ARCTEQ
PART OF ENSTO GROUP

AQ-SAS LV Standard Arc Schemes

Instruction manual

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Disclaimer

Please read these instructions carefully before using the equipment or taking any other actions with respect to the equipment. Only trained and qualified persons are allowed to perform installation, operation, service or maintenance of the equipment. Such qualified persons have the responsibility to take all appropriate measures, including e.g. use of authentication, encryption, anti-virus programs, safe switching programs etc. necessary to ensure a safe and secure environment and usability of the equipment. The warranty granted to the equipment remains in force only provided that the instructions contained in this document have been strictly complied with.

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1 Document information

1.1 Revision notes

Table. 1.1 - 1. Version 1 revision notes

Revision	1.00
Date	9.9.2025
Changes	- First version.
Revision	1.01
Date	04.02.2026
Changes	- Changed png versions of detailed application drawings to PDF versions.
Revision	1.02
Date	09.09.2026
Changes	- Updated the included detailed application drawings to have layers that can be hidden/ shown (devices, I/O, logic matrix, sensors, SLD and zones). - Changed the position of current transformer in application drawings.
Revision	1.03
Date	18.11.2026
Changes	- Fixed BO to BI connection diagram in Basic application with AQ-101LV and Basic application with AQ-103LV.

1.2 Safety information

This document contains important instructions that should be saved for future use. Read the document carefully before installing, operating, servicing, or maintaining this equipment. Please read and follow all the instructions carefully to prevent accidents, injury and damage to property.

Additionally, this document may contain four (4) types of special messages to call the reader's attention to useful information as follows:

NOTICE!
"Notice" messages indicate relevant factors and conditions to the concept discussed in the text, as well as to other relevant advice.

CAUTION!
"Caution" messages indicate a potentially hazardous situation which, if not avoided, **could** result in minor or moderate personal injury, in equipment/property damage, or software corruption.

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WARNING!
"Warning" messages indicate a potentially hazardous situation which, if not avoided, **could** result in death or serious personal injury as well as serious damage to equipment/property.



DANGER!
"Danger" messages indicate an imminently hazardous situation which, if not avoided, **will** result in death or serious personal injury.

These symbols are added throughout the document to ensure all users' personal safety and to avoid unintentional damage to the equipment or connected devices.

Please note that although these warnings relate to direct damage to personnel and/or equipment, it should be understood that operating damaged equipment may also lead to further, indirect damage to personnel and/or equipment. Therefore, we expect any user to fully comply with these special messages.

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1.3 Abbreviations

AQD – Arc quenching device

BI – Binary input

BO – Binary output

CBFP – Circuit breaker failure protection

HSO – High-speed output

L> – Arc light signal

L_{ext}> – Arc light signal received from an external device

I> – Overcurrent detected by the device i.e. internal overcurrent.

I_{ext}> – Overcurrent signal received from an external device.

MT – Master trip

SS – Standard Scheme. Operation logic of the arc protection device. Selectable by the user.

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2 General

Arcteq's AQ 100 series offers a complete solution for arc flash protection focusing on simplicity while maintaining both flexibility and function. The devices are built for a single purpose: to provide effective arc flash protection for low-voltage applications. This LV Standard Arc Schemes (AQ-SAS™) instruction manual includes a collection of pre-engineered, fully tested, and fully documented protection schemes which ensure correct operation in all conditions. The schemes are suitable for various typical switchgear layouts.

This document includes:

- Descriptions of each application
- Example single-line diagrams of the application
- Trip and I/O operation logics
- Setting instructions
- Wiring diagrams

This document is distributed as a ZIP package. In addition to this PDF document, the package includes application drawings of each scheme with higher detail than what you can find in this document.

For detailed information about AQ 100 series devices refer to their manuals at https://www.arcteq.fi/documents-and-software/.

3 Without a tie breaker

This chapter lists various typical arc protection application solutions for substations with one or two incoming feeders. The device types, the used logic schemes and the wiring vary between the solutions, but the main principle is the same in all of them.

Figure. 3 - 1. Fault zones in a substation with one incoming feeder.

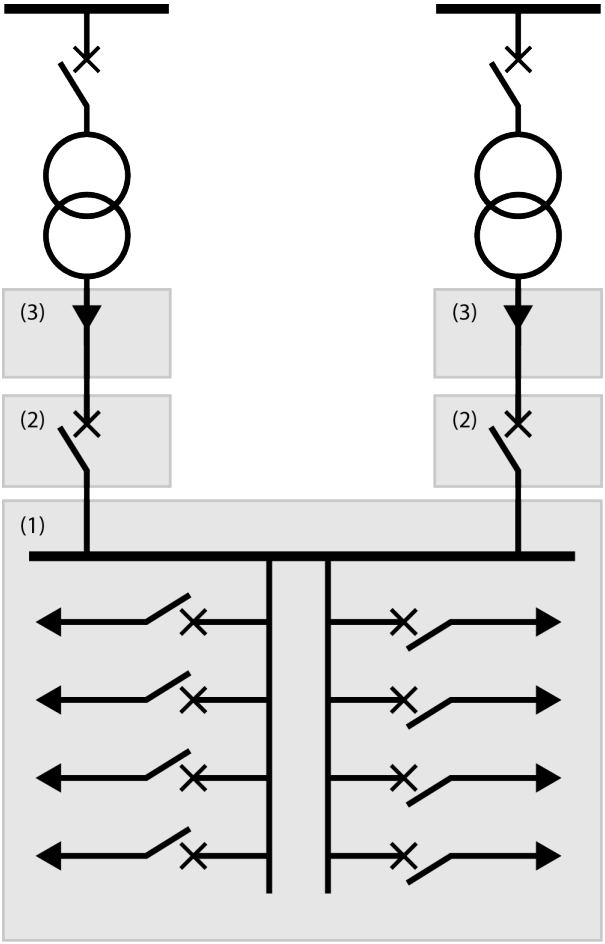


Table. 3 - 2. Arc protection zones of an application without an incoming feeder.

#	Fault location
1	Outgoing feeders and the busbar
2	Incoming feeder circuit breaker compartment
3	Incoming feeder cable compartment

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IM00084

3.1 Basic application with AQ-101LV

In this application, one AQ-110PLV is installed to the incoming feeder and one or more AQ-101LV devices are installed to the outgoing feeder compartments.

AQ-101LV devices:

- detect arc light and forward the signal to the AQ-110PLV device.

AQ-110PLV device:

- receives arc light signals from the AQ-101LV devices
- detects arc light in the incoming feeder
- uses overcurrent detection to confirm arc faults (optional)
- trips the incoming feeder circuit breakers
- sends an activation signal to an arc quenching device (optional).

Figure. 3.1 - 2. Single-line diagram for the basic AQ-101LV application without a tie breaker.

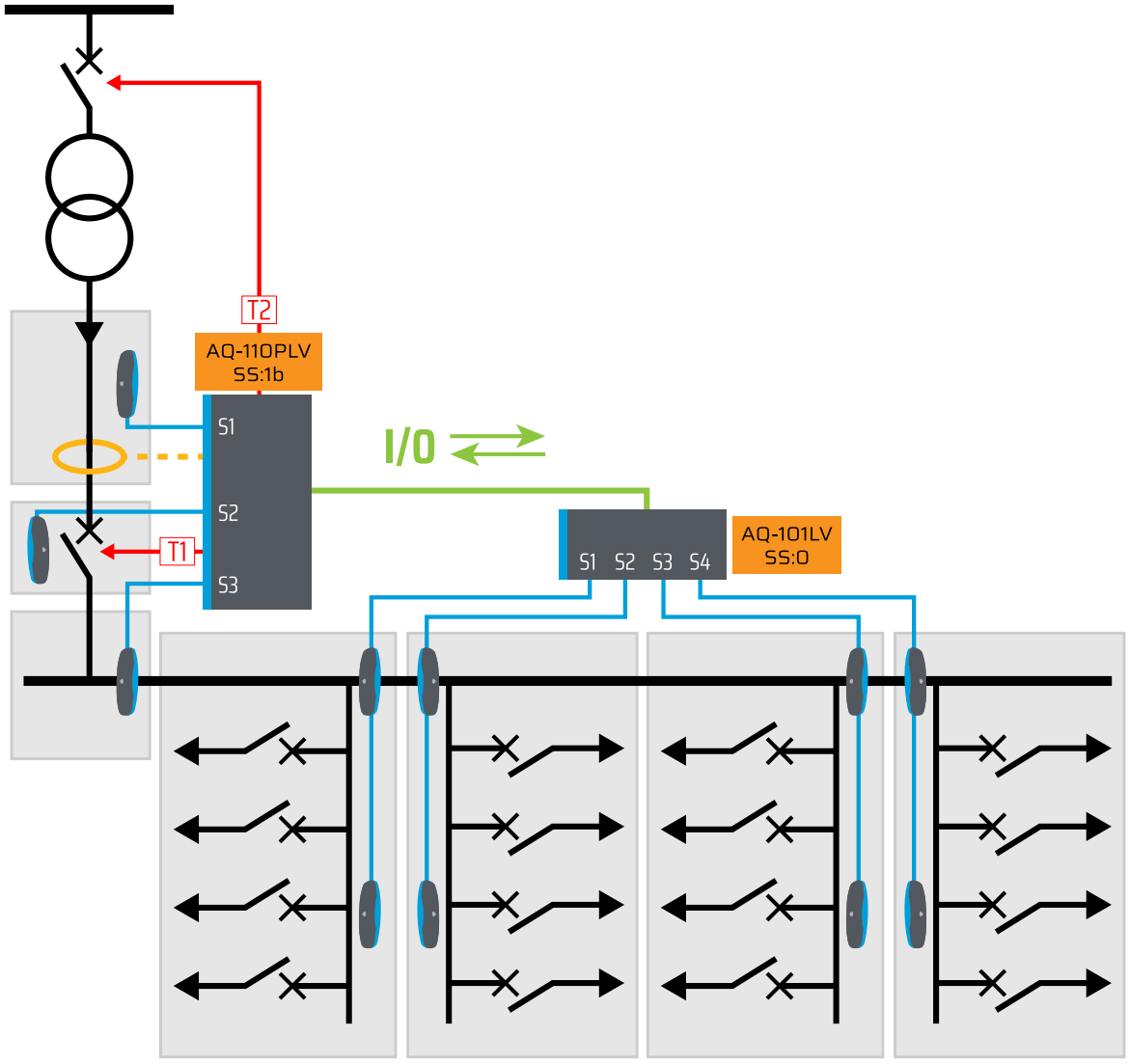


Table. 3.1 - 3. Simplified arc protection operation logic of an application with one incoming feeder.

Fault location	Circuit breaker to trip	CBFP trip
• Outgoing feeders • Busbar	• Incoming feeder	• HV side of incoming feeder
• Incoming feeder circuit breaker compartment • Incoming feeder cable compartment	• Incoming feeder • HV side of incoming feeder	• N/A

3.1.1 Incoming feeder AQ-110PLV (SS:1b)

Table. 3.1.1 - 4. Outputs of the incoming feeder AQ-110PLV (SS:1b) device.

Output	Connects to	Action
T1	Incoming feeder circuit breaker.	Opens circuit breaker.
T2	Incoming feeder HV side circuit breaker.	
T4	Alarming unit (optional).	Trip alarm signal.
AQD	Arc quenching device (optional).	Trips the arc quenching device.

Table. 3.1.1 - 5. Inputs of the incoming feeder AQ-110PLV (SS:1b) device.

Input	Connects to	Action
IL1, IL2, IL3	• Incoming feeder.	• Sensor channels and external light signal (BI2) can be set up to use overcurrent signal as an additional criterion for tripping.
S1	• Incoming feeder cable compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • This channel must be set to "Light only" mode if current measurement point is located after the sensor.
S2	• Incoming feeder circuit breaker compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Trips the arc quenching device with AQD.
S3	• Busbar compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay after CBFP time delay. • Trips the arc quenching device with AQD.
S4	• Optional	
S5		
BI2	• BO1 of outgoing feeder AQ-101LV (SS:0) devices. • Receives light signal.	

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Figure. 3.1.1 - 3. Logic matrix of the incoming feeder AQ-110PLV (SS:1b) device.

