



Partial Discharge Testing Guide



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About This Guide

Partial discharge testing measures small electrical discharges inside high voltage insulation that do not yet bridge the gap between conductor and earth. They are the earliest measurable sign that insulation is degrading. This guide covers partial discharge detection, offline and online testing, the standards that apply, safe set-up and how to read a result on cables, switchgear and transformers.

What a PD Test Is

A measurement of the discharge activity in HV insulation, in picocoulombs for an offline IEC 60270 test or in decibels and millivolts for an online survey. It finds and locates defects before they fail.

When It Is Used

In the factory, at commissioning alongside the withstand test, in routine online surveys of energised plant, and to confirm and locate a defect a survey has flagged.

Why It Matters

Most HV insulation systems are not resistant to PD, so a discharging defect keeps eroding the insulation until it fails (OMICRON, 2020). A withstand test can pass a cable that is still discharging; only a PD measurement sees it.

Guide at a Glance

Measures

Apparent charge in pC offline (IEC 60270); dB or mV online.

Methods

Offline with a test source; online with TEV, ultrasonic, HFCT and UHF sensors.

Test Source

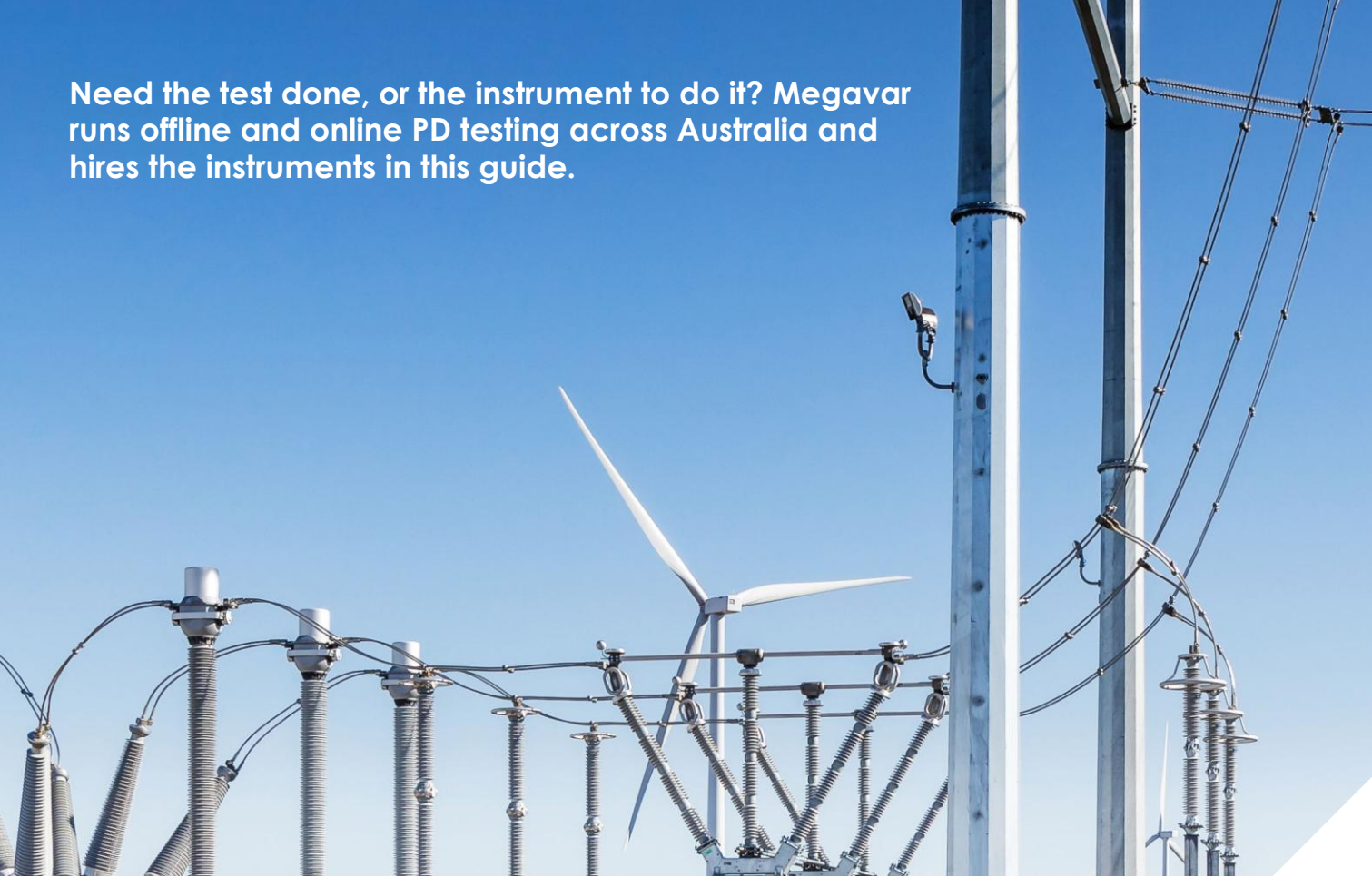
VLF at 0.1 Hz for MV cables; 50 Hz or resonant sets for switchgear and HV cables; for a transformer the voltage is induced through the windings at a frequency above rated (AS/NZS 60076.3:2017 cl 11.1).

