

DOBLE ON-LINE MONITORING

# doblePRIME™

CONDITION INTELLIGENCE FOR KEY ASSETS

DATA | ANALYSIS | DECISIONS

DOBLE ENGINEERING COMPANY



# doblePRIME™

## Condition Monitoring Platform

doblePRIME is a modular condition monitoring platform to improve decision-making and analysis of key assets.

It is comprised of a set of integrated tools that give you the data and analysis you need to make timely tactical and strategic decisions based on real-time information.

Choose from a combination of sensors for dissolved gas analysis, partial discharge, bushings and operational values, including load, tap position and temperatures.

doblePRIME features configurable smart analysis tools, including threshold and limit analysis, trending and expert system analysis, and immediate response.

### GETTING STARTED

Unsure about how to begin? Doble will work with you to help determine the most effective approach to intelligent condition monitoring.

doblePRIME is built to respond to your needs: targeted application for a single parameter on a suspect bushing, or comprehensive monitoring which covers multiple transformers and assets across multiple locations. Identify the motivations for condition monitoring, including PD, DGA, leakage currents, and ensure that they are being addressed with specific monitors.

### SECURE ACCESS

Access doblePRIME dashboards within your cyber secure infrastructure using smart phones, tablets or computers.

doblePRIME works within your existing security infrastructure to supply data and analysis where it is needed: proprietary databases, proprietary software and cloud connections are not needed.

### FAILURE MODES

Different assets may have different failure modes - each with its own timescale for operation. It is important to apply condition monitoring which can detect changes in a timely manner.

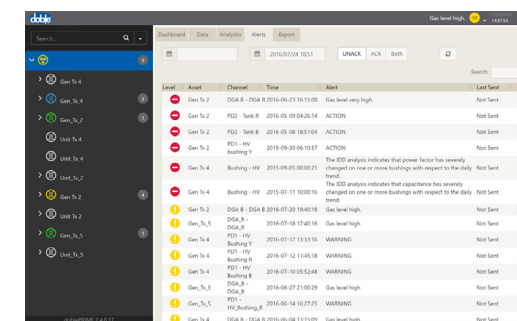
For example, a monitor which looks at the asset every 12 hours will possibly miss a failure mode which takes 3 hours to begin and lead to a failure. doblePRIME can be configured to the most appropriate rate for the application.

### ENCLOSURES

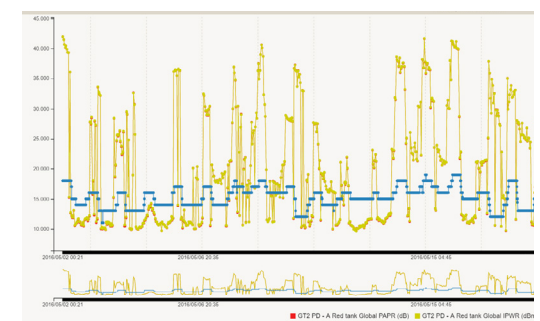
doblePRIME condition monitoring is deployed in IP66/NEMA 4X rated enclosures - including options for climate control, communications, data backup and a separate safety box for power and sensor isolation.



**CONDITIONING MONITORING IN THE FIELD**  
Comprehensive monitoring configuration



**VIEW ALERTS**  
Navigation tree & alert dashboard



**ANALYZE DATA**  
Identify trends & correlations

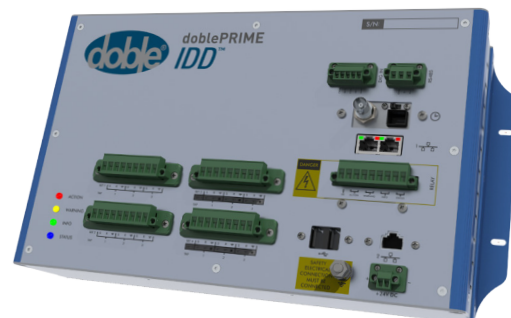
# doblePRIME IDD

## Bushing Monitoring

The **doblePRIME IDD** Bushing Monitor detects deterioration in bushings, finding abnormalities in the insulation and issuing actionable alerts.

