IS-350

Acoustic Microscope

InsightScan
Operation Manual

Version 2.0.1, March 2024

Insight k.k.

Digital Acoustics NonDestructive Diagnostics

Content

1. Important Notice

The present Manual has been prepared to introduce the acoustic microscope IS-350 and its control software InsightScan version 1.0 or higher.

If your IS-350 system is operated with a software version before rev. 2299, then please refer to version 1.0 of the present Manual.

If you are using another acoustic microscope than the IS-350 model, then please contact your Support center (see Chapter 10) to receive a Manual adapted to your measurement system.

1.1. Proprietary Notice and Copyright

The present manual is supplied for the installation of an Insight kk measurement instrument. All information is proprietary in nature and should be treated accordingly. In particular, the data should not be used, duplicated or disclosed, in whole or partially, for the manufacture or procurement of the instrument or any of its parts without written permission of Insight kk.

All information contained in this manual is compiled to the best of Insight kk's knowledge at the time of publication. Insight kk hereby disclaims any liability for any possible errors or misprints.

1.2. Receipt of Equipment

It is the responsibility of the Customer to check the instrument immediately upon arrival, and any claims as to the quantity and/or quality of the instrument must be received within eight (8) days, by means of a registered letter with the return receipt requested. Any claim made after this time shall be considered late and shall have no effect. In the event of delivery of an instrument with defects which are attributable to Insight kk, the nature of which are particularly grave and serious, Insight kk shall have the option of either replacing the instrument or refunding the price of the instrument which has been returned and which Insight kk acknowledges as being defective. Instruments may only be returned to Insight kk by agreement between Insight kk and the Customer and on terms and conditions that they shall mutually agree.

Claims on grounds attributable to the carrier must be addressed to the carrier by the Customer, it being agreed that Insight kk shall have no liability whatsoever, in connection with the carriage of the instrument. It is incumbent upon the Customer to ascertain any anomalies in the delivered instrument and to record the same on the transport documents before acknowledging performance by the carrier.

1.3. Warranty and Liability

Insight kk warrants the instrument to be free from defects in workmanship and/or materials for a period of one (1) year from the date of delivery. Insight kk shall replace or repair, at its sole option and expense, any defective goods or portions thereof. For consumable parts, such as but not limited to acoustic transducers, the period of warranty is limited to a period of six (6) months from the date of delivery. This warranty will apply only if the Customer (a) promptly notifies Insight kk in writing during the warranty period of the claimed defect or nonconformity, and (b) makes the item(s) available for correction at Insight kk's facility or returns the item(s) after obtaining prior written authorization from Insight kk. The Customer shall prepay and be liable for all charges in connection with loading and shipping goods to Insight kk, including applicable insurance and taxes.

Licensed software is not warranted as free from errors or “bugs” and Insight kk’s sole obligation is to use reasonable efforts to supply the Customer with a corrected version after notification of defect.

Insight kk’s liability hereunder is limited solely, at Insight kk’s option, to repair or replace with new or “like new” equivalent goods. Insight kk shall hold all rights, titles, and interest in and to any goods replaced under this warranty provision. The original warranty period shall not be extended by acts of the Customer in compliance with this section.

All warranties shall be void if goods have been repaired, modified, or used in any other way than stated by the systems operation manual, or if repairs have been attempted by any person without the prior written approval of Insight kk.

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES WHATSOEVER, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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In no event shall Insight kk be liable for any incidental or consequential damages (including, but not limited to incidental or consequential damages for lost profits, lost sales, or any other incidental or consequential loss) in connection with the purchase, operation or use of the instruments supplied by Insight kk.

2. Safety Notes

The present manual is supplied for the operation of the Insight IS-350 acoustic microscope.

Before starting to work with the system, please read the present manual carefully and completely.

In case your system is not yet installed, please first refer to the Installation Manual. You might also contact one of Insight's worldwide service addresses (see Chapter 11) for further assistance in system installation.

There are no serviceable parts in the IS-350, other than the circuit protectors and earth leakage circuit breaker. Do not open the IS-350. Do not attempt any system modification, repair, or service other than the regular user maintenance operations introduced in the Operations Manual. Only use Insight consumables and spare parts.

If the IS-350 is not used as prescribed, in particular as described in the Installation and Operation Manuals, the instrument's warranty will be void and the overall equipment as well as the personal safety of the user may be impaired.

Any modification of the system, repair, maintenance, or any activity other than those described in the present manual are strictly reserved to Insight kk personnel, or service engineers trained and authorized to do so by Insight kk.

2.1. Electrical Safety and EMC

2.1.1. Power Supply

The IS-350 needs a power supply of 220 – 230 V AC, 50/60 Hz. It has to be connected by a suitable three-wire cable (phase, neutral, ground).

The maximum absorbed current is 6 A. During standard operation a typical current of < 2 A is absorbed.

When connecting the system to mains power take great care not to bring wet hands, tools, cloths, or other wet items in contact with the power cord, the mains plug, or other parts related to electrical power. Humid surfaces of all kinds are excellent conductors of electricity. Bringing them in contact with electrical power may cause severe injury, including death.

2.1.2. Electromagnetic Compatibility - EMC

The IS-350 is an Electromagnetic Compatibility Class A instrument and is to be used in industrial, commercial, or business environments. Do not use it in the private or residential environment.

2.1.3. Electric Protection

The IS-350 uses six circuit protectors (1 x 5A, 2 x 3A, 2 x 2A, and 1 x 1A), and one earth leakage circuit breaker.

2.2. Handling Safety

The total weight of the IS-350 is 180 kg (scanner only, without water).

HEAVY - Do not move the IS-350 when you are alone. Ask at least a second person for help. The IS-350 is equipped with four wheels for moving the system on flat floors without carrying it (see Figure 1-1). Make sure to use these wheels for moving the system. For placing the system on its wheels, you need to manipulate the length of the system's feet by using a suitable wrench.

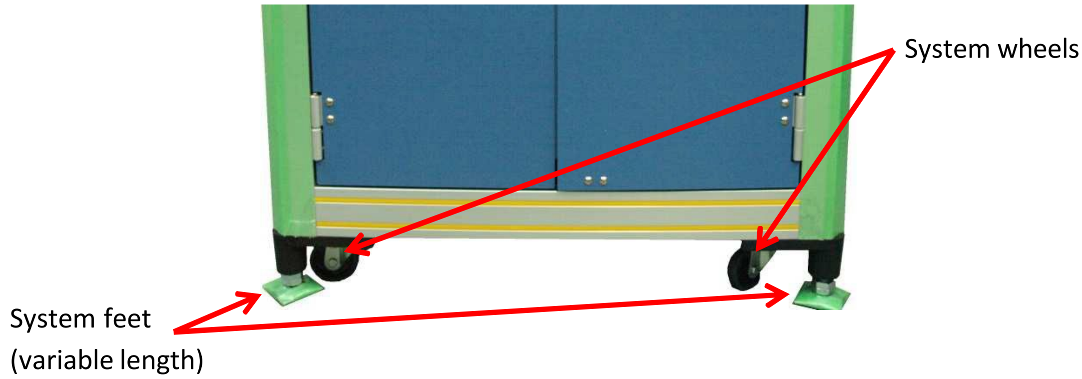


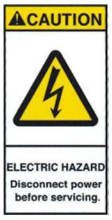
Figure 1-1: For moving the system, it should be lowered onto the four wheels integrated on its bottom side.

2.3. Labels and Signs

The following labels and signs are used on the IS-350 system to either make you aware of hazards or to advise you on issues of interest for a safe and reliable operation of the machine.

General warning sign: This sign makes you aware of a potential general safety hazard. It is applied close to switches, removable covers, electrical connectors or any other area where you should not interact without having read and understood the related description in this Installation Manual, as well as in the system's Operation Manual. This sign is also used throughout the present Manual for highlighting paragraphs that should attract your special attention.

Earth ground: This label identifies the electrical earth ground.



Risk of electrical shock: These two signs advise you against a wide variety of electrical dangers. Access to the electrical part of the machine is strictly restricted to Insight service personnel or Insight's trained and qualified representatives. Never operate the system with any cover open. During maintenance, the system has to be completely disconnected from the main power.

Caution – Crush hazard: This sign advises against crush hazards by moving parts. The scanner head in the IS-350 system is fast-moving in all three directions (x,y,z). Accessing the scanner head during a scan may cause serious injury and is therefore absolutely forbidden. Make sure all motors are stopped before opening the IS-350's front cover.

Caution – No remodeling and decomposition: This sign warns against various kinds of dangers (electrical, mechanical, etc.) related to opening, decomposition or remodeling of the system. There are no serviceable parts inside the IS-350. Do not open the system. Do not attempt to modify, repair or service the system otherwise than described in the Installation and Operation Manuals. Opening the system may expose you to the risk of personal injury, and void the system's warranty.

Caution – Heavy: This sign advises against dangers related to heavyweight. The total system weight of more than 180 kg requires at least two persons to lift and move the system. Do not lift the system when you are alone.

