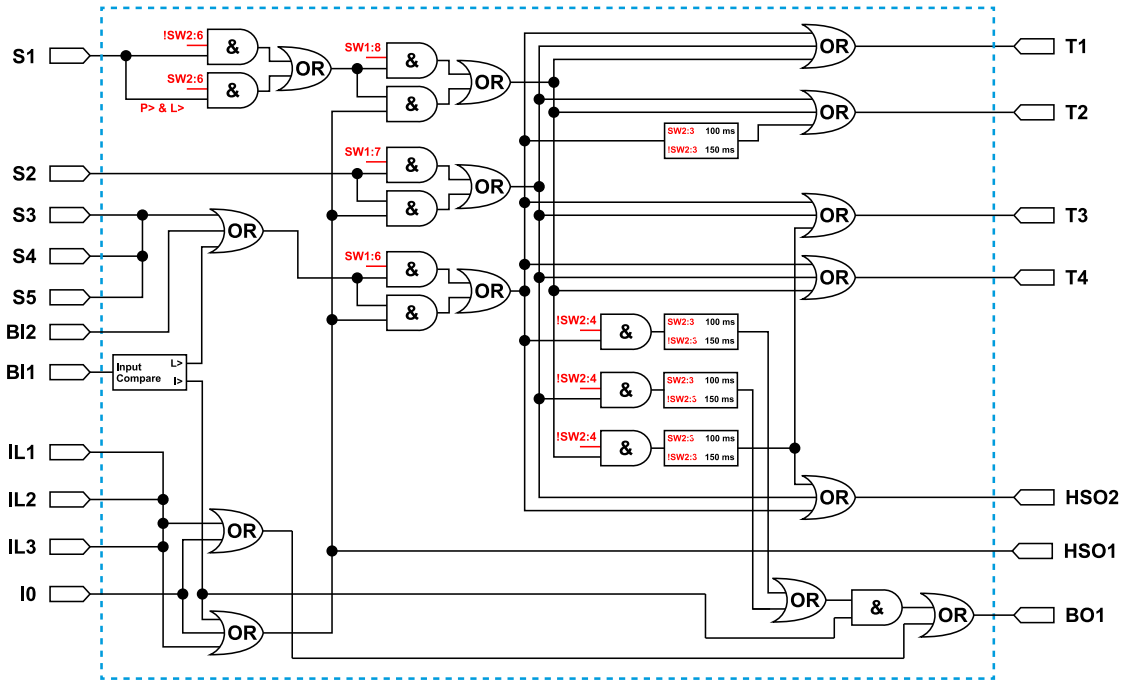


Figure. 4.5.2 - 23. The DIP switch settings for SS:2a.

Figure. 4.5.2 - 24. The trip logic matrix of SS:2a.

SS:2a		OUTPUTS						
		T1	T2	T3	T4	BO1	HSO1	HSO2
INPUTS	S1	x	x	CBFP	x	x	x (I>)	CBFP
	S2	x	x	x	x	x	x (I>)	x
	S3	x	CBFP	x	x	x	x (I>)	x
	S4	x	CBFP	x	x	x	x (I>)	x

SS:2b

The logic scheme SS:2b is applied to selective arc protection solutions with two incoming feeders and one busbar. From the point of view of an AQ-110P, the design of the logic scheme SS:2b is very similar to the previous one (SS:2a). However, the high-speed output HSO1 acts as an additional trip contact in SS:2b. If an AQ-101 unit is applied to protect outgoing feeders, the main responsibility of AQ-110P is to send a master trip (MT) signal to trip all outgoing feeder circuit breakers. The binary output BO1 is responsible for sending overcurrent information to a AQ-110P unit at another incoming feeder.

You can find a more detailed description of this scheme in the AQ-SAS™ booklet.

Figure. 4.5.2 - 25. The logic diagram of SS:2b.

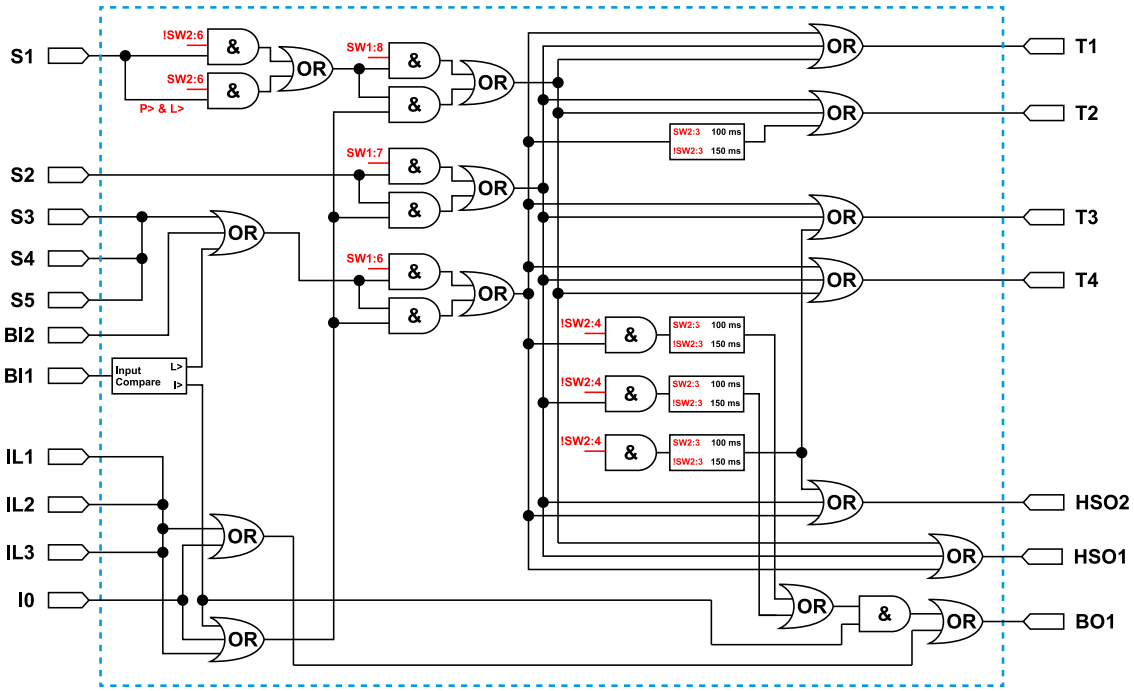


Figure. 4.5.2 - 26. The DIP switch settings for SS:2b.

Figure. 4.5.2 - 27. The trip logic matrix of SS:2b.

SS:2b		OUTPUTS						
		T1	T2	T3	T4	BO1	HSO1	HSO2
INPUTS	S1	x	x	CBFP	x	x	x	x
	S2	x	x	x	x	x	x	x
	S3	x	CBFP	x	x	x	x	x
	S4	x	CBFP	x	x	x	x	x

4.6 Non-volatile memory

All critical system data (such as DIP switch settings and the system setup file) are stored in the non-volatile memory (EPROM) to ensure accurate operation and full self-supervision even if auxiliary power is lost temporarily.

Additionally, all LED indications are stored in the non-volatile memory to provide a quick recovery of the system status indication. This feature is especially important if tripping causes the unit to lose its auxiliary power.

The non-volatile memory does not require a power supply to maintain the information and it retains the settings and the indications permanently without power.