SS:1b		OUTPUTS			
		T1	T2	T4	AQD
INPUTS	S1	x[1]	x[1]	x[1]	
	S2	x[1]	x[1]	x[1]	x[2]
	S3, S4, S5	x[1]	CBFP[1]	x[1]	x[2]
	Lext> AQ-101LV (BI2)	x[1]	CBFP[1]	x[1]	x[2]

1) Activates only if channel has been set to light only mode or phase overcurrent signal (I>) is ON.
2) Activates only if phase overcurrent signal (I>) is ON.

Figure. 3.1.1 - 4. Recommended DIP switch settings of the incoming feeder AQ-110PLV (SS:1b) device.



3.1.2 Outgoing feeders AQ-101LV (SS:0)

Table. 3.1.2 - 6. Outputs of the outgoing feeder AQ-101LV (SS:0) devices.

Output	Connects to	Action
T1	Outgoing feeder circuit breakers (if applicable).	Opens the circuit breakers.
T2		
T3		
T4		
BO1	BI2 of incoming feeder AQ-110PLV (SS:1b) device.	Sends light signal.

Table. 3.1.2 - 7. Inputs of the outgoing feeder AQ-101LV (SS:0) devices.

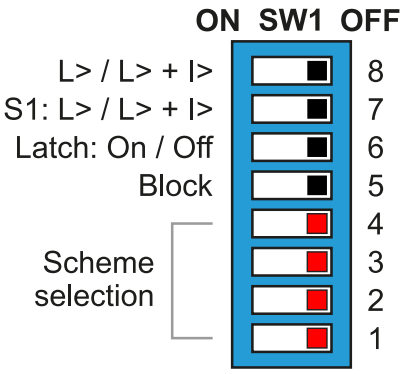
Input	Connects to	Action
S1…S5	• Outgoing feeders. • Busbar compartment.	• Trips outgoing feeders with T1, T2, T3 and T4 relays. • Sends light signal to incoming feeder AQ-110PLV (SS:1b) device with BO1.

Figure. 3.1.2 - 5. Logic matrix of the outgoing feeder AQ-101LV (SS:0) devices.

SS:0		OUTPUTS				
		T1	T2	T3	T4	BO1
INPUTS	S1 - S5	x[1]	x[1]	x[1]	x[1]	x

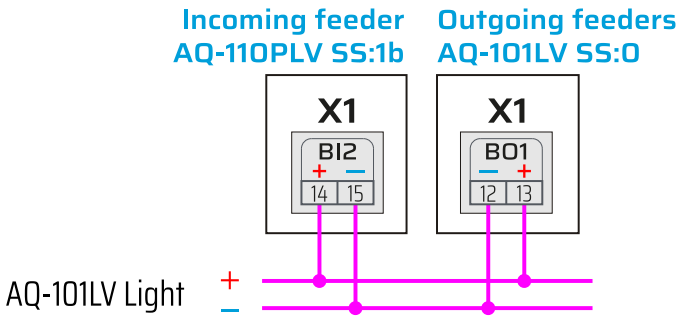
1) Activates only if channel has been set to light only mode or overcurrent signal (BI2) is ON.

Figure. 3.1.2 - 6. Recommended DIP switch settings of the outgoing feeder AQ-101LV (SS:0) devices.



3.1.3 Connections

Figure. 3.1.3 - 7. I/O connections of light signals.



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3.2 Basic application with AQ-103LV

In this application, one AQ-110PLV is installed to the incoming feeder and one or more AQ-103LV devices are installed to the outgoing feeder compartments.

AQ-103LV devices:

- detect arc light and forward the signal to the AQ-110PLV device.

AQ-110PLV device:

- receives arc light signals from the AQ-103LV devices
- detects arc light in the incoming feeder
- uses overcurrent detection to confirm arc faults (optional)
- trips the incoming feeder circuit breakers
- sends an activation signal to an arc quenching device (optional).

Figure. 3.2 - 8. Single-line diagram for the basic AQ-103LV application without a tie breaker.

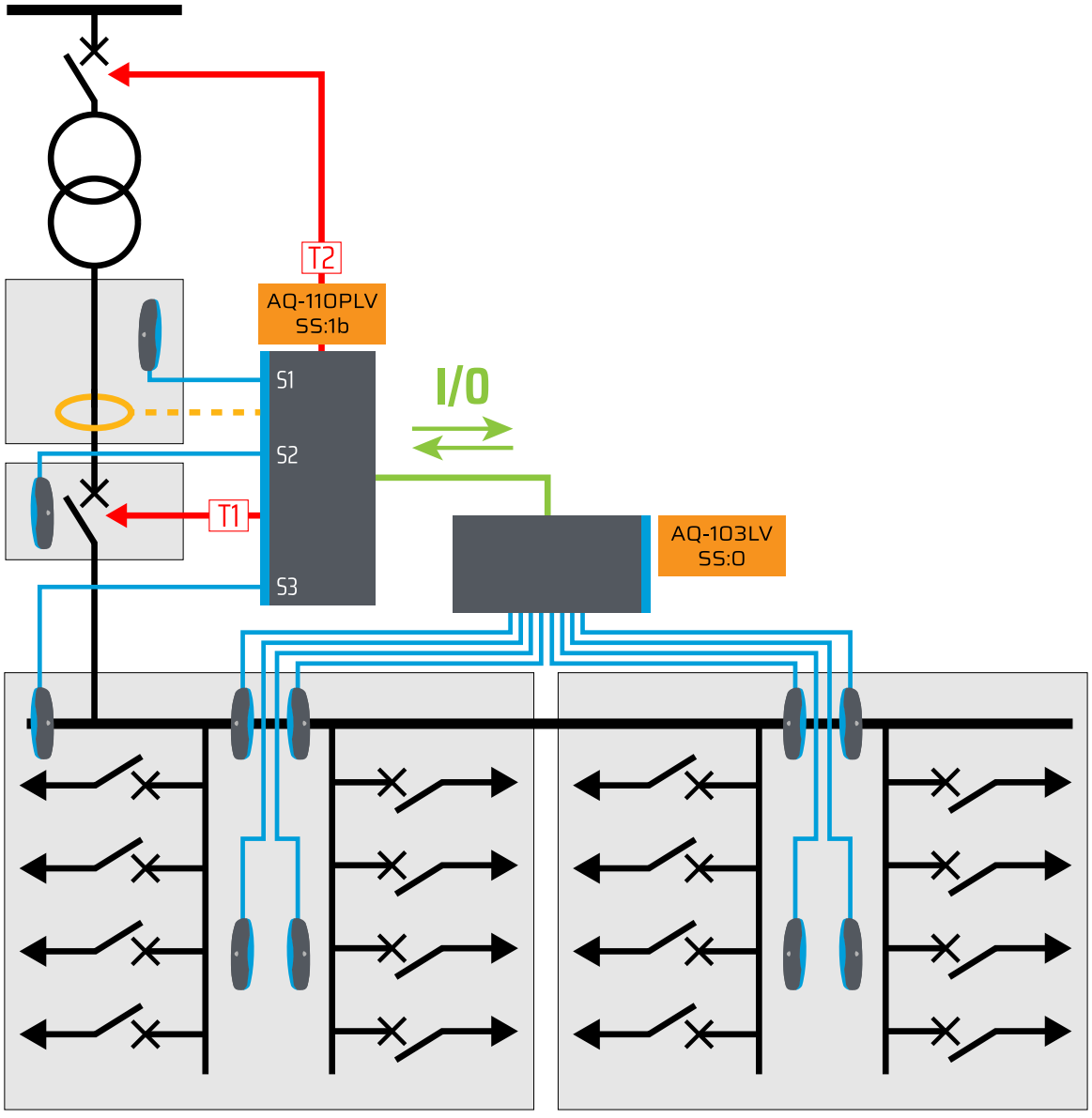


Table. 3.2 - 8. Simplified arc protection operation logic of an application with one incoming feeder.

Fault location	Circuit breaker to trip	CBFP trip
• Outgoing feeders • Busbar	• Incoming feeder	• HV side of incoming feeder
• Incoming feeder circuit breaker compartment • Incoming feeder cable compartment	• Incoming feeder • HV side of incoming feeder	• N/A

3.2.1 Incoming feeder AQ-110PLV (SS:1b)

Table. 3.2.1 - 9. Outputs of the incoming feeder AQ-110PLV (SS:1b) device.

Output	Connects to	Action
T1	Incoming feeder circuit breaker.	Opens circuit breaker.
T2	Incoming feeder HV side circuit breaker.	
T4	Alarming unit (optional).	Trip alarm signal.
AQD	Arc quenching device (optional).	Trips the arc quenching device.

Table. 3.2.1 - 10. Inputs of the incoming feeder AQ-110PLV (SS:1b) device.

Input	Connects to	Action
IL1, IL2, IL3	• Incoming feeder.	• Sensor channels and external light signal (BI2) can be set up to use overcurrent signal as an additional criterion for tripping.
S1	• Incoming feeder cable compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • This channel must be set to "Light only" mode if current measurement point is located after the sensor.
S2	• Incoming feeder circuit breaker compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Trips the arc quenching device with AQD.
S3	• Busbar compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay after CBFP time delay. • Trips the arc quenching device with AQD.
S4	• Optional	
S5		
BI2	• BO1 of outgoing feeder AQ-103LV (SS:0) devices. • Receives light signal.	

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Figure. 3.2.1 - 9. Logic matrix of the incoming feeder AQ-110PLV (SS:1b) device.

SS:1b		OUTPUTS			
		T1	T2	T4	AQD
INPUTS	S1	x[1]	x[1]	x[1]	
	S2	x[1]	x[1]	x[1]	x[2]
	S3, S4, S5	x[1]	CBFP[1]	x[1]	x[2]
	Lext> AQ-103LV (BI2)	x[1]	CBFP[1]	x[1]	x[2]

1) Activates only if channel has been set to light only mode or phase overcurrent signal (I>) is ON.
2) Activates only if phase overcurrent signal (I>) is ON.

Figure. 3.2.1 - 10. Recommended DIP switch settings of the incoming feeder AQ-110PLV (SS:1b) device.



3.2.2 Outgoing feeders AQ-103LV (SS:0)

Table. 3.2.2 - 11. Outputs of the outgoing feeder AQ-103LV (SS:0) devices.

Output	Connects to	Action
T1	Outgoing feeder circuit breakers (if applicable).	Opens the circuit breakers.
T2		
T3		
T4		
HSO1	Alarming unit (optional).	Trip alarm signal.
BO1	BI2 of incoming feeder AQ-110PLV (SS:1b) device.	Sends light signal.

Table. 3.2.2 - 12. Inputs of the outgoing feeder AQ-103LV (SS:0) devices.

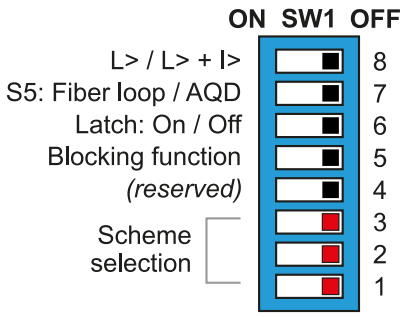
Input	Connects to	Action
S1…S15	• Outgoing feeders. • Busbar compartment.	• Trips outgoing feeders with T1, T2, T3 and T4 relays. • Sends light signal to incoming feeder AQ-110PLV (SS:1b) device with BO1.

Figure. 3.2.2 - 11. Logic matrix of the outgoing feeder AQ-103LV (SS:0) devices.

SS:0		OUTPUTS				
		T1	T2	T3	T4	BO1
INPUTS	S1 - S15	x[1]	x[1]	x[1]	x[1]	x

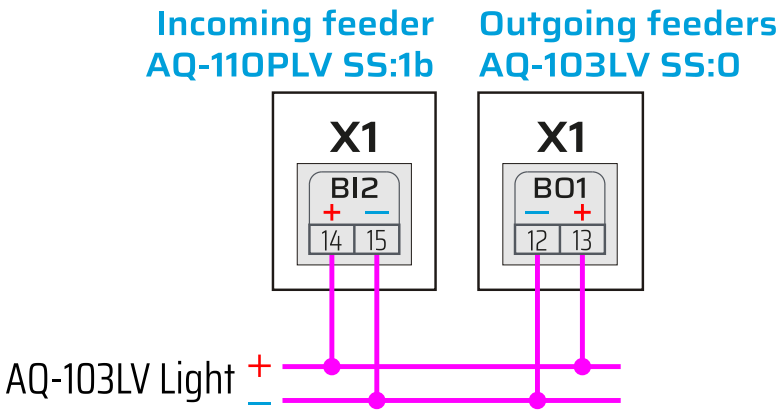
1) Activates only if channel has been set to light only mode or overcurrent signal (BI1) is ON.

