WinTech Partial Discharge Testing and Monitoring Systems

Predictive maintenance to eliminate power equipment failure risk.

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About Us

Wintech Electric has been established in 2006, an affiliated company of Winsome Engineering Consultants. Winsome has considerable experiences over 15 years in engineering construction, such as Taiwan power company, nuclear power, airports, subway, railway, etc. Therefore, we are familiar with and passionately devoted to improving safety in engineering construction and power equipment maintenance.

Because knowing insulation deterioration resulting from partial discharge (PD) in power equipment often leads to failures of high-voltage equipment, WinTech gathered domestic and foreign experts, collaborated famous universities worldwide, and spend several years to develop a series of monitoring systems for detecting PD activities. According to IEC 62478, an international standard for detecting PD, we develop our own techniques “multiple physical quantities” to distinguish PD phenomena. We produce high reliability sensors, and design software for identifying PD frequency and waveform.

Maintaining power supply system stable and safe for customers is our prime concern. We are totally dedicated to providing power system with predictive maintenance-intelligence monitoring for 24 hours to eliminate the risk of equipment failure.
**Classifications of PD Activities**

**Definition:** Partial discharges are electric discharges that occur inside the insulation material of high voltage equipment due to the presence of voids, impurities, or cracks resulting from failures on the manufacturing process, mechanical stress, or insulation ageing process. The PD, which only partially bridges the insulation between conductors, occurs repetitively in a small region, and thus is named partial discharge. Meanwhile, it produces sound, light, heat, electromagnetic signals, and chemical reactions.

**Criterion:** Under the IEC 60270[*] standards, choose the acceptable regulation, such as IEEE 400.3, IEEE C57-124, etc., depending on types of HV equipment.

High Correlation Between PD Activities and Insulation Deterioration

- **Internal discharge**: The initial insulation aging still has the weak electrical signal, which can provide power without instant danger.

- **Insulation deterioration**: PD activities are irreversible and unpredictable. The ignorance of monitoring and observance of PD trend in the long term can cause the accidents resulting from insulation deterioration, and puncture.

- **Electrical accidents**: The economic loss can be up to millions or even several hundred million due to the power failure.
INESTIMABLE LOSSES AND DANGER DUE TO THE POWER FAILURE OF POWER EQUIPMENT...
**PD Multiple Physical Quantities Schematic**

**PREDICTIVE MAINTENANCE**
- NO MORE FEAR, DANGER, AND COST WITH OUR PRODUCTS

<table>
<thead>
<tr>
<th>Initial Discharge</th>
<th>Physical Phenomena</th>
<th>Condition of Equipment</th>
<th>Effects</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro-signal</td>
<td>Micro-signal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faint smell</td>
<td>Faint smell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little sound</td>
<td>Little sound</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weak</td>
<td>Weak</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Electronic signal**
- **Sound**
- **Smell**
- **Light**

**Deterioration in insulation with time**
**Unexpected accident**

- **Power failure**
- **Breakdown**
- **Fire**

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**Enough Time to React - Safe Operation & Beforehand Maintenance**

**Urgent Danger & Power Failure**

**Inestimable Loss**
What is Partial Discharge?

- In electrical engineering, Partial Discharge is a local dielectric breakdown of a small portion of insulation system, where the electric field strength exceeds the breakdown point of the insulation material.
- Protracted partial discharge can erode strength of insulation system and eventually lead to breakdown of insulation, causing equipment failures and affecting power quality.
Leading PD detection techniques - We create accurate and reliable method for detecting PD activities.

1. Sensors: Own-developed high bandwidth and high sensitivity sensors based on standard IEC 62478.

2. Identification Software: We do cross-comparison by observed acoustic, pulse current and microwave signal to examine if PD occurs. Also, for raising the accuracy of identification about PD activities, besides the former physical quantities, we also utilize directivity to distinguish if it is corona discharge, surface discharge, internal discharge, or jamming.

3. Signal Receiving: We replace partial discharge tester with own-developed LeCroy, a wide bandwidth (500MHz), and high gain(2.5GS/s) LeCroy, to perfectly show the PD waves and catch any complicated PD signals.

4. Location of PD Sources:
   A. Locate the PD sources by the signal from the process of changing AE sensor.
   B. Estimate the PD location by the acoustic and electrical signals transmission speed from the time difference between AE sensor and HFCT sensor.
   C. For the equipment without metallic screen, such as power cable, cast-resin transformer, etc., we can locate the PD sources with UHF Antenna Array.

