CMC

Microwave Total Solids Meter

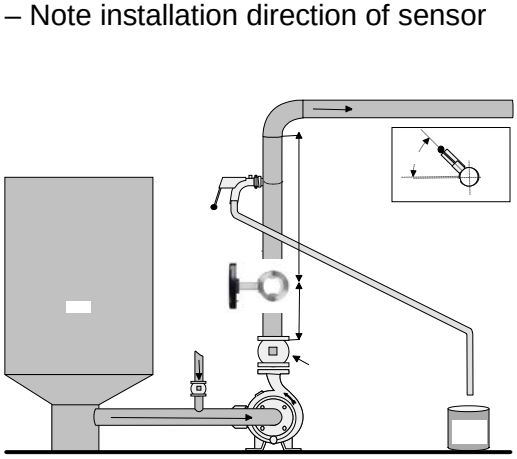
Table of contents

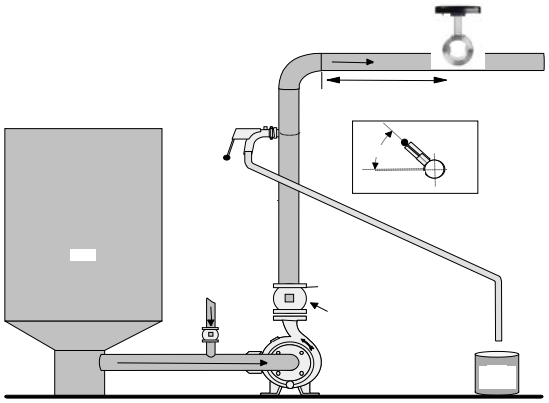
1. Quick start-up guide

Quick guide leads the way to install, start-up and configure necessary parameters in normal case.

1. PREPARING INSTALLATION

– Installation point should have over 1.5 bar pressure
– Conductivity level should be below specification
– Note installation direction of sensor





2. Sensor unit installation

– Sensor is installed between flanges; inst. length 100 mm
– Check installation direction of sensor

3. Display unit installation

– Install display in the place where is easy access
– Interconnect cable length is 10 meter between display and sensor

4. Power on

The CMC is delivered with factory calibration, which means that it will measure total solids concentration as soon as you switch the power on.

When power is switched on first time, the CMC goes to start-up wizard. The wizard guides through the mandatory settings, after wizard is completed, the CMC is ready to measure and outputs consistency to the DCS. Mandatory settings are analog output scaling for total solids concentration output.

5. Calibration

Please check the calibration reading by taking laboratory sample.
Take one laboratory sample and press sample button to store CMC readings.
In case reading differs please make 1 point calibration, by entering laboratory value in CMC and performing calibration calculation. Solids concentration calibration is done by changing slope S-value.

TS% = S * M + Z , where M is measurement value of CMC and Z=offset =0.

6. Final tuning

Additional tuning can be done in PARAMETER menu.

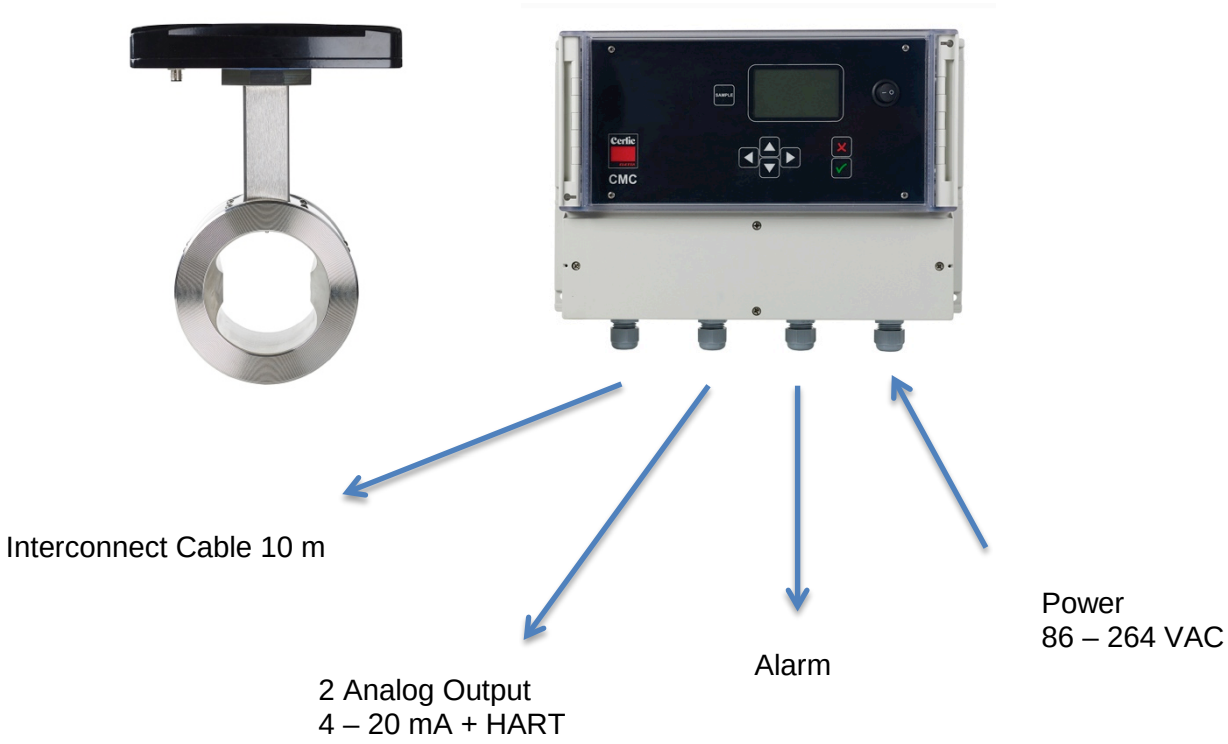
2. Description

System components

CMC microwave total solids concentration transmitter system includes sensor, display unit and interconnect cable.

Sensor of Flow through type (FT) which is installed between DIN, AISI or JIS flanges (wafer type, flanges to be supplied by customer). Pipe dimensions from 50 mm to 300 mm.

Display unit is supplied with 10 meter interconnect cable.
The power supply required is 86 – 264 VAC, 50 – 60 Hz. The display unit supplies power to the sensor and communicates with the sensor. Display unit outputs the analog outputs and alarms to the DCS.



Measurement principle

CMC Microwave total solids concentration transmitter measurement is based on the travel speed of the microwave signal in sludge. Measurement method is called true-phase method.

Transmitter has 2 antennas (transmitter and receiver) between which microwave signal travels. Antennas are positioned on both sides of transmitter.

Microwaves are electromagnetic radiation; the travelling time between antennas depends on the media's dielectric constant. Travelling time is proportional to media concentration. In water microwaves moves at a much slower speed that in sludge. Therefore, concentration can be calculated based on the time it takes the microwaves

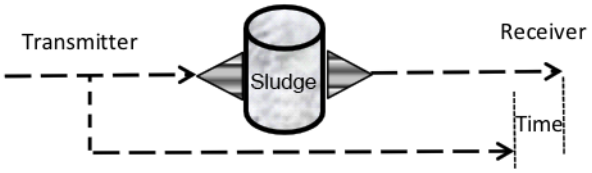
to travel through the measured sludge. Measured time is directly proportional to the concentration.

Measurement is very fast so velocity of the pumped sludge has no effect.

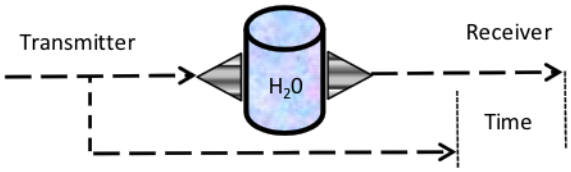
It is essential that there is no free air in the sludge, so requested pressure is over 1.5 bar which keeps air dissolved in sludge. Microwave speed in air is much faster (light speed) than in water and in case air bubbles are present this will have disturbing effect on the dry solids concentration sludge measurement.

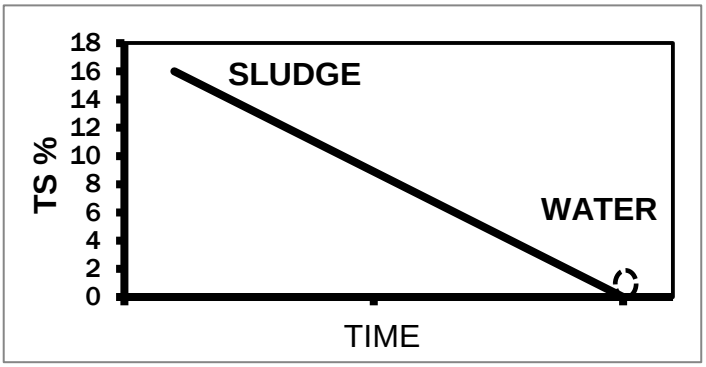
The conductivity of the sludge has effect on microwave signal level and distance travelled. For this reason each sensor type has own maximum conductivity level below which it can work.

Temperature has an effect on microwave speed and true delay and it is compensated inside the unit.



