



#### Applications

- UV absorption measurement (DOC-monitoring)
- Hazen color measurement
- Color measurement in beer, sugar, hydrocarbons, etc.
- Concentration measurement of electrolytes,  $\text{ClO}_2$ ,  $\text{Cl}_2$ ,  $\text{O}_3$ , etc.
- Monitoring of dyeing and decolorizing processes

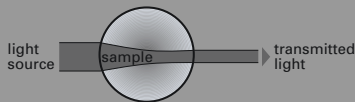
#### Features

- Inline flow cell Varivent, or user-specific
- Bypass flow cell with fouling compensation and alarm
- Turbidity compensation
- Calibration in E/m, Hazen, EBC, ASTM, Saybolt, etc.
- Measuring span 0 – 6000 E/m
- Ex version EEx-d

# ABSORPTION MEASURING INSTRUMENT COLORPLUS

# FUNDAMENTALS

## Absorption measurement



Absorption, the simplest type of photometric measurement, measures the attenuation of a light beam when it is passed through a sample. The attenuation can be caused by dissolved substances (characteristic absorption) or solids (scattered light). To determine the level of a given variable (color, concentration, turbidity), it is important to know which constituent of the sample absorbs light at which wavelength. The following variables can be measured:

## Color measurement

The color of a liquid is specified by the absorption behavior of the dissolved and undissolved constituents at certain wavelengths. The color intensity is determined by measuring the absorption at the complementary wavelength. For example, the degree of yellowness of beer, juice, oils, etc., is obtained by measuring absorption in the blue range. The ColorPlus is so sensitive that it can even verify residual coloration in media that appear colorless to the naked eye.

## Concentration measurement

If a sample contains only isolated substances or ones that do not overlap in their spectra, their concentrations can be determined by absorption measurement applying the Lambert-Beer Law. This is possible, for example, for copper, nickel and chlorine dioxide in liquids and for ozone and chlorine in gases.

## Cumulative parameters

In many cases it is difficult to isolate individual substances, so absorption must be measured cumulatively. Absorption in the ultraviolet range at 254nm, for example, provides a measure of the pollution of water with organic compounds that is in proportion to the DOC level.

## Turbidity

Low turbidity levels are measured most effectively by means of scattered light, but high turbidities can also be measured by means of absorption. The ColorPlus offers the possibility of employing dichromatic measurement at two different wavelengths to measure the the DOC level and/or color and turbidity simultaneously.

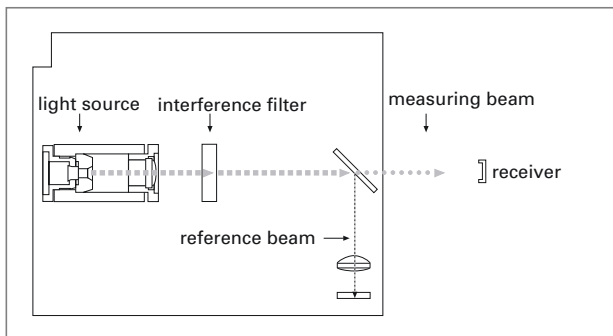
## Measuring method

The ColorPlus uses the proven Sigrist dual-beam method measuring simultaneously the light weakened by passing through the sample and the original beam emerging from the light source. This method elegantly compensates possible sources of error such as light source ageing or temperature effects.

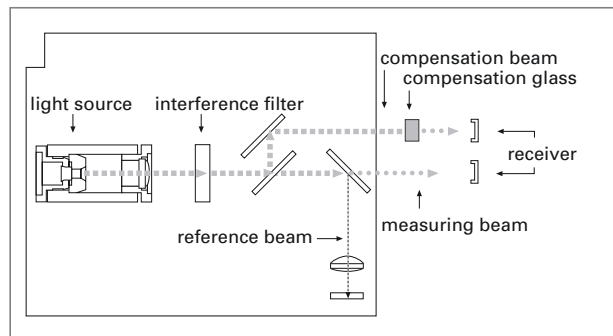
## Ex protection

A version of the ColorPlus with flameproof encapsulation is offered for installation in areas requiring explosion protection.

