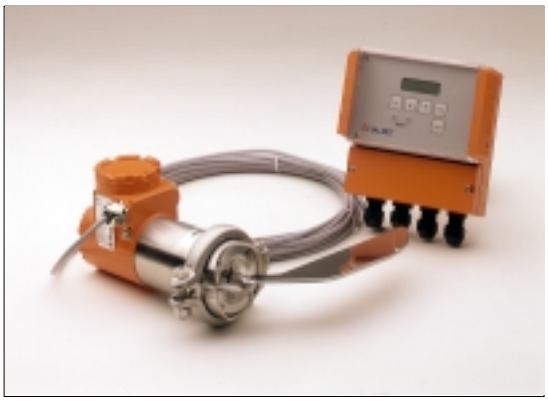
Operating and Installation Instructions



Contents:

WARNING!
Before disconnecting or installing the transmitter, ensure that the process pipe is empty and depressurized. Observe the safety instructions specified for the process.

Metso Field Systems Inc.
Lentokentänkatu 11, P.O.Box 237, FIN-33101
www.metsoautomation.com, Tel. 358 20 483 170,
Fax. 358 20 483 8448
Domicile Tampere, Trade reg. N.o 774. 175, VATFI 15663595

1 PUTTING INTO OPERATION

WARNING !
Before installing the process coupling,
make sure that the process line is empty
and depressurized !

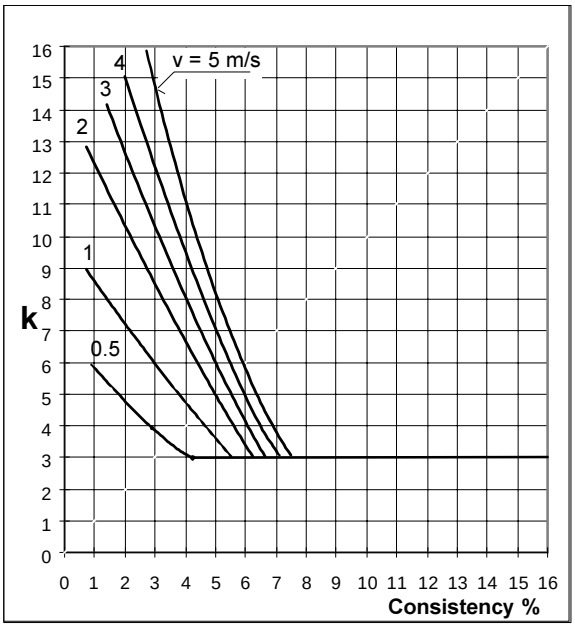
1.1 MECHANICAL INSTALLATION

1.1.1 Points of importance in installation

• The pipe's inside diameter must be at least 100 mm, and flow velocity must be as shown in the **APPLICATION** chapter. If required, the pipe diameter can be altered so as to achieve the desired flow velocity.
• Pulp flow must be laminar.
• The pipe should have sufficiently long straight sections of uniform diameter both upstream and downstream from the transmitter (Fig. 1.1.1a).
• The transmitter must be mounted at **90^{o} angle** to the pump axis and on the side of the line indicated in Figure 1.1.1a, i.e. on the side where the pulp is discharged from the pump.

NOTE! The direction of a pipe bend downstream from the transmitter has no effect.

Minimum lengths of straight pipe sections:
L_{1min} = k x D; L_{2min} = 0.3 x L_{1min} + 250 mm



Example
D = 250 mm, Cs = 3 %, v = 2 m/s

L_{1min} = 8.5 x 250 = 2125 mm
L_{2min} = 0.3 x 2125 + 250 = 887 mm

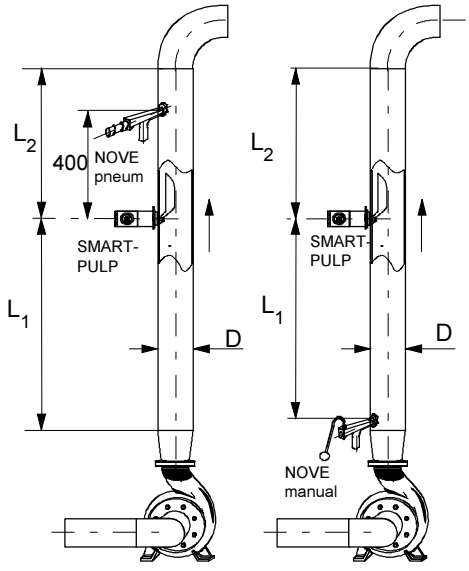
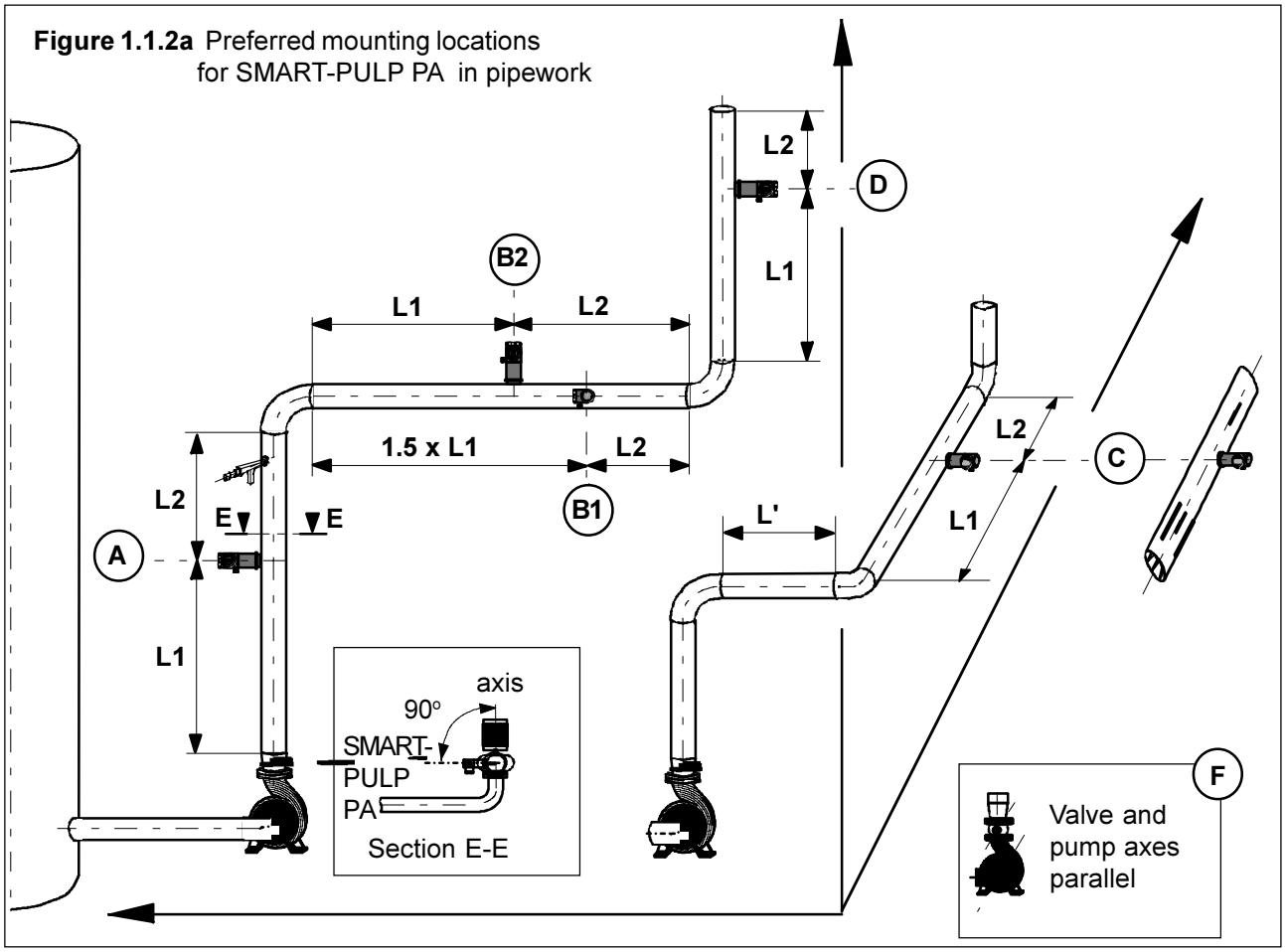


Figure 1.1.1a Determination of coefficient **k** as a function of pulp consistency and flow velocity (see Fig. 1.1.2a)

Figure 1.1.2a Preferred mounting locations for SMART-PULP PA in pipework



1.1.2 Selecting the mounting location

Preferred mounting locations:
1. A, **2.** B1, **3.** B2 or C (D when pipe turns upward again).

Important considerations:

A. This is the preferred location in terms of the control loop's lag time. If the required length of straight pipe (L1 + L2) is not provided, you can use an installation tube FlowDIR-P pipe (Fig. 1.1.2b) that can be welded in place immediately after conical expansion.

NOTE!
The transmitter should be mounted at 90° angle to the pump axis (section E-E).

If the vertical section is shorter than the installation tube or if you want a better alternative, proceed to B1.

B1. In this alternative you install the transmitter on the side of the line to prevent possible air from disturbing the measurement. Notice that straight section L1 before the transmitter is 50% longer than in alternative A. If the straight section is too short, you can use an FlowDIR-P pipe or proceed to alternative B2 or C.

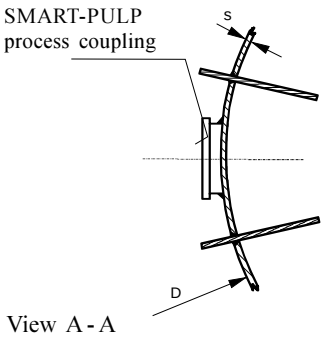
B2. This method may be considered if the straight length of horizontal pipe is too short for alternative B1. Installation on the top side of the pipe always requires careful consideration, because a substantial buildup of air in the pipe may affect the measurement accuracy. We do not recommend this installation method.
C. You may consider this option when horizontal and vertical sections before the transmitter are too short. The double bend before the measurement point will cause problems when L' < L1. The whirling flow produced by the double bend has to be eliminated with FlowDIR-P pipe. In addition, you have to consider the control loop's lag time, which is considerably longer in this alternative than in alternative A.
D. In this method you install the transmitter on the side of a pipe bend's outer curve. Distance from pipe bend is L1. Measurement lag: refer to C.

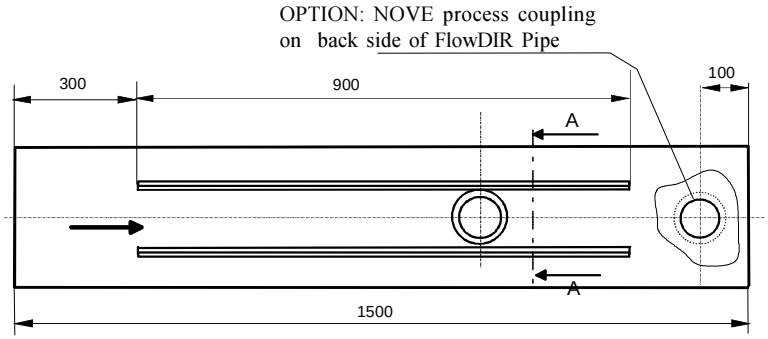
Other considerations:
F. If you have to install a globe valve or butterfly valve between pump and transmitter, the valve's axis must be parallel to the pump's axis to eliminate whirling flow. The valve manufacturer's specifications must be taken into account.

Note! The pipe diameter must not be changed at distance +L2 between the pump outlet cone and the transmitter mounting location.

FlowDIR Pipe

For different process line sizes: DN
Material: AISI 316 L





DN	D x s	P_{max}/bar	Product n:o
100	114.3 x 2	18	A4730188V1
125	139.7 x 2	16	A4730189V1
150	168.3 x 2	12	A4730190V1
200	219.1 x 3	16	A4730180V1
250	273.0 x 4	10	A4730181V1
300	323.9 x 4	10	A4730182V1
350	355.6 x 4	10	A4730183V1
400	406.4 x 5	10	A4730184V1
500	508.0 x 5	8	A4730185V1
600	609.6 x 5	6	A4730186V1
700	711.2 x 6	6	A4730187V1

Figure 1.1.2b Installation tube assembly

Low consistencies (SMART-PULP PA UL)
Low consistencies (see Section 6.1, Applications of different sensor types) are measured with sensor option UL. Use FlowDIR Pipe in main line installations. To measure extremely low consistencies as accurately as possible we recommend a bypass installation that will provide the required flow velocity and stabilized flow. You should be able to limit the flow velocity between 0.1 m/s and 1 m/s. This installation is illustrated in Figure 1.1.2e. The bypass line is connected to the process line with dia. 25 mm pipes for max. 2% Cs consistency, and with dia. 32 mm pipes for max. 3% Cs consistency. At higher than 3% Cs consistencies you use a dia. 40 mm pipe. Do not use a deflector with the UL sensor.
NOTE! Due to the risk of plugging, this installation is not suitable for **unscreened** pulp.

High consistencies (SMART-PULP PA HL)
SMART-PULP HL, the transmitter for high consistencies, is installed on the small-diameter pipe section following the stock pump. This will ensure sufficient flow velocity. See Figure 1.1.2d. This pipe section usually includes other devices, such as a flowmeter and control valve. Recommended installation order is shown in Fig. 1.1.2d.

To protect the sensor, the deflector blade supplied with the transmitter must always be installed in high-consistency applications where standard process coupling is used. In digester blow line installations you have to use the blow coupling shown in Figure 1.1.2i. In that case you will not need a separate deflector in front of the sensor.

Figure 1.1.2c Profile tape: When required, used to shape the coupling before welding

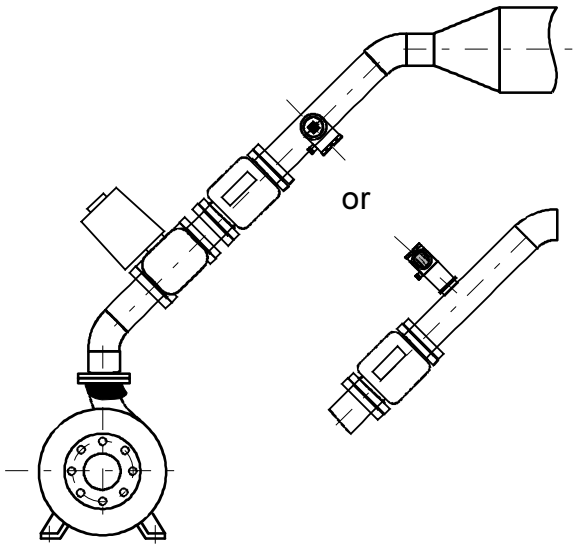


Figure 1.1.2d Installation of SMART-PULP PA HL (4 to 16% consistency range) after MC pump

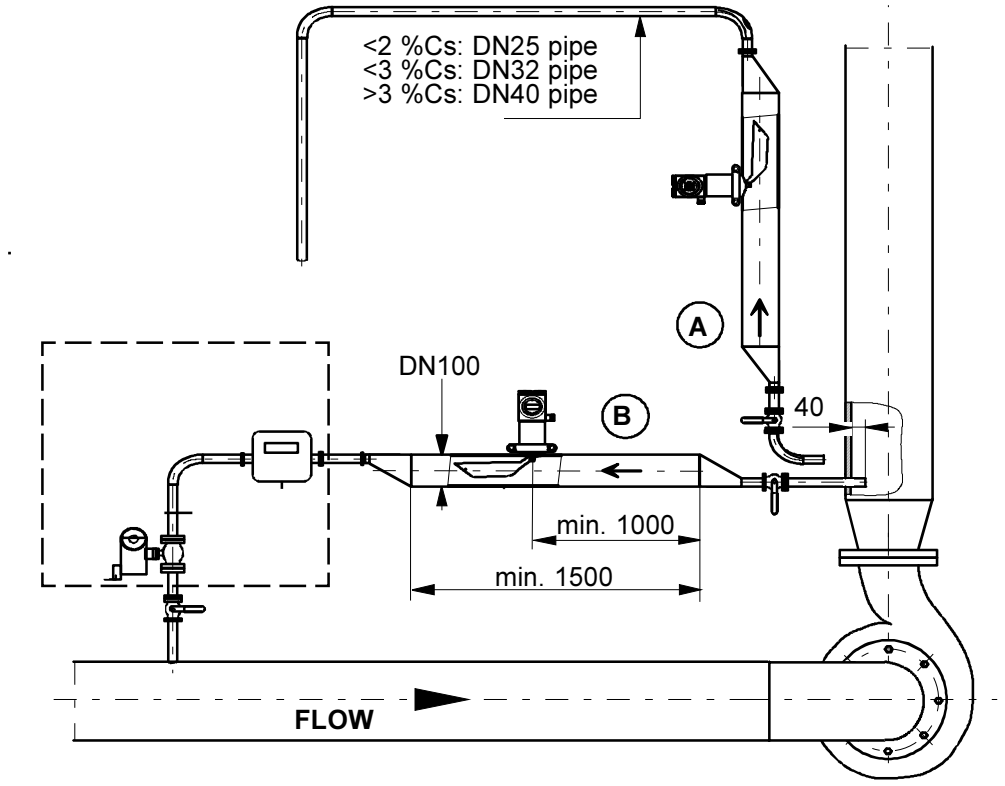


Figure 1.1.2e Low-consistency measurement with bypass line (SMART-PULP UL)

1.1.3 Installation of process couplings and deflectors

SMART-PULP PA LL/LS/GL/RL/HL
Using the welding guide shown in Fig. 1.1.3f, you weld the process coupling exactly at right angles (90° ±0.5°) to the pipe as shown in Fig. 1.1.3a. (Welding instructions are supplied in the kit.)

Procedure:
- Make a dia. 71 mm hole in the pipe.
- If necessary, shape the process coupling to suit the pipe. See Fig. 1.1.2c.
- Attach the process coupling to the welding guide.
- Equalize the height adjustment at both ends of the guide to ensure that the guide is supported steadily on its end pieces and will not rock on the coupling.
- Attach the welding guide to the process pipe with mounting straps.
- Weld the coupling at 4 points on the pipe.
- Remove the guide and complete the welding.

Deflector distances L3 and L4 for types LL/LS/GL/RL: L3 = L4 = 300 mm; and for type HL: L3 = L4 = 150 mm.
The deflector downstream from the sensor is only installed in applications with a risk of back flow that might damage the sensor (e.g. when stopping or starting the process). The deflectors must be centered exactly in line with the process coupling. The deflectors have dia. 5 mm holes to facilitate installation; for instance, you may insert a piece of wire through the holes. In exceptional cases, when process pressure exceeds 10 bar and/or there is exceptionally strong vibration, it is advisable to reinforce the mounting of the process coupling with a reinforcing ring (Fig. 1.1.3b). Deflector's inlet to the pipe should also be reinforced in the same way.

