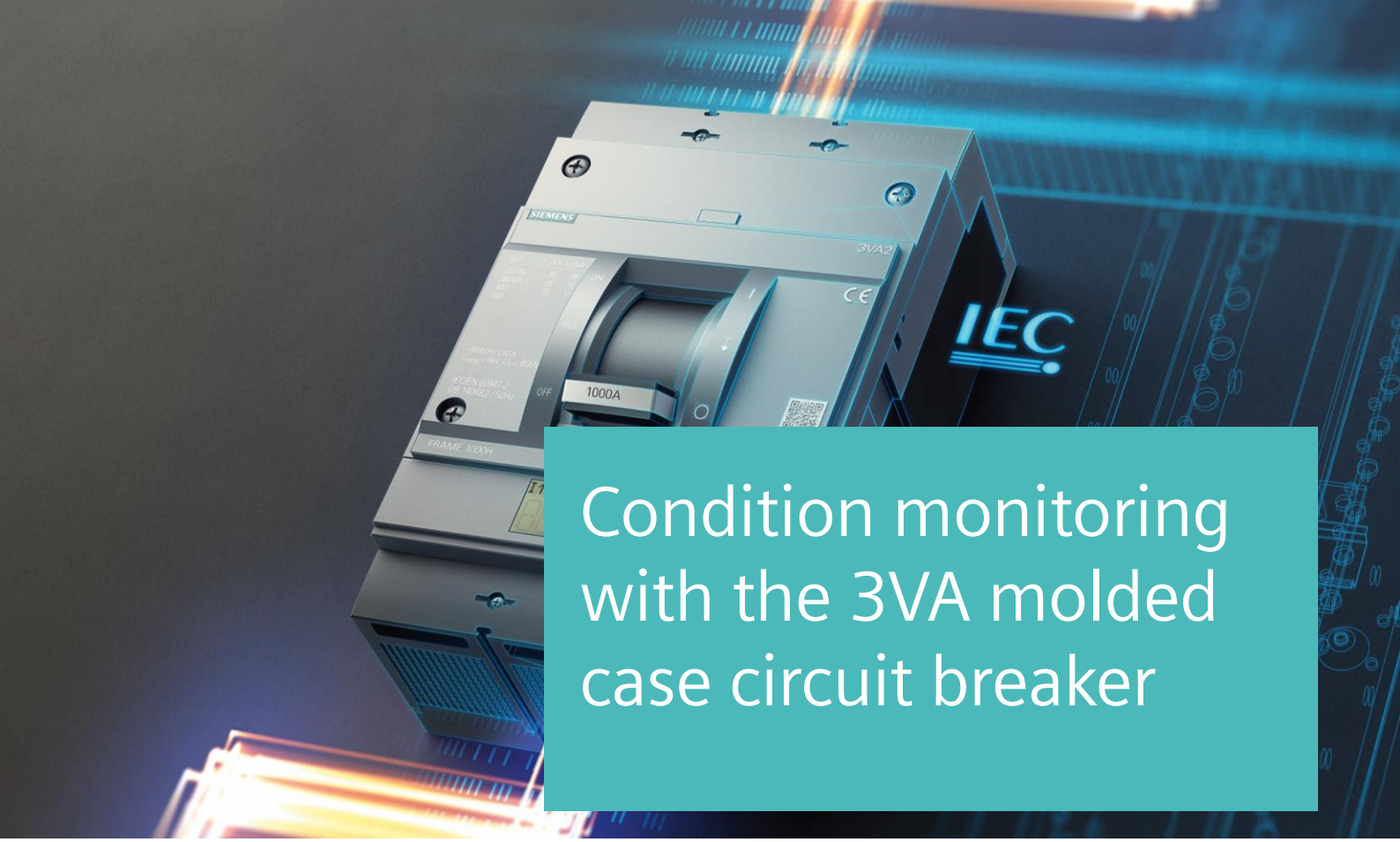


Condition monitoring with the 3VA molded case circuit breaker

Introduction

A reliable power distribution system with components that are always ready for operation increases system availability and avoids unplanned downtimes. In production plants, this enables high productivity, resulting in large production quantities and low unit costs.