5 Arc sensors

The AQ-100 series provides different types of arc sensors to be used with different units and different switchgear types according to specific application requirements. There are two types of sensors: arc light point sensors and arc light fiber optic loop sensors.

Arc light point sensors are typically installed in metal-clad compartments, and they provide a quick and accurate location of the faulted area. Arc light fiber loop sensors typically cover a wider protected area with one fiber, when there is no need to pinpoint the exact location for a fault.

5.1 Arc light point sensor AQ-01

AQ-01 is an arc light point sensor with a light-sensitive photodiode element activated by arc light. The AQ-01 sensors should be mounted in the switchgear cubicles in such a way that the light-sensitive part covers the protected area as completely as possible. Only one sensor should be used per one closed metal-clad compartment. In open spaces (such as a busbar section) the sensors should be mounted no more than two meters apart.

The default light intensity threshold for an AQ-01 sensor is 8,000 lux. Depending on the demand of the application, the default threshold can also be set to 25,000 lux or 50,000 lux. An arc light sensor does not require further settings by the user. Its detection radius is 180 degrees.

Figure. 5.1 - 28. The AQ-01 light sensor.

An AQ-01 is installed either on the compartment wall or through the wall. When wall-mounting, the unit is placed on the wall (with the gray side against the wall) and then fixed to the wall with two screws from the back of the sensor. Through-the-wall mounting is similar: the unit is placed on the wall (with the blue side against the wall and the eye is pushed into the drilled compartment hole for protection) and then fixed to the wall with two screws from the back of the sensor. No external mounting plates are needed regardless of the mounting type; however, mounting brackets can be used if so desired.

Up to three (3) sensors can be connected in series. Installing a connection cable is simple as each end of the sensor has a detachable cover over the cable connectors. Please remember to reattach the cover once the wires have been installed.

NOTE!

The AQ-01 point sensor does not come with a connection cable!

5.2 Arc light and pressure point sensor AQ-02

AQ-02 is an arc light and pressure point sensor that comes with arc light detection and ambient pressure detection. The AQ-02 sensors should be mounted in the switchgear cubicles in such a way that the light-sensitive part covers the protected area as completely as possible. Only one sensor should be used per one closed metal-clad compartment. The AQ-02 sensors cannot be installed in open spaces.

The default light intensity threshold for an AQ-02 sensor is 8,000 lux. Depending on the demand of the application, the default threshold can also be set to 25,000 lux or 50,000 lux. An arc light sensor does not require further settings by the user. Its detection radius is 180 degrees. The pressure threshold is fixed at 0.2 bar above ambient pressure.

Figure. 5.2 - 29. AQ-02 arc light and pressure point sensor.

An AQ-02 can only be installed on the compartment wall as not to block pressure detection located next to "the eye". The unit placed on the wall (with the gray side against the wall), and then fixed to the wall with two screws. No external mounting plates are needed regardless of the mounting type; however, mounting brackets can be used if so desired.

Up to three (3) sensors can be connected in series. Installing a connection cable is simple as each end of the sensor has a detachable cover over the cable connectors. Please remember to reattach the cover once the wires have been installed.

5.3 Arc light fiber optic loop sensor AQ-06

AQ-06 is an arc light fiber optic loop sensor, which is a plastic fiber optic cable. Fiber sensors are distributed through the protected switchgear cells. The fixed light intensity threshold of an AQ-06 sensor is 8,000 lux. The sensor does not require further settings by the user. The sensor's detection radius is 360 degrees.

AQ-06 sensors can be ordered in pre-manufactured lengths of 3…40 meters (3 m, 5 m, 10 m, 15 m, 20 m, 25 m, 30 m, 35 m, 40 m).

5.4 Arc light fiber optic loop sensor AQ-07

AQ-07 is an arc light fiber optic loop sensor, which is a robust fiber optic cable with a practically unlimited bending radius. The sensor contains hundreds of glass fiber drains covered by a plastic tube, thus making it extremely strong and durable. Fiber sensors are distributed through the protected switchgear cells.

AQ-07 sensors can be ordered in pre-manufactured lengths of 3…50 meters (3 m, 5 m, 10 m, 15 m, 20 m, 25 m, 30 m, 35 m, 40 m, 45 m, 50 m).

The fixed light intensity threshold of an AQ-07 sensor is 8,000 lux. The sensor does not require further settings by the user. The sensor's detection radius is 360 degrees.

If necessary, the ends of an AQ-07 cable can be covered with black rubber to avoid light detection outside the protected zone. The covered area can be one (1) or two (2) meters by default; if other lengths are required, please consult the Arcteq sales team. You can find the "Contact and reference information" page at the end of this manual.

5.5 Arc light fiber optic loop sensor AQ-08

AQ-08 is an arc light fiber optic loop sensor. It is designed to withstand temperatures up to 125 ºC, which makes it suitable for e.g. wind turbine windings. AQ-08 is a robust fiber optic cable with a practically unlimited bending radius. The sensor contains hundreds of glass fiber drains that are covered by a plastic tube, thus making it extremely strong and durable. Fiber sensors are distributed through the protected switchgear cells.

AQ-08 sensors can be ordered in pre-manufactured lengths of 3…15 meters (3 m, 5 m, 10 m, 15 m).

The fixed light intensity threshold of an AQ-08 sensor is 8,000 lux. The sensor does not require further settings by the user. The sensor's detection radius is 360 degrees.

5.6 Sensor—unit dependencies

Different sensor types can be used with different arc flash protection units of the AQ-100 series. The table below describes those dependencies.

Table. 5.6 - 6. Sensor—unit dependencies.

	AQ-01	AQ-02	AQ-06	AQ-07	AQ-08
AQ-101	Yes	Yes	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)
AQ-101D	Yes	Yes	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)
AQ-101S	Yes	Yes	No	No	No
AQ-102	No	No	Yes	Yes	Yes
AQ-103	Yes	Yes	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)
AQ-110P	Yes	Yes	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)
AQ-110F	No	No	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)	Yes (when the unit is equipped with the fiber option)

5.7 Connecting sensors

How to connect point sensors

1. Open the sensor covers and detach the connectors.
2. Attach the cable to the connector and to the unit.
3. Reattach the connectors to the sensor.
4. Run the auto-configuration procedure.
5. Once the auto-configuration has been successfully completed, put the sensor covers back in place.

For more detailed instructions, please refer to the "Connecting sensors" chapter in the AQ-0x instruction booklet (arcteq.fi/downloads).

How to connect fiber sensors

1. Drill holes on the compartment wall and cover any sharp edges.
2. Run the fiber through the holes and fasten it to the protected area.
3. Connect the sensor terminals into the Tx and Rx slots at the back of the unit.

The placement of the fiber sensor may require blocking of unwanted light activation. The AQ-07 glass fiber can be ordered with end covers to conceal one (1) or two (2) meters of the fiber on each end. Please refer to the "Arc light fiber optic loop sensor AQ-07" chapter for more information.

6 System self-supervision

Both AQ-110 variants have an extensive self-supervision feature, including both internal functions and external connections. The self-supervision module monitors the power supply, hardware and software malfunctions, as well as problems with the binary input connection(s) and sensor(s). Additionally, the module supervises the DIP switch settings by comparing actual values with the data stored in the non-volatile memory.