Figure. 3.2.2 - 12. Recommended DIP switch settings of the AQ-103LV (SS:0) devices.



3.2.3 Connections

Figure. 3.2.3 - 13. I/O connections of light signals.



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3.3 Two incoming feeders without a tie breaker

In this application, one AQ-110PLV is installed to each incoming feeder and one or more AQ-101LV devices are installed to outgoing feeder compartments.

AQ-101LV devices:

- detect arc light and forward the signal to one of the AQ-110PLV devices.

AQ-110PLV devices:

- receive arc light signals from the AQ-101LV devices
- detect arc light in the incoming feeder
- forward arc light signals to the other AQ-110PLV device
- use overcurrent detection to confirm arc faults (optional)
- trip the incoming feeder circuit breakers
- send an activation signal to an arc quenching device (optional).

NOTICE!
While this chapter uses AQ-101LV with SS:0 for the outgoing feeders, it is possible to use AQ-102 or AQ-103 with SS:0 instead.

Figure. 3.3 - 14. Fault zones in a substation with two incoming feeders.

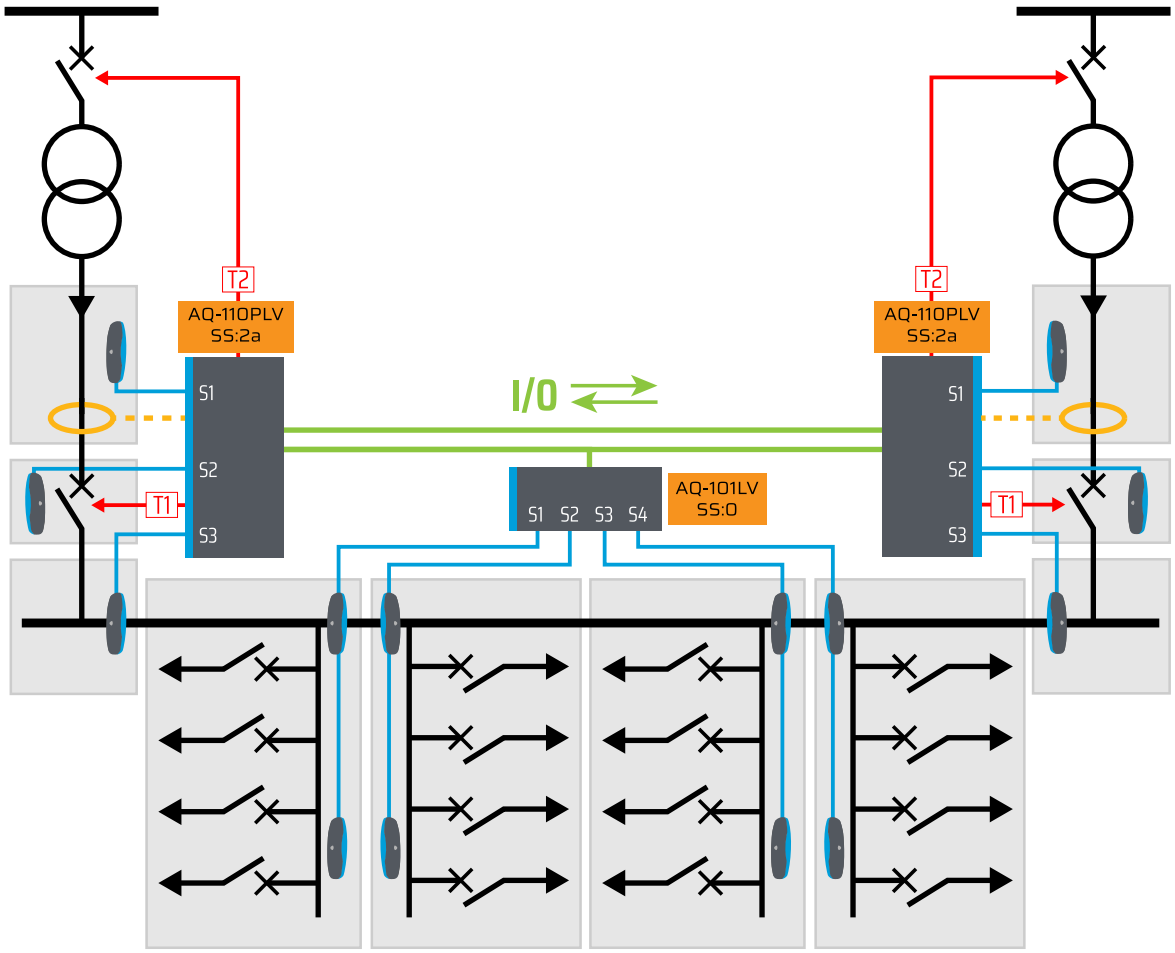


Table. 3.3 - 13. Simplified operation logic description.

Fault location	Circuit breaker to trip	CBFP trip
• Outgoing feeders and the busbar	• Incoming feeders	• HV side of incoming feeders
• Incoming feeder circuit breaker compartment	• Incoming feeder **with the fault** • HV side of incoming feeder **with the fault**	• N/A
• Incoming feeder cable compartment	• The incoming feeder **with the fault** • HV side of the incoming feeder **with the fault**	• N/A

3.3.1 Master incoming feeder AQ-110PLV (SS:2a)

Table. 3.3.1 - 14. Outputs of the master incoming feeder AQ-110PLV (SS:2a) device.

Output	Connects to	Action
T1	Incoming feeder circuit breaker.	Opens circuit breaker.
T2	Incoming feeder HV side circuit breaker.	
BO1	BI1 of follower incoming feeder AQ-110PLV (SS:2a) device.	Sends light signal.
AQD	Arc quenching device (optional).	Trips the arc quenching device.

Table. 3.3.1 - 15. Inputs of the master incoming feeder AQ-110PLV (SS:2a) device.

Input	Connects to	Action
IL1, IL2, IL3	• Incoming feeder.	• Sensor channels and external light signal (**BI1** and **BI2**) can be set up to use overcurrent signal as an additional criterion for tripping.
S1	• Incoming feeder cable compartment.	• Trips incoming feeder circuit breaker with **T1** relay. • Trips incoming feeder HV side circuit breaker with **T2** relay. • Sends light signal with **BO1** to follower incoming feeder AQ-110PLV (SS:2a) device after CBFP time delay. • **This channel must be set to "Light only" mode if current measurement point is located after the sensor.**
S2	• Incoming feeder circuit breaker compartment.	• Trips incoming feeder circuit breaker with **T1** relay. • Trips incoming feeder HV side circuit breaker with **T2** relay. • Sends light signal with **BO1** to follower incoming feeder AQ-110PLV (SS:2a) device. • Trips the arc quenching device with **AQD**.
S3	• Busbar compartment.	• Trips incoming feeder circuit breaker with **T1** relay. • Trips incoming feeder HV side circuit breaker with **T2** relay after CBFP time delay. • Sends light signal with **BO1** to follower incoming feeder AQ-110PLV (SS:2a) device. • Trips the arc quenching device with **AQD**.
S4	• Optional	
S5		

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Input	Connects to	Action
BI2	• BO1 of outgoing feeder AQ-101LV (SS:0) devices. • Receives light signal.	
BI1	• BO1 of follower incoming feeder AQ-110LV (SS:2a) device. • Receives light signal.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay after CBFP time delay. • Trips the arc quenching device with AQD.

Figure. 3.3.1 - 15. Logic matrix of the master incoming feeder AQ-110PLV (SS:2a) device.

SS:2a		OUTPUTS			
		T1	T2	BO1	AQD
INPUTS	S1	x[1]	x[1]	CBFP[1]	
	S2	x[1]	x[1]	x	x[1]
	S3, S4, S5	x[1]	CBFP[1]	x	x[1]
	Lext> AQ-110PLV (BI1)	x[1]	CBFP[1]		x[1]
	Lext> AQ-101LV (BI2)	x[1]	CBFP[1]	x	x[1]

1) Activates only if channel has been set to light only mode or phase overcurrent signal (I>) is ON.

Figure. 3.3.1 - 16. Recommended DIP switch settings of the master incoming feeder AQ-110PLV (SS:2a) device.



3.3.2 Follower incoming feeder AQ-110PLV (SS:2a)

Table. 3.3.2 - 16. Outputs of the follower incoming feeder AQ-110PLV (SS:2a) device.

Output	Connects to	Action
T1	Incoming feeder circuit breaker.	Opens circuit breaker.
T2	Incoming feeder HV side circuit breaker.	
BO1	BI1 of master incoming feeder AQ-110PLV (SS:2a) device.	Sends light signal.

Table. 3.3.2 - 17. Inputs of the follower incoming feeder AQ-110PLV (SS:2a) device.

Input	Connects to	Action
IL1, IL2, IL3	• Incoming feeder.	• Sensor channels and external light signal (BI1 and BI2) can be set up to use overcurrent signal as an additional criterion for tripping.
S1	• Incoming feeder cable compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Sends light signal with BO1 to follower incoming feeder AQ-110PLV (SS:2a) device after CBFP time delay. • This channel must be set to "Light only" mode if current measurement point is located after the sensor.
S2	• Incoming feeder circuit breaker compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Sends light signal with BO1 to follower incoming feeder AQ-110PLV (SS:2a) device.
S3	• Busbar compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay after CBFP time delay. • Sends light signal with BO1 to follower incoming feeder AQ-110PLV (SS:2a) device.
S4	• Optional	
S5		
BI1	• BO1 of master incoming feeder AQ-110PLV (SS:2a) device. • Receives light signal.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay after CBFP time delay.

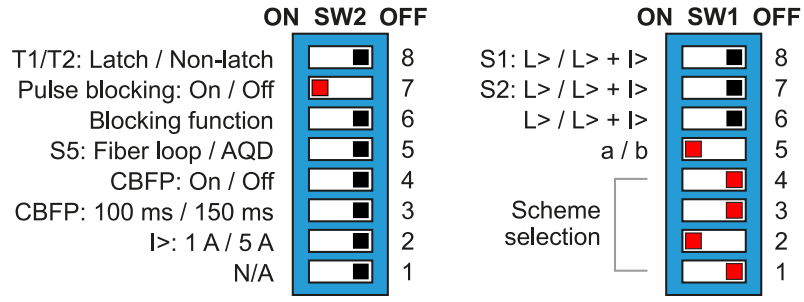
Figure. 3.3.2 - 17. Logic matrix of the follower incoming feeder AQ-110PLV (SS:2a) device.

SS:2a		OUTPUTS			
		T1	T2	BO1	AQD
INPUTS	S1	x[1]	x[1]	CBFP[1]	
	S2	x[1]	x[1]	x	x[1]
	S3, S4, S5	x[1]	CBFP[1]	x	x[1]
	Lext> AQ-110PLV (BI1)	x[1]	CBFP[1]		x[1]
	Lext> AQ-101LV (BI2)	x[1]	CBFP[1]	x	x[1]

1) Activates only if channel has been set to light only mode or phase overcurrent signal (I>) is ON.

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Figure. 3.3.2 - 18. Recommended DIP switch settings of the follower incoming feeder AQ-110PLV (SS:2a) device.



3.3.3 Outgoing feeders AQ-101LV (SS:0)

Table. 3.3.3 - 18. Outputs of the outgoing feeder AQ-101LV (SS:0) devices.

Output	Connects to	Action
T1	Outgoing feeder circuit breakers (if applicable).	Opens the circuit breakers.
T2		
T3		
T4		
BO1	BI2 of master incoming feeder AQ-110PLV (SS:2a) device.	Sends light signal.

Table. 3.3.3 - 19. Inputs of the outgoing feeder AQ-101LV (SS:0) devices.

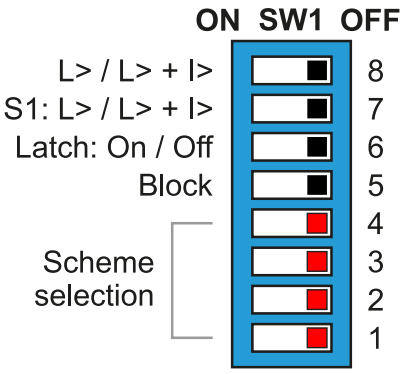
Input	Connects to	Action
S1…S5	• Outgoing feeders. • Busbar compartment.	• Trips outgoing feeders with T1, T2, T3 and T4 relays. • Sends light signal to master incoming feeder AQ-110PLV (SS:2a) device with BO1.

