ARCTEQ®

RELAYABLE POWER

AQ-200

SERIES PROTECTION,CONTROL,
MEASUREMENT AND MONITORING IEDS

CONTENTS

AQ-200 SERIES PROTECTION, CONTROL, MEASUREMENT AND MONITORING IEDS

The AQ-200 series provides an optimal protection and control solution for any utility, power plant, wind-power, off-shore, marine, industrial, commercial or institutional electrical protection and control applications. The AQ-200 series offers integrated or segregated protection control, monitoring, measuring solutions with powerful complementary monitoring, measuring, communication and diagnostics information. The AQ-200 is developed using the latest available technologies providing a totally new dimension and options to protection and control engineers.

AQ-200 BENEFITS

VERSATILE PROTECTION DESIGN

AQ-200 series is characterized by fast, versatile and dependable protection functions with uniquely wide operating frequency band of 6…75Hz making AQ-200 perfect choice for the most demanding protection applications including rotating machines.

MODULARITY

Fully modular hardware construction gives a high level of flexibility; additional I/O or communication cards can be simply plugged in according to application needs.

USABILITY

Maximum use of the IEDs is guaranteed by features such as guided wizards, sophisticated setting aids, highly customizable HMI, file storage of pdf or other supportive documents and extensive user log information. Track down a complete user history register including setting change and other
operational history.

PERFORMANCE

The AQ-200 series offers truly sub-cycle instantaneous triptimes. You can add a fast integrated arc protection to your traditional protection scheme. Powerful PLC programming is included for the most demanding applications allowing for extensive customization. Up to 100 disturbance records of up to 10 seconds each and 10 000 events are stored in non-volatile memory.

COMMUNICATION

Native Ethernet communication provides for fast andseamless communication. The AQ-200 communicates using variety of standard protocols including IEC 61850 substation communication standard with fast GOOSE messaging. AQ-250 units have also been certified for IEC 61850, 2nd edition.

SAVINGS IN ENGINEERING TIME

AQtivate 200 free of charge software suite saves valuable engineering time by offering an intuitive and easy to use human machine interface. Download all relay settings instantly using native 100Mb/s Ethernet connection either at IED front port or rear port through Ethernet network.

STANDARDIZED HARDWARE

Trouble free logistics and stocking with highly standardized hardware design. Five CT inputs with software settable secondary currents and software configurable digital input thresholds for voltage are standard features of AQ-200 series.

IEC 61850 & IEEE 1588

- High-availability Seamless Redundancy (HSR) support
- Parallel Redundancy Protocol (PRP) support
- Precision Time Protocol (PTP) according to IEEE 1588
- IEC 61850 2nd edition support for AQ-250 units

ARCTEQ INNOVATION

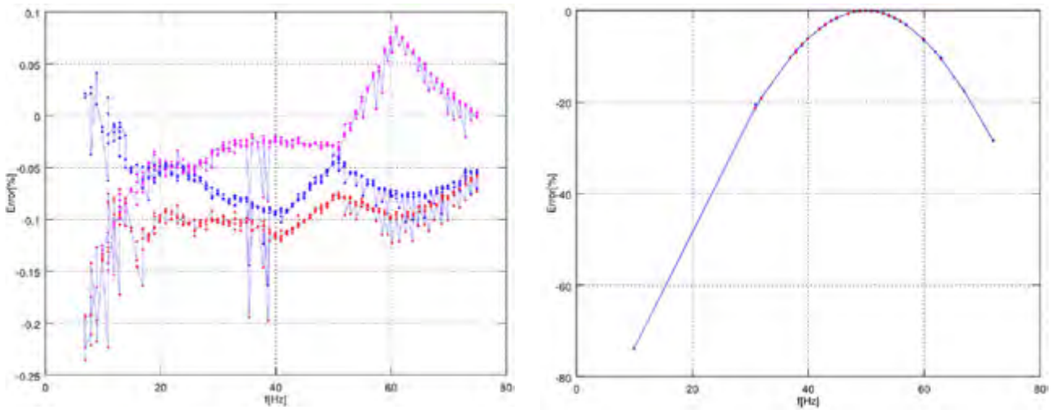
Ultra-accurate measurement technology

ACCURATE AND FREQUENCY INDEPENDENT

Arcteq's AQ-200 series protection and control IEDs are deploying patented measurement technology. This has resulted in a very unique combination of class 0.2S power and energy measurement accuracy, full dynamic measurement range and frequency independent measurement and protection in a single device.

Therefore the AQ-200 series is well applicable for any applications requiring accurate measurement alone, or combination of measurement and protection. Frequency independent measurement technology allows for more accurate rotating machine protections as well.

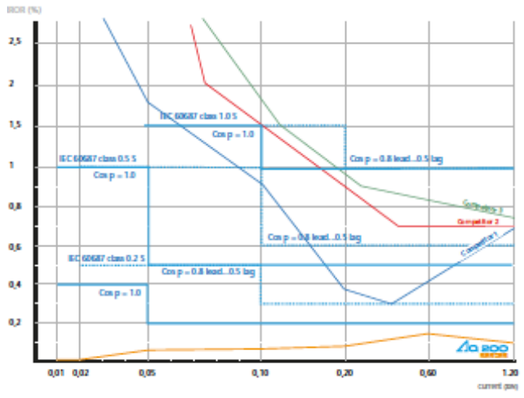
The AQ-200 series provides an optimal protection and control solution for any utility.



The frequency tracking functionality keeps the measurement accuracy in Arcteq protection relays within class 0.2S between 6 and 75 Hz frequency.

PATENTED MEASUREMENT ALGORITHM

The system frequency independent measurement accuracy has been achieved in AQ-200 series devices by adjusting the sample rate of the measurement channels according to the measured system frequency in a way that FFT (Fast Fourier Transformation) calculation can always make use of full power cycle buffer. Furthermore, all analog channels are calibrated against 8 system frequency points for both, magnitude and angle. This frequency dependent correction compensates the used measurement hardware frequency dependencies as the measurement hardware is not linear considering the measured analog signal frequency. Therefore the magnitude and angle measurements need to be calibrated against frequency to obtain high accuracy. Furthermore, the measured channels FFT result fundamental frequency component is corrected for magnitude and angle errors by Arcteq AQ-200 series patented calibration algorithms.



The measurement accuracy in Arcteq protection relays stays within 0.2% even at extremely low currents.

ARCTEQ INNOVATION

Intermittent earth fault protection

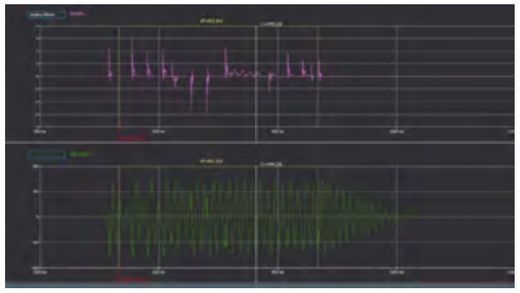
BACKGROUND

Underground cabling of the distribution networks makes them less vulnerable to disturbances, but at the same time leading to higher earth fault currents. Networks are compensated with Petersen coils to keep earth fault currents on lower level. Typically an intermittent earth-fault is a 0.05-1 millisecond self-extinguishing flash-over fault from phase to ground causing heavy transient spikes into the electric network. Traditional non-intermittent directional earth fault protection is unable to operate correctly in this type of fault since it is typically based into FFT (Fast Fourier Transformation) processing results based on fundamental frequency RMS values.

ARCTEQ PATENTED SOLUTION

Arcteq's breakthrough IED technology in AQ-200 series with patented very accurate measurement technology (better than 0.2% for energy and power measurement) combined with up to 3.2kHz sampling rate lays the foundation for accurate algorithms of fast phenomenon such as intermittent earth-fault protection.
The algorithm makes use of the accurate measurement and sampling technology by searching for spikes in I0 and U0 generated by intermittent earth fault strike through. Algorithm is able to remove all unnecessary and confusing data and concentrate only on the spikes. By calculating the delta of raw samples using an innovative patented admittance based formula the polarity of the spikes in I0 and U0 is determined accurately distinguishing effectively a faulty feeder over healthy background feeder. The algorithms have been proven effective in extensive field tests with electrical utilities, and have been installed in networks since 2014.

The AQ-F215 and AQ-F255 feeder terminal is equipped with the intermittent earth fault protection. The protection algorithm combined with 0.2S measurement class and 3.2 kHz sampling frequency, enables it to detect and isolate intermittent earth faults with high accuracy.



The triptime of the intermittent earth fault protection is set to 500 ms. From this disturbance record from AQ-F215 or AQ-F255 relay can be read that the relay detects the intermittent earth faults and trips within the set time.

The algorithms have been proven effective in extensive field tests with electrical utilities, and have been installed in networks since 2014.

ARCTEQ INNOVATION

Broad range multi-criteria earth-fault protection

THE PROBLEM

The increase of medium voltage cabling, connection of distributed generation and compensated networks (Petersen coil) along with distributed compensation has led to new challenges in earth-fault protection of distribution feeders. Challenging combinations of short cable feeders, long overhead feeders and mixed cable and overhead network is increasing significantly among distribution system operators. Relaying on conventional protection methods may lead to either nuisance trips of healthy feeders or undetected faults in faulty feeders. When protecting compensated long-distance cables and overhead lines it is in some cases difficult to distinguish between healthy- and faulty feeder when protection is based on merely measuring the angle and magnitude of residual voltage and currents.

Earth fault protection often requires information on network status (ungrounded or compensated). When changing between these two statuses setting group must be changed and especially in case of distributed compensation the change may be difficult or impossible to arrange.

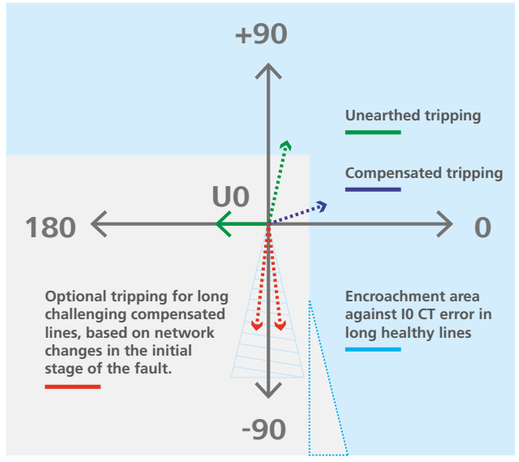
New broad range mode available in AQ-200 series protection and control IEDs can protect against earth-fault in both ungrounded and compensated networks without setting changes.

THE SOLUTION: NEW BROAD RANGE MODE WITH MULTI-CRITERIA DETECTION

New broad range mode available in AQ-200 series protection and control IEDs can protect against earth-fault in both ungrounded and compensated networks without setting changes. The algorithm reliability is further increased using a new multi-criteria detection. This optional additional tripping condition for compensated networks uses Arcteq's patented, high-resolution intermittent earth-fault algorithm with added symmetrical component calculation of phase currents and voltages. If this mode is activated the tripping criteria comprises of a measured residual current in the third or fourth quadrant and the symmetrical components of voltages and currents detecting a fault. No extra parameterization is required compared to traditional method.

Multi-criteria algorithm can be tested with Comtrade files supplied by Arcteq. Function requires connection of 3-phase currents, residual current and zero sequence voltage to operate correctly. To avoid unnecessary trips due to CT errors, encroachment area in compensated long healthy feeders can be added.

NEW BROAD RANGE MODE



Operation of new broad range mode covers both ungrounded and compensated networks and is equipped with optional additional multi-criteria detection for compensated networks to increase the protection reliability.

For a complete coverage of feeder earth-faults in compensated networks, the intermittent / transient type of earth-faults are to be protected by Arcteq's patented intermittent earth-fault protection stage available in the AQ 200 series feeder protection IEDs.

ARCTEQ INNOVATION

Disturbance recorder and power quality

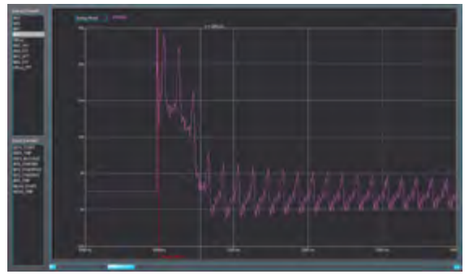
DISTURBANCE RECORDER CAPACITY

The disturbance recorder in AQ 200 series IEDs is a high capacity and fully digital recorder integrated to protection relay. Maximum sample rate of the recorder analog channels is 64 samples per cycle. The recorder supports 96 digital channels simultaneously with measured 9 analog channels. Even all measured and calculated values can be registered as digital channels with 5ms sample time. This feature is useful in for instance motor start up sequence, as users can track fully sampled analogue waveform values and every 5ms sampled RMS values simultaneously. The memory capacity in AQ 200 series IEDs allows for up to 100 non-volatile records with total of 500 second recording time with full sample rate and maximum number of recorded channels.
Recorder output is in general comtrade format and it is compatible with most viewers and relay test sets. The comtrade file is based on the IEEE Std C37.111-1999 standard.

AQ 200 series' disturbance recorder is a great tool for analyzing the performance of the power system in network disturbance situations.

DOCUMENTING VOLTAGE SAGS AND SWELLS WITH DISTURBANCE RECORDER

AQ 200 series' disturbance recorder is a great tool for analyzing the performance of the power system in network disturbance situations. Voltage sags and swells are often monitored for power quality analyzes. The disturbance recorder can be triggered with any signal in the IED. Over -and undervoltage or any programmable protection stages can be used to trigger the recorder. With Arcteq's fast acting protection stages the voltage sags and swells of as little as 10-15ms can be recorded and documented.



Example recording with high harmonic content.

HARMONICS MONITORING

The AQ 200 series IEDs are measuring harmonics of up to 31st order for both currents and voltages. Arcteq's innovative and unique harmonic overcurrent stages (50/50h) can be used for alarming, tripping and triggering the disturbance recorder. Freely settable harmonic overcurrent stages can monitor and act on any of the current harmonics from 2nd to 19th order. The disturbance recorder can record harmonic content up to 31st order.

DISTURBANCE RECORDER SETTING EXAMPLES

Samples per cycle	64	64	64
Analogue channels	8	8	8
Digital channels	24	24	24
Record duration	5s	10s	60s
Total number of records	100	52	8

ARCTEQ INNOVATION
Cable end differential protection

CABLE END FAULTS AND ARC FLASH INCIDENTS
Arc flash faults within the switchgear are typically caused by reasons such as human errors, equipment failures, foreign objects, or animals in the gear or by combination of aging materials, dirt and lack of maintenance. As per empiric data, the most common non-human intruded fault location is the cable compartment, and more precisely the cable end. Degrading insulation level or faulty cable connections are the most common causes for cable end faults. Cable faults often start by a small earth-leakage developing to full single-phase faults. Further, if not detected and tripped, the single-phase faults may develop to cross country or 3-phase faults.

COMPENSATED CABLE END DIFFERENTIAL PROTECTION
Arcteq has developed a proactive cable end protection in its AQ-200 series protection and control IEDs. The aim of the protection function is to provide an early detection of cable end fault. Typically cable end protection is implemented as an alarming function indicating the need of preventive maintenance.

Operating principle is based on low impedance differential protection with settable bias characteristics. Differential current is calculated in between of summed phase currents and selected residual current input measured by a core balance CT.

The function provides natural measurement unbalance compensation to have higher operating sensitivity for monitoring cable end faults. When calculating the residual current from phase currents the natural unbalance may be in total up to 10% with CT's of class 5P. When the natural unbalance current is compensated in this same situation the differential settings may be set more sensitive and the natural unbalance does not affect into the calculation.

If in the cable end should occur any starting faults the cable end differential catches the difference in between of the ingoing and outgoing residual currents and the resulting signal can be used for alarming or tripping purpose for the feeder with failing cable end. The sensitivity of the algorithm and settings can be freely user settable.

THE BENEFIT
Cable end differential protection uses the elements already available in the protection scheme: 3-phase CT's and residual core balance CT. There is no need for extra hardware or wiring. The sensitive compensated cable end differential protection can be used with no extra cost to provide additional switchgear and personnel safety.

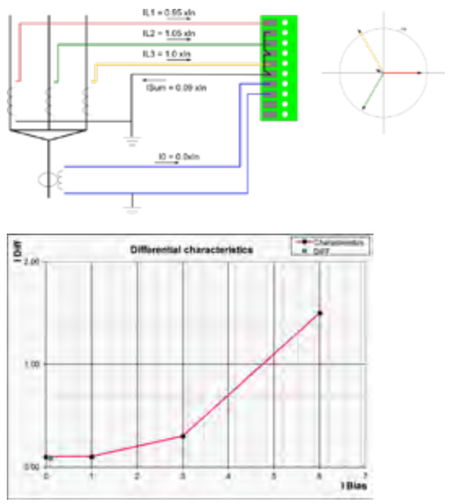


Figure 1: Cable end differential protection without natural unbalance compensation in use. Phase current CT errors are causing significant differential current. Compensation is essential to have a sensitive protection setting.

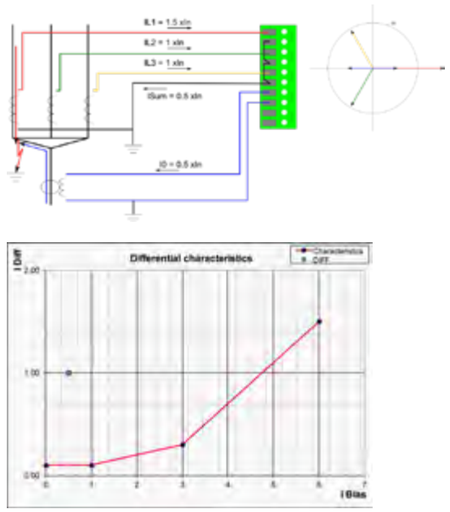


Figure 2: Compensated cable end differential protection during a small earth-leakage current. Due to natural unbalance compensation the function can alarm correctly even on small differential currents.

AQ-200 PROTECTION FUNCTIONS

FEEDER PROTECTION ALGORITHMS

NON-DIRECTIONAL AND DIRECTIONAL OVERCURRENT AND EARTH-FAULT PROTECTION (ANSI 50/51, 50/51N, 67, 67N)
Up to four stages of non-directional overcurrent and earth-fault protection functions and four stages of directional overcurrent and earth-fault functions with wide setting range of 0.1...40xIn for overcurrent and 0.005...40xIn for earth-fault. Directional overcurrent decision is based on positive sequence voltage and voltage memory is used for close in faults. Definite time, IEC or ANSI inverse time curves with settable reset delays to coordinate with electromechanical relays. Instantaneous operate time is <20ms.

Includes option for internal harmonic blocking (2nd and 5th harmonic).

HARMONIC OVERCURRENT PROTECTION (ANSI 50/51H, 68)
Configurable trip or alarm or blocking signal based on extensive harmonic content. Up to four stages based on 2nd, 3rd, 4th, 5th or 7th, 11th, 13th, 15th 17th or 19th harmonic. Definite time, IEC or ANSI inverse time curves with settable reset delays.

PROGRAMMABLE STAGE PGX >/< (99)
"The programmable stage (PGS) is a stage that can be programmed by the user to create more advanced applications either as an individual stage or together with programmable logic. The relay has ten programmable stages, of which each can be set to compare from one to three analog measurements. The programmable stages have over-, under- and rate-of-change available with definite time delay to trip from pick-up included."

CABLE AND TRANSFORMER THERMAL PROTECTION (ANSI 49L/49T)
Thermal protection for cable or transformer overloading based on single (cable) or dual (transformer) time constants used for heating and cooling calculation of the thermal image. Provides maximum allowed load current, two alarm stages and tripping stage. Supports also close request inhibit.

CABLE END DIFFERENTIAL PROTECTION (ANSI 87N)
This protection stage can be configured either as a low impedance restricted earth-fault protection or cable end differential protection. When monitoring cable end healthy condition the function compares differential current of measured phase and core balance CT currents. Natural unbalance compensation due to CT inaccuracies is included for enabling sensitive operation. The function serves for pre-emptive arc fault protection purposes.

TRANSIENT/INTERMITTENT EARTH-FAULT PROTECTION (ANSI 67NT)
This sample based intermittent earth-fault algorithm makes use of AQ-200 series' accurate measurement and sampling technology by searching the transient spikes in both I0 and U0 generated by intermittent earth fault strike through. Algorithm is able to remove all unnecessary and confusing data and concentrate only on the spikes. By calculating the delta of raw samples using an innovative admittance based formula the polarity of the spikes in I0 and U0 is determined accurately distinguishing effectively a faulty feeder over healthy background feeder. Freely settable function operation time guarantees simple coordination with back-up residual voltage protection.

CIRCUIT BREAKER FAILURE PROTECTION (50BF/52BF)
User settable function initiation based on overcurrent or digital input or digital output status alone or in any combination. Two separate levels for Re-Trip and CBFP.

ARC PROTECTION (50ARC/50NARC)
Optional fast arc protection is available in selected models. Stage can be set to operate on any combination of arc light, arc pressure, arc residual current or arc phase current conditions. Typical operation time is 7ms.

VOLTAGE AND FREQUENCY PROTECTION ALGORITHMS

VOLTAGE PROTECTION (ANSI 59/27/59N/47)
Up to four under and overvoltage and residual overvoltage and positive/negative sequence voltage stages with DT or IDMT characteristics and settable voltage thresholds.

FREQUENCY PROTECTION (ANSI 81U/81O/81R)
Up to eight under and overfrequency stages and eight rate of change of frequency stages with DT characteristics. May be applied for extensive load shedding logic or simple underfrequency protection.

VECTOR JUMP PROTECTION (ANSI 78)
The vector jump (or vector shift) protection is suitable to detect most islanding situations and switch off the mains breaker in order to let the generator supply only loads under their rated power value. The algorithm follows the samples of chosen measured voltages (64samples/cycle). Used reference voltage can be all or any phase- to phase or phase- to neutral voltages.