3. Start-Up and Shut-Down

3.1. System Control Elements

Figure 3-1 shows the control elements on the IS-350's front side.

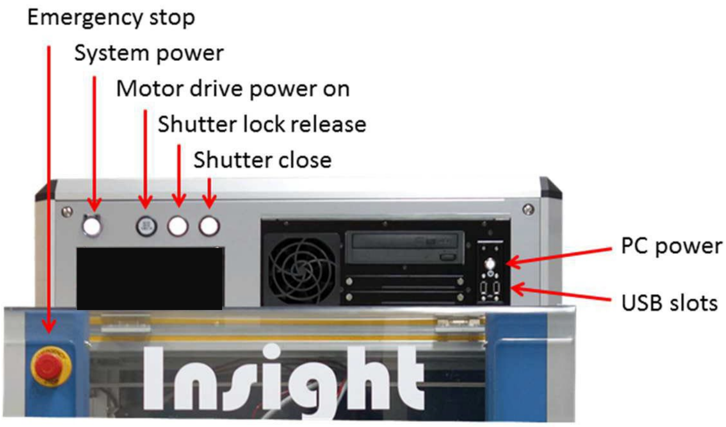


Figure 3-1: Control elements on the IS-350's front side.

- The **Emergency Stop** button allows to immediately stop the motion of the system's motors in case of an emergency. To operate the system again after an emergency stop you need to
  - Close the operating software InsightScan;
  - Release the **Emergency Stop** button by turning it clockwise;
  - Wait for 5 seconds;
  - Push the **Motor drive power on** button (Figure 3-1);
  - Then start InsightScan again. You need to re-initialize the motors during the start-up of InsightScan.
- **System power:** Use the system power switch to switch on and off the IS-350. The switch is illuminated when the power is on, and dark in case the system is switched off. Note that the system's PC is directly connected to mains power, not to the system power. Therefore, you may use the system's PC for data analysis or other tasks even with the scanner itself switched off.
- **Motor drive power on:** This switch is normally illuminated, except in case the **Emergency Stop** is activated. Then the electrical motor drive power is shut down, and the switch becomes dark. Refer to the procedure given above to know how to reset the system after an emergency stop.
- **Shutter lock release:** This switch controls access to the scanning zone via the system's front door. The following visual indications are used:
  - **Switch illuminated:** The front door is closed and secured by an electromagnet. The system is ready for scanning.
  - **Switch blinking**: The switch starts blinking after being pressed. Pressing the switch will deactivate the front door security: Scanning capability will be disabled and opening the front door becomes possible. Blinking and deactivation of the door security mechanism remain active for some seconds only.
  - **Switch illumination off**: The switch illumination is off in case the system's front door is open. The power supply on all motors is shut down. The switch is also off in case the door

is closed and one of the system's motors is running. In this case, the missing illumination indicates that the front door security closure cannot be released until all motors are stopped.

***Note** that shutting down the power supply of the motors implies also that no holding current is present any more, and that all motors can be moved relatively easily by hand which in turn invalidates the current position calibration of the motors. Therefore, before opening the front cover please move the scan head to a position where accidental contact with the mechanics can be avoided. Otherwise, you need to recalibrate the motor positions (see Section 4.5) before continuing to do acquisitions.*

- **Shutter close:** This indicator is illuminated in case the front door is closed, and off in case the front door is open.

The system's control PC is integrated in the rack, and accessible on the front panel as shown in Figure 3-1. It features a **PC power** switch, a CD-ROM drive, and 2 USB slots. The PC needs to be switched on by its **PC power** switch. It is not mandatory to switch the general **System power** on for operating the PC.

3.2. Start-Up

The following system start-up procedure should be followed:

- Switch on the IS-350 scanner by using its system power switch (Figure 3-1).
- Wait for 5 seconds, then push the **Motor drive power on** button.
- Switch on the PC by using the PC power switch (Figure 3-1).
- Launch the InsightScan software.
- In the next window the software asks you to confirm the detected system profile. Click on **Ok** to continue.
- You then will be asked if the scanner is ready to be initialized (see Figure 3-3). You have the following options:
  - Clicking on **Yes** will start the initialization process. Please refer to Section 4.5 for details. In particular, make sure that no sample or other part in the sample tank is hindering the free motion of the measurement head. Otherwise, permanent damage to the measurement head or transducer may occur. In case you would like to apply previously established measurement recipes you need to initialize the system.
  - Clicking on **No** will open the InsightScan software without initialization of the scanner. In this case, the current position of the scanner will be considered as (x,y,z) = (0,0,0). Therefore, in general, the (0,0,0) position will not be in the center of each axis range (as it would be after initialization).
  - Clicking on **Cancel** will close the InsightScan software.
- Finally, the InsightScan main window opens.

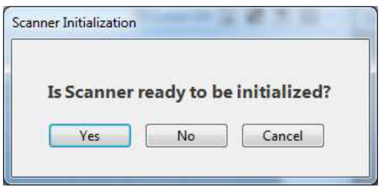


Figure 3-3: This window opens during the InsightScan start-up, to ask you for scanner initialization.

3.3. Screen Layout and Peripherals

3.3.1. Screen Layout

The Layout of the InsightScan main screen can be freely adapted to your preferences. Figure 3-4 shows one possible layout. The following elements can be identified:

1. The **Menu Bar**: This Explorer offers some capabilities which might be temporarily useful for data exploration. It can be pinned to the screen or hidden by clicking on the drawing pin in its upper left corner. (see Section 3.3.2)
2. The **Tool Box**: This column contains functions which are typically often used during the measurement optimization process for new samples. Therefore, the Toolbox can be pinned to the screen or released from it by clicking on the drawing pin in its up-left corner. When unpinned, the toolbox will be hidden to allow for more free space on the screen.
3. The **Main Working Area** is the area where data acquisition is defined and executed, and where some data analysis can be done. It contains sections for setting scan parameters, oscilloscopes for signal analysis, and the StageScope which shows the C-Scan images resulting from the sample scans. The content of this area can partially be influenced by the Peripheral Controls.

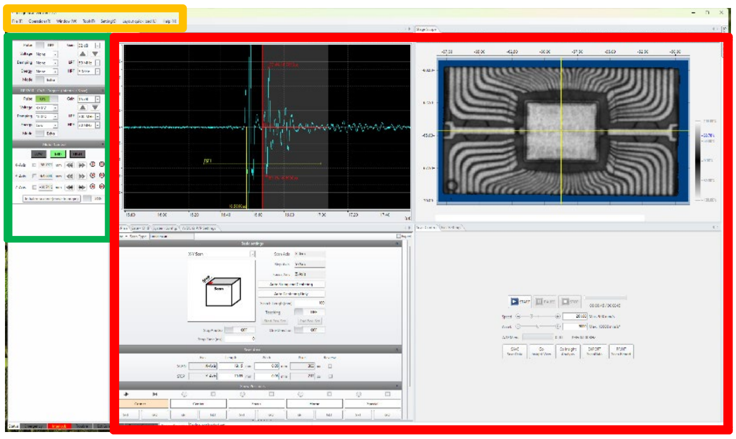
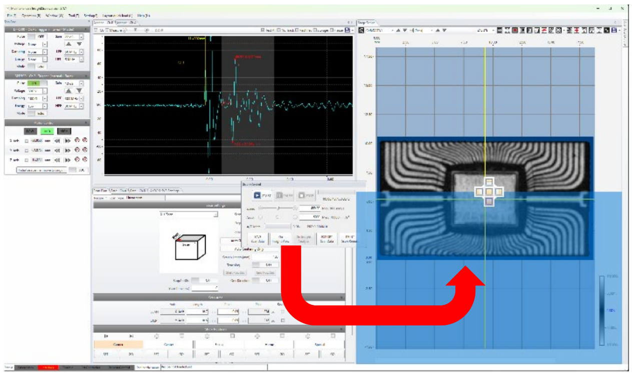


Figure 3-3-1: The InsightScan main screen, including Menu Bar (orange frame), Tool Box (green frame), and the Main Working Area (red frame).

To influence the Main Working Area layout, pick any tab within this area by moving the mouse on it, and keeping the left mouse button pressed. Now move the mouse to another place within the Main Working Area, close to where you would like to have this tab situated. A placement tool including five small icons as shown in Figure 3-5 will open.

Move the mouse on this tool, and place it on one of the five icons. Now release the left mouse button. The tab you moved will be integrated within the tab structure at the new location. Different types of layouts can be stored for future use in the **Layout** menu in the upper menu bar of the screen.