High energy availability is also essential in infrastructure. This makes it possible to implement, for example, lighting and safety systems for which no failures can be tolerated. From hospitals to data centers and glass factories, there are many players in the modern infrastructure and economy who rely on a high level of supply security.

Since the components of industrial plants are subject to operational wear and tear, it is important to know the maintenance requirements and the end of their service life as precisely as possible. This enables operators to permanently reduce costs and optimize the availability of their plant with the help of tailored maintenance concepts.

Contents

Knowing rather than assuming the maintenance requirements

In infrastructure and industry, maintenance tasks are planned well in advance. However, the condition of a piece of equipment, e.g. a circuit breaker, and the resulting optimum time for maintenance are not obvious to the operator. The maintenance date that is set therefore rarely coincides with the optimum maintenance time. Instead, it is scheduled too early or too late, which impairs the efficiency and reliability of the value creation process.

Precise maintenance timing increases efficiency and availability

If a system is serviced too early, unplanned downtimes due to worn equipment can indeed be avoided. However, components that are still functional are then replaced. Consequently, they are not used throughout their entire service life, which reduces efficiency. Even more serious are the consequences of late maintenance. Admittedly, replacement too early is avoided, which initially increases efficiency. If a key component, such as a circuit breaker, fails, the protection and reliability of the entire downstream power supply is jeopardized.

Components such as circuit breakers are exposed to highly fluctuating loads. Without a diagnosis, it is therefore hardly possible to determine a suitable maintenance time in advance. This is precisely where condition monitoring comes into play.

What does condition monitoring mean in general?

The fundamental principle of condition monitoring is that the technical state of a device is checked on a continuous basis. For this purpose, physical data such as temperature, speed, pressure, filling level or vibrations are continually collected. The data are collected, transmitted, evaluated and compared with empirical values. By analyzing the values determined in this way, condition monitoring provides a deeper insight into the plant and helps to develop a better understanding of its condition. In this process, changes at an earlier point in time that indicate progressive wear of individual components also become apparent. In this way, condition monitoring helps the plant operator to better coordinate the maintenance of the monitored devices.

Condition monitoring in the power distribution system

The extent of condition monitoring in a specific case depends on the device, its mode of operation and its location. This white paper deals with condition monitoring for protection devices in power distribution. Circuit breakers are core components in power distribution which, among other things, carry uninterrupted current, can open and close the main contacts during operation, and protect against overload and short circuit. The functionality of a circuit breaker must be ensured by condition monitoring. Up to now, the serviceability of circuit breakers could only be estimated on the basis of the following data:

- Electrical operating cycles
- Mechanical operating cycles
- Trippings (the trip counter distinguishes between different reasons for tripping)
- Operating hours (are measured with the operating hours counter)

In addition to this basic information, the 3VA molded case circuit breaker continuously records the usage pattern of the circuit breaker. It analyzes the data and evaluates them with an algorithm, so that the results can be used to draw conclusions about the state of the equipment. In the 3VA molded case circuit breaker, the patented, intelligent algorithm extends the condition monitoring to include the health indicator and the remaining lifetime.

The health indicator

The serviceability of a circuit breaker depends largely on the contact status of the main contacts. However, switching operations without current, with rated current, as well as at overload trippings and short-circuit releases cause the switching contacts to wear out to varying degrees. The health indicator therefore continuously determines the condition of the contacts based on data recorded directly in the circuit breaker.

Health indicator of the 3VA molded case circuit breaker

The health indicator of the 3VA molded case circuit breaker is determined on the basis of an analysis of the disconnections and tripping operations. Each disconnection and tripping of a molded case circuit breaker changes the state of the main contacts. The state of the main contacts therefore defines the health indicator of the molded case circuit breaker.

In the as-delivered state, the value of this indicator is 100%. The event-related adjustment of the health indicator is activated during commissioning. The indicator value decreases over the operating time depending on the various switching operations and can drop to 0%.

Explanation of the indicator values	
100%	The molded case circuit breaker is in the as-delivered state.
100% to 30%	No restriction on the function of the molded case circuit breaker.
30% to 1%	No restriction on the function of the molded case circuit breaker. However, the maintenance or replacement of the device should be prepared and an appropriate replacement device should be provided. Additional information on the urgency of the replacement can be obtained from the remaining lifetime indicator.
0%	The full function of the device can no longer be guaranteed and the device must be replaced as soon as possible.

