EXPERIENCE. KNOWLEDGE. INSIGHT.

SOLUTIONS BUILT ON A CENTURY OF INNOVATION AND EXPERTISE.
DELIVERING
SOLUTIONS, SERVICES, KNOWLEDGE COMMUNITY
THROUGHOUT THE ELECTRIC POWER INDUSTRY.

- IN-SERVICE TESTING & ASSESSMENT
- OFF-LINE TESTING & ASSESSMENT
- ON-LINE MONITORING
- CONSULTING & TESTING SERVICES
- PROTECTION
- ENTERPRISE ASSET MANAGEMENT
SOLUTIONS

OPTIMIZE OPERATIONS WITH DOBLE SOLUTIONS

You need to understand the condition of your assets. Doble understands the way you work, and we build our diagnostic test equipment and software solutions to suit your operations and testing practices. Our role is to simplify the complexity you face and we do that by offering testing solutions for critical assets and scaling up through enterprise level solutions. Whether you need one testing device, several substation monitoring platforms, or a comprehensive risk management system, Doble has the answer.

PROVIDING FLEXIBILITY FOR YOUR OPERATIONS

Doble provides flexibility for your business, with solutions and service levels that fit your procurement models. So now you can invest capital resources wisely across the asset ownership cycle.
DOBLE ENTERPRISE ASSET MANAGEMENT
dobleARMS™
Asset Risk Management System

UNDERSTAND ASSET CONDITION, CONDUCT LONG-TERM PLANNING AND PREVENT IMPENDING FAILURES

Doble’s Asset Risk Management System (dobleARMS™) brings decades of knowledge and experience with power systems diagnostics and data analysis to the areas of online monitoring, condition assessment and the strategic management of assets. It’s a new breed of application offering real-time event notification around a sophisticated suite of analytics that are infused with Doble’s expertise in asset life-cycle and associated risks. dobleARMS™ provides intelligent alerts and event notification so organizations can make more informed decisions between times of crisis and long-range operational planning. With dobleARMS™, companies can move beyond traditional notions of condition-based maintenance allowing employees to think more strategically about managing risks.

dobleARMS™ is a cost-effective tool for monitoring assets across the enterprise and providing the needed information to maintain and optimize assets - thereby reducing unplanned shutdowns, boosting production, increasing operational efficiency and decreasing maintenance costs.

The dobleARMS™ Difference

Too few or too many details - those are the typical complaints about most asset management systems. Asset managers need to know when a “notification” is a real or developing problem, and which asset needs the most attention. That’s why dobleARMS™ combines real-time with online and offline data sources and then compares the analytic results to Doble’s decades-worth of benchmark data on asset performance. Doble’s knowledgebase contains 80 years of information and over 35 million records from equipment around the world, and offers a considerable advantage to enhanced interpretation and analysis of asset issues.

A Consolidated View

dobleARMS™ is transformational by providing a clear view of asset health from the convenience of your workstation. Instead of wasting critical time searching for the right information, dobleARMS™ searches for the needle in the haystack which is an asset event, and rolls up the salient details to a higher level - offering a consolidated geospatial view with clear, visual understanding of asset condition, criticality and risks. dobleARMS™ gives you the power to drill down to the specific details you want and need to see.
A COMMON SENSE APPROACH TO THE SMART GRID

- Meets FERC, NERC and NIST security and Smart Grid Standards
- Flexible, secure and scalable infrastructure supporting offline and real-time data collection from a variety of data sources
- Places a non-proprietary layer of model management on top of “point-based” protocols
- Eliminates the need to manually manage interface points and changes

**Substation view** – Summary of assets by substation site, providing specific substation detailed view, comparable positioning to rest of sites locations in your fleet.

**Apparatus view** – Presents key details on a specific unit’s status and snapshot of comparable positioning to rest of fleet, as well as summaries of the automated data analysis.

**Assessment view** – In-depth detailed rendering on key subsystems of an asset, with full results view of the automated data analysis.
DOBLE ON-LINE MONITORING

doblePRIME™
CONDITION MONITORING PLATFORM
FOR TRANSFORMERS
doblePRIME™
GET THE POWER OF KNOWING

The doblePRIME™ Condition Monitoring Platform for Transformers gives you a clear, consolidated means to assess overall transformer condition.

doblePRIME™ is uniquely powered by Doble’s decades of on-line monitoring expertise, a century’s worth of transformer diagnostic experience, and intelligent analytics coupled with an unparalleled knowledgebase. doblePRIME™ simplifies and empowers data-based decision making by giving you a single point of access to view and analyze your transformers’ on-line monitoring data.

Experience the value of bringing data and analysis to condition-based interventions – empowering and justifying decisions with the most up-to-date information.

doblePRIME™ keeps a watchful eye on your transformers from oil status, to tap changer condition, to bushing health, incorporating all types of diagnostic indicators, intelligent electronic devices (IED) and sensor data.

doblePRIME™ integrates data from Doble diagnostic devices and also ‘talks’ to any other common IED through standard protocols to incorporate all available data into the decision-making process. The platform incorporates diagnostic indicators such as dissolved gas analysis, partial discharge, harmonics as well as operational values and additional sensor data such as temperature, vibration and voltage.

CREATE YOUR OWN DIAGNOSTIC VIEW

doblePRIME™ brings together all of your transformer’s monitoring data into a single customizable dashboard view. You’ll be able to access your dashboard remotely or on-site to investigate any alerts or alarms. In addition, trends and potential failure modes can be identified, an approach that allows you to diagnose developing issues early on, giving you more time to plan, prevent and intervene.

Get a comprehensive picture of transformer health and fitness through a scalable and customizable solution that works with an existing monitoring program and offers the flexibility to integrate into an asset risk management system, such as dobleARMS™.

doblePRIME Analytics™

doblePRIME Analytics is a data acquisition hub, smart data archive, and data analysis device at the core of the doblePrime Condition Monitoring Platform. It integrates data from monitoring devices, sensors and operational data sources while providing communications, analytics and alerts/alarms.
doblePRIME Delphi DGA™
The doblePRIME Delphi DGA™ device provides data on changes in dissolved gas levels, the early warning signs of developing or incipient problems such as overheating, insulation degradation or mechanical movement within the transformer.

doblePRIME Domino™
The doblePRIME 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.

doblePRIME IDD™
The doblePRIME IDD™ Bushing Monitor detects signs of either ‘rapid onset’ or ‘graceful’ deterioration in bushings, finding abnormalities in the insulation. It provides leakage current and phase analysis for up to 12 bushings. This powerful tool has proven itself through documented bushing saves.

doblePRIME PD-Guard™
The doblePRIME PD-Guard™ continuously monitors partial discharge levels, learning your transformer’s PD behaviors and notifying you of relevant changes in level and severity of discharge pulses. The doblePRIME PD-Guard™ is an 8-channel device which provides spectral and phase resolved PD analysis.
The doblePRIME Analytics is a communication gateway and data analysis device at the core of the doblePrime Condition Monitoring Platform. The doblePRIME Analytics unit aggregates data from monitoring devices, sensors and operational data sources for a comprehensive view of asset condition. It provides communications, analytics and alerts/alarms for any individual monitor or combination of monitoring devices. This interface is scalable and customizable, working with your existing monitoring program and offering the flexibility to integrate into an asset risk management system, such as dobleARMS™.

