ABB lead the intelligent revolution
Intelligent technology (Part 2)
Intelligent Monitor and Diagnosis
The Expert System for Switchgear
Intelligent Technique for Car TPMS

- When tire pressure is too low, leakage or imbalance, all that can have a bad effect for the car, even may cause a traffic accident.

- It is convenient for driver to get online information of tire pressure from TPMS, the driver can arrange inspection and maintenance for any abnormal or unhealthy trend.
Why do we need the intelligent device? Nip in the bud

Potential problems

- Aged materials
- Bad environment
- Disabled interlock
- Fault parts

Fault enlarge

- Discharge or spark
- Equipment burned
- Device broken
- Personal injury
The Expert System for ABB Switchgear

M&D for intelligent temp.
- Temp. of the breaker tulip-contact
- Temp. of busbar lap joints
- Temp. of outgoing cable ends
- Ambient temperature of LV cubicle
- The dynamic diagnose based on real-time load

M&D for the status of CB critical secondary parts
- Charging current of motor
- Charging time of motor
- Active current of closing/opening coils

M&D for CB characteristics
- Closing/opening time and speed
- Contact travel and over run
- Rebounding on opening
- Over stroke
- The pressure for contacts
- Remaining electrical life (VI)
Intelligent Temperature Monitor & Diagnosis

- With RF technology, it is possible to insulate between HV monitoring points and receiver;
- With a supply CT, TR sender unit can work when the current of main circuit is above 10A;
- TR monitoring sub-system shall be able to cover all the normal service condition of switchgear. Its upper limit of working temperature shall be superior to the temperature limit of switchgear.
- The key monitoring points: tulips
- The consequence of failure of the monitoring system shall not have any influence to the conventional function of switchgear.
- Ambient air temperature should be measured as the benchmark of temperature rise.
The dynamic diagnosis based on real-time load

- One fixed temperature value to be set as the alarm threshold, it will be alarmed in case of exceeding this value
- In the actual situation, the running current is far lower than the rated current, it is difficult to reach the alarm threshold
- There must be a yellow alarm blind area
- The new solution for dynamic diagnose based on real-time load can fully avoid this blind spots

Smart current sensor

Algorithm with invention patent

Dynamic diagnose based on real-time load

\[ T_{\text{stable}} = \left( \frac{I}{I_{\text{Ref}}} \right)^{1.6} \times T_{\text{Ref}} + 2 \]

- \( T_{\text{Ref}} \): the stable temperature rise of hotspot of object
- \( I \): the real-time current of object
- \( I_{\text{Ref}} \): the rated current of object
- \( T_{\text{Ref}} \): stable temperature rise under \( I_{\text{Ref}} \), select from table below.
The status of CB critical secondary parts monitor & diagnosis

To be isolated entirely from control/protection system

- HALL sensor
- Non-intrusive measurement for voltage/current
- To monitor each coil and charging motor
- Isolation from relay, there is no any impact on the normal operation in case of the failed condition
M&B for the status of CB critical secondary parts
Help to identify the early potential fault

- Common fault for charging motor: Gear wheel broken.
  - Initial stage: One or two teeth broken, but motor could still be able to finish the charging
  - After several operations the entire gear pairs damaged completely
- The online monitoring system could detect the abnormal current vibration, alarm is given in early stage.
- Replacement plan can be made before it is completely out of work. No emergency cases happened.
CB characteristics monitor & diagnosis

- The status data of CB are obtained by these built-in intelligent sensors, then analyze and calculate these data by using ABB unique algorithm, to realize the monitoring and diagnosis of circuit breaker, it includes:
  - Mechanical characteristic
  - The pressure for contacts
  - Remaining electrical life (VI)
- To improve the reliability and safety of power system.
CB characteristics monitor & diagnosis
Upgrade to CBM from periodic maintenance

To compare the measured important parameters which get from intelligent monitor devices with the standard value and/or average value, finally to evaluate the actual condition.

To reduce maintenance costs and minimize the occurrence of serious accidents.

As regular intervals or according to specifications for maintenance, the aim is to reduce the fault risk or the performance degradation.