Key Values

Inception (PDIV) and extinction (PDEV) voltage against operating voltage.

Judged Against

The equipment standard, asset owner criteria, survey scales and the trend.



Need the test done, or the instrument to do it? Megavar runs offline and online PD testing across Australia and hires the instruments in this guide.

Why Measure Partial Discharge?

Partial Discharge Testing in Four Numbers

1 nF

Coupling capacitor that usually gives acceptable sensitivity (IEC 60270 cl 10)

50 to 200%

Calibration charge as a share of the specified PD magnitude (IEC 60270 cl 5)

250 pC

Maximum in the one-hour transformer induced test (AS/NZS 60076.3 cl 11.3.5)

1.5 U0

Minimum accessory PDEV after a 1.8 U0 prestress, below 69 kV (IEEE 400.3 Table 4)

Why Partial Discharge Matters

An Early Warning

PD is usually present in the early stages of insulation deterioration, so an accurate measurement finds weak points before a complete breakdown (OMICRON, 2020).

Damage Accumulates

Each discharge erodes the insulation a little further. Over months or years the erosion grows into an electrical tree and the insulation fails.

Internal Is Worst

Internal discharges in voids and delaminations are generally the most dangerous type (OMICRON, 2020).

Other Tests Miss It

Insulation resistance and a withstand test can both pass on a cable that is discharging at a joint. Only a PD measurement sees the defect.

Types of Partial Discharge

Internal



Void or delamination inside solid insulation. Most damaging.

Surface



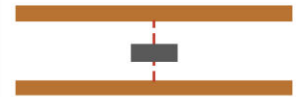
Tracking across a contaminated surface. Affected by humidity.

Corona



Sharp point in air or gas. Usually shows on one half cycle.

Floating metal



Loose or unbonded part between conductor and earth.

Copper: conductor and earth. Red: discharge site.

The four common PD types. The type tells the engineer the likely defect and the best sensor to find it.

When to Test

Factory

Routine PD test to the equipment standard

Commissioning

Offline test with the withstand; baseline

Online survey

Screen the population in service; trend it

After a flag

Offline test to confirm and locate

After repair

Retest the joint or termination

Where Is It Used?

