ARCTEQ
PART OF ENSTO GROUP

AQ-50

Fault detection device

Instruction manual

Table of contents

1 Safety information

WARNING!
Only certified electricians are allowed to perform installation work.

WARNING!
National and local security guidelines must be followed.

WARNING!
Always short-circuit the secondary conductors of the current transformers during maintenance and testing.

WARNING!
If the secondary circuits of the current transformers (CTs) are opened or if their earthing point is missing or removed while the primary side is energized, high voltages can be generated. In the worst case scenario these voltages can be deadly and they can damage the isolation material. Energization of a CT's primary side is not permitted if the secondary side is open or not earthed.

WARNING!
Dangerous voltages can be present on the terminals, even when power is removed from the device.

WARNING!
Violations against these security guidelines can lead to fatalities, personal injury, and/or considerable damage to equipment.

WARNING!
Avoid removing the cover of an AQ-50 device. If it is removed, ensure that all electronic components are protected against electrostatic discharge by proper earthing of both the device and the personnel performing maintenance.

WARNING!
The device should be connected to protective earth at terminal X4.2.

2 Document information

Table. 2 - 1. Version 1 revision notes

Revision	1.00
Date	13.5.2024
Changes	• The first revision of the AQ-50 instruction manual.
Revision	1.01
Date	18.6.2025
Changes	• Added application example drawings to "Introduction" chapter.

3 Abbreviations

ASDU
: Application Service Data Unit

COMTRADE
: Common Transient Data Exchange

DHCP
: Dynamic Host Configuration Protocol

EF
: Earth fault

ESD
: Electrostatic discharge

OC
: Overcurrent

RTU
: Remote Terminal Unit

NTP
: Network Time Protocol

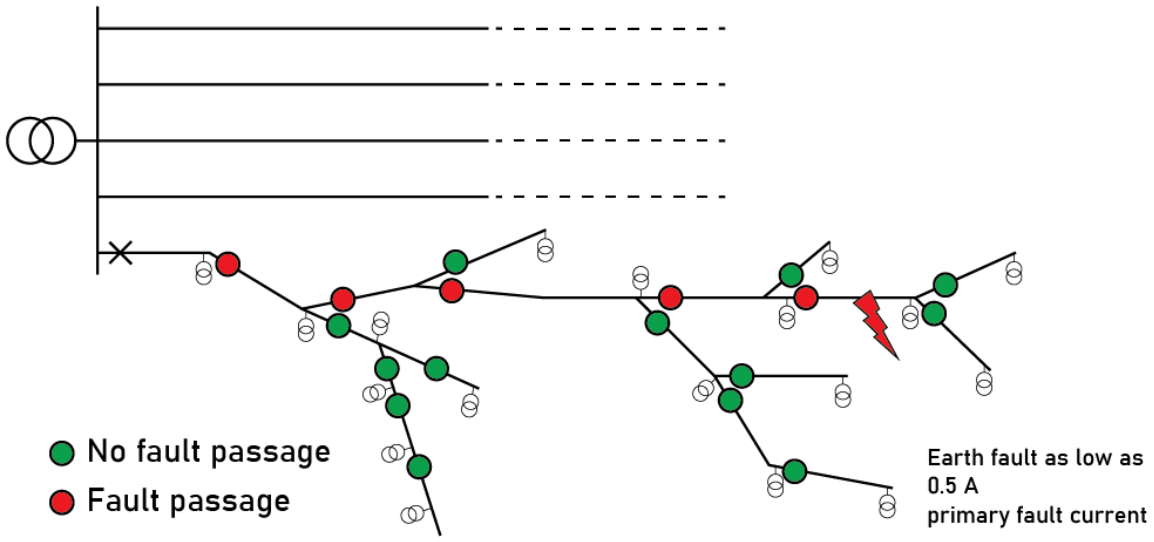
TFR
: Transient Fault Record(-er)

4 Introduction

The AQ-50 fault detection devices leave no fault in distribution networks unnoticed. Their superior capability to detect the most challenging faults, i.e., high impedance and intermittent earth faults with low, down to 0.5 A fault current, delivers fault detection accuracy you can rely on. The AQ-50 fault detection is based on measurement of phase currents only. This saves space and reduces costs significantly as separate voltage measurements are not needed, which makes AQ-50 devices easy to fit in new and retrofit installations. The AQ-50 devices are applicable to any type of cable or overhead line distribution network whether they are compensated, isolated, or directly earthed.

AQ-50 is a fault detection device for overcurrent and earth faults with an integrated remote terminal unit (RTU) functionality. It has I/O for indications and commands, and the device is therefore suitable for a typical secondary substation with up to four objects (i.e. circuit breakers). The standard AQ-50 device detects faults in one (1) feeder. Two expanded versions are available for fault detection in up to six (6) feeders. The communication interface to the remote control center is either IEC 60870-5-101 or IEC 60870-5-104.

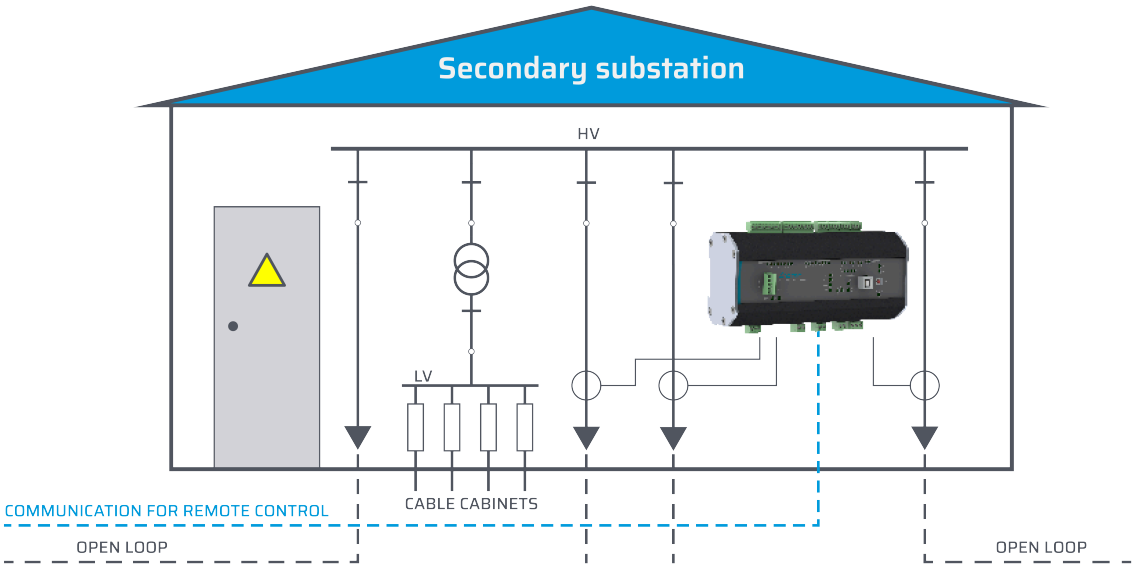
Figure. 4 - 1. AQ-50 fault detectors are capable of true fault pass-through detection.



Typical application

The figure below shows a typical application for an AQ-50 device with an expansion module for in total of three (3) feeders. It can handle a 3+1 secondary substation, including the fault detection of three lines/cables, indications, and control of four objects.

Figure. 4 - 2. Example of a typical application for an AQ-50 device.



Monitoring and control in open loop networks

Figure. 4 - 3. When a fault occurs, the AQ-50 fault detector reports the fault location to SCADA and the feeder protection relay clears the fault.

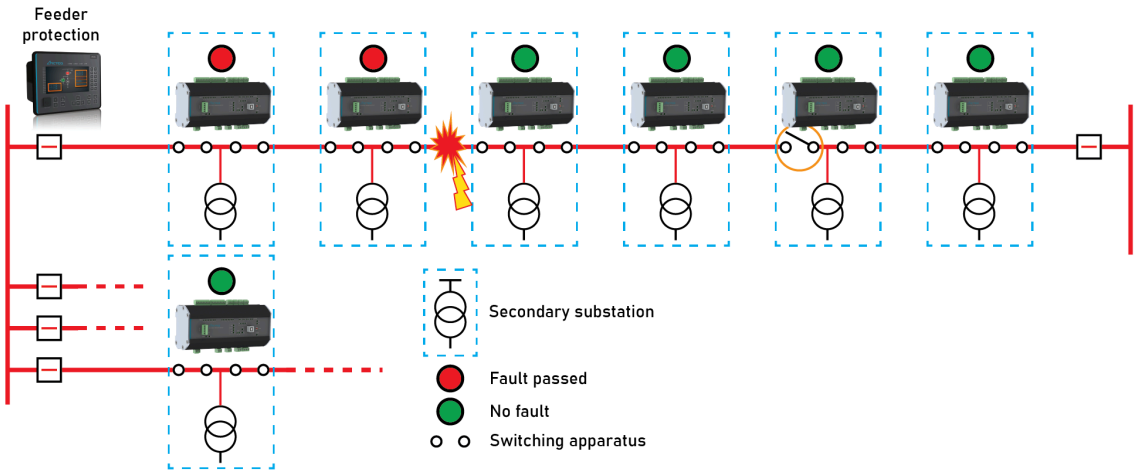
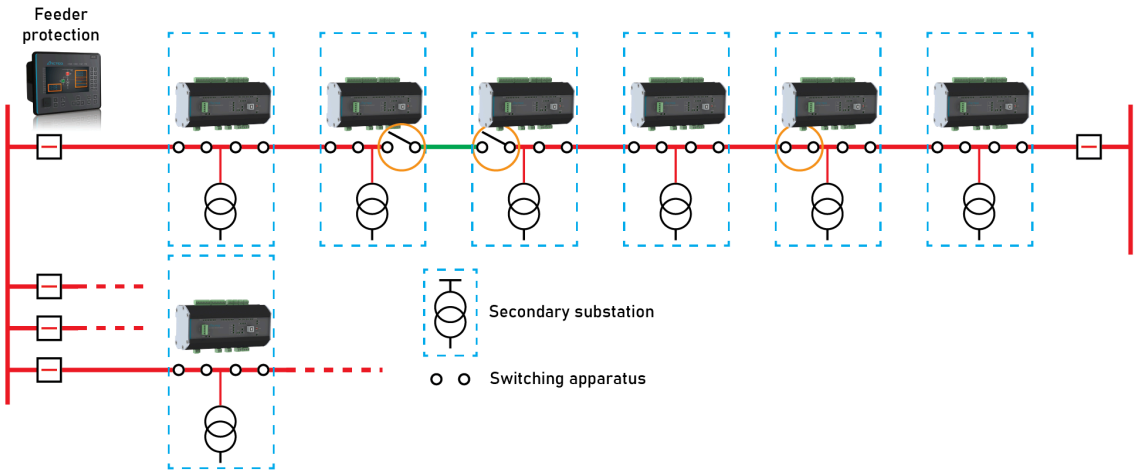


Figure. 4 - 4. After the fault is cleared, SCADA orders AQ-50 fault detectors to isolate the faulty segment, close the open point, and then energize the line again.



4.1 FLISR

AQ-50 fault detectors can be used to create a fully distributed Fault Location, Isolation, and Service Restoration (FLISR) system, where the devices autonomously can isolate the faulty section and restore power in open loop and radial configurations. The advantages are many. No need of a higher level system for the decision making increases speed and availability. The speed of the isolation and restoration depends on the type of communication media used. If the communication delay is short, the process can be completed almost immediately. Each unit communicates with its closest neighbour to determine the fault location.

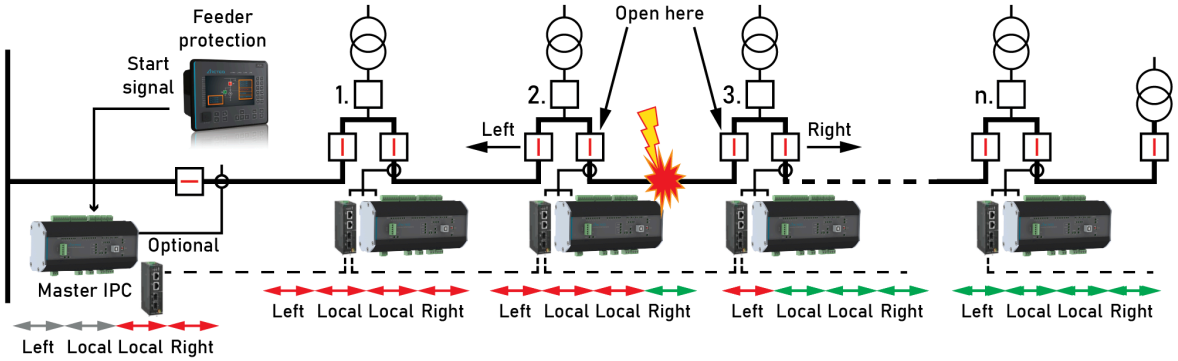
The faulty section is localised by the AQ-50 unit upstream the fault whose neighbour downstream has not seen the fault, and conversely for the unit downstream the fault. If there is ONE open point in the loop it can be closed automatically to restore the power. The function and decision are fully distributed to the AQ-50 unit in the secondary substation. No centralised application is required. It can be activated already with only three units in the loop. One of the units in the loop act as master. It supervises that all units are running, and it also keeps track of the location of the open point in the loop.

If the switching device in the secondary substation is not permitted to break the fault current, or if the communication delay can be longer than the preferred fault clearing time, the switching sequence will wait until the line is de-energised by the line breaker. After isolation of the faulty section the line is automatically reclosed. If required, earth faults and short-circuit faults can be treated differently. E.g., the earth fault current is small in impedance grounded systems and there is usually time enough to wait a while with the decision to disconnect the entire feeder or not.

The feeder relay protection can be used to release the function by its starting contact. If this option is chosen the automatic sequence will only commence if the relay protection has started.

The current can be measured on one or both sides of the secondary substation. If measured on both sides the busbar fault is selectively detected and isolated. A configuration with only one switching device in the secondary substation, such as a line recloser or disconnector, is also covered.

Figure. 4.1 - 5.



5 Overview

AQ-50 consists of two or three printed circuit boards, including a base board, a front board and, if applicable, an expansion board. The following figures show an overview of the three model of AQ-50: AQ-50-XXXX1 (for one feeder), AQ-50-XXXX3 (for three feeders), and AQ-50-XXXX6 (for six feeders).

Figure. 5 - 6. Overview of AQ-50-XXXX1.

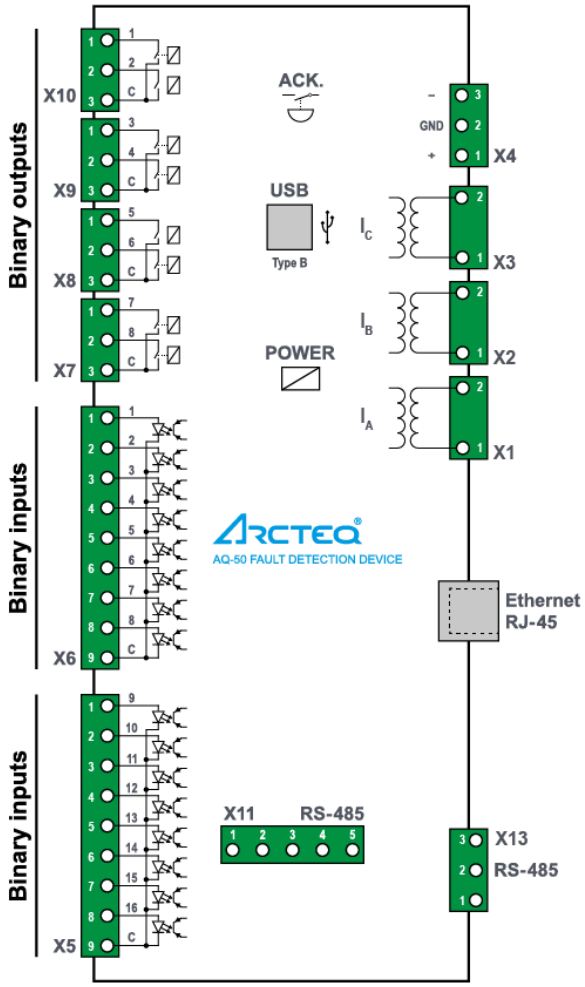


Figure. 5 - 7. Overview of AQ-50-XXXX3.

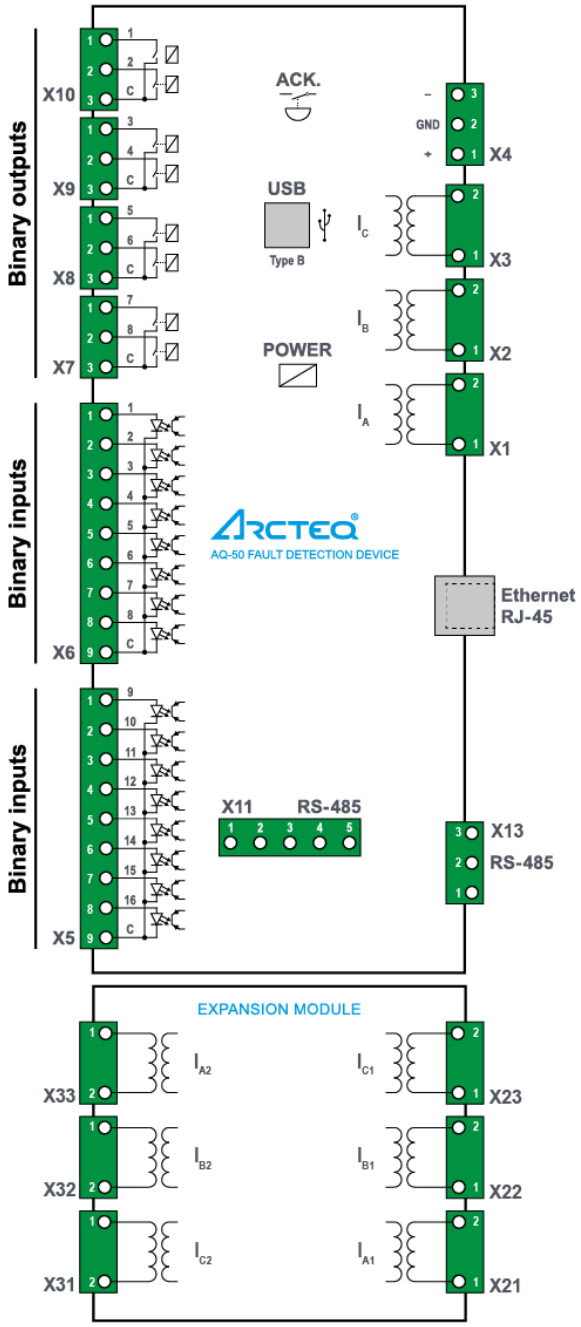
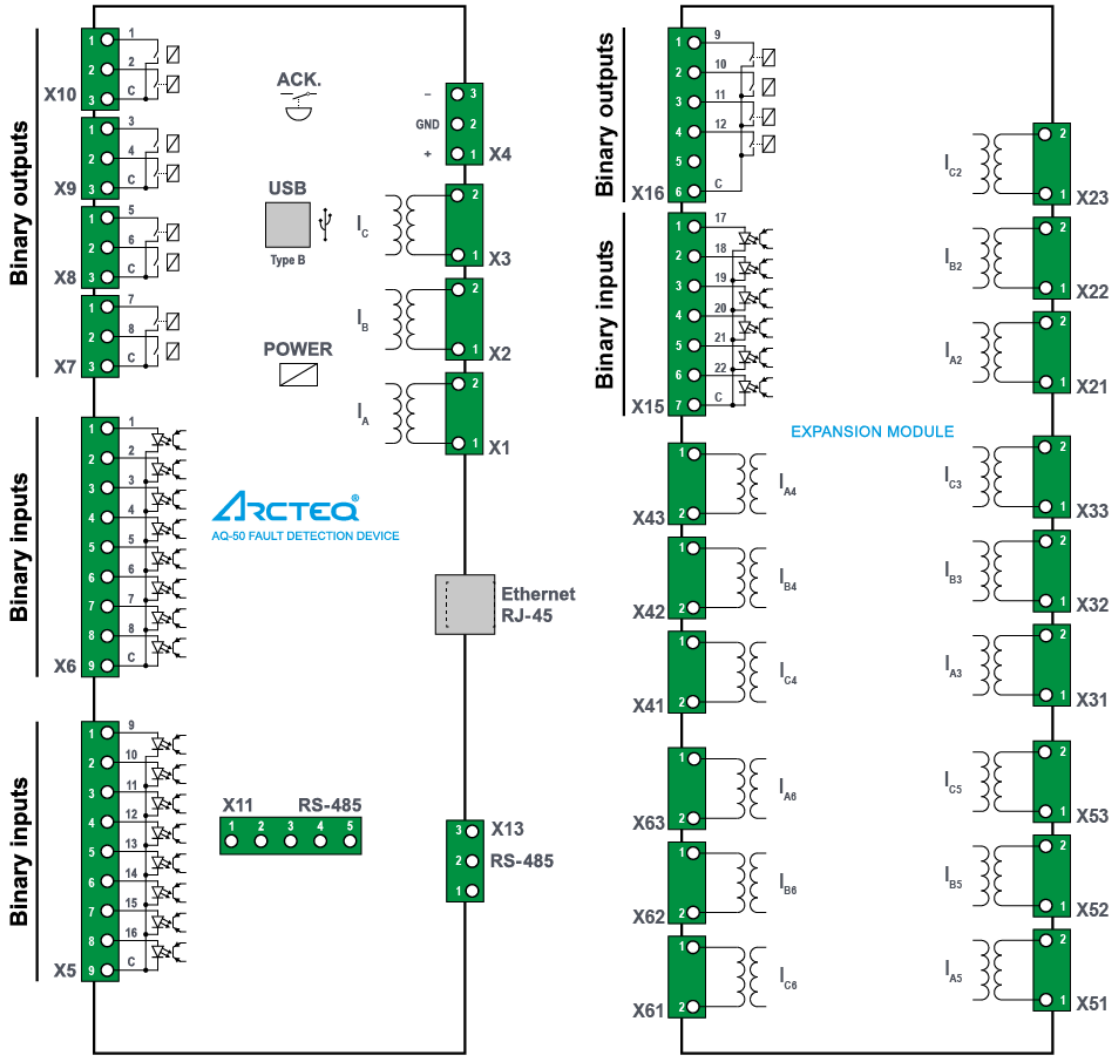