Figure. 3.3.3 - 19. Logic matrix of the outgoing feeder AQ-101LV (SS:0) devices.

SS:0		OUTPUTS				
		T1	T2	T3	T4	BO1
INPUTS	S1 - S5	x[1]	x[1]	x[1]	x[1]	x

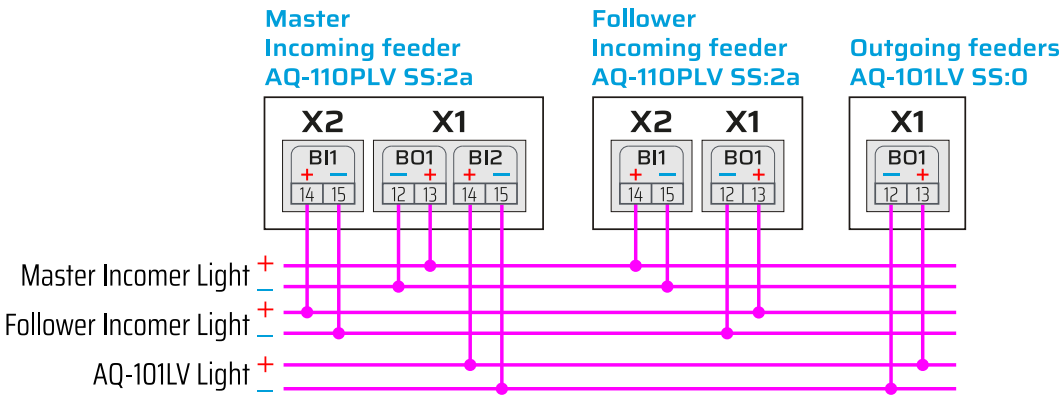
1) Activates only if channel has been set to light only mode or overcurrent signal (BI2) is ON.

Figure. 3.3.3 - 20. Recommended DIP-switch settings of the outgoing feeder AQ-101LV (SS:0) devices.



3.3.4 Connections

Figure. 3.3.4 - 21. I/O connections of light signals.



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3.4 Light-only application with AQ-101LV

In this application, one AQ-101LV is installed to the incoming feeder and one or more AQ-101LV devices are installed to the outgoing feeder compartments. The operation logic is similar to the previous applications, but circuit breaker failure signals are not available (see operation logic table below).

AQ-101LV devices in the outgoing feeder department:

- detect arc light and forward the signal to the AQ-101LV device in the incoming feeder department.

AQ-101LV device in the incoming feeder department:

- receives arc light signals from the other AQ-101LV devices
- detects arc light in the incoming feeder
- trips the incoming feeder circuit breakers.

Figure. 3.4 - 22. Single-line diagram for the light-only AQ-101LV application without a tie breaker.

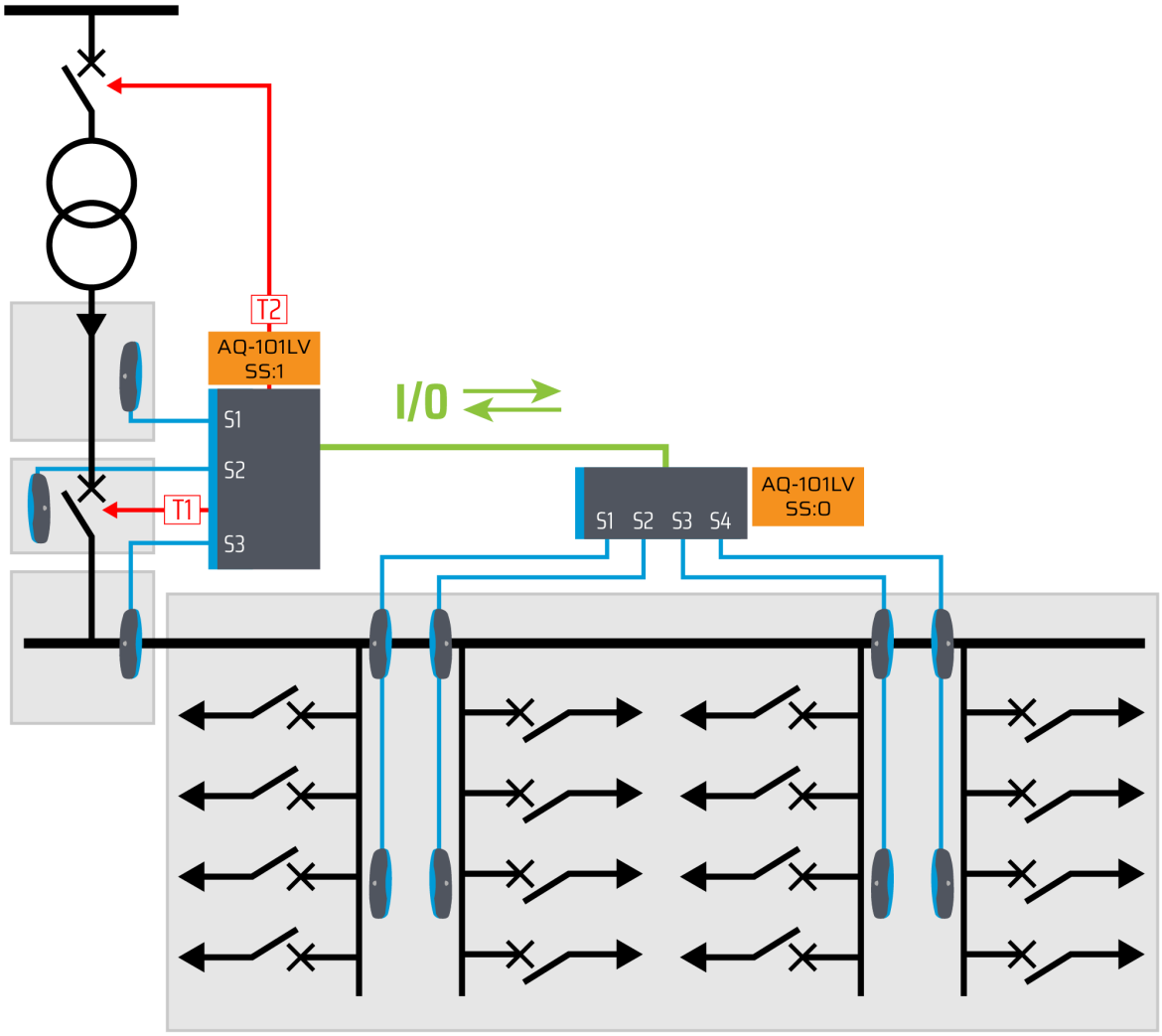


Table. 3.4 - 20. Simplified arc protection operation logic of an application with one incoming feeder.

Fault location	Circuit breaker to trip	CBFP trip
• Outgoing feeders • Busbar	• Incoming feeder	• N/A
• Incoming feeder circuit breaker compartment • Incoming feeder cable compartment	• Incoming feeder • HV side of incoming feeder	• N/A

3.4.1 Incoming feeder AQ-101LV (SS:1)

Table. 3.4.1 - 21. Outputs of the incoming feeder AQ-101LV (SS:1) device.

Output	Connects to	Action
T1	Incoming feeder circuit breaker.	Opens circuit breaker.
T2	Incoming feeder HV side circuit breaker.	
T4	Alarming unit (optional).	Trip alarm signal.

Table. 3.4.1 - 22. Inputs of the incoming feeder AQ-101LV (SS:1) device.

Input	Connects to	Action
S1	• Incoming feeder cable compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay.
S2	• Incoming feeder circuit breaker compartment.	
S3	• Busbar compartment.	• Trips incoming feeder circuit breaker with T1 relay.
S4	• Optional	
S5		
BI2	• BO1 of outgoing feeder AQ-101LV (SS:0) devices. • Receives light signal.	

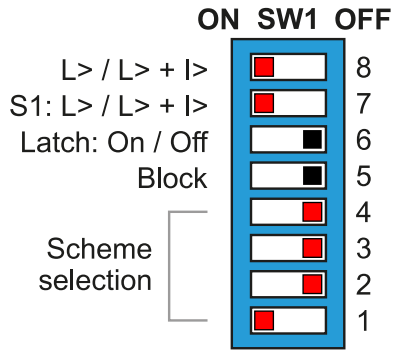
Figure. 3.4.1 - 23. Logic matrix of the incoming feeder AQ-101LV (SS:1) device.

SS:1		OUTPUTS	
		T1	T2
INPUTS	S1	x[1]	x[1]
	S2	x[1]	x[1]
	S3 - S5	x[1]	
	Lext> (BI2)	x[1]	

1) Activates only if channel has been set to light only mode or phase overcurrent signal (BI1) is ON.

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IM00084

Figure. 3.4.1 - 24. Recommended DIP switch settings of the incoming feeder AQ-101LV (SS:1) device.



3.4.2 Outgoing feeders AQ-101LV (SS:0)

Table. 3.4.2 - 23. Outputs of the outgoing feeder AQ-101LV (SS:0) devices.

Output	Connects to	Action
T1	Outgoing feeder circuit breakers (if applicable).	Opens the circuit breakers.
T2		
T3		
T4		
BO1	BI2 of incoming feeder AQ-101LV (SS:1) device.	Sends light signal.

Table. 3.4.2 - 24. Inputs of the outgoing feeder AQ-101LV (SS:0) devices.

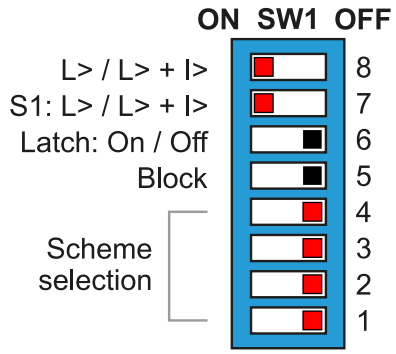
Input	Connects to	Action
S1…S5	• Outgoing feeders. • Busbar compartment.	• Trips outgoing feeders with T1, T2, T3 and T4 relays. • Sends light signal to incoming feeder AQ-101LV (SS:1) device with BO1.

Figure. 3.4.2 - 25. Logic matrix of the outgoing feeder AQ-101LV (SS:0) devices.

SS:0		OUTPUTS				
		T1	T2	T3	T4	BO1
INPUTS	S1 - S5	x[1]	x[1]	x[1]	x[1]	x

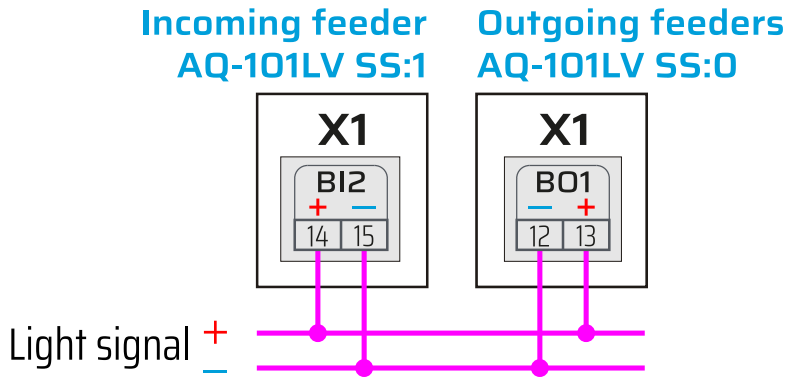
1) Activates only if channel has been set to light only mode or overcurrent signal (BI2) is ON.

Figure. 3.4.2 - 26. Recommended DIP switch settings of the outgoing feeder AQ-101LV (SS:0) devices.



3.4.3 Connections

Figure. 3.4.3 - 27. I/O connections of light signals.



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3.5 Light-only application with AQ-103LV

In this application, one AQ-103LV is installed to the incoming feeder and one or more AQ-103LV devices are installed to the outgoing feeder compartments. The operation logic is non-selective (see operation logic table below).

AQ-103LV devices in the outgoing feeder department:

- detect arc light and forward the signal to the AQ-103LV device in the incoming feeder department.

AQ-103LV device in the incoming feeder department:

- receives arc light signals from the other AQ-103LV devices
- detects arc light in the incoming feeder
- trips the incoming feeder circuit breakers.

