

Application Note:
Volume measurement
and Custom Flume
configuration for
SmartScan50



AN0022SM

APPLICATION NOTE

VOLUME MEASUREMENT AND CUSTOM FLUME CONFIGURATION FOR SMARTSCAN50

Revision Record:

Date	Description	Written by	Rev.
04/06/2005	Initial release	Zohar Petel	1.00

This document contains proprietary information that is the sole property of **Solid Applied Technologies Ltd.** The document is submitted to the recipient for his use only. By receiving this document; the recipient undertakes not to duplicate or to disclose, in part or the whole, any of the information contained herein; to any third party; without a-priory written permission from **Solid Applied Technologies Ltd.**

Table of Contents

1.	SCOPE	3
2.	OBJECTIVES.....	3
3.	THE METHOD OF MEASURING VOLUME.....	4
4.	MANUALLY INSERTING OF TABLE.....	7
5.	SEMI-AUTOMATIC INSERTING OF TABLE	8
6.	CURRENT CONFIGURATION FOR VOLUME	10
7.	CONFIGURING SPECIAL VESSEL SHAPES.....	11
8.	WEIGHT CALCULATIONS	12
9.	THE METHOD OF MEASURING CUSTOM FLUME	13
10.	CURRENT CONFIGURATION FOR CUSTOM FLUME.....	16
	APPENDIX A: VOLUME CALCULATIONS	17

1. SCOPE

This document defines the configuration procedure of *SmartScan50* unit for volume measurement.

2. OBJECTIVES

- Familiarize the user with *SmartScan50* configuration methods for volume measurements.
- Familiarize the user with *SmartScan50* volume measurements using manually inserting of strapping table.
- Familiarize the user with *SmartScan50* volume measurements using semi-automatic inserting of strapping table.
- Familiarize the user with *SmartScan50* 4-20mA configurations for volume and custom flow measurements.
- Familiarize the user with configuration guidance for special vessel shapes.
- Familiarize the user with 'K factor' for weight calculations.
- Familiarize the user with *SmartScan50* Custom Flume measurements using strapping table.

