

Manual

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Inline Turbidity Meter

Model TURBIsmart-F

12° forward scattered light

Chemtronic Waltemode GmbH

40789 Monheim am Rhein
Niederstr. 14
Germany

Phone: +49-(0)2173-57007 Fax: +49-(0)2173-56007
E-Mail: info@chemtronic-gmbh.de
Internet: www.chemtronic-gmbh.de



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Chemtronic Waltemode GmbH is by no means liable for any consequential damages or miscellaneous damages, which occur during the use or storage of the system.

Some countries do not allow the limitation of liability, so that this exclusion is possibly not valid for you.

Warranty conditions

The warranty for this product takes place according to the legal provisions. As place of warranty we explicitly name Chemtronic Waltemode GmbH, Monheim am Rhein, Germany. Chemtronic will charge the additional expenses e.g. travel expenses, overnight cost, etc., in case of warranty service at the customer site.

Consumable parts as well as wearing parts e.g. lamps, gaskets, etc. are not covered by warranty.

Improper use, gross negligence, use of the system outside of the technical specifications, missing or improper maintenance will cause a loss of the warranty claim. Please pay attention to our general terms of contract.

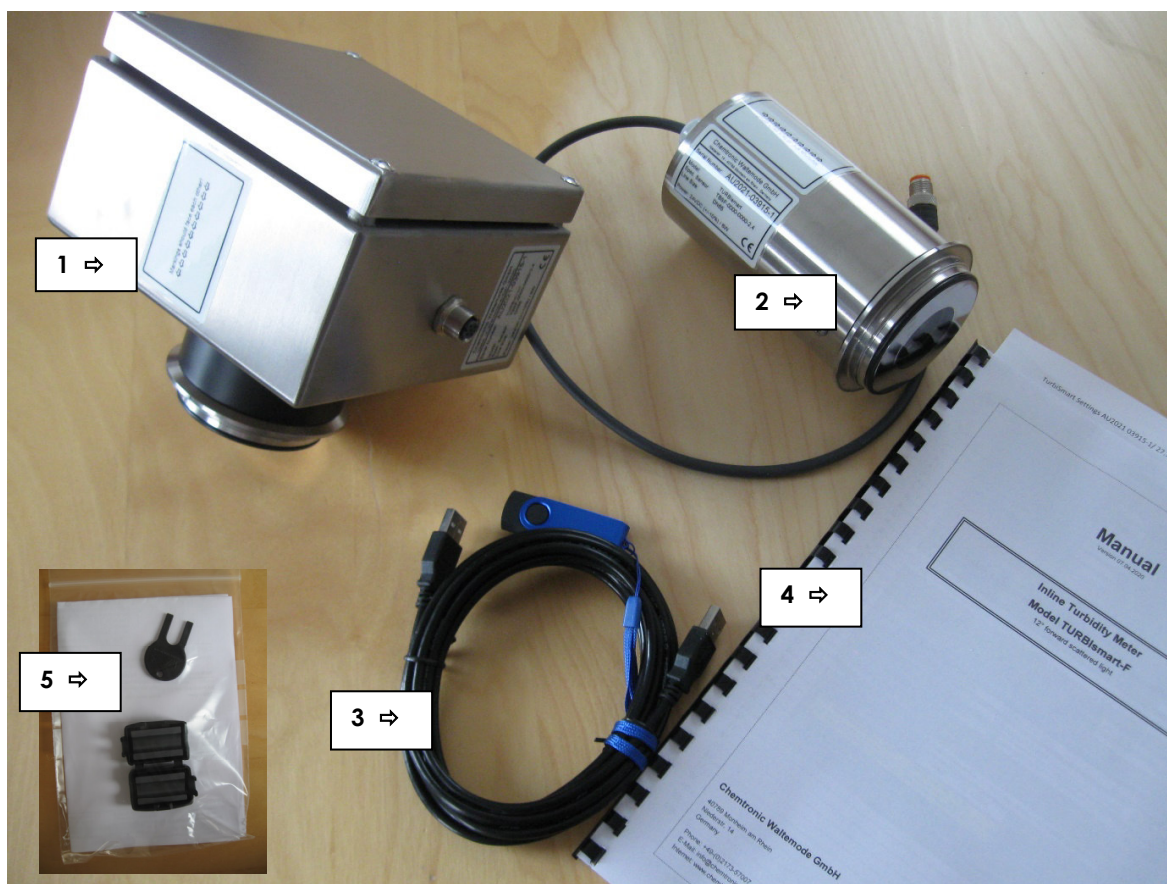
Storage

Please inspect the instrument immediately after receiving for potential shipping damages.

If the instrument has already been unpacked for inspection or testing, or if the instrument has been removed from the process and it is not to be installed or reinstalled for more than 1 day, the following procedure should be observed:

1. If the instrument has been in service, the wetted portion should be thoroughly cleaned (typically with clean water) and then thoroughly dried.
2. In case the original packing material is not available, place the instrument in a sealed heavy plastic bag with a desiccant added to assure clean dry storage.
3. The instrument should then be stored in a protected area until time of installation.

Packing list



- 1.) TURBIsmart-F Part 1 (Detector optic including enclosure with smart transmitter.)
- 2.) TURBIsmart-F Part 2 (Lamp- / LED- optic)
- 3.) USB cable and Software package at USB stick
- 4.) User manual with calibration certificate, FDA, 3.1, 1935/2004 certificates
- 5.) Ferrite core with instructions for 24VDC power supply line

Each system has an individual serial number.



Do not combine items with different serial numbers!



Safety instructions

Take notice to the following general safety instructions during use and operation of the system. Ignoring these instructions or special warnings inside of this manual can damage the sensor, cause inaccurate measurements, and possibly result in unsafe installations. Chemtronic Waltemode GmbH will not take any responsibility for consequences arising from ignoring the safety instructions and warnings.

For ALL chemical liquids

Reagents, standards or the measured product may be toxic or otherwise harmful to human health. Observe appropriate precautions when handling and disposing the reagents. Review the appropriate published material safety data sheets regarding the safe handling and disposal of all these products.

Electrical installation

Qualified technical personnel must perform the electrical installation of the system.

Hazardous area

DO NOT INSTALL the system in hazardous.



Do not install the system in hazardous areas (Ex Zone 0, Ex Zone I, Ex Zone II)



Maintenance

Always disconnect the instrument from power during maintenance, replacement of components, installation of additional components or any other operations at the open instrument.

Only qualified technical personnel must perform this work.

Operating the instrument with open enclosure

Only qualified technical personnel should operate the instrument when the enclosure is open (e.g. during repair or calibration procedure). Be careful that no moisture enters the enclosure.



Some components inside the instrument are energized with voltages, which can cause lethal shocks in case of contact. Be careful during installation, handling and operation of the instrument.



Improper installation / operation of the system

Warranty is void if the system is / was installed improperly, handled improperly, used outside of the technical specifications or damaged by gross negligence.

What does turbidity mean?

Turbidity is an optical impression, which describes the characteristic of a transparent product, to scatter light. A focused light beam will be attenuated and scattered in hazy products, so that this product can become practically opaque in bigger layers.