Flexible query of the indicator values

The current status of the health indicator (in %) can be read on the display of the ETU (Electronic Trip Unit) of the 5-series and 8-series at any time. In addition, various communication applications offer the possibility of querying the health indicator. Besides the configuration software SENTRON powerconfig, the SENTRON powerconfig mobile app and the power monitoring software SENTRON powermanager, these include cloud applications such as SENTRON powermind. The data of the molded case circuit breaker can be forwarded to cloud applications via the IoT data platform 7KN Powercenter 3000.

Representation of the health indicator (in %) on the display of the Electronic Trip Unit ETU

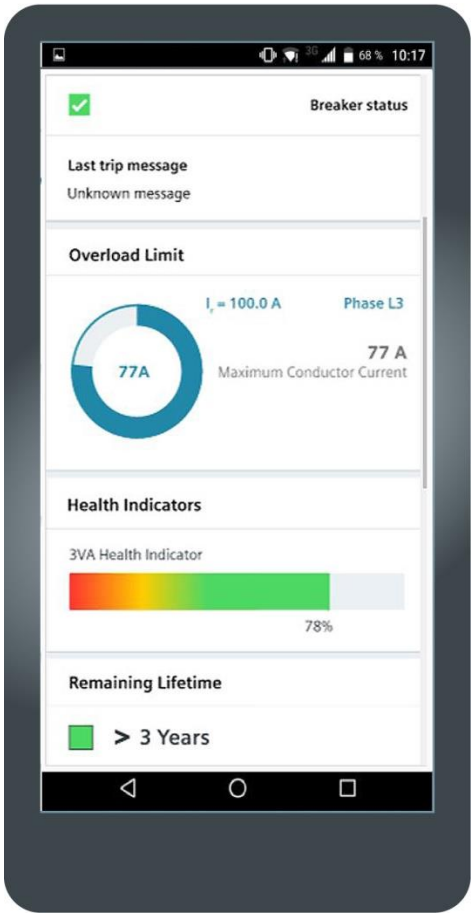
The remaining lifetime

A patented algorithm is used to calculate the remaining lifetime. It analyzes the past usage behavior, projects it into the future, and makes a forecast on this basis. If the usage behavior changes, the remaining lifetime is adjusted accordingly. This is accompanied by the fact that unpredictable trippings can abruptly reduce the remaining service life. They lower the health indicator, which serves as a starting point for calculating the remaining lifetime.

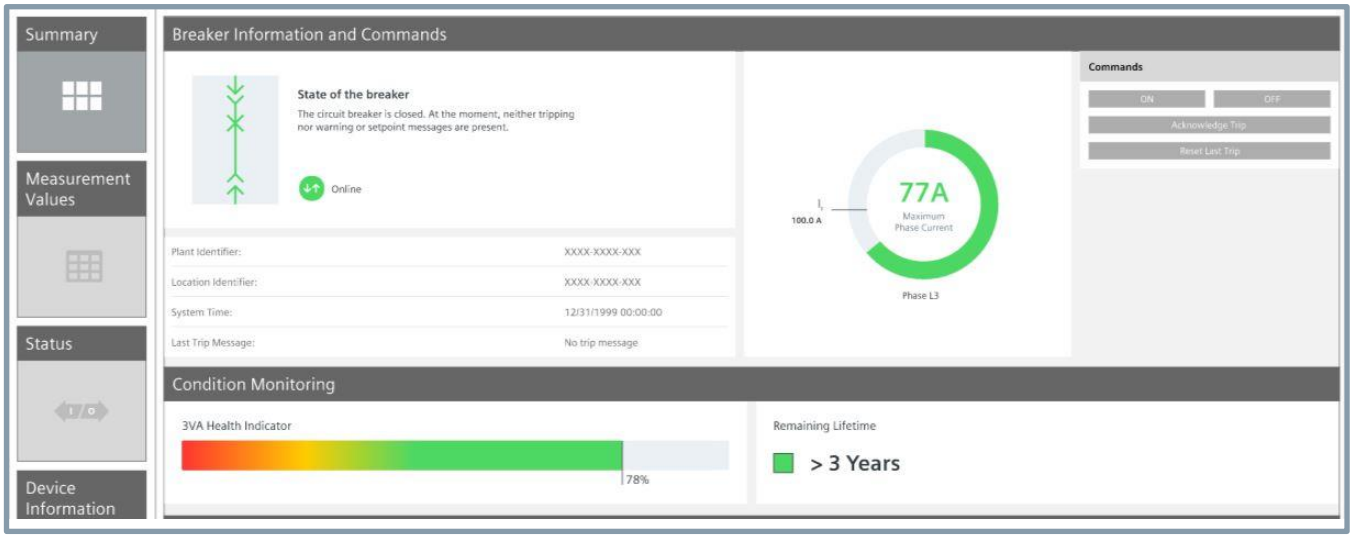
The remaining lifetime is determined continuously. If the calculated remaining lifetime is more than three years, however, the plant operator does not have to take any urgent action (e.g. maintenance or replacement of the device). It is therefore not displayed in detail. Only a remaining lifetime of less than three years is broken down into years, months and weeks.