*IEC 62478
✓ Measure electromagnetic wave (3MHz-3GHz) and acoustic waves (100Hz-250kHz)
✓ Sensors: Acoustic, electromagnetic, and microwave sensors
✓ On-line PD testing, mainly used in on-site testing
✓ Advantage: No need to turn off power, easy testing process
### Classifications of Two International Standards for PD Measurements

<table>
<thead>
<tr>
<th></th>
<th>IEC 60270</th>
<th>IEC 62478</th>
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<tbody>
<tr>
<td>Publication date</td>
<td>1968, and revised in 2000</td>
<td>2016</td>
</tr>
<tr>
<td>Standard</td>
<td>Measured in terms of “quantity”</td>
<td>Measured in terms of “quality”</td>
</tr>
<tr>
<td>Unit</td>
<td>pC</td>
<td>mV or dB</td>
</tr>
<tr>
<td>Calibration</td>
<td>Need</td>
<td>No need</td>
</tr>
<tr>
<td>Method</td>
<td>Off-line (turn off the power)</td>
<td>On-line (no need to turn off the power)</td>
</tr>
<tr>
<td>Sensor</td>
<td>Coupling capacitor</td>
<td>Acoustic, Pulse current, or Microwave sensor</td>
</tr>
<tr>
<td>Main use</td>
<td>Factory Testing; On-site test on a routine basis</td>
<td>24 hours remote monitoring</td>
</tr>
<tr>
<td>Feature</td>
<td>Test if PD activities is acceptable with <strong>complicated</strong> process</td>
<td>Observe the trend of PD activities with <strong>simple</strong> process</td>
</tr>
</tbody>
</table>
Invention Patents: Multiple Physical Quantities

The invention provides a partial discharge detection system and method using multiple physical quantities for an electric power apparatus. The partial discharge detection system includes a first detection element, a second detection element and a partial discharge determination element. The first and second detection elements are configured to detect first and second physical quantities, respectively.
A Novel Miniaturized Vivaldi Antenna Using Tapered Slot Edge With Resonant Cavity Structure for Ultrawideband Applications

Yu-Hsin Lin, Wen-jun Zhou, Senior Member, IEEE, Sheng Yang, Wenhui Li, Pengfu Li, and Jian Yang

1. INTRODUCTION

Ultrawideband (UWB) communication systems have been considered as an attractive option for short-range high-data-rate communication applications. A Vivaldi antenna is widely used as a radiation element for UWB systems due to its low-cost fabrication, low profile, and wideband characteristics. However, it suffers from a narrow impedance bandwidth and low gain at low frequencies. To address these issues, a resonant cavity is introduced to miniaturize the antenna and improve the performance. The proposed antenna is designed by miniaturizing a UWB Vivaldi antenna, which has been extensively used in previous research works. The resonant cavity structure is utilized to enhance the performance of the antenna, resulting in improved bandwidth and gain.

2. ANTENNA DESIGN

The proposed antenna is designed by miniaturizing a UWB Vivaldi antenna, which has been extensively used in previous research works. The resonant cavity structure is utilized to enhance the performance of the antenna, resulting in improved bandwidth and gain.
WinTech PD Products

Summary of Products - Multiple Sensors with Various Frequencies

Signals of Partial Discharge

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>20kHz-250kHz</td>
<td>Ultrasonic wave (sound)</td>
</tr>
<tr>
<td>1kHz</td>
<td>High Frequency Current Transformer (HFCT) Sensor</td>
</tr>
<tr>
<td>10MHz</td>
<td>Transient Earth Voltage (TEV) Sensor</td>
</tr>
<tr>
<td>300MHz</td>
<td>Active Ultra High Frequency (Submerged Type) Sensor</td>
</tr>
<tr>
<td>500MHz</td>
<td>Active Ultra High Frequency (Embedded Type) Sensor</td>
</tr>
<tr>
<td>3GHz</td>
<td>Active Ultra High Frequency (Bus-bar Type) Sensor</td>
</tr>
<tr>
<td>20kHz-250kHz</td>
<td>Voltage/Current (Electromagnetic Field)</td>
</tr>
<tr>
<td>1MHz</td>
<td>Active Ultra High Frequency (Submerged Type) Sensor</td>
</tr>
<tr>
<td>10MHz</td>
<td>Active Ultra High Frequency (Embedded Type) Sensor</td>
</tr>
<tr>
<td>3GHz</td>
<td>Active Ultra High Frequency (Bus-bar Type) Sensor</td>
</tr>
<tr>
<td>20kHz-250kHz</td>
<td>Electromagnetic wave (Microwave)</td>
</tr>
</tbody>
</table>