*) This optional protection blade must be ordered separately.

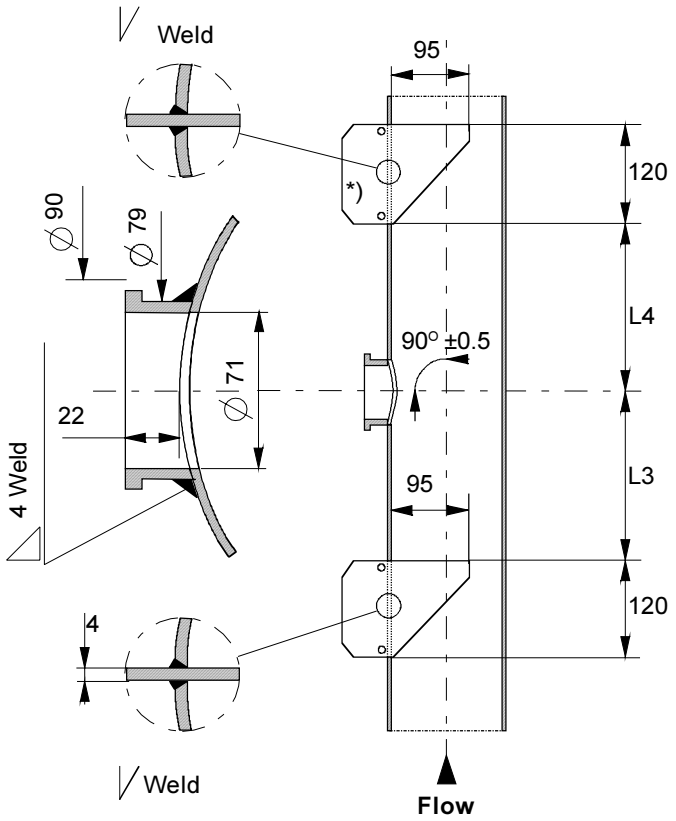


Figure 1.1.3a Installation of SMART-PULP PA LL/LS/GL/RL/HL

SMART-PULP PA UL
Installation in bypass line (Fig. 1.1.2e): Install the process coupling as described above, but exclude the deflectors. When installing in the actual process line you may require an installation tube (Fig. 1.1.2b) without deflectors.

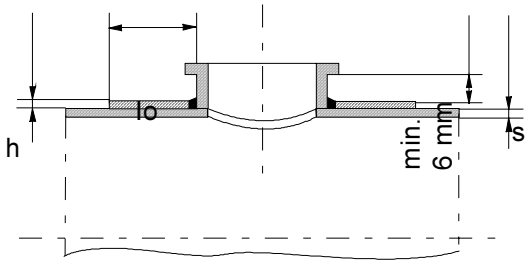
SMART-PULP PA WS
Install the process coupling as shown in Figure 1.1.3c. Cut a 9 mm by 182 mm bevelled hole in the pipe for the deflector. Place the coupling on the pipe and draw the outline of the coupling's bore on the pipe. Then cut out the mounting hole. Remove all burrs from the hole, and round the edges of the hole. Weld the coupling. Install the backflow deflector in line with the coupling's center line.

SMART-PULP PA HL in digester blow line installations

Install the blow line coupling with single bevel weld at right angles against the pipe, as shown in Figure 1.1.3d. See that the deflector is exactly in line with the pipe's center line. The coupling's lower edge should be level with the pipe's inner wall. Regulations concerning pressurized vessel installations must be observed when welding the coupling.

SMART-PULP PA JL

Installation of the process coupling on fiberglass-reinforced plastic pipe is illustrated in Figure 1.1.3e. First make a bevelled hole in the pipe. Then laminate the process coupling carefully on the pipe in accordance with lamination instructions.

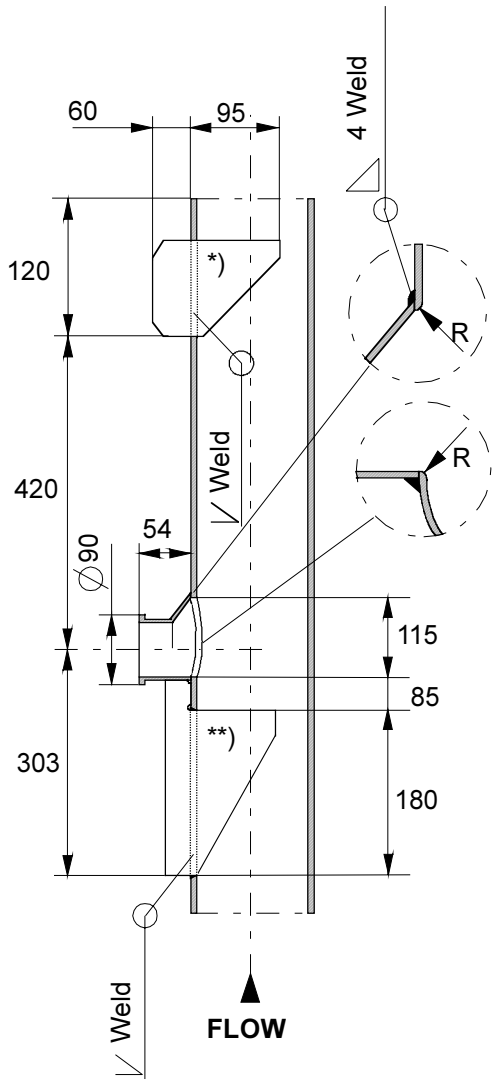


D = pipe's inside diameter
s = pipe's wall thickness
lo = width of reinforcing ring
h = thickness of reinforcing ring

D mm	s mm	p max. bar	T max. °C	h mm	lo mm
250	4	25	100	5	32
400	6	25	100	5	50
500	7	25	100	6	60

NOTE! If the pipe's wall thickness is greater than that given in the table, the thickness of the reinforcing ring can be correspondingly smaller.

Figure 1.1.3b Reinforcing the process coupling



*) Plate thickness 4 mm
**) Plate thickness 8 mm

Figure 1.1.3c Installation for SMART-PULP PA WS process coupling

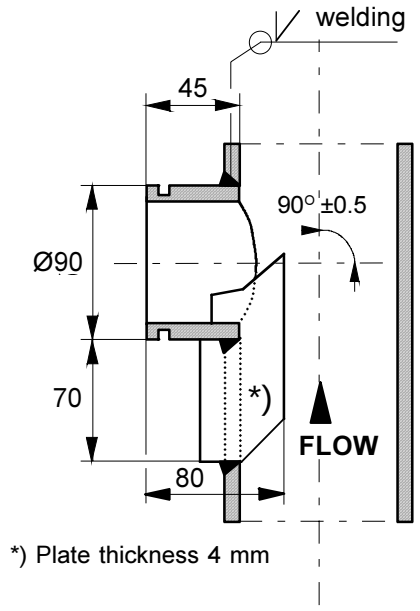


Figure 1.1.3d
Installation of SMART-PULP PA HL in digester blow line

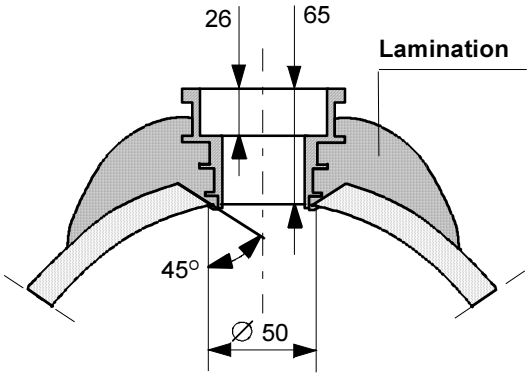


Figure 1.1.3e Installation for SMART-PULP PA JL

Installing the transmitter

Place PTFE gasket in the groove on the transmitter's coupling flange (Fig. 1.1.3g). Attach the transmitter to the process coupling with mounting clamp. Before tightening the screws, ensure that the transmitter's sensor blade is parallel to the direction of flow (±1°). Use a ruler placed against the bottom of the aligning slot to align the sensor. Apply 25 Nm torque to tighten the screws.

Note! When required, the process coupling can be shut with a blind flange.

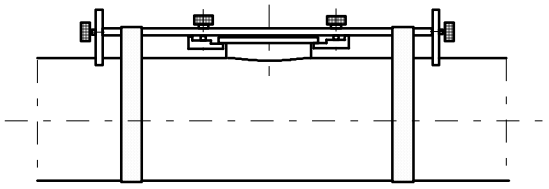
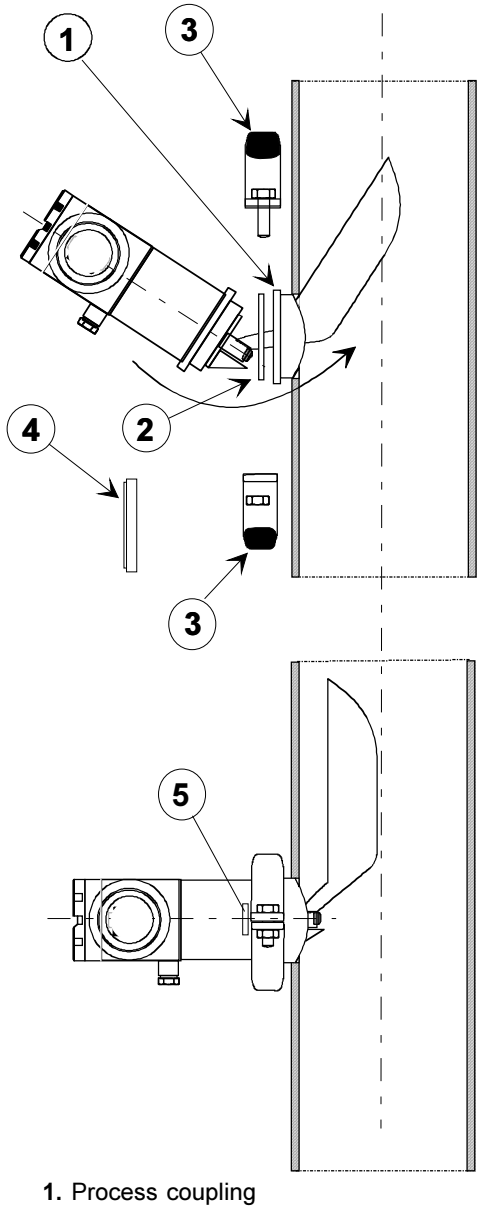


Figure 1.1.3f Process coupling welding guide



1. Process coupling
2. Gasket
3. Mounting clamp
4. Plug
5. Aligning slot

Figure 1.1.3g Mounting parts for SMART-PULP PA

1.2 ELECTRICAL CONNECTIONS

1.2.1 Power supply and wiring

SMART-PULP PA's wiring connections are shown in Figures 1.2.1.

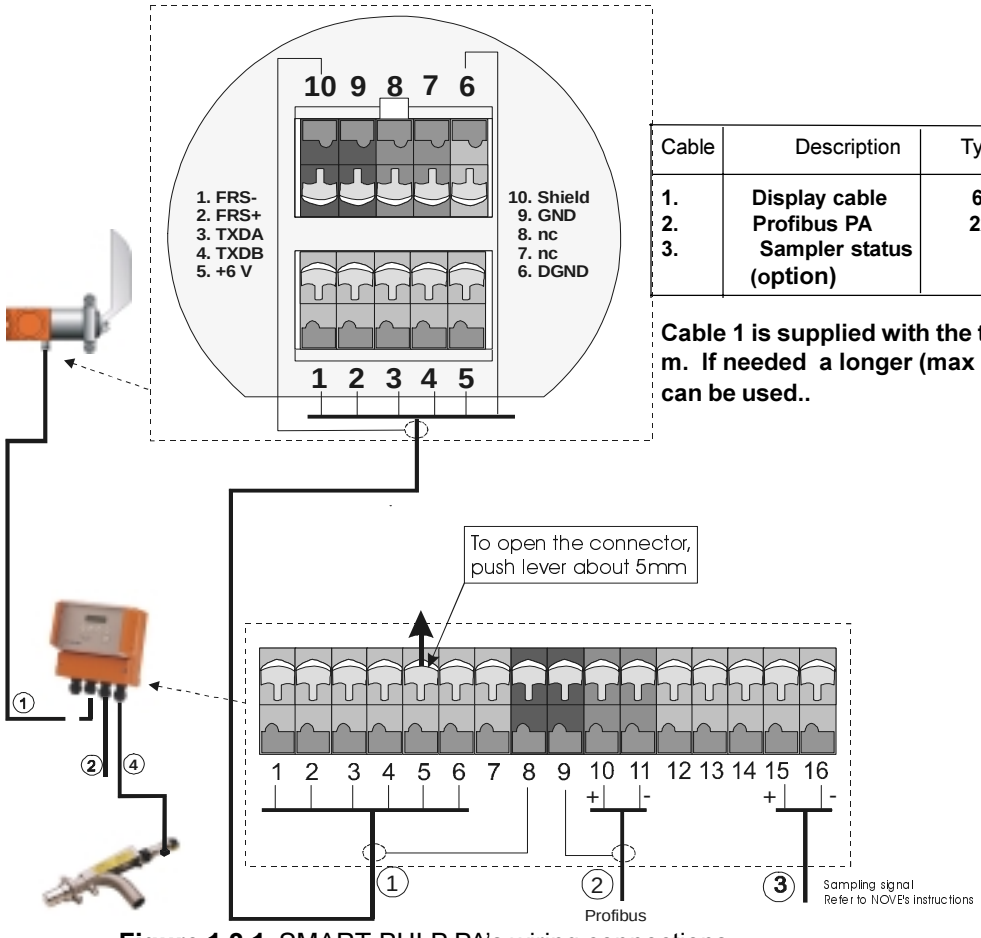
Making the connections:

· Open the connection box cover.

· Insert the cable (2) through the inlet (third from the left). Leave an extra loop of cable outside the transmitter as reserve and to conduct drain water out. Tighten the inlet nut and ensure that the inlet is properly sealed.

· Make the connections as shown in Figure 1.2.1. Connect the groundings in accordance with the control system's instructions.

· Replace the cover.



Cable	Description	Type
1.	Display cable	6x0.25 + shield
2.	Profibus PA	2x + shield
3.	Sampler status (option)	

Cable 1 is supplied with the transmitter length 10 m. If needed a longer (max 30 m) or shorter cable, can be used..

Figure 1.2.1 SMART-PULP PA's wiring connections

1.3 SETTING UP THE TRANSMITTER

QUICK SETTING-UP GUIDE:
CONFIGURATION AND CALIBRATION

When the transmitter is connected to the process for the first time, it will operate on default values set by the manufacturer. The defaults are not sufficient, however, and the transmitter must first be configured and calibrated in the actual process conditions.

The following is a description of the simplest procedure (A) for a transmitter where the sensor blade has been mounted by the supplier (i.e., not a standby transmitter installed to replace e.g. a faulty transmitter).
This procedure enables an already calibrated consistency measurement. The other functions provide useful additional features, but they are not necessary in basic measurement.

The procedure is divided to three parts:

1. Defining the transmitter's basic details, i.e. configuration (A1 and A2).
2. Selecting the pulp types to be measured (A3).
3. Adapting Valmet Automation's laboratory-defined calibration curves, optimized in terms of pulp type and sensor blade, to the actual process conditions (A6).

The appended Tables show the procedure for setting up a transmitter taken into operation for the first time. The Tables show the required keystrokes and the corresponding displays. Steps **A1 through A6** below describe the actions in more detail.
More detailed instructions for the menus are found in the chapter Transmitter Functions (Menus), which gives a detailed description of the Calibration, Configuration, Diagnostics and Measurement menus.

PROCEDURE
A1. Switch on the transmitter. Press [ESC] and [⇓] to access the CONFIGURATION menu. The text CONFIGUR is displayed. Press [ENTER]. The text DAMPING is displayed. This is the first parameter to be adjusted in the configuration menu.
A2. You can select another parameter with the arrow keys. Pressing [ENTER] will display the selected parameter's current

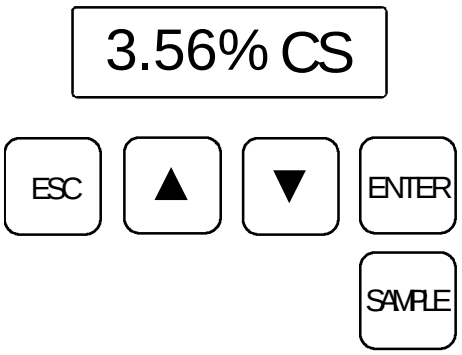


Figure 1.3a SMART-PULP PA's operator unit

The operator unit consists of five pushbutton keys and an 8-character liquid crystal display. Press **ENTER** to accept an option or command. Press **ESC** to go to the next higher menu level or to the previous step, depending on the command. Use the **arrow** keys to view and/or select an option and to change numerical values. Use the **SAMPLE** key to take a sample.

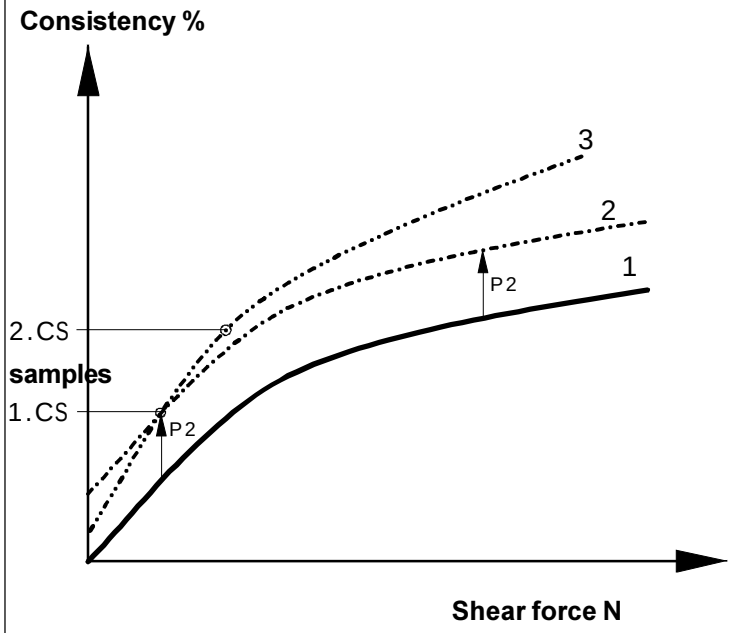


Figure 1.3b SMART-PULP PA Calibration

1: Base curve corresponding to selected sensor and pulp type.
2: Single-point calibrated base curve.
3: Two-point calibrated base curve.