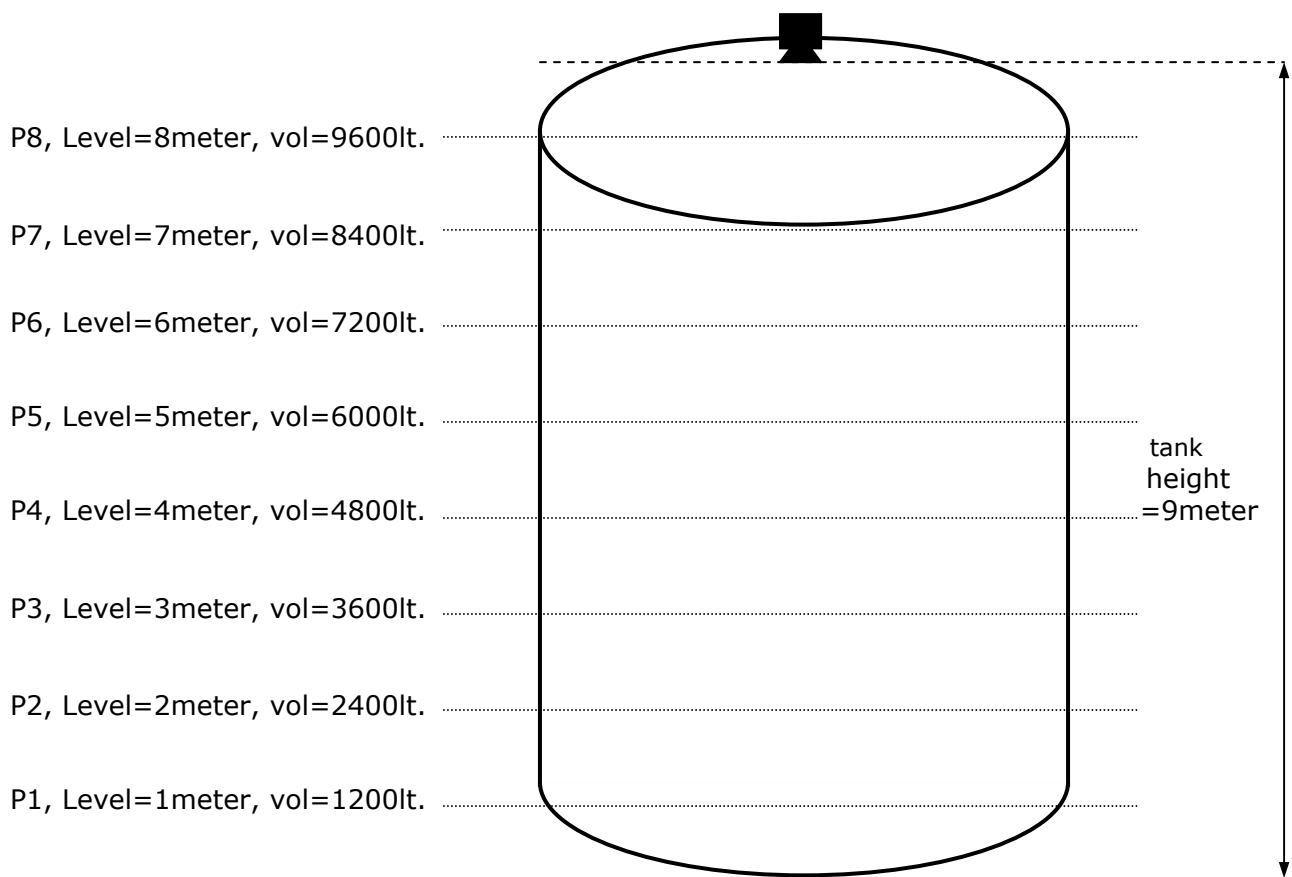
3. THE METHOD OF MEASURING VOLUME

Ultrasonic devices measure the **distance** between the transducer and the measured material top surface. By knowing the tank height, the ultrasonic device calculates the **level** by decreasing the measured distance from the tank height.

When volume measurement is required, the user should configure the **SmartScan50** device to the relation between the volume capacity of the material within the vessel and the corresponding level.

Solid AT SmartScan50 device enable the configuration of a strapping table using 24 linear points. **Per each point the user should define the level measurement and the corresponding volume for this level.**

The drawing below illustrates the inserted Level points on the strapping table:



A strapping table is defined according to the following structure:

Step one: Point number.

Step two: Level from transducer.

Step three: Volume value. The value entered in two separate screens, enables better resolution.

For example, entering a level 4m and volume of 4800lt will be as follows:

Level value: 004.000

Volume value First screen: 004800.

Volume value Second screen: 800.000

Note that the last three digits entered in the previous step, are displayed before the decimal point and that the user can enter one digit after the decimal point.

The strapping table that corresponds to the above drawing should be as follow:

Point	Level	Volume First step	Volume Second step
1	1 meter	001200	200.000
2	2 meter	002400	400.000
3	3 meter	003600	600.000
4	4 meter	004800	800.000
5	5 meter	006000	000.000
6	6 meter	007200	200.000
7	7 meter	008400	400.000
8	8 meter	009600	600.000

① Important notes!

1. Note that values entered in **Level** form and not **Distance**.
2. Note that the first point indicates the bottom of the vessel and the Minimum allowed volume. As you add more points to the strapping table, the level increases equivalent to the volume.
3. Note that there is no need to add a point with a level that equals to the tank height to represent the bottom of the vessel with zero volume.
4. Note that it is forbidden enter **zero** value of volume, the first Volume value should be greater then Zero.
5. Note that the thickness of the strapping table "slices" doesn't need to be even. On the contrary! For different vessel shapes it is quite reasonable to define thinner slices where the volume doesn't increase linearly.
6. Note that a minimum of 8 strapping points is required.
7. Note that there is no option to enter a level value which is grater then the tank height (i.e. tank height is 7 m and entered level point is 8m)

How to set **SmartScan** device to volume measurement?

From the main configuration menu you will need to set the following parameters:

- Type of application – set to Level.
- Units – set your own units (i.e. meter, inch, feet, etc.).
- Tank height – set vessel height bottom to sensor.

Don't define the 4-20mA current values yet.

From the 'additional configuration' menu you will need to set the following parameters:

- Pr.0 – set Ind1 for volume measurement.
- Pr.1 or Pr.2 – Define strapping table.

With **SmartScan** it is possible to define the strapping table in two methods:

- Manually inserting of strapping table: The user enters both Level and volume values.
- Semi-automatic inserting of strapping table: SmartScan measures the level automatically and the user enters the corresponding volume value.

After defining a strapping table in one of the methods mentioned above, set 4mA and 20mA values as described in paragraph 6.

The device is ready for volume measurement after exiting the configuration menu.

① Important notes!

It is always recommended to map vessel interferences using Scan Distance option (refer to page 53 in the SmartScan User Manual).