The **doblePRIME IDD** provides leakage current and phase analysis for up to 12 bushings, measuring parameters for each bushing individually and together. The **doblePRIME IDD** will accept voltage reference for improved analysis with True Power Factor.

Based on thousands of installations worldwide, the **doblePRIME IDD** can operate as a standalone device or as part of a **doblePRIME Condition Monitoring Platform**.



### AVOIDING BUSHING FAILURES: KNOW THE SIGNS

Over almost 20 years of successful bushing monitoring, Doble has identified two distinct failure modes—rapid onset and graceful decay—and have documented and reported cases of averting bushing failures in both modes.

In the graceful failure mode, deterioration in insulation power factor (dissipation factor or tan-delta) occurs over several weeks. For example, Doble bushing monitoring was used on a 'gracefully' failing bushing. It was watched and was able to remain in service until a replacement could be brought in and an outage planned at a convenient time.\*

In an example of the rapid-onset failure mode, Doble bushing monitoring detected the leakage current through a bushing rose by almost 50% in two hours. The system generated an alert. The team had a response plan in place, acted within 120 seconds, and saved the bushing.\*

### DATA COLLECTION: CURRENT & VOLTAGE

The **doblePRIME IDD** collects raw data waveforms from which rms current can be calculated. By performing an auto-correlation the fundamental power system frequency can be calculated and then the rms and harmonics derived.

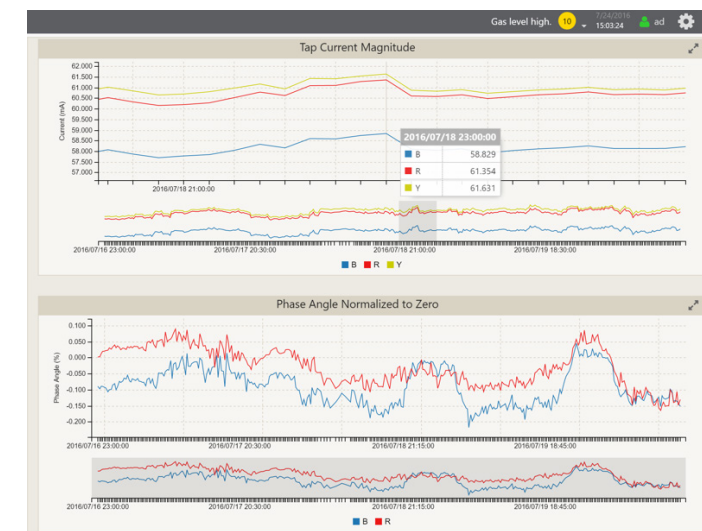
The phase angle is measured so relative phase between bushings can be calculated. If a voltage reference value is available, that may also be recorded (as a waveform) for derivation of the voltage phase angle and calculation of True Power Factor for each bushing. View raw current and voltage waveforms in a diagnostic scope mode.

Measurements are time stamped to externally sourced GPS, IRIG-B or system clock. Waveforms may be stored for future reference and diagnostics.