Visualization of health indicator and remaining lifetime

The predicted remaining lifetime is not displayed on the circuit breaker itself. Like the health indicator, it can be accessed via SENTRON powerconfig, the SENTRON powerconfig mobile app, SENTRON powermanager or via cloud applications such as SENTRON powermind.



Display of power and status data in the SENTRON powerconfig mobile app



Display of the health indicator and remaining lifetime in the power monitoring software SENTRON powermanager

Predictive maintenance

With the health indicator and the remaining lifetime prognosis, the 3VA molded case circuit breaker enables precise planning of plant maintenance and inspections. Plant operators thus benefit from more efficient use of materials and personnel. With increasing operating time, the plant behavior and thus also the wear of the molded case circuit breaker becomes more accurately predictable. The longer the molded case circuit breaker is used in a plant, the more reliable the health indicator and the predicted remaining lifetime will become.

Limits of predictability

The service life of a circuit breaker depends on numerous factors. At present, the 3VA molded case circuit breaker only takes the contact wear into account when calculating the health indicator and the remaining lifetime. Other factors, such as environmental influences (e.g. air humidity or salt spray), are not taken into account. The aging behavior, to which the molded case circuit breaker is subject depending on its use, cannot therefore be represented with the health indicator and the remaining lifetime prognosis.

The remaining lifetime prognosis derives the possible future use from the past use. However, serious tripping events cannot be foreseen. They are therefore not included in the calculation and can abruptly reduce a previously sufficient remaining lifetime to zero.

Device configuration for predictive maintenance

The use of condition monitoring with 3VA molded case circuit breakers is possible with the following devices and preconditions:

- 3VA2 or 3VA6 molded case circuit breakers with an Electronic Trip Unit ETU of the 5-series or 8-series
- ETU (Electronic Trip Unit) with firmware V4.4 or higher
- COM060 communication module with firmware V4.4 or higher
- COM800 or COM100 data concentrators with firmware V4.4 or higher
- The external power supply of the molded case circuit breaker (via the COM800 or COM100 data concentrators) must be ensured over the entire operating time so that the data for the usage analysis can be completely recorded.
- The COM800 or COM100 data concentrators must be put into operation with the SENTRON powerconfig configuration software or via the TIA Portal. The Totally Integrated Automation Portal (TIA Portal) is an engineering platform for automation that comprises numerous software tools.
- If there is a voltage dip or interruption in the auxiliary power supply, the system time of the COM800 or COM100 data concentrators must then be updated. This can be done using the SENTRON powerconfig configuration software or automatically using the SNTP function.

Total overview of the system state

The transmission of maintenance data provides the operator with a holistic picture in which not only an individual component, but also the maintenance status of the entire power distribution system can be viewed. The combination of the health indicators and the remaining lifetime prognoses for all devices of a system yields the following benefits:

1. The maintenance status of the system can be quickly surveyed, components in critical condition can be identified and replaced, and the system availability can therefore be enhanced.

