

A RETRACTABLE PROCESS  
REFRACTOMETER FOR  
BLACK LIQUOR MEASUREMENT

**K-PATENTS**  
PROCESS INSTRUMENTS



SAFE-DRIVE™ PROCESS REFRACTOMETER PR-23-SD

# APPLICATIONS

## WEAK LIQUOR FROM PULP WASHERS

Black liquor concentration is measured with K-Patents Process Refractometer to optimize the consumption of pulp chemicals and usage of water in the washing. The material balances can be calculated and the efficiency of the washing process can be maximized.

## BLACK LIQUOR TO EVAPORATORS

The concentration of feed liquor from washers to evaporation can be kept constant by controlling the mixing liquor with the K-Patents Process Refractometer, thus allowing the capacity of the evaporators to be maximized. Using K-Patents in the intermediate stage the profitability can be increased in the form of minimized steam consumption.

## GREEN LIQUOR TTA IN CAUSTICIZING

Better control of the green liquor in the causticizing process leads to increased capacity of the kraft cooking process. Green liquor total titratable alkali (TTA) content can be controlled by addition of weak wash liquor dilution. TTA has a good correlation with Refractive Index  $n_D$ , which provides an accurate measurement for the green liquor.

## BLACK LIQUOR TO RECOVERY BOILER

Feeding low concentrations of black liquor solids to a kraft chemical recovery boiler burner can cause a steam explosion. K-Patents Process Refractometer measures black liquor in to prevent dangerously low black liquor concentrations from reaching the boiler.



## SAFE-DRIVE™ PROCESS REFRACTOMETER PR-23-SD

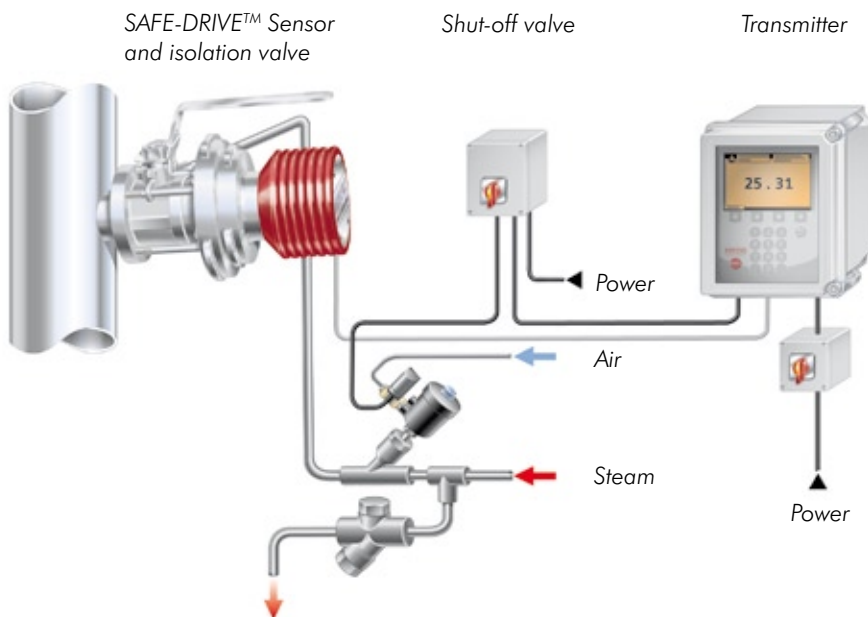


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# SAFE-DRIVE™ SYSTEM

K-Patents SAFE-DRIVE™ Process Refractometer PR-23-SD is a complete heavy-duty system for measuring black liquor dry solids % b.w. in kraft chemical pulp mills. K-Patents SAFE-DRIVE™ Process Refractometer system consists of:

- Retractable SAFE-DRIVE™ Process Refractometer Sensor
- SAFE-DRIVE™ Isolation Valve
- SAFE-DRIVE™ Retractor
- Steam Wash system
- Indicating Transmitter



## CORE-OPTICS

All SAFE-DRIVE™ Sensor's measuring components (light source, prism, temperature sensor and CCD-camera) are in one solid CORE-optics module. The patented CORE-optics is mechanically isolated from the influence of external forces such as temperature shocks, pressure peaks and vibration (US Patent No. 6067151). Therefore, the CORE-optics module needs no mechanical adjustments.

