

## APPLICATION NOTE

# SOLIDSCAN TRACKING RATE CAPABILITIES

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## **1. SCOPE**

This document provides an introduction to the tracking rate capabilities of SolidScan device. The document will refer to different modes and application type in order to provide sufficient information on the proper mode that matches the application.

With this information customers will be able to configure Solid AT' products adequately and achieve proper matching to the environment.

The information provided herein is based on the following SW versions:

- SmartScan 50 Version: 5.073
- SmartScan 25 Version: 2.058
- SmartLite Version: 2.058
- MonoScan Version: 4.090\_0359
- MicroScan Version: 4.090\_0359

## **2. OBJECTIVES**

- Familiarize the user with the available operation mode.
- Familiarize the user with the configuration of the different modes.
- Familiarize the user with the types of filters used in each mode/device.
- Familiarize the user with the tracking rate of each mode.

### 3. INTRODUCTION TO KALMAN FILTER AND AVERAGING FILTER

Humans have been filtering things for virtually our entire history. Water filtering is a simple example. We can filter impurities from water as simply as using our hands to skim dirt and leaves off the top of the water. Another example is filtering out noise from our surroundings by learning to ignore superfluous sounds like traffic, and focus on important sounds, like the voice of the person we're speaking with. There are also many examples in engineering where filtering is desirable. Radio communications signals are often corrupted with noise. A good filtering algorithm can remove the noise from electromagnetic signals while still retaining the useful information.

#### 3.1 Kalman Filter

Kalman filter address the following question: given our knowledge of the behavior of the system, and given our measurements, what is the best estimate of position and velocity? We know how the system behaves according to the system equation, and we have measurements of the position, so how can we determine the best estimate of the system variables? Surely we can do better than just take each measurement at its face value, especially if we suspect that we have a lot of measurement noise.

The Kalman filter is formulated as follows. Suppose we assume that the process noise  $w_k$  is white gaussian noise with a covariance matrix  $Q$ . Further assume that the measurement noise is white gaussian noise with a covariance matrix  $R$ , and that it is not correlated with the process noise. We might want to formulate an estimation algorithm such that the following statistical conditions hold:

- The expected value of our estimate is equal to the expected value of the state. That is, "on average," our estimate of the state will equal the true state.
- We want an estimation algorithm such that of all possible estimation algorithms, our algorithm minimizes the expected value of the square of the estimation error. That is, "on average," our algorithm gives the "smallest" possible estimation error.

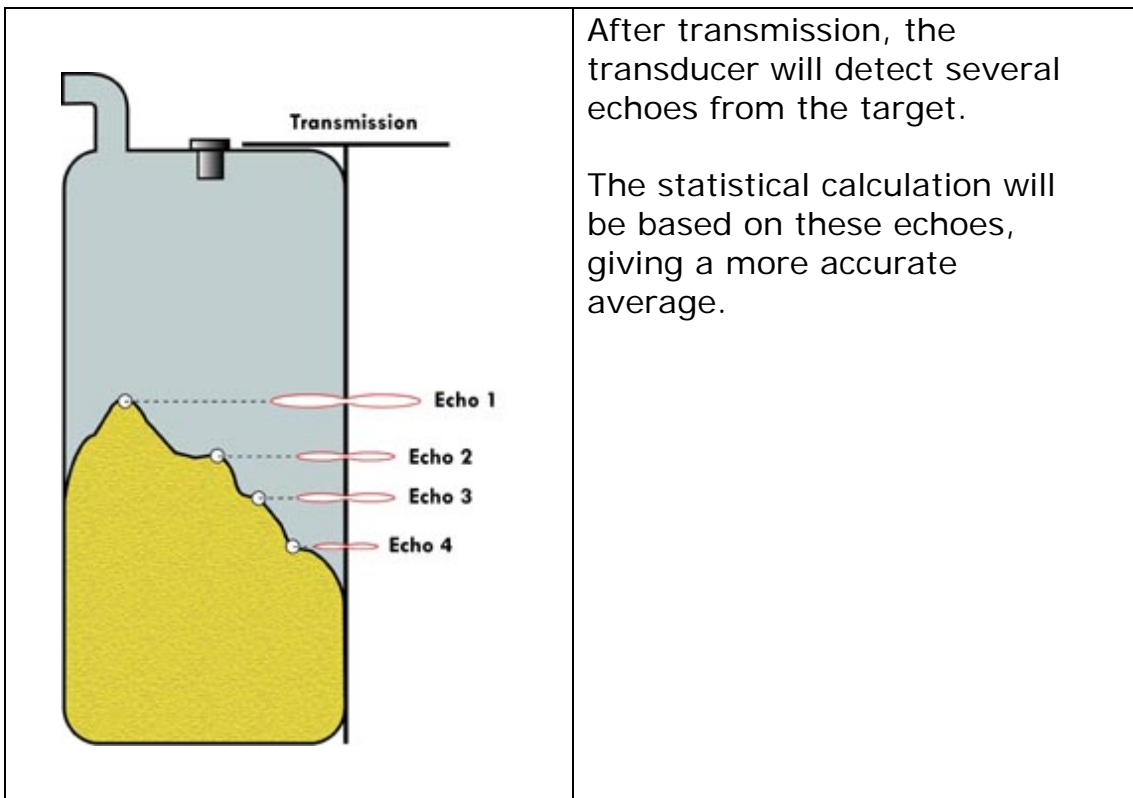
It so happens that the Kalman filter is the estimation algorithm, which satisfies these criteria.

### 3.2 Averaging Filter

The averaging filter is based on statistic processing done during the measurement process. The first stage of the measurement would be a management of the echo's amplitude (search and track), followed by receiving of number of measurements within the reading and mapping readings that fall outside the amplitude range.

