Internal Arc Monitoring System

MAI

Boherdi Electrónica S.R.L.

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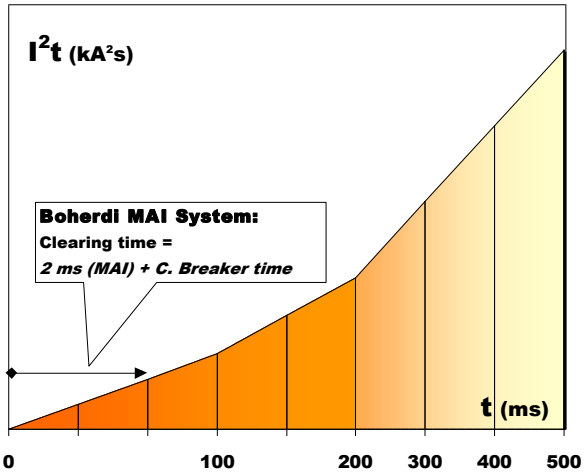
ELECTRONICA

In electrical installations, short circuits can be extremely hazardous. For this reason, steps are normally taken to minimize the consequences of this kind of faults. However, most of the measures taken only partly eliminate the risk of a short circuit, since they do not adequately cover arcing accidents.

Different causes that may lead to arcing accidents.

Human errors: installers working under stress may forget or drop something on live parts of an electric circuit.
Bad connections: a poor connection or a defective contact in a removable circuit breaker (caused by failures in the insertion system or poor maintenance) may cause generation of heat, which in the end leads to an arcing accident.
Animals: animals or vermin entering into electrical installations are very likely to cause short circuits with arcs.
Devices or materials faults: The degradation of insulating devices can cause the beginning of an arc fault.



Effective protection depends on immediate response.

An arc is developed within milliseconds and leads to the discharge of enormous amounts of energy. The energy discharged in the arc is directly proportional to the square of the short-circuit current and the time the arc takes to develop. Therefore, the damage resulting from an arcing accident depends on the arcing current and the time taken in clearing the failure. For a defined value of current, the only parameter we can work on is reducing the arcing time.

Damage evaluation depending on arcing time.

After the investigation of the evolution of the results of an arcing accident inside a switchgear We can identify four stages:
Compression: the arc energy is released into the air contained inside the cubicle causing a rapid build-up of pressure. This is developed during the first 5 to 15ms.
Expansion: the increase of pressure developed during the previous stage leads to the opening of the relief channels, releasing the air and consequently diminishing the pressure inside the cubicle. This takes from 5 to 15ms.
Expulsion: the pressure inside the cubicle decreases, but the hot air is still being expulsed under constant pressure. Temperature increases exponentially. Air release tends to stop when the air inside the cubicle reaches the arc temperature. This stage takes from 40 to 60ms.
Thermal stage: the extreme heat of the arc leads to the damage of the insulating materials. When the arc temperature reaches several thousands of ºC, the structure and conducting materials start melting. This stage lasts until the failure is cleared.

Internal arc test

During the thermal stage, approximately from 70 to 80ms after the arc start, occurs the major damage.

Consequences of arcing accidents

The arc leads to a rapid build-up of pressure and heat. The arc temperature may be over 10,000ºC.

The extreme heat of the arc leads to the burning of metals, which results in generation of toxic gases. The vast amounts of energy cause structural damage.
All this leads to considerable economic losses.

- Loss of production. Long downtimes are to be expected, due to the extensive damage often following an arcing accident.

Besides, if non-arc-proof switchgear is used, it may lead to:

- Risk of life for the workers.
- Injuries due to pressure, heat or the generation of toxic gases.
- Damage to equipment and buildings.

How normal protection works in arcing accidents

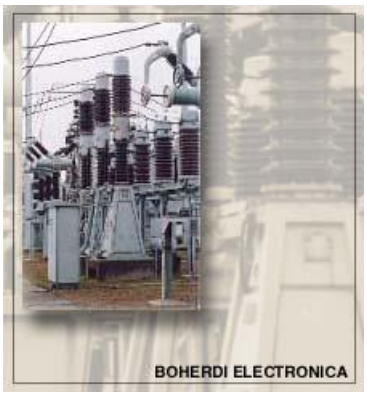
Normal short-circuit protection equipment has problems in detecting the arc fault before considerable damage has occurred. This is due to the fact that in an arc the resistance may be quite high, and consequently the current may not be very high.
The inability of breakers to eliminate the risk of arcing accidents is accentuated if, in order to achieve the required selectivity, the incoming breaker has been delayed by 150-200ms. During the delay time an arc may cause major damage.
Another case is when the incoming breaker is set at a high trip level in order to avoid nuisance tripping due to high inrush currents when energizing the transformer. The fault current upon the occurrence of an arc may be lower than the set level and the breaker then does not trip.

