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POWER FACTOR AND CAPACITANCE DIAGNOSTIC SYSTEM FOR POWER APPARATUS

www.isatest.com
Power Factor and Capacitance diagnostic system for power apparatus

- Fully automatic
- Tan Delta, capacitance, dissipation factor measurements and exciting current test
- Variable output frequency: 15 - 500 Hz
- Output voltage up to 12 kV
- Local control with a large graphic display
- PADS - Power Apparatus Diagnostic Software for automatic testing, assessment and report
- USB interface and Ethernet interface for PC connection
- Compact and lightweight
- Patented technology for capacitance and Tan Delta measurement.
APPLICATION

The following table lists the tests that can be performed on CTs, VTs and PTs.

<table>
<thead>
<tr>
<th>N.</th>
<th>TEST</th>
<th>TEST DESCRIPTION</th>
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<td>CT</td>
<td>Tan Delta measurements</td>
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<td>21</td>
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<td>23</td>
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<td>Tan Delta measurements</td>
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</table>

Tests are performed in accordance with the following IEC standards: IEC61869-2; IEC61869-3; EN 60044-1; EN 60044-2; EN 60044-5; EN 60076-1, and also in accordance with C57.12-90.

GENERAL CHARACTERISTICS

TDX 5000 equipment performs the measurement of the Tan Delta, of the dissipation factor and of the capacitance of a transformer or of any device, at the frequency of the mains or in a wide frequency range. The measurement is performed by patented technology.

TDX 5000 measurement circuitry incorporates a reference high voltage capacitor, rated 200 pF, with a Tan Delta better than 0.005%, and a reference resistor bridge, with accuracy better than 0.01%, and thermal drift less than 1 ppM/°C. The patented circuitry and the variable frequency output make test results immune from external noise.

Available test selections:
- Ungrounded: UST-A; UST-B; UST A+B
- Grounded: GST; GSTg-A; GSTg-B; GSTg-A+B

TDX 5000 is powered by an internal voltage generator with electronic control.

SYSTEM DESCRIPTION

The STS family includes three models: STS 5000, STS 4000 and TDX 5000. TDX 5000 is developed as a compact solution for high voltage Capacitance and Tan Delta (Dissipation Factor) measurements. Using the reactor option, TDX 5000 can also perform tests on rotating machines.

In the local control mode, the selected output is adjustable and metered on the large, graphic LCD display. With the control knob and the LCD display, it is possible to enter the MENU mode, that allows to set many functions and that make TDX 5000 a very powerful testing device, with manual and automatic testing capabilities and with the possibility to transfer test results to a PC via ETHERNET or Pen Drive. The TDMS software suite, which comes with the test set, allows to download, display and analyse test results obtained in local mode. Remote maintenance and diagnostic of the instrument is available via Ethernet. TDMS operates with all Windows® versions.

The ease of operation has been the first goal of TDX 5000 unit. This is why the LCD display is so large and the dialogue in MENU mode is made easy. TDX 5000 includes the detection of the digital signal coming from the RTCD-Compensating Reactor option.

The instrument is housed in a transportable aluminium box, which is provided with cover and handles for ease of transportation. A transport trolley can be optionally supplied.
TDMS - Test & Data Management Software
TDMS, Test & Data Management Software, is a powerful software package providing data management for acceptance and maintenance testing activities. Electrical apparatus data and test results are saved in the TDMS database for historical results analysis. The TDMS database organizes test data and results for the majority of electrical apparatus tested with ISA test sets and related software.

PADS - Power Apparatus Diagnostic Software
PADS - Power Apparatus Diagnostic Software is a powerful software application, included in TDMS software, that optionally allows the remote control of the STS family: STS 5000, STS 4000, TDX 5000. The software performs various tasks, such as:
- Control STS and TD remotely from PC
- Create test plan
- Download stored test results via Ethernet cable
- Create and customize test reports
- Print test results
This program runs under Windows© environment.
Note: Windows is trademark of Microsoft Corporation.

TDX 5000 - FRONT PANEL

- Display
- Keyboard
- Safety Key
- Digital input
- Function keys
- Power ON/OFF
- Multifunction function knob
- Start/Stop
- Emergency push-button
TDX 5000 Power Factor and Capacitance diagnostic system for power apparatus

TDX 5000 - SIDE PANELS

- High voltage output

TDX 5000 - SIDE PANELS

- Ground connection
- Power supply
- Remote start
- Safety warnings
- Measuring inputs UST-A UST-B
- External devices input
- Interfaces

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TEST HEADER

Before starting a test, all relevant test object data are input into the header, which is made of four screens. These data are used by the device for the following test execution. If, during tests, some results do not conform and nominal data are to be modified, the change is made in the Header, so that consistent nominal data and the corresponding test results are saved together.