Figure. 5 - 8. Overview of AQ-50-XXXX6.

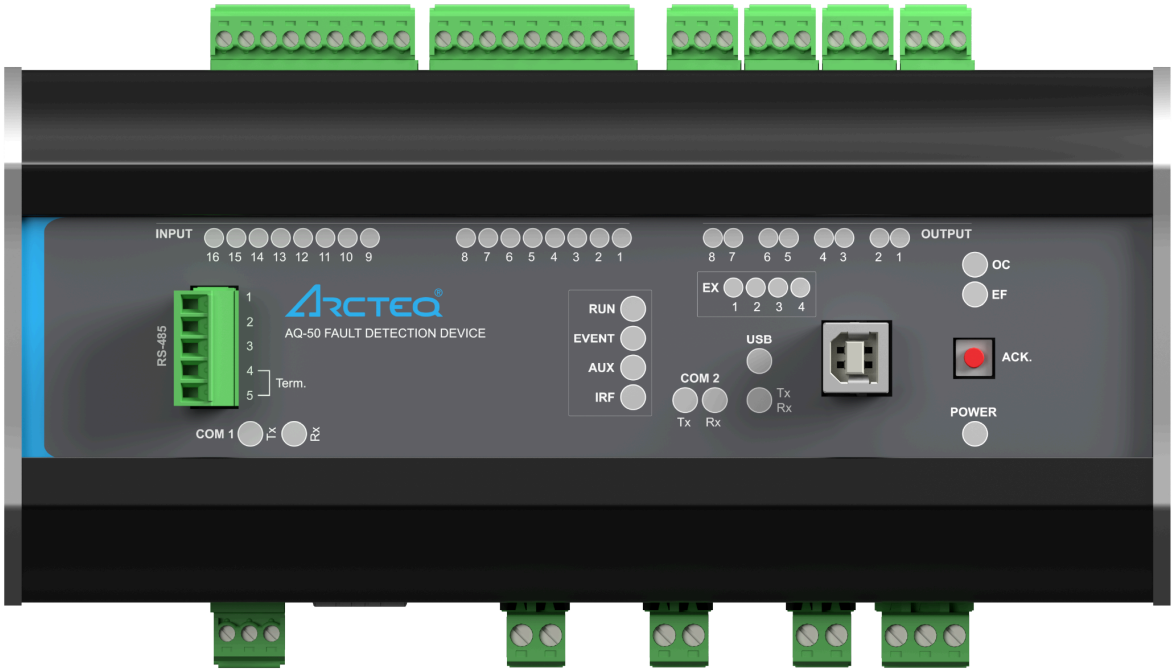


5.1 Front panel – HMI

5.1.1 LED indicators

There are various LED indicators on the front panel for inputs, outputs, communication ports, and status purposes.

Figure. 5.1.1 - 9. Front panel of an AQ-50 device.



Each binary input and output has an LED above its screw terminal, and the LED reflects the position of corresponding input/output. Voltage on an input activates the LED. A closed relay output activates the LED.

Table. 5.1.1 - 2. LED indicator descriptions.

LED	Color	Description
POWER	Green	The device is powered up.
RUN	Green	Flashes normally at a frequency of 0.5 Hz.
EVENT	Yellow	There is an unsent telegram in the queue for COM 1 transmission on the system interface.
AUX	Yellow	The device is handling a frequency deviation.
IRF	Red	Internal relay fault.
USB	Yellow	USB port is connected.
OC	Red	Overcurrent has been detected.
EF	Red	Earth fault has been detected.
Tx (COM 2)	Yellow	A telegram is being sent on the serial COM 2 interface.
Rx (COM 2)	Yellow	A telegram is being received on the serial COM 2 interface.
Tx (COM 1)	Yellow	A telegram is being sent on the serial COM 1 interface.

LED	Color	Description
Rx (COM 1)	Yellow	A telegram is being received on the serial COM 1 interface.
Tx/Rx (USB)	Green or red	A dual-coloured green-red diode which alternates when there is traffic on the USB port. The USB LED is active when a USB link is established.
EX1	Yellow	Fault detector 1 has identified a fault.
EX2	Yellow	Fault detector 2 has identified a fault (only applies to the expanded devices).
EX3	Yellow	Fault detector 3 has identified a fault (only applies to the expanded devices).
EX4	Yellow	Start of a fault detection in Detectors 1-3 in a normal configuration.

5.1.2 Push button for Local Acknowledgement

There is a push button, (ACK.), on the far right of the front panel for local acknowledgement of the overcurrent and earth fault indications, and factory reset. Remote acknowledgement from the dispatch center and automatic self-acknowledgement after a configurable time delay are described in the "Settings – Common.

5.2 Startup

After a DC supply disconnection has caused the device to restart or after a restart has been ordered remotely, the inputs and the outputs are updated with the current status. Any outputs that were activated before the restart return to the inactive position unless the conditions for activation are valid.

5.3 Internal supervision

Internal check of hardware near the CPU as well as of software modules is performed at startup.

- Memory check – activates IRF
- Flash memory check – activates IRF
- Expansion board check – activates IRF
- Execution of software modules – activates IRF
- Supervision of external interfaces – reported in the event log (see the "Event log" chapter).

Supervision of expansion boards and execution of software modules are performed continuously.

5.4 Interfaces

5.4.1 RS-485/RS-422 port for IEC 60870-5-101 Slave (COM1)

AQ-50 has a signal interface on the left of the front panel for connection to the remote control center using the communication protocol IEC 60870-5-101.

This port supports 2-wire (half duplex) communication. It is factory set to 8-E-1 (8 data bits, even parity and 1 stop bit).

There is built-in protection for surge voltages. However, cables for communication that may be subjected to overvoltage must have a primary protection. As a rule of thumb, one can say that cables that leave the building/station must be supplemented with a primary protection.

NOTICE!
Please note that X11 is not named as such on the device's front overlay. It is instead named only "RS-485".

Table. 5.4.1 - 3. Terminals of the RS-485 port.

Terminal designation	Short name	Description
X11:1	TX+	Sender (plus)
X11:2	TX–	Sender (minus)
X11:3	RX(TX)+	Receiver (plus), (also sender when 2-wire)
X11:4	RX(TX)–	Receiver (minus), (also sender when 2-wire)
X11:5	Term.	Termination for receiver. Connect to X11:4 for activation

NOTICE!
The first (master) and last device (last slave) on the communication line should be terminated. This is done on AQ-50 by short-circuiting X11:4 and X11:5.

The terminals X11:3 and X11:4 are used for 2-wire communication. Configuration according to "General Setings - Communication" chapter.

5.4.2 RS-485 port for IEC 60870-5-101 Master (COM2)

AQ-50 has another terminal X13 on the left lower side, where additional units that communicate with IEC 60870-5-101 can be connected. The port only supports 2-wire communication (half duplex). It is factory set to 8-E-1 (8 data bits, even parity and 1 stop bit).

NOTICE!
Note that the IEC 60870-5-101 Master function is an option and is ordered separately, see "Ordering information" chapter.

There is a built-in protection for surge voltages. However, cables for communication that may be subjected to overvoltage must have a primary protection. As a rule of thumb, one can say that cables that leave the building/station must be supplemented with a primary protection.

Table. 5.4.2 - 4. Terminals of the IEC 101.

Terminal designation	Short name	Description
X13:1	RX/TX+	Sender/Receiver (plus)
X13:2	RX/TX-	Sender/Receiver (minus)
X13:3	Term.	Line termination. Connect to X13:2 for activation.

NOTICE!
The first (master) and last device (last slave) on the communication line should be terminated. This is done on AQ-50 by short-circuiting X13:2 and X13:3.

5.4.3 Ethernet interface for IEC 60870-5-104 and Service Port

There is an Ethernet interface, RJ-45 10/100Base - TX Full Duplex, for communication via IEC 60870-5-104 and the remote control center.

This interface is also used as a service port for connecting a service computer using TCP/IP and accessing the built-in web interface of AQ-50. See "Connecting using Ethernet " chapter for more information.

5.4.4 USB port

AQ-50 is equipped with a service port for USB type B. The port is located on the right of the front panel next to the local acknowledge push-button, "ACK.". "Arcteq USB Bridge" software can be used to connect a web browser with AQ-50 device using a USB port. See "Connecting with USB" chapter for more information.

5.4.5 Secondary current inputs, 1 A

Current terminals for phase current transformers are found in the following locations:

- Fault detector 1: Terminals X1-X3 between the RJ-45 connector for Ethernet and the terminal for power supply.
- Fault detector 2: Terminals X21-X23, lower side of the expansion module (left side of AQ-50-XXXX3).
- Fault detector 3: Terminals X31-X33, upper side of the expansion module (left side of AQ-50-XXXX3).

See "Overview" chapter for connection drawings.

5.4.6 Power supply

AQ-50 requires an external power supply of 24…48 VDC which is connected to terminal block X4. The connection is not polarity sensitive.

The unit must be connected to protective earth via X4.2.

6 Earth fault detection

The AQ-50 measures the phase currents only. Current transformers are used for the measurement. The sampling frequency of the phase currents is 2 kHz. The high impedance earth fault detection and intermittent earth fault detection is based on fault transient analyses making the algorithm both fast and sensitive. The method performs reliably for both high impedance as well as transient and arcing faults. The method is based on analysing the change of the phase currents when an earth fault occurs. Detection of an earth fault means that the fault is downstream of the measuring point in a radial network, or that a fault current has passed the measuring point, providing for true fault passthrough detection. Indirectly, this means that the direction of the fault can be identified by measuring phase currents only, without the need of polarizing zero-sequence voltage. The method works for all types of networks from directly grounded to isolated. In particular, this means that for an impedance grounded network, the compensation degree has no significance, and for an isolated network, the natural unbalance between the phases in principle can be infinite.

Figure. 6 - 10. In a healthy feeder, changes in the phase currents are symmetrical.

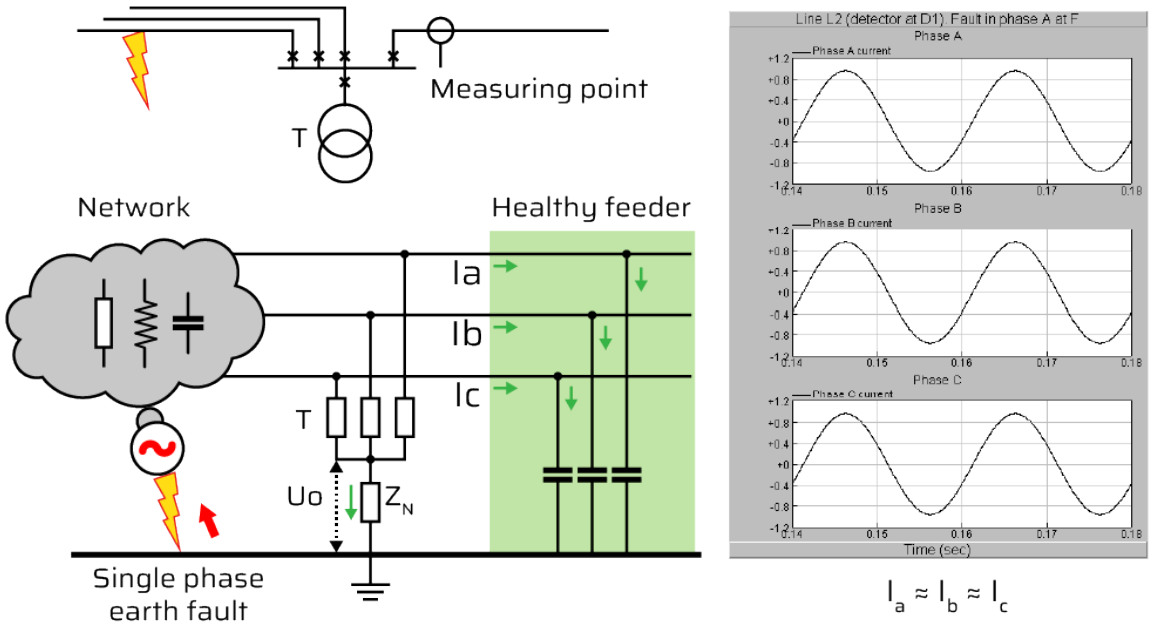


Figure. 6 - 11. When the fault is in the feeder, the algorithm detects asymmetrical current changes in the phases.

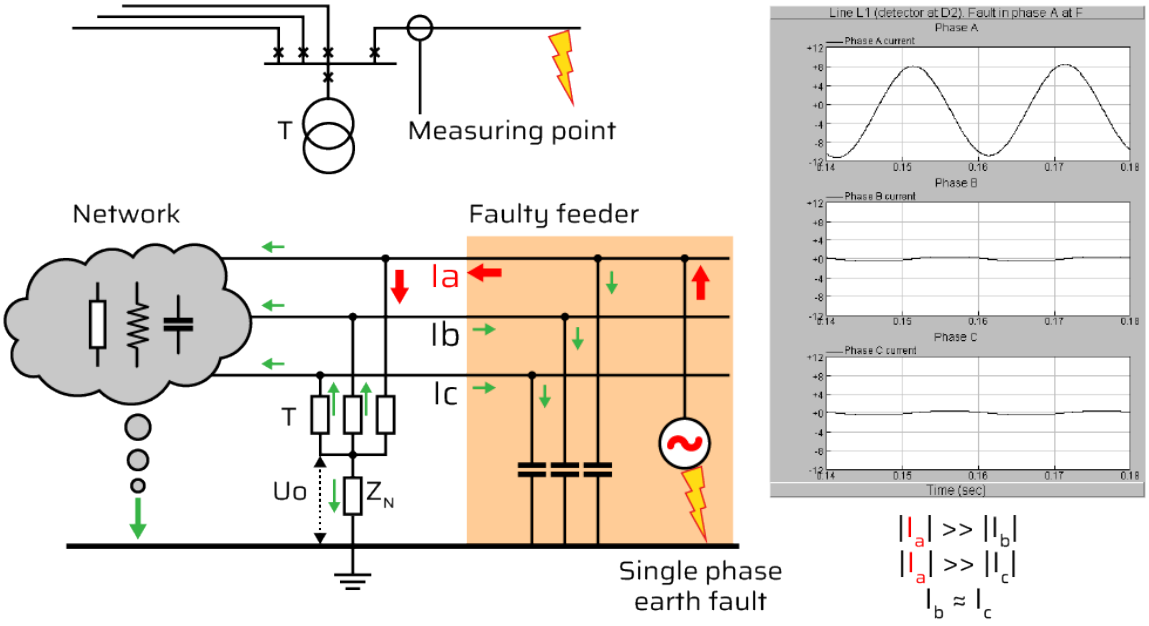
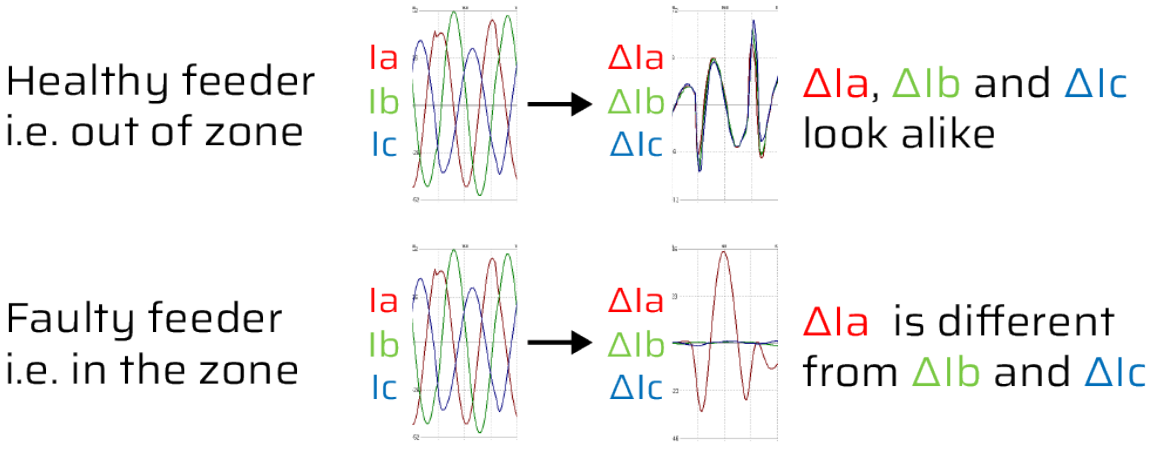


Figure. 6 - 12. Current change in a healthy feeder and in a faulty feeder.