Figure. 3.5 - 28. Single-line diagram for the light-only AQ-103LV application without a tie breaker.

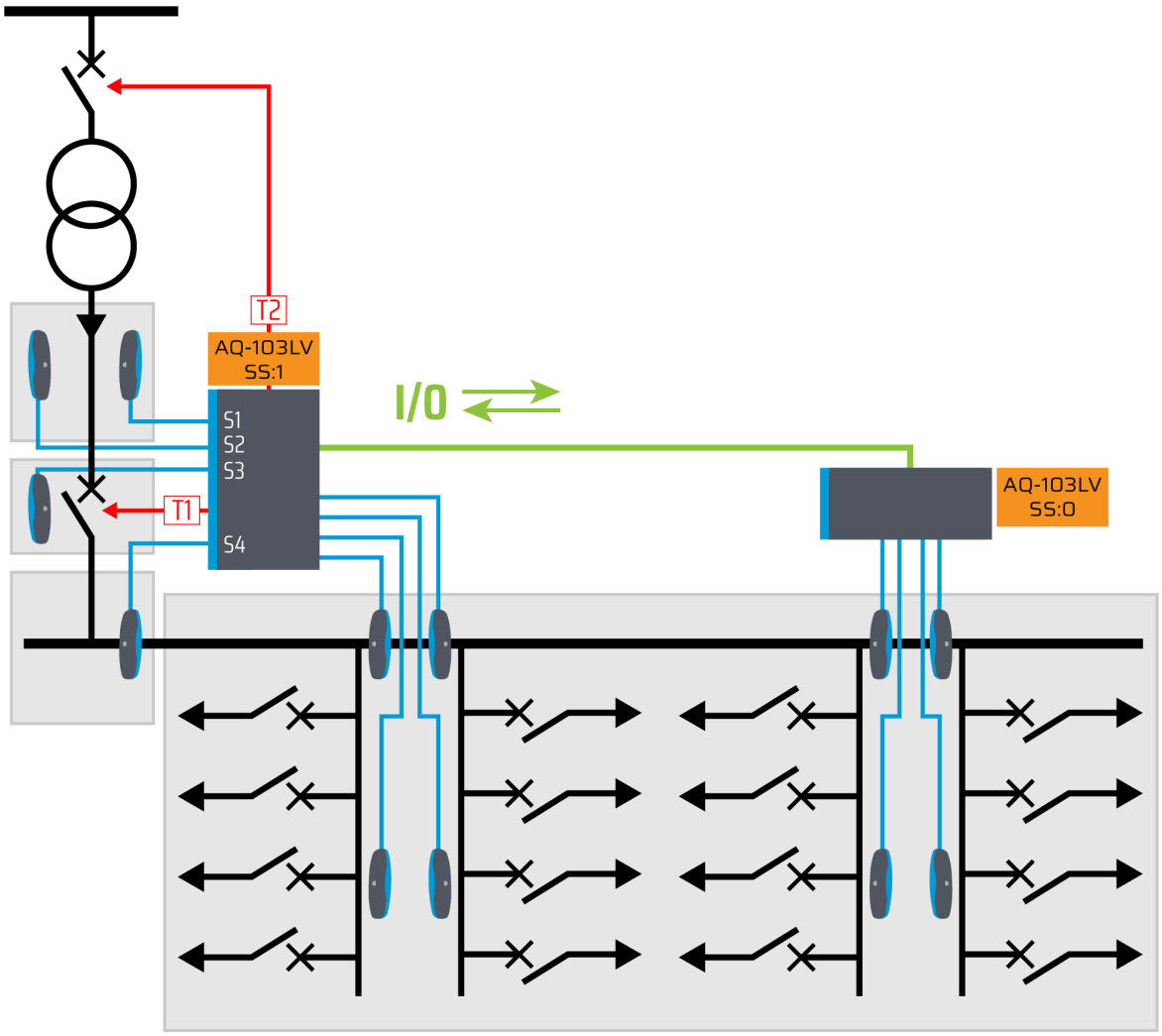


Table. 3.5 - 25. Simplified arc protection operation logic of an application with one incoming feeder.

Fault location	Circuit breaker to trip	CBFP trip
• Outgoing feeders or the busbar • Incoming feeder circuit breaker compartment • Incoming feeder cable compartment	• Incoming feeder • HV side of incoming feeder	• N/A

3.5.1 Incoming feeder AQ-103LV (SS:1)

Table. 3.5.1 - 26. Outputs of the incoming feeder AQ-103LV (SS:1) device.

Output	Connects to	Action
T1	Incoming feeder circuit breaker.	Opens circuit breaker.
T2	Incoming feeder HV side circuit breaker.	
AQD	Arc quenching device (optional).	Trips the arc quenching device.

Table. 3.5.1 - 27. Inputs of the incoming feeder AQ-103LV (SS:1) device.

Input	Connects to	Action
S1	• Incoming feeder cable compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay.
S3	• Incoming feeder circuit breaker compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Trips the arc quenching device with AQD.
S4…S15	• Busbar compartment • Outgoing feeders	
BI2	• BO1 of outgoing feeder AQ-103LV (SS:0) devices. • Receives light signal.	

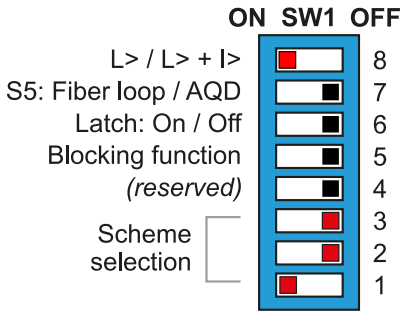
Figure. 3.5.1 - 29. Logic matrix of the incoming feeder AQ-103LV (SS:1) device.

SS:1		OUTPUTS		
		T1	T2	AQD
INPUTS	S1 - S2	x[1]	x[1]	
	S3 - S15	x[1]	x[1]	x[2]
	Lext> (BI2)	x[1]	x[1]	x[2]

1) Activates only if channel has been set to light only mode or phase overcurrent signal (BI1) is ON.
2) Activates only if phase overcurrent signal (BI1) is ON.

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Figure. 3.5.1 - 30. Recommended DIP switch settings of the incoming feeder AQ-103LV (SS:1) device.



3.5.2 Outgoing feeders AQ-103LV (SS:0)

Table. 3.5.2 - 28. Outputs of the outgoing feeder AQ-103LV (SS:0) devices.

Output	Connects to	Action
T1	Outgoing feeder circuit breakers (if applicable).	Opens the circuit breakers.
T2		
T3		
T4		
HSO1	Alarming unit (optional)	Trip alarm signal.
BO1	BI2 of incoming feeder AQ-103LV (SS:1) device.	Sends light signal.

Table. 3.5.2 - 29. Inputs of the outgoing feeder AQ-103LV (SS:0) devices.

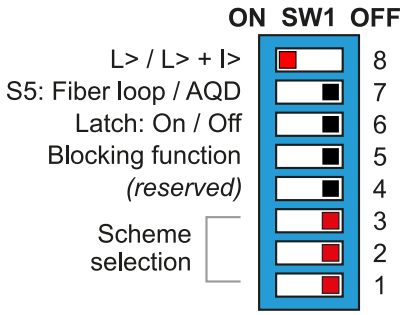
Input	Connects to	Action
S1…S15	• Busbar. • Outgoing feeders.	• Trips outgoing feeders with T1, T2, T3 and T4 relays. • Sends light signal to incoming feeder AQ-103LV (SS:1) device with BO1 after CBFP time delay.

Figure. 3.5.2 - 31. Logic matrix of an outgoing feeder AQ-103LV (SS:0) device.

SS:0		OUTPUTS				
		T1	T2	T3	T4	BO1
INPUTS	S1 - S15	x[1]	x[1]	x[1]	x[1]	x

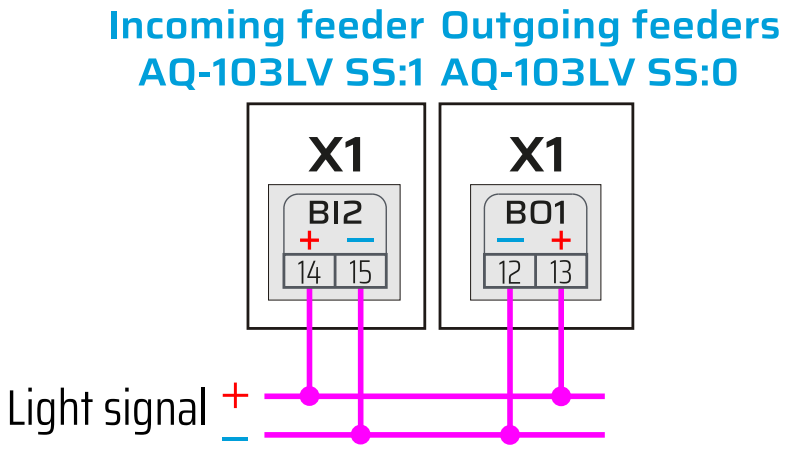
1) Activates only if channel has been set to light only mode or overcurrent signal (BI1) is ON.

Figure. 3.5.2 - 32. Recommended DIP switch settings of the outgoing feeder AQ-103LV (SS:0) devices.



3.5.3 Connections

Figure. 3.5.3 - 33. I/O connections of light signals.



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4 With a tie breaker

This chapter lists various typical arc protection application solutions for substations with two incoming feeders and a tie breaker. The device types, the used logic schemes and the wiring vary between the solutions, but the main principle is the same in all of them.

Figure. 4 - 34. Fault zones in a substation with two incoming feeders and a tie breaker.

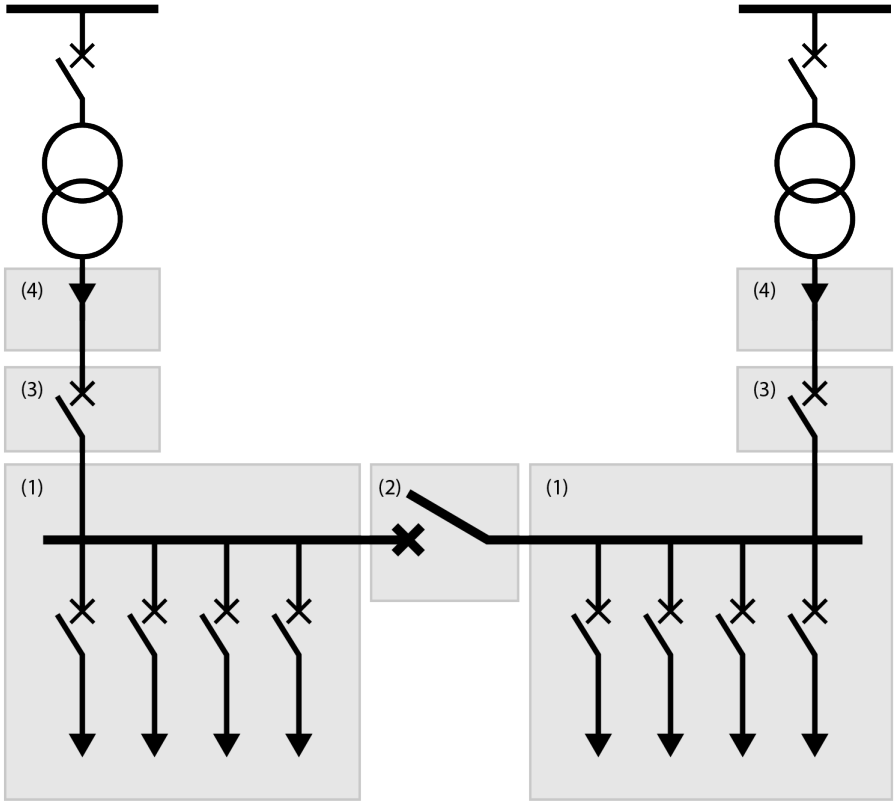


Table. 4 - 30. Arc protection zones of an application without an incoming feeder.

#	Fault location
1	Outgoing feeder compartment or busbar compartment.
2	Tie breaker
3	Incoming feeder circuit breaker compartment
4	Incoming feeder cable compartment

4.1 Basic application with AQ-101LV

In this application, one AQ-110PLV is installed to the incoming feeder and one or more AQ-101LV devices are installed to the outgoing feeder compartments.

AQ-101LV devices:

- detect arc light and forward the signal to the AQ-110PLV device on the same bus section.