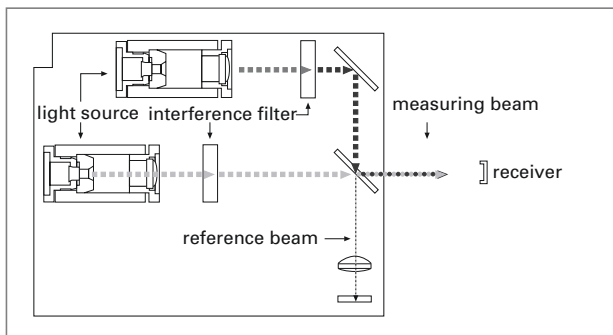
# OPTICAL ARRANGEMENT



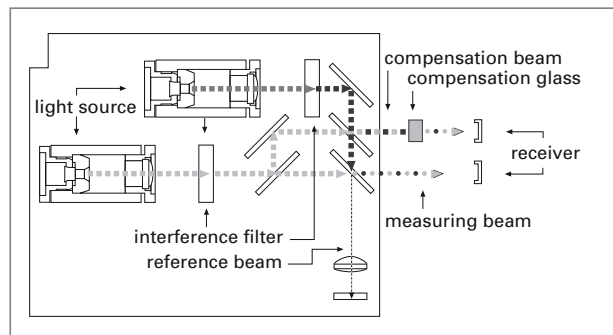
**Inline VIS 1 wavelength**



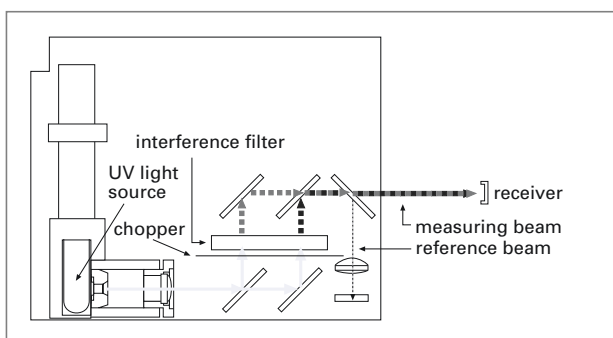
**Bypass VIS 1 wavelength**



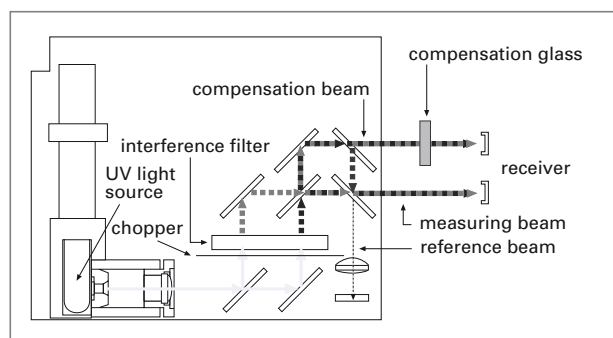
**Inline VIS 2 wavelengths  
(e.g. turbidity compensation)**



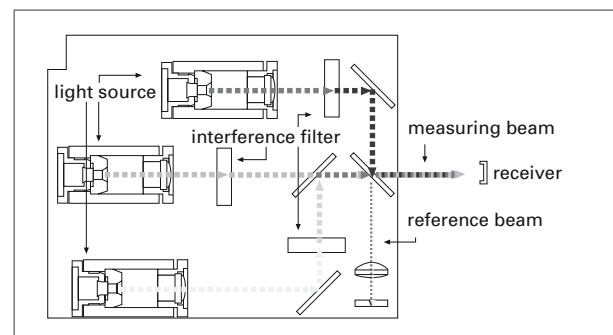
**Bypass VIS 2 wavelengths  
(e.g. turbidity compensation)**