What causes turbidity?

Turbidity is caused by particles in transparent products. A particle is defined as something with a different refractive index as the carrier product. Some examples of particles are minerals, yeast cells, metals, oil drops in water, milk in water, gas bubbles and aerosols.

Measurement of turbidity

Turbidity is not a clearly defined magnitude like e.g. temperature or pressure.

Turbidity is a subjective impression. For this reason turbidity measurement systems will be typically calibrated by using a comparison's standard such as Formazin and Diatomaceous Earth.

Principle of measurement

The 12° forward scatter ratio method:

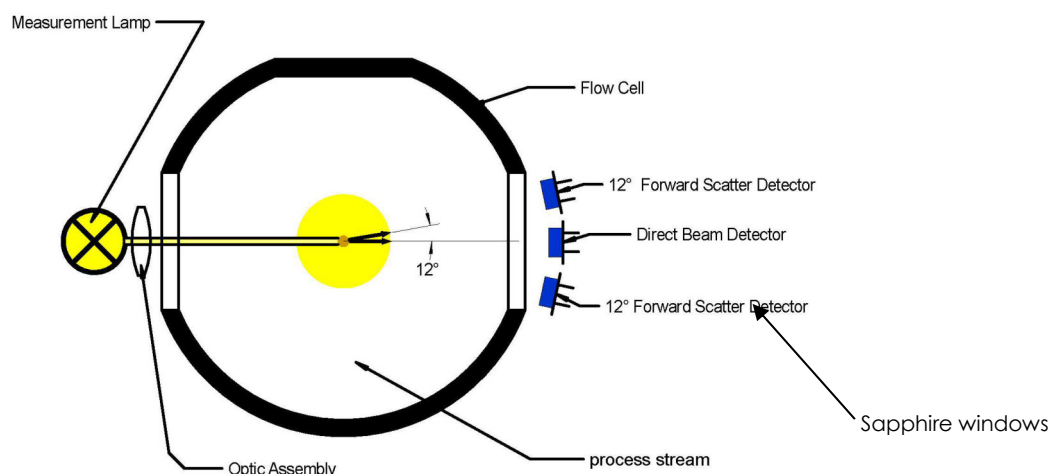
The forward scatter method is typically used at low turbidities and produces nearly mass related measurement results. This means that a small particle causes a low scattered light intensity and a large particle causes a high scattered light intensity. This allows a calibration in mg/l in case the specific weight of the particles is at about 1kg/dm³.

Main applications are quality control, filtration control, oil in water, etc.

12° forward scattered light ratio measurement

The position of the scattered light detector is 12° out of the axis of light beam.

The position of the direct beam detector is located in opposite of the light beam.



An intense collimated beam of light is projected through a sample inside of the flow cell.

The intensity of the light beam is measured by the direct beam detector, located opposite to the light source.
The intensity of the scattered light, is measured by the scatter light detector.

The ratio of scattered and direct light signals, compensate for changes in product color, lamp ageing and window coatings. The signals will be processed as followed:

$$\frac{\text{Scattered light signal}}{\text{Direct light signal}} = \text{Turbidity value}$$

The particles inside the liquid flow decrease the intensity of direct light, and increase the intensity of the scattered light, that means the turbidity rises.

Product color, lamp ageing and window coatings decrease the intensity of direct **and** scattered light in same ratio that means the turbidity value stays constant.

Typical Measuring units

ppm:	Parts per million	FNU ¹ :	Formazin Nephelometric Unit
FTU:	Formazin Turbidity Unit	mg/l:	Milligram per liter
TEF:	Trübungseinheiten Formazin (German for FTU)	gr/l:	Gram per liter
EBC:	European Brewery Convention	% TS:	Percent total solids
NTU ¹ :	Nephelometric Turbidity Unit		

The dependencies on the different measuring units

1 FTU = 1 TEF = 1 NTU¹ = 1 FNU¹ = 0,25 EBC

¹ Nephelometry describes the method of side scatter turbidity measurements, these units are used at 90° side scatter turbidity meters only.

Based on comparisons measurements, by using a 12° forward measurement system we have found the following dependencies.

1 FTU = 1 TEF = 0,25 EBC = 2,05ppm = 2,05 mg/l = 0,00205 g/l = 0,00000205 % TS

* At a specific particle weight of 1 kg/dm, 1mg/l particles in 1 kg of water will correspond to 1ppm.

Typical ranges

The original design of scatter light turbidity meter was used for the detection of low turbidities. The resolution of these instruments is suited easily in ranges lower as 0.1ppm (approx. 0.05 TEF / FTU / FNU / NTU or approx. 0.01EBC) and better. The maximum range is in ideal case lower than 200ppm, but there are as well systems available with a range of more than 8000ppm.

Please take notice:

There are turbidity meters with several different methods of measurement available!

Make sure that your turbidity meters operate according to the same principle of measurement, if you compare measurement results.

For example:

you can compare 90° vs. 90° scattered light turbidity meters, or 12° vs. 12° scattered light turbidity meters.

Never compare turbidity meters with different methods of measurement!

Installation Guidelines



Danger!

Exceeding the specified maximum pressure and / or the specified maximum temperature will cause a very high safety risk. Please read the additional safety instructions before installation and start-up.

- The sensor is manufactured according to the customer's application
- The instrument is factory pre- calibrated according to customers specification (line size of TH- Variline cell).
- The location / installation of the sensor should be in a vertical standpipe.
- If installation occurs in a horizontal pipe, make sure that eventual gas bubbles will escape with the product flow.
- Avoid air and gas bubbles inside the sensor, they cause disturbances. Air and gas bubbles will cause noise and drift of the measurement signal. (The air bubbles are not expected at pressures upwards of 2bar in aqueous solutions).
- The process pressure should never exceed the specification of the sensor.
- The process temperature should never exceed the specification of the sensor.
- In case the process temperature should fall under the dew point or rise above 85°C purge the sensor optic housings with dry instrument air (approx. 10 l/h). Condensed water and excessive temperatures can damage the sensor and cause inaccurate measurements.
- Transmitter and Sensors are sensitive components, do not drop and handle with care.
- Follow the wiring diagram in this manual.
- Please do not use the system in case of any visible mechanical damages!
- The enclosure fits IP65 / Nema 4x protection class.
- The ambient temperature for the system must be in a range of -10°C to 60°C (use dry purge air above 40°C approx. 10 l/h).
- The power consumption of the Instrument is less than 10W.
- Transmitter relay ratings for alarms and external devices are 1 A at 24VDC.
- Do not operate with open enclosure. Exposed electronics will promote the risk of electrical shock and might cause damage to the unit.
- Proper instrument grounding: The instrument must be grounded to avoid electrical shock hazards to personnel and damages to the unit.

Installation and align of the System

Take Notice:
Align Marker A at detector optics and Marker B at light source parallel to each other, at the installation to the TH-Variline flow cell.