4. MANUALLY INSERTING OF TABLE

Use 'Manually inserting of strapping table' when:

1. The ratio between level and volume for your vessel is well known.
2. The vessel has standard shape (cylinder, cone or a combination of the two) and it is quite easy to calculate the ratio between level and volume (refer to appendix A for more information about standard volume calculations).
3. It is not possible to use semi-automatic mode.

Manually inserting of strapping table is done from additional menu configuration, Pr.1.

When entering Pr.1, the device will prompt the first point, P1.

For each point it is now possible to define the required level and the corresponding volume.

For example, for the table discussed before:

P1 <Ent>	
Level:	001.000 <Ent>
Volume, first screen:	001200 <Ent>
Volume, second screen:	200.000 <Ent>
P2 <Ent>	
Level:	002.000 <Ent>
Volume, first screen:	002400 <Ent>
Volume, second screen:	400.000 <Ent>
P3 <Ent>	
Level:	003.000 <Ent>
Volume, first screen:	003600 <Ent>
Volume, second screen:	600.000 <Ent>
...	
P8 <Ent>	
Level:	008.000 <Ent>
Volume, first screen:	009600 <Ent>
Volume, second screen:	600.000 <Esc>

Pressing <Esc> after the eight point defines that this is the strapping table's last point.

5. SEMI-AUTOMATIC INSERTING OF TABLE

Use 'Semi-Automatic inserting of strapping table' when:

1. The ratio between level and volume for your vessel is not known.
2. The vessel has unique shape and it is complicated or impossible to calculate the ratio between level and volume.

The procedure of using semi-automatic inserting of strapping table involves a calibration phase using controlled filling process and after interferences were mapped using 'Scan Distance '.

The procedure is as following:

1. Start with almost empty vessel or at first point where the volume contained is known.
2. The level is calculated automatically in 'Semi-automatic' mode. Accept level by pressing <Ent>. (in case that the level measurement is not the expected value press <Next> to search the next level target.
3. Enter the known volume value.
4. Fill the tank with known volume value. As a result the level of the material within the vessel will be increased.
5. For a new point, the unit will calculate the new level.
6. For the new point enter the new volume value.
7. Repeat steps 4 to 6 until the last point required.

① Important notes!

It is highly recommended that the strapping table points will not overlap the scan distance points (keep a gap of at least 40 cm between the nearest strapping table point and the interference).

For example: if there is an interfering at 2m level, use 'Semi-automatic' level points at 1.6m and 2.4m.

This method enables more accurate volume indications than the manual method, but entails slower calibration due to the need of filling the vessel with known value of volume per point.

This method is activated from Pr.2 of the 'Additional menu'.

For example, the process is as following:

P1 <Ent>	
Level:	Searching 001.00 <Ent>
Volume, first screen:	001200 <Ent>
Volume, second screen:	200.000 <Ent>
P2 <Ent>	
Leve:	Searching 002.00 <Ent>
Volume, first screen:	002400 <Ent>
Volume, second screen:	400.000 <Ent>
P3 <Ent>	
Leve:	Searching 003.00 <Ent>
Volume, first screen:	003600 <Ent>
Volume, second screen:	600.000 <Ent>
...	
P8 <Ent>	
Level:	Searching 008.00 <Ent>
Volume, first screen:	009600 <Ent>
Volume, second screen:	600.000 <Esc>

Pressing <Esc> after point eight defines that point eight is the last point in the strapping table.

6. CURRENT CONFIGURATION FOR VOLUME

Once the user configures the *SmartScan50* to volume and sets the strapping table points, it is possible to configure 4mA and 20mA parameters by volume values.

The value of volume should be entered automatically base on the strapping table the 4mA indication will be configured with first step (minimum value) and the 20mA indication will be configured with the last step (maximum value).

