ELECTRO-PNEUMATIC TANK LEVEL GAUGING AND DRAFT MEASURING SYSTEM

OPERATING MANUAL

MODEL: SML 1000D

March 2010

Revision date 31.3.2010

1. Introduction

1.1 General Description of SML 1000D

The Scanjet Macron SML 1000D is a microprocessor-controlled electro-pneumatic system for remote continuous online measurements of liquid levels in ship tanks, as well as for measuring ship drafts.

The system can also be used for detection and monitoring of water and other fluid ingress in dry compartments, voids and empty tanks.

The electro-pneumatic tank level measuring system consists of measuring piping and one or more cabinets with pressure sensors, flow controllers and necessary electronics for processing and displaying the measured tank pressures as tank levels.

There are no sensors or moving parts inside the tanks requiring tank entry.

Three different cabinet sizes available for the Scanjet Macron SML 1000D electro-pneumatic tank level gauging system –with max. 10, 20 or 30 gauge sensors in one cabinet for measuring pressures tanks, water ingress and drafts.

The different cabinet sizes allow for optimization and efficient distribution of the TLG system cabinets in larger systems, resulting in significant savings as fewer cabinets can be used (saved electronics etc.), and less piping material and work.

All cabinets should be located in easily accessible and safe area for service and check purposes. The cabinets have been designed to be user and maintenance friendly.

2. Operating SML1000D

2.1 Principle of Pneumatic Tank Level Measurements

All Scanjet Macron SML 1000D sensors are inside the system cabinets and mounted in racks. The maximum number of tank level gauging, water ingress detection and draft measuring sensors is 10, 20 or 30 depending on cabinet size. The sensors are gauge (breathing) type requiring normally no atmospheric compensation

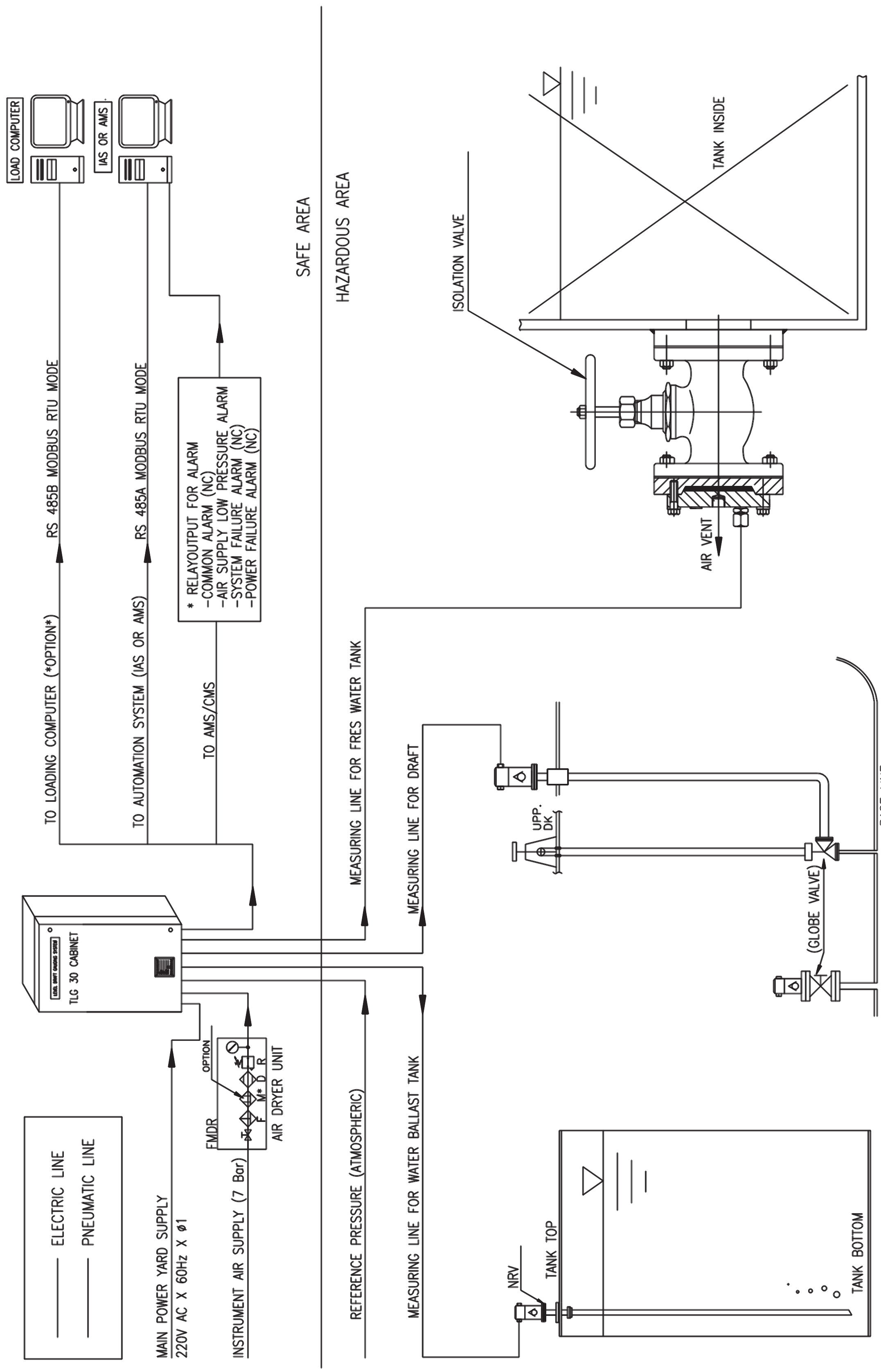
In addition, there may be two atmospheric reference absolute pressure sensors depending on the location of the cabinet. If there are significant pressure differences between outdoor pressure and pressure at cabinet location, then this air pressure difference must be considered when calculating the actual tank levels using the gauge sensors.

There is at least one measuring air pipe from the cabinet to inside every tank measured.

In case there is no manual sounding possibility for a tank, then two independent measuring pipes are required by the Authorities, or alternatively one other type of system, in the same tank.

2.2 Supply Air and Piping

SML 1000D utilizes dry and clean compressed air (instrument air). Based on our experience, we always deliver an air dryer with filter and air pressure regulator to secure the dryness and cleanness of the supply air.



General System Overview

The supply air inlet pressure is approximately 7 bar. The air pressure is reduced with the air pressure regulator to 4.5-5 bar. This eliminates any random pressure fluctuations caused by other consumers connecting and disconnecting to the supply air pipe.

The constant flow controller maintains the airflow constant in the measuring pipe to the tank irrespective of the counter pressure –with increasing tank pressure the air consumption increases as the flow remains constant.

The airflow may be set and adjusted with the screw in front of the airflow controller when necessary. In normal operation, the set value 0.5 Nl/min is recommended for empty tank condition.

The measuring air pipe from the cabinet to the tank side or top has OD 10mm, inside the tank the diameter is increased to OD 20mm (3/4”). The increase in diameter inside the tank is based on our experience showing that this eliminates fluctuations in the measured tank pressures (and thus calculated tank levels) during pumping and discharging operations.

The hydrostatic pressure changes when the fluid level increases or decreases, and sensors record changing tank levels and filling/discharging rates.

By measuring the hydrostatic counter pressure, accurate tank pressures and levels in water ballast tanks, heavy fuel oil, marine diesel oil and various other tanks can be obtained. The same applies to water and fluid ingress detection and monitoring.

The low end of the measuring pipe inside the tank should be as close as possible to the bottom for accurate tank level readings with low tank filling, because it is not possible to create hydrostatic counter pressure with air bubbling below the lower pip end. Consequently, there may be some fluid in the tanks, even if the remote tank level gauging system shows that the tank is empty.

Typically, this distance (offset) is 50-100 mm. The lower end of the pipe should also be sniped at 30^{O} angle for consistent measuring air escape at tank bottom.

For fresh water and some special fluid tanks (wine, edible oils etc.) it is not accepted to use air in the tank because of health reasons (bacteria etc.), or because of chemical reactions caused by oxygen. For these tanks, a pneumatic 1:1 pressure converter is used for measuring the hydrostatic pressure inside. The pneumatic 1:1 pressure converter should be located as close to the bottom as possible.

The Scanjet Macron SML 1000D is self-cleaning because the instrument air is always flowing through the pipes, even when the tanks are empty. As a result, the air pipes stay clean of any sediments even if their low ends are close to the tank bottom.

Every flow controller has a built in by pass feature allowing purging of blocked pipe with full line pressure. By turning the knob on the flow counter clockwise, the purge is opened for the tank and closed by turning clockwise.

2.3 Non-return Valves and Shut-off Valves

The Scanjet Macron SML 1000D has three different non-return valve arrangements for the protection against accidental fluid backflow through measuring lines from tanks, void spaces and drafts.

For every measuring line, there is a built-in non-return valve in the constant flow controller module hindering any backflow of fluid into the cabinet in case supply air pressure is lost.

There is also an air pressure control switch in every cabinet, which closes should the supply air pressure drop below 0.3 MPa, keeping air pressure in the cabinet and the pipes hindering backflow. The switch is automatically opened when the supply air pressure exceeds 0.35 MPa.

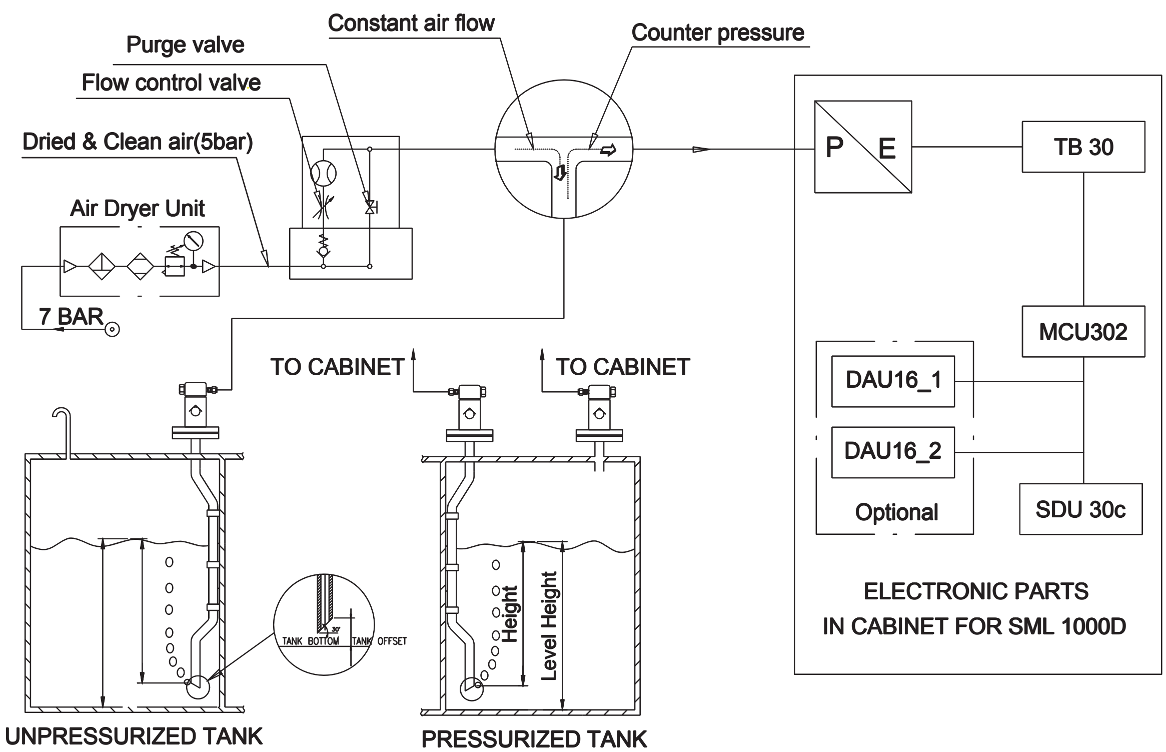
Depending on type and location of the tank, non-return valves are fitted at the tank side or the tank top to prevent backflow from tanks in case the air pressure is lost.

In case the Scanjet Macron SML 1000D cabinet is installed below main deck and tank air vent pipe heads, we recommend that also that high located water ballast tanks such as fore peak and top wing tanks are fitted with non-return valves hindering any backflow of ballast water.

The non-return valves at tank side and top are gravity loaded and the housing with float must be installed in vertical position in order for the float to function properly.

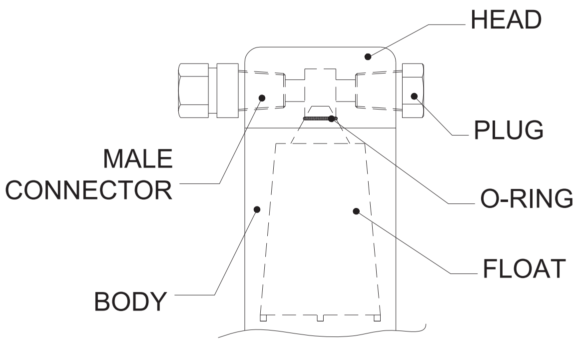
For fuel tanks, side penetrations must be fitted shut-off valve according to safety regulations. We recommend installing non-return valves for these tanks as a safety precaution against accidental spray of fuel oil on hot surfaces, or oil spill in the engine room in case the measuring air pipes are accidentally damaged.

Every draft measuring point is fitted with non-return valve after the globe shut-off valve in order to hinder seawater from entering to the ship through draft measuring openings should the draft measuring pipe be accidentally ruptured or broken.

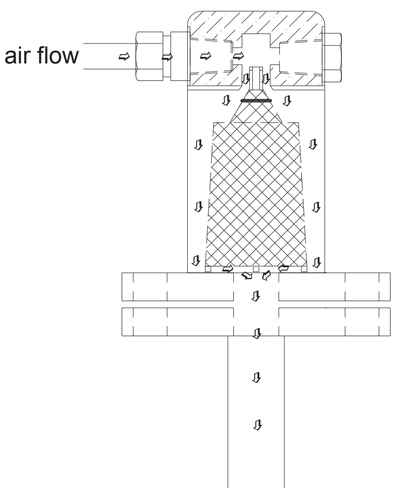


General system overview for pneumatic principle

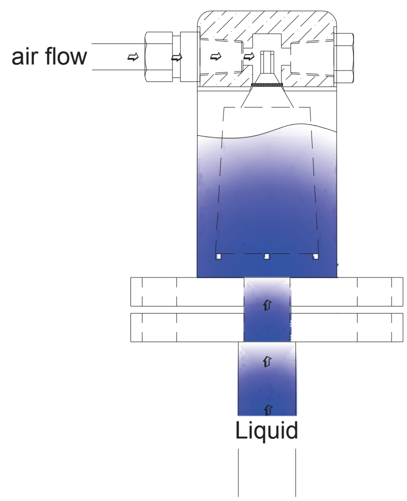
STRUCTURE OF NRV - FS , NRV -FE , NRV-NF



A. How Air Flow in NRV



B. How Water Flow in NRV



All NRVs are constructed in the same way, except for the tank connection, which can be a flange connection or threaded. Also 90^{O} bended NRV construction is available.

- Maximum working pressure: 0.5MPa
- Connection size for yard copper tube: OD10mm or OD8mm
- Method: plastic floater with O-ring

NRV-FS: Non return valve straight type with flange
NRV-FE: Non return valve elbow type with flange
NRV-NS: Non return valve inner threads type without flange

The head of NRV can be disconnected from the body for replacing O-ring by turning counterclockwise direction.

The float moves upwards with the tank level, closes the air supply line, and prevents any back flow of fluid.

Leakage can possibly occur from male connector, plug, head connection or tank connection.

2.4 Tank Level Calculations

The electro-pneumatic tank level and draft measuring system measures continuously online the hydrostatic counter-pressure in tanks and voids spaces and the hydrostatic sea pressure for drafts.

All sensors are located in the cabinet(s) in safe area. The tank levels are calculated in the main control unit from the measured pressures considering the pipe resistance, the distance from tank measuring pipe to inside the bottom and the fluid densities.

The atmospheric pressure compensation depends on the type of sensor and the measured difference between weather deck atmospheric pressure and local cabinet pressure.

2.4.1 Level Calculations for Unpressurized Tanks - Gauge Sensors

Water ballast, fuel oil, lubrication oil, and fresh water tanks are unpressurized tanks that have open-air vent pipes, and should hence not in general contain any gases such as nitrogen or inert gas.

In some double hull oil tankers, inert gas is used in ballast tanks. This type of tanks are pressurized and have pressure release valves– see 2.5 for tank level calculation in pressurized tanks.

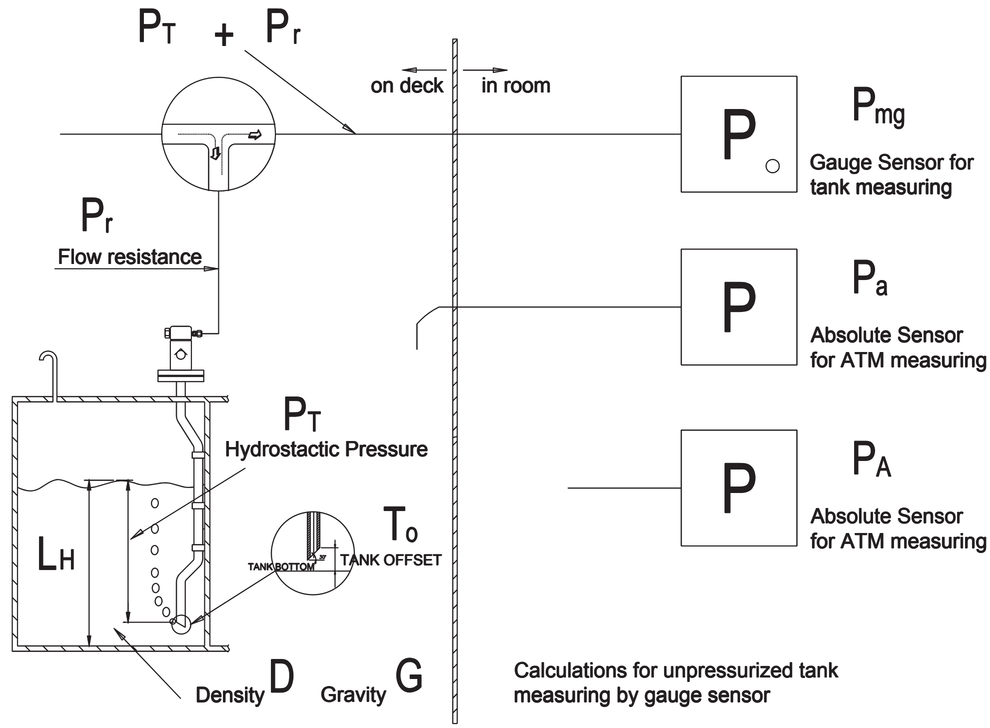
The actual hydrostatic counter pressure from fluid in unpressurized tanks is measured using gauge type pressure sensors (self-breathing). The tank levels displayed on the service display unit (SDU30c) are calculated in the SML 1000D by using below formulae:

Hydrostatic pressure $P_T = P_{mg} - (\Delta P_D - P_r)$
To be added ΔP_D in case $P_A < P_a$, $P_T = P_{mg} + (\Delta P_D - P_r)$
To be subtracted ΔP_D in case $P_A > P_a$, $P_T = P_{mg} - (\Delta P_D - P_r)$
Height $h = P_T$ (mbar) * conversion factor (0.010197162)
Level Height $L_H = (h / D) + T_o$

Below formulae can be used for same results
Hydrostatic pressure $P_T = P_{mg} - (\Delta P_D - P_r)$
Level Height $L_H = (P_T / D * G) + T_o$
The symbols used in above formulae are given in Table 1.

Table.1. Definition of symbols

Tank offset – distance of measuring pipe end from tank bottom	m	T_o
Density of liquid in tank	kg/m^3	D
Air flow resistance in measuring pipe	mbar	P_r
Tank level height	m	L_H
Tank height without density D, and offset To	m	h
Hydrostatic counter pressure in tank	mbar	P_T
Measured pressure acting on gauge sensor	mbar	P_{mg}
Measured pressure acting on absolute sensor	mbar	P_{ma}
Saved cabinet ATM reference pressure value at zero calibration	mbar	P_A
Pressure reading in real time for inside cabinet	mbar	P_a
Difference pressure $\Delta P_D = P_A - P_a$	mbar	ΔP_D
Saved weather deck ATM reference pressure at zero calibration	mbar	P_{AO}
Saved tank measurement pressure as absolute sensor at zero calibration This symbol only is used in calculation when tank measuring sensor is absolute sensor type	mbar	P_{ao}
Difference pressure ; $\Delta Pd = P_{AO} - P_{ao}$	mbar	ΔPd
Gravity acceleration (9.80665 m/s^2)	m/s^2	G



Note! In general, the atmospheric pressure outside on the weather deck, and inside the ship near the SML 1000D cabinet that are almost the same, and no atmospheric compensation is hence needed for the gauge tank level sensors ($\Delta P_D = 0$).