(The effects are exaggerated to make them clearer.)

value, which you can change with the arrow keys. Pressing [ENTER] will save the new value. If you do not want to change the value, press [ESC] to display the parameter's name. Pressing [ESC] always displays the previous higher menu level, until you finally reach the MEASUREMENT menu.

Check and, if required, change at least the following:

BLADE TY (sensor blade type)
MOUNTING (mounting orientation)

The other parameters are additional features which you do not necessarily have to touch. The manufacturer's default values are sufficient for normal operation.

A3. Press [ESC] to go up to the CONFIGUR menu. Press [⇓] to select CALIBRATion, and accept the selection with [ENTER]. The text NEW RECI is now displayed.

You next create at least one new recipe in the NEW RECIpe submenu. Press [ENTER] to go to that submenu. In the recipe you select the recipe number (1 to 8), main pulp type, and filler (ash) content if required. **0.0 is recommended** if you do not know the exact ash content. You accept the P1 and P2 parameters as they are (default values 1.00 and 0.00, respectively).

Pulp types:

The following list describes all pulp types offered by the menu. Selected sensor type will exclude some of the pulp type options. If you cannot get the desired pulp type, ensure that the correct sensor type has been configured and that the transmitter is equipped with that sensor type. ***Mechanical pulps are softwood pulps.***

HWU Unbleached hardwood chemical pulp, e.g. birch pulp or eucalyptus, bagasse and other agro fibers.
HWB Bleached hardwood chemical pulp.
SWU Unbleached softwood chemical pulp, e.g. pine and other softwood pulps.
SWB Bleached softwood chemical pulp.
GW Groundwood, including pressure groundwood.
TMPL Thermomechanical pulp, freeness less than 200ml CSF.
TMPH Thermomechanical pulp, freeness more than 200ml CSF.
RMPL Refiner mechanical pulp, freeness less than 200ml CSF.
RMPH Refiner mechanical pulp, freeness more than 200ml CSF.
CTMP Chemithermo-mechanical pulp.
RCFU Recycled fiber, unscreened; contains debris.
RCFS Recycled fiber, screened.
ROCCU Recycled fiber, packing board, unscreened (OCC).
ROCCS Recycled fiber, packing board (OCC), screened.
ULIN Unlinearized 0-30 N shear force range without temperature correction. Corresponding output display 0-100% instead of pulp consistency.

Even if there is filler, you may accept 0.00% as ash content, provided that you do not want to change the ash content later without sampling and laboratory analysis.

In practice, sampling and 2-point calibration will make the correction for an unknown filler content. However, when filler content changes the transmitter must be recalibrated on the basis of sampling and laboratory analysis. Merely changing the filler content from the operator unit will not suffice if the initial filler value was incorrect at calibration time. On the other hand, if the original filler content was known and was entered into the recipe at the beginning, it can be changed later and obtain the correct measurement result without sampling.

In most applications it is sufficient to define zero filler content and to create a separate recipe for each pulp type and ash content combination.

You can create 1 to 8 recipes, each of which can be calibrated separately on the basis of sampling and laboratory analysis.

The text NEW RECI will be redisplayed after you have accepted all selections and the SAVE OK? prompt with [ENTER]. You can then repeat step A3 for the desired number of recipes. You can also later add new recipes or change existing ones.

A4. The transmitter is now ready for measurement.
Press [ESC] to go to the MEASURE menu, and accept the selection with [ENTER]. Use the arrow keys to display the text RECIPE, and replace it with one of the recipe numbers created in step A3. The sequence is as follows: ENTER / [⇓⇑] / ENTER / ENTER.

A5. Use the arrow keys to go to the CONSISTENCY (CS) display. The displayed consistency value is derived on the basis of the measured shear force from the base curve for the selected pulp type and sensor type saved into the transmitter's memory.

Keystroke	Disp.text	Description
A1	**n.nn%Cs**	Measured consistency (start-up display).
ESC	**MEASURE**	To main menu. The measurement menu.
[⇓]	**CONFIGUR**	To configuration menu.
ENTER	**DAMPING**	————————————————
A2 [⇓][⇓][⇓]		
ENTER	**MOUNTING**	Configuration of mounting position; pipe orientation and transmitter's position on it.
	HOR TOP	**Default value.**
[⇓⇑]	**desired mounting**	**HOR**izontal **TOP**/**SIDE** **VER**tical **UP** flow—
ENTER	**SAVE OK?**	————————————————
ENTER	**MOUNTING**	Sensor type check: sensor blade type and material.
⇓][⇓][		
ENTER	**BLADE TY**	
	default blade type	Should be the same as in installed transmitter.
[⇓⇑]	**correct blade type**	If type was not correct.
ENTER	**SAVE OK?**	
ENTER	**BLADE TY**	————————————————
ESC	**CONFIGUR**	Back to main menu.
[		

Keystroke	Disp.text	Description
[⇓]	**CONFIGUR**	A3
ENTER	**CALIBRAT**	
ENTER	**NEW RECI**	
[⇓⇑]	**RECIPE1**	E.g. recipe number 1 can be accepted.
ENTER	**RECIPEn**	
[⇓⇑]	**ULIN**	Default curve (unlinearized shear force signal). 0-30 N = 0-100%. Recipe's dominant pulp type.
ENTER	**xxxxx**	
[⇓⇑]	**ASH0.0%**	Give filler content (0.0% is recommended if the laboratory command is used).
ENTER	**ASH0.0%**	
ENTER	**P1 1.000**	Curve slope factor. (Base curve = 1.0).
ENTER	**P2 0.000**	Curve offset (base curve = 0.0).
ENTER	**SAVE OK?**	
ESC	**NEW RECI**	A3 can be performed for all recipes. Back to main menu.
ESC	**CALIBRAT**	
ENTER	**MEASURE**	A4 Change active recipe to measurement menu.
[⇑⇑]	**x.xx%Cs**	
ENTER	**RECIPE1**	
[⇓][⇓]		
ENTER	**RECIPEn'**	Active recipe which is to be calibrated. If only one recipe (e.g. 1), accept it.
ENTER	**SAVE OK?**	
[⇓][⇓][⇓]	**NOT CALIB**	A5 Blinking warning for uncalibrated recipe. Consistency reading from base curve. If correct, sampling and laboratory analysis not required.
	x.xxx%Cs	If base curve is not sufficient, go to next Table and continue from A6.
		Most of the cases at least single-point calibration is needed to remove offset between laboratory and transmitter output.

Table 1.3a SMART-PULP Start-up calibration and configuration: menu texts and keystrokes.

A6. (Table 1.3b). **If the transmitter's reading does not correspond to the actual consistency in the pipe**, you have to perform sampling and laboratory analysis and calibrate the recipe on the basis of the results.

CALIBRATION BY MEANS OF SAMPLING

Press [ESC] to move upwards through the menus until the text MEASURE is displayed.
NOTE! The recipe to be calibrated must be active (see A4).
Press [⇓] and [⇓] to display the text CALIBRAT. Press [ENTER] to confirm this selection.

The text NEW RECI is displayed again. Press [⇓] to display the text SAMPLING. Press [ENTER] to confirm this selection.

Now the text 1.START is displayed. Pressing [ENTER] will start average value calculation for Sample No. 1.

You can also activate average value calculation for Sample No. 2 by pressing [⇓] until the text 2.START is displayed, and by accepting this selection with [ENTER].

The blinking text END SAMP indicates that averaging for Sample 1 or 2 is in progress. After taking the actual sample from the pipe, press [ENTER] to accept the END SAMP text.

You can repeat the taking of Sample 1 and 2 the desired number of times. The last results are always retained in memory. A single sample, e.g. No. 1, is sufficient for single-point calibration. Since the sampling can be repeated the desired number of times, press [ESC] to exit the menu.

The menu text SAMPLING is displayed again.
Analyze at least your sample's consistency in laboratory.
Press [⇓] to display the menu text LABORATO.
Accept the selection by pressing [ENTER].

Then use the arrow keys to get the correct recipe number, i.e., the same on which the samples were taken and which you want to calibrate. The displayed default number should be correct unless the recipe number has been changed since sampling.
Press [ENTER] to accept the recipe number.
The text ASH 0.0% is displayed. If you know the filler content, enter it with the arrow keys. Press [ENTER] to accept the filler content. In most cases the filler content setting can be 0.0 even if there is ash, provided that the content remains constant.
The text 1.CSn.nn% is now displayed. n.nn is the same as the average of Sample No.1 measured by SMART-PULP. Use the arrow keys to change the reading in accordance with the laboratory result, and press [ENTER] to accept the value.

Now the text 2.CSn.nn% is displayed. Enter the laboratory result for Sample No. 2, and press [ENTER] to accept the value. In single-point calibration, you can accept the unused sample's value as it is.

The text SAVE OK? is displayed. Press [ENTER] to save.

Keystroke	Disp. text	Description
A6	NOTE! Ensure that the recipe you are calibrating is active (see A4).	
ESC	MEASURE	To calibration mode.
[⇓][⇓]	CALIBRAT	
ENTER	NEW RECI	
[⇓]	SAMPLING	The sampling menu, where samples are averaged.
ENTER	1.START	The 1st sample.
ENTER	END SAM	Take sample from pipe, end averaging.
ENTER	1.CS xx.xx	Sample's average consistency.
ESC	SAMPLING	Process sample in lab.
[⇓]	LABORATO	Go to Laboratory results menu.
ENTER	RECIPE 1	The recipe to be calibrated?
ENTER	ASH 0.0%	
[⇓⇑]	ASH 0.0%	Give filler content if known. 0.0% is recommended if the laboratory command is used.
ENTER	1.CS xx.xx	
[⇓⇑]	1.CS yy.yy	Enter consistency sample's lab result.
ENTER	2.CS mm.mm	Not required in single-point calibration.
ENTER	SAVE OK?	Calculate new calibration.
ENTER	USE 1ST	Is 1st sample used for single-point calibration? Yes.
ENTER	SAVE OK?	Save in non-volatile memory.
ENTER	LABORATO	Back to main menu.
ESC	CALIBRAT	
ESC	MEASURE	To Measurement menu.
ENTER	zz.zz%CS	Calibrated measured value.

Table 1.3b
SMART-PULP Start-up calibration and configuration: menu texts and keystrokes II.

The text USE 1.N is displayed. You can change it to USE 2.N or USE BOTH (= 2-point calibration) with the arrow keys. In most cases you use only one sample (Sample 1) to perform single-point calibration on the basis of it. In that case you just press [ENTER] to accept the USE 1.N command.

Press [ENTER] to the SAVE OK? prompt. If you have proceeded correctly, the text LABORATO is now displayed.
The transmitter is now calibrated, and you can go to the MEASURE menu by pressing [ESC] [ESC] [ENTER].

CALIBRATION WITHOUT SAMPLING

If you detect a difference between the transmitter's reading and analyzed consistency, you can eliminate it directly with zero offset by changing the P2 value (see Table 1.3a). The change in P2 is the same as the detected difference, LAB – measured average.
Use the arrow keys to change the P2 value. The specified zero offset takes effect when you accept the SAVE OK? prompt, after which you can return directly to the MEASURE menu.

When calibration has been completed, it is recommendable to write down all recipes (pulp type, filler, P1 and P2) as well as the configuration. Standby transmitter can then be made operational with minimum effort.

Using the SAMPLE key

A. Press the SAMPLE key to start sample taking, upon which:
- The transmitter starts averaging the measured consistency and displays the average consistency value.

- A symbol at the right-hand side of the display shows the state of binary input 4 as follows:
- When you use a NOVE sampler equipped with a switch via which a 24V voltage is applied to binary input 4 when NOVE is closed, the symbol is O and the consistency display shows 0.00%Cs. When NOVE is open, i.e. in the sampling position, the symbol is C.

- Start taking the sample.
- Wait at least 3 seconds.
- Stop taking the sample.
- Press SAMPLE key, upon which the display again starts showing the current measured value.

The average measured value for the sampling time is now saved in memory for SMART-PULP PA's single-point calibration.
To perform two-point calibration you have to perform sampling in the CALIBRAT/SAMPLING menu.

Configuring and calibrating a standby transmitter used to replace a faulty transmitter (B)

B. If the new transmitter's sensor blade has been replaced by the customer or if there is otherwise reason to suspect an error in shear force measurement, we recommend the DIAGNOSTics menu's TRIM F function (see the Diagnostics chapter) before installing the transmitter in the process.
This will make the transmitter's operation consistent with other corresponding SMART-PULP transmitters. Consistent force measurement enables the new transmitter to be calibrated so that it will operate identically with the replaced transmitter without sampling and laboratory analysis.
It will be sufficient to enter the other transmitter's recipe data (pulp type, filler content, and the P1 and P2 parameters) and configuration (lower and upper range-values, sensor blade type, mounting orientation and damping) to the new transmitter.

2 ON-SITE OPERATION BY DISPLAY UNIT

Operations and calibration from SMART-PULP PA's own operator keys

You can always get to the main menu by pressing **ESC** a sufficient number of times.
You can select the following main functions with arrow keys from the main menu:

1. MEASURE 2. CONFIGURation **3. CALIBRAT**ion **4. DIAGNOST**ics (Chapter 4)

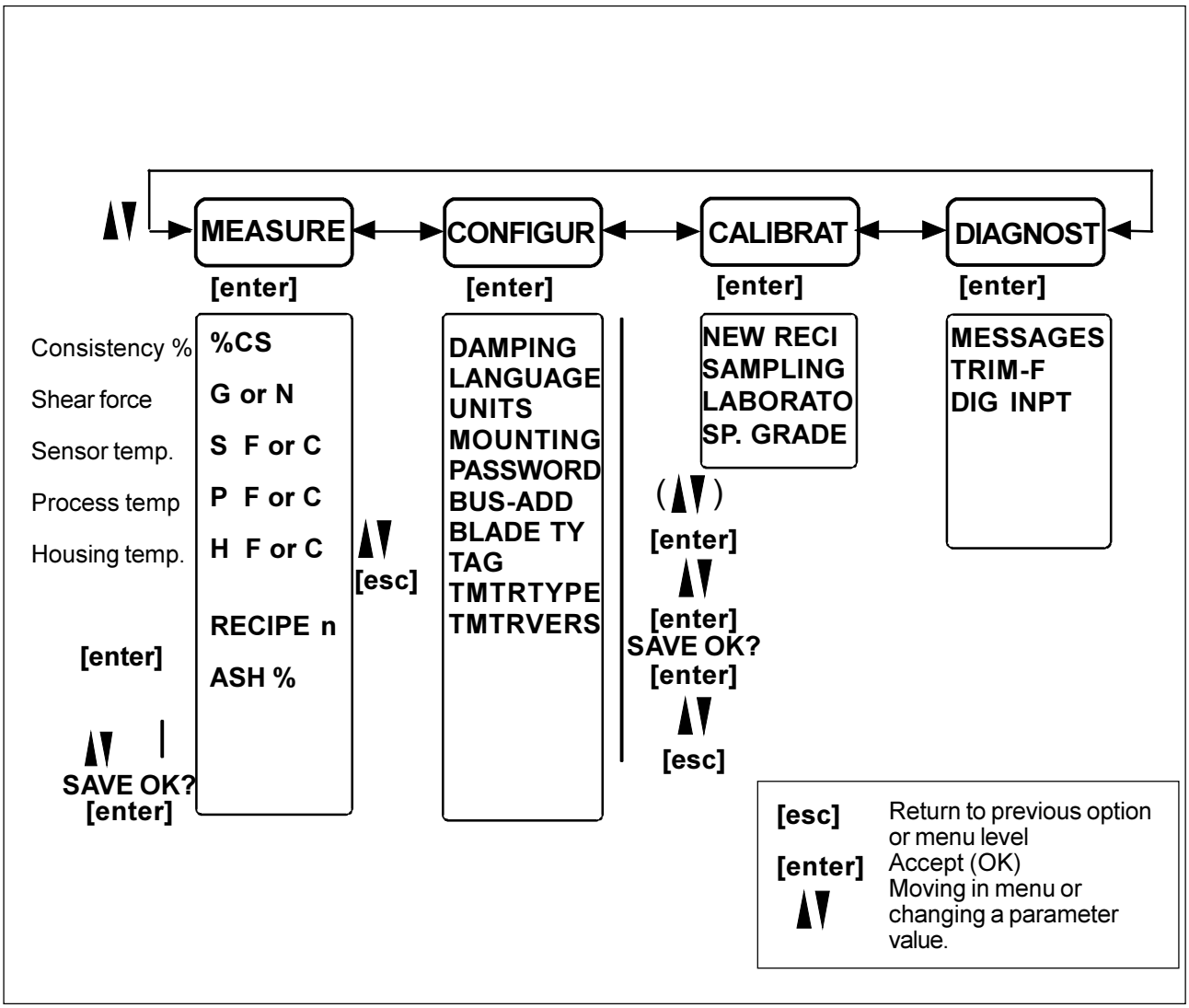


Figure 2 SMART-PULP PA's main menus

ASH% can only be changed in the NEW RECIpe and LABORAT menus. Active recipe (= RECIPE n) must be correct before calibration. The letter r in front of the number refers to remote selection (e.g. through binary inputs). You can switch on remote selection by selecting recipe 0 from the operator terminal.

2.1 MEASUREMENT

The output for uncalibrated measurement (pulp type ULIN) is shown in per cents of maximum span (30N). The consistency percentage display can be activated after configuration and recipe selection . When delivered, the transmitter is provided with typical default configuration and recipe, i.e. pulp type selection.

Calibrations are saved permanently in the transmitter's memory. SMART-PULP PA does not measure ash, i.e. fillers. However, the transmitter is usually calibrated to indicate total consistency. This is done by making the required sensitivity and/or zero offset correction in the calibration curve.

Four (4) optional consistency measurement displays or three (3) optional temperature measurement displays are available. These can be selected with arrow keys:

XX.XX%CS	Pulp's consistency percentage (see note above).
XXXX	Shear force G = grammes, N = Newtons (NOTE! The displayed shear force is the force already corrected for process temperature.)
S XX.X **P XX.X** **H XX.X**	Force sensor's temperature, C = °C and F = °F Pulp temperature, C = °C and F = F° Electronics temperature, C = °C and F = °F
RECIPE X	Recipe selection. NOTE! When performing calibration, the recipe to be calibrated must be active (currently selected). If you want to use remote selection through binary inputs (see Electrical Connections), you have to select 0 as recipe number from the operator keys. Blinking display indicates that calibration has not been done for the recipe in question. The text NOT CALIB displayed after selection of recipe number indicates the same thing. Default factory calibration: P1 = 1.00 and P2 = 0.00.
ASH XX.X%	The ash (filler) content defined in calibration. This can be changed directly from the NEW RECI menu, or from the LABORATO menu in calibration mode (recommended when entering Lab results for samples).

