AQ 100 Series
Arc Flash Protection System
THE CONSEQUENCES OF AN ARC FAULT IN HIGH VOLTAGE SWITCHGEAR
Arc Phenomena
Arc Phenomena

Arc fault - facts

Most devastating type of fault in a MV and LV switchgear

- Current flow through ionized air -> plasma

- Most arc faults are caused by human errors.

- 80% of un-forced arc faults starts in the cable compartment as a phase to ground or phase to phase arc fault.

- A single phase arc fault develops fast to a three phase low impedance high power arc fault.
Arc Phenomena

Reasons

- Human errors
  - accidental touching
  - accidental dropping of tools
  - working in “wrong” feeder

- Mechanical failure – part falling
- Lose connections (bar-bar ; bar-cable)
- Vibrations
- Insulation failure
- Dust & Impurities buildup
- Condensation
- Corrosion
- Animals
- Forgotten parts / tools
- Over-voltage stress - narrow gap
Arc Phenomena

PHASE 1:- COMPRESSION (10….30ms)
- Current flow through ionized air
- Plasma effect
- Rapid release of energy
- Strong light emission

PHASE 2:- EXPANSION (20….50ms)
- Copper expands 67 000 times when vaporized (1.5cl -> 1m²)
- Shock/Pressure wave, 4 bar in a few ms
- Sound wave

PHASE 3:- EMISSION (50….100ms)
- 80% of energy heat radiation, 20 000 ºC
- Wide radiation spectra

PHASE 4:- THERMAL OR ‘BURN-THROUGH’ (100….300ms)
- Spray of molten metal droplets
- Hot shrapnel flying in all directions
- Toxic gases (CuO2)
- Steel and copper fire
Arc Phenomena

600V, 65kA, 300ms
Arc Phenomena

Arc pressure and temperature curve

T / P
20,000 °C

2Bar

Temperature [°C]

Pressure [Bar]

10 20 30 100

t/ms

3A0712 cubicle (Bus 3A07 feeder from UAT)
Arc Phenomena

Result

- It may cause safety hazard to personnel through radiation, thermal convection, arc blast and flying particles, and toxic impact.

- The economic consequences are often very significant.

- Direct damage to equipment causes often only a fraction of the total costs.

- Indirect costs due to long interruption of processes can be quite substantial, not to forget the possible medical and legal expenses, if there are humans involved.
Why Arc Protection?

- Save Lives
- Extend lifetime of old switchgear
- Safe and reliable distribution
- Over current protection tripping time is typically 200…500ms
- Phase to ground arc fault cannot be protected by E/F protection relay where tripping time can be seconds!
- Arc protection gives a 100% selective trip of the faulty zone ALWAYS with a tripping time of less than 7ms including earth faults (Io>arc)

Arc Phenomena

TOO SLOW

40kA, 12kV
60ms total arc clearing time

40kA, 12kV
300ms total arc clearing time
AQ 100 Series
AQ 100 Series

Characteristics of arc protection

• Speed, no intentional delays
• Sensitive, current set-points just above loads sensitive ground-fault set points
• Selectivity, trip only affected feeder(s)
• Secure, dual-sensing prevents false trips
• FULL self-supervision
AQ 100 Series

Provides you

- Speed
- Reliability
- Flexibility
- Simplicity
AQ 100 Series

Speed
- 7ms Tripping time regardless if incomer or outgoing feeder
- 2ms with High Speed Output
Reliability

- EMC tested according to IEC 60255 (protection relay standard)
- Full self-supervision with non-volatile memory including:
  - All sensor
  - Wiring and unit interconnections
  - CT connections
  - Internal electronics
  - Output relays
  - Output relays
  - Power supply
  - Dipswitches

- Each unit has own built-in power supply
- Total isolation for high EMC levels
- Supports long distances between units
- Hard-wired communication between units
AQ 100 Series

Flexibility

- Scalable from small stand alone systems to multi zone full selective schemes.
- Daisy chained Arc sensor installation up to 200m
AQ 100 Series

Simplicity

- Standard Arc Schemes AQ-SAS™:
  pre-tested schemes with setting and wiring instructions
  from instruction booklet according to your specific application

- No external multiplying- or lockout relays needed. Everything “on board”