Plant Tested

Plant	What PD points to	Usual method
MV and HV cables, joints and terminations	Voids in a joint, poor stress control at a termination, damaged insulation	Offline VLF with PD and location by reflectometry; online HFCT
Metalclad switchgear	Voids in cast resin, surface tracking, contamination	Online TEV and ultrasonic survey; offline IEC 60270, limit by agreement (AS/NZS 62271.200 Annex B)
Open terminations, bushings and insulators	Surface discharge and corona	Ultrasonic; UV camera
Power transformers	Insulation defects in windings, leads and bushings	IEC 60270 at the bushing tap during the induced test (AS/NZS 60076.3 cl 11.3); UHF; acoustic location
Gas-insulated switchgear	Particles, protrusions, floating parts	UHF sensors in the enclosure
Rotating machines	Stator winding insulation ageing	IEC 60034-27-1 offline, IEC 60034-27-2 online

Offline Testing

Controlled Voltage

The asset is isolated and energised from a separate source, so the test can go above operating voltage, within the asset owner's limit and never above the rated power frequency withstand of the plant (AS/NZS IEC 60270:2026 cl 8), to find defects that only ignite under stress.

Inception and Extinction

Only an offline test measures PDIV, where PD starts as voltage rises, and PDEV, where it stops as voltage falls (OMICRON, 2020).

Calibrated in Picocoulombs

An IEC 60270 measurement is calibrated, so it can be compared with a limit and with a later test.

Locates the Defect

On a cable, reflectometry on the PD pulses gives the distance to the defect.

Online Testing

No Outage

Online partial discharge testing uses sensors on the outside of energised plant, which makes it the normal way to screen a whole switchroom or cable population.

Operating Voltage Only

The engineer cannot vary the voltage, so an online test cannot measure PDIV or PDEV.

Not IEC 60270 Charge

TEV and ultrasonic read in dB, UHF in mV, and some HFCT systems estimate pC. None is IEC 60270 apparent charge; trend it, do not compare it with an IEC 60270 limit.

Good to Know

An online survey screens. An offline test diagnoses and locates. Use the first to decide where to do the second.

How Does It Work?

The IEC 60270 Circuit

Coupling Capacitor

Connected in parallel with the test object. About 1 nF or more usually gives acceptable sensitivity (AS/NZS IEC 60270:2026 cl 10).

Measuring Impedance

In series with the coupling capacitor. The coupling device turns each PD current pulse into a voltage for the instrument.

Apparent Charge

Expressed in pC: the charge which, injected at the test object terminals, gives the same reading as the PD pulse (AS/NZS IEC 60270:2026 cl 3.3.1).

Bandwidth

A wide-band instrument has a lower limit between 30 and 100 kHz and an upper limit no higher than 1 MHz (AS/NZS IEC 60270:2026 cl 4.3.4).

Sensors for Online Testing

TEV

Transient earth voltage on the metal enclosure, from internal PD. Probe held on the panel face.

Ultrasonic

Airborne sound from surface discharge, at door seals, vents and air gaps.

HFCT

PD current pulses in a cable screen earth, measured at earth potential.

UHF

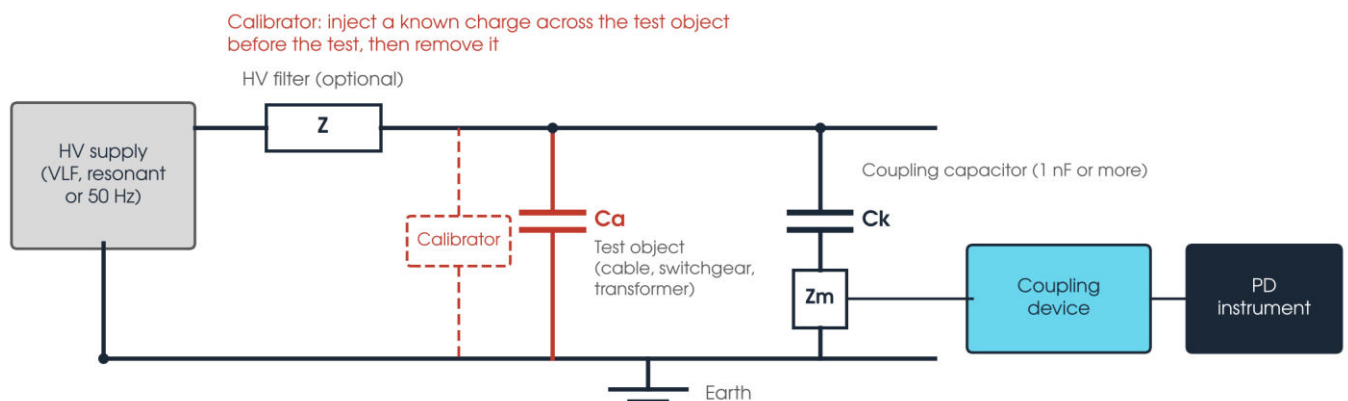
Electromagnetic emission above 100 MHz, mostly in gas-insulated switchgear (OMICRON, 2020).