2.2 CONFIGURATION

In configuration you define and program the application's invariable basic parameters. Configuration is usually done only once, before installing the transmitter. When defining the upper and lower range limits you have to take into account the measurable minimum consistencies and recommended maximum consistencies specified for each sensor/pulp type (see Fig. 6.1b).

However, in configuration it is possible to specify e.g. 0% Cs as the lower range-value regardless of warnings, provided that the consistency will not in actual fact drop below the specified measurable minimum. In the same way, it is possible to exceed the specified upper range-value in configuration. However, the measurement may be affected by flow velocity if the actual consistency in the process goes above the recommended maximum limit.
You should also take into account that the transmitter's minimum span is 0.8% Cs and its maximum span corresponds to 30 N shear force, depending on the selected sensor/pulp type.

DAMPING	Damping the fluctuation of the output signal, 1 to 60 seconds. Define at least the minimum value required to damp harmful fluctuation. Only the mechanical, approx. 2 s damping is provided if you define 1 s.
LANGUAGE	The display's language. Default: the language of the country in question, or English. Available options: Finnish, English, Swedish, French and German.
UNITS	Shear force unit: either G = gram or N = Newton. Temperature unit: either C = °C or F = °F. Default: C-G.
MOUNTING	Mounting position. Options: **HOR TOP** = upper side of horizontal pipe, **HOR SIDE** = side of horizontal pipe, **VER UP** = vertical pipe, upward flow. Default: HOR TOP.
PASSWORD	**000...999.** 000 defines no password protection. If you forget your password, the protection can be canceled with a specific number combination. If the password is other than 000, the prompt PASS = 0 will be displayed when you change other parameters. To answer the prompt, give the correct number combination with the arrow keys and then press ENTER. Default: 000.
BUS-ADD	Profibus address: **0-126.** Default: 126,
BLADE TY	Sensor type: **LL**, **JL**, **GL** etc., and material: **AISI**, **TITAN**ium and **HASTE**lloy. Default: the supplied sensor.
TAG	Measurement point's tag code. Up to 8 characters, either letters or numbers. (Currently selected character is indicated by an apostrophe at the upper left corner.) Select a character with arrow keys. Accept the selection with ENTER, then select the next character. You can move forward from this parameter after handling all the required characters.
TMTRTYPE	Transmitter's type code. E.g. LL-SS-SS, which can be changed in the same way as TAG. Default: code of delivered transmitter.
TMTR VERS	Manufacturer's version code, which you cannot change.

2.3 CALIBRATION

After installation you calibrate the transmitter for each pulp type. Ensure that the configuration described in section 2.2 has been completed before you start calibration. You can save precalibrations for 8 pulps or pulp mixes in the transmitter's memory. The Calibration menu contains the following 4 submenus:

1. NEW RECI (New Recipe) **2. SAMPLING** (Take Sample)
3. LABORATO (Laboratory) **4. SP GRADE** (Special grade correction for recipe No. 1)

General description

Figure 2.3a shows the calibration principle.
Calibration curves for most of the applicable pulp types are saved in SMART-PULP PA's memory for each sensor type.
The calibration curves, experimentally defined in Metso Automation's laboratory, represent consistency (% Cs) as a function of the shear force (N) acting on the sensor.

In the transmitter's post-installation calibration you tune the selected calibration curve for the pulp to be measured on the basis of consistency samples. The tuning is done either as single-point calibration to define the zero offset P2, or as two-point calibration where you also define the curve's slope correction P1 (see Fig. 1.3b). The original curve's P1 = 1 and P2 = 0. In sample-based calibration SMART-PULP PA will itself calculate corrections P1 and P2 in accordance with laboratory results and samples.

You can save 1-8 calibrations for different pulp types in the transmitter's memory. You can take the desired calibration into use either directly from the transmitter or with remote selection through binary inputs.

Calibrations etc. operations are carried out through menus. You do not have to make any mechanical settings. Calibration data is preserved in memory even if power is not switched on.

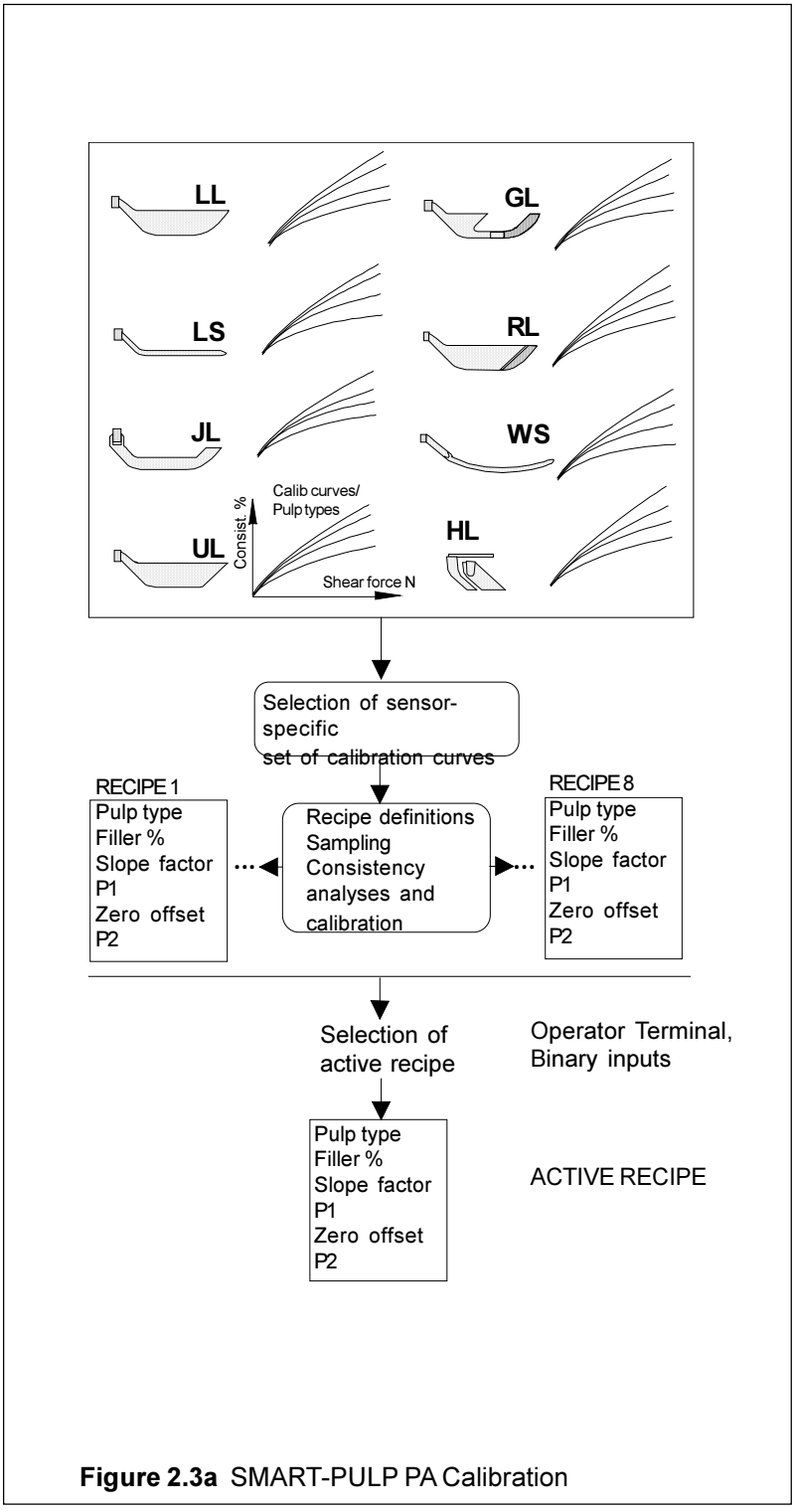


Figure 2.3a SMART-PULP PA Calibration

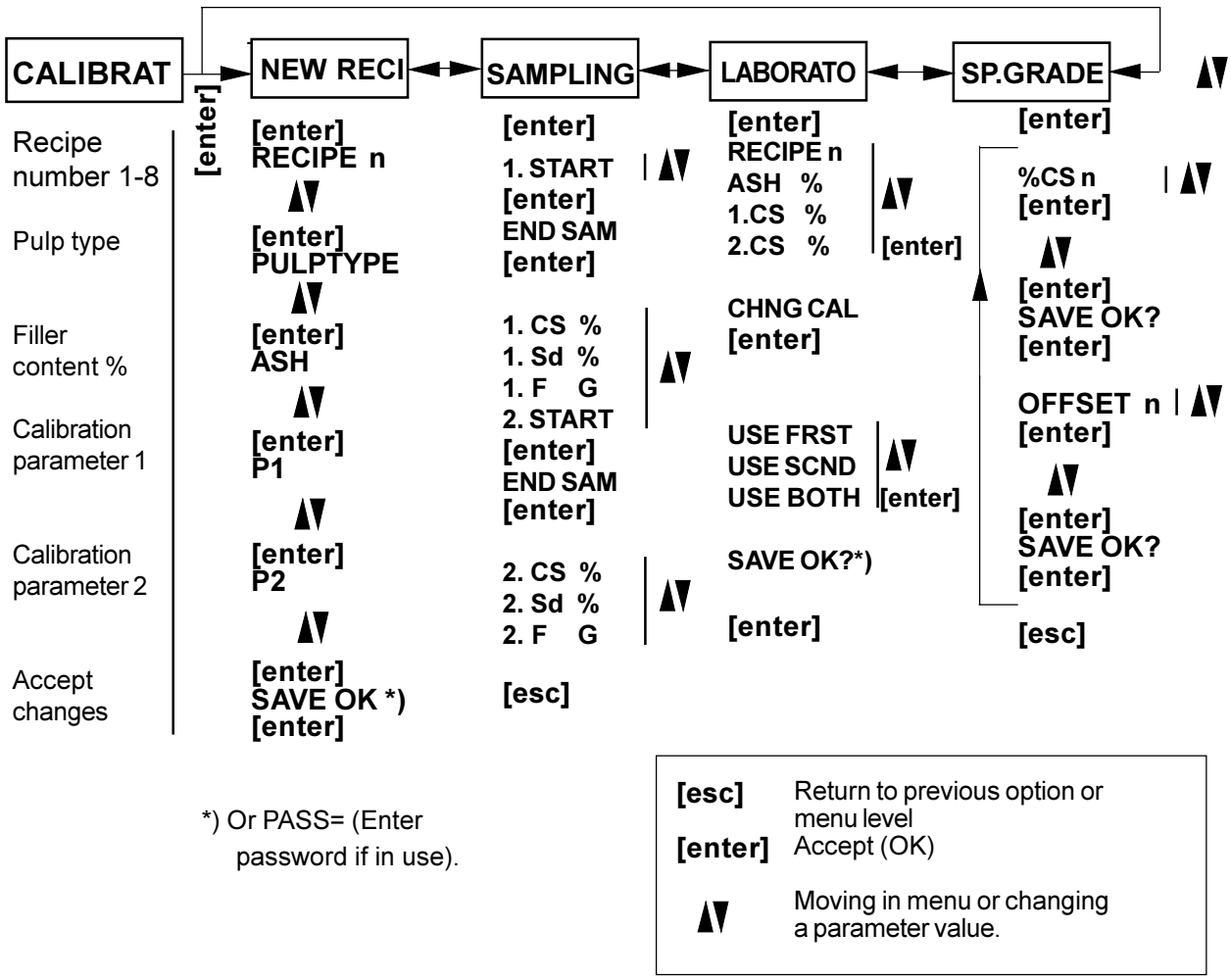


Figure 2.3b SMART-PULP PA Calibration menu

2.3.1 The NEW RECIpe menu

NOTE! The pulp type to be calibrated must be active, i.e. in measurement, when you do the calibration. The recipe number must be the same in the MEASURE and CALIBRAT menus.

NOTE! Since SMART-PULP PA only measures the fiber consistency, variations in filler content after calibration will cause a corresponding error in total consistency measurement where filler is involved.

It is recommendable to write down the CONFIGUR and CALIBRAT/NEW RECI values of configured transmitters, including the P1 and P2 values calculated by SMART-PULP PA after execution of the LABORATO menu. For example, when a faulty transmitter is replaced the new transmitter can then be made identical with the old one by entering the same values in the Configuration menu and the Calibration menu's NEW RECI submenu. For example, if you increase the value of P2 by 0.1, the consistency reading will increase by 0.1% Cs. In other words, you can make the required zero correction without other calibration measures.

RECIPE n	Enter the recipe number. Possible numbers: 1 to 8.
PULPTYPE	Select the pulp type. You can select suitable pulp types for each sensor type (BLADE TY) with the arrow keys. The codes of the available pulp types are given below in the Pulp Types table. A pulp mix is defined on the basis of the dominant pulp component; if the proportions of different components are equal, you are free to specify the pulp mix on the basis of any one of them. (Two-point calibration is recommended.)
ASH %	Gain. In normal calibration use the default P1 = 1.
P1	Curve slope correction factor. In normal calibration use the default P1 = 1.
P2	Offset term (zero correction). In normal calibration use the default P2 = 0.
SAVE OK? **or** **PASS=**	After pressing ENTER to accept the SAVE OK? prompt you return to the NEW RECI level in the menu. If password protection is in use, the SAVE OK? prompt will be replaced by the PASS= prompt. Answer the prompt by toggling for the correct password with the arrow keys, then press ENTER.

Pulp types:
The following list describes all pulp types offered by the menu. Selected sensor type will exclude some of the pulp type options. If you cannot get the desired pulp type, ensure that the correct sensor type has been configured and that the transmitter is equipped with that sensor type. ***NOTE!*** *Mechanical pulps are softwood pulps.*

HWU Unbleached short-fibered chemical pulp, e.g. birch pulp or eucalyptus, bagasse and other agro fibers.
HWB Bleached short-fibered chemical pulp.
SWU Unbleached long-fibered chemical pulp, e.g. pine and other softwood pulps.
SWB Bleached long-fibered chemical pulp.
GW Groundwood, including pressure groundwood.
TMPL Thermomechanical pulp, freeness less than 200ml CSF.
TMPH Thermomechanical pulp, freeness more than 200ml CSF.
RMPL Refiner mechanical pulp, freeness less than 200ml CSF.
RMPH Refiner mechanical pulp, freeness more than 200ml CSF.
CTMP Chemithermo-mechanical pulp.
RCFU Recycled fiber, unscreened; contains debris.
RCFS Recycled fiber, screened.
ROCCU Recycled fiber, packing board, unscreened (OCC).
ROCCS Recycled fiber, packing board (OCC), screened.
ULIN Unlinearized 0-30 N shear force range without temperature correction. Corresponding output display 0-100% instead of pulp consistency.

2.3.2 The SAMPLING menu

NOTE! When calibrating Recipe 1 the SP GRADE calibration table must be erased.
SMART-PULP PA helps you in sample taking by calculating the average consistency value and standard deviation for the sampling period. SMART-PULP PA is able to calculate and remember two samples. The sample(s) can be handled as follows:

Two calibration alternatives:

1. Single-point calibration
In this calibration the selected curve, which converts the sensor's shear force to consistency signal, is moved in the direction of consistency so as to effect a zero offset at the calibration point to eliminate the difference between measured consistency and sample consistency. The slope of the curve does not change. The value of P2 changes in accordance with the zero offset, while the value of P1 (slope factor) stays unchanged.

In single-point calibration you can also take two samples and use the one taken while the process was steadier. The samples should preferably taken at so-called setpoint consistency.

Single-point calibration is in most cases sufficient in consistency control applications.
The calculation formula:
P2 = LAB – sample average
P1 = unchanged

2. Two-point calibration
In this calibration the selected curve, which converts the sensor's shear force to consistency signal, is moved in the direction of consistency so as to effect a zero offset and to change the slope of the curve. The curve is adjusted to pass through two consistency points. SMART-PULP PA calculates new values for P1 and P2.

IMPORTANT: In two-point calibration the difference between the consistency points must be at least 25%, calculated from the lower point. This is to prevent possible sampling and consistency analysis errors from having a noticeable effect on the slope of the curve. SMART-PULP will issue a warning against calibrating at less than 25% consistency difference by blinking the USE BOTH text (0.8 < Cs2/Cs1 < 1.25).

Two-point calibration is recommended when you want accurate measurement over a wide measuring range and/or when you are calibrating a pulp mix or pulp type that does not have a predefined calibration curve in the menu, or pulp that has a large unknown filler content. Considerable differences may also occur between different recycled fiber pulps relative to the basic slope of the calibration curve.
The calculation formula:
P1 = (2 Cs LAB – 1 Cs LAB) / (2 Cs SAMPLE – 1 Cs SAMPLE) P2 = 1 Cs LAB – (P1 x 1 Cs SAMPLE)

Before starting, check from the MEASURE menu that the recipe to be calibrated is active.

1 START
Press ENTER to start sample taking.

END SAM
The display blinks until you press ENTER again to tell SMART-PULP that sample taking has been completed.
The average consistency reading for the sampling period is saved in memory.
- When you use a NOVE sampler equipped with a switch via which a 24V voltage is applied to binary input 4 when NOVE is closed, the displayed symbol is O and the consistency display shows 0.00%Cs. When NOVE is open, i.e. in the sampling position, the symbol is C.

1. CS X.XX%
Average consistency for the sampling period. Press an arrow key to proceed.
1. Sd X.XX%
Standard deviation. Blinking Sd display indicates that standard deviation for the sampling period was more than 5% of the sample average. It is then advisable to wait for the process to become steady and take a new sample. Press an arrow key to proceed.

1. F XXXXG
Shear force corresponding to the displayed consistency. Press an arrow key to proceed.

Taking a second sample is not compulsory in single-point calibration.

2 START
Start taking a second sample. The same as 1 START. 2.CSX.XX%, 2.SdX.XX% and 2.FXXXXG are the same as above.

If required, repeat the procedure for one or both samples.
Finally press ESC to return to the main menu.

2.3.3 The LABORATO menu
When laboratory results are available, activate the LABORATO submenu from the Calibration menu:

RECIPE n
Select the number of the recipe you want to calibrate.

