



State-of-the-art monitoring for
generator circuit-breakers

GMS600 Monitoring System

Enabling your digital future

At Hitachi Energy we use leading open digital platforms to bring our grids into the age of the sustainable energy future. We are contributing pioneering solutions that are making the world's power grids stronger, smarter and greener.

Hitachi Energy is a leader in the design and manufacturing of generator circuit-breakers (GCBs) since 1954 with more than 8,000 deliveries in over 100 countries. We offer the widest and most modern portfolio of GCBs in SF₆ and vacuum technology with a range of short-circuit current ratings from 50 kA to 300 kA and nominal currents from 3,150 A to over 50,000 A to meet the demand of all types of power plants around the globe.

GCBs protect the important assets in power plants such as generators and transformers by clearing potential harmful short-circuit faults in tens of milliseconds preventing severe damages and possibly lengthy plant downtime.

At the heart of the digital GCB is the intelligent monitoring capability - aggregating, analyzing and managing health data collected through GMS600 monitoring system.

Hitachi Energy's next generation monitoring systems GMS600 provide full control of GCB operational parameters enabling preventive and predictive maintenance. It supports the overall increase of power plant safety and reliability whilst enabling cost-effective lifetime management by the innovative Value Based Customer Care (VBCC) concept of Hitachi Energy.



GMS600 monitoring system

One step ahead towards digitalization



PREVENTIVE & PREDICTIVE MAINTENANCE

Condition monitoring and detailed knowledge of GCB performance trends allow to manage a proactive and cost effective maintenance program to increase the power plant availability. GMS600 enables power plant operators to better align and coordinate GCB maintenance activities within the scheduled plant shutdowns.



ASSET HEALTH FOR GCB

Real-time remote monitoring of GCB health status (temperature, gas and ablation) increases availability and facilitates fast and reliable implementation of corrective measures.



OUTSTANDING RELIABILITY

The constant monitoring help maximising plant availability by identifying early warning states to avoid unplanned outages. In the meantime, it improves diagnostic capability in case of plant failure thanks to recorded data.



IMPROVED OPERATIONAL PERFORMANCE

Improve GCB availability and reduce power plant O&M costs by comparing project-specific performance indicators with aggregated fleet data accessing all relevant asset condition information in one seamless interface.

How it works

The GMS600 is a novel monitoring system for GCBs that has been specifically developed to support power plant operators and maintenance engineers for a proactive and cost-effective maintenance program, while improving diagnostic capability through the recorded data and threshold levels.

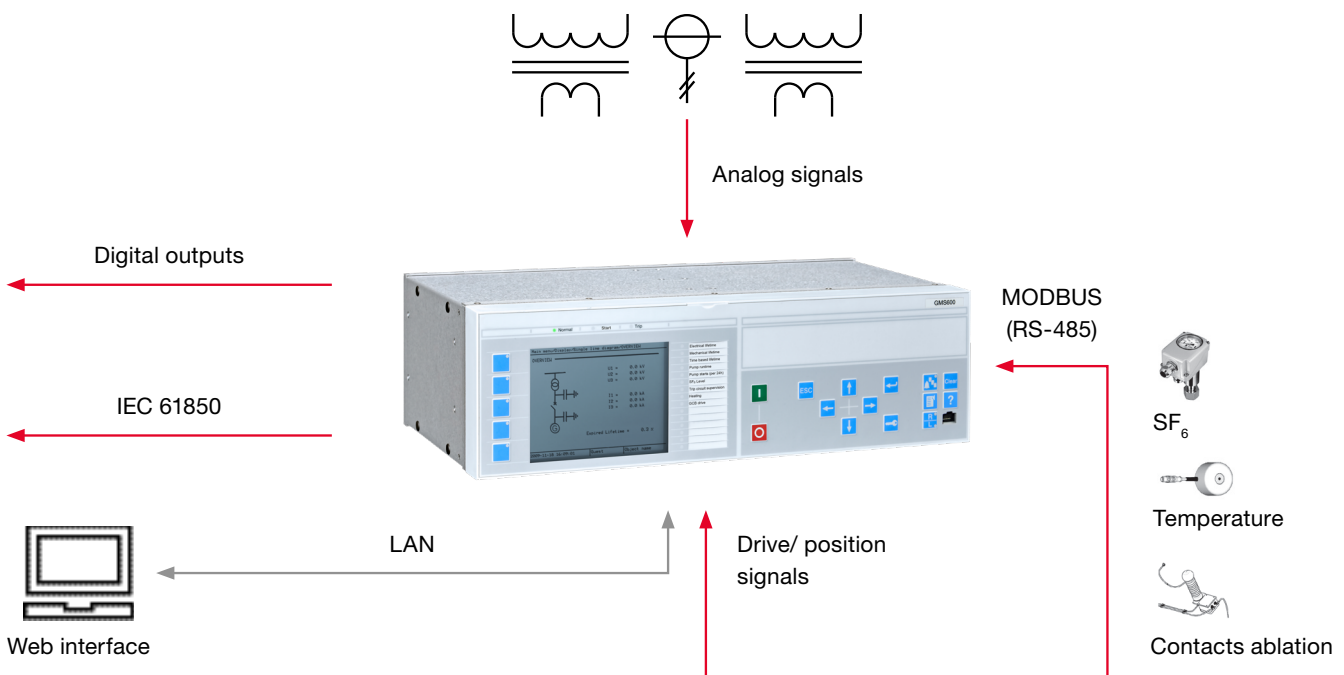
Built on the well-proven technology, it offers unique features such as SF₆ gas monitoring and trending (GMS600-G), temperature monitoring of primary conductors (GMS600-T) and ablation monitoring (GMS600-A). In addition, it is also able to provide operating mechanism supervision. GMS600 can be integrated in new GCBs or retrofitted into existing GCB applications.