Good to Know

Internal PD is best detected by TEV, surface PD by ultrasonic (EA Technology, 2020). Carry both.

Measuring Circuit

Conventional (IEC 60270) PD measuring circuit. After OMICRON (2020), Figure 1.



The calibrator is connected across the test object before the test, so the instrument reads apparent charge in picocoulombs.

How Do I Set Up Safely?

Permits, Isolation and Earthing

1 Access Permit

For an offline test, the permit covers the whole circuit under test, including the remote end of a cable.

2 Isolated, Proved Dead, Earthed

Confirm it at the plant with the permit issuer before connecting anything.

3 Disconnect Connected Plant

Remove surge arresters, VTs and anything else that would load or clip the test voltage, and record what was removed. For a switchgear PD test to AS/NZS 62271.200 Annex B the VTs stay connected (B.4).

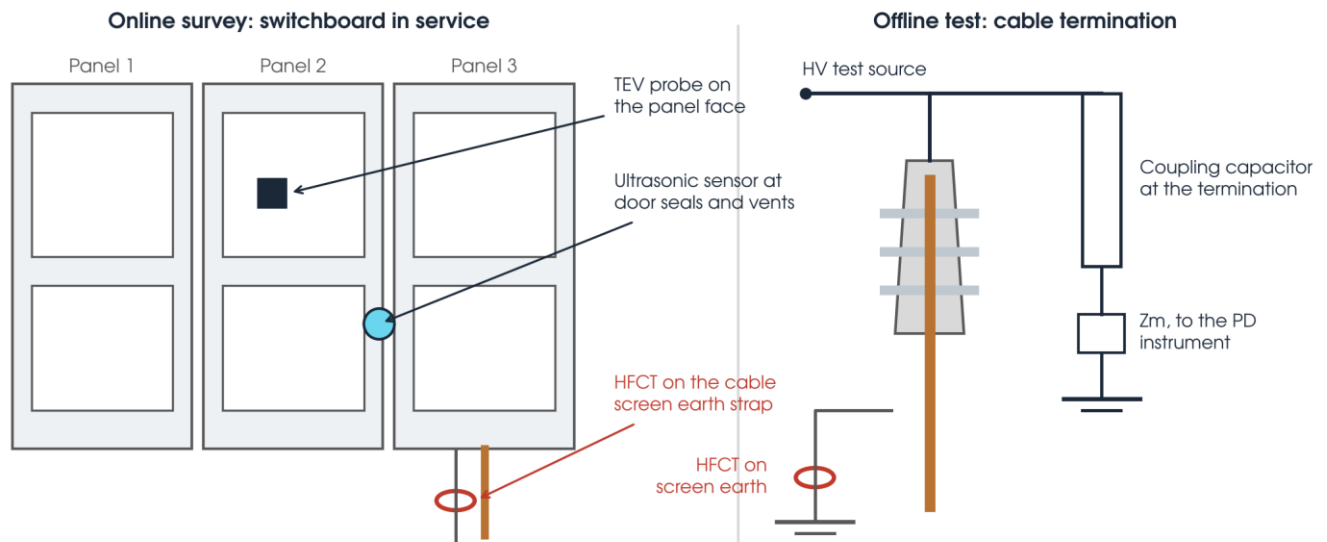
4 Barricade Both Ends

A cable carries the test voltage along its whole length. Guard and sign the remote end and keep communication with it.