MACHINE PROTECTION ALGORITHMS

DIFFERENTIAL PROTECTION (ANSI 87T/87G/87M)
Generic differential protection applicable for transformers, motors, generators or other machines requiring sensitive protection stabilized for out-zone faults. Stage features integrated 2nd and 5th harmonic blocking and predefined or custom setting of protected objects' connection group. Stage verifies object nominal values and connection group settings.

MOTOR AND GENERATOR THERMAL PROTECTION (ANSI 49M/49G)
Highly accurate motor and generator thermal modeling based on up to total of five time constants. Stator and rotor heating and cooling time constants can be set independently according to the application. Dedicated cooling time constant may be used for running and stopped machine independently. Contribution of the stator and rotor time constant effect can be set freely. Negative phase sequence current bias setting guarantees an optimal thermal image in unbalanced conditions. Ambient temperature biasing is supported either from manually set level or reading from RTD. Thermal image function calculates and displays the estimated temperatures in percentage, Celsius or Fahrenheit for easy reading of the motor thermal capacity used. Two independent alarm levels and trip and restart inhibit levels can be set easily.

MOTOR START-UP SUPERVISION/LOCKED ROTOR PROTECTION (ANSI 48, 14)
Start-up/locked rotor protection with speed switch provides definite and inverse time protection for motor starting situations. Optional speed switch can be connected to function via a normally open (NO) or normally closed (NC) contact. Accurate protection starting from 6Hz in soft start applications.

FREQUENT START SUPERVISION (ANSI 66/86)
The function inhibits motor starting based on maximum permitted starts per hour and/or motor thermal capacity. Maximum starts in cold or hot situation can be set separately as well as the minimum time in between starts. If allowed amount of starts is used the function will inhibit further starts until the motor is cooled enough to allow a new starting attempt.

LOSS OF LOAD PROTECTION (ANSI 37)
Undercurrent based loss of load protection is typically applied for conveyor controlling motors or other applications where loss of mechanical load is possible. Instant operation may be set for the most critical applications preventing further damage in case of lost load.

MECHANICAL JAM PROTECTION (ANSI 51M)
Motor mechanical jam protection is activated only after the motor has started. The mechanical jam protection can be set very sensitive due to being disabled during motor start.

UNBALANCE PROTECTION (ANSI 46/46R/46L)
Up to four user settable stages based on either negative sequence current I2 or ratio of negative/positive sequence currents I2/I1 (broken conductor or loss of phase protection).

POWER PROTECTION (ANSI 32/37/32R)
Over power, under power and reverse power protection may be applied for overload, loss-of-load and generator turbine protection with DT characteristics and settable 3 phase active power thresholds.

SYNCHRONOUS MACHINE PROTECTION (ANSI 40/51V/64S/21U/24/55)
Among other stages the loss of field, voltage restrained overcurrent, 100% stator earth-fault, under impedance and volts per hertz and power factor protection stages do provide all necessary for efficient generator and other synchronous machine protection.

Highly accurate motor and generator thermal modeling based on up to total of five time constants.

AQ-200 CONTROL FUNCTIONS

SETTING GROUP CHANGE CONTROL
Change between up to 8 setting groups by any digital signal including GOOSE message or force change overrule of local controls either from setting tool, HMI or SCADA.

OBJECT CONTROL
Up to 5 locally or remotely controllable objects and 5 status indications. Visualize and control objects locally by means of large graphic MIMIC display.

AUTO-RECLOSE (ANSI 79)
Up to 5 independent or scheme controlled shots initiated by five priority requests with possibility to set parallel signals in each request. Request inputs may be binary inputs, virtual inputs or GOOSE messages.

COLD-LOAD PICK-UP FUNCTION
Programmable cold-load pick-up function for blocking protection functions based on cold-loads.

SWITCH ON TO FAULT FUNCTION
Speed up protection in case of closing on fault or forgotten protective earthing. Function may control other protection function or initiate direct tripping. Typical operate time <20ms.

SYNCHROCHECK AND SYNCHROSWITCH (ANSI 25)
Synchrocheck function has three stages SYN1, SYN2 and SYN3. Function may be applied to check of synchronism over one or two or three circuit breakers. Algorithm checks voltages, frequencies and phase angles. All "dead" and "live" bus combinations are supported.

SYNCHRONIZER (ANSI 25)
The synchronizing function is used for automatic synchronizing of generators to power grids. Proper synchronizing is essential to avoid inrush currents and power system oscillations as well as thermal and mechanical stress on the generator when connecting a synchronous generator to the grid. The function controls amplitude, speed and phase-angle between the two voltages to allow a close command signal to the generator circuit breaker.

AUTOMATIC TRANSFORMER VOLTAGE REGULATOR, AVR (ANSI 90)
Voltage regulator keeps the transformer secondary voltages in the given voltage window based in to the measured phase-to-phase voltage. Transformer tap can be controlled with low and high speed schemes. Internal overcurrent and low voltage blockings prevent burning of the tap during overcurrent faults and traverse of the tap to high position on bus de-energisations. In case of high overvoltage instant voltage low function controls tap to low position as fast as tap changer mechanics allows to reduce the high voltage time to minimum.

EXCITATION CONTROL
Synchronous machine excitation control can be used for any machines of up to 250MVA. Different control modes include automatic voltage regulator, field current regulator and reactive power control among others.

AQ-200 MONITORING FUNCTIONS

CT SUPERVISION
Alarms or blocks in case of lose wiring by constantly monitoring phase current instant values as well as key calculated magnitudes of the phase currents. Monitor the residual current circuit also if the residual current is measured from dedicated residual current CT.

FUSE FAILURE (VT SUPERVISION)
Alarm or block in case of lose wiring or blown fuse by constantly monitoring connected instant values and calculated magnitudes. In IED where both voltage and current measurements are available the magnitudes are cross compared in order to segregate VT failure from fault. Also MCB trip direct connect is supported in the VT supervision function.

CIRCUIT BREAKER WEAR
Monitor the circuit breaker lifetime and maintenance needs due to interrupting currents and mechanical wearing. Function monitors the circuit breaker manufacturer given data for the breaker operating cycles in relation to the interrupted current magnitudes.

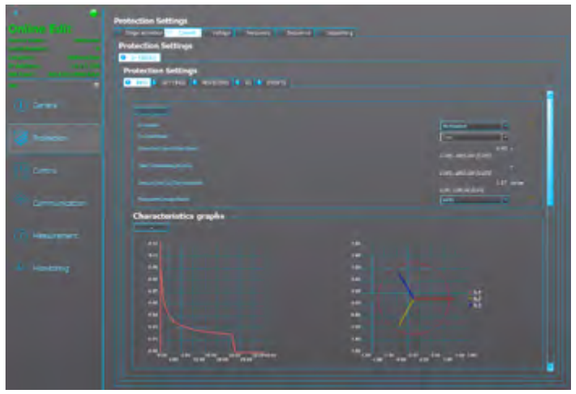
TOTAL HARMONIC DISTORTION
Measure constantly phase and residual current and voltage magnitudes and the harmonic content of the monitored signals up to 31st harmonic component. Display THD online and create alarm limits for each channel individually.

UNIQUE MEASUREMENT ACCURACY

- Up to class 0.2S power and energy measurement
- Cost savings in eliminating external measurement devices
- More accurate protection

AQTIVATE 200
Setting and configuration software suite

All AQ-200 series IEDs can be conveniently configured and set using easy to use and powerful AQtivate 200 free of charge software suite. Protection setting, I/O configuration, logic programming, HMI display, communication protocol parameters and sophisticated on-line monitoring are in-built functions of the software suite. The AQtivate 200 can be used in off-line or on-line mode through Ethernet connection at the relay front port or network at relay rear ports. Inbuilt AQviewer software provides for comtrade disturbance recorder analysis. The AQtivate 200 runs on all Windows operating systems and is backwards compatible with older firmware versions.



Clear grouping of IED functions guarantees familiar working experience with AQtivate 200 software suite. Only the activated functions are displayed for convenient setting and commissioning.

All AQ-200 series IEDs can be conveniently configured and set using easy to use and powerful AQtivate 200 free of charge software suite.

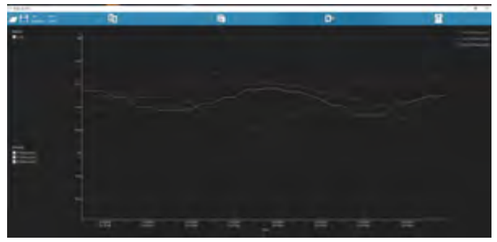
With the AQ 250 graphical mimic editor it is easy to build informative color displays for the IED's.

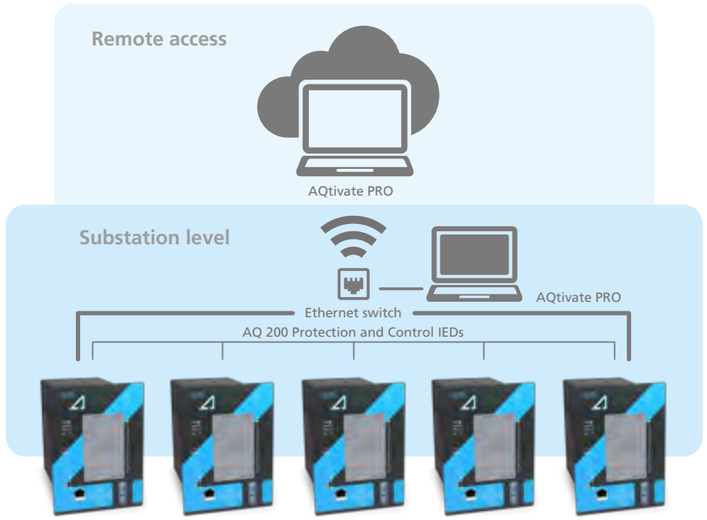
With the logic editor the functionality of the IED can be extended by using common logic gates.

On-line status displays of vectors, logic, blocking and matrix signals save time in troubleshooting and project commissioning and testing stage.

AQTIVATE PRO
Substation Management Software

The AQtivate PRO – Windows based substation management software is bringing a new level of efficiency in substation monitoring and protection maintenance. Automatic recognizion of AQ-200 series IEDs connected in Ethernet network makes AQtivate PRO truly a plug and play software for substation management.





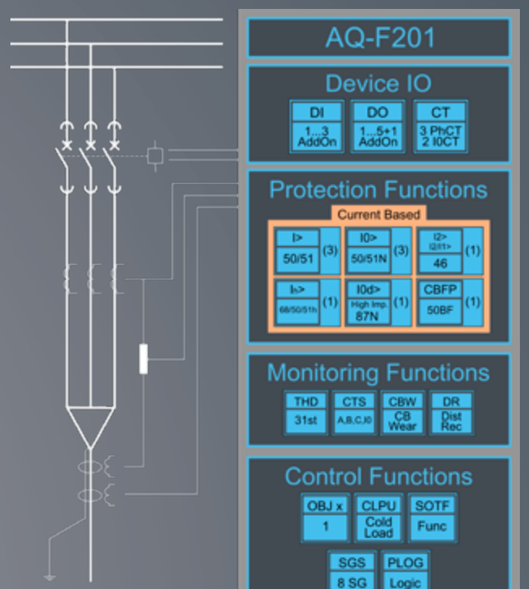
AQtivate PRO provides cost effective and virtually engineering free software for managing the AQ-200 series IEDs over Ethernet network. Functionality includes convenient downloading and uploading of engineering and maintenance files, automatic retrieving of disturbance recorder files, visualizing of substation events, alarms and switching device statuses and control of circuit breakers.

AQTIVATE PRO SOFTWARE MODULES

Feature\ Module	Engineering	Monitoring	Control	Full
Automatic IED recognition over Ethernet	✓	✓	✓	✓
AQtivate 200 remote access	✓	✓	✓	✓
Drag and drop of IED setting and CID files	✓	✓	✓	✓
Automatic disturbance recorder download	✓	✓	✓	✓
Substation event and alarm lists		✓	✓	✓
Substation online measurement		✓	✓	✓
Measurement trend displays		✓	✓	✓
Switching device status monitoring		✓	✓	✓
Switching device remote control			✓	✓
Protection maintenance module (Includes Engineering module)	✓ (option)	✓ (option)	✓ (option)	✓

AQ-F201 Overcurrent and earth-fault relay

The AQ-F201 offers a compact solution for any application requiring non-directional overcurrent and earth-fault protection. Selection of supportive functions for protection, measurement, monitoring, control and communication along with large programmable HMI guarantee the best in class price performance ratio for basic range of relays.



- **Basic range**
- **Price performance ratio**

PROTECTION FUNCTIONS

- Three-phase overcurrent, 3 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 3 stages INST, DT or IDMT (50/51N)
- Harmonic overcurrent / inrush blocking, 1 stage INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 1 stage INST, DT or IDMT (46/46R/46L)
- High impedance restricted earth fault (87N)
- Breaker failure protection (50BF,52BF)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Current THD and harmonics (up to 31st)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Trip circuit supervision (TCS)
- Control
- Controllable objects: 1
- Cold-load pick-up block
- Switch onto fault logic
- 8 setting groups

HARDWARE

- Current inputs: 5
- Digital inputs: 3 (fixed)
- Output relays: 5+1 (fixed)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

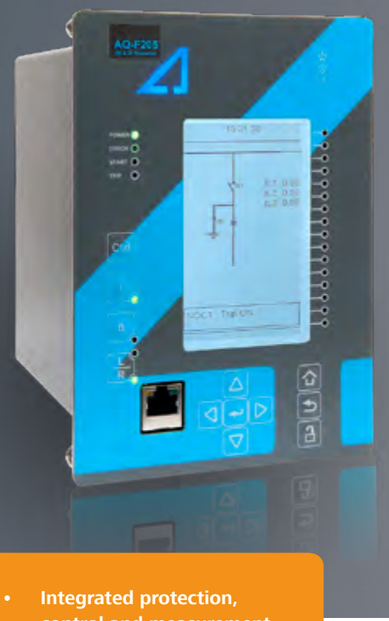
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)

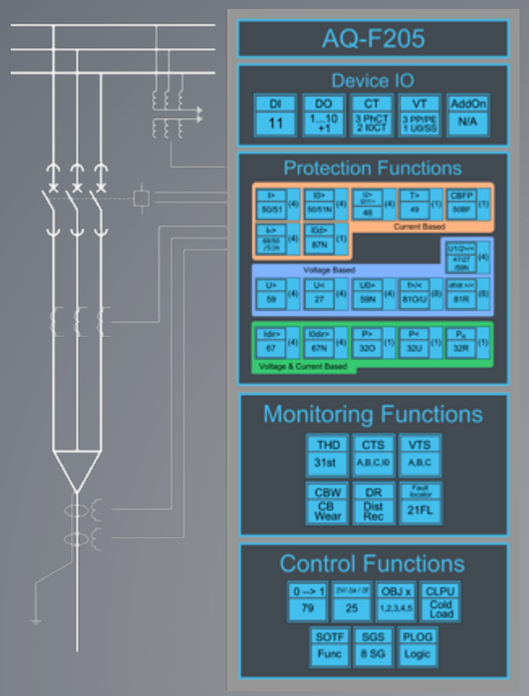
COMMUNICATION PROTOCOLS STANDARD

- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-F205 Feeder protection relay

The AQ-F205 is suitable for any application requiring directional overcurrent and earth-fault protection along with voltage and frequency protections. The AQ-F205 comes with complimentary measurement, monitoring, control and communication features. Its standard configuration of 11 digital inputs and 10 relay outputs along with large programmable HMI allows for variety of adaptations.





- **Integrated protection, control and measurement**
- **Price performance ratio**

PROTECTION FUNCTIONS

- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Directional overcurrent, 4 stages INST, DT or IDMT (67)
- Directional earth-fault, 4 stages INST, DT or IDMT (67N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 4 stages INST, DT or IDMT (46/46R/46L)
- High/low impedance restricted earth fault / cable end differential (87N)
- Cable thermal protection (49L)
- Overvoltage, 4 stages INST, DT or IDMT (59)
- Undervoltage, 4 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative/positive sequence over voltage, 4 stages INST, DT or IDMT (47)
- Over/under frequency, 8 stages INST or DT (81O/81U)
- Rate of change of frequency, 8 stages INST or DT or IDMT (81R)
- Over/Under/Reverse power (32/37/32R)
- Breaker failure protection (50BF/52BF)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Fault locator (21FL)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 5
- Synchro-check (25)
- Autorecloser (79)
- Cold-load pick-up block
- Switch onto fault logic
- 8 setting groups

HARDWARE

- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 11 (fixed)
- Output relays: 10+1 (fixed)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

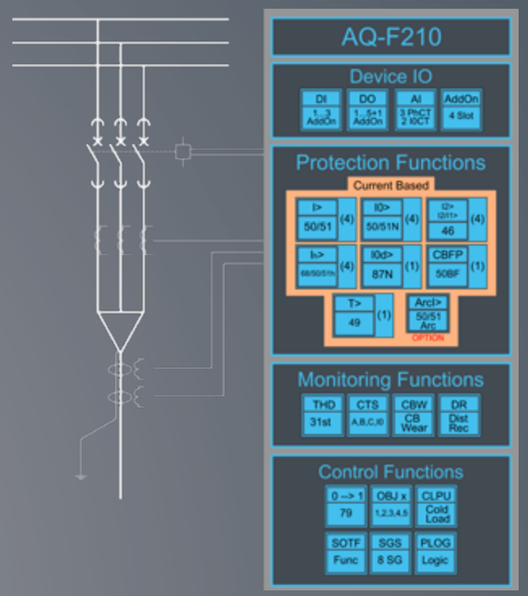
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)

COMMUNICATION PROTOCOLS STANDARD

- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-F210 Feeder protection IED

The AQ-F210 offers a modular feeder protection and control solution for non-directional overcurrent and earth-fault protection with automatic reclosing. Up to four optional I/O or communication cards are available for more comprehensive monitoring and control applications. The AQ-F210 communicates using various protocols including IEC 61850 substation communication standard.



- **Cable end differential protection**
- **Low-impedance REF protection**
- **Harmonics protection and control**
- **5-shot scheme controlled autorecloser**

PROTECTION FUNCTIONS

- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 4 stages INST, DT or IDMT (46/46R/46L)
- High/low impedance restricted earth fault / cable end differential (87N)
- Breaker failure protection (50BF/52BF)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Current THD and harmonics (up to 31st)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 5
- Autorecloser (79)
- Cold-load pick-up block
- Switch onto fault logic
- 8 setting groups

HARDWARE

- Current inputs: 5
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS

- Digital inputs optional: +8/16/24/32
- Digital outputs optional: +5/10/15
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

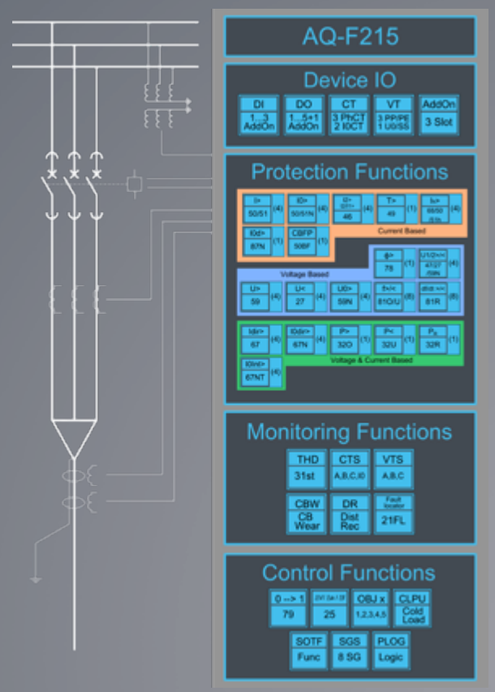
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-F215 Feeder protection IED

The AQ-F215 offers a modular feeder protection and control solution for applications requiring both current and voltage based protections along with complete measurements. Up to three optional I/O or communication cards are available for more comprehensive monitoring and control applications. The AQ-F215 communicates using various protocols including IEC 61850 substation communication standard.



- **Double busbar control**
- **Directional and voltage protection**
- **Cable end differential protection**
- **Low-impedance REF protection**
- **Harmonics protection and control**
- **5-shot scheme controlled autorecloser**
- **Up to class 0.2S power and energy measurement**

PROTECTION FUNCTIONS

- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Directional overcurrent, 4 stages INST, DT or IDMT (67)
- Directional earth-fault, 4 stages INST, DT or IDMT (67N)
- Transient earth-fault (67NT)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 4 stages INST, DT or IDMT 46/46R/46L
- High/low impedance restricted earth fault / cable end differential * (87N)
- Cable thermal protection (49L)
- Overvoltage, 4 stages INST, DT or IDMT (59)
- Undervoltage, 4 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative/positive sequence over voltage, 4 stages INST, DT or IDMT (47)
- Vector jump, 1 stage (78) Over/ under frequency, 8 stages INST or DT (81O/81U)
- Rate of change of frequency, 8 stages INST or DT or IDMT (81R)
- Over/Under/Reverse power (32/37/32R)
- Breaker failure protection (50BF/52BF)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 5
- Synchro-check (25)
- Autorecloser (79)
- Cold-load pick-up block
- Switch onto fault logic
- 8 setting groups

HARDWARE

- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (3 SLOTS)

- Digital inputs optional: +8/16/24
- Digital outputs optional: +5/10/15
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

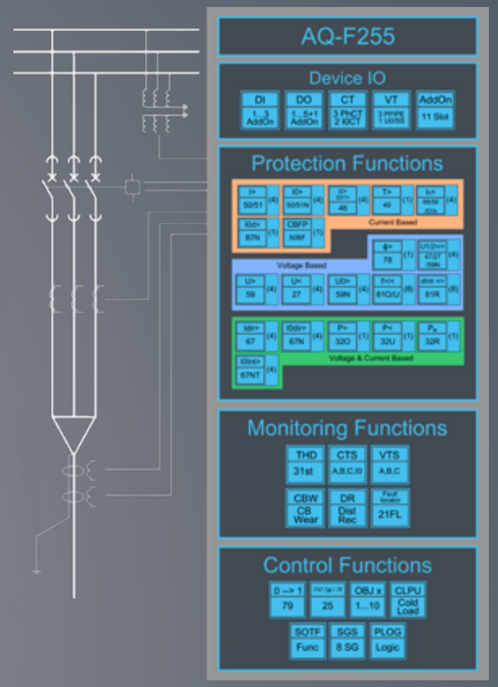
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-F255 Feeder protection IED

The AQ-F255 offers a modular feeder protection and control solution for applications requiring large I/O capacity. Up to 11 optional I/O or communication cards are available for extensive monitoring and control applications. The AQ-F255 communicates using various protocols including IEC 61850 substation communication standard.