Lots of operators and heavy equipments.
The expert system for switchgear
Innovation and change for the switchgear management

1. Intelligent monitor & diagnosis
2. Upgrade to CBM from periodic maintenance
3. To relieve the operator workload
4. To reduce maintenance costs
5. Innovated switchgear management solution

November, 2016
ABB MV sensor
Advanced measurement for smart applications
MV Switchgear and 3 key components

Protection relay

Circuit breaker

Instrument transformers for current and voltage measurement
Historical development of switchgear key components
Protection relays

Electromechanical relays
Static relays
Digital relays (Protection terminals)

Development in used technologies and working principles
Historical development of switchgear key components

Circuit breakers

Air and magnetic principles

Oil principles

Vacuum and SF₆ principles

Development in used technologies and working principles
Historical development of switchgear key components

Instrument transformers (ITs)

- ITs with oil insulation
- ITs with epoxy resin
- Changes in used material and design only

November, 2016
Historical development of switchgear key components
Next step in evolution of instrument transformers

MV sensors – Electronic instrument transformer

Development in structure, used technologies and working principles
**MV sensor principal**

**Current sensor**

- ABB Rogowski coil
  - $U_s = 150 \text{ mV}$ for $50 \text{ Hz}$
  - $U_s = 180 \text{ mV}$ for $60 \text{ Hz}$
- Proven technology
- Accuracy up to class $0.5$
- Complies with IEC 60044-8
- Pure passive element

\[ u_s(t) = M \frac{di_p(t)}{dt} \]
MV sensor principal
Voltage sensor

- ABB resistive and capacitive voltage dividers
- 1:10000 transformation ratio
- Proven technology
- Accuracy up to class 0.5
- Complies with IEC 60044-7
- Pure passive element

\[ U_S = \frac{R_2}{R_1 + R_2} U_P \]
\[ u_s = \frac{C_1}{C_1 + C_2} u_P \]
MV sensor principal
Current sensor - Linear characteristic = No saturation
MV sensor application
Measurement and protection

Separate cores for measurement and protection purposes

Measurement and protection fulfilled by the same device
MV sensor application

Accuracy compensation

Before compensation

After compensation

Protection accuracy limit class 5P

Metering accuracy limit class

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<tr>
<th>Lpr (%)</th>
<th>5</th>
<th>20</th>
<th>100</th>
<th>Kpr x 100</th>
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Table:

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<tr>
<td>Amplitude percent D</td>
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<tr>
<td>Amplitude percent C</td>
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<td>Rated Secondary Voltage</td>
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<td>Reverse polarity</td>
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</table>

November, 2016
MV sensor application
Installation and cable connection

KECA

KEVA

RJ-45 output, direct into ABB relays
MV sensor application
Other installation for specific application

KECA
KEVA
KEVCR
KECA
MV sensor application
Unigear digital

- Based on ABB KECA, KEVA sensors and Relion IED, IEC61850 technology platform, digital smart switchgear solution
MV sensor application
Digital switchgear system

Sensors and IEC 61850 communication in UniGear Digital

- Analog 3xI
- Digital data
- Analog 3xU
- Digital data for Differential protection
MV sensor
More safety and reliability

- Ferroresonance free, no need of damping devices
- No need of VT fuses
- Low voltage secondary output prevents electric shock
- Secondary circuit can be left open or short-circuited
- Free of maintenance
MV sensor
Easier and faster process

- Standardized products, simplified BOM maintenance
- Simplified rating selection, zero engineering
- Stock available, quick delivery
MV sensor
Simplified installation and debugging

- Easy for installation and cable connection
- Online data monitoring, easy for debugging
- Easy for upgrade or extension
MV sensor
Space saving for switchgear

- No specific PT panel needed.
- Busbar voltage measurement data online sharing between different panels based on IEC61850-9-2 network
- Minimize equipment investment, installation, and debugging cost
MV sensor
Environmental friendly

- Less material (steel, copper, resin) consumption
- Energy saving with low secondary output
- Less CO2 emission
MV sensor
Milestones

- ABB medium-voltage sensors on the market since 1993
- More than 120,000 units in operation
  - Regions coverage: Europe, Australia, USA, China, etc
  - Widespread applied in MV distribution grid
Power and productivity for a better world™