AQ-110PLV devices:

- receives arc light signals from the AQ-101LV devices in the same bus section.
- detects arc light in the incoming feeder
- uses overcurrent detection to confirm arc faults (optional)
- forwards overcurrent signal to the other AQ-110PLV device
- trips the incoming feeder circuit breakers and the tie breaker.
- sends an activation signal to an arc quenching device (optional).

Figure. 4.1 - 35. Single-line diagram for the basic AQ-101LV application with a tie breaker.

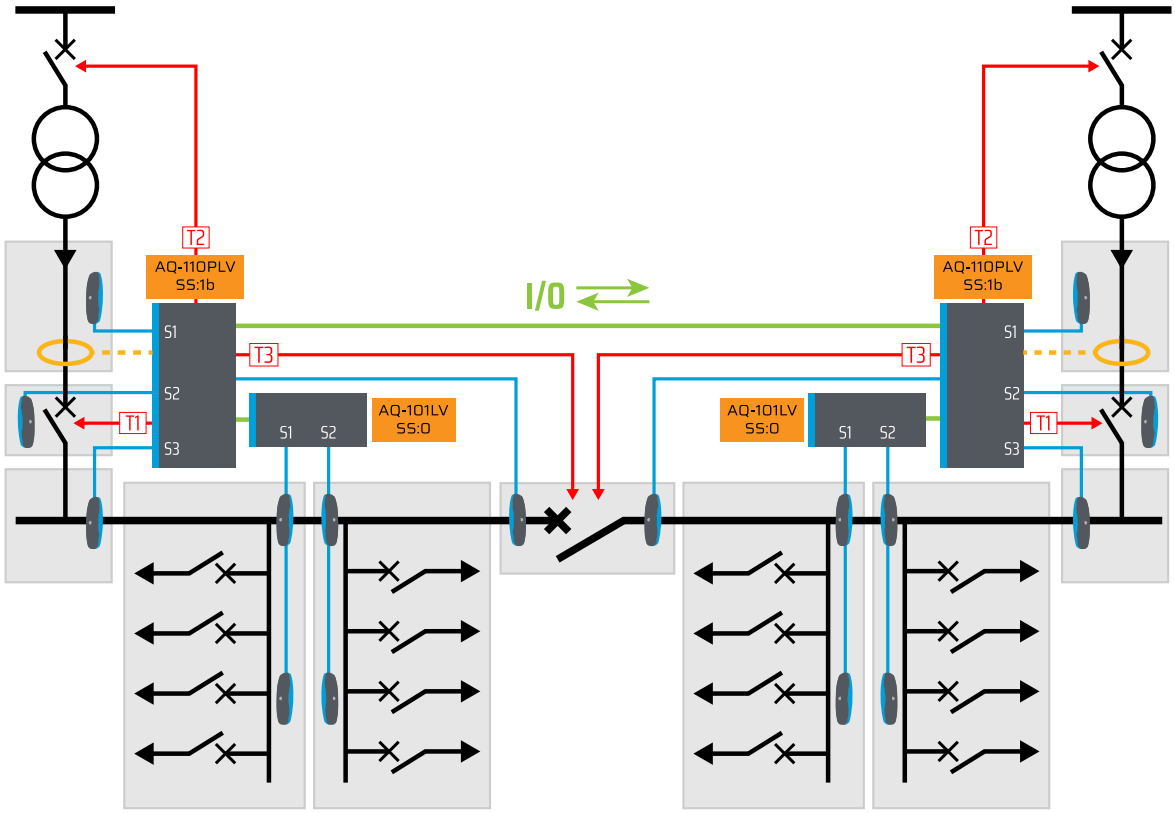


Table. 4.1 - 31. Simplified arc protection operation logic of an application with one incoming feeder.

Fault location	Circuit breaker to trip	CBFP trip
Outgoing feeders or the busbar	• Incoming feeder in the same section. • Tie breaker.	• HV side of the incoming feeder in the same section.

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Fault location	Circuit breaker to trip	CBFP trip
Tie breaker	• Incoming feeders on both sides of the tie breaker. • Tie breaker.	• HV side of the incoming feeder in both sides of the tie breaker.
Incoming feeder circuit breaker compartment	• Incoming feeder with the fault. • HV side of the incoming feeder with the fault. • Tie breaker.	• N/A.
Incoming feeder cable compartment	• Incoming feeder with the fault. • HV side of the incoming feeder with the fault.	• Tie breaker.

4.1.1 Incoming feeder AQ-110PLV (SS:1b)

Table. 4.1.1 - 32. Outputs of the incoming feeder AQ-110PLV (SS:1b) device.

Output	Connects to	Action
T1	Incoming feeder circuit breaker.	Opens circuit breaker.
T2	Incoming feeder HV side circuit breaker.	
T3	Tie breaker.	
T4	Alarming unit (optional).	Trip alarm signal.
BO1	BI1 of the incoming feeder device on the other side of the tie breaker.	Sends overcurrent signal.
AQD	Arc quenching device (optional).	Trips the arc quenching device.

Table. 4.1.1 - 33. Inputs of the incoming feeder AQ-110PLV (SS:1b) device.

Input	Connects to	Action
IL1, IL2, IL3	• Incoming feeder.	• Sensor channels and external light signal (**BI2**) can be set up to use overcurrent signal as an additional criterion for tripping.
BI1	• BO1 of incoming feeder device on the other side of the tie breaker. • Receives overcurrent signal.	
S1	• Incoming feeder cable compartment.	• Trips incoming feeder circuit breaker with **T1** relay. • Trips incoming feeder HV side circuit breaker with **T2** relay. • Trips the tie breaker with **T3** relay after CBFP time delay. • **This channel must be set to "Light only" mode if current measurement point is located after the sensor.**
S2	• Incoming feeder circuit breaker compartment.	• Trips incoming feeder circuit breaker with **T1** relay. • Trips incoming feeder HV side circuit breaker with **T2** relay. • Trips the tie breaker with **T3** relay. • Trips arc quenching device with **AQD**.

Input	Connects to	Action
S3	• Busbar compartment.	• Trips incoming feeder circuit breaker with **T1** relay. • Trips the tie breaker with **T3** relay. • Trips incoming feeder HV side circuit breaker with **T2** relay after CBFP time delay. • Trips arc quenching device with **AQD**.
S4	• Tie breaker.	
S5	• Optional.	
BI2	• **BO1** of outgoing feeder AQ-101LV (SS:0) devices in the same section. • Receives light signal.	

Figure. 4.1.1 - 36. Logic matrix of the incoming feeder AQ-110PLV (SS:1b) device.

SS:1b		OUTPUTS					
		T1	**T2**	**T3**	**T4**	**BO1**	**AQD**
INPUTS	**S1**	x[1]	x[1]	CBFP[1]	x[1]		
	S2	x[1]	x[1]	x[1]	x[1]		x[2]
	S3, S4, S5	x[1]	CBFP[1]	x[1]	x[1]		x[2]
	Lext> AQ-101LV (BI2)	x[1]	CBFP[1]	x[1]	x[1]		x[2]
	I> Overcurrent					x	

1) Activates only if channel has been set to light only mode or any overcurrent signal (I> or BI1) is ON.
2) Activates only if any overcurrent signal (I> or BI1) is ON.

Figure. 4.1.1 - 37. Recommended DIP switch settings of the incoming feeder AQ-110PLV (SS:1b) device.



4.1.2 Outgoing feeders AQ-101LV (SS:0)

Table. 4.1.2 - 34. Outputs of the outgoing feeder AQ-101LV (SS:0) devices.

Output	Connects to	Action
T1	Outgoing feeder circuit breakers (if applicable).	Opens the circuit breakers.
T2		
T3		
T4		
BO1	BI2 of incoming feeder AQ-110PLV (SS:1b) device in the same section.	Sends light signal.

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Table. 4.1.2 - 35. Inputs of the outgoing feeder AQ-101LV (SS:0) devices.

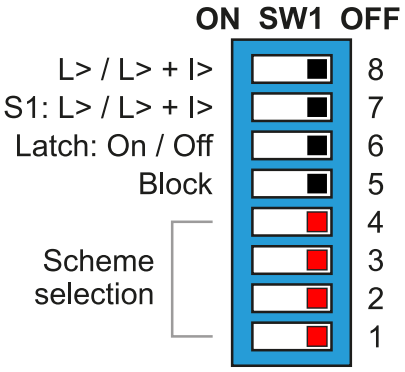
Input	Connects to	Action
S1…S5	• Outgoing feeders. • Busbar compartment.	• Trips outgoing feeders with T1, T2, T3 and T4 relays. • Sends light signal to incoming feeder AQ-110PLV (SS:1b) device with BO1.

Figure. 4.1.2 - 38. Logic matrix of an outgoing feeder AQ-101LV (SS:0) device.

SS:0		OUTPUTS				
		T1	T2	T3	T4	BO1
INPUTS	S1 - S5	x[1]	x[1]	x[1]	x[1]	x

1) Activates only if channel has been set to light only mode or overcurrent signal (BI2) is ON.

Figure. 4.1.2 - 39. Recommended DIP switch settings of the AQ-101LV (SS:0) devices.



4.1.3 Connections

Figure. 4.1.3 - 40. I/O connections of overcurrent signals.

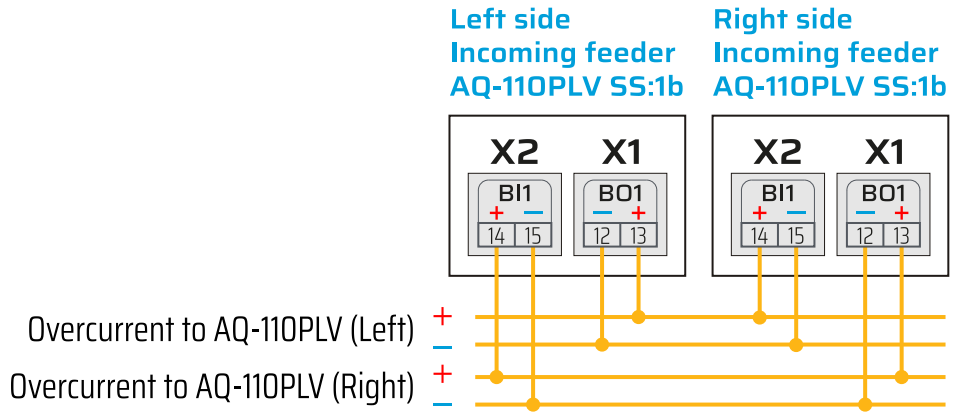
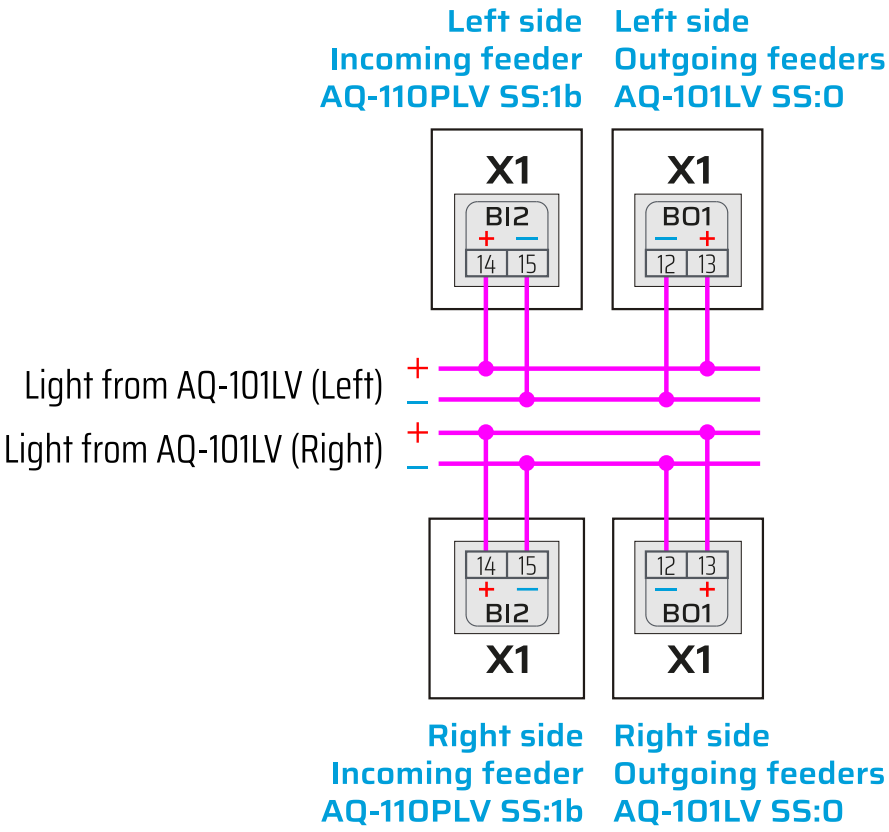


Figure. 4.1.3 - 41. I/O connections of light signals.