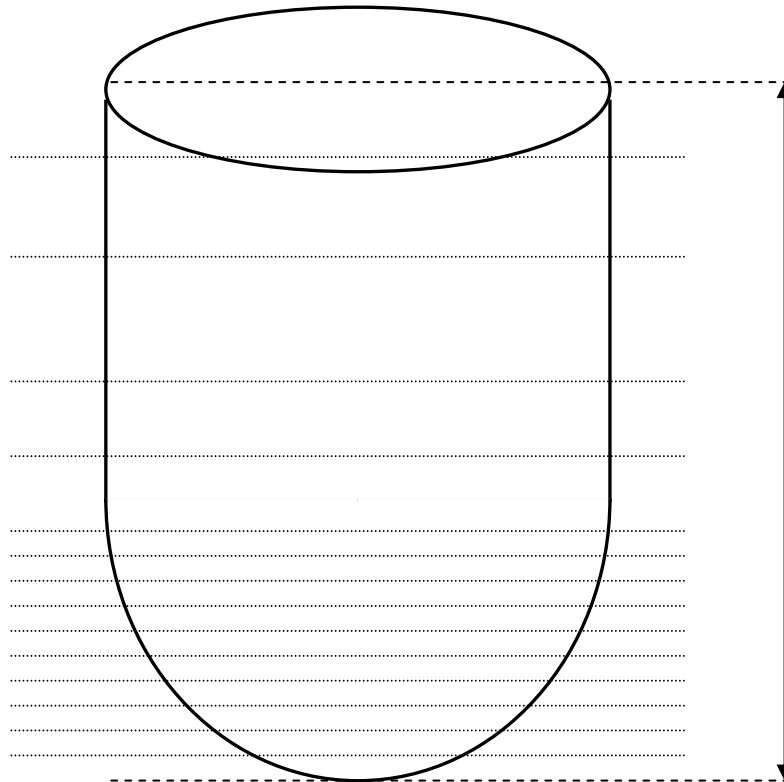
For example base on the strapping table in paragraph 3 the 4mA and 20mA will be configured as following:

- 4mA - 001200
- 20mA - 009600

7. CONFIGURING SPECIAL VESSEL SHAPES

For vessels, which are not completely conical or cylindrical in shape, the volume is not linear with tank height. As a result, user may like to define the strapping tables "slices" unevenly – at least on the non-cylindrical part.

An example of such configuration is illustrated in the following drawing:



In the above drawing one can see that a small deviation in vessel bottom level creates high deviation in volume, while at higher levels of the vessel the ratio between level and volume is quite linear.

As result, it is better to define more "slices" at the bottom of the vessel (where the high deviation in volume creates accuracy which is not acceptable).

All instructions, which are specified in the prior chapters, should be followed in such case as well.

It is recommended to use all 24 strapping table points for better accuracy, mainly on the bottom of the vessel.

8. WEIGHT CALCULATIONS

In some applications the user would like to see the weight value of the vessel content.

Weight can be calculated by knowing the volume and the material specific gravity density.

Let the measured volume be 'Y' and the material gravity density be 'K', the weight 'X' can be calculated as follows:

$$\begin{aligned}(\text{Weight}) &= (\text{material gravity density}) \cdot (\text{Volume}) \\ X &= K \cdot Y\end{aligned}$$

The 'K Factor' should be defined in Pr.3 of the 'additional menu' and the default value of 'K Factor' is 001.000.

