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APPLICATION NOTE

MONOSCAN - EFFECTIVE INSTALALTION TIPS

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1. SCOPE

This document gives few tips for using, configuring and installing **Mono***Scan*® device in an effective way. The **Mono***Scan* unit is applicable for level measurement of both solids and liquids (including open channel flow) and all tips are relevant for these applications. Although all mentioned tips could be found in the **Mono***Scan* User Manual as well, in here we elaborate and emphasize more to illustrate what is a good installation.

2. OBJECTIVES

- Familiarize the user with tank height configuration techniques.
- Familiarize the user with Scan Distance option.
- Familiarize the user with **Mono***Scan* installations via pipes.
- Familiarize the user with operation mode setting.
- Using **Mono***Scan* for open channel flow.

3. SETTING TANK HEIGHT VALUE

Tank height parameter represents the distance between the transducer and the bottom of the tank. Therefore tank height is the maximum distance that would be measured in a specific application.
In most cases, this parameter is defined by simply checking the tank's diagram or based on prior knowledge. This knowledge is usually an assumption not a real measurement that will define whether the known value is true or accurate.

The **Mono***Scan* unit measures the distance from the transducer to the surface level (d) and calculates the level (L) by knowing in advance the tank height (h) using the following formula:

$$L=h-d$$

An error while configuring tank height will cause an error in the calculated level.

Another problem may occur when the tank is empty, or almost empty.
If the measured distance is higher than the tank height, the **Mono***Scan* will display 'EEEE' message. This indication might not be sufficient for some of the users.

Let us examine the following example:

- A tank height defined as 8 meters (26.2ft).
- The measured distance is 8.05meters (26.4ft). As a result, the **Mono***Scan* will display 'EEEE' since the measured distance is higher than the tank height. Of course this is wrong.

By measuring the real value of tank height, one may find that the real tank height is not 8 meters (26.2ft) but 8.1 meters (26.5ft). In such a case the distance as measured by the **Mono***Scan* is correct and a level of 5cm (1.96ft) will be displayed.

From the above, it is clear that for an efficient installation it is better to verify and measure the tank height parameter.
The best way to do so is to use the **Mono***Scan* as a measuring tool.

Solid AT recommends that upon installing the Mono*Scan*, the tank will be empty.

When the tank is empty a maximal distance from the transducer to the bottom of the tank can be measured. This measured value is the real actual tank height and this is the parameter that should be entered in Pr.2 (tank height parameter).
Note that Pr.2 default value is the maximum range supported for a specific application (refer to Appendix A).

! To conclude, use the **Mono***Scan* in its default configuration to measure the real actual tank height by installing the **Mono***Scan* when the tank is empty and then measure the real value from the transducer to the bottom of the tank. This value should be entered in Pr.2.

4. USING SCAN DISATANCE OPTION

Scan distance is one of the most important features available in the Mono*Scan* and we strongly recommend using this feature during the installation process.

The measured distance between the transducer and the level surface is measured by an acoustic pulse that is emitted by the transducer and is bounced back from the level surface. The time interval measured between the time the pulse was emitted and the time it was received back, multiplied with the known sound velocity of the media, reflect the measured distance. This is all true as long as the acoustic pulse is bounced back from the level surface. However, in some cases the tank may contain one or more obstacles that might cause interferences in the way of the acoustic pulse. These interferences are also known as 'false targets' since the acoustic pulses bounced from these obstacles reflect a measurement that is different from the real level surface and is actually a wrong (false) measurement.
Scan Distance locates obstacles that create 'false targets' and false measurements, by mapping the tank and defining whether a measurement is real (true) or not (false).

Scan Distance is operated from function Pr.3 in the **Mono*Scan*** menu. In this mode the unit will display '00SE' which indicates that the **Mono*Scan*** is now searching for interferences.
When the acoustic pulse will bounce from a target (any target) the **Mono*Scan*** will display the distance measurement corresponding to the first target located in the tank. The user now needs to determine whether this measurement represent a real target or a false one.
In case the measured distance represents a false target, the user should press <Nxt>. In return the **Mono*Scan*** will save this target as a false target and will continue to the next target.
In case the measured distance represents a real target, the user should press <Ent>. In return the **Mono*Scan*** will exit from the Scan Distance mode and will return to its regular operating mode.

The **Mono*Scan*** is capable of storing up to four interferences located in the tank. After storing four interference signals the memory act as FIFO (first in first out), the fifth signal will erase the first signal and so on.

The only question left is how the user can determine whether a measurement represent a real target or a false one.

SolidAT recommends that when installing the Mono *Scan*, the tank will be empty.

When the tank is empty all interferences are exposed to the **Mono*Scan*** (when the tank is not empty the surface level can cover some of these interferences). Moreover, we know what distance measurement to expect! When the tank is empty, the only legal distance measurement value should be the one that equals the tank height parameter, as entered in Pr.2.