Who Should Test

Competent, authorised testing personnel under the asset owner's safety rules. At Megavar, assessed testers; less experienced staff work under direct supervision.

Sensor Placement



Online: TEV on the panel face, ultrasonic at seals and vents, HFCT on the cable screen earth. Offline: a coupling capacitor at the termination.

Important

This guide describes general practice for competent HV testing personnel. It is not a work procedure. Work under the asset owner's safety rules, the access permit and a site-specific safe work method statement. Manufacturer and asset owner criteria take precedence over the general guidance here.

Hazards Specific to PD Testing

Stored Charge

A cable holds charge after a VLF or AC test. Discharge and earth it before touching a lead.

Online Surveys Are Live Work

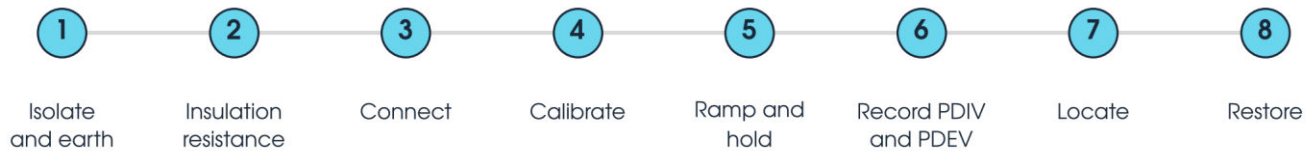
The plant stays energised. Survey from the outside under the site's rules for working near energised equipment; never open a panel to take a reading.

Insulation Resistance Voltage

SA Power Networks limits insulation resistance testing of 11 kV and 33 kV cables to 5,000 V DC, because higher DC voltage on field-aged XLPE accelerates water tree growth (TS105, 2021).

How Do I Make the Measurement?

Eight Steps



Steps 1 to 4

1 Isolate and Earth

Isolate, prove dead and earth the asset, and remove connected plant.

2 Insulation Resistance

A gross fault will not survive a PD test and gives no useful PD data, so test the insulation resistance first.

3 Connect

Coupling capacitor and measuring impedance for IEC 60270, or an HFCT on the cable screen earth.

4 Calibrate

Inject a known charge at the test object terminals, between 50% and 200% of the specified PD magnitude (AS/NZS IEC 60270:2026 cl 5). Record the background: about twice it is the smallest PD you can resolve (cl 10).

Steps 5 to 8

5 Ramp and Hold

Raise the voltage in steps to the level in the test plan, never above the asset owner's limit for that plant, holding long enough at each step to record the phase-resolved pattern.

6 Record PDIV and PDEV

Inception on the way up, magnitude at each step, extinction on the way down.

7 Locate

On a cable, use reflectometry on the PD pulses to find the distance to the defect.

8 Restore

Discharge, re-earth and reconnect the removed plant per the permit.

Good to Know

The test circuit calibration is valid only for that object, set-up and instrument. Change any of them and calibrate again (OMICRON, 2020).

Common Mistakes

Calibrator Away from the Terminals

Calibration must be done as close as possible to the test object terminals, or the reading is wrong (OMICRON, 2020).

No Background Recorded

Without the noise level, a low reading cannot be told apart from noise.

Reading Online Values as IEC 60270

Online readings, including HFCT pC estimates, are not IEC 60270 apparent charge and cannot be compared with its limits.

More Common Mistakes

No Phase-Resolved Pattern

The pattern is what identifies the defect type. A magnitude alone does not.

