Surge Protection System
M-LB-5000

Protection against surge voltage caused by lightning or due to issues during ongoing operation, such as switching operations or electrostatic discharge. The protection modules provide condition monitoring with a traffic-light display for immediate readability. The diagnostic data can also be integrated into the control level without any additional wiring.

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1 Surge Protection for Measurement and Control Circuits with Diagnostics

The effectiveness of a lightning protection system and any related surge protection devices must be checked regularly in accordance with the IEC 62305 standard.

The surge arresters installed are typically checked by removing the device and carrying out the test using a testing device. However, this process is no longer necessary with the new M-LB-5000 device system.

The diagnostic function of the M-LB-5000 surge protection system provides information about the status of the device, which is continuously monitored. A traffic-light display on the front of the device indicates the device status. This status can also be transferred as a status message to the control level via remote signaling contacts, meaning the protection provided by the M-LB-5000 series can be monitored in an easy and efficient way.

This technical paper explains how the diagnostic function works, the possibilities it offers, and what limitations it has.

2 Layout

A typical surge protection device for measurement and control signals in the M-LB-5000 series consists of these core elements:

- Gas discharge tube
- Decoupling elements (inductors)
- Suppressor diodes

![Layout of a surge protection device](image-url)
2.1 Components Used

2.1.1 Gas Discharge Tube

A gas discharge tube (GDT) is a sealed component filled with noble gases. It works in a similar way to a voltage-dependent switch.

The main advantages of this component include its long service life and high discharge capacity in relation to its size.

Once the voltage reaches a specific level, the gas in the gas discharge tube ionizes and forms an arc. As a result, the voltage at the gas discharge tube abruptly drops from the response voltage to the burning voltage.

The main failure mechanism is that the trigger voltage of the gas discharge tube increases or decreases as a result of impulse loads.

The decisive factors for the amount of wear on a gas discharge tube are the number of impulse loads and the amount of energy they contain.

In the worst-case scenario, the gas discharge tube can completely lose its protective effect if it is significantly overloaded, or can short circuit and break.

2.1.2 Suppressor Diode

Suppressor diodes (Transient Voltage Suppressor (TVS) diodes) are specialist diodes that have been specifically developed to protect sensitive electronics. A PN junction with a large surface area guarantees a high level of ampacity.

A suppressor diode does not wear as long as it is operated within the limits of its specifications.

If the silicon in the diode body becomes too hot, TVS diodes tend to fail due to short circuiting.

It is very rare for this to be a gradual process—the component failure typically follows a single case of overloading.

2.1.3 Decoupling Element

The decoupling element has the task of providing the trigger voltage for the gas discharge tube. It can be implemented as resistor or inductor.

The typical cause of failure is degradation or destruction by thermal stress as a result of sustained high currents. This can be caused by undesired shifts in the ground potential.

2.1.4 Function

The voltage source that hits the input allows the input voltage (green) to increase to the trigger voltage of the gas discharge tube. This causes the input voltage to drop to the burning voltage of the gas discharge tube.

The output voltage (orange) is limited by the suppressor diode to the terminal voltage of the suppressor diode.

The decoupling element ensures that the limiting effect of suppressor diode does not have an effect on the increase in voltage at the input that allows the gas discharge tube to ignite.
2.2 Diagnostic Function

2.2.1 Layout

For the diagnostic function, the decoupling element designed as an inductor is equipped with a secondary coil.

This transformer ensures that the diagnostics and measurement and control circuits are galvanically isolated.

By means of this transformer the voltage rise and its duration is detected by the diagnostics circuit.

The resulting voltage signal is interpreted in the diagnostic circuit.

2.2.2 Parameters Detected

The following overload situations are detected by the M LB 5000 diagnostics circuit:

- Number of times that the gas discharge tube has ignited
- Continuous detection of the silicon temperature in the suppressor diodes
- Interior temperature of the surge protection module

Within the device, the measured values are compared with the specifications on the data sheet for each component as well as empirically determined data.

This data is then used to determine the status of the surge protection device. It is displayed on the device and signaled via remote signaling contacts.

2.2.3 Possibilities and Limitations

The diagnostic function is able to reveal the failure mechanisms described above. Situations where the surge protector is damaged by improper use are very hard to detect, this is where the diagnostic curcuit reaches its limits. Typical situations like this are miswiring or voltage levels exceeding the datasheet specification leading to a subcomponent destruction.

For this reasons it is recommended to use existing line fault detection mechanisms where ever possible. This does not mean additional effort or cost, since line fault detection is available for all typical signals in measurement and control loops from field device up to the control level.
2.3 Advantages of the Diagnostic Function

The ability to obtain information about the status of the surge protection module provides opportunities to reduce operating costs and increase plant availability.

2.3.1 Reducing Operating Costs

The diagnostic function reduces the operating costs of the surge protection device because the test procedure is faster.

- The surge protection modules no longer need to be tested individually using a testing device (measuring kit, etc.), thereby saving time
- Evaluating the remote signaling contacts is a simple method of documenting the plant status
- A simple visual inspection can be incorporated into routine inspections

2.3.2 Increased Plant Availability

The diagnostic function results in higher plant availability.

Maintenance operations can be performed in a targeted manner before the protective function is lost. This prevents any consequential damage to the instrumentation or control level, which therefore also prevents system failure.

The information relating to the status of the surge protection device allows weak points across all of the surge protection measures to be identified in a targeted manner—and, where possible, to be properly remedied.

If the situation occurs that the surge protection device for some signals in a plant section is significantly worn, remedial action can be defined and its effectiveness verified.
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