Averaging filter is very suitable for solids applications, where the target is not flat, therefore the transmission may detect different targets. Due to the arrangement of the material the reading may jump from the highest point to the lowest point.

The use of an averaging filter will eliminate the possibility of "jumps" since it will give the average result of the different targets detected during the measuring process.



## 4. SELECTING THE OPERATION MODES

The operation modes function enables you to set SolidScan devices to compensate for environmental conditions that affect the measurement readings.

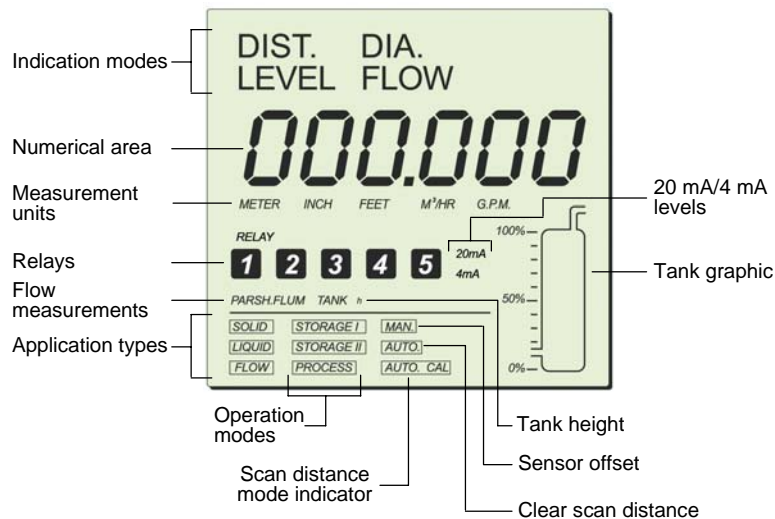
For solid and liquid applications, each mode determines the reaction time required for SolidScan to recalibrate when there is a change in the environmental conditions.

### 4.1 SmartScan and SmartLite







SmartScan 25, SmartScan 50 and SmartLite offer 3 modes:

#### **STORAGE I, STORAGE II and PROCESS.**

The modes settings are defined by making a selection from the main menu.



To select the mode:

Press/Action	Display	Explanation
 or 		Used to toggle between the speed modes.
		
		
		Saves the selected speed mode.

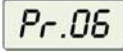







## 4.2 MonoScan and MicroScan

MonoScan and MicroScan offer 2 modes:

**HIGH DYNAMIC** and **LOW DYNAMIC**.

The modes setting are accessible via Pr.06.

To select the speed mode:

Press/Action	Display	Explanation
{		Required menu selection.
{	 or  or 	Displays the current speed mode setting.
{	 or 	Used to toggle between the speed modes.
{	 	Saves the selected speed mode.

## 5. MODES CAPABILITIES

Depending on the specific requirements for your application, you can select a mode that provides faster readings but with less precision (by performing a smaller number of calculations per cycle), or slower readings with a greater degree of accuracy (by performing a larger number of calculations per cycle).

## 5.1 SmartScan

Following are the available modes for SmartScan 50, SmartScan 25 and SmarLite:

### SmartScan 50

Mode	<b>STORAGE I</b>	<b>STORAGE II</b>	<b>PROCESS</b>
Application			
Liquid and Open channel	2-5 cm per Min	10-25 cm per Min	100 cm per Min
	Kalman Filter High averaging (100 samples)	Kalman Filter High averaging (100 samples)	Kalman Filter Low averaging (50 samples)
Solid	2-5 cm per Min	10-25 cm per Min	100 cm per Min
	Averaging Filter (100 steps) and Kalman Filter High averaging (100 samples)	Averaging Filter (50 steps) and Kalman Filter with High averaging (100 samples)	Kalman Filter Low averaging (50 samples)

## SmartScan 25

Mode	<b>STORAGE I</b>	<b>STORAGE II</b>	<b>PROCESS</b>
Application			
Liquid and Open channel	2-5 cm per Min	10-25 cm per Min	100 cm per Min
	Kalman Filter High averaging (100 samples)	Kalman Filter High averaging (100 samples)	Kalman Filter Low averaging (50 samples)
Solid	2-5 cm per Min	10-25 cm per Min	100 cm per Min
	Averaging Filter (100 steps) and Kalman Filter High averaging (100 samples)	Averaging Filter (50 steps) and Kalman Filter with High averaging (100 samples)	Kalman Filter Low averaging (50 samples)

## SmartLite

Mode	<b>STORAGE I</b>	<b>STORAGE II</b>	<b>PROCESS</b>
Application			
Liquid	2-5 cm per Min	10-25 cm per Min	100 cm per Min
	Kalman Filter High averaging (100 samples)	Kalman Filter High averaging (100 samples)	Kalman Filter Low averaging (50 samples)

## 5.2 MonoScan

Following are the available modes for MonoScan and MicroScan:

### MonoScan

Mode	SE 0	SE 1
<b>Application</b>	<b>Low Dynamic</b>	<b>High Dynamic</b>
Liquid and Open channel	80 cm per Min	100 cm per Min
	Low averaging (248 samples)	High averaging (128 samples)
Solid	80 cm per Min	<b>NA</b>
	Low averaging (248 samples)	
Fail-safe timer	10 minutes	3 minutes

### MicroScan

Mode	SE 0	SE 1
<b>Application</b>	<b>Low Dynamic</b>	<b>High Dynamic</b>
Liquid	80 cm per Min	100 cm per Min
	Low averaging (248 samples)	High averaging (128 samples)
Solid	80 cm per Min	<b>NA</b>
	Low averaging (248 samples)	
Fail-safe timer	10 minutes	3 minutes

Note: Fail-safe timer determines the waiting period from a lost of echo till a transmission of an error signal.