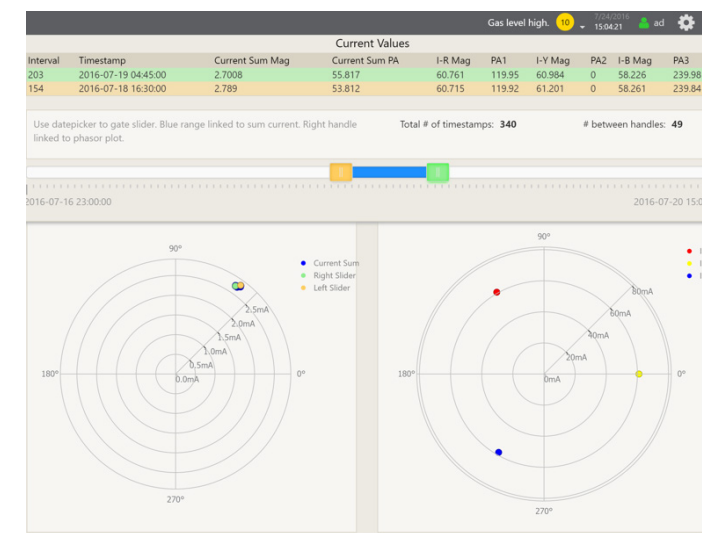
\*"Condition Monitoring in the Real World", International Conference of Doble Clients, 2013

### doblePRIME IDD KEY FEATURES

- Captures bushing current waveforms in real time
- Calculates values for power factor and capacitance
- Records data at user specified intervals, or ad hoc
- Displays alerts locally and remotely on mobile phone, tablet or PC
- No proprietary data formats or software needed
- Intelligent Expert System learns what is normal for your bushings
- Responds to and creates a history of subtle changes in bushing condition
- Modular system available in six or twelve channel versions
- Voltage ratio capability
- Optional external voltage reference inputs for true power factor



**IDD RAW DATA**  
Individual leakage currents & phase angles plotted against time



**SUM CURRENTS DATA**  
Data is animated to show development of possible fault

### SAFETY: STARTING AT INSTALLATION

The **doblePRIME IDD** uses multiple redundant safety systems and ground paths, including transorbs and sparkgaps, to ensure transients are safely conducted to ground.

During an installation, the tap cap is replaced with an **IDD bushing adapter**; the grounding of the tap is then maintained through the **doblePRIME IDD**.

For harsh environments, armored cables are available, meeting full military specification protection. For high criticality applications, and for those in areas with significant switching transients, protection remote from the bushing is available.



# doblePRIME PD-GUARD

## Partial Discharge Monitoring

Partial discharge eats away at insulation – putting assets at risk and system reliability in jeopardy. Early indications of insulation deterioration can be detected with partial discharge tools.

Use the **doblePRIME PD-Guard** Partial Discharge Monitor in cases where early detection of partial discharge is critical, or where continuous updates on partial discharge status is required.

The **doblePRIME PD-Guard** can operate as a standalone device or as part of a **doblePRIME Condition Monitoring Platform**.



### CLEAR ANALYSIS

Analysis of partial discharge signals can be complex. We built our analysis tools to be clear and powerful - detecting and alerting on rising partial discharge levels.

Our sensitive statistical tools track the level and severity of the discharge sources. This is achieved by taking spectral data and deriving a measure of the 'spikiness' or PD-like nature of the signals, and simultaneously tracking the energy of the signal.

If the measured signals are growing in PD nature and energy, there is strong indication that further investigation is required.

### UNDERSTANDING THE DATA & ALERTS

PD monitoring can generate a lot of data. PD signals in the time domain may be measured up to 1 GHz and produce a large quantity of data points.

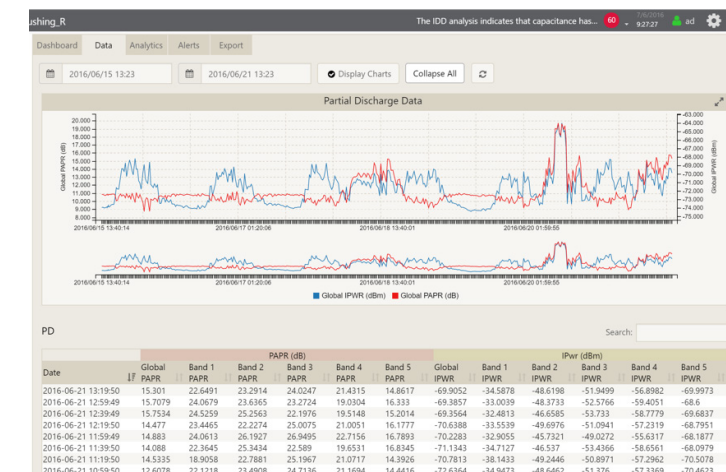
For monitoring purposes, we apply a statistical approach to track the energy of the signals recorded and the severity of the PD. These allow for tracking and trending over time, and generation of meaningful alerts.