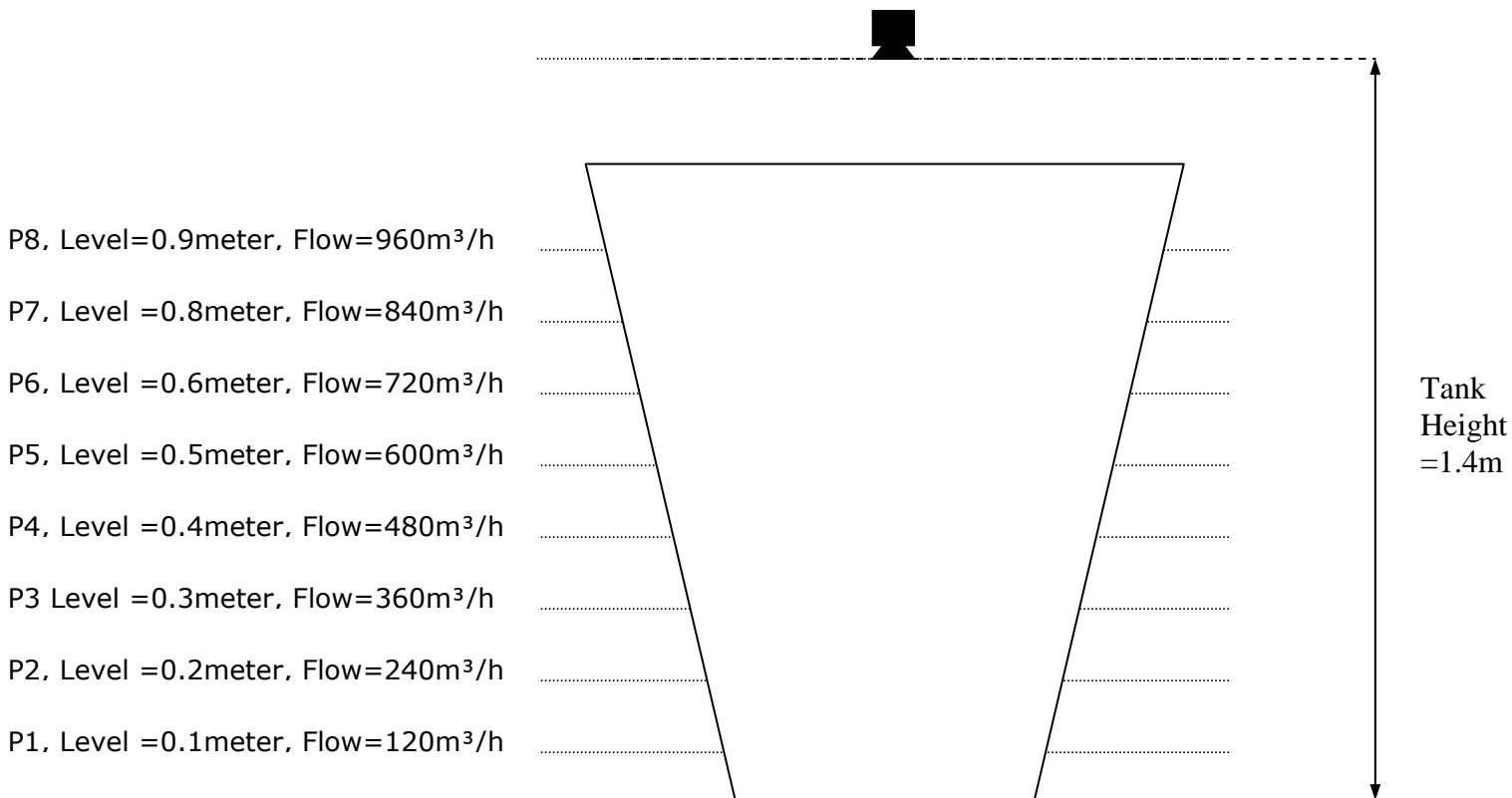
9. THE METHOD OF MEASURING CUSTOM FLUME

Ultrasonic devices measure the **distance** between the transducer and the measured material top surface. By knowing the tank height, the ultrasonic device calculates the **level** by decreasing the measured distance from the tank height.

When custom flume measurement is required, the user should configure the **SmartScan** device to the relation between the flow of the material within the vessel and the corresponding level.

Solid AT's SmartScan devices enable the configuration of a strapping table using 24 linear points. **Per each point the user should define the level measurement and the corresponding flow for this level.**

The drawing below illustrates the inserted Level points on the strapping table:



A strapping table is defined according to the following structure:

Step one: Point number.

Step two: Application Level.

Step three: Flow value. The value entered in two separate screens, enables better resolution.

For example, entering a level 0.4m value of 480M³/h will be as follows:

Level value: 000.400

Flow value First screen: 000480.

Flow value Second screen: 480.000

Note that the last three digits entered in the previous step, are displayed before the decimal point and that the user can enter one digit after the decimal point.

The strapping table that corresponds to the above drawing should be as follow:

Point	Level	Flow First step	flow Second step
1	0.1 meter	000120	120.000
2	0.2 meter	000240	240.000
3	0.3 meter	000360	360.000
4	0.4 meter	000480	480.000
5	0.5 meter	000600	600.000
6	0.6 meter	000720	720.000
7	0.7 meter	000840	840.000
8	0.8 meter	000960	960.000

① Important notes!

1. Note that values entered in **Level** form and not **Distance**.
2. Note that the first point indicates the bottom of the flume and the Minimum allowed flow (it should be the first point value and not 0 level – empty flume). As you add more points to the strapping table, the level increases equivalent to the flow.
3. The first point can be any value greater then zero
4. Note that the thickness of the strapping table “slices” doesn’t need to be even. On the contrary! For different flume shapes it is quite reasonable to define thinner slices where the flow doesn’t increase linearly.
5. Note that a minimum of 8 strapping points is required.
6. Note that there is no option to enter a level value which is greater then the tank’s height (i.e. tank height is 1.4m and entered level point is 1.6m)

How to set **SmartScan50** device to Custom Flume measurement?