The monitoring system provides precise indication of the GCB's remaining time-to- preventive maintenance based on cumulative current interruptions, total number of mechanical operations and time from last overhaul.

An important novel feature is temperature monitoring of the current-carrying path. At such high currents as those normally carried by a GCB, even a slight increase of electrical resistance in the current-carrying path can lead to a large temperature increase. The GMS600 reads out the measured data of all temperature sensors at a rate of approximately one sensor

sample per second. This raw temperature data is processed by a temperature evaluation module every minute, and a warning or alarm is generated in case the temperature deviation of the three sensors per phase exceeds the set limit or the temperature reaches the maximum tolerated level. All information is displayed to the GCB operator locally by local human machine interface as well as remotely by webserver and web client application. Data can be transmitted over the power plant network by the modern communication protocols IEC 61850 and DNP3.

A recent advance in monitoring system led to the launch of the global first online contacts erosion monitoring system for GCBs. Predominantly during opening operations, some material is ablated from the GCB arcing contact system resulting in reduced overlapping times, i.e. the time elapsed between the opening of the main and the arcing contacts during switching operations. The wear on arcing contacts of GCBs can be better monitored by measuring the overlapping time of the contacts. This time is critical for the proper operation of a GCB, and overhaul becomes necessary if the overlapping time is shorter than a minimum acceptable value which does not allow the current to commutate from the main to the arcing contacts during an opening operation.



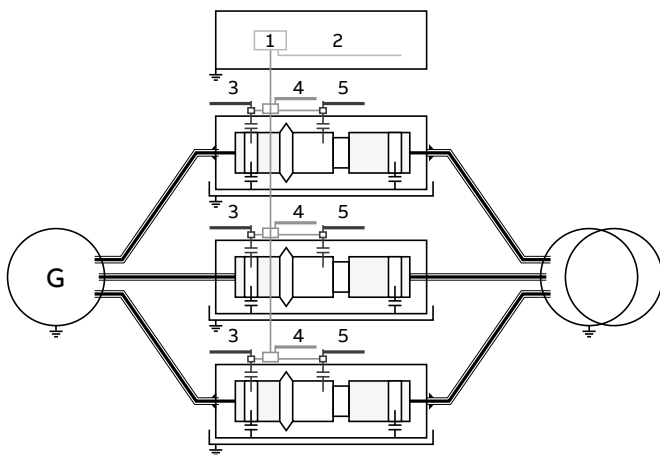
1(a) GMS600 monitoring system and sensors

The overlapping time is typically measured using the dynamic contact resistance measurement (DRM) technique, which evaluates the contact resistance during an operation of the GCB. The measurement consists in injecting a DC current in one phase of the GCB and requires the GCB to be taken out of service and isolated from the rest of the power plant.