- **Large I/O capability**
- **Directional and voltage protection**
- **Cable end differential protection**
- **Low-impedance REF protection**
- **Harmonics protection and control**
- **5-shot scheme controlled autorecloser**
- **Up to class 0.2S power and energy measurement**

PROTECTION FUNCTIONS

- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Directional overcurrent, 4 stages INST, DT or IDMT (67)
- Directional earth-fault, 4 stages INST, DT or IDMT (67N)
- Transient earth-fault (67NT)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT
- (50/51H, 68)
- Current unbalance / broken conductor, 4 stages INST, DT or IDMT
- 46/46R/46L
- High/low impedance restricted earth fault / cable end differential * (87N)
- Cable thermal protection (49L)
- Overvoltage, 4 stages INST, DT or IDMT (59)
- Undervoltage, 4 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative/positive sequence overvoltage, 4 stages INST, DT or IDMT (47)
- Vector jump, 1 stage (78) Over/ under frequency, 8 stages INST or DT (81O/81U)
- Rate of change of frequency, 8 stages INST or DT or IDMT (81R)
- Over/Under/Reverse power (32/37/32R)
- Breaker failure protection (50BF/52BF)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Energy (E+, E-, Eq+, Eq-)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 10
- Synchro-check (25)
- Autorecloser (79)
- Cold-load pick-up block
- Switch onto fault logic
- 8 setting groups

HARDWARE

- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (11 SLOTS)

- Digital inputs optional: +8/16/24/32/4 0/48/56/64/72/80/88
- Digital outputs optional: +5/10/15/20/25
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified
- below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

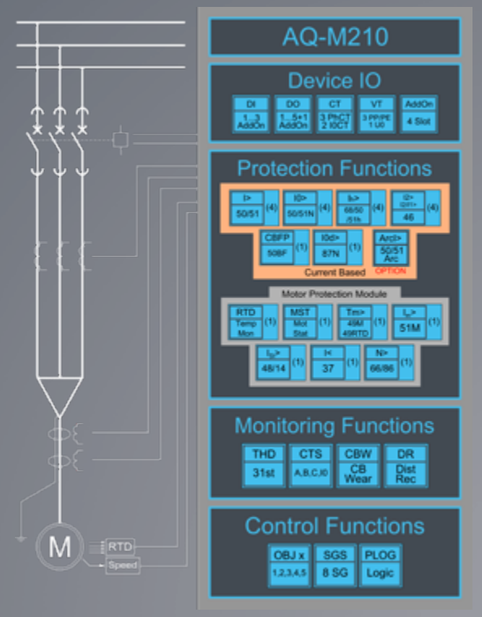
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, editions 1 & 2
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-M210 Motor protection IED

The AQ-M210 offers a modular motor protection and control solution for small and medium size motors. Up to four optional I/O or communication cards are available for more comprehensive monitoring and control applications. Up to 12 RTD signals can be connected for thermal alarming and tripping. The AQ-M210 communicates using various protocols including IEC 61850 substation communication standard.



- **5 time constant accurate thermal model**
- **Soft-start protection starting from 6Hz**
- **Star-delta started motor supervision**
- **2-speed motor protection**

PROTECTION FUNCTIONS

- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 4 stages INST, DT or IDMT (46/46R/46L)
- Cable end differential (87N)
- Motor thermal overload (49M)
- Motor start-up / locked rotor super vision with speed switch (48, 14)
- Restart inhibit / frequent starts (66/86)
- Undercurrent/loss of load (37)
- Mechanical jam (51M)
- Breaker failure protection (50BF/52BF)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Current THD and harmonics (up to 31st)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 5
- 8 setting groups

HARDWARE

- Current inputs: 5
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (4 SLOTS)

- Digital inputs optional: +8/16/24/32
- Digital outputs optional: +5/10/15
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

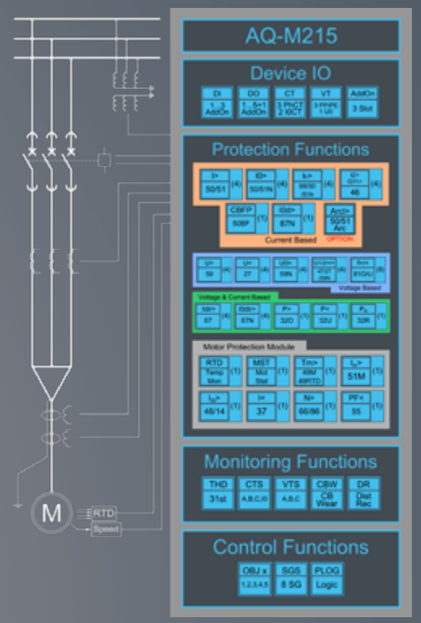
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-M215 Motor protection IED

The AQ-M215 offers a modular motor protection and control solution for larger and more important motors requiring both current and voltage based protection functions along with complete measurements. Up to three optional I/O or communication cards are available for more comprehensive monitoring and control applications. Up to 16 RTD signals can be connected for thermal alarming and tripping. The AQ-M215 communicates using various protocols including IEC 61850 substation communication standard.



- **Powerful motor management**
- **5 time constant accurate thermal model**
- **Soft-start protection starting from 6Hz**
- **Star-delta started motor supervision**
- **2-speed motor protection**
- **Up to class 0.2S power and energy measurement**

PROTECTION FUNCTIONS

- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Directional overcurrent, 4 stages INST, DT or IDMT (67)
- Directional (sensitive) earth-fault, 4 stages INST, DT or IDMT (67N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 4 stages INST, DT or IDMT (46/46R/46L)
- Cable end differential (87N)
- Motor thermal overload (49M)
- Motor start-up / locked rotor super vision with speed switch (48, 14)
- Restart inhibit / frequent starts (66/86)
- Undercurrent/loss of load (37)
- Power factor protection (55)
- Mechanical jam (51M)
- Overvoltage, 4 stages INST, DT or IDMT (59)
- Undervoltage, 4 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative/positive sequence over voltage, 4 stages INST, DT or IDMT (47)
- Over/under frequency, 8 stages INST or DT (81O/81U)
- Over/Under/Reverse power (32/37/32R)
- Breaker failure protection (50BF/52BF)
- Arc protection (optional) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 5
- 8 setting groups

HARDWARE

- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (3 SLOTS)

- Digital inputs optional: +8/16/24
- Digital outputs optional: +5/10/15
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

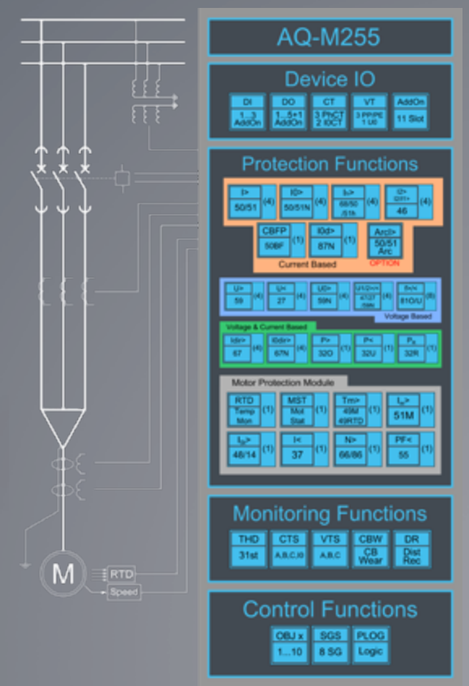
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-M255 Motor protection IED

The AQ-M255 offers a modular motor protection and control solution for larger and more important motors with large I/O capacity. Up to 11 optional I/O or communication cards are available for extensive monitoring and control applications. Up to 16 RTD signals can be connected for thermal alarming and tripping. The AQ-M255 communicates using various protocols including IEC 61850 substation communication standard.



- **Powerful motor management with large I/O capability**
- **5 time constant accurate thermal model**
- **Soft-start protection starting from 6Hz**
- **Star-delta started motor supervision**
- **2-speed motor protection**
- **Up to class 0.2S power and energy**
- **measurement**
- **Asynchronous or synchronous motors**

PROTECTION FUNCTIONS

- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Directional overcurrent, 4 stages INST, DT or IDMT (67)
- Directional (sensitive) earth-fault, 4 stages INST, DT or IDMT (67N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 4 stages INST, DT or IDMT (46/46R/46L)
- Cable end differential (87N)
- Motor thermal overload (49M)
- Motor start-up / locked rotor super vision with speed switch (48, 14)
- Restart inhibit / frequent starts (66/86)
- Undercurrent/loss of load (37)
- Power factor protection (55)
- Mechanical jam (51M)
- Loss of field (40)
- Impedance and reactance protection (21Z / 21X)
- Overvoltage, 4 stages INST, DT or IDMT (59)
- Undervoltage, 4 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative/positive sequence over voltage, 4 stages INST, DT or IDMT (47)
- Over/under frequency, 8 stages INST or DT(81O/81U)
- Over/Under/Reverse power (32/37/32R)
- Breaker failure protection (50BF/52BF)
- Arc protection (optional) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 10
- 8 setting groups

HARDWARE

- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (11 SLOTS)

- Digital inputs optional: +8/16/24/32/40/48/56/64 /72/80/88
- Digital outputs optional: +5/10/15/20/25
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

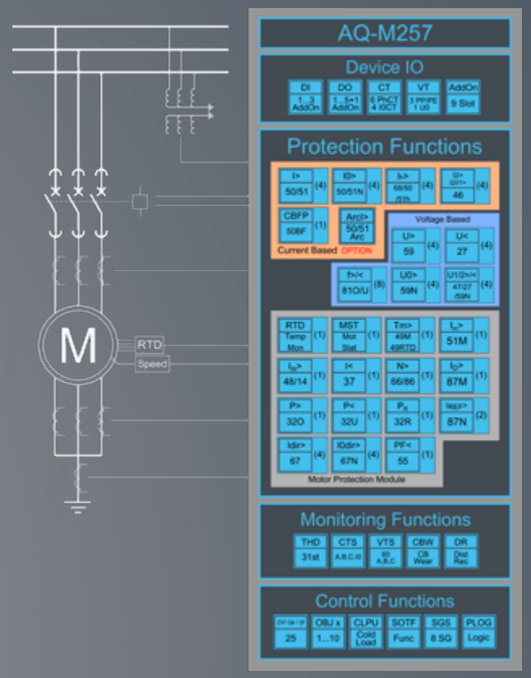
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, editions 1 & 2
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-M257 Motor protection IED

The AQ-M257 offers a modular motor protection and control solution for large and important asynchronous or synchronous motors requiring differential protection. Up to 9 optional I/O or communication cards are available for extensive monitoring and control applications. Up to 16 RTD signals can be connected for thermal alarming and tripping. The AQ-M257 communicates using various protocols including IEC 61850 substation communication standard.



- **Differential protection**
- **Large I/O capability**
- **5 time constant accurate thermal model**
- **Soft-start protection starting from 6Hz**
- **Star-delta started motor supervision**
- **2-speed motor protection**
- **Up to class 0.2S power and energy measurement**
- **Asynchronous or synchronous motors**

PROTECTION FUNCTIONS

- Motor differential (87M)
- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Directional overcurrent, 4 stages INST, DT or IDMT (67)
- Directional (sensitive) earth-fault, 4 stages INST, DT or IDMT (67N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 4 stages INST, DT or IDMT (46/46R/46L)
- Cable end differential (87N)
- Motor thermal overload (49M)
- Motor start-up / locked rotor super vision with speed switch (48, 14)
- Restart inhibit / frequent starts (66/86)
- Undercurrent/loss of load (37)
- Power factor protection (55)
- Mechanical jam (51M)
- Loss of field (40)
- Impedance and reactance protection (21Z / 21X)
- Overvoltage, 4 stages INST, DT or IDMT (59)
- Undervoltage, 4 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative/positive sequence over voltage, 4 stages INST, DT or IDMT (47)
- Over/under frequency, 8 stages INST or DT (81O/81U)
- Over/Under/Reverse power (32/37/32R)
- Breaker failure protection (50BF/52BF)
- Arc protection (optional) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 10
- 8 setting groups

HARDWARE

- Current inputs: 10
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (9 SLOTS)

- Digital inputs optional: +8/16/24/32/40/48/56/64/72
- Digital outputs optional: +5/10/15/20/25
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

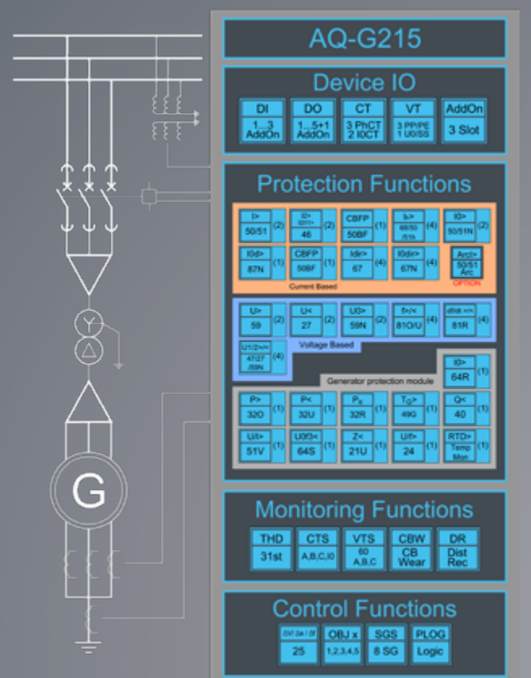
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double RJ 45 or LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, editions 1 & 2
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-G215 Generator protection IED

The AQ-G215 generator protection IED is well suited for machines requiring complete generator protections. It can be combined with AQ-T216 to protect larger machines requiring differential protection and greater protection redundancy. The AQ-G215 communicates using various protocols including IEC 61850 substation communication standard.



- **Cost efficient generator protection**

PROTECTION FUNCTIONS

- Three-phase overcurrent, 2 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 2 stages INST, DT or IDMT (50/51N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 2 stages INST, DT or IDMT (46/46R/46L)
- High/low impedance restricted earth fault / cable end differential * (87N)
- Directional overcurrent, 4 stages INST, DT or IDMT (67)
- Directional (sensitive) earth-fault, 4 stages INST, DT or IDMT (67N)
- Overvoltage, 2 stages INST, DT or IDMT (59)
- Undervoltage, 2 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 2 stages INST, DT or IDMT (59N)
- Negative sequence overvoltage, 2 stages INST, DT or IDMT (59N/47)
- Over/under frequency, 4 stages INST or DT (81O/81U)
- Rate of change of frequency, 4 stages INST or DT or IDMT (81R)
- Loss of field (40)
- Voltage restrained overcurrent (51V)
- Field ground / 100% stator earth-fault (64S)
- Over/Under/Reverse power (32/37/32R)
- Generator thermal overload (49G/49RTD)
- Under impedance (21U)
- Volts per hertz (24)
- Power factor protection (55)
- Breaker failure protection (50BF/52BF)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 5
- Synchro-check (25)
- 8 setting groups

HARDWARE

- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (3 SLOTS)

- Digital inputs optional: +8/16/24
- Digital outputs optional: +5/10/15
- Arc protection (12 sensors +2xHSO+BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15 000

COMMUNICATION MEDIA

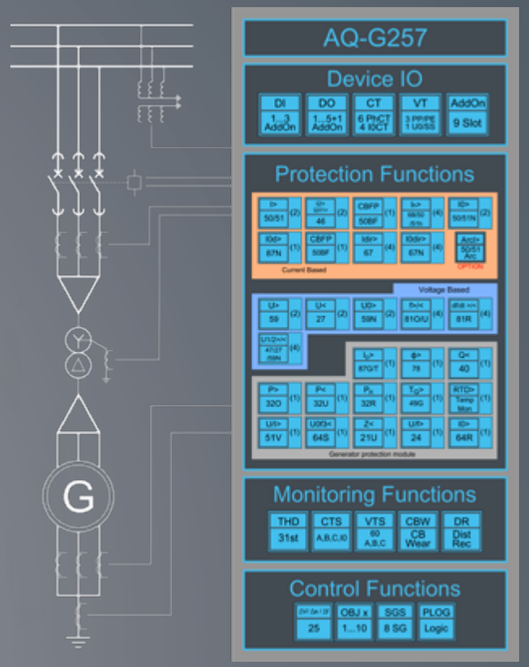
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double RJ 45 or LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-G257 Generator protection IED

The AQ-G257 generator protection IED is well suited for large machines requiring complete generator protection and differential protection. Up to 9 optional I/O or communication cards are available for extensive monitoring and control applications. Up to 16 RTD signals can be connected for thermal alarming and tripping. The AQ-G257 communicates using various protocols including IEC 61850 substation communication standard.



- **Complete synchronous machine protection**
- **Power measurements up to class 0.2S**
- **Synchronizer and synchro-check for safe power grid connection**

PROTECTION FUNCTIONS

- Generator/transformer differential (87G/T)
- Three-phase overcurrent, 2 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 2 stages INST, DT or IDMT (50/51N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken conductor, 2 stages INST, DT or IDMT (46/46R/46L)
- High/low impedance restricted earth fault / cable end differential * (87N)
- Directional overcurrent, 4 stages INST, DT or IDMT (67)
- Directional (sensitive) earth-fault, 4 stages INST, DT or IDMT (67N)
- Overvoltage, 2 stages INST, DT or IDMT (59)
- Undervoltage, 2 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 2 stages INST, DT or IDMT (59N)
- Positive/Negative sequence over voltage, 2 stages INST, DT or IDMT (59N/47)
- Over/under frequency, 4 stages INST or DT (81O/81U)
- Rate of change of frequency, 4 stages INST or DT or IDMT (81R)
- Loss of field (40)
- Voltage restrained overcurrent (51V)
- Field ground / 100% stator earth-fault (64S)
- Rotor earth-fault protection (64R)
- Over/Under/Reverse power (32/37/32R)
- Generator thermal overload (49G/49RTD)
- Under impedance (21U)
- Volts per hertz (24)
- Power factor protection (55)
- Out of step / pole slip (78)
- Breaker failure protection (50BF/52BF)
- Inadvertant energizing (50/27)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL

- Controllable objects: 10
- Synchro-check (25)
- 8 setting groups
- Synchronizer (option)

HARDWARE

- Current inputs: 10
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (9 SLOTS)

- Digital inputs optional: +8/16/24/32/40/48/56/64/72
- Digital outputs optional: +5/10/15/20/25
- Arc protection (12 sensors+2xHSO+BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, editions 1 & 2
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

THE GENERATOR AND MOTOR COMMANDER

SYNCHRONOUS MACHINE PROTECTION & CONTROL IN ONE PACKAGE

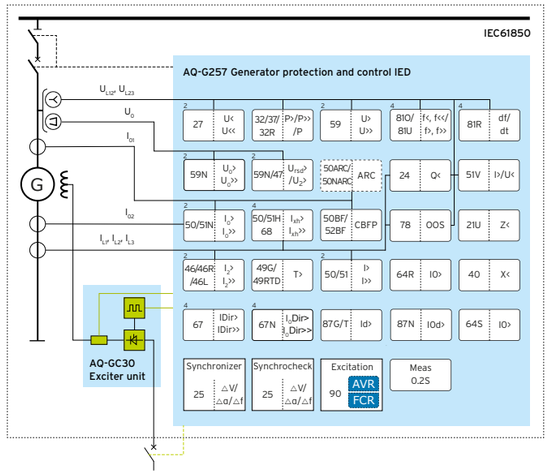
The Generator and Motor Commander combines protection and control of synchronous machines into one unit. Compared to traditional systems with several separate units and software, the Generator Commander takes less space and saves considerable hours of engineering time. Operation is smooth as there is only one interface to the system.

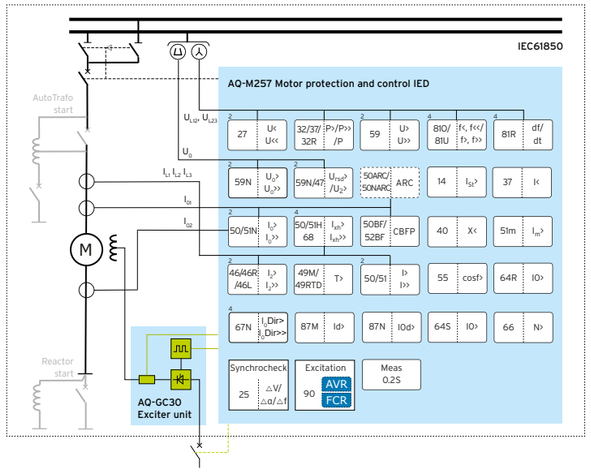
INCLUDED IN THE COMMANDER:

- Generator or Motor Protection
- Differential Protection
- Synchronizer with synchro check
- Power system stabilizer (PSS)
- Excitation control with external IGBT bridge
- Diode monitoring
- Power and Energy measurement (0.2S)
- IEC 61850, IEC 103/101/104, Modbus, DNP 3.0 and SPA protocols

BENEFITS OF THE GENERATOR COMMANDER:

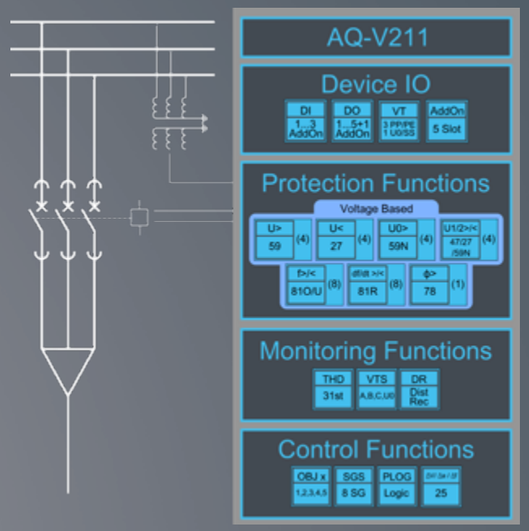
- Over 86% space savings compared to traditional solution.
- Less spare parts needed.
- One, easy to use, software saves engineering time.
- The included software wizard adapts the data from the generator specifications and calculates the majority of the parameters directly.