The answer is to extinguish the arc before severe damage arises.

Amazing results have been achieved thanks to the use of MAI System (Internal Arc Monitoring System) developed by Boherdi Electrónica. Thanks to a response time shorter than 2ms, it allows the clearance of the failure in 55-65ms depending on the breaker opening time.
The advantages are:

- Safety of the personnel even when switchgear door is open
- Reduced damage inside the cubicles
- Reduced downtime
- Reduced repair and reconstruction expenses

Reliability and support



Boherdi Electrónica is the leader in Arc Guard Systems in Argentina. We cover more than the 80% of the market with more than 300 systems already sold. Our systems have been working for over 10 years in the most important energy distributing companies.
Our products fulfill the most severe international standards and have been tested in well-recognized laboratories.
We offer pre and post selling service and technical advice.
Our products have acquired recognition throughout Latin American countries such as Brazil, Uruguay, Bolivia and Paraguay.

Internal Arc Monitoring System MAI

Boherdi Electrónica has developed a system that allows a significant reduction of the damage caused by an arcing accident.

By using Boherdi's Internal Arc Monitoring System, combined with last generation breakers the total disconnection time can be reduced to less than 55ms.

How it works

The purpose of the Internal Arc Monitoring System is to quickly disconnect the switchgear directly after an arcing fault. The system, through its optical detectors detects any large increase in light intensity. When an arc is detected, the Internal Arc Monitoring System sends a trip signal directly to the power breakers. This guarantees the shortest time of arc beyond any delay caused by relay protection or set delays due to selectivity.

Time of response

El Internal Arc Monitoring System is extremely quickly, sends a trip signal in approximately 1-2 ms. The total disconnection time depends on the kind of breaker used, but usually the total process takes less than 65ms.

Immunity and reliability

In the environment of switchgear and other electrical installations, elevated electromagnetic fields are common, especially in the event of a fault. Our Internal Arc Monitoring System has been designed to withstand the severest electromagnetic disturbances, and has satisfyingly passed electromagnetic compatibility tests under international standards. Besides, the use of fiber optics for both, to receive light information from the optical detectors and the communication between the units of the system, allows a reliable and completely immune to electromagnetic disturbances functioning.

Easy Installation

The Internal Arc Monitoring System is easily installed in any type of electrical installation, new and old switchgear. The fiber optic cables can be installed without any concern about the power or control cabling since they are nonconductive and not sensitive to electrical or magnetic fields. The detectors have wide-angle lens, so their placement is not crucial. These detectors are placed in the ends of the fiber optic, one by each compartment to supervise. If It's necessary, after a fault for example, the detectors can be replaced without removing the whole fiber optic section installed.

More reliability. Monitor with current sensor

The optical detectors can react to other forms of intense light, such as the flashes of a camera or the light produced by an arc welder machine.
To avoid the loss of energy caused by undesired trips, it can be used an Internal Arc Monitoring System with current sensor unit. The use of this feature allows setting a current level right above the normal levels of operation. Below this preset level no trip is allowed.

Internal Arc Monitoring System MAI - Components:

Internal Arc Monitor MAI2-SC

- Pre setting tripping; by arc light or arc light and current.
- Led numerical display, shows the last input activated by arc light.
- 8 arc light inputs.
- 4 solid-state tripping outputs.
- 3 optical inputs, allows reception of over current information.
- 2 optical outputs, over current retransmission and arc light retransmission.
- 2 NO contacts indicating trip occurred.
- Internal supervision output.

Internal Arc Monitor MAI-CC

- Pre setting tripping by arc light or arc light and current.
- Three-phase current sensor board for 1 or 5 A nominal current, with adjustable over current setting.
- Led numerical display, shows the last input activated by arc light.
- 8 arc light inputs.
- 4 solid-state tripping outputs.
- 3 optical inputs, allows reception of over current information.
- 2 optical outputs, over current retransmission and arc light retransmission.
- 2 NO contacts indicating trip occurred.
- Internal supervision output

Optical mixer MO2.

- Simplifies the installation by transmitting the arc light from three detectors through a single output.
- 3 arc light optical inputs. (4 inputs optional.)
- 1 optical output, logical “OR” of the inputs.
- Internal supervision output.