- Auto configuration
  unit configures itself with touch of one push button

- Single push button operation
AQ 100 series units

- **AQ 110P**
  - Current, point sensor and trip unit

- **AQ 110F**
  - Current, fiber loop sensor and trip unit

- **AQ 101**
  - Point sensor and trip unit

- **AQ 102**
  - Fiber loop sensor and trip unit

- **AQ 01, AQ 06, AQ 07**
  - Fiber loop sensors
Arc sensors

AQ 01 – Arc light point sensor

AQ 06 – Arc light plastic fiber sensor

AQ 07 – Arc light glass fiber sensor
AQ 01

AQ 01 sensor

- Arc light point sensor unit
- Maximum 3 sensors in line (up to 100m line)
- Snap-in cable connector for quick installation
- Shielded cable connection
- IP 61 mechanical protection
- EMC compatible with IEC60255-22-4 (Fast transient 4kV)
- Vibration proof
AQ 01

AQ 01 sensor

- 3 sensors in one line (up to 100m line) = easy wiring
- Plug-in cable connector for = easy and fast installation
- Self-supervision including photodiode (light pulse) = 100% self-supervision
AQ 100 Series

- Compact size
- Novel current sensing technology
- Multi drop arc point sensor support
- Optimized cost structure
- Single push button operation
- Customizable text pocket for LEDs
- Fully non-volatile indications
- Wide range auxiliary power supply
- Up to 4 trip output in each unit
- Complies with the Protection Relay Standard
AQ 101 Point Sensor Unit

LED indication
- Power LED
- Error LED (full self-supervision)
- Sensor activation
- Trip indication
- Binary input activations (2 pcs)
- Binary output activation

Push button:
- Installation of device
- Reset of activations

Text pocket
- for LED dependent customer texts
AQ 101 Point Sensor Unit

Inputs

- 4 Arc sensor inputs (max 3 sensors / input)
- 2 x Binary inputs (threshold 24/110/220 Vdc)
- Wide range power supply, 24...80Vdc / 80...240Vac/dc
- Arc fiber loop sensor (optional)
- Dedicated smoke sensor input (occupies one sensor input)

Outputs

- 3 Selective trip relays outputs (T1-T3)
- 1 Lock-out relay (safety loop) or trip relay (T4)
- 1 Self-supervision alarm relay (CO)
- 1 Binary output (configurable L> or TRIP, 0V / 24Vdc)
AQ 102 Fiber Sensor Unit (available Q2/2011)

LED indication:
- Power LED
- Error LED (full self-supervision)
- Sensor activation
- Trip indication
- Binary input activations (2 pcs)
- Binary output activation

Push button:
- Installation of device
- Reset of activations

Text pocket
- for LED dependent customer texts
Inputs:
- 3 Fiber loop sensor channels
- 2 x Binary inputs (threshold 24/110/220 Vdc)
- Wide range power supply, 24...80Vdc / 80...240Vac/dc

Output:
- 3 Selective trip relays outputs (T1-T3)
- 1 Lock-out relay (safety loop) or trip relay (T4)
- 1 Self-supervision alarm relay (CO)
- 1 Binary output (configurable L> or TRIP, 0V / 24Vdc)
AQ 110P Current and Point Sensor Unit

LED indication
- Power LED
- Error LED (full self-supervision)
- Sensor activation
- I> pick up (separate for each phase)
- Io> Pick up
- Binary input activations (2 pcs)
- Binary output activation
- High Speed Output (HSO) activation (2 pcs)
- Trip indication (T1, T2, T3 and T4)

Push button:
- Installation of device (press for 3s.)
- Reset of activations

Text pocket
- for LED dependent customer texts
AQ 110P Current and Point Sensor Unit

Inputs:
- 3 current inputs (1A / 5A)
- Io input (1A / 5A)
- 4 Arc sensor inputs (3 sensors / channel)
- 1 fiber sensor channel (optional)
- 2 x DI
- Wide range power supply, 24...80Vdc alt. 80...240Vac/dc

Outputs:
- 4 Trip relays
- 2 High Speed Outputs (HSO) *
- 1 Lock out relay (option)
- 1 Self-supervision alarm relay (CO)

* Can be used as 2ms Trip Outputs
AQ 110F Current and Fiber Sensor Unit (Q2/2011)