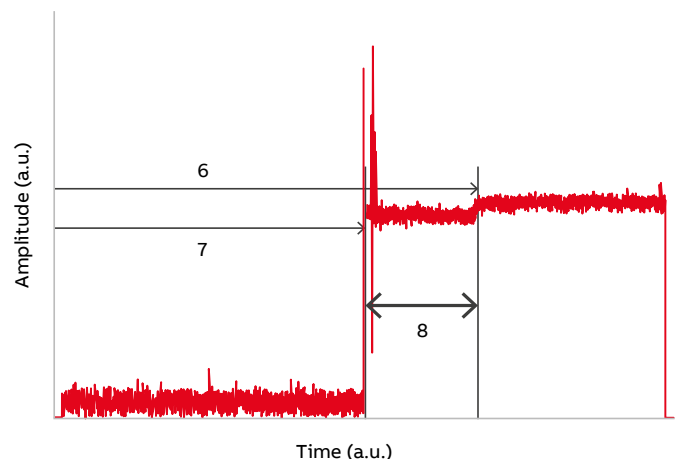
The innovative method to measure the contact overlapping time is based on a concept which transmits high-frequency signals across the GCB (see figure 1(b)). A test signal is generated by the phase module and is fed into the conductor via the capacitive voltage divider on the transformer side. The signal is then received through a second capacitive voltage divider on the generator side. The amplitude of the received test signal varies depending on the position of the GCB, i.e., closed, main contacts open, or arcing contacts open. Evaluation of this amplitude variation allows to calculate the overlapping time of the two contact systems.

The presented innovative solution offers the possibility to perform a direct contact erosion measurement with high accuracy and does not need the GCB to be taken out of service, thus increasing the availability of the power plant. This enables new service concepts to be implemented, promoting the transition from the traditional reactive maintenance work to an optimized maintenance planning based on residual lifetime prediction and supported by faster response, higher flexibility and simplified inspections and overhauls.

The possibility to accurately measure the erosion of the GCB contacts is of special importance in applications which involve a high number of switching operations such as in pumped storage power plants. The use of a monitoring system to support the maximization of the usage of equipment plays a key role in optimizing system performance and reducing operating costs.



Concept diagram



Course of test signal during closing operation of GCB

- 1 Monitoring system
- 2 Power supply and communication interface
- 3 Receiving capacitive voltage divider
- 4 Phase module (electronic controller)
- 5 Transmitting capacitive voltage divider
- 6 Time at which the main contact system is closed
- 7 Time at which the arcing contact system is closed

1(b) GMS600 concept diagram and test signal of closing operation

Ablation Monitoring

Global first in the market

The GMS600 monitoring system family has been enlarged with new functionalities with even higher reliability. Based on the well-proven technology, a unique solution to boost asset performance management.

Ablation measurement

As a global leader in technology and innovation, has developed a new solution to provide even more accurate information without the need to interrupt the generator circuit-breaker activity.

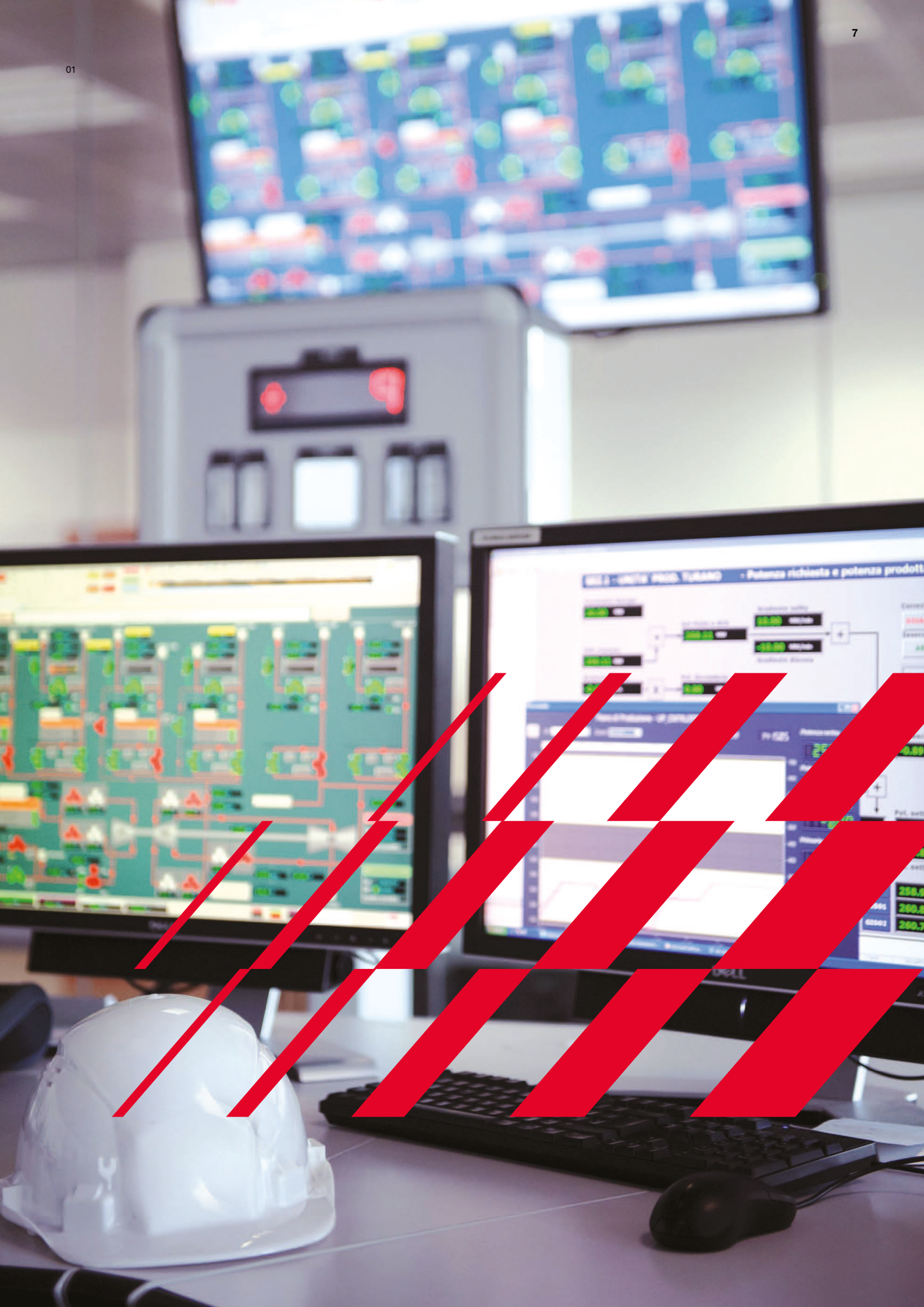
The GMS600-A is the first product in the market that is able to measure online contacts overlapping time and give indication of the ablation without the need to go out of operation. GMS600-A unlocks a new era of monitoring: a more powerful monitoring system that helps optimize power plant performance while decreasing lifecycle costs. It supports fleet management in optimizing maintenance planning and maximizing GCB lifetime.

As easy as press a button, GMS600-A ensures flexibility taking the maintenance planning to the next level.

GMS600-A



- 01 Maximize lifetime of GCB
- 02 Online measurement and visualization of residual lifetime of GCB based on project
- 03 High accuracy contacts erosion measurement
- 04 Maintenance planning optimized:
 - Faster response
 - Higher flexibility
 - Simplified inspections and overhauls



Key benefits



TIME TO MAINTENANCE

The analysis for time to maintenance provides information of the remaining time to service based on the evaluation of the actual close-open operations. Computation is performed considering the electrical lifetime, the number of operations and the time period. This information allows power plant operators and maintenance engineers for earlier planning of service activities in combination with planned shut-downs of the power plant units.



SF6 GAS MONITORING AND TRENDING

In line with the highest standards in terms of environment protection, Hitachi Energy GCBs have the lowest SF6 leakage rate and the monitoring system GMS600-G keeps it under control. GMS600-G is equipped with a transducer for online measurement of the SF6 gas density and an algorithm calculates the actual leakage rate and relevant trending over time. Unexpected gas leakages can be detected earliest possible.



