IMM2000 Online Monitoring System for Insulation of Capacitive Equipment
IMM2000 Online monitoring system for insulation of capacitive equipment

1. OVERVIEW

The insulation performance of HV equipment such as HV bushings, current transformers, capacitive voltage transformers, coupling capacitors and lightning arresters are gradually affected due to the influence of environmental conditions such as pollution, chemical corrosion, electric flash, heat, and mechanical force during long-term operation, and can cause serious defects. If the defects are not discovered and taken in time, the potential defects will gradually develop and may cause insulation breakdown, equipment damage and cause huge losses. "IMM2000 Online Monitoring System for insulation of capacitive equipment" is highly reliable on-line monitoring equipment for continuous, real-time, on-line monitoring of dielectric loss, final screen current and capacitance of high voltage bushings, high voltage transformers and other power equipment. The insulation status of the equipment can be grasped in time, and according to the horizontal comparison of similar equipment, the longitudinal comparison of the same equipment, and the development trend of insulation characteristics, early detection of latent faults, early warning and avoiding accidents.

In order to reduce the blindness of power failure test and maintenance, reduce maintenance costs, and timely discover the insulation defects of electrical equipment in operation, and improve the reliability of power supply of power system, it is imperative to conduct online monitoring of high-voltage equipment.
2. **IMM2000 system composition**

IMM2000 consists of system voltage monitoring unit (IMM-U), capacitive device monitoring unit (IMM-C), iron core grounding current monitoring unit (IMM-I), MOA lightning arrester monitoring unit (IMM-M), environmental monitoring unit (IMM-E), data processing server (IMM-Z), application software and communication cable.

![Image of IMM2000 system components](image1.png)

3. **IMM2000 system principle**

After receiving the synchronous acquisition command, the system monitoring unit (IMM-U) and the capacitive device monitoring unit (IMM-C) track the system frequency, use the reference source to achieve simultaneous sampling, the capacitive device monitoring unit receive the data of the voltage monitoring unit and processed the data, the result data is sent to the data processing server (IMM-Z) installed in the control room through the CAN field bus. The data processing server processes and stores the data, and compares it horizontally and longitudinally through the expert diagnosis system, diagnosis, early warning, and realize online monitoring of insulation status.
4. **IMM2000 series monitoring unit working principle**

Using zero-flux micro-current sensor, high-precision synchronous AD, tracking grid frequency and high-precision synchronous sampling through DSP and CPLD, using optimized Fourier analysis method to obtain amplitude and phase, and then obtain electrical parameters such as the required leakage current, dielectric loss, equivalent capacitance etc.

5. **IMM2000 system main technical features**

System structure: hierarchical distributed system structure, modular design

Detection principle: using core-type zero-flux micro-current sensor technology, the phase error is within 2 points

Hardware platform: Based on DSP, CPLD and high-precision synchronous AD, the all-digital, integrated on-site monitoring unit professionally measures small signals and prevents electromagnetic interference.

Data acquisition: grid frequency tracking technology, reference source synchronization technology

Data processing: Fourier spectrum analysis, multiple harmonic voltage measurements

Communication method: CAN fieldbus communication mode is adopted between field monitoring unit and data processing server, communication is more reliable

Network protocol: support TCP/IP network protocol, support remote monitoring and remote maintenance, support IEC61850 protocol, meet the requirements of intelligent substation online monitoring and comprehensive self-management management

Display mode: report mode / trend mode
Alarm mode: There are two levels of alarm, sound and light alarm; alarm signal can be transmitted remotely.

Intelligent components: can be transformed into intelligent component module form (see Drawing 14). Designed according to the Q/GDW/Z 410-2010 "High-voltage Equipment Intelligent Technology Guide", installed in MDD3000T intelligent component cabinet.

6. IMM2000 system technical parameters

Analysis period: minimum 2 seconds, set by the user, the default is 1 hour

Data storage life: 10 years

Sensor measurement range: 50μA ~ 1000mA

Working environment temperature: -40 °C ~ +55 °C

Working relative humidity: 5 to 95%, no condensation

Working power: AC 240V ± 10%, 50HZ

Impact resistance: meets GB/T 14537 standard (can withstand severe grade I)

Anti-vibration: meets GB/T 11287 standard (can withstand severe grade I)

Electromagnetic compatibility: meet GB/T17262, IEC61000 and Q/GDW 535-2010 standards