Single Sensor Type Online

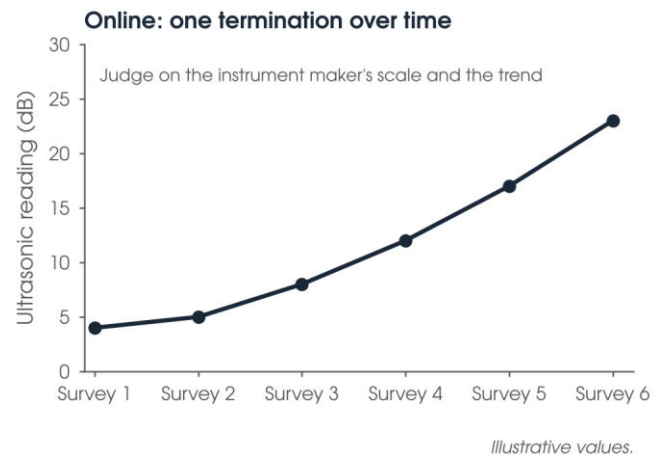
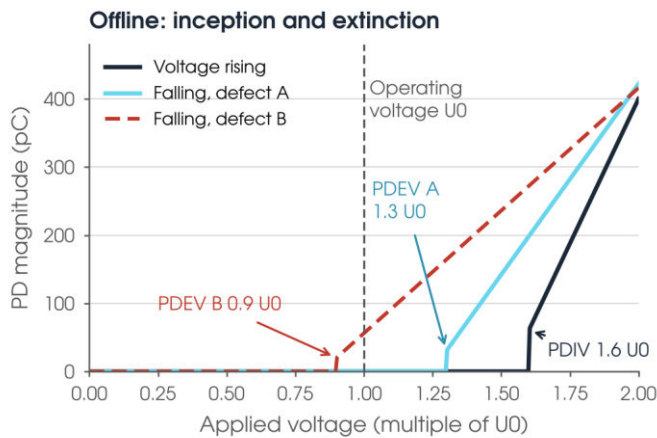
Surface PD can be loud acoustically and invisible to TEV, and the reverse for internal PD.

Trending Different Methods

Compare readings only from the same method, frequency and instrument settings.

How Do I Read the Result?

Inception, Extinction and the Trend



Defect B keeps discharging at operating voltage because its PDEV is below U_0 . The termination on the right shows a rising trend over six surveys.

Comparing the Result

Transformer Limit

Valid only with background of 50 pC or less at start and end. Pass: no voltage collapse; no reading above 250 pC in the hour at $1.58 U_r/\sqrt{3}$; no rise over 50 pC and no rising trend in the last 20 min; then 100 pC or less at $1.2 U_r/\sqrt{3}$ (AS/NZS 60076.3:2017 cl 11.3.5).

Cable Limits

Factory: 20 pC or less at 200% U_0 and 5 pC or less at 150% U_0 on MV cable to 19/33 kV (AS/NZS 1429.1:2006 Table 3.1 item 9(a)); no detectable PD above 10 pC (5 pC on accessories) at 1.5 U_0 from 30 to 150 kV (IEC 60840:2020 cl 9.2). After laying, IEC 60840 leaves criteria to agreement (cl 16.3); below 69 kV, IEEE 400.3-2022 Table 4 looks for accessory PDEV of at least 1.5 U_0 after a 1.8 U_0 prestress.

PDEV Against Operating Voltage

A defect whose PDEV is below operating voltage discharges continuously in service and is the one to fix first.

Trend

A rising magnitude or a falling PDIV between tests means the defect is growing.

What the Pattern Tells You

Internal Discharge

Few pulses per cycle, little affected by humidity, rarely audible.

Surface Discharge

Many pulses per cycle, affected by humidity, often audible.