Operating principle





Linear response

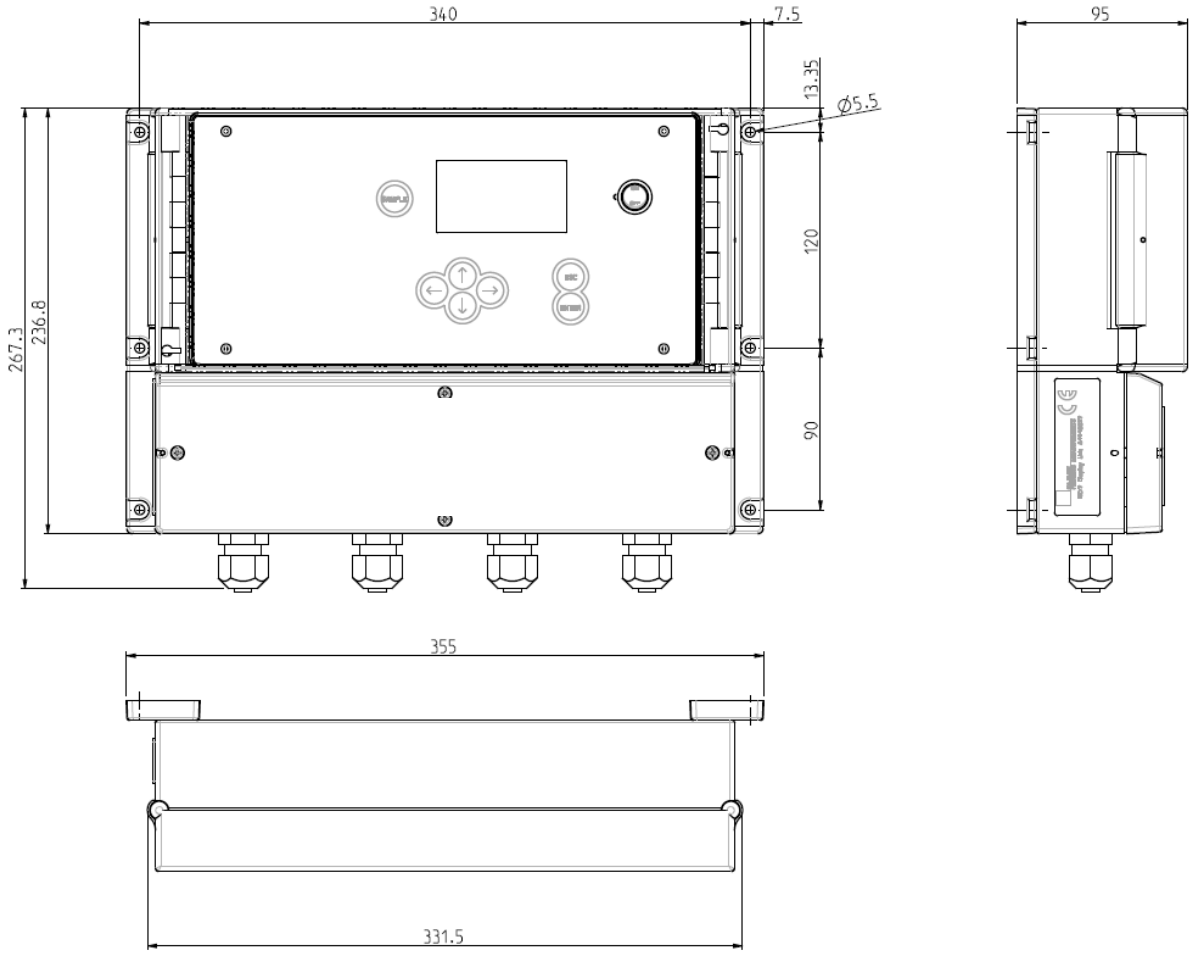
3. Installation instructions

Manufacturer supplied components:

- CMC sensor unit, 1 ea
- Display unit, 1 ea
- Interconnect cable, 1 ea

Display unit installation

Install the display unit to the wall for easy access. Standard interconnect cable length is 10 meter to the sensor, but longer cables are available. Cable has quick connector at sensor end and display unit end has strip connectors.



Display unit dimensions.

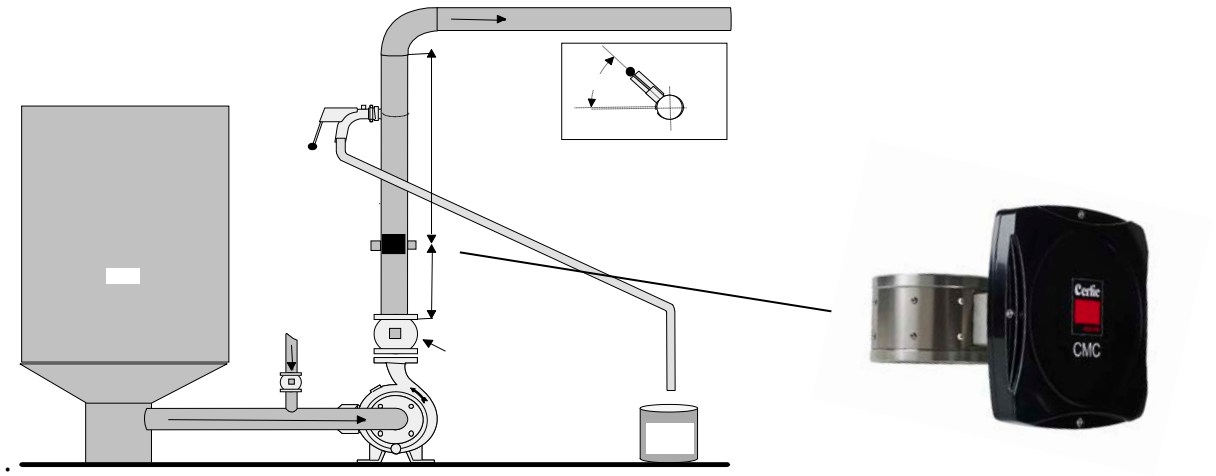
Sensor installation

The CMC Flow through senor is installed so called sandwich installation (wafer type) between flanges. (Flanges are not supplied with the sensor.)

Sandwich installation

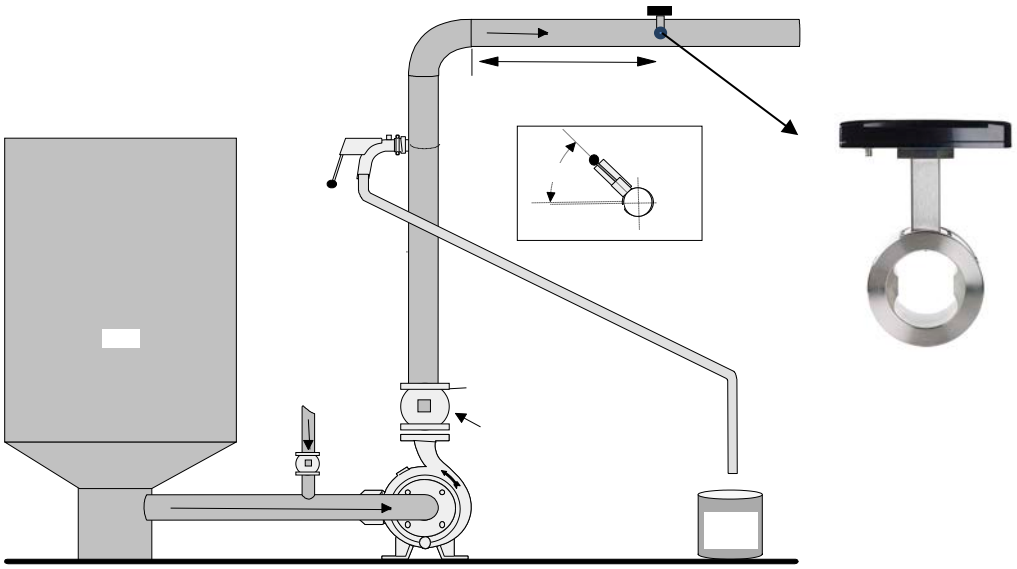
Sensor can be installed in vertical pipeline, horizontal pipeline or inclined pipeline.

Vertical pipelines install sensor so that main flow is directed between antennas. The sensor can be installed directly after pump. Antennas shall be perpendicularly with the pump shaft.



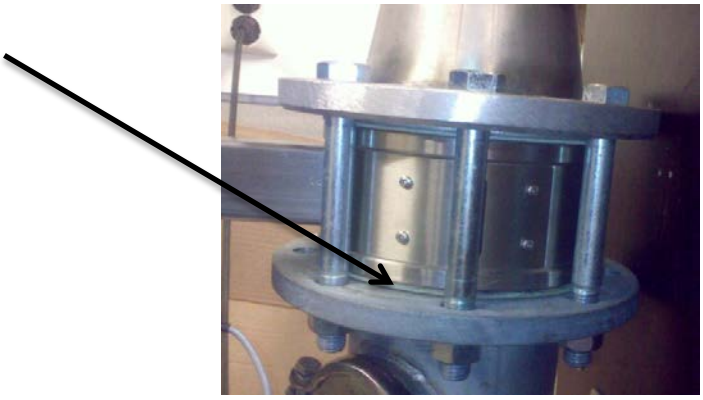
Vertical pipeline installation.

In horizontal pipelines locate antennas horizontally and electronics on the top of pipeline. This will ensure that antenna is on side of pipeline and not on the top where is possibility to have air pocket.



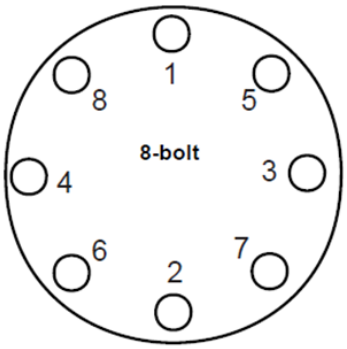
Installation of sandwich sensor Gaskets

The sensor requires a gasket at each of its connections to piping. The gasket material selected must be compatible with the process fluid and operating conditions.



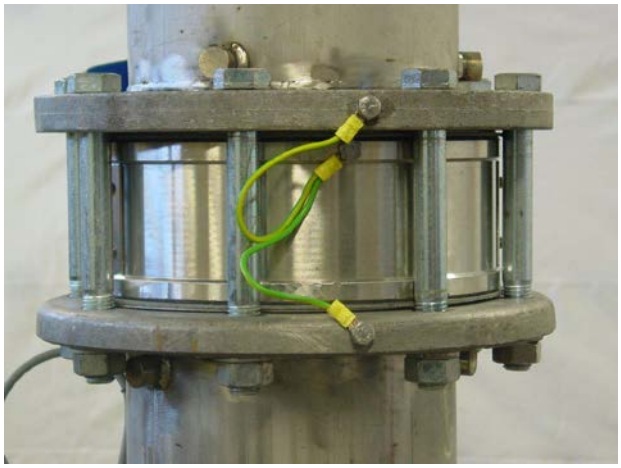
Flange Bolts

Tighten bolts evenly. Tightening of the flange bolts please follow the following introduction.



Grounding

Grounding of sensor is important especially on pipelines which do not automatically make grounding. Grounding is also recommended in metal pipes where plastic seals are being used.



Grounding of sensor

CMC-IT Installation

Install sensor so that main pulp flow is directed between antennas. Recommended sensor location: 3 times pipe dia. after pump. If enough pressure (>1.5 bar) is not available, install the sensor right after pump.
Minimum pipe diameter where IT sensor can be installed is DN150.
Antena tip should be facing against flow.

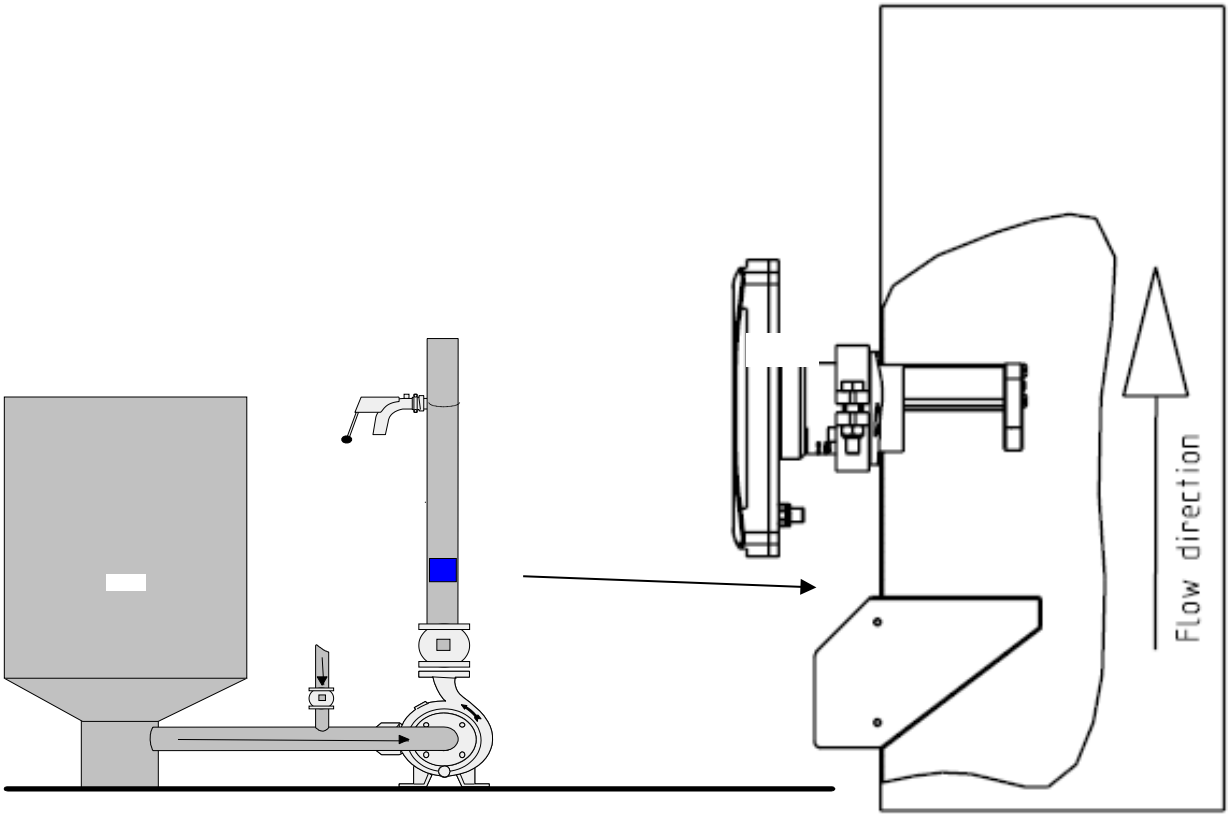
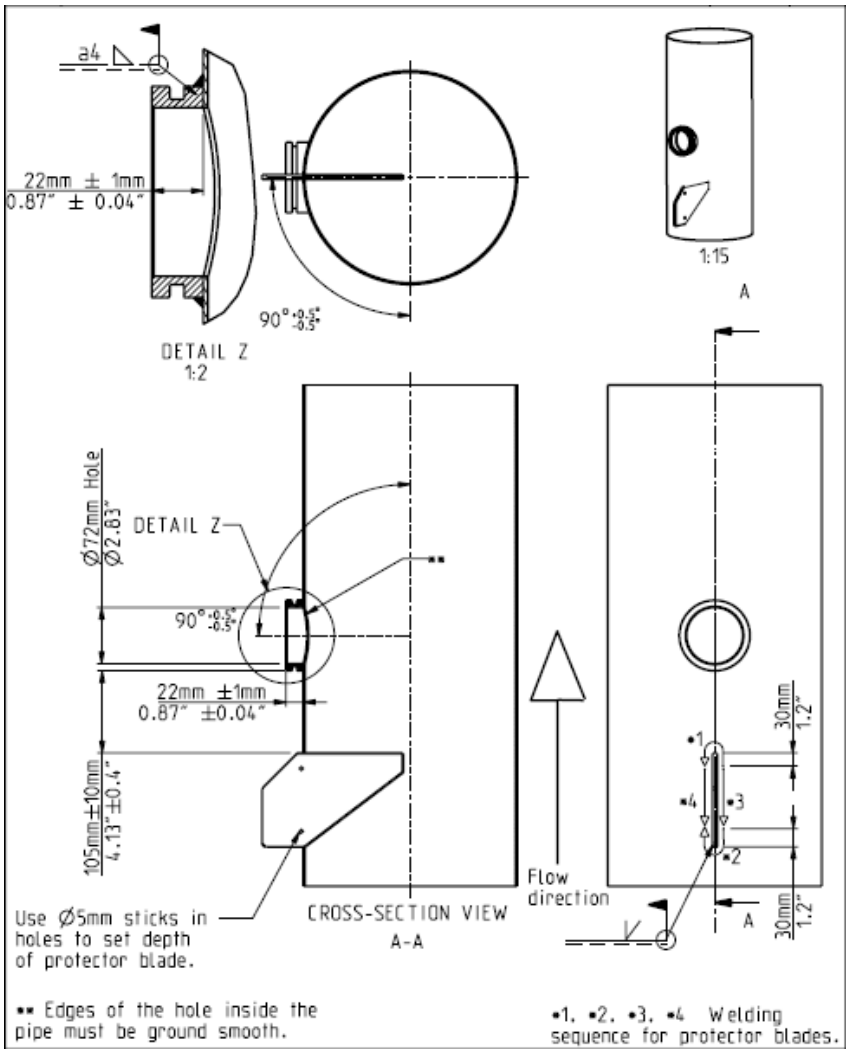


Fig. 4.8. Pipeline installation of CMC-IT model.

Welding instructions in fig below.

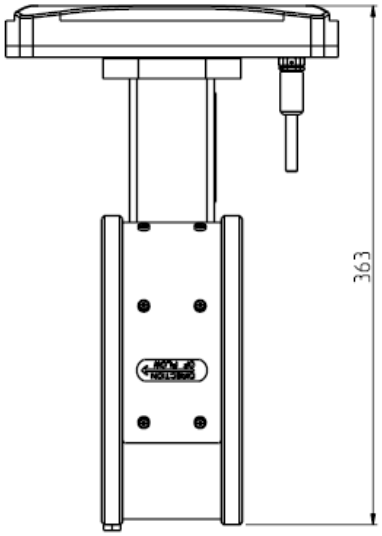
1. Verify that the process is shut down, appropriate valves are closed and the pressure inside the pipe is fully released. The pipe should be empty.
2. Cut a hole Ø72 mm (2.8”) in the pipe. To prevent fiber debris from collecting on the edge of the cut-out, ensure that the edges of the hole inside the pipe are ground smooth. Fiber debris collected at this point can interfere the measurement.
3. Shape the saddle to fit the process pipe diameter. (Saddle is precut for pipe DN100 (4”) and must be modified for larger line sizes).
4. Place the saddle over the hole in the pipe. Verify that the hole is centered with respect to the saddle and the appropriate distance from the pipe is maintained. Fillet weld around the entire perimeter of the saddle to attach it to the pipe. Saddle must be welded exactly parallel to process pipe.



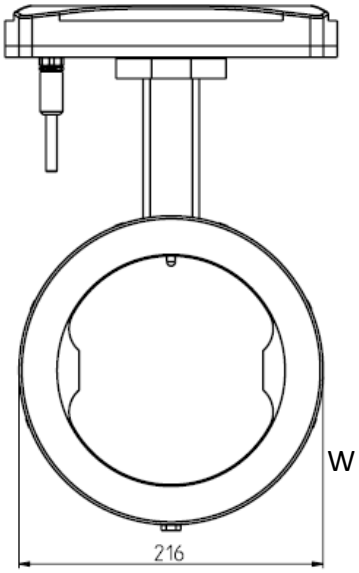
Disconnects

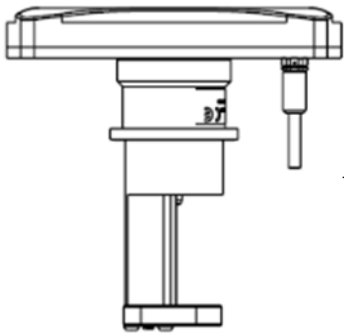
Clearly label the disconnect or circuit breaker and locate near the transmitter and per local electrical requirements and standards.

CMC sensor dimensions

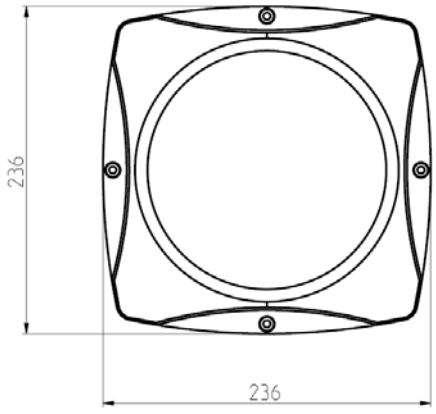


H





Sensor	H	W	L	Kg
CMC 80	285	138	100	10
CMC 100	307	160	100	12
CMC 150	363	216	100	16
CMC 200	417	270	100	20
CMC 250	467	320	100	25
CMC 300	521	374	100	30
CMC-IT	233	69	69	12



4. Wiring

The terminals for the electrical cables are located under the bottom cover of the display unit. The layout of the connection board is shown in figure 5.1.