7. IMM2000 system test indicators

<table>
<thead>
<tr>
<th>Monitoring Unit name</th>
<th>Monitoring parameters</th>
<th>Measurement range</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>System voltage monitoring unit (IMM-U)</td>
<td>Bus voltage</td>
<td>35kV~1000kV</td>
<td>±0.5%</td>
</tr>
<tr>
<td>Harmonic voltage</td>
<td>3, 5, 7, 9 times</td>
<td>±2%</td>
<td></td>
</tr>
<tr>
<td>System frequency</td>
<td>45~65 Hz</td>
<td>±0.01Hz</td>
<td></td>
</tr>
<tr>
<td>Capacitive equipment monitoring unit (IMM-C)</td>
<td>Final screen current</td>
<td>100μA~1000mA</td>
<td>±1% or 100μA</td>
</tr>
<tr>
<td>Dielectric loss</td>
<td>0.1~30%</td>
<td>±0.1%</td>
<td></td>
</tr>
<tr>
<td>Equivalent capacitance</td>
<td>50PF~5000PF</td>
<td>±1% or 0.5°C</td>
<td></td>
</tr>
<tr>
<td>Site environmental monitoring unit (IMM-E)</td>
<td>Ambient temperature</td>
<td>-40°C~80°C</td>
<td>±1% or ±0.5°C</td>
</tr>
<tr>
<td>Ambient humidity</td>
<td>0~100%RH</td>
<td>±2%</td>
<td></td>
</tr>
</tbody>
</table>
| Transformer core monitoring unit (IMM-I) | Core grounding current | 1mA~10A | ±2.5mA ( <100mA )
| | | | ±2.5% ( >=100mA ) |
| MOA arrester monitoring unit (IMM-M) | Leakage current | 100μA~50mA | ± ( Standard readings×5%+5μA ) |
| Resistive current | 10μA~10mA | ± ( Standard readings×5%+5μA ) |
| Capacitive current | 50μA~50mA | ± ( Standard readings×5%+5μA ) |

Note: Standard readings are standard measuring instrument readings
8. IMM2000 system software technical characteristics

IMM2000 system software, considering multi-user, remote online monitoring and other application characteristics, adopts object-oriented design and client/server architecture, which makes the system have good scalability and reusability.

IMM2000 system software integrates service mode, client mode and debugging mode. Users can enter the corresponding system by modifying the configuration parameters. The software runs on Win2000 and above, and supports concurrent connections and query operations of multiple users. The server can display detailed communication information, historical data, real-time data, waveform data, and provide horizontal comparison function of the device; the client can remotely query real-time data, historical data and horizontal comparison data, and can configure specific parameters.

The IMM2000 data center server uses SQL Server 2000 database with stable reliability, availability, support for Internet and XML technologies.

The IMM2000 software system adopts flexible network access mode. The network communication protocol conforms to the standard TCP/IP communication protocol, supports IEC61850 protocol, and can be easily connected to the substation automation management system to meet the intelligent substation online monitoring system.

9. Remote monitoring network of IMM2000 system

The IMM2000 online monitoring system realizes the network remote function through the user's power data communication network. With the remote function, the user can display all functions of the monitoring interface, data query, and parameter setting at the remote end.
The IMM2000 system can form a three-level remote power equipment online monitoring network. A power plant or substation can use one data processing server (IMM-Z) to control multiple sets of system voltage monitoring units (IMM-U), capacitive equipment monitoring unit (IMM-C) and one set of on-site environmental monitoring Unit (IMM-E) through CAN fieldbus. Each group of field monitoring units can monitor one set of capacitive power equipment.

The data processing server (IMM-Z) of the IMM2000 system can be directly connected to the plant-level or local-level LAN. Any terminal browser on the LAN can browse the data processing server (IMM-Z) database under authorized condition.

Cross-LAN users (superior users) and our remote monitoring center can remotely monitor and remotely maintain through the Internet.

10. IMM2000 system software main function
The system adopts multi-level user management based on authority, provides strict user level setting, and strictly controls the access rights of each user to ensure the confidentiality and security of relevant data.

The software can display the historical data curve and data report for the system data at any time, and provide the user with the function of “horizontal” and “vertical” data...
comparison. User can operate the curve graphic such as partial enlargement, reduction, and custom display effects, all reports and graphics can be exported, saved, and printed out, as the basis for the reasonable analysis of the running status tracking analysis and maintenance plan.

The system adopts a rule-driven approach in the early warning analysis mechanism, so users can easily configure the warning conditions and other content according to their needs.

IMM2000 system provides intuitive real-time data and waveform data curve.
IMM2000 system provides intuitive horizontal data comparison graphs, reports, and printing function.

11. **IMM2000 system site erection sample**

Installation example as smart components

- An installation instance in the form of a smart component

  - Casing insulation terminal screen current sensor
  - Core grounding current sensor

- Smart component cabinet field installation diagram
  - Control panel
12. System Integration: MDD3000T TMU online monitoring system solution

Based on on-line monitoring of casing insulation (including environmental temperature and humidity monitoring), on-line monitoring of partial discharge, on-line monitoring of dissolved gases in oil, on-line monitoring of oil in water, on-line monitoring of core grounding current, etc., the MDD3000T intelligent transformer online monitoring system was established.
Drawing 18: MDD3000T TMU components
13. Test report