**FEATURES**

- Comprehensive dashboard view for all components integrated into the doblePRIME Condition Monitoring Platform, e.g. DGA, thermal, partial discharge and bushing monitors
- Aggregates and analyzes data from monitoring devices, sensors and operational data sources
- Geographic information system interface also gives access to individual monitors and asset information
- Accepts direct inputs from analog sources, such as temperature probes and V/I measurement devices
- Intelligent Expert System with advanced analytics learns system characteristics
- Advanced communications capability
- Data historian and data integrity validation
- Provides condition and operation status analyses

**BENEFITS**

- Scalable, customizable device pulls data from your preferred combination of monitoring devices and sensors to give a more complete view of asset health
- Save costly equipment by quickly reacting to rapid deterioration warnings
- Identify problems and diagnose the severity of the situation
- Plan for replacements in a proactive, risk management approach
- Flexible device can be the core of your condition monitoring platform for one asset or one substation; it can also connect that location to a comprehensive risk management system, such as dobleARMS™
- See all relevant data through server-based, geographic information system architecture for rapid visualization and situational awareness
- Provide key information to tactical and strategic asset management systems
Flexible and Modular to Suit Your Needs

Every substation or system is slightly different as are the operational and budgetary considerations that go along with them. Doble understands this and has taken an integrated platform approach. This lets you cost-effectively deploy a solution that fulfills your needs today and can scale whenever you are ready or necessity dictates.

Coverage For Your Entire System

The doblePRIME Condition Monitoring Platform is comprised of a set of core instruments, 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 Doble solution.
DOBLE ON-LINE MONITORING
doblePRIME DELPHI MINI
Dissolved Gas Analysis Monitor

FOR SINGLE-VALUE, ON-LINE DISSOLVED GAS ANALYSIS IN REAL TIME

The doblePRIME Delphi Mini is a dissolved gas analysis (DGA) monitor that helps you track transformer health by providing early warning signs of problems such as overheating, insulation degradation or mechanical movement within the transformer. The doblePRIME Delphi Mini provides this valuable information in real time, second by second, through analysis of the insulating oil.

The Delphi Mini is immune to oil surges and vacuums that may affect other sensors; in addition, the Delphi Mini contains self-testing diagnostics to monitor its own performance. Designed to fit your monitoring program, the doblePRIME Delphi Mini can operate as a standalone device or as part of a doblePRIME Condition Monitoring Platform through analysis of the insulating oil.

FEATURES

• Patented vacuum resistant membrane prevents failure during oil surges, maintenance or other activities
• Available as a composite gas monitor or hydrogen monitor
• Self-testing provides assurance of reliable results
• Single valve application – useful when there are limited valves
• Optional pump for situations where there is a possibility of poor oil circulation
• Rapid response – less than 8 minutes for 90% response to step change
• Alarms and closing contacts – relays, digital and analog outputs

BENEFITS

• Cost-effective updates on transformer health between regular DGA samples
• Alerts you when there is a sudden change in dissolved gas levels due to a developing fault within the transformer
• Notifications give you time to plan instead of reacting to a failure
• Actionable intelligence helps you determine what steps to take: maintenance, testing, load management or replacement
• Use as a standalone product, networked to existing SCADA system, or as part of a doblePRIME Condition Monitoring Platform

www.doble.com
doblePRIME DELPHI MINI TECHNICAL SPECIFICATIONS

**MEASURED VALUES (RELATIVE SENSITIVITY)**

<table>
<thead>
<tr>
<th>Gas</th>
<th>Percentage</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>100%</td>
<td>0 - 5000 ppm</td>
</tr>
<tr>
<td>If composite, Hydrogen and these additional gases:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Monoxide*</td>
<td>10-20%</td>
<td></td>
</tr>
<tr>
<td>Acetylene*</td>
<td>10-20%</td>
<td></td>
</tr>
<tr>
<td>Ethylene*</td>
<td>2-8%</td>
<td></td>
</tr>
</tbody>
</table>

*Sensitivity to this gas is calculated during manufacture and may vary between sensors.

**INPUTS AND OUTPUTS**

<table>
<thead>
<tr>
<th>Standard Outputs</th>
<th>RS485, Modbus RTU, 2 channels 4-20mA, relays contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-20 mA Channel 1</td>
<td>Gas Level (Scaled 0 - 5000 ppm)</td>
</tr>
<tr>
<td>4-20 mA Channel 2</td>
<td>Hourly Trend (Scaled 0 - 5000 ppm)</td>
</tr>
<tr>
<td>Dry Contacts</td>
<td>2 Rating: 5A/240VAC</td>
</tr>
</tbody>
</table>

**Alarm Types**

- Normal
- Gas Hi
- Gas Hi-Hi

(also indicated on front panel)

**External Alarm Indicators**

- Green = Normal
- Orange = High
- Red = High-High

**Optional**

- Host PC Software Support Networking Windows 2000/XP/7

**ADDITIONAL DETAILS**

- **Weight**: 6.4 lbs/ 2.9 kgs
- **Hardware & Firmware**: Microprocessor, watchdog and real-time clock with embedded firmware
- **Valve Mounting Options**: DN50 (Metric), 1.5 inch NPT (English)
- **Data Storage**: Built in short term, long term and status
- **Power Supply**: 50/60 Hz 110/220 V

**OPERATING ENVIRONMENT**

- Oil Pressure at Sensor: Can withstand absolute vacuum to 0.7 Mpa (100 psi)
- Outdoor Protection: Meets IEC 60529, IP 55
- Vibration: Meets IEC 68-2-5
- Mechanical: Brushed aluminium enclosure
- EMC: Meets IEC 61000-4-2/4/5/8, Grade 4
- Electronics Temperature Range: -40°C to 60°C (-4°F to 140°F)

**SENSOR TEMPERATURE RANGE**

- Gas Sensor: -20°C to 70°C (-4°F to 158°F) at sensor face, -20°C to 105°C (-4°F to 221°F) with finned attachment
- Standards: CE marked RoHS compliant

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>PART #</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV-CG</td>
<td>Delphi Mini, Composite Gas Sensor</td>
</tr>
<tr>
<td>DV-H</td>
<td>Delphi Mini, Hydrogen Sensor</td>
</tr>
</tbody>
</table>

Adapters available in common valve sizes
DOBLE ON-LINE MONITORING
doblePRIME IDD
Bushing Monitor

FOR ON-LINE MONITORING
OF BUSHINGS AND CURRENT TRANSFORMERS

The doblePRIME IDD Bushing Monitor detects deterioration in bushings, finding abnormalities in the insulation and issuing actionable alerts. Over almost 20 years of successful monitoring Doble has identified two distinct failure modes - rapid onset and graceful decay - and have cases of averting bushing failures in both modes. The doblePRIME IDD Bushing Monitor provides leakage current and phase analysis for up to 12 bushings, measuring parameters for each bushing individually and together. This intelligent device uses its embedded Expert System to provide you with notifications and alarms based on comparisons between off-line and calculated on-line data. Designed to fit your monitoring program, the doblePRIME IDD Bushing Monitor can operate as a standalone device or as part of a doblePRIME Condition Monitoring Platform.

