ARC DETECTION SYSTEM FOR LV &MV SWGR'S

What is an Arc fault & how it will form?

Arcing fault is short circuit via ionized gas (air) between one live part and ground or between live parts. High power arc-flash faults can be characterized as electrical explosions. They release large amounts of energy in the form of radiant heat, intense light, and high pressure waves. The temperature of the plasma can reach 20, 000 K. The increase of the temperature expands the volume of the air causing a pressure wave. Because of the high temperature, circuit components can change physical state from solid to vapor. E.g. copper expands by a factor of 67, 000 in vaporizing, which significantly increases the pressure. In addition to danger caused by radiation, heat and pressure wave, there may be shrapnel and toxic gases, causing additional personnel hazard.

Why the arc detection system is necessary?

Majority of arc-flash faults in switchgear is caused by human errors. Entering into a live panel or field, careless use of tools or leaving temporary earth connected are common operating errors. Typical causes of arcing faults are loose connections, insufficient mechanical dimensioning, equipment malfunction, contamination or degradation of insulation, and animals.

Arcing faults cause both personnel hazard and significant economic losses due to damage to equipment and interruption of processes. To reduce this arc hazards Arc Detection is necessary.

What is an Arc detection system?

The arc detection system is nothing but it will detects an arc fault in the electrical network (LV & MV switchboard) & gives trip command to open the breaker, it will reduce the collateral damages for switchgear & personal hazard.

Methods of Arc detection

- Arc-resistant switchgear
- Bus differential protection
- Zone selective interlocking
- Current limiting devices
- Optical sensing based protection

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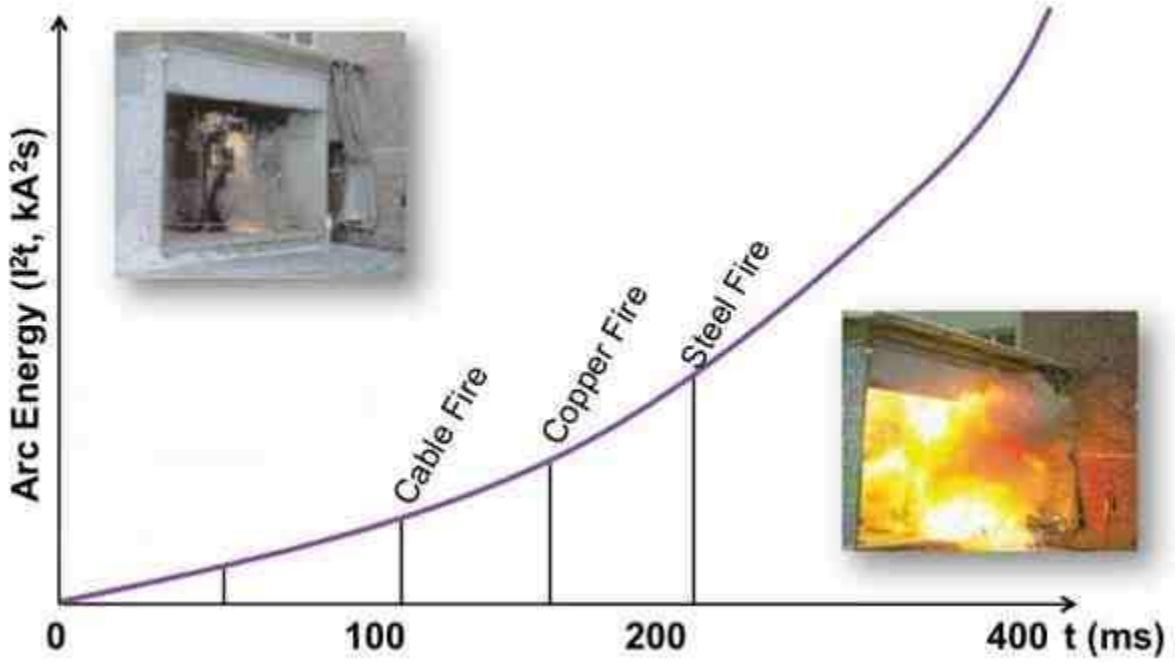
Traditional systems with Numerical Protection Relays can require 150 to 400 msec to detect the arc flash, signal the breaker to trip, and open the breaker. Arc Protection relays can reduce this time to approximately 50-100 msec. This can greatly reduce the amount of damaging energy because arc flash incident energy is linearly proportional to the duration of the arc flash. Please see below:



Also it is important to highlight that the arc fault current is usually less than the available bolted fault current, especially in low voltage systems the arcing current can be less than half of the bolted current and below the rating of circuit breakers. Unless these devices have been selected to handle the arc fault condition, they will not trip and the full force of an arc flash will occur. So basically you can have an arc fault but no trip by conventional system, only when it is too late.