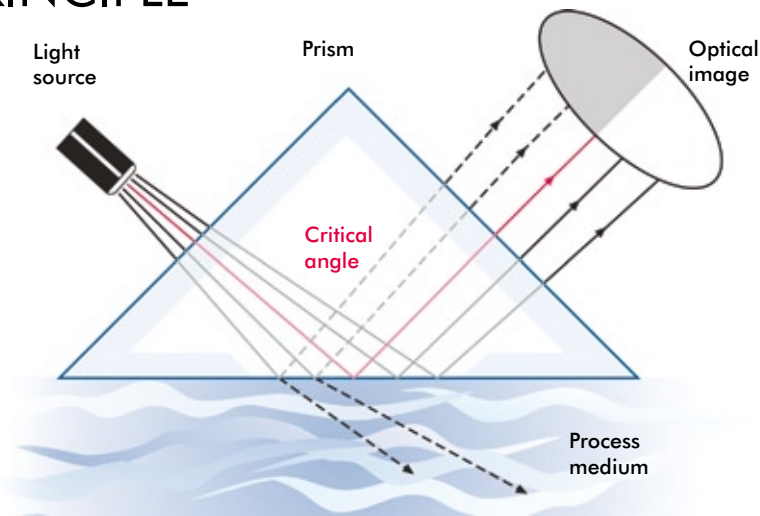
## CALIBRATION

The SAFE-DRIVE™ Process Refractometer PR-23-SD is factory calibrated to measure refractive index  $n_D$  and temperature  $T$  in standard units. Each sensor has identical whole range calibration  $n_D = 1.32 \dots 1.53$  (corresponding to 0-100 %). Because the PR-23-SD sensors have identical calibration, and each sensor gives Refractive Index  $n_D$  and temperature as output, all sensors can be freely interchanged without any inconvenience of optical calibration or parameter changes.

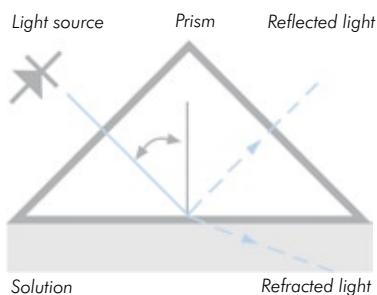
## VERIFICATION

K-Patents' manufacturing process is ISO 9001 certified. K-Patents also supports the verification within the user's own quality system. Each SAFE-DRIVE™ PR-23-SD Sensor is provided with a calibration certificate comparing a set of standard liquids to the actual sensor output. Therefore, the calibration and accuracy can be easily verified on-site using standard liquids and the transmitter's menu guided verification procedure.

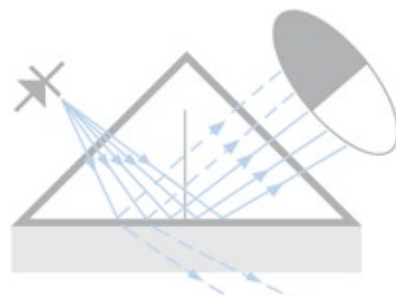
# DIGITAL MEASUREMENT PRINCIPLE



The light source sends light against the interface between a prism and the process solution, where the rays meet the surface at different angles.