When the unit's condition is healthy, the "Power" LED is lit and the system failure (SF) relay is energized. If the self-supervision function detects a faulty condition or if the power supply fails, the SF relay is released and the "Error" LED becomes lit.

If a sensor failure occurs, the unit will go into Error mode. The "Error" LED turns on, the SF relay releases, and the LED of the corresponding faulty sensor channel starts blinking. In this situation the unit is still in the protection mode, although the faulty sensor channel is blocked. If the error is resolved, the unit automatically clears the system failure status, energizing the SF relay and turning off the "Error" LED. If one or more of the sensors are disconnected, the healthy sensors remain in use and the unit remains operational accordingly. However, the unit remains in Error mode until the disconnected sensors are repaired.

The unit goes into SF alarm mode, if a DIP switch setting is changed after the system setup procedure has been performed. However, the configured (stored) settings are still valid and the unit is still operational.

In AQ-110 units the self-supervision module also monitors the current transformer circuit. If the current flow exceeds $0.2 \times I_n$, the unit assumes that the switchgear is energized and the module monitors the phases for an open connection. If at least one of the phases remains above $0.2 \times I_n$ while the others are at zero, the unit issues an open CT alarm: the SF relay is released, the "Error" LED is turned on and the LED of the faulty phase(s) starts blinking.

7 Application example: two incomers with a tie breaker (main-tie-main)

This chapter describes an example of a fully selective arc flash protection application with two incomers and a tie breaker. It usually requires a sensor unit with overcurrent measurement (AQ-110P or AQ-110F) for each incoming feeder as well as an arc fault detection unit (AQ-101 or AQ-102) for each outgoing feeder. An arc fault can be detected by (point or fiber loop) sensors in each switchgear compartment.

This application example is based on a typical main-tie-main configured power distribution system. It consists of two independent incomers, four outgoing feeders and one bus tie breaker. The relevant arc flash protection components are listed in the table below.

Table. 7 - 7. Components for a main-tie-main arc flash protection.

Device	Location	Quantity	Comments
AQ-110P	Incomer	1	The left-hand side bus section incomer.
AQ-101	Outgoing feeder	2	The left-hand side bus section outgoing feeders.
AQ-01	Each compartment	9	The cable, circuit breaker and busbar compartments.
AQ-01	Tie compartment	2	The circuit breaker and busbar compartments.
AQ-110F	Incomer	1	The right-hand side bus section incomer.
AQ-102	Outgoing feeder	2	The right-hand side bus section outgoing feeder.
AQ-07	Cable and circuit breaker compartments	6	The cable and circuit breaker compartments.
AQ-07	Busbar compartment	1	The whole right-hand side section busbar.

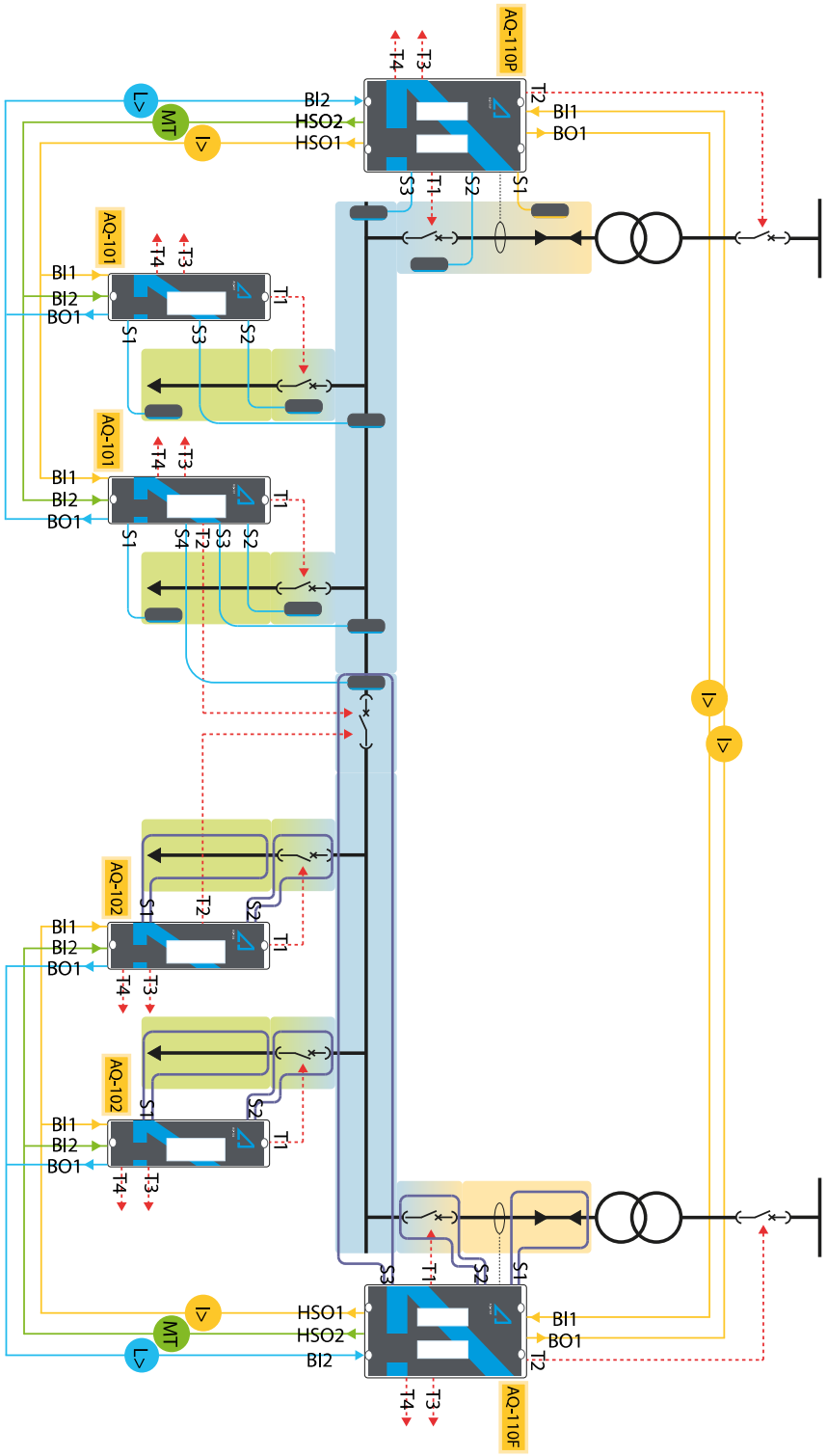
When an arc fault is detected in a cable compartment, it only trips the circuit breaker of the local feeder. When an arc fault occurs in an incomer cable compartment, the AQ-110 unit can send the trip signals upstream to the circuit breaker.

When an arc fault is detected in an incomer breaker compartment, the AQ-110 unit trips the incomer circuit breaker and the incomer upstream circuit breaker. At the same time it also sends the master trip signal to all connected AQ-101/102 units in order to trip all outgoing feeder breakers in the bus section. When an arc fault is detected in an outgoing breaker compartment, the AQ-110 unit trips the incomer circuit breaker, and sends the master trip signal to all connected AQ-101/102 units.

When an arc fault is detected in the busbar compartment, the AQ-110 unit trips the incomer circuit breaker, and sends the master trip signal to all connected AQ-101/102 units in order to trip all outgoing feeder breakers in the bus section.