FEATURES
• Capture 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
• 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 armored cables & junction boxes for optimal performance in harsh environments
• Optional external voltage reference inputs

BENEFITS
• Save costly equipment by quickly reacting to rapid deterioration warnings
• Identify problem bushings and diagnose the severity of the situation
• Plan for bushing replacements in a proactive, risk management approach
• Monitor up to 12 bushings, either individually or in sets of three
• Use as a standalone product, networked to existing SCADA system, or as part of a doblePRIME Condition Monitoring Platform
• Records both raw waveforms and derived values to allow for deep analysis
• Notifications based on latest analysis techniques - and built on Doble’s decades of experience in the field

www.doble.com
**doblePRIME IDD TECHNICAL SPECIFICATIONS**

### DATA ACQUISITION

<table>
<thead>
<tr>
<th>Inputs</th>
<th>3, 6 or 12 channel options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector</td>
<td>Screw terminal</td>
</tr>
<tr>
<td>Measurement method</td>
<td>Leakage current raw waveform and relative phase</td>
</tr>
<tr>
<td>Tap Current Range</td>
<td>1 - 200 mA</td>
</tr>
<tr>
<td>Bushings Monitored</td>
<td>Up to 4 sets of 3 bushings</td>
</tr>
</tbody>
</table>

| Bushing-Bushing Isolation | >2500 V        |
| Bushing-Host Isolation    | >2500 V        |
| Magnitude Accuracy         | ±1% of reading |
| Phase Accuracy             | 0.01 Degrees   |
| Resolution                 | 0.1% of input signal peak |
| Voltage reference          | Optional, input as digital or analog |

### CPU, MEMORY AND BUSES

- Host CPU: ARM Cortex @ 180MHz
- Memory: 32MB RAM, 16MB flash

### STORAGE

- SD Card slot for result storage (up to 32GB, SDHC compatible)
  (Note: SD card is inside unit and cannot be removed without opening the case)

### PERIPHERALS

- USB 1.1 host and client controllers
- RS485 network interface (Modbus RTU Slave)
- Ethernet interface (Modbus TCP Server, HTTP, VNC, WebDAV Server)
- Status LED (Condition, Info, Warning, Action)
- Status Relay, 240VAC 5A (Condition, Info, Warning, Action)

### ENVIRONMENTAL

- Humidity: 0-95% non-condensing
- Operating temperature: -20°C to +50°C
- Extended temperature: -40°C to +75°C
- Storage temperature: -20°C to +70°C

### MECHANICAL DATA

- Height: 200mm / 7.9 in
- Width: 330mm / 13.0 in
- Depth: 82mm / 3.2 in
- Weight: 2kg / 4.4 lbs
- Construction: Anodized aluminium

### MOUNTING OPTIONS

- Panel mount | DIN Rail | Rubber feet

### POWER SUPPLY

- External supply: 24 V DC @ 1 A

An optional power adapter can be supplied to suit global mains voltage

*Ask about complete enclosure solutions with specific environment, network and power options.*

---

**Detect Slow or Rapid Failures**

Bushings can fail slowly, giving you time to plan for replacement; they can also fail rapidly, leaving little time to act. With intelligent monitoring from Doble Engineering Company you can proactively manage risk in both situations and plan for replacements.

**Safety Starting at Installation**

The doblePRIME IDD uses multiple redundant safety systems & ground paths, including transorbs & 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.
DOBLE ON-LINE MONITORING
doblePRIME PD-GUARD
Partial Discharge Analyzer

FOR THE CONTINUOUS MONITORING OF PARTIAL DISCHARGE

The doblePRIME PD-Guard continuously monitors partial discharge (PD) in transformers, rotating machines, cables and switchgear including GIS and metal clad. It analyzes RF emissions in the HF, VHF and lower UHF ranges. Install on critical assets and configure using a computer, tablet or web-enabled device to monitor PD activity. The doblePRIME PD-Guard provides local alarms and will communicate data and notifications across standard interface channels and through to networked supervisory systems.

The doblePRIME PD-Guard works with a variety of sensors including antenna for airborne PD, CTs for individual or bundled conductors, UHF drain valve probes for in-tank applications and bushing tap connectors. Designed to fit your monitoring program, the doblePRIME PD-Guard can operate as a standalone device or as part of a doblePRIME Condition Monitoring Platform.

FEATURES

- An independent PD monitoring system, configured via computer, tablet or web-enabled device
- Visual alert status indication
- Built-in Expert System learns PD behaviour and indicates changes in frequency and/or severity of measured PD levels
- 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

BENEFITS

- Monitor PD in critical and high-risk assets
- Save costly equipment by quickly reacting to rapid insulation deterioration warnings
- Identify problem areas, diagnose the severity of the situation and plan action and intervention
- Plan for further testing, maintenance and replacements in a proactive, risk management approach
- Use as a standalone product, networked to existing SCADA system, or as part of a doblePRIME Condition Monitoring Platform
**TUNERS (BOTH)**

<table>
<thead>
<tr>
<th>Input</th>
<th>4 or 8 channels, multiplexed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector</td>
<td>BNC</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 Ω</td>
</tr>
<tr>
<td>Maximum Input</td>
<td>+10 dBm for reading (+25 dBm with optional attenuation)</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>60 dB</td>
</tr>
<tr>
<td>Detection</td>
<td>Peak, quasi-peak and average detector</td>
</tr>
<tr>
<td>Processing</td>
<td>Continuous, Average, Max Hold and differential</td>
</tr>
</tbody>
</table>

**RFI TUNER 1**

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>50 kHz to 50 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>9 kHz / 120 kHz</td>
</tr>
<tr>
<td>Noise Floor</td>
<td>Approximately -90 dBm for peak detect or -100 dBm for average detect (RBW 9 kHz)</td>
</tr>
</tbody>
</table>

**RFI TUNER 2**

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>50 MHz to 1000 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>± 100 kHz</td>
</tr>
<tr>
<td>Resolution</td>
<td>120 kHz / 1 MHz / 6 MHz</td>
</tr>
<tr>
<td>Noise Floor</td>
<td>Approximately -80 dBm for peak detect or -90 dBm for average detect (RBW 6 MHz)</td>
</tr>
</tbody>
</table>

**EMI MODE**

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>50 kHz to 100 MHz (seamless sweep using both tuners)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>9 kHz / 120 kHz</td>
</tr>
</tbody>
</table>

**AC SYNCHRONISATION**

Wired sync to external AC source

**MEASUREMENT MODES**

<table>
<thead>
<tr>
<th>RF modes</th>
<th>Spectrum, Oscilloscope [Time resolved], Level meter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results Output</td>
<td>IPwr (Integrated Power), PAPR (Peak-Average Power Ratio), PRPD (Phase Resolved PD)</td>
</tr>
</tbody>
</table>

**CPU, MEMORY AND BUSES**

<table>
<thead>
<tr>
<th>Host CPU</th>
<th>Intel/Marvell PXA270 @ 500MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory</td>
<td>64MB RAM, 32MB flash</td>
</tr>
</tbody>
</table>

**STORAGE**

On board data storage of 32GB

**PERIPHERALS**

USB 1.1 host and client controllers
RS485 network interface (Modbus RTU Slave)
Ethernet interface (Modbus TCP Server, HTTP, VNC, WebDAV Server)
Status LED [Condition, Info, Warning, Action]
Status Relay, 240VAC 5A [Condition, Info, Warning, Action]

**ENVIRONMENTAL**

Humidity: 0-95% non-condensing
Operating temperature: -20°C to +50°C
Extended temperature: -40°C to +75°C
Storage temperature: -20°C to +70°C

**MECHANICAL DATA**

Height: 200mm / 7.9 in
Width: 330mm / 13.0 in
Depth: 82mm / 3.2 in
Weight: 2kg / 4.4 lbs
Construction: Anodized aluminium

**MOUNTING OPTIONS**

Panel mount
DIN Rail
Rubber feet

**POWER SUPPLY**

External supply: 24 V DC @ 1 A
An optional power adapter can be supplied to suit global mains voltage

*Ask about complete enclosure solutions with specific environment, network and power options.*
DOBLE PROTECTION TESTING

F6150sv
Power System Simulator

ALL-IN-ONE SOLUTION FOR TESTING IEC 61850-BASED PROTECTION DEVICES AND SCHEMES

The Doble F6150sv is your versatile solution for testing IEC 61850-based protection devices and schemes. This power system simulator performs the simplest through the most complex tests. The F6150sv has the highest output current of any simulator on the market - all within a single box. Meeting all your testing needs, the F6150sv is available in three different models. The F6150sv tests IEC 61850-based systems at the process level and station level using both sampled values and GOOSE messages.*