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4.2 Basic application with AQ-103LV

In this application, one AQ-110PLV is installed to each incoming feeder and one or more AQ-103LV devices are installed to outgoing feeder compartments.

AQ-103LV devices:

- detect arc light and forward the signal to the AQ-110PLV device on the same bus section.

AQ-110PLV devices:

- receives arc light signals from the AQ-103LV devices in the same bus section.
- detects arc light in the incoming feeder
- uses overcurrent detection to confirm arc faults (optional)
- forwards overcurrent signal to the other AQ-110PLV device
- trips the incoming feeder circuit breakers and the tie breaker.
- sends an activation signal to an arc quenching device (optional).

Figure. 4.2 - 42. Single-line diagram for the basic AQ-103LV application with a tie breaker.

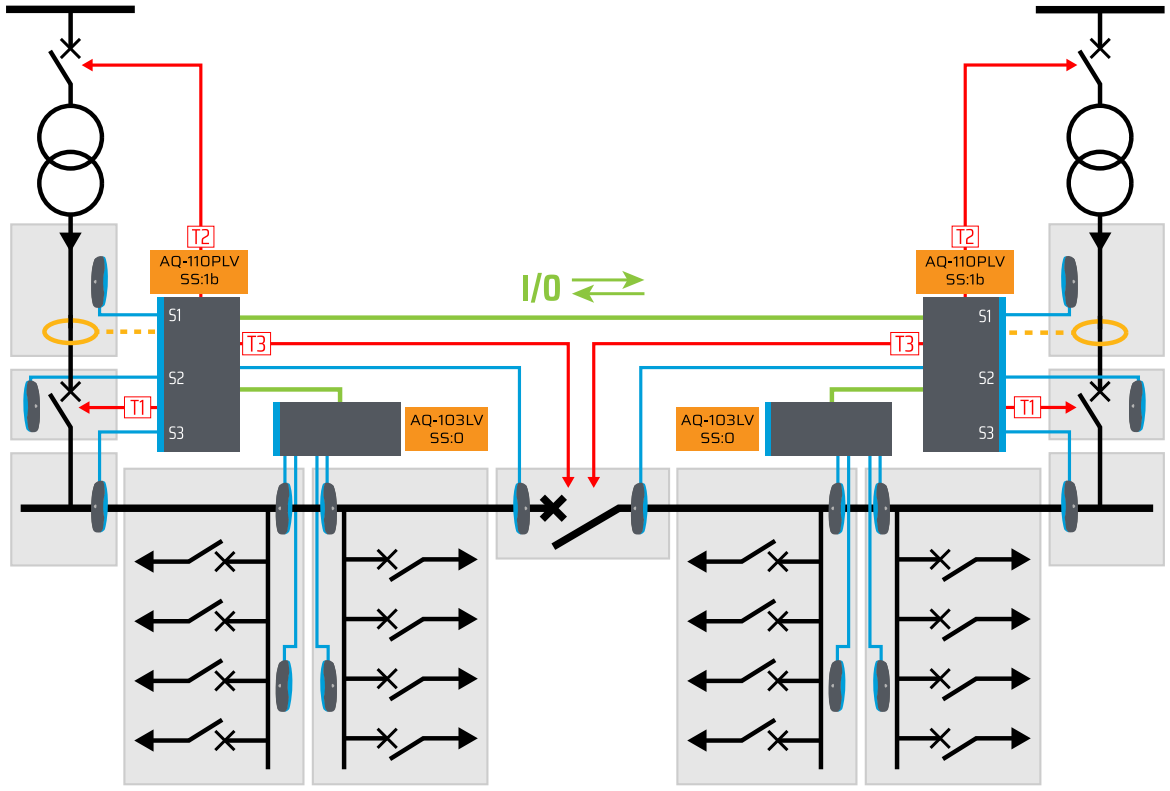


Table. 4.2 - 36. Simplified arc protection operation logic of an application with one incoming feeder.

Fault location	Circuit breaker to trip	CBFP trip
Outgoing feeders or the busbar	• Incoming feeder in the same section. • Tie breaker.	• HV side of the incoming feeder in the same section

Fault location	Circuit breaker to trip	CBFP trip
Tie breaker	• Incoming feeders on both sides of the tie breaker. • Tie breaker.	• HV side of the incoming feeder on both sides of the tie breaker.
Incoming feeder circuit breaker compartment	• Incoming feeder with the fault. • HV side of the incoming feeder with the fault. • Tie breaker.	• N/A
Incoming feeder cable compartment	• Incoming feeder with the fault. • HV side of the incoming feeder with the fault.	• Tie breaker.

4.2.1 Incoming feeder AQ-110PLV (SS:1b)

Table. 4.2.1 - 37. Outputs of the incoming feeder AQ-110PLV (SS:1b) device.

Output	Connects to	Action
T1	Incoming feeder circuit breaker.	Opens circuit breaker.
T2	Incoming feeder HV side circuit breaker.	
T3	Tie breaker.	
T4	Alarming unit (optional).	Trip alarm signal.
BO1	BI1 of the incoming feeder device on the other side of the tie breaker.	Sends overcurrent signal.
AQD	Arc quenching device (optional).	Trips the arc quenching device.

Table. 4.2.1 - 38. Inputs of the incoming feeder AQ-110PLV (SS:1b) device.

Input	Connects to	Action
IL1, IL2, IL3	• Incoming feeder.	• Sensor channels and external light signal (BI2) can be set up to use overcurrent signal as an additional criterion for tripping.
BI1	• BO1 of incoming feeder device on the other side of the tie breaker. • Receives overcurrent signal.	
S1	• Incoming feeder cable compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Trips the tie breaker with T3 relay after CBFP time delay. • This channel must be set to "Light only" mode if current measurement point is located after the sensor.
S2	• Incoming feeder circuit breaker compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Trips the tie breaker with T3 relay. • Trips arc quenching device with AQD.

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Input	Connects to	Action
S3	• Busbar compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips the tie breaker with T3 relay. • Trips incoming feeder HV side circuit breaker with T2 relay after CBFP time delay. • Trips arc quenching device with AQD.
S4	• Tie breaker.	
S5	• Optional.	
BI2	• BO1 of outgoing feeder AQ-103LV (SS:0) devices. • Receives light signal.	

Figure. 4.2.1 - 43. Logic matrix of the incoming feeder AQ-110PLV (SS:1b) device.

SS:1b		OUTPUTS					
		T1	T2	T3	T4	BO1	AQD
INPUTS	S1	x[1]	x[1]	CBFP[1]	x[1]		
	S2	x[1]	x[1]	x[1]	x[1]		x[2]
	S3, S4, S5	x[1]	CBFP[1]	x[1]	x[1]		x[2]
	Lext> AQ-103LV (BI2)	x[1]	CBFP[1]	x[1]	x[1]		x[2]
	I> Overcurrent					x	

1) Activates only if channel has been set to light only mode or any overcurrent signal (I> or BI1) is ON.
2) Activates only if any overcurrent signal (I> or BI1) is ON.

Figure. 4.2.1 - 44. Recommended DIP switch settings of the incoming feeder AQ-110PLV (SS:1b) device.



4.2.2 Outgoing feeders AQ-103LV (SS:0)

Table. 4.2.2 - 39. Outputs of the outgoing feeder AQ-103LV (SS:0) devices.

Output	Connects to	Action
T1	Outgoing feeder circuit breakers (if applicable).	Opens the circuit breakers.
T2		
T3		
T4		
HSO	Alarming unit (optional).	Trip alarm signal.
BO1	BI2 of incoming feeder AQ-110PLV (SS:1b) device in the same section.	Sends light signal.

Table. 4.2.2 - 40. Inputs of the outgoing feeder AQ-103LV (SS:0) devices.

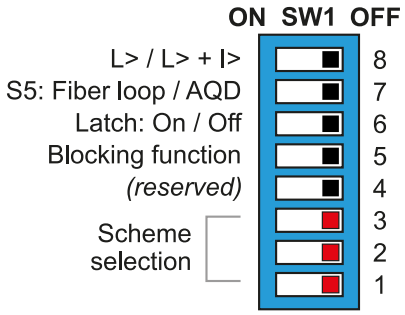
Input	Connects to	Action
S1…S15	• Outgoing feeders. • Busbar compartment.	• Trips outgoing feeders with T1, T2, T3 and T4 relays. • Sends light signal to incoming feeder AQ-110PLV (SS:1b) device with BO1.

Figure. 4.2.2 - 45. Logic matrix of the outgoing feeder AQ-103LV (SS:0) devices.

SS:0		OUTPUTS				
		T1	T2	T3	T4	BO1
INPUTS	S1 - S15	x[1]	x[1]	x[1]	x[1]	x

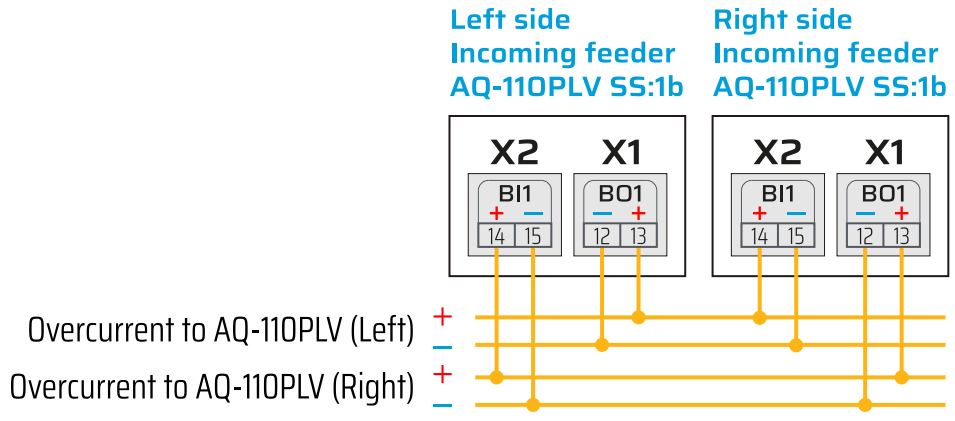
1) Activates only if channel has been set to light only mode or overcurrent signal (BI1) is ON.

Figure. 4.2.2 - 46. Recommended DIP switch settings of the outgoing feeder AQ-103LV (SS:0) devices.



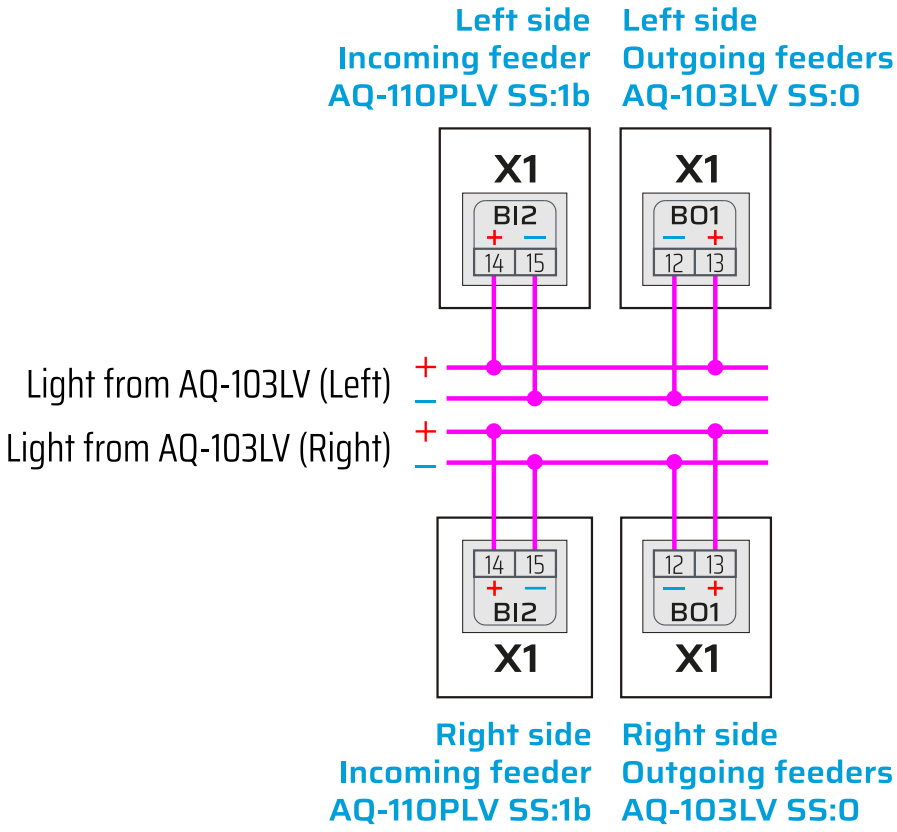
4.2.3 Connections

Figure. 4.2.3 - 47. I/O connections of overcurrent signals.