When an arc fault occurs in a breaker or busbar compartment, the T3 trip contact of an AQ-110 can be used to trip the tie breaker. Alternatively, the T2 trip contact of an AQ101 or AQ-102 can be used to trip the tie breaker.

Figure. 7 - 30. A main-tie-main application with AQ-100 series products.



8 Connections

The figures below depict the connections of AQ-110P and AQ-110F. Please note that the SF relay is in the de-energized position; also note that the unit has been halved for the image to allow for space for all connector explanations.

Figure. 8 - 31. Rear terminals of AQ-110P.

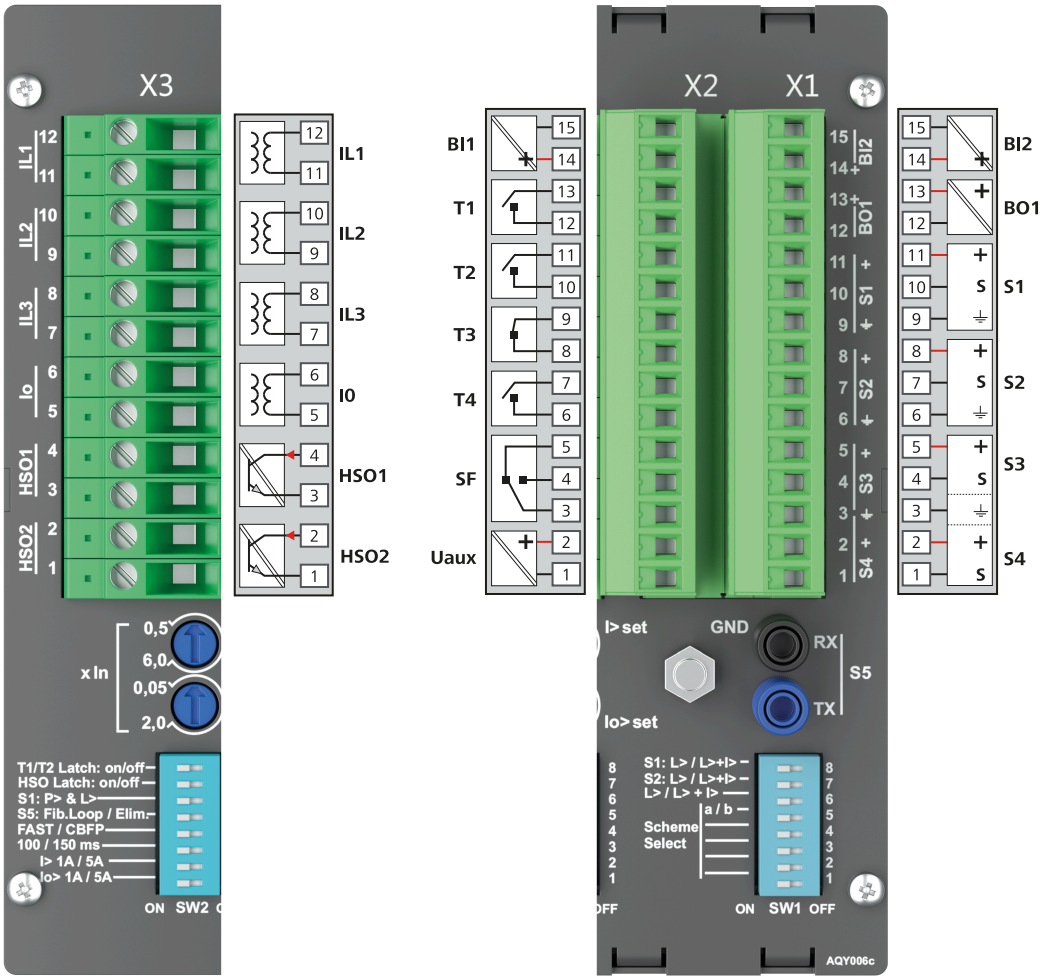
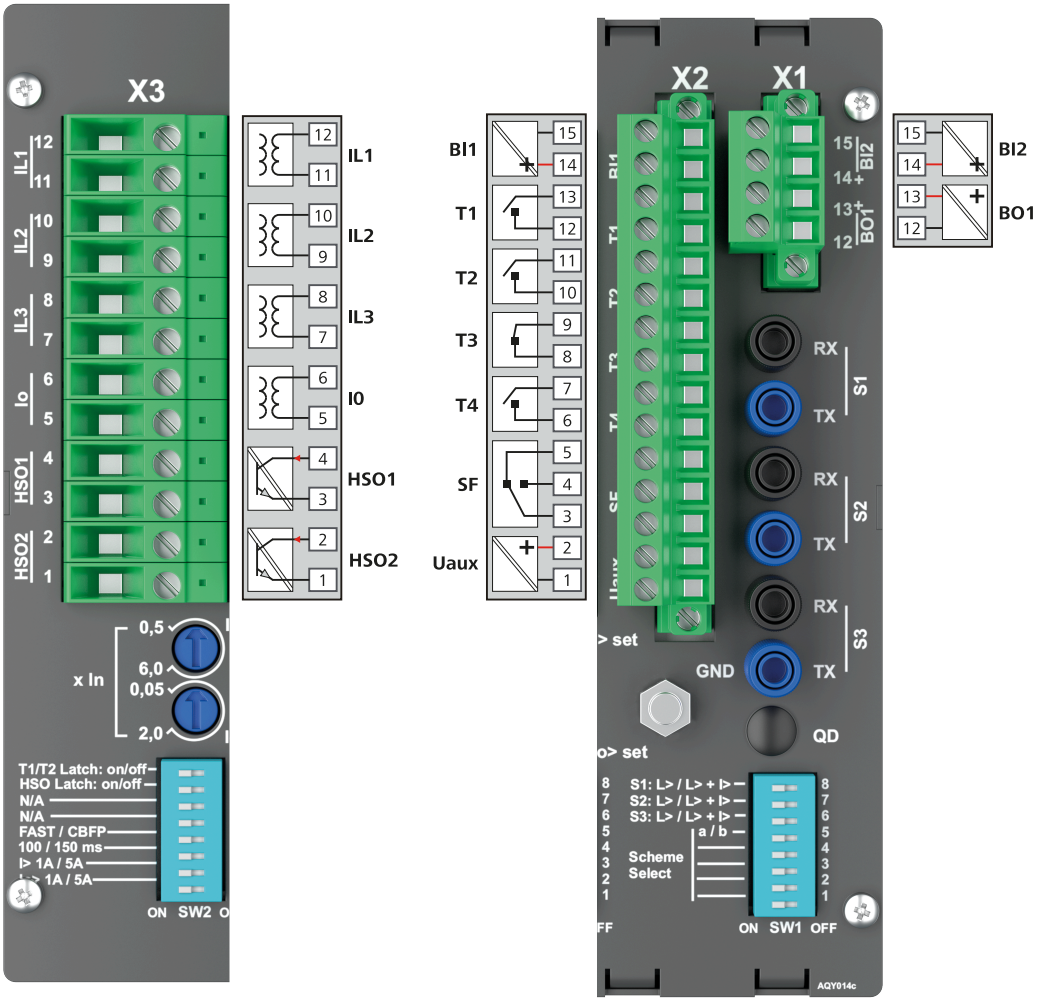


Figure. 8 - 32. Rear terminals of AQ-110F.