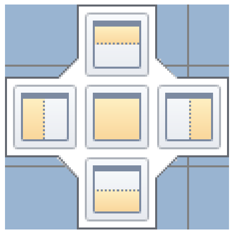
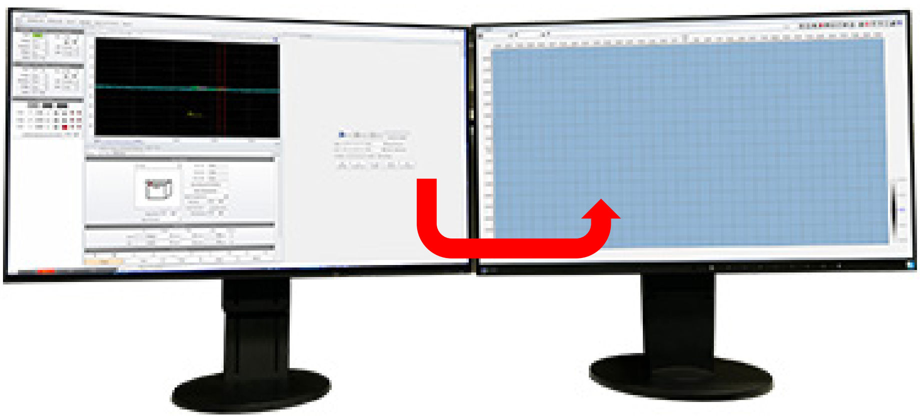


Figure 3-5

Figure 3-3-1-3: Adapting the Main Working Area layout to your needs: In this example, the Scan Plan tab has been dragged and moved to the right side of the Main Working Area, onto the lower one of the five placement tool icons (red arrow). When releasing the mouse button, the Scan Plan tab will be located in the blue shaded area.

One monitor can display scan recipe seting and scan image result

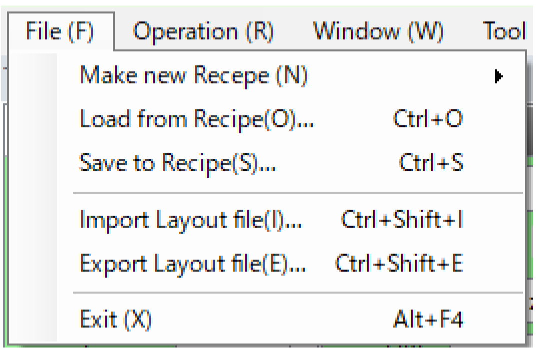


Option unit(two monitor):if there are two monitors,pop-up screen can move to another monitor. One monitor is for scan recipe seting.Onther monitor is for displaying scan image result

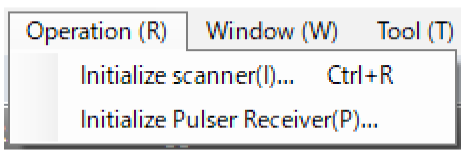
3.3.2. Peripherals Controls

Some of the tabs present on the InsightScan screen which control peripheral properties of the software can be switched on or off (shown or hidden) by pull-down menus on the upper left part of the InsightScan main screen:

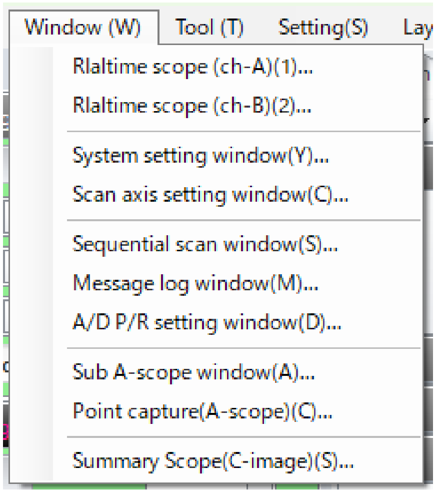
- The **File** tab: Save and load recipes and layouts.



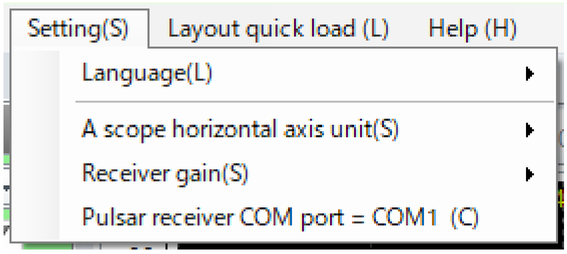
- The **Operation** tab: Initialization of the device and pulsar receiver by a check box.



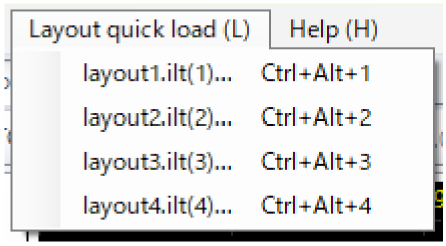
- The **Window** tab: Select what to display in the main work area (red frame)



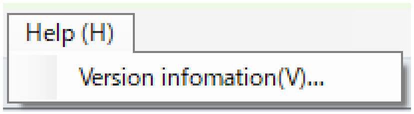
- The **Setting** tab: A menu of basic display settings for InsightScan. Any changes require a restart of InsightScan.



- The **Layout quick load**: Loading a saved layout



- **Help**: Shows the version number of InsightScan, and other information.



3.4. Shut-Down

⚠ *Transducers are sensitive devices. Therefore, before shutting down the IS-350, you should remove the transducer from the system, let dry the water (**do not rub on the transducer tip!**) and store it in a safe place.* Then, you may shut down the system:

1. Close the InsightScan software.
2. Shut down the PC.
3. Switch off the IS-350 by using its main switch.

4. Basic Operation Tasks

4.1. Accessing the Scan Area

For safety reasons, the access to the scan area is protected by a door equipped with an electromagnetic interlock. Access to the scan area requires the following:

- Make sure none of the system's motors is running.
- Press the Shutter lock release button (Figure 4-1).
- While this button's light is flashing, pull down the sliding door by its upper metallic handle.
- Then swing open the upper Plexiglas cover.

Figure 4-1: Procedure to follow for accessing the IS-350's scan area.

You need to close both covers again before being able to move the motors.

Note *that opening the front cover for security reasons shuts down the power supply on all motors. This implies also that no holding current is present any more, and that all motors can be moved relatively easily by hand which in turn invalidates the current position calibration of the motors. Therefore, before opening the front cover please move the scan head to a position where accidental contact with the mechanics can be avoided. Otherwise, you need to recalibrate the motor positions (see Section 4.5) before continuing to do acquisitions.*

4.2. Filling and Draining the Sample Tank

For filling the tank, you should first move the scan head to a position where it does not hinder the access to the tank, e.g. to the very back position on the *y*-axis (see Section 4.4). Then open the system's front cover as described above.

The sample tank should be filled with clean tap water. If necessary, the tank should be cleaned prior to filling. The quantity of water to be used depends on the experimental configuration. It might be a good idea to install the appropriate sample holder prior to filling the tank (see below). The water level should be at about 1-2 cm above the sample surface to be examined. In any case, you need to take care that no electrical connector of the transducer is immerging into the water, or even close to the water surface (consider wave formation through the scan movement). You should also keep a safety distance of at least 2-3 cm between water level and the upper border of the tank.

For easy removal of the water the IS-350 is equipped with a purging hose situated in the lower equipment bay, which is easily accessible when opening the respective door (Figure 4-2). If your system is equipped with an optional water circulation pump as shown in Figure 4-2, then first make sure to switch off the pump before purging. Then you may open the purge valve and drain the water into a suitable recipient via the water outlet hose. *Remember closing the purge valve immediately after finishing the draining process.*

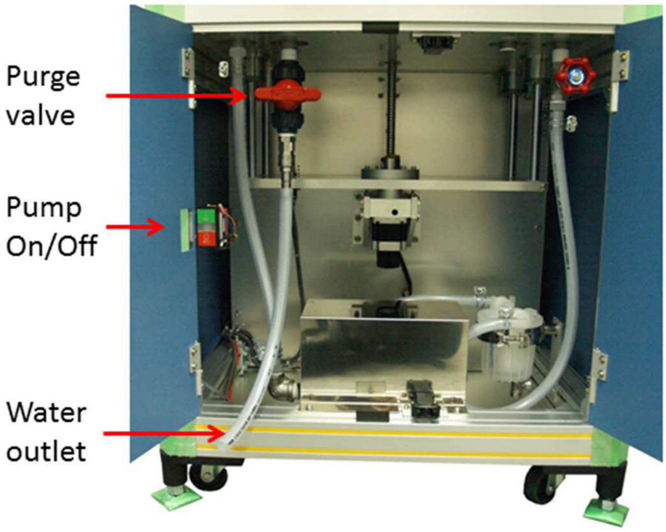


Figure 4-2: View of the water purge system situated in the lower equipment bay. The water circulator and filter as well as the driving motor for the height variation of the sample holder are optional items which may not be present in your specific equipment.

4.3. Setting Up the Sample Holder

In its standard version, the IS-350 is equipped with a stainless-steel sample holder as shown in Figure 4-3. The lower support rails of the holder are levelled (i.e. in a perfectly horizontal position) when the system leaves the factory. Therefore, when using the original equipment, no specific levelling of the sample holder needs to be done by the user.

The exact position of the sample holder can be adjusted by moving the upper support rails back and forth, and/or by moving the sample holder to the left or to the right on those rails. The final position can be fixed by screws.