ASH X.XX%
The filler percentage defined in the NEW RECI menu. You do not change this unless a more specific value is obtained from laboratory.
Entering the filler content is optional if the transmitter is recalibrated each time the filler content changes.

1 CS X.XX%
The average of SMART-PULP's consistency reading at sampling time. Change this in accordance with the total consistency indicated by the laboratory results.

2 CS X.XX%
See above.

CHNG CAL
Select the calibration method.

USE FRST
Accept single-point calibration with first sample, or press arrow key to go to the next option.

USE SCND
Accept single-point calibration with second sample, or press arrow key to go to the next or previous option.

USE BOTH
Accept two-point calibration with both samples, or press arrow key to go to the previous options. If the difference between the two samples is less than 25% of the consistency level, the display blinks as a warning of possible error. However, you can still accept the calibration.

SAVE OK?
Press ENTER to accept the new calibration for the selected recipe. If password is in use, you have to enter and confirm the password.
The NO SAMP message indicates that no sample(s) has been taken.
The REPEAT CA message asks you to repeat the sample taking, because the change in the basic calibration curve would otherwise be unnatural (for example, higher shear force would represent lower consistency). P1<0.1 or >10, or P2>10 or <-10.
The W CAL OUT message warns of a suspiciously large change in the basic calibration curve, but you can still accept the calibration. P1<0.5 or >1.5, or P2>1.0 or <-1.0.

2.3.4 The SP GRADE menu

If the available pulp type curves in some special cases are unsatisfactory even after two-point calibration or if a new special sensor blade is used with an older transmitter, the **SP**ecial **GRADE** menu offers you the chance to correct **the curve of recipe No. 1 through a max. 16-point offset table.**

Through the table you enter the known consistency offsets relative to the calibrated curve at the desired consistency levels.

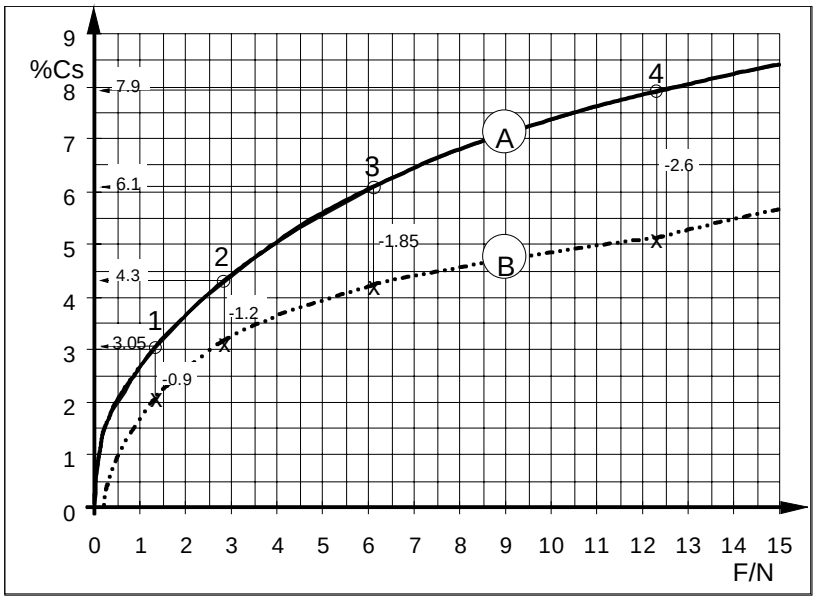
For consistencies below the table's minimum non-zero consistency level you apply that minimum's offset.

For consistencies above the table's maximum consistency level you apply that maximum's offset.

For consistencies between the table values you apply linear interpolation of the offsets of the next lower and next higher consistencies.

Figure 2.3.4 shows a calibration example. The order in which you proceed is free.

NOTE! When performing single-point or two-point calibration for Recipe 1, erase the SP GRADE calibration table first.



An example of calibration for special pulp type:

Selected basic curve A: Sensor RL, Pulp RCFS
Calibration curve corrected through 4 points: B
Table: Calibration points and correction need based on lab samples.

Point No.	Consistency reading/%Cs	Consistency offset/%Cs
1	3.05	-0.9
2	4.3	-1.2
3	6.1	-1.85
4	7.9	-2.6

Figure 2.3.4

2.4 Sample taking and processing

It is important that the sample be representative. This means that the sample should be taken from a representative point in the line, from a representative depth in the pipe and over a representative time period, and that the sample is transferred in representative condition to the sample receptacle and to laboratory regardless of the sampling time. Even if the entire sequence from process pipe to laboratory result is carried out in the best possible manner, the margin of error in the result is rarely better than ±5% of the reading. At 3.0% consistency level this means ±0.15% Cs for 3% Cs pulp.

1. Representative point in pipe

You should observe the sampler's (e.g. Valmet NOVE) installation instructions when choosing the mounting location for the sampler. In particular, you should avoid installing the sampler on the inside curve of a pipe bend.

2. Representative depth in pipe

The sampler should reach past the pipe wall towards the center of the pipe, so as to eliminate the effects of the water layer near the pipe wall and of its variation with flow velocity.

3. Representative time period

Since there may be considerable momentary consistency variations in the pipe, you should try to obtain a representative average to the sample receptacle. A large sample volume or several consecutive smaller portions will help you to obtain such representative average.

4. Representative sample to receptacle

Critical factors in sample taking include the opening and closing of the sampler, velocity of flow, and possible splashing of the sample.

It is recommendable that the sampler be flushed after each use to avoid clogging and dry lumps.

You should first allow the sample to flow for a few seconds, and then "scoop" a suitable portion from the flow e.g. by passing the flexible sample tube several times over the sample receptacle.

The sample flow should be as high as possible, but the sample should not splash from the receptacle. Too small flow may dilute the sample.

5. Representative sample to laboratory

Sedimentation will occur if the sample is allowed to remain at standstill even for a short time. Always stir the sample with special care when separating a smaller portion from a large sample. Such smaller portions should be scooped with a ladle, never poured.

The best result will be obtained by taking several samples directly from the pipe to separate receptacles, and by processing all samples separately and completely. This will prevent the distorting effect of stirring and of taking a partial sample.
Keeping the several samples separate from the very beginning will allow you to determine the time-related representativeness and efficiency of sampling from the standard deviation between the samples. You will get more information from several small samples than from a single large one.

6. Sample processing

In the laboratory it is important to ensure the weighing scales' accuracy and proper timing during and after drying. The TAPPI 240 om-88 Standard ensures ±10% repeatability in determination of consistency. In actual practice this error can be about halved. Even then the error may be significant when evaluating the efficiency of the measurement or the need for recalibrating the transmitter.

7. Examining the results and recalibrating the transmitter

The need for recalibrating the transmitter can be determined if SMART-PULP PA accepted the samples and standard deviation between separate analyses was not too great. Experience has shown that there is no need to recalibrate the transmitter on the basis of a single batch of samples if the difference between the average of the samples and the transmitter's indication is less than ±5% of the reading.

In recalibration we recommend halving the difference. The transmitter's output will then approach the laboratory result by half the difference, and a random sample/laboratory error will not have a too large effect.

3 DEVICE DATABASE FILE (GSD), MEASUREMENT STATUS AND DIAGNOSTICS

3.1 Introduction, Installation and Overview of GSD File

Smart-Pulp PA is a PROFIBUS PA compatible consistency transmitter which conforms to the PROFIBUS-PA Profile for Process Control Devices Version 3.0.

Data exchange between a slave device such as Smart-Pulp PA and a master can be either cyclical or acyclical.

Cyclical communications are the primary type of communications and are handled by a **class-1 master**, normally a DCS or PLC.

Acyclical communications are handled by a **class-2 master**. This type of communications is typically used for device configuration and diagnostics, and the class-2 master is often a laptop computer running configuration software such as Simatic PDM.

Cyclical data exchange between a class-1 master and slave device to are configured with a device database file (GSD).

The GSD is loaded into the class-1 master during commisioning of the device.

This document explains the GSD file supplied with the Metso Automation Smart-Pulp PA device.

In addition this document also explains the meaning of the measurement status byte which is included in the cyclical data transfer with a class-1 master.

For full information regarding GSD files see document “EN 50 170 Vol 2 Working with PROFIBUS DP Device Description Data Files GSD Version 1.1 August 23, 1999”.

3.1.2 Installation of GSD file

The GSD for Smart-Pulp PA is called **MET_063A.GSD** and can be found from the installation CD-ROM supplied with the device.

The exact procedure for installation of the GSD file will depend on the system you are using, so please refer to that systems documentation for further details.

If you use Simatic Manager then the GSD file can be installed by running the DeviceInstall.exe program included on the installation CD-ROM.

3.1.3 Overview of GSD file

Every PROFIBUS class-1 master and all field devices with slave functionality have to be described by the manufacturer with a GSD file.

3.1.3.1 How the GSD is used

GSD files are used when configuring and commissioning a device on a PROFIBUS DP network.

Each manufacturer of a PROFIBUS class-1 master makes available a configuration tool. The configuring tool reads the device specific GSD file and from it generates a parameter set for the class-1 master that will handle cyclical data exchange with the device.

3.1.3.1 Contents of the GSD

The GSD is an ASCII text electronic data sheet containing the following types of information,

- o supported transmission rates
- o length of input/output data to be exchanged
- o meaning of diagnostic data
- o field device type (compact, modular)
- o text assignments for symbolic configuring
- o supported services

The parameters of the Smart-Pulp PA GSD are more fully explained in section 3.2 below.

3.2 GSD database parameters

Parameters defines in the Smart-Pulp PA GSD file are explained in the table below,

Field Name	Value	Description
GSD_Revision	1	Revision code of the GSD file
Vendor_Name	Metso Automation	Device manufacturer
Model_Name	Smart-Pulp PA	Manufacturers model name for the device
Revision	1.0	Device revision
Ident_Number	0x063A	Device type (assigned by PNO)
Protocol_Ident	0	Protocol identifier (0 = PROFIBUS DP)
Station_Type	0	PA Device type (0 = slave)
FMS_supp	0	Indicates whether device is a FMS/DP mixed device (0 = DP only)
Hardware_Release	“1.00”	Device hardware revision
Software_Release	“1.01”	Device software revision
Bitmap_Device	“Spulp”	Name of bitmap file (*.dib) used to display the device as a symbol during normal operation
9.6_supp	1	Device supports 9.6 kBaud
19.2_supp	1	Device supports 19.2 kBaud
31.25_supp	1	Device supports 31.25 kBaud
45.45_supp	1	Device supports 45.45 kBaud
93.75_supp	1	Device supports 93.75 kBaud
187.5_supp	1	Device supports 187.5 kBaud
500_supp	1	Device supports 500 kBaud
1.5M_supp	1	Device supports 1.5 Mbaud
3M_supp	1	Device supports 3 Mbaud
6M_supp	1	Device supports 6 Mbaud
12M_supp	1	Device supports 12 kBaud
MaxTsdr_9.6	60	Maximum station delay time to respond to telegram at 9.6 kBaud (bit time)

MaxTsdr_19.2	60	Maximum station delay time to respond to telegram at 19.2 kBaud (bit time)
MaxTsdr_31.25	100	Maximum station delay time to respond to telegram at 31.25 kBaud (bit time)
MaxTsdr_45.45	250	Maximum station delay time to respond to telegram at 45.45 kBaud (bit time)
MaxTsdr_93.75	1000	Maximum station delay time to respond to telegram at 93.76 kBaud (bit time)
MaxTsdr_187.5	60	Maximum station delay time to respond to telegram at 187.5 kBaud (bit time)
MaxTsdr_500	100	Maximum station delay time to respond to telegram at 500 kBaud (bit time)
MaxTsdr_1.5M	150	Maximum station delay time to respond to telegram at 1.5 MBaud (bit time)
MaxTsdr_3M	250	Maximum station delay time to respond to telegram at 3 MBaud (bit time)
MaxTsdr_6M	450	Maximum station delay time to respond to telegram at 6 MBaud (bit time)
MaxTsdr_12M	800	Maximum station delay time to respond t o telegram at 12 MBaud (bit time)
Min_Slave_Intervall	100	Minimum interval between cyclical data poll cycles (1 unit = 100 mS)
Set_Slave_Add_supp	1	The DP device supports the function Set_Slave_Add, allowing the adress to be set via PROFIBUS
Fail_Safe	1	Indicates whether the DP Slave accepts a data telegram without data in place of a data telegram with data = 0 in the status CLEARS of the DP-Masters (class 1).
Slave_Family	12	Slave family I/0
Max_Diag_Data_Len	20	Maximum length of diagnostic information
User_Prm_Data_Len	0	Maximum length of user parameter data
Modular_Station	1	0 = compact station, 1 = modular station
Max_Module	1	Defines the maximum number of modules of a modular station
Max_Input_Len	15	Maximum length of the input data of a modular station in bytes
Max_Output_Len	10	Maximum length of the output data of a modular station in bytes
Max_Data_Len	25	Largest total of the length of output and input data of a modular station in bytes.

Table 1. Device database parameters specified for Smart-Pulp PA

3.3 GSD modules

3.3.1 Cyclical data exchange

Cyclical communications between the PROFIBUS class-1 master (PLC/DCS) and Smart-Pulp PA slave device works essentially as follows,

1. At a regular interval PLC/DCS sends a read command to the Smart-Pulp PA device.
2. Smart-Pulp PA responds with the current consistency measurement and measurement status.

This communication is configured using GSD modules as described in section 3. During DCS/PLC configuration of cyclical data exchange, the configuration software reads the GSD file and asks the user to select which module should be used.

3.3.2 GSD modules

Smart-Pulp PA has only one function block of type Analog Input. Therefore only one module is required. This module configures the class-1 master to read back the AI function block cyclical value OUT.

This module is given in two formats as follows,

- Short identifier format: "AI Short ID" 0x94
- Extended identifier format: "AI Long ID" 0x42, 0x84, 0x08, 0x05

Short format is provided for compatibility with older PROFIBUS DP PLCs. This format only configures the number of input/output data bytes.

Extended identifier format provides additional information about the data types. For example bytes 0x08 and 0x05 indicate that data consists of a float value followed by one byte unsigned integer value (data type 8 is "Floating Point", data type 5 is "Unsigned8" according to the DPV1 specification).

3.3.3 Cyclical data

Profile 3.0 AI function block devices support only one cyclical parameter called OUT. In the case of in Smart-Pulp PA this value is the percent consistency value.

The data type of value OUT is a Value & Status Floating point. This data structure consists of a four byte floating point value, and a one byte status value which indicates the quality of the floating point value.

Element	Element name	Type	Size
1	Value	Float IEEE-754	4
2	Status	Unsigned8	1

Table 2. List of elements of Value & Status Floating Point data structure

3.3.4 Cyclical value status

The status byte for OUT provides information about the quality of the process value.

The status information below also applies to the temperature sensor values which are also of type Value & Status Floating point. These values are only available through acyclical communications.

Primary status values are **good, uncertain, and bad**.

3.3.4.1 Meaning of individual bits in the status byte

Status byte values and their meanings are shown in the table below.. Explanations of what the status value indicates are given in sections 3.3.4.2 – 3.3.4.4.

The status byte is defined according to the table below, where value x = don't care (can be 0 or 1).

Value when bits zero	Quality bits		Additional bits				Limit bits		Meaning
	7	6	5	4	3	2	1	0	
0x00	0	0	0	0	0	0	x	x	bad
0x0C	0	0	0	0	1	1	x	x	bad, device failure
0x1C	0	0	0	0	1	1	x	x	bad, out of service
0x40	0	1	0	0	0	0	x	x	uncertain
0x44	0	1	0	0	0	1	x	x	uncertain, last usable value
0x48	0	1	0	0	1	0	x	x	uncertain, substituted value
0x50	0	1	0	1	0	0	x	x	uncertain, sensor conversion not accurate
0x80	1	0	0	0	0	0	x	x	good
0x88	1	0	0	0	1	0	x	x	good, active advisory alarm
0x8C	1	0	0	0	1	1	x	x	good, active critical alarm
	x	x	x	x	x	x	0	0	value is not limited
	x	x	x	x	x	x	0	1	value is low limited
	x	x	x	x	x	x	1	0	value is high limited
	x	x	x	x	x	x	1	1	value is constant

Table 3. Meaning of bits in Status byte

3.3.4.2 Good

If the consistency measurement status is good this means the following,

- No device error is detected by the internal diagnostics.
- The consistency value is correct according to the device calibration, and within the range specified for the selected blade type.

3.3.4.3 Uncertain

If the consistency measurement status is uncertain this means one of the following,

- The consistency value is more that 20% outside the minimum or maximum value specified for the blade type. Status will be **uncertain, conversion not accurate**.
- One of the temperature values (sensor, process or housing) is outside of the allowed range. Status will be **uncertain, conversion not accurate**.
- If the fail safe value is set to either **use default value** or last usable value, and a critical error occurs, then the OUT value is set to **uncertain, substituted value** or **uncertain, last usable value**.

3.3.4.4 Bad

If the consistency measurement status is bad this means the following,

- The internal diagnostics of Smart-Pulp PA has detected one of the following critical errors
  - CPU memory error
  - Sensor AD conversion timeout
  - Force sensor AD limit fault
  - Sensor temperature AD limit fault
  - Process temperature AD limit fault
  - Housing temperature AD limit fault
  - FBI card to device communications failure

3.5 DDLM_Slave_Diag Diagnostics Services

If the class-1 master supports the **DDLM_Slave_Diag** service then specific diagnostics are available from the device in the event of a failure.

Diagnostics information is accessed through two parameters of the physical block as follows,

- The **DIAGNOSIS** parameter consists of four bytes of standard diagnostics information from the device. The meaning of each bit of each byte is defined within the PROFIBUS PA Profile for Process Control Devices Version 3.0 specification.

- The **DIAGNOSIS_EXTENSION** parameter from the Physical block consists of six bytes of manufacturer specific diagnostics information from the device. The meaning of each bit of each byte is defined by the manufacturer and is specific to the device. This parameter is included in the DDLM_Slave_Diag service only if the *PROFIBUS Ident Number* is selected to be manufacturer specific (Hexadecimal 63A).

The meaning of the DIAGNOSIS bytes is given in table 5 below. In the case of the standard DIAGNOSIS bytes those actually used in Smart-Pulp PA shown in bold text.