8.1 Outputs

8.1.1 Trip relays

This unit has two (2) integrated trip relays for tripping circuit breakers, namely T1 and T2. Their type is normally open (NO).

T3 can function either as an electronic lock-out relay or as a trip relay. When T3 is configured as an electronic lock-out relay, its type is normally closed (NC) and it holds its position until it receives a manual reset command or until auxiliary power supply is lost. When re-applying the auxiliary power supply, the electronic lock-out relay returns to the same contact condition it had prior to the power loss. This normally closed relay output can also be used for tripping contactor-controlled devices. If the application so requires, T3 can also be ordered as normally open (NO) from the factory. This choice is specified when ordering this unit.

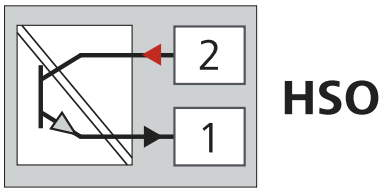
T4 is a common trip relay that operates whenever T1 or T2 operates. It can be used either for tripping one additional disconnecting device, or as a trip alarm in a (local or remote) monitoring and alarming system.

8.1.2 High-speed output(s)

The unit contains two (2) high-speed semiconductor outputs, namely HSO1 and HSO2. These outputs can used as heavy-duty signaling outputs. Due to their high current-carrying capacity, HSO1 and HSO2 can supply current or light information to a maximum of twenty (20) pieces of AQ-100 series units without a need for signal amplifiers. The operation of these high-speed outputs depends on the DIP switch settings (for more information, please refer to the "DIP switch settings" chapter).

The output's direction of rotation is as follows: the signal goes in the even pin and out from the odd pin (see the image below, as detailed in the unit's side sticker).

Figure. 8.1.2 - 33. The high-speed output's direction of rotation.



Please note that the high-speed output is polarity-sensitive (see the "Wiring" chapter for more information).

8.1.3 Binary outputs

The unit has one (1) binary output: BO1 (+24 VDC). The binary output function can be configured with the DIP switches. For more information on the configuration, please refer to the "DIP switch settings" chapter.

Please note that the binary ouput is polarity-sensitive (see the "Wiring" chapter for more information).

8.1.4 System failure relay

The system failure (SF) relay is of the change-over type (NO/NC) and it is energized when the unit is in a healthy condition. Whenever the unit detects a system error or a disconnection between the auxiliary power supply and the contacts, the SF relay changes its state. The state stays this way until the unit returns to a healthy condition and the SF relay is energized again.

8.2 Inputs

8.2.1 Current measurement inputs

Both AQ-110x variants have four (4) CT inputs for measuring the three phase currents and the residual current. Both the phase current and the residual current inputs can be configured to a nominal current of 1 A or 5 A with the DIP switches (for more information, please refer to the "DIP switch settings" chapter). The "System self-supervision" chapter describes the setting of current threshold levels in more detail. The same chapter also describes the open circuit detection feature included in the AQ-110x units.

8.2.2 Arc sensor channels

AQ-110P has four (4) arc point sensor channels: S1, S2, S3 and S4. You can connect a maximum of three (3) arc point sensors to each channel.

S5 is the optional fiber optic loop sensor channel with a transceiver (Tx) terminal and a receiver (Rx) terminal. The function of S5 is controlled with the DIP switches (please refer to the "DIP switch settings" chapter for more information). When S5 is configured as a fiber optic loop sensor, one of its ends is connected to "Tx" and the other to "Rx". This sensor loop is then continuously monitored by a test light pulse that travels through the loop. If a discontinuity is detected, the unit goes into Error mode and activates the "Error" LED and the SF relay output.

Alternatively, S5 can be configured to control the arc quenching system. Similarly, the unit sends a continuous light pulse to the arc quenching system for self-supervision purposes.

AQ-110F has three (3) arc fiber loop sensor channels: S1, S2 and S3. Each channel has a transceiver (Tx) terminal and a receiver (Rx) terminal. Also, there is an additional transceiver (Tx) terminal available for arc quenching system control.

For more information on sensors, please refer to the "Arc sensors" chapter as well as to the AQ-0x instruction booklet which can be found on Arcteq's website (https://www.arcteq.fi/downloads/).

8.2.3 Binary inputs

Both AQ-110x variants contain two (2) binary inputs, BI1 and BI2.

The function of the binary inputs is selected with the DIP switches according to the SAS application used (for more information, please refer to the "DIP switch settings" chapter in this manual). Typically, the binary inputs are used for receiving arc light information from AQ-101 and AQ-102 units as well as for receiving overcurrent information from other AQ-110x units.

The binary inputs are activated when a connected DC signal exceeds the specified nominal threshold level of the corresponding input. The nominal threshold level for AQ-110x units is 24 VDC. Please note that the actual activation of the binary input occurs earlier than the specified nominal threshold value (see Chapter 11.5, "Techical Data").

8.3 Auxiliary voltage

The auxiliary power supply voltage is 92….265 V AC/DC. Alternatively, the optional auxiliary power supply can be of 18…72 V DC. This choice must be specified when ordering.

9 Testing

It is recommended that the unit is tested prior to substation energizing. Testing is carried out by simulating an arc light for each sensor and verifying that the unit tripped and that the correct indicator LED turned on.

Any high-quality camera with an interchangable lens works well to simulate arc light. Having a self-timer helps with the testing process because it can be connected to the test kit. Any strong flashlight works to test non-latched signals and the CBFP function. Before testing please check that the equipment used has a fully charged battery.

9.1 Testing the light-only mode

1. Check that the DIP switch settings are positioned according to your application.
2. Activate the camera flash within 30 cm (12 inches) of the sensor that is being tested.
3. Verify that the indicator LED of the corresponding sensor channel is lit.
4. Verify the activation(s) of the relay output(s) by checking the circuit breaker's status, or by monitoring the trip contact's status. The circuit breaker should open, or the contacts operate. Please note that you achieve the best test results when you operate the circuit breaker while testing.
5. Verify that the indicator LED(s) of the corresponding relay output(s) is lit.
6. If you are using the BO1 binary output and/or one or both of the high-speed outputs, verify their signal activation either through the status change of the relevant input, or by measuring the signal output voltage. Please note that BO1 is of the non-latched type.
7. If you are using the BO1 binary output and/or one or both of the high-speed outputs, also verify that their corresponding LED is lit.
8. Press the SET push button to reset all indications and latches.
9. If you are using the BI2 binary input as the master trip, activate it and verify that the trip has occurred by repeating the steps 4 and 5.
10. Press the SET push button to reset all indications and latches.
11. Repeat the steps 1 through 10 for all sensors.

9.2 Testing the light and current mode

1. Check that the DIP switch settings are positioned according to your application.
2. Activate the following two things simultaneously: the camera flash within 30 cm (12 inches) of the sensor unit that is being tested, and the BI1 binary input used for the overcurrent condition (I>).
3. Verify that the indicator LED of the corresponding sensor channel is lit.
4. Verify that the indicator LED of the BI1 binary input is lit.
5. Verify the activation(s) of the relay output(s) by checking the circuit breaker's status, or by monitoring the trip contact's status. The circuit breaker should open, or the contacts operate. Please note that you achieve the best test results when you operate the circuit breaker while testing.
6. Verify that the indicator LED(s) of the corresponding relay output(s) is lit.
7. If you are using the BO1 binary output or a high-speed output (HSO1 and/or HSO2), verify the signal activation either through the status change of the relevant input, or by measuring the signal output voltage.
8. If you are using the BO1 binary output or a high-speed output (HSO1 and/or HSO2), also verify that the corresponding LED is lit. Please note that BO1 is of the non-latched type.
9. If you are using the BI2 binary input, verify its correct operations by activating the input.
10. Activate the camera flash within 30 cm (12 inches) of the point sensor unit but do not activate the binary input used for the overcurrent condition (I>).
11. Verify that no trip has occured and only the indicator LED of the sensor activation is lit.

