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www.ofilsystems.com
solution@ofilsystems.com

OFIL SYSTEMS

NEWSLETTER

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OFIL at CIGRE 2026

OFIL participated with a dedicated booth, showcasing our latest technologies and solutions.

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Why UV Corona Imaging Is Becoming an Industry Standard

As utilities and industrial operators continue to increase system voltages, equipment power density, and network reliability requirements, early detection of external partial discharge (PD) has become more important than ever.

One technology that is increasingly recognized across the electrical industry is solar-blind ultraviolet (UV) corona imaging. Over the past decade, leading organizations including IEEE, IEC, EPRI, and NFPA have published standards and technical guides that reference UV corona inspection as a valuable method for detecting, locating, and evaluating external partial discharge on energized high-voltage equipment.

Rather than replacing conventional electrical PD measurements or thermal imaging, UV inspection complements these techniques by providing direct visual localization of corona activity during normal daylight operation. This enables maintenance teams to identify developing insulation problems earlier, prioritize corrective actions, and improve the effectiveness of condition-based maintenance programs.

Today, UV imaging is referenced across a wide range of applications.

A Growing Role in Modern Asset Management

The growing number of international standards referencing UV corona imaging reflects the industry's increasing focus on proactive asset management and condition-based maintenance. As electrical systems continue to operate at higher voltages, with greater power density and more compact designs, external partial discharge becomes an increasingly important reliability concern. UV corona imaging provides maintenance teams with a safe, non-contact, daylight inspection method that complements thermal imaging, electrical PD measurements, and visual inspections.

From manufacturing quality control to transmission line inspections, robotic monitoring, and UAV-based surveys, UV technology has become an established part of modern high-voltage diagnostic programs.

As these standards continue to evolve, the role of UV corona imaging in improving equipment reliability, reducing unplanned outages, and supporting data-driven maintenance strategies is expected to continue expanding.

Guidance spans transmission, substations, rotating machines, robotics, UAV inspection, partial discharge measurement, and predictive maintenance.

KEY STANDARDS AND GUIDELINES

STANDARD / GUIDE		APPLICATION / SCOPE	HOW UV CORONA IMAGING IS REFERENCED
EPRI	EPRI – Daytime Discharge Inspection Guide	Transmission & Distribution Overhead Lines and Substations	Provides practical methodologies for daytime corona inspections using solar-blind UV cameras to detect insulation deterioration, damaged hardware, contamination, and abnormal electric field conditions while equipment remains energized.
EPRI	EPRI Yellow Book (2023)	Overhead Transmission Inspection, Assessment, and Asset Management	Discusses the application of UV inspection as part of comprehensive transmission asset management. UV imaging is recommended for evaluating composite insulators, grading rings, fittings, and other components susceptible to corona discharge.
EPRI	EPRI Red Book (2023)	AC Transmission Line Reference Book (200 kV and Above)	Explains corona formation, its effects on transmission systems, and methods used to detect it. UV imaging is identified as an effective optical technique for locating corona on energized transmission hardware.
IEEE	IEEE 3328-2025	Recommended Practice for Wheeled Robots for Substation Inspection	Identifies UV imagers as one of the recommended sensing technologies for autonomous substation inspection. Specifies operation within the solar-blind UV spectrum (240–280 nm) for reliable daylight corona detection.
IEEE	IEEE 3327-2025	Recommended Practice for UAV-Based Substation Inspection	Recognizes UV inspection payloads as part of modern drone-based substation inspections. Identifies inspection targets such as insulators, connectors, clamps, and other components where corona activity commonly develops.
IEEE	IEEE 2833-2024	Guide for Overhead Transmission Lines with Composite Insulated Crossarm Supports	Recommends UV imaging as one of several complementary inspection technologies for assessing transmission line insulation. UV cameras are used to identify corona activity, evaluate electric field stress, and detect surface defects on composite insulation systems.
IEEE	IEEE 1829-2025	Guide for Conducting Corona Tests on Hardware for Overhead Transmission Lines and Substations	Establishes standardized procedures for corona performance testing of transmission and substation hardware. UV cameras are specifically identified as an approved method for performing visual corona inspections.
IEEE	IEEE 1799-2022	Recommended Practice for Quality Control Testing of External Discharges on Stator Coils, Bars, and Windings	Describes procedures for detecting external partial discharge during rotating machine manufacturing and testing. Recognizes UV corona imaging as an inspection method that allows discharge activity to be detected under normal lighting conditions, eliminating the need for blackout testing while improving defect localization.
IEEE	IEEE 1434-2014	Guide for the Measurement of Partial Discharges in AC Electric Machinery	Discusses methods for measuring and locating partial discharge in rotating machines. Explains that UV corona imaging can be used alongside electrical PD measurements to accurately locate external discharge sites on stator windings, coils, and bars.
IEEE	IEEE 56-2016	Guide for Insulation Maintenance of Electric Machines	Identifies corona activity as an important insulation aging mechanism and discusses diagnostic methods used to detect insulation deterioration. Recommends periodic inspection of equipment for evidence of corona-related damage and surface discharge.
IEC	IEC 60270	High-Voltage Test Techniques – Partial Discharge Measurement	International standard for electrical partial discharge measurement. While primarily focused on charge-based PD measurements, it references complementary guidance for evaluating external discharges, including the use of UV corona imaging described in IEEE 1799.
NFPA	NFPA 70B	Standard for Electrical Equipment Maintenance	Includes ultraviolet detection among the recommended diagnostic methods for predictive maintenance of electrical equipment. UV inspection is recognized as a technique for identifying insulation degradation and external discharge activity before failures occur.