Corona

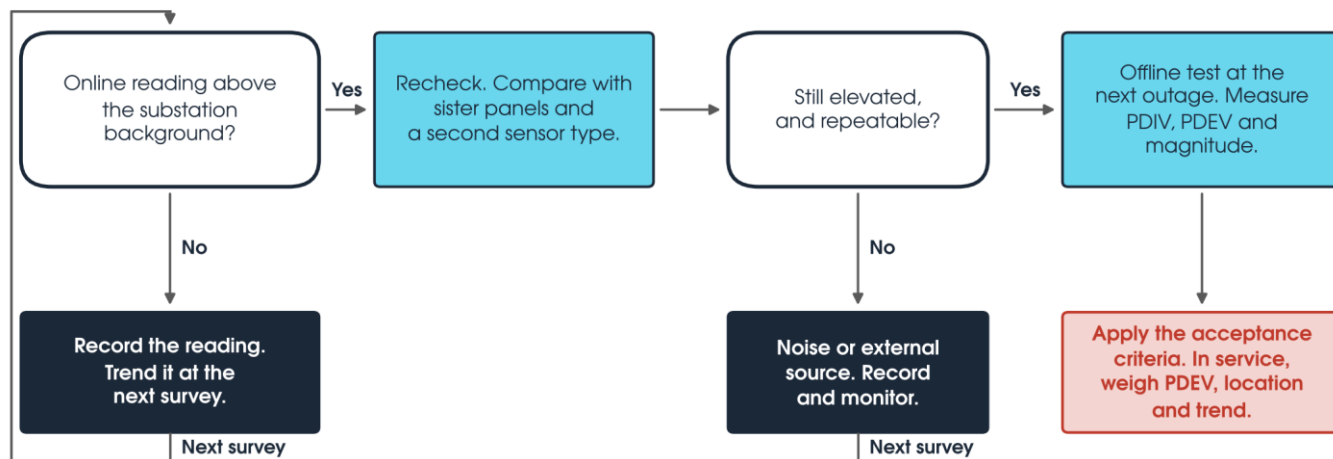
A sharp point in air or gas; usually on one half cycle. Less damaging to bulk insulation, but find the cause.

Noise

Random noise that does not lock to the supply phase, or drive and thyristor interference at fixed phase positions every cycle; both are separated from PD by gating and by the pattern, never by subtracting them from the reading (AS/NZS IEC 60270:2026 cl 10).

Is My Result OK?

Decision Path



Judging an Online Survey

Online reading	What it suggests	Action
At substation background	No observable activity	Record it and trend it at the next survey
Elevated but not repeatable	Noise or an external source	Recheck with a second sensor type; record and monitor
Elevated and repeatable	Possible PD at that location	Compare with sister panels; survey more often; plan an offline test
Rising between surveys	A defect that is growing	Offline test at the next outage to measure PDIV and PDEV and locate it

Judge TEV, ultrasonic and HFCT readings on the instrument manufacturer's survey scale, in its own units and boundary values, together with the background, the phase-resolved pattern, the trend and the risk the asset carries.

What to Report

Calibration and Background

Calibration factor, charge injected and background noise level.

Per Phase

PDIV, PDEV and PD magnitude at operating and test voltage.

Pattern and Location

The phase-resolved pattern at each point, and the defect location on a cable.

The Recommendation

Against the Criteria

The standard, asset owner or survey scale the result was judged against.

Plain Action

Accept, monitor and retest, or locate and repair, with the reason.

Good to Know

A scale is a screening aid. The asset owner's criterion and the trend override it.

How Does PD Fit with VLF and Tan Delta?

Withstand or Diagnostic?

VLF Withstand

A pass or fail proof test at 0.1 Hz: 60 min on a new circuit, 30 min on an aged one (IEEE 400.2-2024 cl 5.1.1).

Partial Discharge

A diagnostic test that finds and locates localised defects without necessarily breaking anything.

Tan Delta

Measures the overall dielectric loss, which rises as XLPE water trees or paper insulation age.

The Three Cable Tests

Run Together

On an MV cable, Megavar combines the VLF or resonant withstand with an MPD 600 PD measurement in one energisation.

Measured in Steps

PD readings are commonly taken at 0.5 to 2.0 U₀ (BAUR, 2014) and tan delta at 0.5, 1.0 and 1.5 U₀, with the withstand level as an optional final step (IEEE 400.2-2024 cl 5.4.2), then the withstand is held.

Good to Know

A cable can pass the VLF withstand and still carry a discharging joint the withstand did not find. Only the PD measurement sees it.