Acoustic Emission (AE) Sensor
High Frequency Current Transformer (HFCT) Sensor
Transient Earth Voltage (TEV) Sensor
Active Ultra High Frequency (Submerged Type) Sensor
Active Ultra High Frequency (Embedded Type) Sensor
Active Ultra High Frequency (Bus-bar Type) Sensor
Flexible Magnetic Coupler (FMC) Sensor
Ultra High Frequency Current Transformer (UHFCT) Sensor
Active Ultra High Frequency (GIS Type) Sensor
Ultra High Frequency Antenna Array Locator

MADE IN TAIWAN
Wintech attended 2017 Taipei International Invention Show and Technomart in Taipei World Trade Center Hall 1. Our product "UHF Antenna Array Locator" stood out among over 1300 candidates from Taiwan and other countries, and was ranked as second place in Platinum Prize (23 winners in Platinum Prize). Wintech's director Mr. Yang, Wan Mu personally received the trophy awarded by Intellectual Property Office of Economy Ministry.

Wintech's "UHF Antenna Array Locator" is excellent at locating where partial discharge occurs in medium and high voltage equipment. It is a sensor with high directivity, high gain and high bandwidth. Locating the flaws of insulation by electromagnetic signal of partial discharge in high-voltage equipment, especially in transformer station, Switchgear Transformer, Cast-Resin Transformer. It was published and recognized in a distinguished journal, IEEE.
WinTech PD Products

WinTech Power

WinTech PD Diagnostic System is used for partial discharge (PD) testing on medium voltage (MV) and high voltage (HV) equipment, such as power cables, various transformers, switchgear, etc.

WinTech PD Diagnostic System is suitable for on-line monitoring and on-line testing. With our developed high quality sensors, the performance of PD diagnosis can further be enhanced.
WinTech PD Products

**Wintech Power (Partial Discharge Diagnostic System)-Features**

- **Wideband, High Sampling Rate, High Resolution**: Accurately Measure PD waveform.
- **Large Memory**: Full waveform record for data analysis and identification.
- **Simple User Interface**: Intuitive UI with real-time PRPD plot and data trend.
- **Signal Analysis Software**: Analyze data to achieve efficient diagnosis including PD identification, long-time trend chart, and report generation.
- **Remote Monitoring Software**: Off-site system control and setting with functions of offsite data backup and send alarm e-mail.
- **24 hours PD On-line Monitoring System**: Provide various detecting modes for customers’ detecting requirements if needed.
WinTech PD Products

**Wintech Power (Partial Discharge Diagnostic System)**

- **PD Capture**
  - Setting for system, including data record, trigger level, etc.

- **CxTraceLoad**
  - Retrieve background value, record parameter, and original wave shape

- **AutoMail**
  - For email setting, including alert, content, recipient

- **Data Upload**
  - Upload data to assigned server

- **Remote control**
- **Data Retrieval**

**RDPC Line**
WinTech PD Products

Partial Discharge Detector - SA

- **Waveform, FFT, TF Map, volts**, PD phase (PRPD), number of PD, and PD trend Record display
- Suitable for various MV and HV power equipment detection
- 24 Hours on-line monitoring
- Economical and efficient
- 7” Color touch screen
- Alarm light, warning sound, and instant alert email or message delivery

### Technical Specification

<table>
<thead>
<tr>
<th>Model</th>
<th>PDD-SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel</td>
<td>2 - 4 - 6</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>1Mhz-80Mhz</td>
</tr>
<tr>
<td>Measured Range</td>
<td>1mV - 2V (50Ω)</td>
</tr>
<tr>
<td>Communication Port</td>
<td>Built-in RJ-45 &amp; USB x 4</td>
</tr>
<tr>
<td>Power Supply</td>
<td>90 - 264 VAC / 45 Hz - 66 Hz</td>
</tr>
<tr>
<td>Dimensions</td>
<td>220mm x 170mm x 140 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>&lt; 2 kg</td>
</tr>
<tr>
<td>Functions</td>
<td>24 hours on-line monitoring</td>
</tr>
<tr>
<td></td>
<td>7” color touch screen</td>
</tr>
<tr>
<td></td>
<td>Discharge level display (safety, warning, alarm)</td>
</tr>
<tr>
<td></td>
<td>Alarm light, warning sound</td>
</tr>
<tr>
<td></td>
<td>Waveform, FFT, TF map, PRPD, number of PD, Trend chart</td>
</tr>
<tr>
<td></td>
<td>Off-site data backup, and alert email (with Internet)</td>
</tr>
</tbody>
</table>
Partial Discharge Detector—Features

- Diagnose insulation deterioration of power equipment to avoid equipment breakage and property loss, suitable for various transformers, switchgear, power cable, etc.
- Two signals comparison for PD identification: eliminate jamming from signal outside, and avoid false alarm.
- Phase Resolved Partial Discharge (PRPD) analysis corresponds with partial discharge occurrence frequency to identify the PD signal accurately.
- PD progress data record: create trend chart, predict insulated condition in advance.
- Automatically sends email alerts to administrators.
- PD Detector is the best instrument to detect early failure of power equipment.
WinTech PD Detector 24H Intelligent Remote Monitoring Systems
—Application of “Internet of Things” and “Smart Grids”
Applications and Objects

For medium and high voltage equipment running 24 hours a day, 365 days a year

High-tech industry: semiconductor, precision panel, biotechnology plants, substation, etc.

Traditional industry: iron and steel industry

Public construction: airport, railway, subway, highway, tunnel, and power cable car

Power supply plants

Sewage treatment plants

Refuse incineration plants
WinTech PD Application

Case 1 - PD Phenomenon in Gas Insulated Switchgear

Cause: Metal particles and protrusion | Bubble and crack on spacer | Moisture in SF6

HV GIS online testing according to IEC 62478

- Sensor: Chap.5.4.3.1 #11 & Chap.5.4.6 #14
- Measure Method: Annex C.1 Gas Insulated Switchgear #22-26
WinTech PD Application

Case 1 - Testing and Monitoring System Installation for Gas Insulated Switchgear
WinTech PD Application

Case 2 - PD Phenomenon in Cast-Resin Transformer

Cause: Bubble and crack in resin | Metal protrusion

HV TR online testing according to IEC 62478
- Sensor: Chap.5.4.3.1 #11 & Chap.5.4.6 #14
- Measure Method: Annex C.3
  Transformer #28-29
Case 2 - Testing and Monitoring System Installation for Cast-Resin Transformer

WinTech PD Application
WinTech PD Application

Case 3 - PD Phenomenon in Oil Immersed Transformer

Cause: Insulating oil deterioration | Metal protrusion | Bubble in insulating oil and coil

HV OIL TR online testing according to IEC 62478

- Sensor: Chap.5.4.3.1 #11 & Chap.5.4.6 #14
- Measure Method: Annex C.3
- Transformer #28-29
WinTech PD Application

Case 3 - Testing and Monitoring System Installation for Oil Immersed Transformer

B Diagonal

A Diagonal

UHF-OTS
For power equipment still under construction

Online Testing
24 H Online Detecting

24 H Online Detecting

OR
WinTech PD Application

Case 4 - PD Phenomenon in High-Voltage (HV) Switchgear

Cause: Insulation deterioration | Metal protrusion | Cracks | Poor connection

Insulation deterioration, impurities, cracks, etc.

HV PANEL online testing according to IEC 62478

- Sensor: Chap.5.4.3.1 #11 & Chap.5.4.6 #14
WinTech PD Application

Case 4 - Testing and Monitoring System Installation for HV Switchgear
WinTech PD Application

Case 5 - PD Phenomenon in Power Cables

Cause: Crack | Metal protrusion | Steam | Poor installation

HV CABLE online testing according to IEC 62478

- Sensor: Chap.5.4.3.1 #11 & Chap.5.4.6 #14
- Measure Method: Annex C.3
  Cable # 29-32
WinTech PD Application

Case 5 - Testing and Monitoring System Installation for Power Cables
WinTech PD Application

Case 6 - Testing and Monitoring System Installation for Rotating Machinery (Hydrogenerator)

Note: If a power equipment is still under construction, UHF Sensor can be installed on it with/without drilling the hole of the equipment. If it is an established equipment, TEV sensor can be installed on it directly.
24 hours PD Monitoring Project (1) in Magong Airport, Penghu
Application: Switchgear Transformer
Wintech Detector 24 Hours On-line Monitoring
24 hours PD Monitoring Project (2) in UPCC (Logistics), Hualien
Application: Switchgear
Wintech Detector 24 Hours On-line Monitoring

HFCT Sensor
PD Detector
TEV Sensor
24 hours PD Monitoring Project (3) in Sewage Treatment Plant, Kaohsiung
Application: 69kV Oil Immersed Transformer and Switchgear
Wintech Power 24 Hours On-line Monitoring

Data transmission to central control room
24 hours PD Monitoring Project (4) in NTU Hospital, Taipei
Application: 22.8kV VCB Switchgear
Wintech Detector 24 Hours On-line Monitoring
24 hours PD Monitoring Project (5) in Kang Chiao Intl School (Linkou)
Application: 22.8kV VCB Switchgear
Wintech Detector 24 hours On-line Monitoring
24 hours PD Monitoring Project (6) in Southern Taiwan Science Park (STSP), Tainan
Application: 345 kV Power Cable
Wintech Detector 24 hours On-line Monitoring
24 hours PD Monitoring Project (7) in Kaohsiung Light Rail