Deeper investigation using spectra and phase or time resolved plots may also be performed through the PD-Guard.

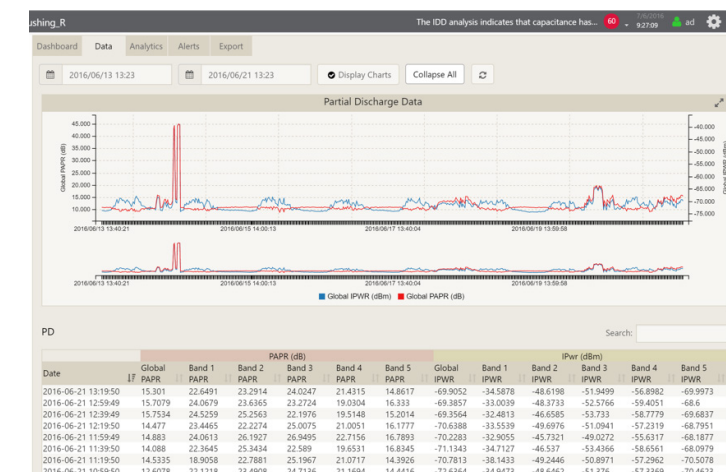
The alerts generated by PD signals are managed by an Alert State Machine. This allows for discrimination of likely PD signals against noise signals such as would be generated by tap changer operations or switching surges. A number of successive measurements above the threshold are required before an alert state is triggered.

### doblePRIME PD-GUARD KEY FEATURES

- An independent PD monitoring system, accessed & configured via computer, tablet or web-enabled device
- Local visual alert status indication
- Alert State Machine thresholds allow for detection of PD while avoiding false positives due to noise events such as tap changer operations or breaker switching
- Alarm relays for external notification
- Broadband RF signal detection including peak, average and quasi-peak
- Quasi-peak detector is designed in the spirit of the CISPR 16-1-1:2010 EMI standard and in line with best field practices
- Use phase-resolved and time-resolved plots for detailed diagnostics



**TYPICAL BUSHING PARTIAL DISCHARGE DATA**  
Typical statistics tracked over two weeks for a single transformer bushing



**SPIKES SHOW SEVERE INDICATION OF PD PRESENCE**  
Sustained PD burst detected and used to generate alerts

### SURVEY. TEST. MONITOR.

Doble recommends a three-step approach to the detection and management of partial discharge in key assets.

**SURVEY** – Requiring minimal training, use the proven, handheld PDS or DFA tools for simple spectral analysis. Regular surveys provide baseline and comparative scans to detect sources of partial discharge at a location.

**TEST** – Using the PD-Smart, make detailed analysis of partial discharge in equipment. Diagnose and assess the level of deterioration using phase-resolved, time-resolved, and spectral analysis. Use this information to help plan your next steps.

**MONITOR** – Use the **doblePRIME PD-Guard** in cases where early detection of partial discharge is critical, or where continuous updates on partial discharge status are required.



# doblePRIME DELPHI

## Dissolved Gas Analysis Monitoring



The dolePRIME Delphi is a dissolved gas analysis (DGA) monitor that provides early warning signs of problems such as overheating, insulation degradation or mechanical movement.

The dolePRIME Delphi provides this valuable information in real time, second by second, through analysis of the insulating oil.