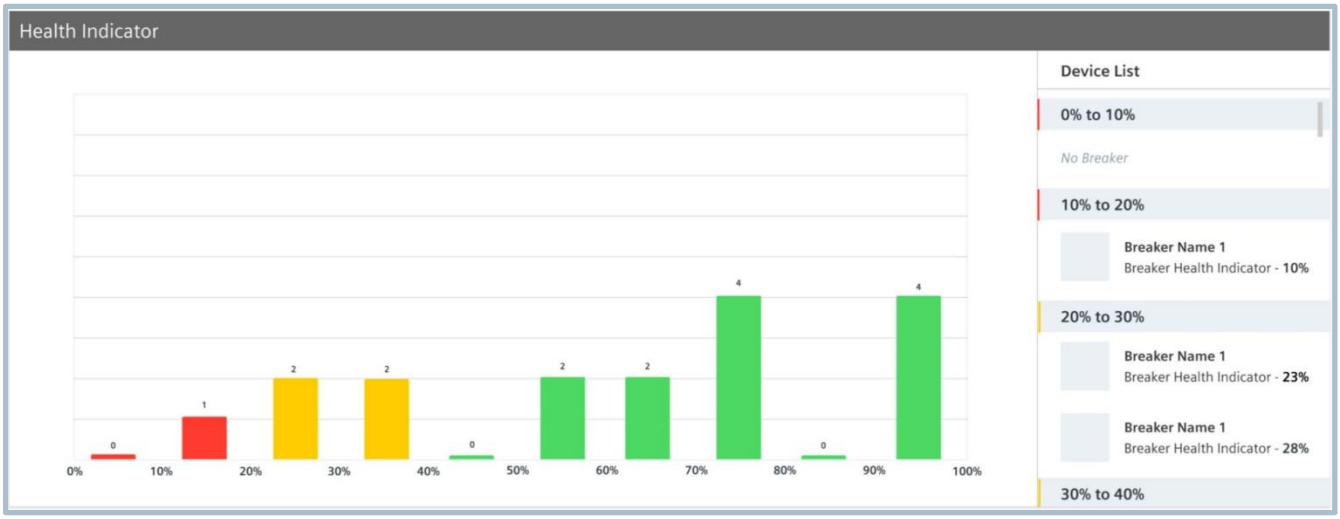
2. Maintenance activities can be planned well in advance, and personnel and material can be made available with pinpoint accuracy. This leads to streamlined system availability at reduced costs.

3. Last but not least, a transparent maintenance requirement provides operators with the certainty that spontaneous failures caused by components that are maintained too late become a thing of the past and do not further impair system availability.

Recognizing maintenance requirements at first glance

The following figure shows the user interface of the power monitoring software SENTRON powermanager and the SENTRON powermind app in the MindSphere cloud. It provides an example for an overview of the health indicator values relating to the molded case circuit breakers in a power distribution system.

At first glance, it is clear that one molded case circuit breaker is in the critical range between 10% and 20%. For two other devices, the health indicator value is between 20% and 30%. With the help of the predicted remaining lifetime, the operator should get an idea of when it makes sense to replace these three devices.



Part of the user interface of the power monitoring software SENTRON powermanager and the SENTRON powermind app in the MindSphere cloud.

A second example for a user interface shows the classification of the devices according to their remaining lifetime. The time setting ranges "< 1 year", "1 to 3 years" and "> 3 years" are shown both graphically and in table form, and the respective circuit breakers and their quantity are listed.

Part of a visualization example for the remaining lifetime in the power monitoring software SENTRON powermanager and the SENTRON powermind app in the MindSphere cloud.

In addition to these overview representations, which provide information on the overall condition of the plant, further detailed information for diagnosis and statistics can be called up for each molded case circuit breaker.

Summary

In modern power distribution systems, industrial communication is becoming more and more important. Functionalities such as condition monitoring only become possible through the acquisition and transmission of data and their evaluation using intelligent algorithms. Predictive maintenance of systems and their components based on real usage data reduces downtimes, contributes to higher system availability, and allows process optimization. 3VA molded case circuit breakers make their condition and any maintenance requirements visible on the basis of the predicted remaining lifetime and the health indicator. Maintenance measures or the replacement of devices can thus be planned months in advance and can be optimally coordinated. The necessary personnel and material resources can also be scheduled early on. This optimizes energy availability, while time and cost savings can be achieved for the maintenance tasks.

Further information

You can find all the latest news on the 3VA molded case circuit breaker at www.siemens.com/3va

You can find all news on the subject of digitization at www.siemens.com/lowvoltage/digitalization

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