7 Fault detection states

The earth fault detection sequence goes through discrete states. These states can be seen in the transient fault recording ("Transient fault recorder" chapter). For each state, an evaluation is made if certain conditions are met to proceed to the next state. If these conditions are not met, a controlled return to the basic state is made.

0 IDLE – This is the basic state. The detector continuously evaluates any changes in the residual current, I_N.

2 TRIG – An earth fault somewhere in the network is triggered by detecting a sudden change of I_N. The size of the change is related to the sensitivity, the smaller the change, the higher the impedance of the earth fault. During a short period after TRIG, the nature of the error is evaluated. Depending on the result, the state changes to either RESET, EVAL-T, or EVAL-A.

3 EVAL-T – In this state, supplementary calculations are made especially for high impedance faults. From this state, the detector always continues to EVAL-A.

4 EVAL-A – State to determine whether the detector should go to START or RESET.

5 START – Here, a timer for the set time delay is started. The detector proceeds to the DETECT or TRIP states if the changed I_N exists after the set time. The state will return to RESET if the condition is not met.

6 DETECT/TRIP – This state means that a fault has been detected. Controlled return to IDLE via RESET will follow.

8 REIGNITION – This state means the same as DETECT but indicates that the fault is reigniting or arcing.

1 RESET – The detector will temporarily and as short as possible be in this state for the return to IDLE to be controlled.

Similar states also exist for overcurrent, non-directional earth fault and phase interruption. Only the overcurrent detection states for stage 1 are displayed in the transient fault recording:

0 IDLE

2 START

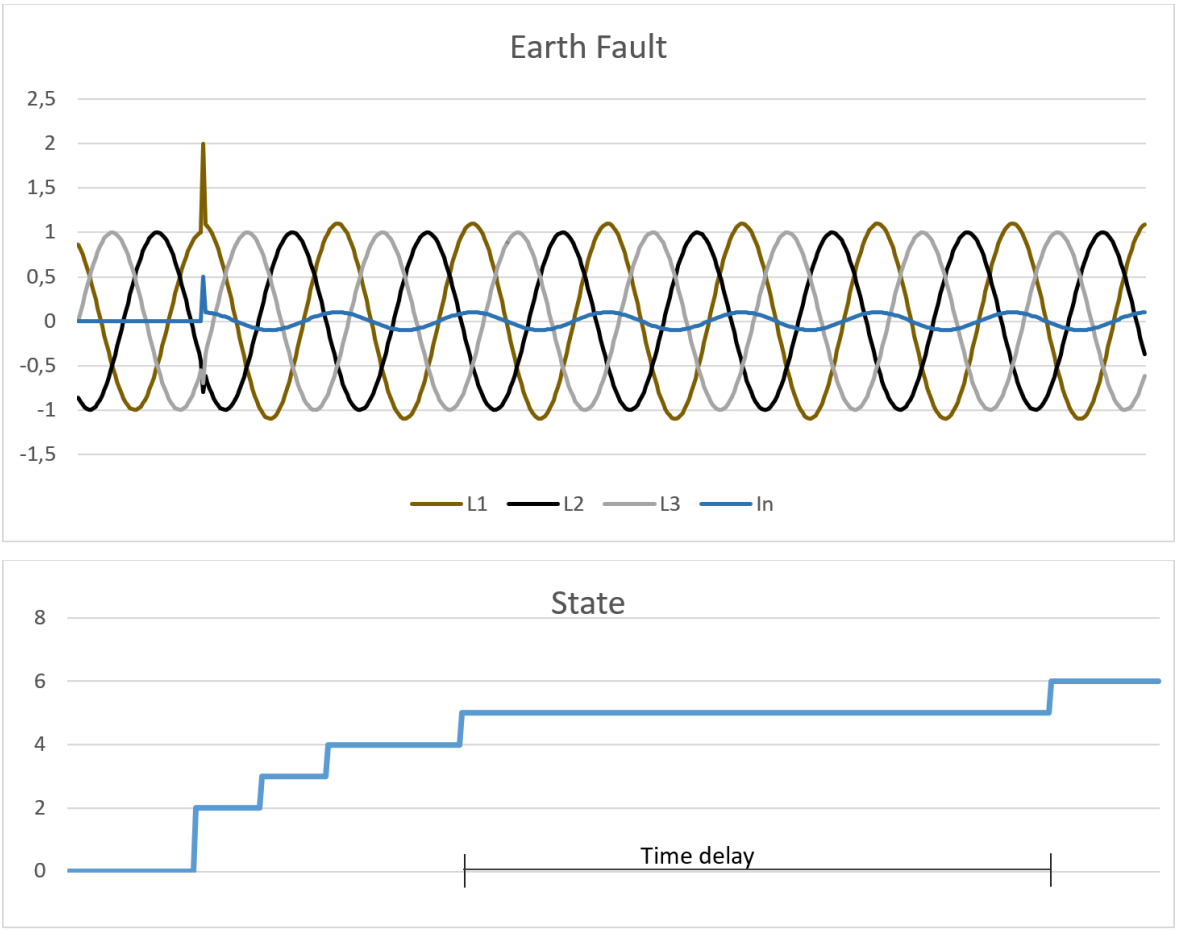
4 DETECT/TRIP

The State signal in the transient fault recording file contains information on the state of both earth fault and overcurrent. The state signal is an 8-bit value where the lower nibble indicates the state of the earth fault detector and the upper one indicates the state of overcurrent one. For example, the value 34 decimals (22 hexadecimal) means that ground fault has state 2-TRIG and overcurrent 2-START.

Evaluation of earth faults

See the example below showing an earth fault and the corresponding state changes during the evaluation process.

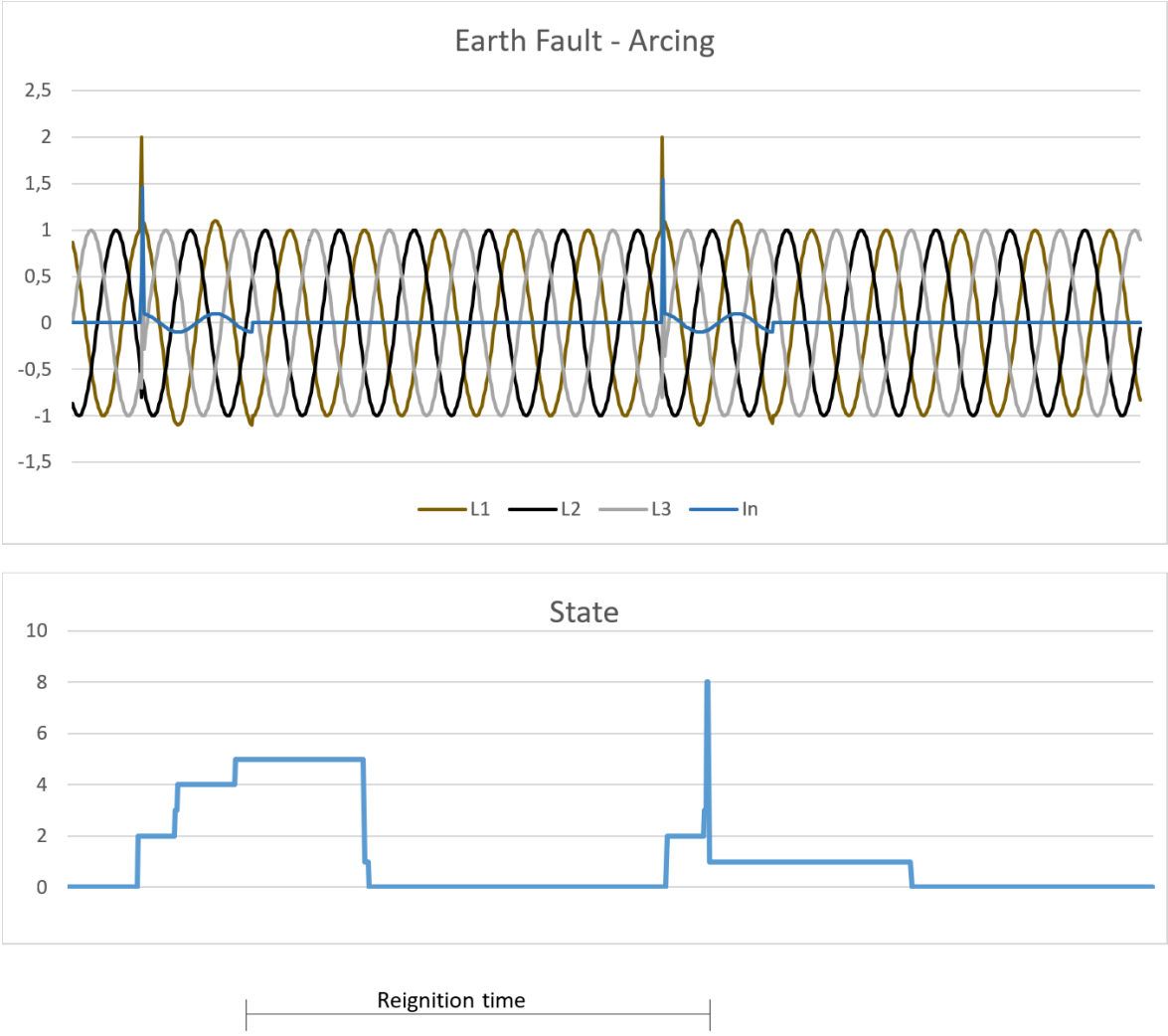
Figure. 7 - 13. States during the evaluation of a permanent earth fault.



Evaluation of intermittent and arcing faults

An arcing earth fault is characterized by its transient nature. It extinguishes and then returns with a new transient after a certain time or with a certain frequency. If the time delay is short enough, a single transient may be sufficient for the detector to go to the TRIP state. If an error occurs and the detector reaches the START state, the reignition timer is started. If the fault returns within the set reignition time, the detector will indicate TRIP immediately when the START state is reached. Thus, it does not wait for the normal time delay between START and TRIP to expire. Two consecutive starts within a certain time is evaluated as an arcing fault. The method ensures that an arcing error does not start and reset repeatedly.

Figure. 7 - 14. Earth fault with arcing characteristics – after the second ”START” the detector progresses immediately to state TRIP.



7.1 Evaluation of earth faults

7.2 Evaluation of intermittent and arcing faults

An arcing earth fault is characterized by its transient nature. It extinguishes and then returns with a new transient after a certain time or with a certain frequency. If the time delay is short enough, a single transient may be sufficient for the detector to go to the TRIP state. If an error occurs and the detector reaches the START state, the reignition timer is started. If the fault returns within the set reignition time, the detector will indicate TRIP immediately when the START state is reached. Thus, it does not wait for the normal time delay between START and TRIP to expire. Two consecutive starts within a certain time is evaluated as an arcing fault. The method ensures that an arcing error does not start and reset repeatedly.

8 Settings – Common

Detector function settings can be found on the website on tab Config/Detector. Here are two or four subtabs: Common, Detector 1, Detector 2, Detector 3, etc.

Figure. 8 - 15. Settings for the Detector functions.

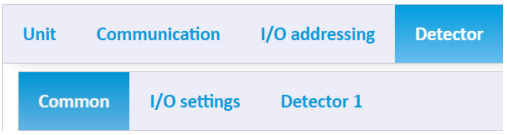


Table. 8 - 5. Auto acknowledge.

Parameter	Range	Factory value	Unit	Description
Enable	• Yes • No	Yes	-	Activation of automatic acknowledge.
Auto ack delay	0...48	4	hour	Time for automatic acknowledge after fault detection. The unit can be seconds, minutes, or hours. Maximum time is 48 h.

The function for transient fault recordings is described in detail in the"Transient fault recorders – TFR" chapter. There are limitations in the number of transient fault recordings that can be stored in runtime memory. If there is a need to ensure that there is always space for a new disturbance recording, the parameter *Enable immediate ack* can be checked. Observe that previous recordings can be deleted if the detector restarts due to new events.

Table. 8 - 6. TFR functions.

Parameter	Range	Factory value	Description
Enable immediate ack	• Yes • No	No	Activation of automatic acknowledge of TFR.
Enable TFR at EF trig	• Yes • No	No	Activate TFR from earth fault trigger.
Pretrigger	1...1 000 ms	140 ms	Time for the first data point of the record.

Table. 8 - 7. Specialist settings.

Parameter	Range	Factory value	Unit	Description
Post Trip Blocking Time	0...1 000 000	2 000	ms	Time for blocking of detector functions after fault detection.
Test qualifier	0...4294967295	0	-	Parameter for test.

9 Settings – I/O settings

Analog inputs are used to digitize signals that represent various primary values. There are a variety of settings that can condition these input signals. These settings are briefly described below.

Table. 9 - 8. Parameter descriptions.

Parameter	Range	Description
Scale	0..2 000	Scaling factor, from secondary to primary values (ratio).
Decimals	0..3	Number of decimals for the value presented in the web interface.

Table. 9 - 9. Specialist settings.

Parameter	Range	Description
Offset	0.000..1.000	Offset added to the secondary value before scaling it.
Ref value	0..2 000	The reference value represents 100% of the nominal primary value, and is used for the calculation of deadbands. For phase currents the reference value is linked to the Scale value.
Unit - prefix (Does not affect the amplitude of the input signal.)	-, m, k, M	E.g., m(illi), k(ilo or M(ega).
Unit - unit	-, A, W, VA, Hz, degC	SI unit of the primary signal.

Table. 9 - 10. I/O settings.

Signal	Range	Factory value	Description
Dx Ly Current	1...2 000.0 A	300.0 A	Ratio phase y, detector x

NOTICE!
The ratio is Primary/Secondary current. This also applies to display of other currents.

Table. 9 - 11. Other factory default settings for the number of decimals.

Signal	Factory value No of decimals	Description
Unit temperature	1	See "Analog Inputs - Internal" chapter.
Dx Neutral Current	2	See "Analog inputs - Analog input detector" chapter.
Dx Max fault current	0	
Dx Max current	1	
Dx Average current	1	

Signal	Factory value No of decimals	Description
Dx Fault phase	0	

10 Detector settings – Detector n

10.1 Overcurrent

AQ-50 has two overcurrent stages that operate independently of each other. When overcurrent is enabled, it means that both stages are activated. The start signal is common. This means that START overcurrent is generated by either stage 1 or stage 2 starting. The overcurrent function measures the RMS value of all phases. Inverse time characteristics can be activated for stage 1 using the parameter *Enable*.

The START signal is generated if the current in a phase exceeds the set levels, Level 1 or Level 2. TRIP overcurrent is generated after the set time delays, Delay 1 or Delay 2. If the setting *Input qualifier* is selected to any input, 1-16, no TRIP output signal and message to remote control will be created until there is voltage on the selected input within set time, determined by the parameter *Event delay*. However, the internal event is always generated.

If inverse time characteristics is used, Delay 1 is ignored and is replaced with a calculated delay time according to IEC 60255,

$$t = TMS \times \left(\frac{k}{\left(\frac{I}{I_{Level\ 1}} \right)^{\alpha} - 1} \right)$$

Where TMS is a parameter of own choice and k and α are defined by the choice of inverse curve according to the following table.

Table. 10.1 - 12. k and α values of different available curve types.

Curve type	k	
Standard inverse	0,14	0,02
Very inverse	13,5	1
Extremely inverse	80	2
Long inverse	120	1

If inverse time characteristics is chosen, stage 1 starts at 105% of Level 1.

Table. 10.1 - 13. Overcurrent settings.

Parameter	Range	Factory value	Unit	Description
Enable	• Disabled • Definite • Standard inv • Very inv • Extremely inv • Long inv	Disabled	-	Overcurrent stage activated
Level 1	0...10 000.0	500.0	A	Overcurrent level stage 1
Delay 1	0...10 000	40	ms	Time delay between START and TRIP stage 1
TMS 1	0.05...1.00	0.05	-	Time multiplier at inverse time stage 1
Level 2	0...10 000.0	10 000.0	A	Overcurrent level stage 2
Delay 2	0...10 000	10 000	ms	Time delay between START and TRIP stage 2
Event delay	0...25 000	0	ms	Time delay for TRIP interlocked with input
Input qualifier	0...16	0 (non)	-	Input for release of TRIP
Trip relay	0...8	0 (non)	-	TRIP output relay
Relay pulse	100...60 000	500	ms	Pulse length of TRIP output signal
Level 1 - set point address. The device restarts 10 seconds after last Set point command	0...16 777 214	0	-	Address for Set point command in accordance with IEC 60870-5-101/-104
Delay 1 - set point address	0...16 777 214	0	-	Address for Set point command in accordance with IEC 60870-5-101/-104

10.2 Earth fault, General

The AQ-50 devices have two types of earth fault detectors; transient earth fault function, and a supplementary non-directional earth fault function that can be employed when switching onto faults. The non-directional function can also be used to detect fault connection, that a phase is missing or that one phase is connected with the wrong polarity. Both methods work independently of each other. Both will set the indication earth fault START.

10.3 Earth fault transient

AQ-50 initially triggers a ground fault detection sequence on a change in the zero-sequence system. The current level corresponds to the zero-sequence current measured by the detector.

A START signal is generated if the detector reaches State 5, according to "Detection states" chapter. Ground fault TRIP is generated after set time (parameter *Delay*) or if immediately without delay if the reignition timer has been started by a previous transient. If the setting Input qualifier is selected to any input, 1-16, no TRIP output signal and message to remote control will be created until there is voltage on the selected input within set time, determined by the parameter *Event delay*. However, the internal event is always generated.

Table. 10.3 - 14. Earth fault transient settings.

Parameter	Range	Factory value	Unit	Description
Enable	• Yes • No	No	-	Earth fault transient function activated.
Level	0.1...100.0	2.0	A	Earth fault current level.
Delay	0...10 000	100	ms	Time delay between START and TRIP.
Event delay	0...25 000	0	ms	Time delay for TRIP interlocked with input.
Input qualifier	0...16	0 (non)	-	Input for release of TRIP.
Trip relay	0...8	0 (non)	-	TRIP output relay.
Relay pulse	100...60 000	500	ms	Pulse length of TRIP output signal.
Reignition enable	• Yes • No	Yes	-	Reignition feature activated.
Reignition delay	0...25 000	2 500	ms	Time window for reignition to be identified.
Level 1 - set point address. The device restarts 10 seconds after last Set point command	0...16 777 214	0	-	Address for Set point command in accordance with IEC 60870-5-101/-104.
Delay 1 - set point address	0...16 777 214	0	-	Adress for Set point command in accordance with IEC 60870-5-101/-104.

Table. 10.3 - 15. Specialist settings.

Parameter	Range	Factory value	Unit	Description
Trig level	0.0...100.0	90% of Level	A	Trig level for earth fault – not possible to set
Asym level	1.0...1000.0	3.0	-	Asymmetry level
TPAD level	1.0...1000.0	1.5	-	Alternative asymmetry level
TPAD angle 1	0.0...100.0	30.0	deg	Angle restriction 1
TPAD angle 2	90.0...270.0	150.0	deg	Angle restriction 2
Early start	0...2	0	-	Alternative for the reignition function

Parameter	Range	Factory value	Unit	Description
Fast reset	0...1	0	-	Deactivation of fast reset i r.0.2.3
Minimum arcing time	0...25 000	0	ms	Shortest time for reignition/arcing fault

10.4 Non-directional earth fault

Activation of non-directional earth fault can be selected as "Always" or only after closing of the circuit breaker, "Only at Close". Closing or energization is detected using an input indicating ON, specified by the parameter *Input qualifier*, or by using the current change. The two alternative ways of detecting a closed circuit breaker work in parallel. The earth fault function is activated during a set time, determined by the parameter *Event delay*.