Higher Voltage, Higher Stakes: The emerging partial discharge challenge in EV and electric-aircraft motors

Electrification is pushing motor design into new territory. Higher voltage, faster switching, greater power density, and operation at altitude are improving performance - but they are also creating a smaller margin for insulation defects and partial discharge.

A hidden reliability challenge

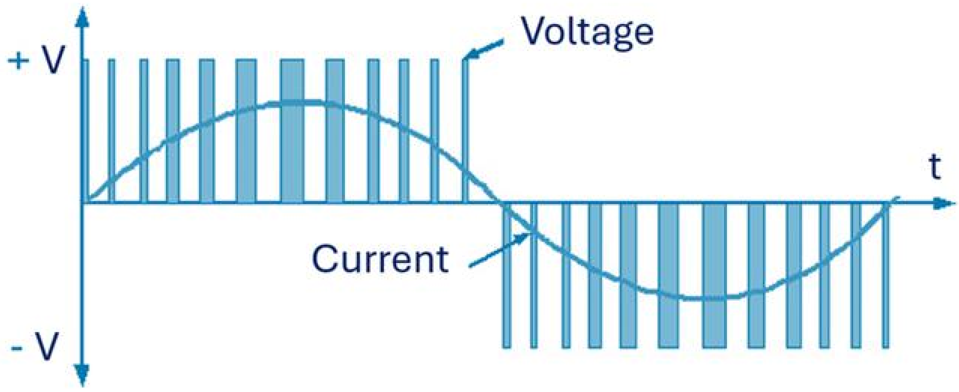
Electric vehicles and electric aircraft are being designed to deliver more power from lighter, smaller, and more efficient systems. In EVs, the industry is increasingly moving from traditional 400 V architectures toward 800 V systems and beyond. At the same power level, higher voltage can reduce current, helping enable faster charging, lower electrical losses, improved thermal management, and potentially lighter cabling. It also supports the performance expected from the next generation of electric powertrains.

At the same time, motor designers are pursuing higher power density, more compact and intricate geometries, and new material strategies, including efforts to reduce dependence on rare-earth elements. These trends are valuable, but together they can increase electrical stress on the winding insulation. Partial discharge (PD) - a localized electrical breakdown that does not immediately bridge the insulation - can gradually erode that insulation and eventually contribute to premature failure.

Why PWM changes the testing environment

An EV motor is not supplied by a clean sinusoidal voltage. Its inverter rapidly switches the battery's DC power to create the voltage waveform needed to control motor speed and torque. This pulse-width modulation (PWM) is essential for efficient operation, but its fast voltage transitions and steep rise times can produce uneven voltage distribution across the first turns of a winding and place concentrated stress on the insulation. As voltages and switching speeds rise, the challenge becomes more significant.