In case your system is equipped with through-transmission measurement capabilities, another specific sample holder as shown in Figure 4-4 is supplied. Its very thin plastic base plate allows the acoustic waves to pass through the holder with minimum absorption. This holder fits into the same support rails as the standard stainless-steel holder and can be fixed by using the same clamps. You should reserve the use of this through transmission holder for small, lightweight samples in order not to damage the thin fragile plastic.

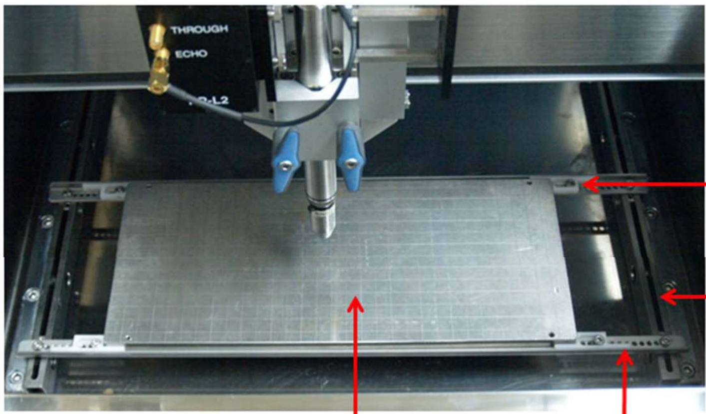


Figure 4-3: View of the standard sample holder of the IS-350 system. The lower support rails are levelled (i.e. perfectly horizontally mounted) in factory, no levelling by the user is required.

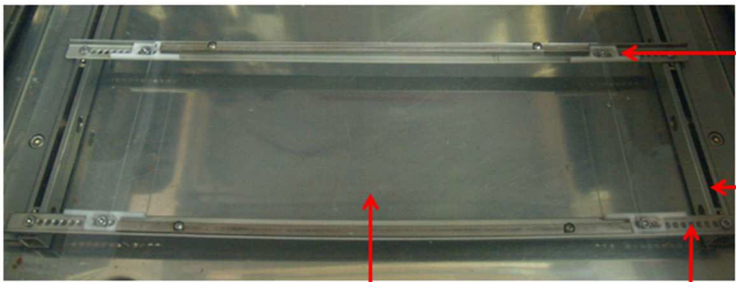


Figure 4-4: View of the specific through transmission sample holder of the IS-350. This holder is supplied together with the optional through transmission equipment.

4.4. Moving the Motors

The Motor Control window shown in Figure 4-5 allows to manually move the *x*-, *y*,- and *z*-axis motors in your IS-350 system. The motor speed during manual motor movement can be selected between **LOW**, medium (**MID**) and **HIGH** by clicking on the respective field. Then, each motor can be moved continuously in either direction by clicking on the **<<** or the **>>** symbol on the right-hand side of the respective motor. The position of each motor (in mm on its respective axis) is displayed. After correct motor initialization, the indicated numerical values show the absolute position of each motor in the (*x*,*y*,*z*) coordinate system introduced in Section 4.5. As an alternative, for each motor, the current position can be set to “0” by ticking the small box on the right-hand side of the axis name. When un-ticking the box, the absolute values are shown again.

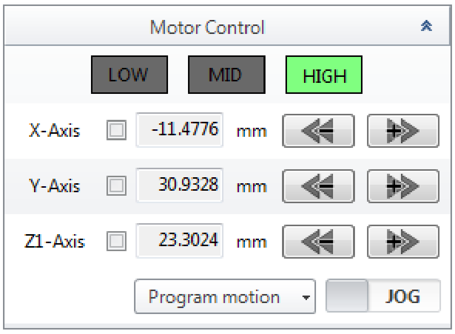


Figure 4-5: View of the manual motor control window.

Before moving a motor, first make sure that no physical obstacle is hindering the movement of the measurement head in the IS-350. In particular, before moving downwards on the *z*-axis make sure that there is sufficient space underneath the measurement head, in particular when you do such a movement with the transducer mounted. Depending on the selected transducer model, the transducer's front surface can be extremely fragile, and crashing the transducer into the sample, the tank ground plate or any other obstacle might permanently damage the transducer.

For coarse movements, with sufficient space to do so, the medium or even high motor speed can be selected. However, moving downwards on the *z*-axis should always be done in the **LOW-speed** mode.

The pull-down menu **Program motion** allows you to perform an **Initialization** procedure. For details see Section 4.5.

If you toggle from **JOG** to **INDEX**, then an additional index box appears in between the arrows for the left and right movement of the motors. In these index boxes, you may indicate increments (in mm) for each motor. Instead of being continuous, the motor movement will now be controlled by these increments: clicking on a left or right-side arrow will decrement or increment the motor position by the value indicated in the box.

4.5. Scanner Initialization

The coordinate system of the scanner's measurement volume is defined by three axes:

- x-axis: Scan axis,
- y-axis: Step axis,
- z-axis: Focus axis.

The Scanner Initialization procedure is necessary to determine the origin of the axis system. The scanner position is not memorized when shutting down the InsightScan control software. Due to the absence of any holding current when the system is switched off, the three motors can move freely and any memorized absolute motor position would bear the risk of false indexation of the axis when booting the system again. Therefore, at each restart of InsightScan, the scanner needs to be initialized when proper absolute positions need to be known. Initialization can be done as part of the start-up procedure, by clicking **Yes** in the window shown in Figure 3-3. It can also be done by clicking on **Program Motion -> Initialize** in the Motor Control window (Figure 4-5).

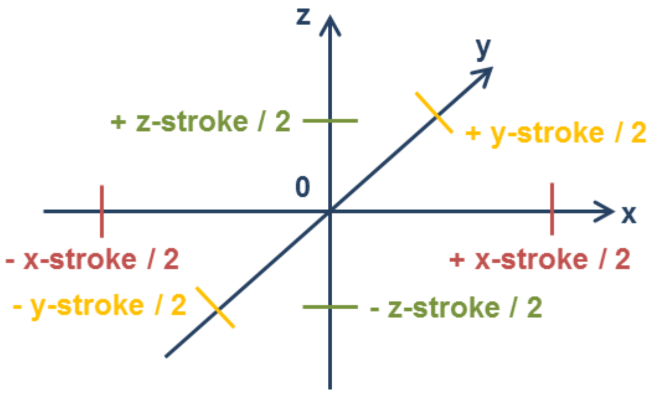


Figure 4-6: The IS-350 reference system is centered within the stroke of each motor. The displacement range on each axis is from -stroke/2 to +stroke/2.

During the initialization procedure, the scanner head will be moved to the *Initialization position*, which is the outer left position on the x-axis, the outer rear position on the y-axis, and the top position on the z-axis. Therefore, before starting the Initialization procedure, you need to make sure that no sample or any other object in the IS-350's water tank is hindering the free motion of the scanner. Any object present in the tank might permanently damage the measurement head and in particular the transducer.

The **Initialization** position moves the scanner head to a fixed point on the border of the measurement volume, whose position is defined by one end switch in each of the three directions in space. Additionally, the length (or stroke) of each axis is known by the software. Based on these indications, the software creates a coordinate system with the 0-position in the center of the measurement volume, and a displacement range of ±stroke/2 on each axis, as shown in Figure 4-6.

5. Measurement Preparations

This Chapter shows you how to prepare your IS-350 system for doing a measurement: Selection and mounting of remote pulser and transducer, initialization of the DPR, and parameter settings for the pulser/receiver. These preparations are different for systems with one single acquisition channel or with two channels.

5.1. Data Acquisition Overview

5.1.1. Single Channel Instruments

Single Channel instruments are those instruments which are equipped with a digital pulser/receiver (DPR) with one channel. In this case, all data acquisition is done by using the same DPR channel, and changing the instrument setup from one acoustic frequency to another is extremely simple. A schematic overview of the operation principle of single-channel systems is shown in Figure 5-0.

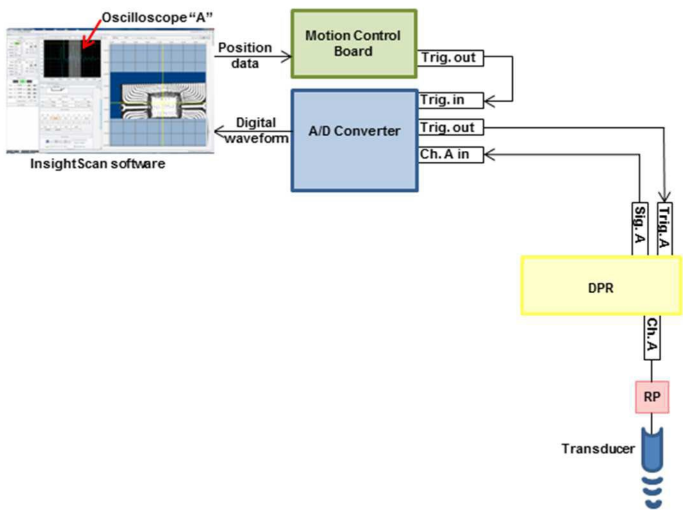


Figure 5-0: Wiring scheme of a single channel IS-350 system.