FEATURES

- Simulate three streams of IEC 61850 9-2LE sampled values through one fiber-optic port and one copper (RJ45) port*
- Wi-Fi capable (optional)
- Simulates (publishes) and subscribes to IEC 61850 GOOSE messages involving multiple IEDs**
- Performs standard relay calibration and verification testing of high-burden (electromechanical), solid-state, and microprocessor-based relays
- Delivers full VA power with resistive, inductive and capacitive loads at maximum current rating. The following ranges are available with the F6005 Enhanced Rating Option: (6 x 35, 3 x 70, 1 x 210 A)
- Performs state simulation and transient testing
- Tests 0.2-class metering CTs and transducers
- Implements end-to-end testing of communications-based schemes with GPS time syncing
- Maximum of 12 high-level analog sources (six voltage, six current) configurable for bench testing and proof-of-concept testing for complicated relaying schemes

BENEFITS

- Select from a number of instrument models that feature various power levels and complexity. Choose the best solution according to your testing and budgetary requirements.
- Rugged construction and proven state-of-the art design provide laboratory accuracy with uncompromising field performance
- Convenient front-panel display indicates active voltage/current amplitudes and phase values during testing

---

*F6870 Sampled Values option required
**F6860 GSE Configurator option required
## DOBLE F6150sv CUSTOMIZED MODELS

<table>
<thead>
<tr>
<th>NAME</th>
<th>F6150sv</th>
<th>F6150sv-SGD</th>
<th>F6150sv-IEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION</td>
<td>PREMIER MODEL</td>
<td>GRID DISTRIBUTION MODEL</td>
<td>IEC MODEL</td>
</tr>
<tr>
<td>Applications</td>
<td>Test IEC 61850-based protection devices and schemes</td>
<td>Test IEC 61850-based protection devices and schemes</td>
<td>Test IEC 61850-based protection devices and schemes</td>
</tr>
<tr>
<td></td>
<td>Maximum power to test high-burden relays</td>
<td>Test digital three-phase systems</td>
<td>Test S&amp;C Electric IntelliRupter® and other devices using low-level sources</td>
</tr>
<tr>
<td></td>
<td>Test complex schemes</td>
<td>Test single-phase &amp; low-burden, three-phase relays</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Run in mixed mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Highlights</td>
<td>Maximum of 12 high-level analog sources are available at any time</td>
<td>Maximum of 8 high-level analog sources are available at any time</td>
<td>Maximum of 12 low-level analog sources are available at any time</td>
</tr>
<tr>
<td></td>
<td>Maximum of 12 low-level analog sources are available at any time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Details</td>
<td>6 AC/DC Amplifiers: 3 x 150 VA Voltages &amp; 3 x 150/225 VA currents</td>
<td>4 AC/DC Amplifiers: 2 x 150 VA Voltages, 2 x 175/262.5 VA currents</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC volts: (1 x 600 V), (3 x 300 V), (6 x 150 V)</td>
<td>AC volts: (1 x 600 V), (2 x 300 V), (4 x 150 V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC amps: (1 x 180 A), (3 x 60 A), (6 x 30 A)</td>
<td>AC amps: (1 x 120 A), (2 x 60 A), (4 x 30 A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Each 150 VA Voltage/Current amplifier can be split into 2 x 75 VA sources; total 12 sources</td>
<td>Each 150 VA Voltage/Current amplifier can be split into 2 x 75 VA sources; total 8 sources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WITH OPTIONAL F6005 INCLUDED</td>
<td>WITH F6005 OPTION INCLUDED</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Each 175/262.5 VA Current amplifier can be split into 2 x 87.5/131.25 VA sources; total 6 sources</td>
<td>Each 175/262.5 VA Current amplifier can be split into 2 x 87.5/131.25 VA sources; total 4 sources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC amps: (1 x 210 A), (3 x 70 A), (6 x 35 A)</td>
<td>AC amps: (1 x 140 A), (2 x 70 A), (4 x 35 A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Each 175/262.5 VA Current source can be combined into 1 x 525/787.5 VA source or 1 x 175/262.5 VA &amp; 1 x 350/525 VA sources</td>
<td>Each 175/262.5 VA Current source can be combined into 1 x 350/525 VA source</td>
<td></td>
</tr>
</tbody>
</table>
DOBLE OFF-LINE TESTING & ASSESSMENT

M7100™
High-Voltage Asset Analyzer

THE MOST-COMPREHENSIVE SOLUTION FOR COMMISSIONING, DIAGNOSTIC AND SCHEDULED MAINTENANCE TESTING

The Doble M7100 High-Voltage Asset Analyzer is your complete solution for high voltage testing. With an intuitive design and dual high-voltage leads, the M7100 will greatly reduce the number of ladder trips technicians are exposed to per job—sometimes cutting the number to nearly one third, significantly improving the safety and quality of field work by limiting exposure to the workforce and reducing errors.

The M7100 automates multiple tests, previously performed by several pieces of equipment, cutting down testing time from seven hours to one and a half hours. By dramatically reducing testing time, you can now maximize outage periods by performing more maintenance during the hours previously devoted to testing.

FEATURES

• Built-in Low Voltage/High Current Multi-Frequency Source
• Combined Source and Measurement Test Leads
• True 4-Terminal measurements
• Intuitive design where the color or number is the connection
• Patent pending, dual high-voltage leads that allow you to switch between Source and Measurement – both capabilities are within each HV lead
• Enhanced safety features include new safety switch design

BENEFITS

• Finish testing in a third of the time
• Maximize your outages and limit safety risk
• Replace a truck full of instruments and cables
• Greatly reduce the number of ladder trips technicians are exposed to per job
**INCLUDED ACCESSORIES**

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage Cables</td>
<td>2</td>
</tr>
<tr>
<td>Low Voltage Cables</td>
<td>4</td>
</tr>
<tr>
<td>(Red, Blue, Yellow, Black)</td>
<td></td>
</tr>
<tr>
<td>Measurement Cables</td>
<td>3</td>
</tr>
<tr>
<td>(Red, Blue, Yellow)</td>
<td></td>
</tr>
<tr>
<td>Ground Lead (Copper)</td>
<td>1</td>
</tr>
<tr>
<td>OLTC Control Cable</td>
<td>1</td>
</tr>
<tr>
<td>USB Cable</td>
<td>1</td>
</tr>
<tr>
<td>Ethernet Cable</td>
<td>1</td>
</tr>
<tr>
<td>AC Power Cord (20A AC)</td>
<td>1</td>
</tr>
<tr>
<td>External Temperature &amp; Humidity</td>
<td>1</td>
</tr>
<tr>
<td>Module w/Cable</td>
<td>1</td>
</tr>
<tr>
<td>External LED Strobe Lamp w/Cable</td>
<td>1</td>
</tr>
<tr>
<td>1.5 m Integrated Safety Switch/Cable</td>
<td>1</td>
</tr>
<tr>
<td>10 m Integrated Safety Switch/Cable</td>
<td>1</td>
</tr>
<tr>
<td>Doble Bushing Tap Adapters</td>
<td>4</td>
</tr>
<tr>
<td>Hot Collar Straps</td>
<td>7</td>
</tr>
<tr>
<td>5 ft Copper Jumpers</td>
<td>5</td>
</tr>
</tbody>
</table>

**OPTIONAL ACCESSORIES**

M7 Truck
MFL Liquid Insulation Test Cell
Type C Resonator (Up to 12 kV)
Doble Universal Controller (DUC)
IEC 61850 Adapter Kit *Coming in 2015*
M110: DC AMP *Coming in 2016*
M120: AC AMP *Coming in 2016*
M140 Capacitor Bank Kit *Coming in 2015*