12. If you are using the BO1 signal and have configured it to send light information, verify that it is activated.
13. Press the SET push button to reset all indications and latches.
14. If you are using the BI2 binary input as the master trip, activate it and verify that the trip has occurred by repeating the steps 5 and 6.
15. Press the SET push button to reset all indications and latches.
16. Repeat the steps 1 through 15 for all sensors.

9.3 Testing the CBFP function

The circuit breaker failure protection (CBFP) function is tested by taking the light signal and the secondary trip criterion signal (if applicable) and leaving them active for longer than the set CBFP time (that is, 100 or 150 ms). The T2 trip relay and the BO1 binary output must be active after the set time delay has passed to confirm the CBFP function operates correctly.

9.4 Testing the unit operation time

An operation time test is not required at commissioning as it is performed by the manufacturer both as a type test and as a routine production test. If you want to have more information of these tests, please refer to the routine test reports sent with the AQ-110 unit and/or consult your nearest Arcteq representative for the type test reports.

However, if it is deemed necessary, you can conduct an on-site timing test with the following instructions.

1. Use a calibrated relay test set.
2. Connect one of the test set's outputs to a strong camera flash to initialize the flash and to configure the set's timer to start simultaneously with the flash.
3. Connect one of the AQ-110 unit's trip outputs (T1, T2, T3, T4) or high-speed outputs (HSO1, HSO2) to a test set input and configure the input to stop the timer.
4. Place the camera flash within 20 cm (12 inches) of the sensor.
5. Initiate the flash and the timer by using the test set output.
6. Read the measured time between the simulated arc light and the operation of the trip contact.
7. Subtract the digital input delay of the test set from the final measured time (if applicable). For specific test instructions, please consult the manufacturer of the relay test set.

9.5 Test plan example

Basic data	
Date:	
Substation:	
Switchgear:	
Serial number:	

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Preconditions		Additional notes
Trip mode (channel 1):	___ L> ___ L> + I>	
Trip mode (channels 2, 3, 4):	___ L> ___ L> + I>	
BI master trip in use:	___ Yes ___ No	
CBFP in use:	___ Yes ___ No	
CBFP time setting:	___ 100 ms ___ 150 ms	

Object activated		LED active	T1, T2, T3, T4 active	BO1 active	Additional notes
Sensor channel 1	S1				
	S2				
	S3				
Sensor channel 2	S1				
	S2				
	S3				
Sensor channel 3	S1				
	S2				
	S3				
Sensor channel 4	S1				
	S2				
	S3				
Fiber sensor channel					
Binary inputs	BI1				
	BI2				
Phase current (IL1, IL2, IL3)					
Residual current (I0)					

Involved personnel	
Tested by:	
Approved by:	

10 Troubleshooting

Table. 10 - 8. Troubleshooting guide for AQ-110x variants.

Problem	Possible solution(s)
The sensor does not activate during testing.	Check the sensor's cable wiring (see the "Arc sensors" chapter for more information). or Check the testing equipment, especially the camera flash intensity (see the "Testing" chapter for more information).
The trip relay does not operate even when the sensor is activated.	Check the DIP switch settings (see the "DIP switch settings" chapter for more information).
The current measurement's indicator LED is continuously lit.	Check the set current threshold (see the "Current threshold settings" chapter for more information).
The current measurent's indicator LED is blinking.	Check that the connections of the three phase currents are correct (see the "System self-supervision" for more information).

11 Technical data

11.1 Mounting and installation

Table. 11.1 - 9. Technical data for relay mounting and installation (AQ-110P).

Panel: - material - thickness (min...max)	 metal 1.0...5.0 mm (0.04...0.20 in)
Panel mounting: - screw type - key size - tightening torque (min...max)	 ISO 14581 M4x12, galvanized Torx T20 1.5...2.0 N·m (13.3...17.7 lbf·in)
Grounding: - nut type - key size - tightening torque (min...max)	 DIN934-M5 galvanized 8 2.5...3.0 N·m (22.1...26.6 lbf·in)
Connectors X1 and X2: - connector type - wire cross section (min...max) - minimum stripping length - screw tightening torque (min...max)	 Phoenix Contact MSTB 2,5/15-ST-5,08 BD:1-15 0.2...2.5 mm^2 (24...13 AWG) 7 mm (0.28 in) 0.5...0.6 N·m (4.4...5.3 lbf·in)
Connector X3: - wire cross section (min...max) - minimum stripping length - screw tightening torque (min...max)	 0.5...6.0 mm^2 (20...9 AWG) 14 mm (0.55 in) 0.5...0.6 N·m (4.4...5.3 lbf·in)
Fiber connectors: - nut tightening torque	 light finger tightening

Table. 11.1 - 10. Technical data for relay mounting and installation (AQ-110F).

Panel: - material - thickness (min...max)	 metal 1.0...5.0 mm (0.04...0.20 in)
Panel mounting: - screw type - key size - tightening torque (min...max)	 ISO 14581 M4x12, galvanized Torx T20 1.5...2.0 N·m (13.3...17.7 lbf·in)
Grounding: - nut type - key size - tightening torque (min...max)	 DIN934-M5 galvanized 8 2.5...3.0 N·m (22.1...26.6 lbf·in)
Connector X1: - connector type - wire cross section (min...max) - minimum stripping length - screw tightening torque (min...max)	 Phoenix Contact FRONT-MSTB 2,5/4-STF-5,08 0.34...2.5 mm^2 (24...12 AWG) 10 mm (0.39 in) 0.5...0.6 N·m (4.4...5.3 lbf·in)
Connector X2: - connector type - wire cross section (min...max) - minimum stripping length - screw tightening torque (min...max)	 Phoenix Contact FRONT-MSTB 2,5/15-STF-5,08 0.34...2.5 mm^2 (24...12 AWG) 10 mm (0.39 in) 0.5...0.6 N·m (4.4...5.3 lbf·in)

Connector X3: - wire cross section (min...max) - minimum stripping length - screw tightening torque (min...max)	 0.5...6.0 mm^2 (20...9 AWG) 14 mm (0.55 in) 0.5...0.6 N·m (4.4...5.3 lbf·in)
Fiber connectors: - nut tightening torque	 light finger tightening

11.2 Operating times

Table. 11.2 - 11. Technical data for relay operating times.

Trip time using HSO	2 ms*
Trip time using mechanical trip relays	7 ms*
Reset time: - light stage - overcurrent stage	 1 ms 50 ms

*) The total trip time when using both the arc light (L>) or phase/residual overcurrent (I>) from this unit and the arc light (L>) from an AQ-101 variant or an AQ-102 unit.

11.3 Auxiliary voltage

Table. 11.3 - 12. Technical data for the relay auxiliary voltage (Uaux).