The meaning of the indication class in tables 5 and 6 is as follows,

Indication class	Explanation
A	Bit reset automatically after 10 seconds
R	Active as long as the reason for the message exists

Table 4. Indication classes

Byte	Bit	Description	Indication class	Used in Smart-Pulp PA
1	**0**	**Hardware failure, electronic**	**R**	**Yes**
	1	Hardware failure, mechanical	R	No
	2	Motor temperature too high	R	No
	3	Electronics temperature too high	R	No
	4	**Memory error**	**R**	**Yes**
	5	Failure in measurement	R	No
	6	Device not initialized	R	No
	7	Device self calibration failed	R	No
2	**0**	**Zero point error**	**R**	**Yes**
	1	Power supply failure (electrical, pneumatic)	R	No
	2	**Configuration not valid**	**R**	**Yes**
	3	**Warm boot carried out**	**A**	**Yes**
	4	Cold boot carried out	R	No
	5	Maintenance required	R	No
	6	Characterisation invalid	R	No
	7	Set to 1 if the ident number of the running cyclic data transfer and the value of Physical Block IDENT_NUMBER_SELECTOR paramater are different	R	No
3	0..7	Reserved for use with PNO		No
4	0..6	Reserved for use with PNO		No
4	**7**	**More diagnosis information is available**		**Yes**

Table 5. Diagnosis parameter bit-enumeration.

The meaning of the DIAGNOSIS_EXTENSION bytes is given in table 6 below. All of these are implemented in Smart-Pulp PA.

Byte	Bit	Description	Indication class
1	0	Reserved	R
1	1	Reserved	R
1	2	Reserved	R
1	3	Reserved	R
1	4	Reserved	R
1	5	Reserved	R
1	6	Reserved	R
1	7	Reserved	R
2	0	Write failed, wrong mode	R
2	1	Reserved	R
2	2	Write failed, invalid value	R
2	3	Reserved	R
2	4	FBI to device communications timeout	R
2	5	Write failed, wrong data type	R
2	6	FBI and device parameters not same	R
2	7	Unexpected device response	R
3	0	Device to FBI checksum error	R
3	1	Device to FBI packet response error	R
3	2	Sensor temperature AD limit error	R
3	3	Process temperature AD limit error	R
3	4	Housing temperature AD limit error	R
3	5	Sensor temperature value out of range	R
3	6	Process temperature value out of range	R
3	7	Housing temperature out of range	R
4	0	Primary variable out of limits	R
4	1	Reserved	R
4	2	Device CPU memory error	R
4	3	FBI to device checksum error	R
4	4	AD conversion timeout error	R
4	5	Reserved	R
4	6	Configuration changed from local user interface	R
4	7	Primary variable AD limit fault	R

Table 6. Diagnosis Extension parameter bit-enumeration.

4 SMART-PULP PA'S CONSTRUCTION

SMART-PULP uses a piezoresistive force transducer to measure the shear force acting on its sensor blade. The shear force is proportional to pulp consistency. Oil damping prevents pipework vibration from affecting the measurement.

The pulp, force transducer and electronics temperatures are measured, and the effects of temperature variations are compensated for arithmetically in the electronics.

On the basis of calibration curves stored in the transmitter's memory, SMART-PULP's electronics convert the shear force into a signal proportional to consistency. Calibration is performed fully electronically on menu basis. Communications between transmitter and operator terminal are conducted through an RS485 interface.

4.1 Mechanical Construction

Mechanical (refer to Fig. 3.1a).
The sensor blade is mounted on a taper pin with taper joint. The taper pin has a narrowing, or "mechanical fuse", at which the pin will flex in case the sensor blade is overloaded. This will prevent damage to the transmitter's interior.
The taper pin is threaded to a counter pin. An inlet diaphragm is pressed between the taper pin and counter pin to prevent the admission of the process medium into the transmitter's interior. The diaphragm is sealed on the inlet cone with a double O-ring around its rim.
The hole in the rotatable inlet cone is eccentric, enabling compensation for static pressure. The counter pin connects with a damping cylinder pivoted on the transmitter's body. Shear force F1 generates force F2 to the piezoresistive transducer through the sensor blade, taper pin, counter pin, damping cylinder, connecting column and connecting wire.

The piezoresistive transducer is fastened to the inner body attached to the transmitter's body. Motion limit clearance prevents overloading of the force transducer. The free space inside the body is filled with damping silicone oil, and an expansion diaphragm permits thermal expansion of the oil.

The gaskets are O-rings, made of special rubber, and PTFE rings.
The transducer that measures the process temperature is located inside the transmitter's body as close as possible to the surface in touch with the process medium. The wiring from the electronics to the process temperature transducer and force transducer passes through inlet plugs in the inner cover.
The electronics in the electronics housing are installed in a plastic cylinder supported through a retainer cup on the cover at the top.

4.2 Construction of Electronics

Electronics (refer to Fig. 3.1b).
The piezoresistive force transducer and electronics have been adapted to each other at the manufacturer's factory.
The electronics are mounted on two circuit boards. The force transducer has a Wheatstone bridge composed of four resistors that measure mechanical strain and temperature. The four conductors from the bridge's connection points are wired to the the electronics.

The electronics are provided with their own temperature transducer.
Wiring from the electronics housing to the terminal board passes via radio interference filters.
Connections in the connection box are made to a terminal strip equipped with spring clamps. The cable to the operator unit passes through a water-resistant bushing.

The transmitter's operator unit is a separate plastic case containing a display, operating keys, spring-operated wiring terminals, electronics of Profibus PA interface and 4 water-resistant cable inlet bushings.

The operator unit has an 8-character letter/number liquid crystal display and five pushbutton keys.

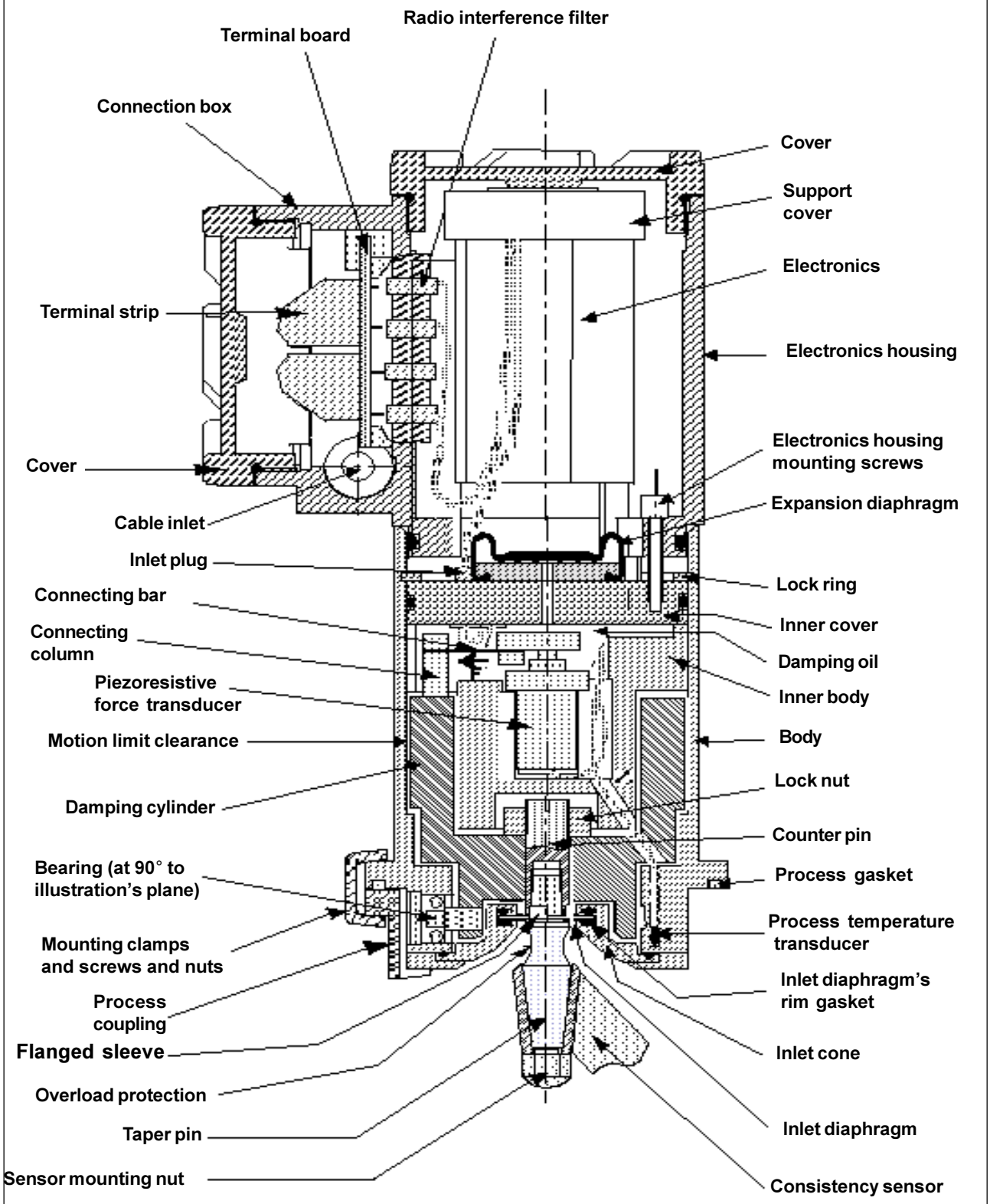


Figure 3.1a SMART-PULP Mechanical construction

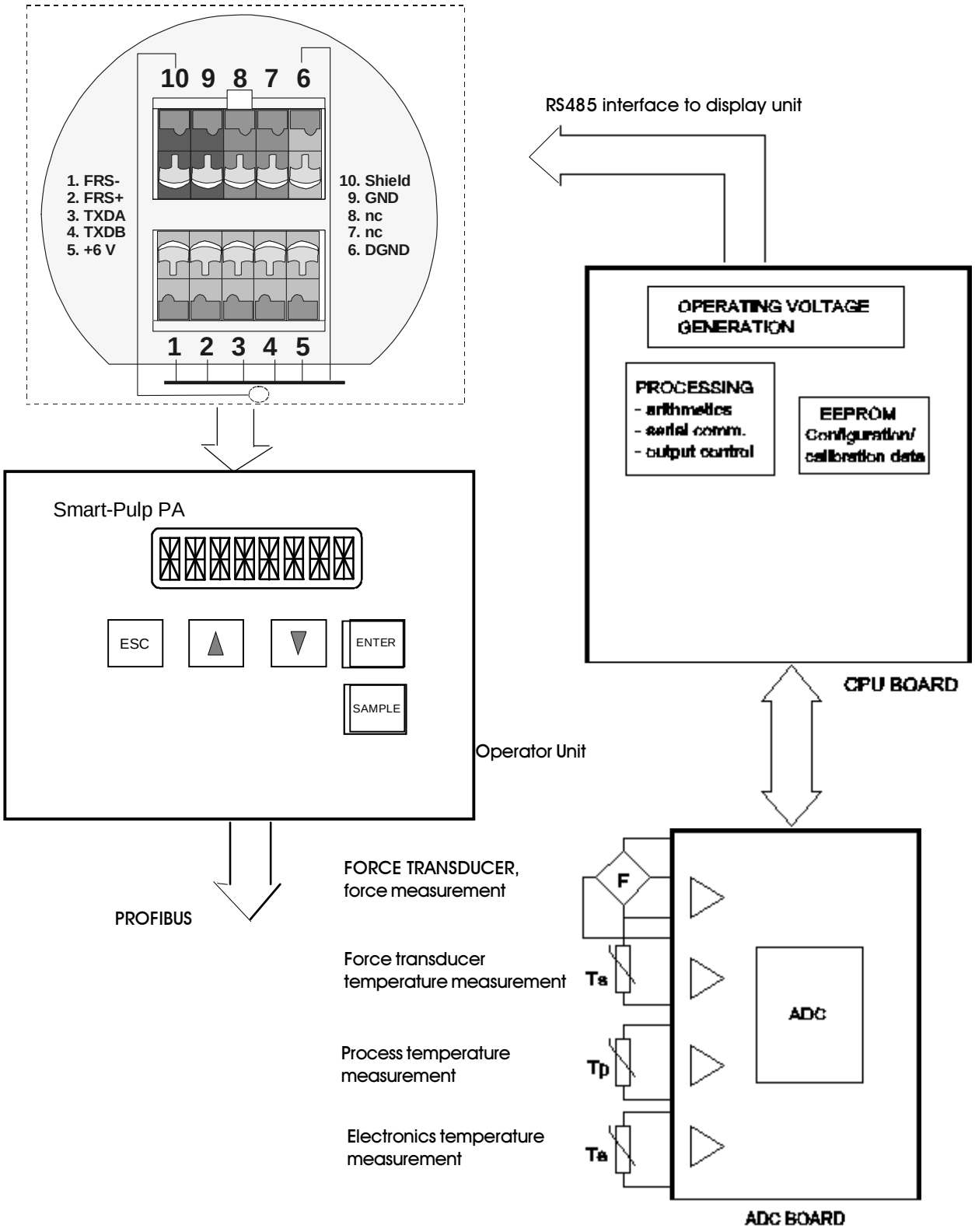


Figure 3.1b SMART-PULP Electronics

5 MAINTENANCE AND DIAGNOSTICS

5.1 Troubleshooting

The transmitter monitors its own operation continuously. Any detected faults are shown in error messages that can be read from the transmitter's own display.

SMART-PULP PA does not find all faults by itself. The user's actions are required in such cases. The necessary actions are defined in connection with the error messages. In this section we discuss faults not detected by the transmitter, and describe the measures that should be carried out before contacting the supplier.

Faults and actions:

1. A substantial deviation between SMART-PULP PA's consistency reading and laboratory results. However, SMART-PULP measures in the normal manner and responds to consistency.

The most common causes for this error:
- A change in pulp type or mix proportion.
- The pulp contains fillers whose amount varies.
- SMART-PULP PA has not been installed as instructed, and turbulent flow occurs at the measuring point.
- Flow velocity is below/above the specified limit.
- The pulp type is not suitable for the installed sensor type.
- There is a double pipe bend upstream from the trans mitter, and the installation does not include a flow straightener element to eliminate the resultant strong whirling flow.
- A change in fiber properties.
- Accumulations of pulp on the sensor surface, on the taper pin and in the inlet cone.

Remove the transmitter from the process. Then use the service stand and weights to see whether SMART-PULP PA measures the weights correctly with the TRIM F function. After initial start-up calibration you should monitor the transmitter's operation regularly with samples and readjust the Zero when required. All actions should be recorded in a transmitter-specific log.

2. SMART-PULP does not respond to consistency.

- Remove the transmitter from the process and mount it on the service stand. Load the sensor blade with different weights and use the TRIM F function to determine the change in output relative to the applied load.

- Deflect the sensor blade alternately in the plus and minus directions and see whether the output reading returns to the same value at the same load.

- Open the electronics housing cover and ensure that all wires are firmly attached to the terminal pins.

Rectifying this fault usually requires factory servicing.

3. SMART-PULP operates in the normal manner, but does not obey the operator keys or the display does not respond.

Open the electronics housing. Are all 6 wires to the connection box attached to their inlet filters.

5.2 Error messages

Select **MESSAGES** in the **DIAGNOST** menu. Toggle through the messages with the arrow keys. Press [ENTER]. The transmitter displays the **ERASE?** Prompt. Press [ENTER] if you want to remove the selected message. Proceed in the same way to read and remove the rest of the messages. When the text NO MESS is displayed, press [ESC] to return to the highest level in the diagnostics menu.

Serious faults/errors:
The following faults are so serious that the transmitter's normal operation is terminated .

Error message Description

CPU.EE ER Memory fault on configuration data.
FORCE ER Shear force channel faulty.
T. SEN ER Sensor (transducer) temperature channel faulty.
T. PRO ER Process temperature channel faulty.
T. HOU ER Electronics housing temperature channel faulty.
COMM ER Communication between transmitter and Profibus PA not working

Less serious faults/errors:

AD ERROR AD converter error. Conversion restarted.

Warnings and error messages during operation:

W. NO CAL The current recipe has not been calibrated, and the base curve is used instead. Blinking recipe text indicates the same.

NO SAMPLE No sample has been taken. Blinking USE BOTH indicates that the difference between sample consistencies is less than the recommended 25%.

Blinking Sd display indicates that standard deviation was over 5% of sample average. Wait for the process to get settled, then take a new sample.

CAL HI This warns about a suspiciously large change in basic calibration curve, but the calibration can be accepted.

REPEA CA Asks you to repeat sampling, because change in basic calibration curve would be unnatural. For example, higher shear force would represent lower consistency. P1<0.1 or >10, or P2>10 or <-10.

WRONG PW Wrong password.

LOW CS Consistency (%) defined in configuration is too low. Does not prevent you from making the selection.

HIGH CS Consistency (%) defined in configuration is too high. Does not prevent you from making the selection.

5.3 Checking the operation of force mesurement

Since SMART-PULP displays and communicates the shear force in digital format, the transmitter is provided with the **TRIM F** function for trimming these displays. The need for calibration depends on the individual transmitter. Stability in force measurement is better than 0.25% max. per 6 months, corresponding to 7.5g per 6 months in shear force.

Normal regular consistency calibration will rectify the effect of the force transducer's zero drift on consistency measurement, but if you want to utilize the force information separately you must also calibrate the transmitter's shear force measurement. If you want a standby transmitter that replaces a faulty one to operate identically with the replaced transmitter without sampling, you have to calibrate the transmitter's force measurement regularly (e.g. once a year).

Using traceably calibrated weights for calibration will provide a traceably calibrated shear force measurement, as required by modern quality systems.

The **TRIM F** function requires that you mount the transmitter with the sensor blade pointing directly downwards. In two-point calibration the blade's weight is measured without additional weights and with a measured additional weight (1 to 3 kg). These two points allow the checking and, when necessary, recalibration of the force measurement. When desired, you can also calibrate the zero point alone. In that case you only have to measure the sensor blade's own weight. The transmitter eliminates the blade's own weight from the displayed reading, and displays 0 g.

TRIM-F Calibration of shear force measurement

Select the **TRIM F** function in the **DIAGNOST** menu. Then select **1. WEIGHT** from the submenu. The displayed value is close to 0 g, because no weight is attached to the sensor blade and the blade's own weight has been eliminated. Allow the reading to become stable. Then use the arrow keys to adjust the displayed value to zero and press [ENTER] to accept the value.