The same switching that stresses the insulation also complicates PD measurement. PWM inverters generate strong electrical noise around each switching event. These transients can be far larger than the PD pulses being measured, masking the signal, saturating sensors, or making it difficult to separate a real discharge from the inverter's normal operation. In addition, PD under repetitive fast pulses does not necessarily behave the same way it does under conventional sinusoidal AC test voltage. A test approach based only on traditional AC conditions may therefore provide an incomplete picture of the stresses seen in service.

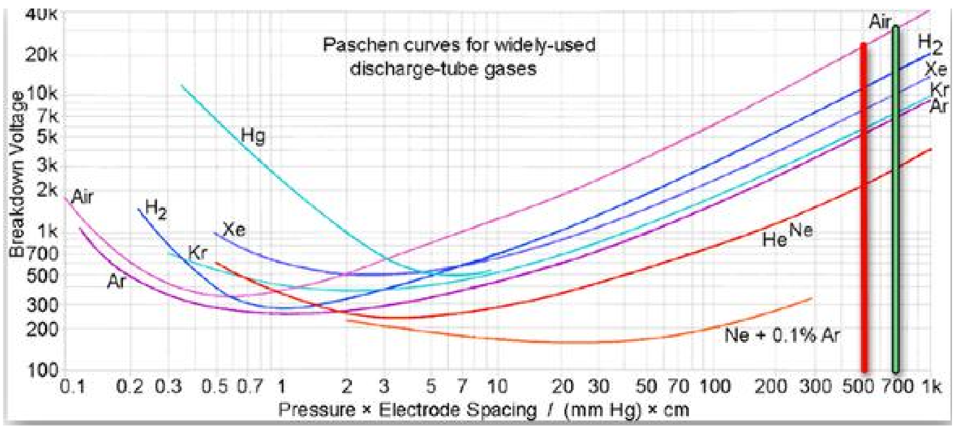


PWM inverter voltage pulses generating the controlled sinusoidal current supplied to the motor.

This is where optical detection can add a valuable perspective. UV imaging detects the ultraviolet emissions produced by corona and surface PD without being affected by the inverter's electromagnetic switching noise. When the emitting area is visible to the camera, the result is not only an indication that discharge is present, but also a clear view of where it is occurring.

Electric aircraft: the additional challenge of altitude
Electric-aircraft propulsion brings the same pressure for higher voltage and power density, with even stricter requirements for weight, size, efficiency, and reliability. It also introduces an operating condition that road vehicles do not face: reduced air pressure at altitude.

According to Paschen's Law, the voltage required for electrical breakdown in air depends on pressure and gap distance. As an aircraft climbs and pressure falls, the breakdown voltage for relevant air gaps can decrease substantially; under representative conditions at 10,000 feet, it may be roughly 40% lower than at sea level. An insulation system that appears PD-free during a ground test may therefore face a more demanding environment in flight. For aircraft motors, maintaining PD-free performance throughout the operating envelope is not only a lifetime consideration - it is central to safe, dependable propulsion.



Paschen curves showing how air pressure and electrode spacing influence electrical breakdown voltage.

OFIL's development focus

OFIL is advancing UV imaging methods for motor insulation development, validation, and fault investigation. The goal is to complement established electrical measurements with noise-immune visual evidence and practical localization of discharge activity. Recent work on motor stators illustrates this approach.

Adding Spatial Information to Partial Discharge Testing

Recent testing on motor stators demonstrates how UV imaging can complement conventional electrical partial discharge measurements by adding spatial information to the diagnostic process.

UV imaging was evaluated during AC, Surge, and RPDIV testing, with measurements repeated at different viewing angles, working distances, and voltage levels. During RPDIV testing, the electrical measurement system identified the presence and inception of partial discharge, while UV imaging provided a visual indication of where the discharge activity was occurring on the stator. The new UV imaging setup proved highly effective for both phase-to-ground and phase-to-phase inspections, clearly showing discharges from each individual phase.

Heatmap overlays enabled the detected UV activity to be mapped directly onto the stator. Repeated observations from different viewing positions showed discharge activity associated with the same physical area, demonstrating the potential of UV imaging to support repeatable localization of PD sources.

Illustration based on a 3D motor-stator model, showing how UV-detected partial discharge activity can be spatially mapped to specific locations on the stator windings and between stator-core slots.