2.4.2 Tank Level Calculations for Unpressurized Tanks - Absolute Sensors

The formulae below is applied for absolute sensors

Hydrostatic pressure $P_T = P_{ma} - (\Delta Pd - P_r)$

To be added ΔP_D in case $P_{AO} > P_{ao}$, $P_T = P_{mg} + \Delta Pd - P_r$

To be subtracted ΔP_D in case $P_{AO} < P_{ao}$, $P_T = P_{mg} - (\Delta Pd - P_r)$

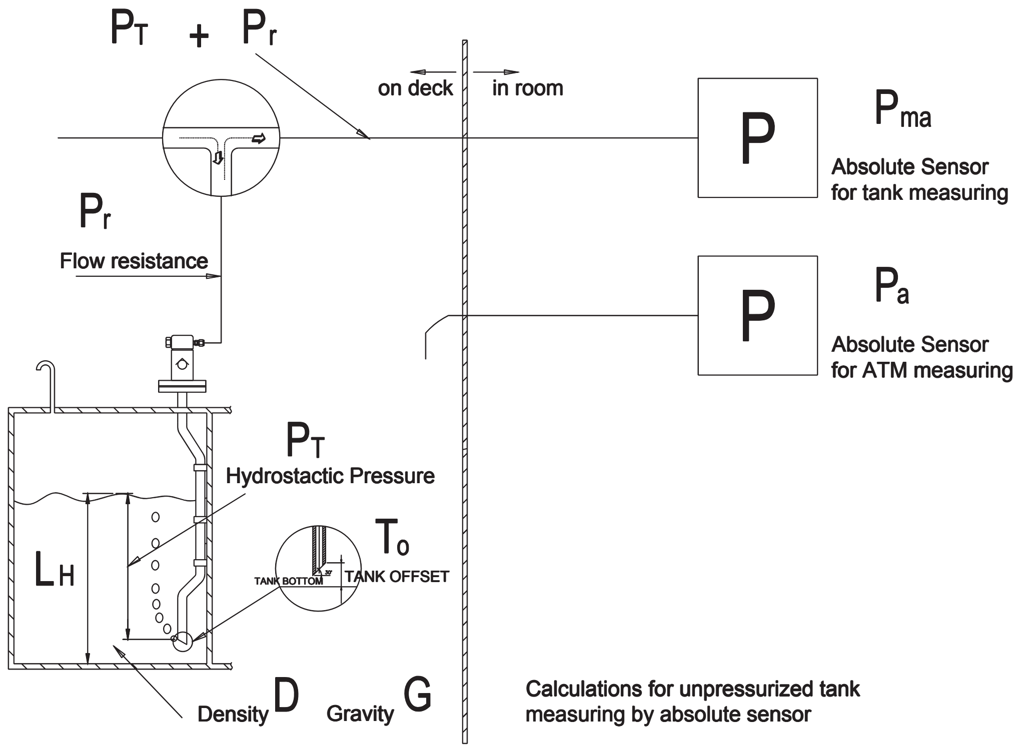
Height h = P_T (mbar) * conversion factor (0.010197162)

Level Height $L_H = (h / D) + T_o$

Below formula also can be used as same results

Hydrostatic pressure $P_T = P_{ma} - (\Delta Pd - P_r)$

Level Height $L_H = (P_T / D * G) + T_o$



2.4.3 Approximate Tank Level Calculations using Pressure Instrument

The SML 1000D measures continuously the actual tank pressures online.
In case the air supply is lost, there will still be pressure in the measuring pipes, because the air pressure switch inside the cabinet and the non-return valves inside the flow controllers will close when supply air pressure drops.

The tank levels are then calculated as described in 2.4.1 and 2.4.2 respectively until the air supply is restored.

In case the power supply is lost because of ship general electrical blackout or other similar reason, then the tank levels are not calculated and shown in the SML 1000D (unless the tank level gauging system has been supplied with an emergency generator and compressor unit for supply air).
However, the tank pressures can still be measured with a pressure instrument for every tank measuring line from the tank level gauging system cabinet as described below.

Following factors provide approximate values for tank pressure conversion into level height.

To	bar	mbar	kPa
mH_2O	10.197162	0.010197162	0.10197162

For example:

1. The pressure instrument reading is 1068 mbar
2. To convert: 1068 mbar * 0.010197162 = 10,890 mH_2O
3. If the tank offset, the fluid density, and the flow resistance are known, these can be applied to obtain a more accurate tank level.
   Tank offset: 0.1m, Density: 1.025 kg/m^3 and Flow resistance: 3 mbar

   Level Height = (((1068 mbar – 3 mbar) * 0.010197162) / 1.025) + 0.1 m
   = 10.695 mH_2O

Note! ATM reference pressure is disregarded in above calculation

2.5 Tank Level Calculations for Pressurized Tanks

Most pressurized cargo tanks should have nitrogen or inert gas for protection against explosion.

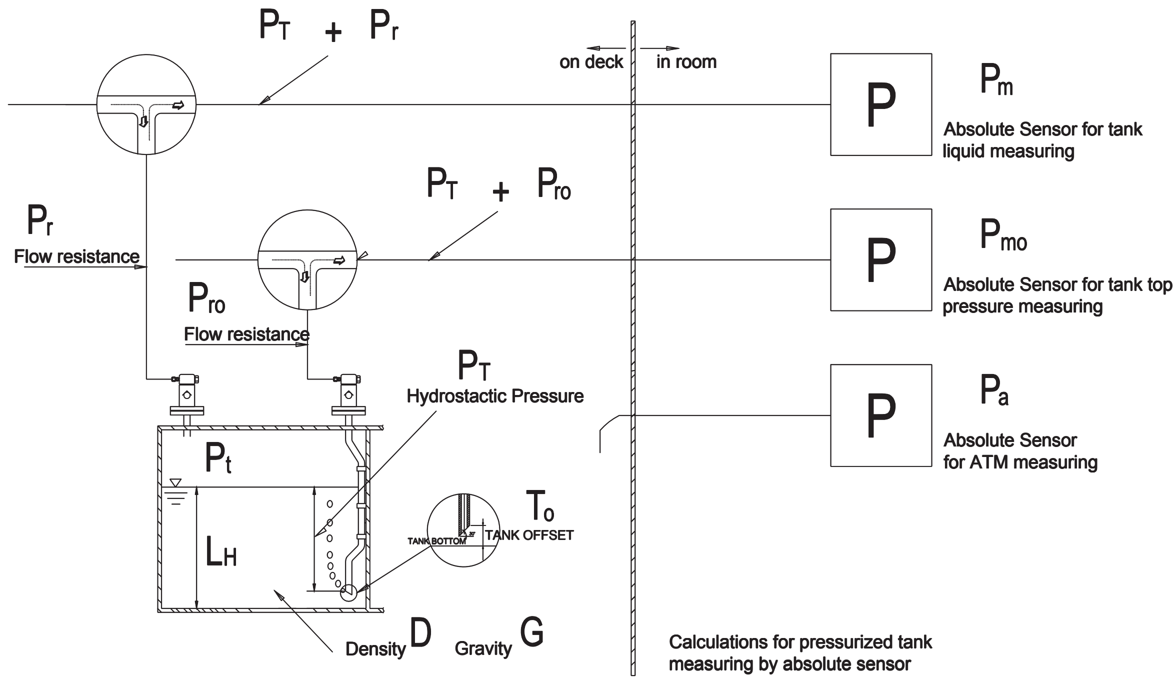
The actual hydrostatic counter pressure from fluid in pressurized tanks is measured using absolute type pressure sensors (vacuum).

The tank levels displayed on the service display unit (SDU30c) are calculated in the SML 1000D by using below formulae:

Measured pressure	$P_{ma} = P_T + P_t + P_r$
Measured pressure	$P_{mo} = P_t + P_{ro}$
Tank Top pressure	$P_t = P_{mo} - (\Delta Pd - P_{ro})$
Hydrostactic pressure	$P_T = P_{ma} - (P_t - \Delta Pd - P_r)$
Level Height	$L_H = (P_T / D * G) + T_o$

Table 2. Definition of Symbols

Tank offset – distance of measuring pipe end from tank bottom	m	T_o
Density of liquid in tank	kg/m^3	D
Air flow resistance for measuring pipe in liquid	mbar	P_r
Air flow resistance for measuring pipe in tank ullage space	mbar	P_{ro}
Tank level height	m	L_H
Tank height without density D, and offset To	m	h
Hydrostatic counter pressure in tank	mbar	P_T
Tank ullage pressure – in air above the liquid surface	mbar	P_t
Measured pressure for tank liquid	mbar	P_{ma}
Measured pressure for tank ullage pressure	mbar	P_{mo}
Saved cabinet ATM reference pressure value at zero calibration	mbar	P_A
Actual ATM pressure at the time of measurement for inside cabinet	mbar	P_a
Difference pressure $\Delta P_D = P_A - P_a$	mbar	ΔP_D
Saved weather deck ATM reference pressure at zero calibration	mbar	P_{AO}
Saved tank measurement pressure as absolute sensor at zero calibration	mbar	P_{ao}
Difference pressure ; $\Delta Pd = P_{AO} - P_{ao}$	mbar	ΔP_d
Gravity acceleration (9.80665 m/s^2)	m/s^2	G



2.6 Air Flow Controller – Pneumatic Units

For every measuring line there is a flow controller unit inside the SML 1000D cabinet. The air flow controller unit consists of following components:

(1) Purge Valve, (2) Flow Control Valve, (3) Air flow indicator, (4) Air filter , (5) Fiber dry,

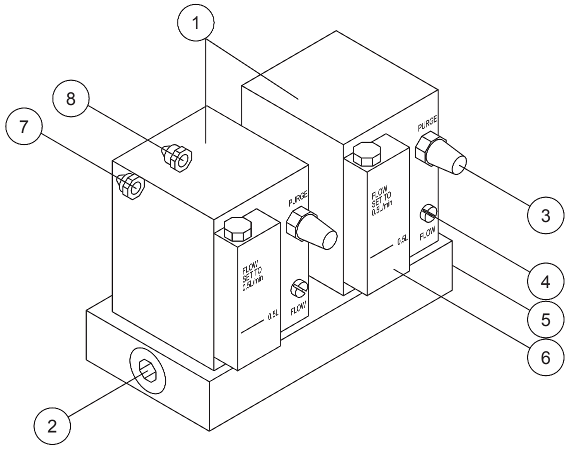
(6) Air Regulator, (7) Upper part of modulator (Air flow controller), and (8) Lower part of modulator (Manifold), see figure on the next page.

2.6.1 Constant Air Flow Controller and Purging Valve

The constant air flow controller includes a check valve in the manifold and a purge valve, a constant flow control valve, flow indicator, and two barb fittings in the upper part.

The instrument air will flow through the check valve. A spring will push the valve to close when the inlet working pressure is less than 0.3 MPa.

The flow adjustment screw in front of the controller is used to set the constant air flow to the tank for optimum measuring conditions.



No.	DESCRIPTION
1	UPPER MODULATOR
2	REGULATED/DRIED AIR INLET
3	PURGE VALVE
4	FLOW CONTROL VALVE
5	LOWER MODULATOR (MANIFOLD)
6	FLOW INDICATOR
7	CONSTANT AIR OUTLET FOR SENSOR
8	CONSTANT AIR OUTLET FOR TANK

The air flow screw on the front of the air flow controller will regulate the air flow rate in the pneumatic measuring line. The set air flow rate is adjusted to increase/decrease by turning the screw counterclockwise/clockwise.

The air flow indicator shows the actual air flow in the measuring pipe.

It is recommended that all air flow adjustments are carried out to show same air flow rate of approximately 0.5L/ min on the air flow indicator. The air flow can be adjusted from 0.2L ~ 1.0L / min.

Air purging is used for testing and cleaning tank and draft measuring pipes. The purge valve is opened turning the knob counterclockwise and closed clockwise.

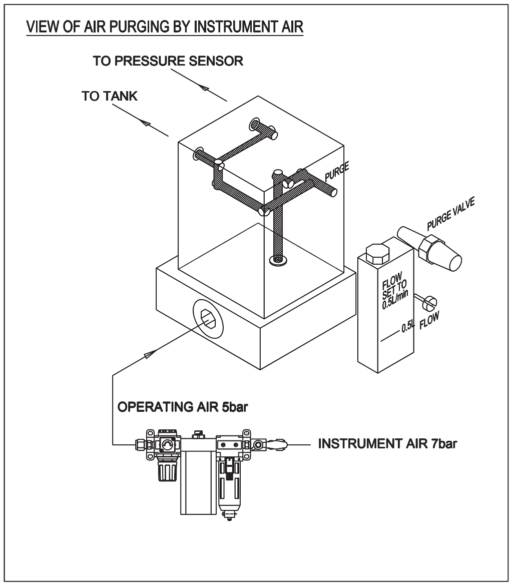
During purging, the airflow controller is bypassed by opening purge valve knob, and high pressure supply air enters the measuring line to tank directly.

The purge valve must always be kept closed when tank levels and drafts are measured.

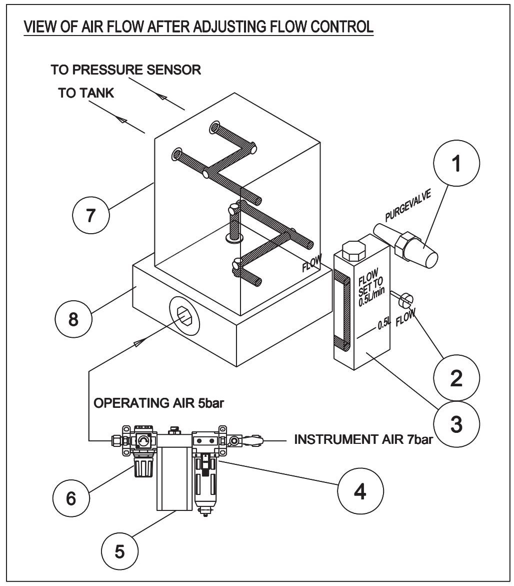
In case the valve is partly open or has a leakage, the tank level shown on the LCD will be higher than the real tank level. The leakage will result in pressure drop in the measuring line, and the air flow must increase in the tank measuring pipe to match the hydrostatic counter pressure. Consequently the pressure acting on the sensor will be higher and the level shown will be higher.

When purging, the tank level will show more than the real tank level because the 5 bar purge pressure is directly acting on the sensor.

In case the measuring line is clogged, this can be opened in most cases by purging at high/full supply air pressure 5 or 7 bar.



(A)



(B)

Air purging flow in air flow controller (A)

Prior to commissioning, the measuring lines should be blown free of any dirt and moisture by opening purge valve knob (1) counterclockwise.

The compressed air will go through the purge valve to the connected pressure sensor and to the tank bottom when the purge valve is opened.

During purging, the tank level will indicate full range or more because the compressed pressure air is acting directly on the pressure sensor.

When finished purging, the purge valve must be closed completely by turning the valve knob clockwise. After a few seconds, the present actual level measuring result will show on the LCD.

Air flow during tank level and draft measuring (B)

The constant air flow is controlled by the air flow control valve (2), which is mounted on the front side of the air flow controller unit.

The constant air flow rate can be different in each tank depending on the length of the measuring pipe.

The air flow rate adjustment must be done when there is no counter pressure in the tank so that the correct measuring pipe flow resistance is obtained.

2.6.2 Adjusting Constant Air Flow

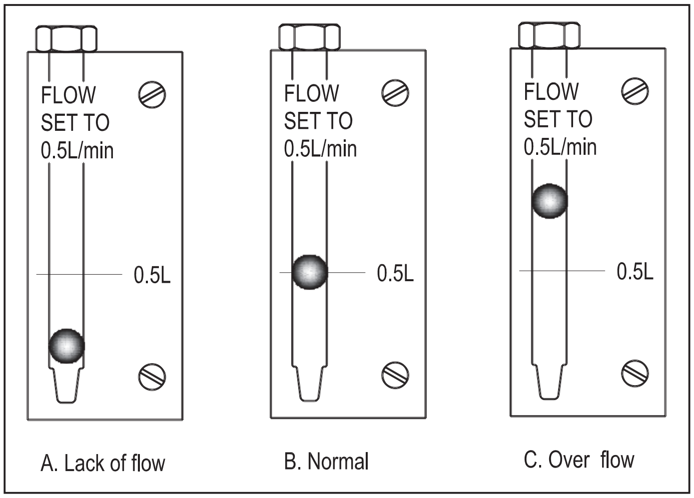
It is important to ensure that the following conditions have been checked before adjusting the constant air flow rate.

Make sure that:

- the stop valve (6) is open
- the pressure gauge (7) on air dryer unit shows 5 bar after it has been regulated
- the purge valve (2) on the unit is closed completely.
- if the flow control valve (4) is completely closed, the black ball is at the bottom
- the tank is empty. If not, the measuring line must be disconnected from the non-return valve to measure correct flow resistance.
- in case there is a counter-pressure in the line, the value of flow resistance is much higher than expected. It means that the level calculation will be wrong.

When everything above is checked and done, the constant air flow can be adjusted and then air flow resistance also measured by shown on the display unit SDU 30c at the same time.

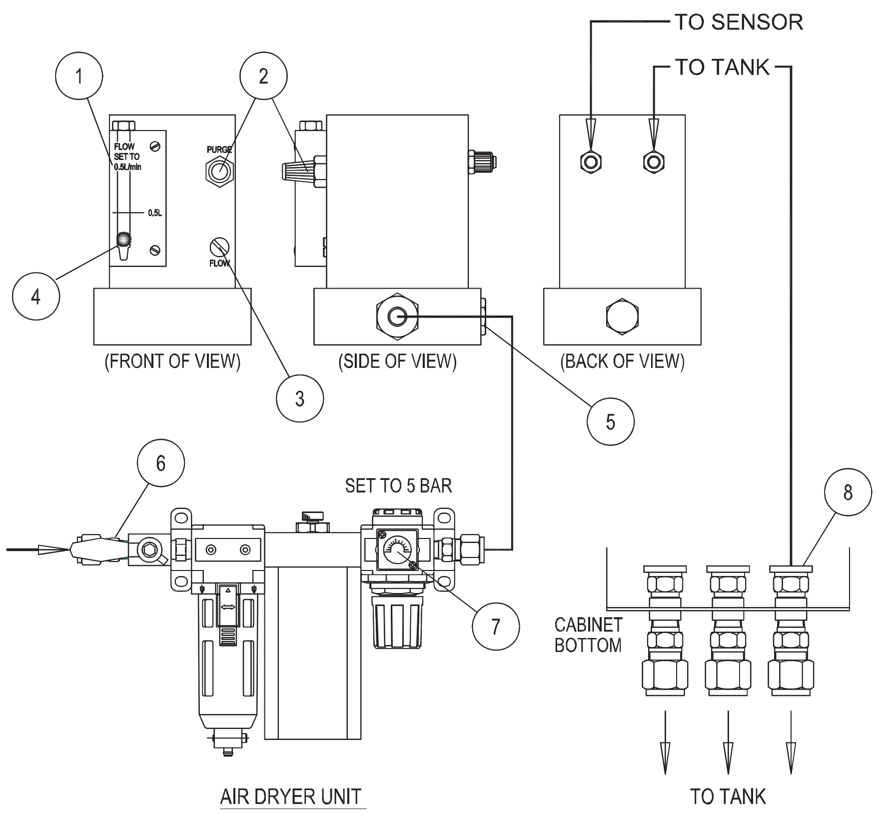
It is recommended to set the ball position at 0.5 L/min using the flow control valve when the above conditions are met.



If tank liquid filling/unloading rate is low, the airflow rate can be decreased manually from B condition. Then the normal air flow setting will be below 0.5L/min line on the air flow indicator.

If the tank filling and unloading rate is higher than the measuring result update rate (e.g. updating speed for tank level on LCD), then the airflow can be increased to be above the 0.5L/min as in figure C.

Warning!
If the flow rate for one of the tanks is adjusted upwards or downwards after commissioning, the measuring pipe flow resistance must be measured again in empty tank for correct compensation of the measured tank level, because the measuring pipe resistance is dependent on the actual flow rate. If not the pipe resistance is measured again for new air flow value, then the tank levels calculated will be wrong!



NO	DESCRIPTION
1	FLOW INDICATOR
2	PURGE VALVE
3	FLOW CONTROL VALVE
4	BALL
5	INTERNAL CHECK VALVE (NON RETURN VALVE)
6	STOP VALVE
7	PRESSURE GAUGE ON AIR REGULATOR
8	ONE TOUCH FITTING IN THE BOTTOM OF TLG CABINET

2.6.3 Air Purging Procedure

The SML 1000D is an electro-pneumatic tank level and draft measuring system operating at an air pressure of 4.5-5 bar. Because the system is continuously blowing air at a constant flow rate of 0.5L/min also into empty tanks, the system is self-cleaning even when the low end of the measuring pipe is close to the tank bottom, where sediments are found in ballast water tanks.

In case the tank level gauging system is completely shut down, like during dry-docking, there might be some sediments at, or even inside the lower end of the measuring pipe. If the measuring pipe from the cabinet to the tank is disconnected either from the non-return valve or at the cabinet, sediments may enter in the measuring pipe because there will be no air pressure in the measuring pipe after disconnecting.

These sediments may be removed by opening the purge screw on the air flow controller for the measuring pipe in question. Usually this 5 bar pressure sufficient to open the clogged measuring pipe. In case the pipe remains clogged after purging at 5 bar, then full 7 bar may be used by increasing the air flow to full at the air pressure regulator.

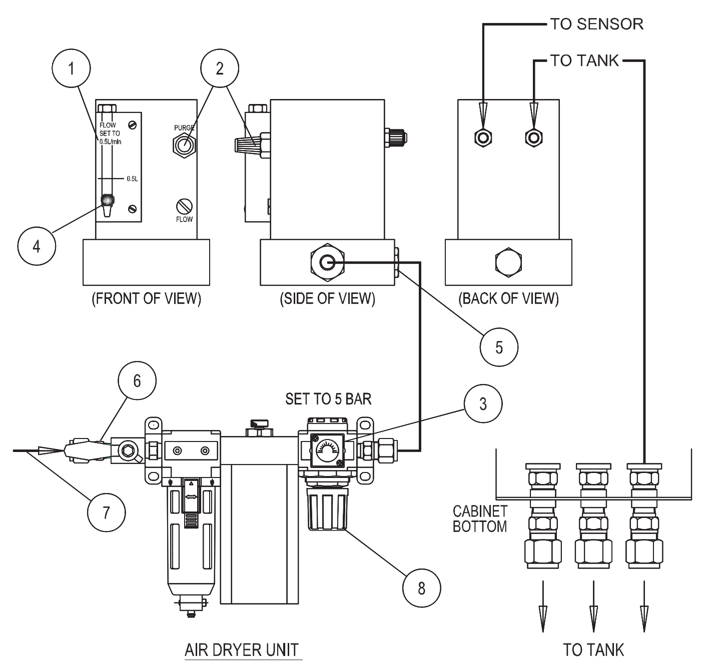
<u>How a clogged measuring line is detected?</u>

The clogging is easily observed, because the tank level increases/or decreases even when no pumping is carried out.

