**L&W Autoline TSO**

Lorentzen & Wettre Products | Automated paper testing

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**BENEFITS**
- Strong correlation with important strength properties as SCT, RCT
- Better runnability – analyze/tune/optimize:
  - furnish preparation and headbox
  - forming, press and drying
- Reduced testing time

**FEATURES**
- Based on the proven L&W TSO Tester
- Non-destructive method
- TSO profiles
- TSIMD/CD profiles
- TSIArea profiles
- TSIMD profiles
- TSICD profiles

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**Why measure TSO?**
Measurement data is used to optimize the performance of important stages in the production process, such as forming at the headbox as well as the performance in the press and drying sections. A TSI/TSO-optimized paper machine makes it easier to achieve specifications for compressive, tensile, and bursting strength. A typical application troubleshoots problems related to the headbox, such as pressure pulsations or a deviating pressure profile. The goal for a strip cut in CD is a symmetrical profile at a certain TSI- and TSI-MD/CD ratio level with a TSO-angle as minimal as possible.

**Measurement results**
The module uses the same measuring technology as the well-proven L&W TSO Tester laboratory stand-alone testing equipment. That has been the industry standard since 1992. The measurement results are presented as a polar diagram or high resolution profile, which provides the complete picture of the paper sheet's elastic properties. Take advantage of the combined experience of more than thousands of users. Accurate TSO measurements help to lower costs through optimization of fiber usage, as well as refining energy consumption, controlling the dimensional stability of produced paper, and increasing runnability in the printing press. TSO measurements are the solution to many other paper-machine oriented and end-user problems.

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L&W Autoline TSO is ideal for process optimization, as it measures early in the process to allow corrective action in the headbox, press, and dryer – saving raw material, as well as time. It uses ultrasonic technique to measure Tensile Stiffness Index (TSI) and Tensile Stiffness Orientation (TSO) and the results can be used to predict the performance of paper, and when manufacturing corrugated board.

L&W Autoline TSO can also be used for predictions of the runnability of a paper in applications like sheeting, copying, and printing operations. In a multicolor printing process the orientation of hygro-expansion (related to the TSO-angle) needs to be under control. In corrugated board manufacturing matching liner single facer and double backer with the same TSI/TSO-value is important to avoid twist or warp.
DEFINITION
The speed of an ultrasonic pulse in the plane of a paper depends on the elastic properties of the paper – its tensile stiffness index (TSI). TSI can be compared with Young’s modulus (or the “E” modulus) for other materials. The relationship can be expressed as:

\[ TSI = v^2 \times c \]

where:

- \( TSI \) = tensile stiffness index (kNm/g or MNm/kg) of the paper measured using the ultrasonic method
- \( v \) = propagation velocity (km/s) of the ultrasonic pulse
- \( c \) = a dimensionless constant close to 1 depending on Poisson’s ratio for the paper

Velocity is measured in eight directions. The result is converted by the processor using a Fourier transformation to an ellipse. The ellipse shows the elasticity in all directions of the plane of the paper. This allows the identification of the direction of the greatest stiffness. This property is known as TSI\text{\textsubscript{MAX}}.

The difference between the machine direction in the sheet and the direction for TSI\text{\textsubscript{MAX}} is referred to as the TSI\text{\textsubscript{ANGLE}}. Other reported properties are:

- TSI\text{\textsubscript{MD}} = tensile stiffness index in the machine direction
- TSI\text{\textsubscript{CD}} = tensile stiffness index in the cross direction
- TSI\text{\textsubscript{MD/CD}} = tensile stiffness index ratio (i.e. the anisotropy in the sheet)
- TSI\text{\textsubscript{MAX}} = tensile stiffness index, maximum value
- TSI\text{\textsubscript{MIN}} = tensile stiffness index, minimum value
- TSI\text{\textsubscript{AREA}} = the tensile stiffness index, ellipse surface area

Technical specifications
- L&W Autoline TSO Tester, code 626

<table>
<thead>
<tr>
<th>Property</th>
<th>Measurement values</th>
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<tbody>
<tr>
<td>TSI\text{\textsubscript{MD}}</td>
<td>0–25 kNm/g</td>
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<tr>
<td>TSI\text{\textsubscript{CD}}</td>
<td>-90 to +90 degrees</td>
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Measurement
- Method: Ultrasound propagation speed in the plane of the sheet
- Measuring time: 6 s per test point

Results
- Measurement values:
  - TSI\text{\textsubscript{MD}}
  - TSI\text{\textsubscript{CD}}
  - TSI\text{\textsubscript{MD/CD}}
  - TSI\text{\textsubscript{MAX}}
  - TSI\text{\textsubscript{MIN}}
  - TSI\text{\textsubscript{AREA}}
  - TSI\text{\textsubscript{ANGLE}}

Sample
- Grammage: Approx. within the range 30–500 g/m²

Installation requirements
- Power: 10 W
- Air pressure: min. 600 kPa, max. 1 MPa
- Air consumption: average 1.2 NL/min (max. 38 NL/min)
- Dimensions: 0.2 × 0.6 × 0.7 m (8 × 24 × 28 in)
- Net weight: 14 kg (30 lb)

Possible combination modules
- L&W Autoline Thickness

Standards
- N/A

Measurement principle
An ultrasonic longitudinal pulse is sent from the transmitter along the paper to the receiver 100 mm apart, from the transmitter. The average pulse velocity in the paper is used in the calculation of Tensile Stiffness index (TSI).