AQ-V211 Voltage protection IED

The AQ-V211 offers a modular voltage protection solution for substations. Voltage and frequency protection, synchro-check and synchronizer with up to five optional I/O or communication cards and powerful logic programming possibility make AQ-V211 optimal for demanding load shedding or automatic transfer applications. The AQ-V211 communicates using various protocols including IEC 61850 substation communication standard.



- **8 frequency stages and 8 setting groups for load shedding**
- **Synchrocheck for up to three circuit breakers**
- **Synchronizer for machine frequency and voltage control**

PROTECTION FUNCTIONS
- Overvoltage, 4 stages INST, DT or IDMT (59)
- Undervoltage, 4 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative/positive sequence over voltage, 4 stages INST, DT or IDMT (47)
- Vector jump, 1 stage (78)
- Over/under frequency, 8 stages INST or DT (81O/81U
- Rate of change of frequency, 8 stages INST or DT or IDMT (81R)

MEASURING AND MONITORING
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Voltage THD and harmonics (up to 31st)
- Disturbance recorder (3.2 kHz)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL
- Controllable objects: 5
- Synchro-check (25)
- 8 setting groups
- Synchronizer (option)

HARDWARE
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (5 SLOTS)
- Digital inputs optional: +8/16/24/32/40
- Digital outputs optional: +5/10/15
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

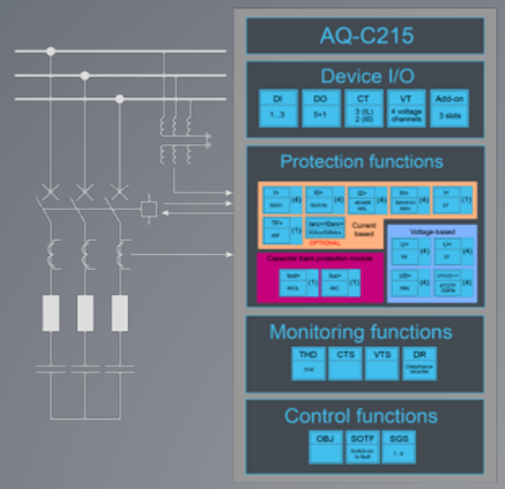
EVENT RECORDING
- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD
- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-C215 Capacitor bank protection IED

The AQ-C215 capacitor bank protection IED has been specifically designed for the protection of capacitor banks. It includes capacitor bank current unbalance and overload protections in addition to standard overcurrent, earth fault, and voltage protections. AQ-C215 has an I/O capacity of up to three (3) optional I/O or communication card slots which allow for more comprehensive monitoring and control applications. AQ-C215 communicates using various protocols, including the IEC 61850 substation communication standard.



- **Overcurrent, earth fault, and voltage protections**
- **Capacitor bank unbalance protection with natural unbalance compensation**
- **Capacitor bank overload protection**
- **Harmonic overcurrent protection**
- **Current, voltage, energy, and power measurements**
- **Up to 100 disturbance records**

PROTECTION FUNCTIONS
- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Current unbalance / broken conductor, 4 stages INST, DT or IDMT (46/46R/46L)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Capacitor bank overload, 2 stages (49OL)
- Capacitor bank current unbalance (46C)
- Undercurrent / loss of load (37)
- Overvoltage, 4 stages INST, DT or IDMT (59)
- Undervoltage, 4 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative/positive sequence over voltage, 4 stages INST, DT or IDMT (47)
- Line thermal overload (49F)
- Arc protection (optional) (50ARC/50NARC)

MEASURING AND MONITORING
- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL
- Controllable objects: 10
- 8 setting groups
- Switch-on-to-fault (SOTF)

HARDWARE
- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (3 SLOTS)
- Digital inputs optional: +8/16/24
- Digital outputs optional: +5/10
- Arc protection (12 sensors +2xHSO + BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out + 1xmA in
- Communication media (specified below)

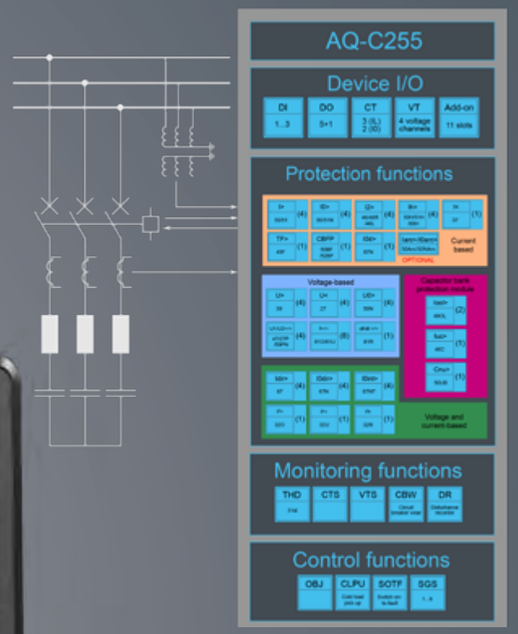
EVENT RECORDING
- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD
- IEC 61850
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-C255 Capacitor bank protection IED

AQ-C255 has been specifically designed for the protection of capacitor banks. It includes three capacitor bank specific protection functions: the capacitor bank module consists of protections for capacitor overload, capacitor neutral unbalance, and capacitor bank current unbalance. These are accompanied by the standard overcurrent, earth fault and voltage protections. AQ-C255 has a large I/O capacity of up to eleven (11) optional I/O or communication card slots which allow for more comprehensive monitoring and control applications. AQ-C255 communicates using various protocols including IEC 61850 substation communication standard.



- **Large I/O capability**
- **A capacitor bank module that includes three functions specific to capacitor bank protection**
- **Power factor controller**
- **Power and energy measurement up to Class 0.2S**

PROTECTION FUNCTIONS
- Three-phase overcurrent, 4 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 4 stages INST, DT or IDMT (50/51N)
- Directional overcurrent, 4 stages (67)
- Directional (sensitive) earth-fault, 4 stages INST, DT or IDMT (67N)
- Transient earth-fault (67NT)
- Current unbalance / broken conductor, 4 stages (46/46R/46L)
- Harmonic overcurrent / inrush blocking, 4 stages (50/51H, 68)
- High/low impedance restricted earth fault / cable end differential (87N)
- Capacitor bank overload, 2 stages (49OL)
- Capacitor bank neutral unbalance (50UB)
- Capacitor bank current unbalance (46C)
- Undercurrent / loss of load (37)
- Overvoltage, 4 stages (59)
- Undervoltage, 4 stages (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative / positive sequence overvoltage, 4 stages (47)
- Breaker failure protection (50BF/52BF)
- Over / Under / Reverse power (32/37/32R)
- Over / under frequency, 8 stages INST or DT (81O/81U)
- Rate of change of frequency, 4 stages INST, DT or IDMT (81R)
- Line thermal overload (49F)
- Arc protection (optional), (50ARC/50NARC)

MEASURING AND MONITORING
- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL
- Controllable objects: 10
- 8 setting groups

HARDWARE
- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (11 SLOTS)
- Digital inputs optional: +8/16
- Digital inputs optional: +8/16/24/ /32/40/48/56/64/72/80/88
- Digital outputs optional: +5/10/15/20/25
- Arc protection (12 sensors +2xHSO+BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

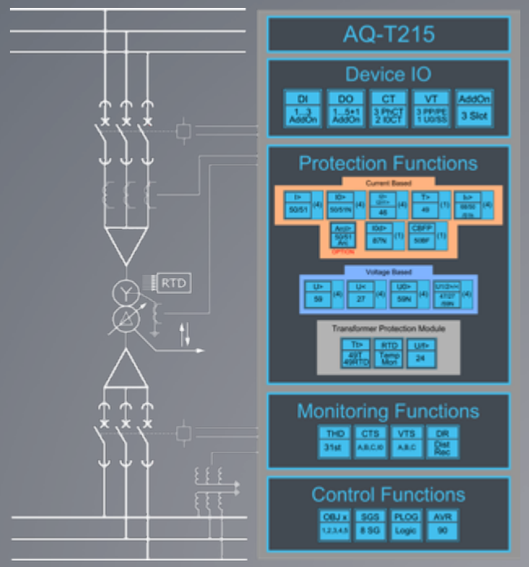
EVENT RECORDING
- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD
- IEC 61850, editions 1 & 2
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-T215 Voltage regulating IED

AQ-T215 is a voltage regulating IED. It comes with current and voltage based protection functions as well making it suitable for combined transformer voltage regulation and back-up protection. Transformer monitoring module included as a standard feature provides for statistical information for preventive maintenance purposes. The AQ-T215 communicates using various protocols including IEC 61850 substation communication standard.



- **Automatic / manual voltage regulating (AVR)**
- **Transformer back-up protection**
- **Through fault and overloading statistics for preventive maintenance**

PROTECTION FUNCTIONS
- High/low impedance restricted earth fault / cable end differential * (87N1, 87N2)
- Transformer thermal overload (49T/49RTD)
- Three-phase overcurrent, 2+2 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 3 stages INST, DT or IDMT (50/51N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken con ductor, 2+2 stages INST, DT or IDMT (46/46R/46L)
- Overvoltage, 4 stages INST, DT or IDMT (59)
- Undervoltage, 4 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 4 stages INST, DT or IDMT (59N)
- Negative/positive sequence overvoltage, 4 stages INST, DT or IDMT (47)
- Volts per hertz (24)
- Breaker failure protection (50BF/52BF)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING
- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and har monics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL
- Automatic voltage regulator (90)
- Controllable objects: 5
- 8 setting groups

HARDWARE
- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (3 SLOTS)
- Digital inputs optional: +8/16/24
- Digital outputs optional: +5/10/15
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

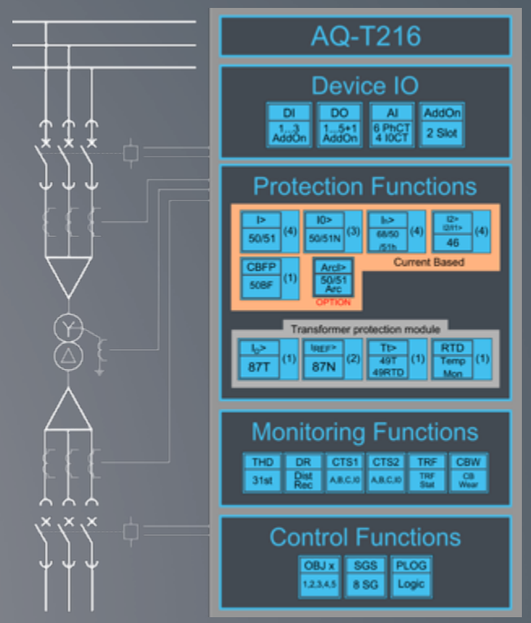
EVENT RECORDING
- Non-volatile disturbance records:100
- Non-volatile event records: 15000

COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD
- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-T216 Transformer protection IED

AQ-T216 is a transformer protection IED with sophisticated and easy to use differential protection function. The AQ-T216 transformer protection IED provides for both low and high side overcurrent, earth-fault, negative sequence and two independent restricted earth-fault instances. The AQ-T216 can be applied for generator and motor differential protection as well. The AQ-T216 communicates using various protocols including IEC 61850 substation communication standard.



- **Predifined or custom connection group selection**
- **2nd and 5th harmonic blocking**
- **Automatic verification of connection group and nominal value settings**
- **Through fault and overloading statistics for preventive maintenance**

PROTECTION FUNCTIONS
- 2 winding transformer differential (87T)
- High/low impedance restricted earth fault / cable end differential * (87N1, 87N2)
- Transformer thermal overload (49T/49RTD)
- Three-phase overcurrent, 2+2 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 3 stages INST, DT or IDMT (50/51N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken con ductor, 2+2 stages INST, DT or IDMT (46/46R/46L)
- Breaker failure protection (50BF/52BF)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING
- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Current THD and harmonics (up to 31st)
- Frequency (f)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS), 2 instances
- Trip circuit supervision (TCS)

CONTROL
- Controllable objects: 5
- 8 setting groups

HARDWARE
- Current inputs: 10
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (2 SLOTS)
- Digital inputs optional: +8/16
- Digital outputs optional: +5/10
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

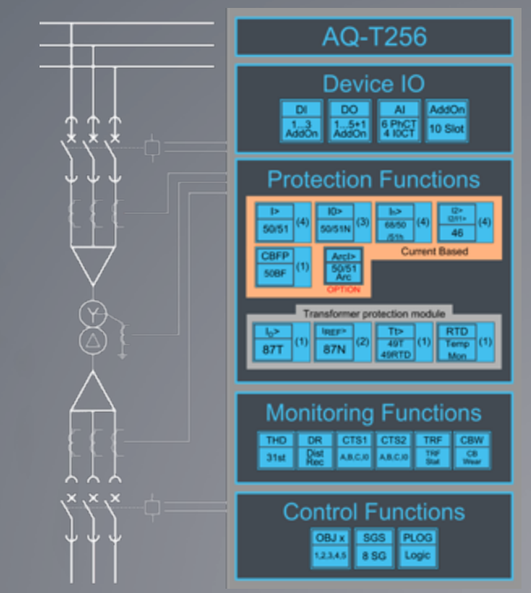
EVENT RECORDING
- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD
- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-T256 Transformer protection IED

AQ-T256 is a transformer protection IED with sophisticated and easy to use differential protection function. The AQ-T256 transformer protection IED provides for both low and high side overcurrent, earth-fault, negative sequence and two independent restricted earth-fault instances. Up to 10 optional I/O or communication cards are available for extensive monitoring and control applications. The AQ-T256 communicates using various protocols including IEC 61850 substation communication standard.



- **Large I/O capability**
- **Predifined or custom connection group selection**
- **2nd and 5th harmonic blocking**
- **Automatic verification of connection group and nominal value settings**
- **Through fault and overloading statistics for preventive maintenance**

PROTECTION FUNCTIONS
- 2 winding transformer differential (87T)
- High/low impedance restricted earth fault/cable end differential * (87N1, 87N2)
- Transformer thermal overload (49T/49RTD)
- Three-phase overcurrent, 2+2 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 3 stages INST, DT or IDMT (50/51N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken con ductor, 2+2 stages INST, DT or IDMT (46/46R/46L)
- Breaker failure protection (50BF/52BF)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING
- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Current THD and harmonics (up to 31st)
- Frequency (f)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS), 2 instances
- Trip circuit supervision (TCS)

CONTROL
- Controllable objects: 10
- 8 setting groups

HARDWARE
- Current inputs: 10
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (10 SLOTS)
- Digital inputs optional: +8/16/24/32/40/48/56/64/72/80
- Digital outputs optional: +5/10/15/20/25
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING
- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

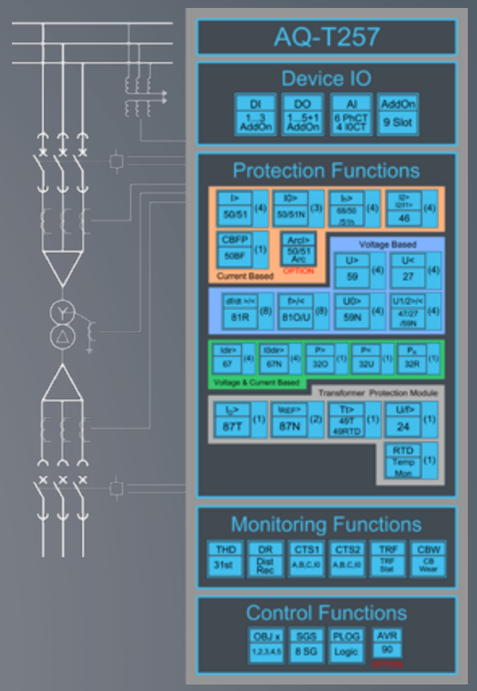
COMMUNICATION PROTOCOLS STANDARD
- IEC 61850, editions 1 & 2
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

SELECTION TABLE

			Feeder protection					Machine protection						Transformer protection				Busbar protection	Control, monitoring and measuring						Capacitor bank protection	
Protection functions	**IEC**	**ANSI**	**AQ-F201**	**AQ-F205**	**AQ-F210**	**AQ-F215**	**AQ-F255**	**AQ-M210**	**AQ-M215**	**AQ-M255**	**AQ-M257**	**AQ-G215**	**AQ-G257**	**AQ-T215**	**AQ-T216**	**AQ-T256**	**AQ-T257**	**AQ-V211**	**AQ-S214**	**AQ-S215**	**AQ-S254**	**AQ-S255**	**AQ-P215**	**AQ-E215**	**AQ-C215**	**AQ-C255**
Non-directional overcurrent protection	I>	50/51	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								✓	✓
Non-directional earth fault protection	I0>	50N/51N	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								✓	✓
Directional overcurrent protection	Idir>	67		✓		✓	✓		✓	✓	✓	✓	✓	✓			✓									✓
Directional earth fault protection	I0dir>	67N		✓		✓	✓		✓	✓	✓	✓	✓	✓			✓									✓
Intermittent earth fault protection	I0int>	67NT				✓	✓		✓																	✓
Negative sequence overcurrent/ phase current reversal/ current unbalance pr.	I2>	46/46R/46L	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								✓	✓
Harmonic overcurrent protection	Ih>	50H/51H/68H	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓								✓	✓
Low-impedance or high-impedance restricted earth fault/ cable end differential pr.	I0d>	87N		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓											✓
Capacitor bank overload protection	Icol>	49OL																							✓	✓
Capacitor bank neutral unbalance protection	Cnu>	50UB																								✓
Capacitor bank current unbalance protection	Iuc>	46C																							✓	✓
Non-directional undercurrent protection	I<	37						✓	✓	✓	✓														✓	✓
Voltage-restrained overcurrent protection	Iv>	51V				✓	✓					✓	✓													
Overvoltage protection	U>	59		✓		✓	✓		✓	✓	✓	✓	✓	✓			✓	✓							✓	✓
Undervoltage protection	U<	27		✓		✓	✓		✓	✓	✓	✓	✓	✓			✓	✓							✓	✓
Neutral overvoltage protection	U0>	59N		✓		✓	✓		✓	✓	✓	✓	✓	✓			✓	✓							✓	✓
Sequence voltage protection	U1/U2>/<	47/27P/59PN		✓		✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓							✓	✓
Fault indicating functions (energy monitoring functions)																								✓		
Circuit breaker failure protection	CBFP	50BF/52BF	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓				✓
Overpower protection	P>	32O		✓		✓	✓							✓												✓
Underpower protection	P<	32U		✓		✓	✓							✓												✓
Reverse power protection	Pr	32R		✓		✓	✓							✓												✓
Power protection	P, Q, S>/<	32								✓	✓	✓	✓				✓									✓
Overfrequency and underfrequency protection	f>/<	81O/81U		✓		✓	✓		✓	✓	✓	✓	✓	✓			✓	✓								✓
Rate-of-change of frequency protection	df/dt>/<	81R		✓		✓	✓		✓	✓		✓	✓	✓												✓
Volts-per-hertz overexcitation protection	V/Hz>	24										✓	✓	✓		✓	✓									
Power factor protection	PF<	55							✓		✓	✓	✓													
Underexcitation protection	Q<	40										✓	✓													
Underimpedance protection	Z<	21U										✓	✓	✓												
Inadvertent energizing protection	I>U<I.A.E.	50/27											✓													
Resistance temperature detectors								✓	✓		✓		✓	✓	✓	✓	✓		✓		✓		✓			✓
Line thermal overload protection	TF>	49F	✓	✓	✓	✓	✓																		✓	✓
Motor status monitoring								✓	✓	✓	✓															
Machine/transformer differential protection	Idx>	87T/87M/87G											✓		✓	✓	✓									
Motor start/ locked rotor monitoring	Ist>	48/14						✓	✓	✓	✓															
Machine thermal overload protection	TM>	49M						✓	✓	✓	✓	✓	✓													
Mechanical jam protection	Im>	51M						✓	✓	✓	✓															
100 % stator earth fault protection	U03rd>	64S										✓	✓													
Frequent start protection	N>	66						✓	✓	✓	✓															
Transformer status monitoring														✓	✓	✓	✓									
Transformer thermal overload protection	TT>	49T												✓	✓	✓	✓									
Programmable stage	PGx>/<	99			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓		✓	✓
Arc fault protection	Iarc>/I0Arc>	50Arc/50NArc						optional	optional	optional	optional	optional	optional	optional	optional	optional	optional								optional	optional
Control																										
Objects to control and monitor			1	5	5	5	10	5	5	10	10	5	10	5	5	10	10	5	10	10	10	10		10	5	10
Alarms																			64		128					
Automatic voltage regulator														✓			✓									
Cold load pick-up			✓	✓	✓	✓	✓							✓	✓											✓
Switch-on-to-fault	SOTF		✓	✓	✓	✓	✓									✓	✓	✓							✓	✓
Vector jump	Δ□	78					✓					✓	✓	✓		✓	✓	✓								
Auto-recloser	0 □ 1	79		✓	✓	✓	✓													✓		✓				
Zero sequence recloser		79N				✓	✓																			
Synchrocheck	ΔV/Δa/Δf	25		✓		✓	✓					✓	✓	✓		✓	✓	✓		✓		✓				
Synchronizer	ΔV/Δa/Δf	25											optional					optional								
Measuring and monitoring																										
Phase, sequence and residual currents			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓
Phase, sequence and residual voltage				✓		✓	✓		✓	✓	✓	✓	✓	✓			✓	✓		✓		✓	✓	✓	✓	✓
Power and energy class 0.5				✓		✓	✓		✓	✓	✓	✓	✓	✓			✓			✓		✓		✓	✓	
Power and energy class 0.25						optional	optional		optional	optional	optional	optional	optional	optional			optional			optional		optional	✓	optional		
Current transformer supervision			✓	✓	✓	✓	✓	✓	✓	✓	✓(2)	✓	✓ (2)	✓	✓ (2)	✓ (2)	✓ (2)			✓		✓	✓	✓	✓	✓
Voltage transformer supervision (fuse failure)		60		✓		✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	✓	✓	✓	✓
Disturbance recorder (max. 15 000 permanent event records)			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Circuit breaker wear monitoring			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓			✓
Total harmonic distortion			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓
Fault locator		21FL		✓		✓	✓							✓		✓	✓			✓		✓	✓			
Hardware																										
Current inputs			5	5	5	5	5	5	5	5	10	5	10	5	10	10	10			5		5	5	5	5	5
Voltage inputs				4		4	4		4	4	4	4	4	4			4	x		4		4	4	4	4	4
Empty module slots					4	3	11	4	3	11	9	3	9	3	2	10	9	5	6	3	14	11	3	3	3	11
Digital inputs (standard)			3	11	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Digital outputs (standard)			5	10	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Digital inputs (optional; does NOT include the inputs in the CPU module)					8…32	8…24	8…88	8…32	8…24	8…88	8…72	8…24	8…72	8…24	8…16	8…80	8…72	8…40	8…48	8…24	8…112	8…88	8…24	8…24	8…48	8…88
Digital outputs (optional; does NOT include the outputs in the CPU module)					5…10	5…10	5…30	5…10	5…10	5…30	5…30	5…10	5…30	5…10	5…10	5…30	5…30	5…10	5…10	5…10	5…30	5…30	5…10	5…10	5…10	5…30
Communication interface																										
RJ-45 100 Mbps Ethernet (front), RJ-45 100 Mbps Ethernet and RS-485 (rear)			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2 x RJ-45 100 Mb Ethernet & IRIG-B					optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional		optional	
2 x ST 100 Mb Ethernet & IRIG-B					optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional		optional	
Double LC 100 Mbps communication module					optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional
RS 323 serial fiber (PP/PG/GP/GG)					optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional	optional		optional	
Communication protocols																										
IEC 61850 (ed. 1)					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IEC 61850 (ed. 2)							optional			optional	optional		optional			optional	optional	✓	✓		optional	optional				optional
IEC 60870-5-103/101/104, Modbus RTU and TCP/IP, DNP 3.0 and DNP 3.0 over TCP/IP, SPA			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