So with optical arc flash protection less damage than traditional system. For traditional protection, it is possible to add more protection features such as bus differential relay protection and reduce time, but systems, mainly relevant for MV, get more complex and cost will go up compared to optical arc flash solution.

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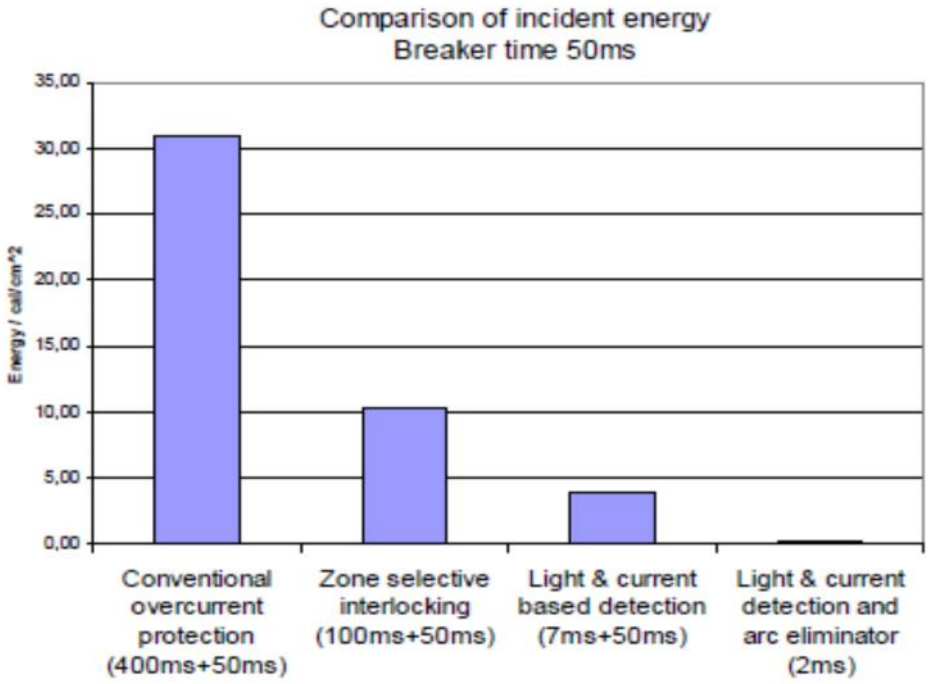

Comparison of incident energy of different protection methods.

A rule of thumb is that fault has to be cleared at 80-100 msec at the latest. Below is the result of an 50kA arc test. Left picture with conventional overcurrent protection (500ms) right picture with Light & Current based protection (50ms), so the difference is dramatic as you can see.

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Test result with 500ms arcing time **Test result with light and current based**

According to comparison of incident energy of different protection methods & Test results Optical sensor (Light & Current) based arc flash protection is clearing the fault at less time.

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MEYLE Make Optical sensor (Light & Current) based arc flash protection

An arcing fault produces instantaneously radiation that can be detected by analyzing visible light. Optical sensor based arc flash protection enables very short fault clearing time. In order to avoid false tripping, overcurrent condition is normally combined with light detection (dual sensing). Because majority of arc flash faults start as single phase faults, it is essential to measure the neutral current as well, because this way it is possible to clear the fault in its early stages.
The operation of the arc flash protection is based on simultaneous light and phase overcurrent or ground overcurrent conditions. For special purposes, “light only” condition can also be used.

Arc flash protection is usually implemented by separate system using arc flash detectors connected to dedicated arc protection relays. Overcurrent, earth fault etc. protection is carried out by other relays. A comprehensive, selective arc flash protection system comprises of arc flash sensors.

Arc flash sensors can be point sensors or fiber optic sensors. Selection of sensor type depends on the application. According to practical experience, fiber optic loops are cost effective to apply for low voltage switchgear or motor control center with multiple compartments.

Advantages of point sensors are easy new and retrofit installation and provision of exact fault location indication as sensors are installed in each protected compartment.

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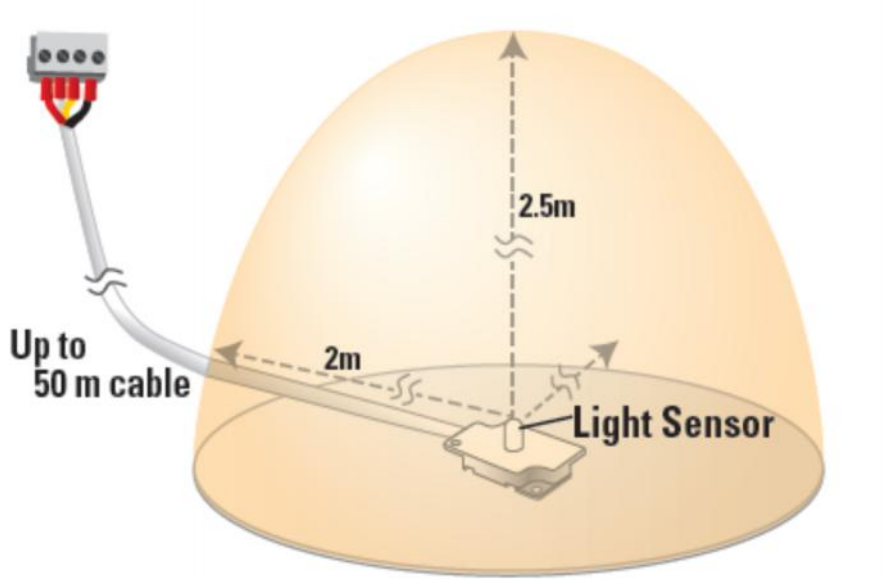
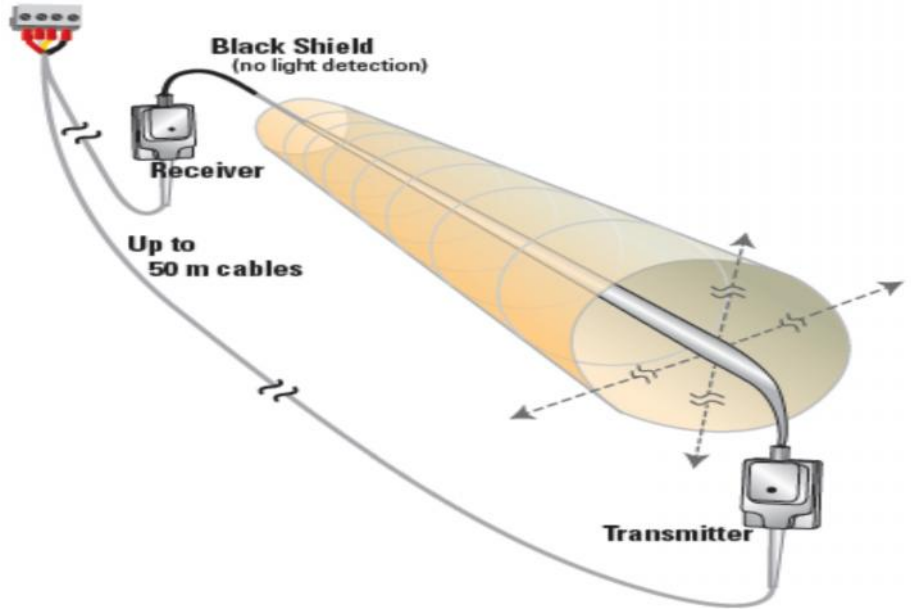
Regardless of the sensor type, it is essential that the arc flash protection system has self-supervision including the sensors and cables.

1. Point Sensor



The point sensor has a detection area of a 2-m half-sphere for arcs of 3 kA or more. A built-in LED verify the function of the light sensor, wiring, and electronics. If the does not detect the sensor-check LED, a sensor-fail alarm will occur, and the sensor LED will show short red flashing. The sensor includes 10 m of shielded three-wire electrical cable which can easily be shortened or extended to a maximum of 50 m.

2. Fiber Optic Sensor



The fiber-optic sensor has a 360° detection zone along the fiber's length, Each Sensor has a built-in LED which enables the control unit to verify the function of the fiber-optic light sensor, wiring, and electronics. If the relay does not detect the sensor-check LED, a sensor-fail alarm will occur, and the sensor LED will show short red flashing.