Application: 22.8 kV Cast-Resin Transformer

Wintech Detector 24 hours On-line Monitoring
24 hours PD Monitoring Project (8) in Central Weather Bureau, Taipei

Application: 22.8 kV Cast-Resin Transformer
Wintech Detector 24 hours On-line Monitoring
24 hours PD Monitoring Project (9) in National Communication Commission, Taipei

Application: 22.8 kV Cast-Resin Transformer
Wintech Detector 24 hours On-line Monitoring
## 24 hours PD Monitoring Projects Lists

<table>
<thead>
<tr>
<th>Object</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magong Airport</td>
<td>24 hours on-line monitoring for 22.8kV switchgear</td>
</tr>
<tr>
<td>Taiwan Power Research Institute (Southern Taiwan Science Park)</td>
<td>24 hours on-line monitoring for 345kV (and above) power cable located in underground passage</td>
</tr>
<tr>
<td>NTU Hospital</td>
<td>24 hours on-line monitoring for 22.8kV switchgear</td>
</tr>
<tr>
<td>Kaohsiung Sewage treatment plant</td>
<td>24 hours on-line monitoring for 69kV oil immersed transformer &amp; switchgear</td>
</tr>
<tr>
<td>UPCC (Logistics)</td>
<td>24 hours on-line monitoring for 22.8kV switchgear</td>
</tr>
<tr>
<td>Kang Chiao Intl school (Linkou)</td>
<td>24 hours on-line monitoring for 22.8kV HV substation</td>
</tr>
<tr>
<td>Kaohsiung Light Rail</td>
<td>24 hours on-line monitoring for 22.8kV cast-resin transformer</td>
</tr>
<tr>
<td>Central Weather Bureau</td>
<td>24 hours on-line monitoring for 11.4kV-22.8kV oil immersed transformer &amp; 22.8 kV cast-resin transformer</td>
</tr>
<tr>
<td>National Communication Commission</td>
<td>24 hours on-line monitoring for 22.8kV cast-resin transformer</td>
</tr>
<tr>
<td>Tainan Water Resources Substation</td>
<td>24 hours on-line monitoring for 22.8kV VCB&amp;GCV</td>
</tr>
<tr>
<td>Nan Ya Plastic Substation</td>
<td>24 hours on-line monitoring for 33.5KV&amp;22.8KV VCB&amp;GCV</td>
</tr>
<tr>
<td>The Third nuclear power plant</td>
<td>24 hours on-line monitoring for 13.8KV &amp; 4.16KV NPBD</td>
</tr>
<tr>
<td>National Center for High-Performance Computing</td>
<td>24 hours on-line monitoring for 22.8kV cast-resin transformer</td>
</tr>
<tr>
<td>Hefei Changxin Wafer Factory (China)</td>
<td>24 hours on-line monitoring for 22.8kV cast-resin transformer &amp; VCB</td>
</tr>
<tr>
<td>Hangzhou International Airport (China)</td>
<td>24 hours on-line monitoring for 220kV power cable located in underground passage</td>
</tr>
<tr>
<td>Pilot Project in TNB (Malaysia)</td>
<td>24 hours on-line monitoring for C-GIS</td>
</tr>
</tbody>
</table>
WinTech PD Products—Own Advantages

❖ Multiple physical quantities monitoring techniques (cross-comparison): WinTech develops various sensors to detect multiple physical quantities. Our advanced techniques are officially recognized and awarded by Ministry of Economic Affairs, R.O.C., in 2017 Taipei International Invention Show and Technomart.

❖ All PD products are “Own-developed (Made in Taiwan)”: WinTech gathered domestic and foreign experts from domestic and foreign who have related experiences over 10 years, collaborated famous universities worldwide, and developed a series of precise sensors which are non-invasive for various electrical equipment individually.

❖ Built-in active PD signal receiver in UHF Sensor: increasing the accuracy for detection in the early period of deterioration.

❖ First patent possession and publication on “Antenna Array” in the world for locating the PD activities.

❖ WinTech detector and WinTech power are the highest level measurement systems developed by our team, including physical facilities and software, to detect PD activities with connecting to sensors.

❖ Human centered design, and multiple-language support.

❖ Sensors can be customized and mass production, frequency ranging from 20K-3000MHz.

❖ Acceptable by TCP/IP internet communication regulations, and realized by the concepts of “Internet of Things”, and “Smart Grid”.

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