- The tank level increases slowly to full height.
- The flow indicator ball moves gradually towards bottom from original setting.
- The same results are obtained if the measuring pipe is pressed together or bent severely somewhere between the cabinet and the tank. The condition of the measuring pipe should be checked to find possible damage.
- If none of the above applies, then there may be a problem with the purge valve.

<u>How to purge a measuring pipe?</u>

1. Open the purge valve (2 in the figure below) by turning the knob on the air flow controller counterclockwise to purge the measuring line at 5 bar pressure.
2. Let the purge valve be open for 1-2 minutes.
3. Close the purge valve by turning it clockwise until it is closed.
4. The flow rate indicator ball should now show 0.5 L/min.
5. If the ball is not at 0.5 L/min, repeat the procedures 1-3 above 1-2 times.
6. In case the ball after the above is not at 0.5 L/min, proceed as below
7. Increase the pressure from 5 bar to 7 bar by turning air pressure regulator (8)
8. Check that pressure gauge (3) shows 7 bar
9. Open the purge valve (2) on the air flow controller
10. After purging, reduce the air pressure back to the normal working pressure 5 bar



NO	DESCRIPTION
1	FLOW INDICATOR
2	PURGE VALVE
3	PRESSURE GAUGE
4	BALL
5	INTERNAL CHECK VALVE (NON RETURN VALVE)
6	STOP VALVE
7	AIR SUPPLY PRESSURE 7BAR
8	AIR REGULATOR ADJUSTING KNOB

What if purging does not open the measuring pipe in the tank?

This is a very rare situation, which we have not observed during our 20 years of experience from electro-pneumatic tank level gauging on some 3500 ships.

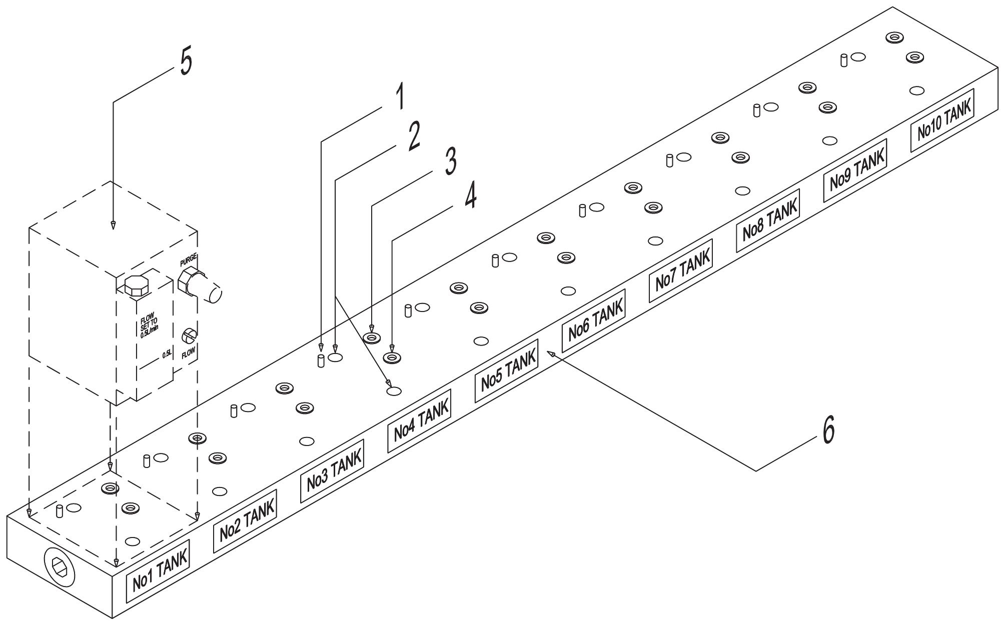
For such a problem, we propose to remove the non-return valve at the tank top or the tank side and to insert into the measuring pipe a steel wire long enough to reach the bottom. Pulling and pushing this steel wire up and down should remove any dried mud or similar in the measuring pipe.

After this manual wire cleaning, connect the non-return valve and check that the air flow indicator ball is at 0,5L/min. Additional purging may be needed to remove remaining loose sediments in the measuring pipe.

2.6.4 Manifold

As standard, 10 air flow controllers can be connected to one manifold. It is also possible to install fewer air flow controllers to the manifold. Then a block plate should be mounted to cover the unused flow controller positions.

1. Hole of position pin
2. Threads for tighten upper and lower part each other
3. Penetration hole for constant air flow, which is connected to a flow control valve and is sealed by O-ring
4. Penetration hole for air purging line and seal between two parts by O-ring
5. Air flow controller
6. Manifold block



2.7 Air Dryer Unit

The instrument air from the air receiver should be dry and clean. However, experience shows that this is not always the case onboard, especially not for older ships where the compressors may leak oil into the instrument air.

Consequently, Scanjet Macron always includes an air dryer unit in the standard SML 1000D system scope of supply.

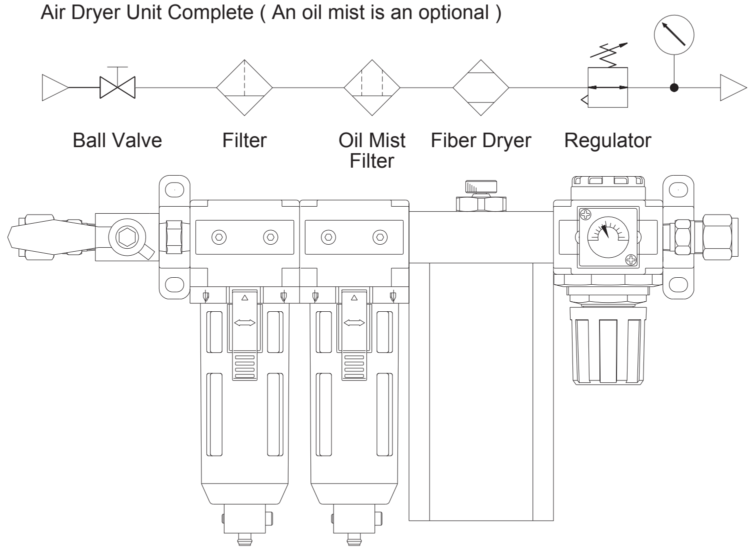
The air dryer unit is always mounted outside the cabinet(s).The air dryer unit consists of a shut-off valve, an air filter, a fiber dryer, and an air pressure regulator as standard supply. An oil mist filter can be added (option), which is installed between the air filter and the fiber dryer as shown below.

The air pressure regulator reduces the supply instrument air pressure from about 7 bars down to 5 bars for steady air flow.

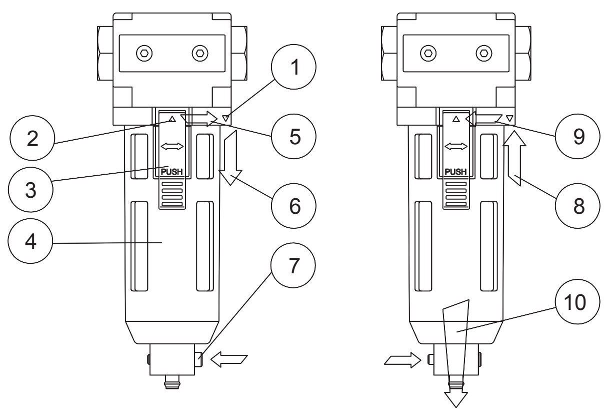
The drainage from air filter is not automatic. Section 2.7.1 shows how to drain the filter manually.

How often manual draining should be done depends on the air quality from air receiver, and must be considered based on experience gained onboard.

Air Dryer Unit Complete (An oil mist is an optional)



2.7.1 Air Filter and Optional Oil Mist Filter



<u>Cleaning and Replacing Instructions</u>

The bowl (4) should be removed for cleaning and replacing the filter element according to following procedure:

1. Close the supply air with the shut-off valve in order to eliminate the existing pressure in the bowl
2. Make sure that the mark "▲" (2) on the lever of locker and the mark "▼" (1) on the body.
3. Turn the bowl (4) while pushing the locker lever (3) in arrow (5) direction (counterclockwise) until a mark (2) sets to another mark (1)
4. Pull the bowl (4) downward in (6) direction
5. If the bowl needs cleaning, please use a neutral detergent. No alcohol or thinner should be used!
6. The filter element needs to be cleaned or replaced if the supply instrument air pressure drop is equal to or more than 0.07 MPa.
7. After cleaning or replacing the filter element, the bowl (4) must be assembled by reversing the above procedure.

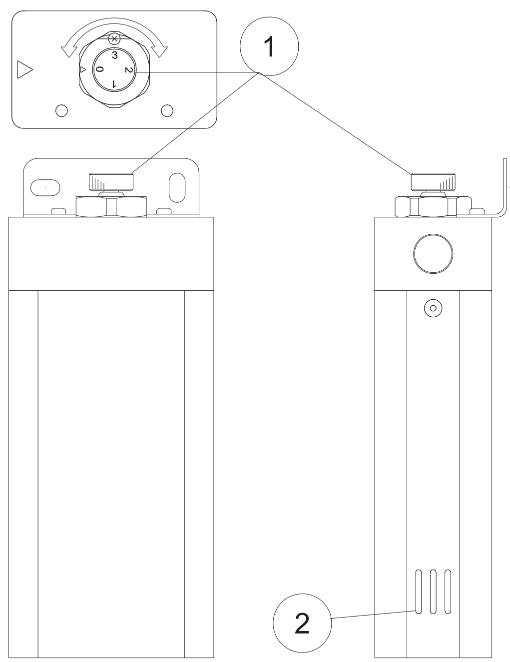
There are three different types of filters, which can be used depending on the supply air quality.

Name	Filtration capacity	Pressure drop ≥ 0.07 MPa	Scope of supply
Air filter	5 µm	Re-usable after cleaning	As standard
Mist filter	0.3 µm	To be replaced	Optional
Micro-mist filter	0.01 µm	To be replaced	Optional

Draining
Push the cock (7) in the bottom of the filter manually towards left and filter is drained as shown in (10).
After draining is finished, the cock (7) must be pushed towards right (original position).
Please refer to the commissioning and service manual for how to replace the filter element.

2.7.2 Air Fiber Dryer

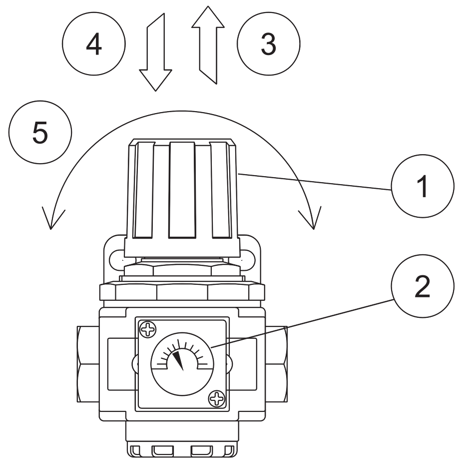
The compressed humid air enters the air fiber dryer, and flows into the hollow tube in the casing of the fiber air dryer.



Operating Instructions
1. On the top of the unit, there is an adjusting dial (1) for adjusting the purging air rate, which be set from 1 (low) to 3 (max).
2. The flow rate capacity is 80 L/min with dial set at 1. This means that one fiber dryer unit is enough for 60 measuring points at the same tank.

2.7.3 Air Flow Pressure Regulator

Operating Regulator



The air flow pressure regulator set to 0.5 MPa when the SML 1000D system is delivered and commissioned.

<u>Adjusting the Supply Air Pressure</u>

There is no need to adjust the supply air pressure except in case of purging with 5 bar is not enough to clean the clogged measuring pipe.

<u>To use full 7 bar supply air pressure for purging do following:</u>

1. The pressure gauge (2) shows the present air pressure and this pressure can be changed by turning the adjusting knob (1).
2. Unlock the knob by pulling up (3) before turning.
3. The pressure increases by turning the knob clockwise, and drops when turning counterclockwise.
4. After adjusting, lock the knob by pushing it down again.

2.8 Pneumatic 1:1 Converter

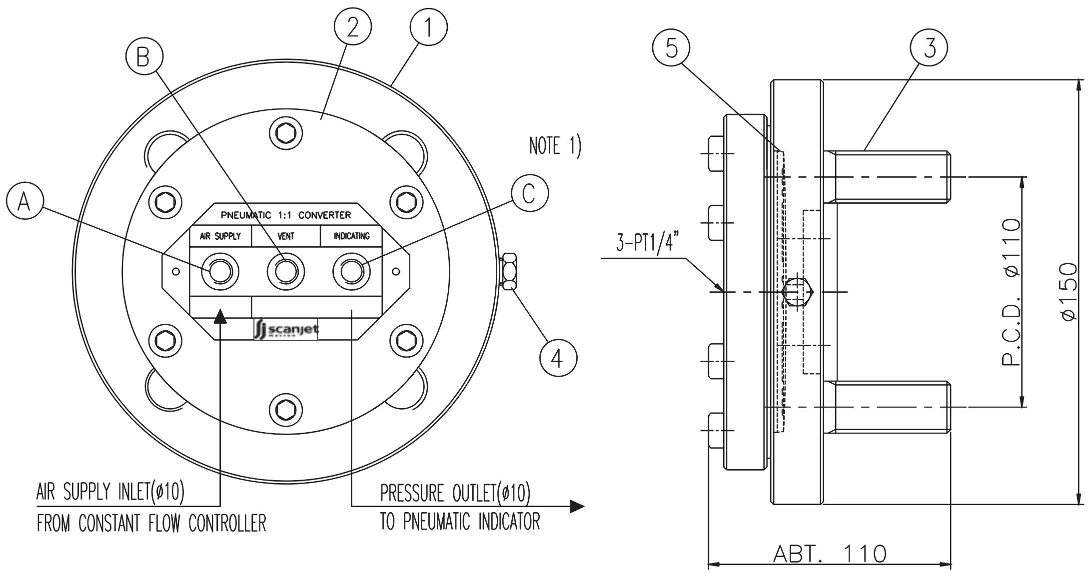
To measure the hydrostatic pressure in tanks where air bubbling is prohibited, such as fresh water tanks and potable water tanks, the pneumatic 1:1 pressure converter can be used.

The pneumatic 1:1 pressure converter is installed outside the tank as low as possible to tank bottom. It is connected to the cabinet with one measuring pipe and with a pipe to free air.

Before installation of the pneumatic 1:1 pressure converter, the measuring pipe must be blown clean by using compressed air to remove any dust/dirt inside of pipe before connecting the line to the converter.

If there is dust/dirt on the membrane surface in the converter, it will not show accurate measuring results.

The pressure converter must be stored indoors well protected from dust and moisture before installing onboard the ship.



NO.	DESCRIPTION	SIZE	MAT'L	Q'TY	REMARK
1	MOUNTING FLANGE	PN10 DN40	SUS304*	1	JIS 10K-50A
2	BODY		BS	1	
3	STUD BOLT	M16	SUS304*	4	
4	TEST PLUG for TANK		SUS304*	1	
5	MEMBRANE		RUBBER	1	
6	VENT CONTROL V/V		BS/PC	1	

Note! There are three connections (A, B, and C) in front of the converter as shown in the figure above.

The air pipe from the SML 1000D cabinet is connected to A. Connection B (air vent) breathes freely into the atmospheric air. The connection "C" should be plugged if there is no local pneumatic level indicator.

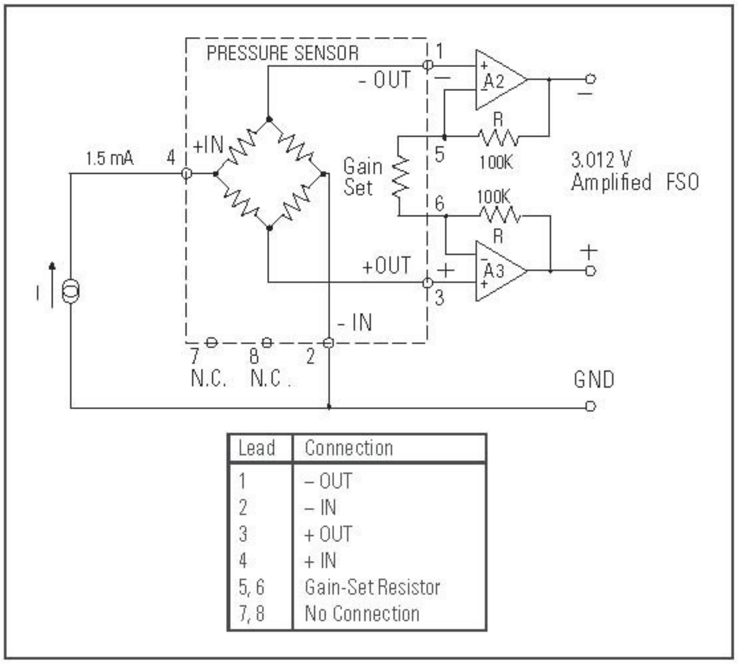
2.9 Sensors

The tank fluid creates a hydrostatic counter pressure against the air flowing out from the measuring pipe end inside the tank. The draft sensors measure the hydrostatic counter pressure measured from the sea level down to the location of the draft measuring point.

The hydrostatic pressure acts on the silicon pressure sensor, which has an overload capacity of 3 times full scale. Every gauge sensor has ion implanted piezoresistive strain gauges in a Wheatstone bridge configuration using micromachining techniques.

The piezoresistive sensor registers the hydrostatic pressure as a resistance change, which is then converted into a voltage from 0-100mV corresponding to the actual hydrostatic pressure. This voltage is amplified by the sensor card to an output signal of 0.4V to 3.6V (or 4-20 mA for analog version) and is compensated for offset, sensitivity, temperature drift and nonlinearity.

The piezoresistive sensor is more accurate and less susceptible to zero setting drift etc. than a piezoelectric sensor. The piezoresistive sensor in SML 1000D is also temperature compensated for 0^{O} C to + 60^{O}C contributing to improved performance.



Piezoresistive pressure sensor with signal amplification

Selecting the sensor measuring range

The SML 1000D has two measuring ranges for the tank and draft sensors. The sensor range is selected based on the actual height of each tank and the ship's draft as obtained from the tank tables.

NOTE! Please make sure you select correct sensor range for each tank and draft measuring sensor if you need to replace a defect sensor!

Selecting a sensor with big measuring range for a low tank will result in less accurate measurement of the hydrostatic pressure inside the tank, and consequently the calculated tank level displayed will not be as accurate when compared with a sensor with small range.

Selecting a sensor with small measuring range for a deep tank will result in wrong measurement for pressures at higher tank levels, i.e. for levels above the sensor range.

Different sensor types and maximum sensor measuring ranges for SML 1000D

Name	Pressure Range	Applicable tanks
GSB 30	0 – 21.092 mH2O, gauge	Except pressurized tank
GSB 50	0 – 35.153 mH2O, gauge	Except pressurized tank
ASB 30	0 – 21.092 mH2O, absolute	All of tanks
ASB 50	0 – 35.153 mH2O, absolute	All of tanks

2.9.1 Gauge Pressure Sensors

The gauge pressure sensor measures relative pressure, i.e. the actual hydrostatic pressure in the unpressurized tank directly, because the gauge sensor is self-breathing.

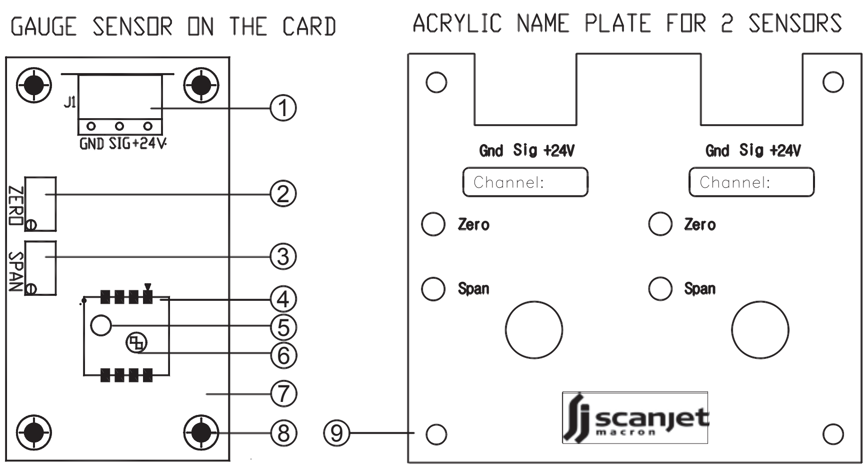
Self-breathing means that the atmospheric air pressure at the location of the cabinet acts on the other side of the membrane, and the tank pressure, which consists of the hydrostatic pressure and the atmospheric air pressure on the weather deck on the other.

As the local air pressure in the cabinet and the air pressure on the weather deck are in most cases almost the same, the measured tank pressure is equal to the hydrostatic pressure.

In case the cabinet is located in an area with strong local air pressure variations, such as on car decks with heavy fans starting and stopping resulting in air pressure variations, also the air pressure differences must be considered, when calculating the tank levels.

The gauge sensor is mounted on a PCB card with adjusters for zero setting and span.

There are two connections on the sensor card; - one is the electric cable connection on the sensor card and another is pneumatic urethane color tube connection, which is directly connected to the gauge sensor itself as well as to the air flow controller.