If the device is a PT, the capacitance tests and the no-load current test can be pre-set together, to form a single Test Plan. The Test Plan can be saved and recalled; up to 64 different plans can be stored into memory.

Nominal values window: from these nominal data, the program computes the nominal saturation knee.

Tests header window: test reference data.

Tolerances window allows setting the tolerances for each of the available tests.

Test selection window: it allows selecting the test to be performed.

At the end of the programming, starting the first test will execute the complete sequence. During the test, test results are stored in the memory. The test set minimizes the test duration, in order to avoid over-heating the components. The same feature is available when controlling the test set via PC by PADS.
POWER FACTOR, CAPACITANCE AND TAN-DELTA FOR CT, VT, POWER TRANSFORMER AND CB

- **POWER FACTOR, CAPACITANCE AND TAN DELTA**
  
  The test is performed connecting TDX 5000 to the high AC voltage source to test target.
  
  Input parameters are: Winding, test voltage and frequency, test mode, and the nominal capacitance, PF, DF.
  
  The display shows the following data:
  
  - Test voltage, current and frequency
  - Capacitance, Tan Delta and power factor
  - Power data: active, reactive and apparent
  - Impedance: module, argument and components.

- **NO-LOAD CURRENT**
  
  The test is performed connecting TDX 5000 to the high AC voltage source to the test target.
  
  Input parameters are: the tap number, the type of Tap changer, the test voltage and the frequency. The test set applies the high voltage and measures the output current during the test.
  
  The display shows:
  
  - The test voltage
  - The current and the phase shift
  - The power losses
  - The reactance.
OTHER FUNCTIONS

- **PADS SOFTWARE**
  The PADS software is a powerful application, included in the TDMS software, which provides connectivity to the instruments of the STS family. The software performs various tasks, such as:
  - Edit and upload to the instrument the test headers
  - Create and modify plans containing one or more tests
  - Optionally remote control of the execution of test plans (start, interruption, results assessment)
  - Download and save results of tests previously performed by the instrument
  - Open and save results on the PC
  - Print test results.

**TDX 5000 SPECIFICATION**

**GENERATOR CHARACTERISTICS**

<table>
<thead>
<tr>
<th>MAX VOLTAGE OUTPUT V</th>
<th>CURRENT OUTPUT A</th>
<th>MAX OUTPUT DURATION T Max</th>
<th>FREQUENCY Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>12000</td>
<td>300 mA</td>
<td>120 s</td>
<td>15 to 500</td>
</tr>
<tr>
<td>12000</td>
<td>125 mA</td>
<td>&gt; 1 hour</td>
<td>15 to 500</td>
</tr>
<tr>
<td>12000</td>
<td>100 mA</td>
<td>steady</td>
<td>15 to 500</td>
</tr>
</tbody>
</table>

*Note: at 10 kV the output (current value and duration) has the same characteristic.*

Voltage and current output metering accuracy and resolution.

<table>
<thead>
<tr>
<th>INTERNAL MEASURE</th>
<th>RESOLUTION</th>
<th>TYPICAL ACCURACY ± % (rdg) ± % (rg)</th>
<th>GUARANTEED ACCURACY ± % (rdg) ± % (rg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12000 V AC</td>
<td>1V</td>
<td>±0.2%±0.05V</td>
<td>&lt;0.3%+1V</td>
</tr>
<tr>
<td>5 A AC ( @ inputs A or B&gt;10 mA)</td>
<td>1 mA</td>
<td>±0.2%±0.1mA</td>
<td>&lt;0.5%</td>
</tr>
<tr>
<td>&lt;10 mA AC ( @ inputs A or B)</td>
<td>0.1 µA</td>
<td>±0.2%±0.1µA</td>
<td>&lt;0.3%+0.1µA</td>
</tr>
</tbody>
</table>

- Frequency range: 15 to 500 Hz. Frequency accuracy: 50 ppm typical; 100 ppm maximum.
- Connections: by a double shielded HV connector, two Ground sockets (case and external shield of HV cable), and two measurement sockets (A and B).