First, the InsightScan software transmits the position of the measurement to be done (*x*-, *y*-, *z*-values) to the motion control board, which moves the transducer to that position. When the transducer arrives at the measurement position, the motion control board issues a trigger signal, which is received by the **Trig. in** the input of the A/D converter board. The A/D board then triggers the DPR for sending a negative high voltage pulse via the **Channel A** remote pulser **RP** into the transducer, generating an emitted sound wave. The reflected sound wave is collected by the same transducer and generates an electrical signal on the DPR's **Signal A** output, which is hard-wired to the **Channel A input** of the A/D converter board. After digitalization, the entire signal waveform is transmitted to the InsightScan software. Acoustic microscopy typical C-scan data can be extracted from the acquired waveform by the use of multiple gates. However, for each single data point (each (x,y) position) the entire digital waveform can be stored in the computer, making it possible to re-analyse the sample with new gate settings without the need of physically rescanning it.

In the single-channel version of the IS-350, only the so-called **Channel A** exists for both DPR and A/D board. All connections between the PC, Motion Control Board, A/D Converter board and DPR are hardwired, and cannot be changed by the user. On the other side, the remote pulser **RP** and the

transducer are interchangeable by the user, in order to be able to mount the remote pulser and transducer with an acoustic frequency adapted to the specific application. The possible frequency range of the transducers depends on the specific DPR model mounted in the IS-350, see Section 5.2.2 for details.

5.1.2. Two-Channel Instruments

In the case of two-channel IS-350 instruments, the integrated DPR and A/D Converter board have both 2 channels, denominated **channel A** and **B**. In this case, *in general,* channel A is reserved for low-frequency measurements (typically 1-50 MHz transducer), and channel B is for high-frequency measurements. The following general introduction will consider this case only. However, other configurations are possible (see Section 5.2.2).

Let us first consider the operation of a low-frequency transducer, as shown in Figure 5-1.

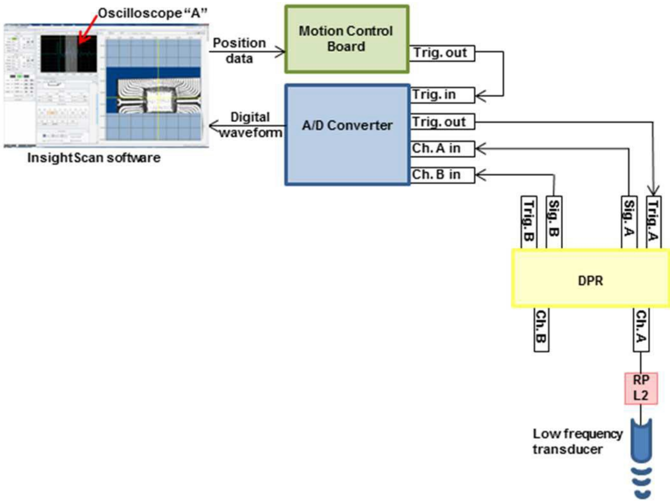


Figure 5-1: Wiring scheme for the use a double channel IS-350 system with one low frequency (1-50 MHz) transducer.

For low-frequency applications in standard two-channel systems, the wiring principle is the same as in the case of single-channel systems. **Channel A** is used both on the A/D converter board and on the DPR. **Channel A** is now reserved for operating only low-frequency remote pulsers (typically **RP-L2**) and transducers (typically < 50 MHz).

Additionally, on both the A/D converter board and DPR a second **Channel B** is now present, and the **Channel B input** of the A/D board is hardwired to the **Signal B output** of the DPR. In Figure 5-1, except for the connections from the **DPR Channel A** output to the RP-L2 and from the RP-L2 to the transducer, all other connections are hard-wired inside the IS-350, and can thus not be changed by the user.

For operating higher frequency transducers, the **DPR Channel B** needs to be used, as shown in Figure 5-2. The transducer is now connected to the **DPR Channel B**, and the A/D conversion of the signal is done by **Channel B of the A/D converter board**. The cabling between the now not used Channels A of both DPR and A/D converter board can stay in place (see Figure 5-2), in the same way as the B Channels of DPR and A/D converter can stay cabled in case a low-frequency transducer is used on Channel A (see Figure 5-1).

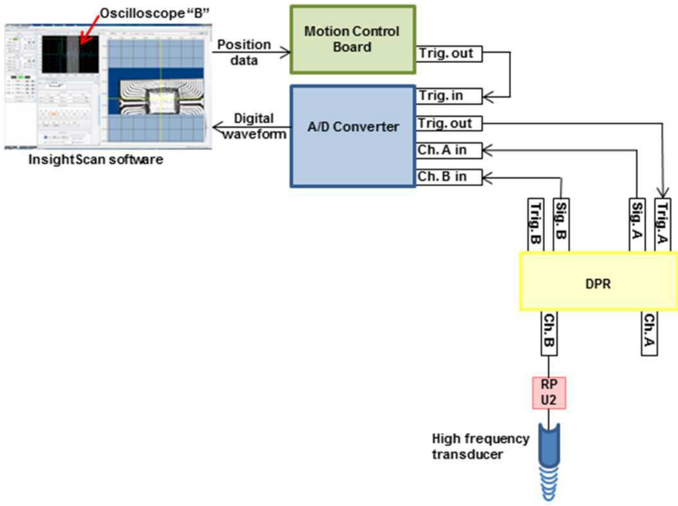


Figure 5-2: Wiring scheme for the use of the IS-350 with one high frequency (50-300 MHz) transducer.

Note that even when used with high-frequency transducers (Figure 5-2), using the **Channel B** output, the DPR is still triggered on its **Trig. An** input. In this case, the DPR's **Trig. A** is set into the *Master* mode and the **Trig. B** is set into the *Slave* mode. The **Channel B** timing is thus driven by the **Channel A** trigger, without an electrical trigger signal being present at the **Trig. B** connector.

5.2. Transducer, Remote Pulser and Acquisition Channel Selection

5.2.1. Transducer and Remote Pulser Selection

The remote pulser and the transducer need to be selected following your specific application. The selection of the transducer which is well adapted to your application is of special importance for obtaining high-quality acoustic images. Hundreds of different transducers are today available. In case of doubt, please do not hesitate to contact an Insight office for more detailed recommendations concerning transducers adapted to your specific application.

The further preparation of your IS-350 system for measurement depends on the transducer frequency that has been chosen. Therefore, before setting up the IS-350 as described in the following sections you need to decide about the appropriate transducer frequency.

The remote pulser needs to be selected as a function of the transducer frequency to be used. Three remote pulser models are available (Table 5-1). In case your selected frequency can be reached with either one of two different remote pulsers, then additional selection criteria might be the pulse amplitude, pulse width or pulse fall time of the two potentially usable remote pulsers.

Table 5-1: Operation characteristics of the IS-350 adapted remote pulsers.

Remote pulser model	**Transducer frequency range**	Maximum pulse amplitude	Maximum pulse width	Fall time
RP-L2	**1 - 65 MHz**	- 155 V	< 125 ns	< 8.0 ns
RP-H4	**40 - 165 MHz**	- 140V	< 6.5 ns	< 2.6 ns
RP-U4	**100 - 250 MHz**	- 220 V	< 1.4 ns	< 1.1 ns

5.2.2. DPR and A/D Board Channel Selection

As introduced in detail in Section 5.1 your IS-350 system is equipped with either a single or a dual-channel data acquisition chain.

In single-channel systems, only channel A is used in all measurement configurations (Table 5-2). This configuration is set up on your system both in terms of hardware and software during system installation and you do not need to change anything on the A/D converter and DPR configuration during your work with the system.

Table 5-2: DPR and A/DC channel selection depending on the selected transducer frequency and remote pulser. Remote pulsers and frequencies indicated in upright characters *are those for which the corresponding IS-350 system is optimized for. Remote pulsers and frequencies indicated in italic characters are those which are possible with some limitations with the corresponding IS-350 system.*

<table>
<tr><th>IS-350 Model</th><th>DPR and A/D Converter Channel</th><th>DPR Frequency Range</th><th>Compatible Remote Pulsers</th></tr>
<tr><td colspan="4">Single Channel Systems</td></tr>
<tr><td>IS-350-VLF</td><td>A</td><td>1 – 35 MHz</td><td>RP-L2 (1-35 MHz)</td></tr>
<tr><td>IS-350-LF</td><td>A</td><td>1 – 50 MHz</td><td>RP-L2 (1-50 MHz)</td></tr>
<tr><td>IS-350-HF</td><td>A</td><td>40 – 300 MHz optimum
5 – 250 MHz possible</td><td>RP-L2 (5-65 MHz)
RP-H4 (40-165 MHz)
RP-U4 (100-250 MHz)</td></tr>
<tr><td colspan="4">Dual Channel Systems</td></tr>
<tr><td rowspan="2">IS-350-Universal</td><td>A</td><td>1 - 50 MHz</td><td>RP-L2 (1-50 MHz)</td></tr>
<tr><td>B</td><td>40 - 300 MHz optimum
5 – 250 MHz possible</td><td>RP-L2 (5-65 MHz)
RP-H4 (40-165 MHz)
RP-U4 (100-250 MHz)</td></tr>
<tr><td rowspan="2">IS-350-customized</td><td>A</td><td rowspan="2">Configurable from
1 – 250 MHz</td><td rowspan="2">Selection available depending on DPR configuration:
RP-L2 (1-65 MHz)
RP-H4 (40-165 MHz)
RP-U4 (100-250 MHz)</td></tr>
<tr><td>B</td></tr>
</table>

In dual channel systems the IS-350's DPR and the A/D converter board are both equipped with two channels A and B, which are used for different transducer frequency ranges as summarized in Table 5-2. Therefore, depending on the selected transducer and remote pulser you need to prepare your system for data acquisition either via channel A or channel B. Every IS-350 channel is optimized to be used in a specific frequency range. The remote pulsers for this frequency range are indicated in the upright characters. In some cases, operation of the system outside the optimized frequency range is possible with some limitations. The related remote pulsers and frequencies are indicated in *italic characters*.