The non-directional earth fault function measures the residual current, Ia + Ib + Ic. The measurement method can be chosen between RMS and Fundamental. The latter means that only the fundamental harmonic is measured, since characteristic harmonics are suppressed.

START signal is generated when the sum current exceeds the set threshold (the parameter *Level*). TRIP earth fault is generated after the set time (the parameter *Delay*).

Table. 10.4 - 16. Non-directional earth fault settings.

Parameter	Range	Factory value	Unit	Description
Enable	• Never • Always • Only at close	Always	-	Non-directional earth fault function activated
Level	0.1...500.0	10.0	A	Earth fault current level
Delay	0...10 000	100	ms	Time delay between START and TRIP
Event delay	0...25 000	0	ms	Time delay for TRIP interlocked with input, alternatively time window for activation after closing of circuit breaker
Input qualifier	0...16	0 (non)	-	Input for release of TRIP, alternatively input for ON indication for activation after closing of circuit breaker
Trip relay	0...8	0 (non)	-	TRIP output relay
Relay pulse	100..60 000	500	ms	Pulse length of TRIP output signal
Measurement type	• RMS • Fundamental	RMS	-	Measurement method RMS or Fundamental
Low level	0.1...500.0	1.0	A	Current level before for switch-on detection.
High level	0.1...500.0	30.0	A	Current level after for switch-on detection.

11 Phase break

A phase break is identified as a failure of a phase without grounding. Typical scenario is the interruption due to a down fallen phase conductor that does not get in contact with ground. The following criteria must be met for phase interruptions to be detected:

- Residual current < Low Level
- Current in one of the phases < Low Level
- Current in the other two phases > High Level

When the three criteria at the same time have been fulfilled during the set time (*Delay*), a phase break is detected. Phase breaks do not result in a start signal. Note that if a phase is missing but the two remaining have a phase difference of 120 degrees, there will be no phase break. Such a fault is indicated by a non-directional earth fault.

Table. 11 - 17. Phase break settings.

Parameter	Range	Factory value	Unit	Description
Enable	• Yes • No	No	-	Phase break function activated
Low Level	0.1...1000.0	5.0	A	Max current for lost phase and residual current
High Level	0.1...1000.0	20.0	A	Min current level for healthy phases
Delay	0...10 000	5 000	ms	Time delay between START and TRIP
Trip relay	0...8	0 (non)	-	TRIP output relay
Relay pulse	100...60 000	500	ms	Pulse length of TRIP output signal

12 Service interface

The built-in web server in AQ-50 gives authorized access to all settings, status information, file transfer, and event lists. It can be accessed either via Ethernet RJ-45 or USB type B. Using Chrome or Firefox web browsers is recommended.

12.1 Connecting using Ethernet

The prerequisite for connecting via Ethernet is that the service computer has IP settings that match with those of the AQ-50 device that you want to connect to, meaning that they have the same subnet and subnet mask.

Table. 12.1 - 18. Factory settings.

Parameter	Value
IP address	192.168.0.31
Net mask	255.255.255.0
Standard gateway	192.168.0.1

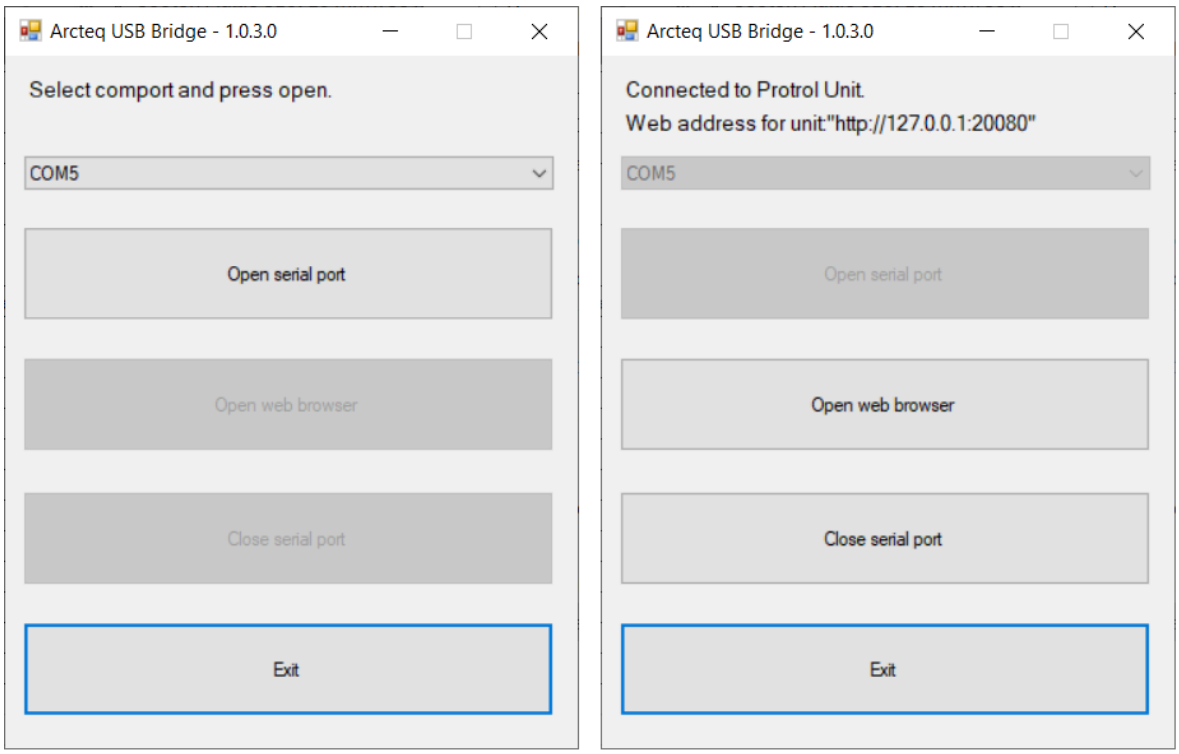
The above settings mean that AQ-50 is accessible via computers with addresses within the 192.168.0.x range, or redirected addresses via the gateway/router.

12.2 Connecting using USB

It is also possible to connect using USB type B. This requires the use of a separate software, Arcteq USB Bridge for Windows 7/10. This software is available on Arcteq's website, together with a link to download necessary drivers. Below is a brief description of how to connect using this software.

- Start Arcteq USB Bridge.
    - If an AQ-50 device is found by the program, the current COM port is displayed. See the left image in figure below.
- Click on "Open serial port".
    - If connected to a device, the other buttons will light up. See the right image in figure below.
- Open the default browser by clicking "Open web browser".
    - To start the web browser manually, please enter 127.0.0.1:20080/ in the address bar.

Figure. 12.2 - 16. When starting Arcteq USB Bridge, the left picture is displayed. Select the proposed COM port and click "Open serial port". After this, it is possible to open the default browser by pressing "Open web browser" (right image).



12.3 Login

After connecting to the AQ-50 device, a login screen is displayed. This includes information about the connected AQ-50 device and the input field for logging in.

Figure. 12.3 - 17. The login field of the web server requires a login name and corresponding password.

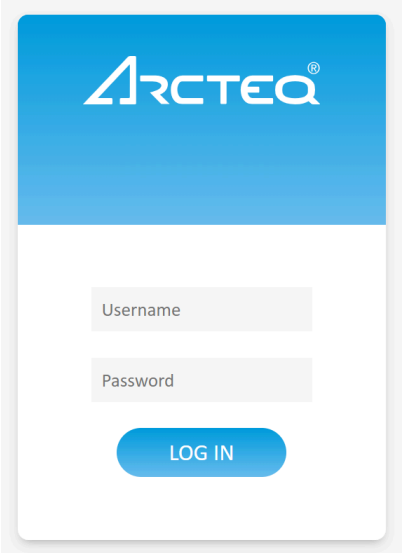


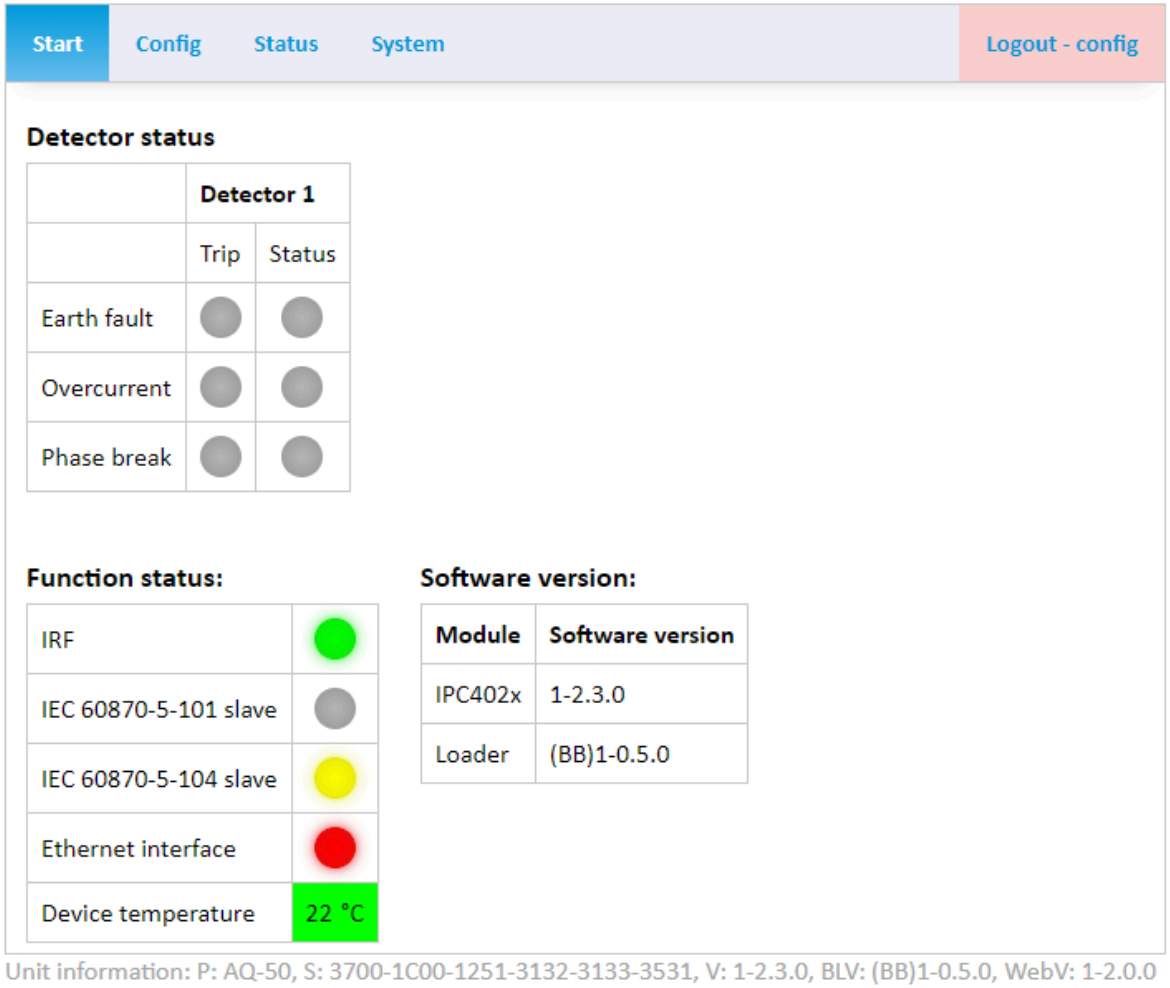
Table. 12.3 - 19. Selectable standard users.

User	Default Password	User properties
status	status	• Display settings • Download of disturbance files
config	config	• Display / change of normal settings • Download of disturbance files • Firmware upgrade
admin	availability	• Same as config, and in addition user administration and password • Display / change of special settings

Please note that special characters cannot be used in passwords! The following "User administration" section of "Configuration and settings" chapter describes how to change your password.

12.4 Start tab and device information

Figure. 12.4 - 18. Start tab.



After logging in, the Start tab is displayed. This includes the status and information about the connected device, as well as tabs for other functions.

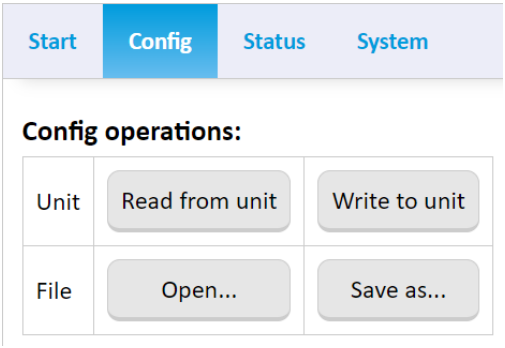
At the bottom of all web pages, there are the unit's unique ID number and version on software. Copy the information field and attach it to the support case or complaint.

The service interface has a built-in timeout, which means that automatic logout is done after a period of inactivity.

13 Configuration and settings

Configuration is done using the web interface. See "Service interface" chapter for details on connection to the device and its web interface.

Figure. 13 - 19. All settings can be found on the Config tab.



Write/Save settings

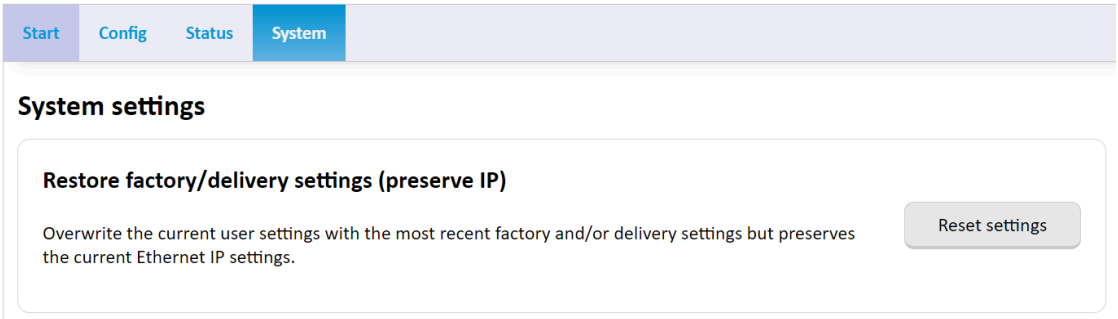
- When new settings are to be saved and activated in the AQ-50 unit, press the "Write to unit" button.
- The settings are then transferred to the device.
- The device will restart automatically.
- You need to login again after the restart.
- The settings can also be saved to a local "IPXCFG" file using the "Save as…" button.

Read/Open settings

- "Read from unit" button reads the settings currently in use. Note that this will revert all of the unwritten changes you might have made during the session.
- Settings saved on an "IPXCFG" file are loaded using the "Open…" button.

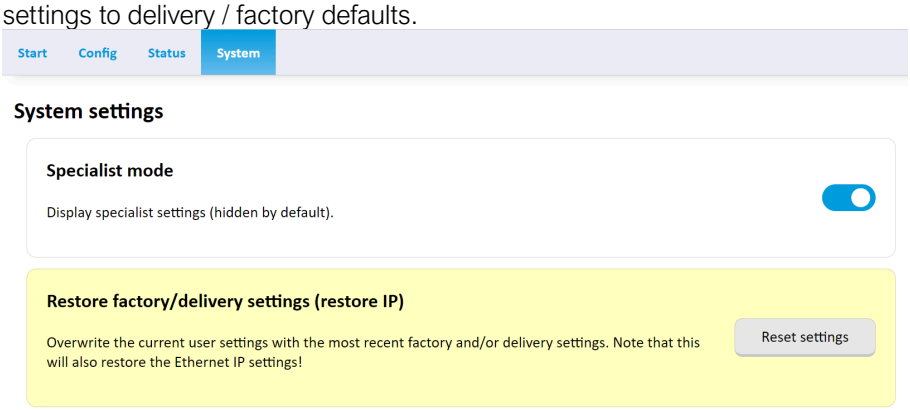
Reset settings

- Reset to factory settings is made on the Systemtab.



- Note that passwords for the different login levels are also reset. Internet settings, the device's IP address, etc., are not reset. This also applies to IP addresses for IEC 60870-5-104.

- Complete reset to factory:
  A complete reset, including all Internet settings, can be done in two different ways:
    - From web interface:
        - Note that there is a great risk of losing the ability to remotely connect to the device after the reset, depending on the changed IP address and other internet settings!
        - In order to be able to make a complete reset via the web interface, the user must log in as the administrator admin.
        - On the "System" tab you first activate specialist mode, by pressing the button Display specialist settings. After that the button for full reset is displayed, Reset settings to delivery / factory defaults.

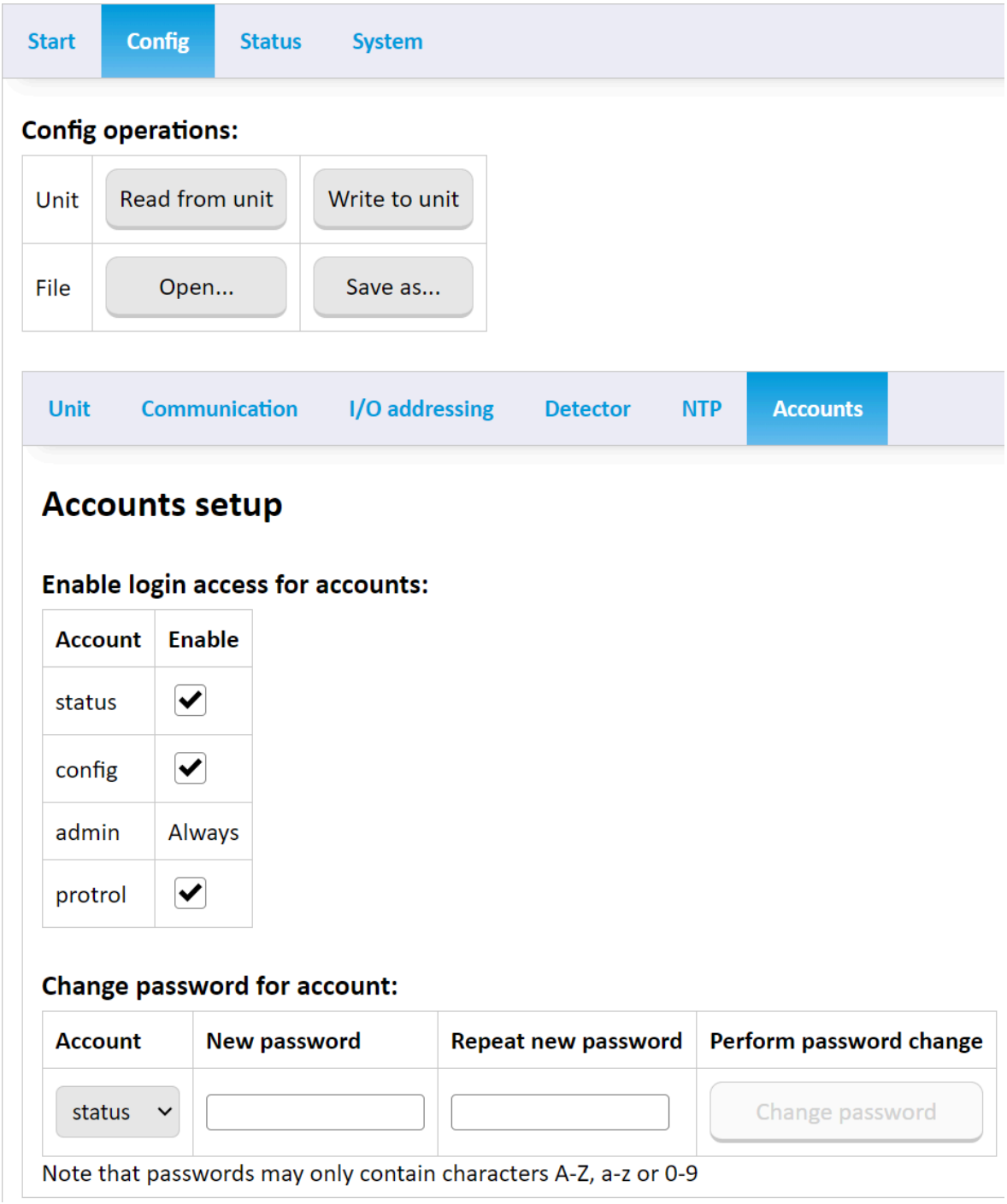


    - A full reset to factory settings can also be done using the acknowledge button (ACK) on the front card by following these steps:
        - Restart the device by power cycling it.
        - Press and hold the ACK button when the first LEDs light up (IRF etc.).
        - After a while the EX LEDs are lit. Release the ACK button before they have counted down entirely. Avoid a reset by pressing the ACK button until the device is in normal operation.
        - The unit now resets the settings and then restarts.