Gauge sensor card components

Item no	Description
1	Terminal Block (Single level and Clamping yoke connection)
2	Zero adjuster
3	Span adjuster
4	Piezoresistive sensor
5	Tube for connection, the pneumatic tube will be connected to this
6	Reference for gauge sensor If sensor is absolute type, there is no reference hole. It just blind
7	Printed circuit board
8	The PCB supporter will be mounted on the hole to install acrylic plate
9	Black acrylic plate cover.

Two pressure sensors cards are mounted on one UM profile, which is mounted on a DIN rail at the back of the flow controller manifold rack, making access after turning the flow controller rack 90^O or more forward.

Each flow rack contains up to 5 UM profiles with a total of 10 sensors, and a maximum of three racks fits in a cabinet.

Using a UM profile with two sensors means that not everything needs to be opened and disconnected for replacing a defect or malfunctioning sensor, but only that UM profile containing the sensor that needs to be replaced. This is user friendly and saves time.

The tank level and draft sensor cards can be replaced one by one, and are fully interchangeable without any need for calibration or other adjustments, provided that the measuring range of the sensor is the same.

The two sensors on the UM profile are protected by an acrylic plate on top of the sensor card.

The pressure sensors zero setting & span can be adjusted without removing the acrylic plate cover.

Calculating Tank Levels from Sensor Voltage

All sensor cables are connected to the TB 30 (Terminal Board). The electric signals are transferred to MCU302 (main Control Processor Unit) with 0.4V to 3.6V that will be in proportion to the hydrostatic pressure in the tanks and for the drafts.

For sensor cable wiring connection between terminal block (item 1), and terminal board (TB30), please see section 2.9.2.

The voltage output range after amplification is from 0.4V to 3.6V, and values can be measured on the terminal board for each channel by digital multi-meter.

The obtained voltage value can be converted to tank level as an approximately value.

Example: It is simple to convert voltage to level mH_2O as shown below.
0.4V = 0 mH_2O for zero setting
3.6V = 21.092 mH_2O (2068.4 mbar) for maximum if GSB 30/ASB 30 sensor is connected
Tank offset = 0.1m
Density = 1025 kg/m^3
If the value given is 2.56 VDC
In this example, “X” denotes the converted level from voltage
X = ((2.56 – 0.4) / 3.2) * 21.092 mH_2O = ((14.237 mH_2O / 1025))*1000 + 0.1 m = 13.99 m
(air flow pipe resistance value is not considered)
When GSB 50/ASB 50 sensor is connected with the same parameters, the results is
X = ((2.56 – 0.4) / 3.2) * 35.153 mH_2O = ((23.728 mH_2O / 1025))*1000 + 0.1 m =23.25 m
If we use mbar instead of mH_2O, we should use conversion factor to change from mbar to mH_2O.
(Density = 1025 kg/m^3 is equal to 1.025 t/m^3)

2.9.2 Absolute Pressure Sensors

The absolute pressure sensor measures pressure, i.e. the actual hydrostatic pressure in the tank including the atmospheric air pressure acting in the tank.

The absolute pressure sensor is not self-breathing but has a vacuum on the other side of the pressure sensor membrane.

If absolute pressure sensors are used the system for unpressurized tank level gauging instead of gauge pressure sensors, then it is necessary to install one absolute pressure sensor on weather deck for atmospheric reference air pressure measuring.

This means that the atmospheric air pressure on the weather deck acting in the tank must be subtracted from the measured tank pressure in order to obtain the correct tank level values.

In Scanjet Macron SML 1000D, absolute pressure sensors are used for:

a) atmospheric reference air pressure measurements
b) electro-pneumatic tank level measurements for pressurized tanks

A. Atmospheric air pressure reference measuring

For SML 1000D, which has gauge sensors for measuring levels in unpressurized tanks and drafts, two absolute sensors may be included inside the cabinet in order to compensate for atmospheric air pressure variations in case the cabinet(s) is installed in an area with possibly strong local air pressure variations, such as on car deck(s) or in engine room.

For atmospheric air pressure compensation, one absolute sensor is installed for measuring the on weather deck air pressure, and the other for measuring the local atmospheric air pressure inside the cabinet (because the gauge sensors use this local atmospheric air pressure as reference for the gauge sensor relative pressure.

If the cabinet is located in an area with no pressure variations, then ATM reference pressure compensation is not necessary, and the absolute pressure sensors need not be installed.

Note! Atmospheric reference pressure measuring pipe on deck and inside cabinet

Particular care should be given the installation of the atmospheric reference measuring pipe on deck. Our experience shows that moisture can accumulate in this pipe if there are any bends, and this will result in erroneous random tank levels as the measured reference pressure will not be correct.

The atmospheric air pipe end of the on deck should be bent downwards to avoid any ingress of water. An absolute pressure sensor inside the cabinet does not require any tube connection, because it measures the air pressure inside the cabinet.

B. Electro-pneumatic tank level measuring for pressurized tanks

Measuring the tank level in pressurized tanks is only possible by using two absolute pressure sensors for the same tank.

One of the absolute sensors measure the hydrostatic pressure of the actual fluid level by blowing air into the tank through a measuring pipe extending down as far as possible inside the tank, with the pipe distance from the bottom to be used as offset. Basically, in the same way as for unpressurized tanks, but with absolute sensor instead.

The other absolute sensor measures the ullage (space in tank above the fluid) air pressure. The measuring air pipe can be quite short so that also the ullage pressure at high filling level is measured.

The hydrostatic pressure and ullage pressure act on the absolute pressure sensor located in the cabinet. The ullage pressure is measured with the other absolute pressure sensor, and the pressure difference between the two sensors in the same tank give the actual hydrostatic pressure and hence the tank level can be calculated.

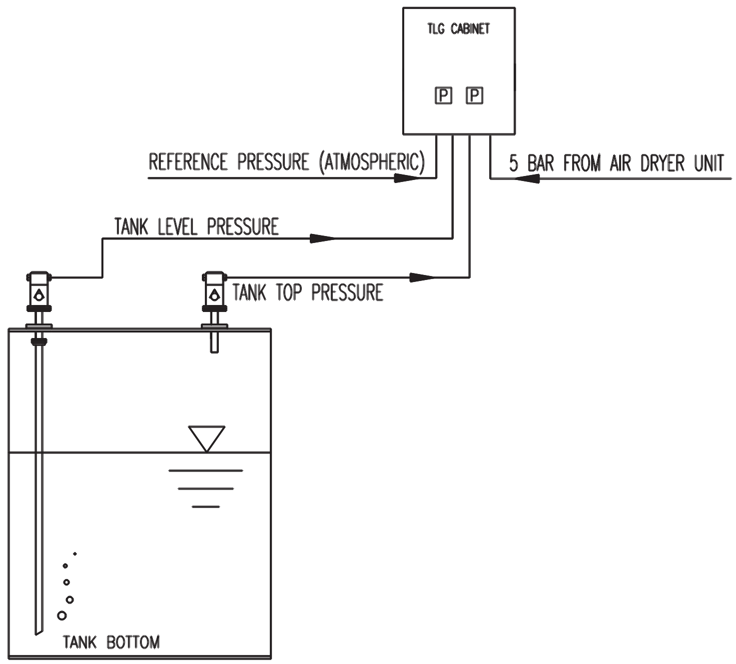
The absolute tank pressure sensors are located inside the SML 1000D cabinet in same manner as the gauge pressure sensors.

There are no limitations in combining gauge and absolute sensor measurements in the same cabinet and system. It is only the sensor that is different, the tank pressure signals are processed in same way.

Except of course, if atmospheric air pressure variation requires that the gauge pressure sensors are compensated. As explained above, pressurized tanks do not need any atmospheric pressure compensation.

The Scanjet Macron TLG system should be protected from ullage inert gas and other harmful gases by quick close valve or similar.

The absolute pressure sensor cards are similar to the gauge pressure cards. The only difference is that the absolute pressure sensor does not have a breathing hole, because it has vacuum on the other side of the membrane.

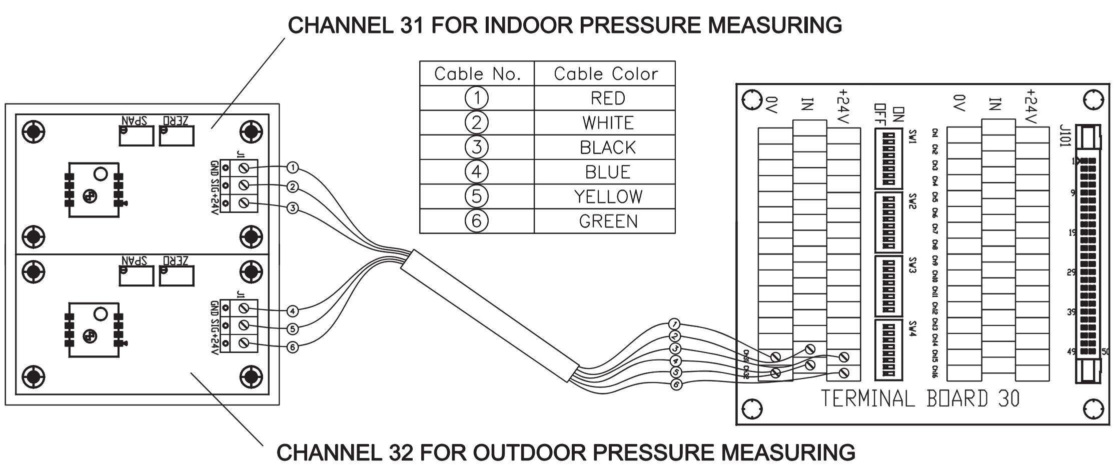


Pressurized cargo tank for measuring line connection example drawing

One or two absolute pressure sensor cards are mounted in a UM profile on a DIN rail.

All absolute pressure sensor cables are connected to a TB 30 (Terminal board), and the electric signals are transferred to the MCU 302 (Main control processor unit) for ATM reference pressure compensation

The two absolute sensors for atmospheric pressure measuring should not be connected to other channels.



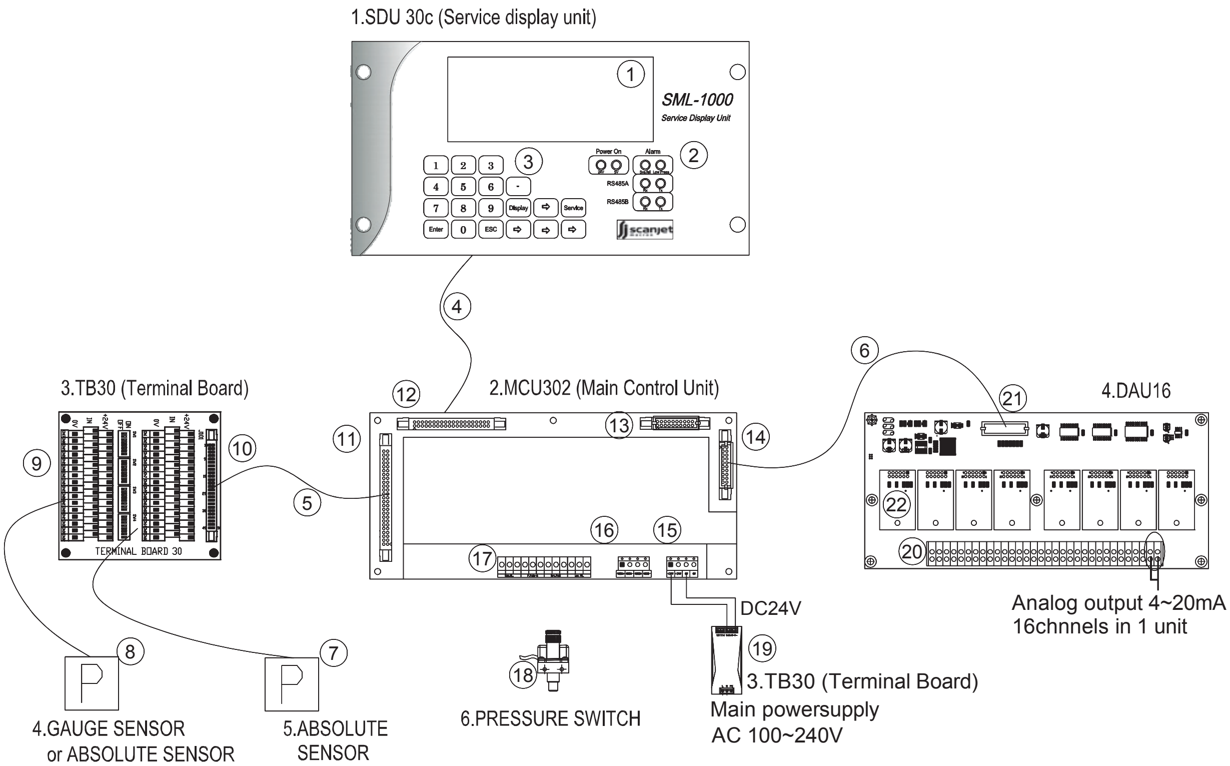
Cable No.	Cable Color
1	RED
2	WHITE
3	BLACK
4	BLUE
5	YELLOW
6	GREEN

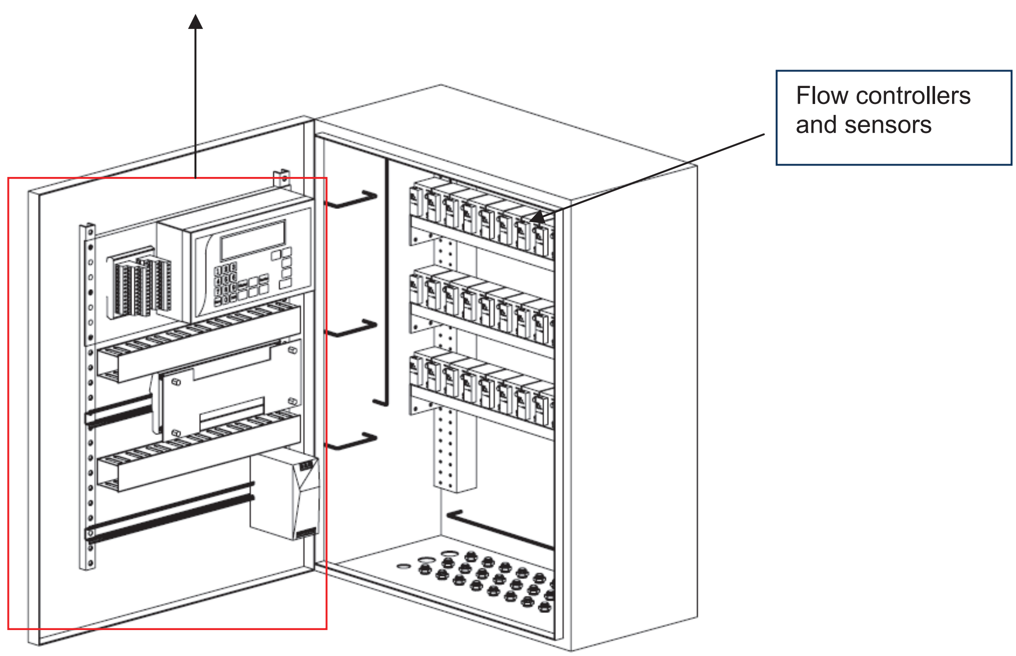
If there are only 10 measuring points in the cabinet, then a smaller terminal board TB 16 can be supplied to which up to 14 sensors can be connected and with 2 channels available for ATM pressure sensor as Ch15 and Ch16.

3 Electronic Units

Below is an overview of all major electronic components, which are located on the inside of the tank level gauging cabinet door.

The pressure sensors and pressure switch are not mounted on the door, but to the right in the cabinet. See number explanation in the table on next page.





This section contains brief functional description of the main electronic components of the SML1000D cabinet.

The system consists of the following electronic PCB:

- Main control processor unit (MCU302)
- Digital analog convert unit (DAU16) as option
- Service display unit (SDU30c) for SML 1000D fully digital model
- Gauge pressure sensor card (GSB30 for 0.2MPa range, GSB50 for 0.35MPa range)
- Absolute pressure sensor card (ASB30 for 0.2MPa range, ASB50 for 0.35MPa range)

The system can give 4~20mA analog signal to connected analog pointer instruments with re-scalable function by DAU16 card, which can be supplied as option.

List of the electronic components

Item no	Description
1	Character- LCD, 4 lines x 20 characters
2	LEDs for Power supply, Alarm Status and Communication Status
3	Keys for service display unit operation
4	Ribbon cable with 2x20 - pin connector
5	Ribbon cable with 2x25 - pin connector
6	Ribbon cable with 2x10 - pin connector
7	Absolute Sensor, 2 sensors are connected to TB30 for 1 cabinet
8	Gauge Sensor for tank measurement, Up to 30 sensors
9	Terminal Block (Triple level and Clamping yoke connection), 32 sets
10	Socket, 2x25 – pin on TB30
11	Socket, 2x25 – pin on MCU302
12	Socket, 2x20 – pin on MCU302
13	Socket, 2x10 – pin on MCU302 for DAU16 unit_2 connection
14	Socket, 2x10 – pin on MCU302 for DAU16 unit_1 connection
15	Terminal Block (Single level and Clamping yoke connection) Power supply connection
16	Terminal Block (Single level and Clamping yoke connection) 2-Communication connection
17	Terminal Block (Single level and Clamping yoke connection) 3- Relay output to external PC and 1- Relay input from pressure switch
18	Pressure switch for low pressure alarm, Activate less than 3 bar
19	Power Supply Unit (Input: VAC 100~240 and output: VDC 24, 3A)
20	Terminal Block (Single level and Clamping yoke connection) The connected yard cables should be transferred current signals to analog pointer instruments or any possible current I/O module
21	Socket, 2x10 – pin on DAU16
22	Re scale card, 2 channels in 1 card 8 cards could be connected with 1 DAU16 unit for 16 analog output

3.1 MCU302 (Main Control Processor Unit)

The main control processor unit can be mounted either on the inside of the cabinet door, or flush mounted on outside the door.
The MCU302 unit provides following output signals to the system and to external systems like ship automation and loading computer.

- 2 x RS-485 Communication Port, Modbus RTU for communication with loading computer and ship automation system
- 3 x Alarm relay output for external alarm activation
- 1 x Relay input for pressure switch from air supply low pressure alarm (0,3 MPa)
- 1 x Digital input for low pressure inlet alarm as NC, activated at 0,3 MPa pressure
- 1 x Address setting DIP switch(SW1), it can be set up to 15
- Up to 15 cabinets can be connected in parallel with same RS-485, a total of 450 measuring points can be operated in one system. If one system has 15 cabinets with 30 sensors in each, then updating time for new level is approximately 60 seconds
- LED lamp power is +5V and +24V

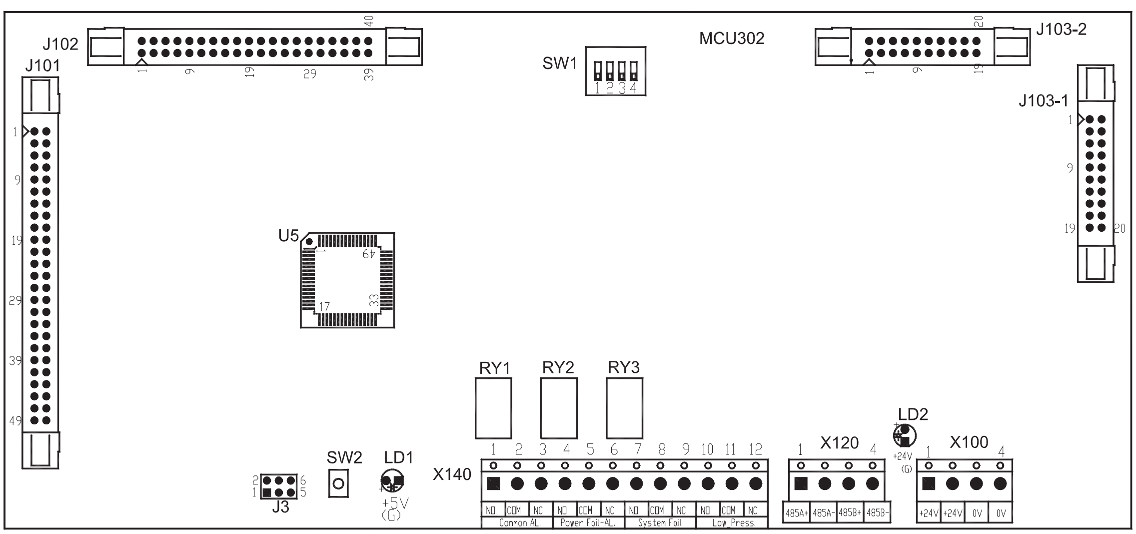
The MCU302 unit has 4 terminal sockets for ribbon cable communication with components, terminal board, service display unit, and DAU 16 units.

- 2 x Terminal sockets (J103-1 & J103-2) with 20 pins for DAU16 connection
- 1 x Terminal socket (J102) with 40 pins for SDU30c connection
- 1 x Terminal socket (J101) with 50 pins for TB 30, Purpose: sensor cable connection

The MCU302 unit has 20 terminal blocks at the bottom of board

- Terminal block number, X100, DC24V power supply connection
- Terminal block number, X120, 2- Serial Communication Port for external system
- Terminal block number, X140, 3 relay-output for external alarm and Low Pressure alarm indication on the SDU30c

The electrical connection drawing is provided separately in the TLG system working drawings.



The below abbreviations are indicated on the PCB of MCU302 and describe what functions/meanings are having.