*Future enhancements

**SUPPORTED STANDARDS**

<table>
<thead>
<tr>
<th>NETA</th>
<th>2011 Maintenance 7.2.2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007 Acceptance 7.19.2</td>
</tr>
<tr>
<td>IEEE</td>
<td>C57.152 - 2013</td>
</tr>
<tr>
<td></td>
<td>62 - 1995</td>
</tr>
<tr>
<td></td>
<td>C57.13 - 2008</td>
</tr>
<tr>
<td></td>
<td>C57.13.6 - 2005</td>
</tr>
<tr>
<td></td>
<td>C57.19.01 - 2000</td>
</tr>
<tr>
<td></td>
<td>286 - 2000</td>
</tr>
<tr>
<td>IEC</td>
<td>60076-1 - 2011</td>
</tr>
<tr>
<td></td>
<td>60137 - 2003</td>
</tr>
<tr>
<td></td>
<td>61850-9-2-Ed.2 B:2011</td>
</tr>
<tr>
<td>IEC/TR</td>
<td>60894 - 1987</td>
</tr>
</tbody>
</table>

**TEST CAPABILITIES**

- Power Factor/Tan Delta
- Variable Frequency Power Factor/Tan Delta
- Dielectric
- Demagnetization Feature
- 3 Phase Turns Ratio
- 10 kV Turns Ratio
- Leakage Reactance (1Ø, 3Ø)
- 3 Phase Winding DC Resistance
- 3 Phase 10kV (Single Phase) Exciting Current and Loss
- Dielectric Frequency Response (DFR) *
- OLTC Dynamic Resistance Measurement (DRM) *
- External Reference *
- Capacitor Bank *
- Primary Injection *
- µOhm Meter *

*Future enhancements*
The M4100 is the world’s premier power apparatus and insulation test instrument. Its unique combination of test capabilities and artificial intelligence analysis software makes it the power industry’s most trusted Power Factor/Tan-Delta instrument. These instruments are used around the globe thanks to their comprehensive testing options, safety features and measurement accuracy.

FEATURES
- Rugged Power Unit Module
- High Accuracy Measurement Module
- Doble Universal Controller interoperability
- High Reliability Interface Module
- Expanded DTA6 Software system & FRANK™ Artificial Intelligence Engine
- GFIC Class B and RCBO Compatibility
- Safety firmware and sensing system

BENEFITS
- Safety is our priority - from safety switches, power strobes and ground earth relay interlocks
- Software firmware system is now even faster and more precise in sensing abnormal current, temperature and voltage operation before a user would notice
- The system conducts a continuous temperature analysis and adjusts set-points based on the changing test environment
- FRANK™, the First Response Analytics Knowledgebase, helps you instantly analyse your test results, providing clear recommendations and explanations

DIAGNOSTIC CAPABILITIES
- 12 kV Power Factor/Tan-Delta capacitance testing to assess insulation condition & dielectric loss
- High stress and high accuracy 10 kV TTR with the dobleTTR Capacitor
- Winding Leakage Reactance testing with the M4110 to detect winding deformation or damage
- 10 kV Single-Phase Excitation Current testing to detect degraded turn-to-turn insulation damage and magnetic circuit anomalies
M4100 4TH GEN TECHNICAL SPECIFICATIONS

Operating Temperature  
-20° to 50° C / -4° to 122° F

Dry Heat  
IEC 60068-2-2

Cold  
IEC 60068-2-1

Shock & Vibration  
IEC 60068-2-27, IEC 60068-2-7 & ASTM D999.75

Drop Test  
EC 60068-2-6

Weight  
95 lb / 43 kg

Dimensions (HxWxD)  
10.3 x 20 x 25.3 (in) / 26 x 50.8 x 64.1 (cm)

Software  
DTA6 Basic

Power Input  
95-264 VAC, Auto Sensing  
47 to 63 Hz  
Accommodates Inverter and Portable Generators  
16 A max at 110 V  
10 A max at 220 V  
Accommodates GFIC/RCBO Class A & B

Field Verification & Calibration  
Integrated Self-Calibration & Verification Module  
3 Resistive Standards  
Amplifier Test Range: 7-All Nominal Test Ranges  
Coverage: Watts, Amps, Power Factor/Tan-Delta, Internal Source Loss, HV Cable, LV Cable(s)

Safety Features  
Open Ground Detection Circuit  
Abnormal Current Sensing System with continuous temperature compensation  
Safety Switches: 2-Deadman  
Safety Strobe

Source Output  
3 kVA  
25 V to 12 kV  
Output Current:  
Continuous @ 100 mA at 10 kV  
30 minutes @ 200 mA at 10 kV  
4 minutes @ 300 mA at 10 kV

Power Factor/Tan-Delta Measurement  
Range: 0 to ±100.00%  
Resolution: 0.01% [0.0001]  
Typical Accuracy: ± 0.005%

Capacitance Measurement  
Range: 0 to 100 μF  
Resolution: 0.01 pf

Inductance Measurement  
Range: 6 H to 10 MH  
Resolution: 0.01 H

Watts Measurement  
Range: 0 to 2 kW, actual power  
Resolution: 0.5 mW

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>PART #</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>M4K60</td>
<td>M4100 with cables, strobe, T/H Sensor, safety switches(2), DTA6 Basic software, M4151 Field Calibration Module &amp; 65’ HV Cable.</td>
</tr>
<tr>
<td>M4K100</td>
<td>Includes all of the above with 100’ HV Cable instead of 65’ HV Cable.</td>
</tr>
</tbody>
</table>

INCLUDED ACCESSORIES

<table>
<thead>
<tr>
<th>PART #</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>02D-0024-02</td>
<td>HV Cable 65’ with Hook (included with M4K60)</td>
</tr>
<tr>
<td>02D-0024-01</td>
<td>HV Cable 100’ with Hook (included with M4K100)</td>
</tr>
<tr>
<td>02B-0020-03</td>
<td>Lead, Low Voltage Red 65</td>
</tr>
<tr>
<td>02B-0020-02</td>
<td>Lead, Low Voltage Blue 65</td>
</tr>
<tr>
<td>020-0048-01</td>
<td>1 Set Hot Collars [5 at different lengths]</td>
</tr>
<tr>
<td>02B-0026-02</td>
<td>5’ Copper Bare Copper Jumper</td>
</tr>
<tr>
<td>03B-1137-01</td>
<td>C2 Tap Adapters, ASEA GO Types</td>
</tr>
<tr>
<td>02B-0089-01</td>
<td>C2 Tap Adapters, Westinghouse type O “hockey stick”</td>
</tr>
<tr>
<td>212-0416</td>
<td>C2 Tap Adapters, Westinghouse type O Plus</td>
</tr>
<tr>
<td>02B-0012-01</td>
<td>C2 Tap Adapters, Westinghouse type OS, S</td>
</tr>
<tr>
<td>03C-1318-02</td>
<td>Temperature/Humidity Sensor</td>
</tr>
<tr>
<td>05B-0493-01</td>
<td>Temperature/Humidity Sensor Cable</td>
</tr>
<tr>
<td>2FA-0280-01</td>
<td>Hook M2 Cable 3-inch, M Series</td>
</tr>
<tr>
<td>09C-0613-01</td>
<td>Safety Strobe Light</td>
</tr>
<tr>
<td>05B-0492-01</td>
<td>Safety Strobe Light Cable</td>
</tr>
<tr>
<td>02C-5200-01</td>
<td>M4300 Field Transporter for M4100</td>
</tr>
<tr>
<td>903-0031</td>
<td>M4100 Transportation Case</td>
</tr>
<tr>
<td>903-0034</td>
<td>M4300 Field Transporter Transportation Case</td>
</tr>
<tr>
<td>02C-5200-01</td>
<td>MFL (M-Oil) Liquid Insulation Test Cell and carrying case</td>
</tr>
<tr>
<td>010-0105-01</td>
<td>M4110 Leakage Reactance Interface (includes cables)</td>
</tr>
<tr>
<td>030-1684-01</td>
<td>M4140 CapBank Kit</td>
</tr>
<tr>
<td>03D-2010-01</td>
<td>Doble Universal Controller™, Tablet PC Controller</td>
</tr>
<tr>
<td>03B-0706-01</td>
<td>doble TTR Capacitor and Carry Case</td>
</tr>
</tbody>
</table>
Use the Doble M5400 Sweep Frequency Response Analyser to detect mechanical failure or movement of windings due to short circuits, mechanical stresses or transportation. Sweep Frequency Response Analysis is a proven technique, pioneered by Doble, for making accurate and repeatable measurements. The sweep approach is the industry standard and the preferred method for making frequency domain measurements.

**FEATURES**

- Instrument sends excitation signals to transformer and measures the retuning signals across a broad frequency range
- Provides a frequency response measurement from 10 Hz to 25 MHz
- Measures frequency response at logarithmically spaced intervals of 1.2%
- Auto-scales each frequency measurement for an overall dynamic range of 80 dB with a ±1 dB accuracy
- Highest combination of dynamic range and accuracy available
- Simple, robust test leads that meet IEC standards

**BENEFITS**

- Ensure transformer performance, reduce maintenance costs and increase the service life of transformers
- Identify problems such as core movement, winding deformation & displacement, faulty core grounds, partial winding collapse, hoop buckling, broken or loose clamping structures, shorted turns & open windings
- Use as part of your regular maintenance program or any time you suspect a problem
- Measurements are highly repeatable so even subtle changes can be used for diagnostic purposes
M5400 TECHNICAL SPECIFICATIONS

EXCITATION SOURCE
- Channels: 1
- Frequency Range: 10 Hz – 25 MHz
- Output Voltage: 20 V peak-to-peak at 50 Ohms
- Output Protection: Short circuit protected
- Source Impedance: 50 Ohms
- Calibration Interval: 3 years

MEASUREMENT CHANNELS
- Channels: 2
- Sampling: Simultaneous
- Frequency Range: 10 Hz – 25 MHz
- Max. Sampling rate: 100 MS/s
- Input Impedance: 50 Ohms
- Calibration Interval: 3 years

DATA COLLECTION
- Test Method: Sweep Frequency
- PC Comm: Ethernet USB/Serial
- Frequency Range: 10 Hz – 25 MHz
- Number of Points: 1000 points (Default) Up to 1800 points (Extended Range)
- Point Spacing: 1.2 % Logarithmic
- Dynamic Range: >90 dB
- Repeatability: ±1 dB to -80 dB
- IF Bandwidth: < 10% of active frequency

DATA DISPLAY
- Scaling: Linear/Log
- Frequency Range: 10 Hz – 25 MHz, user defined within frequency range
- Plotting: Frequency vs. Magnitude / Phase
- Analysis: Difference, Sub-band Cross-Correlation

PHYSICAL SPECIFICATIONS
- Dimensions: 18.2 x 13.4 x 6.7 inch 46.2 x 34.0 x 17.0 cm
- Weight: 13.1 lbs (6.0 kg)
- Power Supply: 100-240V AC
- Temperature: 0° to 50°C operating, -25° to + 70°C storage
- Relative Humidity: 0% to 95 % non condensing

TEST LEADS CONSTRUCTION
- Integrated three lead system in single cable set
- Standard (362 kV and below): 60 ft/ 18 m
- Optional (> 362 kV): 100 ft/ 30 m

M5400 RANGE
The M5400 provides a frequency response measurement from 10 Hz to 25 MHz. Doble recommends the default setting of 20 Hz - 2 MHz for transformers as there is limited diagnostic value in measurements outside of this range. The diagnostic frequency range of 20 Hz to 2 MHz covers the most important diagnostic areas:
- Core and Magnetic Properties
- Winding Movement and Deformation
- Interconnections – Leads and Tap Changers

M5400 RESOLUTION
The M5400 measures the frequency response at logarithmically spaced frequency intervals of 1.2%. A constant excitation level is maintained for each frequency measurement. The M5400 has the ability to auto-scale each frequency measurement providing an overall dynamic range of 80 dB with a ±1 dB accuracy. This gives the highest combination of dynamic range and accuracy available.

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>PART #</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5400</td>
<td>Doble M5400 Sweep Frequency Response Analyzer</td>
</tr>
</tbody>
</table>

Includes test set, instruction materials, software, 60 ft. SFRA test lead, ground extensions, safety ground, power cord and communication cables.
Dissolved gas analysis (DGA) is a powerful diagnostic tool to help you understand the health and condition of power transformers and other oil-filled equipment. The Delphi Portable, part of Doble’s line of DGA instruments, provides timely and actionable information on key dissolved gases in insulating oil. This portable device helps identify and track faults by monitoring composite gas levels and tracking individual gases when those levels change.

The Delphi Portable uses patented technology for accuracy and repeatability, giving you the data you need to make effective asset maintenance and operational decisions. The standard Delphi provides a highly cost-effective ‘check engine light’ monitoring approach; the Delphi Portable is used when you need a closer look at the data.

**FEATURES**

- Measures key gases and moisture
- Combines traditional DGA analysis and Doble’s own Dissolved Gas Anomaly Indication system: DG-AI
- Easy to operate user interface within the device
- Printer built in to the test set for a hard copy of your results

**BENEFITS**

- Accurate and repeatable results for maintenance and operational decisions
- Built-in data storage and data management
- Powerful tool for use in the field or the laboratory
- Export data to any standard database, maintenance management system or upload into dobleARMS™
- Measurements backed by the dobleDATABASE of laboratory and field test results
- Minimal maintenance required: check the printer paper, run calibration standards and check results
### Detection Ranges for Key Gases in Oil

<table>
<thead>
<tr>
<th>Gas</th>
<th>Lower Limit/ppm</th>
<th>Upper Limit/ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>5</td>
<td>5,000</td>
</tr>
<tr>
<td>Methane</td>
<td>1</td>
<td>50,000</td>
</tr>
<tr>
<td>Ethane</td>
<td>1</td>
<td>50,000</td>
</tr>
<tr>
<td>Ethylene</td>
<td>1</td>
<td>50,000</td>
</tr>
<tr>
<td>Acetylene</td>
<td>.5</td>
<td>50,000</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>5</td>
<td>50,000</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>5</td>
<td>50,000</td>
</tr>
</tbody>
</table>

### Moisture Measurement

<table>
<thead>
<tr>
<th>Moisture</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Physical & Mechanical

- **Ambient operating temperature**: 40°C
- **Operating sample temperature**: 0°C - +45°C
- **Storage temperature**: -30°C - +80°C
- **Humidity**: 90% (non-condensing @30°C)
- **Vibration endurance**: IEC 60068-2-6, Test Fc
- **Drop/Shock**: IEC 60068-2-31 and ISTA 1A
- **Mains input frequency range**: 47-63Hz
- **Mains input voltage range**: Universal 90-250VAC
- **Weight**: < 15kg
- **Gas cell volume**: < 10ml
- **Oil volume in extraction unit**: <=45ml

### Measurement Parameters

- **Dynamic range**: 500 - 50,000
- **Zero drift**: ± detection limit per 1 month
- **Measurement repeatability**: 5% of measured value in reference conditions
- **Range drift**: 5% of measured value per 12 months
- **Accuracy**: ± 5% or ± 2 ppm (whichever is greater)
- **±1% RH at 0-90% RH for H2O according to the specifications of the Figaro sensor for H2**

### Data Analysis and Interface

- **Screen**: Built in touch screen, virtual key pad
- **Communication**: USB 2.0
- **Built in Linux Processor**: Storage for thousands of results
- **Processor Details**: CPU: Intel® Atom™ Z510 1.1GHz; System memory: DDR2-533 1 GB; SSD (data storage): CompactFlash™ type-II 16 GB
- **Standards**: IEEE, CIGRE, Duval, Doble DG-Al, Rogers’ Ratios

### Standards

- EN61326-1:2006 Radiated emissions (Class A)
- EN61326-1:2006 Conducted emissions (Class A)
- EN61000-3-2:2000 Steady state & fluctuating harmonics
- EN61000-3-3:2001 Flicker testing
- IEC61000-4-2:2001 Electrostatic discharge immunity testing
- IEC61000-4-3:2002 Radiated immunity
- IEC61000-4-4:2001 Electrical fast transient/burst immunity testing
- IEC61000-4-5:2001 Surge immunity
- IEC61000-4-6:2001 Conducted RF immunity
- IEC61000-4-8:2001 Magnetic field immunity
- IEC61000-4-11:2001 Voltage dips and interrupts
A surge arrester may be inexpensive, but it has an important role in protecting your transformers. The Doble LCM500 can measure condition while the arrester is still in service, measuring the quality of the metal oxide blocks and helping manage the risk of failure. With the LCM500, it takes less than 15 minutes to establish that your surge arresters are healthy and the transformer is still protected.

**FEATURES**

- Portable, battery-operated instrument for regular condition assessment of surge arresters
- Unique identification of each surge arrester makes data management easy
- Instrument can store 1000 surge arrester IDs and measurements performed in the field
- Defines individual surge arrester types including operational parameters
- Software includes possibility to perform evaluation of groups of surge arresters e.g. same type of arresters or alternatively for a region.

**BENEFITS**

- Safe and effective assessment of metal oxide surge arresters
- Inspection of a surge arrester takes less than 15 minutes on location and can be performed with the arrester in service
- Can be used for short-term monitoring of one arrester to investigate details in leakage current changes versus time
**LCM500 TECHNICAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>MECHANICAL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions (WxHxD)</td>
<td>47 x 35.7 x 17.6 cm</td>
</tr>
<tr>
<td></td>
<td>18.50 x 14.06 x 6.93 in</td>
</tr>
<tr>
<td>Weight</td>
<td>7.5 kg / 16.5 lbs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENVIRONMENTAL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IP classification</td>
<td>IP67 [closed case]</td>
</tr>
<tr>
<td></td>
<td>IP51 [open lid]</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-10°C to +50°C / 14°F to 122°F</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20°C to +70°C / -4°F to 158°F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POWER SUPPLY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>12 - 15 VDC or 85 - 264 VAC 47 - 63 Hz</td>
</tr>
<tr>
<td>Battery</td>
<td>9.6V 2600 mAh</td>
</tr>
<tr>
<td>Capacity</td>
<td>8 hours</td>
</tr>
<tr>
<td>Charging time</td>
<td>1.5 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MEASURING RANGE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total arrester leakage current</td>
<td>200 – 16000 μA</td>
</tr>
<tr>
<td>Resistive current</td>
<td>0 – 9000 μA</td>
</tr>
<tr>
<td>Frequency range</td>
<td>47 – 63 Hz [system voltage 50Hz or 60Hz]</td>
</tr>
<tr>
<td>Field probe</td>
<td>0-5Vac</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±5 % or ±5 μA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIRELESS SENSORS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery powered wireless current probe and field antenna</td>
<td>Rechargeable (charges in instrument lid) 9V 500mAh</td>
</tr>
<tr>
<td></td>
<td>Digital radio communication at 434.075-434.525 MHz*</td>
</tr>
<tr>
<td></td>
<td>Probes can be set at 16 distinct channels</td>
</tr>
<tr>
<td></td>
<td>Probes are in addition separated by their serial numbers</td>
</tr>
</tbody>
</table>

* May vary between countries

**LCM TECHNIQUE**

Well-proven and acknowledged monitoring technique using third-order harmonic analysis with compensation. Rated according IEC 60099-5 as the best field monitoring technique for Metal Oxide Surge Arresters (MOSA). LCM500 measurements are automatically normalized to standard ambient temperature (+20°C) and 0.7x rated arrester voltage based on recorded temperature and operating voltage during field measurement. Measurements performed under different conditions can thereby easily be compared.

**PERFORMING FIELD MEASUREMENTS**

LCM500 is designed for trending the condition of metal oxide surge arresters. Arrester ID is downloaded from PC software to LCM500 instrument prior to performing inspection of surge arresters. LCM500 can store 1000 arrester IDs. On location choose correct arrester ID and perform measurement. After completion of field measurements stored data are transferred from LCM500 instrument to PC software. You are now ready to perform analysis and plan your next inspection.

**APPLICATION**

Doble leakage current monitors can be used to trend the condition of all types of metal oxide surge arresters on an insulated base with one separate grounding system conductor.

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>PART #</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TN-25000</td>
<td>LCM500 with case, Clip-on CT, Field Probe, Rod Adapter, power cable and test cables</td>
</tr>
<tr>
<td></td>
<td>Field Probe rod is not included.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACCESSORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>TN-25156</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Identify and locate insulation defects with the DFA300, a surveying tool that combines radio frequency interference (RFI) and acoustic emission (AE). It can detect and locate partial discharge (PD) in a few seconds. Designed for surveying live, high voltage apparatus, its versatility makes it the perfect, multi-purpose tool for condition-based maintenance programs.

**FEATURES**

- Combination tool uses both RFI and acoustic technology
- Registers RFI from apparatus with insulation problems including PD and arcing
- Locate and diagnose internal problems using the acoustic sensor on grounded surfaces
- Easy to use, handheld device with large display screen

**BENEFITS**

- Perform non-invasive surveys of critical assets
- Identify and locate insulation defects in gas insulated and open air substations, transformers, instrument transformers and cable terminations
- Convenient tool for daily use or routine substation surveys along with thermography
**DFA 300 TECHNICAL SPECIFICATIONS**

### INPUT CHANNEL DESCRIPTION

The DFA300 is a dual function instrument capable of analysing either acoustic or RF emissions. There is a single input connection which can accept either a RF or an acoustic sensor.

#### ACoustIC EMISSION CHANNEL

<table>
<thead>
<tr>
<th>Inputs</th>
<th>1 channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector</td>
<td>BNC</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>50Ω or 22kΩ, software switchable (low noise preamp: 22kΩ only)</td>
</tr>
<tr>
<td>AE Operating Freq</td>
<td>10 kHz to 500 kHz at -3dB points</td>
</tr>
<tr>
<td>Phantom Power</td>
<td>28 VDC on BNC centre conductor (100mA current limited), software switchable</td>
</tr>
<tr>
<td>AE Sensor</td>
<td>R3a (standard), R6a, R6b, R15a R15I (optional)</td>
</tr>
</tbody>
</table>

#### UHF CHANNEL

<table>
<thead>
<tr>
<th>Inputs</th>
<th>1 channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector</td>
<td>BNC</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>50-1000 MHz with 6 MHz RBW</td>
</tr>
<tr>
<td>Accuracy</td>
<td>± 100 kHz</td>
</tr>
<tr>
<td>Detection Types</td>
<td>Peak and average detector</td>
</tr>
<tr>
<td>Sweep Processing</td>
<td>Continuous, Average, Max Hold and differential</td>
</tr>
</tbody>
</table>

### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>PART #</th>
<th>PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TN-33000</td>
<td>Double DFA300 Complete with transport case, antennas, acoustic sensor, battery charger, neck strap and wireless synchronization adapter. Software is included.</td>
</tr>
</tbody>
</table>