The Channel selection is done both by software and by hardware settings in the IS-350 system. The following Sections will show you how to set up your A/D converter and DPR in case of two-channel systems.

5.2.3. Hardware Channel Selection

Depending on the type of remote pulser that you use, you need to make sure that it is connected to the appropriate channel of the DPR and A/DC board. Use Table 5.2 to identify the suitable remote pulser model and channel for your application.

The input connectors of the two DPR Channels A and B are located in the top left corner behind the scan mechanics (Figure 5-3). Connect the pulser cable from the remote pulser to the appropriate channel of the DPR connector. Mounting and cabling of the remote pulser itself will be presented in the next Section.

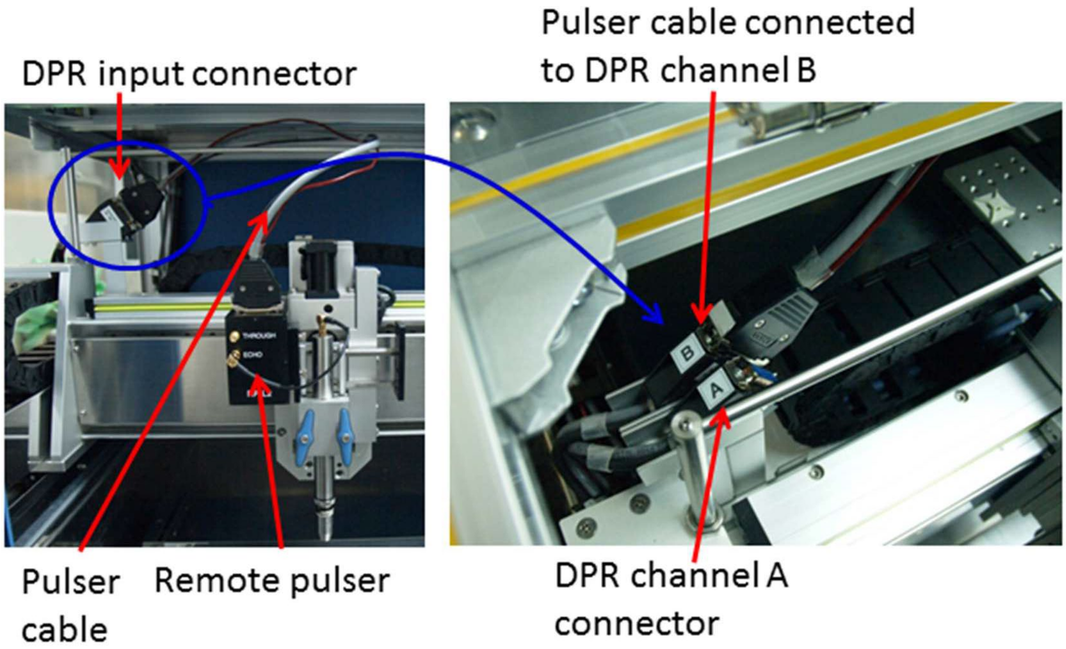


Figure 5-3: View of the data cable connection between Remote Pulser and DPR in case of two-channel systems. Left: The data cable connects the remote pulser to the DPR input connector. Right: Close view of the DPR connector in the back left area of the IS-350. Here the data cable is connected to DPR channel B, corresponding to the rear side DPR connector. Note that in single channel systems only on DPR input connector (for channel A) is present.

5.3. Installation of Remote Pulser and Transducer

5.3.1. Mounting of Remote Pulser and Pulse-Echo Type Transducer

The case of a High Frequency Transducer

The setup for a high-frequency transducer used for pulse-echo measurements is shown in Figure 5-4. After selecting the remote pulser and transducer best suited for your measurement, please proceed to their installation in the following way:

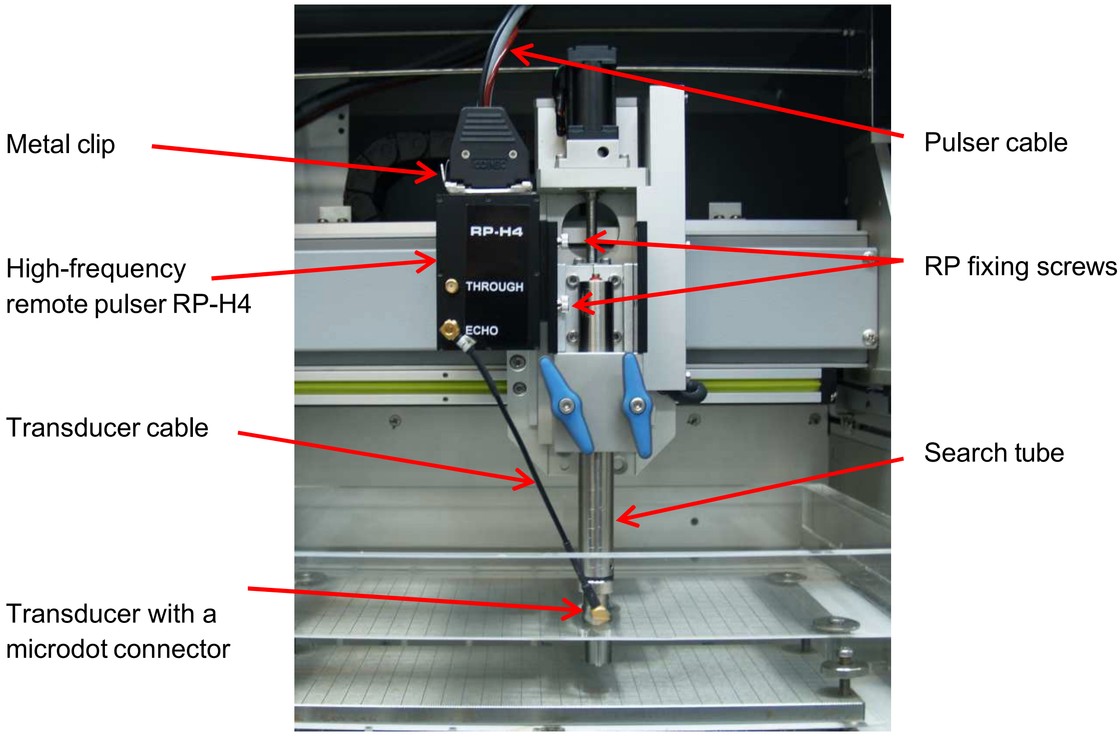


Figure 5-4: View of the ultrasonic measurement head, with the RP-H4 remote pulser and high frequency echo-type transducer mounted.

- Switch on your IS-350, boot the PC.
- Make sure that no sample or other part is present in the tank (except the sample plate and the water).
- Start the InsightScan software. **Initialize** the scanner during software launch (Click **YES** in the respective dialog).
- Use the manual motor control to move the measurement head to a position where you can easily work on it. In general, this position will be close to the centre of the x-axis, close to the front position on the y-axis, and close to the top position of the z-axis.

⚠ *Make sure pulsing of the pulser/receiver is switched off, by moving the **Pulse** switch shown in Figure 6-1 to the **OFF** position. Otherwise, high-voltage pulses are sent to the transducer, which represents an imminent danger to your personal health if you unplug the cables with the pulses ON.*

- Remove the pulser cable from the remote pulser in place, by carefully pressing on the metal clip while simultaneously carefully pulling the pulser cable connector upwards.

- Remove any transducer cable which might be in place, by carefully loosening its microdot connections (on the remote pulser and the transducer). Note that depending on whether a high-frequency or a low-frequency transducer was used before you changed the set-up, the transducer cable will either be connected close to the transducer's tip in the vicinity of the water surface, or on top of the search tube.
- Remove the remote pulser by loosening its two fixing screws.
- Put the selected remote pulser in place, and fix it by putting back the two fixing screws.
- Plug the pulser cable into the corresponding connector on the remote pulser.
- Unscrew the transducer from the search tube, by turning it counter-clockwise. For easy screwing, take advantage of the knurled part of the transducer close to its connection with the search tube.
- Put the new transducer in place.
- High-frequency transducers have an integrated microdot connector. Run a cable directly from the ECHO connector on the remote pulser to the transducer's microdot connector, as shown in Figure 5-4.