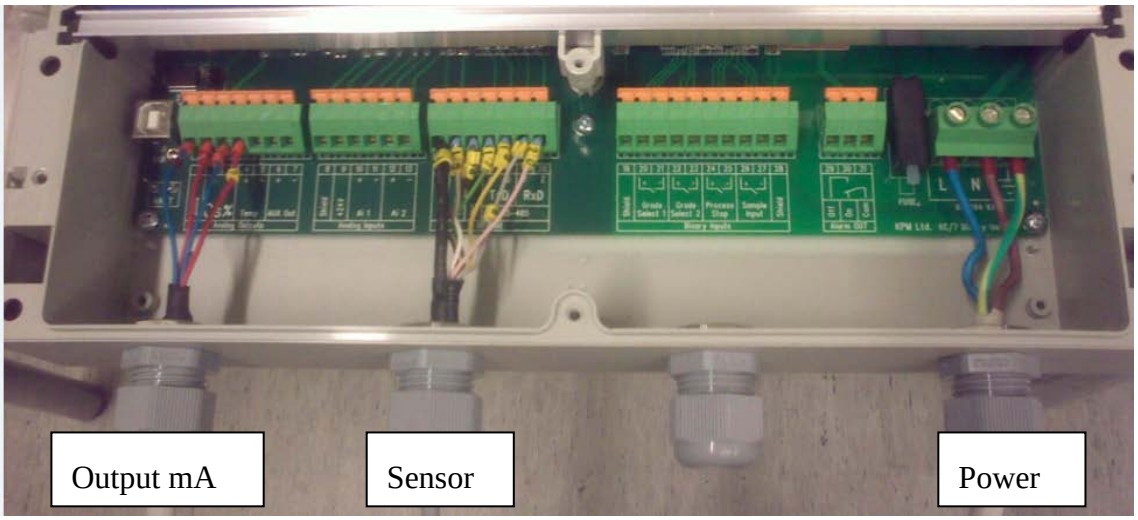


Figure 5.1. Display Unit terminal strip

Electric connections

Display unit is connected to sensor unit with 10 meter interconnect cable. Cable will be connected to strip terminals from Display unit end and quick connector from sensor end. Locate the display unit in place for easy access.

Connect power (86 – 264 VAC, 47 – 63 Hz) to terminal strip on the right side in display unit.

Sensor cable (Interconnect cable) connection to terminals 14 - 20.

Current output terminals are 2 and 3 for concentration. Terminals 4 and 5 are reserved for Temperature.

Alarm relay OFF is normally closed. It opens in case the built-in self-diagnostics detects a failure. If power is lost or turned off the alarm relay OFF is OPEN. Alarm ON works the opposite way.

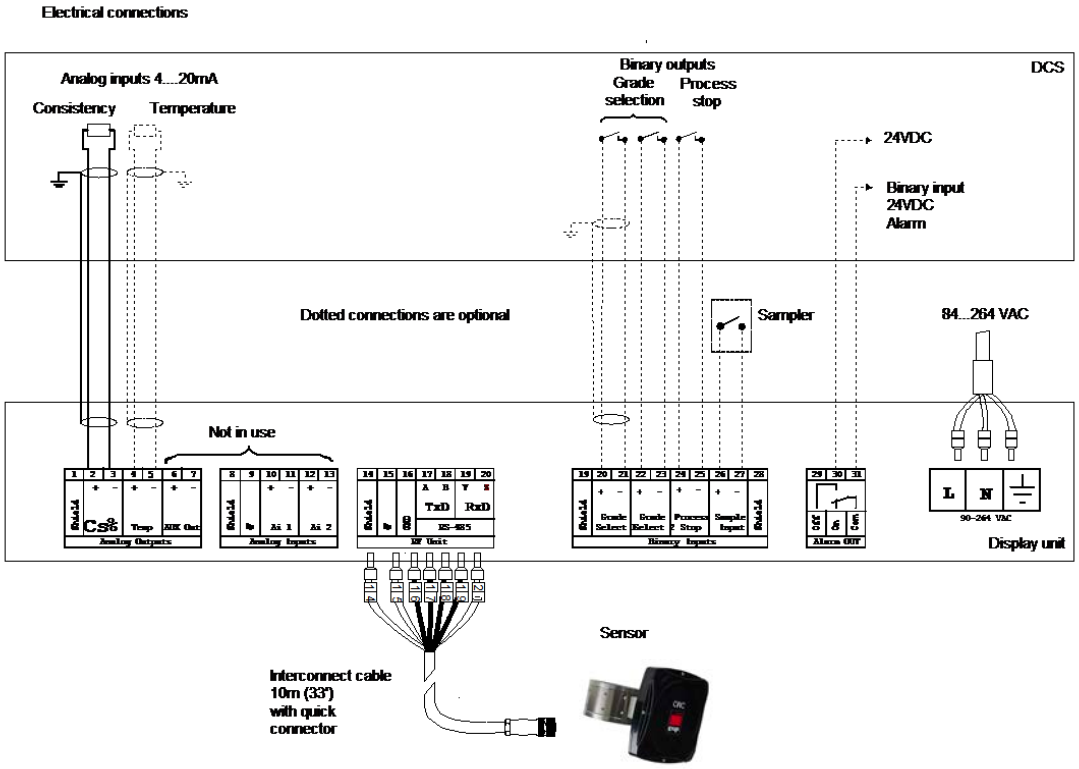


Figure 5.2. Electrical connections

5. Display unit operation and configuration

Display and operating keyboard

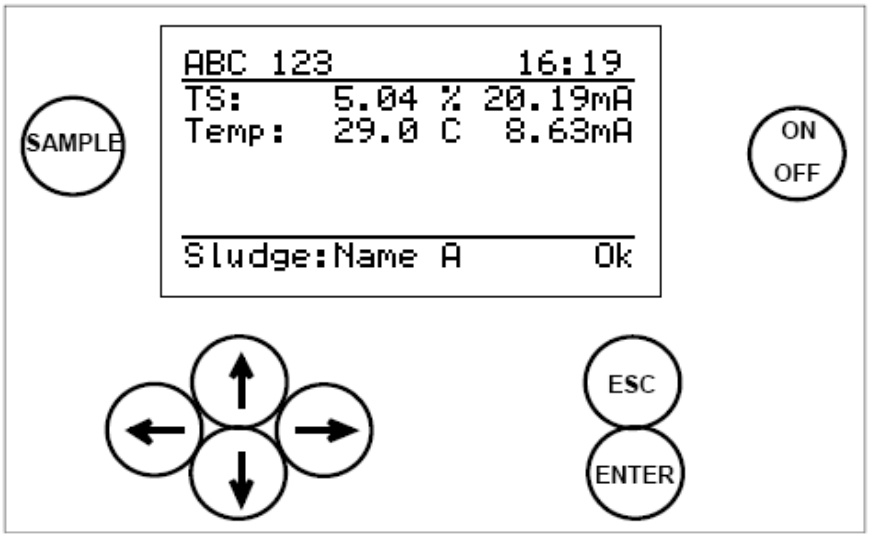


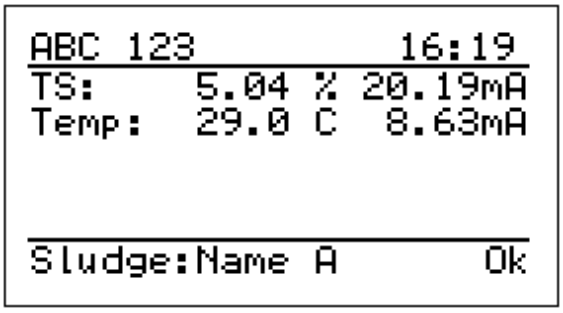
Figure 6.1. Display and keyboard.

The display contains 7 lines, with 21 characters in a line. The main display (fig 6.1) shows:
– Tag number and time.
– Concentration signal level as percentage and output in milliamps.
– Temperature as degrees (C / F) and output in milliamps
– Recipe and status.

Common properties in other menus:
– Selected line is highlighted
– Upper right corner shows:
  * Number of lines/pages in that menu.
  * Arrow shows, if hidden lines.
– Help menus in bottom.

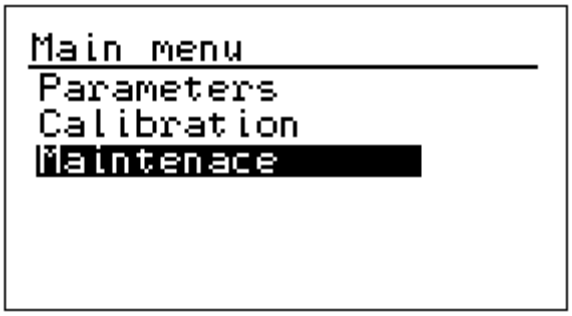
Keyboard
– ON/OFF button: Switch the mains on/off.
– Arrows: Scroll the menus and rows or adjust values.
– Esc: Delete changes and/or return back to the previous menu.
– Enter: Accept data and input changes.
– Sample: Averages the measured values. After sampling the program asks if the values will be stored (ENTER) or discarded ESC). In case nothing is pressed then sensor stores sample automatically after 3 minutes.

Main menu



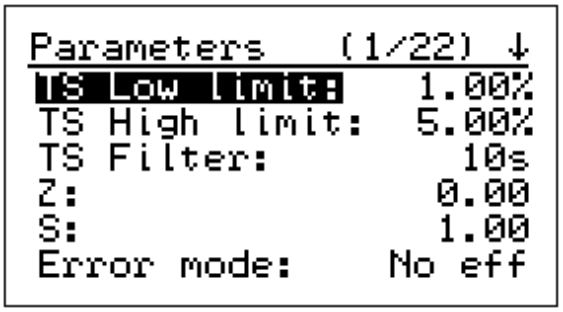
Arrow right or left brings trend data of dry solids concentration. There are three levels in time (2 min, 1 hour and 24 hour).
From trend data arrow down brings Temperature trend.

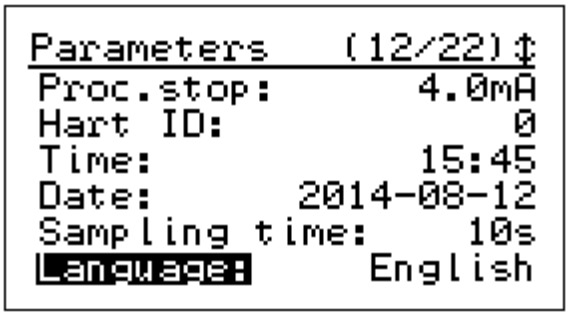
Arrow up or down bring another menus.



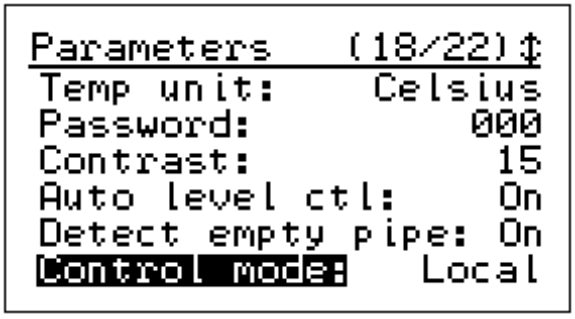
Parameters

Parameter menu is to read and list all existing parameters in same display. This menu allows also changes. Please note that before changing any parameter there should be reason to change it.





AO1 = Analog output 1 (for TS concentration output)
Calibration paramters Z= zero and S=slope.
Error mode = Effect on display when self diagnostics detects an error.
Proc.Stop = Analog output level when Process stop bibary input is activated.
Hart id= address,
Time and Date for sampling identification and error log,
Sampling time = averaging time when sample button is pressed
Language for local settings (English, Swedish, German and Finnish available)



Temperature unit for local settings (Celcius and Fahrenheit available)
Password to operate CMC display, in case 000 no password requested,
Contrast to change display intensity
Auto level ctr = on, this is to automatically adjust signal strength in case there are changes

Analog Output

Analog output scaling and filtering can be done in Parameters menu. Output 1 is for concentration and output 2 for temperature. Output number 3 is not in use.

Error mode for Analog Output signal can be configured of following selection:

No effect, 3.5 mA, 22 mA or freeze. Error mode selection determines how Analog Output 1 behaves when self-diagnostic finds an error in the device.

Process stop binary input can be used to force measurement to certain value during process is down. When process pipeline is empty CMC measurement will show very high concentration number and then analog output signal will show 20 mA. This may be unwanted situation for operators. Analog output can be forced for example to 4 mA during process stop when binary input is connected.

Process stop signal level (No effect, 4.0 mA, 20 mA or freeze) can be determined for cases when binary input (24,25) is active.

Hart address is for communicating with HART through Analog output 1.

Analog inputs are not in use in CMC
Date and time are set for sampling purposes and for data logging
Languages available at a moment are English, Swedish, German and Finnish
Temperature unit can be changed Celsius/ Fahrenheit
Password 000 means no password needed
Contrast will change display intensity

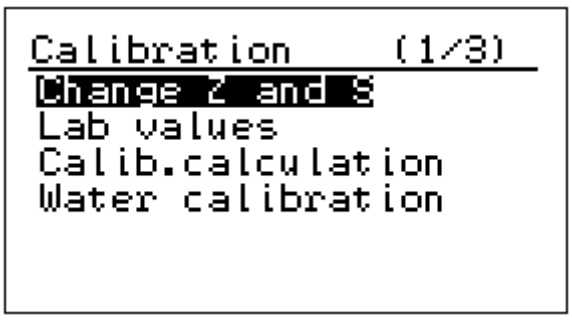
Calibration

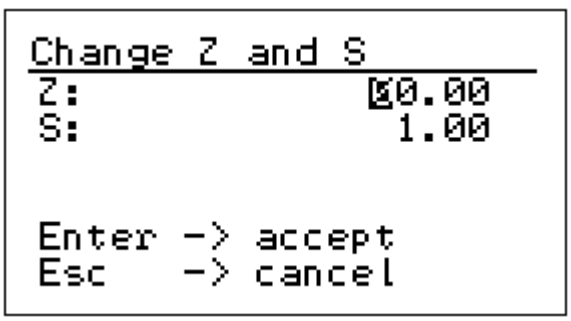
The CMC is delivered with factory calibration, which means that it will measure concentration as soon as you switch the power on. Factory calibration is performed during the final testing using clean water.

We recommend that you check the calibration or calibrate the device to the actual sludge and laboratory procedures. This allows the device settings to be optimized for the sludge properties in which it will be used.

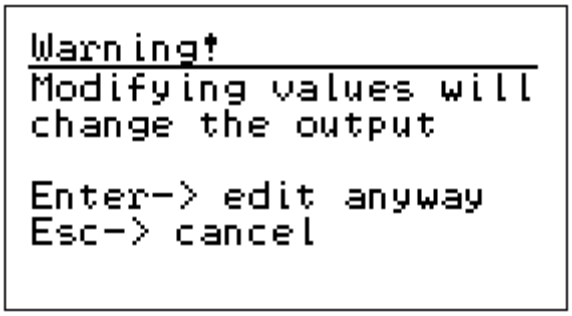
Calibration parameters Z (=zero) and S (=slope) are for calibrating the unit to adjust the output to the laboratory samples.

Calibration is normally done with 1 point calibration by changing the Slope=S–value.





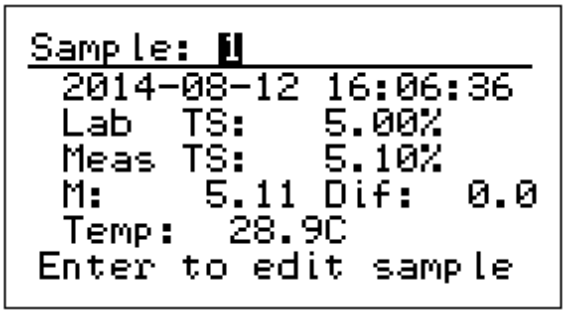
Warning will appear when active existing calibration is changed. Active means grade which is selected to Analog Output.



Lab values

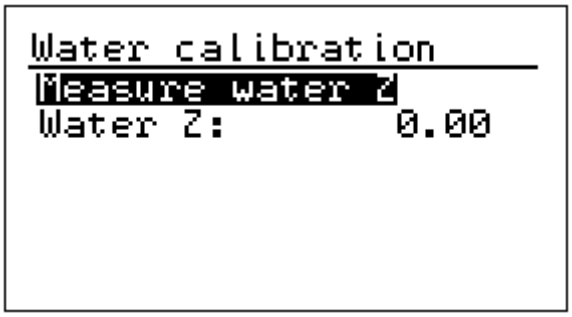
Laboratory values can be entered after sample has been stored into CMC memory. When sample button has been pressed, then raw measurements are stored into CMC memory. This can be done by pressing ENTER button right after sample taking or CMC stores values automatically after 5 minutes if no button is pressed.

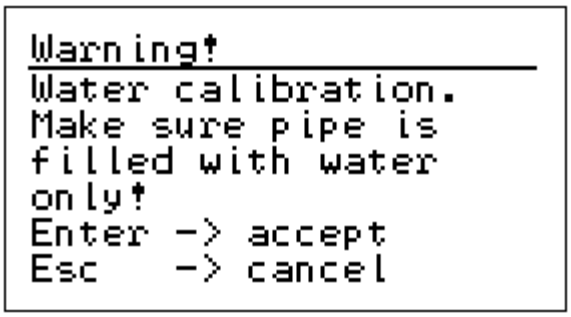
Entering laboratory values first choose sample based on date and time. Last sample is always set number 1 and there are 20 samples stored in the memory. When new sample is stored it will delete the oldest sample in case memory is full.



Water Calibration is normally not needed to do at all.

Water Calibration can be performed in special cases when it is assumed that for example ceramic windows are getting dirty. When doing water calibration it is essential that pipeline is filled with clean water and no air bubbles are present.





Single point calibration

Perform calibration by taking a TS-concentration sample and pressing sample button to store measured values. When measured concentration differs from laboratory value please calculate new SLOPE S-value following:
New S = Old S * (Lab-value / CMC-value)
For example CMC display = 3,20 % and laboratory result is 3.33 %. Old S=1.00.
New S= 1.00 * (3.33 / 3.20) = 1.04

Enter new slope value into Change Z and S: menu in place of S:

To perform this calculation in CMC display You can enter Laboratory value in

CALIBRATION -> LAB VALUES. After this point has been entered please perform CALIB. CALCULATION and choose grade and save calculation result by ENTER.

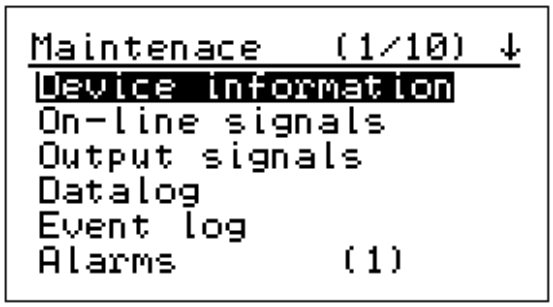
Multi point calibration

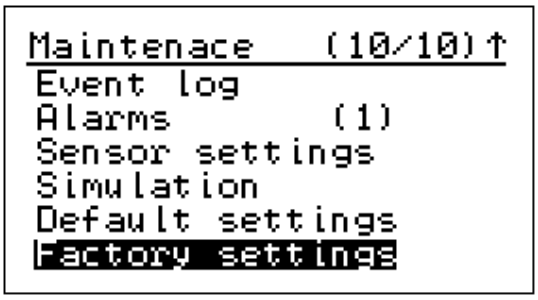
Multi point calibration can be used when minimum 2 samples are stored into sensor memory.
Pressing Sample button, sensor stores measured values in memory with a time stamp. Storing happens when Enter is pressed or after 5 minutes when no button is pressed. Esc avoids storing in 5 minute scope after sample button pressing.

Laboratory values should be entered respectively in CMC memory. When 2 or more samples are stored calculation can be performed. Laboratory value 0.0 % means that this point is not included in calibration. Default value for slope is S=1.0 and for offset Z=0.0.

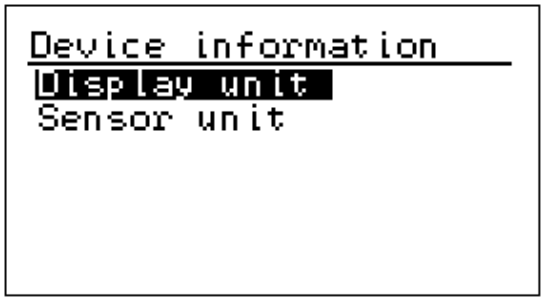
Please note that there shall be some variation in concentration readings (about 1.0 %) before slope calculation gives reliable value.

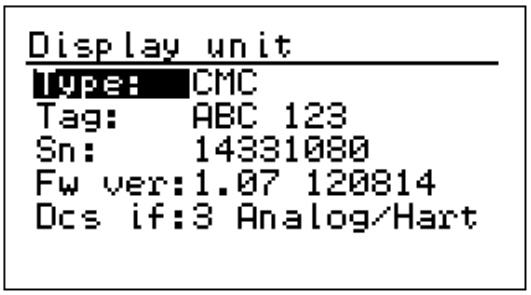
Maintenance

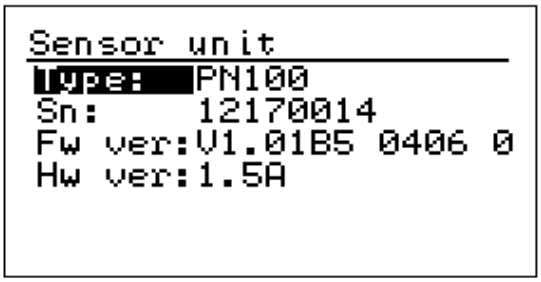




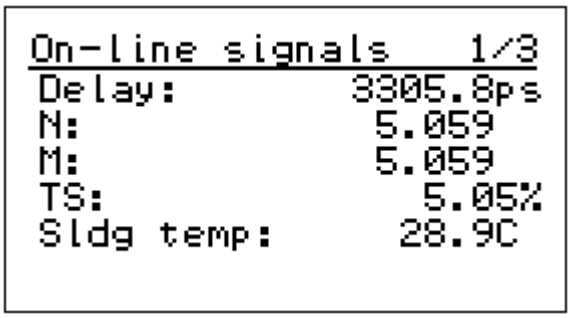
Device information is to display existing display and sensor type, software version and serial number.

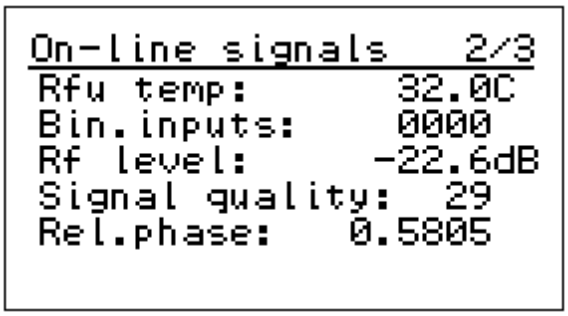


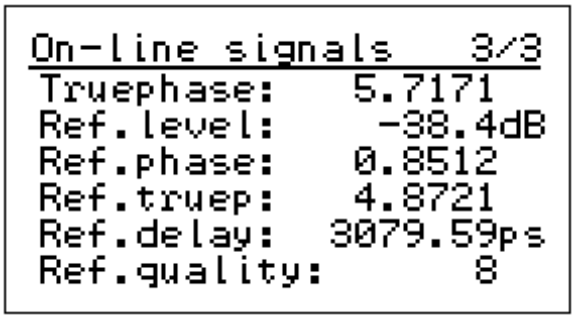




On-line signals will display measured signal levels, which may be needed for troubleshooting purposes.







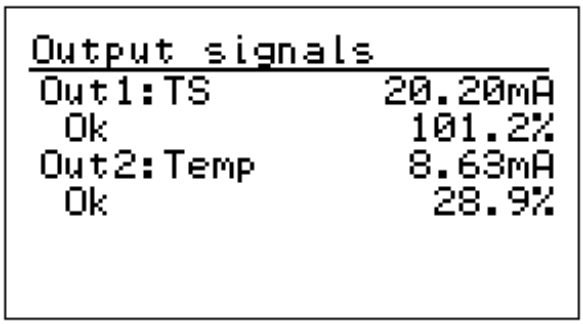
Delay: The measured microwave signal delay in picoseconds
N: Concentration measurement before water calibration
M: Concentration measurement after compensations
Sldg Temp: temperature of the sludge
RFU temp: temperature of the electronics of the sensor

Bin. Inputs: status of the binary inputs
RF level: attenuation of the received microwave signal in dB

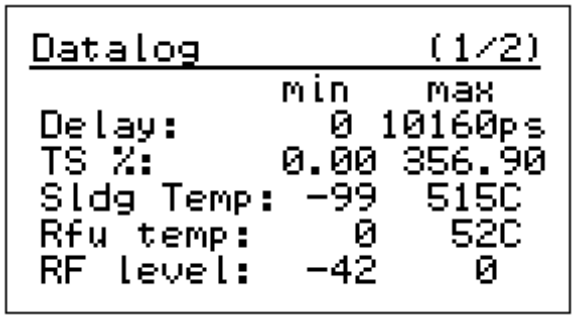
Signal quality: quality of the measurement signal, shall be below 50
Rel phase: phase measurement
Truephase: Phase including full counts of n

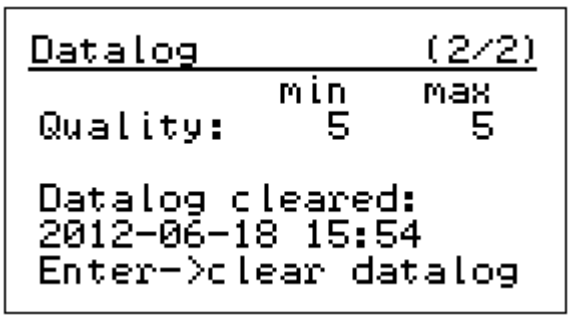
Ref. level: attenuation of the reference microwave signal in dB
Ref. phase: phase measurement of the reference channel
Ref. truep: Phase including full counts of n of the ref. channel
Ref. delay: The reference signal delay in picoseconds
Signal quality: quality of the reference signal, shall be below 20

Output signal will display existing Analog output as milliamps and percentage.

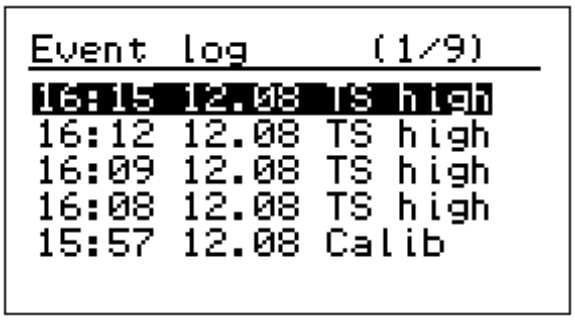


Datalog collects minimum and maximum values since clearance time. Please, remember to clear these counters during start-up time.

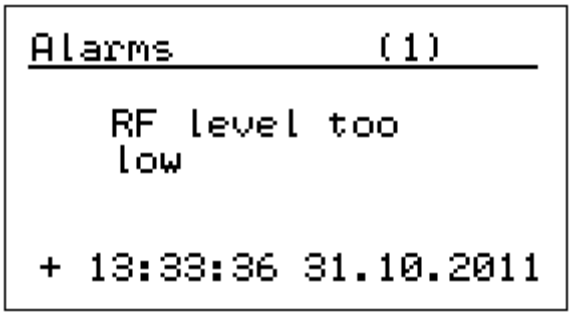




Event log collects all configuration changes and boot-ups etc. In memory stays 250 last modifications.



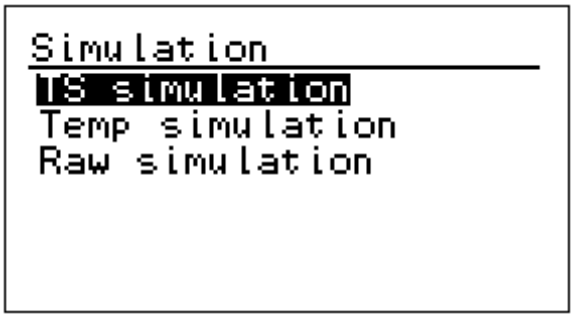
Alarm menu will display active alarms at that moment. In case there are no alarms then nothing is displayed. In case more than one alarm is active at same time then there is number of alarms in brackets.

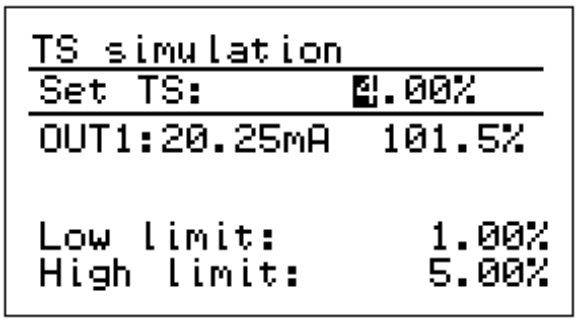


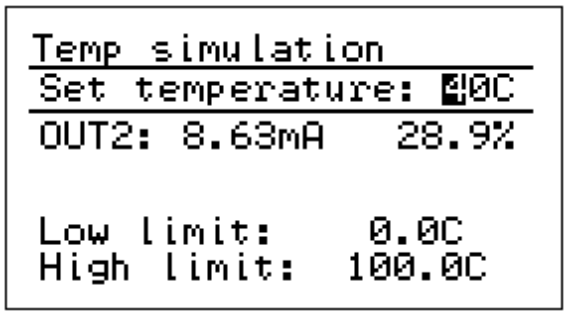
Sensor settings will display Auto Level Control ON or OFF. Normally it is ON. This feature will set automatically signal level to optimal depending on process conditions for example because of conductivity changes.

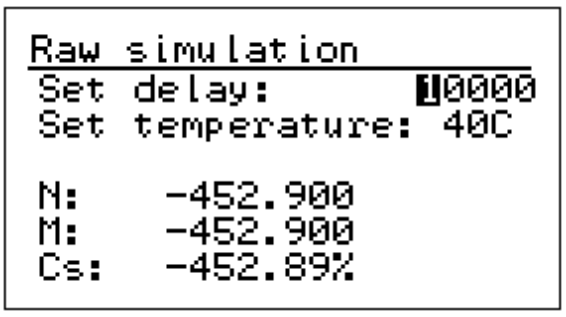
Detect empty pipe: This is normally OFF. Empty pipe detection can be used sometimes when pipe is getting empty during shut down. Signal quality works as detection limit for empty pipe detection. Normally signal Quality is over 100, when pipeline is empty.
RFU GD check: this is normally ON. In case of extreme conditions OFF can be used.