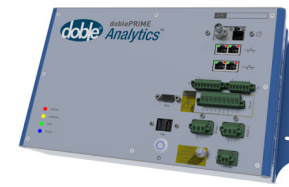
The Delphi is immune to oil surges and vacuums that may affect other sensors; in addition, the Delphi contains self-testing diagnostics to monitor its own performance.

### doblePRIME DELPHI KEY FEATURES

- Patented vacuum resistant membrane prevents failure during oil surges, maintenance or other activities
- Rapid response – less than 8 minutes for 90% response to step change
- Alarms and closing contacts – relays, digital and analog outputs
- Available as a composite gas monitor or hydrogen monitor in standard and mini versions

# doblePRIME ANALYTICS

## Integration & Analysis Module



doblePRIME condition monitoring devices can stand alone and provide targeted data and alerts.

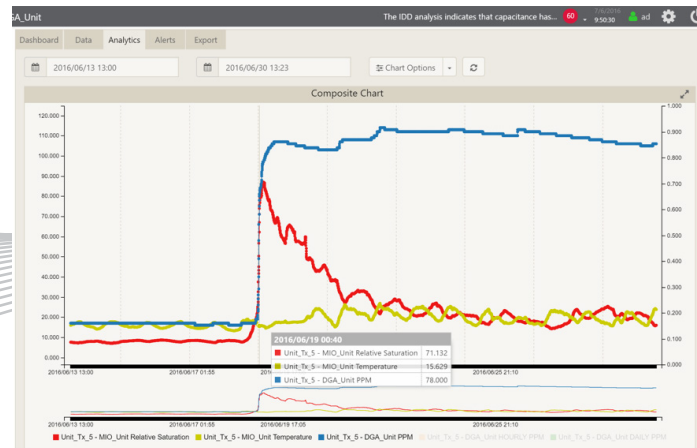
The dolePRIME Analytics module provides a means to collate and combine data from multiple modules in a single user interface with charting and analysis capabilities.

The dolePRIME Analytics unit provides back-up storage for individual monitors, allowing for years of data archiving, and appropriate expert system and analysis tools to identify and alert you to anomalous asset performance.

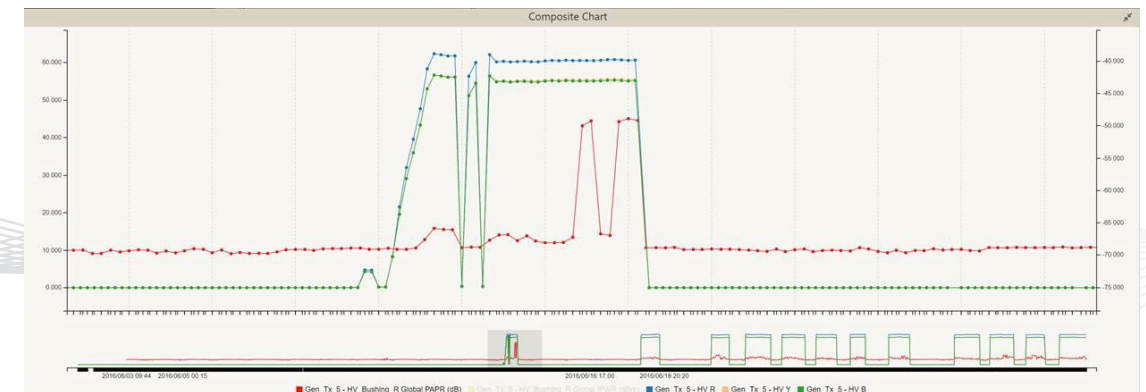
doblePRIME Analytics offers data visualization, system configuration, communications and data management tools.