User administration

Activation/deactivation of users and replacement of passwords are made on the Config/Accounts tab.

Figure. 13 - 20. Administration of accounts can be done when the user is logged in as admin.



The administrator can activate/deactivate all accounts except for the admin account. Please observe that the passwords can only to consist of capital letters, lower case letters and the numbers 0-9. Special characters and other national characters are not allowed.

13.1 Device settings - Unit

The AQ-50 device has general settings on the "Unit" tab, listed in the table beneath. The Watchdog relay closes when all is normal. If there is an internal fault, the relay opens. If power supply is missing, the relay will remain open.

Table. 13.1 - 20. Parameter descriptions

Parameter	Range	Factory value	Description
Unit information:			
Site	-	Default	Site reference. If the disturbance recording files shall be visualized using Arcteq-Tool, the station name is not allowed to have spaces. Alternatively, the files must be edited before they can be loaded by the tool.
Free Text	-	-	Text of choice for extra information.
Watchdog output:			
Enable	• Yes • No	No	Activation of the Watchdog feature
Watchdog relay	1...8	1	Choice of relay output
DAT3012. Connects to terminal X13. DAT3012 cannot be used in conjunction with the function IEC 60870-5-101 master.			
Enable	• Yes • No	No	Activation of external PT100 module DAT3012

Table. 13.1 - 21. Specialist settings

Parameter	Range	Factory value	Description
LOFA:			
Enable	• Yes • No	No	Enabling the external current sensor LOFA.

13.2 Current sensors for over head lines – LOFA

AQ-50 is available with current sensors, LOFA, for up to three overhead lines. Upon delivery, the AQ-50 device is configured with calibration data for the current sensors to be used. There can be reasons to update calibration data, for example, if the AQ-50 or the any of the current sensors need to be replaced. Management of calibration information is done on the tabs Config/LOFA/LOFA x.

Read/Open settings:

- Reading of settings is automatically performed when the web server is accessed. The settings can be reloaded by pressing Read from unit.
- Settings stored on file can be uploaded to the web browser by pressing Load saved LOFA calibration. After this, they are displayed in the web browser but have not yet been downloaded to the AQ-50 device.

Write/Save settings:

- To save and activate new settings, press Write to unit.

- The settings are first transferred to from the web browser to the AQ-50 device. When this is successful, the device will restart automatically with the new settings activated.
- The settings can be backuped to file. This is done by pressing Save current LOFA calibration.

The Status LED shows status information for the LOFA sensors as follows:

- Green – AQ-50 is configured for using LOFA
- Yellow – Calibration mode is activated

13.3 Time synchronization – NTP

AQ-50 has support for time synchronization using NTP. Settings can be found on the Config/NTPtab.

Figure. 13.3 - 21. Configuration of NTP.

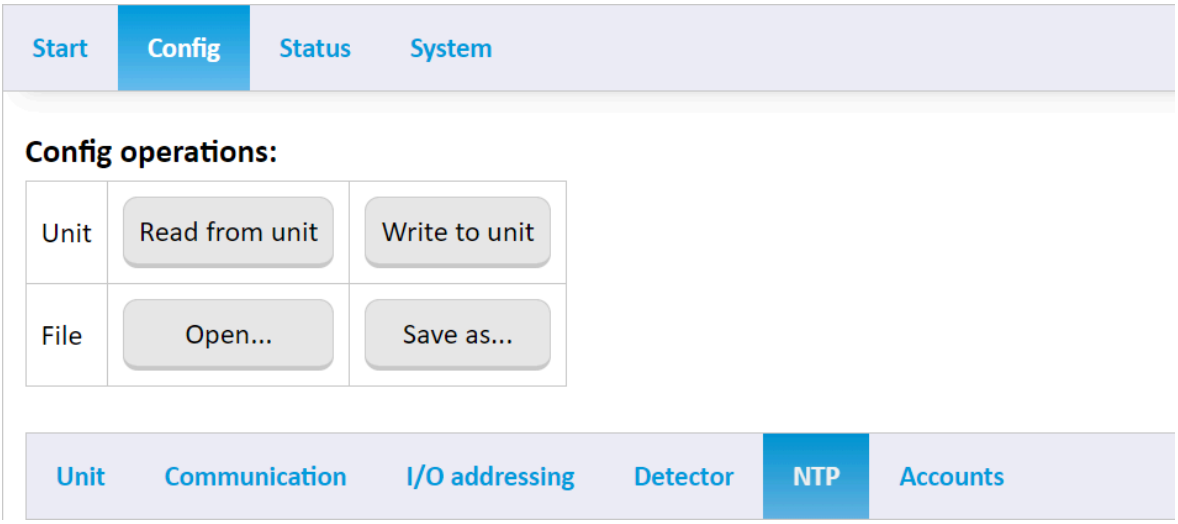


Table. 13.3 - 22. NTP time synchronization parameters.

Parameter	Range	Factory value	Description
Enable NTP	• Yes • No	No	Activation of NTP.
UTC offset	-900...900 min	0 min	Adjustment, offset, of time.
IP address primary NTP	-	0.0.0.0	Primary NTP server.
IP address secondary NTP	-	0.0.0.0	Secondary NTP server.

AQ-50 time is used for time stamping of indications, events, and disturbance recordings. The time resolution is 1 ms.

When NTP is activated, time synchronisation using IEC 60870-101/-104 is disabled.

14 Fault detector functions

AQ-50 contains the following fault detector functions:

- Overcurrent - detects short circuit or overload
- Earth fault transient - sensitive earth fault detection and detection of intermittent earth faults
- Earth fault non-directional – residual current based detection
- Phase break - for detection of the loss of a phase

15 Remote control interface

AQ-50 includes an integrated RTU (Remote Terminal Unit) function.

All physical binary and analog inputs can be configured to communicate values to a remote control system. Physical outputs can be set up to be controlled from remote.

Also events from fault detector functions as well as various objects for activation and objects for acknowledgment can be assigned to the remote control system.

AQ-50 supports the communication protocols IEC 60870-5-101 and IEC 60870-5-104.

In addition, there is an option which makes it possible to use AQ-50 as a local -101 Master. With this option it is possible to connect several -101 slaves to AQ-50 and access them in the remote control center.

Please observe that IEC 60870-5-101 Master is optional and must be ordered separately, refer to the "Ordering information" chapter.

IEC 60870-5-101

- Physical interface for IEC 60870-5-101 is RS-485 (X11).
- Both 2 and 4 wire communication is supported for RS-485 communication.
- Terminate RS-485 by short-circuiting inputs 4 and 5 on the X11 terminal. Only the last device should be terminated if there additional AQ-50 on the same RS-485 loop.

IEC 60870-5-104

- Physical interface for IEC 60870-5-104 is RJ45 10/100Base – TX Full Duplex.

IEC 60870-5-101 Master (ordering option)

- Physical interface for IEC 60870-5-101 Master is 2 wire communication via RS-485 (X13).
- Refer to " RS-485 port for IEC 60870-5-101 Master (COM 2)" chapter for detailed information regarding the physical connection.

For more information regarding settings for communication, objects and more, see the following chapters.

A general description on how to configure AQ-50 can be found in the "Configuration and settings" chapter.

15.1 Events, queues, and interrogation

Status changes of physical binary inputs and internal logical events are timestamped upon detection with a time resolution of 1 ms. If the status change is shorter than 1 ms, the event is suppressed. Events are added to internal queues and sent in the order of creation. The "EVENT" LED on the device is active when events are waiting to be transported on the system interface.

For analog signals, changes larger than the deadbands result a message which is added to the internal queues. See "Analog Inputs (I/O addressing – Analog Inputs)" chapter for detailed information about configuration. Normally, only the last analog message per signal is kept in the buffers. It is possible to activate buffering of analog signals if that is desired.

The queues are using the principle FIFO – First In First Out and can buffer a maximum of 500 events. When a queue is full, the oldest event is discarded to make place for the last event. If the event queues are not full, all status changes will generate time stamped event messages and no information is lost.

There are functions that will limit the creation of events when an input changes status too often. See "Binary Inputs – Input 1-16/22/37" chapter for more information.

When a communication link has been initiated by the master interface, events are transmitted according to the chosen protocol and a prioritized order (class 1 and 2 for IEC 60870-5-101/104). For IEC 60870-5-104, the events are sent immediately when they have been added to the queues. If IEC 60870-5-101 is used, the events are transmitted after requests from the master interface.

At general interrogation, events are created for all objects defined in the device. The current status of all input signals, physical and logical, are collected and added to internal queues with no delay. The events are sent in the order they have been added to the queues.

If the AQ-50 device is acting master for other slaves, it will collect events from all active slaves. Due to speed limitations in the master-slave transmission there will be a delay until all status updates are retransmitted to the control center.

15.2 General settings – Communication

This chapter describes the configuration settings for remote communication; IP addresses, and general settings for IEC 60870-5-101 and IEC 60870-5-104.

15.2.1 Ethernet

Figure. 15.2.1 - 22. The settings for Ethernet are found on the Config/Communication/Ethernet tab:

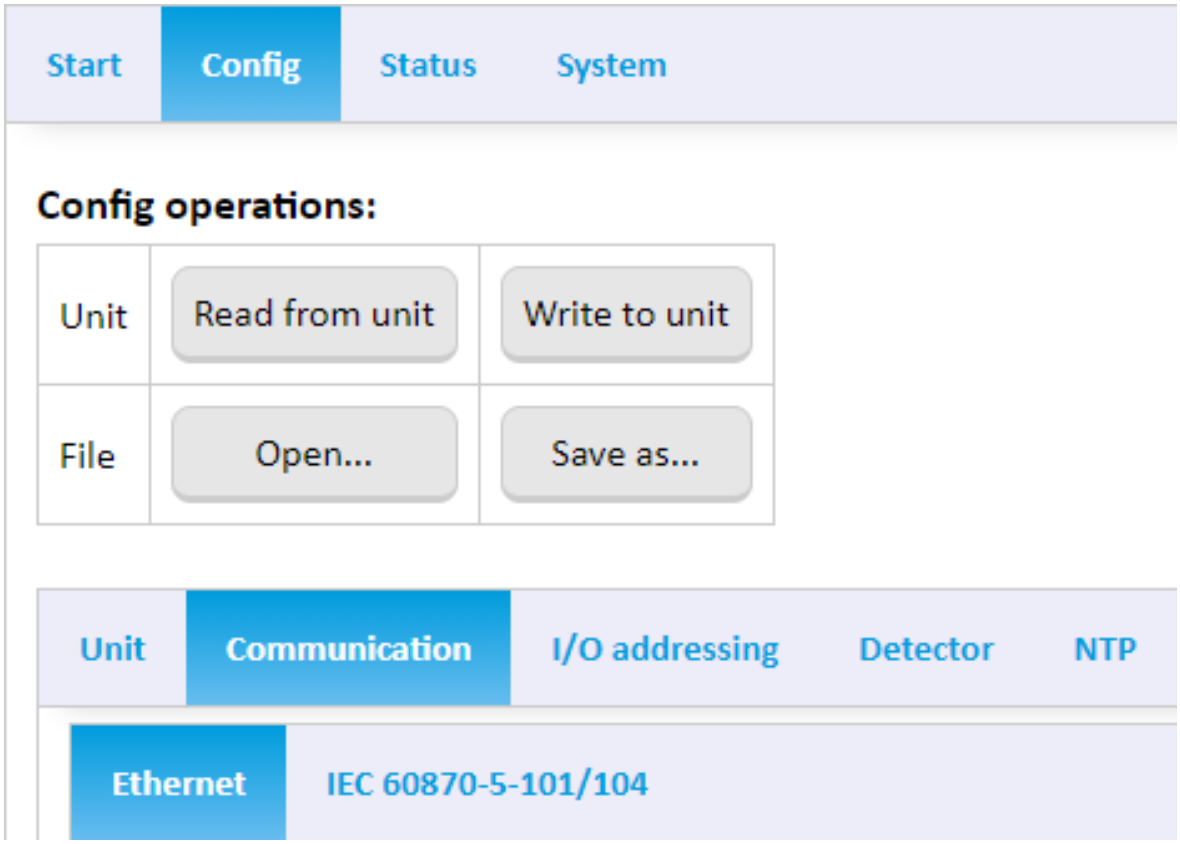


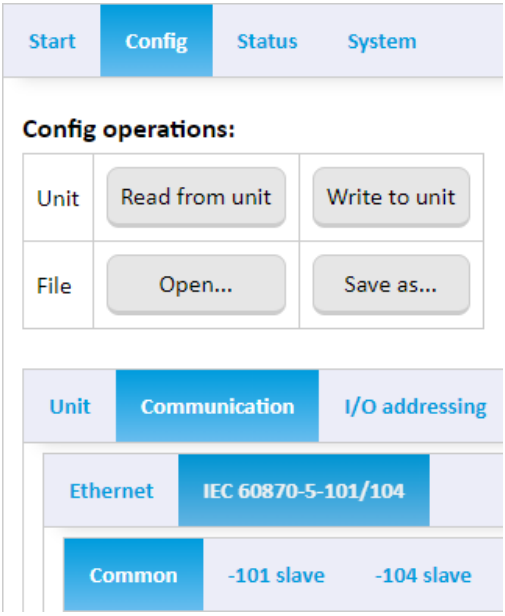
Table. 15.2.1 - 23. Ethernet settings.

Parameter	Range	Factory value	Description
Settings for unit:			
Enable static IP	• Yes • No	Yes	Fixed or dynamic IP address (via DHCP).
IP address	Range according to common notation (4 bytes in decimal form, 0..255). Observe that the address 0.0.0.0 is not allowed.	192.168.0.31	Fixed IP address for the device.
Netmask		255.255.255.0	Netmask.
Gateway		192.168.0.1	IP address for network gateway.
Trusted IP addresses for IEC 60870-5-104:			
IP address n	Range according to common notation (4 bytes in decimal form, 0..255). Observe that the address 0.0.0.0 is not allowed.	192.168.0.10n	Address n of IEC 60870-5-104 master (n = 1, 2, …)
Enable n	• Yes • No	No	Accept connection from this address. If no address is specified, connection is accepted from all addresses (within the Netmask).

15.2.2 IEC 60870-5-101/104

There are three sub-tabs on the IEC 60870-5-101/104 tab, or four if the option ”-101 Master” is enabled.

Figure. 15.2.2 - 23. IEC 60870-5-101/104 tab.



IEC 60870-5-101/104 – Common

Table. 15.2.2 - 24. Common settings.

Parameter	Range	Factory value	Description
Common address (CA)	1...254 1...65 534	1	Common ASDU address. Can have range 1 octet or 2 octets.
Use end of init (M_EI)	• Yes • No	Yes	The device shall send a startup message.
Slave interface	• No slave • -101 slave • -104 slave	-104 slave	Choice of remote control interface.
Select timeout	1...3 600 s	30 s	Specifies how long to wait for the Execute command after an object has been Selected. If no Execute command arrives within the set time, the order will be interrupted.
Cyclic analog transmission	0...86 400 s	0 s	Period for cyclic transmission of analog values.
Invert double point open/close for all physical Binary inputs	• Yes • No	No	Invert all physical open/close indications for binary inputs.
Invert double point open/close for all physical Binary outputs	• Yes • No	No	Invert all physical open/close orders for binary outputs.

Table. 15.2.2 - 25. IEC -101/-104 master.

Option			
Master interface	Choice of interface to sub-slaves	• No master • -101 master	No master

Table. 15.2.2 - 26. Specialist settings.

Parameter	Range	Factory value	Description
Only send positive flank from detector	• Yes • No	No	Transfer indications only at status change from OFF -> ON.
Queue analog events	• Yes • No	No	Activate buffer for analog signals.

Parameter	Range	Factory value	Description
Only send packed data	• Yes • No	No	For option LoRaWAN – if activated, only a pre-determined set of signals will be transmitted.
Chattering analog input blocking time	0…86 400 ms	3000 ms	Minimum update interval for analog signals. Value 0 means that analog signals are updated when the deadband is exceeded. Otherer blocking times are limited by the parameter Cyclic analog transmission if it is set >0.
Output command short pulse	0…65 535 ms	100 ms	A command order can be specified for short pulse duration (qualifier of command). This requires that the object parameter Pulse time is set to zero for the object of interest.
Output command long pulse	0…65 535 ms	1 000 ms	A command order can be specified for long pulse duration (qualifier of command). This requires that the object parameter Pulse time is set to zero for the object of interest.

IEC 60870-5-101/104 – -101 slave

Table. 15.2.2 - 27. 101 slave settings.

Parameter	Range	Factory value	Unit	Description
Protocol settings:				
Link address (LA)	1..2541...65 534	1	-	Link address (RTU address).Can have range 1 octet or 2 octets.
Common address (CA)	-	-	-	RTU address. Configured on the Common tab. This is for information only and cannot be changed by the user.
Time tag type	-	CP56	-	Specifies what type of time format AQ-50 uses. This is for information only and cannot be changed by the user.
Link address (LA) size	0...2	1	octets	Size of link address.
Common address (CA) size	1...2	2	octets	Size of RTU address.
Object address (OA) size	1...3	3	octets	Size of Object address.
Cause of transmission (COT) size	1...2	2	octets	Size of ”COT”.
Port settings. The port is set to 8-E-1 (8 data bits, even parity and 1 stop bit).				
Port type	1..4	1	-	Choice of physical interface: 1. 2 wire RS-485 2. 4 wire RS-422

Parameter	Range	Factory value	Unit	Description
Baudrate	• 1 200 • 2 400 • 4 800 • 9 600	9 600	Bit/s	Communication speed.
Response delay	2..1 000	10	ms	Delay before response is transmitted.