Optical mixer MOD-S

- Simplifies the installation by transmitting the arc light from up to four detectors through a single output.
- 3 arc light optical inputs. (4 inputs optional.)
- 1 optical output, logical “OR” of the inputs.
- Internal supervision output.
- Reset/test button for manual reset or for test of indicators leds.
- Up to 4 leds indicates the last active input.
- Monostable output, allows remotely signalize arc in the cable compartment.

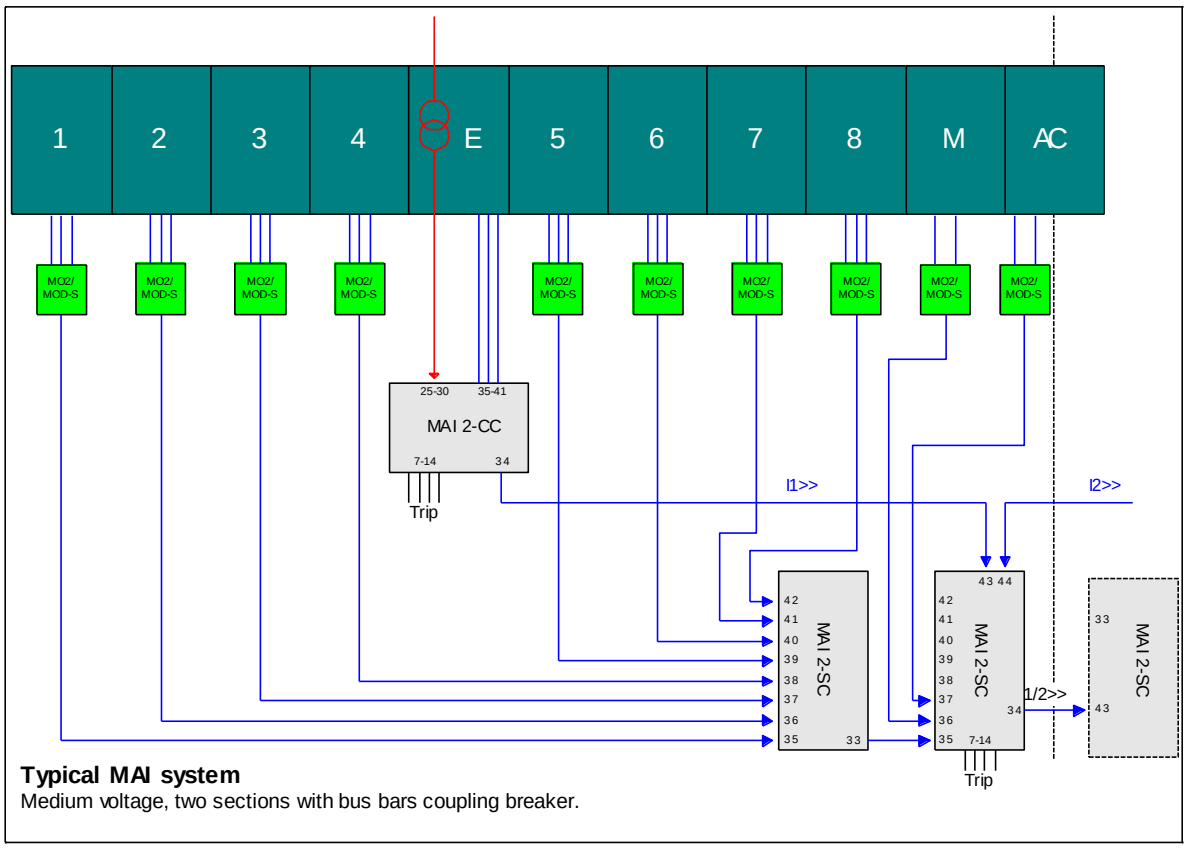
Optical mixer MOD-T

- Simplifies the installation by transmitting the arc light from up to three detectors through a single output.
- Monostable output, allows to open the local input breaker when the arc occurs in the cable compartment (input 3.)
- 3 arc light optical inputs. (4 inputs optional.)
- 1 optical output, logical “OR” of up to three inputs (0, 1 or 2).
- Internal supervision output.
- Reset/test button for manual reset or for test of indicators leds.
- Up to 4 leds indicates the last active input.

Detectors and fiber optics.

- Removable detectors with wide detection angle.
- Holder brace included.
- Plastic fiber optic.

Typical connecting diagram with MO2 or MOD-S.