Your high-frequency transducer for pulse-echo measurements is now correctly installed. Refer to the following Sections for updating the software set-up to the new hardware configuration.

The case of Low-Frequency Transducers

The mechanical mounting of a low-frequency transducer for pulse-echo type measurements is very similar to the mounting of a high-frequency transducer (see above). The only difference is that low-frequency transducers in general do not have a microdot connector directly on the transducers.

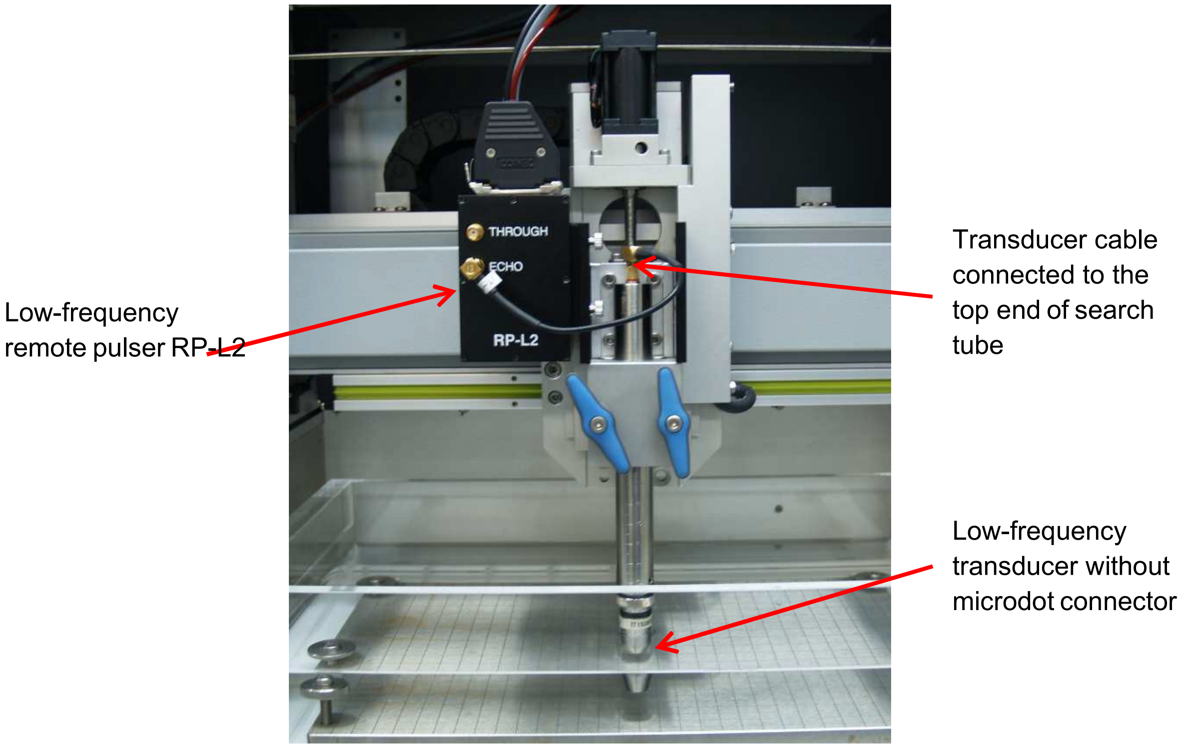


Figure 5-5: View of the ultrasonic measurement head, with the RP-L2 remote pulser and a low-frequency echo-type transducer mounted.

Instead, the electrical pulse is fed into the transducer via the search tube. Therefore, the transducer cable needs to be connected to the microdot connector on top of the search tube, as shown in Figure 5-5.

*Remember to make sure the pulsing of the pulser/receiver is switched off, by moving the **Pulse** switch shown in Figure 6-1 to the **OFF** position when working on the remote pulser and transducer. Otherwise, high-voltage pulses are sent to the transducer, which represents an imminent danger to your personal health if you unplug the cables with the pulses ON.*

Refer to the following Sections for updating the software set-up to the new hardware configuration.

5.3.2. Mounting of Remote Pulser and Through-Transmission-Type Transducer

For measurements in the Through-Transmission mode, the thin plastic sample holder and an additional ultrasonic receiver need to be installed.

*Remember to make sure the pulsing of the pulser/receiver is switched off, by moving the **Pulse** switch shown in Figure 6-1 to the **OFF** position when working on the remote pulser and transducer. Otherwise, high-voltage pulses are sent to the transducer, which represents an imminent danger to your personal health if you unplug the cables with the pulses **ON**.*

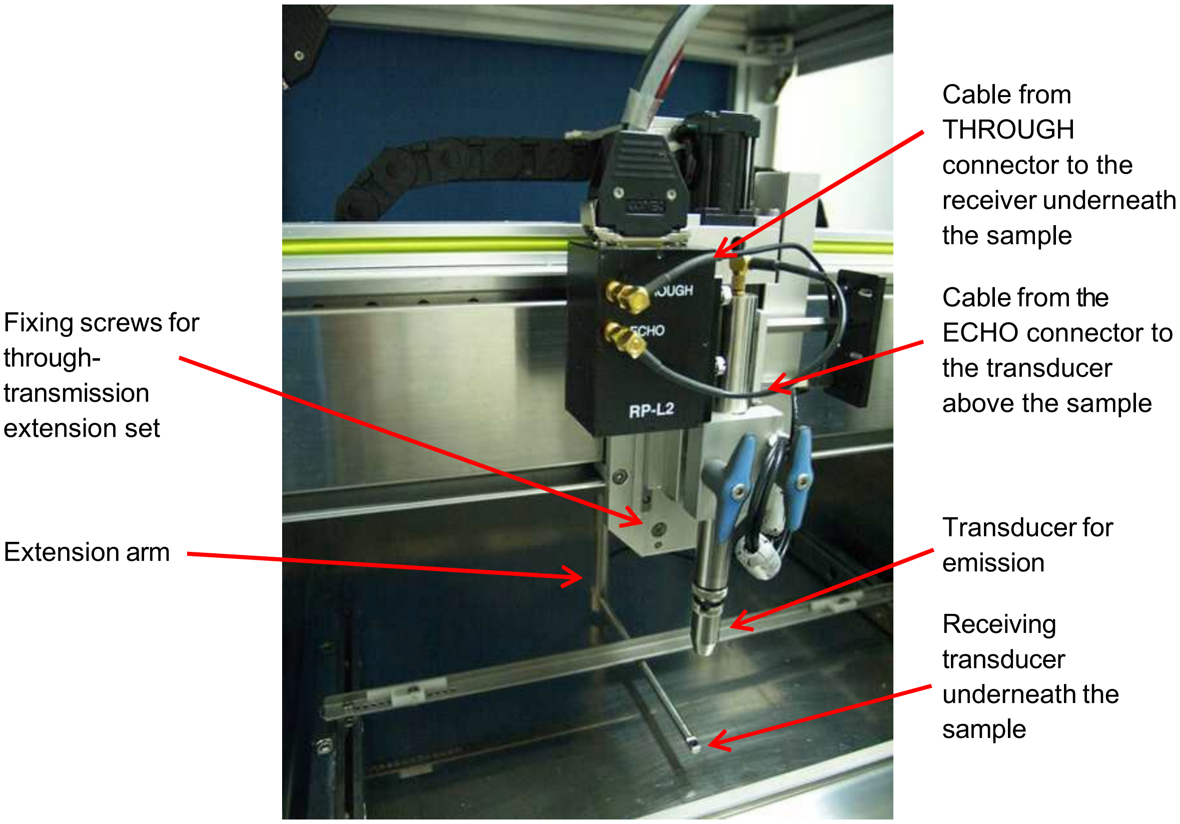


Figure 5-6: View of the ultrasonic measurement head with the RP-L2 remote pulser and a low-frequency through-transmission type transducer mounted. For better visibility, the thin plastic sample holder is not mounted in this image.

First, mount the selected remote pulser (in general the model RP-L2) and the appropriate transducer as described above. Use a microdot cable to connect the remote pulser's **ECHO** connector to the transducer. As through-transmission measurements are generally done at relatively low frequencies, it is likely that the electrical pulse needs to be fed into the transducer via the search tube, as shown in Figure 5-6.

Now fix the through transmission extension set to the measurement head, by using the two Phillips screws shown in Figure 5-6. The through transmission receiver is mounted in the outer tip of the receiver arm. Use the two adjustment screws indicated in Figure 5-6 to optimize the height, angle, and extension of the receiver arm in the following way:

- The arm's height needs to be adjusted such as the receiver being placed underneath the plastic sample holder. The receiver and its arm should touch neither the plastic sample holder nor the bottom plate of the tank. Note that the receiver arm's height does not vary when moving up and down the (emitting) transducer along the z-axis.
- The receiver should be placed exactly vertically under the (emitting) transducer. Adjust the length of the receiver arm as well as its angle accordingly. As a first approach, visual adjustment by eye is sufficient. For fine adjustment, you may later optimize the amplitude of the received signal with no sample placed in between the (emitting) transducer and receiver.