Auxiliary power supply	92…265 V AC/DC 18…72 V DC (optional)
Maximum interruption	100 ms
Maximum power consumption	5 W, < 10 mΩ
Standby current	90 mA

11.4 Current measuring circuits

Table. 11.4 - 13. Technical data for the current measurement circuits (IL1, IL2, IL3, I0).

Nominal current	1 A or 5 A
Rated frequency	2…1,000 Hz
Number of inputs	3 (phase) + 1 (residual)
Thermal withstand: - continuous - 10 s - 1 s	 30 A 100 A 500 A
Overcurrent setting range: - phase overcurrent - residual overcurrent	 0.5…6.0 × I_N 0.05…2.00 × I_N
Measurement accuracy	10 %
Rated AC burden (VA)	10 mΩ (input resistance)
Power consumption of current input circuit	< 10 mΩ

11.5 Binary inputs

Table. 11.5 - 14. Technical data for the relay binary inputs (BI1, BI2).

Nominal threshold voltage	24 V DC
Threshold: - pick-up - drip-off	 ≥ 16 V DC ≤ 15 V DC
Rated current	3 mA
Number of inputs	2

11.6 Trip relays

Table. 11.6 - 15. Technical data for the trip relays (T1, T2, ~~T3~~, T4).

Number of trip relays	4 NO or 3 NO + 1 NC
Voltage withstand	250 V AC/DC
Carry: - continuous carry - make-and-carry for 3 s - make-and-carry for 0.5 s	 5 A 16 A 30 A
Breaking capacity DC*	40 W (0.36 A at 110 V DC)
Contact material	AgNi 90/10

*) When the time constant L/R = 40 ms.

11.7 High-speed output(s)

Table. 11.7 - 16. Technical data for the high-speed outputs (HSO1, HSO2).

Number of outputs	2
Rated voltage	250 V DC
Carry: - continuous carry - make-and-carry for 3 s - make-and-carry for 0.5 s	 2 A 6 A 15 A
Breaking capacity DC*	1 A/110 W
Contact material	Semiconductor

*) When the time constant L/R = 40 ms.

11.8 Binary output(s)

Table. 11.8 - 17. Technical data for the relay binary output (BO1).

Number of outputs	1
Rated voltage	+24 V DC
Rated current (max.)	20 mA

11.9 System failure relay

Table. 11.9 - 18. Technical data for the system failure relay (SF).

Number of SF relays	1
Rated voltage	250 V AC/DC
Carry: - continuous carry - make-and-carry for 3 s - make-and-carry for 0.5 s	 5 A 16 A 30 A
Breaking capacity DC*	40 W (0.36 A at 110 V DC)
Contact material	AgNi 90/10

*) When the time constant L/R = 40 ms.

11.10 Sensors

AQ-01 point sensor

Table. 11.10 - 19. Technical data for the AQ-01 light point sensor.

Light intensity threshold	8,000 lux 25,000 lux 50,000 lux
Detection radius	180º
Mechanical protection	IP 20
Sensor cable specification	Shielded twisted pair 0.75 mm^2 (AWG: 18)
Maximum sensor cable length (per channel)	200 m
Operating temperature	–20…+85 ºC

AQ-02 point sensor

Table. 11.10 - 20. Technical data for the AQ-02 light and pressure point sensor.

Light intensity threshold	8,000 lux 25,000 lux 50,000 lux
Pressure threshold (fixed)	0.2 bar above ambient pressure
Pressure measuring accuracy	±1.8 % (of full scale)
Detection radius	180º
Mechanical protection	IP 20
Sensor cable specification	Shielded twisted pair 0.75 mm^2 (AWG: 18)
Maximum sensor cable length (per channel)	200 m
Operating temperature	–20…+85 ºC

AQ-06 fiber optic loop sensor

Table. 11.10 - 21. Technical data for the AQ-06 fiber optic loop sensor.

Material	Plastic fiber
Light intensity threshold	8,000 lux
Cable length (min…max)	3…40 m
Cable diameter	1.0 mm
Detection radius	360º
Bending radius	5 cm
Operating temperature	–40…+85 ºC

AQ-07 fiber optic loop sensor

Table. 11.10 - 22. Technical data for the AQ-07 fiber optic loop sensor.

Material	Covered glass fiber
Light intensity threshold	8,000 lux
Cable length (min…max)	3…50 m
Cable diameter	1.2 mm
Detection radius	360º
Bending radius	1 cm
Operating temperature	–40…+85 ºC

AQ-08 fiber optic loop sensor

Table. 11.10 - 23. Technical data for the AQ-08 fiber optic loop sensor.

Material	Covered glass fiber
Light intensity threshold	8,000 lux
Cable length (min…max)	3…15 m
Cable diameter	1.2 mm
Detection radius	360º
Bending radius	1 cm
Operating temperature	–40…+125 ºC

11.11 Disturbance tests

Table. 11.11 - 24. Technical data for the disturbance tests.

Electromagnetic compatibility test	CE-approved and tested according to EN 50081-2 and EN 50082-2
Conducted emission (EN 55011, class A)	0.15…30.00 Hz

Radiated emission (EN 55011, class A)	30.00…1,000.00 MHz
Electrostatic discharge immunity (IEC 244-222 and EN 61000-4-2, level 4)	Air discharge: 15 kV Contact discharge: 8 kV
Electrical fast transients (EN 61000-4-4, class III & IEC 801-4, level 4)	Power supply input: 4 kV, 5/50 ns Other inputs and outputs: 4 kV, 5/50 ns
Surge immunity (EN 61000-4-5, level 4)	Between wires: 2 kV, 1.2/50 µs Between wire and earth: 4 kV, 1.2/50 µs
RF electromagnetic field (EN 61000-4-3, level 3)	f = 80…1,000 MHz, 10 V/m
Conducted RF field (EN 61000-4-6, level 3)	f = 150 kHz…80 MHz, 10 V/m

11.12 Voltage tests

Table. 11.12 - 25. Technical data for the voltage tests.

Insulation test voltage (IEC 60255-5)	2 kV, 50 Hz, 1 min
Impulse test voltage (IEC 60255-5)	5 kV, 1.2/50 µs, 0.5 J

11.13 Mechanical tests

Table. 11.13 - 26. Technical data for the mechanical tests.

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

11.14 Environmental conditions

Table. 11.14 - 27. Technical data for the environmental conditions.