A Combined Cable Test



Illustrative sequence. Withstand level and hold time: IEEE 400.2-2024 cl 5.1.1 or the asset owner's specification.

Recommended Solutions		
Instrument	Rating	Best used for
Omicron MPD 600	IEC 60270	Offline PD measurement and location on cables, transformers, GIS, switchgear and machines
Omicron MCC 210	100 kV	Coupling capacitor for PD and tan delta measurement
EA Technology UltraTEV Plus²	TEV, ultrasonic	Online PD surveys of switchgear, terminations and transformers
SUTE 300 kV Resonant Test Set	300 kV, 25 to 300 Hz	AC withstand source for cables, transformers and GIS during a PD test
Phenix 500 kV Resonant Test Set	500 kV, 45 to 300 Hz	Low-noise AC source for large capacitive test objects
Phenix BK130	130 kV AC	AC withstand on cables, switchgear and insulators

Every instrument is available calibrated, with leads, from Megavar's offices in Hobart, Launceston, Adelaide and Newcastle: [partial discharge testing equipment hire](#).

Frequently Asked Questions

Common Questions

How to perform a partial discharge test?

Isolate and earth the asset, test its insulation resistance, connect and calibrate the PD system, then raise the voltage in steps and record PDIV, the magnitude at each step and PDEV. On a cable, locate any defect by reflectometry.

How is partial discharge detected?

From the by-products of each discharge: a current pulse (coupling capacitor or HFCT), transient earth voltage, UHF emission, or sound. Good surveys use more than one.

What is the IEC standard for partial discharge testing?

IEC 60270 (AS/NZS IEC 60270:2026) for calibrated measurement in pC; IEC TS 62478 for the other methods. Limits sit in equipment standards such as AS/NZS 60076.3 and IEC 60840.

Can I perform a partial discharge test online?

Yes. TEV, ultrasonic, HFCT and UHF sensors work on energised plant with no outage, at operating voltage only.

Standards and References

AS/NZS IEC 60270:2026 (IEC 60270:2025), Charge-based measurement of partial discharges.

IEC TS 62478, Measurement of partial discharges by electromagnetic and acoustic methods.

AS/NZS 60076.3:2017 incl. Amd 1, power transformer dielectric tests. AS/NZS 1429.1:2006, MV polymeric cables. IEC 60840:2020, cables 30 to 150 kV.

IEEE Std 400.2-2024 (VLF) and IEEE Std 400.3-2022 (field PD testing of shielded power cable).

AS 61869.1:2024, AS 61869.2:2021 and AS 61869.3:2021, instrument transformers. AS/NZS 62271.200:2026, metal-enclosed switchgear. IEC 60034-27-1 and 27-2, machines.

OMICRON, A Guide for PD Measurements on MV and HV Apparatus, Parts 1 and 2, 2020.

OMICRON, Diagnostic Testing and Monitoring of MV Switchgear, 2026.

EA Technology, Introduction to Partial Discharge (IEEE Alberta), 2020.

BAUR, VLF Sine 0.1 Hz Testing and Diagnostics, 2014.

SA Power Networks, TS105 Testing Standard for Distribution up to 33 kV, 2021.

More Questions

What is the difference between PD testing and VLF testing?

VLF is a pass or fail withstand test. PD is a diagnostic that finds and locates defects. They are usually run together.

What are the three big tests performed when testing a cable?

Insulation resistance, the VLF withstand, and the diagnostic pair of partial discharge and tan delta.

Which PD equipment does Megavar hire?

The Omicron MPD 600 and MCC 210, the UltraTEV Plus², and resonant test sets to 300 kV and 500 kV.

Does Megavar test as well as hire?

Yes. Our engineers run offline and online PD testing across Australia. Call 1300 730 499.

Hire or Have It Tested

Have It Tested

Megavar's engineers carry out [partial discharge testing](#) and [HV cable testing](#) across Australia.

Next Step

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Testing: service@megavar.com.au



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