The fiber-optic sensors have three components:

1. A fiber-optic cable bundle terminating on both ends, one end covered with a black sleeve, and the other is uncovered. Both ends are terminated at the factory.
2. A transmitter with a white enclosure and a white thumb nut.
3. A receiver with a white enclosure, a black thumb nut, and an adjustment screw behind an access hole.

Both the receiver and the transmitter connect to a single input on the Control Unit using shielded three-wire electrical cable. The receiver and transmitter each include 10 m of shielded three-wire electrical cable that can easily be shortened or extended to a maximum of 50 m. All three components are monitored to ensure continuity and correct operation.

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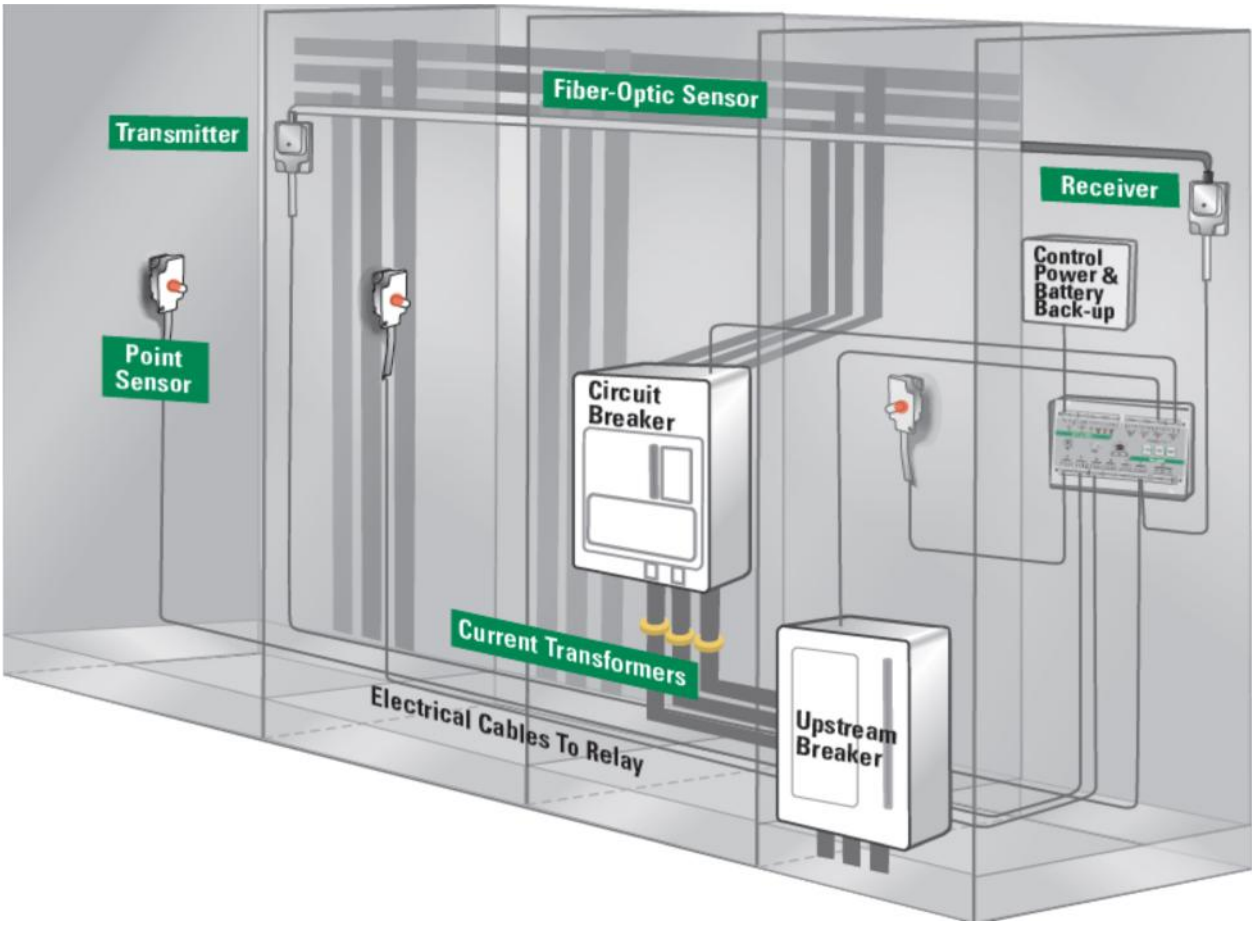
Examples for Sensor Placement



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