Maßstab 1:1		Gewicht	
Werkstoff			
Align of Measuring Arms			
Datum	Name		
Bearb.	JHeidkamp		
Gepr.			
Norm			
		20032019-3 Blatt 1 1 Blätter	
Urspr.:		Ers. durch:	

Software Installation (TURBIsmart-F Configuration / Calibration)

System Requirements

Supported Operating Systems	Microsoft Windows 7, 8, 10
Requirements	Microsoft.NET Framework 4.5 (x86 & x64)
RAM	2GB
Hard Disk Space	< 1MB

Installation Procedure Messenger Graph Software

- I. Close any open programs that are running on your computer before starting the installation.
- II. Double click on setup.exe.
- III. Software installs automatically

Connect TURBIsmart-F to a PC- or Laptop

Connect instrument to the mains (see wiring Diagram)

Connect your PC/Laptop to TURBIsmart-F using USB Cable Type A Male to Micro Type B Male.



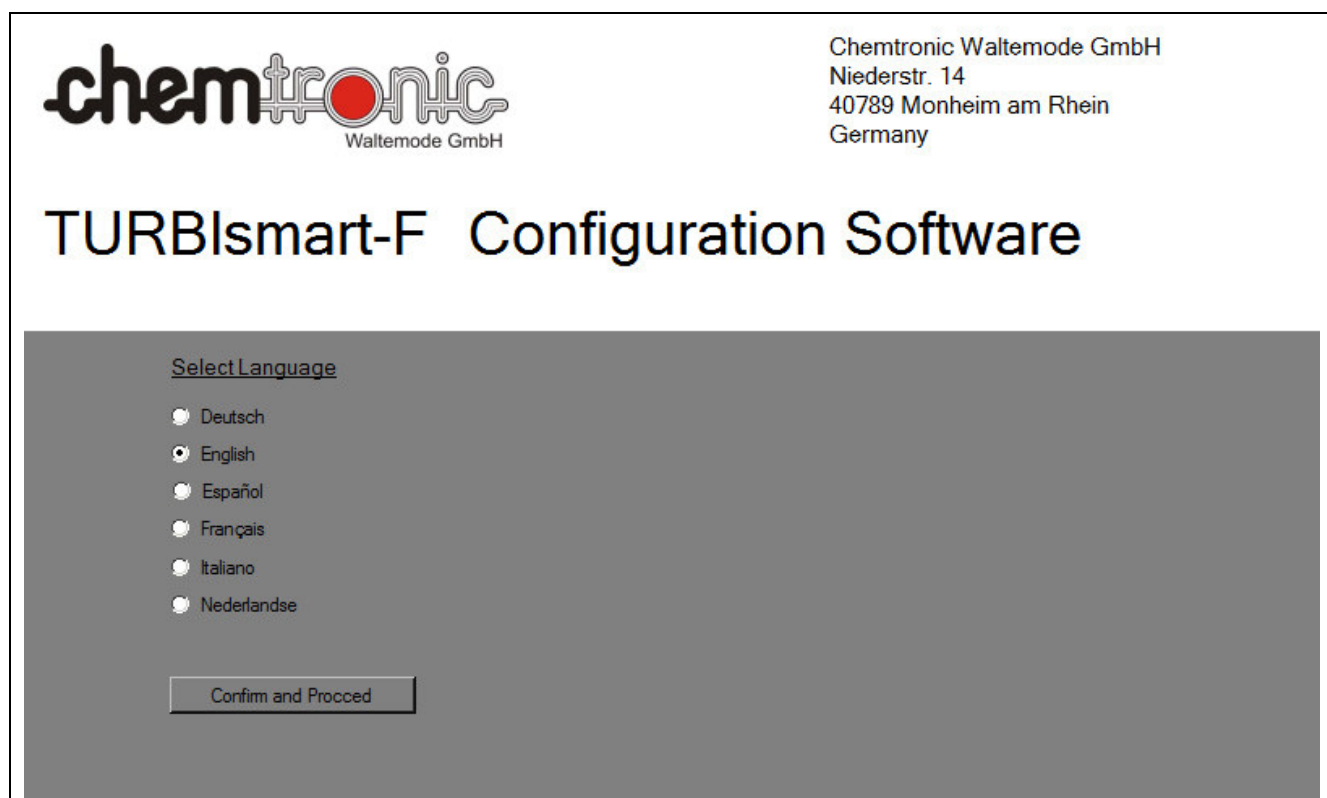
Take Notice:

The USB- connector of the TURBIsmart-F-P is located under the cover cap at the outside of transmitter enclosure.

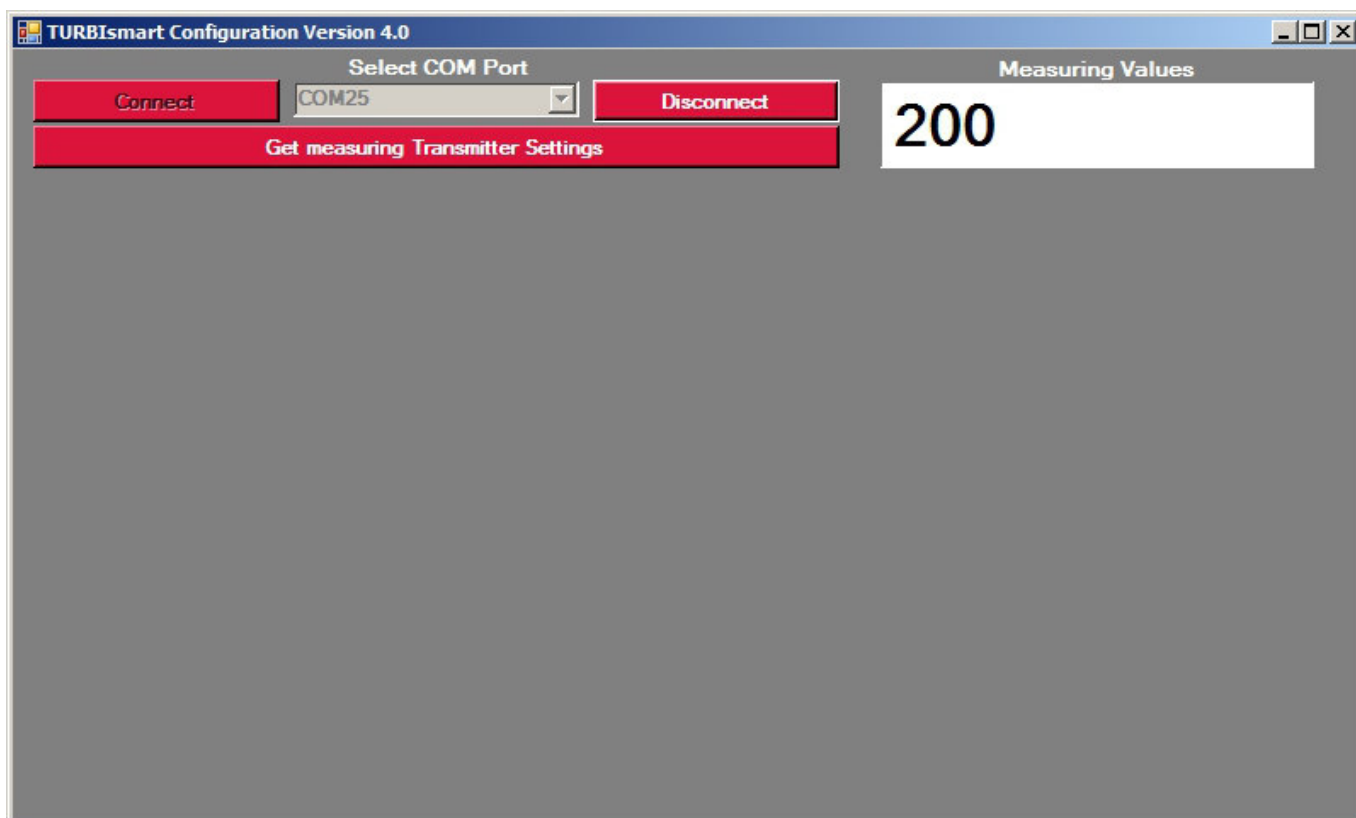
TURBIsmart-F Software

Start Software per click/double click on the TURBIsmart-F icon.