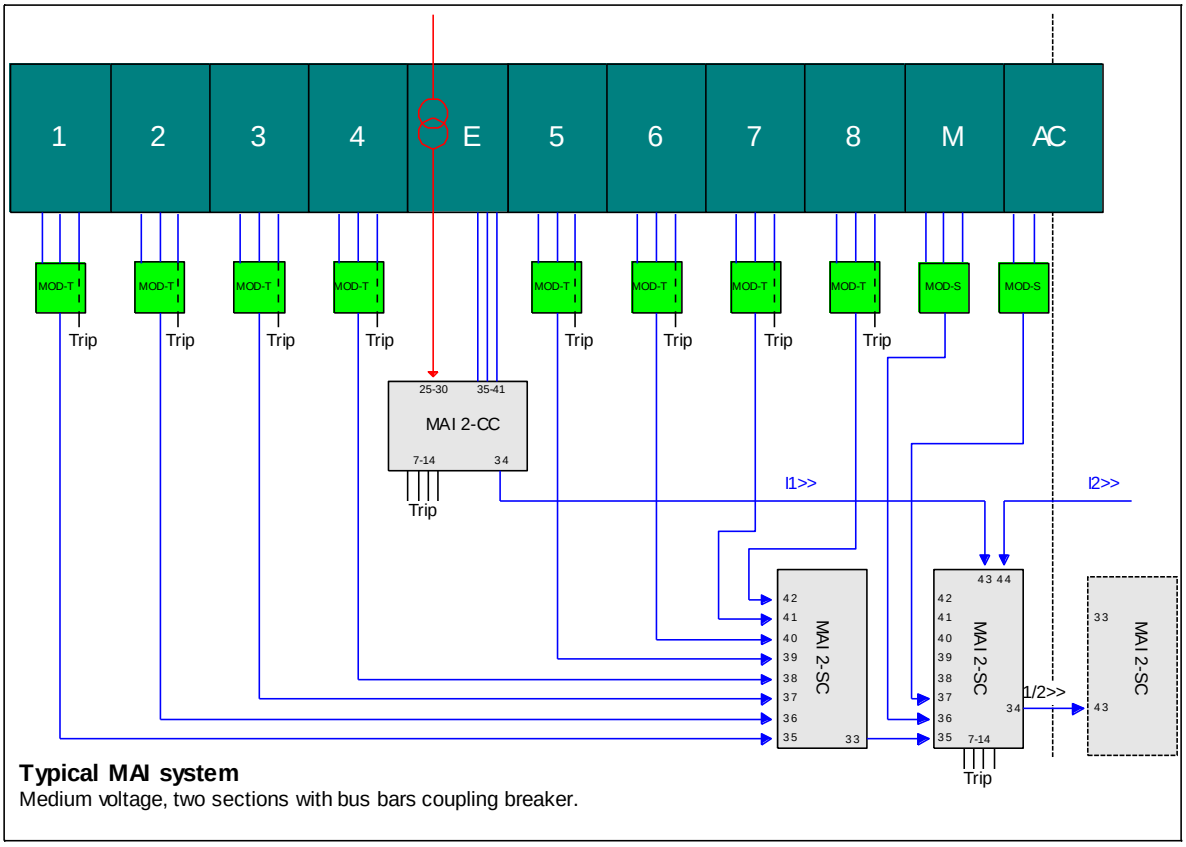


Typical MAI system
Medium voltage, two sections with bus bars coupling breaker.

In the figure, you can observe the connection diagram of our Internal Arc Monitoring System for a medium voltage distribution substation. The installation has 16 feeders, 2 inputs, 2 measurement switchgear and 1 coupling breaker.

This system allows clearing the failure leaving out of service only the section where an arc occurred, since it sends trip signals to the input breaker of that section and to the coupling breaker, in this case these trips are conditioned to the presence of light and current simultaneously.
When an arc occurs in the input cells, opening the input breaker may not be enough. In this case, upstream breakers are tripped to clear the failure.

Typical connecting diagram with MOD-T



Typical MAI system
Medium voltage, two sections with bus bars coupling breaker.

In this case the system uses MOD-T, if the arc occurs in the cable compartment and it is received by the input 3, the system allows clearing the failure leaving out of service the cell where the arc occurred, this trip will be generated only by light. If the arc occurs in the inputs 0, 1 or 2, this system allows clearing the failure leaving out of service only the section where an arc occurred, since it sends trip signals to the input breaker of that section and to the coupling breaker, in this case these trips are conditioned to the presence of light and current simultaneously.
When an arc occurs in the input cells, opening the input breaker may not be enough. In this case, upstream breakers are tripped to clear the failure.

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