### doblePRIME ANALYTICS KEY FEATURES

- Accepts data from multiple condition monitoring devices
- Provides network and hub capabilities and a single point of contact for all devices
- Applies analytics and displays/overlays data from multiple devices
- Backs up data from multiple units for redundant storage



**DGA, RELATIVE HUMIDITY & OIL TEMPERATURE**  
Composite data from Delphi and DOMINO monitors



**ANALYZE DATA FROM VARIOUS MODULES**  
PD from a bushing overlaid by leakage current provides more context for analysis

# doblePRIME DOMINO

## Moisture-in-oil Monitoring



The dolePRIME DOMINO provides real time data for moisture in oil, giving indications of relative saturation or absolute ppm levels.

This is useful information, especially when a transformer is being loaded in excess of nameplate or when the transformer is undergoing abnormal load cycles.

The dolePRIME DOMINO provides continuous reliable measurement of the water content of electrical insulating liquids and other types of oils.

### doblePRIME DOMINO KEY FEATURES

- Continuous results in parts per million (ppm), relative saturation and temperature
- Monitors oil reconditioning in systems as small as a single filter cartridge – to as large as a mobile or stationary processing plant
- Helps determine filter changeout, process efficiency and when to terminate processing

# doblePRIME iO

## Analog & Digital Data Module



The dolePRIME iO is a device that accepts current, voltage, temperature and relay inputs to your dolePRIME system.

Data sources include load or operational data, tap position indicators, inputs from other vendor devices, and more.