IEC 60870-5-101/104 – -104 slave

Table. 15.2.2 - 28. 104 slave settings

Parameter	Range	Factory value	Unit	Description
APDU timeout (t1)	1...3600	15	s	Time limit for sent unconfirmed message.If the time has expired, communication is closed.
ACKN timeout (t2)	1...3600	10	s	Deadline for received unconfirmed messages. Confirmation (ackn) is sent no later than this time.
TEST timeout (t3)	1...3600	30	s	Test message timeout. Test message is sent no later than this time.
k unackn I format ASDU	1...255	12	-	Maximum number of unconfirmed messages (I format). If exceeded, communication is closed.
w ackn I format ASDU	1...255	8	-	Maximum number of unconfirmed received messages (I format). Confirmation (ackn) will be sent no later than this number.
Command timetag timeout	1...3600	30	s	Maximum difference between local time in the unit and time marking on an order. If the telegram does not arrive in time, the order is not allowed.
Time tag type	-	CP56	-	Specifies the type of time format AQ-50 uses.
Common address(CA) size	-	2	octet	Size of the RTU address, number of octets. This is for information only and cannot be changed by the user.
Object address(OA) size	-	3	octet	Size of the object address, number of octets. This is for information only and cannot be changed by the user.
Cause of transmission (COT) size	-	2	octet	Size of ”COT”, number of octets. This is for information only and cannot be changed by the user.

IEC 60870-5-101 Master (optional)

AQ-50 can be obtained with the option IEC -101-master for AQ-50. With this option, AQ-50 can act local IEC-101 master, which enables the user to connect an additional number of local -101 slaves.

The settings are found on the Communication/IEC 60870-5-101/104/-101 master tab.

General guidelines:

- The adress size settings (parameters on line 3-6 in the table on the following page) must be identical to those which are used by the SCADA system (-101 or -104 slave).
- The values of Common and Link Adress must match for master and slave.
- If the checkbox Use master common address is checked, the following applies:
    - The master cannot have a value in the upper octet of the object addresses.
    - All objects of all slaves must have unique object addresses. The SCADA system interpretes it as all objects are from the same RTU, i.e., the AQ-50 that acts -101 master.
    - For the -101 master to be able to resend commands from the remote control center, each upper octet of every object address must be identical to the Common address of the slave. Please see the following examples.
        - Binary output 3, in the second slave, shall be controlled by the SCADA system.
        - In this example, the second slave has Common address 5.
        - Binary output 3 has typically object address 21003 in the factory settings.This must be changed to 5.21003 (structured address), which equals 348 683 decimal.
    - The common address for the slave must be between 1 and 254.
- If the checkbox Use master common address is NOT checked, there are no restrictions to the choice of object addresses. In that case, the remote control system experiences all slaves as separate RTU's.
- If contact with a slave is lost, all objects belonging to that slave are sent to the remote control center with the Invalid flag set. This, however, is only done if an interrogation prevously has been made from this specific slave. In addition, an object indicating lost slave communication is activated (see "IEC 60870-5-101/-104 Master" chapter).

Table. 15.2.2 - 29. Settings for the 101 master.

Parameter	Range	Factory value	Unit	Description
Protocol settings:				
Use master common address	Yes or No	Yes	-	See description on previous page.
Time tag type	-	CP56	-	Specifies the type of time format AQ-50 uses. This is for information only and cannot be changed by the user.
Link address (LA) size	0...2	1	octet	Size of link address.
Common address (CA) size	1...2	2	octet	Size of RTU address.
Object address (OA) size	1...3	3	octet	Size of Object address.
Cause of transmission (COT) size	1...2	2	octet	Size of "COT".
Slave link addresses, Slave x				
Link address x	0..2540...65 534	0	-	Link address of local slave(s). Can have length 1 or two octets.0 means no slave is connected.
Common address x	0..2540...65 534	0	-	RTU address for local slave(s). Can have length 1 or 3 octets.0 means no slave is connected.

Parameter	Range	Factory value	Unit	Description
Port settings (The port is set to 8-E-1, i.e., 8 data bits, even parity and 1 stop bit.)				
Port type	-	-	-	2-wire RS-485
Baudrate	• 1 200 • 2 400 • 4 800 • 9 600	9 600	Bit/s	Communication speed.

15.2.3 IEC 60870-5-101 Master (optional)

AQ-50 can be obtained with the option IEC -101 Master for AQ-50. With this option, AQ-50 can act local IEC-101 master, which enables the user to connect an additional number of local -101 slaves.

The settings are found on the Communication/IEC 60870-5-101/104/-101 master tab.

General guidelines:

- The adress size settings (parameters on line 3-6 in the table on the following page) must be identical to those which are used by the SCADA system (-101 or -104 slave).
- The values of Common and Link Adress must match for master and slave.
- If the checkbox Use master common address is checked, the following applies:
    - The master cannot have a value in the upper octet of the object addresses.
    - All objects of all slaves must have unique object addresses. The SCADA system interpretes it as all objects are from the same RTU, i.e., the AQ-50 that acts -101 master.
    - For the -101 master to be able to resend commands from the remote control center, each upper octet of every object address must be identical to the Common address of the slave. Please see the following examples.
        - Binary output 3, in the second slave, shall be controlled by the SCADA system.
        - In this example, the second slave has Common address 5.
        - Binary output 3 has typically object address 21003 in the factory settings.This must be changed to 5.21003 (structured address), which equals 348 683 decimal.
    - The common address for the slave must be between 1 and 254.
- If the checkbox Use master common address is NOT checked, there are no restrictions to the choice of object addresses. In that case, the remote control system experiences all slaves as separate RTU's.
- If contact with a slave is lost, all objects belonging to that slave are sent to the remote control center with the Invalid flag set. This, however, is only done if an interrogation prevously has been made from this specific slave. In addition, an object indicating lost slave communication is activated (see IEC 60870-5-101/-104 Master chapter).

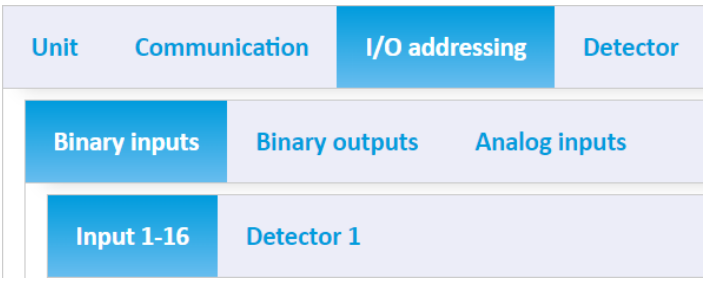
Table. 15.2.3 - 30. Settings for the 101 master.

Parameter	Range	Factory value	Unit	Description
Protocol settings:				
Use master common address	• Yes • No	Yes	-	See description on previous page.

Parameter	Range	Factory value	Unit	Description
Time tag type	-	CP56	-	Specifies the type of time format AQ-50 uses. This is for information only and cannot be changed by the user.
Link address (LA) size	0...2	1	octets	Size of link address.
Common address (CA) size	1...2	2	octets	Size of RTU address.
Object address (OA) size	1...3	3	octets	Size of Object address.
Cause of transmission (COT) size	1...2	2	octets	Size of "COT".
Slave link addresses, Slave x:				
Link address x	0...2540...65 534	0	-	Link address of local slave(s).Can have length 1 or two octets.0 means no slave is connected. Address 0 means that no slave is expected to be connected.
Common address x	0...2540...65 534	0	-	RTU address for local slave(s).Can have length 1 or 3 octets.0 means no slave is connected.
Port settings. The port is set to 8-E-1, i.e., 8 data bits, even parity and 1 stop bit.				
Port type	-	-	-	2-wire RS-485.
Baudrate	• 1 200 • 2 400 • 4 800 • 9 600	9 600	Bit/s	Communication speed.

15.3 Binary inputs

Figure. 15.3 - 24. Communication settings for all binary inputs are found under Config – I/O-addressing – Binary Inputs.



On the tab Input 1-16/22/37 all physical and system signals are listed. If the device is AQ-50-XXXX3 or AQ-50-XXXX6, there are additional physical binary inputs available.

The "Detector 1...6" tabs contain binary objects for the fault detector functions. Up to six detectors can be used, the settings are identical.

All binary inputs can be setup in the same manner. Beneath is a general description.

For more information on each specific object, please refer to the chapter that describes it.

Table. 15.3 - 31. Binary input settings.

Parameter	Range	Description
Description	—	Brief descriptive name for the object.
Type	• Single point • Double point	Type of indication; Single or Double. If Double point is used, this means for indication <OFF> that input n is high and input n+1 is low. Input n low and input n+1 high results correspondingly in indication <ON>.
Settings – Blocked	• Yes • No	The signal is blocked, i.e. no value / status is sent to the remote end. Also applies to "interrogation" (status request).
Settings – Negative	• Yes • No	The signal is inverted, i.e. an energized input is transmitted with low status to remote end.
Settings – Time tagged	• Yes • No	The signal is timestamped upon change. The time is also sent to the remote end.
Delay	0...65 535 ms	Number of milliseconds after the signal has changed status before a message is sent to the remote end. Applies to a positive change state change (0 -> 1). When Settings – Negative has been chosen, the opposite applies.
Address 8	0...255	Upper octet of the address. Decimal representation.
Address 16	0...65 535	Lower octets of the address. Decimal representation.

15.3.1 Binary inputs 1-16/22/37

Settings for binary objects connected to physical inputs on the device, the "ACK." button and IRF.

Limitation of events from binary inputs that change status frequently can be made using the parameter Delay, see description in the table on the previous chapter.

Only specific settings and differences to the normal are described below. See "Binary inputs" chapter for a general description of the various configuration options.

The objects have the following factory settings:

- Type: Single point
- Settings – Blocked: No
- Settings – Negative: No
- Settings – Time tagged: Yes
- Delay: 0 ms

Table. 15.3.1 - 32. Settings – Input 1-16/22/37

Parameter	Description	Factory valueaddress lower octets	Description
ACK. button	Object linked to the ACK button on the front panel.Can only have the type single indication.	100	Object linked to the ACK button on the front panel.Can only have the type single indication.
Input n	Object connected to physical inputs n (n = 1-15).	100+n	Object connected to physical inputs n (n = 1-15).
Input 16	Object connected to physical input 16. Can only have the type single indication.	116	Object connected to physical input 16. Can only have the type single indication.
Input 16 + n	Object connected to physical inputs 16 + n (n = 1-5).	150+n	Object connected to physical inputs 16 + n (n = 1-5).
Input 22	Object connected to physical input 22.Can only have the type single indication.	122	Object connected to physical input 22. Can only have the type single indication.
Input 22 + n	Object connected to physical inputs 22 + n (n = 1-14).	160+n	Object connected to physical inputs 22 + n (n = 1-14).
Input 37	Object connected to physical input 37.Can only have the type single indication.	175	Object connected to physical input 37.Can only have the type single indication.
IRF	Indication for internal error.Can only have the type single indication.	117	Indication for internal error. Can only have the type single indication.

NOTICE!
Higher octet is always "0" as a factory default.

15.3.2 Fault detector binary signals

Binary object settings associated with fault detector functions.

Only specific settings and differences to the normal are described below. See "Binary inputs" chapter for a general description of the various configuration options.

None of the indications can be of double type.

Table. 15.3.2 - 33. Factory settings of objects 1-10.

Type	Single point
Settings – Blocked	No
Settings – Negative	No
Settings – Time tagged	Yes
Delay	0 ms

Objects 1-10 can't be of the type double indication.

Table. 15.3.2 - 34. Factory settings of objects 11-13

Type	Logical input 1: Double point Logical input 2: Single point EF Trip (reigntion): Single point
Settings – Blocked	Yes
Settings – Negative	No
Settings – Time tagged	No
Delay	0 ms

For more information regarding fault detector functions and their specific signals, refer to "Fault detector functions" chapter.

Table. 15.3.2 - 35. Fault detector m settings. m = 1, 2 or 3 depending on the detector. Factory settings for the upper octet are always 0.

Parameter	Factory value address lower octets	Description
OC Start	m20	Overcurrent – START indication
OC1 Trip	m21	Overcurrent – TRIP indication, level 1
OC2 Trip	m22	Overcurrent – TRIP indication, level 2
EF Start	m23	Earth fault – START indication
EF Trip	m24	Earth fault – TRIP indication
EF Start (non dir.)	m25	Earth fault, non-directional – START indication
EF Trip (non dir.)	m26	Earth fault, non-directional – TRIP indication
Phase break	m27	Indication for phase break
OC Trip Ind	m28	Indication mirroring the LED OC Trip.
EF Trip Ind	m29	Indication mirroring the LED EF Trip.
Logical input 1	0 (Not activated)	Logical object 1, from additional software functions.
Logical input 2	0 (Not activated)	Logical object 2, currently not used
EF Trip (reignition)	0 (Not activated)	Earth fault – TRIP indication at arcing earth fault

15.3.3 IEC 60870-5-101/-104 Master

If the AQ-50 device is configured to be master, see section "IEC 60870-5-101 master", an additional subtab is displayed which lists binary inputs that mirror the status of the slaves. Configuration of these supervision objects is made in the same way as for other logical inputs.

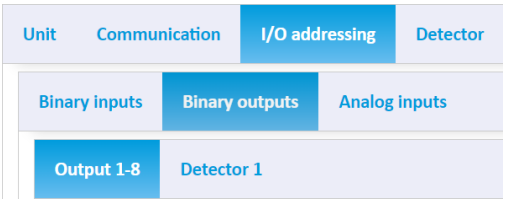
See "Binary inputs" chapter for the general description of object settings.

Table. 15.3.3 - 36. Factory settings of supervision objects.

Type	Single point (fixed)
Settings – Blocked	Yes
Settings – Negative	No
Settings – Time tagged	Yes
Delay	0 ms
Address	0.00

15.4 Binary outputs

Figure. 15.4 - 25. Settings for all binary outputs are available on the Config – I/O-addressing – Binary Outputs subtabs.



On the Output 1-8/13/22 tab all physical outputs are listed. If the device is an AQ-50-XXXX3 or AQ-50-XXXX6, there are additional physical binary outputs available. Fault detector 1...6 contains binary outputs for the fault detector functions. All binary outputs have the same parameter settings. Below is a general description. For more information on each individual item, see the following chapters.

Table. 15.4 - 37. Binary output settings.

Parameter	Range	Description
Description	-	Brief descriptive name for the object.
Type	• Single command • Double command	Type of object; Single or Double. For Double command <OFF> this means that output relay n is closed and output relay n+1 is opened. The command <ON> opens output relay n and closes output relay n+1.
Settings – Blocked	• Yes • No	The signal is blocked, i.e. no order or command is executed.
Settings – Direct Excute	• Yes • No	The order is executed directly, ie no select is needed.
Pulse time	0...65 535 ms	Number of milliseconds that the output signal should be high.
Address 8	0...255	Upper octet of the address. Decimal.
Address 16	0...65 535	Lower octets of the address. Decimal.

15.4.1 Output 1-8/13/22

Settings for binary objects connected to physical outputs on the device, as well as the "ACK." button.

Only specific settings and differences to the normal are described below. See the beginning of this chapter for a general description of the various configuration options.

From factory, all objects are set as single command and the sequence selected/executed.

Table. 15.4.1 - 38. Factory settings of objects.

Type	Single command
Settings - Blocked	No
Settings - Negative	No
Pulse time	100 ms (200 ms fixed pulse time for object Ack)

Table. 15.4.1 - 39. Output 1-8/13/22 settings.

Parameter	Factory value address lower octets	Description
Ack	21000	Object connected to the ACK button on the front panel.Can only have the type single command.Pulse time cannot be changed, fixed time of 200 ms.
Output n	21000+n	Objects connected to physical outputs n.
Output 8	21008	Object connected to physical output 8. Can only have the type single command.
Output 8 + n	21008+n	Objects connected to physical outputs 8 + n (n = 1-4).
Output 13	21013	Object connected to physical output 13. Can only have the type single command.
Output 13 + n	21013+n	Objects connected to physical outputs 13 + n (n = 1-8).
Output 22	21022	Object connected to physical output 22. Can only have the type single command.

NOTICE!
The upper octet has always factory setting 0.

15.4.2 Fault detector binary outputs

Settings for binary outputs linked to customer specific functions.

AQ-50 has a number of logical outputs that can be used to activate and control various customized functions. In the standard version, there are no functions associated with these objects. However, they are visible via the web interface and a brief general description is therefore made here.

See the beginning of this chapter for a general description of the various configuration options.

From factory, all objects are set as a single command and the sequence selected/executed.

Table. 15.4.2 - 40. Factory settings of objects.

Type	Logical output 1: Double command Logical output 2-13: Single command
Settings - Blocked	Yes
Settings - Negative	Yes
Pulse time	100 ms

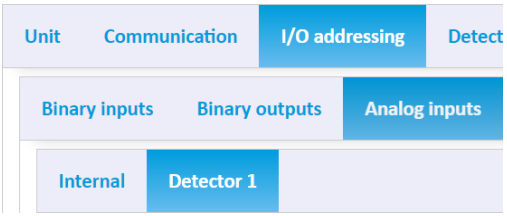
Since the items are not used, they are set to Blocked upon delivery.

Table. 15.4.2 - 41. Detector m settings. m = 1, 2 or 3 depending on detector number.

Parameter	Factory value address lower octets	Description
Logical output n	21m0n	Logical object for controlling customized functions.

15.5 Analog inputs (I/O addressing – Analog Inputs)

Figure. 15.5 - 26. Settings for all analog inputs can be found in the Config - I / O addressing - Analog Inputs subtabs.



The "Internal" tab contains internal analogue system signals.

"Detector 1...6" tabs list analog signals from their fault detector functions.

All analog signals have the same setting options. Below is a general description.

For more information on each individual item, see the following tab descriptions.

Table. 15.5 - 42. Parameter descriptions.

Parameter	Range	Description
Description	-	Brief descriptive name for the object.

Parameter	Range	Description
Type	• Normalized [0–100 %] • Normalized [0–120 %] • Floating point [SI] • Scaled [SI*1] • Scaled [SI*10] • Scaled [SI*100]	Type of analogue object. Different formats and scaling. For a detailed description of what the different types provide regarding format, scaling and how the deadband is defined, see descriptions in the following text.
Settings – Blocked	• Yes • No	The signal is blocked, i.e. no value / status is sent to the remote end.Also applies to "interrogation" (status request).
Settings – Timetagged	• Yes • No	The signal is timestamped upon change. The time is also sent to the remote end.
Settings – Cyclic	• Yes • No	The signal is sent using cyclic transmission.
Deadband [%]		Deadband - indicates how much change is needed for a new value to be sent to the remote end. For a detailed description of what the different types provide regarding format, scaling and how the deadband is defined, see descriptions in the next chapter.
Address 8	0...255	Upper octet of the address. Decimal.
Address 16	0...65 535	Lower octets of the address. Decimal.

15.5.1 Internal

Settings for internal analog objects of the device.

Only specific settings and differences to the normal are described below. See the previous chapter for a general description of the configuration options.

Table. 15.5.1 - 43. Settings.

Parameter	Factory valueaddress lower octets	Description
Unit temperature	3001	Temperature measurement inside the device. Default: • Type: Float [SI] • Blocked: No • Time tagged: No • Cyclic: No • Deadband: 5.0 %

Table. 15.5.1 - 44. Type and deadband.

Object	Type / Deadband	Description
Unit temperature	Normalized [0-100 %]	Normalized to 100 degrees Celsius.
	Normalized [0-120 %]	Normalized to 120 degrees Celsius.
	Float [SI]	Floating point corresponding to Celsius degrees.
	Scaled [SI*1]	Integers corresponding to Celsius degrees.
	Scaled [SI*10]	Integers corresponding to 0.1 Celsius degrees
	Scaled [SI*100]	Integers corresponding to 0.01 Celsius degrees.
Unit temperature	Deadband [%]	Set as a percentage of 100 degrees Celsius.

15.5.2 Fault detector analog inputs

This subtab contains settings for analog inputs connected to fault detector functions.

See "Analog inputs" chapter for a general description of the configuration options.

Table. 15.5.2 - 45. Object 1-4 and 6-7 factory settings.

Type	Float [SI]
Settings - Blocked	No
Settings - Time tagged	No
Settings - Cyclic	No
Deadband	10.0 % (except object Neutral Current) 1.0 % (object Neutral Current)

The objects Max Fault Current and Fault Phase do not use deadband, and Fault Phase is of type Scaled [SI*1]. Max Fault Current is recalculated upon detected overcurrent, and Fault Phase is updated when the functions for overcurrent or directional earth fault react.

Current values are reflecting primary values.

If Cyclic transmission is activated for an object, the object will be updated spontaneously also when its value is outside the deadband. If no spontaneous transmission is desired, the deadband must be set to a high value.

For more information on the fault detector functions and the objects see "Fault detector functions" chapter.

Table. 15.5.2 - 46. Settings.

Object	Factory value address lower octets	Description
L1 Current	3m01	Measured current (rms) at input L1 / Ia.

Object	Factory value address lower octets	Description
L2 Current	3m02	Measured current (rms) at input L2 / Ib.
L3 Current	3m03	Measured current (rms) at input L3 / Ic.
Neutral Current	3m04	Calculated residual current 3I0 (rms).
Max Fault Current	3m05	Maximum fault current (rms), I>/I>>
Max Current	3m06	Maximum current (rms).
Average Current Period	3m07	Average current value (rms), 15 min.
Fault Phase	3m08	Faulty phase / phases.The following values can be sent: - 0,1,2,3,12,13,23,123 Can only be of the types: - "Float [SI]" or "Scaled [SI*1]"

NOTICE!
1, 2 or 3 depending on the fault detector.

Table. 15.5.2 - 47. Type and deadband.

Object	Type / Deadband	Description
Ly Current	Normalized [0-100 %]	Normalized primary current according to reference value on tab I/O Settings. Example: Reference value = 300/1 Value 0 ó 0 A Value 1.0 ó 300 A
	Normalized [0-120 %]	Normalized primary current according to reference value on tab I/O Settings times 1.2. Example: Reference value = 300/1 Value 0 ó 0 A Value 1.0 ó 360 A
	Float [SI]	Primary current in Amperes, as floating point.
	Scaled [SI*1]	Primary current in Amperes, as integer.
	Scaled [SI*10]	Primary current in 0.1 Amperes, as integer.
	Scaled [SI*100]	Primary current in 0.01 Amperes, as integer.
Ly Current	Deadband [%]	Set as a percentage of to reference value on tab I/O Settings.Example: Reference value = 300/1 1 % ó 3 A
Neutral Current	Type	Identical to ”Ly Current”
	Deadband	Identical to”Ly Current”
Max Fault Current	Float [SI]	Primary current in Amperes, as floating point.
	Scaled [SI*1]	Primary current in Amperes, as integer.

Object	Type / Deadband	Description
	Deadband [%]	Not used. Sent upon detected overcurrent (OC).
Max Current	Type	Identical to ”Lx Current” ovan.
	Deadband	Identical to ”Lx Current” ovan.
Average Current	Type	Identical to ”Lx Current” ovan.
	Deadband	Identical to ”Lx Current” ovan.
Fault Phase	Float [SI]	Faulty phase, as floating point.
	Scaled [SI*1]	Faulty phase, as integer.
	Deadband	Not used. Sent upon detected fault (OC/EF).

16 Event log and site manager

16.1 Event log

The event registration that logs events in the device, Event log, can be found in the web interface under the *Status* tab. Here, both internal events and events generated by detector functions are shown. An event has four different fields:

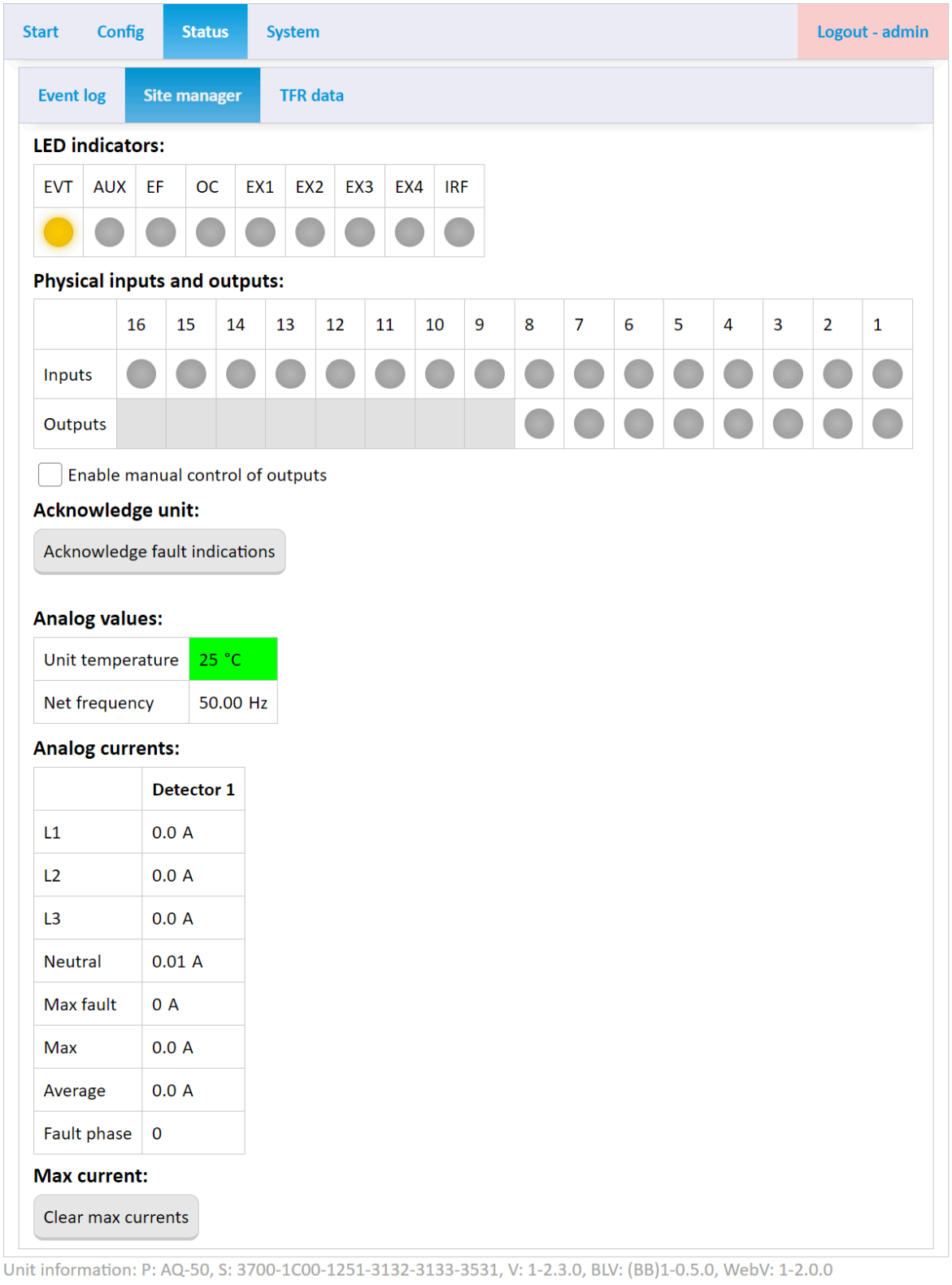
- Timestamp - time marking
- Type - type of event can be Error, Warning, Info or Debug
- Text - description of the event
- Extra information - four fields for extra information mainly for internal use

Additional diagnosing information is also displayed in the event log. For the EF Detected event, the first digit tells which detector has started. In this case, it is Detector 1. The second digit of the EF Detected is the State. Here it is 8 which means that it was the reignition function that detected the fault. Third digit for EF NONDIR Detected or EF Detected indicates that faulty phase is L2. For overcurrent, there are also options 12, 13, 23 or 123, which show which phases are involved.

16.2 Site manager

Site manager is found in the web interface on the *Status* tab.

Figure. 16.2 - 27. Site manager for AQ-50.



Please note that Site manager will adjust to the type of AQ-50 device that is used and on what options that are activated.

Table. 16.2 - 48. Site Manager tab indicators.

Indicator	Description
EVT	Yellow diode indicating that there is an unsent telegram in the queue for slave transmission on the system interface
AUX	Yellow diode that normally indicates that the device is handling a frequency deviation
EF	Red diode indicating that an earth fault has been detected
OC	Red diode indicating that an overcurrent has been detected
EX1	Yellow diode indicating that Detector 1 has identified a fault
EX2	Yellow diode indicating that Detector 2 has identified a fault – applies to expanded device
EX3	Yellow diode indicating that Detector 3 has identified a fault – applies to expanded device
EX4	Yellow diode that in normal configuration indicates start fault detection, detector 1-3
IRF	Red diode that indicates internal fault
Inputs 1 - 8/ 10/16	Yellow indicator for active input.
Outputs 1 – 3/8	Yellow indicator for active output.

On the *Site manager* tab, the status of the following is displayed:

- Indications: the status of each LED is mirrored.
- Temperature: measured inside the device and displayed with an offset of -15 degrees in standard design. E.g., if the unit measures 43 degrees, the value 28 is displayed.
- Current values, primary values.
    - Phase currents and residual current.
    - Max fault current.
    - Max current tracking pointer - resets with the Send max clear unit button.
    - 15 minutes mean value of minimum phase current.
- Faulty phase(s) for last registered fault.
- Current time: RTC time.

The "Send ACK to unit" button works just like the physical button on the device. Note that the value Max is not reset.

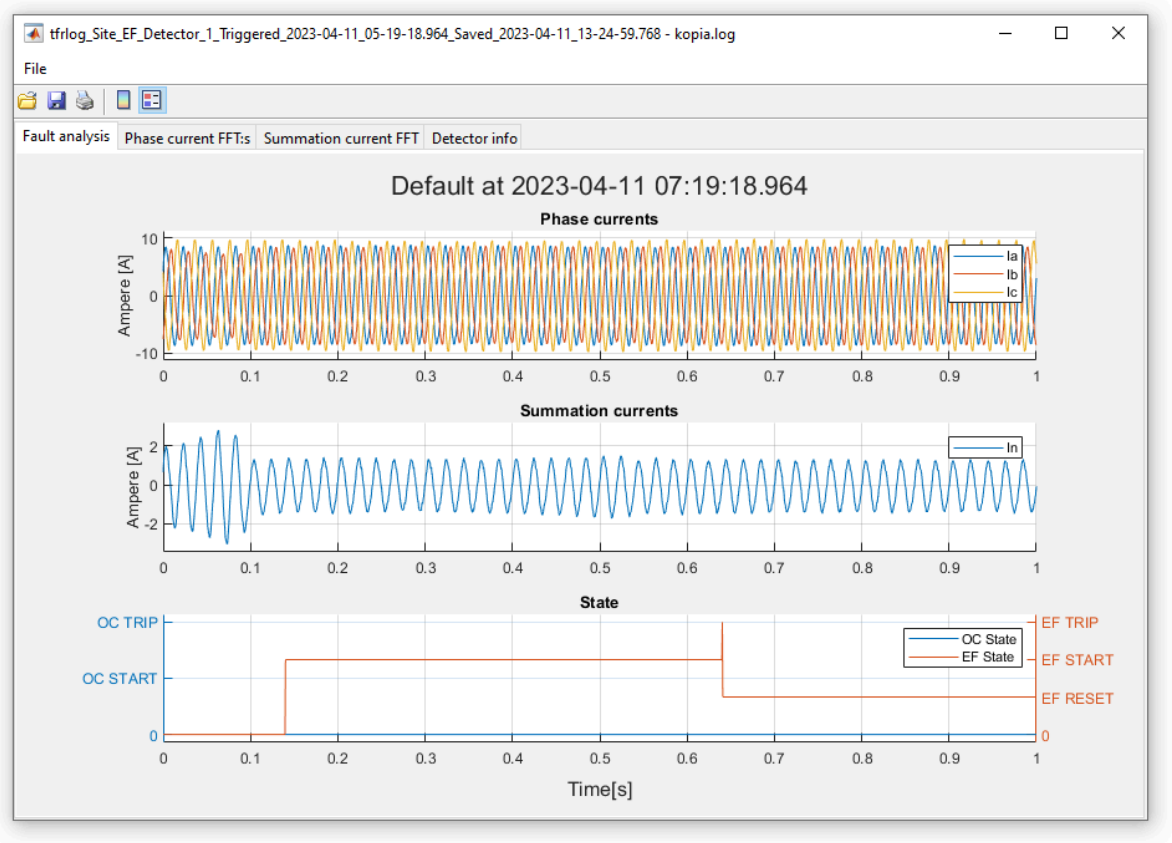
Site manager is typically used to check the device status via the Ethernet interface and in conjunction with commissioning to obtain current values. A good way to verify that all phase currents are correctly connected is, for example, to read the amplitudes. If they are equal and the sum current at the same time is small, the connection is likely to be correct.

There is a checkbox that enables activation of the outputs via the web interface. It is checked as long as you are logged in. To activate an output, simply click on the LED symbol. It then lights up and closes the relay output for 3 seconds.

17 Transient fault recorder - TFR

The built-in transient fault recording function registers currents and events from the last detected faults. It is possible to connect to the service port to analyse signals and events in detail. The transient fault recordings can be downloaded using the web interface and be analysed offline. The recordings can be converted to COMTRADE format.

Figure. 17 - 28. TRF file opened in TRF Plotter software.



The transient fault recorder saves the current phases and State during 1 s with the resolution 2 000 Hz, including the time that is specified by the parameter Pretrigger. See "Detection states" chapter for more details on State. Transient fault recording data is found on subtab *Status/TFR data*. If there are more than one detector, one file per detector is saved regardless of which one that triggers the recording. To download the interference file, simply click on the button "Detector 1", "Detector 2", or "Detector x". Depending on the browser settings, you can select the file name and destination for the download.

The "Type" column specifies what triggered the file to be saved. For example, the earth fault function may have started. The following events trigger the transient fault recorder:

- START overcurrent
- START earth fault
- START non-directional earth fault
- Manual trigger by pressing Capture active live data.

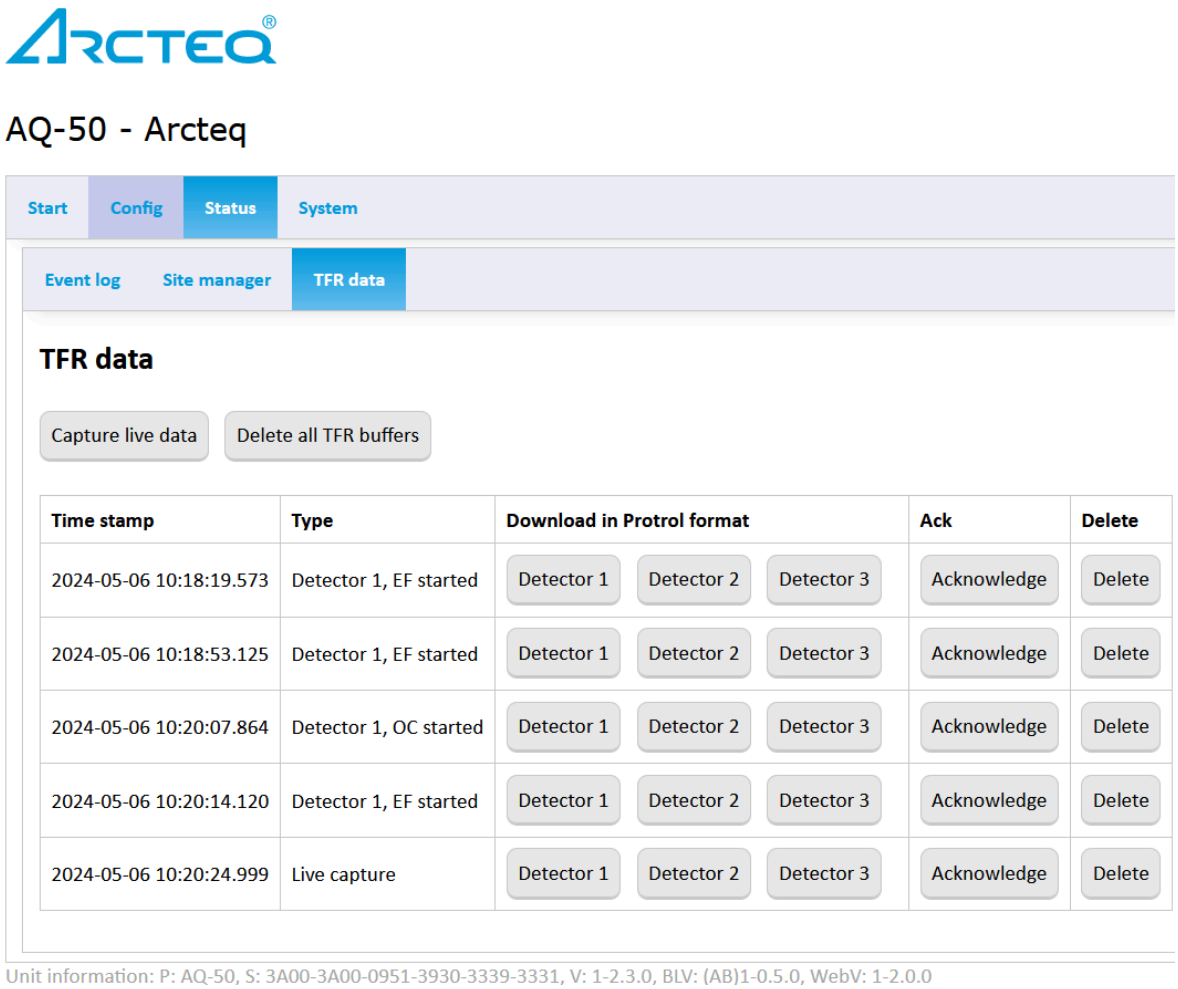
The rightmost column contains a button, "Acknowledge". The purpose of the function is that non-acknowledged disturbances files should not be overwritten and valuable information lost. A disturbance file can be acknowledged in several ways:

1. Press the button for the respective interference in the *TFR data* subtab. Only this specific disturbance is acknowledged.
2. Press the physical button on the AQ-50 device. All disturbances are acknowledged.
3. By automatic acknowledgment after some time, a setting on the Config/Detector/Commonsubtab. All disturbances are acknowledged.
4. By sending a telegram, single command to the device, addressing Acknowledge, binary outputs. All disturbances are acknowledged.

A maximum of ten disturbances records are saved. Only a disturbance record that is acknowledged can be discarded. The oldest acknowledged disturbance record will be next to be discarded. This means that after an acknowledgment, AQ-50 is always ready to register a new disturbance file.

The disturbance records are stored in non-volatile memory. It is possible to erase individual or all disturbance records manually.