Abbreviation:

LD 1; Green Color LED, It will activate when DC24V power is connected
LD 2; Green Color LED, It will activate when converted from DC24V to safe power DC5V
J3; 6 pin connector for program downloads. This is only used by service engineers.
SW 1; Cabinet address setting switch
SW 2; Reset key, This key can be used for re-loading data such as the latest setting values

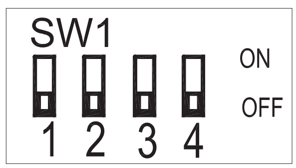
- If key SW 2 is pressed, the system has to be restarted by switching main power off/on

RY1; Relay for Common alarm as normally close contact
RY2; Relay for Power Fail alarm as normally close contact
RY3; Relay for System Failure (=Sensor Failure) alarm as normally close contact

When more than 2 cabinets are connected, the SW 1 of each cabinet must have different settings and should be the same as the cabinet number, which is shown on the name plate on the door.

The program will display the cabinet number on the LCD when the display starts up. More information is provided later in this manual.

The switch SW 1 is located on the top of the MCU302 main board. The switch has four selectors as shown below.



Up to 15 cabinets can be parallel connected to same RS485, with a total 450 measuring points

Cabinet address	SW1			
	$1(2^{0=1})$	$2(2^{1=2})$	$3(2^{2=4})$	$4(2^{3=8})$
1	ON	OFF	OFF	OFF
2	OFF	ON	OFF	OFF
3	ON	ON	OFF	OFF
4	OFF	OFF	ON	OFF
5	ON	OFF	ON	OFF
6	OFF	ON	ON	OFF
7	ON	ON	ON	OFF
8	OFF	OFF	OFF	ON
9	ON	OFF	OFF	ON
10	OFF	ON	OFF	ON
11	ON	ON	OFF	ON
12	OFF	OFF	ON	ON
13	ON	OFF	ON	ON
14	OFF	ON	ON	ON
15	ON	ON	ON	ON

3.2 SDU30c (Service Display Unit)

The MCU302 incorporates a liquid crystal display (LCD) as service display unit.
The SDU30c consists of a Liquid Crystal Display (LCD), 19 key press buttons, several LED lamps such as for Rx/Tx communication, Fault Alarm and Power On.

- To access the menu on the LCD, the user must press the **ESC** key.

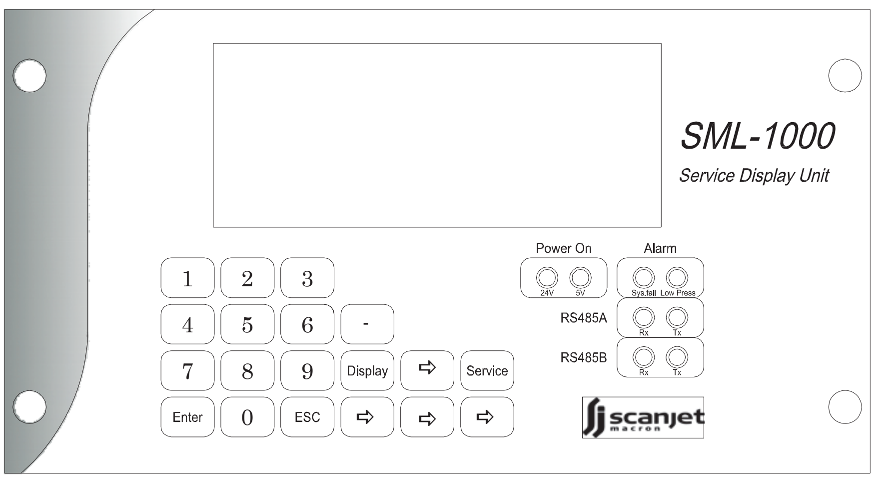
This provides visual access to all the data required to operate the system and displays the tank measuring data and other input setting values.

The screen will not show any characters if no key is pressed for 20 minutes.

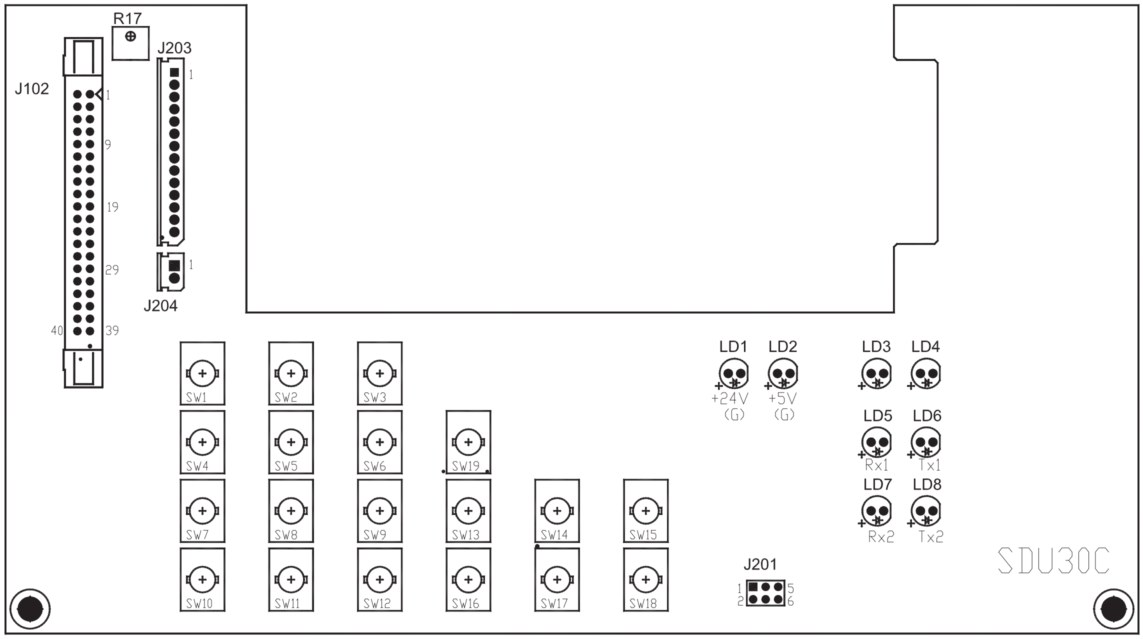
LED's in front of the display unit

- Power On MCU302 power supply +24V; Green and +5V; Green
- Alarm Alarms are activated. System Fail; Red Low Pressure; Red
- RS485A Communicating status with external PC 1,
  Rx: Received (Green), Tx: Transmitted (Yellow)
- RS485B Communicating status with external PC 2,
  Rx: Received (Green), Tx: Transmitted (Yellow)

A. FRONT PANEL WITH LCD OF SDU 30C



B. PRINTED CIRCUIT BOARD FOR SDU 30C



The SDU30c PCB terminal name and component abbreviations:

- J102; Terminal Socket with 40-pins. Should be connected to MCU302 J102 by ribbon cable
- J203; Terminal Socket for LCD power supply and data transmission
- J204; LCD back light On/Off signal
- J201; 6-pins connector for LCD program download. It is only used by service engineer with programming kit
- LD1; Power on green LED for DC 24V supply
- LD2; Power on green LED for DC 5V supply
- LD3; Alarm indication red LED for system failure or sensor failure
- LD4; Alarm indication red LED for low pressure supply, less than 3.0 bar
- LD5; Received signal green LED for communication port 1, RS485 A
- LD6; Transmitted signal yellow LED for communication port 1, RS485 A
- LD7; Received signal green LED for communication port 2, RS485 B
- LD8; Transmitted signal yellow LED for communication port 2, RS485 B
- R17; Adjustable screw for brightness of LCD

3.3 Terminal Board for Sensor Connection

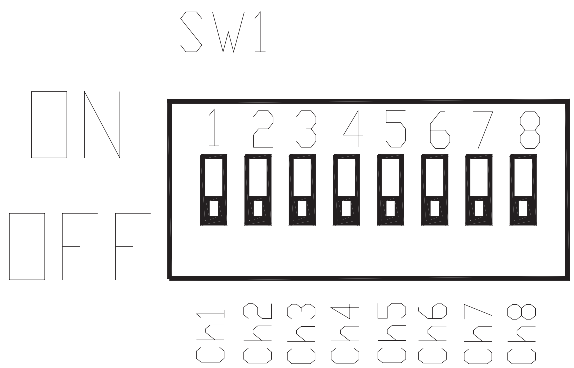
The 3-wire sensor cables are connected to the terminal board (TB30), and a ribbon cable with 50 pins male connector is connected with a socket (J101).

The selectable switch each of channels as on/off that is located at the middle of the terminal board and thus it must be used when the sensor is replaced.

There are DIP switches for connecting/disconnecting power to the sensor in order to protect the sensors from electric shock when replacing a defect sensor.

If a sensor is to be replaced, the DIP switch has to be in OFF position without switching off the main power supply.

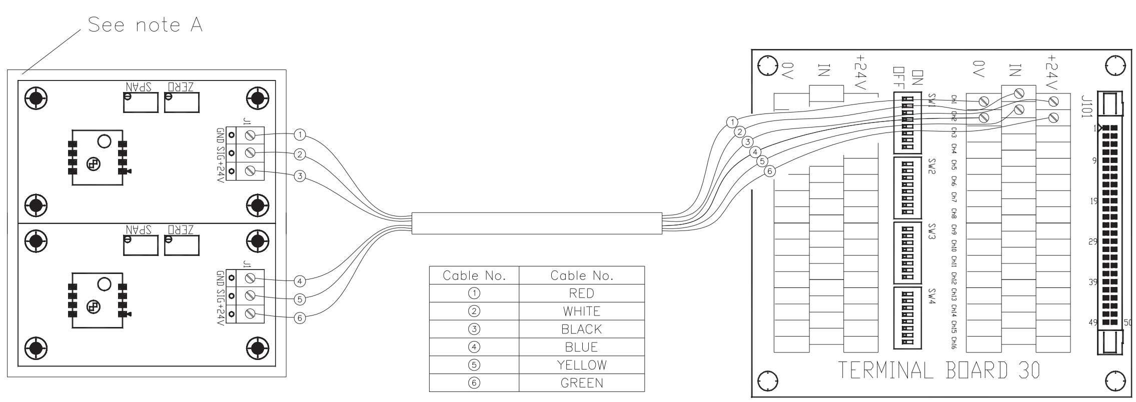
There are four DIP switches mounted on the SW1 board, and one DIP switch has 8 channels



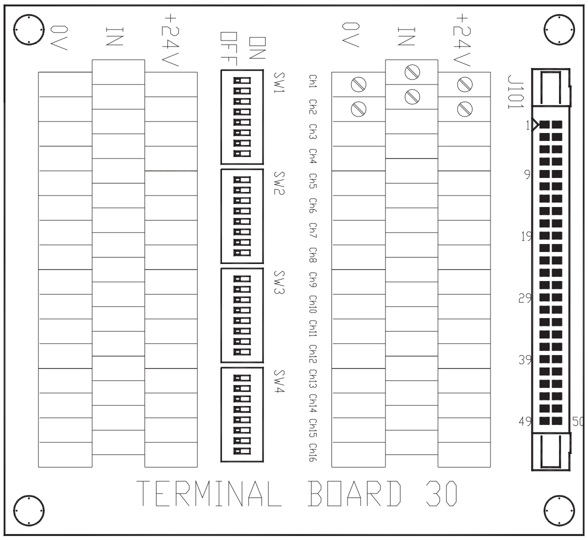
SW 1: Channel 1 ~ 8
SW 2: Channel 9 ~ 18
SW 3: Channel 19 ~ 24
SW 4: Channel 25 ~ 30 and including ATM sensor as 31 and 32 channel

The cable wire connection on between sensor card terminal and terminal board TB30 is shown below.

CABLE CONNECTION EXAMPLE BETWEEN SENSOR CARD AND TERMINAL BOARD

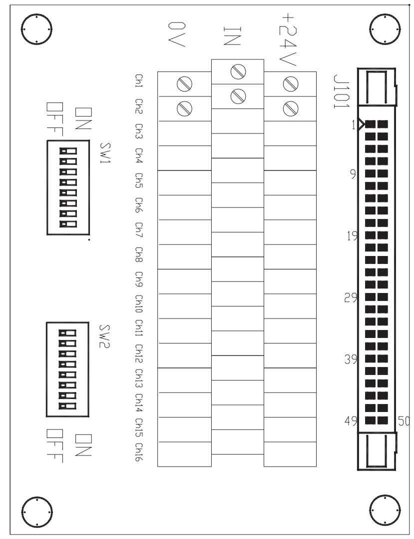


TB 30 (TERMINAL BOARD 30)



UP TO 30 measuring points

TB 16 (TERMINAL BOARD 16)



UP TO 14 measuring points

In case TB16 (Terminal Board 16) is mounted in cabinet, the DIP switch is available with 14 measuring points and 2 switches are used for ATM pressure sensor .

SW 1: Channel 1 ~ 8
SW 2: Channel 9 ~14 and including ATM sensor as 15 and 16 channel

Note! UM Profile
Individual adaptation of the UM profile to PCB dimensions means that electronics circuits can be made rail mountable.
Generally, the UM profile in SML 1000D has 2 pressure sensor cards and a black acrylic protection plate. The cables between sensor card and TB30 are pair twisted 6 shielded different sheath color wires.

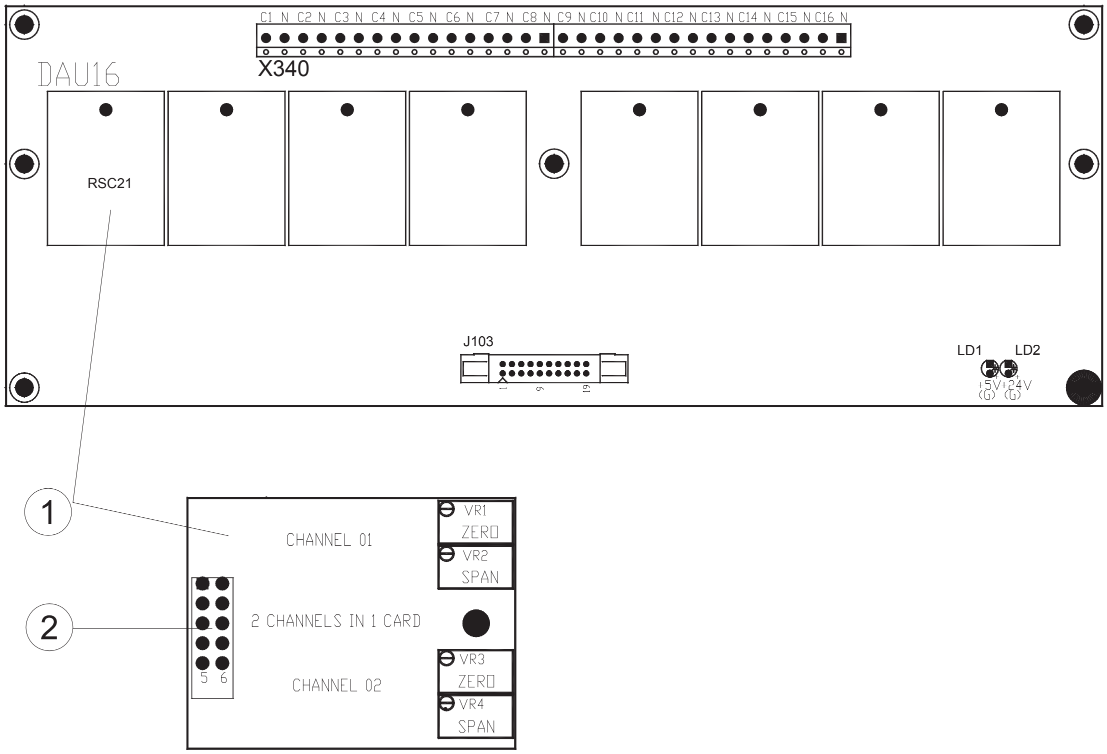
3.4 Digital to Analog Converter (DAU16) – Optional

The digital to analog converter card DAU16 can be supplied with the SML 1000D in case local analog pointer instruments are installed to show tank levels and/or volumes.

The SML 1000D system cabinet can contain 2 x DAU16 for max. 30 analog outputs. Only one DAU16 can be installed if no more than 15 analog outputs are needed.

Eight RSC21 re-scaling cards can be installed in a DAU16 unit and each card has 2 channels with individually adjustable zero and span as shown below.

DIGITAL ANALOG CONVERTER UNIT 16 CHANNELS IN A UNIT



RE SCALE CARD FOR DAU 16

The connector (2) on RSC21 card is connected with DAU 16 main board, and the terminal socket J103 can be connected to either J103-1 or J103-2 on the MCU302 board.

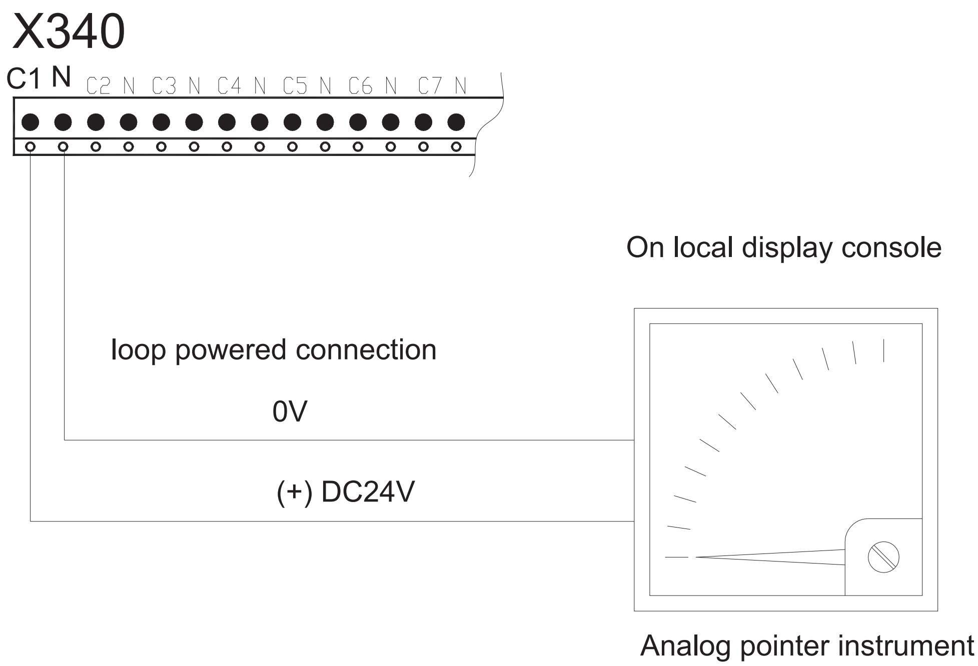
In case 2 x DAU16 units are included in the system, then one of the two is connected to J103-1 and will be taken care of the analog outputs from channel 01 to 16, and the other DAU16 unit connected to J103-2 terminal socket on the MCU302 that will work for channels (17 to 30).

There are two green LEDs for DC 24V and DC 5V power supply respectively on the left bottom corner of DAU16 main board. These are marked as LD1 and LD2.

Following example shows connection between Channel 1 of X340 terminal block on DAU 16 board, and analog pointer instrument as loop powered connection.

See Commissioning and Service Manual for detailed description on how to adjust zero and span if necessary.

On the drawing example shown below, terminal block X340 is located on the DAU16 main board and all of yard cables should be connected directly to X340 terminal block according to electric cable connection drawing.



The DAU16 can be used with external display as loop powered connection.

Note! The cables to the analog pointer instrument should not be installed close to high current cables or other disturbing equipment.

The DAU 16 unit can be connected to both analog pointer instruments and digital display units.

In general, the minimum tank level or height for pointer instrument scale is 4 mA, and the maximum as 20mA.

Please see the Commissioning and Service manual, section 3 for menu program for scaling measures.

3.4.1 Supply Air Pressure Switch

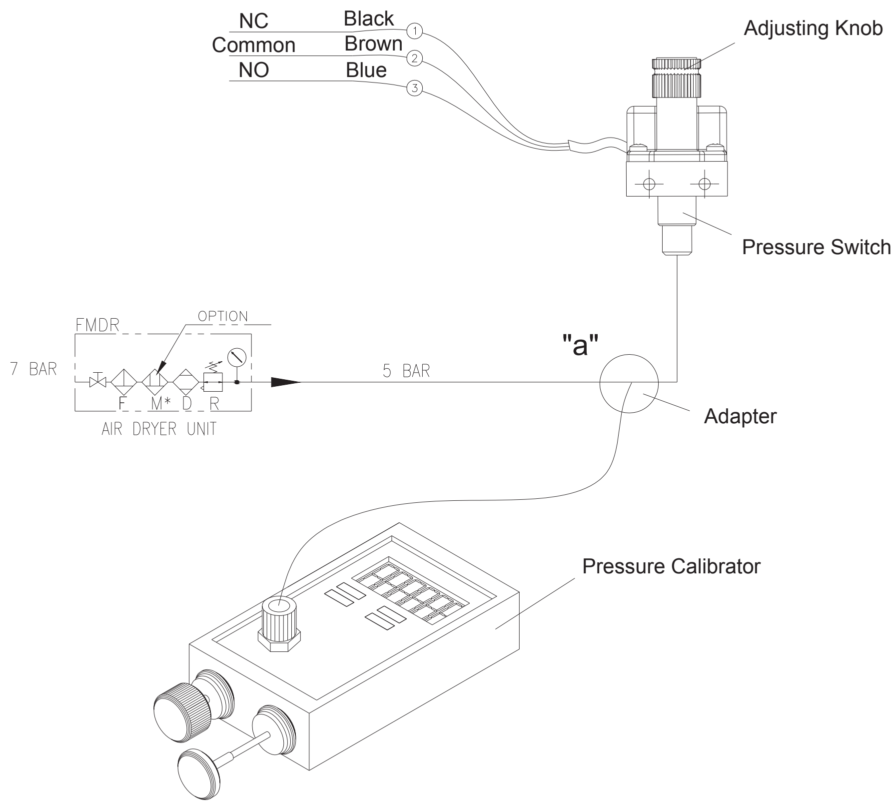
A supply air pressure switch is installed in the cabinet, and closes the supply air pipe in case the supply air pressure drops below appr. 0,3 MPa. An alarm is given to the automation system low supply air pressure. The alarm is also shown in the LCD.