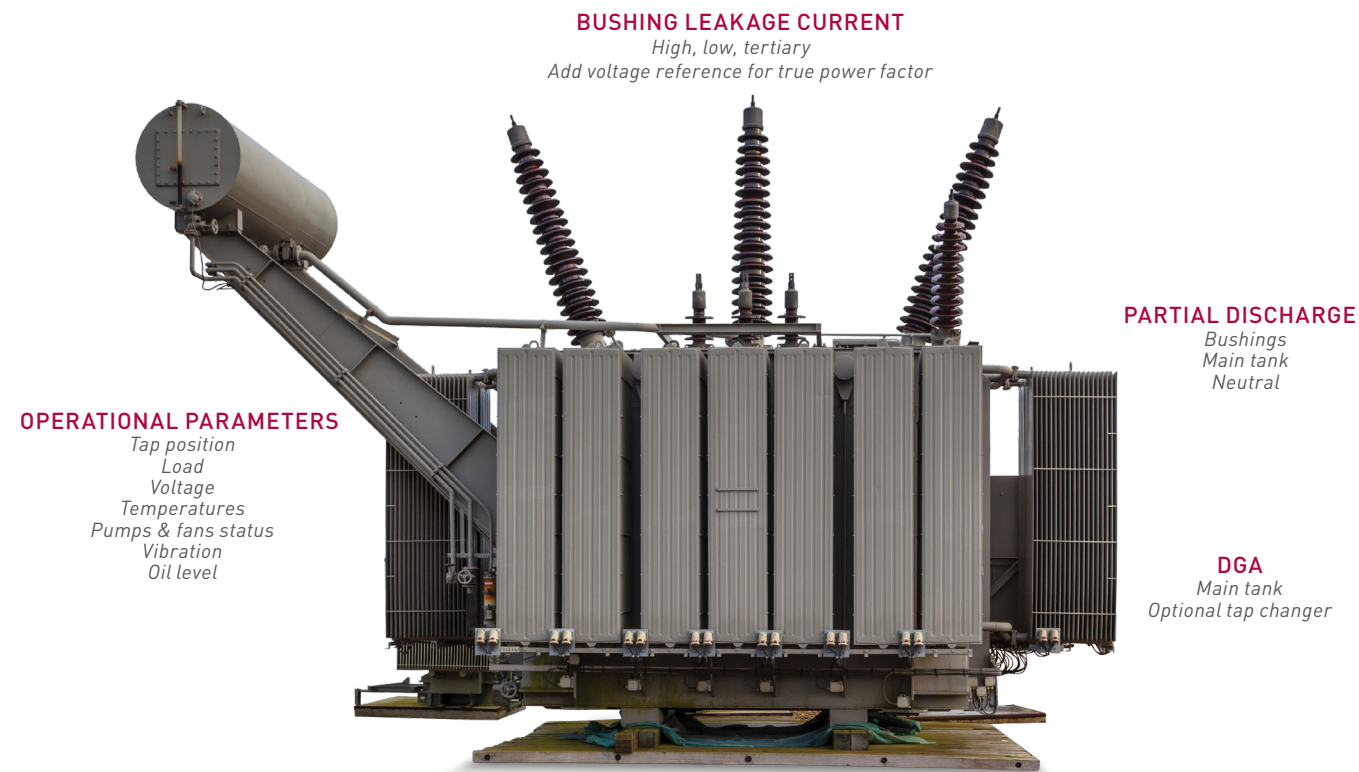
### doblePRIME iO KEY FEATURES

- Multiple analog/digital inputs, including currents, voltages, temperature sensors
- Stores and displays data
- Provides a means to record operational parameters and data
- Fully networkable



# doblePRIME™

## Flexible & Modular Monitoring



**doblePRIME MEASUREMENT PARAMETERS**  
Select the appropriate measurement parameters to support your condition monitoring decisions



Every substation or system is slightly different as are the operational and budgetary considerations that go along with them.

By taking a platform approach, you can cost-effectively deploy a solution that fulfills your needs today and can scale whenever you are ready or necessity dictates.

doblePRIME can also link to an asset risk management system such as **dobleARMS®** for the advanced analytics, root cause and financial analysis needed to justify capital decisions and long-term strategic asset plans.

Together, doblePRIME and dobleARMS underpin smart decisions for an intelligent grid and can provide value from day one of deployment.

## Package Options

doblePRIME is a flexible and expandable condition monitoring system. It can grow to meet developing or changing needs.

Each module (IDD, PD-Guard, iO, etc.) can stand alone or can be part of a more comprehensive monitoring system. What you choose to use should be defined by your goals for condition monitoring.

We have outlined a number of package options for common monitoring arrangements. We can also help you customize your doblePRIME monitoring options.

Packages are available preconfigured and in prewired enclosures.

| MONITORING PACKAGE OPTIONS* | DESCRIPTION   | IDD | PD-GUARD | ANALYTICS | iO | DELPHI | DOMINO |
|-----------------------------|---|-----|----------|-----------|----|--------|--------|
| dP Bushing                  | Bushing leakage current monitoring with relative voltage option                       | ☑   |          |           |    |        |        |
| dP Bushing+                 | Bushing monitoring with temperature compensation                                      | ☑   |          |           | ☑  |        |        |
| dP PD + Bushing             | Overall partial discharge (bushings/neutral/main-tank) & bushing                      | ☑   | ☑        |           |    |        |        |
| dP Oils                     | DGA/Moisture for oil analysis   |     |          | ☑         |    | ☑      | ☑      |
| dP Complete                 | Bushings/PD/Oil/temperatures & operational data for a transformer or three phase bank | ☑   | ☑        | ☑         | ☑  | ☑      | ☑      |
| dP Station                  | Site system – multiple transformers, multiple monitors, single point of access        | ☑☑  | ☑☑       | ☑         | ☑☑ | ☑☑     | ☑☑     |