OPERATING MECHANISM SUPERVISION

Hydro-mechanical spring charged operating mechanisms type HMB are the most reliable for GCB. Supervision of certain parameters of the circuit-breaker operating mechanism will detect any change in performance characteristics for early and preventive planning of cor-



DATA LOGGING

Data logging allows a quick and easy analysis of any event involving the GCB which provides the following features:

- logs all important events into the GMS600, including warnings and alarms, change of settings, etc.
- triggers when a certain limit of interrupted current is exceeded
- logs with time stamps, close and open operations, root mean square (rms) values of interrupted current, sum of ablation factor and other events; logs temperature and gas density values over time and logs operating mechanism pump starts.



WEBSERVER FUNCTIONALITY

Webservice functionality allows access from remote to the actual and logged values of GMS600 via Ethernet by any internet browsers. With this functionality is possible to have all the relevant information available at first view

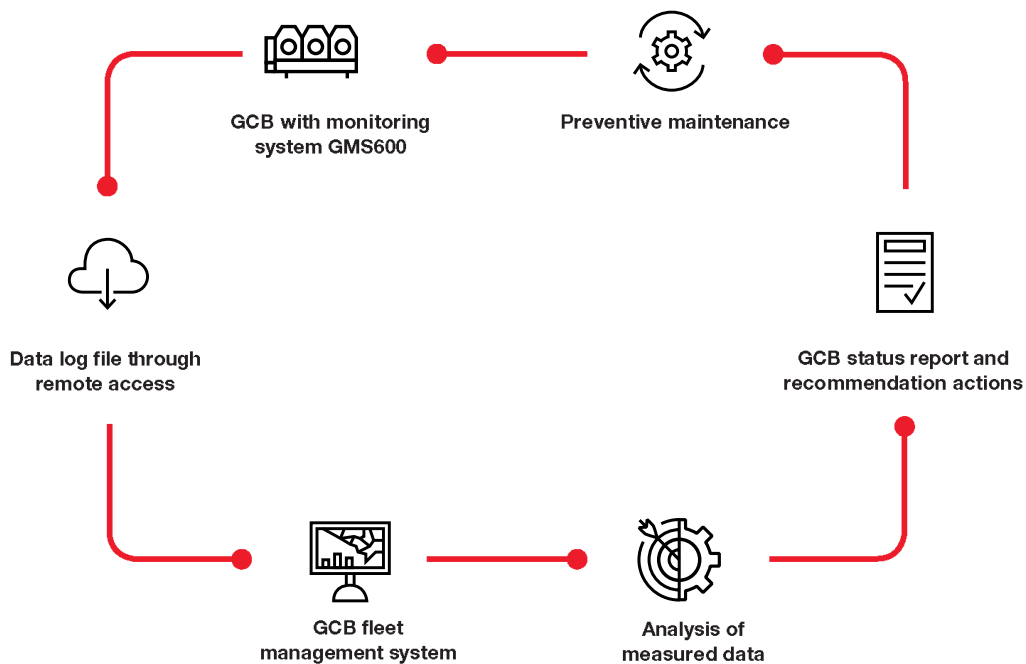
as well as download and export logged data in Comtradeformat for analysis and archiving.



WARNINGS AND ALARM INDICATION

Warnings and alarms are displayed locally on the GMS600 via LEDs. Availability of centralized data provides remote access via webservice or other available communication protocols. The recording to the data log of the device allows comprehensive and in-depth offline analysis.

Value Based Customer Care



GMS600 turns raw data acquired from GCB operations into diagnostic and prognostic information. Key operational parameters such as close and open operations during normal operation of power plant (as well as during exceptional events such as load rejections and short-circuit faults) are recorded and properly evaluated to determine the impact on the expected time to service.

Thanks to a real-time update and export of the log file from the GMS600 (in accordance with the agreements and user's profile), Hitachi Energy is able to extrapolate measured data.

The **Value Based Customer Care** includes benefits such as:

- customized report with an overall summary of the GCB fleet condition and a detailed technical analysis for every single GCB.
- reduced maintenance costs with Hitachi Energy recommendations and service due dates based on the breaker condition and the usage of the GCB.
- harmonized maintenance planning allowing power plant operators to better coordinate GCB maintenance activities within the scheduled plant shutdowns.
- prolongs lifetime of GCB avoiding unplanned outages of the breaker for the best cost-effective lifetime management

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