From the main configuration menu you will need to set the following parameters:

- Type of application – set to Flow.
- Units – choose your own units (i.e. M³/h, G.P.M).
- Tank height – distance from bottom of flume to sensor’s surface

Don’t define the 4-20mA current values yet.

From the ‘Main menu’ menu you will need to set the following parameters:

- PARSH.FLUM
- For custom flume use 0.E01 (for additional information please check **SmartScan** user’s manual)

After defining a strapping table in one of the methods mentioned above, set 4mA and 20mA values as described in the user manual.

The device is ready for custom flume measurement after exiting the configuration menu.

10. CURRENT CONFIGURATION FOR CUSTOM FLUME

Once the user configures the *SmartScan50* to custom flume and sets the strapping table points, it is possible to configure 4mA and 20mA parameters by flow values.

The value of flow should be entered manually according to the strapping table, the 4mA indication should be configured with first step (minimum value) and the 20mA indication should be configured with the last step (maximum value).

For example base on the strapping table in paragraph 9 the 4mA and 20mA should be configured as following:

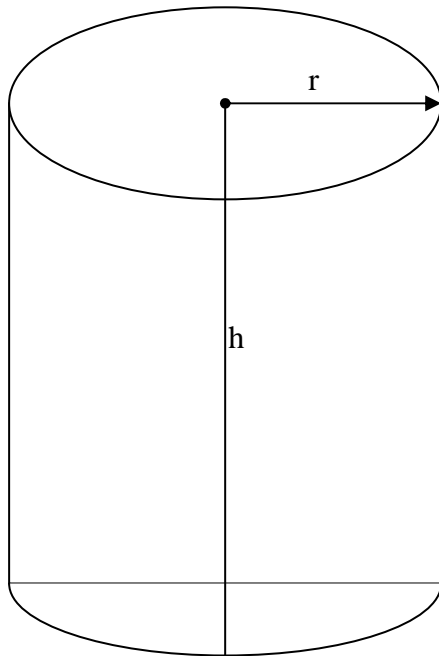
- 4mA - 000120
- 20mA - 000960

ⓘ Important notes!

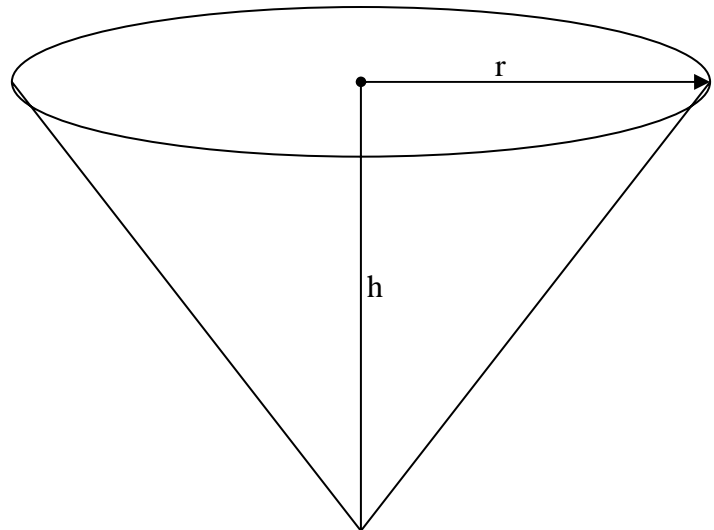
- Note that the 20mA default value is 55490

APPENDIX A: VOLUME CALCULATIONS

When the vessel has a cylindrical or conical standard shape, it is easy to calculate the volume of the vessel according to basic volume equations. The following figure illustrates cylindrical and conical vessel volume calculations.



$$V = \pi r^2 h$$



$$V = \frac{1}{3} \pi r^2 h$$

Using the above equations, it is easy to calculate the height-to-volume ratio.

For example, assume a cylinder shaped vessel with 2-meter radius and 8 meter height. The following table defines the height-to-volume ratio:

Height	Volume
1meter	$V = \pi r^2 h = \pi 2^2 1 = 12.57$
2meter	$V = \pi r^2 h = \pi 2^2 2 = 25.13$
3meter	$V = \pi r^2 h = \pi 2^2 3 = 37.70$
4meter	$V = \pi r^2 h = \pi 2^2 4 = 50.27$
5meter	$V = \pi r^2 h = \pi 2^2 5 = 62.83$
6meter	$V = \pi r^2 h = \pi 2^2 6 = 75.40$
7meter	$V = \pi r^2 h = \pi 2^2 7 = 87.96$
8meter	$V = \pi r^2 h = \pi 2^2 8 = 100.53$