If you are only recalibrating the zero and do not want to check sensitivity, select and confirm the **CHNG CAL** command and then the **USE FRST** subcommand. If you also want to check and, when necessary, recalibrate the sensitivity, attach a 1-3 kg weight to the sensor blade after accepting the

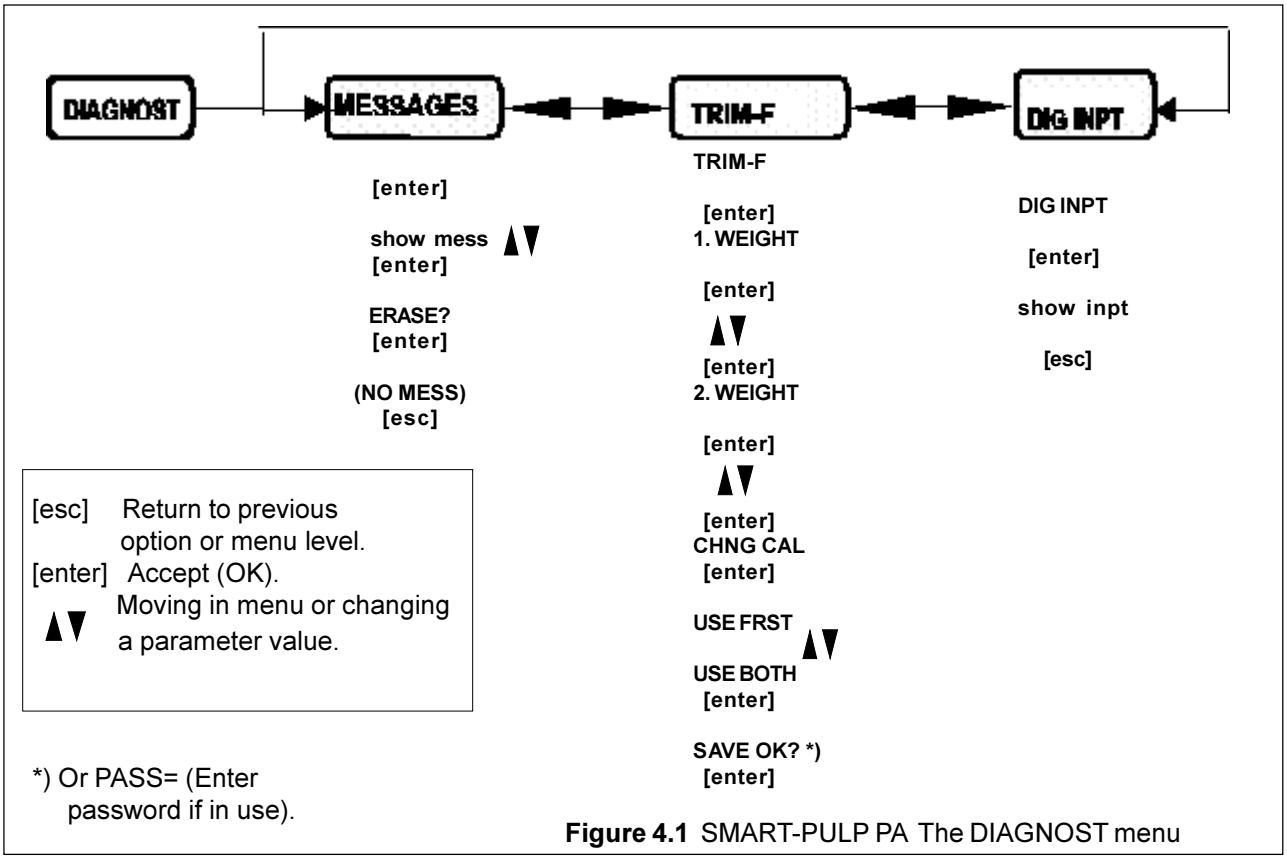


Figure 4.1 SMART-PULP PA The DIAGNOST menu

unweighted **1. WEIGHT** command. Then select and confirm the **2. WEIGHT** command. The weight measured by the transmitter is now displayed. Allow the reading to become stable, and then use the arrow keys to adjust for the correct reading (i.e. the same as the applied weight). Accept this value and then accept **SAVE OK** and **USE BOTH**.

NOTE! The reading should be stabilized before you press the arrow keys.

In both cases SMART-PULP finally asks **SAVE OK?**. Press [ENTER] if you want to save the results. If password is in use (not 000), the prompt PASS= will replace SAVE OK? Use the arrow keys to enter the correct password and then press [ENTER].

5.4 Replacing the sensor blade

Procedure:

- The sensor blade's retaining nut is secured with Loctite. The nut can be unscrewed without heating.
- First unscrew the nut, and then detach the sensor from its taper joint with an extracting tool.
- When re-installing the sensor, make sure that it is exactly parallel to the direction of flow. Check the alignment with a ruler placed against the bottom of the sensor's alignment slot.
A special tool is available for aligning the sensor. The alignment accuracy must be better than $\pm 1°$.
- Finally secure the sensor's retaining nut with Loctite 270. Ensure that none of the locking medium is allowed to run to the sensor's taper assembly. Use 20 Nm torque to tighten the nut.

.

6 PARTS LIST

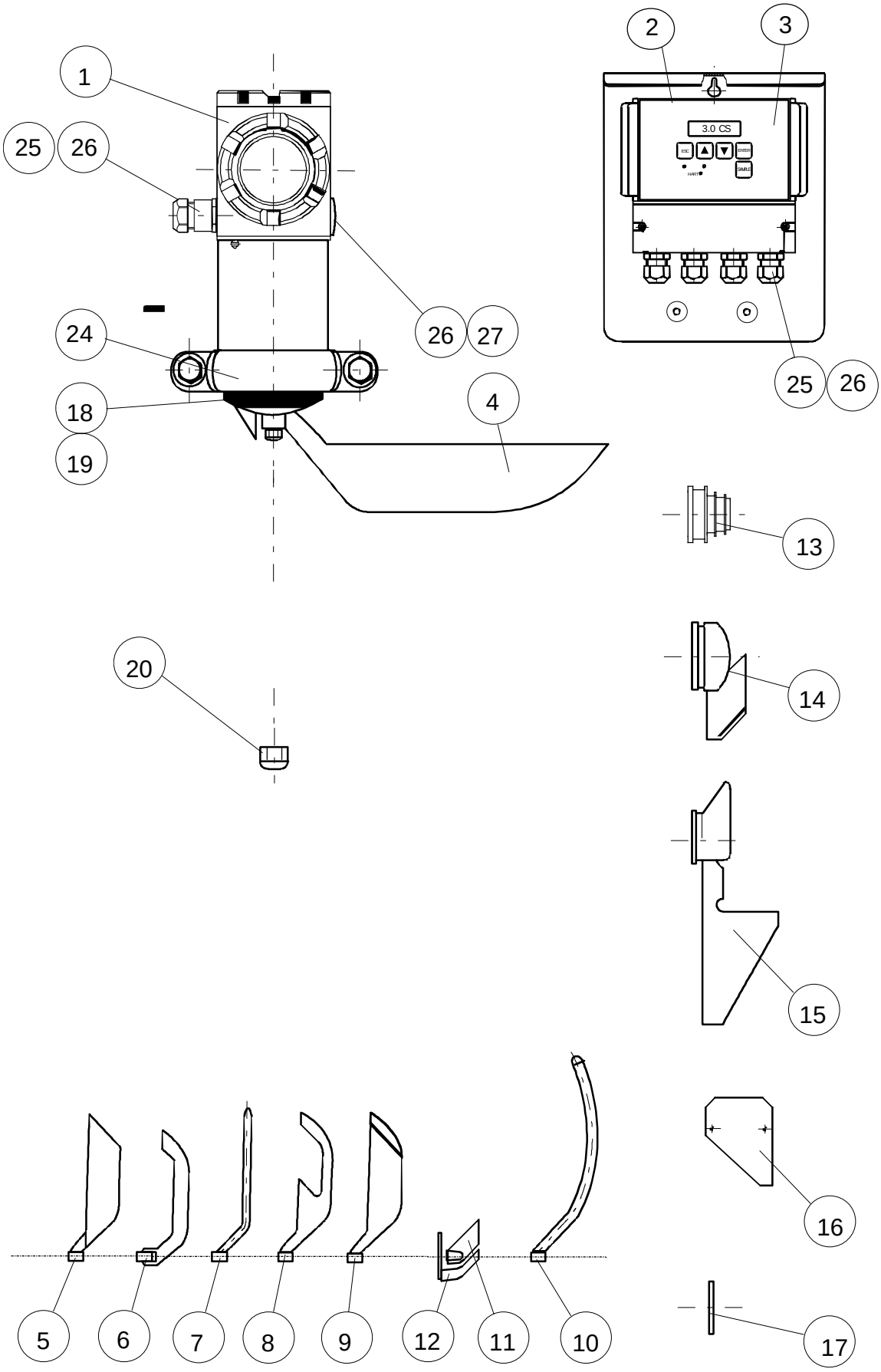
When ordering spares, please quote this document's number (W4770021V1.0) and date (October 21, 2001), the transmitter's name (SMART-PULP PA), type (sensor/material options, e.g. RL/SS), serial number, and the number and name of the required part.

Example: **W4770021V1.0, October 02, 2001, SMART-PULP PA, RL/SS, No. 014030690, 9 RL sensor** (serial number is made up as follows: 01 = year, 40 = week, 30690 = ordinal number).

Part No.	Code No.	Part name
1	A4770110	Transmitter body without senser
2	A4770024	Operator Unit , complete
3	A4770112	Keybord-Display Panel
4	T541440	Sensor LL
5	T550039	Sensor UL
6	T550323	Sensor JL
7	T541441	Sensor LS
8	T552441	Sensor GL
9	T552560	Sensor RL
10	T551790	Sensor WS
11	T548760	Sensor HL
12	T1031008	Retaining ring HL
13	V551865	Coupling JL , titanium
14	V552436	Blow line coupling
15	T10310044	WS coupling
16	T550062	Deflector plate
17	T523950	Plug
18	T500870	Coupling
19	80500860	Gasket PTFE
20	T550395	Special nut
21	A4730050V1.0	Cabel 10m (from Transmitter to Operation unit)
22	A4730050V1.0	Cabel 20m (from Transmitter to Operation unit)
23	A4730050V1.0	Cabel 30m (from Transmitter to Operation unit)
24	V8222000	Mounting clamp assy.
25	72900020	Gland packing
26	80001815	O-ring 18x1.5
27	72900014	Plug

Part No. 1, 4 -12 and 14 - 20 are for Stainless Steel (SS) material.
Other materials (Ti, HC) please contact local representative.

Tools
Sensor mounting tool
Sensor removing tool
Calibration stand
Calibration weight set


1
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7 APPLICATIONS

The SMART-PULP PA transmitter is used for pulp consistency measurement in the pulp and paper industry. The transmitter is installed directly in the stock line (see Fig. 6).

SMART-PULP PA is supplied with an operator unit, a sensor to suit the process application, process coupling, process gasket and deflector plate (deflector is not used with UL and JL sensors).

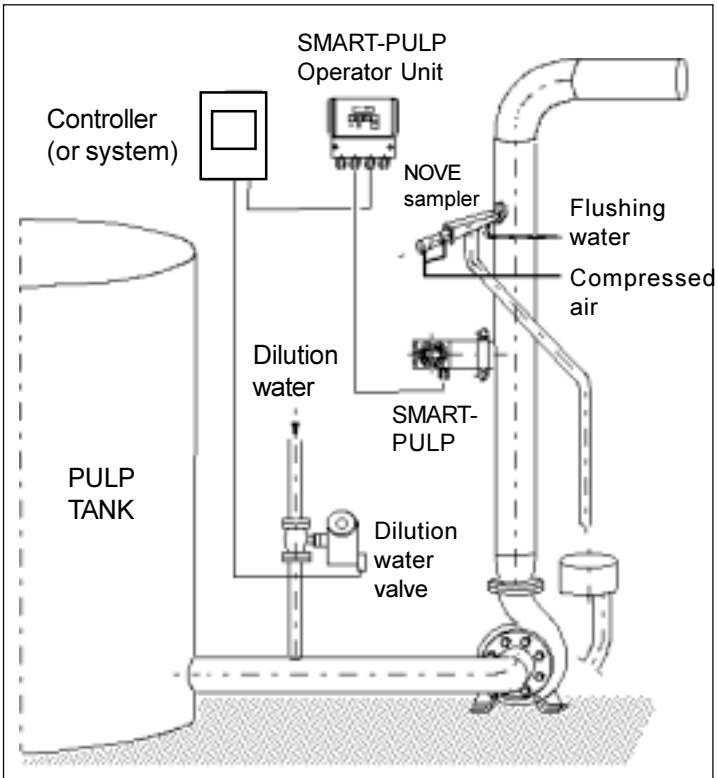


Figure 6 SMART-PULP PA's typical consistency control application

7.1 Applications of different sensor types

SMART-PULP PA is supplied with different optional sensor types (Fig. 6.1a).

Figures 6.1b show the flow velocity and consistency ranges best suited for the different sensor options and pulp types.

When choosing a sensor for a particular application we specify a "window" whose width represents the process's flow velocity range (e.g. 1.2 to 3 m/s), and whose height represents the consistency range (e.g. 2.5 to 2.8% Cs).
The specified "window" should fit inside the white area of each diagram. The transmitter will operate outside the area, but flow velocity may then affect the measurement or there may be some other disturbances.

The Consistency Advisor PC program supplied by Valmet Automation Kajaani Oy can also be used to select the best sensor. The program also calculates and prints the required minimum lengths of straight pipe sections.

The effect of flow velocity variations on the accuracy of the measurement result will be negligible on the recommended measurement ranges when the transmitter is installed according to the specified instructions.

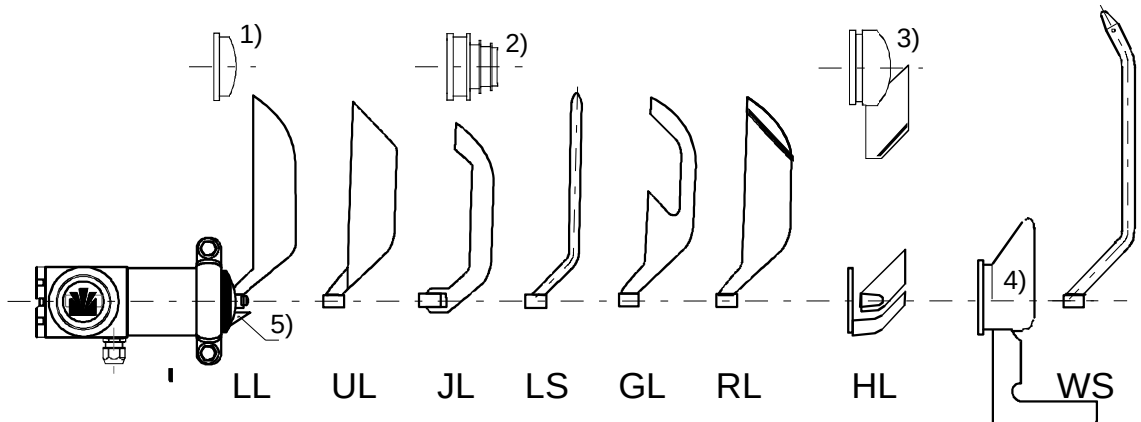
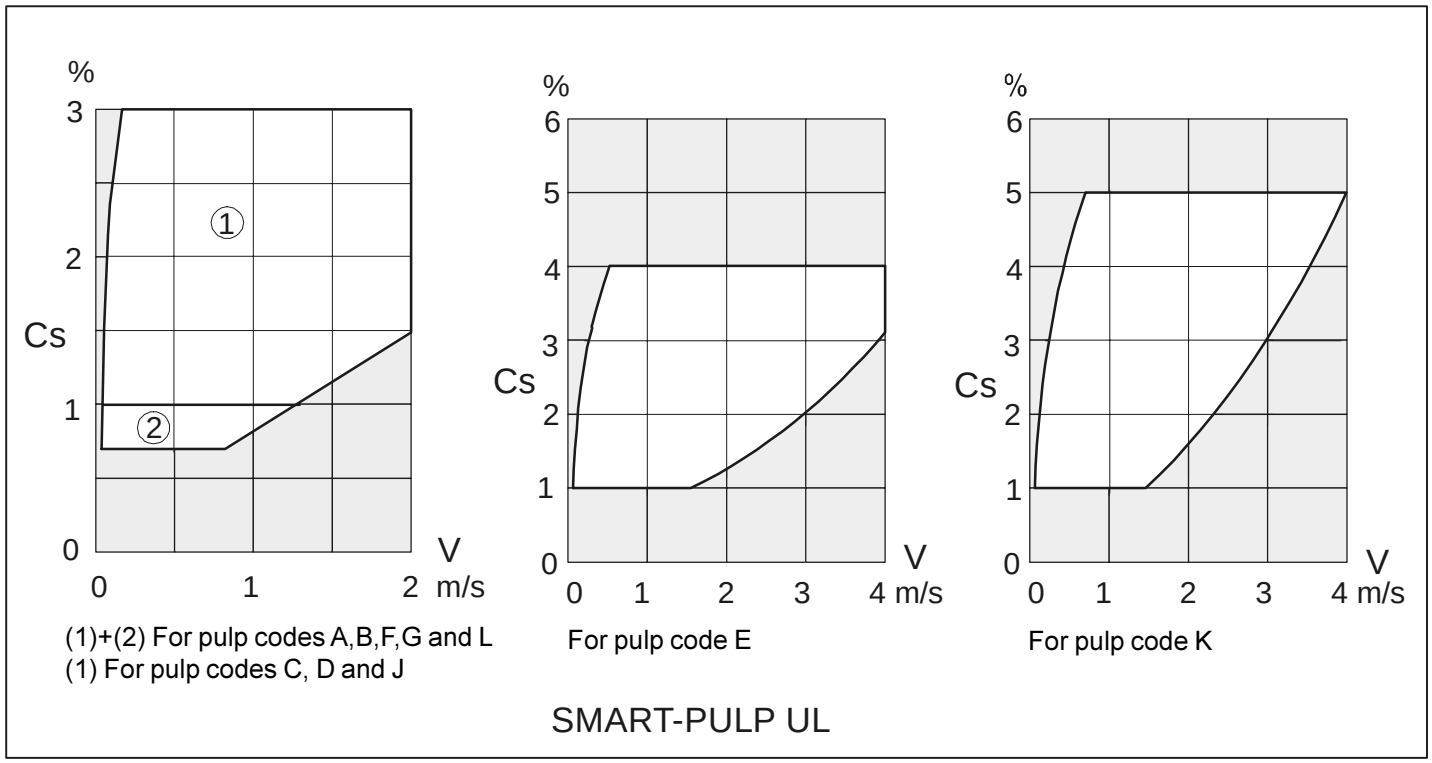


Figure 6.1a SMART-PULP PA transmitter's sensor types and process couplings
1) Std coupling, 2) Coupling for plastic pipe, 3) HL blow-line coupling
4) WS coupling
5) For LL, GL, RL, UL and LS sensors

Pulp types corresponding to the codes (A, B,...) are specified in the appended table.