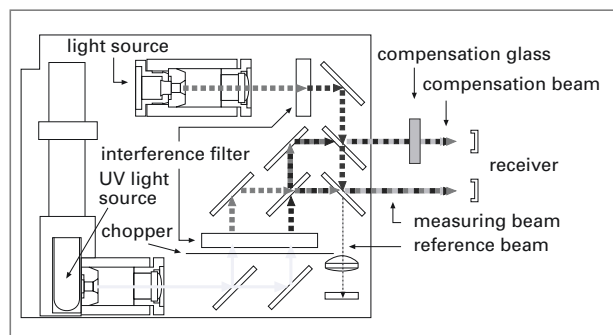
**Inline UV/VIS 2 wavelengths**



**Bypass UV/VIS 2 wavelengths**



**Inline VIS 3 wavelengths  
(tristimulus measurement)**



**Bypass UV/VIS 3 wavelengths  
(DOC/color turbidity-compensated)**

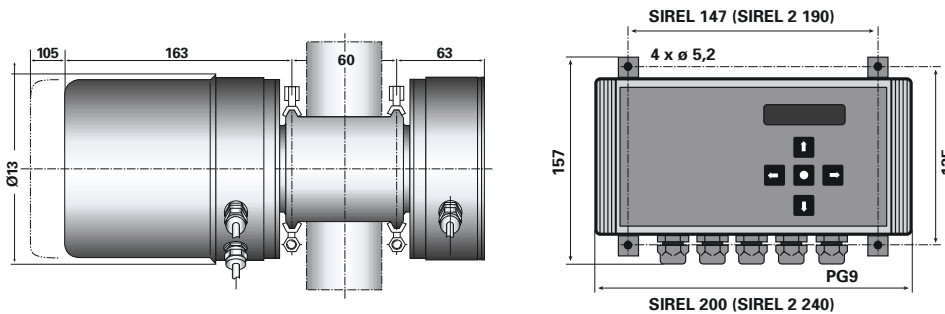
# CALIBRATION AND INSTALLATION

The basic unit of absorption measurement is light attenuation, which is stated in logarithmic extinction units E or, with reference to length, in E/m. Where concentrations are measured, it is no problem to convert directly to units such as g/l or mg/m<sup>3</sup>. For color measurement, various color scales – APHA-Hazen, EBC, ASTM, Saybolt, etc. are possible on the basis of calibration solutions or comparative scales

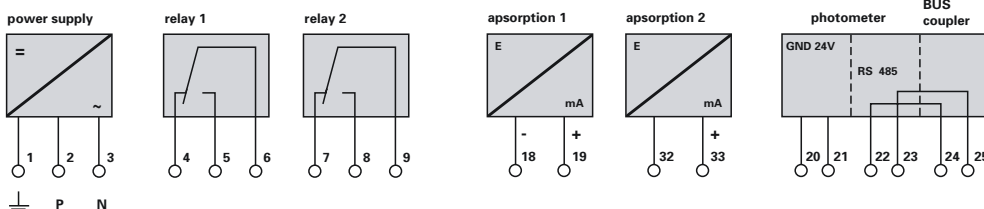
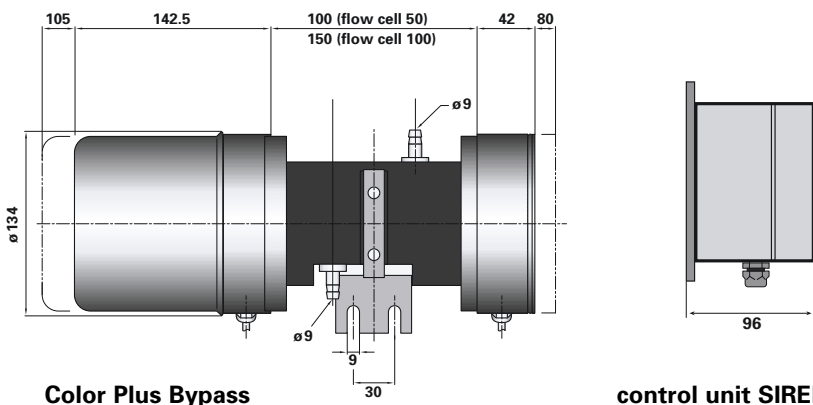
The ColorPlus is calibrated at the factory in one of these units to suit the customer's wishes and is then delivered ready for use. The calibration can be checked periodically by carrying out a zero adjustment with a zero medium, e.g. distilled water, and a calibration check with the built-in checking filter with defined absorption.

## Calibration and units

## Dimensions



**Color Plus In-Line on Varivent housing DN40**



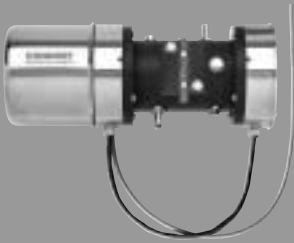
## Wiring diagram

# LIGHT SOURCES AND FLOW CELLS

## Light sources

The ColorPlus is built to accommodate up to three different light sources in the ultraviolet (UV) and visible (VIS) ranges. Depending on the required wavelengths, a mercury bulb (254, 313, 365, 436, 546 nm) or one, two or three LEDs (365 to 700 nm) are installed. The wavelengths are then defined precisely by means of interference filters.