Specified ambient service temperature	–35…+70 ºC
Transportation and storage temperature	–40…+70 ºC
Relative humidity	Up to 97 %
Altitude	Up to 2,000 m above sea level

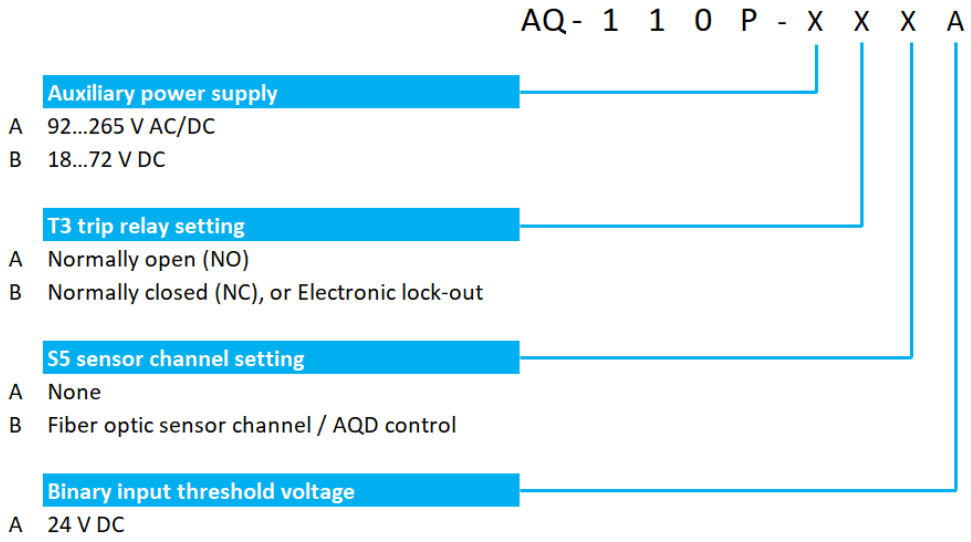
11.15 Casing

Table. 11.15 - 28. Technical data for the device casing.

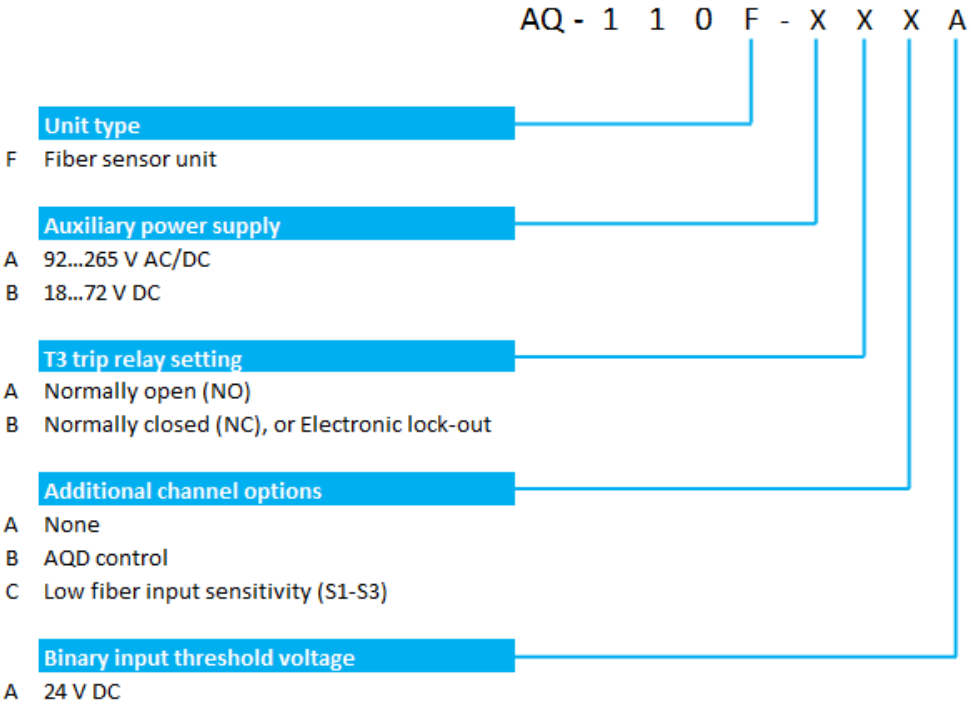
Protection: - front - back	 IP 52 IP 20
Device dimensions (W × H × D)	102 × 177 × 161 mm
Weight	1.2 kg

12 Ordering information

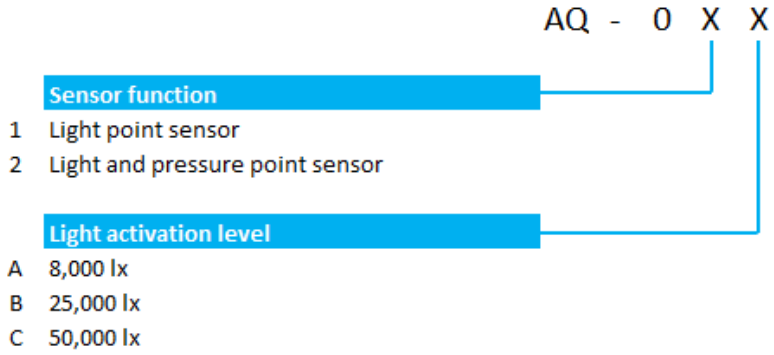
AQ-110P current measurement and arc sensing unit



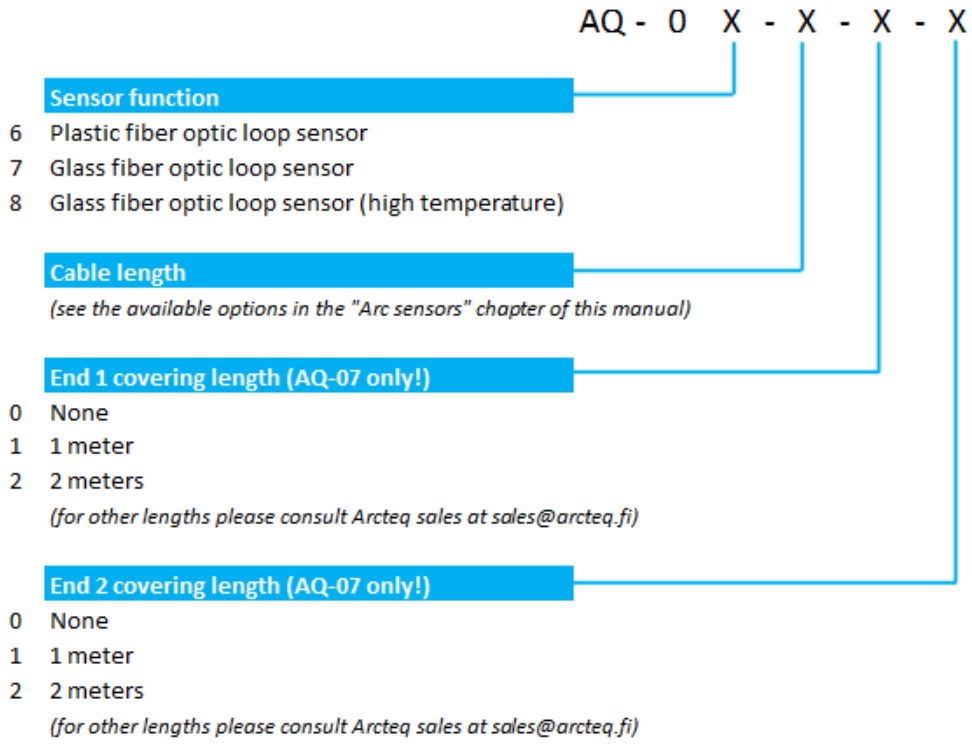
AQ-110F current measurement and arc sensing unit



AQ-0x point sensors



AQ-0x fiber optic loop sensors



Accessories

Order code	Description	Note	Manufacturer
AQX006	Wall mounting bracket	For AQ-103 and AQ-110x variants (MV and LV).	Arcteq Ltd.
AQX016	Wall mounting bracket	For AQ-101, AQ-101S and AQ-102 units (MV and LV).	Arcteq Ltd.

13 Contact and reference information

Manufacturer

Arcteq Relays Ltd.

Visiting and postal address

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