Simulation simulates Analog output signal for Concentration and Temperature. Raw simulation simulates calculation.

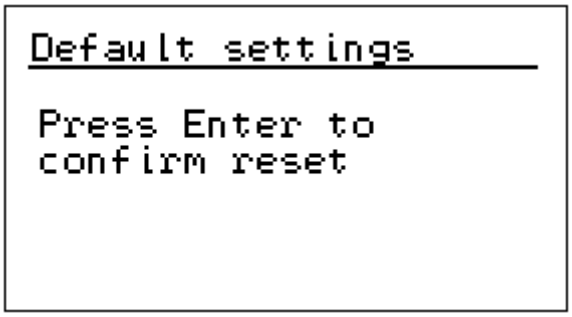








Default settings will reset parameters to default setting of the unit.



Factory settings

Factory setting is for basic configuration of the unit. Customer does not need to enter this menu.

6. Start-up

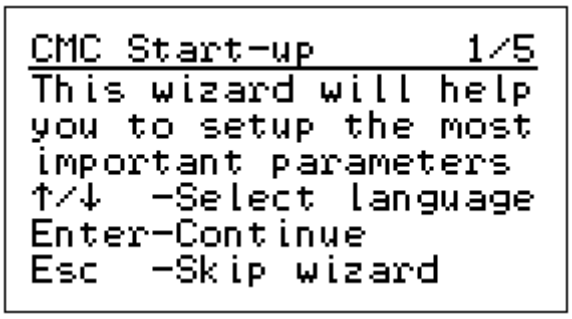
Sensor installation

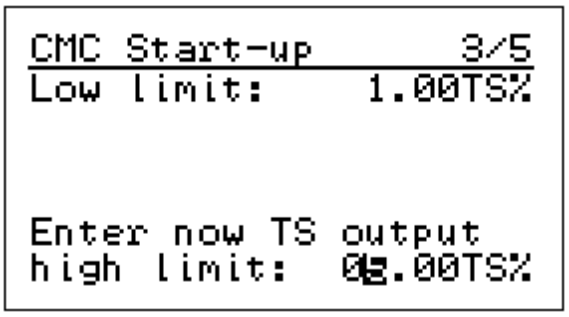
1. Make sure that the sensor is installed correctly and pressure and conductivity requirements are filled. Pressure should be over 1.5 bar to avoid free air in pulp
2. Connect the sensor cable, turn the power ON.

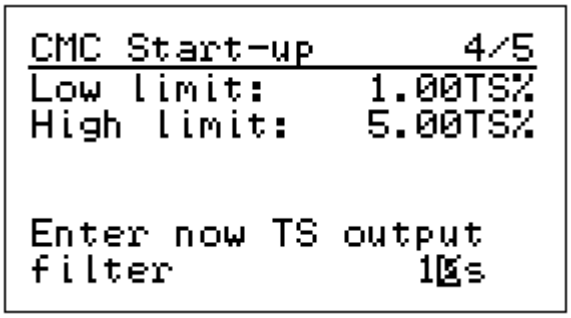
Set-up

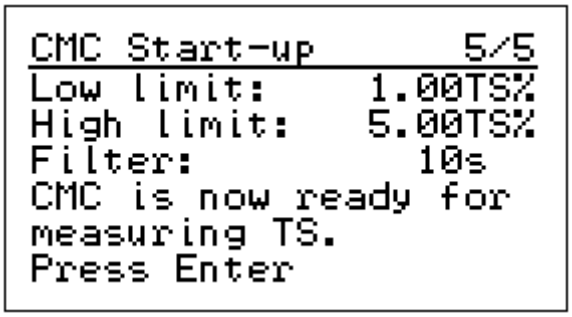
The CMC is delivered with factory calibration, which means that it will measure consistency as soon as you switch the power on.

When power is switched on first time, the CMC goes to start-up wizard. The wizard guides through the mandatory settings, after wizard is completed, the CMC is ready to measure and outputs concentration to the DCS.









If the Wizard is not used, the configuration of the Analog output can be done the following way:

Please configure Analog output scaling and filtering in Parameter menu and unit is ready measuring concentration of dry solids.

Please check the measurement reading by taking laboratory sample.
Take one laboratory sample and press sample button to store CMC readings.
In case reading differs please make 1 point calibration.

Parameters

Parameter list is the place to make unit configuration and set-up. There are analog output scaling and configuration for Total Solids Concentration and Temperature Outputs.

1. In Parameters menu set Analog output 1 scaling. Set AO1 Low limit value for 4 mA , AO2 High limit for 20 mA and AO1 Filter for damping.

2. Calibration parameters Z= zero and S= slope.

3. Error mode is analog output 1 mode in case error is detected (no effect, freeze, 22 mA, 3,5 mA)

4. Process stop effect on analog output 1, when Binary input for process stop is activated. Binary input is contact information only. This is normally used to force measurement to 4 mA when pipeline is empty or when pump is not running.

5. Hart ID is Hart communication address
6. Set date and time
7. Set sampling duration time to store measurement values
8. Set Language
9. Set Temperature unit
10. Set password; 000 means no password needed
11. Set display contrast
12. Set Auto level control ON. This is normally always ON.

Calibration

The CMC is delivered with factory calibration, which means that it will measure concentration as soon as you switch the power on. Factory calibration is performed on the device in connection with final testing using clean water.

We recommend that you check the calibration or calibrate the device again when setting it up. This allows the device settings to be optimized for the conditions in which it will be used.

Single point calibration

The single point calibration can be done by 2 different ways:

1. Perform calibration by taking a concentration sample and pressing sample button to store measured values.

If measured total solids concentration differs from laboratory value, calculate new S (Slope) in CMC display. Enter Laboratory value in

CALIBRATION -> LAB VALUES.

after entered, please perform CALIB. CALCULATION and choose grade and save calculation result (S= slope) by ENTER

2. Or calculate the new S (Slope) value manually by:
   New S = Old S * (Lab-value / CMC value)
   Enter new slope value into Calibration menu.

Multi point calibration

Multi point calibration can be used when minimum 2 samples are stored into sensor memory. Taking multiple samples by pressing Sample button, sensor stores measured values in memory. Laboratory values should be entered respectively in CMC memory. When 2 or more samples are stored calculation can be performed.

Please note that there shall be some variation in total solids readings (about 1.0 %) before slope calculation gives reliable value.

Default value for slope is S= 1.0 and for offset Z=0.0.

7. Maintenance

Regular maintenance

Periodic maintenance and care are necessary to obtain reliable slurry measurement over time. Because the TS meter has no moving parts, no mechanical maintenance is required, but the user have to ensure that the sensor antennas are kept as clean as possible, for example by flushing with hot water or manual cleaning. When the sensor starts to show a big difference to the analyzed value, a recalibration may be necessary.

Alarms

Description	Limit	Action
Sensor communication error		Activates relay + analog output error mode
Delay out of limits	Values depends on sensor model	Alarm list
Sensor or sludge temp too high	over 100C	Alarm list
Sensor or sludge temp too low	below 0C	Alarm list
TS %- reading too high	Analog Output high	Alarm list
TS %- reading too low	Analog Output high	Alarm list
RF level too low	signal below -35db	Alarm list

Troubleshooting

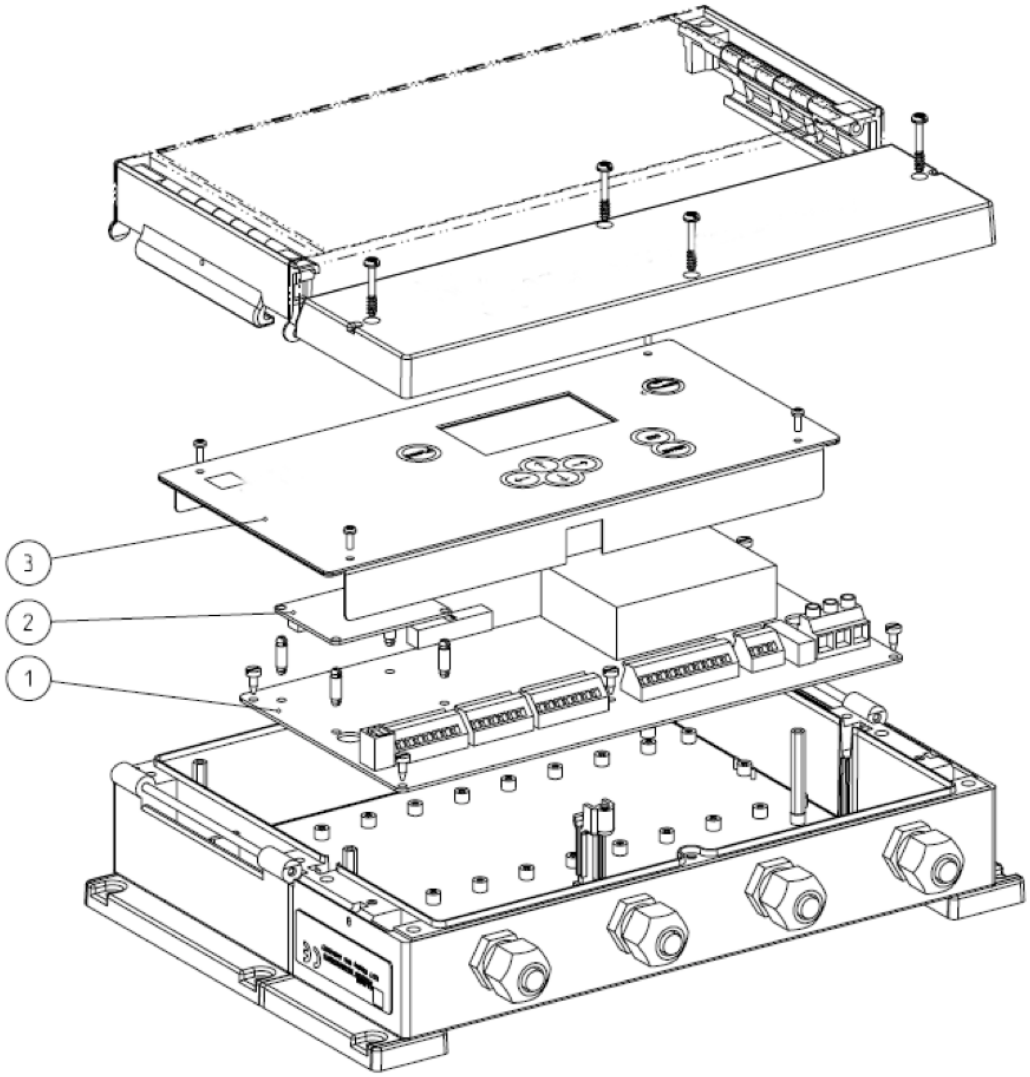
For troubleshooting purposes please read On-Line signal values on maintenance menu.