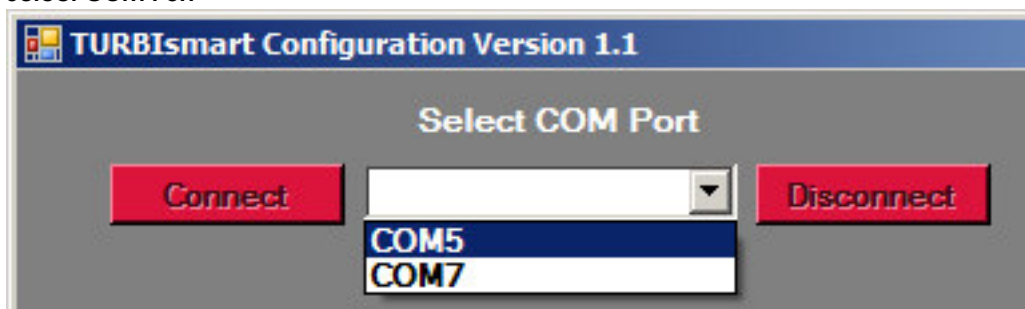
Select Language



Select your language and proceed!



Select COM Port



Select the COM port of your turbidity meter, click “connect” button and then the “Get Settings” button.



Finding the correct COM Port:

Shut down TURBIsmart-F software. Disconnect USB cable.

Restart software, go to “Select COM Port”, look to the list of active Ports.

Shut down TURBIsmart-F software again. Reconnect USB cable.

Restart software; go to “Select COM Port”, Com Port list shows now the additional Port of the instrument. Select these COM port and click “Connect Button”.

A click to the “Get measuring Transmitter Settings” button will transfer the current transmitter settings and measuring values to the screen.

Set measuring Range

Adjust or enter your measuring range.



Take Notice:

The maximum possible measuring range depends by the settings in calibration menu!

Enter measuring Unit

Allows entering an application specific measuring unit like ppm, mg/l, EBC, FTU, ...
The measuring unit is limited to four characters (ASC II).

Set Damping

The Damping function averages the last measuring results of the instrument.
The instrument displays always the average of the last 6 results, in case the Damping is set to "6",
This makes readings more stable and protects for measuring outliers.
Damping can be set between "1" and "25".

Adjust Zero Offset

The instrument provides a physical zero point.
This means that "0" scattered light intensity will provide a "0" measuring result.
Even ultra pure liquids will provide a low scattered signal if you switch measuring lamp on.
This low signal is caused by optics, particles and the molecular stray light effects.
Adjust Zero Offset allows to shift the low reading to make the instrument results closer to "0".



Take Notice:

Use ultra pure liquids without bubbles / particles only in case you like to shift "0" reading of the instrument.

Adjust Gain

Adjust Gain allows a correction of the instrument reading at a known turbidity.

Example:

Instrument reading: "0.95"

Turbidity inside the flow cell : "1.00"

Gain must be set to "1.05" to result a reading of "1.00" ($0.95 \times 1.05 = 1$)

Set Relay Setpoint

The "Relay Setpoint" defines the switching point of the alarm relay.

Set Relay Hysteresis

The hysteresis affects the relay setpoint.

Following settings: setpoint "2.00" and hysteresis "0.1"

Alarm will be switched at "2.1" and reset will be switched at "1.9"

So alarm switching point will be (setpoint + hysteresis)

and reset will be (setpoint – hysteresis).



Take Notice:

All Settings you change (Range, Damping, Zero, Gain, etc.) will be immediately transferred via USB to instrument's measuring electronic! But they are not in the permanent memory. So a reset or power on off will restore the old settings.

Apply Settings to Transmitter

Stores new settings (Range, Damping, Zero, Gain , etc.) to the permanent memory of the measuring electronic!

Save Settings to File

Stores a backup of your instrument settings onto the hard disc of your computer / laptop. The backup files are in txt format and located at C:/Chemtronic_TURBIsmart.



Take Notice:

We strictly recommend to backup the factory settings of the instrument before you do any changes at the instrument settings.

Read Settings from File

Read a backup file from the hard disc of your computer (data recovery).

Enter Access Code

The Access code for expert level: "1212"

Enter Access code: 1212

Click to Button "Expert Access" to access calibration menu

Calibration



Items required for calibration

- 1.) TH- Variline flow cell in the same size as installed at your process pipe.
 - 2.) Blanking plugs to seal the flow cell.
 - 3.) Distilled or DE – Water
 - 4.) Four calibration samples with given concentration
- The sample volume depends by the volume of your flow cell.

Example: Calibration to a measuring range of maximum 200mg/l.

In Menu „Basic Settings“:
Assign measuring unit (in this example „ppm“)
Set „Zero Offset“ to „0.00“
Set „GAIN“ to „1,00“
Enter „Access Code“ „1212“ and confirm
Access „Calibration Menu“

Set maximum Range

Adjust or enter your maximum measuring range.

The maximum range allows for values between 5 and 4000.

We recommend too set the maximum measuring range double as high as your actual measuring range. This will allow you to change your actual measuring range (Basic Menu) up to the value of your maximum range without preceding a new calibration.



Please take notice:

Your measuring range (Basic Settings) cannot exceed your maximum measuring range. Changing the maximum measuring range will require a new calibration. The maximum range calculates the values for the concentrations of the samples required for calibration.

Required sample concentrations calculated by your maximum range and will be displayed at the four “Read Sample” buttons.

Read Sample XXXX

Example calibration 0-200ppm

Prepare four calibration samples:

Sample 1 = 50ppm

Sample 2 = 120ppm

Sample 3 = 170ppm

Sample 4 = 200ppm

- 1.) Clean the flow cell of your device thoroughly.
- 2.) Close one end of the flow-through cell with the blanking plug.
- 3.) Clean the flow cell again and rinse it with distilled water/DE water.
- 4.) Empty the flow cell.
- 5.) Fill the flow cell (avoid air bubbles) with the 50mg/l sample.
- 6.) Make sure that the level of the calibration liquid is above the measuring windows.
- 7.) Wait one minute to allow any air bubbles to escape.
- 8.) Cover the open end of the flow cell to protect the optical components from ambient light.
- 9.) Press button "Read sample 50 mg/l " to get a signal value.
- 10.) Press button "Read sample 50 mg/l " again, to check if signal value is reproducible.



Please take notice:

Smaller changes of the signal value are normal when reading the samples.

- 11.) Empty the flow cell
- 12.) Fill the through cell (avoid formation of air bubbles) with the 120mg/l sample.
- 13.) Make sure that the level of the calibration liquid is above the measuring windows.
- 14.) Wait one minute to allow any air bubbles to escape.
- 15.) Cover the open end of the flow cell to protect the optical components from ambient light.
- 16.) Press button "Read sample 120mg/l " to get a signal value.
- 17.) Press button "Read sample 120mg/l " again, to check if signal value is reproducible.

Proceed with Samples 170ppm and 200ppm.



Take Notice:

Push button "Transfer Settings to Transmitter" in menu "Basic Settings" to finalize your calibration otherwise you will get the previous calibration after reset or power on/off. Transfer Settings to Transmitter will store the new calibration into the permanent memory of the instrument!

Measuring Screen

TURBIsmart Configuration Version 4.0

Chemtronic Waltemode GmbH

Measuring Values
140 ppm

Settings

Measuring Range	0 - 200
Measuring Unit	ppm
Damping	25
Relay Setpoint	2,54
Relay Hysteresis	0,1

System Fail, Transmission Low!

Setpoint Relay: Alarm on!

- UV Photometer
- NIR Photometer
- Color Photometer
- Scattered Light Turbidity Photometer

Basic Settings

The measuring screen is the standard menu if the system is used with a PC / Panel PC.
The menu displays the some general settings, system health information and measuring values.

Maintenance Work

The sensor model TURBIsmart-F is almost free of maintenance.

It is recommended to check calibration every 24 months.

Depending by application, coatings may form on the Metaglas windows.

A slight coating formation or clouding of the windows is compensated by the ratio measurement. In case of extremely strong coating formation, it may be necessary to clean the measuring windows at fixed intervals. The cleaning interval is determined by the operator depending on the application.

The product pipe must be unpressurized and empty before starting the cleaning.

For cleaning, open the clamps on the measuring windows and pull off the measuring arms.

Clean the windows with a suitable cleaning agent, a cloth or a soft brush.

In case of mineral / lime coatings, we recommend placing the windows in diluted acetic acid for a few minutes.



Please take notice:

In case of measuring hazardous substances (corrosive / toxic substances).

Appropriate protective measures must be taken before cleaning.

(Protective clothing, safety goggles, gloves, if necessary breathing mask).

Make absolutely sure that the measuring cell is emptied and depressurized before starting the cleaning procedure.

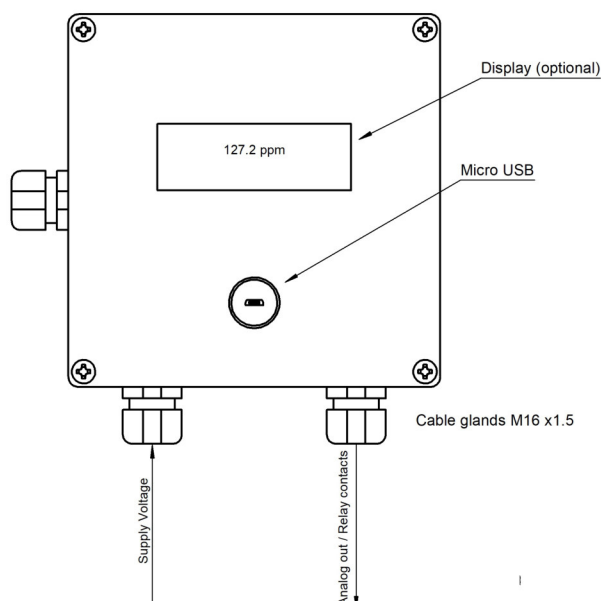
By reassembly, make sure that the markers A and B on the measuring cell are aligned (see drawing page 8).

List of Spare Parts / Wearing Parts

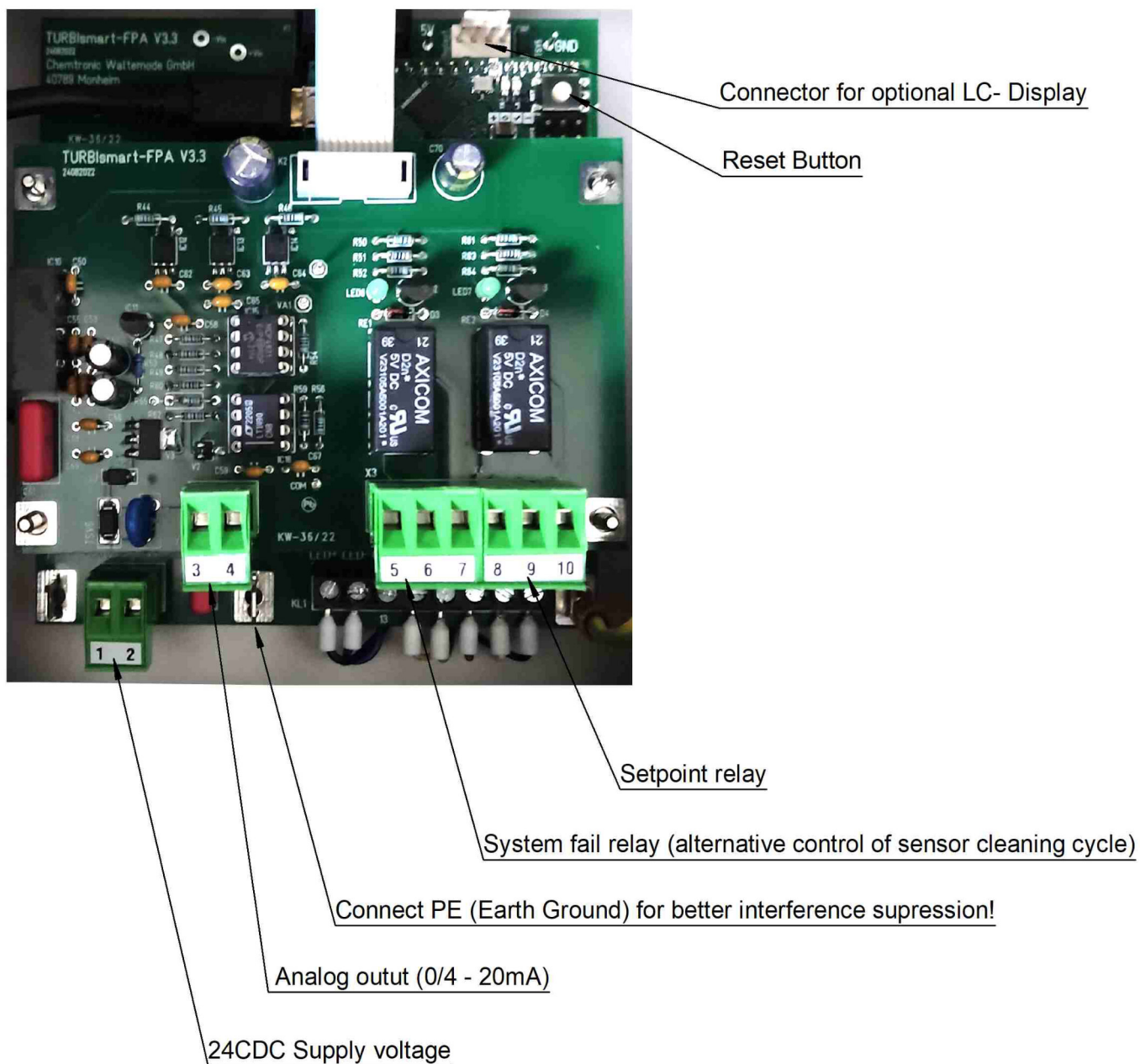
No wearing parts / spare parts stocking required.

We recommend sending the unit in for general maintenance after approx. 6 years of operation.

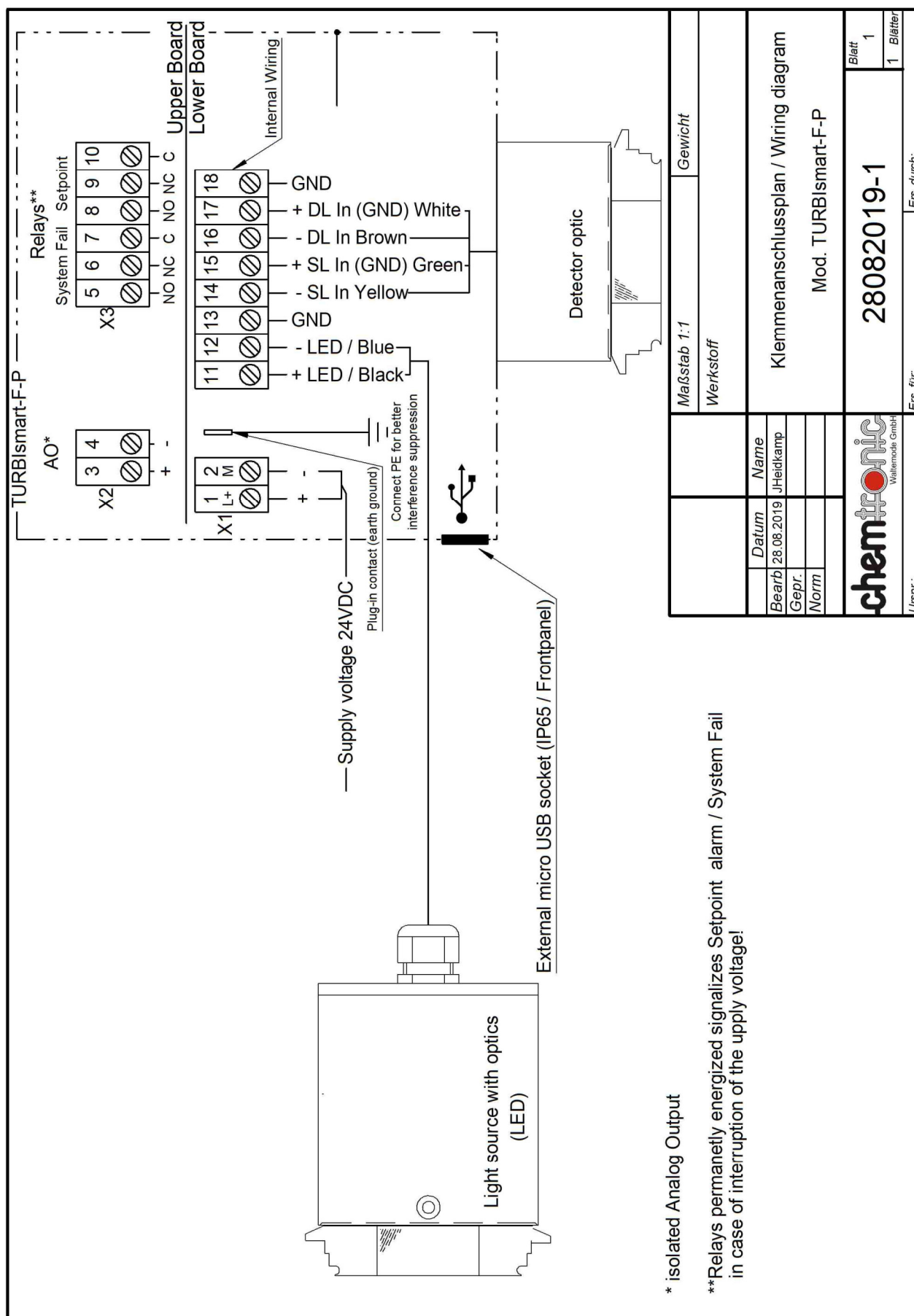
Front View showing Display and USB



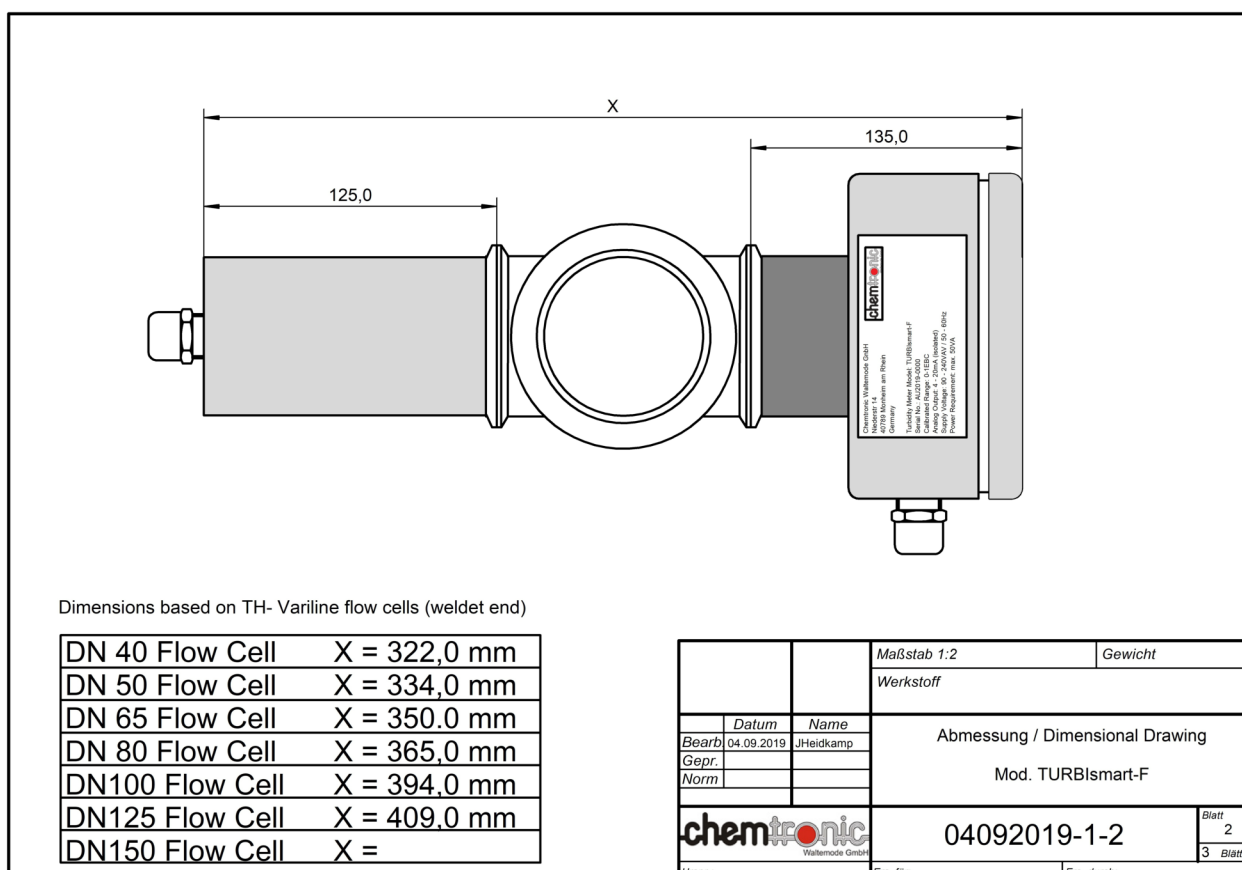
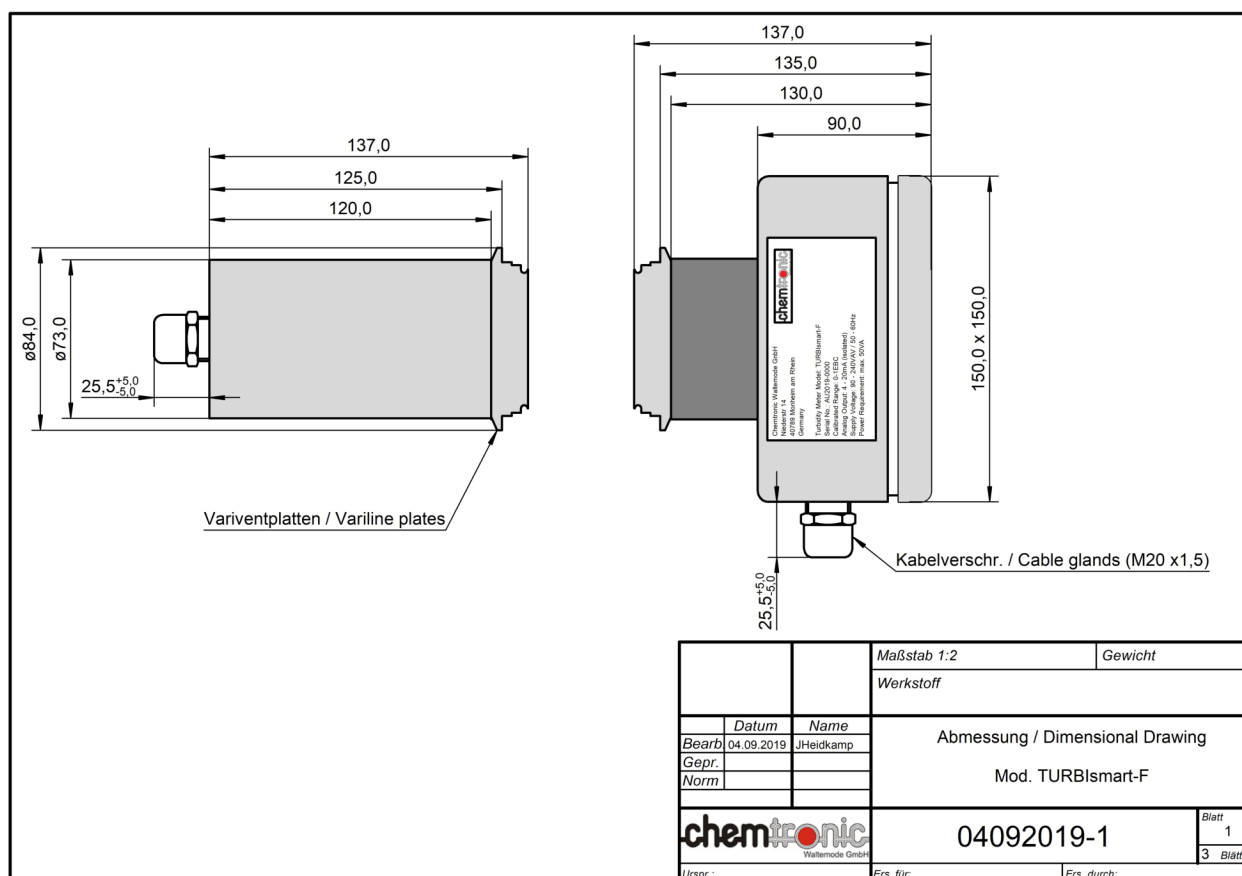
Wiring Terminals (Circuit Boards)



Wiring Diagram TURBIsmart-F

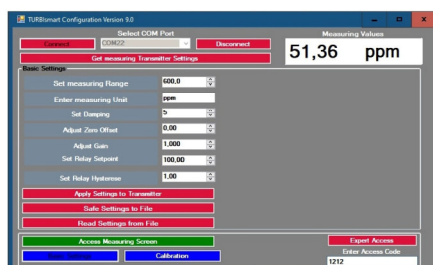
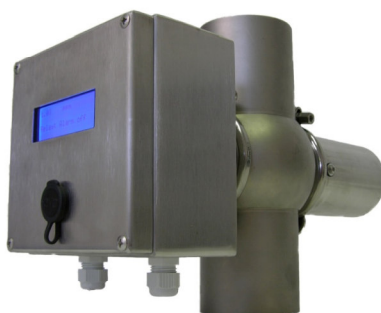


Dimensional Drawings TURBIsmart-F Series



Technical Data / Data Sheet TURBIsmart-F

Model TURBIsmart-F



- Principle of measurement: 12° forward scattered light
- Low maintenance / long service life
- Extended calibration interval: Typical 18 month
- Configuration via PC, Laptop
- Menu - based, intuitive User Interface
- Serial Interface: USB
- Optional backlit LCD
- Outputs: 4-20mA, Relay Setpoint, Relay system fail
- Fitting of measuring Curve
- Measuring Ranges: Programmable
- Measuring Units: EBC, FTU, TEF, ppm (others on request)
- Protection Class: IP65 / Nema 4x
- Light Source: IR-LED
- Steel melted measuring Windows -dead space free, sealless
- Optional: Sapphire measuring Windows available
- Dead space free, hygienic TH-Variline flowcells
- Hygienic Design / Cleaning in place (CIP)

Description:

The turbidity meter Model TURBIsmart-F uses the principle of 12° forward scattered light to detect suspended particles in liquids. The system has been designed for continuous operation with long life time. A ratio measurement of direct- / scatter light assure highly reliable and repeatable measurement results. Inaccuracies caused by product color, ageing of light source or window coating will be compensated. The forward scatter measuring results are nearly independent of particle size and will correlate to product concentration. The integrated transmitter allows an easy setup and calibration.

Applications:

- Filtration control
- Product quality
- Water in fuel
- Oil in water / Water in oil

Operational areas:

- Breweries
- Beverages
- Dairies
- Liquid processing

Technical Data:

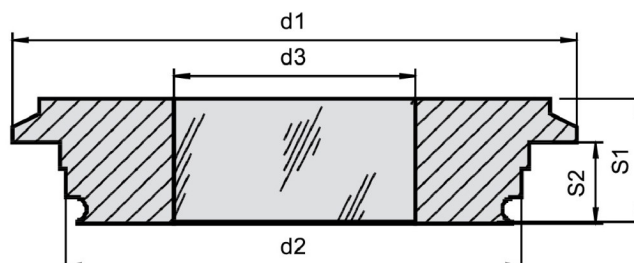
Line sizes:	DN 25 – DN 125 (TH- Variline flow cells)	Reproducibility:	± 1 %
Process pressure:	PN 10 / ANSI class 150	Protection class:	IP65 / NEMA 4X
Temperature range:	maximal 120°C / 140°C short time	Cleaning:	Cleaning in place (CIP)
Sensor material:	1.4404 / 316L	Supply:	24VDC ± 10 %
Window material:	Metaglas (optional sapphire)	Analog output:	4-20mA, 500 Ohm (isolated)
Gasket material:	No additional window gaskets required	Relay outputs:	Contact ratings 24VDC/1A
Measuring range:	typical 0-1 ...10 (others on request)	Interface:	USB

Chemtronic Waltemode GmbH

40789 Monheim Niederstr. 14 Germany Phone: +49-(0)2173-57007 Telefax: +49-(0)2173-56007 E-mail: info@chemtronic-gmbh.de Internet: www.chemtronic-gmbh.de

Technical Data / Data Sheet TURBIsmart-F

METAGLAS® Sight Glass with Luminaire for VARIVENT®-In-Line Fittings



Applications

- VARIVENT® In-Line flanges
- VARIVENT® In-Line housings

Advantages

- Housing free of dead zones, no domes or pools
- Pre-determined distortion of O-Ring by metal contact faces
- Suitable for CIP and SIP treatment
- Security against total failure
- Long operating life
- Crevice free seal

Technical data

Manufactured and tested to:

- Directive for pressure equipment 2014/68/EU, Module H (DIN/EN/ISO 9001)
- AD2000 Standards W0/TRD 100
- Sight glass fused to metal conforming to DIN 7079
- Materials to VdTÜV specifications and the DIN/EN designated standards
- Glass: Borosilicate to DIN 7080 / DIN 7079

Material certificates

- Certificate of Conformity EN 10204-3.1 (or 3.2 for extra costs)

Operating conditions

- Pressure: 25 bar
- Temperature: see table

Ring materials	Operating temperature
1.4462	-30°C to +280°C
2.4602	-60°C to +300°C
2.4605	-60°C to +300°C
2.4610	-60°C to +300°C

Process connections		d1	d2	d3	S1	S2	O-Ring
F	VARIVENT DN 25, 1" OD and 25 ISO	66	49,90	25	19	12,2	42 x 3,0
N	VARIVENT 32 ISO 6" IPS	84	67,95	35	17	12,3	60 x 3,0
G	VARIVENT DN100 and DN 125	142	122,90	65	21	21	113 x 4,0

Chemtronic Waltemode GmbH

40789 Monheim Niederstr. 14 Germany Phone: +49-(0)2173-57007 Telefax: +49-(0)2173-56007 E-mail: info@chemtronic-gmbh.de Internet: www.chemtronic-gmbh.de

FDA conformity of Metaglas

Declaration of Conformity (FDA)

Herberts Industrieglas GmbH & Co. KG

We hereby certify that all our sight glasses METAGLAS made from duplex stainless steel or Hastelloy C and borosilicate glass are manufactured and tested according to DIN 7079. Borosilicate glass Suprax 8488 (Schott) as used for METAGLAS sight glasses complies with the requirements of the US Food and Drug Administration Regulations for materials used in contact with food.

The chemical durability of borosilicate glass Suprax 8488 (Schott) complies with European Pharmacopoeia 7.8 Glass Type I

United States Pharmacopoeia USP 36-NF 31 Glass Type I

METAGLAS sight glasses with borosilicate glass – concave both faces are suitable for food applications according to Regulation (EC) No 1935/2004.

METAGLAS sight glasses are in conformity with the requirements of REACH 1907/2006/EC and RoHS2011/65/EC.

METAGLAS sight glasses do not contain the following elements and / or their oxides and chemical compounds:

Cadmium (Cd)

Lead (Pb)

Mercury (Hg)

Hexavalent Chromium (Cr 6+)

Polybrominated Biphenyls (PBB)

Polybrominated Diphenyl Ethers (PBDE)

Polychlorinated Biphenyls (PCB)

Polychlorinated Diphenyl Ethers (PCDE)

Bis(2-Ethylhexyl)phthalate (DEHP)

Benzyl Butyl Phthalate (BBP)

Dibutyl Phthalate (DBT)

Diisobutyl Phthalate (DIPT)

Polychlorinated Naphthalene

Organic Tin Compounds

Asbestos

AZO Compounds

METAGLAS sight glasses do not contain particles of Human or Animal origin.

Herberts Industrieglas GmbH & Co. KG hereby certifies that METAGLAS sight glasses are TSE free.

October 2019

Karl Schuller (CEO)



EU Certificate of conformity (CE)



EU-Konformitätserklärung EU Declaration of Conformity



Der Hersteller:
The Manufacturer:
Chemtronic Waltemode GmbH
Niederstr. 14
40789 Monheim am Rhein / Germany

erklärt hiermit das das Prozess Fotometer
herewith declares that the process photometer:

Model TURBIsmart-F

folgenden europäischen Richtlinien entspricht:
complies with the following European directives:

2014/30/EU	Richtlinie über die elektromagnetische Verträglichkeit Electromagnetic compatibility
2014/35/EU	Niederspannungsrichtlinie Electrical equipment designed for use within certain voltage limits

Angewandte harmonisierte Normen / Applied harmonized standards

EN61010-1 /2020	Sicherheitsbestimmungen für Mess-, Steuer-, Regel- und Laborgeräte Safety requirements for equipment for measurement, control, & laboratory use
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Störfestigkeit / Immunity standard (EN61326-1)

EN61000-4-2 /2009 & EN61000-4-3 /2020 & EN61000-4-4 /2012 & EN61000-4-5 /2014¹⁾ +A1
EN61000-4-6 /2014¹⁾ +AC & EN61000-4-8 /2010 & EN61000-4-11 /2020¹⁾ +AC

Störaussendung / Emission

EN55011/2016 + A1, A11 & EN61000-3-2/2014¹⁾ & EN61000-3-3/2013¹⁾

Bemerkungen / Comments

- ¹⁾ Verwendung der aktuellen Ausgabe / Use of the current edition
- ²⁾ Prüfling enthält gemäß Herstellerangaben keine magnetisch sensitiven Elemente
- ³⁾ Prüfling mit Gleichspannung versorgt / Test object supplied with DC- voltage

Monheim den 16.10. 2022

Gunnar Waltemode
Geschäftsführer / General Manager