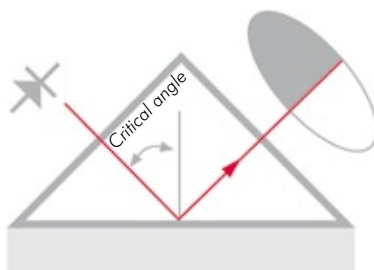


Depending on the angle, some rays are totally reflected. Some rays are only partially reflected, and most of the light is refracted into the process solution.



Thus an optical image with a dark sector and a light sector is created.

The angle corresponding to the shadow line is called the Critical angle of Total Reflection. The Critical angle is a function of the refractive index and therefore the concentration of the solution.



A digital CCD-camera detects the optical image and the shadow line. The camera transforms the optical image point-by-point to an electrical signal. The exact shadow line position is located and the refractive index  $n_D$  is determined.

A built-in temperature sensor measures the temperature  $T$  on the interface of the process liquid. The indicating transmitter converts the refractive index  $n_D$  and temperature  $T$  to concentration units.

The diagnostics program ensures that the measurement is reliable.

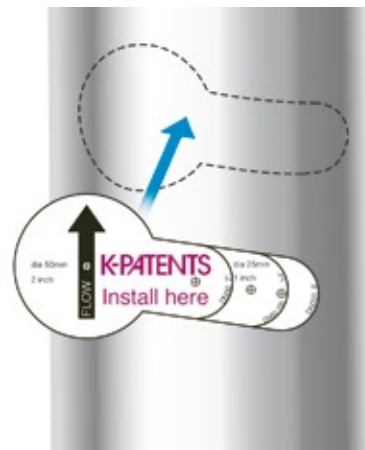
# ETHERNET SOLUTION

K-Patents SAFE-DRIVE™ Process Refractometer PR-23-SD includes an Ethernet based communication solution which allows connection to computer networks (LAN) and to the Internet. Real-time measurement data and diagnostic information may be obtained through this interface.

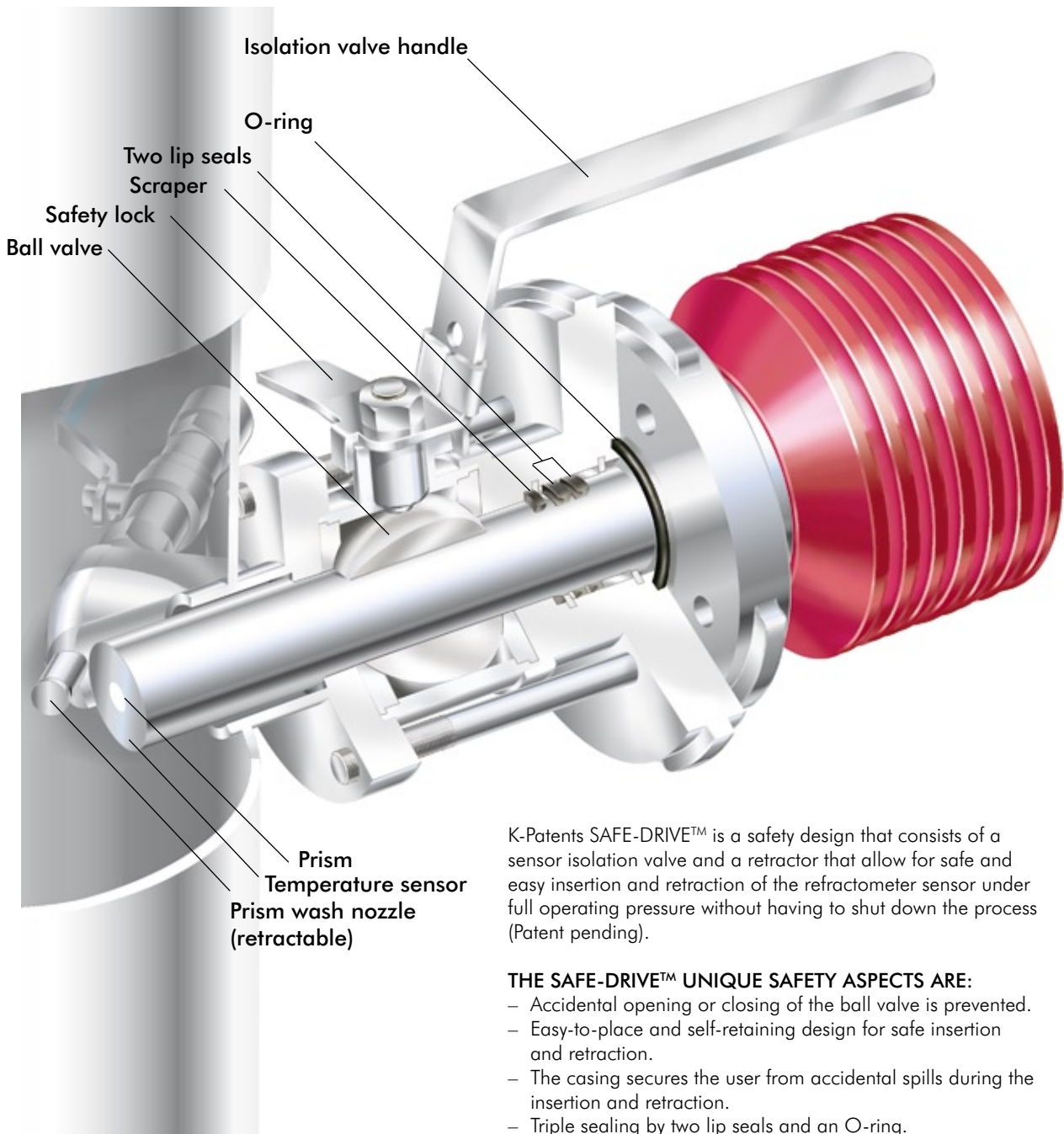
The SAFE-DRIVE™ PR-23-SD has also a built-in web server, which makes it possible to remotely review instrument data and diagnostics without having to go to the field.