Let us examine the entire Scan Distance procedure with an example:
Mono*Scan* device is installed above an empty 8.34m (27.3ft), tank ready for Scan Distance

1. Verify that the tank height parameter (Pr.2) is correct, as explained in chapter 3.
2. Activate Scan Distance by selecting Pr.3.
3. The **Mono***Scan* will display '00SE' indicating it is mapping the tank.
4. Assume a distance of "1.243m" (4.04ft) is displayed after few seconds. Since the tank is empty we expect to see a value of 8.34m (27.3ft), therefore this measurement reflects a false target. Save this interference by pressing <Nxt> key. This will save the interference in the Scan Distance table and then will continue with the interferences test.
5. The **Mono***Scan* will display '00SE' indicating it is continuing mapping the vessel.
6. Assume a distance of "2.563m" (8.39ft) is displayed after few seconds. Since the tank is empty we expect to see a value of 8.34m (27.3ft), therefore this measurement reflects a false target. Save this interference by pressing <Nxt> key. This will save the interference in the Scan.
7. Always monitor the number of interferences you store in the Scan Distance table. If there are more than four interferences you will need to consider other solution - like the SmartScan unit that supports up to 8 interferences or installation via a pipe (refer to the next chapter for more information).
8. Assume a distance of "8.331m" (27.3ft) is displayed. Since the tank is empty we expect to see a value of 8.34m (27.3ft) however, the deviation between the measured distance and the known measured tank height is within the accuracy limitation of the device. Since the measurement reflects the real measurement (the bottom of the tank), exit Scan Distance by pressing <Ent> key. As a result, **Mono***Scan* will return to its regular operation mode.

! Important Notes:

- Measurement results in Scan Distance mode are in Distance form (and not Level form).
- Always verify whether the distance measured reflects the real known level, considering **Mono***Scan* known measurement deviation (refer to Appendix A).

Another interesting question is what will be the **Mono***Scan* response in case we stored interference distanced 1.234m (4.04ft) from the transducer and the surface level distance is the same?
The answer to this question is that in Scan Distance the **Mono***Scan* is not only storing the distance from the transducer to the false target, but also saving an indication about the amplitude of the return acoustic pulse. Assuming that even when the level will be distanced exactly 1.234m (4.04ft) from the transducer, statically it is almost impossible that it will return the exact amount of energy as the false target (as different materials attenuates the acoustic pulse differently). In this way the

Mono*Scan* separates between the acoustic pulse bounced from a real level and the acoustic pulse bounced from the false target already stored; even if the distance is the same.

Again, we emphasize the importance of the Scan Distance test as even if false targets cannot be seen, they are often present. Also, we emphasize the importance of activating the Scan Distance when the tank is empty so all interferences will be located (won't be covered by material surface) and so the user would know what distance to expect.

Lastly, we will discuss the case where the acoustic interference located in the dead zone. Let us examine the following example: **Mono***Scan* standardrangedeadzoneis0.60m(1.96ft).Incaseinterferenceis
located in a distance of 0.43m (1.41ft), the **Mono***Scan* will be locked on this false target and will not be able to measure anything else. Since the false target is located in the dead zone, the unit will not recall any legal measurement and the **Mono***Scan* will display a constant "FFFF". In such case the user should know that it is possible that a false target will be located in the dead zone and therefore should not be considered. Activating Scan Distance will eliminate this false target.

! To conclude, it is always recommended using the Scan Distance option with any installation. Scan Distance is activated in function Pr.3. During the process the user must instruct the device whether the measured distance represent a false target (press <Nxt>) or real target (press <Ent>). It is highly advised to use Scan Distance when the tank is empty, when all interferences are exposed and user expect a measurement result equal to the tank height.

5. INSTALLING MONOSCAN VIA A PIPE

A user should consider installing the **Mono***Scan* via a pipe in the following circumstances:

1. Increasing dead zone area:
The **Mono***Scan* has a dead zone of 0.60m (1.96ft) in Standard Range and 0.25m (0.82ft) in Short Range. In this distance the transducer cannot separate between the acoustic pulse that bounced from the level surface and the internal vibration of the transducer. Thus, it is required to install the **Mono***Scan* in a way that the measured surface level will not exceed this distance from the transducer. In case the level penetrates the dead zone, it is recommended to install the **Mono***Scan* a bit higher than its original location. A solution for that could be to elevate the ***MonoScan*** position using a pipe.

2. Eliminate close interferences:
In case interferences are located very close to the transducer, it is possible to eliminate them via a pipe. Measuring via a pipe provides the **Mono***Scan* a clean environment (clean from acoustic interferences) and by that increases the **Mono***Scan* functionally. A pipe is a better solution than the Scan Distance for interferences in close proximity to the transducer, as the number of interferences can be stored in the **Mono***Scan* is limited to four and each stored interference slows the device operation. From this aspect, a pipe is a win-win situation.