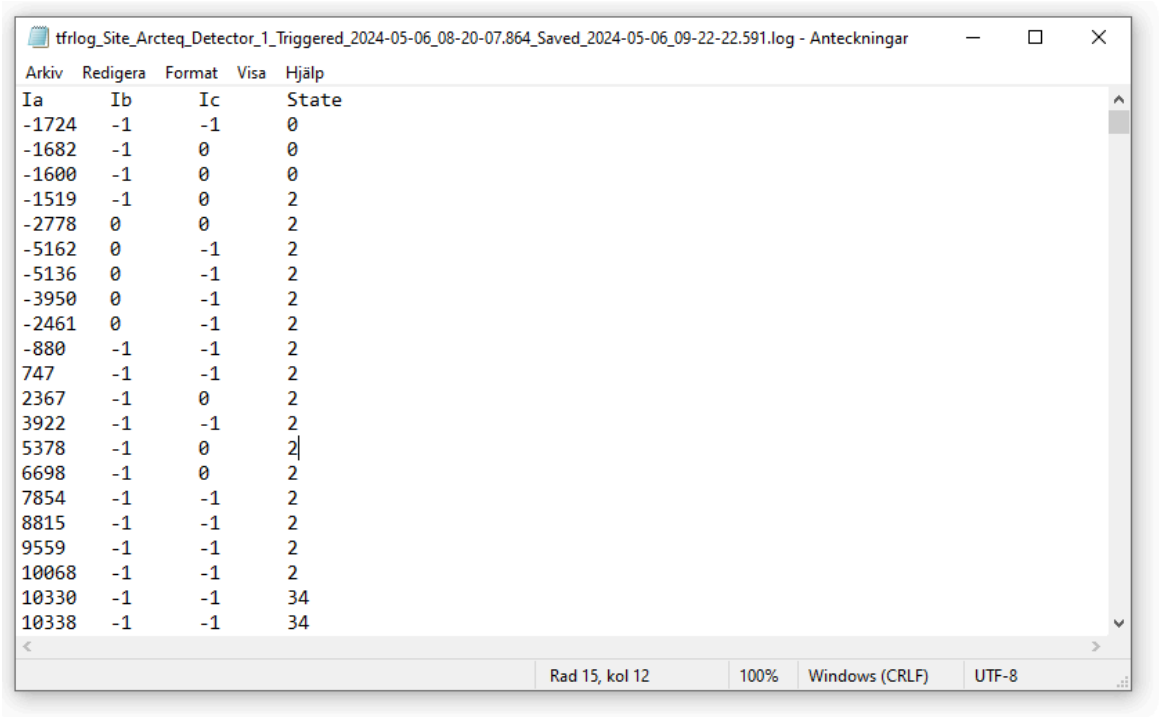
Figure. 17 - 29. TFR data subtab of the web interface.



There is a modern tool for viewing AQ-50 transient fault recordings, Arcteq TFR Plotter.

For conversion to COMTRADE there is *COMTRADE converter* software available on Arcteq's web page.

Figure. 17 - 30. The log file with TFR data – phase currents and State.



At the end of the log file there is additional information to obtain traceability during error analysis. Here can be found, among other things, version number, detector type, station name and scaling information.

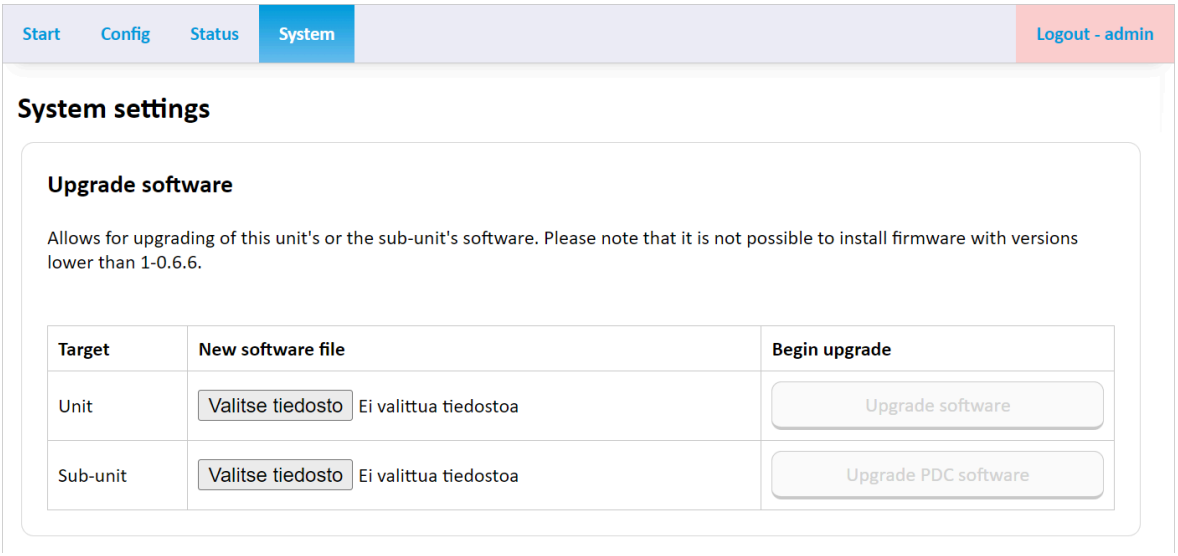
Some of the information is necessary for the conversion to COMTRADE to work. This applies to frequency, sampling frequency, CT ratio, resolution (RatedBinary), and time stamp.

- Upload a stored TFR file from the test device or select a previously uploaded file.
- Specify where to save a converted file. By default, it is saved in the same directory as the original data. It is possible to change file names if desired. The tool recognizes the type of data separation, eg loss or comma. Separation type can also be specified.
- When the file is selected, the configuration file and data file are displayed to the right. Change any input, scaling, labels, etc., if necessary.
- Convert by clicking Create COMTRADE files.

18 Firmware upgrade

Choose a Bundle file for firmware upgrade on the *System* tab and activate the software upgrade by pressing "Start SW upgrade".

Figure. 18 - 31. System tab for AQ-50.



After restart of the device, which will be performed automatically, it is recommended to check the current software version.

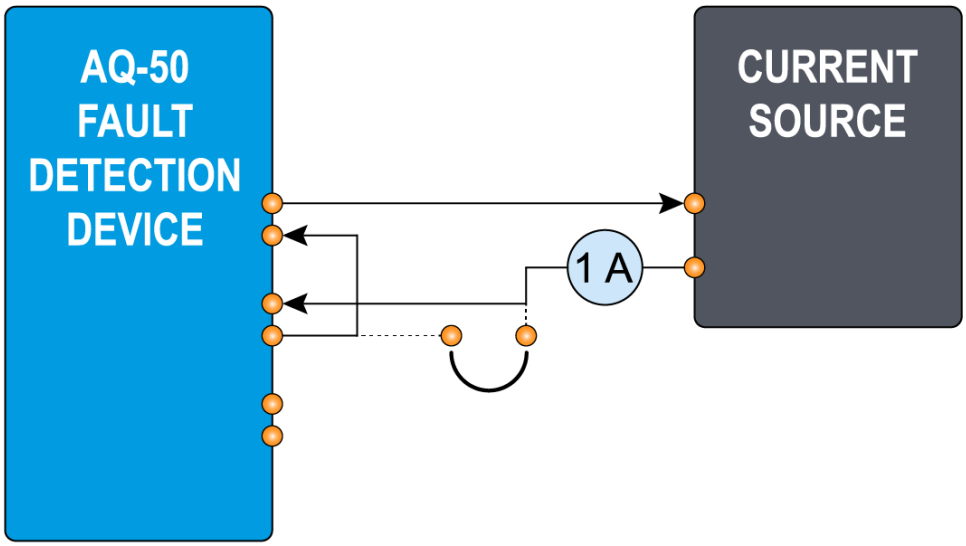
Please note that it is not possible to downgrade firmware of the device to versions before 1-0.6.6 from firmware 1-2.2.0 or higher.

19 Checklist for commissioning and testing

1. Check the polarity and level of the auxiliary voltage before powering up the AQ-50.
2. Connect to AQ-50 via the Ethernet or USB interface. Log in as config or admin.
3. Open the *Sitemanager* sub-tab.
4. Test binary inputs by applying 24 VDC at one input at a time. Verify that:
    a. The correct LED on the unit lights up.
    b. The corresponding LED symbol in the Site manager is activated.
    c. Corresponding indication message is sent via the selected remote interface.
5. Check EnableManual control of outputs box in Site manager. If required, disconnect the outputs from external objects. Verify that:
    a. The correct LED on the unit lights up when activated in Site manager.
    b. The correct output is activated. Measure the resistance across the output on terminal block. It should be < 1 Ohm when the relay is active.
    c. If possible, activate the output via the remote interface.
6. If the station is in operation, the phase currents connected and with a measurable current, check that:
    a. The correct amplitude is displayed in the Site manager.
    b. The currents are symmetrically presented in Site manager. If the amplitudes are equal and the residual current near 0 is safe, the connection is correct.
    c. Create a disturbance file and check that the phase sequence is the expected one.
    d. Measurement values are displayed correctly in the remote control center.

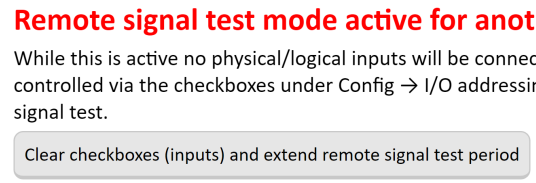
7. To test overcurrent and earth fault detector functions:
    a. Inject current with a one or three phase instrument. Check the indications for each function of the front panel of the device, in the Site manager, in the Event log and, if possible, in the remote control end.

Figure. 19 - 32. Current injection in two opposing phases.

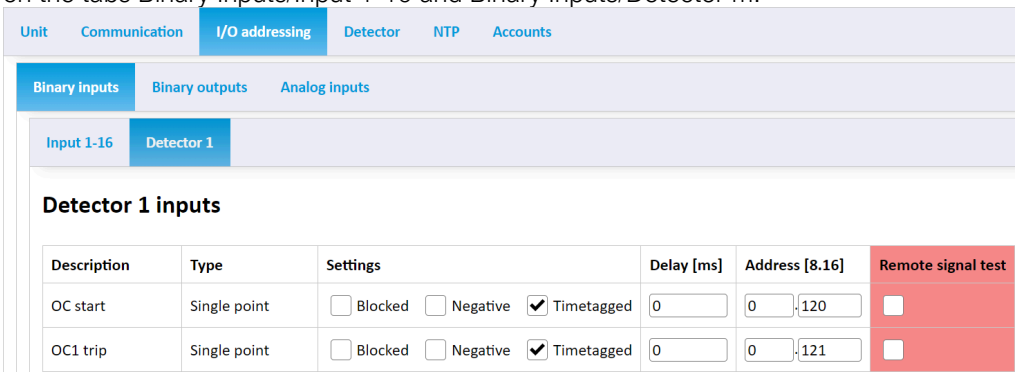


    b. With a current connected in counter phase to two inputs, both overcurrents and earth faults can be verified. For testing of earth faults, typically apply 0.5 A and then short-circuit one of the phases swiftly on a terminal or directly on the plug-in contact of the device.
    c. If no current injection instrument is available and if the station is in operation with measurable currents, a simple test of the earth fault detector can be performed by short-circuiting a phase briefly on the terminal.

d. If it is not possible to apply voltage/current on the inputs and there is no load current available, one can use simulated signals to verify the logical connection to the remote control center.On the tab *System* it is possible to activate the function for testing signals to the remote control center by pressing the button "Activate remote signal test".The following text is shown:



A new column, Remote signal test, is then added to the object settings for binary inputs on the tabs Binary Inputs/Input 1-16 and Binary Inputs/Detector m.



Clicking on a checkbox creates an object that is sent to the remote control center. In this way it is possible to verify that the object addresses of the AQ-50 device and the remote end match. Please observe that activation of the remote signal test overrides the actual status of the binary inputs. On the tab *System* it is possible to manually deactivate the remote signal test function by pressing the button "Deactivate remote signal test". The device spontaneously returns to normal state 30 minutes after activation.

20 Technical data

Table. 20 - 49. General technical data.

Dimensions (l x w x h)	AQ-50-XXXX1: 195 x 105 x 65 mm AQ-50-XXXX3: 290 x 105 x 65 mm AQ-50-XXXX6: 435 x 105 x 65 mm
Dimensions including plugin female contacts (l x w x h)	AQ-50-XXXX1: 195 x 115 x 75 mm AQ-50-XXXX3: 290 x 115 x 75 mm AQ-50-XXXX6: 435 x 115 x 75 mm
Weight	660/950 g
Assembly	DIN bracket
Ambient temp	-40...+70 °C
Supply voltage	24...48 VDC
Supply current	appr 100 mA at 24 VDC 100 mA is the supply current for AQ-50
Standards	• EN 61000-6-2 – Immunity • EN 61000-6-4 – Emission Class B • EN 61000-6-5 – For installation in medium voltage substations • EN 60068-2 – Environmental
Tests according to	• EN 61000-4-2 • EN 61000-4-3 • EN 61000-4-4 • EN 61000-4-6 • EN 60068-2-1 • EN 60068-2-2 • EN 60068-2-30
EU directives	ROHS, EMC

Table. 20 - 50. Inputs and outputs.

Binary inputs	16 BI, 24 – 110 VDC AQ-50-XXXX6 has 22 binary inputs
Binary outputs	8 BO, max 115 VAC / 150 VDC Two groups with 2 relays, 8 A breaking current at 30 VDC (contacts X8 and X10). Two groups with 2 relays , 5 A breaking current at 30 VDC (contacts X7 and X9). These can in one group be replaced with a latching relay if needed. AQ-50-XXXX6 has 5 additional relays, 5 A breaking current at 30 VDC
Analog inputs	AQ-50-XXXX1: 3 AI AQ-50-XXXX3: 9 AI AQ-50-XXXX6: 15 AI 1 A rated current, Ith 2 A cont. / 20 A, 1 s

All binary inputs and outputs have LED indicators. Binary outputs are galvanically isolated.

Table. 20 - 51. Service port.

USB	Type B
Ethernet	RJ-45 10/100Base – TX Full Dupl

Table. 20 - 52. Time synchronisation.

Standard	IEC60870-5-101/104 or NTP
Clock drift	Max. 3 ppm

Table. 20 - 53. System port, Slave.

RS-485	Plugin contact/DSUB9 Both 2- and 4-wire communication is supported. Bus termination can be done by connecting X11:4 and X11:5.
Ethernet	RJ-45 10/100Base – TX Full Dupl

Table. 20 - 54. Communication protocol, Slave.

Standard	IEC60870-5-101/104

Table. 20 - 55. System port, Master.

RS-485	Plugin contact. 2-wire communication. Bus termination can be done by connecting X13:2 and X13:3, also see the "Overview" chapter.

Table. 20 - 56. Communication protocol, Master.

Standard	IEC60870-5-101

21 Ordering information

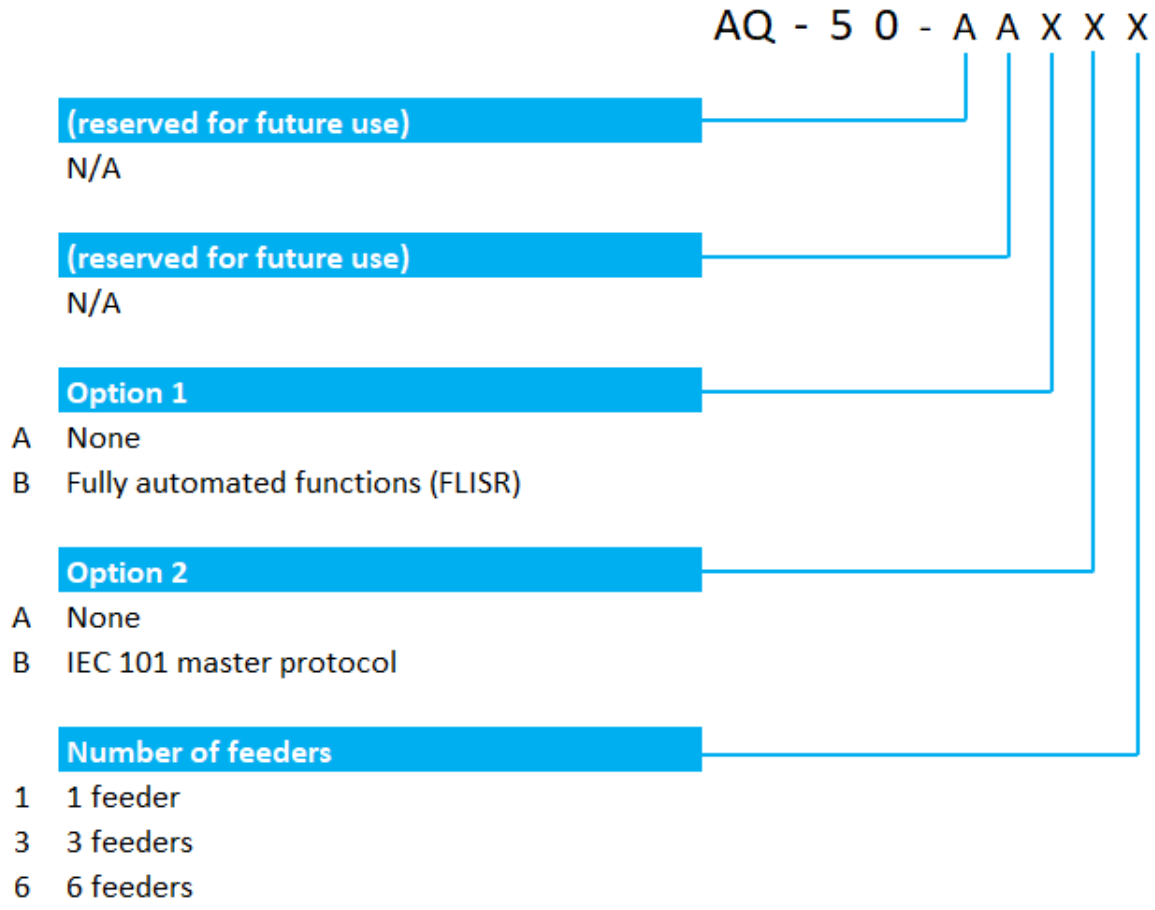


Table. 21 - 57. Accessories

Order code	Description
AX15004	Standard cabinet for one feeder.
AX15005	Standard cabinet for three feeders.
AX15013	Standard cabinet for six feeders.
AX550	150/1 A clip-together split-core CT, 4 m cable
AX551	300/1 A clip-together split-core CT, 4 m cable
AX580	150/1 A clip-together split-core CT, 8 m cable
AX581	300/1 A clip-together split-core CT, 8 m cable
AX512	LOFA split-core current sensor, 12 kV overhead line
AX524	LOFA split-core current sensor, 24 kV overhead line
AX420	Battery charger, 24 V DC, 2.5 A
AX422	Battery charger, 24 V DC, 5.0 A

Order code	Description
AX430	Battery, 12 V, 7 Ah, longlife
AX330	PxC RS-485 modem for PDC
AX510	OVP overvoltage protection, RS-485
AX520	PxL, LORA interface

22 Contact and reference information

Manufacturer

Arcteq Relays Ltd.

Visiting and postal address

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65300 Vaasa, Finland

Contacts

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E-mail (sales):	sales@arcteq.fi