When air pressure is restored to 0,3 MPa, the switch opens automatically and the alarm is deactivated. The contact switch is normally closed.

The alarm point can be adjusted with the alarm push-lock knob.

The pressure switch cable for low pressure alarm activation can be directly connected to either the main board (MCU302), or to an external I/O module.

If the cable is connected to an external system directly, an alarm will not be shown in the SML 1000D system.



The relay on the MCU302 will activate as normally closed contact (Brown – Black) and as shown above, the pressure calibrator should be connected to pressure switch air inlet instead of original pneumatic line when adjusting the switch.

In order to get a new alarm point, a digital multi-meter and pressure calibrator should be connected to pressure switch, and make sure that air stop valve on air dryer unit is closed before doing connection.

When turn adjusting knob clockwise direction, a new set alarm point will higher than before, and when turning the other way (counterclockwise), it will be lower.

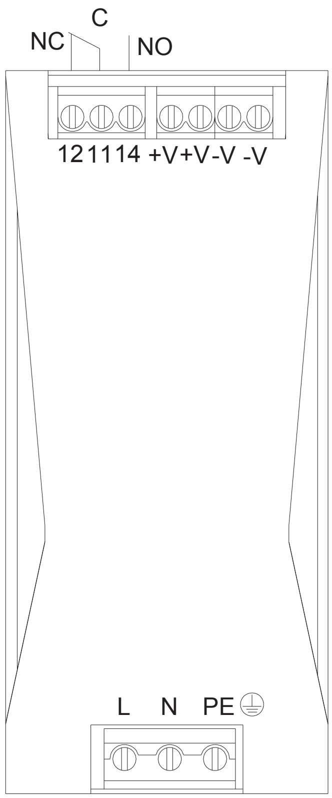
The adjusting knob should be locked by pushing it down after the new setting is completed and all disconnected parts should be reconnected.

3.4.2 Power Supply Unit (SNT 30)

A compact single-phase switched-mode power supply module is mounted inside the cabinet. This power supply module complies with all mandatory national and international standards and approvals.

The power supply unit consists of a transformer for alternating voltage into different direct voltage of any value. A rectifier circuit is used to convert a secondary alternating voltage into a pulsating direct voltage, which is then smoothed by means of a filter circuit.

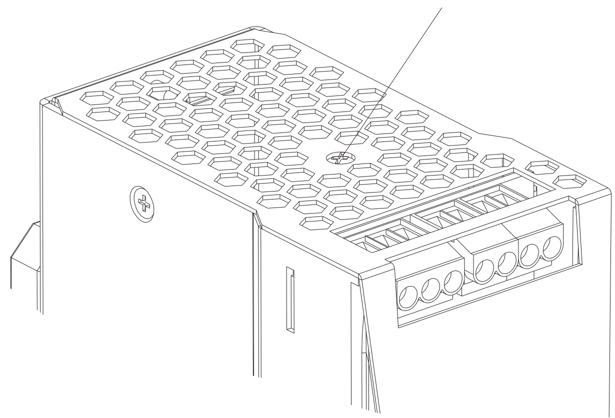
A detailed technical description is given in the Functional & Technical Description Manual.



Front view of the unit

Power Supply Unit

Input: 100-240VAC 50/60Hz 2.0-1.0A
Output: 24VDC 3.0A
Model: CP SNT 70W 24V 3A



Top view of the unit

Note! The ground cable should be grounded to the ship's hull and the terminal (12, 11 and 14) can be used for relay output.

There is screw on the center of power unit top for adjusting the power DC output, varying from DC24V to DC28V.

4. User Manual for Service Display Unit Operation

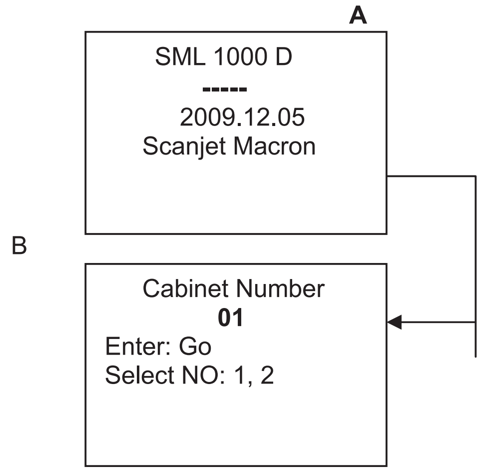
This section shows how to operate and use "DISPLAY" and "SERVICE" menu on the SDU 30c unit.

Key definitions

Enter	After selecting a tank by using Left & Right arrow keys, press "Enter" to show values
ESC	To cancel the present display
➡	For Next tank selection
⬅	For Previous tank selection

4.1 Starting up the Service Display Unit SDU30c

Every time the service display unit is started, the following window is shown for initializing the system.



Initializing the SDU30c
The screen will automatically change from **A** to **B** after initializing for 5 seconds

Text explanation for A & B screens

On the "A" screen

- SML 1000 D: Model name of system
- **----- :** Initializing the system for 5 seconds
- 2009.12.05: Delivery date from factory
- Scanjet Macron: Company name

On the "B" screen

- **01 :** Cabinet address is showing automatically, depends on SW1 setting on MCU302 board
- Enter: Go : If press "Enter" key, the display will show only cabinet 1
- Select NO: 1, 2 : The figures 1 & 2 means that two cabinets were delivered

If there are three cabinets in the system, the figures 1,2 and 3 will be shown.

If there is just one cabinet, it will also show "Select cabinet number 1".

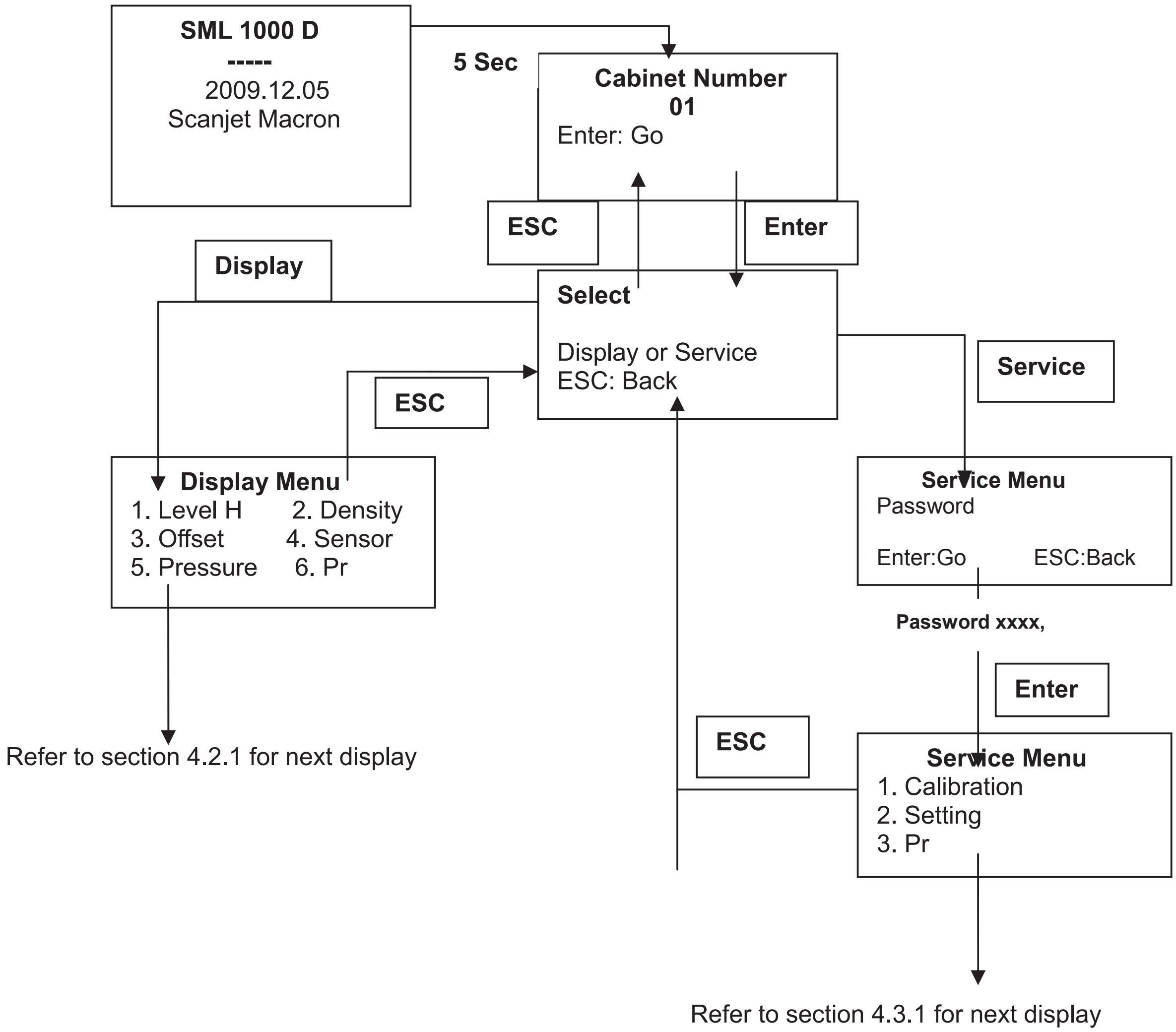
4.1.1 Single Cabinet in a System

When the system is delivered with only one cabinet, it is not allowed to select another cabinet.

This section shows the windows to select either display mode or service mode after initializing for 5 seconds

The display mode has 6 different menus showing the measuring results (pressures and calculated levels) and the tank data (offset and pipe flow resistance) saved for each sensor in the memory.

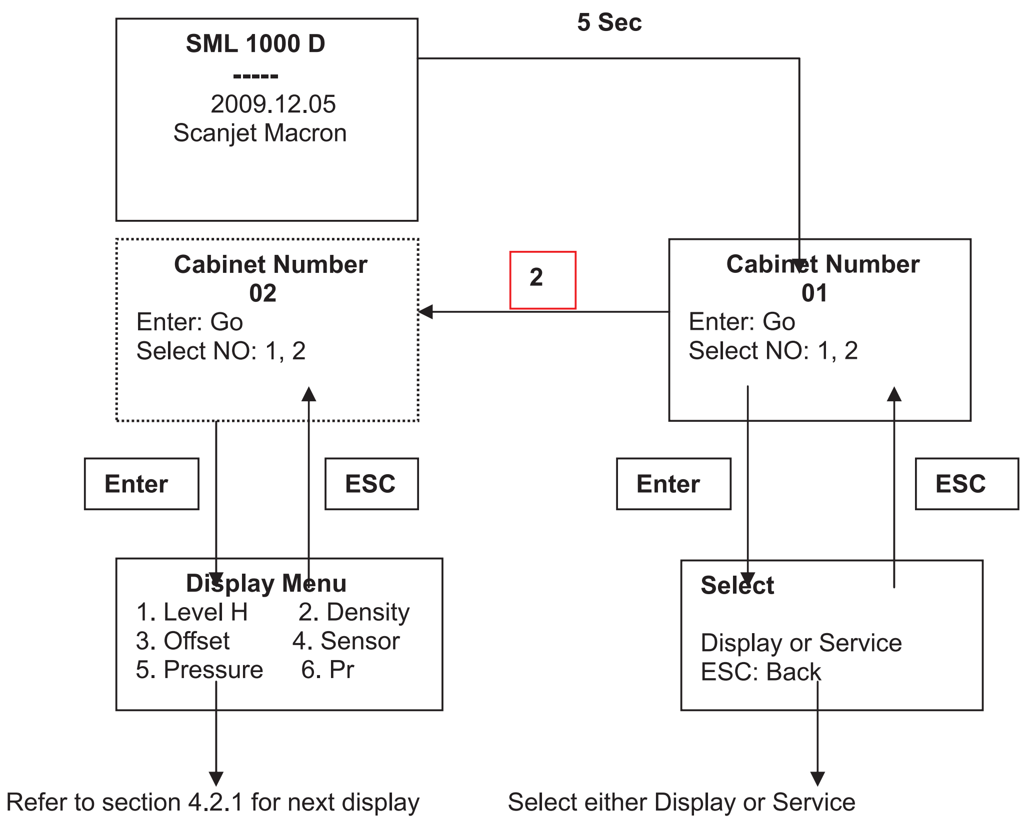
The service mode has 3 menus to calibrate the sensor and to give a new value for tank data such as density, tank offset and analog output scaling.


SML 1000 D

2009.12.05
Scanjet Macron
5 Sec
Cabinet Number
01
Enter: Go
ESC
Enter
Display
Select
Display or Service
ESC: Back
ESC
Service
Display Menu
1. Level H
2. Density
3. Offset
4. Sensor
5. Pressure
6. Pr
Service Menu
Password
Enter:Go
ESC:Back
Password xxxx,
Enter
ESC
Service Menu
1. Calibration
2. Setting
3. Pr
Refer to section 4.2.1 for next display
Refer to section 4.3.1 for next display

4.1.2 Number of Cabinets in a SML 1000D System

When the system is delivered with two cabinets or more, the operator can select the cabinet number(s) and the measuring results for all cabinets.
In case the cabinet number “02” is selected from cabinet “01”, the service menu is not available but the display menu will be shown for cabinet number “02”.



Up to 15 cabinets can be connected in parallel to same RS-485 by MODBUS RTU mode protocol. A total of 450 measuring points can be viewed and operated in one system.

4.2 Display Mode

If it is necessary to calibrate sensors and to change density and tank offset, the user must switch to the "Service mode", and enter service password (Default is 1234).

After initializing and pressing "Display" key, the display will show the tank level height results and saved data such as density, pipe end offset, and pipe flow resistance values for every connected sensor and measuring pipe.

There are 6 options in the main display menu, and the following description shows the features of each menu.

1. Level Height (Refer to section 2.4 and 2.5 Calculations)
The display shows the calculated tank level height, corrected for tank offset, pipe resistance and density.

2. Density
The display shows the density of liquid as the latest input. Changing density can be done in the Service menu. The density can also be changed in the loading computer and in the automation system. This density overruns then density set in the cabinet. The density can also be changed in the Service menu.

3. Offset : Tank Pipe Offset
The display shows the pipe offset in the tank. The offset can be changed in the Service menu. The pipe offset is the distance measured from bottom of tank to upper end of the sniped measuring pipe in the tank. The offset is recorded and saved for every tank during installation / commissioning.

4. Sensor
The display shows the sensor status either OK or E
"OK" means everything is good condition
"E" means ERROR. If sensor has "E" on the status of sensor, the sensor cannot measure the pressure and all of measuring results are not displayed.
What to do when Sensor shows status "E"?

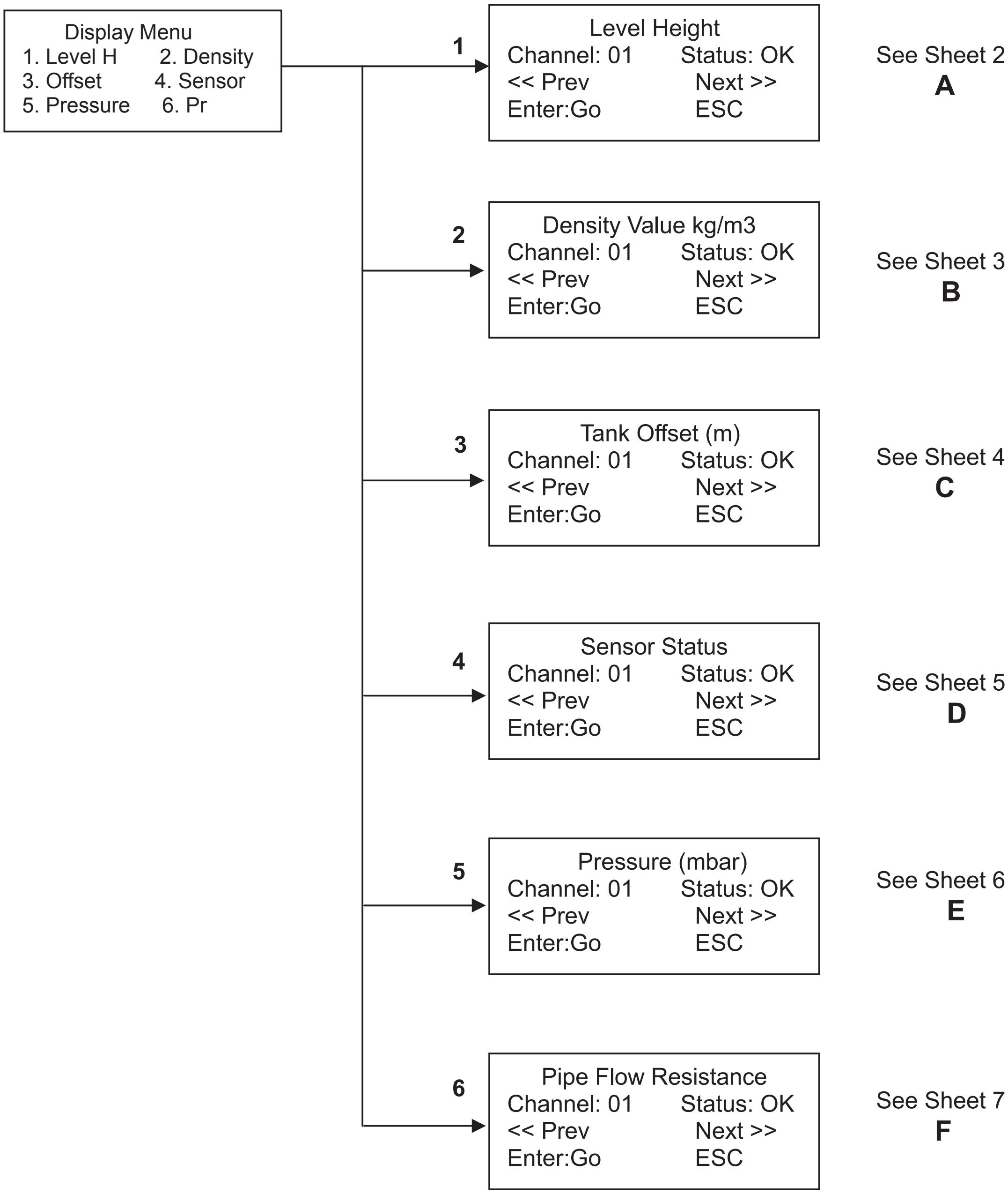
- Check first the condition of sensor
- Then decide to replace the sensor or not

5. Pressure
The display shows the pressure value in mbar if sensor is OK.
If the sensor is not working properly, it will display only "E

6. Pr: Pipe Flow Resistance
The display shows the pipe flow resistance which has been measured when the tank was empty.

4.2.1 Display Menu, Sheet 1

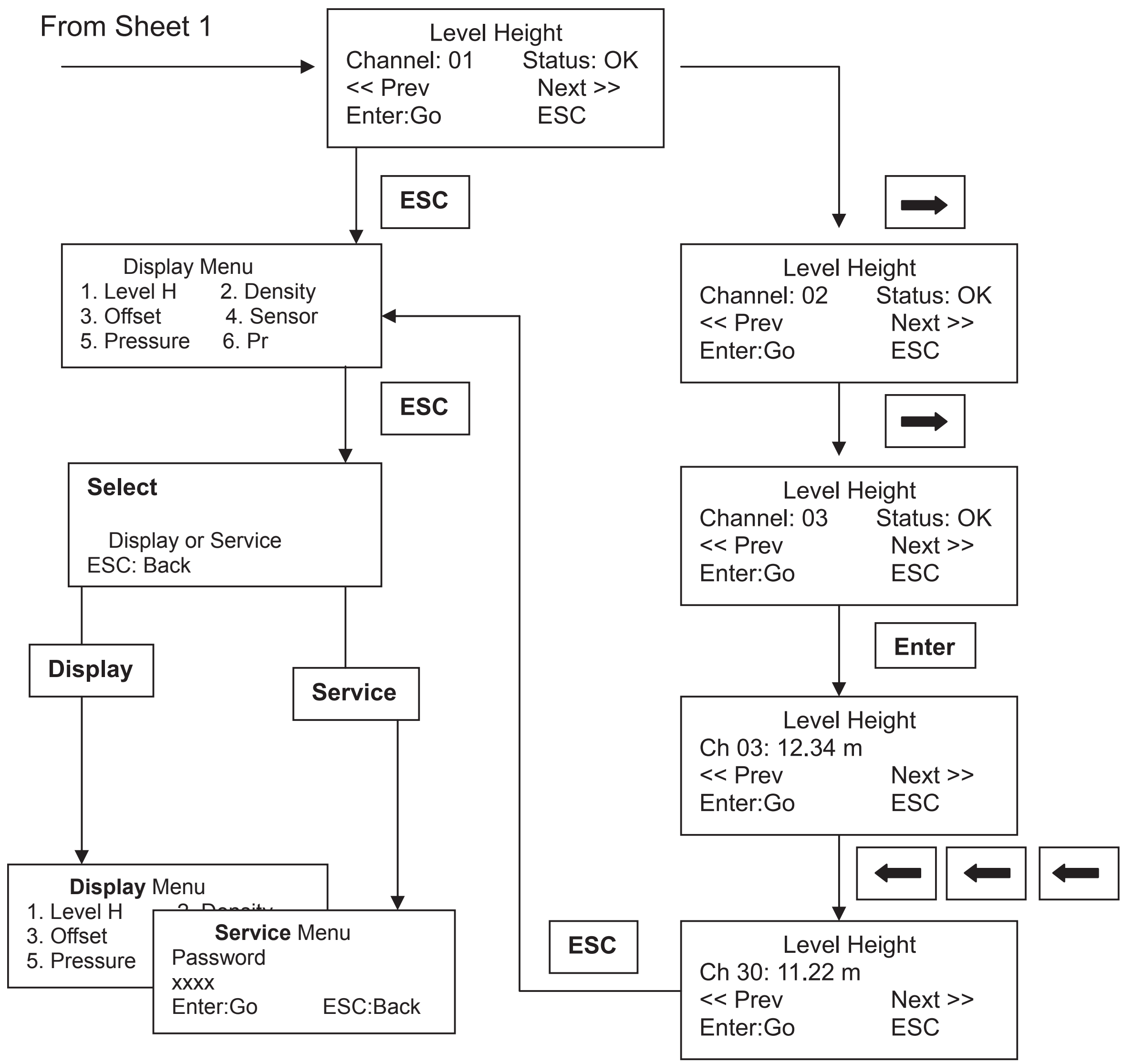
Press the key "Display" on the panel



The user can select the number from 1 to 6 on the Display menu
The LCD will show measuring point selection display and status of current measuring point as any of keys are pressed.