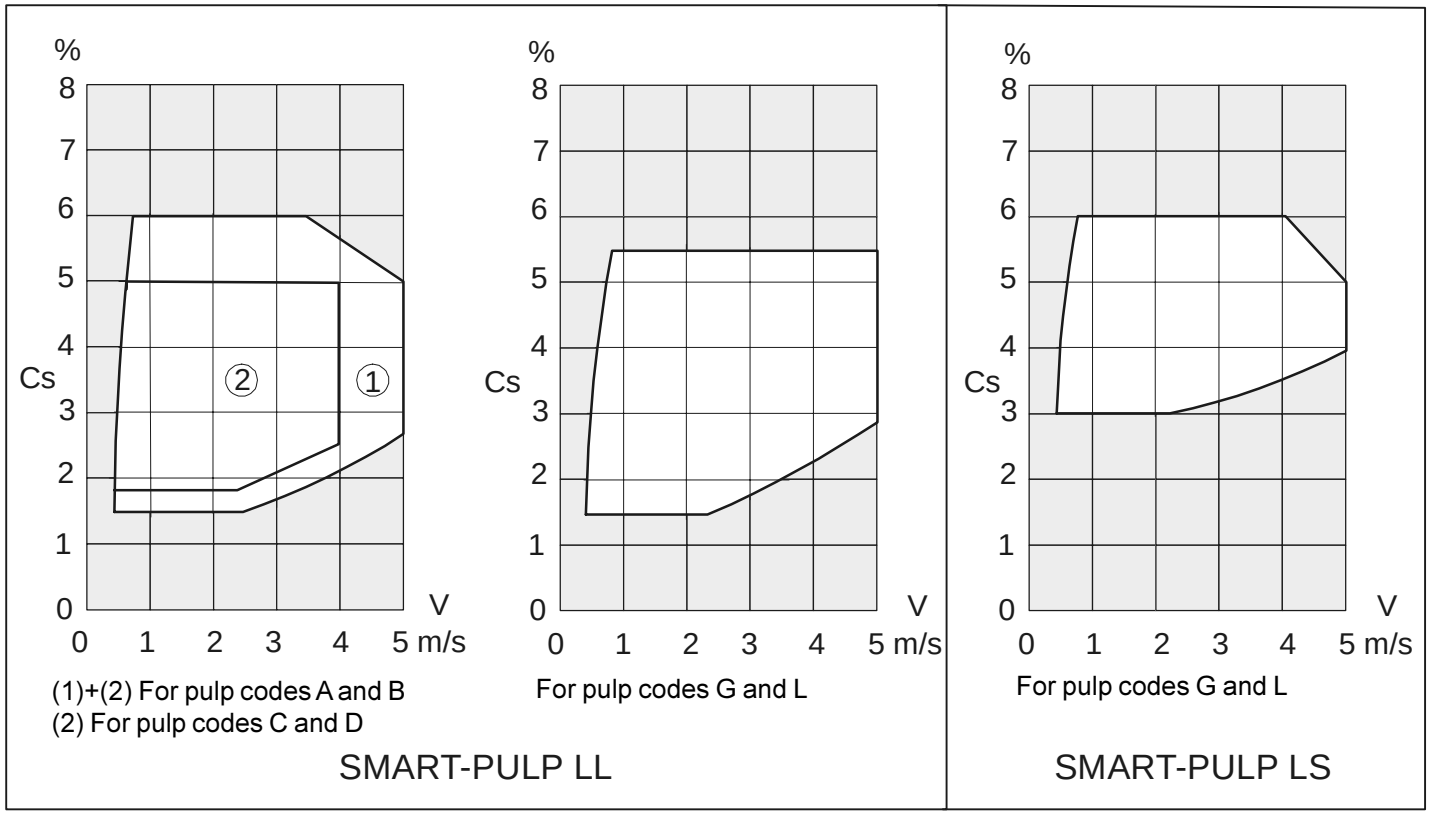
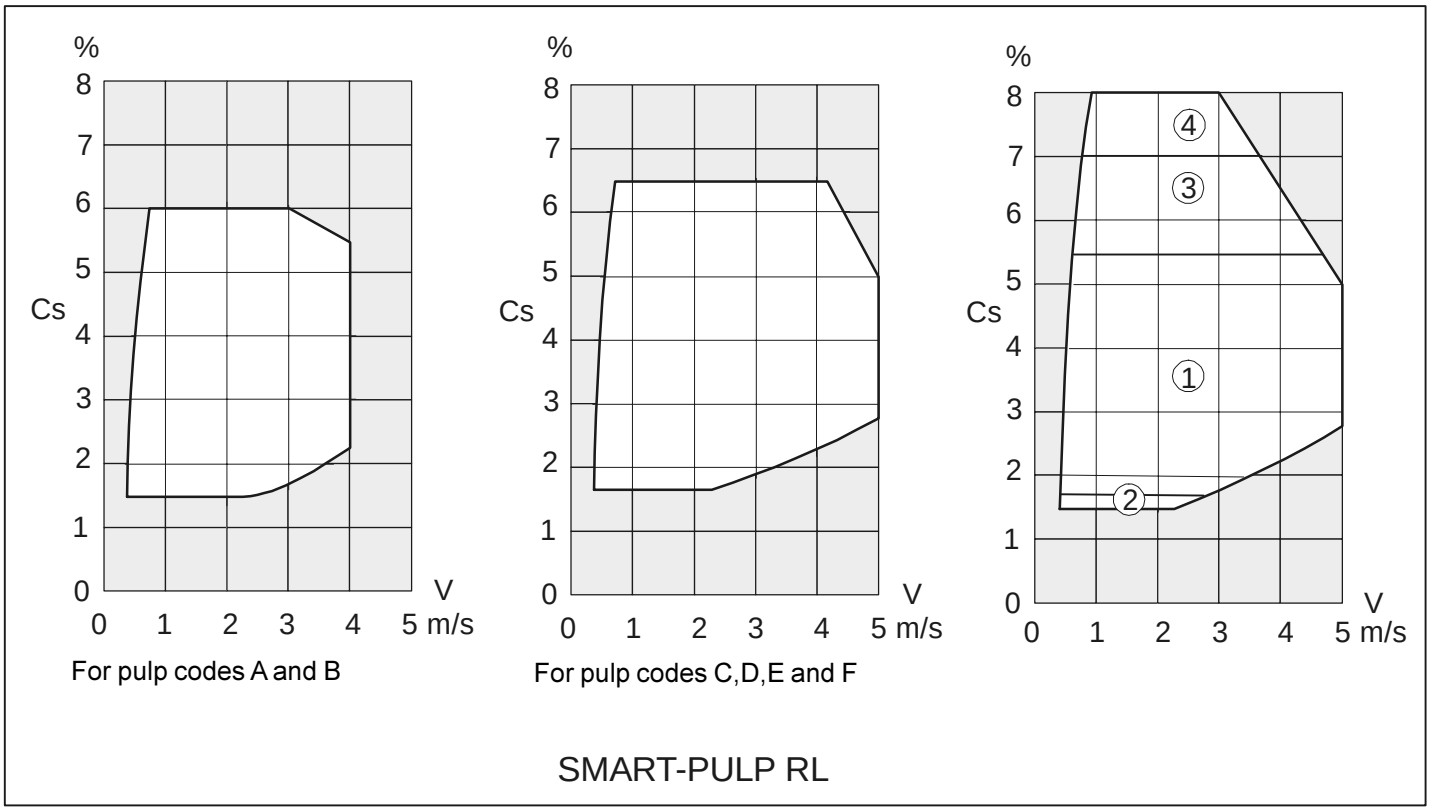


Figure 6.1b Flow velocities/consistency ranges/pulp types for different sensor options (cont. on next page)

Pulp types corresponding to the codes (A, B,...) are specified in the appended table.



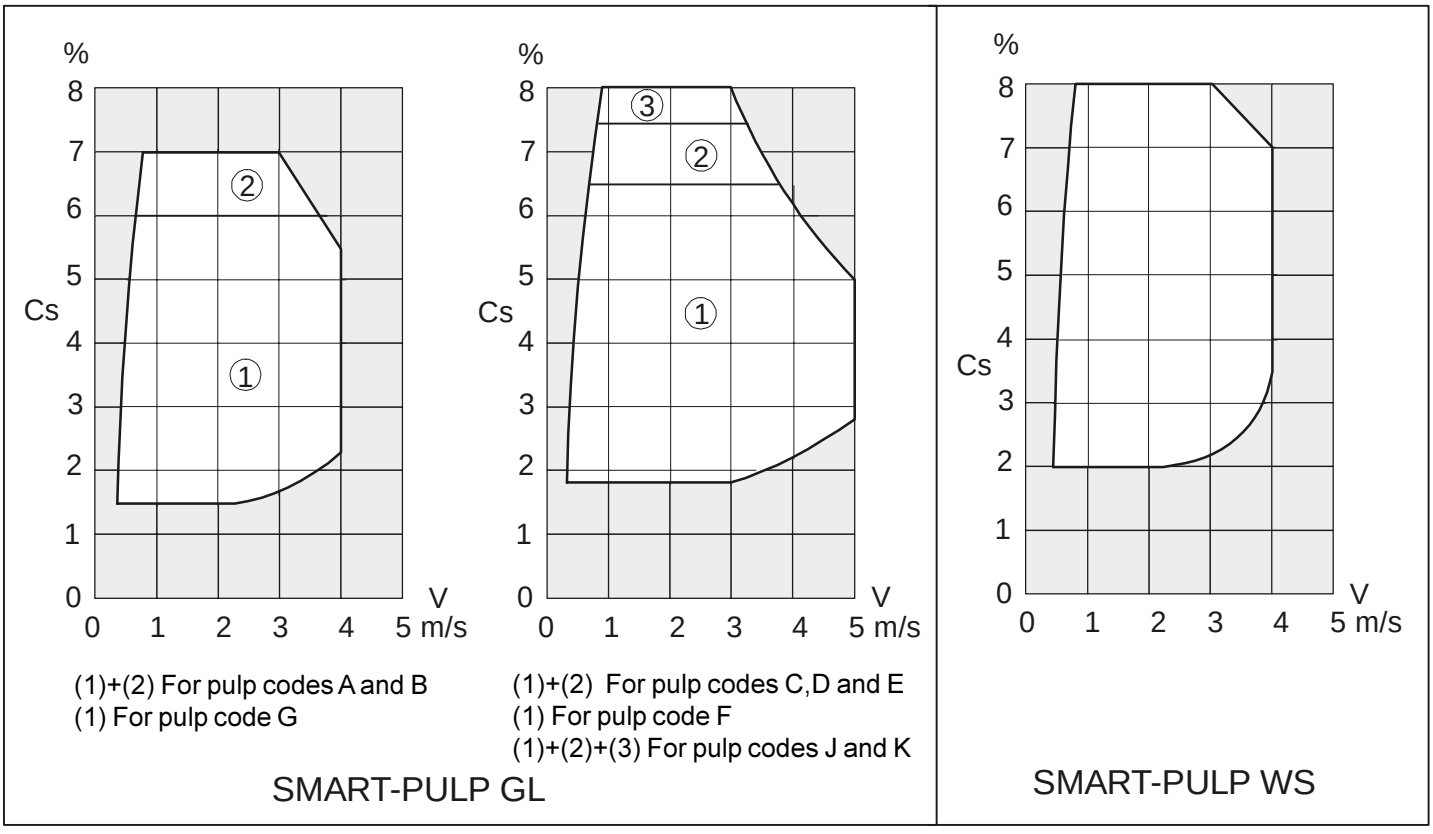
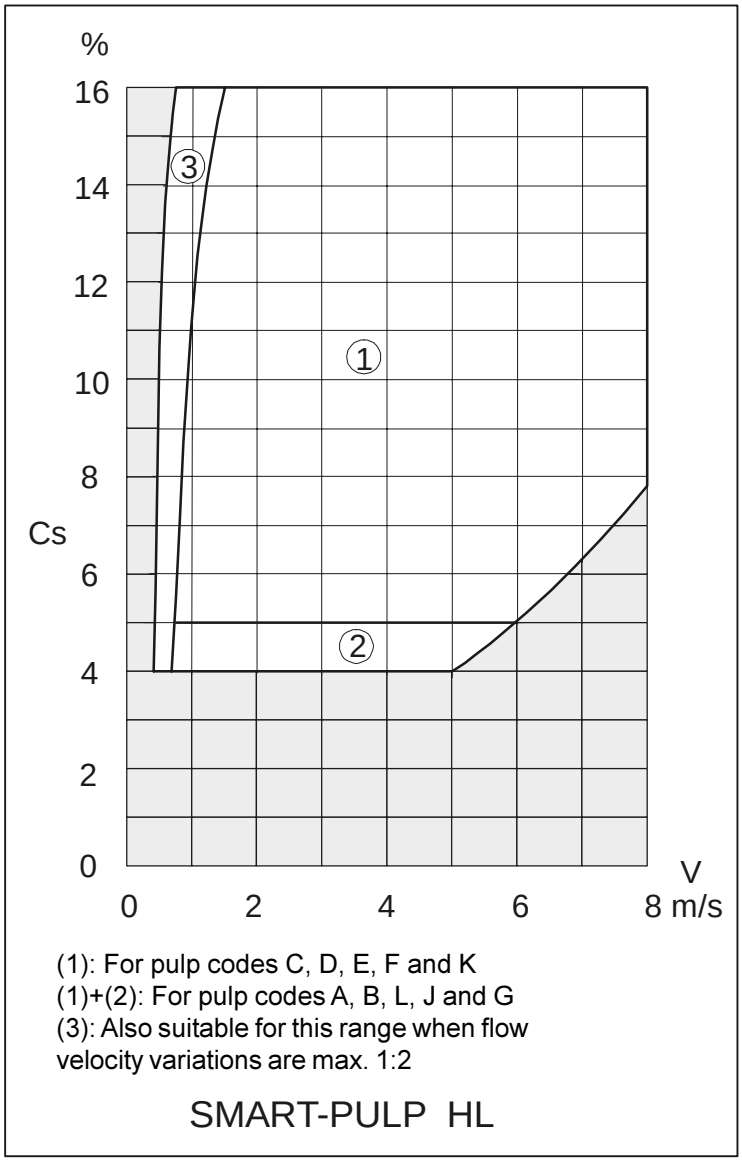


Figure 6.1b Flow velocities/consistency ranges/pulp types for different sensor options
(cont. from previous page)



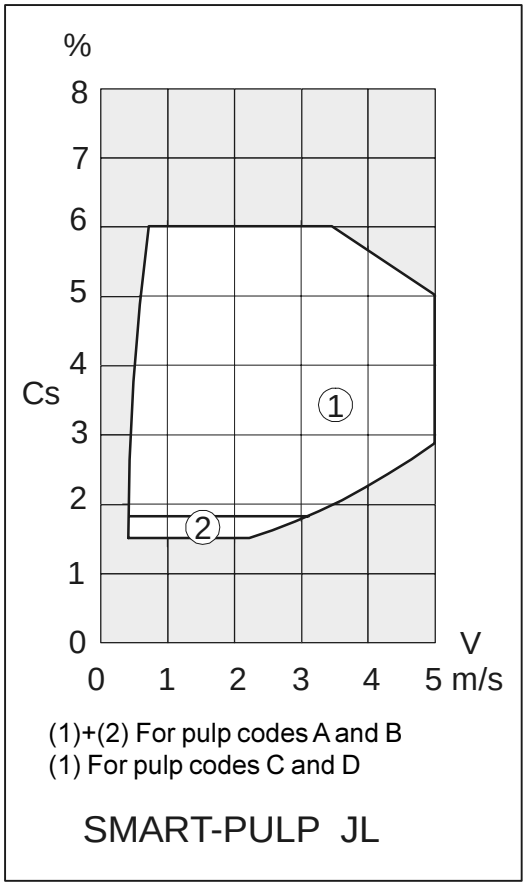


Figure 6.1b Flow velocities/consistency ranges/pulp types for different sensor options (cont. from previous page)

Pulp type codes used in Fig. 6.1b

Code	Pulp type	Recipe code for pulp type	Application ranges of sensor types (% Cs)							
			UL	LL	LS	GL	RL	WS	HL	JL
A	SW unbleached	SWU	0.7-3	1.5-6		(1.7-7)	(1.5-6)		4-16	1.5-6
B	SW bleached	SWB	0.7-3	1.5-6		(1.7-7)	(1.5-6)		4-16	1.5-6
C	HW unbleached	HWU	1-3	(1.8-5)		1.8-7.5	1.7-6.5		5-16	1.8-6
D	HW bleached	HWB	1-3	(1.8-5)		1.8-7.5	1.7-6.5		5-16	1.8-6
E	Groundwood	GW	1-4			1.8-7.5	1.7-6.5		5-16	
F	RMP, TMP, CSF < 200 ml (SR > 52) 3)	RMPL, TMPL	0.7-3			1.5-6.5	1.7-6.5		5-16	
G	RMP, TMP, CSF > 200 ml (SR < 52) 3)	RMPH, TMPH	0.7-3	1.5-5.5	3-6	(1.5-6)			4-16	
H	Recycled fiber, OCC, unscreened	ROCCU						2-8		
I	Recycled fiber, unscreened	RCFU						2-8		
J	Recycled fiber, OCC, screened	ROCCS	1-3			1.7-8	1.5-7		4-16	
K	Recycled fiber, screened	RCFS	1-5			1.8-8	1.7-8		5-16	
L	CTMP	CTMP	0.7-3	1.5-5.5	3-6		(1.5-5.5)		4-16	

3) Wood raw material: Spruce
Notice when choosing the sensor type:
Applications whose consistencies are enclosed in parentheses are not optimum solutions for the specified pulp as regards the sensor type; they are applicable for other pulp types.

7.2 Materials for wetted parts

Metal parts in contact with process medium:

a. AISI316
Used in most applications.

b. Titanium, marked with Ti
Used in applications that contain chlorine or chlorine dioxide.

c. Hastelloy C276, Marked with HC
Used in applications that contain both chlorine dioxide and peroxide.

Gaskets in contact with process medium:

· Part Nos. 90 and 131 in Parts List: PTFE.

· Part Nos. 80 and 39 in Parts List: special rubber.

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