☑ One of this specific module is included in this package

☑☑ Multiple modules are recommended in this type of package

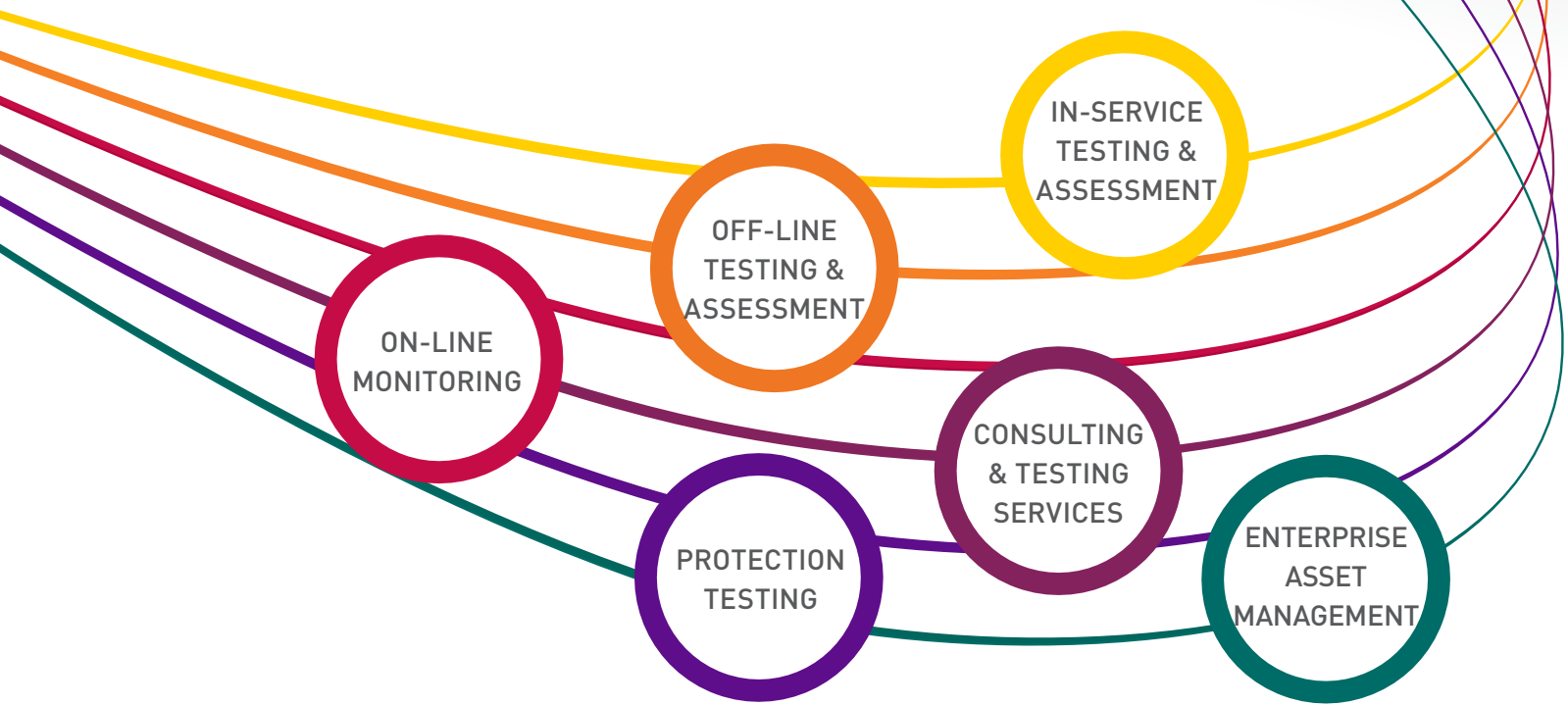
\*We have outlined a number of package options for common monitoring arrangements. We can also help you customize your doblePRIME monitoring options.

## COVERAGE FOR YOUR ENTIRE SYSTEM

The doblePRIME Condition Monitoring Platform is comprised of a set of core modules, together with complementary instruments and services that extend diagnostic capabilities.

These integrated tools give you the data and analysis you need to make the right tactical and strategic decisions on time and in time with real-time information.

Doble's unparalleled experience in on-line and off-line testing and our unique database of millions of test records comes through in every analysis provided by your doblePRIME system.



Doble Engineering Company  
Worldwide Headquarters | 85 Walnut Street, Watertown, MA 02472 USA

[www.doble.com](http://www.doble.com)

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