AQ-T257 Transformer protection IED

AQ-T257 is a transformer protection IED with differential protection function and integrated AVR function. The AQ-T257 transformer protection IED provides also for complete current and voltage based protection functions and full measurements. Up to 9 optional I/O or communication cards are avai-lable for extensive monitoring and control applications. The AQ-T257 communicates using various protocols including IEC 61850 substation communication standard.



- **Large I/O capability**
- **Automatic / manual voltage regulating (AVR)**
- **Complete transformer protection**
- **2nd and 5th harmonic blocking**
- **Automatic verification of connection group and nominal value settings**
- **Through fault and overloading statistics for preventive maintenance**
- **Up to class 0.2S power and energy measuring**

PROTECTION FUNCTIONS

- 2-winding transformer differential (87T)
- High/low impedance restricted earth fault / cable end differential * (87N1, 87N2)
- Transformer thermal overload (49T/49RTD)
- Three-phase overcurrent, 2+2 stages INST, DT or IDMT (50/51)
- Earth-fault (sensitive), 3 stages INST, DT or IDMT (50/51N)
- Harmonic overcurrent / inrush blocking, 4 stages INST, DT or IDMT (50/51H, 68)
- Current unbalance / broken con ductor, 2+2 stages INST, DT or IDMT (46/46R/46L)
- Directional overcurrent, 4 stages INST, DT or IDMT (67)
- Directional (sensitive) earth-fault, 4 stages INST, DT or IDMT (67N)
- Overvoltage, 2 stages INST, DT or IDMT (59)
- Undervoltage, 2 stages INST, DT or IDMT (27)
- Zero sequence overvoltage, 2 stages INST, DT or IDMT (59N)
- Positive/Negative sequence over voltage, 2 stages INST, DT or IDMT (59N/47)
- Over/under frequency, 4 stages INST or DT or IDMT (81R)
- Rate of change of frequency, 4 stages INST or DT or IDMT (81R)
- Volts per hertz (24)
- Breaker failure protection (50BF/52BF)
- Arc protection (option) (50ARC/50NARC)

MEASURING AND MONITORING

- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Circuit breaker wear (CBW)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL

- Automatic voltage regulator (90) (option)
- Controllable objects: 10
- Synchro-check (25)
- 8 setting groups

HARDWARE

- Current inputs: 10
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (9 SLOTS)

- Digital inputs optional: +8/16/24/32/40/48/56/64/72
- Digital outputs optional: +5/10/15/20/25
- Arc protection (12 sensors +2xHSO +BI)
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA

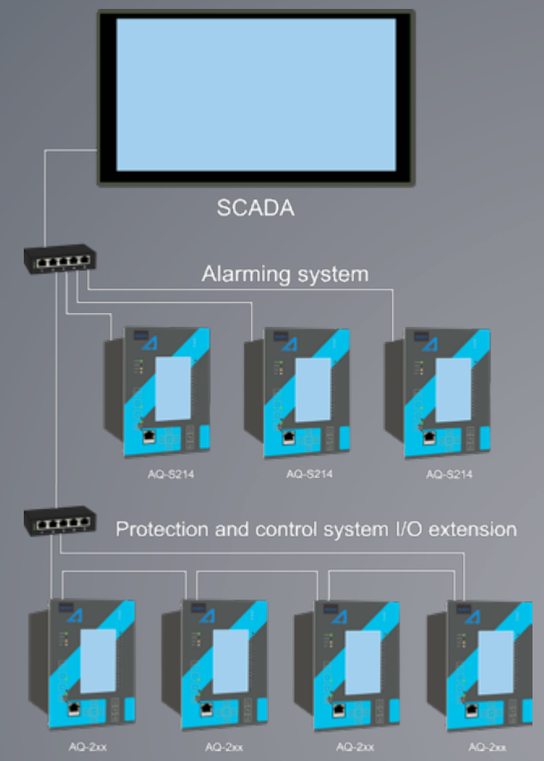
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, editions 1 & 2
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-S214 Alarm and indication IED

AQ-S214 alarm and indication IED can be applied for substation general I/O extension, control and alarm annunciation. Up to six I/O or communication cards can be inserted depending on application requirements. Easy to use and powerful logic programming expands further the application range to more demanding control, alarm and indication needs. Large freely programmable HMI display provides quick visualization of the object, alarm and event status. The AQ-S214 communicates using various protocols including IEC 61850 substation communication standard.



ALARM, CONTROL AND INDICATIONS

- Controllable objects: 10
- Alarm views
- 64 programmable alarms

HARDWARE

- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (6 SLOTS)

- Digital inputs optional: +8/16/24/32/40/48/56/64
- Digital outputs optional: +5/10/15
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING

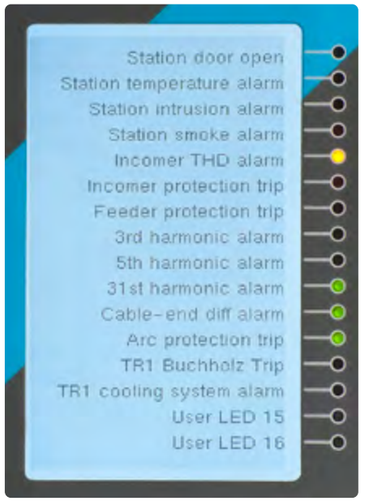
- Non-volatile event records: 15000

COMMUNICATION MEDIA

- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

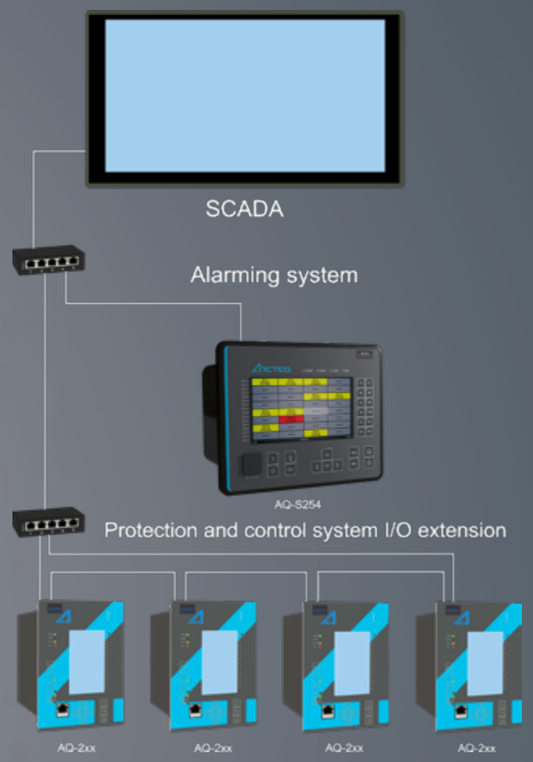
COMMUNICATION PROTOCOLS STANDARD

- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA



AQ-S254 Alarm and indication IED

AQ-S254 alarm and indication IED can be applied for substation general I/O extension, control and alarm annunciation. Up to 14 I/O or communication cards can be inserted depending on application requirements. Easy to use and powerful logic programming expands further the application range to more demanding control, alarm and indication needs. Large freely programmable HMI display provides quick visualization of the object, alarm and event status. The AQ-S254 communicates using various protocols including IEC 61850 substation communication standard.



- **Modern alarm annunciation and I/O extension with IEC 61850 and GOOSE communication**

ALARM, CONTROL AND INDICATIONS
- Controllable objects: 10
- Configurable alarm annunciator view
- 16 LEDs
- 128 configurable alarms with annunciator view

HARDWARE
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (14 SLOTS)
- Digital inputs optional: +8/16/24/32/40/48/56/64/72/80/88/96/104/112
- Digital outputs optional: +5/10/15/20/25
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING
- Non-volatile event records: 15000

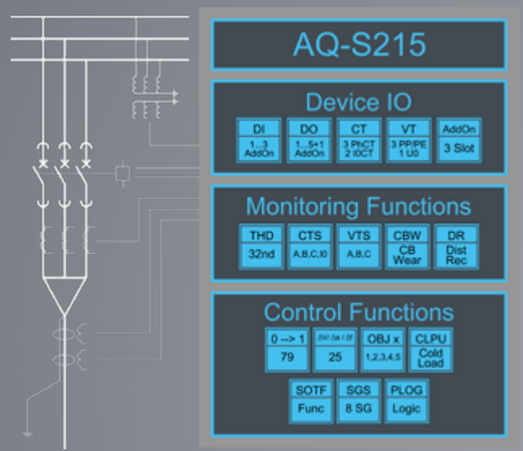
COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD
- IEC 61850, editions 1 & 2
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-S215 Bay control IED

AQ-S215 bay control IED may be applied for various types of control applications. The AQ-S215 comes with full current, voltage, power and energy measurement capability and may be equipped with additional I/O depending on application needs. Easy to use and powerful logic programming expands further the application range to more demanding control needs. Up to three optional I/O or communication cards can be inserted depending on application requirements. Large freely programmable HMI display provides quick visualization of the object, alarm and event status. The AQ-S215 communicates using various protocols including IEC 61850 substation communication standard.

The AQ-S215 configured for medium voltage double busbar bay control application where it is utilized as a part of distributed smart grid solution instead of conventional centralized RTU. Benefits of smart distributed solution include reduced wiring, operational redundancy, bay oriented alarm and status windows and integrated disturbance recorder function.



- **Smart grid control**

MEASURING AND MONITORING
- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL
- Controllable objects: 5
- Synchro-check (25)
- Autorecloser (79)
- 8 setting groups

HARDWARE
- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (3 SLOTS)
- Digital inputs optional: +8/16/24
- Digital outputs optional: +5/10/15
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

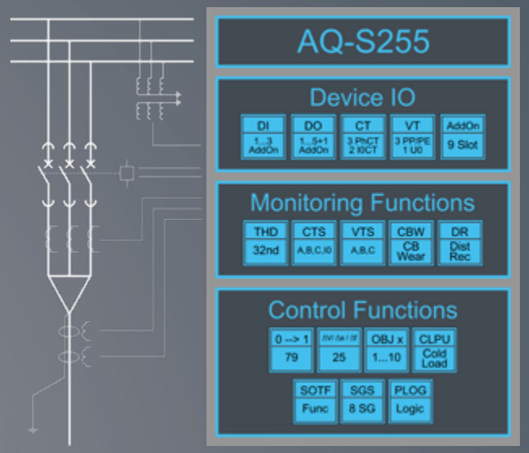
EVENT RECORDING
- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD
- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-S255 Bay control IED

AQ-S255 bay control IED may be applied for demanding control applications. The AQ-S255 comes with full current, voltage, power and energy measurement capability and may be equipped with additional I/O depending on application needs. Easy to use and powerful logic programming expands further the application range to more demanding control needs. Up to 11 optional I/O or communication cards can be inserted depending on application requirements. Large freely programmable HMI display provides quick visualization of the object, alarm and event status. The AQ-S255 communicates using various protocols including IEC 61850 substation communication standard.



- **Bay control unit with extensive IO**
- **Synchrocheck for up to three circuit breakers**

MEASURING AND MONITORING
- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and har monics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Disturbance recorder (3.2 kHz)
- Current transformer supervision (CTS)
- Fuse failure (VTS)
- Trip circuit supervision (TCS)

CONTROL
- Controllable objects: 10
- Synchro-check (25)
- Autorecloser (79)
- 8 setting groups

HARDWARE
- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (11 SLOTS)
- Digital inputs optional: +8/16/24/32/40/48/56/64/72/80/88
- Digital outputs optional: +5/10/15/20/25
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

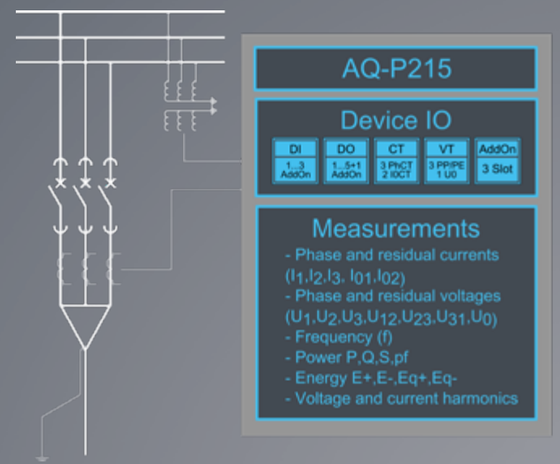
EVENT RECORDING
- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD
- IEC 61850, editions 1 & 2
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

AQ-P215 Power monitoring IED

AQ-P215 is a novel power monitoring IED for any demanding metering and power monitoring applications. The AQ-P215 offers a unique combination of high accuracy power and energy measurement of class 0.2S with dynamic measurement range up to 250A secondary current. Freely configurable data logging, programmable logic and disturbance recorder features allows for variety of power quality monitoring applications. The AQ-P215 communicates using various protocols including IEC 61850 substation communication standard.



- **Accuracy class 0.2S**
- **Frequency independent measurement – patented frequency tracking algorithm guarantees measurement accuracy at 6-75Hz**
- **Power quality analysis – harmonics, THD and disturbance recording**
- **Powerful disturbance recorder with up to 64 samples per cycle sampling rate**
- **Dynamic measuring range up to 250A secondary – effective disturbance recording when coupled to protection CT**
- **Calendar feature with automatic day-light saving and leap year adjustment**
- **Programmable logic functions**
- **Extensive data logging capability**

MEASURING AND MONITORING
- Phase and residual currents (IL1, IL2, IL3, I01, I02)
- Voltage measurements (UL1-UL3, U12-U31, U0, SS)
- Current and voltage THD and harmonics (up to 31st)
- Frequency (f)
- Power (P, Q, S, pf)
- Energy (E+, E-, Eq+, Eq-)
- Current transformer supervision (CTS)
- Fuse failure (VTS)

POWER QUALITY AND DATA LOGGING
- Voltage and current harmonics up to 31st
- Total harmonic distortion (THD)
- Disturbance recorder (3.2 kHz)
- Freely configurable data logging in flash memory

HARDWARE
- Current inputs: 5
- Voltage inputs: 4
- Digital inputs: 3 (standard)
- Output relays: 5+1 (standard)

OPTIONS (3 SLOTS)
- Digital inputs optional: +8/16/24
- Digital outputs optional: +5/10/15
- 2xmA in + 4xRTD in OR 8xRTD in
- 4xmA out+1xmA in
- Communication media (specified below)

EVENT RECORDING
- Non-volatile disturbance records: 100
- Non-volatile event records: 15000

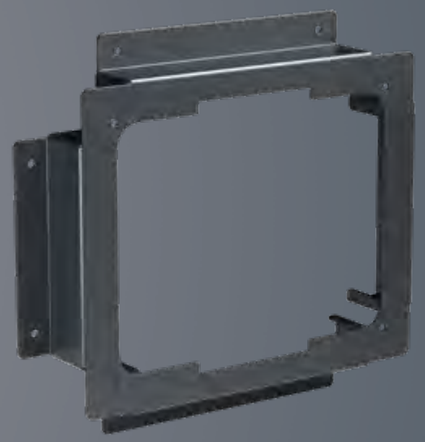
COMMUNICATION MEDIA
- RJ 45 Ethernet 100Mb (front standard)
- RJ 45 Ethernet 100Mb and RS 485 (rear standard)
- Double LC Ethernet 100Mb (option)
- RS232 + serial fibre PP/PG/GP/GG (option)

COMMUNICATION PROTOCOLS STANDARD
- IEC 61850, edition 1
- IEC 60870-5-103/101/104
- Modbus RTU, Modbus TCP/IP
- DNP 3.0, DNP 3.0 over TCP/IP
- SPA

Accessories

RAISING FRAMES

When a raising frame is used for installing a protection relay to the door of a cabinet, it leaves more room for the installation on the inside of the door. There are four raising frame options, depending on the relay model and on how much the relay needs to jut out from the background. For AQ-210 units there are two available options: 40 mm (AX010) and 87 mm (AX009). For AQ-250 units there are two available options: 40 mm (AX014) and 120 mm (AX013).



WALL MOUNTING BRACKETS

Wall mounting brackets are used for mounting relays on a wall. The arm is mounted on the wall and the relay is mounted on the bracket and locked into place. There are two types of wall mounting brackets available: AX012 for AQ-210 units and AX015 for AQ-250 units.

COMBIFLEX FRAME

The Combiflex frame (AX011) enables the installation of an AQ-21x device directly into a Combiflex case system. Please note that this accessory is only available for AQ-210 units!

ADAM MODULES

The external ADAM modules provide additional RTD or thermocouple milliampere inputs. There are two types of modules available:

- ADAM-4015-CE: a preconfigured six-channel module with 2- or 3-wire RTD inputs (AX007)
- ADAM-4018+-BE: a preconfigured eight-channel module with thermocouple mA inputs (AX008)

Please note that both modules require an external power supply.