4.2.2 Fluid Level Height on Display Menu - Sheet 2

A



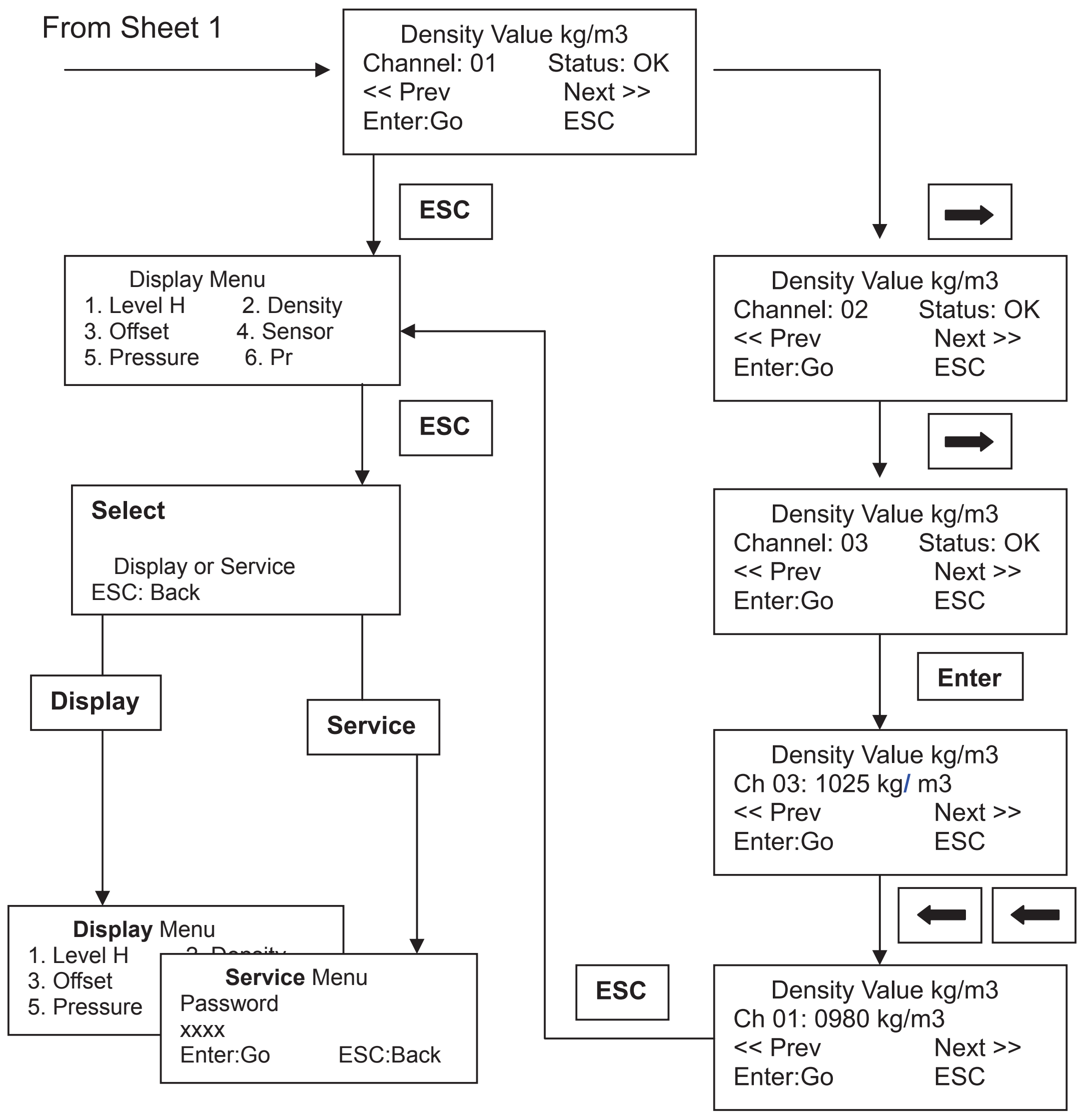
The sensor measuring results can be read in this window if the sensor status is OK.
In case sensor status is “E” on the display, the measuring result also will be “E”.

By using (<<) left key or (>>) right key on the panel, the channels of measuring points can be displayed.

It is not possible to change channel number directly by entering numbers instead of using arrow keys to select channels.

The level height is displayed in meters.

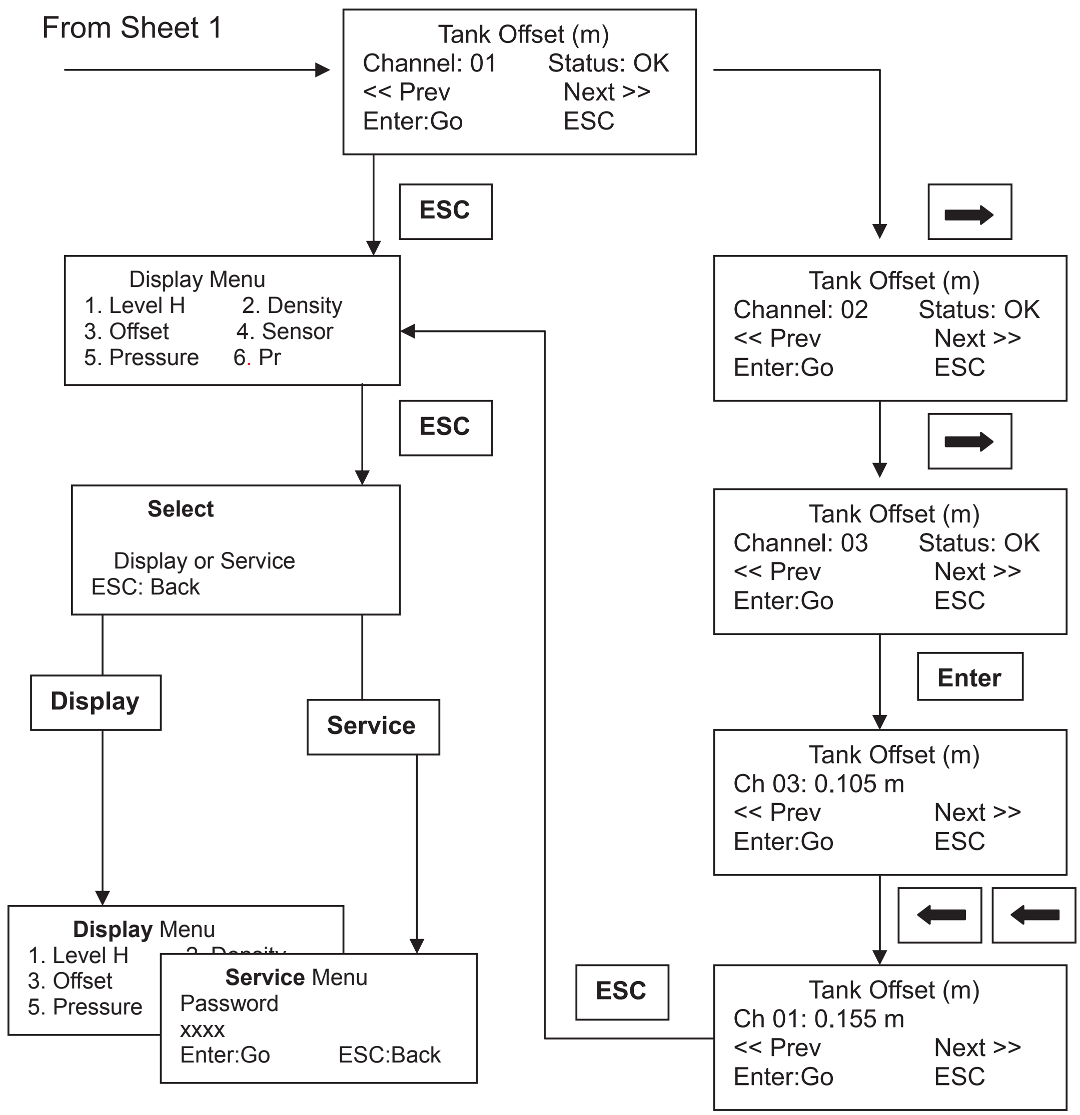
4.2.3 Density on Display Menu - Sheet 3
B



The latest saved density value is shown and the current status of sensor is displayed before pressing "Enter" key.

In order to change density value from 0980 kg/m3 of channel 01, the service menu must be opened as above. The density can also be changed in the loading computer and in the automation system. This density overruns then density set in the cabinet.

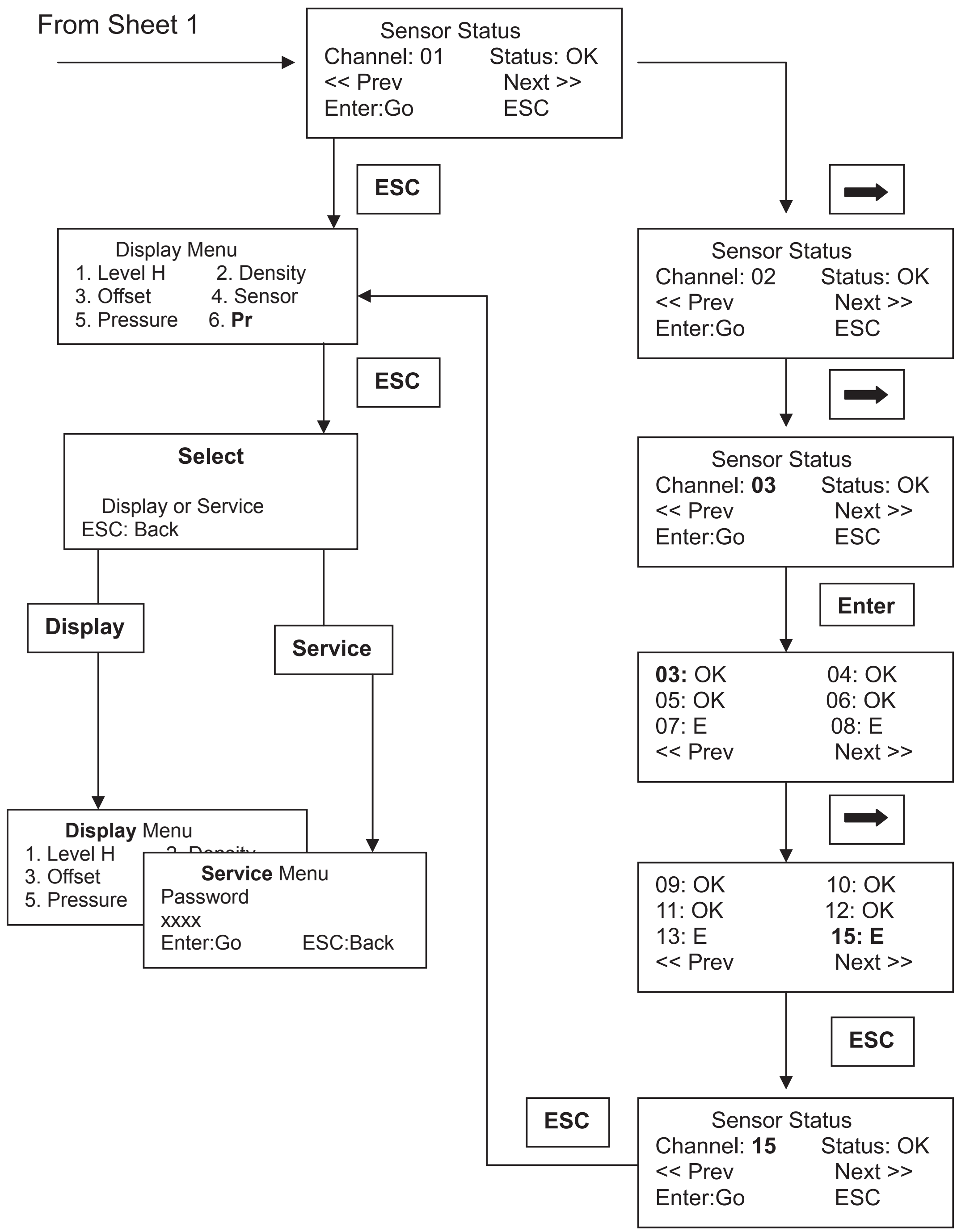
4.2.4 Offset on Display Menu - Sheet 4
C



The latest saved tank offset value is shown and the current status of sensor is displayed before pressing “Enter” key.

In order to change tank offset value from 0.105m of channel 03, the service menu must be opened as above.

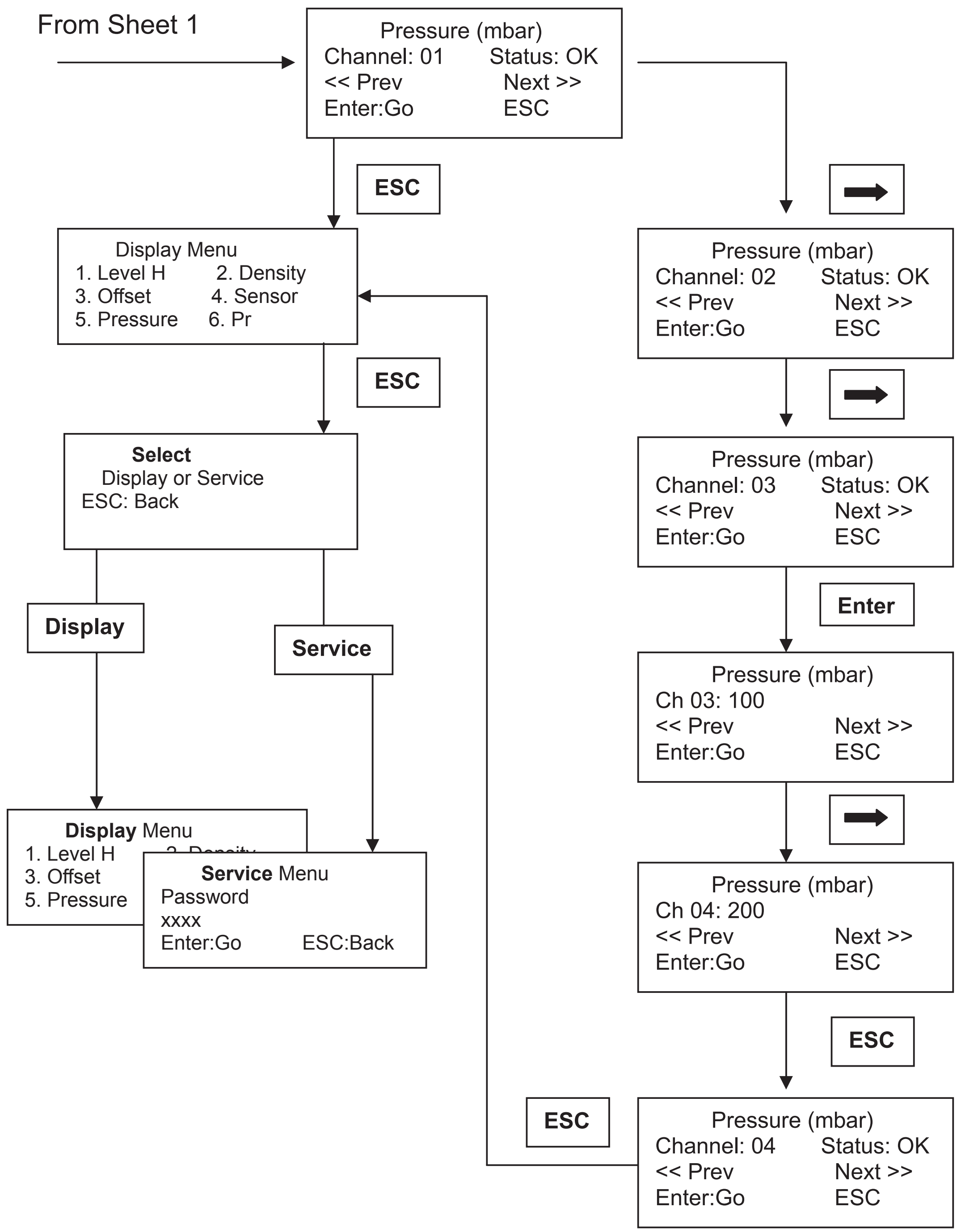
4.2.5 Sensor Status on Display Menu - Sheet 5
D



The display shows the sensor status either “OK” or “E” for five tanks at the same time.

When press an arrow key, the display will show another new five sensors status with “OK” or “E”.

4.2.6 Pressure reading on Display Menu - Sheet 6
E



The pressure is displayed in mbar and another unit is not available

The indicated pressure considers flow resistance (P_r) and thus it can be used for converting the hydrostatic pressure to level height based on 2.4.3 section conversion table.

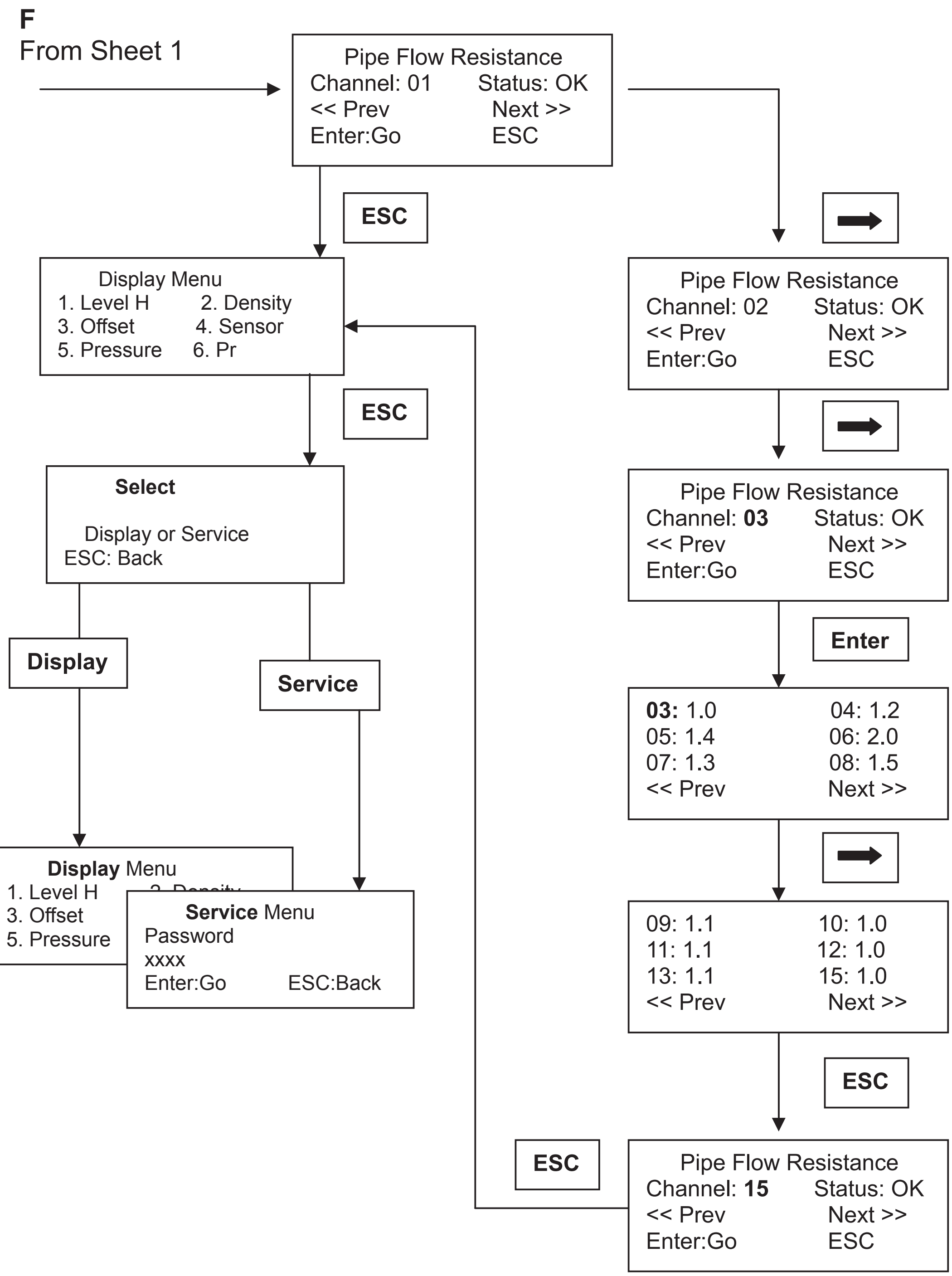
4.2.7 Pipe Flow Resistance on Display Menu, Sheet 7

Unit: mbar

Flow resistance means the air pressure loss at constant air flow in the measuring pipe. This air pressure loss is measured in an empty tank, or equivalent condition.

During commissioning on board the vessel, it should be checked that the pipe resistance has been recorded and stored.