**TEST MEASUREMENTS**

- **Capacitance**
  Measurement range 1, from 1 pF to 3uF. Resolution: 6 digits. Accuracy, typical: ± 0.03% of the value ± 0.1 pF; guaranteed: < 0.1% of the value +1pF (from 45 to 70 Hz).

- **Tan Delta or dissipation factor DF**
  Measurement range 1: from 0 to 10% (capacitive). Resolution: 5 digits; accuracy, typical: 0.05% of the value ± 0.005%; guaranteed: 0.1% of the value ± 0.005% (from 45 to 70 Hz, current < 10 mA).
  Measurement range 2: from 0 to 100%. Resolution: 5 digits; accuracy, typical: 0.3% of the value ± 0.01%; guaranteed: 0.5% of the value ± 0.02%.
  Measurement range 3: over 100%. Resolution: 5 digits; accuracy, typical: 0.5% of the value ± 0.03%; guaranteed: 0.8% of the value ± 0.05%.

- **Power factor PF (or cos(φ))**
  Measurement range 1: from 0 to 10% (capacitive). Resolution: 5 digits; accuracy, typical: 0.05% of the value ± 0.005%; guaranteed: 0.1% of the value ± 0.005% (from 45 to 70 Hz, current < 10 mA).
  Measurement range 2: from 0 to 100%. Resolution: 5 digits; accuracy, typical: 0.3% of the value ± 0.02%; guaranteed: 0.5% of the value ± 0.02%.

- **Impedance**
  From 1kOhm to 1400 MOhm. Accuracy, typical 0.3% of the value ± 0.1%, guaranteed <0.5% of the value. Resolution: 6 digits.
**TDX 5000** Power Factor and Capacitance diagnostic system for power apparatus

- **Power**
  - Measurement ranges: 10 kW, 100 kW, 1 MW. Resolution (5 digits): 0.1 mW; accuracy: <0.5% of the value ± 1 mW.
  - The same ranges and accuracies are applied to reactive and apparent power measurements.

- **Inductance**
  - Measurement range 1: from 1 H to 10 kH. Resolution (5 digits): 0.1 mH; accuracy, typical: 0.3% of the value ± 0.5 mH; guaranteed: 0.5% of the value.
  - Measurement range 2: from 100 H to 1 MH. Resolution (5 digits): 1 H; accuracy, typical: 0.3% of the value; guaranteed: <0.5% of the value.

- **Output frequency**
  - AC output frequency range: 15 to 500 Hz

- **Digital input**
  - Binary input used only for RCTD - Compensating reactor option.

- **Display**
  - The large graphic display has the following characteristics:
    - Pixels: 640 x 480, coloured
    - LCD type: TFT
    - View area: 132 x 99 mm
    - Backlight.

- **Local test set control**
  - Local test control: by the START / STOP pushbutton. After the test selection, pressing it, the output is generated, according to the type of test. During ON, if a manual control test is selected, the operator adjusts the output at the desired value.
  - Test saving:
    - Automatic save
    - After operator confirmation.

**ACCESSORIES SUPPLIED**

**CONNECTION CABLES**
- One mains supply cable, 2 m long.
- One grounding cable, 6 m long.
- One ETHERNET interface cable.
- One USB pen drive.
- 1 High voltage connection cable, 20 m long, 25 kV, with earth screen, for the connection to the device under test, terminated on the device side with an isolated banana plug and on the TDX 5000 side with two plugs: one for the HV and the other one for the ground. The cable is mounted on a wheel.
  - 1 clamp, 25 mm opening, with a connector which mates with the HV cable.
  - 1 bigger clamp, 40 mm opening, with a connector which mates with the HV cable.
  - 2 shielded connection cables, 20 m long, for the connection to the metering points. Terminated on the TDX 5000 side with the metering connector and on the device side with a banana plug. Cables are mounted on wheels.
  - 2 clamps, 25 mm opening, terminated with banana sockets, which allow connecting to the metering point.
  - 2 Kelvin type clamps, 65 mm opening, with banana plugs, which allow connecting to the metering point.
  - 1 hot collar cable, 1 m long, with connector.

**OTHER CHARACTERISTICS**

- **Communication interfaces**
  - Slave USB and ETHERNET for the PC connection
  - USB port for the USB key.

- **Interfaces to external modules:**
  - Alarms to a flashing light
  - Remote start input.

- **Mains supply**
  - 100-230 V ± 15%; 50-60 Hz
  - Maximum supply current: 16 A.