TECHNICAL DATA

HARDWARE

Current measurement module	
Measurement channels / CT inputs	Three phase currents, One coarse residual current, and One sensitive residual current. Total of five separate CT inputs.
Phase current inputs (A,B,C)	
Rated current In	5A (configurable 0.2A…10A)
Thermal withstand	30A continuous 100A for 10s 500A for 1s 1250A for 0.01s
Frequency measurement range	from 6Hz to 75Hz fundamental, up to 31st harmonic current
Current measurement range	25mA…250A(rms)
Current measurement inaccuracy	0.005xIn…4xIn < ±0.5% or < ±15mA 4xIn…20xIn < ±0.5% 20xIn…50xIn < ±1.0%
Angle measurement inaccuracy	< ±0.1 °
Burden (50Hz/60Hz)	<0.1VA
Coarse residual current input (I01)	
Rated current In	1A (configurable 0.2A…10A)
Thermal withstand	25A continuous 100A for 10s 500A for 1s 1250A for 0.01s
Frequency measurement range	from 6Hz to 75Hz fundamental, up to 31st harmonic current
Current measurement range	2mA…150A(rms)
Current measurement inaccuracy	0.002xIn…10xIn < ±0.5% or < ±3mA 10xIn…150xIn < ±0.5%
Angle measurement inaccuracy	< ±0.1 °
Burden (50Hz/60Hz)	<0.1VA
Fine residual current input (I02)	
Rated current In	0.2A (configurable 0.2A…10A)
Thermal withstand	25A continuous 100A for 10s 500A for 1s 1250A for 0.01s
Frequency measurement range	from 6Hz to 75Hz fundamental, up to 31st harmonic current
Current measurement range	0.4mA…75A(rms)
Current measurement inaccuracy	0.002xIn…25xIn < ±0.5% or < ±0.6mA 25xIn…375xIn < ±0.5%
Angle measurement inaccuracy	< ±0.1 °
Burden (50Hz/60Hz)	<0.1VA
Terminal block	
Solid or stranded wire Phoenix Contact FRONT 4H-6,35	Maximum wire diameter: 4 mm²

Voltage measurement module	
Measurement channels / VT inputs	Total of four separate VT inputs.
Voltage inputs (U1, U2, U3, U4)	
Voltage measuring range	0.01…480.00V (RMS)
Thermal withstand	630VRMS continuous
Frequency measurement range	from 6Hz to 75Hz fundamental, up to 31st harmonic voltage
Voltage measurement inaccuracy	0.01…480V < ±0.2% or < ±10mV
Angle measurement inaccuracy	< ±0.5 degrees
Burden (50Hz/60Hz)	<0.02VA
Terminal block	
Solid or stranded wire Phoenix Contact PC 5% 8-STCL1-7.62	Maximum wire diameter: 4 mm²

AUXILIARY VOLTAGE

Power supply model A	
Rated auxiliary voltage	85…265V(AC/DC)
Power consumption	< 7W < 15W
Maximum permitted interrupt time	< 150ms with 110VDC
DC ripple	< 15 %
Terminal block	
Solid or stranded wire Phoenix Contact MSTB2,5-5,08	Maximum wire diameter: 2.5 mm²

Power supply model B	
Rated auxiliary voltage	18…72VDC
Power consumption	< 7W < 15W
Maximum permitted interrupt time	< 150ms with 110VDC
DC ripple	< 15 %
Terminal block	
Solid or stranded wire Phoenix Contact MSTB2,5-5,08	Maximum wire diameter: 2.5 mm²

BINARY INPUTS

Isolated binary inputs with software settable threshold	
Rated auxiliary voltage	5…265V(AC/DC)
Pick-up threshold Release threshold	Software settable: 5…240V, by step of 1V Software settable: 5…240V, by step of 1V
Scanning rate	5 ms
Pick-up delay	Software settable: 0…1800s
Polarity	Software settable: Normally On / Normally Off
Current drain	2 mA
Terminal block	
Solid or stranded wire Phoenix Contact MSTB2,5-5,08	Maximum wire diameter: 2.5 mm²

BINARY OUTPUTS

Normal Open binary outputs	
Rated auxiliary voltage	265V(AC/DC)
Continuous carry	5A
Make and carry 0.5s Make and carry 3s	30A 15A
Breaking capacity, DC (L/R = 40 ms) at 48VDC at 110 VDC at 220 VDC	 1A 0.4A 0.2A
Control rate	5 ms
Polarity	Software settable: Normally On / Normally Off
Contact material	
Terminal block	
Solid or stranded wire Phoenix Contact MSTB2,5-5,08	Maximum wire diameter: 2.5 mm²

Change-Over binary outputs	
Rated auxiliary voltage	265V(AC/DC)
Continuous carry	5A
Make and carry 0.5s Make and carry 3s	30A 15A
Breaking capacity, DC (L/R = 40 ms) at 48VDC at 110 VDC at 220 VDC	 1A 0.4A 0.2A
Control rate	5 ms
Polarity	Software settable: Normally On / Normally Off
Contact material	
Terminal block	
Solid or stranded wire Phoenix Contact MSTB2,5-5,08	Maximum wire diameter: 2.5 mm²

mA/RTD input option card “F”	
Number of channels	8 RTD or 2mA + 6 RTD
Type of sensor	PT 100, PT 1000, Thermocoupler K,J,T,S
Type of connection	2/3/4-wire

COMMUNICATION PORTS

Front panel local communication port	
Port media	Copper Ethernet RJ-45
Number of ports	1pcs
Port protocols	PC-protocols, FTP, Telnet
Data transfer rate	100 MB
System integration	Cannot be used for system protocols, only for local programming

Rear panel system communication port A	
Port media	Copper Ethernet RJ-45
Number of ports	1pcs
Port protocols	Modbus TCP, DNP 3.0, FTP, Telnet, IEC 61850, IEC-104, NTP
Data transfer rate	100 MB
System integration	Can be used for system protocols and for local programming

Rear panel system communication port B	
Port media	Copper RS-485
Number of ports	1pcs
Port protocols	Modbus RTU, DNP 3.0, IEC-103, IEC-101, SPA
Data transfer rate	65580 kB/s
System integration	Can be used for system protocols

Rear panel system communication port option card “J”	
Port media	LC fiber optic
Number of ports	2
Port protocols	Modbus TCP, DNP 3.0, FTP, Telnet, IEC 61850, HSR, PRP, IEC-104, NTP, IEEE 1588
Data transfer rate	100 MB
System integration	Can be used for system protocols

Rear panel system communication port option cards “L, M, N, O”	
Port media	Serial fiber and RS 232
Number of ports	2
Port protocols	Modbus RTU, DNP 3.0, IEC-103, IEC-101, SPA, IRIG-B
Data transfer rate	65580 kB/s
System integration	Can be used for system protocols

Human Machine Interface	
Display	LCD 320x160 (93.7 x 58.5 mm)
Programmable LEDs	16 (green / yellow)

MEASUREMENT ACCURACY

Frequency, power and energy measurement accuracy	
Frequency measuring range Inaccuracy	6…75 Hz fundamental, up to 31st harmonic current and voltage 10 mHz
Power measurement P, Q, S Inaccuracy	Frequency range 6…75 Hz 1 % of value or 3 VA of secondary
Energy measurement Energy and power metering inaccuracy	Frequency range 6…75 Hz IEC 62053-22 class 0.5S (50/60Hz) as standard IEC 62053-22 class 0.2S (50/60Hz) option available (See order code for details)

PROTECTION FUNCTIONS

CURRENT PROTECTION FUNCTIONS

Unbalance (46/46R/46L) I2>, I2>>, I2>>>, I2>>>>	
Input signals	
Input magnitudes	Phase current fundamental freq RMS
Pick-up	
Used magnitude	Negative sequence component I2pu Relative unbalance I2/I1
Pick-up setting	0.01…40.00 x In, setting step 0.01 x In (I2pu) 1.00…200.00 %, setting step 0.01 % (I2/I1)
Minimum phase current (least 1 phase above)	0.01…2.00 x In, setting step 0.01 x In
Inaccuracy Starting I2pu Starting I2/I1	 ±1.0 %I2SET or ±100 mA (0.10…4.0 x IN) ±1.0 %I2SET / I1SET or ±100 mA (0.10…4.0 x IN)
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio >1.05)	 ±1.0 % or ±30 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000 step 0.0001 0…5.0000 step 0.0001 0…250.0000 step 0.0001
Inaccuracy IDMT operating time IDMT minimum operating time; 20 ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio >1.05)	 <70 ms
Reset	
Reset ratio	97 % of pick-up setting
Reset time setting Inaccuracy: Reset time	0.010 … 10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Line thermal overload (49L) TF>	
Input current magnitude	Phase current TRMS max (31 harmonic)
Time constants τ	1
Time constant value	0.0…500.00 min by step of 0.1 min
Service factor (max overloading)	0.01…5.00 by step of 0.01 x In
Thermal model biasing	Ambient temperature (Set -60.0 … 500.0 deg by step of 0.1 deg and RTD) Negative sequence current
Thermal replica temperature estimates	Selectable deg C or deg F
Outputs	Alarm 1 (0…150% by step of 1%) Alarm 2 (0…150% by step of 1%) Thermal Trip (0…150% by step of 1%) Trip delay (0.000…3600.000s by step of 0.005s) Restart Inhibit (0…150% by step of 1%)
Inaccuracy Starting Operating time	 ±0.5% of set pick-up value ±5 % or ± 500ms

Overcurrent (50/51) I>, I>>, I>>>, I>>>>	
Input signals	
Input magnitudes	Phase current fundamental freq RMS Phase current TRMS Phase current peak-to-peak
Pick-up	
Pick-up current setting	0.10…40.00 x In, setting step 0.01 x In
Inaccuracy Current	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET)
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio > 3) Definite Time (Im/Iset ratio 1.05…3)	 ±1.0 % or ±20 ms ±1.0 % or ±30 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000 step 0.0001 0…5.0000 step 0.0001 0…250.0000 step 0.0001
Inaccuracy IDMT operating time IDMT minimum operating time; 20 ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio > 3) (Im/Iset ratio 1.05…3)	 <35 ms (typical 25 ms) <50 ms
Reset	
Reset ratio	97 % of pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010 … 10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Arc protection (50Arc/50NArc) IArc> I0Arc> (option)	
Input signals	
Input magnitudes Input arc point sensors	Sample based phase current measurement Sample based residual current measurement S1, S2, S3, S4 (pressure and light or light only)
System frequency operating range	6.00…75.00 Hz
Pick-up	
Pick-up current setting (phase current) Pick-up current setting (residual current) Pick-up light intensity	0.50…40.00 x In, setting step 0.01 x In 0.10…40.00 x In, setting step 0.01 x In 8000, 25000 or 50000 Lux (sensor selectable in order code)
Starting inaccuracy ArcI> & ArcI0>	±3% of set pick-up value > 0.5 x In setting. 5 mA < 0.5 x In setting
Point sensor detection radius	180 degrees
Operation time	
Light only Semiconductor outputs HSO1 and HSO2 Regular relay outputs	 Typically 7 ms (3…12 ms) Typically 11 ms (6.5…18 ms)
Light + current criteria (zone1…4) Semiconductor outputs HSO1 and HSO2 Regular relay outputs	 Typically 8 ms (4…13 ms) Typically 14 ms (9…18.5 ms)
Arc BI only Semiconductor outputs HSO1 and HSO2 Regular relay outputs	 Typically 7 ms (3…12 ms) Typically 12 ms (8…16.5 ms)
Reset	
Reset ratio for current	97 %
Reset time	Typically <30 ms

Earth fault (50N/51N) I0>, I0>>, I0>>>, I0>>>>	
Input signals	
Input magnitudes	Residual current fundamental freq RMS Residual current TRMS Residual current peak-to-peak
Pick-up	
Used magnitude	Measured residual current I01 (1 A) Measured residual current I02 (0.2 A) Calculated residual current I0Calc (5 A)
Pick-up current setting	0.005…40.00 x In, setting step 0.001 x In
Inaccuracy Starting I01 (1 A) Starting I02 (0.2 A) Starting I0Calc (5 A)	 ±0.5 %I0SET or ±3 mA (0.005…10.0 x ISET) ±1.5 %I0SET or ±1.0 mA (0.005…25.0 x ISET) ±1.0 %I0SET or ±15 mA (0.005…4.0 x ISET)
Operating time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio > 3) Definite Time (Im/Iset ratio 1.05…3)	 ±1.0 % or ±20 ms ±1.0 % or ±30 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000 step 0.0001 0…5.0000 step 0.0001 0…250.0000 step 0.0001
Inaccuracy IDMT operating time IDMT minimum operating time; 20 ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio > 3) (Im/Iset ratio 1.05…3)	 <35 ms (typical 25 ms) <50 ms
Reset	
Reset ratio	97 % of pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010 … 10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Directional overcurrent (67) Idir>, Idir>>, Idir>>>, Idir>>>>	
Input signals	
Input magnitudes	Phase current fundamental freq RMS Phase current TRMS Phase current peak-to-peak P-P +U0 voltage fundamental frequency RMS P-E voltage fundamental frequency RMS
Pick-up	
Characteristic direction	Forward (0°), Reverse (180°), Non-directional
Operating sector size (+/-)	1.00…180.00 deg, setting step 0.10 deg
Pick-up current setting	0.10…40.00 x In, setting step 0.01 x In
Inaccuracy Current U1/I1 angle (U > 15 V) U1/I1 angle (U = 1…15 V)	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET) ±0.15 ° ±1.5 °
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio > 3) Definite Time (Im/Iset ratio 1.05…3)	 ±1.0 % or ±20 ms ±1.0 % or ±30 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000 step 0.0001 0…5.0000 step 0.0001 0…250.0000 step 0.0001
Inaccuracy IDMT operating time IDMT minimum operating time; 20 ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio > 3) (Im/Iset ratio 1.05…3)	 <35 ms (typical 25 ms) <50 ms
Reset	
Reset ratio Current U1/I1 angle	 97 % of pick-up current setting 2.0 °
Reset time setting Inaccuracy: Reset time	0.010 … 10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Directional earth fault (67N) I0dir>, I0dir>>, I0dir>>>, I0dir>>>>

Input signals	
Input current magnitudes Input voltage magnitude	Residual current fundamental freq RMS Residual current TRMS Residual current peak-to-peak Zero sequence voltage fundamental freq RMS
Pick-up	
Used current magnitude Used voltage magnitude	Measured residual current I01 (1 A) Measured residual current I02 (0.2 A) Calculated residual current I0Calc (5 A) Measured zero sequence voltage U0 Calculated zero sequence voltage U0
Characteristic direction	Unearthed (Varmetric 90°) Petersen coil GND (Wattmetric 180°) Grounded (Adjustable sector)
When grounded mode is active Trip area center Trip area size (+/-)	 0.00…360.00 deg, setting step 0.10 deg 45.00…135.00 deg, setting step 0.10 deg
Pick-up current setting Pick-up voltage setting	0.005…40.00 x In, setting step 0.001 x In 1.00…50.00 % U0n, setting step 0.01 x In
Inaccuracy Starting I01 (1 A) Starting I02 (0.2 A) Starting I0Calc (5 A) Voltage U0 and U0Calc U0/I0 angle (U > 15 V) U0/I0 angle (U = 1…15 V)	 ±0.5 %I0SET or ±3 mA (0.005…10.0 x ISET) ±1.5 %I0SET or ±1.0 mA (0.005…25.0 x ISET) ±1.0 %I0SET or ±15 mA (0.005…4.0 x ISET) ±1.0 %U0SET or ±30 mV ±0.1 ° (I0Calc ±0.5 °) ±1.0 °
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio 1.05→)	 ±1.0 % or ±30 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000 step 0.0001 0…5.0000 step 0.0001 0…250.0000 step 0.0001
Inaccuracy IDMT operating time IDMT minimum operating time; 20 ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio > 3) (Im/Iset ratio 1.05…3)	 <40 ms (typical 30 ms) <50 ms
Reset	
Reset ratio Current and voltage U0/I0 angle	 97 % of pick-up current and voltage setting 2.0 °
Reset time setting Inaccuracy: Reset time	0.000 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Intermittent/transient earth fault (67NT) I0Int>

Input signals	
Input current magnitudes Input voltage magnitude	Residual current samples Zero sequence voltage samples
Pick-up	
Used current magnitude Used voltage magnitude	Measured residual current I01 (1 A) Measured residual current I02 (0.2 A) Measured zero sequence voltage U0
Spikes to trip	1…50, setting step 1
Pick-up current setting Pick-up voltage setting	0.05…40.00 x In, setting step 0.001 x In 1.00…100.00 % U0n, setting step 0.01 x In
Inaccuracy Starting I01 (1 A) Starting I02 (0.2 A) Voltage U0	 ±0.5 %I0SET or ±3 mA (0.005…10.0 x ISET) ±1.5 %I0SET or ±1.0 mA (0.005…25.0 x ISET) ±1.0 %U0SET or ±30 mV
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio 1.05→)	 ±1.0 % or ±30 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio 1.05→)	 <15 ms
Reset time	
Reset time setting (FWD and REV) Inaccuracy: Reset time	0.000 … 1800.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

CAPACITOR BANK PROTECTION FUNCTIONS

Capacitor bank overload protection (49OL) Icol>, Icol>>

Input signals	
Current inputs	Phase current inputs: IL1 (A), IL2 (B), IL3 (C)
Current input magnitudes	RMS phase currents TRMS phase currents Peak-to-peak phase currents
Pick-up	
Pick-up current setting	0.10…50.00 x In, setting step 0.01 x In
Inrush 2nd harmonic blocking	0.10…50.00 %I_{fund}, setting step 0.01 %I_{fund}
Inaccuracy: - Current - 2nd harmonic blocking	 ±0.5 %Iset or ±15 mA (0.10…4.0 × Iset) ±1.0 %-unit of the 2nd harmonic setting
Operation time	
Definite time function operating time setting	0.00…1 800.00 s, setting step 0.005 s
Inaccuracy: - Definite time: Im/Iset ratio > 3 - Definite time: Im/Iset ratio = 1.05…3	 ±1.0 % or ±20 ms ±1.0 % or ±30 ms
IDMT setting parameters: - k Time dial setting for IDMT - A IDMT constant - B IDMT constant - C IDMT constant	 0.01…25.00, step 0.01 0…250.0000, step 0.0001 0…5.0000, step 0.0001 0…250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Retardation time (overshoot)	<25 ms
Instant operating time	
Start time and instant operation time (trip): - I_m/I_{set} ratio > 3 - I_m/I_{set} ratio = 1.05…3	 <35 ms (typically 25 ms) <50 ms
Reset	
Reset ratio	97 % of the pick-up current setting
Reset time setting	0.010…10.000 s, step 0.005 s
Inaccuracy: Reset time	±1.0 % or ±50 ms
Instant reset time and start-up reset	<50 ms

Capacitor bank neutral unbalance protection (50UB) Cnu>

Measurement inputs	
Current inputs	Phase current inputs: IL1 (A), IL2 (B), IL3 (C)
Current input magnitudes	RMS phase currents TRMS phase currents Peak-to-peak phase currents
Pick-up	
Pick-up current setting	0.10…50.00 x In, setting step 0.0001 x In
Inrush 2nd harmonic blocking	0.10…50.00 %I_{fund}, setting step 0.01 %I_{fund}
Inaccuracy: - Current - 2nd harmonic blocking	 ±0.5 %Iset or ±15 mA (0.10…4.0 × I_{set}) ±1.0 %-unit of the 2nd harmonic setting
Operation time	
Definite time function operating time setting	0.00…1 800.00 s, setting step 0.005 s
Inaccuracy: - Definite time: Im/Iset ratio > 3 - Definite time: Im/Iset ratio = 1.05…3	 ±1.0 % or ±20 ms ±1.0 % or ±30 ms
IDMT setting parameters: - k Time dial setting for IDMT - A IDMT constant - B IDMT constant - C IDMT constant	 0.01…25.00, step 0.01 0…250.0000, step 0.0001 0…5.0000, step 0.0001 0…250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Retardation time (overshoot)	<25 ms
Instant operating time	
Start time and instant operation time (trip): - I_m/I_{set} ratio > 3 - I_m/I_{set} ratio = 1.05…3	 <35 ms (typically 25 ms) <50 ms
Reset	
Reset ratio	97 % of the pick-up current setting
Reset time setting	0.010…10.000 s, step 0.005 s
Inaccuracy: Reset time	±1.0 % or ±50 ms
Instant reset time and start-up reset	<50 ms

Capacitor bank current unbalance protection (46C) Iuc>

Measurement inputs	
Current inputs	Phase current inputs: IL1 (A), IL2 (B), IL3 (C)
Current input magnitudes	RMS phase currents TRMS phase currents Peak-to-peak phase currents
Pick-up	
Pick-up current setting	0.10…50.00 x In, setting step 0.0001 x I_n
Inrush 2nd harmonic blocking	0.10…50.00 %I_{fund}, setting step 0.01 %I_{fund}
Inaccuracy: - Current - 2nd harmonic blocking	 ±0.5 %I_{set} or ±15 mA (0.10…4.0 × I_{set}) ±1.0 %-unit of the 2nd harmonic setting
Operation time	
Definite time function operating time setting	0.00…1 800.00 s, setting step 0.005 s
Inaccuracy: - Definite time: I_m/I_{set} ratio > 3 - Definite time: I_m/I_{set} ratio = 1.05…3	 ±1.0 % or ±20 ms ±1.0 % or ±30 ms
IDMT setting parameters: - k Time dial setting for IDMT - A IDMT constant - B IDMT constant - C IDMT constant	 0.01…25.00, step 0.01 0…250.0000, step 0.0001 0…5.0000, step 0.0001 0…250.0000, step 0.0001
Inaccuracy: - IDMT operating time - IDMT minimum operating time	 ±1.5 % or ±20 ms ±20 ms
Retardation time (overshoot)	<25 ms
Instant operating time	
Start time and instant operation time (trip): - I_m/I_{set} ratio > 3 - I_m/I_{set} ratio = 1.05…3	 <35 ms (typically 25 ms) <50 ms
Reset	
Reset ratio	97 % of the pick-up current setting
Reset time setting	0.010…10.000 s, step 0.005 s
Inaccuracy: Reset time	±1.0 % or ±50 ms
Instant reset time and start-up reset	<50 ms

VOLTAGE AND FREQUENCY PROTECTION FUNCTIONS

Under voltage (27) U<, U<<, U<<<, U<<<<

Input signals	
Measured magnitudes	P-P voltage fundamental frequency RMS P-E voltage fundamental frequency RMS
Pick-up	
Pick-up terms	1 voltage 2 voltages 3 voltages
Pick-up setting	20.00…120.00 %Un, setting step 0.01 %Un
Inaccuracy Voltage	 ±1.5 %USET or ±30 mV
Low voltage block	
Pick-up setting	0.00…80.00 %Un, setting step 0.01 %Un
Voltage	±1.5 %USET or ±30 mV
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Um/Uset ratio 1.05→)	 ±1.0 % or ±35 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000 step 0.0001 0…5.0000 step 0.0001 0…250.0000 step 0.0001
Inaccuracy IDMT operating time IDMT minimum operating time; 20 ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): Um/Uset ratio 1.05→	 <65 ms
Reset	
Reset ratio	103 % of pick-up voltage setting
Reset time setting Inaccuracy: Reset time	0.010 … 10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Overvoltage (59) U>, U>>, U>>>, U>>>>