This combination provides complementary diagnostic information: conventional electrical testing characterizes the presence and electrical behavior of PD, while UV imaging can help identify its physical origin. For motor manufacturers and service organizations, this additional spatial information can support faster fault investigation and more targeted inspection of stator insulation.

A more complete view of insulation health

The next generation of electric motors will require more than simply raising voltage ratings. Manufacturers will need test strategies that reflect fast-switching operating conditions, account for the altitude envelope where relevant, and combine different forms of diagnostic evidence. Electrical PD measurement remains essential for characterizing inception and signal behavior; UV imaging adds the spatial context needed to see and localize accessible discharge activity.

By bringing these perspectives together, motor manufacturers, research laboratories, and service organizations can investigate faults faster, validate insulation designs with greater confidence, and support the reliable electrification of both road and air transportation.

Related reading: Detecting Partial Discharge in EV Motors: The Hidden Challenge of PWM Inverters

Closer to the Customer, Closer to the Risk: Why UV Inspection Matters on Distribution Lines

Corona and UV inspection are commonly associated with high-voltage transmission lines. Transmission networks carry large amounts of electricity over long distances, typically at voltages ranging from approximately 69 kV to more than 700 kV.
Distribution networks serve a different purpose. They carry electricity from substations to homes, businesses, industrial facilities, and public infrastructure. Primary distribution systems typically operate between approximately 4 kV and 35 kV before transformers reduce the voltage further for end users.

UV inspection is often overlooked on distribution networks because of the misconception that corona discharge is only relevant at transmission voltages. In practice, distribution assets can develop corona, gap discharge, and arcing due to damaged or contaminated components, inadequate clearances, poor grounding, loose connections, and installation defects. These networks should therefore be included in UV inspection programs, particularly because they operate close to customers and frequently have limited redundancy.

Voltage is only part of the equation

Corona discharge occurs when the electric field around an energized component becomes strong enough to ionize the surrounding air. System voltage affects this process, but it is not the only factor.

A strong electric field can develop locally around sharp edges, damaged conductor strands, contaminated insulators, loose connections, small air gaps, and incorrectly installed hardware. Inadequate grounding, poor bonding, or insufficient spacing between conductors can also create corona, gap discharge, or arcing, even when the system operates far below transmission voltage.

The risk is particularly relevant across distribution networks, where long exposed spans, wooden poles, aging hardware, and components exposed to pollution, moisture, vegetation, and other challenging environmental conditions can increase the likelihood of electrical discharge.

These conditions can progress from localized discharge to insulation damage, carbonization, flashover, fire, equipment failure, or an outage. Routine UV inspection allows utilities to identify and locate this activity while the equipment is energized, supporting corrective maintenance before the condition develops into a larger event.

Distribution is closer to people and sensitive infrastructure

Distribution equipment is installed where people live and work. Lines and components are located beside homes, roads, schools, commercial areas, industrial sites, and public spaces. This makes the consequences of a developing electrical discharge different from those on a remote transmission corridor.

Corona discharge and arcing can produce audible noise that disturbs nearby residents. The same activity can generate radio-frequency interference. Because distribution lines are close to customers and communication infrastructure, this interference may affect radio, television, telecommunications, and other sensitive systems. Near airports or similar facilities, identifying and eliminating potential sources of interference can be particularly important.

Safety is also a greater concern when energized equipment is installed close to pedestrians, vehicles, buildings, and vegetation. A developing discharge on a damaged component or wooden pole is not only a maintenance issue. It may create a risk of fire, falling equipment, public exposure, or a sudden failure in a populated area.

The importance of a distribution anomaly should therefore not be judged only by its voltage or discharge intensity. Its location and potential impact must also be considered.

Less redundancy can mean greater customer impact

Transmission networks are generally designed with multiple paths that allow electricity to be rerouted when a line or component is unavailable. Distribution networks often have fewer alternatives.

In many areas, a neighborhood, commercial district, or critical facility is supplied by a single distribution feeder. If that feeder fails and no practical backup path is available, the customers connected to it lose power until the problem is located, isolated, and repaired.

