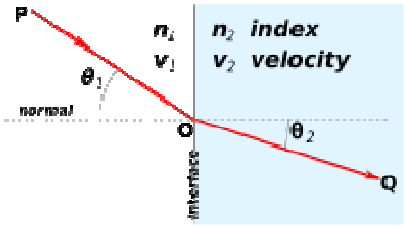
BASE BA-RFR
In-Line Refractometer
(Spectrophotometry based)

The BASE BA-RFR is part of the **BAGGI BASE®** Instruments Series. They are the result of combining the latest state-of-the-art-technology with over 50 years of industry experience.



The BA-RFR refractometer is designed for the measurement of the refractive index (RI) of fluids (either gas or liquid) that are transparent to the UV-Visible light. Therefore any other physical or chemical property related to this index can be measured. Typical applications are the measurement of the amount of sugar in grape juice (must), or, more generally, the concentration of solutes in a solvent.

Despite being a low-cost and a low-maintenance instrument, a resolution of $5x10^{-4}$ is acheived. This refractometer is designed for **in-line** operation in a wide variety of plants (from food and beverage industry to oil and gas industry). An ATEX certified version is available for use in potentially explosive atmospheres.

The instrument is offered either as a stand-alone system, or integrated in a multi-purpose UV spectroscopy package, comprising typically:

- a H2S in water analyzer (absorption measurement);
- an Oil in Water analyzer (fluorescence measurement)
- a dissolved Oxygen analyzer (fluorescence measurement)

Principle of Operation

The principle of operation of the refractometer is outlined hereafter.

The light, emitted by the spectroscope in the UV-Visible band, is conveyed, through an optical fiber, into the cell filled with the sample under measurement. Within the cell, a transparent diffraction grating is placed at an angle (θ_{in}) with respect to the direction of light. Please refer to the drawing.

The light entering the grating is refracted by the angle θ.

The refractive index of the sample under measurement (n_{sample}) and the refractive index of the grating ($n_{grating}$) are tied together by Snell's law:

$$n_{sample} \cdot \sin(\theta_{in}) = n_{grating} \cdot \sin(\theta)$$

The diffraction grating, hit by the light, originates a laterally scattered wave with wavelength λ, according to Bragg's law:

$$\lambda = 2d \cdot n_{grating} \cdot \cos(\theta - \varphi)$$

where

- "d" is the spacing within the lattice in the diffraction grating
- "φ" is the angle between the lattice plane and the diffraction grating surface

The diffracted wavelength λ does not exit the measurement cell and does not reach the spectrometer, while the other wavelengths exit the cell via an optical fiber and are detected by the spectrometer.

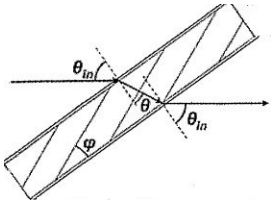
An embedded computer analyses the spectrum detected by the spectrometer, notices the missing diffracted wavelength and calculates the refractive index of the sample by applying Snell's and Bragg's laws.

The response curve (refractive index versus diffracted wavelength) is practically linear, therefore it can be obtained by calibrating the instrument, without the need of knowing with high precision the physical parameters of the diffraction grating.

A temperature sensor is available for measuring the sample temperature, in order to compensate automatically the RI change due to temperature variations.

The system is completed by the Control Unit, made by the BASE® Series embedded computer and the related actuators. This unit runs the application software for:

- collecting the measurement values from the sensors (photometer and temperature probe); if other instruments (such as H2S or Oil in Water analyzers) are integrated in the system, they share the same control unit;
- evaluating the mathematical formulas for Refractive Index calculation;
- archiving the results in standard CSV format;
- presenting a graphical user interface (GUI) to the Operator;
- transmitting remotely the information/alarms via current loops, relay signals, serial lines and WiFi;
- calibrating the instrument;



B.A.G.G.I . SrL – V.le Campania,29 20133 Milano Italy – Tel. +39 02715547 – Fax +39 027490571 – baggi@baggi.com

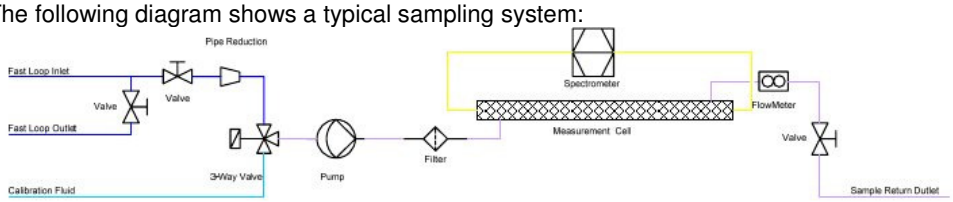
The figure beneath shows the Control Unit in the ATEX certified version (optional). This one is contained, together with the spectrophotometer, within a Stainless Steel 316L enclosure provided with a protective air purge system and a Vortex cooler (connected to the plant instrument air). Magnetic push buttons allow controlling the system without opening the cabinet.

The wetted parts (optical cell) are in AISI 316L or in Hastelloy (optional).
ATEX compliance:

- II 2 G Ex px II T6
- II 3 G Ex pz II T6

The Control Unit allows prompt software upgrades by means of USB keys. Therefore it is very easy to add applications for managing galvanic sensors (e.g. for dissolved CO2 or O3 measurements) and spectrophotometers (e.g. for H2S measurement).

The following diagram shows a typical sampling system:



Sensor Specifications	
Type	Photometric absorbance
Sample temperature	5° to 95°C (-15° to 203°F)
Sample pressure	0 to 30 psig typical (varies according to the model)
Range	1.3150 … 1.3840 n_D (0 … 33 Brix) when visible light spectroscopy is used; other ranges available when UV or IR spectroscopy is used
Measurement units	Refractive Index (n_D) , degree Brix, or Customer's choice
Accuracy - instrument	+/- 1% FS (due to optics, electronics, algorithms).
Accuracy - overall	Function of the sample representativeness and of instrument calibration; optimized by BAGGI either by in-field survey or by sample laboratory analysis
Resolution	$5x10^{-4}$
Sample cell material	AISI 316L or Hastelloy
Response time	90% of final value < 10 sec.
Control Unit Specifications (ATEX version)	
External input/output (according to the software packages installed)	- Analog input: four inputs filtered with transient protection - Analog output: three isolated outputs, 4 – 20 mA (standard) - Analog output: three additional isolated outputs (optional) - Digital input: six digital inputs (optional) - Digital output: four isolated relay signals (alarm and warning) - Digital output: four additional relay signals (optional) - Serial line: RS-232/RS-422/RS-485 with Modbus/Profibus/FieldbusFoundationProtocol - Ethernet card: two 10/100 mbps with RJ-45 port - One integrated WiFi card 11 Mbit/s
Power	90-264 VAC, 47-63 Hz; 6A max
Operating environment	- 0 °C to 40 °C (32 °F to 104 °F) - 0 °C to 55 °C (32 °F to 131 °F) with vortex cooler
Enclosure protection	IP66
Dimensions/Weight	- Wall Mount: 500mm H x 400mm L x 250mm D (19.68" H x 15.74" L x 9.84" D) - Weight: 15 Kg approx.
ATEX Compliance	II 2 G Ex px II T6 II 3 G Ex pz II T6

All the specifications subject to change without notice

For specific requirements, please contact the e-mail address below:
baggi@baggi.com
or visit our site:
http://sensevolution.baggi.com

B.A.G.G.I . SrL – V.le Campania,29 20133 Milano Italy – Tel. +39 02715547 – Fax +39 027490571 – baggi@baggi.com