### POWER SUPPLY

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>External Supply</td>
<td>External DC adapter, 12V @ 2A</td>
</tr>
<tr>
<td>DC Adapter</td>
<td>85-264 VAC (47-63 Hz) / 12 VDC</td>
</tr>
<tr>
<td>Internal Battery</td>
<td>Li-Ion, high capacity 7.2V, 91 Wh</td>
</tr>
<tr>
<td>Battery Life</td>
<td>&gt;4 hours</td>
</tr>
<tr>
<td>Charging Time</td>
<td>1.5 hours</td>
</tr>
</tbody>
</table>

### MECHANICAL

| Instrument           | 225 x 310 x 70 mm [WxHxD] |
|                      | Weight: 2.4 kg |
| Transport Case       | 425 x 284 x 155 mm [WxHxD] |
|                      | Weight: 3.4 kg |
| Total Weight         | 6.0 kg incl. instrument, transport case, manuals, CD and charger |

### LCD SCREEN

| Display               | TFT, 6.4” Transreflective |
| Size (W x H)          | 132 x 100 mm |
| Resolution            | 640 x 480 pixels, 256 colours |
| Backlight             | LED |

### DATA STORAGE

| Internal              | NV Flash memory (SD) |
| External              | USB storage class compliant USB Flash Drive/Hard Disk Drive |
| Data Transfer         | Measurements can be downloaded to a PC |
| Real Time Clock       | Battery backed |

### ENVIRONMENTAL

| Enclosure             | IP66 – top covers closed |
| Electrostatic discharge according to EN 61000-4-2 | IP51 – top covers open |
| Humidity              | 0-95% non-condensing |
| Temperature           | Operating temperature: -10 to +50°C |
|                       | Storage temperature: -20 to +70°C |
SERVICES

DYNAMIC SUPPORT WITH DOBLE SERVICES

Our depth of experience allows us to provide you with an array of services that goes beyond tools and technology. Our global, multidisciplinary team of chemists and engineers works as an extension of your organization, providing comprehensive, unbiased expert advice and support. We provide neutral and independent insight into the problems you face.

DOBLE CLIENT SERVICES GROUP

THE FULL DOBLE COMMUNITY ENGAGEMENT

For even the most experienced technician, situations in the field are rarely black and white. Membership in the Doble Client Services Group gives you certainly and reliability. Make the right interpretation and the right decision – the first time and every time. Trust that your testing and diagnostic instrumentation is state-of-the-art and works on demand, or will be replaced within 24 hours. Train your test technicians and power engineers on the most current test practices and procedures.

As part of the Doble Client Services Group, you gain the full Doble experience. You join a vast community of experts. You gain access to the industry’s most comprehensive resource libraries on the power grid. You also learn what your peers are doing, and what apparatus troubles and failures they are experiencing.

Today, more than ever, you need to invest your workforce and capital resources wisely across the ownership cycle of every asset. Take advantage of the full Doble community promise.
DOBLE CONSULTING & TESTING SERVICES

INDUSTRY EXPERTS AT YOUR SERVICE

Today many companies are increasingly looking to outsource for answers to their toughest testing and diagnostic challenges. You need a partner with broad expertise in chemistry, online and off-line electrical testing, and transformer design and manufacturing experience. Our wide variety of skills fits together with yours, collaborating with your in-house experts, and giving you a complete picture of your situation, so you can focus your resources where they are really needed. Services include:

- Specification writing & review
- Design reviews
- Manufacturing plant inspections
- Factory witness testing
- Test data review
- Root cause analysis
- Condition assessment
- Fleet asset health review
- Forensic analysis
- Partial discharge testing
- EMI diagnostics survey
- In-service substation surveys
- Off-line electrical testing
- High-voltage laboratory services

DOBLE HAS HELPED MORE THAN 5500 CLIENTS IN 110 COUNTRIES IMPROVE OPERATIONS AND OPTIMIZE SYSTEM PERFORMANCE.

THAT’S EXPERIENCE YOU CAN COUNT ON.

DOBLE INSULATING MATERIALS LABORATORY SERVICES

TRULY ONE OF A KIND

The industry has come to rely on Doble’s expert laboratory services, which were established in 1933. Today, Doble possesses the widest scope of insulating material testing capabilities in asset diagnostics. We offer over 200 different tests on liquid and solid insulating materials.

Our chemists and engineers will help you identify the cause of apparatus problems and provide detailed test reports with data analysis and recommendations for next steps. Testing categories include:

- Transformer oil purchase specification testing
- Corrosive sulfur & passivators
- Dissolved gas analysis
- Furanic compounds in oil
- Water-in-oil analysis
- Degree of polymerization
- Oil quality screens
- Metals-in-oil
- Polychlorinated biphenyls (PCBs)
THE DOBLE CLIENT SERVICE ADVANTAGE

When you become a Doble Client Service Group member, a team of engineers has your back. This resource – backed by the deepest knowledge base in the power industry – is always there when you need it: when there’s a problem, a question in the field, and when schedules are tight.

You gain access to:

- Over 30 field experts with more than 600 years of combined industry experience.
- 2500 power engineer community members – accessible via online forums and events.
- 44 million technical and maintenance data points, on over 100,000 assets, collected over decades.

Doble Client Service members renew year after year, decade after decade – because of the many benefits of membership:

**KNOWLEDGE**

Become the “go to” person in your company on apparatus reliably and maintenance.

**CONFIDENCE**

When there’s an issue, we answer questions in real time, while the tester is still out in the field so that mistakes can be detected or investigative tests can be performed before an asset is returned to service.

**BEST-PRACTICES**

Gain the insights and best practices of the very best of the industry, based on actual field experiences worldwide, to keep your operation performing in peak condition. Anticipate issues based on troubles and failures being experienced throughout the industry, accurately decide on asset repairs versus replacements, discover different operating philosophies and practices, and stay up to date on technical advancements.

**RELIABILITY**

Never be in possession of obsolete, battered or inaccurate test equipment. If any problem is encountered, a complete replacement test set is shipped within 24 hours. All test sets are constantly updated with the latest engineering enhancement and newest features.

“YOU GUYS ARE DEPENDABLE, NOT JUST YOUR EQUIPMENT BUT YOUR PEOPLE.
I CAN PICK UP THE PHONE AND GET MY QUESTIONS ANSWERED IN A TIMELY FASHION, THAT’S WORTH SOMETHING”

Ferguson Electric
Paul Reily, President
GET THE MOST FROM YOUR DOBLE CLIENT SERVICE ENGAGEMENT

A perpetual warranty, equipment upgrades and worry-free use of Doble test instruments is only the beginning. Doble Client Service engagements support every aspect of your testing and diagnostic needs.

We are your long-term workforce development partner and your emergency expert on-call when situations are urgent. Take full advantage with:

- **Unlimited expert consultation** with a dedicated Doble Principal Engineer on matters related to testing procedures, test data analysis and apparatus maintenance. Doble’s Client Service engineers serve as an extension of your own team, providing the assistance you need to manage your assets.

- Maintain and improve your staff’s skill set with five days of **on-site training** every year. Doble’s experienced engineers tailor training to your needs, including testing theory and techniques, how to apply the right test to the right situation, and hands-on field testing and test results analysis.

- Doble also offers on-site transformer factory test training, for impartial perspective and report analysis for additional fee.

- Access the ’**Ask Doble**’ Technical Exchange Forum where 2500 industry power engineers exchange knowledge, share advice, discuss problems and successes, poll peers for vendor recommendations, and get feedback and ideas.

- Take advantage of **Doble material insulation laboratory services** to provide answers and solutions based on a wide range of testing capabilities – from the standard to the highly specialized customized test protocols for unique cases.
SOLUTIONS AND SERVICES YOU NEED. 
AND A COMMUNITY THAT ENHANCES THEM.

Wherever you are in the power industry, at any given place in your asset ownership cycle, through all your testing practices, Doble is with you, through solutions, services and our knowledge community.