## Bypass flow cell with compensation of window contamination



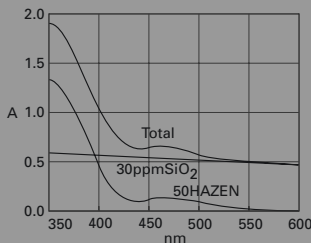
For the measurement of color and UV absorption in water treatment, a PVC bypass flow cell is offered with an optical path length of 50 mm or 100 mm. Two light beams are passed through the bypass flow cell (see opposite diagrams). One of them also passes through an additional compensation glass, which is used for calculating and compensating the window contamination. This system prevents reading falsification caused by window fouling and reduces the need for maintenance such as adjustment and window cleaning. If contamination ever becomes excessive, an alarm is given. The flow cell is mounted on a wall or a suitable stand.

## Inline flow cell

Varivent<sup>®</sup> flow cells are offered for inline measurement. Suitable housings of stainless steel are available for pipe diameters from DN40 to 6". The optical path length (OPL), which is important in obtaining the desired measuring range, is set with OPL bits. These housings permit easy installation of the sensor and optimal CIP/SIP cleaning.

To meet special user requirements, flow cells are also available in other materials (PVDF, Titanium, Hastelloy) or with special characteristics (heating, cooling, purging jackets).

## Turbidity compensation



Suspended solids always affect absorption measurement. Instead of depending on filtration to remove them, the ColorPlus is able to eliminate turbidity disturbances effectively by measuring at a second wavelength. The basic precondition here is: the turbidity should not cause more than 1/3 of the total absorption level. Alternatively, an optional filter unit is available for removing the turbidity substances.

## Operation and communication

The SIREL control unit is used to operate the ColorPlus. The SIREL's two-line LC display and plain-text operator guidance makes it very easy to operate, configure and service the ColorPlus. The SIREL possesses a 0/4 .. 20 mA current output and two independently configurable relay contacts that can be used for limit or alarm functions.

A bus coupler is available optionally for connection to PROFIBUS DP. This setup permits direct transmission of the readings and control of the instrument via the digital interface.

# SPECIFICATIONS

## Absorption measurement

<b>Measuring principle:</b>	absorption
<b>Wavelengths UV:</b>	254, 313, 365, 436, 546 nm
<b>Wavelengths VIS:</b>	365 nm, 390 – 700 nm
<b>Measuring span:</b>	0 ... 3 E
<b>Measuring ranges:</b>	8 ranges from 0 .. 0.05 E to 0 .. 3 E, freely configurable
<b>Resolution:</b>	0.001E
<b>Units:</b>	E, E/m, APHA-Hazen, EBC, Saybolt, ASTM

## Photometer

<b>Degree of protection:</b>	IP 65
<b>Weight:</b>	4 .. 4.3 kg, depending on version
<b>Enclosure material:</b>	stainless steel 1.4301
<b>Ambient temperature:</b>	-20°C ... +50 °C (ColorPlus UV from 30°C with optional cooling)
<b>ATEX protection class:</b>	EEx-d II (option, available in 2004)

## Bypass flow cell

<b>Flow cell material:</b>	PVC
<b>Window material:</b>	borosilicate (VIS) / quartz (UV)
<b>Seals:</b>	EPDM
<b>Sample temperature:</b>	50°C
<b>Sample pressure:</b>	600 kPa (6 bar)
<b>Sample flow:</b>	0,5 ... 1 l/min
<b>Connections:</b>	inlet / outlet 9 mm o.d.

## Varivent® flow cell

<b>Flow cell material:</b>	stainless steel 1.4404
<b>Window material:</b>	borosilicate (VIS) / quartz (UV) / sapphire
<b>Seals:</b>	EPDM, FPM, FFPM
<b>Sample temperature:</b>	180°C (from 100°C with optional cooling)
<b>Sample pressure:</b>	2000 kPa (20 bar)

## SIREL control unit

<b>Power supply:</b>	85 ... 264 V / 47 ... 440 Hz ; 24 V DC
<b>Power input:</b>	21 W (UV), 12 W (VIS)
<b>Display:</b>	LC display with plain text information
<b>Current output:</b>	0/4...20 mA; max. load 600 W, max. 24 V
<b>Limits:</b>	2 separately configurable relay contacts 250 V AC, 4 A
<b>Degree of protection:</b>	IP 65
<b>Weight:</b>	1.5 kg

Represented by:

