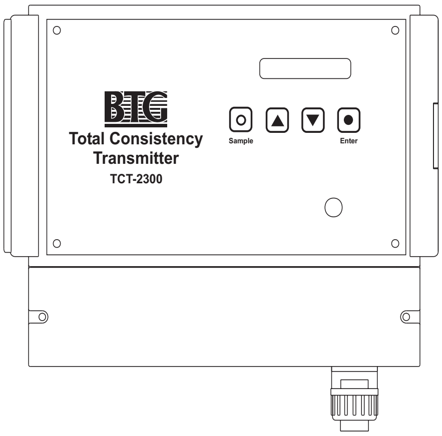
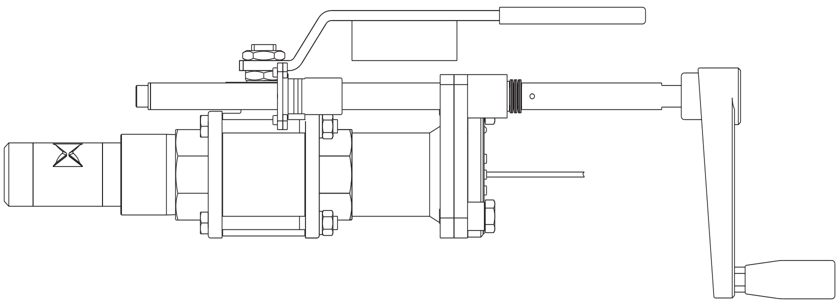
User Manual

TCT-2301

Smart optical low consistency transmitter





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Disclaimer

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1 Product introduction

Total consistency transmitter

- Measures total consistency, independent of varying content of filler and fines, with a unique measuring method – enables accurate consistency measurement
- Virtually insensitive to flow variations and temperature changes – for high accuracy and reproducibility
- No moving parts and non-clogging probe design – gives low maintenance costs
- Simple calibration and documentation – provides easy start up and usage
- Simple installation – for low installation costs
- Probe can be retracted without shutting down the process

1.1 General

The TCT-2301 is an in-line transmitter for measuring total consistency of pulp suspensions in the range 0.01-3.5%.

Based on BTG's patented Peak Method (see section 1.3) of optical analysis, the TCT-2301 is virtually insensitive to variations in filler and fines content, making it particularly suitable for use with recycled and mechanical pulp suspensions.

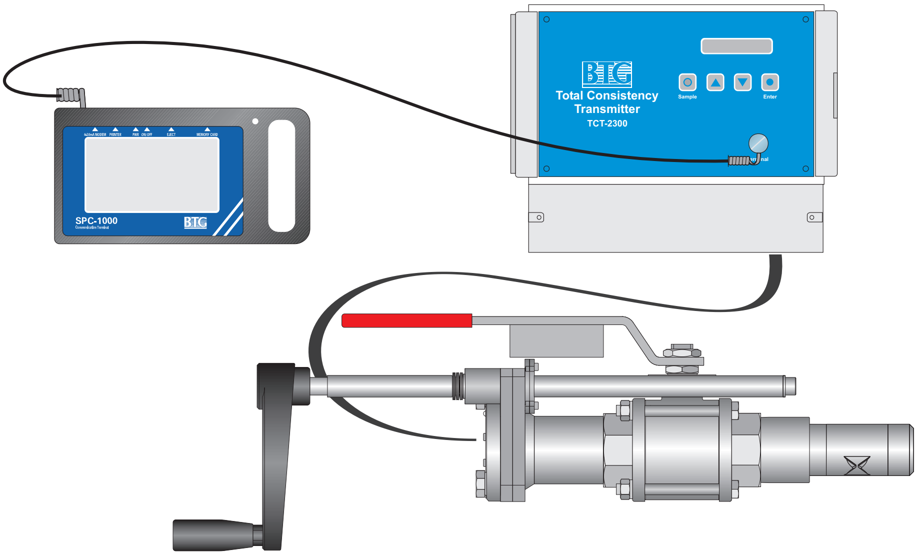
The transmitter is mounted in-line, without any special bypass arrangement, for optimized functioning of the control loop. The instrument's unique probe, without electronic components, makes the transmitter insensitive to variations in temperature and vibration. The probe is connected to the wall-mounted electronics unit by an optical fiber.

An integrated fail-safe system means the probe can be installed and retracted safely without shutting down the process, even in high pressure applications.

The transmitter's non-clogging and self-cleaning features ensure trouble-free and accurate operation with easy maintenance.

The TCT-2301 employs modern microprocessor technology, including fast data collection with a separate signal processor, digital data processing with advanced signal analysis.

Fig 1 Smart optical low consistency transmitter TCT-2301 with SPC-1000 hand-held terminal



The TCT-2301 is served by the SPC-1000 hand-held terminal, which works not only with the TCT-2301, but also with all instruments in the BTG family of smart transmitters.

The SPC-1000 can be connected at any point on the 4-20 mA output signal loop. Communication with a DCS is by means of a superimposed digitized signal according to a standard Hart® protocol. In addition, the unit is prepared for fieldbus digital communication.

BTG has adopted the OPC communication standard, which enables any OPC equipped system direct access to TCT-2301 transmitters.

1.2 Technical data

Type	TCT-2301 in-line smart optical consistency transmitter for pulp slurries. One analog output for total consistency.
Manufacturer	BTG, Säffle, Sweden
Measuring principle	Light scattering using the Peak-method. Performed by light transmission of NIR, 880 nm
Measuring range	Total consistency 0.01 to max. 3.5% (0.1 - 35 g/l) depending on fiber type and filler content
Measuring accuracy	± 0.004%
Repeatability	0.0001%

Process conditions	
Process pressure	PN 16 (232 psi at 68 °F)
Media temperature	Max. 150ºC (302 °F)
Max. ambient temperature	Probe: 150ºC (302 °F) Electronics box: 50ºC (122 °F)
Process pH	4-9
Storage temperature	Min. - 20ºC (70 °F)

Standardization	
Standardization	Quality-assured in accordance with ISO 9001. Designed in accordance with relevant CE standards. See section 1.8: *CE-declaration of conformity*

Probe	
Mounting	Mounted through a ball valve assembly.
Material	Stainless steel to SS 2343, equiv. to ANSI 316, DIN X5 CrNiMo 18.22, B.S.316 S16/En 58J
Connection	Optical connection to electronics box.
Weight	Probe 3.3 kg (7.2 lb) Valve assembly approx. 3.8 kg (8.4 lb)

Electronics Box

Supply voltage	Supply voltage 84 - 264 VAC, 50/60 Hz, max. 50 VA - automatic setting. Output voltage 24 VDC, regulated. Output power max. 40 VA, max. constant power 1800 mA at an ambient temperature of 50°C (122°F). Approved according to UL, CSA, VDE.
Output signal - analog	4-20 mA. Isolated against mains supply / protective earth. Built in insulation amplifier Current limited to 21 mA. Loop load signal: voltage supply / load 21.6 VDC / max. 1030 Ω 24 VDC / max. 1100 Ω 26.4 VDC / max. 1270 Ω Min. (nom.) load for communication with hand-held terminal 250 Ω.
Input signal - analog	0 / 4-20 mA
Output signal - digital	Superimposed signal over 4-20 mA current loop according to standard HART® protocol and BELL 202 modem. Follows HART® universal commands.
Power consumption	Max 600 mA incl. hand-held terminal (excl. 200 mA) at 24 VDC
Measuring ranges (analog)	Four separate, individually programmable, externally connectable with binary-coded switch. Also accessible via the communications link.
Input – digital (measuring ranges)	2 x 2 optically isolated contact inputs.
Alarm function (digital)	Optocoupler output. Provides alarm signal on low/ high LED curr./cons.level /internal temp.
Electronic Enclosure	Made of polycarbonate thermoplastic with a transparent cover. Metal-plated internally to protect against interference.
Protection rating	IP65, NEMA 4x, UL, CSA
Weight	Electronics box 2.4 kg (5.3 lb)

Communications

Option 1:	Using the BTG SPC-1000 handheld terminal jacked into the electronics box. The digital communication is superimposed over the 4-20 mA current loop.
Option 2:	Directly with the DCS. See "Output signal - digital". Allows HART® universal commands.
Option 3:	RS-485 for connection to OPC-server. OPC program provided by BTG. Note: Only for DCS/OCS systems with OPC capabilities.
Option 4:	Prepared for fieldbus communication e.g. Profibus or Fieldbus Foundation.
Signal transmission	10 m (33 ft) quartz glass optic fibers included, protected in a flexible conduit. On request 20 (66 ft), 30 (98 ft) and 40 m (131 ft).

Accessories

Hand-held terminal, SPC-1000
See data sheet D218.55

Smart Lab Sampler, SLS-1000
See data sheet D218.62

Documentation program for PC

Probe cleaning device: PCD-1000
See data sheet D2020.

PCD-1000 cleaning device (option)

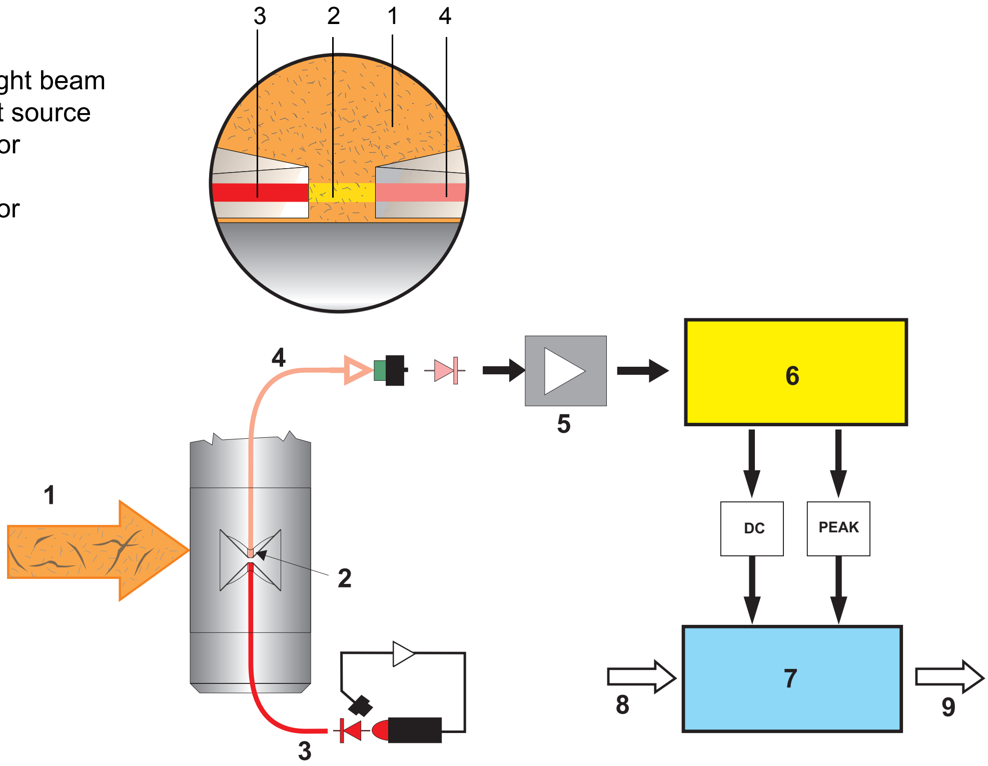
Weight	9.5kg/20.9lb including valve and probe.
Dimensions	See page 2.
Ambient temp.	50ºC/122 °F
Air supply/conn.	Filtered 4-7bar (58-102 psi). Ø6/4mm (0.236/0.157)
Water conn.	Mechanically cleaned, 4-10bar (58-145 psi). Inlet Ø8,5mm (0.335in) Outlet Ø17mm (0.669in)
Supply voltage	24V DC supply from TCT-2301 electronics box. Min. 4 x 0.75mm² (AWG18)

1.3 Measuring principle

1.3.1 The Peak Method

Fig 2 Operating principle

1 Pulp flow
2 Measuring gap with light beam
3 Optical fiber from light source
4 Optical fiber to detector
5 Amplifier
6 Digital signal processor
7 Microprocessor
8 Input signals
9 Output signals



The TCT-2301 employs the patented peak method for measuring total consistency of pulp suspensions. This technology is based on the fact that suspensions contain both large and small particles. Large particles are typically fibers and small particles are fillers and fines.

Close study of a suspension sample shows that the high number of small particles in the suspension remains relatively constant over time. On the other hand, there are far fewer large particles and their number varies significantly over time.

The large particles form a relatively transparent network, within which the small particles move freely. A narrow light beam directed through the suspension is generally affected by both the large and small particles. There is however an interval when only small particles affect the light beam, and this is know as the "Peak" period.

During the other time periods, the light beam is affected by both the large and small particles. Fig 2 and fig 3 illustrate this principle.

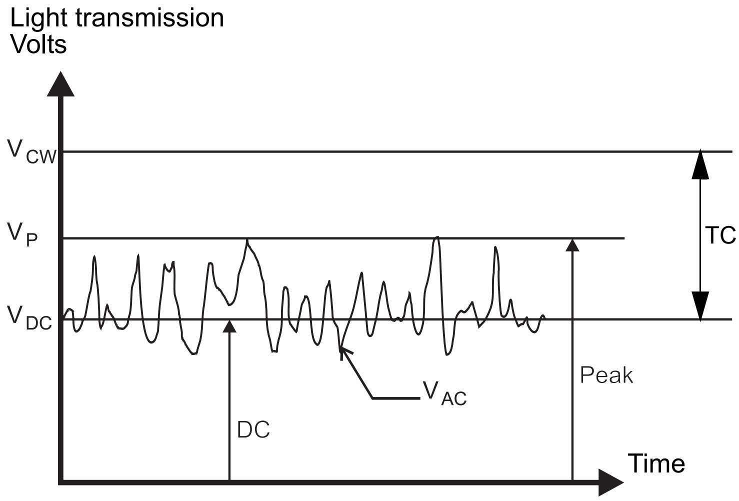
In fig 2, a light beam passes through the pulp flow (1). The transmitted light is detected by a photo detector. The detector signal is amplified (5) and then treated by the signal processor (6).

Three signals are computed by the detector signal: The mean value, V_{DC}, the peak value, V_P and the AC-component, V_{AC}. Typical time graph showing the detector signal is displayed in fig 3.

The total consistency is obtained by adding the further treated V_P and the V_{DC} values.

Fig 3 Output signal

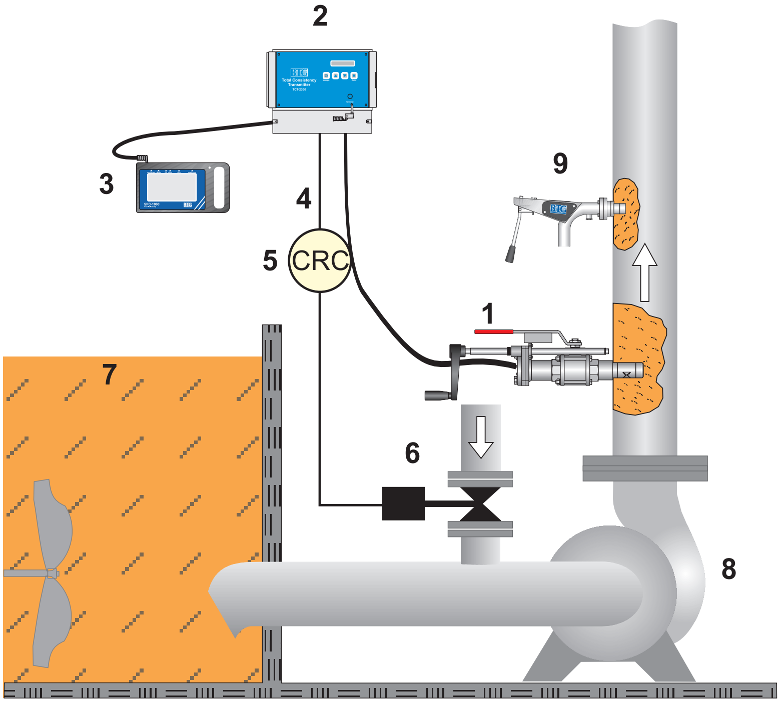
V_{CW}	Clear water
V_P	Peak value
V_{DC}	Direct current signals
V_{AC}	Alternating current signals
TC	Total Consistency



1.4 System description

Fig 4 Typical control loop for consistency control of the TCT-2301

1 Measuring probe
2 Electronics box
3 Hand-held terminal SPC-1000
4 3/4 wire system for analog output
5 Controller/recorder (DCS)
6 Dilution water valve
7 Pulp chest with sufficient mixing
8 Stock pump
9 BTG sampling valve type MPS-1000



The system consists of a probe (1) connected by an optical fiber to an electronics box (2) The probe contains only optical fibers. A ball valve arrangement that is welded to the pipe system make it possible to remove the probe without interrupting the process.

The electronics box contains electronics card, power supply, electrical and optical connections. To set up the transmitter a hand-held terminal (3) type SPC-1000 must first be connected (see fig 4).

The hand-held terminal allows the operator to set up and monitor the system. It includes a liquid crystal display (LCD) with a touchscreen keypad.

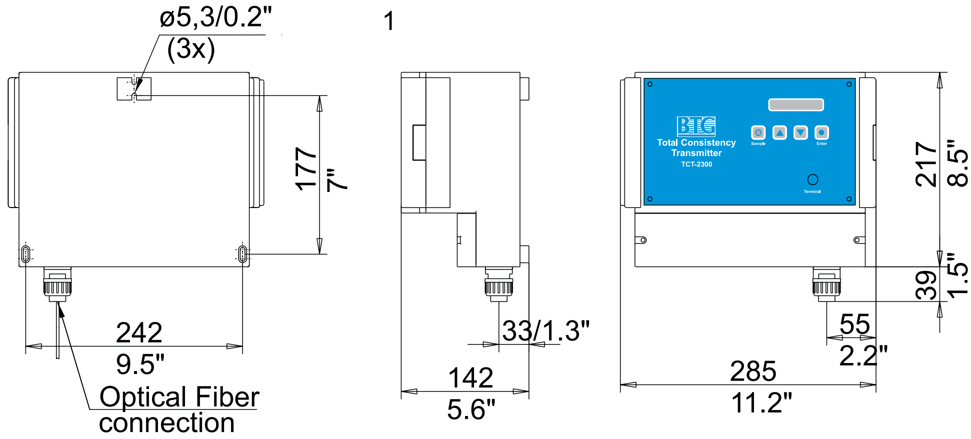
1.5 Typical applications

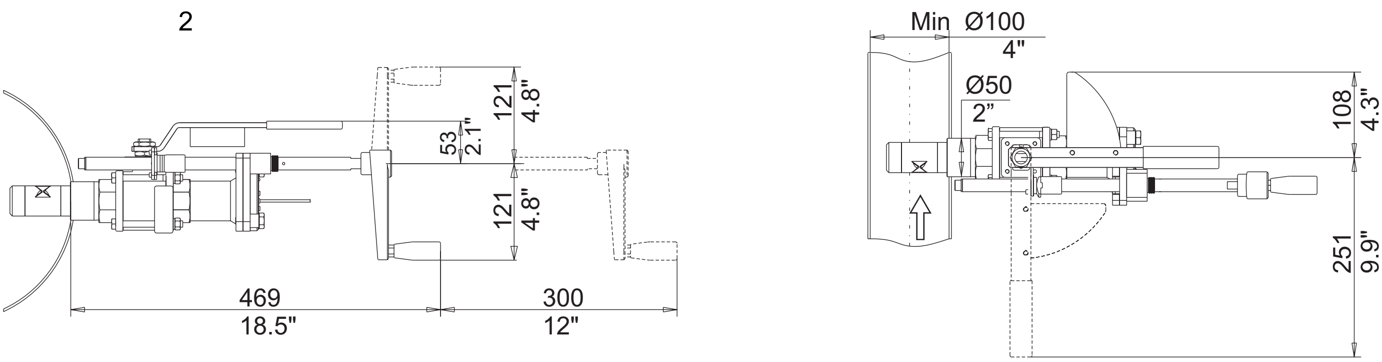
- **Control of flotation systems or wash stages for de-inking of recycled fibers**
- **Control of screening and cyclone cleaning processes**
- **Monitoring of TMP/CTMP steam and hot-water recovery systems**

1.6 Dimensions

Fig 5 TCT-2301 Dimensions

1 Electronics box
2 Probe with retraction system

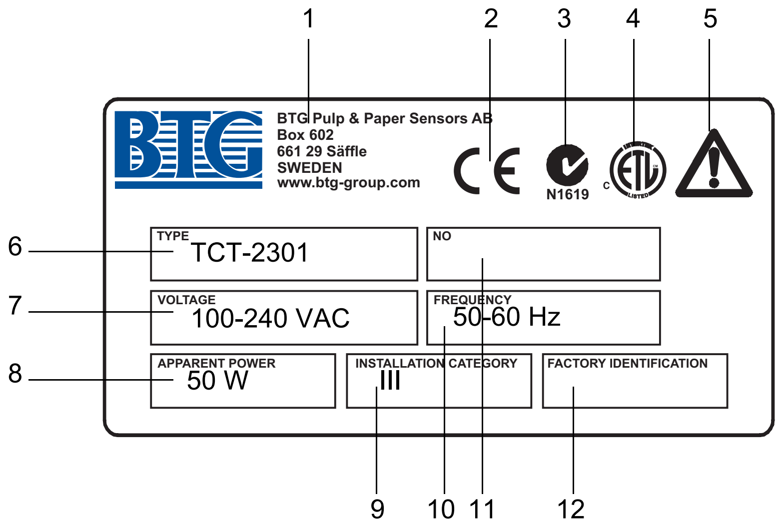




1.7 Type sign explanations

Fig 6 Type sign

1 Manufacturer
2 CE-marking
3 C-TIC marking
4 ETL-marking
5 Warning sign
6 Type specification
7 Voltage
8 Apparent power
9 Installation category
10 Frequency
11 Manufacturing number
12 Factory Identification



Always refer to the type sign when ordering spare parts.

1. Manufacturer

2. CE-marking

The TCT-2301 is approved according to CE directives.

3. CSA-marking

The TCT-2301 electronics box is approved according to Australian C-TIC N1619 directives.

4. ETL-marking

The TCT-2301 electronics box is approved by ETL

5. Warning sign

The device is designed for industrial use. Installation, handling and service must only be carried out by trained and authorized personnel and according to relevant standards. Read the manual for detailed information and pay special attention to the warning signs!

6. Type specification

7. Voltage

Automatically adjustable between 100-240V AC.

8. Apparent power

According to CE directive. Max. continuous output.

9. Installation category

According to CE directive. Resistant to transients.

10.Frequency

The unit operates both 50 and 60 Hz.

11.Manufacturing number

BTG internal product identification number.

12.Factory identification

1.8 CE-declaration of conformity

CE-Declaration of Conformity

According to EN 45014

Manufacturer´s Name	BTG Pulp & Paper Sensors AB
Manufacturer´s Address	P.O. Box 602 S- 661 29 SÄFFLE, Sweden
declares that the product:	
Product Name	Total Consistency Transmitter
Model Number	TCT-2300/2301/2302/with FCI-1000
complies with the amendments and requirements of the:	**Machinery Directive** 89/392/EEC **Low Voltage Directive** 73/23/EEC **EMC Directive** 89/336/EEC **PED Directive** 97/23/EEC
and conforms with the following product standards and PED conformity assessment procedure	
Safety	EN 292/1-2
LVD	EN 61010-1
PED	**Pressure equipment for piping.** In accordance to Article 1, Table 9, art.3 (3), Annex II (Sound eng. practise) **Must not bear CE-marking**
EMC	EN 50081-2 Aug.93 EN 61000-6-2 Apr.02
Quality System	ISO 9001 monitored by Lloyd`s Register Quality Assurance
Säffle **Mars 2002**	
	Tom Gustavsson, MD

2 Safety recommendations

2.1 General safety recommendations

See section 1.2: *Technical data* for detailed information.

Installation, handling and service must only be carried out by trained and authorized personnel and according to valid standards.

- The product is designed for industrial use.
- Installation category: III
- Shock protection: Class I
- Pollution degree: 2
- IP Code: IP65 / NEMA 4X
- The product complies with the EEC directives and relevant standards:

  To meet the EMC directive the following precautions have to be taken:

  1. All wiring has to be shielded.

Power supply electronics:	shielded, coverage≥ 80%
Interface cable:	coverage 100% aluminum

  2. All units are tested as a complete system to conform with relevant CE directives and their standards.

  When using the unit in other combinations, BTG cannot guarantee the CE directive conformity.

  The unit in combination with customer installed external devices may conform with EMC and safety requirements when properly installed and using an adequate CE marked equipment.

  The system operator is responsible for the CE directive conformity. Conformity must be checked by inspection.

- Take precautions when handling equipment in pressurized/hot lines.

2.2 Product specific safety recommendations

These safety recommendations are based on a risk analysis carried out in accordance with the requirements of the machinery and low voltage directive in order to comply with European standards for CE marking.

2.2.1 General

The possibility of risk from a consistency transmitter in operation only arises when covers have been removed during installation and servicing, due to hazardous electrical voltage.

Read these safety recommendations before installing the transmitter. Follow the recommendations when installing the transmitter, starting up and servicing. Use warning signs for safety information!

These safety recommendations apply to the transmitter fitted with an AC powered electronics box. Mounting parts, such as the weld-in studs, are dealt with in accordance with the pressure vessel standards of the respective countries.

⇨ **For good personal and functional safety: Use only parts which have been manufactured or approved by BTG.**

2.2.2 Selecting a transmitter model and assembly parts

Pressurized parts must be suited to the current maximum pipe pressure in relation to temperature. Select a material for the parts that are in contact with the medium so that corrosion does not occur.

2.2.3 Installing mounting details

Welding and subsequent inspection should take place in accordance with current standards and regulations.

Be sure that the pipe is empty before opening it!

2.2.4 Installing the transmitter

- Construct a platform or use safe and approved ladders if the transmitter is located high up. This platform will make it easier to fit and start-up the transmitter and carry out service in the future.
- The rubber quality of the transmitter seal (O-ring) should be selected to suit the current medium. The O-ring supplied is suitable for this application.
- Screw the valve assembly firmly onto the weld-in stud.

Check that the screws/nut holding the valve/probe together are mounted and properly tightened.

- Install the probe into the valve assembly. Fit the two screws locking the probe in place. Check that these screws are properly tightened, as well as the four screws holding the valve together. See section 3.2.5: *Mounting the probe in the valve assembly* for details.
- When the probe has been installed, carry out test pressurization using water in the pipeline. The correct test pressure depends on standards and regulations in each country. In some lines for which inspection is required, a pressure test must be carried out before the product can be commissioned.

2.2.5 Installing the electronics box

DANGER!
High voltage inside the electronics box. Connections may only be carried out by qualified personnel.

A hazardous voltage is used to drive the electronics box. The electronics box may only be connected by a qualified electrician in accordance with instructions. The earth ground should be connected correctly and checked.

It should be possible to switch off the voltage in the distribution centre, for example. A clear warning, such as a sign, should let other people know that work is in progress and the switch must not be touched.

- Use only metallic cable fittings with shield connection for the electronics box.

2.2.6 Starting up and servicing the transmitter

Read through the following points before starting up and servicing the transmitter. Bear also in mind that the points mentioned above contain important information for these operations.

To prevent electrical shock — connect the protective earth ⏚ PE properly.

- Before removing the probe from the valve assembly, check carefully that the valve is closed. **Hot or corrosive liquid flowing out under pressure may cause serious chemical burn injuries!**
- Take care when opening the cover of the electronics box with built-in power supply unit. **It contains live parts that may cause electric shocks.** Live parts are protected against normal contact provided that connections are made correctly.
- When the probe is exposed to dangerous basic or acidic corrosive media, it should be removed from the pipeline regularly for inspection. Replace any damaged seals. If the probe's pressurized parts have corroded, check that the material is correct for the application. **Leakage may cause personal injury or damage to equipment due to corrosion or burning!**

3 Installation instructions

3.1 Before you start

This section contains instructions for planning and implementing the installation of the BTG TCT-2301 in-line consistency transmitter.

If you are in doubt whether the model you plan to install is the same in all respects as the model described in this manual, or you have any questions about installation, please contact your BTG sales engineer.

When you are satisfied that your TCT-2301 has been correctly installed and are ready to power up the system for calibration, please turn to section 3.5: *Checklist before start*.

Double check items in the list before powering up. This list can help ensure a trouble-free initialization of your system.

This section introduces the essential components of the system.

This introductory section is followed by:

section 3.2: ***Installing the transmitter***

This section contains detailed instructions for installing the transmitter.

section 3.3: ***Installing the electronics box***

This section describes how to connect mains power supply, inputs and outputs.

section 3.4: ***Probe cleaning system (option)***

This section describes how to install the PCD-1000.

section 3.5: ***Checklist before start***

When you are satisfied that your TCT-2301 has been correctly installed and are ready to power up the system for calibration, please turn to this section.

3.1.1 Visual inspection

This product was inspected and tested prior to shipment. However, even the best products can sustain shipping damage that will only be seen if the product is inspected. Before proceeding check the probe assembly, the hand-held terminal, and the electronics box for shipping damage. Look for loose screws, wires or electronic components.

3.1.2 Installation and operating conditions

⚠ **For safety precautions please refer to section 2. Product type sign explanations see section 1.7**

The Consistency Transmitter is a precision tool and must be properly installed to ensure reliable service. Please, read the following instructions and user information before installing the transmitter.

The transmitter is manufactured to provide accurate and reliable measurements over a long period of time.

⇨ **Correct installation will ensure maximum operating life of the transmitter.**

3.2 Installing the transmitter

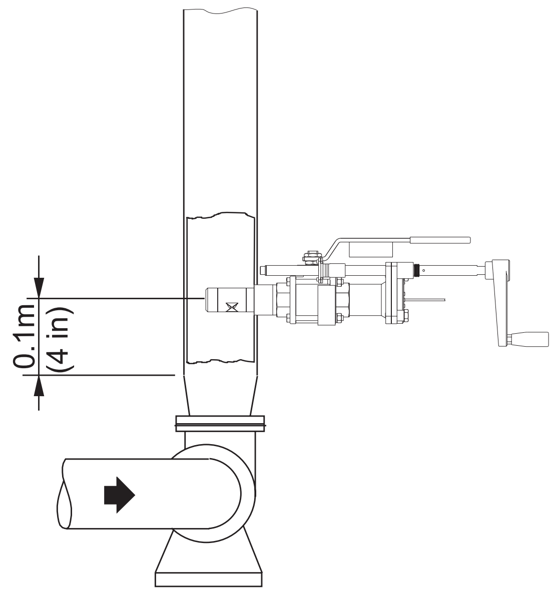
Warning: To avoid personnel injuries, burning injuries, aggressive chemical injuries etc., it is extremely important that the pipe is depressurized and empty before opening it for installation or removal of the equipment.

3.2.1 Positioning the transmitter

To make an accurate and reliable measurement it is critical to find the correct installation point.

Fig 4 on page 8 shows a typical installation. Your BTG sales engineer can help you select the location that will give the best results in relation to your control strategy.

Fig 7 Recommended distance between pump and consistency transmitter. Can also be placed in the cone after the pump. Turbulent flow will give the best measuring conditions for this type of transmitter.



⇨ **Minimum recommended flow velocity: 1 m/s (3.3 ft/s).**

⇨ **To minimize time lag, locate the probe close to the dilution point.**

Fig 8 Installation of the probe in relation to different pumps

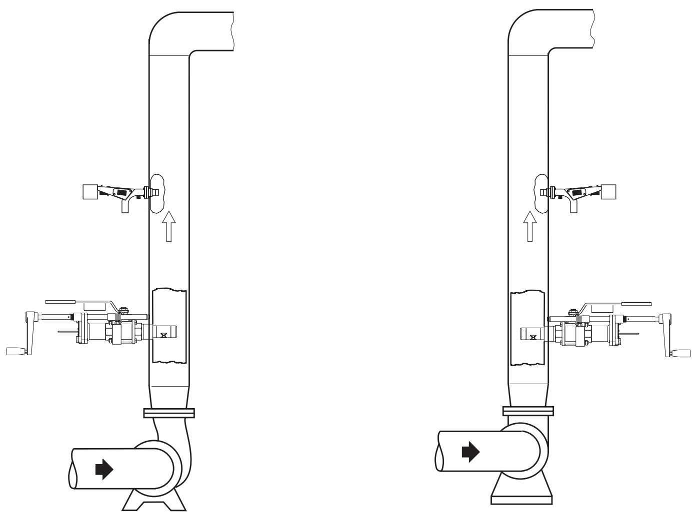
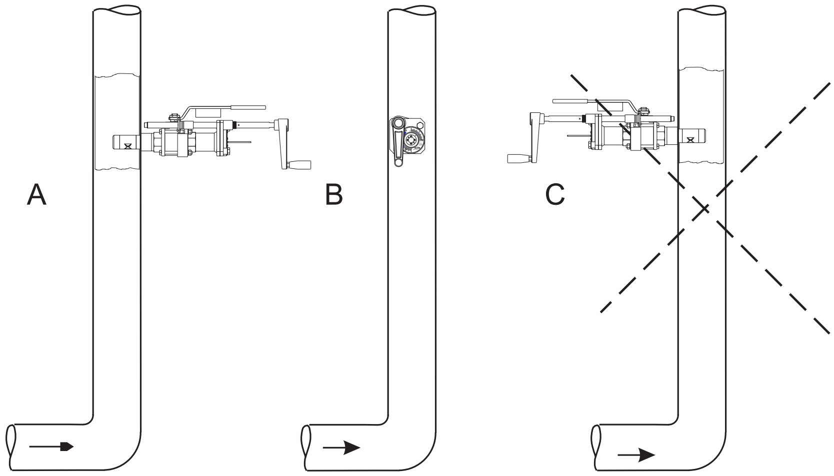


Fig 9 Installation of the probe near a pipe elbow

⇨ **Alternative A is the most suitable. Avoid alternative C.**



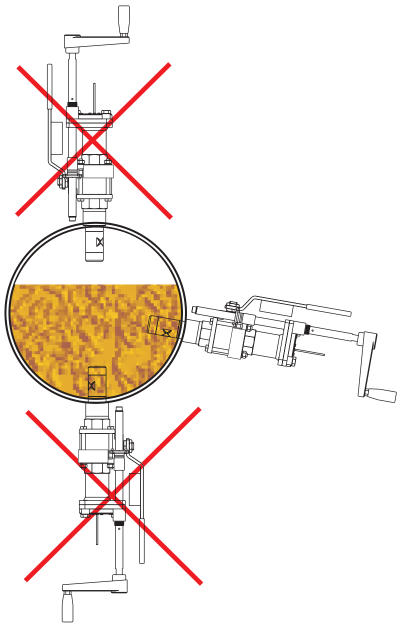
Important recommendations:

1. Do not install the probe where there is trapped air or where air may be sucked into the process.
2. If there is risk of flocculation in the pulp suspension, install the probe where the flow rates exceeds 1 m/s (3.3 ft/sec).
   This applies particularly to long-fiber pulp suspensions.
3. Install the probe so that it is protected from direct mechanical damage.
4. Protect the probe from heavy vibration such as cavitation or unbalanced pumps. One method is to install a rubber bellows in the line.

If the probe is installed in a horizontal pipe, always install it at the side of the pipe rather than at the top or bottom to avoid problems with trapped air or dirt. Remember the clearance requirements, so that the probe can be mounted in the ball valve arrangement.

5. The ball valve assembly should be mounted at a 90° angle to the pipe line.
6. The ball valve assembly should be mounted on the side of the pipe line. A small angle downwards makes it possible for the pulp to evacuate when the probe is retracted and also makes the insertion of the probe easier. See fig 10 below.

Fig 10 Installation of the probe in a horizontal pipe.

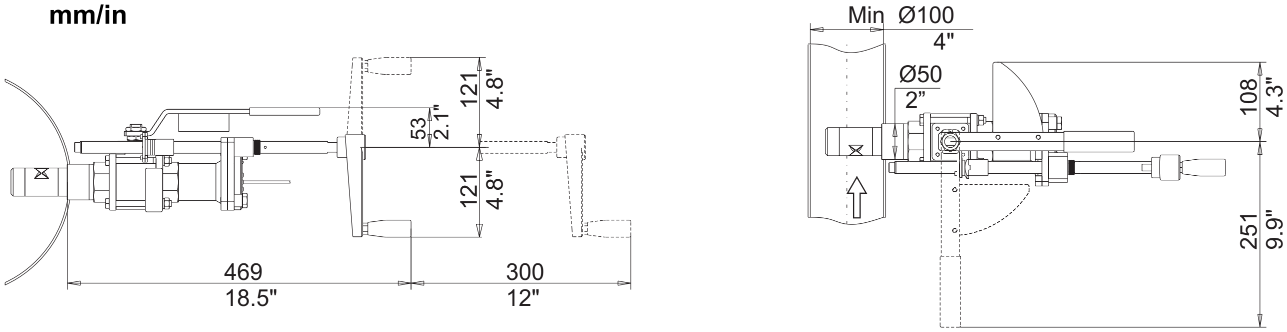


3.2.2 Probe clearance requirements

The installed length of the probe, inserted into the ball valve arrangement, is approximately 470 mm (18.5 in) long. You will also need a minimum distance of 300 mm (11.8 in) to remove the probe from the pulp line. Leave sufficient room around the probe to perform this task.

The probe weighs approximately 3.3 kg (7.2 lbs).

Fig 11 Probe. Dimensions in mm/in



⇨ **Remember to provide access room for an operator, as well as the full depth of the probe assembly and the electronics box.**

3.2.3 Sampling valve

The sampling valve should be installed close to the transmitter. This helps to ensure that the laboratory sample is representative of the sample measured by the transmitter.

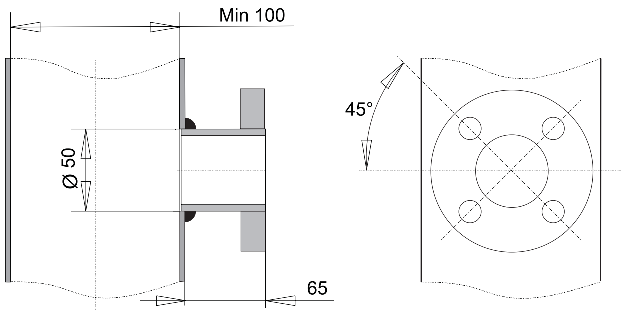
Installing an appropriate BTG sampling valve, will ensure reliable results.

⇨ **Install the sampling valve up or downstream of the transmitter but not closer than 0.5 m (1.5 ft) to the transmitter to avoid disturbances.**

3.2.4 Installing the ball valve assembly

1. Mark the position on the pipe wall where the probe is to be located.
2. Drill a 50 mm / 2” inch hole in the pipe at the marked position.
3. Adapt the welded stud profile to the pipe. Adjust length according to fig 12.

Fig 12 Mounting the flanged weld-in stud

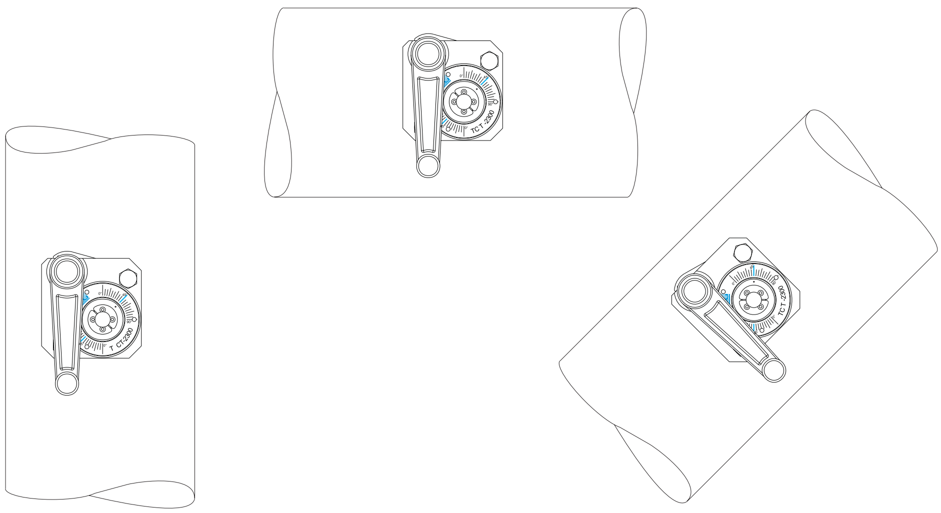


4. Make sure the weld-in stud is aligned to the pipe. See fig 12.
5. Weld the stud to the pipe. A full penetration weld must be used.

⇨ **If the probe is delivered with a PCD-1000, refer to section 3.4: *Probe cleaning system (option)*.**

6. Mount the ball valve arrangement. The slot for the crank handle must be located upwards since there is a scale on the probe that must be adjusted before the probe is mounted.

Fig 13 Mounting positions of the probe.

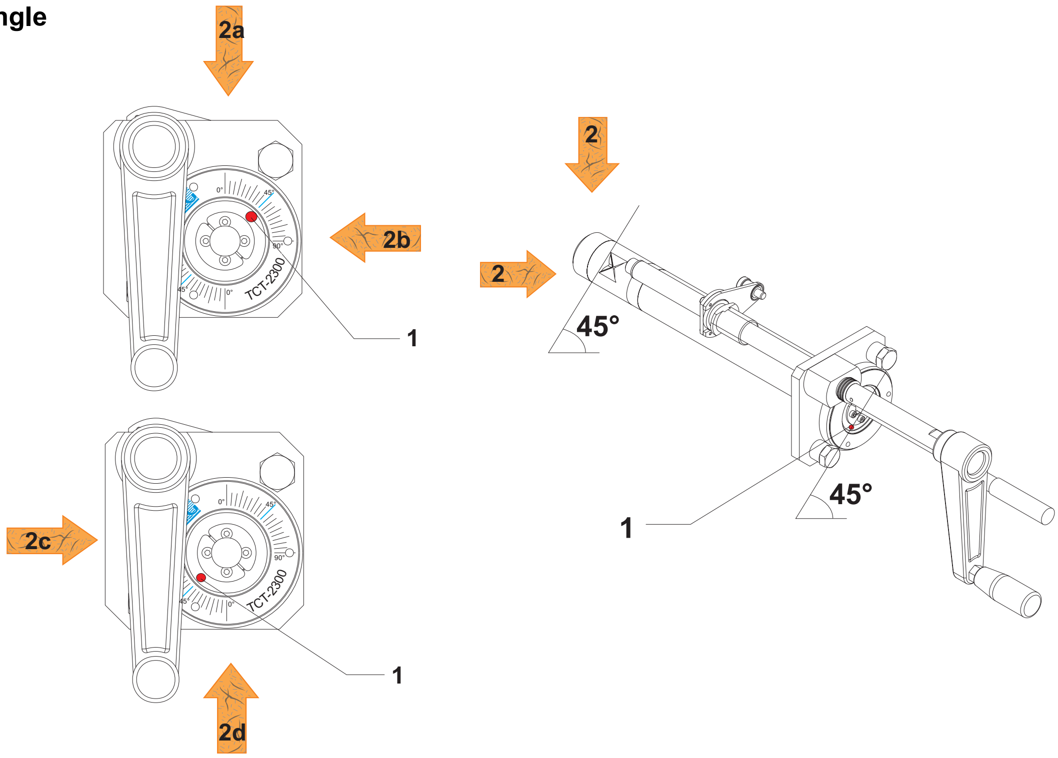


3.2.5 Mounting the probe in the valve assembly

1. Make sure the measuring gap on the probe is at a 45° angle to the pulp flow. The angle may have to be changed after start-up.

Fig 14 Measuring gap angle adjustment

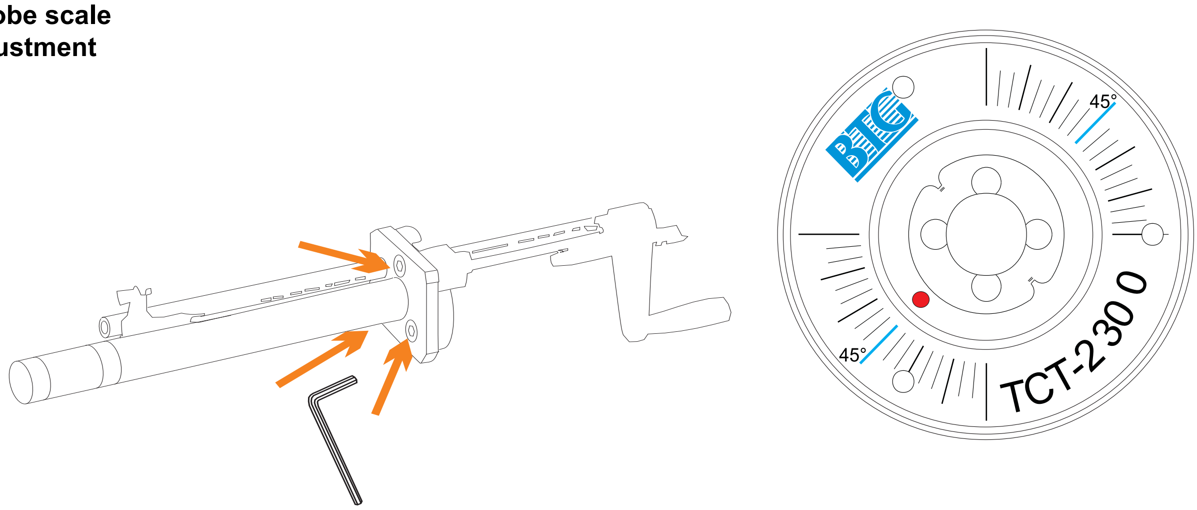
1 Punch mark
2 Pulp flow direction



If the angle is not correct, loosen the three screws that hold the probe flange and adjust the probe so that the punch mark on the probe is at the 45° line on the scale. Tighten the three screws properly. A suitable allen key is included in the delivery.

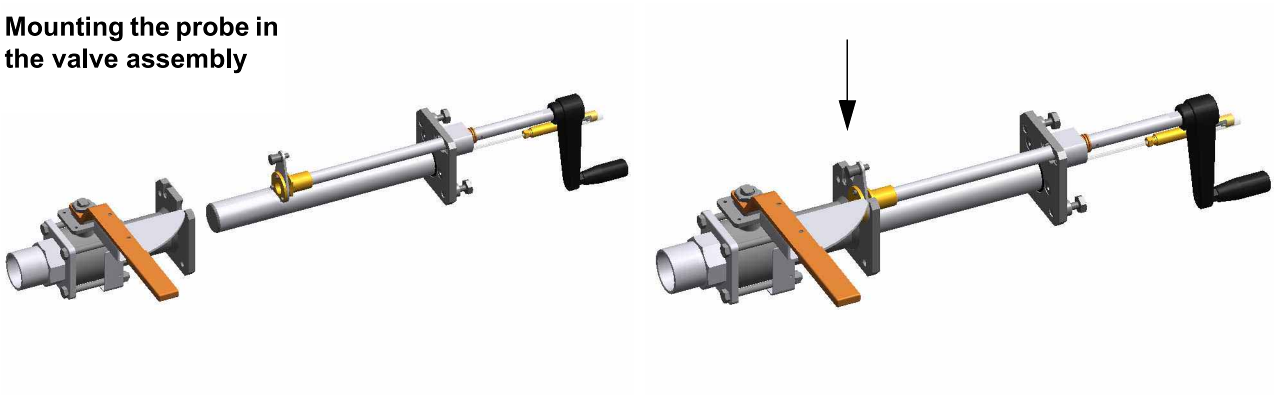
⇨ **Angles other than 45° can be used in some installations. See section 4.2.3: *Adjustment of measuring gap angle.***

Fig 15 Probe scale adjustment



2. Apply a small amount of o-ring lubricant to the o-ring in the ball valve housing.
3. Make sure the o-ring on the probe flange is mounted.
4. Insert the probe, using a twisting motion to get the probe tip to enter the o-ring. Place the flexible insertion screw in the correct position and make sure the hook with its locking device is in the correct position and secured.

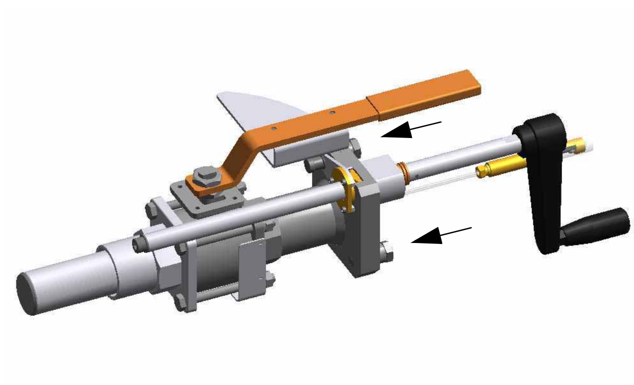
Fig 16 Mounting the probe in the valve assembly



5. Open the ball valve and insert the probe by cranking the handle.

6. Secure the probe in inserted position with the two security screws

Avoid getting O-ring lubricant on the measuring gap



⇨ **Secure the two security screws properly**

7. When removing the probe, reverse the above procedures.

3.3 Installing the electronics box

3.3.1 Choosing a site for the electronics box

⇨ **Locate the electronics box close to the transmitter/ sampling valve to achieve a correct and convenient connection of the SPC-1000 hand-held terminal for calibration and monitoring.**

The hand terminal SPC-1000 can be positioned in a holder, located close to the electronics box. See fig 20.

Fig 17 Dimensions of the electronics box

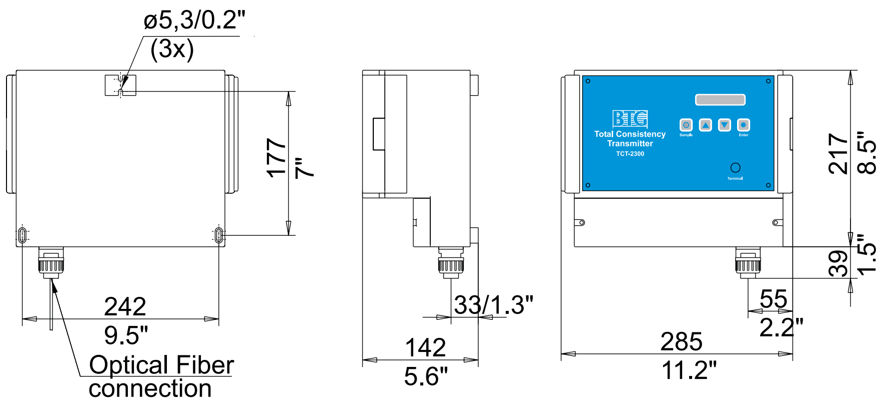
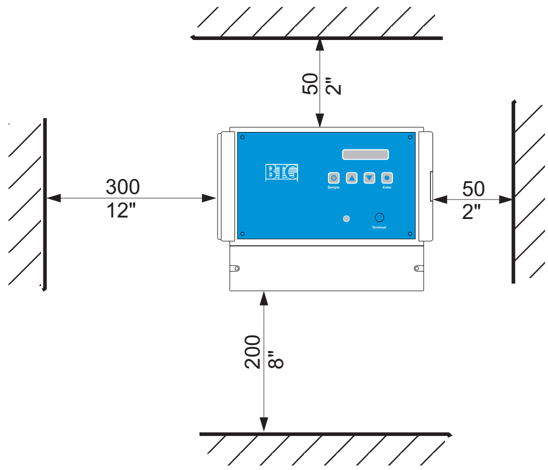


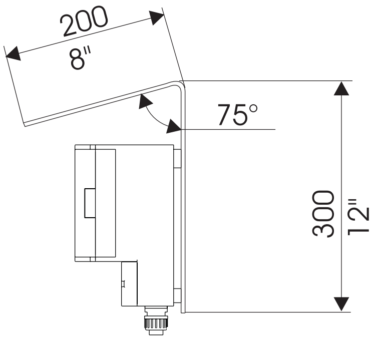
Fig 18 Electronics box clearances



Install the box in a position where it will be protected from mechanical damage.

BTG recommends that a roof or overhang is located above the electronics box to protect it against spray and pulp. If the box is located outdoors a roof will protect the unit from direct sunlight which can cause excessive operating temperatures. If possible, the SPC-1000 mounted in its holder should also be protected.

Fig 19 Protecting roof for Electronics box



The electronics box is equipped with three attachment lugs and should be bolted to a wall.

Fig 20 Wall mounted brackets positioning the SPC-1000, for easier operation

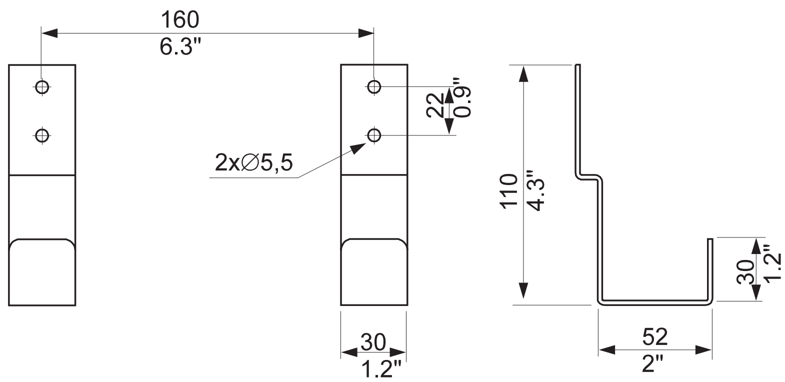
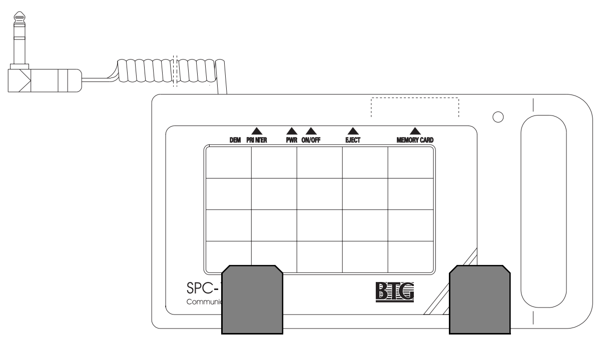


Fig 21 SPC-1000 positioned in the brackets



3.3.2 Electronics box design

⇨ **Electronics boxes manufactured by BTG are designed to meet personal safety and interference requirements under the European CE directive and Canadian CSA requirements.**

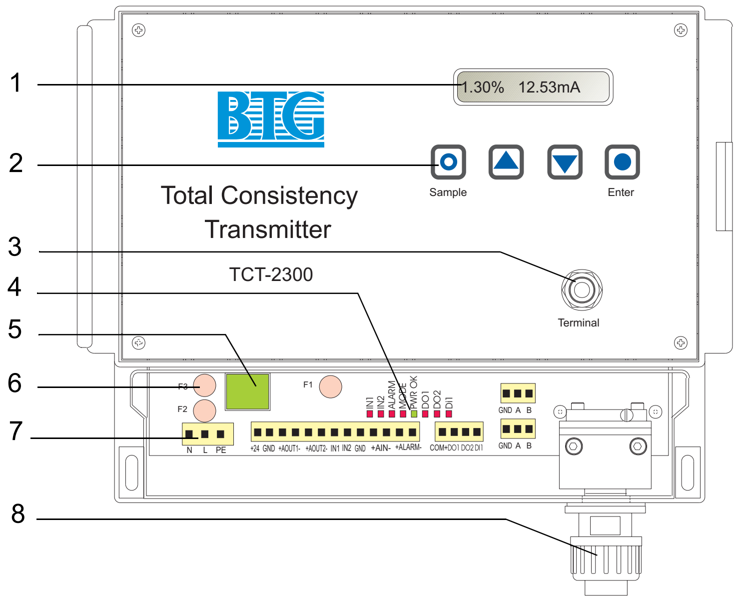
The plastic enclosures are made of polycarbonate thermoplastic. They are metal-plated internally to protect against interference.

Metal screw caps for attaching connection cable shield are an important part of the interference suppression system.

The electronics box is supplied with an external jack connection for the hand terminal, SPC-1000/A, and the Smart Lab Sampler, SLS-1000.

Fig 22 Electronics box

1 Display
2 Operating buttons
3 SPC-1000/A connection
4 LEDs
5 Power switch
6 Fuses
7 Electrical connections
8 Optical fiber connection



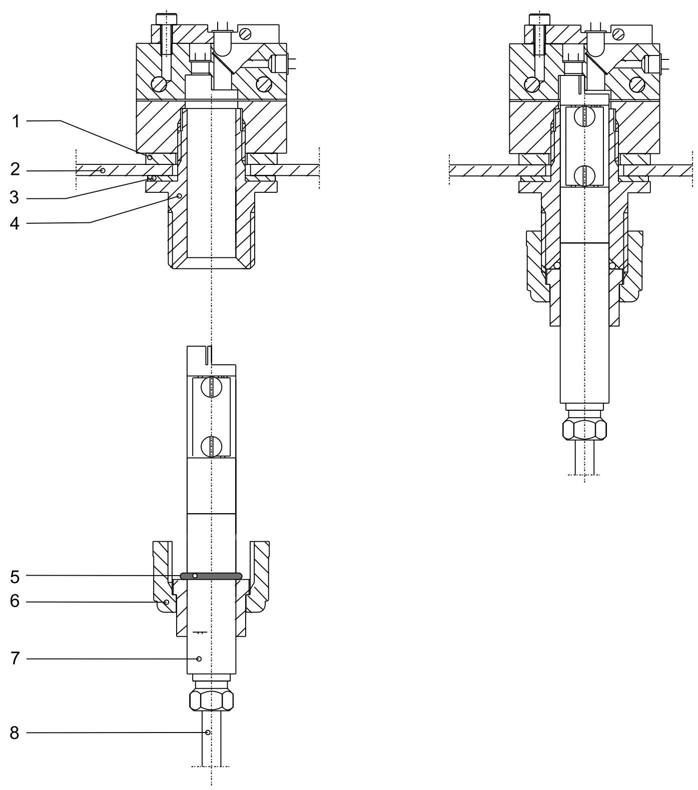
3.3.3 Connecting the measuring probe to the electronics box

The optical connection is on the lower right side of the electronics box. Remove the protective cover on the electronics box connector, and on the optical connector on the probe. Note the position for the optical connector in fig 23. The connector fits only in one position. Make sure the O-ring is mounted on the probe connector. Push the connector all the way in. Try to turn the connector (this should not be possible) to verify that it is in the end position. Secure the connection properly with the plastic nut. Coil the extra optical fiber and secure it under the electronics box in order to avoid the risk of mechanical damage.

⇨ **Make sure the optical connector from the probe is positioned correctly and pushed all the way in before securing it with the plastic nut.**

Fig 23 Optical connection

1 Aluminum washer
2 Electronics box
3 Rubber sealing
4 Electronics box optical connector
5 O-ring
6 Plastic nut
7 Probe optical connector
8 Optical fiber to probe



⇨ **The optical fiber must not be coiled with a radius smaller than 50mm (2 in) Locate it so that is protected and not subject to risk of mechanical damage.**

The standard optical fiber is 10 m (33 ft). It is possible to use optical fiber up to 40 m (131 ft) long. Contact your BTG sales engineer for more information regarding optional fiber lengths.

⇨ **Do not cut the optical fiber.**

3.3.4 External wiring dimensions

BTG recommends properly dimensioned wire, shielded and twisted in pairs, for connection between the electronics box and external equipment. See also section 2.1: *General safety recommendations*.

Power supply cable:

Electronics box with built-in power supply unit:

- Shielded (80%)
- 3 x 0.75 mm^2 (3 x AWG18) with PE.
- Cable diameter: 7,5-13 mm
- In accordance with the IEC 227/245 standard

Output signal cables:

- Shielded (80%), twisted pair
- Min. 2 x 0.3 mm^2 (2 x AWG24).
  The size typically used is 2 x 0.75 mm^2 (2 x AWG18)
- Cable diameter: 6-11 mm

Range select cable:

- Shielded (80%), twisted pair
- Min. 2 x 0.3 + 2 x 0.3 mm^2 (2 x AWG24 + 2 x AWG24)
- Cable diameter: 6-11 mm

Alarm/AUX-in cable:

- Shielded (80%), twisted pair
- Min. 2 x 0.3 mm^2 (2 x AWG24)
- Cable diameter: 6-11 mm

⇨ **Signal cables can be combined to one or two cables.**

3.3.5 Main power supply connections

DANGER!
High voltage within the electronics box. Connections may only be carried out by qualified personnel

To prevent electrical shock - connect the protective earth properly ⏚ PE

Important: Before installation, ensure that:

1. All power to the system has been turned off.
2. The 2AT fuses on the main card, marked F2 and F3, are installed.

The conduit for the power supply to the electronics box should be installed in the leftmost hole.

Wiring the main power supply screw terminal:

The earth wire must be connected to the terminal indicated by the **protective earth** symbol ⏚ PE.

See fig 26 on page 32.

3. Strip the cable covering (insulation) to expose the shortest possible length of the connection wires.

⇨ **Unshielded long, looped wires may cause interference! This can interfere with the signal!**

4. Once the wires are inserted, tighten the screws to secure them. Mount the connector in its position.
5. To ensure interference-free operation a shielded cable should be used. Make sure the shield is correctly connected - fig 24.

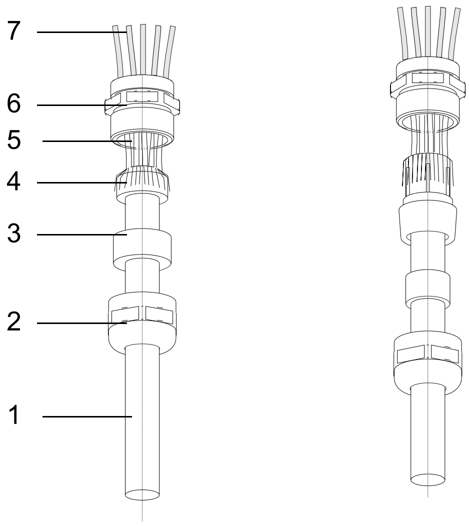


Fig 24 Connection of cable shield, in special cable screw cap (metal)

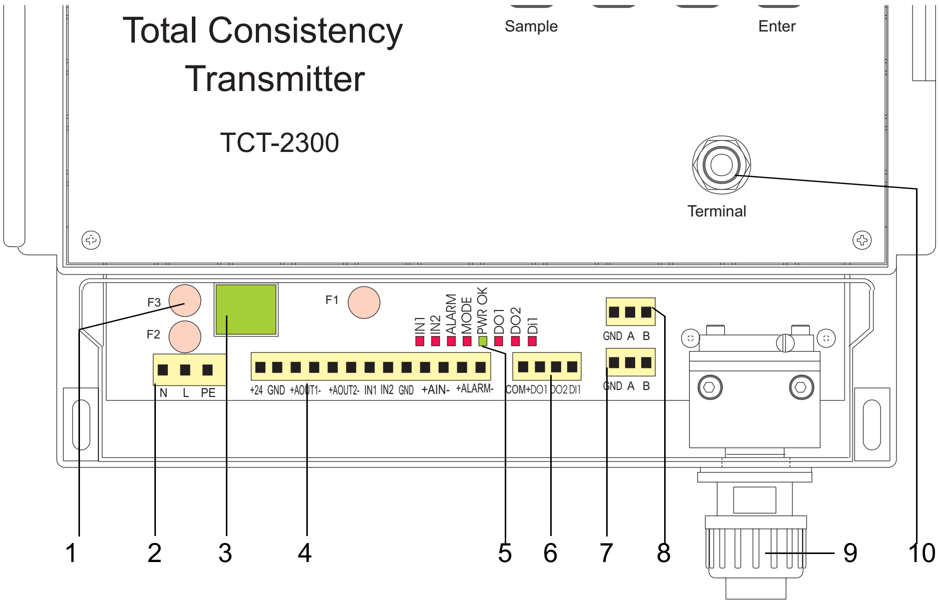
1 Connection cable for power supply, measuring range etc.
2 Nut
3 Sealing ring
4 Insert ring
5 Cable shield
6 Socket
7 Free wires

⇨ **Tighten nut fully for maximum contact for the shield.**

6. Turn on the main power supply.

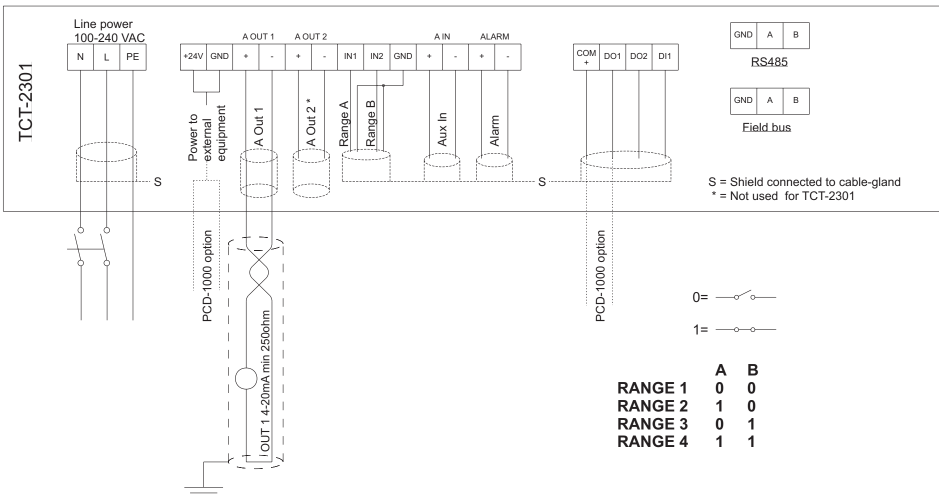
Fig 25 Power connections – electronics box

1 Fuses
2 Power connection 100-240 V AC
3 Power switch
4 24 VDC out
4-20mA output signals
Range setting
0-20 mA input signals
Alarm
5 LEDs
6 Digital signals
7 Fieldbus
8 RS-485
9 Optical fiber connection
10 SPC-1000/A connection



7. Switch on the main power on the electronics card. The power LED should now light up. See fig 25. If not, check first the connections and then the 2 AT fuse for the power supply located inside the electronics box.
Check the 24 V DC at terminal +24, GND - fig 26.

Fig 26 Wiring diagram for electronics box TCT-2301



Notes on fig 26:

- An external 2-pole switch close to the electronics box is required.
- Standard output signal 4-20 mA with superimposed digital signal according to Hart®-protocol. See section 3.3.7.
- Four different measuring ranges (RANGE 1-4) are available. The setting of the respective measuring range is arranged via a binary code switch (range setting - see fig 26 switch A/B) or DCS.
- The unit is prepared for fieldbus. To access the communication an additional circuit card is required.

Explanation for fig 26 TCT-2301 wiring diagrams.

Terminal	Function
N	Neutral
L	Phase 85-264 V AC, 47-440 Hz, power fuse 2AT
PE, ⏚	Protective earth
+24	+24V DC (to optional PCD-1000)
GND	Ground, 0V DC (to optional PCD-1000)
AOUT 1+	Output signal 4-20mA
AOUT 1-	Output signal 4-20mA
AOUT 2+	Not used
AOUT 2-	Not used
IN1	Range A for external range setting
IN2	Range B for external range setting
GND	Ground, Common for range A and B
AIN+	Input signal 0-20mA (from external equipment)
AIN-	Input signal 0-20mA (from external equipment)
ALARM+	Alarm from TCT
ALARM-	Alarm from TCT
COM +	Common (to optional PCD-1000)
DO 1	Digital output signal 1(to optional PCD-1000)
DO 2	Digital output signal 2
DI 1	Digital input signal 1
RS-485 GND	Ground
RS-485 A	Serial connection
RS-485 B	Serial connection
Fieldbus GND	Ground
Fieldbus A	Fieldbus connection
Fieldbus B	Fieldbus connection

⇨ **To enable communication using the Hart®-protocol, and use of a hand-held terminal, a 250 Ω min. circuit resistance is required.
A 250 Ω resistor is connected at terminals A OUT+ and A OUT- at the factory.
Remove the resistor when connecting the output signal.**

3.3.6 Transmitter input and output, measuring range connections

Important: Before installation, ensure that:

1. The mains power supply is connected according to section 3.3.5.
2. The mains power is turned OFF.
3. To ensure interference-free operation, the cable fittings should be adapted for shielded cables. See fig 24 on page 31.

To ensure disturbance-free operation it is essential that cable shields are correctly connected in the cable screw caps - see fig 24.

Wiring the signal screw terminals:

The screw terminals are in the lower section of the connection terminal fig 25 on page 32.

4. Strip the cable covering so the shield is exposed. Use the shortest possible length of the connection wires.

⇨ **Unshielded long, looped wires may cause signal interference! Strip only enough insulation from the wires to insert them. The wires are connected according to fig 26 on page 32. Once the wires are inserted, tighten the screws to secure them.**

5. Tighten the nut fully to ensure a good contact for the shield.
6. Turn on the power and test the functionality.

3.3.7 Digital communication using the Hart®-protocol

Certain functions are available as a digital signal under the Hart®-protocol and BELL 202 modem standard.

⇨ **The transmitter complies to Hart®-protocol standard requirements. A BTG handheld terminal is used to set and calibrate the transmitter. As this unit provides additional functions not covered by the Hart®-protocol, a standard Hart®competitive terminal offers only limited functionality.**

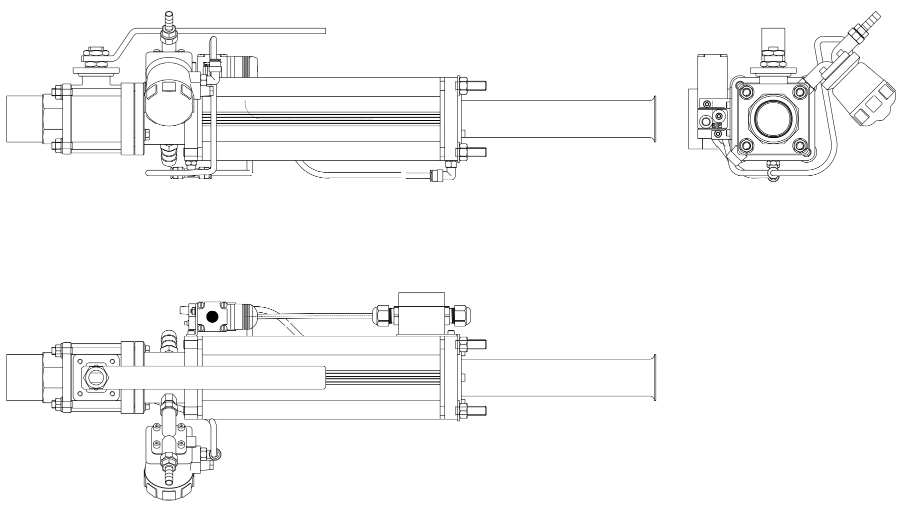
Communication takes place as a superimposed signal over the 4-20 mA output signal loop.

⇨ **For details, please contact the Hart® Communication Foundation or BTG.**

3.4 Probe cleaning system (option)

This section describes how to install the PCD-1000 probe cleaning device. The system can be delivered as a separate unit for rebuilding existing units or together with a complete TCT-2301 transmitter. If the cleaning system is ordered with the TCT-2301 the probe will be mounted in the cleaning device at the BTG factory. The installation method is described for both cases.

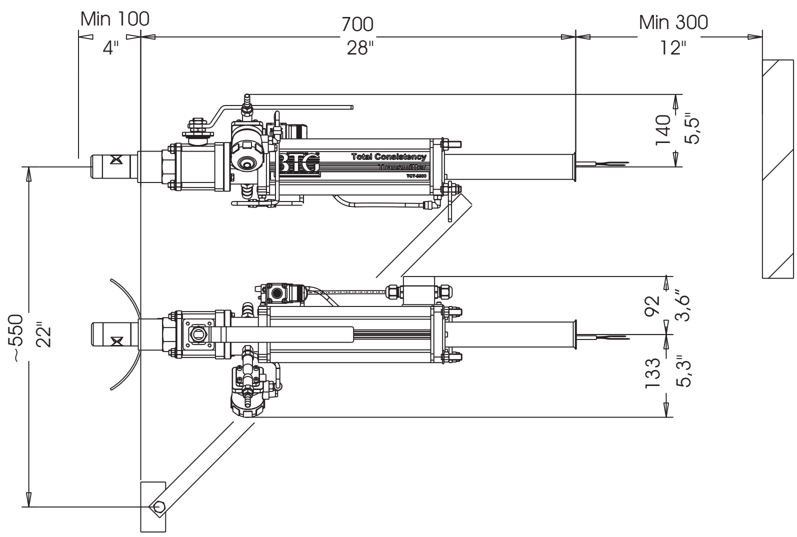
Fig 27 PCD-1000 probe cleaning device



3.4.1 Dimensions and installation clearance

Ensure that there is sufficient clearance to remove the probe and cleaning device from the valve assembly.

Fig 28 PCD-1000 dimensions



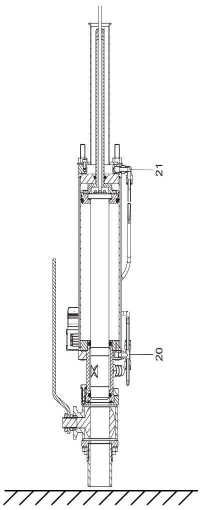
The installed device is approx. 700 mm (28 in) long. You will need at least 300 mm (12 in) to remove the device from the valve arrangement. The cleaning device weighs approx. 9.5 kg (21 lbs) including the TCT-2301 probe.

3.4.2 Installing the PCD-1000 upgrade kit

This section describes how to upgrade an existing TCT-2301 transmitter with the probe cleaning device PCD-1000/A (accessory).

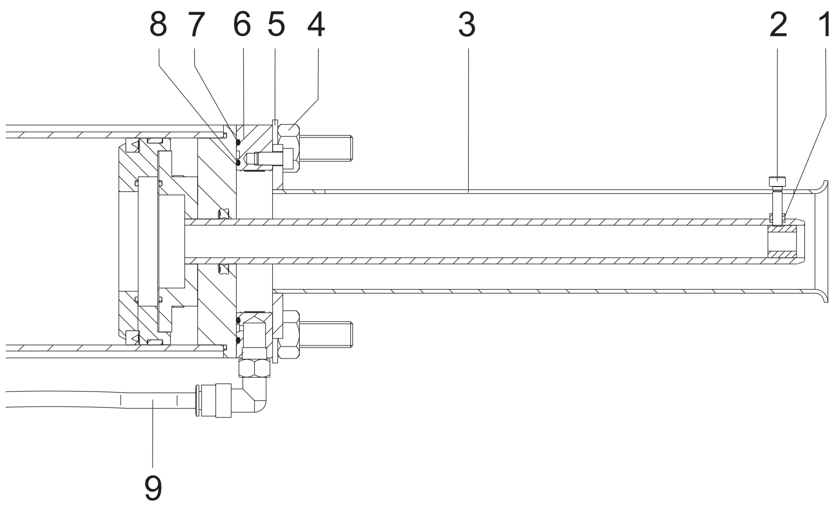
⇨ **Make sure the pipe is empty and pressureless before starting the installation.**

1. Remove the TCT-2301 probe from the existing valve arrangement, note the measuring angle, that is, the measuring gap angle in relation to the pulp flow.
2. Disconnect the optical connection from the TCT-2301 electronics box. Protect the optical connection with a plastic tube or similar.
3. Remove the handle and the flange with the angle scale.
4. Place the cleaning device on a workbench with the valve facing downwards.

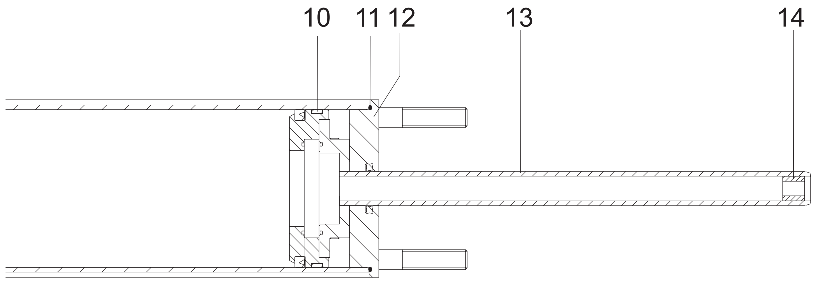


⇨ **To keep all O-rings in position during disassembly/assembly, always place the cleaning device in a upright position with the valve facing downwards.**

Fig 29 Sequence of installing the PCD-1000 upgrade kit



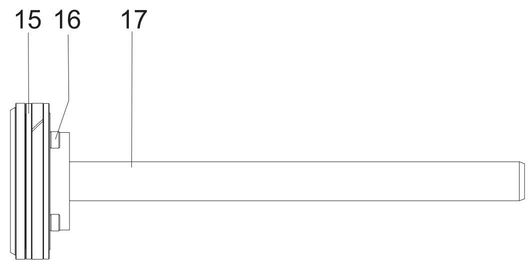
5. Unscrew and remove the screw (2) and the nut (1).
6. Unscrew and remove the nuts (4) and the washers (5).
7. Loosen the air tube (9) from the nipple and remove the rear cylinder flanged end (6) together with the protective sleeve (3).
   Keep track of the O-rings (7 and 8).



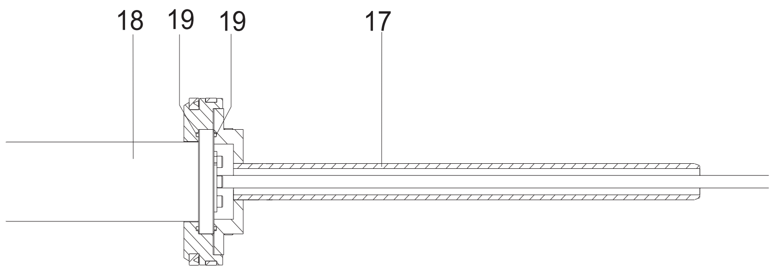
8. Remove cylinder flanged end (12) and pull out piston with guiding rod (13). Keep track of O-ring (11) and guide ring (10).

   Alternatively, pull out the cylinder flanged end and piston in one piece and separate them afterwards.

9. Remove the rubber bushing (14) from the guiding rod.



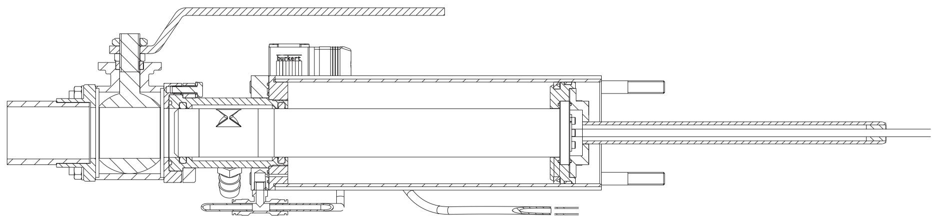
10. Loosen the screws (16) and separate the piston (15) and guiding rod (17) from each other.



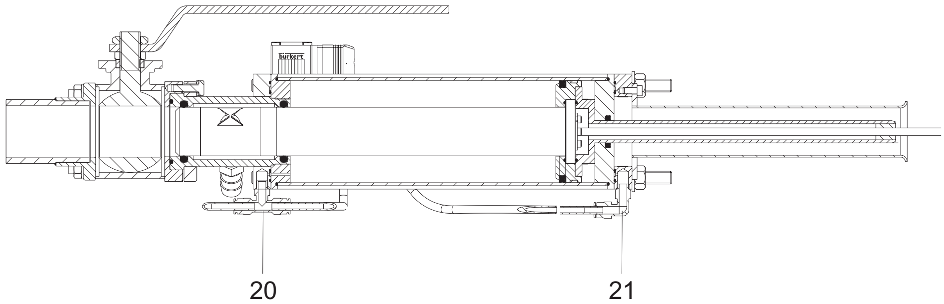
11. Insert the probe (18) in the piston (15) and the fiber cable in the guiding rod (17).

12. Make sure that the screw hole on the edge of the guiding rod is aligned with the measuring gap on the probe. Then join the piston and the guiding rod with the screws (16). Do not forget the O-rings (19).

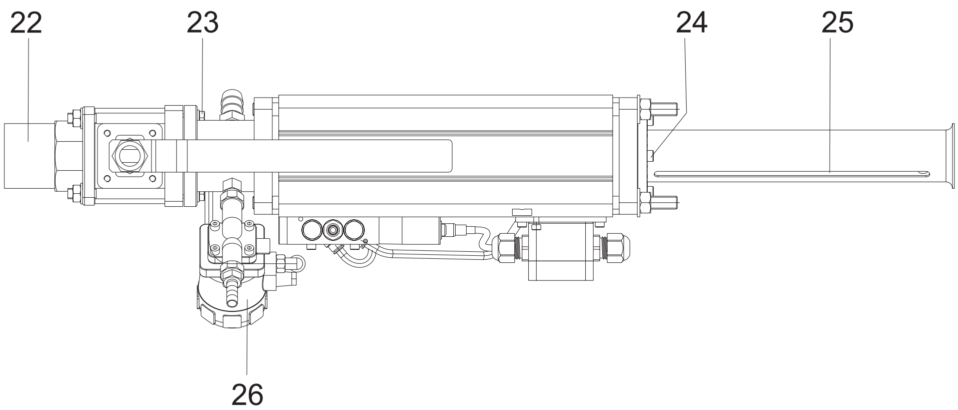
13. Put the accompanying rubber bushing (14) over the fiber cable and push it into the tip of the guiding rod.



14. Push the probe and piston into the cylinder. Make sure the guide ring (10) is in position.



15. Mount the cylinder flanged end (12), the rear cylinder flanged end (6), and the protective sleeve (3), to the cylinder.
    Make sure that the O-rings (7, 8, and 11) are in their proper positions, and that the nipple (21) on the rear cylinder flanged end are positioned on the same side of the cylinder as the nipple (20) on the front cylinder flanged end. The parts must be pulled over the optic cable.
16. Mount the nuts (4) and washers (5), but do not tighten them fully.
17. Connect the air tube (9) to the nipple (21) on the rear cylinder flanged end.

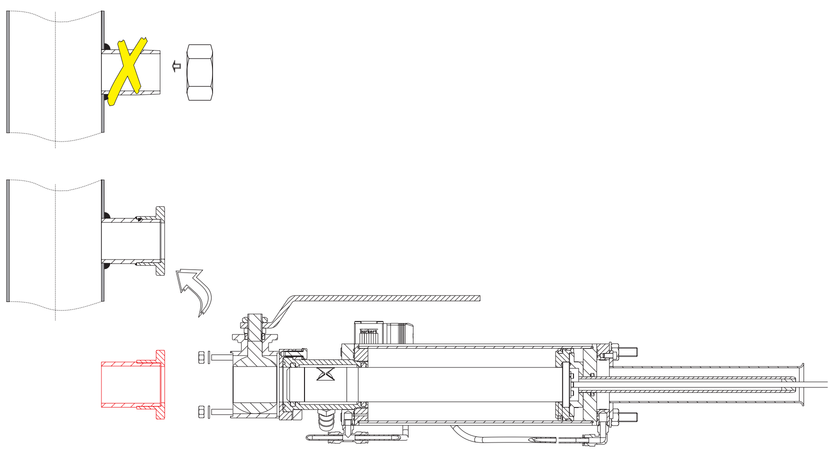


18. Loosen the screws (24) and turn the protective sleeve until the screw hole on the guiding rod is visible through the slot (25).

19. Connect the protective sleeve to the guiding rod with the screw (1) and nut (2).
    The slot on the protective sleeve is now aligned with the measuring gap.
20. Turn the probe, by turning the protective sleeve, until the measuring gap is pointing 45° towards the pulp flow. Use the angle scale on the rear cylinder flanged end for assistance.
21. Tighten the screws (24) to fasten the protective sleeve and to fix the angle of the probe.
22. Loosen the screws (23).
23. Turn the flushing valve (26) so that the inlet faces the measuring gap of the probe. The air cylinder shall at this stage have its quadratic external cross section turned the same way as the flanged ends of the ball valve.
24. Tighten the screws (23) and the nuts (5).
25. If the existing TCT-2301 is mounted with a threaded weld-in stud between the ball valve assembly and pipe, the new flanged weld-in stud (22) must be used.
    Weld the new flanged weld-in stud to the pipe in a new position according to section 3.2.4.
    Plug the old weld-in stud with a blind flange (accessory).

Fig 30 Mounting the weld-in stud

The threaded weld-in stud is not dimensioned to hold the PCD-1000



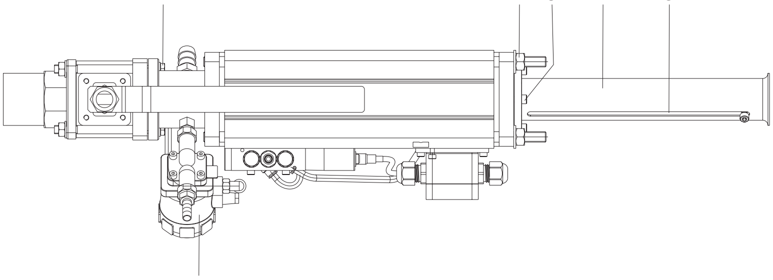
26. If the existing TCT-2301 is mounted with a flanged weld-in stud, remove the delivered weld-in stud from the cleaning device and mount the PCD-1000 to the existing flanged weld-in stud.

If the transmitter is submitted to vibration we recommend using reinforcement. See fig 28 on page 35.

3.4.3 Installing the PCD-1000 probe cleaning device

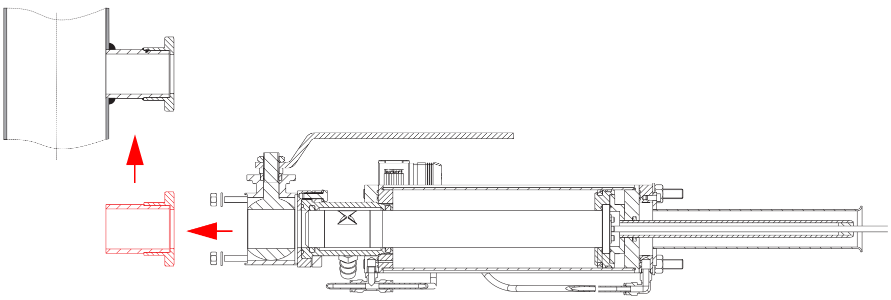
This section describes how to install the probe cleaning device PCD-1000/A that is delivered with a TCT-2301 probe. (Option)

⇨ **Make sure the pipe is empty and pressureless before starting the installation**



1. Loosen the screws (3) that holds the protective sleeve (4) fixed.
2. Loosen the nuts (2).
3. Turn the probe, by turning the protective sleeve, until the measuring gap is at a 45° angle to the pulp flow. The slot (3) on the protective sleeve is aligned with the measuring gap. Use the angle scale on the rear cylinder flanged end for assistance.
4. Tighten the screws (3) to fasten the protective sleeve (4) and to fix the angle of the probe.
5. Loosen the screws (1).
6. Turn the flushing valve (6) so that the inlet faces the measuring gap of the probe. The air cylinder shall at this stage have its quadratic external cross section turned the same way as the flanged ends of the ball valve.
7. Tighten the screws (1) and nuts (2).

Fig 31 Mounting the weld in stud



8. Remove the flanged weld-in stud from the cleaning device and weld the flanged weld-in stud to the pipe, according to section 3.2.4.
9. Remount the PCD-1000 to the flanged weld-in stud.

If the transmitter is submitted to vibration we recommend using reinforcement. See fig 28 on page 35.

3.4.3.1 Probe cleaning device connections

Three connections are needed to make the cleaning device operational.

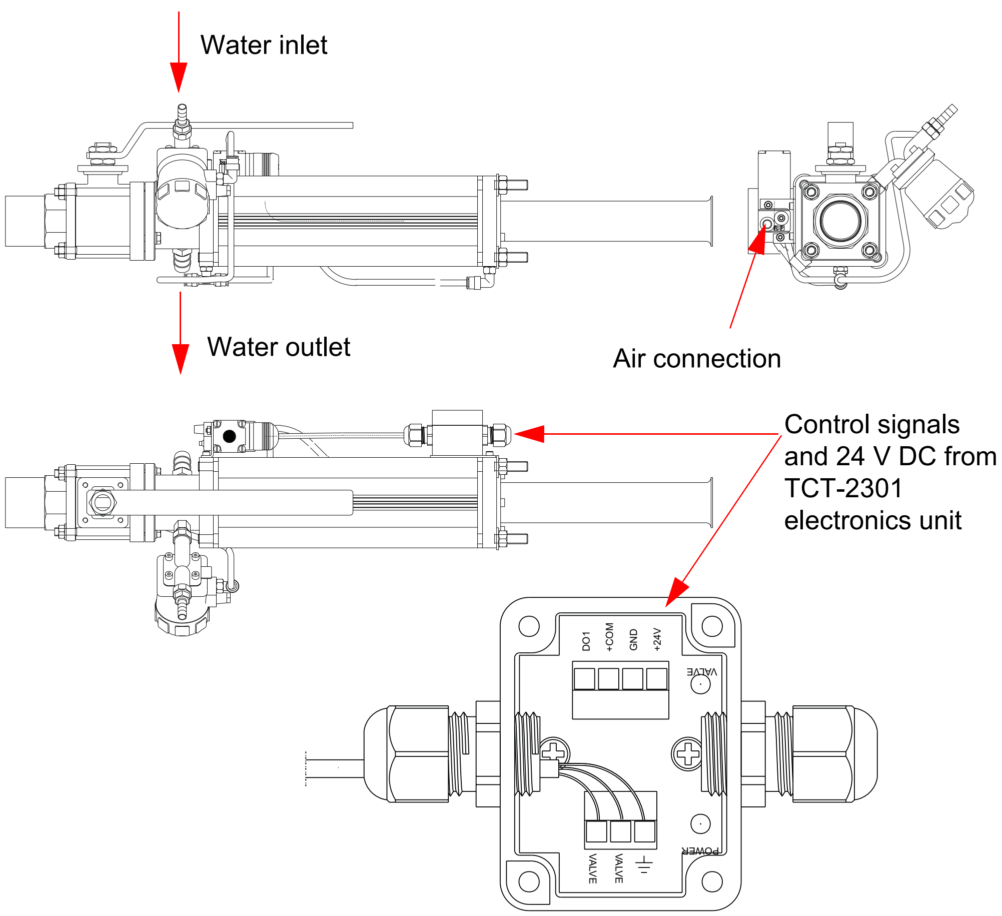
Connection requirement:

Water: Use standard water quality.

Air: 4-8 bar (58-100psi) or at least half the process pressure.

1. Connect water to the membrane valve. The connection is 8.5mm (0.33 in)
2. Connect air to the solenoid valve by 6/4 (1/4 in) hose.
3. Connect the control signal and 24V DC supply from the TCT-2301 electronics box. See section 3.3.5: *Main power supply connections*.

Fig 32 Cleaning device connections



3.4.4 Controlling the cleaning device

All settings to control the cleaning device are made from the TCT-2301 electronics box. Instructions can be found in section 4.6.2.1: *How to change settings and collect samples*.

3.5 Checklist before start

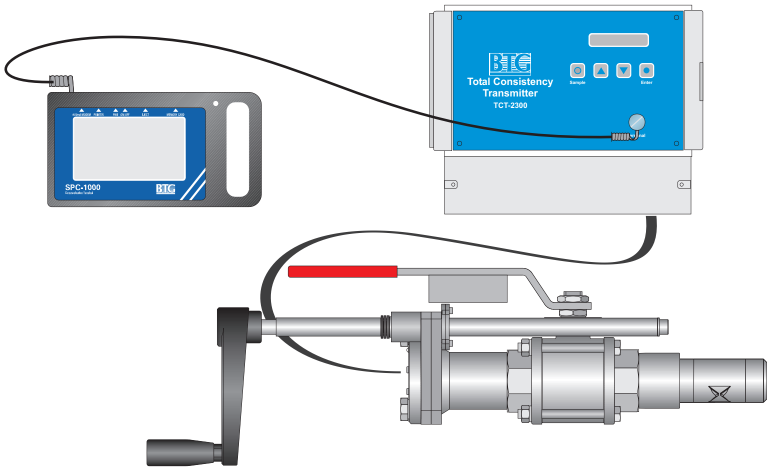
When you are confident that your TCT-2301 has been correctly installed, and are ready to power up the system for calibration and/or testing, run through this brief check list before powering up. Using this list will help ensure trouble-free initialization of your system.

1. Make a clear water adjustment before installing the probe in the ball-valve arrangement. See TCT-2301 operating instructions, section 4.2.
2. Check that the measuring gap on the probe is at the correct angle to the pulp flow.
3. Check that the transmitter is fully inserted and the two security screws are properly tightened.
4. Ensure that the optical fiber is protected from mechanical damage, and attached securely to the transmitter.
5. Check all wiring.
6. Switch on the mains power supply.
7. Connect the hand-held terminal to the electronics box. Switch it on and check that the display lights up.

Proceed to the TCT-2301 Operation instructions.

4 Operating instructions

Fig 33 TCT-2301 consistency transmitter with electronics box and hand terminal



4.1 Starting the transmitter

All settings are made from the hand-terminal, SPC-1000, or from the electronics box.

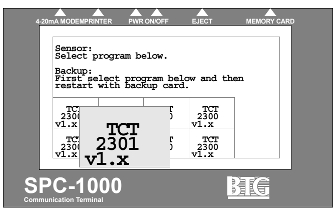
This chapter describes the handling of the transmitter and its possibilities

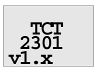
All functions can be accessed from the hand-terminal, while the display on the electronics box only provides certain functions, see description in section 4.6: *Electronics box display menu*.

Before getting started, the transmitter must be installed in the pulp line, the electronics box wired electrically and connected, and the power switched on according to section 3: *Installation instructions*.

The hand-terminal, SPC-1000, is very easy to handle. It is equipped with a touch-screen with buttons to make selections and settings. See section 4.7: *Hand-held Terminal SPC-1000* for further information.

Connect the SPC-1000 to the front of the electronics box. Switch on the hand-terminal.



Select 

from the menu.

Before making any changes, always read all transmitter data 

.

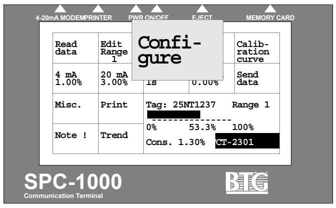
Should a failure message appear on the screen, see section 5.4.3: *Software Fault feedback SPC-1000* for action, if necessary.

All changes made must be downloaded to the transmitter to take effect.

Use 

. This function can be password protected. See section 4.7.2: *Code protection*.

4.1.1 Adjusting TAG / Serial no.

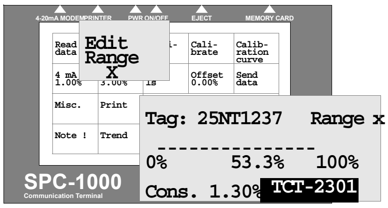


The TAG is the transmitter identification name in the process. Maximum 8 identification characters can be entered (letters and/or digits).

The setting is done using [Confi-gure] followed by [Tag.no 25NT1237].

Enter the required TAG. The buttons have several characters, select the correct one by pressing several times, wait two seconds and the cursor will jump to the next position.

4.1.2 Measuring range



The transmitter can handle four different measuring ranges and calibrations. Different ranges make it possible to have different calibrations for different qualities and conditions in the process.

Connection of different ranges is done via binary inputs, see section 3.3.6: *Transmitter input and output, measuring range connections*.

Range 1 is always active if nothing is connected to the binary inputs.

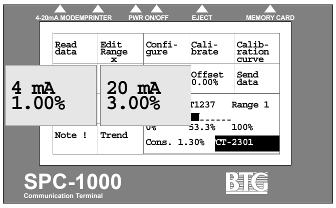
Make sure changes are made in correct range, select using [Edit Range X].

The active range is shown on the main menu, lower right ”*Range: X*”

4.1.3 Select measuring unit

Unit selection is made using **Confi-gure** , **Tx. Spec** . Press **Unit xxx** to switch between mg/l and %. End by pressing **Send page** .

4.1.4 Setting measuring span



Try to keep the measuring span as narrow as possible.

Specify the consistency values represented by output signals of 4 mA and 20 mA respectively.

4.2 Clear water adjustment

4.2.1 At start up

A high-quality consistency measurement depends on a good zero reference value. The zero reference value is the signal when the probe is put in Clear Water (CW).

⇨ **The water used for clear water adjustment must be of drinking water quality.**

The purpose of this adjustment is to establish the LED intensity setpoint in water to have a zero reference when measuring in water.
It also provides a comparison value when cleaning the probe.

For LED intensity adjustment select `Confi- gure` .

The following menu appears, see fig 34. Then press `Led int. adjust`

Fig 34 Configure sub-menu

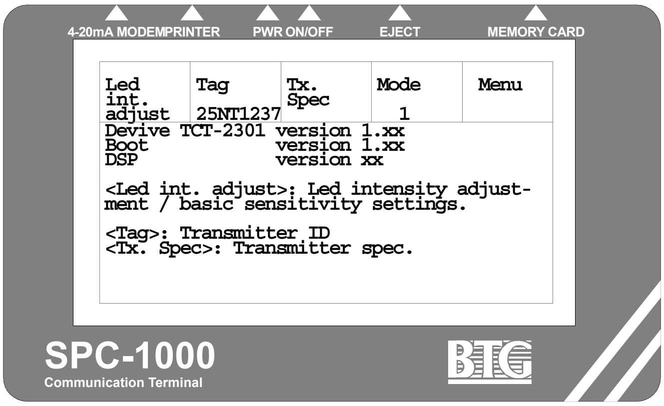
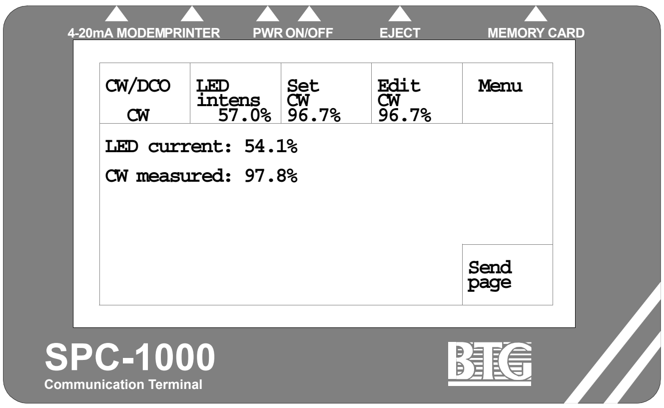


Fig 35 shows the following menu.

Fig 35 LED int. adjust sub-menu.



1. Fill a bucket of drinking water and put the probe in the water. Make

sure that no air bubbles are trapped in the measuring gap on the probe.
Remove any air bubbles with your fingers.

2. Make sure the transmitter is set for clear water, [CW/DCO CW] . If the key is set on [CW/DCO DCO] a dark signal adjustment will be made. This adjustment has been made in the factory and need not be repeated. The dark signal adjustment is made using the plastic plug in the optical connection instead of the probe.
3. Check that the CW measured value is 100% ± 5. If this is the case no further action is needed, continue with 4.3.2. Otherwise continue with point 4.
4. Change the LED intensity by pressing [LED intens 57.0%] .
   Change the LED intensity in steps by 2. Send the setting to the transmitter by pressing [Send page] and [Send change] .
5. Check that the CW measured value is close to 100% (±2%). If not, repeat step 4.
6. When the CW measured value is stable press [Set CW 96.7%] to store the value. Send the setting to the transmitter by pressing [Send page] and [Send change] .
7. Install the probe in the valve arrangement and lock it properly using the two screws.

Changing the LED intensity adjustment changes the setting of the transmitter. This must be done only when the probe is in clear water.

⇨ **Check that the measuring gap on the probe faces the flow at the correct angle. See section 3.2.5 for instruction on how to change the angle.**
See section 4.2.3 for recommended angle settings

⇨ **The key *"Edit CW xx.x%"* is used to manually send a water value to the transmitter if needed.**

4.2.2 Selecting the correct ”mode”

The TCT-2301 has preset calibration curves for different fiber types. Fiber types are divided into two main groups, low-strength pulp (short fiber) and high-strength pulp (long fiber).

This setting is located under [Confi-gure]. See fig 34 on page 46.

Press the [Mode 1] key to select the correct preset calibration curve depending on the actual fiber type:

[Mode 1] : **This mode is for short-fiber pulps, such as recycled and groundwood.**

[Mode 2] : **This mode is for pulp types such as kraft pulp, TMP, CTMP etc.**

[Mode 3] : **This mode contains a linear curve and is not normally used.**

⇨ **Please contact BTG for further information on different pulp and fiber types.**

4.2.3 Adjustment of measuring gap angle.

It is important that the measuring gap faces the flow at the correct angle. Follow these guidelines.

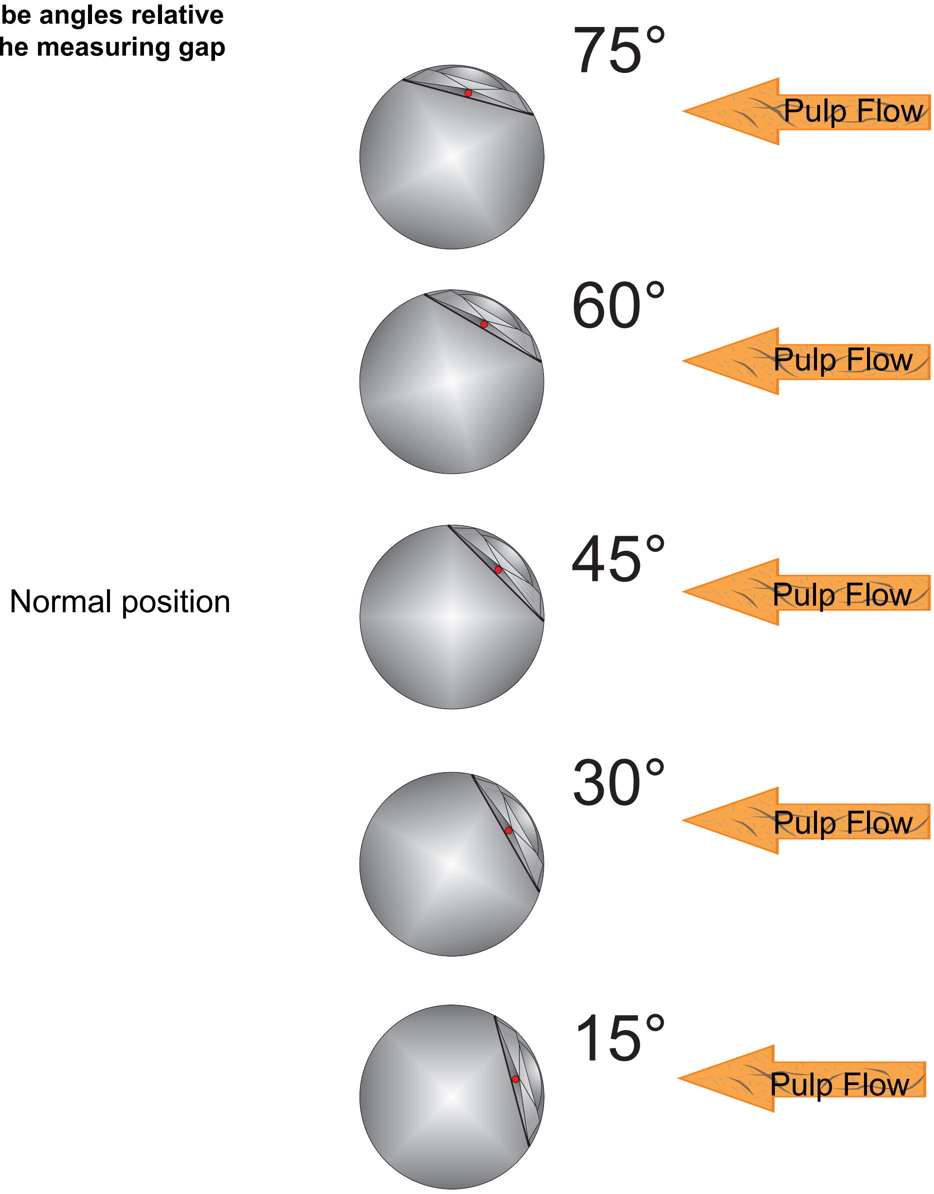
Start with the standard setting, 45° facing the flow.

If the signal from the transmitter appears to be unstable despite using the angles above, make the following quick test to see if can be improved. Remove the probe from the line, see section 3.2.5: *Mounting the probe in the valve assembly*, and adjust the angle in 15° increments. (15°, 30°, 45°, 60°, 75°). Install the probe and observe the signal from the transmitter.

⇨ **Contact BTG for further technical information.**

⇨ **Never go under a 15° or over a 75° angle to the measuring gap. This could spoil the cleaning effect of the measuring gap and/or create a plugging effect.**

Fig 36 Probe angles relative to the measuring gap



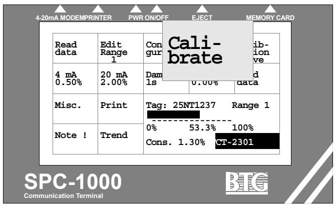
⇨ **Definition:**
At 0° the measuring gap points directly towards the flow.
At 90° the measuring gap points towards the pipe wall.

The transmitter is now ready for calibration against pulp samples.

4.3 Calibration

This section assumes that you have completed section 4.2, and studied the operation of the hand-held terminal as described in section 4.8.

4.3.1 General remarks on calibration



The transmitter should be calibrated for the specific application after it has been installed in the line and all connections have been made.

The measuring principle used by this transmitter is insensitive to different wood species and normally one calibration can be used with different pulp/stock qualities.

The amount of filler can vary in different pulp/stock qualities and this can affect the output signal. This can be handled by using different calibrations (Measuring range).

4.3.1.1 Criteria for calibration

1. The transmitter is installed and has been started up.
2. A clear water adjustment must have been made as per section 4.2: *Clear water adjustment*.
3. The hand-held terminal must be connected to the electronics box and switched on, and the transmitter data read into the terminal as per section 4.1: *Starting the transmitter*.
4. The correct mode must be selected as per section 4.2.2: *Selecting the correct ”mode”*.
5. The pulp must have representative consistency and flow values.

4.3.2 General remarks on sampling

> **The only way to calibrate the transmitter correctly** is to take correct laboratory samples and adjust the transmitter accordingly.

Additional information can be found in *”**Accurate Consistency** — a hand-book in consistency measurement in pulp and paper processing”*, available from BTG.

To ensure acceptable precision in laboratory samples, *we recommend use of BTG sampling valves.*

Sampling procedure:

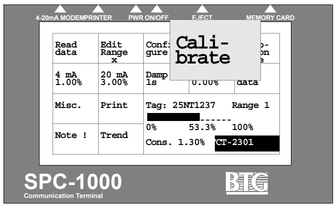
1. Install the sampling valve close to the transmitter. The valve should be installed so there is no interference from pipe bends, pumps, etc. Recommendations regarding turbulence damping zones are the same as for the transmitter itself.
2. Take at least two, preferably three, laboratory samples. Calculate the mean value; reject samples that deviate widely from the mean. Take an adequate volume for sampling – at least 500 ml (1/2 US quart) for a reliable sample.
3. Make sure that samples for calibration and subsequent checking are **always taken in the same manner** regardless of who does the sampling. Similarly, the **laboratory procedure** must always be exactly the same.

The design of, and compliance with, sampling routines is crucial in assuring uniform treatment of samples. Calibration and future precision of measurement by the transmitter depend on this.

During calibration, the pulp flow past the Transmitter must be *representative* for the position in which it is installed.

To simplify and improve the regular follow-up routines, the BTG Smart lab sampler - SLS-1000 is a useful aid.

4.3.3 Calibration procedure



Normal calibration is very simple, only one sample needs to be taken.

The functionality of the TCT-2301 means that a single point calibration or even the preprogrammed curve is often fully adequate.

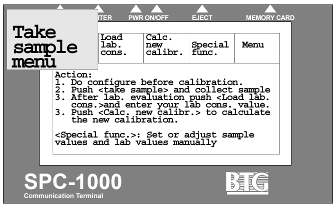
Since only one sample is taken, it is very important that it is correct. Therefore, take out a large sample so that several consistency determinations can be made at the lab, and an average value can be downloaded to the transmitter.

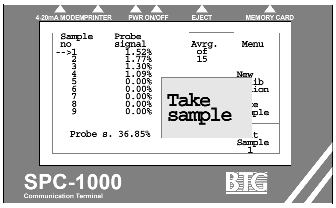
⇨ **It is important to read data to the SPC each time it is connected. It is also important to continuously send all changes.**

4.3.3.1 Summary

1. Collect values using the SPC at the same time as pulp samples are taken from the line.
2. Evaluate the sample at the lab.
3. Enter the lab value in the SPC.
4. Calculate calibration constants.
5. Send the calibration values to the transmitter.

4.3.3.2 Take sample





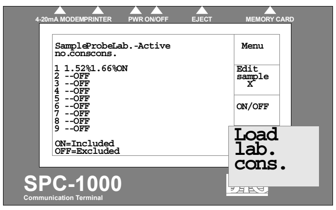
The [Take sample] menu is located under the Calibration menu.

1. Select a free position in the table using [Edit sample X], note the number on the sampling can.
2. Select the number of measuring values the transmitter is to collect by pressing [Avrg. of X]. The time for collecting measuring values is the time needed to take a sample from the line (it takes approximately 2 seconds to collect a value, so an average of 5 takes approximately 10 seconds).
3. Press [Take sample].
4. Collect pulp samples from the line.
5. The handterminal displays a graph of signal stability during the sampling. Evaluate the samples displayed to see how stable the signal was.
6. If OK, press [Accept], if not press [Cancel] and take a new sample.

The value is now stored in the SPC and can now be sent to the transmitter. From the main menu, press [Send data].

Evaluate the sample in the lab.

4.3.3.3 Load lab value



Read all data again from the transmitter to the SPC-1000.

Enter the consistency value as follows:

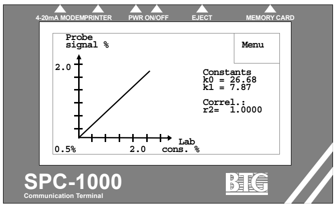
1. Go to menu [Cali-brate] and [Load lab. cons.].
2. Step to correct position for the sample using [Edit sample X].
3. Press [ON/OFF] to active the value (*"ON"*).
4. Press and enter the lab value.

Return to the main menu and [Send data].

4.3.3.4 Calculate calibration

The calibration will not be effective until the calibration value is calculated.

Go to menu [Cali-brate] and [Calc new calibr.] .



The calculation is presented in a graph.

To activate the calibration, send the calibration value to the transmitter.

Go to main menu and [Send data] .

4.3.4 Multi-point calibration

When single-point calibration is not sufficient a multi-point calibration can be used.

Take samples for up to 9 calibration points under different conditions. Try to collect samples that cover the entire consistency span.

If the calibration points (the lab value) are spread over at least half the chosen measuring span, both calibration constants K0 and K1 will be affected. Otherwise only K1 will be affected and K0 will be 0.

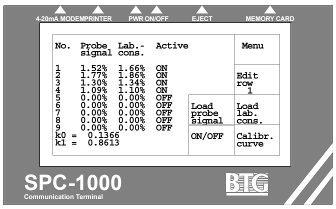
The more points you sample, and the wider their spread within the measuring span, the more accurate the calibration will be.

Perform sampling as in single-point calibration, but take more samples and activate more than one sample in the ”Load lab menu”.

Calculate new K0 and K1.

4.3.5 Calibration with given constants

The two calibration constants K0 and K1 define the calibration curve.



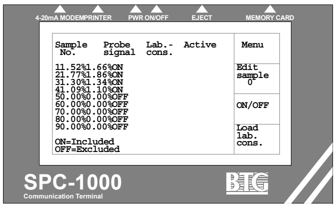
It is a simple matter to enter new constants under [Cali-brate] , [Special func.] . Step down through the menu [Edit row x] and enter desired value.

4.3.6 Calibration table

All values collected for calibration are stored in a single table.

Up to 9 samples can be stored in the table even if only one is used for the calibration (single-point calibration).

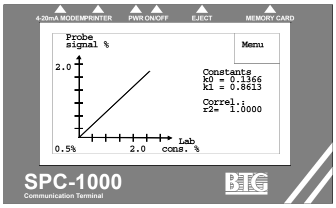
The samples can be activated (ON) in the calibration.



Columns in the load lab menu shown to the left are explained below:

Sample no:	1 to 9
Probe signal:	Value from probe.
Lab cons:	Consistency. Evaluated from sample.
Active:	If this sample is used in calibration Active is set to ON, otherwise it is set to OFF.

4.3.7 Calibration curve



This function is located in the main menu under `Calib- ration curve` .

The probe signal is displayed as a function of the set measuring span xx - xx%. Probe signal points within the predetermined measuring span are displayed. Note that activated calibration points outside the measuring span affect the correlation.

The two calibration constants K0 and K1, and the special correlation factor r2, provide a guide. Note that the displayed probe signal and the measuring span are the same.

4.4 Other functions

4.4.1 Setting time constant (damping)

Do not set a time constant that is too long as this reduces the accuracy of the control system.

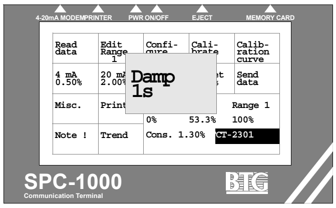
The time constant is set after calibration is complete. Set it so that the signal is stable, normally at 2 to 10 seconds.

If you find that you have to set a very long time constant because the probe signal is unsteady, the transmitter is probably working in an unstable, poorly mixed pulp flow. In such a case you should consider:

- relocating the transmitter further from the source of turbulence.
- improving the remixing system or the supply of dilution water, etc.

If the time constant is too long, the high precision level of the transmitter is reduced. Contact BTG for further advice.

Procedure:



1. Study the stability of the signal under MAIN MENU option [Trend].
2. Go to MAIN MENU option [Damp Xs]. Enter a suitable time constant, e.g. 5 seconds. Press [Send data], [Send change].
3. Return to [Trend] and study the result.
4. If necessary, adjust the time constant.

4.4.2 Setting alarm limits

In the system there is one alarm. The alarm can be set on:

- Cons (Output value, chan. 1)
- Itemp (internal temperature)
- AnaIn (analog input, 0-20mA)
- LedCur (LED current, 0-1000%)

When the alarm is active it affects the digital output signal called Alarm and the value will be written to an event log in the transmitter.

The alarm output should be connected to mill equipment. See section 3.3.6: *Transmitter input and output, measuring range connections* for details.

1. From main menu, press [Misc], [Alarm & diag-nostics].
2. Select alarm to set using [Set alarm]. (One alarm only)
3. Select limits to activate the alarm using [High x.x] and [Low x.x].

   The same units are used for the set value as for the selected alarm.
4. Activate alarm using [Alarm ON].

4.4.3 Offset adjustment

Offset adjustment can be made in two ways:

A: Based on a laboratory sample

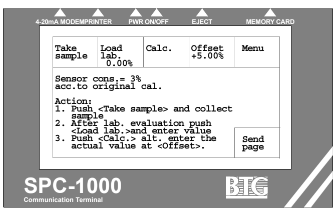
B: Based on a deviation detected from laboratory samples.

⇨ **The entire calibration curve is moved on the basis of a single point, so it is most important that the laboratory sample value for that point is correct.**

The offset adjustment, which is a zero point displacement, can be made on all types of calibrations.

A. Offset adjustment based on a laboratory sample

Procedure:



1. Go to MAIN MENU option [Offset x.xx%].

2. Press [Take sample] , [Start] and save the consistency value to memory in the normal manner, taking correct laboratory samples at the same time.

3. Load the corresponding laboratory sample value, [Load lab. cons. x,x%] xx %. The consistency **according to the original curve** appears in the display, and after pressing [Calc.] the offset consistency appears in the [Offset x.xx%] key in the offset menu.

4. Press [Send page] to transfer the offset adjustment to the transmitter.

5. The offset adjustment can be cancelled at [Offset 0.00%] if you enter the value Ø (zero).

B. Offset adjustment based on a detected deviation

A deviation can be entered directly if a deviation from the laboratory values is detected during regular monitoring of a transmitter's display. Note however that the deviation should be verified by several laboratory samples before carrying out zero point adjustment.

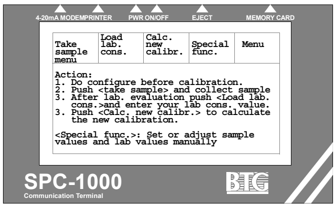
Procedure:

1. Go to the main menu function [Offset x.xx%] .

2. Press [Offset x.xx%] in the submenu and enter the detected deviation.

3. Transfer the value to the transmitter using [Send page] . (Clear the value by going back to the Offset function and entering 0.)

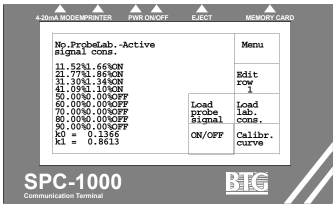
4.4.4 Manual loading of probe signal settings



This function is located under Cali- brate , Special func. .

It is a special function which can be useful in certain cases.

Procedure:

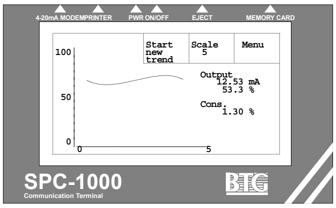


1. Go to MAIN MENU option Cali- brate , Special func. .
2. Step between values Edit row x and load the desired probe signal setting by pressing Load probe signal . Exit by pressing the Menu key.
3. Press Send data , Send change to send calibration data to the transmitter.

4.5 Evaluation and documentation of calibration

When you have made a calibration it should be evaluated, documented and backed up. This data is needed for possible fault tracing, or if the transmitter or electronics card is replaced.

4.5.1 Trend



This function is in the main menu under Trend .

The time scale of the display is changed by pressing Scale 5 . It starts from the point at which the button is pressed.

The 4 - 20 mA output signal is displayed as 0 - 100%. This means that the resolution is relatively low - approximately 1% (0.16 mA) - but the display is still a useful tool when setting parameters such as the time constant Damp 1s .

4.5.2 Documenting calibrations with printer

A standard printer is an invaluable aid that simplifies evaluation and documentation of transmitter settings.

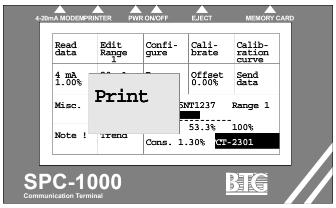
The printer must be EPSON-compatible with an RS232 serial input. The recommended model is SEIKO DPU 414**.** The printer should be set to a baud rate of 2400.

An alternative is to use a special PC program for print out. See section 4.5.4: *Documenting calibration using a PC*.

Documentation can also be made manually. Make a written record of all data listed on the printout shown in fig 37 on page 62, and draw a calibration graph.

⇨ **Actual data is also available at** `Cali- brate` , `Load lab. cons.` **.**

1. Plug the printer into the hand-held terminal socket marked ”PRINTER*”*. Switch on the printer.



2. Select the measuring range to be printed `Edit range X` .

3. In the MAIN MENU press `Print` .

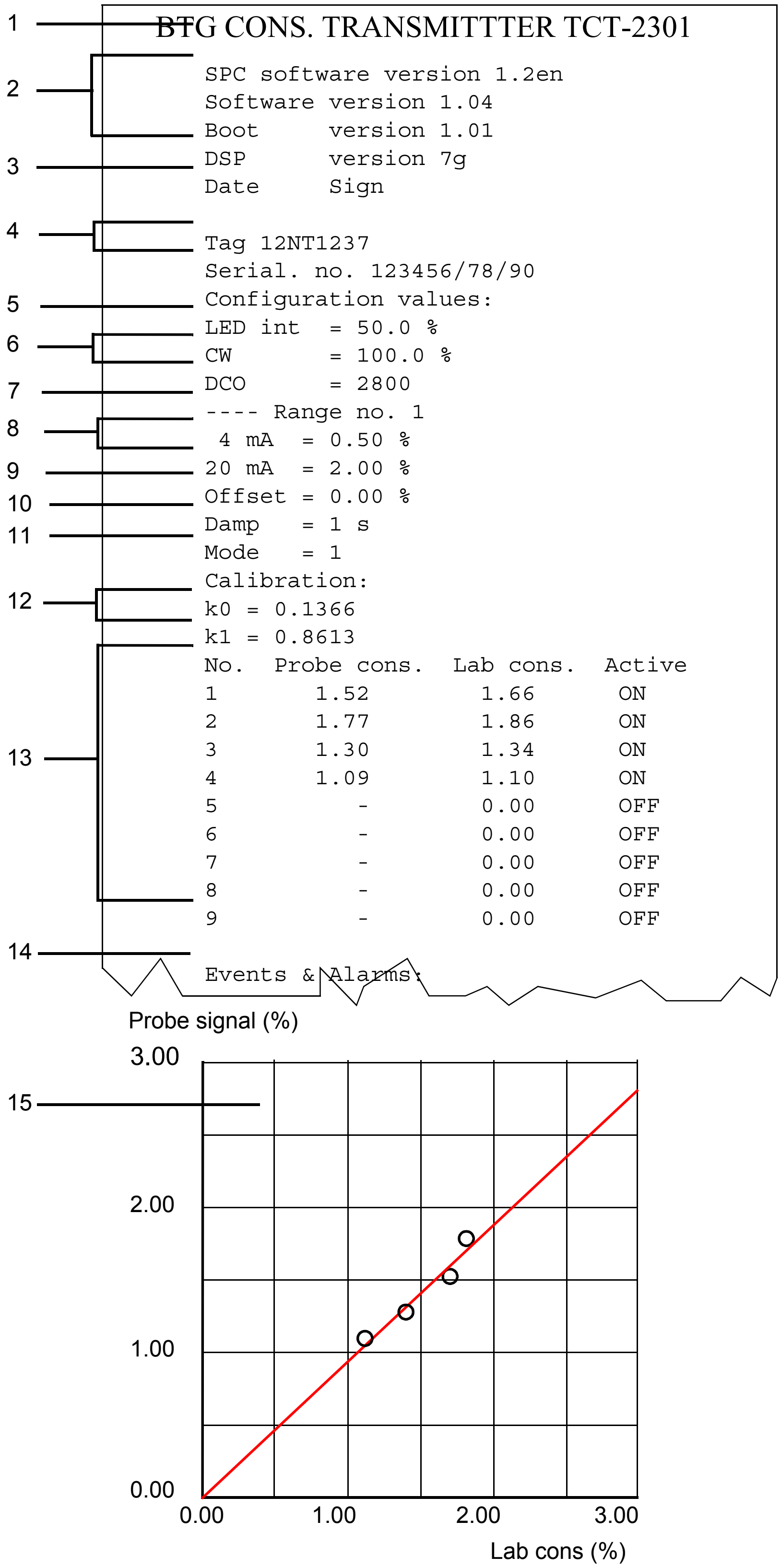
   Then select preferred printer type and a printout is made.

If the display reads ”Reply time out”, check that the printer is correctly plugged in, that the battery is charged or the printer is connected to an AC adapter and that the baud rate (2400) is correctly set.

A sample printout is shown in fig 37 on page 62.

Fig 37 Sample of calibration documentation printout from printer or PC

1 Tx. model
2 Software version
3 Operator data
4 Tx. data
5 LED int.
6 Clear water value
7 Range
8 Measuring span
9 Consistency offset
10 Damping time
11 Mode (fiber type)
12 Calibration constants
13 Calibration data
14 Data log.



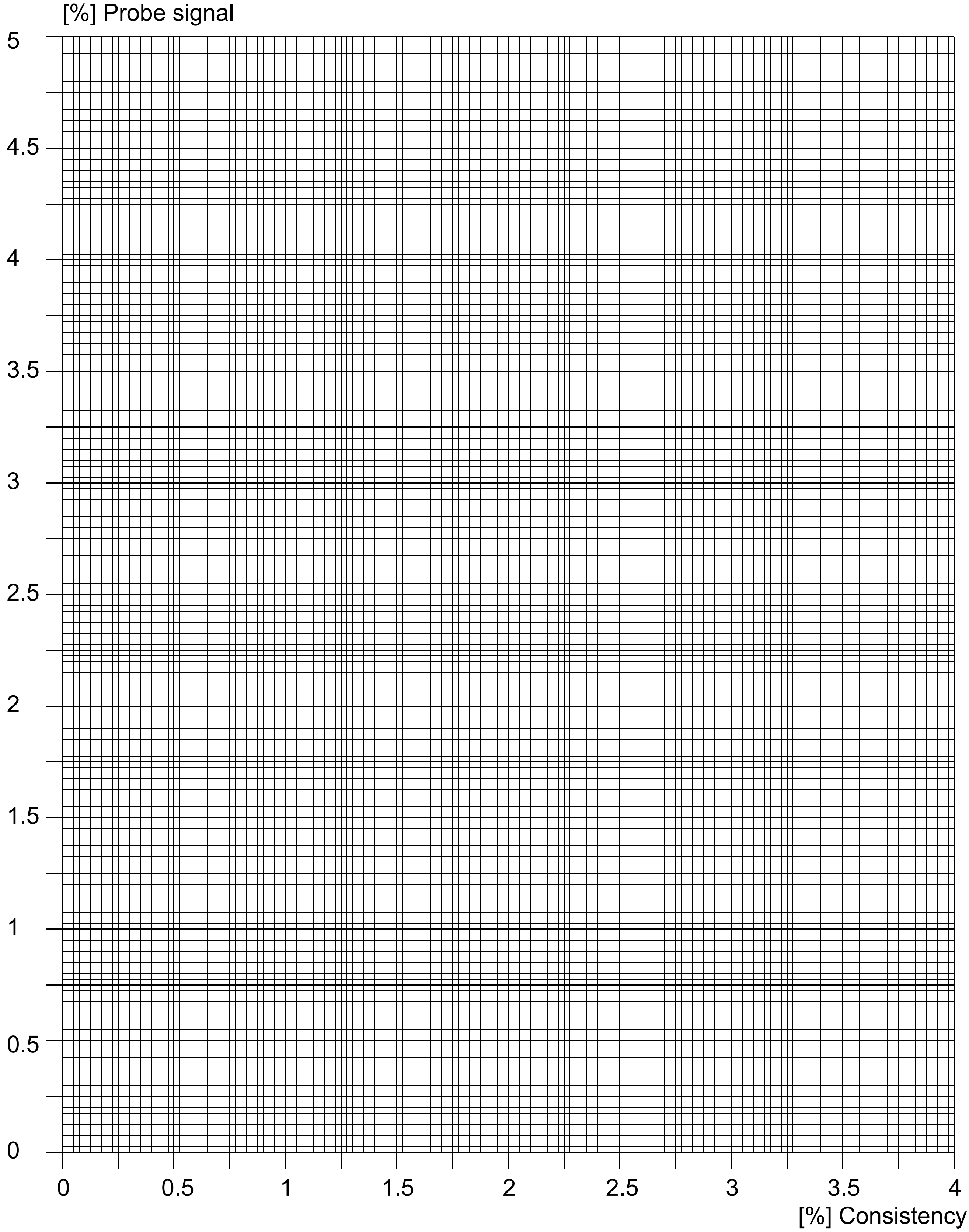
```
BTG CONS. TRANSMITTTER TCT-2301
SPC software version 1.2en
Software version 1.04
Boot     version 1.01
DSP      version 7g
Date     Sign

Tag 12NT1237
Serial. no. 123456/78/90
Configuration values:
LED int   = 50.0 %
CW        = 100.0 %
DCO       = 2800
---- Range no. 1
 4 mA   = 0.50 %
20 mA   = 2.00 %
Offset  = 0.00 %
Damp    = 1 s
Mode    = 1
Calibration:
k0 = 0.1366
k1 = 0.8613
No.  Probe cons.  Lab cons.  Active
1       1.52        1.66       ON
2       1.77        1.86       ON
3       1.30        1.34       ON
4       1.09        1.10       ON
5          -        0.00       OFF
6          -        0.00       OFF
7          -        0.00       OFF
8          -        0.00       OFF
9          -        0.00       OFF

Events & Alarms:
```


* Note: The probe signal values shown in this diagram diagram are not printed on a normal printout.

Fig 38 Calibration diagram for TCT



4.5.3 Documenting calibration using the ”back-up card”

Always switch off the hand-held terminal when changing a memory card. The terminal could be damaged in some cases if this is not done!

All transmitter settings, calibration data and transmitter data can be stored on a special SRAM memory card. This is the ”back-up card”. The card replaces the standard ”sensor card” which holds the transmitter program. The back-up card can store up to 25 complete transmitter settings, including all four measuring ranges. For practical reasons, it is preferable to store only one mill section´s transmitters (TAG) on one card.

A. Storing the transmitter’s data on the back-up card (Store data).

1. With sensor card inserted make a standard complete calibration and adjustment of the relevant transmitter.

   Download data [Read data] from the transmitter.

2. Switch off the hand-held terminal and replace the sensor card with the back-up card.

3. Switch on the hand-held terminal. Press [BACKUP CARD] .

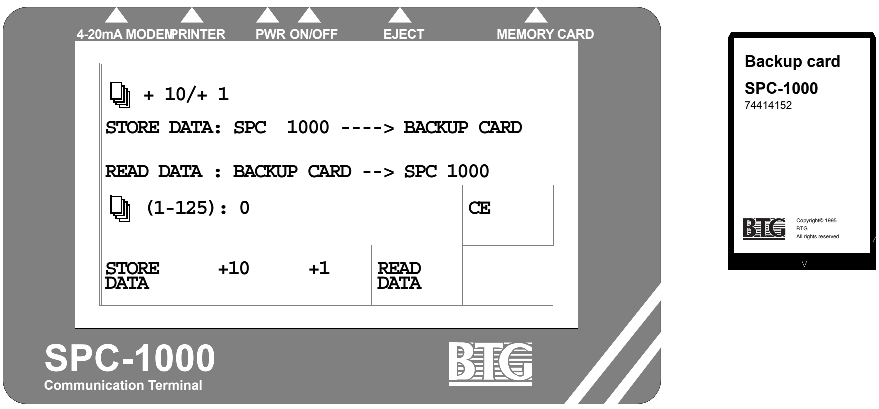
   The message for this function is displayed only in English.

4. Select the relevant storage position. Data can be stored on every fifth position e.g. 5, 10, 15, 20....up to 125, with a total of 25 positions.
   For example, in the case of storage position No. 30 press

   [+10] one time (+25 in each step) = 25 and [+1] one time (+5 in each step) = 5. 25+5=30

⇨ **Transmitter data can only be stored at every fifth position (5, 10, 15 etc.).**

Fig 39 Store data menu



5. Press [STORE DATA] to store the terminal’s transmitter adjustment for

the relevant transmitter (TAG) on the back-up card.

Then press `Verify` for storage to be executed.

⇨ **Note the relevant TAG and the number of the storage position on a separate identification list.**

All four measuring ranges will be stored so each one must be clearly identified in the identification list.

6. Switch off the terminal and replace the back-up card with the sensor card.

Store the back-up card in a safe place protected from moisture. The card is an object of considerable value.

The back-up card can be protected against accidental or unwanted data input by using its write-protect. Activate the write-protect switch to block input.

B. Retrieving transmitter data stored on the back-up card.

1. With sensor card inserted, select `TCT 2301 v1.0` .
2. Switch off the hand-held terminal and replace the sensor card with the back-up card.
3. Switch on the hand-held terminal. Press `BACKUP CARD` .

   The message for this function is displayed only in English.
4. Select the relevant storage position.
   For example, in the case of storage position No. 30 press

   `+10` one time (+25 in each step) = 25 and

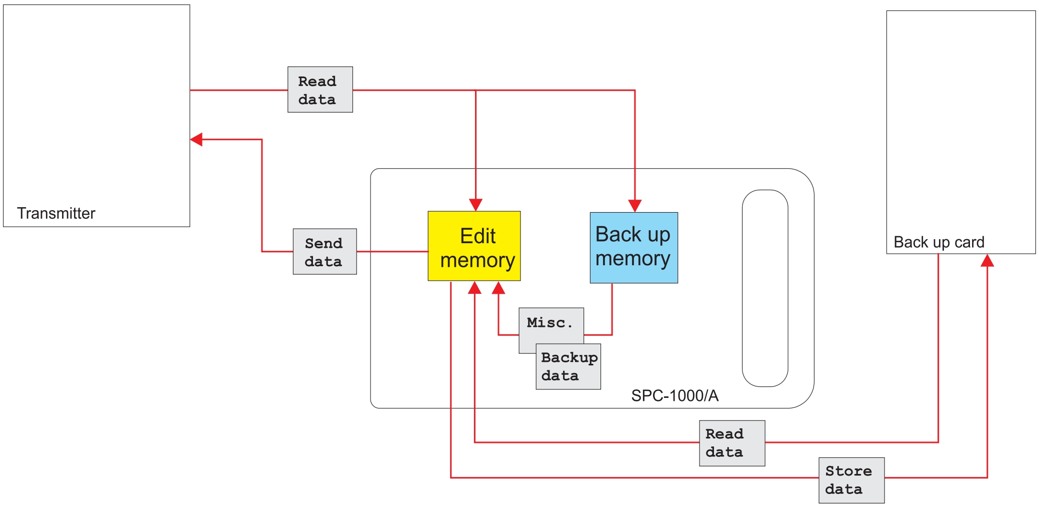
   `+1` one time (+5 in each step) = 5. 25+5=30
5. Press `Read data` to access the relevant transmitter setting from the back-up card and transfer this to the terminal's memory. The relevant Tag number is shown in the identification list as per Item 5 section A: *Storing the transmitter's data on the back-up card (Store data).* Press `Verify` .
6. Switch off the hand-held terminal and replace the back-up card with the sensor card.

7. Switch on the hand-held terminal. Press, TCT 2301 v1.0 .

⇨ **Do not ” Read data ” from the transmitter. If so the values obtained from the backup card will be erased.**

8. The data for the respective measuring range is now available in the terminal for further processing.

Fig 40 Store function of the SPC-1000



4.5.4 Documenting calibration using a PC

If you use Windows 3.1 or later, you can use the ”SPC-1000 Documentation” software, available from BTG. If you have several BTG smart transmitters this is a practical way of storing all transmitter data within the same file.

Installation — Document PC:

The SPC-1000 Documentation program for Windows® comes with an automated installation program called *setup*.

⇨ **”SPC-1000 Documentation” Version 1.21 or later must be used.**

Installing the ”SPC-1000 Documentation” program:

1. Start Windows. Insert the installation diskette (marked ”SPC-1000 Documentation”) into drive A (or relevant drive).

2. Choose Run.

3. In the Command Line text box, type: *a:\setup*, then select *OK*.

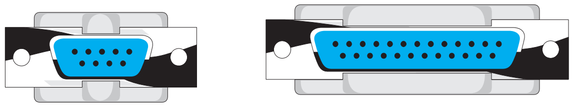
4. Follow the instructions to install the program to your hard drive.

Connection and starting your program:

⇨ **Arrange a suitable library in the File manager to help you to keep track of downloaded files (TAGs).**

1. Plug the serial cable into a free comm port on your computer, using either a 25-pin or a 9-pin, and into the hand-held terminal (marked ”PRINTER”).

Fig 41 PC serial connections



2. Double click on the BTG icon.
3. Double click on the SPC-1000 terminal icon.
4. Click on ”*CommPort*”, ”*Settings*” and select the connected comm-port. (normally selected automatically)
5. For more help click on the menu choice ”Help”.
6. Switch on the handheld terminal and press `Read data` .
7. Send data to PC: Main menu option `Print` .
8. Press option `PC` and values as well as calibration curve are copied to PC.
9. Save (and print if necessary).

4.6 Electronics box display menu

4.6.1 General information

The TCT-2301 electronics box is equipped with a display and four keys. The dimension of the display is one row with sixteen characters. This allows the operator to make some basic adjustments without using the handheld terminal SPC-1000. To make a complete calibration or other major settings the SPC-1000 must be used. Settings made using the electronics box can be read from the SPC-1000 for documentation and printout.

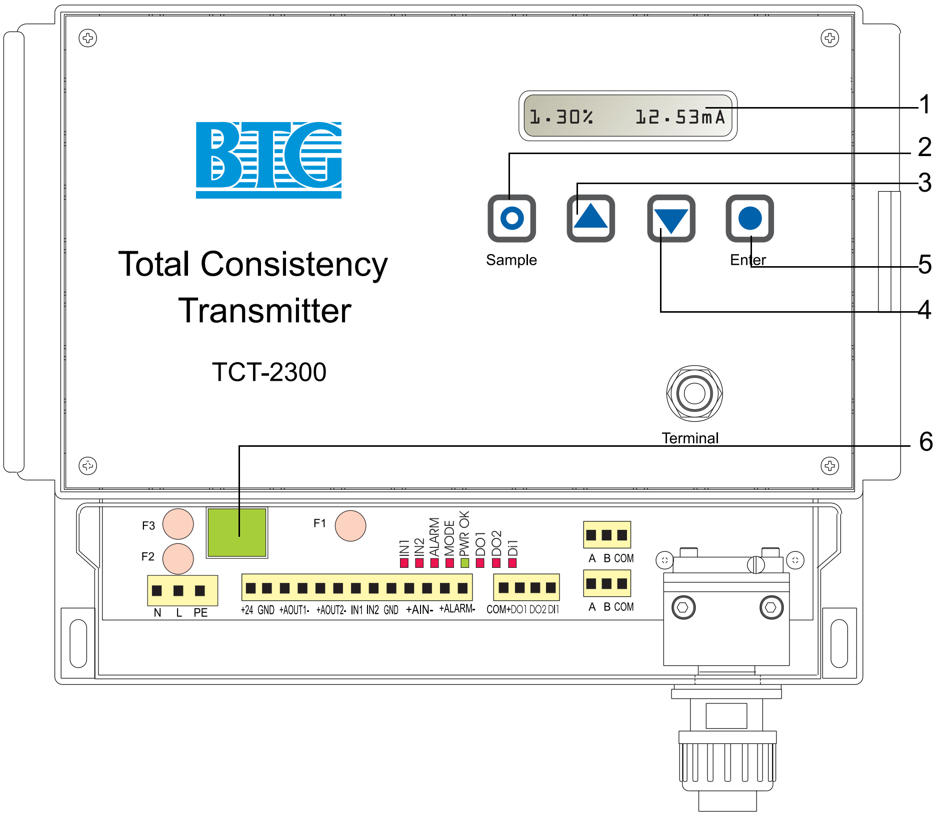


Fig 42 Electronics box front panel with buttons and display

1 Display: 1 row 16 characters
2 Sample button: to store probe signal for calibration or consistency value for offset adjustment.
3 Arrow up button: to scroll in the menu, change a value or discard sample
4 Arrow down button: to scroll in the menu, change a value or discard sample
5 Enter button: to select menu options, verify entered values
6 Power button

4.6.2 Menu structure

⇨ **After 15 seconds, the transmitter always returns to the result display regardless of where it was in the menu structure.**

Start up display	`TCT-2301` `Ver x.x`	Shows transmitter model TCT-2301 and software version.
Result display 1	`1.30%  TCONS`	Result display, shows consistency.
Result display 2	`12.53mA TCONS`	Result display, shows consistency output signal.
Range setting	`RANGE 1`	Current measuring range, can be changed to feed in values for other ranges (range 1, 2, 3 and 4).
Span setting	`SPAN`	Measuring span, low limit = 4mA high limit = 20mA.
Offset adjustment	`OFFSET`	Consistency offset if required.
Damping setting	`DAMPING`	Damping on output signal.
Calibration setting	`CALIBRATION`	Calibration constants for the transmitter.
Cleaning cycle	`CLEANING`	The cleaning system is an option for the TCT. All time settings to control the system are made here.
Language selection	`LANGUAGE  en`	Language setting, in this case English.

Press the arrow buttons to step between menu items.

4.6.2.1 How to change settings and collect samples

Result display

`1.30% TCONS`

When the result display is shown, samples can be collected for calibration purposes.

Press the sample [button] and collect a sample from the pipe for lab evaluation.

`NO:5 *`

The display indicates the position in the calibration table where the sample will be stored. The first empty position in the table is selected.
Mark the lab sample with this number. Value X will be counted down for each signal stored. An average will then be calculated.

`NO:5 1.30% OK?`

Save the sample by pressing enter [button], discard the sample by pressing [up] or [down].

`SAMPLE SAVED`

Enter [button].

`NOT SAVED`

[up] or [down].

`SAMPLE TAB FULL`

If all nine samples in the calibration table are already used, select the sample to be replaced with a new probe signal value.

`9`

Press enter [button] and select which calibration sample to replace using the [up] or [down] buttons. Verify with enter [button]. Press [up] or [down] to return to result display without replacing any calibration sample.

`NO:9 *`

The display indicates the position, take out the lab sample at the same time.

`NO:9 1.35% OK?`

Enter [button] to save the value, [up] or [down] to discard.

⇨ **Always mark the lab sample with the number indicated on the display. The handheld terminal SPC-1000 must be used if you are making a complete calibration.**

Range setting

`RANGE 1`

Press enter to select another range.

`1`

Press or to specify range. Verify by pressing enter. Note! The transmitter is still operating on the range set by the external switch.

Span setting

`SPAN`

Press enter to change span.

`0.50-2.00 %`

The first number is blinking, press or to change the number, press enter when ready and go to next number and repeat the procedure.

`1.00-2.50 %`

When the last number is blinking, press or to change and enter when ready.

`SPAN`

The result will be stored in the transmitter and the display will return to the menu.

Offset adjustment

`OFFSET`

`SAMPLE *`

Press the sample in this position and collect a sample from the pipe for lab evaluation.

`1.77% OK?`

Press enter to save the value, press or to discard the value.

`SAMPLE SAVED` Enter .

`NOT SAVED` or .

`OFFSET` When the lab evaluation is ready, step down to offset and press enter .

`1.77% +0.00%` Calculate the offset, this means the lab value minus the saved value. If the lab value is 1.69 the offset in this case will be 1.69–1.77=–0.08%.

`1.77% -0.00%` The + sign is blinking, press or to change sign, press enter when ready.

The first digit starts to blink, press enter twice to step to the last digit.

`1.77% -0.08%` Press or to change the digit.

End by pressing enter .

`OFFSET` The display will return to the menu.

Damping setting

`DAMPING` Press enter if the damping value is to be changed.

`00 s` Press or to change value, verify with enter .

Calibration setting

`CALIBRATION` Calibration constants for the transmitter. Press enter and then or to step between calibration constants.

	`K0 0.2`	Press enter if the value is to be changed. Press or to change value, verify with enter .
	`K1 1.15`	Press enter if the value is to be changed. Press or to change value, verify with enter .
Cleaning cycle (option)	`CLEANING`	Press enter to change the cleaning cycle. Use the arrow buttons to step between Cycle, Flush and Resume.
	`CYCLE 0000 m`	Press enter to change the cycle time. This is the time in minutes between each cleaning.
	`0000 m`	Press or to change value, verify with enter . (Set to 0 if not used.)
	`FLUSH 00s`	Press enter to change the flush time. This is the time in seconds that it takes to retract the probe and to flush the measuring gap clean.
	`00s`	Press or to change value, verify with enter . (Set to 0 if not used.)
	`RESUME 00s`	Press enter to change the resume time. This time is to allow the probe enter back into the pipe before the TCT-2301 starts to measure again. Also set in seconds.
	`00s`	Press or to change value, verify with enter . (set to 0 if not used)

Language selection

`LANGUAGE   en`

Selected language is indicated by the lower case letters.

`English`

`Svenska`

`Español`

`Italiano`

`Deutsch`

`Português`

`Suomi`

`Français`

Press enter to change language.

Scroll with the or keys to the desired language.

Verify with enter .

4.7 Hand-held Terminal SPC-1000

When communicating with the sensor, the hand-held terminal is normally placed in the special terminal holder installed on a wall close to the electronics box.

Fig 43 Handling the SPC-1000 terminal

When the terminal is not in the wall terminal holder, place it on your left forearm (for right-handed users) and hold it securely using the hole in the handle. This is the most practical and safest way of using it, you can work properly without damaging the terminal.

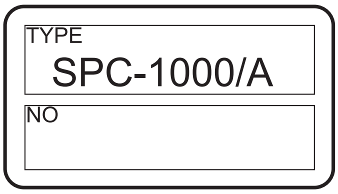
The telephone jack on the spiral cable can be parked in the hole in the rubber transport casing.

Make sure that your hand-held terminal is upgraded to a SPC-1000/A

You may need to upgrade your SPC-1000 to use it with the TCT-2301.

Check the sign on the back of the SPC-1000 to see if you have the required version SPC-1000/A.

Fig 44 Type sign



If you have a previous version of SPC-1000, an upgrade kit is available. You can also send it to BTG for upgrading.

SPC-1000/A version can be used with all BTG smart transmitters.

⇨ **Treat the terminal with care. Do not abuse it physically, submerge it or spray it with water. Avoid storing it in a humid environment for long periods.**

4.7.1 Power supply

The hand-held terminal can be powered in three different ways:

- 12 V DC supply from the electronics box
- 12 V DC supply from an AC adapter
- 9 V DC from an internal battery.

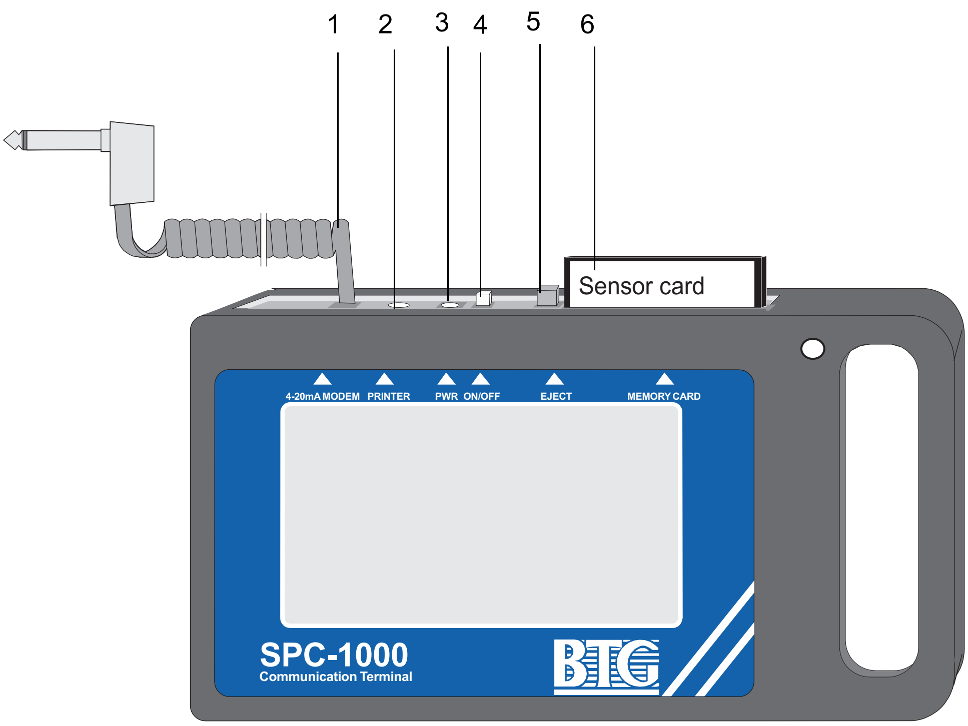
12 V DC supply from an electronics box.

This is the normal way of providing power for transmitter calibration and process monitoring. The terminal's telephone jack is connected to the electronics box jack connection.

This also provides a communications link with the transmitter. When this supply option is chosen, the display lighting comes on for best visibility.

Fig 45 Hand-held terminal SPC-1000 Connections

1. 4-20mA modem connection
2. Printer connection
3. Power connection
4. Power ON/OFF
5. Eject
6. Memory card slot



12 V DC supply from an AC adapter.

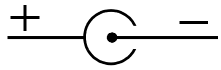
This type of power supply is suitable during simulation and documentation such as when the terminal is used at a desk.

A portable AC adapter is supplied with the hand-held terminal. The AC adapter is available for 110 V AC or 220 V AC. The output supply is 12 V DC.

Check that the AC adapter is suited to power supply voltage (110 *or* 220 VAC).

The AC adapter is supplied with a cord for plugging in to the mains power supply. In some cases, the molded plug may not fit your outlet. Replace the plug with a suitable standard plug if this is the case.

The AC adapter's 12 V connection is a socket located on top of the terminal. This is marked "PWR". (12 V DC/0.4 A AC adapter, DC jack with 2 mm connection pins.) The + connection goes to the casing and the – connection goes to the center pin.



The display lighting also comes on when the 12 V power supply is used.

9 V DC supply from an integral battery.

The battery power supply is used, for example, when the terminal is connected to the 4 - 20 mA signal loop at a location other than at the electronics box.

An internal standard 9 V DC battery is located behind a cover on the back of the terminal. To provide maximum operating time, a type 6F22 high-power alkaline 9 V DC battery should be used. A battery of this type will operate for approximately 3 hours.

⇨ **Switch off the terminal immediately after use to maximize operating time.**

Rechargeable batteries or manganese batteries provide much shorter operating times. Display lighting does **not** come on in battery mode in order to maximize battery life and operating time. Display readability is however sufficient in normal room lighting.

4.7.2 Code protection

A security code can be entered to prevent unauthorized adjustment of transmitter settings. All functions in the hand-held terminal can still be accessed. Code protection prevents the settings on the hand-held terminal from reaching the transmitter if the security code is not entered. A personal code can be entered and, if this is lost, a general code is available.

⇨ **General code: 42600.**

A. Initial activation of the security code / input of a personal code

1. This should be done at the **first opportunity** during installation.

   Go to [Send data] in the main menu. Press [Turn code ON/OFF] followed by [Menu], [Send Change]. ”*Load code*” will be displayed.

   Enter 42600 (applies only on this occasion). Press [Enter Menu].

2. Enter your personal code. ”New value” will appear. Enter your personal code, e.g. 123 (max 8 digits) and press [Enter Menu].

3. Press [Code OFF] to get [Code ON]. Your new code is now activated.

   Finish by pressing [Menu].
   Data can now be transferred to the transmitter. If you wish to check that the code has been entered, press [Send data] and [Send all]. The signal transfer will not take place without the input instruction for the code being displayed.

B. Changing your personal code

Go to [Send data] , [Turn code ON/OFF] . Press [Change code] "Load code" will be displayed. Enter your old personal code (or the general BTG code). "New value" will then be displayed. Enter your new code. Press Enter.

C. Deactivating the code you have entered

Press [Send data] , [Turn code on/off] . Press the [Code on/off] "button" and enter your personal code.

D. Activating the code you have entered

Press [Send data] , [Turn code on/off] . Press the [Code on/off] "button" so that it displays "code on".

4.8 Digital communication according to the Hart®-protocol

Certain functions are available as a digital signal according to the Hart®-protocol and BELL 202 modem standard.

⇨ **The transmitter complies to Hart®-protocol standard requirements. To set and calibrate the transmitter the BTG hand-held terminal is required. Since additional functions are not covered by the Hart®-protocol, a standard Hart® competitive terminal can only be used for certain functions.**

Communication takes place as a superimposed signal over the 4-20 mA output signal loop.

⇨ **For details, please contact the Hart® Communication Foundation or BTG.**

5 Service instructions

5.1 Maintenance planning and quality assurance

In April 1993, BTG Källe Inventing AB attained ISO 9001 certification for development, design and production of process control equipment for the pulp and paper industry. Factory repairs are made in accordance with the appropriate requirements for new products. Every transmitter is tested according to a specified program. The result is documented and included in the delivery.

5.1.1 Inspection of the accuracy/calibration of the consistency transmitter

Inspection should be made against **laboratory samples with the** transmitter mounted in the pipe and running in operational mode.
Comparison of lab samples can generate several types of error. The transmitter should be calibrated against many lab samples and adjusted accordingly. Thus, comparison to **one lab sample only** can cause error.

The sample can be **extracted from the pipe** in a number of ways. Different types of sampling valves, respectively common ball valves, result in a various number of serious sources of error, which will not be discussed here. The guiding rule for good sampling is generally that **the samples shall be extracted from the pipe in a uniform, repeatable way in accordance with the original calibration**. The sample volume **must not be too small**. At least 0.5 liter / 0.13 US gallon is necessary. The sample, **after extraction from the pipe**, must be treated in a **uniform, repeatable way**. The lab analysis is to be in accordance with established standards, e.g., SCAN-C 17:64 or valid TAPPI standard. Rapid analysis with the sample dried on a heating plate is not a reliable method.

Should a deviation be discovered, remove the transmitter from the pipe and clean the measuring gap. If this does not improve the situation, a recalibration (or possibly a zero point offset) of the transmitter may be necessary.

A printout, or other automatic documentation, is an excellent complement to the ordinary protocol for documentation purposes.

5.1.2 Calibration recommendations

Calibration recommendations regarding comparison to lab samples and previous calibrations.

Twice per year:

Transmitters used for simpler measurements, e.g. for indicating purposes

Every month:

Transmitters used for measuring/control function of vital importance to the process

Once a week or after a considerable change of process variables:

Transmitters used for measuring/control function of vital importance to the process or used for debiting purposes

⇨ **The above recommendations are intended as a general guide and should be adapted based on actual experience.**

5.1.3 Maintenance of the transmitter

Maintenance needs will depend on the transmitter position, media influence, and ambient conditions.

Regular maintenance includes:

- Cleaning the measuring gap.
- Inspection of wetted rubber details and metal parts for damage twice per year if exposed to aggressive chemicals.

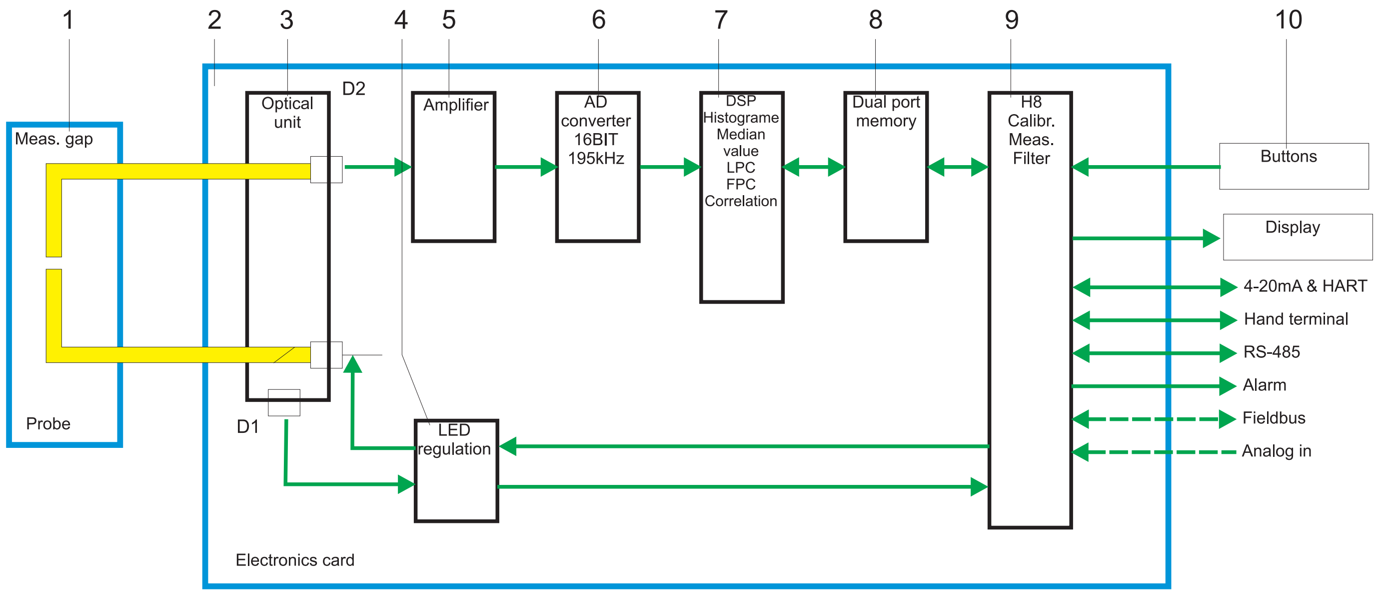
Long-term maintenance includes:

- Replacement of seals, typically after 5 years of operation.

5.1.4 Functional description

A light shines through the pulp suspension from the electronics card via the optical fiber cable. The light that passes through the suspension is measured and analyzed. The final measuring value is then converted into an analog output signal and shown on the display. The display also shows the value of the analog output signal generated by the instrument.

Fig 46 Electronics schematic diagram



1. Measuring gap inserted in the pulp suspension.
2. Processor card fitted in the electronics box.
3. Optical unit where the light beam through the fiber suspension is measured.
4. LED intensity control.
5. Amplifier for the incoming signal.
6. A/D converter of the measuring signal.
7. Digital signal processor (DSP) for handling and analysis of the signal to the measuring value used for consistency calculation.
8. Dual port memory for exchange of data between DSP and H8 processor.
9. Main processor handling calculations, communications etc.
10. Buttons and display positioned on the front of the electronics box.

5.2 Service electronics

5.2.1 Electronics troubleshooting

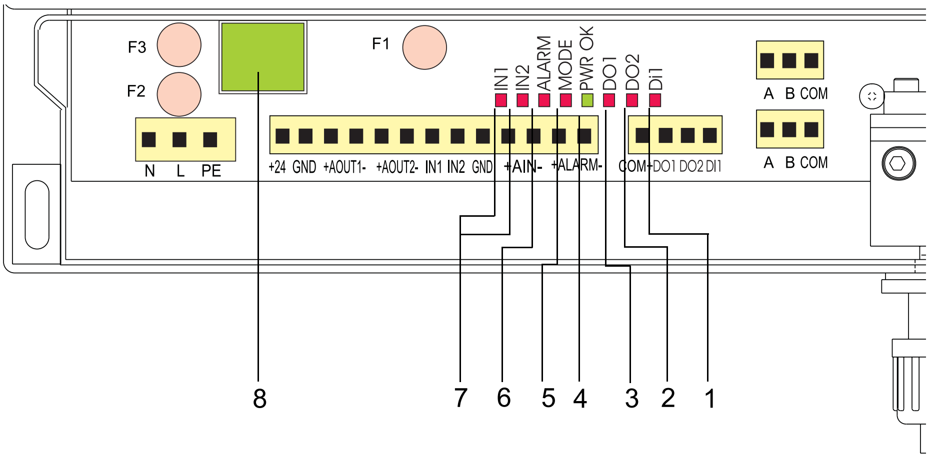
Symptom	Probable cause	Solution
1. Instrument does not power up	1.1. No power to instrument	Check line voltage
	1.2. Fuse on card blown	Change fuse. See fig 48 on page 88, F2 and F3 for incoming power and F1 for 24 V power on the card.
	1.3. Bad power supply	Check testpoint ”TP 15” and points 1.1 and 1.2 first. If still a problem change power supply. See section 5.2.5.
	1.4. Internal power supply on electronics card is broken	Change the electronics card. See section 5.2.4.
2. No information on display	2.1. No power to instrument	See point 1 above
	2.2. Display cable is loose	Check cable. See section 5.2.6.
	2.3. Display is broken	Change the front panel. See section 5.2.6.
3. Display buttons don’t work.	3.1. Display/button cable is loose	Check cable. See section 5.2.6.
	3.2. One ore more buttons is broken	Change front panel. See section 5.2.6.
4. No output signal	4.1. No power to instrument	See point 1 above
	4.2. Not measuring	Check if value in display
	4.3. Bad connections	Check ”AOUT” connection
	4.4. Bad analog out configuration	Check calibration. See section 5.2.7.
	4.5. Analog output circuit is broken	Change the electronics card. See section 5.2.4.
5. Can’t change range from digital input	5.1. Bad connection	Check connection. See section 5.2.9.
	5.2. Configured for software range setting	Change to hardware setting. See section 5.2.9.
6. The SPC does not work	6.1. Wrong program in the SPC	Switch off the SPC and change to correct sensor card and program.

Symptom	Probable cause	Solution
	6.2. Wrong SPC version	SPC-1000/A is required (an upgraded version of SPC-1000 is needed as in section 4.1)
	6.3. Not 250 Ω in 4-20mA measure loop	If connected to the DCS, ensure the loop has a resistance of at least 250Ω. If not connected to DCS there has to be a resistor of 250Ω connected between ”+AOUT” and ”-AOUT”.
	6.4. The analog output signal is not between 4-20 mA	See point 4. above.
	6.5. Connector bad or loose	Check the connector from SPC to electronics card. See section 5.2.6.
	6.6. SPC/Hart communication circuit is interrupted	Change the whole electronics card. See section 5.2.4.
7. Clear water calibration can't be made	7.1. Optical cable is not connected into electronics box.	Connect the probe optical connector. See section 3.3.3.
	7.2. Optical cable is damaged	Change the complete probe and optical cable. See section 5.3.3.
	7.3. LED circuits on card is interrupted.	Check testpoint ”TP3” with ”LED intens” set to 100% according to section 5.2.3. If values are no good change the electronics card as in section 5.2.4.

5.2.2 Electronics card LED functions

Fig 47 LEDs on the electronics card

1 DI1
2 DO2
3 DO1
4 PWR OK
5 MODE
6 ALARM
7 IN2 and IN1
8 Power switch



1. DI1
   Digital in 1 (not used)
2. DO2
   Digital out 2 (not used)
3. DO1
   Digital out 1. Lit when PCD-1000 function is activated. (Option)
4. PWR OK.
   Lit when power to the card is on
5. MODE.
   Indicate program function.
   – Slow flash (approx. 2 second interval). The program is running normal.
   – Fast flash (approx. 2 second interval). Indicates that the processor is running but doesn't have any software. Contact your BTG office.
   – No flash (lit or dark). Processor or program is not running.
6. ALARM.
   Lit when alarm function is activated.
7. IN2 and IN1
   Indicates selected range, see below. (Lit=1 Dark=0)

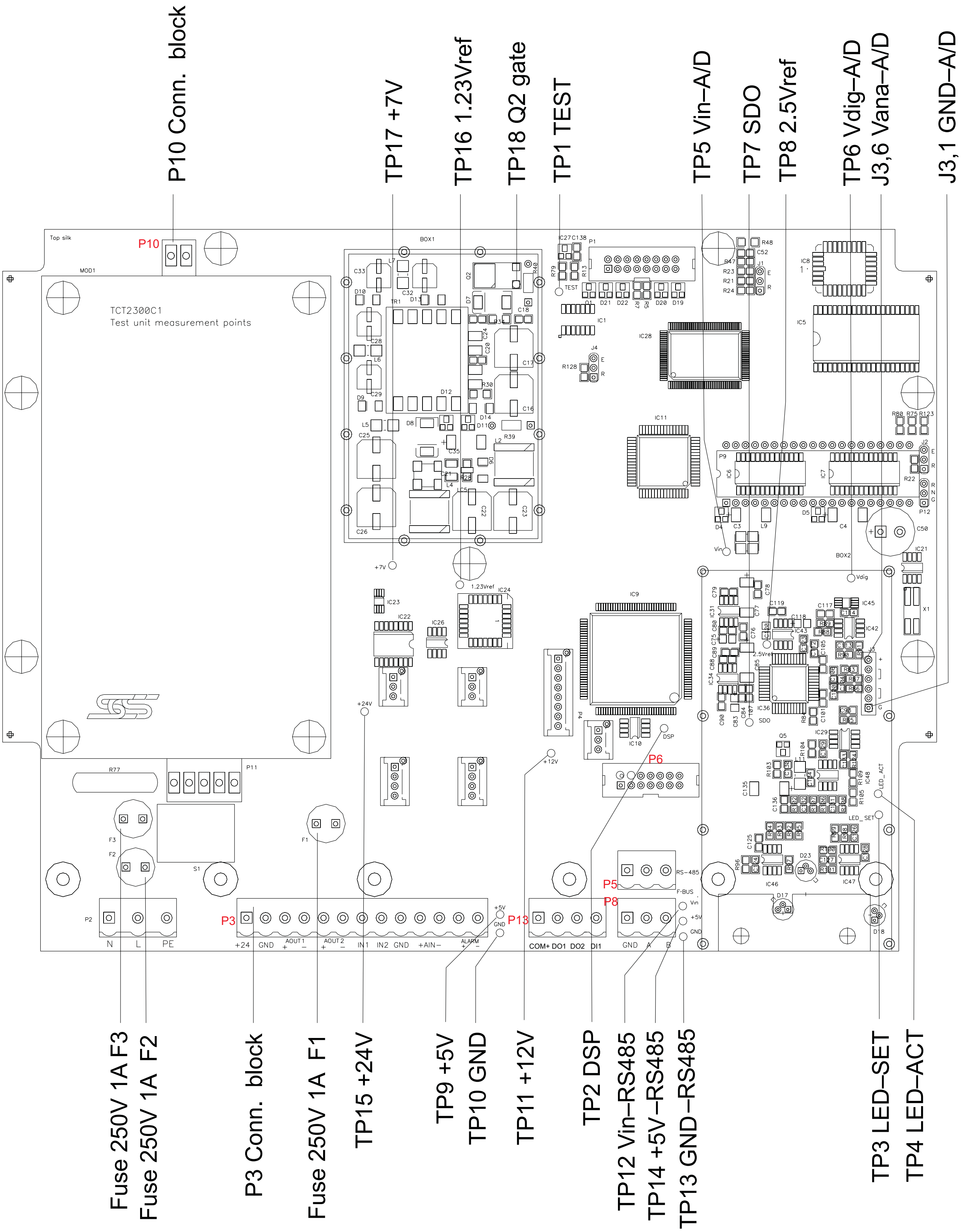
IN1	IN2	Range
0	0	1
1	0	2
0	1	3
1	1	4

8. Power switch on incoming power supply. Lit when 24 V DC is supplied to the card (before fuse F1).

5.2.3 Function and testpoints of electronics card

TP	Label	Min.	Max	Unit	Comment
	F1		1	A	Fuse for 24 V DC on the card. 250V 1A.
	F2		1	A	Fuse for input power. 250V 1A.
	F3		1	A	Fuse for input power. 250V 1A.
P10/ P3	+24	210	240	mA	Current consumption at 24VDC. Measured at P10 when powered by 220VAC. Measured at P3/+24V when powered by 24VDC. Deviation (210 to 240 mA) depend mainly on status of LCD backlight, current loop output and DSP.
P3	+24/GND	23.5	24.5	V	Output voltage of MOD1 24VDC power supply. Measured at P3/+24 and P3/GND.
TP17	+7V	7	8	V	System supply from DC-DC converter.
TP9	+5V	4.95	5.05	V	Regulated system supply from DC-DC converter.
TP15	+24V	23	26	V	Supply to current loop transmitter.
TP11	+12V	11.5	12.5	V	Supply to external hand terminal.
TP13	GND-RS485	20		MΩ	Isolation between RS485 IF and other circuits (measured at TP13 to P3,GND).
TP12	Vin-RS485	6	7	V	Supply to RS485 IF from DC-DC converter (measured at TP13 to TP12).
TP14	+5V-RS485	4.9	5.1	V	Regulated supply to RS485 IF (measured at TP13 to TP14).
J3,1	GND-A/D	990	1010	W	Isolation between optronics and system supply (measured at P3/GND to J3,1).
TP5	Vin-A/D	6	7	V	Supply to optronics from DC-DC converter (measured at J3,1 to TP5).
TP6	Vdig-A/D	4.9	5.1	V	Supply to digital circuitry on optronics module.
J3,6	+Vana-A/D	4.9	5.1	V	Supply to analog circuitry on optronics module.
P6,2	A/D - input	.99	1.01	V	Offset voltage, negative A/D input.
P6,4	A/D + input	1.1	3.5	V	Positive A/D input, value depends on current IR intensity return. No light gives approximate 1.1 V.
TP3	LED SET	0	4	V	IR intensity setpoint from D/A to IR output regulator.
TP4	LED ACT	0	4	V	Actual LED current (4V corresponds to 50 mA, which is maximum) to obtain intensity set by LED SET (not directly comparable - LED SET is IR intensity and LED ACT is LED current).
TP8	2.5Vref	2.495	2.505	V	A/D reference voltage.
P3, 3-4	+AOUT-	2	21	mA	Analog output signal, depending on measured value and span.

Fig 48 Measurement points on the electronics card



5.2.4 Changing the electronics card

If the circuit card is faulty the complete card must be replaced.

Tools required:
Screwdriver (medium size), Star screwdriver (medium size), Block wrench 19 mm.

It is important to save all card information in the SPC before removing the card. All information about calibration and other settings are in the instrument. If no previous print out or backup is available, make one before removing the card.

DANGER!
High voltage within the electronics box. Connections may only be carried out by qualified personnel.

⇨ **Before replacing the card, disconnect line voltage to the card (it is not sufficient to cut it off using the switch on the card).**

All numbers refer to fig 49 on page 90.

1. Unscrew the lower cover on the box (2).
2. Check that all LEDs are off (12). If not, power is still on and should be disconnected.
3. Unscrew the optical holder (4) and loosen the optical connection. Put the protective cover over the optical connection.
   The cover is included with delivery.
4. Screw out the inner optical holder (3) that is screwed to the optical module on the circuit card.
5. Loosen all connection blocks (13) to which cables are connected. Screws need not be screwed out as the contact strip can be pulled out from the card.
6. Loosen the four screws on the front (1) and carefully lift out the front plate. Loosen the display switch (5) by pulling it straight out from the card. Also loosen the SPC-connection (11) by pulling it straight out from the card. It may be necessary to loosen the locking flap using a flat screw driver.
7. Unfasten the screws (7) holding the card to the box.
8. The card can now be removed – carefully, due to the tight space. Lift first the upper part with display connection (5).

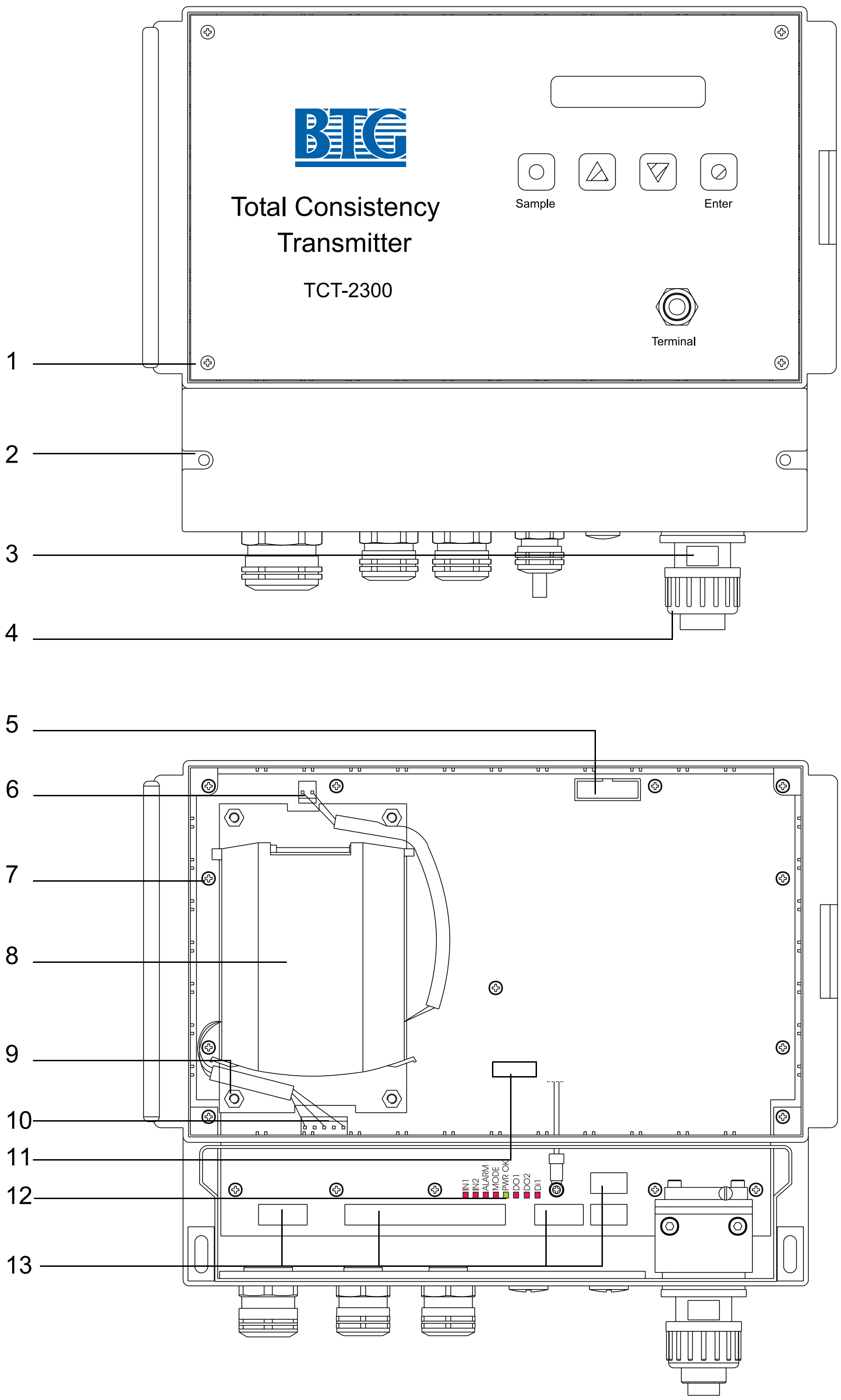
Insert the new card by following the instructions above in reverse.

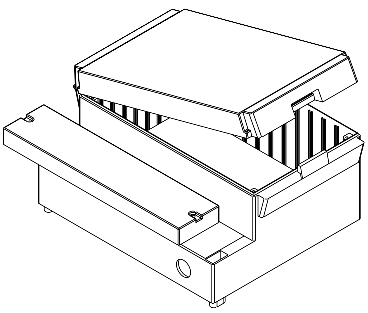
Ensure the optical connection is inserted in the correct position (see fig 23 on page 29).

Install the connection pipe (3) before screwing down the card in the box. Check that optical unit, intermediate washer, box wall and connection

Fig 49 Changing the electronics card

1 Screws for upper cover (4x)
2 Screws for lower cover (2x)
3 Connection pipe
4 Plastic nut
5 Display connection
6 12 V DC connection
7 Screws for electronics card (13x)
8 Power supply
9 Screws for power supply (4x)
10 85-240 V AC connection
11 SPC-1000 connection
12 LEDs
13 External connection blocks





Connect the optical connection pipe carefully as the card can easily be damaged.
Hold the optical connection part off the card while the optical connection pipe is fastened.

pipe butt against each other (important for grounding). See fig 23 on page 29.

When everything is mounted and power switched on, information will be shown on the display.

The new card will not have any information about calibration and other settings.

Connect SPC with the reinstalled safety copy and push Send data ,

Send all to the instrument.

If no safety copy is available see section 4: *Operating instructions*.

⇨ **Perform a new water calibration as in section 5.3.2: *Check clear water value and clean of probe*.**

5.2.5 Change of power supply

If there is something wrong with the 24V-power supply, the whole part must be changed.

Tools required:
Star screwdriver (medium size), Socket wrench or Block wrench 7 mm

All numbers refer to fig 49 on page 90.

Before opening the electronics box, disconnect line voltage to the unit.

DANGER!
High voltage within the electronics box. Connections may only be carried out by qualified personnel.

⇨ **Remove line voltage to the card (it is not sufficient to cut it off with the switch on the card).**

1. Unscrew lower cover (2).
2. Check that all LEDs are switched off (12). If not, the power is still on and should be disconnected.
3. Open the protection front cover.
4. Loosen the four screws on the front (1) and carefully lift out the front plate. Loosen the display switch (5) by pulling it straight out from the card. Also loosen the SPC-connection (11) by pulling it straight out from the card. It may be necessary to loosen the locking flap using a flat screw driver.
5. Loosen connectors (6 & 10) from the power supply card.
6. Unscrew the four tall nuts (9) with the socket wrench.
7. Lift the power supply unit (8) straight out.

To mount the new power supply unit, reverse the above procedures.

5.2.6 Changing the front panel

If there is something wrong with the display or buttons, the whole front cover has to be replaced.

⇨ **The instrument will work without display and buttons.**

DANGER!
High voltage within the electronics box.
Connections may only be carried out by qualified personnel.

Tools required:
Star screwdriver (medium size), Block wrench 15 mm,

All numbers refer to fig 49 on page 90.

1. Unscrew lower cover (2).
2. Switch off power supply button (12).
3. Open the protection front cover.
4. Unscrew the upper cover (1) and lift the front carefully. Loosen display contact (5) by lifting it carefully from the electronics card.
5. Unscrew the SPC-connector from the front cover.

To mount the new front cover, reverse the above procedures.

5.2.7 Check analog out

The display shows the analog output value. Use a digital multimeter to measure the current on connector ”P3” pin 3 and 4, labeled ”+AOUT–”.

If the measured value doesn’t correspond to the expected value, the calibration has to be redone.

5.2.7.1 Calibrate analog out

Tools required:
Star screwdriver (medium size), Screwdriver (medium size), Digital multimeter (DMM), SPC-1000/A

All numbers refer to fig 49 on page 90.

1. Unscrew lower cover (2) on electronics box.
2. Connect the DMM set to mA (the smallest range for 20 mA) in series connection with the resistor on ”AOUT+”, connector ”P3 pin 3”.
3. From the SPC main menu, push Misc. and Factory setting . Enter ”1632”

and push [Enter/ menu] .

4. Push key [Test value] . Enter ”4”, push [Enter/ menu] , [Send page] and then [Send change] .

   Read value on DMM. If the value is not correct, adjust using the keys [4 up] or [4 down] , and then push [Send page] and then [Send change] to obtain the new signal. Keep repeating these actions until exactly 4.00 mA is read on the DMM. (The test signal ”Test value” is active for approximate 15 seconds before the output signal is reset to the value generated by the instrument.)

5. To calibrate 20 mA, push key [Test value x] and enter 20. Push [Enter/ menu] , [Send page] and then [Send change] .

6. Read value on DMM. If not correct repeat point 4 but use [20 up] or [20 down] to adjust.

7. Disconnect DMM and replace cables and the lower cover.

5.2.8 Checking communication to and from SPC-1000/A

First make sure you are using an upgraded version of the hand terminal, type SPC-1000/A

Check that a resistor (249 ohms) is fitted between terminals ”AOUT+” and ”AOUT–”. If the signal is output to a DCS, the resistor must be positioned in series with the DCS.

Connect SPC-1000 and switch on the hand terminal.

Go to main menu and select [Read data] , [Yes] .

If no error message is displayed, communication works.
For an explanation of error message, see section 5.4.3: *Software Fault feedback SPC-1000*.

If there is a problem, check the current signal on analog out, measured in series between ”AOUT+” and ”AOUT–”. The current should be between 2 and 21 mA to get a working communication.

5.2.9 Checking range inputs

There are 4 different ranges to configure in the instrument. The ranges can be switched in 2 ways, using either digital input or software.

5.2.9.1 Change range input using digital input (hardware)

Create a short circuit between terminals ”IN1” and ”GND”. Check that LED ”IN1” is lit up and that ”Range” on the main menu on the hand terminal changes to ”2”.

Then create a short circuit between terminal ”IN2” and ”GND”. Check that LED ”IN2” is lit up and that ”Range” is changed to ”3”on the main menu.

If the range not is affected by the digital input see next section 5.2.9.2.

5.2.9.2 Change range using software

It is possible to change range using the SPC-1000. The instrument must be in Range Software (R.SW) Mode.

1. To change range, push `Confi-gure` , `Tx. Spec.` from main menu on SPC.
2. Push `Mode` to change.

   If range is chosen from digital input (hardware) the Mode button has *R.HW*.
   If range is chosen from SPC (software) the Mode button has *R. SW.* There is an other button at the right, *Range: x,* for range selection.

⇨ **If Mode button is in state *R.SW* the range cannot be set from digital input.**

5.2.10 Checking the alarm output

Tools required:
Digital multimeter (DMM), SPC-1000/A

1. Push [Misc] , [Alarm & diag-nostics] .
2. Check that the key to the left shows ”Set alarm”. The key second from the left should show ”Alarm ON”. If not push [Alarm OFF] .
3. Push the key [Low 0.0] and enter the measured value +1%.
4. Check that key” High” is higher than ”Low”.
5. To download new limit values to the transmitter, push the (flashing) key [Send page] and then [Send change] .
6. Check (diode meas. using the DMM) between terminal ”Alarm+” and ”Alarm–”. It should be less than 1V.
7. Check that LED ”ALARM” lights up when the alarm is activated.
8. Push [Alarm ON] until it shows [Alarm OFF] .

Push [Send page] and then [Send change] and check that LED ”ALARM” goes out and that the DMM measures “OL” (overload).

5.3 Service probe and valve arrangement

Tools required:
Block wrench 17 mm, 19 mm Small brush

Consumables required:
Lubricant for sealings (use MOLYKOTE 111 or equivalent for EPDM or Viton O-rings)

Spare parts required:
O-ring 27014000, O-ring 27014018.

5.3.1 Pull out the probe from the ball valve

To avoid personnel injuries, burning injuries, aggressive chemical injuries etc., it is of utmost importance that the safety equipment on the ball valve assembly functions correctly.

For details see section 3.2.5: *Mounting the probe in the valve assembly*.

1. Turn off the instrument at the electronics box.
2. Loosen the two safety screws on the flange.
3. Unscrew the probe.
4. Close the valve.
5. Loosen the locking device on the flexible insertion screw at the probe flange.
6. Pull out the probe

5.3.2 Check clear water value and clean of probe

In some installations it may be necessary to clean the probe's measuring gap. Check the CW measured value before and after cleaning to see if the cleaning has had an effect. The time interval between cleaning depends on the installation.

⇨ **Clean the measuring gap using a tooth brush (or similar), clean water, and a 4-5% chlorine solution. Dry with a cotton rag.**

1. Start with `Read data` , `Yes` .
2. Select `Confi- gure` and `Led int. adjust` .
3. Fill a bucket of water (drinking water quality) and put the probe in the water. Make sure that no air bubbles are trapped in the measuring gap on the probe. Remove any air bubbles with your finger tips.
4. Make sure the transmitter is set for clear water, `CW/DCO CW` . Compare the old water value that is on the key: `Set CW 96.7%` , with the new value that appears on the display, CW measured: xx%
5. Check that the CW measured value is 100% +/- 5. If this is the case no further action needs to be taken, go to point 10. Otherwise continue with point 6.
6. *Alt1*. If the new value is more than 5% less than the old value, clean the probe tip. After cleaning compare the two values. If the values are within 2% of each other continue with step 9. Otherwise continue with step 7.
   Alt2. If the new value is more than 5% higher than the old value, adjust the LED intensity setting. Continue with step 7.

7. Change the LED intensity by pressing Led intens xx . Change the LED intensity in steps of 2.

   Send the setting to the transmitter by pressing Send page and Send change .

8. Check that the CW measured value is close to 100% (+/-2%). If not, repeat step 7.

9. When the CW measured value is stable, press Set CW 96.7% to store the value. Send the setting to the transmitter by pressing Send page and Send change . The new clear water value is now stored in the transmitter.

10. Install the probe in the valve arrangement again. Lock it properly using the two screws.

⇨ **Check the clear water (CW) value on a regular base to ensure a high quality measurement.**

5.3.3 Change the probe with fiber connection

1. Connect the optical probe connector to the optical connector on the electronics box.
   For details and pictures see section 3.3.3 on page 29.

⇨ **Make sure the optical connector from the probe is positioned correctly and pushed all the way in before securing it with the plastic nut.**

2. Secure the connection properly with the plastic nut. Coil the extra optical fiber and secure it under the electronics box in order to avoid risk of mechanical damage.

⇨ **The optical fiber must not be coiled with a radius less than 50mm (2 in). Locate the fiber so it is protected and not likely to incur mechanical damage.**

3. Turn on the instrument at the electronics box.
4. Before inserting the probe into the pipe, a clear water calibration should be performed. See section 5.3.2: *Check clear water value and clean of probe*.
5. Insert the probe into the pipe.
6. Make a new offset calibration based on a laboratory sample, see section 4.4.3 on page 57.
   If there is a large difference, do a new calibration with one or more lab values with different consistency values.

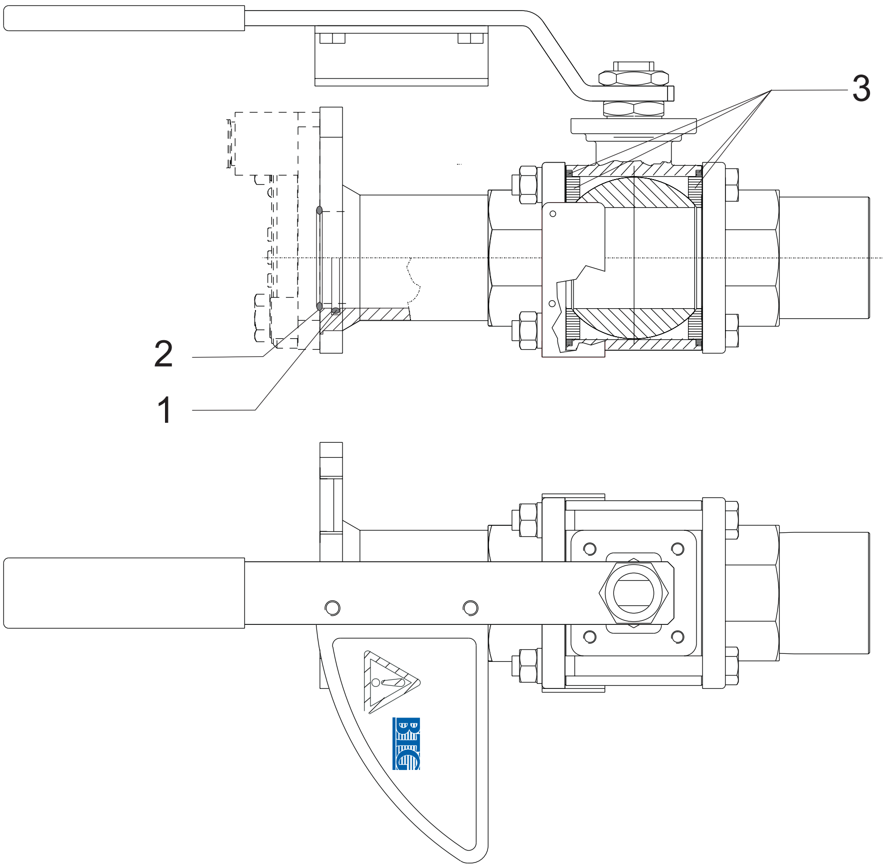
5.3.4 Replacing ball valve seals

The process must be shut down and the pipe must be empty.

1. Make the replacement according to fig 50.
   Grease the sealings with sealing lubricant after the replacement.

Fig 50 Sealings in ball valve arrangement

1 O-ring
2 O-ring on probe
3 Packings (not available from BTG)



If a new valve is mounted make sure the handle with it's security plate is mounted.

5.3.5 Inserting the probe

⚠ **Avoid getting O-ring lubricant in the measuring gap.**

For details see section 3.2.5: *Mounting the probe in the valve assembly*.

1. Make sure the measuring gap on the probe is pointing at an angle of 45° (or the same angle as the replaced probe) to the pulp flow.
2. Apply a small amount of o-ring lubricant to the o-ring in the ball valve housing.
3. Make sure the o-ring on the probe flange is mounted. See fig 50 pos. 2.
4. Insert the probe, using a twisting motion to get the probe tip to enter the o-ring. Place the flexible insertion screw in the correct position and make sure the hook with its locking device is in the correct position and secured.
5. Open the ball valve and insert the probe by cranking the handle.
6. Secure the probe in inserted position with the two security screws.

⇨ **Secure the two security screws properly.**

5.4 Service software

5.4.1 Software revisions

⇨ **This instruction relates to software version 1.x on the sensor card, and version 1.xx on the application software.**

To find out which sensor card program version you are running, press the

Note ! button on the main menu on the SPC-1000.

The version of the application software appears on the electronics box screen when power is switched on.

It can also be seen from the SPC-1000. Press the Confi- gure button and the version can be read: Device TCT-2301 version X.XX.

5.4.2 Troubleshooting functions

There are a number of important functions in relation to trouble shooting on the transmitter. These functions can be found under MAIN MENU option Confi- gure , as well as on the printout, and are not further explained inhere.

5.4.2.1 Alarm & diagnostics

The instrument has an alarm- and error-log.

Here you can find information about changes that have been made and observations / alarm-limits that have been exceeded, etc. This can be useful for trouble-shooting.

To check the events-log, go to the main menu on SPC, push key Misc ,

then push sub menu Alarm & diag- nostics and sub menu Show log . The last 100 events are stored here.

The latest event is displayed first. To check previous events, push key

Prev .

Each post in the list includes:

Date:	**Date and time when the event occurred.**
Event:	**Text for the event (if an alarm it is preceded by an *).**
Value:	**Value related to the event (if a value is not relevant it is indicated by 0.0).**
Range:	**Range in force when the event occurred.**

There are two types of events reported in the log, Alarm and Exceptions.

Alarm is preceded by an * and is configured by the user. See section 4.4.2: *Setting alarm limits*.

Exception are events reported by the system and they are mostly user-generated changes.

The following will be treated as an Exception:

Event	***Description* Text**	**Description**
System start	“Started.”	When the system is started up again after a power failure. (Normal start-up).
New program version	“New progr.”	When a new program has been downloaded in the instrument (same or a new version) all settings will be reset to default.
Change of settings	“New config”	When a setting has been altered, from SPC or display buttons, this exception will be generated. In some cases there will be additional information about the command that has been sent (that is, about which data has been changed).
Alarm shut off	”Clr Alarm”	When all active alarms have been shut off this will be registered.
Failure in the operative system	”System Fail”	This message will be sent if a failure in the operative system occurs.

5.4.3 Software Fault feedback SPC-1000

The SPC communicates with the instrument using HART protocol. The SPC and has a Master-Slave relation with the instrument, where the SPC is *Master* (secondary master) and the instrument is *Slave*.

Error messages showing in the SPC start with *Cmd* *, where * represents the command that caused the error.

The following error messages can occur:

Error message	Probable cause	Solution
Comm line busy	The line is occupied by another master. SPC tries five times to find a time gap that is sufficiently long.	This must not happen and depends on the other master not following the HART standard. Disconnect or shut off the other transmitting master.
Not from slave	Response comes from another master, not from the instrument.	Disconnect all HART units except the one you want to communicate with – some terminals behave improperly.
Comm error	Communication error/parity error.	Can be due to surrounding heavy disturbances or poor cables. Should the error remain, check all connections.
Wrong slave ID	Response from slave other than the one the SPC sent message to.	Normally this error does not occur since there should be only one slave. Disconnect the other slaves.
Wrong reply cmd	Erroneous reply to a command, the instrument answers to a question other than the one put out by SPC.	Probably other units on the cable are the cause of the communication disturbance. Try to disconnect them.
Cmd resp error	Error in the protocol between SPC and the instrument, making it difficult for the instrument to understand SPC properly.	Update the software in SPC or the instrument so that they can understand each other.
Data length err	The command is not the correct length, it is too short.	Update the software in SPC or the instrument so that they can understand each other.
Invalid message	Errors in the message part, corresponding to check sum below.	Probably faulty cables between instrument and SPC.
Invalid chksum	Wrong check sum on parcel (normally results in re-sending).	Probably faulty cables between instrument and SPC.

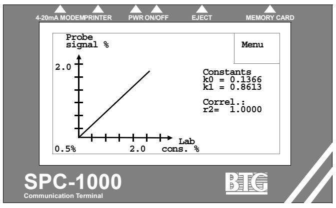
Error message	Probable cause	Solution
Reply time out	The instrument doesn't answer on command. (Waiting time 256 ms).	SPC is probably not connected to the instrument or the instrument isn't switched on. Also check the cables between SPC and the instrument.
HART rev error	Wrong version of the HART protocol. Should be version 5.	Update the software in SPC or the instrument so that they can understand one another.
Not *TCT-2300* dev	Wrong type of instrument. (*TCT-2300* is the expected type of instrument, that is, it is controlled from the application started in SPC).	Select the correct program in SPC or the correct instrument to connect it to.
TCT-2300 rev err	Correct type of instrument (in this case a TCT-2300 is expected), but the protocol version is not compatible.	Update the software in SPC or the instrument so that they can understand one another.
Dev change/repl	Another instrument is connected than that which the data comes from. Identified by the serial number.	Connect to the correct instrument and start by READ DATA. If the instrument is the correct one, continue to perform READ DATA.

5.5 Evaluating calibrations

By studying the calibration curve, calibration constants, and correlation factor you can pinpoint and correct most calibration errors.

Typical errors in *single point* calibration:

Symptom 1:



Calibration lacks precision

The further away from the calibration point, the greater the error.

The slope of the curve is not correct.

Action:

Improve the calibration with at least one more lab sample. This will give a more accurate slope of the straight line.

Try to vary the consistency so that the calibration points cover the entire measuring range.

Symptom 2:

The measurement correlates poorly to lab samples

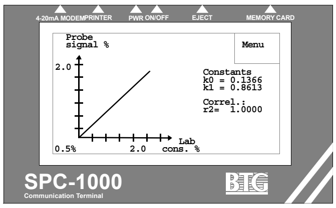
When using single-point calibration, process consistency should not deviate too much from the nominal value or accuracy is reduced.

However, the calibration should always be correct at the consistency point where the calibration was made.

If the consistency can vary, for example due to other changes in operating conditions, we recommend that you make a multi-point calibration.

Typical errors in *multi-point* and *updated* calibrations:

Symptom 3:



Wide scatter of calibration points around calibration line (low correlation factor)

Action:

Check the sampling equipment and quality of sampling methods. This is the most common cause of lack of precision in calibration.

You can also try deactivating the most likely deviant samples. Does the probe signal fluctuate widely? If so, the probable reason is that the transmitter is measuring in non-homogenous, badly mixed pulp. Check transmitter location. It may not be located correctly; refer to the Installation Instructions for advice on relocation.

Symptom 4:

Poor precision outside normal working range. Calibration points are too few or too closely grouped

Action:

Enter more calibration points, making sure that they **cover as much as possible of the measuring span**.

5.6 Troubleshooting, general

If the consistency transmitter does not work satisfactorily and the fault is not apparent, use the following fault tracing procedure.

Fault tracing is also dealt with in the section 5.2: *Service electronics* and section 5.4: *Service software*.

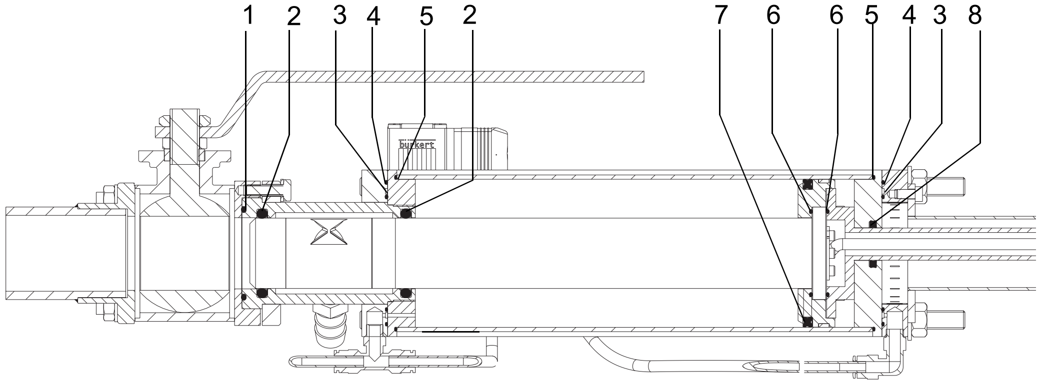
Symptom	Probable cause	Solution
1. Output signal varies with change in flow	1.1. Wrong probe angle relative to the flow.	Turn the probe. See section 3.2.5.
	1.2. The transmitter is not mounted according to instructions. It may be installed at a point where the pulp suspension is layered, and the layering may vary with the rate of flow.	Check the installation with reference to the installation instructions. Note the length of the turbulence damping zone after the pump.
2. Abnormally unsteady output signal.	2.1. Chosen time-constant for damping is too short.	Increase damping until signal stabilizes.
3. Cons is too high	3.1. Something is stuck in the measuring gap.	Take out probe and clean the gap. Check CW calibration. See section 5.3.2.
	3.2. Fiber connection is damaged.	Check if there is any damage on the fiber connection. Check CW calibration. See section 5.3.2.

5.7 Maintenance of the cleaning system.

This section describes how to remove the cleaning device, with the air cylinder, solenoid valve, water valve etc., from the pipe and disassemble and assemble it again.

Fig 51 Sealing kit (accessory)

1 O-ring
2 O-ring
3 O-ring
4 O-ring
5 O-ring
6 O-ring
7 X-ring
8 X-ring



A. Removal

1. Loosen the electrical contact at the solenoid valve to move the measuring probe outwards to its outer position “out of the process”.
2. Close the sluice valve.
3. Shut off air and water supply. Loosen their connections from the transmitter.
4. Screw out the three hexagon-headed screws that join the transmitter to the sluice valve, holding up the transmitter at the same time.
5. Loosen the fiber fitting on the electronics cabinet and pull out the fiber. Protect the fiber probe with the accompanying plastic sleeve.

A. Dismantling

1. Place the transmitter in a vertical position on a workbench, with the tip pointing downwards.
2. Loosen the air tube and the four nuts at the rear cylinder flanged end of the transmitter.
3. Remove the rear cylinder ends, one quadratic and one cylindrical. Then carefully pull off the outer cylinder pipe. Pull out the probe.
4. Replace the sealing and piston rings around the probe if necessary. Check the X-ring on the rear round gable and the inner O-ring on the front gable. Replace if necessary. Grease all sealings and O-rings with silicone grease.
5. Check that the thin O-rings on the outer flanged end are OK and that they are in the correct positions in their grooves. Use plenty of silicone grease to help keep them in position during mounting.

B. Mounting

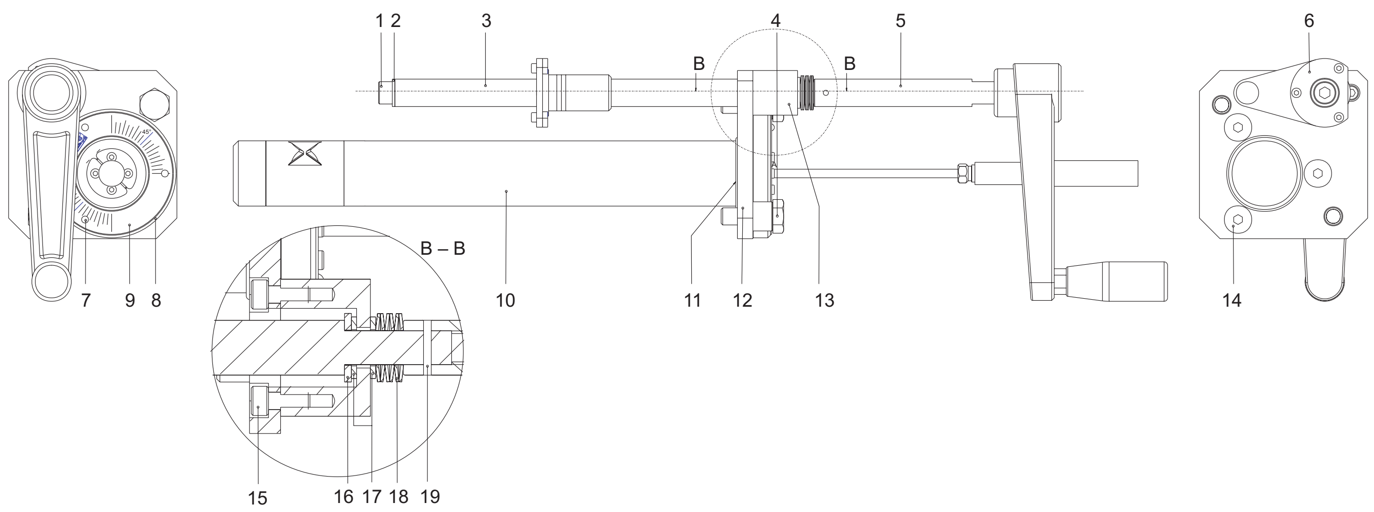
1. Check that the front cylinder end is properly fastened. Otherwise, use strong Loctite to fasten it.
2. Place the transmitter on the workbench with the four (4) screws (pin bolts) pointing upwards.
3. Mount the two thin O-rings for the front flanged end by pushing them over the round end and then position them in their grooves using silicone grease.
   Note! There is no O-ring in the middle groove as this is intended for the air supply.
4. Grease all O-rings and sealing rings with silicone grease.

C. Mount the cylinder pipe

1. Mount the probe. Compress the piston ring while guiding the probe into the cylinder pipe. Take care that neither sealing ring nor piston ring are dislocated.
2. Turn the probe until the measuring gap faces the water inlet.
3. Carefully lift the cylinder pipe and check that the sealing ring is in its proper position.
4. Mount a new X-ring to the rear round end and place the end into position.
5. Put the outer flanged end into position and fasten it with the four nuts. Note! Be careful that the O-rings on the front and rear ends are not dislocated or squeezed, keep them in position with silicone grease.
6. Re-install the air tube.
7. Fit the transmitter to the sluice valve, use three (3) hexagon-headed screws and tighten.
8. Open the sluice valve. Connect electricity and air.

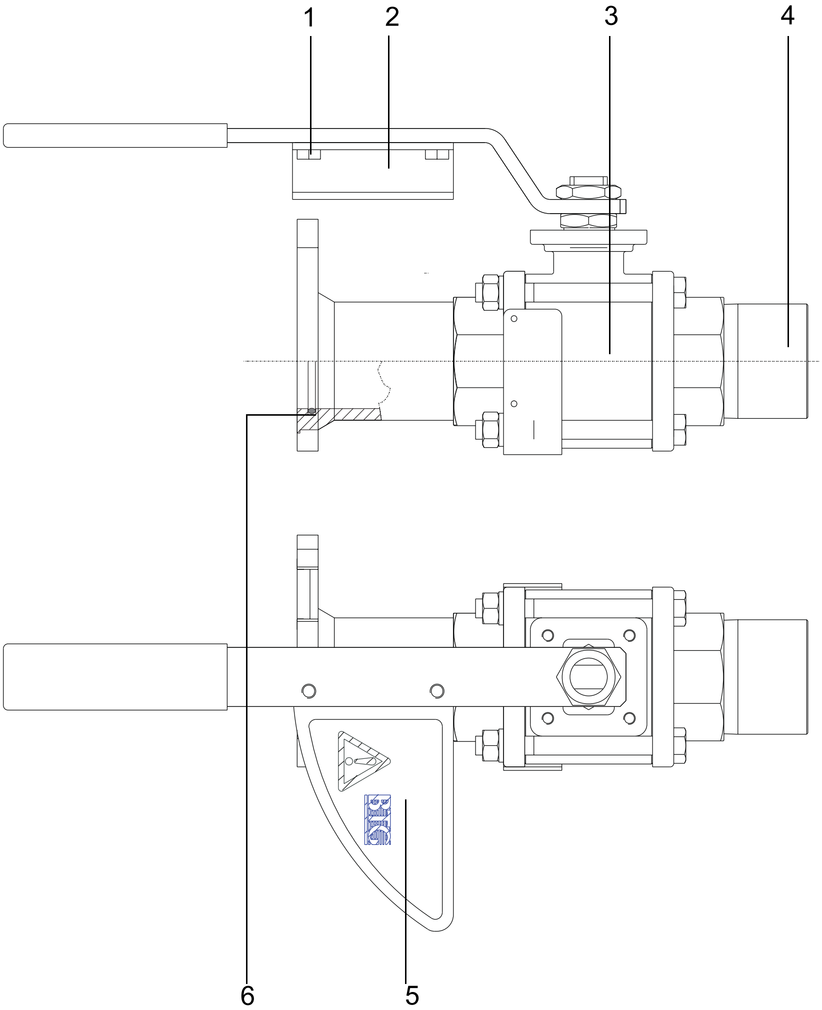
6 Parts list

6.1 Probe



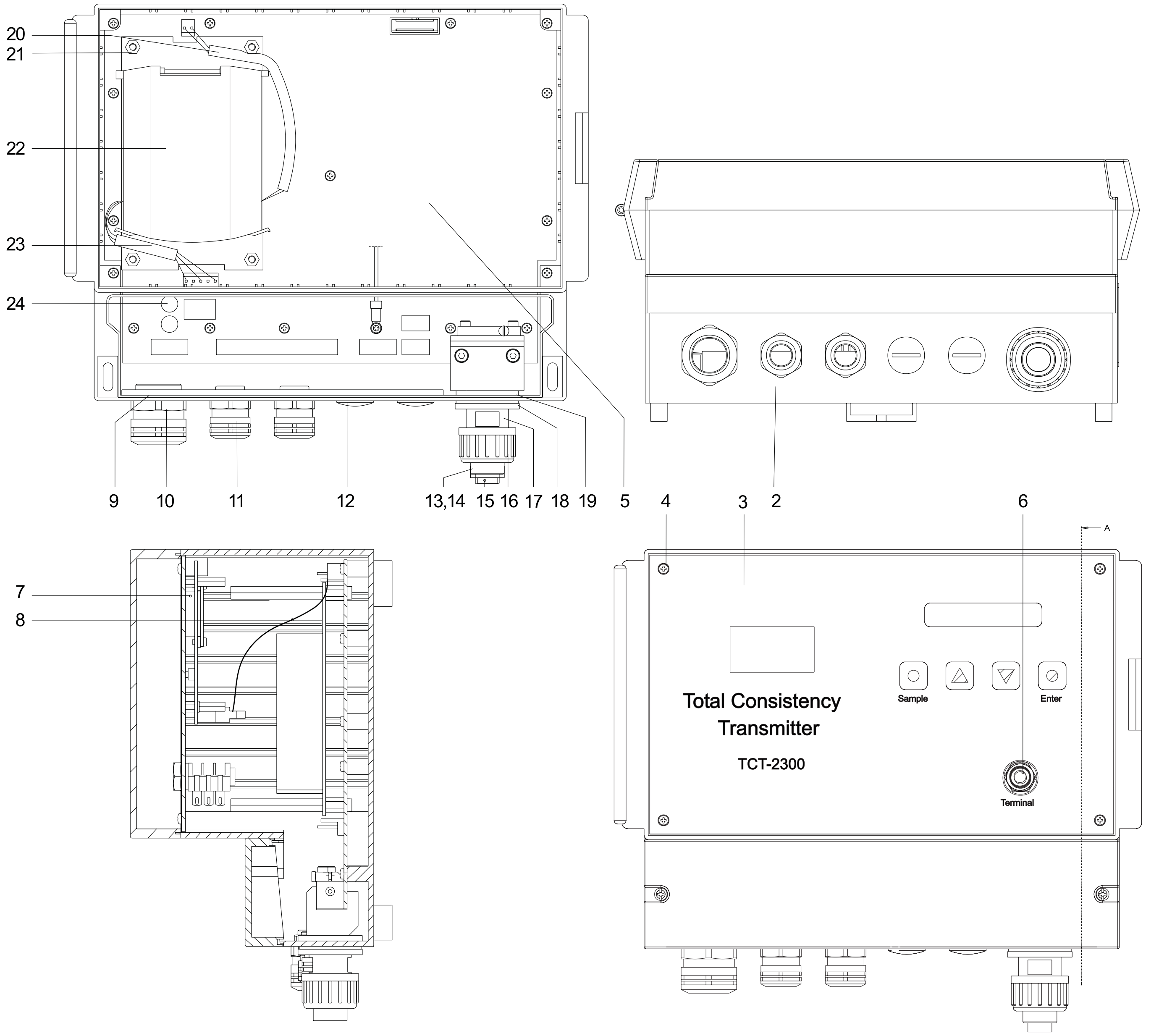
Item No.	Rec. spare parts	Qty	Part No.	Spare Part	Description
1	(*)	1	15020449	Screw MC6S 8x10H	SS steel 2343
2	(*)	1	17001926	Washer BRB ∅8,4x16	SS steel 2343
3	(*)	1	A0005231	Rod	SS steel 2343-02
4	(*)	2	A0006296	Screw to flange M10	
5	(*)	1	84458884	Crank complete	
6	(*)	1	A0004804	Rod lock complete	
7		3	15011976	Drive screw KDS 2x5	SS steel 2333
8		1	A0005090	Outer probe flange	SS steel 2343-02
9		1	A0006429	Protractor	SS steel 2343-02
10	(*)	1	A0005314	Probe with optical fiber	Specify opt. fib. length (10, 20, 30 or 40m).
11	*	1	27014000	O-ring ∅36,2x3	EPDM
12		1	A0006288	Inner probe flange complete	
13	(*)	1	A0005207	Rod holder	SS steel 2343-02
14	(*)	3	15005366	Screw MF6S M8x16	SS steel 2343
15	(*)	2	15001548	Screw MC6S 5x12	SS steel 2343
16	(*)	1	17002593	Washer ∅10,5x20x2	SS steel 2343
17	(*)	2	14460398	Washer	Wolf ZX-100
18	(*)	6	19001379	Spring TF 20x10,2x0,8	SS steel 2331
19	(*)	1	18002733	Notched pin ∅3x16 ISO 2339	SS steel 2346-04

6.2 Valve arrangement



Item No.	Rec. spare parts	Qty	Part No.	Spare Part	Description
1	(*)	2	15005663	Screw M6S 6x10	A4-70
2		1	A0005462	Security plate	SS steel 2343-02
3	(*)	1	A0005066	Ball valve, complete	AISI 316 Valpres
4		1	A0005454	Weld-in stud, threaded type	SS steel 2343
			A0043901	Weld-in stud, flanged type	SS steel 2343
5		1	A0005918	Warning label	
6	*	1	27014018	O-ring ∅37,47x5,	EPDM

6.3 TCT-2301


20
21
22
23
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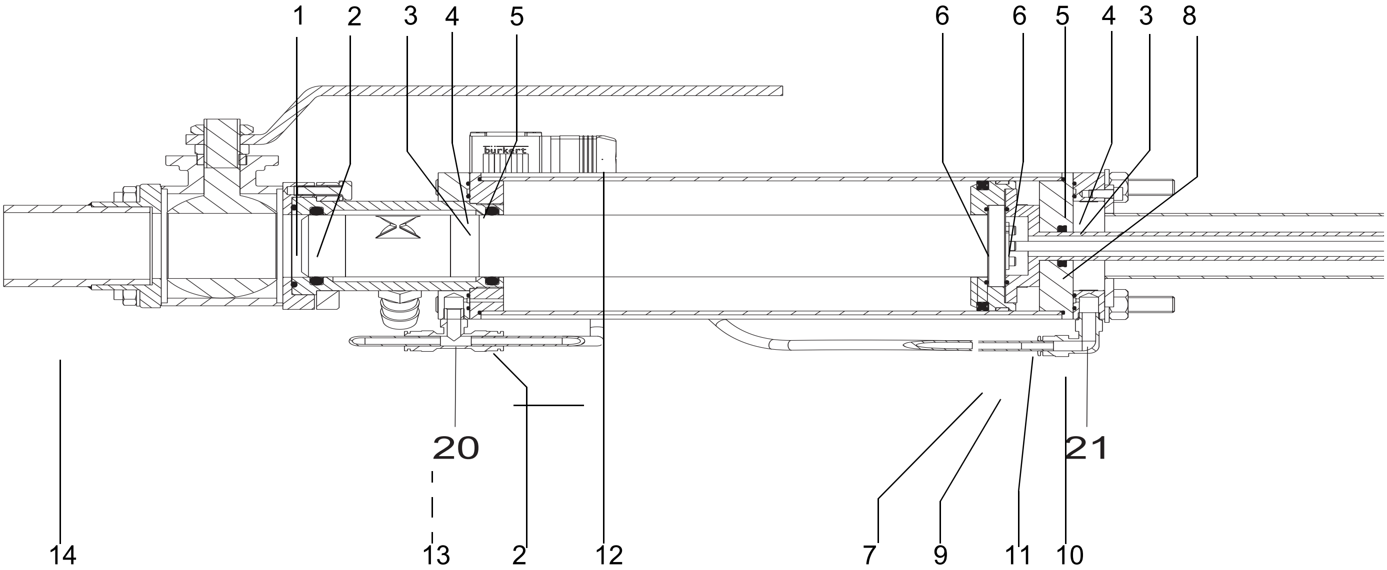
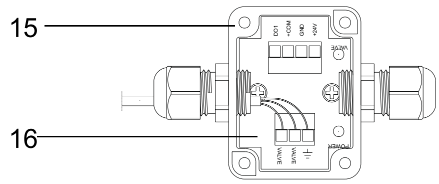
9
10
11
12
13,14
15
16
17
18
19
5
4
3
2
6
7
8
A
Total Consistency Transmitter
TCT-2300
Sample
Enter
Terminal

Item No.	Rec. spare parts	Qty	Part No.	Spare Part	Description
1		1	A0019083	Electronics box, complete	TCT-2301
2		1	A0037697	Enclosure	RCP2500
3		1	A0006619	Front panel, complete	
4		17	15020696	Screw	RXK-H ST2,9x9,5
5	*	1	A0019091	Electronics card, complete	TCT-2301
6		1	A0006635	Jack connection, complete	
7	(*)	1	A0006601	Display card, complete	
8	(*)	1	A0007039	Cable to display	
9		1	A0038935	Plate	
10		1	46028221	Cable fitting	M20x1.5
11		2	46028213	Cable fitting	M16x1.5
12		2	46028130	Blind plug	M12x1.5
13		1	A0006528	Plastic connection	PVC
14	*	1	27008507	O-ring ∅13,1x1,6	Viton
15		1	A0008342	Plug	PVC
16		1	37009743	Plastic nut G5/8	PVC
17		1	A0006486	Connection pipe	SS al 4212-06
18		1	A0006551	Rubber washer	Rubber 1722
19		1	17002767	Distance washer	SS 2333
20	(*)	1	A0015909	Cable 24VDC	
21		4	25002387	Screw DHM 4070x50	
22	*	1	46027330	Power supply 24VDC	Puls
23	(*)	1	A0015891	Cable 110VAC/220VAC	
24	*	3	46022638	Fuse	250V 2AT

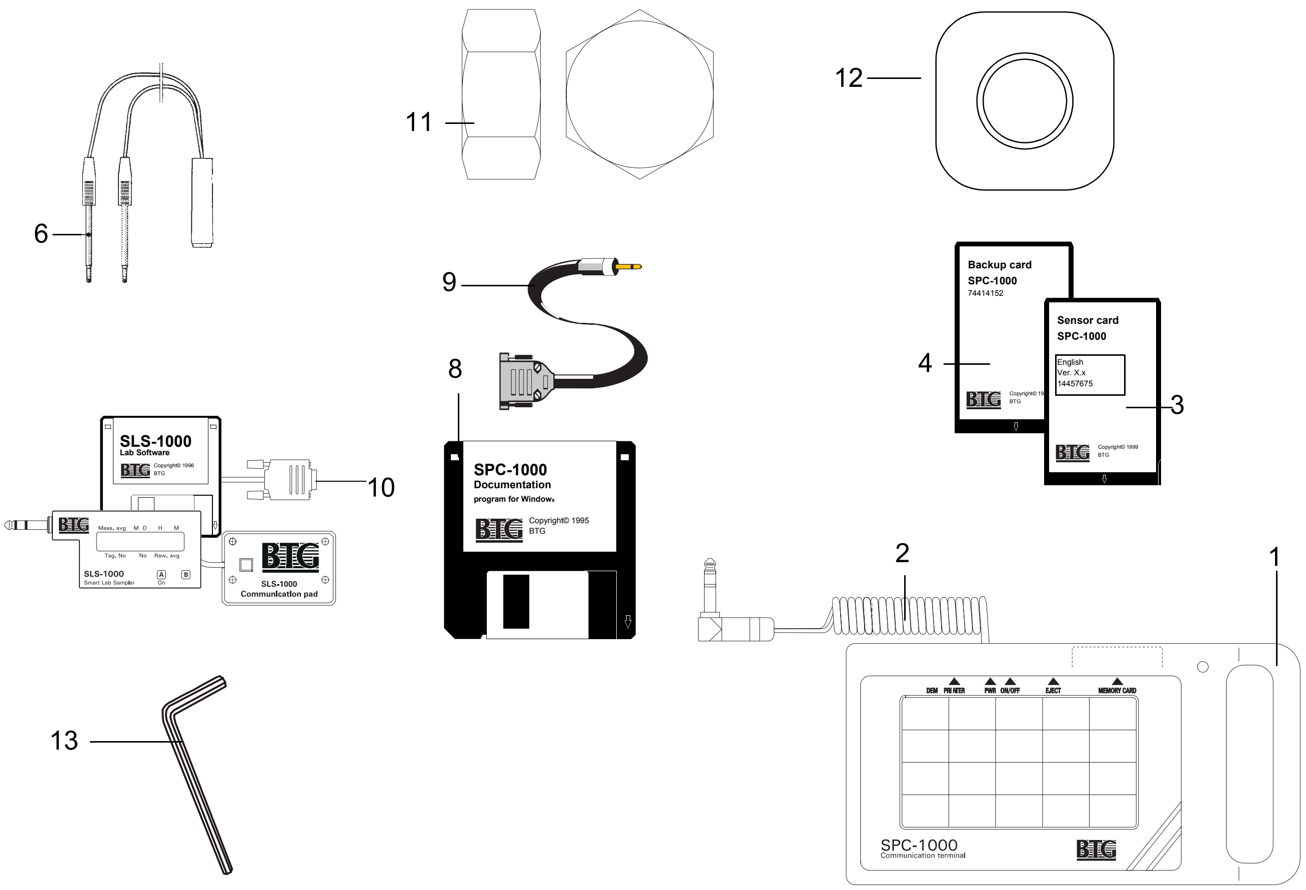
6.4 Cleaning device





Item No.	Rec. spare parts	Qty	Part No.	Spare Part	Description
1	*	1	27012871	O-ring Ø44,2x1,3	EPDM
2		2	27016179	O-ring Ø37,47x5,34	EPDM
3		2	27014448	O-ring Ø59,0x1,6	Nitril
4		2	27014455	O-ring Ø74,8x1,6	Nitril
5		2	27014430	O-ring Ø80,0x1,6	Nitril
6		2	27014422	O-ring Ø43,0x1,6	Nitril
7	*	1	27014828	X-ring 69,22 x 5,34	Nitril
8	*	1	27001494	X-ring Ø20,22x3,53	Nitril
9		1	26004895	Guide	
10		1	A0016436	Cylinder end	
11		1	A0086082	Guiding rod	
12	*	1	A0085209	Solenoid valve	
13	(*)	1	35008358	Diaphragm valve	
14		1	A0043901	Weld-in stud, flanged type	
15		1	A0051763	Connection box, complete	
16		1	A0053124	Circuit card	
	*	1	A0037705	Sealing kit	Consist of item 1-8 and Silicone grease 48001887

6.5 Accessories



Item No.	Rec. spare parts	Qty	Part No.	Spare Part	Description
1	(*)	1	93253847	Hand held terminal, SPC-1000	
2	(*)	1	84396449	Connection cable complete	
3	(*)	1	74399536	Sensor card,	State language version
4	(*)	1	74414152	Backup card	
5		1	46021309	Mains adapter	220 VAC / 12 VDC
		Alt.	46021317		110 VAC / 12 VDC
6		1	74417959	Adapter for terminal connection	
7	*	1	46019873	Alkaline battery	9V 6LR61
8		1	84437508	Installation disk for backup data on PC	
9		1	84437516	PC Cable, to SPC-1000	
10		1	83340372	Smart Lab Sampler, complete	
11		1	37016128	Blind flange	For threaded stud
12		1	A0054460	Blind flange complete	For flanged stud
13		1	56015787	Allen key 5mm	

Remarks

Screws, nuts, etc.:	Symbol **SS** states stainless acid-proof steel to SS 2343. Strength 8.8 is standard.

All symbols are according to Swedish standards.

Notes:

Recommended spare parts marked * are typical for two years operation.
Recommended spare parts marked (*) are less likely to fail but are recommended when a large number of transmitters are to be maintained.