- **Dimensions:** 450 (W) x 530 (H) x 215 (D) mm.
- **Weight:** 39 kg.

- **Transport case**
  - The transport case allows delivering TDX 5000 with no concern about shocks up to a fall of 1 m. The case is supplied with handles and wheels.
OPTIONAL ACCESSORIES

FOLDABLE TROLLEY
The trolley eases the transport of TDX 5000.

RCTD - COMPENSATING REACTOR
This module is useful for testing Tan Delta in rotating machines with TDX 5000 and allows increasing the test current and getting the maximum test voltage with high capacitive burdens. Each RCTD is composed by two inductors with a nominal value of 40H and a steady current of 0.4A. The maximum current on each inductor can be up to 1A for more than 10s. The inductors can be connected in parallel on the load in order to increase the test frequency. It is possible to connect two RCTD in parallel in order to have three or four inductors connected together (2 x 80 H total).

CAP-CAL CALIBRATOR MODULE
Purpose of the calibrator is to check the correctness of TDX 5000 measurement. The calibrator includes an extremely high accuracy high voltage capacitor, which comes with a certificate issued by ISA lab.

STOIL CELL FOR THE HV TEST OF THE DIELECTRIC OIL
The option allows testing that the oil characteristics of isolation are met and that there is no contamination. The option is made of a suitable glass container with electrodes; the electrodes are connected to TDX 5000 for the test execution. The test result, displayed by TDX 5000, is the oil Tan Delta. Cell characteristics are the followings:
- Maximum test voltage: 12 kV
- Cell volume: about 1l
- Capacitance of the empty cell: 60 pF.

DIGITAL THERMO HYGROMETER
Tan Delta tests are influenced by temperature and humidity. The option allows measuring these parameters and to input them into the test settings. Meter characteristics:
- Temperature range: -10°C to 60°C.
- Temperature measurement accuracy: ± 0.4°C.
- Humidity measurement range: 5 % to 95% RH.
- Accuracy of humidity measurement: ± 2.5% RH, over the whole range.
- Dimensions: 141 x 71 x 27 mm. Weight: 150 g.
REMOTE SAFETY SWITCH
If it is desired to start the test remotely from the test set, the optional switch allows to do it, up to the distance of 20 m, which is the length of the cable provided.

WARNING STROBE LIGHT
The warning strobe light alerts when the test is completed, or when there are alarms. The light is self-powered, and turns on (flashes) upon the test set command. A siren is also included.

OPTIONAL SOFTWARE
PADS - Power Apparatus Diagnostic Software
PADS - Power Apparatus Diagnostic Software is a powerful software application, included in TDMS software, that allow the remote control of the STS family: STS 5000, STS 4000, TDX 5000. Please refer to PADS datasheet for more information.

APPLICABLE STANDARDS
The test set conforms to the EEC directives regarding Electromagnetic Compatibility and Low-Voltage instruments.
  - Input/output protection: IP 2X - IEC69529; IP 4X for HV output.
  - Operating temperature: -10°C to 55°C; storage: -20°C to 70°C.
  - Relative humidity: 5-95% without condensing.

ORDERING INFORMATION

<table>
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<th>CODE</th>
<th>MODULE</th>
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<td>TDX 5000 - with TDMS software*, standard test cable kit and transport case</td>
</tr>
<tr>
<td>10176P</td>
<td>PADS software (primary)- Primary, CTs, VTs test module</td>
</tr>
<tr>
<td>10176T</td>
<td>PADS software (trasfo)- Power transformer and Tan Delta test module</td>
</tr>
<tr>
<td>10176F</td>
<td>PADS (full)- Full software suite (includes 10176P &amp; 10176T)</td>
</tr>
<tr>
<td>40175</td>
<td>CAP-CAL Calibration module</td>
</tr>
<tr>
<td>42175</td>
<td>Remote safety switch</td>
</tr>
<tr>
<td>44175</td>
<td>Digital thermo hygrometer</td>
</tr>
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<td>43175</td>
<td>Warning strobe light</td>
</tr>
<tr>
<td>47175</td>
<td>RCTD - Compensating reactor for TDX 5000</td>
</tr>
<tr>
<td>48175</td>
<td>Cable test kit for RCTD</td>
</tr>
<tr>
<td>19175</td>
<td>Transport case for RCTD</td>
</tr>
<tr>
<td>13175</td>
<td>STOIL Cell for the eletric test of insulating oil of the transformer</td>
</tr>
<tr>
<td>67175</td>
<td>Heavy duty plastic transport case for TDX 5000</td>
</tr>
<tr>
<td>68175</td>
<td>Trolley for TDX 5000</td>
</tr>
<tr>
<td>66175</td>
<td>Cable test kit for TDX 5000</td>
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*PADS - Power Apparatus Diagnostic Software is NOT included into basic unit price. It should be expressly ordered.