3. Overcoming large obstacles:
When there are interferences caused by large obstacles located inside the tank, it is still possible to achieve accurate measurement results by installing the **Mono***Scan* through a long pipe. When the measured fluid in enters the pipe and reaches the same level as in the tank, the indication received by the **Mono***Scan* unit will be accurate disregarding environmental obstacles and noises.

Since the variety of pipes is quite wide, Solid AT tested and found that a pipewithaninternaldiameterof 3'' and a length of 1 meter is the appropriate solution for **Mono***Scan*. In addition, it is always recommended to use Scan Distance when using a pipe to eliminate interferences that may be caused by the pipe itself.

It is important to understand that installing the **Mono***Scan* via a pipe some times increase the tank height (the distance from the transducer to the bottom of the tank) and by therefore Pr.2 should be configured accordingly.

! To conclude, installing via a pipe should be considered in case the surface level may penetrate the device dead zone, to eliminate acoustic interfaces that are close to the transducer and to improve measurement of liquids by using a long pipe to overcome environmental noises. A recommended pipe is with an internal diameter of 3'' and a length of 1 meter.

6. CONFIGURING OPERATION MODE

Mono*Scan* L and O models support two operation modes – low or high dynamic.
When configuring Pr.6, the user may choose low dynamic (SE0) or high dynamic (SE1).

The main difference between high dynamic mode and low dynamic mode is the statistic processing. In the Low dynamic mode, there is a use of a sliding average algorithm. In the high dynamic mode there is a use of a simple average algorithm. In both cases the first stage of the measurement would be a management of the echo's amplitude (search and track).

The following describes the measurement process:
The low dynamic mode is receiving 20 measurements during each reading. In order to show a reading there is a need of 8 echoes, within the amplitude window. If the echo is outside the amplitude range, it would not be taken into account when calculating the average.
The high dynamic mode is receiving 8 measurements during each reading. In a proper environment, the process of calculating the average of 8 echoes is faster than calculating 20 echoes and therefore the results are shown faster.

It is preferable to use the Low dynamic mode in tanks with slow activity.
The response time in this mode will be 2cm/min accuracy 0.25%
When working with tanks with rapid fluctuations it is preferable to use High dynamic. In this case the response time will be 4cm/min accuracy 0.30%.

In both modes the response time is depended on the power consumption.

! To conclude, Low or High Dynamic can be activated through Pr.06 in the **Mono***Scan*. It is recommended to use these modes in relevancy to the type of process in the tank. Note that these modes affect the time response of the **Mono***Scan*.

7. USING MONOSCAN IN OPEN CHANNEL FLOW APPLICATIONS

Mono*Scan* ***O*** model gives the user the ability of measuring the flow of a specific flume or weir.
The **Mono***Scan* measures the level of fluid in the flume or weir. By knowing the exact type of the flume, its geometrical shape and its dimensions it converts the level to flow utilizing a set of internal formulas.

When using the **Mono***Scan* to measure flow in an open channel, the user must refer to the following notes:

1. **Mono***Scan* supports up to nine different types of flumes and weirs, in both American and European standards. Refer to the User Manual for a list of supported flumes and weirs and their dimensions.
2. Refer to the flume and weir drawing. In most cases there is a certain distance defined where the transducer should be installed away from the flume/weir's throat.
3. In case of an open channel application, the tank height parameter is the distance between the transducer and the bottom of the flume. All installation tips introduced in this application note for tanks, are also relevant for open channel applications.
4. Use **Mono***Scan* ***O*** short range, because it has the best accuracy available, 1.25cm (0.04in)! (Refer to appendix A). Use **Mono***Scan* ***O*** standard range only in rare cases where you are forced to install the transducer higher than 5m (16.4ft) above the bottom of the flume.

APPENDIX A: ACCURACY AND RANGES TABLE

Following is a table that summarizes the supported ranges and accuracy for the different **Mono***Scan* models.
Mono*Scan* accuracy is 0.25% of maximum operating range (in low dynamic mode). As a result, the ranges and measurement deviation are as follow:

MonoScan model	Application	Max. Operation Range	Max. Measurement deviation
Standard Range	Liquid	15 m (49.2ft)	3.75cm (1.47ft)
	Flow	15 m (49.2ft)	3.75cm (1.47ft)
	Solid	8.5 m (27.8ft)	2.125cm (0.836in)
Short Range	Liquid	5 m (16.4ft)	1.25cm (0.04in)
	Flow	5 m (16.4ft)	1.25cm (0.04in)
	Solid	5 m (16.4ft)	1.25cm (0.04in)