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Figure. 4.2.3 - 48. I/O connections of light signals.



4.3 Light-only application with AQ-103LV

In this application, one AQ-103LV is installed to each incoming feeder. If needed, one or more AQ-103LV devices are installed to outgoing feeder compartments. Operation logic is much simpler compared to previous applications (see operation logic table below).

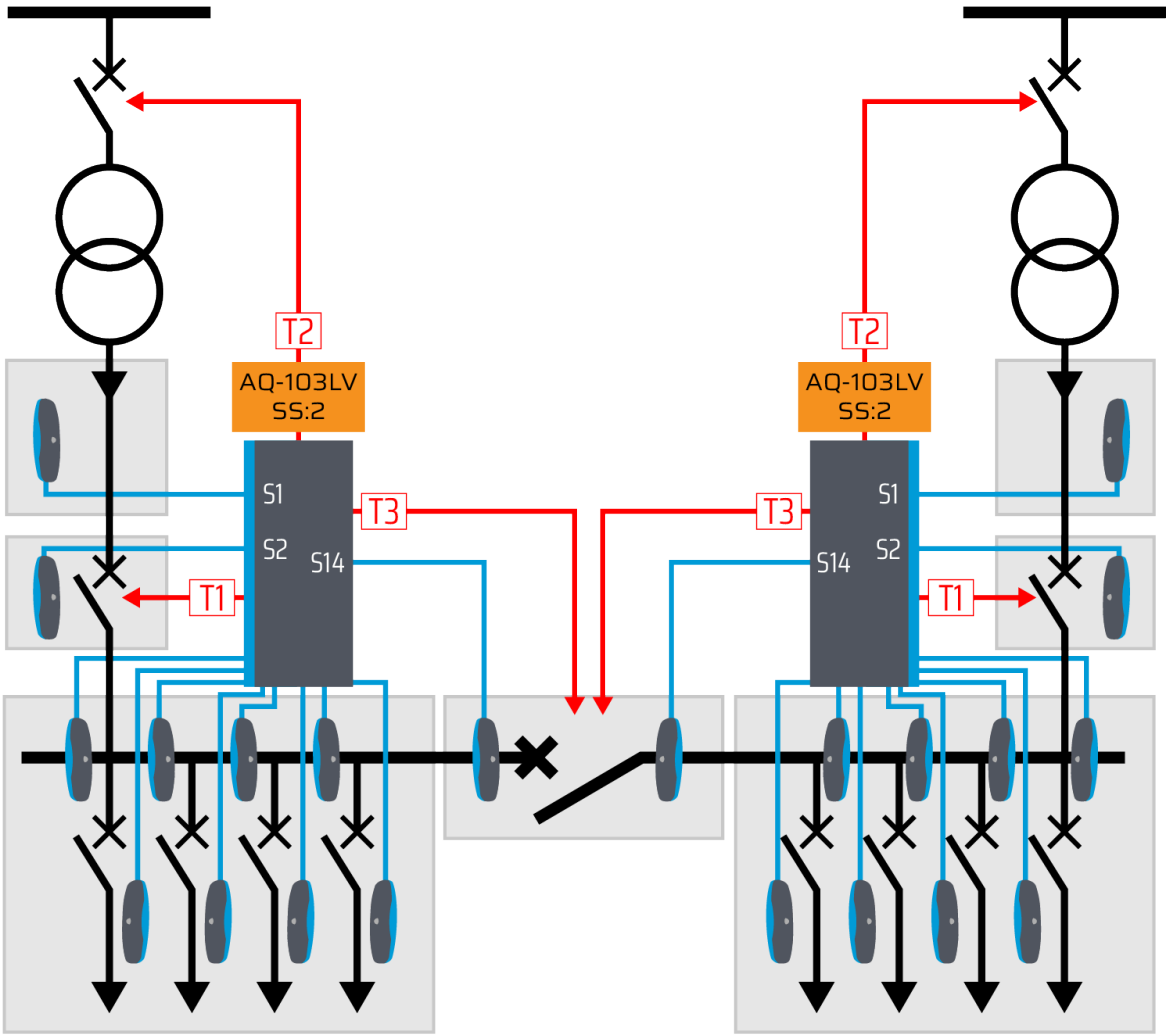
AQ-103LV devices in the outgoing feeder compartments:

- detect arc light and forward the signal to the AQ-103LV device on the same bus section.

AQ-103LV devices in the incoming feeder compartments:

- receives arc light signals from the AQ-103LV devices in the same bus section.
- detects arc light in the incoming feeder
- trips the incoming feeder circuit breakers and the tie breaker
- sends an activation signal to an arc quenching device (optional).

Figure. 4.3 - 49. Single-line diagram for the basic AQ-103LV application with a tie breaker.



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Table. 4.3 - 41. Simplified arc protection operation logic of an application with one incoming feeder.

Fault location	Circuit breaker to trip	CBFP trip
• Outgoing feeders • Busbar	• Incoming feeder in the same section. • Tie breaker.	• N/A
• Tie breaker	• Tie breaker. • Both incoming feeders.	• N/A
• Incoming feeder circuit breaker compartment	• Incoming feeder with the fault. • HV side of the incoming feeder with the fault. • Tie breaker.	• N/A
• Incoming feeder cable compartment	• Incoming feeder with the fault. • HV side of the incoming feeder with the fault.	• N/A

4.3.1 Incoming feeder AQ-103LV (SS:2)

Table. 4.3.1 - 42. Outputs of the incoming feeder AQ-103LV (SS:2) device.

Output	Connects to	Action
T1	Incoming feeder circuit breaker.	Opens circuit breaker.
T2	Incoming feeder HV side circuit breaker.	
T3	Tie breaker.	
T4	Incoming feeder circuit breaker on the other side of the tie breaker (optional).	
HSO	Alarming unit (optional).	Trip alarm signal.
BO1	N/A	N/A
AQD	Arc quenching device (optional).	Trips the arc quenching device.

Table. 4.3.1 - 43. Inputs of the incoming feeder AQ-103LV (SS:2) device.

Input	Connects to	Action
S1	• Incoming feeder cable compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay.
S2	• Incoming feeder circuit breaker compartment.	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Trips the tie breaker with T3 relay.
S3…S13, S15	• Busbar compartment • Outgoing feeders	• Trips incoming feeder circuit breaker with T1 relay. • Trips the tie breaker with T3 relay. • Trips arc quenching device with AQD.

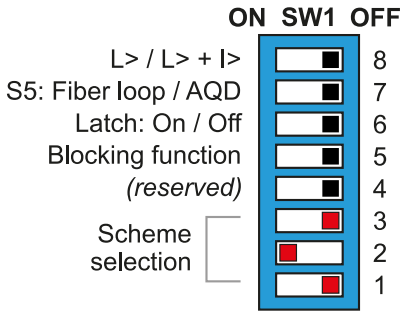
Input	Connects to	Action
S14	• Tie breaker (optional)	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Trips the tie breaker with T3 relay. • Trips the incoming feeder on the other side of the tie breaker with T4 relay. • Trips arc quenching device with AQD.
BI2	• BO1 of outgoing feeder AQ-103LV (SS:0) devices. • Receives light signal. • Optional	• Trips incoming feeder circuit breaker with T1 relay. • Trips incoming feeder HV side circuit breaker with T2 relay. • Trips the tie breaker with T3 relay. • Trips the incoming feeder circuit breaker on the other side of the tie breaker with T4 relay (optional). • Trips arc quenching device with AQD.

Figure. 4.3.1 - 50. Logic matrix of the incoming feeder AQ-103LV (SS:2) device.

SS:2		OUTPUTS					
		T1	T2	T3	T4	HSO	AQD
INPUTS	S1	x[1]	x[1]			x[1]	
	S2	x[1]	x[1]	x[1]		x[1]	
	S3 - S13	x[1]		x[1]		x[1]	x[2]
	S14	x[1]		x[1]	x[1]	x[1]	x[2]
	S15	x[1]		x[1]		x[1]	x[2]
	Lext> (BI2)	x[1]		x[1]		x[1]	

1) Activates only if channel has been set to light only mode or overcurrent signal (BI1) is ON.
2) Activates only if overcurrent signal (BI1) is ON.

Figure. 4.3.1 - 51. Recommended DIP switch settings of the incoming feeder AQ-103LV (SS:2) device.



4.3.2 Outgoing feeders AQ-103LV (SS:0)

Table. 4.3.2 - 44. Outputs of the outgoing feeder AQ-103LV (SS:0) devices.

Output	Connects to	Action
T1	Outgoing feeder circuit breakers (if applicable).	Opens the circuit breakers.
T2		

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Output	Connects to	Action
T3		
T4		
HSO	Alarming unit (optional).	Trip alarm signal.
BO1	BI2 of incoming feeder AQ-103LV (SS:2) device in the same section.	Sends light signal.

Table. 4.3.2 - 45. Inputs of the outgoing feeder AQ-103LV (SS:0) devices.

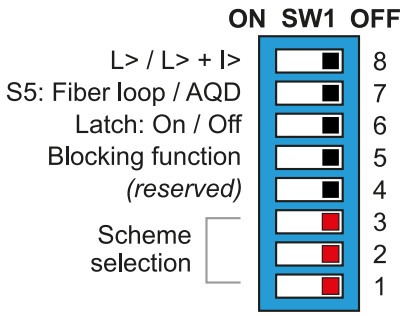
Input	Connects to	Action
BI1	• Overcurrent signal from an external device. • Optional.	• If a sensor channel has been set to "Light and current" mode, this input must be active for the sensor channel to trip.
BI2	• N/A	• N/A
S1…S15	• Outgoing feeders. • Busbar compartment.	• Trips outgoing feeders with T1, T2, T3 and T4 relays. • Sends light signal to incoming feeder AQ-103LV (SS:2) device with BO1.

Figure. 4.3.2 - 52. Logic matrix of the outgoing feeder AQ-103LV (SS:0) devices.

SS:0		OUTPUTS				
		T1	T2	T3	T4	BO1
INPUTS	S1 - S15	x[1]	x[1]	x[1]	x[1]	x

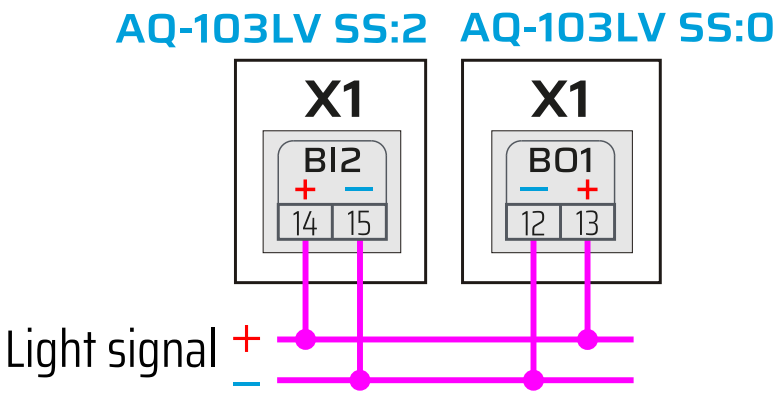
1) Activates only if channel has been set to light only mode or overcurrent signal (BI1) is ON.

Figure. 4.3.2 - 53. Recommended DIP switch settings of the outgoing feeder AQ-103LV (SS:0) devices.



4.3.3 Connections

Figure. 4.3.3 - 54. I/O connections of light signals.



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