Input signals	
Measured magnitudes	P-P voltage fundamental frequency RMS P-E voltage fundamental frequency RMS
Pick-up	
Pick-up terms	1 voltage 2 voltages 3 voltages
Pick-up setting	50.00…150.00 %Un, setting step 0.01 %Un
Inaccuracy Voltage	 ±1.5 %USET
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy -Definite Time (Um/Uset ratio 1.05→)	 ±1.0 % or ±35 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000 step 0.0001 0…5.0000 step 0.0001 0…250.0000 step 0.0001
Inaccuracy IDMT operating time IDMT minimum operating time; 20 ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): Um/Uset ratio 1.05→	 <65 ms
Reset	
Reset ratio	103 % of pick-up voltage setting
Reset time setting Inaccuracy: Reset time	0.010 … 10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Neutral overvoltage (59N) U0>, U0>>, U0>>>, U0>>>>

Input signals	
Input magnitudes	U0 voltage fundamental frequency RMS
Pick-up	
Pick-up voltage setting	1.00…50.00 % U0n, setting step 0.01 x In
Inaccuracy Voltage U0 Voltage U0Calc	 ±1.5 %U0SET or ±30 mV ±150 mV
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (U0m/U0set ratio 1.05→)	 ±1.0 % or ±35 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000 step 0.0001 0…5.0000 step 0.0001 0…250.0000 step 0.0001
Inaccuracy IDMT operating time IDMT minimum operating time; 20 ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): U0m/U0set ratio 1.05→	 <50 ms
Reset	
Reset ratio	97 % of pick-up voltage setting
Reset time setting Inaccuracy: Reset time	0.000 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Frequency (81O/81U) f>/<, f>>/<<, f>>>/<<<, f>>>>/<<<<

Input signals	
Input magnitudes	Fixed Tracking
Freq reference1 Freq reference2 Freq reference3	CT1IL1, CT2IL1, VT1U1, VT2U1 CT1IL2, CT2IL2, VT1U2, VT2U2 CT1IL3, CT2IL3, VT1U3, VT2U3
Pick-up	
f> pick-up setting f< pick-up setting	10.00…70.00 Hz, setting step 0.01 Hz 7.00…65.00 Hz, setting step 0.01 Hz
Inaccuracy (sampling mode) Fixed Tracking	 ±15 mHz (50 / 60 Hz fixed frequency) ±15 mHz (U > 30 V secondary) ±20 mHz (I > 30 % of rated secondary)
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio +/- 50mHz)	 ±1.5 % or ±50 ms (max step size 100mHz)
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio +/- 50mHz) FIXED mode (Im/Iset ratio +/- 50mHz) TRACKING mode	 <70 ms (max step size 100mHz) <2 cycles or <50 ms (max step size 100mHz)

Frequency (81O/81U) f>/<, f>>/<<, f>>>/<<<, f>>>>/<<<<

Input signals	
Input magnitudes	Fixed Tracking

Rate of change of frequency (81R) df/dt>/< 1…8

Input signals	
Sampling mode	Fixed Tracking
Freq reference1 Freq reference2 Freq reference3	CT1IL1, CT2IL1, VT1U1, VT2U1 CT1IL2, CT2IL2, VT1U2, VT2U2 CT1IL3, CT2IL3, VT1U3, VT2U3
Pick-up	
Df/dt>/< pick-up setting f> limit f< limit	0.05…1.00 Hz/s, setting step 0.01 Hz 10.00…70.00 Hz, setting step 0.01 Hz 7.00…65.00 Hz, setting step 0.01 Hz
Inaccuracy df/dt frequency	 ±5.0 %ISET or ±20 mHz/s ±15 mHz (U > 30 V secondary) ±20 mHz (I > 30 % of rated secondary)
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio +/- 50mHz)	 ±2.5 % or ±100 ms (max step size 100mHz)
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio +/-20mHz overreach) (Im/Iset ratio +/- 200mHz overreach)	 <150 ms <90 ms
Reset	
Reset ratio (Frequency limit)	0.020 Hz
Instant reset time and start-up reset (Im/Iset ratio +/- 50mHz)	 <2 cycles or <50 ms (max step size 100mHz)

Vector jump tech

Input signals	
Input magnitudes	Phase currents, I01, I02 I0Calc fundamental freq RMS Digital input status, Digital output status
Pick-up	
Pick-up current setting IL1…IL3 I01, I02, I0Calc	 0.10…40.00 x In, setting step 0.01 x In 0.005…40.00 x In, setting step 0.005 x In
Inaccuracy Starting phase current (5A) Starting I01 (1 A) Starting I02 (0.2 A) Starting I0Calc (5 A)	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET) ±0.5 %I0SET or ±3 mA (0.005…10.0 x ISET) ±1.5 %I0SET or ±1.0 mA (0.005…25.0 x ISET) ±1.0 %I0SET or ±15 mA (0.005…4.0 x ISET)
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio 1.05→)	 ±1.0 % or ±50 ms
Reset	
Reset ratio	97 % of pick-up current setting
Reset time	<50 ms

SEQUENCE AND SUPPORTING PROTECTION FUNCTIONS

Power (32/37) P>, P<, PREV>

Input signals	
Input magnitudes	Phase current and voltage fundamental freq RMS
Pick-up	
P> PREV>	0.10…150000.00 kW, setting step 0.01 kW -15000.00…-1.00 kW, setting step 0.01 kW
P< Low Power block Pset<	0.00…150000.00 kW, setting step 0.01 kW 0.00…100000.00 kW, setting step 0.01 kW
Inaccuracy Power	 Typically <1.0 %PSET
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Pm/Pset ratio 1.05→)	 ±1.0 % or ±35 ms
Instant operation time	
Start time and instant operation time (trip): (Pm/Pset ratio 1.05→)	 <50 ms
Reset	
Reset ratio	0.97/1.03 x Pset
Reset time setting Inaccuracy: Reset time	0.000 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Note! - Voltage measurement starts from 0.5V and current measurement from 50mA. In case either or both is missing the power measurement is forced to 0kW. In case the settings allow (low power block = 0 kW), the P< might be on trip state during this condition. Trip is released when voltage and current is started to measure.

- When low power block is set to zero it is not in use. Also power measurement below 1.00 kW is forced to zero (P< blocked).

Breaker failure (50BF) CBFP

Input signals	
Input magnitudes	Phase currents, I01, I02 I0Calc fundamental freq RMS Digital input status, Digital output status
Pick-up	
Pick-up current setting IL1…IL3 I01, I02, I0Calc	 0.10…40.00 x In, setting step 0.01 x In 0.005…40.00 x In, setting step 0.005 x In
Inaccuracy Starting phase current (5A) Starting I01 (1 A) Starting I02 (0.2 A) Starting I0Calc (5 A)	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET) ±0.5 %I0SET or ±3 mA (0.005…10.0 x ISET) ±1.5 %I0SET or ±1.0 mA (0.005…25.0 x ISET) ±1.0 %I0SET or ±15 mA (0.005…4.0 x ISET)
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio 1.05→)	 ±1.0 % or ±50 ms
Reset	
Reset ratio	97 % of pick-up current setting
Reset time	<50 ms

Harmonic OC (50H/51H 68H) Ih>, Ih>>, Ih>>>, Ih>>>>

Input signals	
Input magnitudes	Phase current IL1/IL2/IL3 TRMS Residual current I01 TRMS Residual current I02 TRMS
Pick-up	
Harmonic selection	2nd, 3rd, 4th, 5th, 7th, 9th, 11th, 13th, 15th, 17th or 19th
Used magnitude	Harmonic per unit xIn Harmonic relative Ih/IL
Pick-up setting	0.05…2.00 x In, setting step 0.01 x In (xIn) 5.00…200.00 %, setting step 0.01 % (Ih/IL)
Inaccuracy Starting x In Starting Ih/IL	 <0.03 xIn (2nd, 3rd, 5th) <0.03 xIn tolerance to Ih (2nd, 3rd, 5th)
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio 1.05→)	 ±1.0 % or ±30 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000 step 0.0001 0…5.0000 step 0.0001 0…250.0000 step 0.0001
Inaccuracy IDMT operating time IDMT minimum operating time; 20ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio >1.05)	 <50 ms
Reset	
Reset ratio	95 % of pick-up setting
Reset time setting Inaccuracy: Reset time	0.010 … 10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Restricted earth fault / Cable end differential (87N) I0d>

Input magnitudes	Phase currents, I01, I02 fundamental frequency RMS Calculated bias and residual differential currents
Operating modes	Restricted earth fault Cable end differential
Characteristics	Biased differential with 3 settable sections and 2 slopes
Pick-up current sensitivity setting	0.01…50.00% (In), setting step 0.01 %
Slope 1	0.00…150.00%, setting step 0.01%
Slope 2	0.00…250.00%, setting step 0.01%
Start time	Typically <14 ms
Reset time	With current monitoring typically <14ms
Reset ratio	97 % for current measurement
Inaccuracy Starting Operating time	 ±3% of set pick-up value > 0.5 x In setting. 5 mA < 0.5 x In setting < 20 ms

MACHINE PROTECTION FUNCTIONS

Loss of load (37) I<

Input signals	
Input magnitudes	Phase current fundamental freq RMS
Pick-up	
Pick-up current setting	0.10…40.00 x In, setting step 0.10 x In
Inaccuracy Current	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET)
Operation time	
Definite time function operating time setting	0.00…150.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio 0.95)	 ±1.0 % or ±30 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio 0.95)	 <50 ms
Reset	
Reset ratio	103 % of pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Start / Locked rotor (48/14) ISt>

Input signals	
Input magnitudes	Phase current fundamental freq RMS
Pick-up	
Pick-up current setting	0.10…40.00 x In, setting step 0.10 x In
Inaccuracy Current	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET)
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Cumulative I2t sum inverse operation time	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio 0.95)	 ±1.0 % or ±30 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio 1.05)	 <50 ms
Reset	
Reset ratio	97 % of pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Motor thermal overload (49M) Tm>

Input signals	
Input magnitudes	Phase current TRMS (up to 31st harmonic)
Pick-up (Heating)	
NPS bias factor (unbalance effect) Pick-up current setting Thermal alarm and trip level setting range Motor service factor	0.1…10.0, setting step 0.1 0.00…40.00 x In, setting step 0.01 x In 0.0…150.0 %, setting step 0.1 % 0.01…5.00 x In, setting step 0.01 x In
Cold condition Long heat T const (cold) Short heat T const (cold)	 0.0…500.0 min, setting step 0.1 min 0.0…500.0 min, setting step 0.1 min
Hot condition Long heat T const (hot) Short heat T const (hot) Hot condition theta limit (Cold → Hot spot)	 0.0…500.0 min, setting step 0.1 min 0.0…500.0 min, setting step 0.1 min 0.00…100.00 %, setting step 0.01 %
Reset (Cooling)	
Reset ratio (pick-up and alarms)	99 %
Stop condition Long cool T const (stop) Short cool T const (stop) Short cool T in use time	 0.0…500.0 min, setting step 0.1 min 0.0…500.0 min, setting step 0.1 min 0.0…3000.0 min, setting step 0.1 min
Run condition Long cool T const (stop)	 0.0…500.0 min, setting step 0.1 min
Operation time	
Definite time function operating time setting	0.0…3600.0 s, setting step 0.1 s
Inaccuracy Pick-up and reset	 ±1.0 % or ±30 ms
Environmental settings	
Reset ratio	97 % of pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Mechanical jam (50M) Im>

Input signals	
Input magnitudes	Phase current fundamental freq RMS
Pick-up	
Pick-up current setting	0.10…40.00 x In, setting step 0.10 x In
Inaccuracy Current	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET)
Operation time	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio 0.95)	 ±1.0 % or ±30 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio 1.05)	 <50 ms
Reset	
Reset ratio	97 % of pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Frequent start protection (66/86) N>

Input magnitudes	Motor start monitor set start signals
Dependent of motor thermal status	Yes
Starts when cold	1…100 starts by step of 1 start
Starts when hot	1…100 starts by step of 1 start
Monitor data	Used starts Available starts Alarms, Inhibits, Blocks Inhibit, Alarm time on Time since last start
Start time	max 5 ms from detected start-up
Inaccuracy Starting Definite Time operating time	 ±3% of set pick-up value > 0.5 x In setting. 5 mA < 0.5 x In setting (from MST function) ±0.5 % or ±10 ms of the counter deduct

Under impedance (21G) Z<

Input signals	
Input magnitudes	P-E impedances Pos. seq. impedances
Pick-up	
Pick-up setting	0.1…150.0 Ohm, setting step 0.1 Ohm
Inaccuracy -Impedance calculation	 Typically <5.0 %ZSET
Operation time	
Definite time function operating time setting	 0.00…1800.00 s, setting step 0.005 s
Inaccuracy - Definite Time (Zm/Zset ratio 1.05→)	 ±1.0 % or ±35 ms
Instant operation time	
Start time and instant operation time (trip): (Zm/Zset ratio 0.95)	 <50 ms
Reset	
Reset ratio	0.97 x Zset
Reset time setting Inaccuracy: Reset time	0.010 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	 <50 ms

Note! - Voltage measurement starts from 0.5V and current measurement from 50mA. In case either or both is missing the impedance measurement is forced to infinite.

- During three phase short circuits the angle memory is active for 0.5 seconds in case the voltage drops below 1.0 V.

Over excitation (24) V/HZ>

Input signals	
Input magnitudes Freq reference1 Freq reference2 Freq reference3	P-P voltage fundamental frequency RMS P-E voltage fundamental frequency RMS CT1IL1, CT2IL1, VT1U1, VT2U1 CT1IL2, CT2IL2, VT1U2, VT2U2 CT1IL3, CT2IL3, VT1U3, VT2U3
Pick-up	
Pick-up V/Hz setting	1.00…30.00 %, setting step 0.01 %
Inaccuracy -V/Hz	 ±1.0 %
Operation time	
Definite time function operating time setting	 0.00…1800.00 s, setting step 0.005 s
Inaccuracy -Definite Time (Im/Iset ratio 0.95)	 ±1.0 % or ±30 ms
Instant operation time	
Start time and instant operation time (trip): (Um/Uset ratio 0.95)	 <50 ms
Reset	
Reset ratio	99 % of pick-up setting
Reset time setting Inaccuracy: Reset time	0.010 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	 <50 ms

Under excitation (40) Q>

Input signals	
Input magnitudes	Phase current and voltage fundamental freq RMS
Pick-up	
Pick-up setting	0.10…100000.00 kVar, setting step 0.01 kVar
Inaccuracy - Reactive power	 Typically <1.0 %QSET
Operation time	
Definite time function operating time setting	 0.00…1800.00 s, setting step 0.005 s
Inaccuracy - Definite Time (Qm/Qset ratio 1.05→)	 ±1.0 % or ±35 ms
Instant operation time	
Start time and instant operation time (trip): (Qm/Qset ratio 0.95)	 <50 ms
Reset	
Reset ratio	0.97 x Qset
Reset time setting Inaccuracy: Reset time	0.010 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	 <50 ms

Note! -Voltage measurement starts from 0.5V and current measurement from 50mA. In case either or both is missing the reactive power measurement is forced to 0kVar.

Voltage restrained overcurrent (51V) IV>

Input signals	
Input current magnitudes Input voltage magnitudes	Phase current fundamental freq RMS Phase current TRMS Phase current peak-to-peak P-P voltage fundamental frequency RMS P-E voltage fundamental frequency RMS
Pick-up	
Pick-up current setting (point 1 &2)	0.10…40.00 x In, setting step 0.01 x In
Pick-up voltage setting (point 1 &2)	0.00…150.00 %Un, setting step 0.01 %Un
Inaccuracy -Current -Voltage	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET) ±1.5 %USET or ±30 mV
Operation time	
Definite time function operating time setting	 0.00…1800.00 s, setting step 0.005 s
Inaccuracy -Definite Time (Im/Iset ratio > 3) -Definite Time (Im/Iset ratio 1.05…3)	 ±1.0 % or ±20 ms ±1.0 % or ±30 ms
IDMT operating time setting (ANSI / IEC)	0.02…1800.00 s, setting step 0.001 x parameter
IDMT setting parameters k Time dial setting for IDMT A IDMT Constant B IDMT Constant C IDMT Constant	 0.01…25.00 step 0.01 0…250.0000step 0.0001 0…5.0000 step 0.0001 0…250.0000step 0.0001
Inaccuracy -IDMT operating time -IDMT minimum operating time; 20 ms	 ±1.5 % or ±20 ms ±20 ms
Instant operation time	
Start time and instant operation time (trip): (Im/Iset ratio > 3) (Im/Iset ratio 1.05…3)	 <35 ms (typical 25 ms) <50 ms
Reset	
Reset ratio -Current	 97 % of pick-up current setting
Reset time setting Inaccuracy: Reset time	0.010 … 10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Power factor (55) PF<

Input signals	
Input magnitudes	Phase current fundamental freq RMS P-E or PP voltage fundamental frequency RMS
Pick-up	
Pick-up P.F. setting	0.00…0.99, setting step 0.01
Inaccuracy -P.F. (when U > 1.0 V and I > 0.1 A)	 ±0.001
Operation time	
Definite time function operating time setting	 0.00…1800.00 s, setting step 0.005 s
Inaccuracy -Definite Time (Least 0.01 below setting)	 ±1.0 % or ±30 ms
Instant operation time	
Start time and instant operation time (trip):(Least 0.01 below setting)	 <50 ms
Reset	
Reset ratio	1.03 of P.F. setting
Reset time	<50 ms

Note! Minimum voltage for P.F. calculation is 1.0 V secondary and minimum current is 0.1 A secondary.

Neutral 3rd harmonic under voltage (64S) U03RD<

Input signals	
Input voltage magnitudes	Zero sequence voltage fundamental freq RMS
Pick-up	
Pick-up voltage setting	5.00…95.00 %U0n, setting step 0.01 %U0n
Inaccuracy -U03rd	 ±1.0 %U0SET
No load block	
In use toggle	No / Yes
No load –current setting	0.10…0.50 x In, setting step 0.01 x In
Operation time	
Definite time function operating time setting	 0.00…1800.00 s, setting step 0.005 s
Inaccuracy -Definite Time (Im/Iset ratio 0.95)	 ±1.0 % or ±30 ms
Instant operation time	
Start time and instant operation time (trip): (Um/Uset ratio 0.95)	 <50 ms
Reset	
Reset ratio	103 % of pick-up voltage setting
Reset time setting Inaccuracy: Reset time	0.010 … 150.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

Note! Even one phase current is enough to fill the no load block –condition.

TRANSFORMER PROTECTION FUNCTIONS

Transformer thermal overload (49TR) TR>

Input current magnitude	Phase current TRMS max (31 harmonic)
Time constants τ	1 heating, 1 cooling
Time constant value	0.0…500.00 min by step of 0.1 min
Service factor (max overloading)	0.01…5.00 by step of 0.01 x In
Thermal model biasing	Ambient temperature (Set -60.0 … 500.0 deg by step of 0.1 deg and RTD) Negative sequence current
Thermal replica temperature estimates	Selectable deg C or deg F
Outputs	Alarm 1 (0…150% by step of 1%) Alarm 2 (0…150% by step of 1%) Thermal Trip (0…150% by step of 1%) Trip delay (0.000…3600.000s by step of 0.005s) Restart Inhibit (0…150% by step of 1%)
Inaccuracy Starting Operating time	 ±0.5% of set pick-up value ±5 % or ± 500ms

Transformer differential Idb>, Idi>,I0dHV>,I0dLV> (87T,87N)

Input magnitudes	Phase currents from HV (IL1, IL2, IL3) and LV (I'L1, I'L2, I'L3) sides. For REF protection stages fundamental residual current measurements from inputs I01 and I02 from both sides. Fundamental, 2nd and 5th harmonics.
Features	Percentage (biased) differential with settable pickup, 2 turnpoints and 2 slopes. Non-biased and non-blocked second stage. Low impedance REF for 2 sides with independent percentage (biased) operating characteristic (identical to phase fault characteristics).
Settings	
Differential calculation mode	Add or Subtract. Depends of the current direction in CTs.
Bias calculation mode	Average or maximum. Depends of the desired sensitivity/stability requirements.
Idb> Pick-up	0.01…100.00% by step of 0.01%, Default 10.00%
Turnpoint 1	0.01…50.00xIn by step of 0.01xIn, Default 1.00xIn
Slope 1	0.01…250.00% by step of 0.01%, Default 10.00%
Turnpoint 2	0.01…50.00xIn by step of 0.01xIn, Default 3.00xIn
Slope 2	0.01…250.00% by step of 0.01%, Default 200.00%
Idi> Pick-up	200.00%...1500.00% by step of 0.01%, Default 600.00%
Internal harmonic blocking selection	None, 2nd harmonic, 5th harmonic, both.
2nd harmonic blocking Pick-up	0.01…50.00% by step of 0.01%, Default 15.00%
5th harmonic blocking Pick-up	0.01…50.00% by step of 0.01%, Default 35.00%
Outputs	Biased differential Idb> trip Biased differential Idb> blocked Non-biased differential Idi> trip Non-biased differential Idi> blocked 2nd harmonic blocking active 5th harmonic blocking active
Operating time	Typically 25 ms with harmonic blockings enabled Typically 15 ms without harmonic blockings
Inaccuracy Differential current detection Operating time	 ±3% of set pick-up value > 0.5 x In setting. 5 mA < 0.5 x In setting ± 5ms from the beginning of the fault

Transformer monitoring function (TRF)

Control scale	Common transformer data settings for all functions in transformer module, protection logic, HMI and IO.
Features	Status hours counters (normal load, overload, high overload) Transformer status signals Transformer data for functions
Settings	Transformer application nominal data
Outputs	Light /No load (Im < 0.2xIn) Inrush HV side detected (Im < 0.2xIn → Im >1.3 xIn) Inrush LV side detected (Im < 0.2xIn → Im >1.3 xIn) Load normal (Im > 0.2xIn… Im <1.0 xIn) Overloading (Im > 1.0xIn… Im <1.3 xIn) High overload (Im > 1.3xIn)
Inaccuracy Current detection Detection time	 ±3% of set pick-up value > 0.5 x In setting. 5 mA < 0.5 x In setting ±0.5 % or ±10 ms