LED indication
- Power LED
- Error led (full self-supervision)
- Sensor activation
- I> pick up (separate for each phase)
- Io> Pick up
- Binary input activations (2 pcs)
- Binary output activation
- HSO activation (2 pcs)
- Trip indication (T1 and T2)

Push button:
- Installation of device (press for 3s.)
- Reset of activations

Text pocket
- for LED dependent customer texts
Inputs
- 3 current inputs (1A / 5A)
- Io input (1A / 5A)
- 3 Fiber loop sensor channels
- 1 fiber output (optional)
- 2 x DI
- Wide range power supply, 24...80Vdc alt. 80...240Vac/dc

Outputs
- 4 Trip relays
- 2 High Speed Outputs (HSO) *
- 1 Lock out relay (option)
- 1 Self-supervision alarm relay (CO)

* Can be used as 2ms Trip Outputs
# Product features

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<th>Features</th>
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<th>AQ 110P</th>
<th>AQ 102</th>
<th>AQ 101</th>
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<tr>
<td>Wide range power supply (18-72Vdc or 80-265Vac/dc)</td>
<td>✔️</td>
<td>✔️</td>
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<td>3 phase current detection (1/5A)</td>
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<td>Residual current detection (1/5A)</td>
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<tr>
<td>Max number of point sensors</td>
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<td>12</td>
<td>12</td>
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<tr>
<td>Max number of fiber loop sensors</td>
<td>3</td>
<td>1 (option)</td>
<td>3</td>
<td>1 (option)</td>
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<td>Connectivity to AQ 2000 arc quenching system</td>
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<tr>
<td>High Speed Outputs (2ms trip time)</td>
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<tr>
<td>Number of trip relays (7ms trip time)</td>
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<td>System failure relay</td>
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<tr>
<td>Binary outputs (24Vdc)</td>
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<tr>
<td>Binary inputs (24V/10/220Vdc)</td>
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<td>Push button</td>
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<tr>
<td>Non-volatile memory</td>
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<tr>
<td>Indication LEDs</td>
<td>20</td>
<td>20</td>
<td>12</td>
<td>12</td>
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</table>

*Optionally one normally closed electronic lock-out/trip relay available*
Applications

Using the Standard Arc Schemes

AQ-SAS™
Applications

AQ-SAS™

SS:2A
One Incomer Scheme

SAS™ Ia1*

Selective Feeder Trip

- MV application
- Point sensors
- Selective feeder trip
- Master trip
- Full CBFP

*) Included in AQ SAS Instruction Booklet
One Incomer Scheme

SAS™ Ib1*

Non-selective Feeder Trip

- MV/LV application
- Point sensors
- Master trip
- Full CBFP

*) Included in AQ SAS Instruction Booklet
One Incomer Scheme

SAS™ Ib1*

Non-selective Feeder Trip

- MV/LV application
- Point sensors
- Master trip
- Full CBFP

*) Included in AQ SAS Instruction Booklet
One Incomer Scheme

SAS™ Ib1*

Non-selective Feeder Trip

- LV and MV applications
- Fiber loop solution
- Master trip
- Full CBFP

*) Included in AQ SAS Instruction Booklet
2 Incomer 1 Tie breaker Scheme

- MV application
- Point sensors
- Selective feeder trip
- Master trip
- Full CBFP

*) Included in AQ SAS Instruction Booklet
2 Incomer 1 Tie Breaker Scheme

- MV application
- Point sensors
- Master trip
- Full CBFP

*) Included in AQ SAS Instruction Booklet
2 Incomer 1 Tie Breaker Scheme

- MV application
- Point sensors
- Master trip
- Full CBFP

*) Included in AQ SAS Instruction Booklet
Multi-Incomer Schemes

- MV application
- Point sensors
- Selective feeder trip
- Master trip
- Full CBFP
AQ 2000 -arc quenching system

✓ up to 17.5kV
✓ 40kA, 1s
Wind power application

- PMSG protection
- High temp fiber optic sensor AQ 08 applied to generator windings
- Inverter cabinet arc protection
- LV switchgear arc protection
TNB Double Busbar Scheme with Section Breaker
Conclusions

- Arcteq provides full arc protection and mitigation solution
- AQ 100 series can be used in low-end stand-alone applications and up to more complex and selective systems
- AQ saves significantly total project life cycle cost