- Delay value depends on meter size, concentration and temperature.
  - RF level is normally around -25 dB.
  - Signal Quality is normally below 20. Lower number means better signal quality. Signal quality being over 50 means poor quality
  - Relative phase and True phase values are basic raw measurements
  - Reference channel values are displayed on third page and normally stay stable.

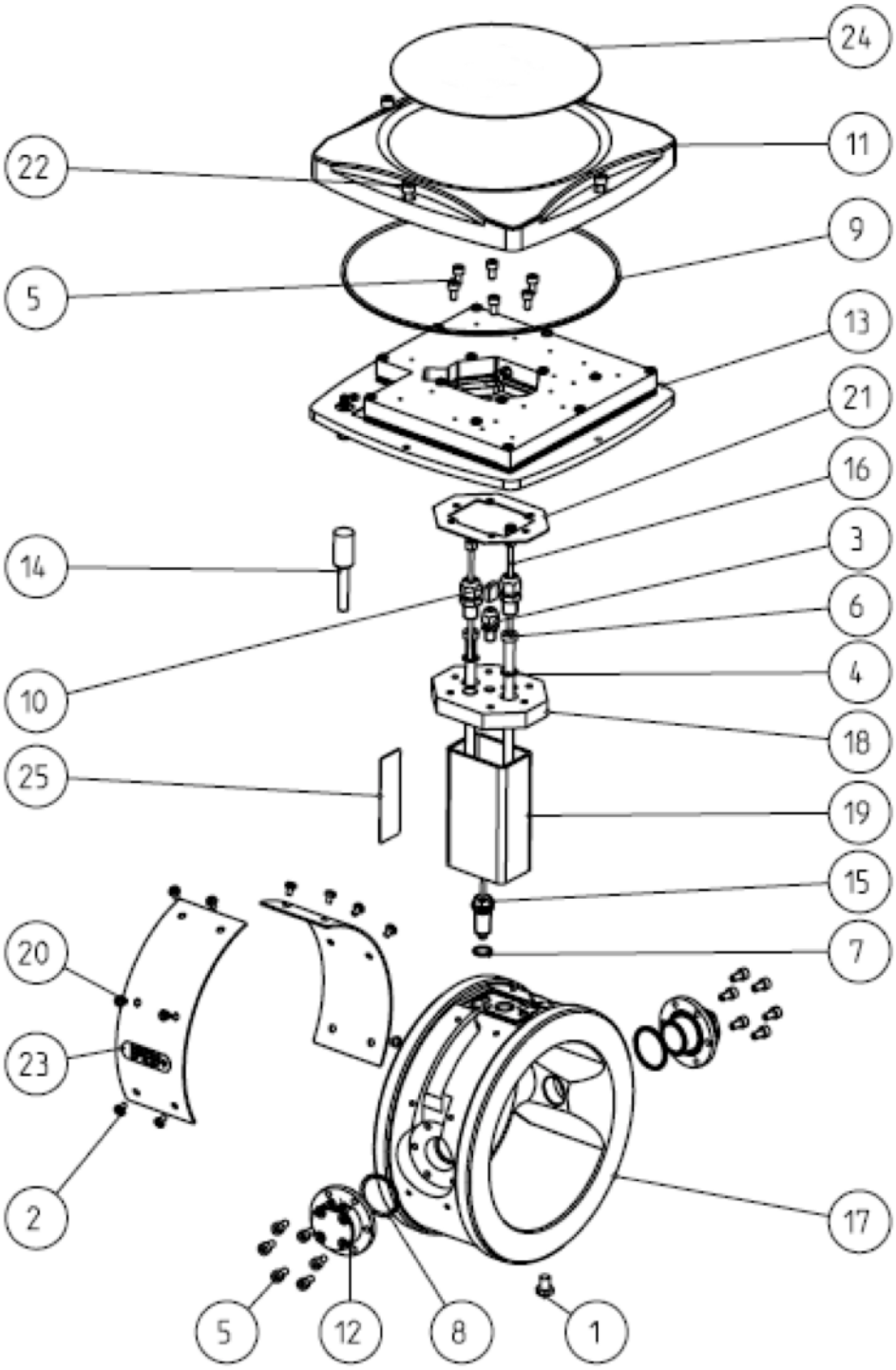
8. Spare parts

Control unit

1. CMC Measuring board
2. CMC Analog board
3. CMC display plate assembly



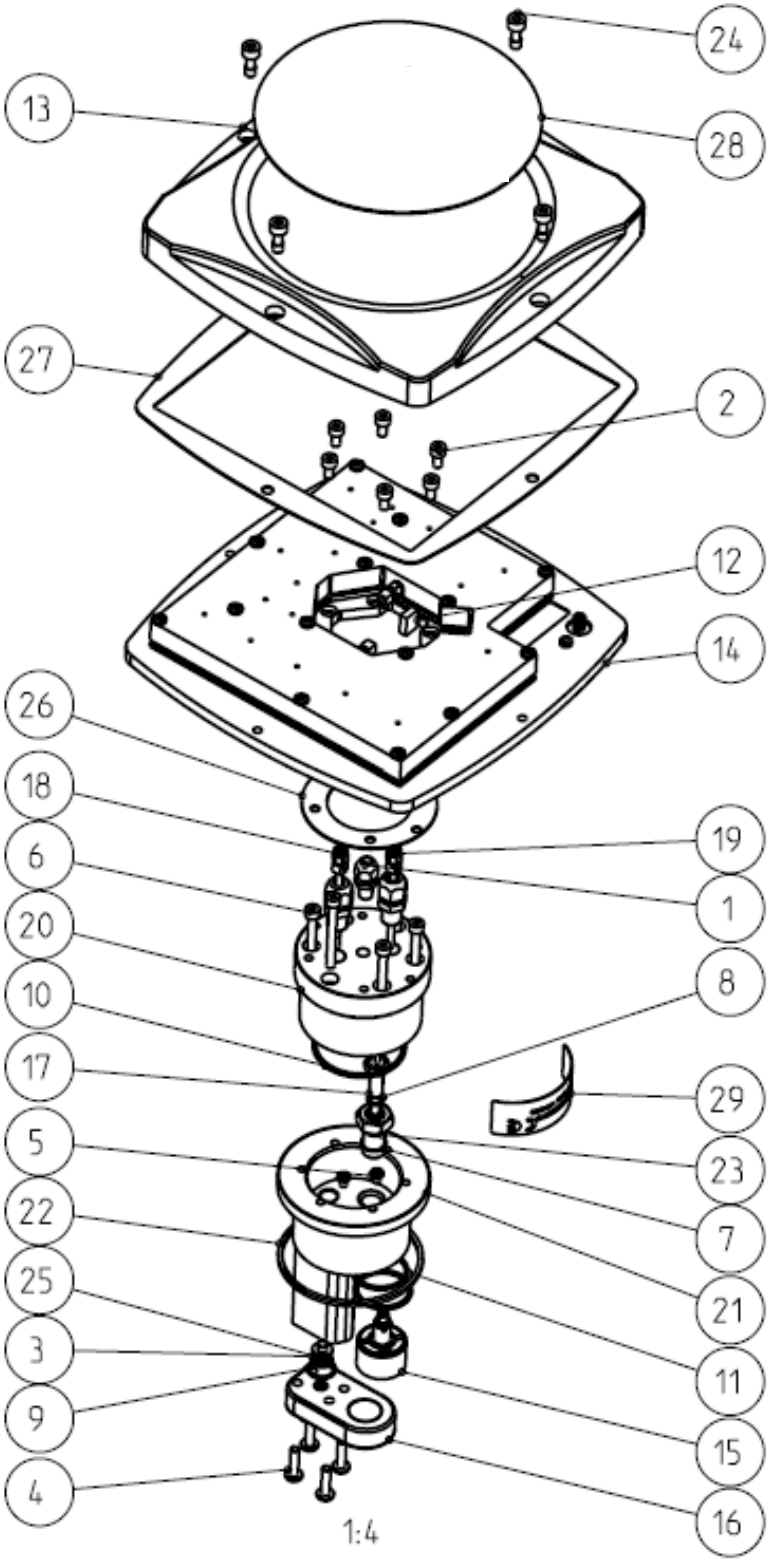
CMC Sensor – exploded view



CMC Specification

Part	Description	Part	Description
1	Screw M8*10	17	Frame body
2	Screw M4*6	18	Adapter plate
3	Cable Bushing M8*1	19	Neck
4	Washer M8	20	Cover plate
5	Screw M5*10	21	Gasket
6	Screw M8*120	22	Cover screw
7	O-ring 12*1.5	23	Direction of flow
8	O-ring 31.42*2.62	24	Logo
9	O-ring 250*3	25	Type label
10	Receptable housing		
11	Cover		
12	Antenna assembly		
13	RF Unit assembly		
14	Interconnect Cable		
15	PT-100		
16	Antenna cable		

CMC-IT sensor – exploded view



CMC- IT specification

Part	Description	Part	Description
1	Cable Bushing M8*1	21	CMC IT body
2	Screw M5*10	22	Gasket
3	Lock ring	23	PT100 Adapter
4	Screw M5*20	24	CMC Cover Screw
5	Screw M4*6	25	IT Ring
6	Screw M5*50	26	IT Gasket
7	O-ring 12*1.5	27	Flat Gasket for Cover
8	O-ring 7*1.5	28	CMC Sensor Label
9	O-ring 14*1.5	29	CMC Device Label
10	O-ring 50.3*2.4		
11	O-ring 30*2		
12	Receptacle housing AMP 280359		
13	Cover		
14	CMC RF unit assembly		
15	IT Rear Antenna		
16	IT Front Antenna		
17	PT100 sensor assy		
18	CMC IT Front Antenna Cable		
19	CMC IT Rear Antenna Cable		
20	CMC IT Base		

9. Contact

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