Checked and measured flow resistance values can be displayed for 6 channels at the same time on the display



4.3 Service Mode

The service mode is used to set and change the basic measuring settings for each sensor and measuring pipe during commissioning.
There are 3 numbers in main service menu, and the following description shows the features of each menu.

1. Calibration
There are two sub-menus for calibration of gauge and absolute pressure sensors. One is pressure sensor zero point settings and the other is analog output re-scaling.

A. Pressure sensor
The zero points for pressure sensors can be adjusted if the crew has a pressure calibrator. Before zero point calibrating, ensure that the air supply is stopped and there is no pressure in the measuring line. The sensor should be kept to atmospheric pressure for zero calibration.

B. AO Rescaling (Scaling for analog outputs 4-20mA)
As an option, the program can be given to analog pointer instrument as 4-20mA. These scaling values are set depend on the device measuring range which is printed on scale plate of the device.

2. Setting
There are 3 sub-menus for this setting as below and it can be edited corresponding to specified information

A. Tank Pipe Offset
The distance from the upper end of sniped measuring pipe to the lowest bottom of tank.
The indicating offset is displayed in meters, and the user should give a new value without decimal when the value is entered.

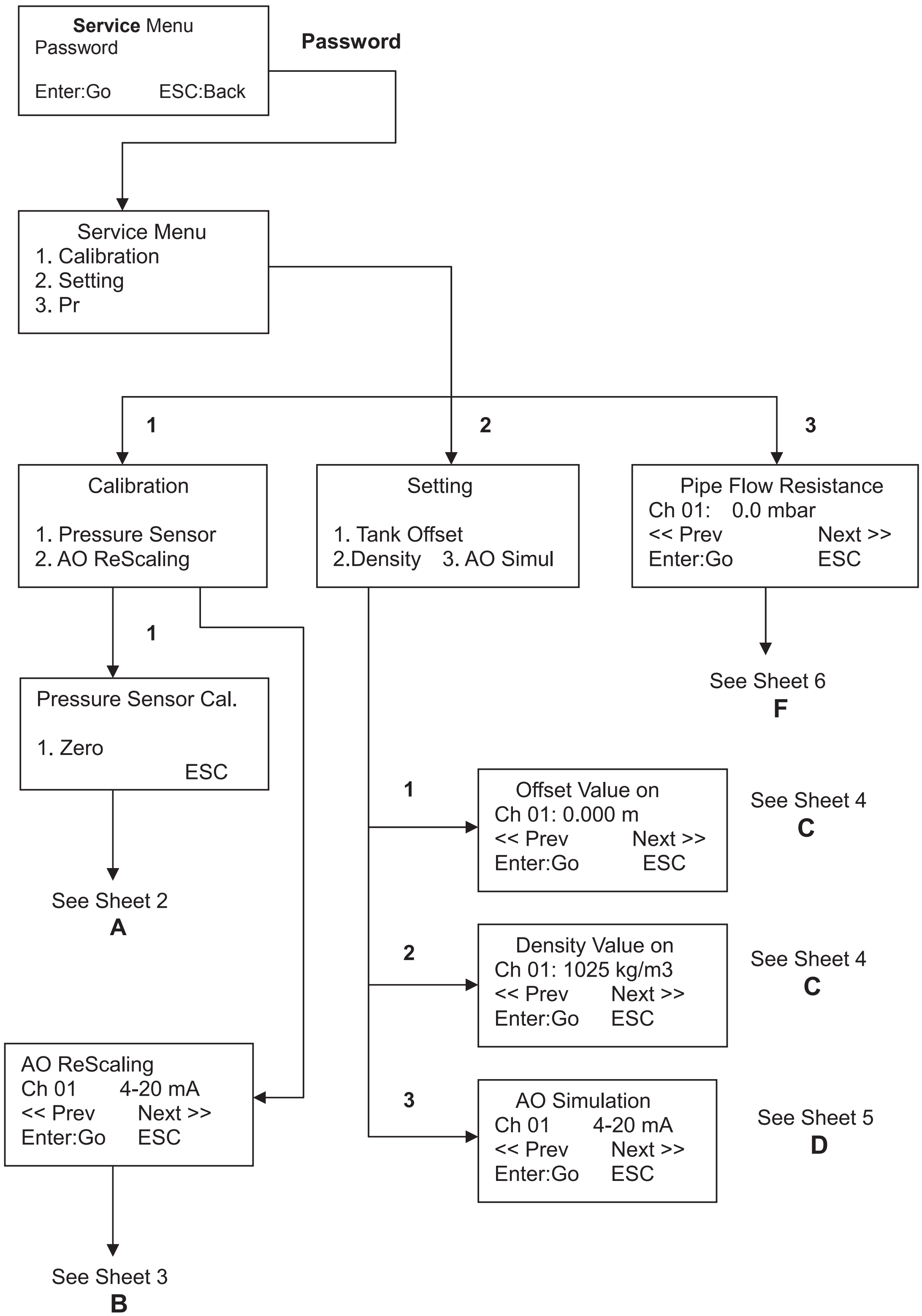
B. Density
Unit is kg/m3 (SI standard) and the user should give a new value without decimal when the value is entered.
To change density from 1000 kg/m3 to 0850 kg/m3.
There is no decimal key on the SDU30c. So, User only press key 0850.
After that 0850 kg/m3 will display on the LCD.

C. AO Simulation
This menu is used to generate current for testing analog pointer instrument if connected as option.
Then the user can verify both the analog device and giving signal

3. Pr
The flow resistance value has to be measured during commissioning and it must be done when the tank is empty or in similar condition. This is a set value and not automatically changed.
If there is very high flow resistance in some line even if no liquid in tank, then the measuring line is most likely clogged or bent.

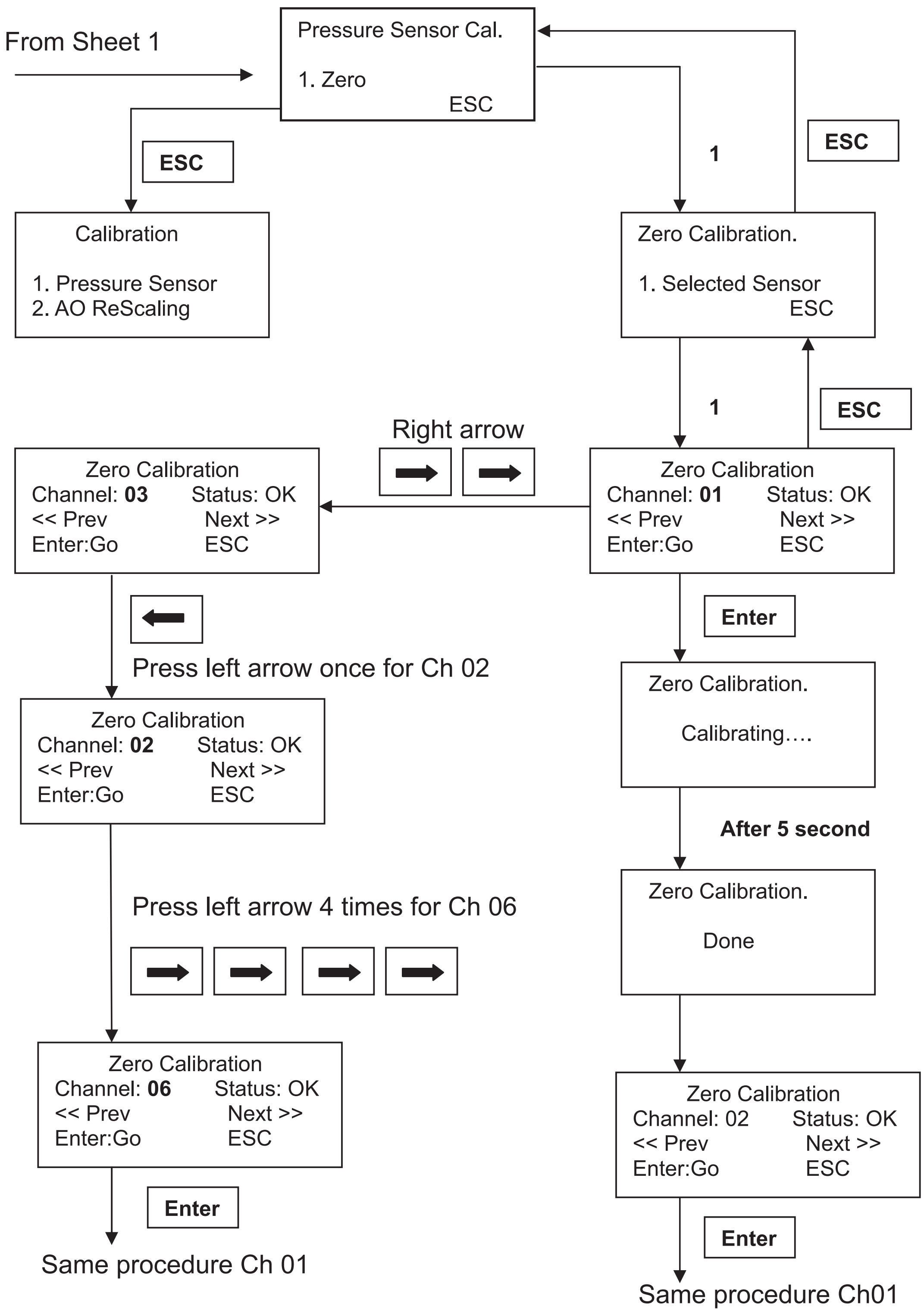
4.3.1 Service Menu - Sheet 1

Password is set to 1234 as default



4.3.2 Calibration of Pressure Sensor- Service Menu Sheet 2

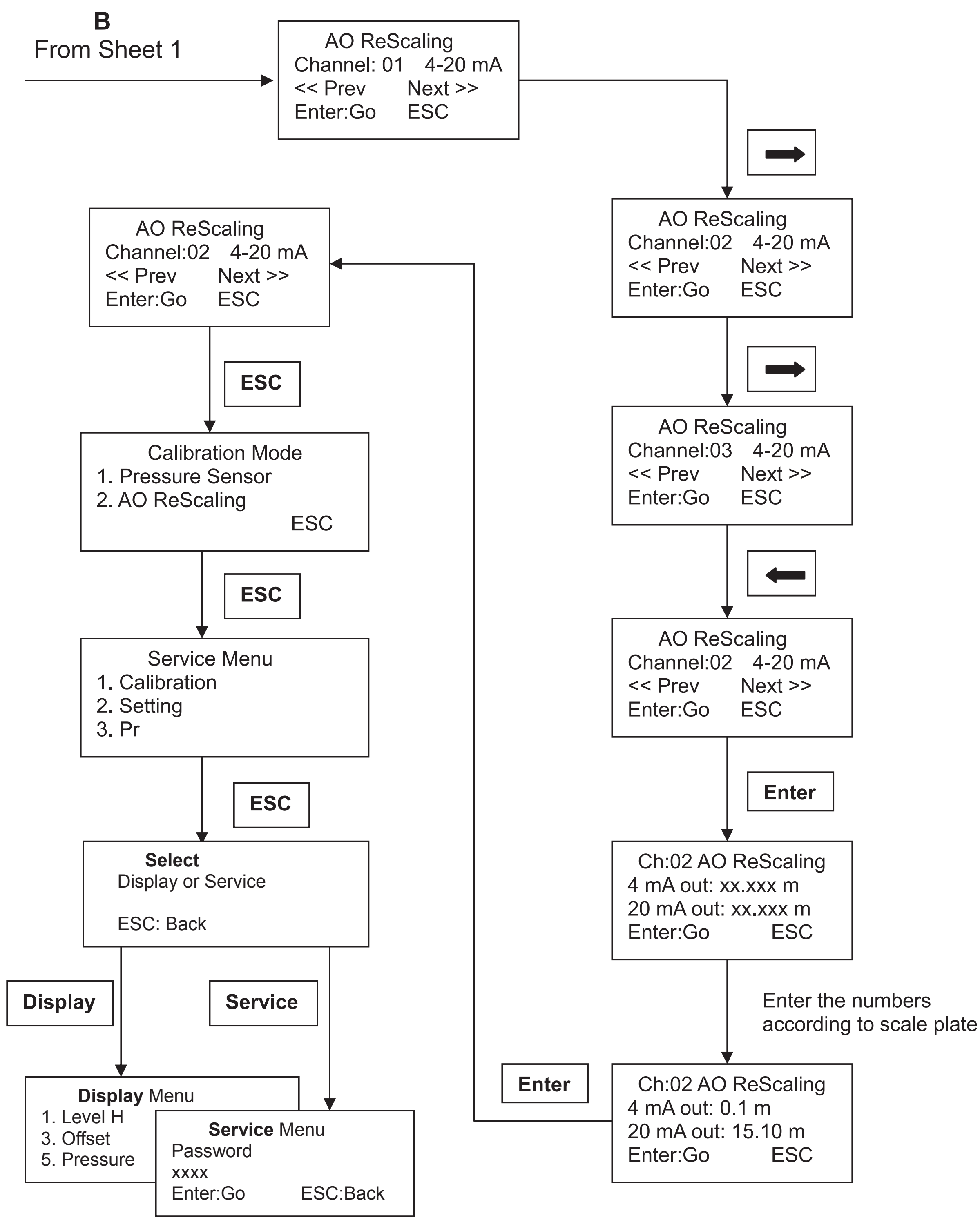
A



Note! When zero point is calibrated, the measuring pipe pressure should be equal to atmospheric air pressure.

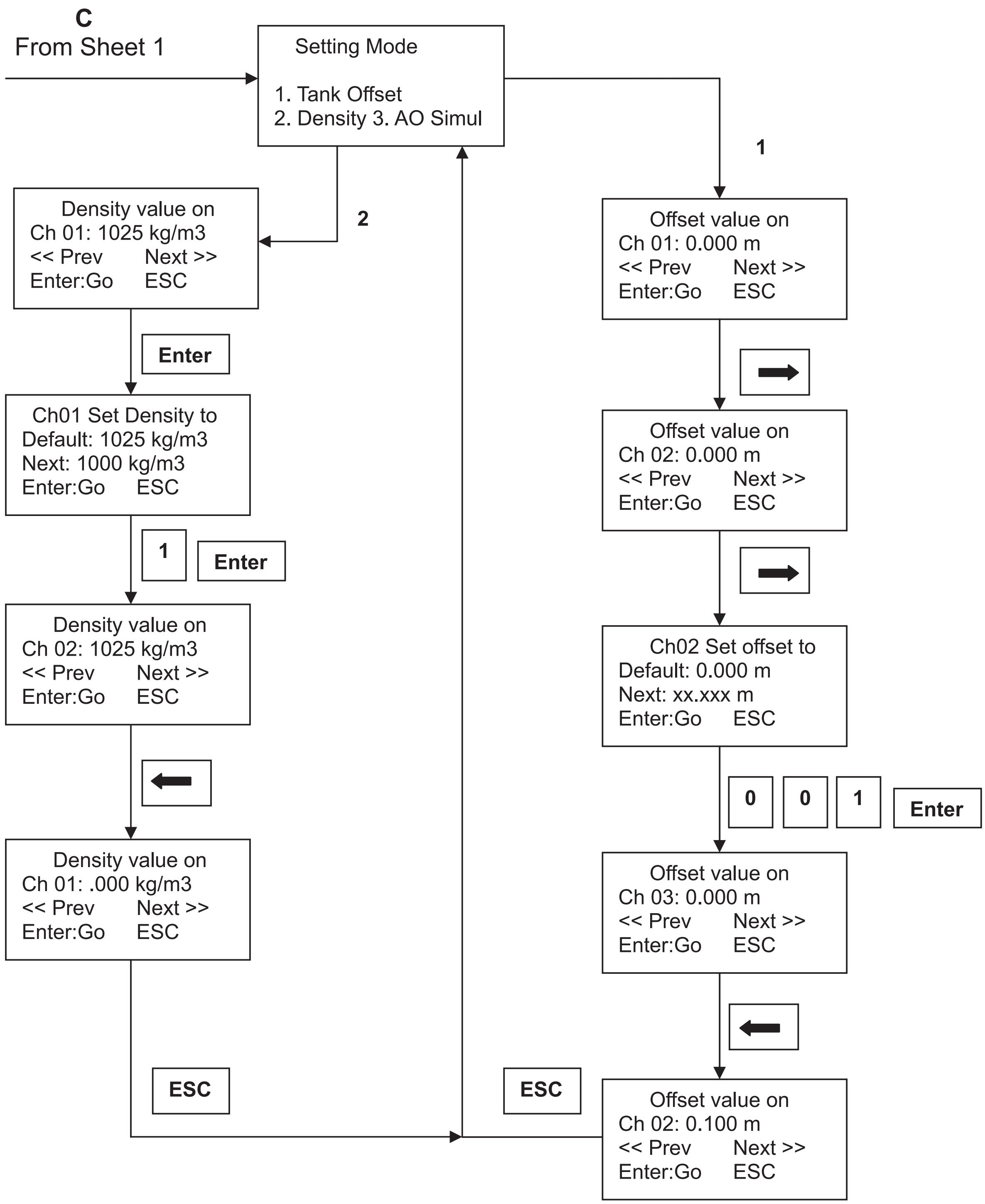
4.3.3 Calibration Analog Output Rescaling- Service Menu Sheet 3 -- Optional Function

This AO Rescaling is only available when DAU16 unit is included in the system
If there are no analog pointer instruments, the AO Rescaling function will not be shown on Service Display Unit



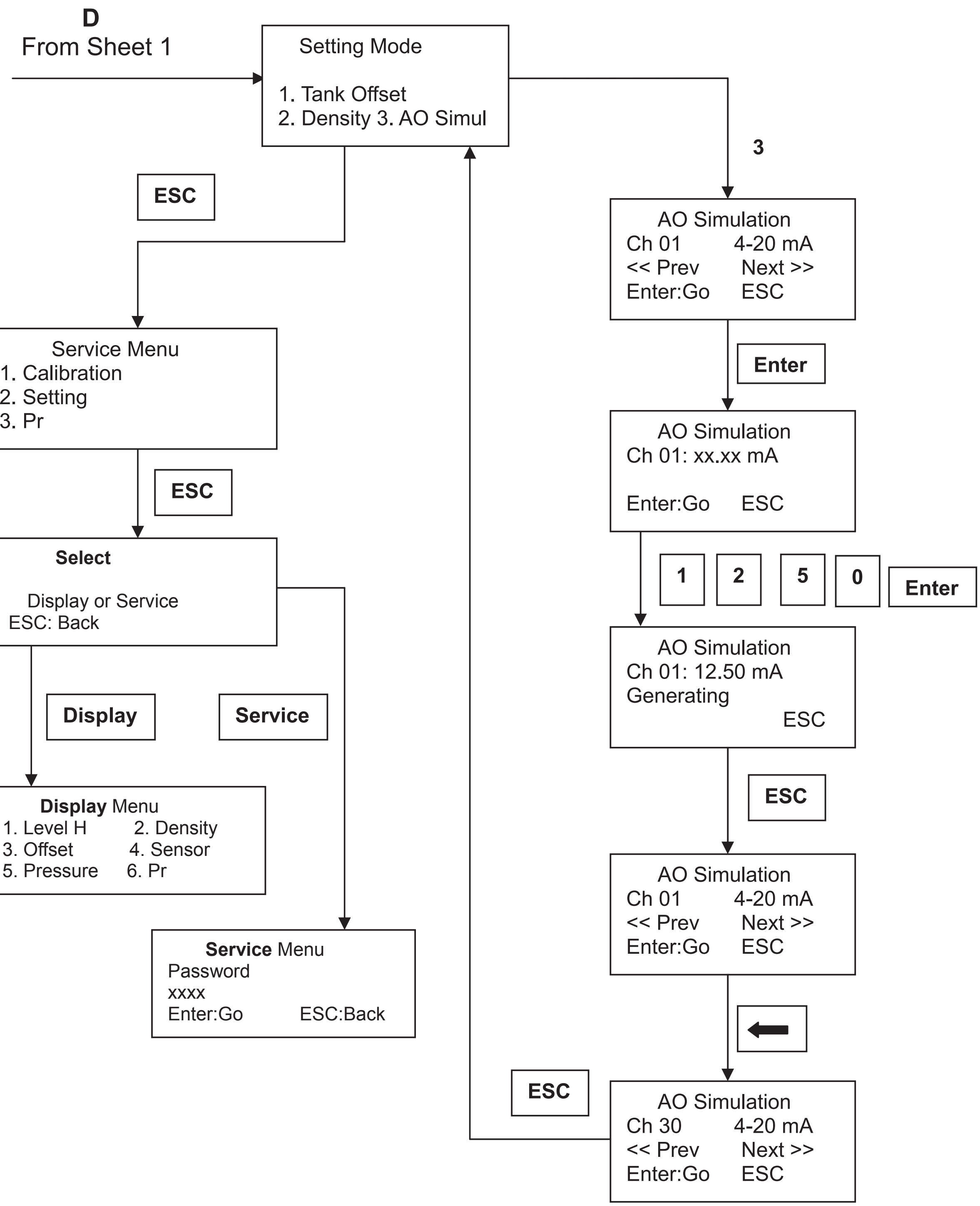
4.3.4 Setting of Tank Offset & Density - Service Menu Sheet 4

After inserted a new value and then press "Enter" key, the LCD will show next channel as below. So, use left arrow key to confirm the value which is correctly inserted.



4.3.5 Analog Output Simulation - Service Menu, Sheet 5 -- Optional Function

This AO simulation is only available when DAU16 unit is included in the system.
If there are no analog pointer instruments, the AO simulation function will not be shown on Service Display Unit.



4.3.6 Flow Resistance - Service Menu Sheet 6

Unit: mbar

There should be no liquid in the tank when measuring Pr value.

Alternatively disconnect the measuring pipe at the non-return valve, and measure pipe resistance from the cabinet to the tank top or tank side at the pipe end.
If measured result is very higher than others, it should be checked and corrected