COMPARISON TABLE OF THE STS FAMILY

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<th>HIGH VOLTAGE</th>
<th>LOW AC-DC OUTPUTS</th>
<th>TAN DELTA TESTS</th>
<th>OPTIONAL HIGH AC CURRENT WITH BUX 3000</th>
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</thead>
<tbody>
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<td>STS 5000</td>
<td>□</td>
<td>□</td>
<td>□ with TD 5000</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>STS 4000</td>
<td>□</td>
<td>□</td>
<td>□ with TD 5000</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>TDX 5000</td>
<td>□</td>
<td>□</td>
<td>□ with TD 5000</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

□ For USA and Germany, only TDX 5000 is available.
## COMPARISON TABLE OF THE STS FAMILY TESTS

<table>
<thead>
<tr>
<th>NO.</th>
<th>TEST OF</th>
<th>TEST DESCRIPTION</th>
<th>STS 5000</th>
<th>STS 4000</th>
<th>TDX 5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CT</td>
<td>Ratio, Voltage mode</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>2</td>
<td>CT</td>
<td>Ratio, polarity and burden with high AC current</td>
<td>✔️</td>
<td>WITH BUX 3000</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>3</td>
<td>CT</td>
<td>Burden; secondary side</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>4</td>
<td>CT</td>
<td>Excitation curve</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>5</td>
<td>CT</td>
<td>Winding or burden resistance</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>6</td>
<td>CT</td>
<td>Voltage withstand</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>7</td>
<td>CT</td>
<td>Remote polarity check</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>8</td>
<td>CT</td>
<td>Rogowski coil transformers</td>
<td>✔️</td>
<td>WITH BUX 3000</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>9</td>
<td>CT</td>
<td>Low power transformers</td>
<td>✔️</td>
<td>WITH BUX 3000</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>10</td>
<td>CT</td>
<td>Tan(δ) measurements</td>
<td>✔️</td>
<td>WITH TD 5000</td>
<td>✔️</td>
</tr>
<tr>
<td>11</td>
<td>VT</td>
<td>Ratio; polarity</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>12</td>
<td>VT</td>
<td>Burden, secondary side</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>13</td>
<td>VT</td>
<td>Ratio, electronic transformers</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>14</td>
<td>VT</td>
<td>Voltage withstand</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>15</td>
<td>VT</td>
<td>Remote polarity check</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>16</td>
<td>VT</td>
<td>Tan(δ) measurements</td>
<td>✔️</td>
<td>WITH TD 5000</td>
<td>✔️</td>
</tr>
<tr>
<td>17</td>
<td>PT</td>
<td>Ratio per TAP</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>18</td>
<td>PT</td>
<td>Static and dynamic resistance of Tap Changer contacts</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>19</td>
<td>PT</td>
<td>Excitation current</td>
<td>✔️</td>
<td>WITH TD 5000</td>
<td>✔️</td>
</tr>
<tr>
<td>20</td>
<td>PT</td>
<td>Short circuit impedance</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>21</td>
<td>PT</td>
<td>Tan(δ) measurements</td>
<td>✔️</td>
<td>WITH TD 5000</td>
<td>✔️</td>
</tr>
<tr>
<td>22</td>
<td>CB</td>
<td>High DC current micro-Ohmmeter test</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>23</td>
<td>CB</td>
<td>Tan(δ) measurements</td>
<td>✔️</td>
<td>WITH TD 5000</td>
<td>✔️</td>
</tr>
<tr>
<td>24</td>
<td>VT/RELAY</td>
<td>Current threshold and timing</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>25</td>
<td>R</td>
<td>Ground resistance and resistivity</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>26</td>
<td>R</td>
<td>Step and touch voltages</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
<tr>
<td>27</td>
<td>L</td>
<td>Measurement of line impedance and of the related parameters</td>
<td>✔️</td>
<td>✔️</td>
<td>NOT AVAILABLE</td>
</tr>
</tbody>
</table>