# INSTALLATION

The SAFE-DRIVE™ Process Refractometer PR-23-SD Sensor is very easy to install by welding to any vertical or horizontal pipe line with 2 inch or larger diameter. The need for separate spool pieces or pipe sections is eliminated. A welding stencil guides the correct welding.



# SAFE-DRIVE™ DESIGN



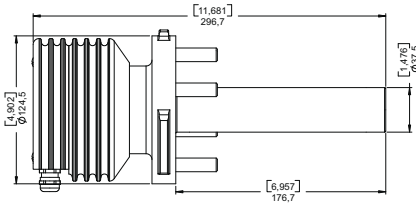
K-Patents SAFE-DRIVE™ is a safety design that consists of a sensor isolation valve and a retractor that allow for safe and easy insertion and retraction of the refractometer sensor under full operating pressure without having to shut down the process (Patent pending).

#### THE SAFE-DRIVE™ UNIQUE SAFETY ASPECTS ARE:

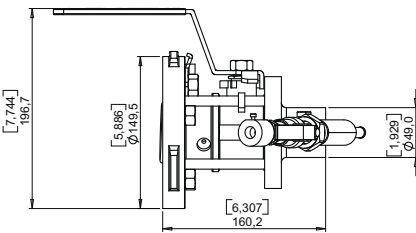
- Accidental opening or closing of the ball valve is prevented.
- Easy-to-place and self-retaining design for safe insertion and retraction.
- The casing secures the user from accidental spills during the insertion and retraction.
- Triple sealing by two lip seals and an O-ring.
- The retractable prism wash nozzle can be safely removed for service check.

# SPECIFICATIONS

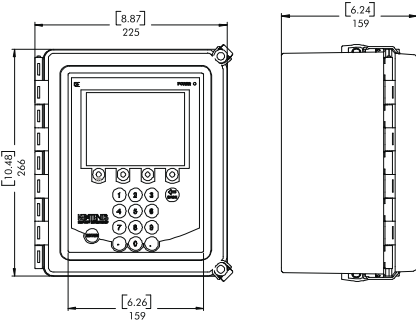
SAFE-DRIVE™ Sensor PR-23-SD



SAFE-DRIVE™ Isolation valve SDI-23



Indicating transmitter DTR



Refractive Index range:	Full range, $n_D = 1.3200...1.5300$ (corresponds to 0...100 % b.w.)
Accuracy:	Refractive index $n_D \pm 0.0002$ (corresponds typically to $\pm 0.1\%$ by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Instrument verification:	According to ISO 9000 quality system: with standard R.I. liquids and Transmitter's menu guided procedure
Ambient temperature:	Sensor: max. 45°C (113°F), min. -20°C (-4°F) Indicating transmitter: max. 50°C (122°F), min. 0°C (32°F)

**SAFE-DRIVE™ SENSOR PR-23-SD AND ISOLATION VALVE SDI-23 (Patent pending)**

CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED), 589 nm wavelength, sodium D-line
Temperature sensor:	Built-in Pt-1000, automatic digital temperature compensation
Isolation valve connection:	SAFE-DRIVE™ Flange 1.5 inch 300 lbs/DN 40 PN 25 (Patent pending)
Process pressure:	Static pressure up to 20 bar (300 psi)/operational pressure up to 10 bar (150 psi)
Process temperature:	-20°C...180°C (-4°F...350°F)
Sensor process wetted parts, standard:	SAF 2205/Duplex steel SS 2377, Werkstoff-Nr. 1.4462, UNS S31803/prism spinel, prism gaskets PTFE (Teflon®)
Sensor protection class:	IP67, Nema 4X
Isolation valve process wetted parts:	SAF 2205/Duplex steel SS 2377, Werkstoff-Nr. 1.4462, UNS S31803, AISI 316 L/ flange gasket Viton®/Lip seals Bronze Teflon® and ELGILOY/AISI301 spring
Isolation valve process connection:	By welding to pipe sizes of 2"-24", for both vertical and horizontal pipe lines
Prism wash:	Retractable steam wash nozzle with check valves
Sensor and Isolation valve weight:	10.5 kg (23 lbs)

**SAFE-DRIVE™ RETRACTOR SDR-23 (Patent pending):**

Retractor weight:	7.7 kg (17 lbs)
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**INDICATING TRANSMITTER DTR:**

Display:	320x240 pixel graphical LCD with LED backlight
Current output:	Two independent current outputs, 4-20 mA, max. load 1000 Ohm, galvanic isolation 1500 VDC or AC (peak), hold function during prism wash
Ethernet connection:	10/100 Mbit/s, data acquisition over UDP/IP Protocol with K-Patents PR-11111 data logging software
Power:	AC input 100-240 VAC/50-60 Hz, optional 24 VDC, 30 VA
Alarms/Wash relays:	Two built-in signal relays, max. 250 V/3 A
Sensor connectivity:	One or two sensors can be connected to the DTR. Sensors independent of each other: own parameter sets and usable in different applications. Two current outputs configurable independently to indicate process concentration or temperature of either sensor.

Transmitter protection class:	Enclosure IP66, Nema 4X
Indicating transmitter weight:	4.5 kg (10 lbs)

<b>INTERCONNECTING CABLE:</b>	IEC 61158-2 compliant two-wire cable
Interconnecting cable length:	Standard 10 m (33 ft), max. 200 m (660 ft)

<b>OPTIONS:</b>	Stainless steel sensor housing, prism wash, cable fittings to the Indicating transmitter: European cable glands M20x1.5 or US conduit hubs
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<b>ORDERING INFORMATION:</b>	- Desired measurement range and scale	- Process flow rate
	- Properties of process solution	- Supply voltage and frequency
	- Process temperature range	- Options and accessories
	- Process pipe size	



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