CONTROL FUNCTIONS

Synchrocheck (25) SYN1, SYN2, SYN3

Input signals	
Input magnitudes	P-P voltage fundamental frequency RMS P-E voltage fundamental frequency RMS
Pick-up	
U diff < setting	0.02…50.00 %Un, setting step 0.01 %Un
Angle diff < setting	1.0…90.0 deg, setting step 0.10 deg
Freq diff < setting	0.05…0.50 Hz, setting step 0.01 Hz
Inaccuracy Voltage Frequency Angle	 ±1.5 %USET or ±30 mV ±15 mHz (U > 30 V secondary) ±0.15 ° / ±1.5 °(U > 15 V / U = 1…15 V)
Reset	
Reset ratio Voltage Frequency Angle	 +0.003 %Un to U diff < setting 0.02 Hz 0.2 °
Activation time	
Activation (frequency measured) Activation (frequency not measured)	<30 ms <60 ms
Reset	<35 ms
Bypass modes	
Voltage check mode (excluding LL)	LL+LD, LL+DL, LL+DD, LL+LD+DL, LL+LD+DD, LL+DL+DD, bypass
U live > limit U dead < limit	0.10…100.00 %Un, setting step 0.01 %Un 0.00…100.00 %Un, setting step 0.01 %Un

Autoreclosing function (79) 0 → 1

Input signals	
Input signals	Software signals (Protection, Logics, etc.) GOOSE messages Binary inputs
Requests	
REQ1-5	5 priority request inputs, possibility to set parallel signals to each request
Shots	
1-5 shots	5 independently –or scheme controlled shots in each AR request
Operation time	
Operating time setting Lockout after successful AR Object close reclaim time AR shot starting delay AR shot dead time delay AR shot action time AR shot specific reclaim time	0.00…1800.00 s, setting step 0.005 s
Inaccuracy	±1.0 % or ±30 ms

Cold load pick-up CLP

Input signals	
Input magnitudes	Phase current fundamental freq RMS
Pick-up	
Pick-up current setting I Low / I High / I Over	 0.10…40.00 x In, setting step 0.01 x In
Reset ratio	97 / 103 % of pick-up current setting
Inaccuracy Current	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET)
CLP act release (actual block release)	
Release time (act): (Im/I_High ratio > 1.05	<35 ms
CLP activation time	
Activation time (act): (Im/I_Low ratio < 0.95)	<45 ms
Operation time	
Definite time function operating time setting CLPU tset / CLPU tmax / CLPU tmin	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Im/Iset ratio > 1.05)	 ±1.0 % or ±30 ms

Switch on to fault SOTF

Definite time function operating time setting for activation time	0.000…1800.000 s, setting step 0.005 s
Inaccuracy Starting Definite Time operating time	 ±5 ms from received init signal. ±0.5 % or ±10 ms

Object control

Input signals	Binary inputs Software signals GOOSE messages
Output signals	Close command output Open command output
Definite time function operating time setting for all timers	0.00…1800.00 s, setting step 0.02 s
Inaccuracy Definite Time operating time	 ±0.5 % or ±10 ms

Set group settings

Setting groups	8 independent control prioritized setting groups
Control scale	Common for all installed functions which support setting groups
Control mode Local Remote	 Any digital signal available in the device Force change overrule of local controls either from setting tool, HMI or SCADA
Reaction time	<5 ms from receiving the control signal

MONITORING FUNCTIONS

Fault locator (21FL) X → km

Input signals	
Input magnitudes	Phase current fundamental freq RMS
Pick-up	
Trigger current >	0.00…40.00 x In, setting step 0.01 x In
Inaccuracy Triggering	 ±0.5 %ISET or ±15 mA (0.10…4.0 x ISET)
Reactance	
Reactance per kilometer	0.000…5.000 s, setting step 0.001 ohm/km
Inaccuracy Reactance	 ±5.0 % (Typically)
Operation	
Activation	From trip signal of any protection stage
Minimum operation time	Least 0.040 s stage operation time required

Fuse failure (60) VTS

Input signals	
Measured magnitudes	P-P voltage fundamental frequency RMS P-E voltage fundamental frequency RMS
Pickup	
Pickup setting Voltage low pickup Voltage high pickup Angle shift limit	 0.05…0.50 x Un, setting step 0.01 x Un 0.50…1.10 x Un, setting step 0.01 x Un 2.00…90.00 deg, setting step 0.10 deg
Inaccuracy Voltage U angle(U > 1 V)	 ±1.5 %USET ±1.5 °
Digital input pickup (optional)	0 → 1 or inverse
Time delay for alarm	
Definite time function operating time setting	0.00…1800.00 s, setting step 0.005 s
Inaccuracy Definite Time (Um/Uset ratio > 1.05 / 0.95)	 ±1.0 % or ±35 ms
Instant operation time (alarm): (Um/Uset ratio > 1.05 / 0.95)	 <50 ms
Reset	
Reset ratio	97 / 103 % of pickup voltage setting
Reset time setting Inaccuracy: Reset time	0.010 … 10.000 s, step 0.005 s ±1.0 % or ±35 ms
Instant reset time and start-up reset	<50 ms

CB wear	
Breaker characteristics settings: Nominal breaking current Maximum breaking current Operations with nominal current Operations with maximum breaking current	 0.00…100.00 kA by step of 0.001 kA 0.00…100.00 kA by step of 0.001 kA 0…200000 Operations by step of 1 Operation 0…200000 Operations by step of 1 Operation
Pick-up setting for Alarm 1 and Alarm 2	0…200000 operations, setting step 1 operation
Inaccuracy for current/operations counter Current measurement element Operation counter	 0.1xIn > I < 2 xIn ±0.2% of measured current, rest 0.5% ±0.5% of operations deducted

Disturbance recorder	
Sample rate	8, 16, 32 or 64 sample / cycle
Recording length	0.1…1800, setting step 0.001 Maximum length according chosen signals
Amount of recordings	0…1000, 60MB shared flash memory reserved Maximum amount of recordings according chosen signals and operation time setting combined
Recorder analogue channels	0…9 channels Freely selectable
Recorder digital channels	0…96 channels Freely selectable analogue and binary signals 5ms sample rate (FFT)

AQ 200 SERIES TESTS AND ENVIRONMENTAL CONDITIONS

ELECTRICAL ENVIRONMENT COMPATIBILITY

Disturbance tests	
All tests	CE approved and tested according to EN 50081-2, EN 50082-2
Emission Conducted (EN 55011 class A) Emitted (EN 55011 class A)	 0.15 - 30 MHz 30 - 1 000 MHz
Immunity Static discharge (ESD) (According to IEC244-22-2 and EN61000-4-2, class III) Fast transients (EFT) (According to EN61000-4-4, class III and IEC801-4, level 4) Surge (According to EN61000-4-5 [09/96], level 4) RF electromagnetic field test (According. to EN 61000-4-3, class III) Conducted RF field (According. to EN 61000-4-6, class III)	 Air discharge 15 kV Contact discharge 8 kV Power supply input 4kV, 5/50ns other inputs and outputs 4kV, 5/50ns Between wires 2 kV / 1.2/50µs Between wire and earth 4 kV / 1.2/50µs f = 80….1000 MHz 10V /m f = 150 kHz….80 MHz 10V

Voltage tests	
Insulation test voltage acc- to IEC 60255-5	2 kV, 50Hz, 1min
Impulse test voltage acc- to IEC 60255-5	5 kV, 1.2/50us, 0.5J

PHYSICAL ENVIRONMENT COMPATIBILITY

Mechanical tests	
Vibration test	2 … 13.2 Hz ±3.5mm 13.2 … 100Hz, ±1.0g
Shock/Bump test acc. to IEC 60255-21-2	20g, 1000 bumps/dir.

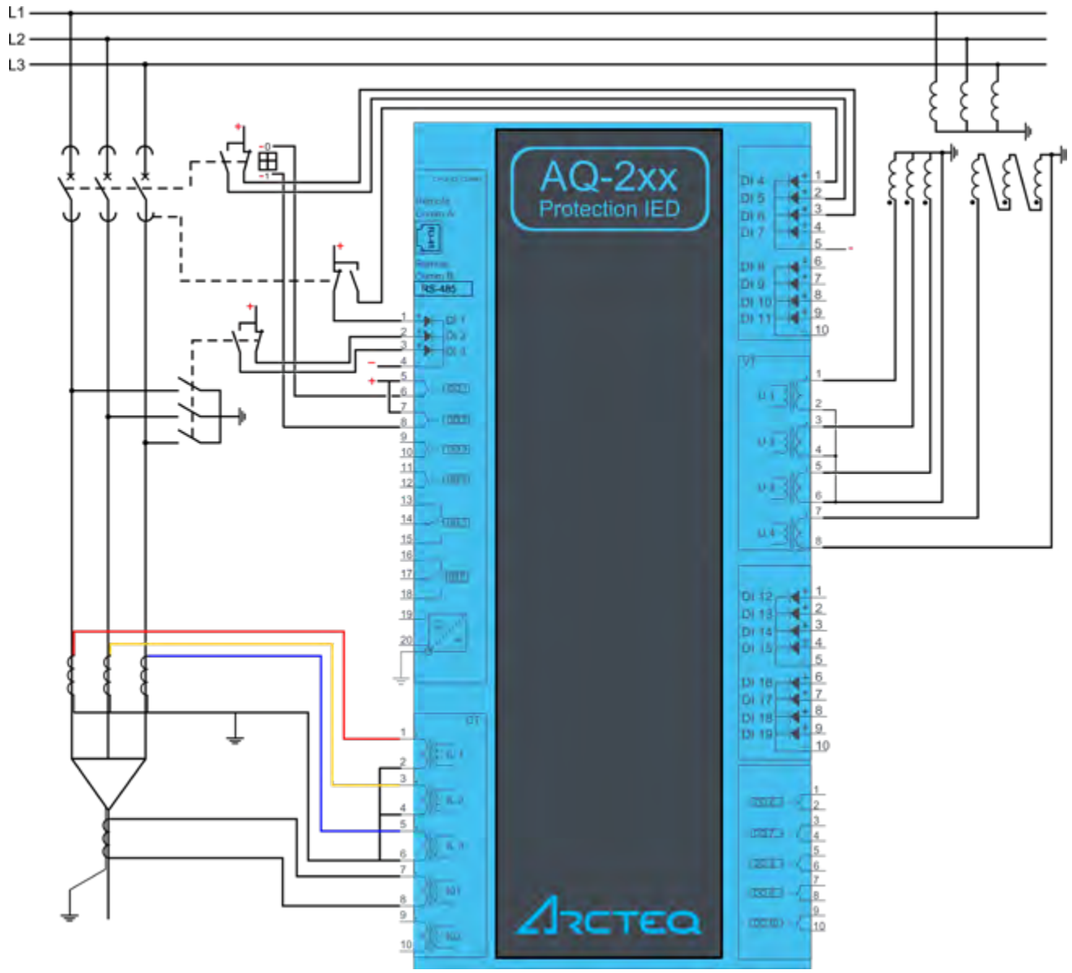
Environmental tests	
Damp Heat	IEC 60068-2-30
Dry Heat	IEC 60068-2-2
Cold Test	IEC 60068-2-1

Environmental conditions	
Casing protection degree	IP54 front IP21 rear
Ambient service temperature range	-35…+70°C
Transport and storage temperature range	-40…+70°C

CASING AND PACKAGE

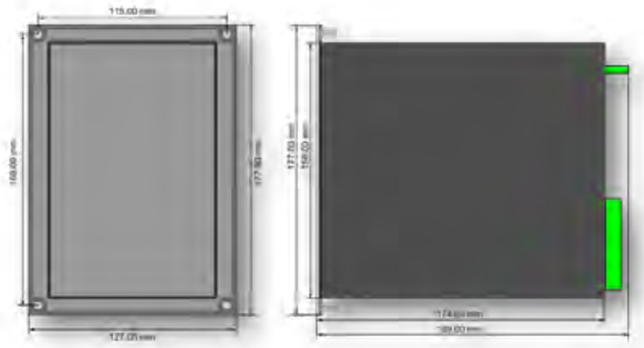
Dimensions and weight	
Device dimensions (W x H x D mm)	Casing height 4U, width ¼ rack, depth 210 mm
Package dimensions (W x H x D mm)	230(w) x 120(h) x 210(d) mm
Weight	Device 1.5kg In package 2kg

TYPICAL WIRING DIAGRAM

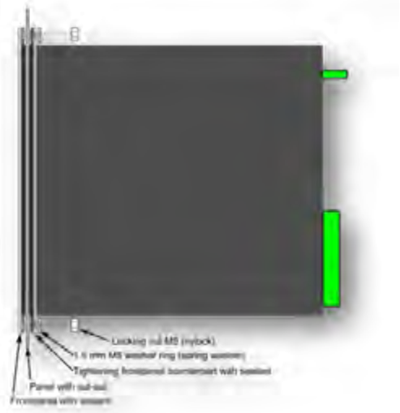


AQ-200 series IED typical wiring diagram illustrated with 3 phase and residual current measurement along with 3 phase to neutral and residual voltage measurements. Other alternative connections are available, for example with phase to phase voltage and synchrocheck reference voltage connections. All analogue channel measurement mode settings, polarities and nominal values can be conveniently changed by software. For details refer to corresponding instruction manual.

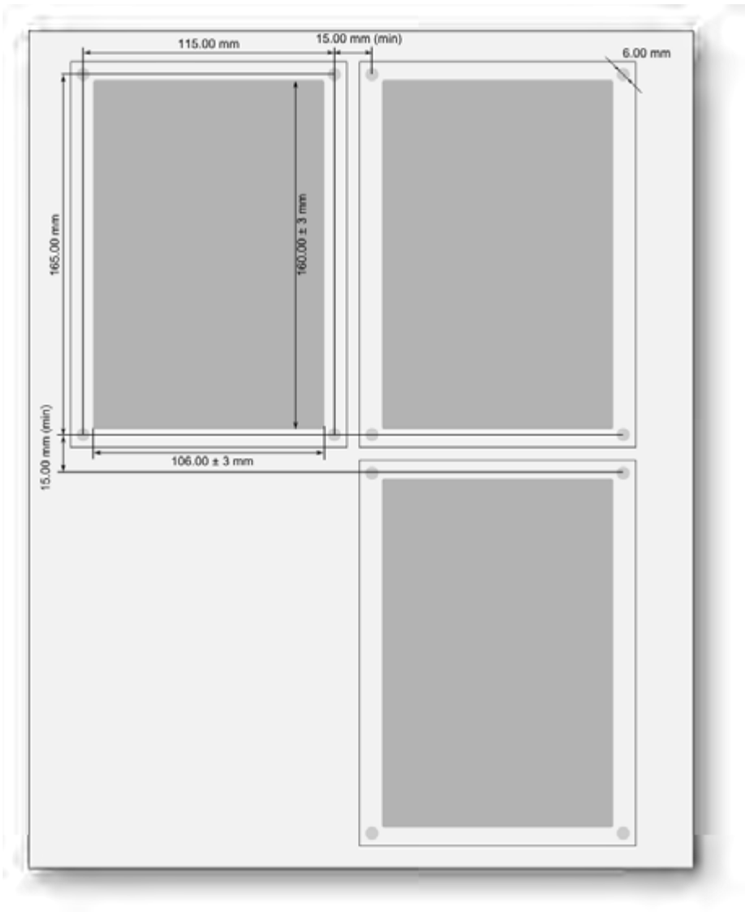
AQ-210 INSTALLATION AND DIMENSIONS



Dimensions of the AQ-21x IED.

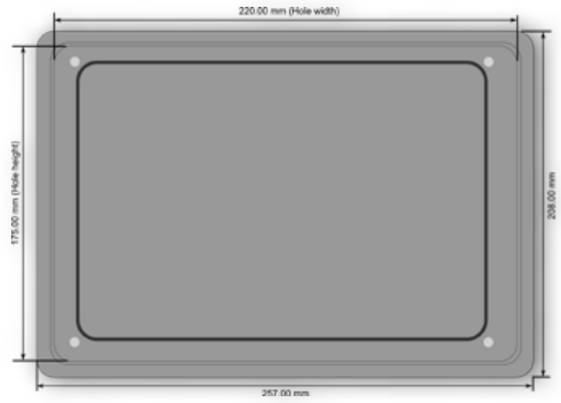


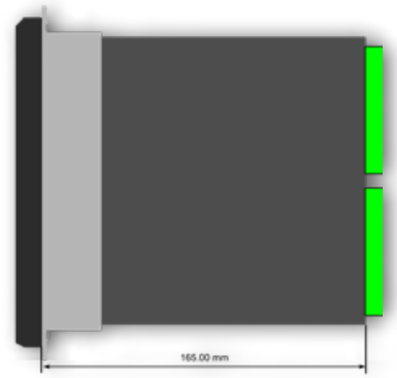
Installation of the AQ-21x IED



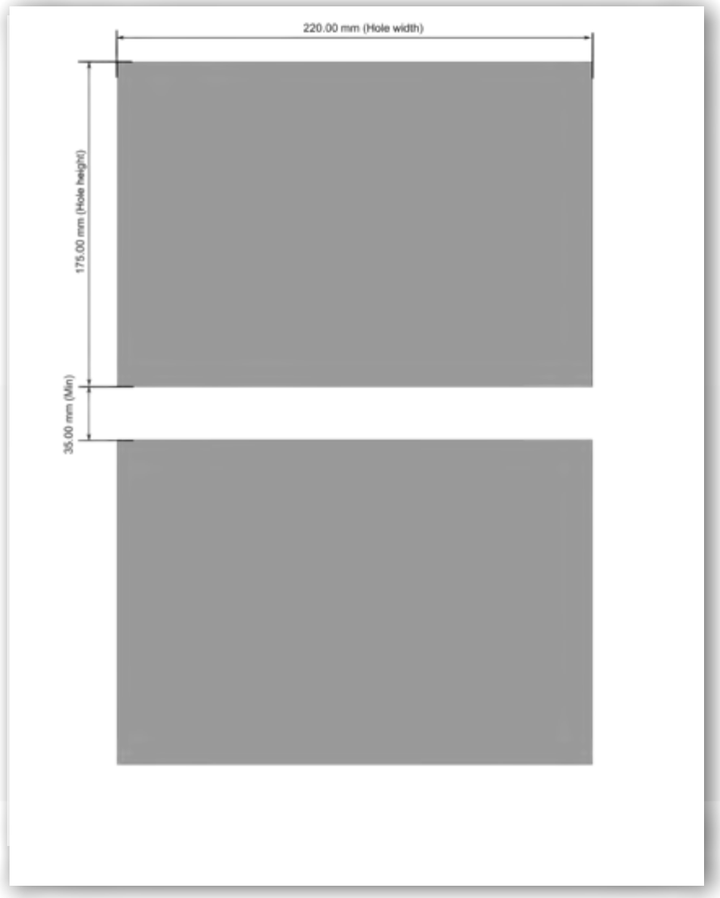
Panel cut-out and spacing of the AQ-21xx IED.

AQ-250 INSTALLATION AND DIMENSIONS

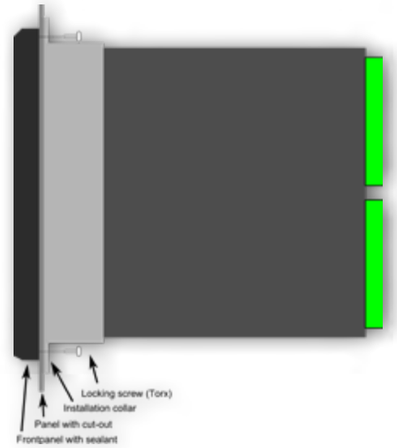




Dimensions of the AQ-25x IED.



Panel cut-out and spacing of the AQ-25x IED.



Installation of the AQ-25x IED

ORDER CODE

GENERIC TYPE DESIGNATION

AQ - X 2 X X X - X X X X X X X - X X X

IED model

F Feeder protection
G Generator protection
M Motor protection
P Power measurement
S Control, Transducer and Alarm + indication
T Transformer protection
V Voltage protection

Device size

1 1/4 of 19" rack

Analogue channels

0 5 Current measurement channels
1 4 Voltage measurement channels
4 No analog measurement
5 5 Current measurement channels and 4 voltage measurement channels
6 10 Current measurement channels
7 10 Current and 4 voltage

Functionality package

A Standard

Mounting

P Panel mounted

Auxiliary power supply

H 80...265 Vac/dc
L 18...72 Vdc

Extra I/O slots

A None
B 8 Binary inputs
C 5 Binary outputs
D Arc protection
F 8 x RTD input **
I 4 x mA outputs - 1 x mA input
J Double LC 100Mb Ethernet (Redundant) *
L Serial RS232 - Serial fiber (PP) *
M Serial RS232 - Serial fiber (PG) *
N Serial RS232 - Serial fiber (GP) *
O Serial RS232 - Serial fiber (GG) *

Reserved to future use

A N/A

Terminals and PCBs

A 3 Binary inputs, 24V nominal threshold
B 3 Binary inputs, 110V nominal threshold
C 3 Binary inputs, 220V nominal threshold

PCBs (Not available)

A Standards
B Conformal coating (PCBs)

Terminals

A Standard
B Ring lug terminals ***

Measurement accuracy class

0 Power/Energy measurement accuracy class 0.5
2 Power/Energy measurement accuracy class 0.2S
8 N/A

** One card at most per IED*
*** Two cards at most per IED (F option cards that have been delivered prior to 2022 also have a valid 2 × mA input).*
**** Consult for product availability*

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RELAYABLE POWER

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