A relatively small defect can therefore interrupt electricity to hundreds or thousands of customers. The effect may be even more significant when the circuit supplies hospitals, communication facilities, water infrastructure, transportation systems, or industrial operations.

Early detection is particularly valuable under these conditions. Finding an abnormal discharge during a planned UV inspection allows the utility to investigate and schedule corrective action. Discovering the same defect only after failure means responding to an outage, often under greater time pressure and with higher operational and public consequences.

What UV inspection can reveal

Solar-blind UV cameras detect the ultraviolet emissions generated by corona and arcing and overlay the activity on a visible image. This allows inspectors to locate the source while inspecting energized equipment during daylight.

On distribution networks, UV technology can help identify:

- Damaged or contaminated insulators
- Loose connections and unintended air gaps
- Discharge from switches, cutouts, connectors, and terminations
- Inadequate conductor clearances
- Grounding or bonding problems
- Arcing on or near wooden structures
- Sources of audible noise or radio-frequency interference

RFI investigations demonstrate the value of precise localization. Other methods may indicate that interference is present in the general area, but UV imaging can help identify the specific component producing the discharge. This can shorten the investigation and support focused corrective maintenance.

UV Findings from the Field

Corona Activity on Distribution Insulators

Early detection preventing insulation degradation and unexpected failure.

Periodic UV inspection detected corona discharge at the live end of insulators on two phases, where persistent activity could damage the insulation and its hydrophobic coating and increase the risk of failure in humid or wet conditions.
Early detection enabled the insulators to be replaced during a scheduled outage, reducing the risk of unexpected failure and service interruption.

Hidden Tie-Wire Discharge Detected by UAV

UV inspection reveals an installation defect invisible to visual inspection.

A UAV-mounted UV camera detected corona partial discharge on a tie wire that appeared normal during visual inspection. The discharge was caused by improper installation of the tie wire and was damaging the insulation material.

Critical Insulator Failure & Voltage Leakage

UV detection identifies an immediate safety hazard requiring corrective action.

UV inspection detected corona discharge at the dead end of a distribution-line insulator, indicating insulator failure and voltage leakage toward the pole. This presents a serious safety hazard and requires immediate corrective action.

UV complements thermal inspection

Infrared inspection is widely used on distribution systems, but UV and thermal cameras detect different physical phenomena.

Thermal inspection identifies abnormal heating, often caused by excessive resistance, loading, or poor connections. UV inspection identifies ionization and electrical discharge in air. A developing defect may emit UV before it produces a meaningful increase in temperature. Conversely, a thermal anomaly may have no UV signature.

The technologies are therefore complementary rather than interchangeable.

A Smarter Strategy for Distribution Reliability

Not every distribution line requires the same inspection frequency. A targeted, risk-based UV program can prioritize higher-voltage feeders, circuits with recurring faults, aging infrastructure, contaminated environments, wooden structures, tight conductor clearances, RFI or noise complaints, and lines supplying critical or densely populated areas.

Distribution networks are close to people, often have limited redundancy, and directly serve customers and sensitive infrastructure. UV inspection should therefore be included as part of their condition-monitoring strategy, alongside visible and thermal inspection.

The question should not be whether distribution voltage is “high enough” for UV inspection. The better question is whether an undetected discharge could create an outage, safety hazard, noise complaint, interference problem, or fire risk.

In many distribution applications, the answer is clearly yes.

New Gridnostic Website Now Live

Gridnostic has launched its new website, providing a dedicated home for its AI-enhanced platform for electrical inspection data management, analysis, and diagnostics.

Built specifically for electrical asset inspections, Gridnostic brings together UV, thermal, and RGB inspection data within a single GIS-based environment.

The platform transforms inspection findings into structured, actionable information through AI analytics, EPRI-aligned severity assessment, asset-based data management, and automated reporting.

From substations and distribution networks to transmission grids, Gridnostic helps utilities and inspection teams move from scattered inspection images to a clearer understanding of asset condition and maintenance priorities.

The new website provides an overview of the platform’s capabilities, applications, and real-world results.

Discover Gridnostic: gridnostic.ai

Gridnostic is also featured on **Technology Radar Map**
The TDI technology rada`r map is a tool used to visualize and assess the maturity, relevance, and adoption status of Transmission and Distribution technologies.