Finally, connect the receiver cable to the **THROUGH** connector of the remote pulser.

Your through-transmission measurement set-up is now ready. Refer to the following Sections for updating the software set-up to the new hardware configuration.

5.4. Software Channel Selection and Initialization

Software channel selection and software initialization need to be done after finishing the complete hardware set-up of your system. The software will auto-evaluate some parts of your hardware configuration, such as the type of the used remote pulser. Therefore, doing the software initialization before finishing the hardware set-up will lead to malfunction.

5.4.1. DPR Parameter Settings

The DPR parameters are set in the **Pulser/Receiver Settings** window in the **A/DC & P/R Settings** tab shown in Figure 5-7. First, set the **COM port** to which the DPR is connected. In most cases, it will be either *COM 1* or *COM3*, but other settings might be possible depending on your specific computer configuration. Select the **COM port** and click on **Initialize**. If the correct COM port is selected, and the DPR is successfully initialized, either one or two windows for setting additional DPR parameters as shown in Figure 6-1 should show up in your InsightScan main window. If such windows do not show up, change the COM port setting and try to initialize again.

⚠ The DPR initialization has to be done each time that you disconnect a remote pulser from the DPR, i.e. from the DPR connectors shown in Figure 5-3. Therefore, each time you change the remote pulser configuration, keep in mind to initialize the DPR before using the system.

Finally, you need to select for each Channel (A or B) if it is used in the *Echo* or in the *Through* **Mode**. Note that only the indication for the Channel that you are actually using is relevant. The other Channel may remain in either one of the two modes.

5.4.2. A/DC Parameter Settings

The A/DC parameters are set in the **A/DC Settings** window in the **A/DC & P/R Settings** tab shown in Figure 5-8. In the Basic section, your A/DC board type and serial number are indicated. The following settings need to be done.

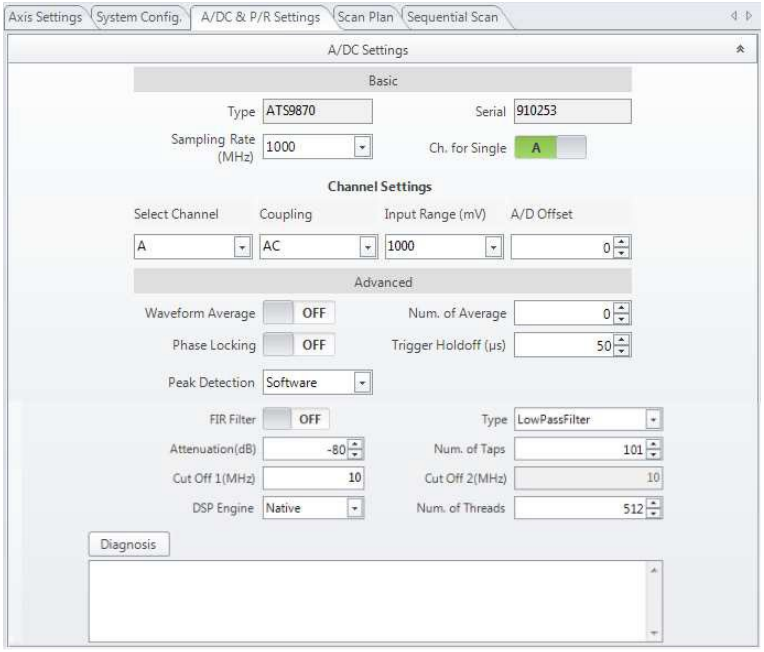


Figure 5-8: View of the window for setting the A/DC parameters.

- Toggle the **Channel** switch to the correct position, depending on whether you are using the *A* or the *B* channel for data acquisition.
- Choose the A/DC **Sampling Rate**. The maximum sampling rate to be used with your system depends on the A/D converter board model, which is indicated in the **Type** field. Refer to Table 5-3 to know the maximum allowed Sampling Rate for your system. Note that you may use a lower than the maximum allowed sampling rate. The acquisition speed will increase slightly, and the result data file size will decrease, in particular when you store the full waveform data.
- Choose the **Input range (mV)**. The indicated value (standard: 400 mV) defines the voltage range which is digitalized. An indication of 400 mV input range means that the board's full number of bits used on the input voltage range - 400 mV ... + 400 mV, which is adapted to the voltage output range of the DPR pulser/receiver. Therefore, it is strongly recommended to use a 400-mV input range for all measurements.
- Set the **Offset**. This allows to offset of the incoming voltage by the chosen value (i.e. move the voltage baseline on the oscilloscope).

*Table 5-3: Maximum sampling rates for different models of the A/DC board. The **Max. hardware sampling rate**, limited by the hardware of each board, can be extended by a factor of up to 4 by using the IS-350's oversampling technology.*

A/DC Type	Max. hardware sampling rate	Max. rate with oversampling
ATS9872	1000 MHz	4000 MHz
ATS9870	1000 MHz	4000 MHz
ATS9350	500 MHz	2000 MHz
ATS9625	250 MHz	1000 MHz
ATS9462	180 MHz	720 MHz
ATS860	250 MHz	1000 MHz
ATS660	125 MHz	500 MHz

In the **Advanced** section, other control parameters for the A/D board can be set. These parameters are not necessary for standard everyday operation of the Insight acoustic microscopes, and should therefore stay disabled (*OFF*). If, in a very specific application, you feel it might be useful to use these parameters, please contact one of the Service centres indicated in the last Chapter of this Manual.

6. Doing a Measurement

This Chapter guides you through the successive steps for taking measurements.

6.1. Initial Pulse Settings

Before starting a measurement, the electrical characteristics of the Pulser/Receiver need to be set. This is done in either the **DPR500 - CH.A** or in the **DPR500 - Ch.B** (Figure 6-1) window, depending on which channel is currently used.

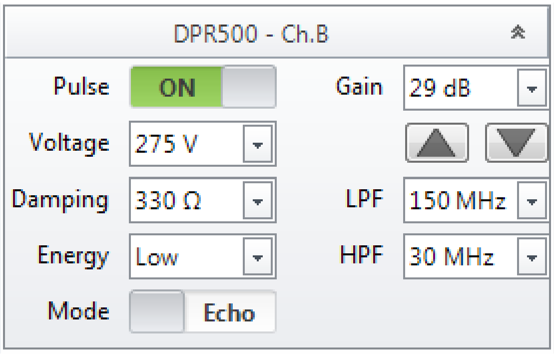


Figure 6-1: Window for setting the electrical characteristics of the DPR channel B. In case of channel A is used, the window for channel A needs to be used.

Table 6-1: Possible values for DPR channel A in case of a IS-350-Universal system.

Channel A	with RP-L2	with RP-H4
Pulse	On, Off	
Voltage (negative)	275, 276, 277, ... 499, 500 V	330, 331, 332, ... 379, 380 V
Damping	330, 104, 44, 34 Ω	100, 50, 33, 25 Ω
Energy	Low, High	
Mode	Echo, Through	
Gain	-13, -12, -11, ... +65, +66 dB	
Low Pass Filter LPF	3, 7.5, 10, 15, 22.5, 50 MHz	
High Pass Filter HPF	0.001, 1, 2.5, 5, 7.5, 12.5 MHz	

Table 6-2: Possible values for DPR channel B in case of a IS-350-Universal system.

Channel B	with RP-L2	with RP-H4	with RP-U4
Pulse	On, Off		
Voltage (negative)	275, 276, ... 499, 500 V	330, 331, ... 379, 380 V	143 V
Damping	330, 104, 44, 34 Ω	100, 50, 33, 25 Ω	100, 50, 21, 17 Ω
Energy	Low, High		
Mode	Echo, Through		
Gain	-22, -21, -20, ... +49, +50 dB		
Low Pass Filter LPF	150, 300 MHz		
High Pass Filter HPF	5, 30 MHz		

Tables 6-1 and 6-2 summarize the possible values for the two channels A and B as a function of the used remote pulser, for an IS-350-Universal system. The following considerations should guide you when setting the values for your application:

- **Pulse**: Toggle between **Pulse On** and **Pulse Off**. *Do not forget to switch the pulse **On** before starting the measurements.*
- **Voltage**: This value corresponds to the amplitude of the high-voltage pulse sent to the transducer. Increasing the voltage influences the signal-to-noise ratio and the pulse shape. Note that the higher the used voltage is, the higher the risk of damaging the transducer. For some of the transducers supplied by Insight maximum allowed voltage values are noted in the datasheet. For all other transducers (without explicit voltage limitation), you should try to work with as low a voltage as possible. In general, it is recommended to keep the voltage <400 V for transducers used with the RP-L2, and <360 V for transducers used with the RP-H4.
- **Damping**: The **Damping** parameter allows to adaptation of the impedance of the receiver to the impedance of the transducer. When setting up a new measurement, you should first use the highest **Damping** value. Once the signal is obtained, you may try to find a "cleaner" waveform and C-scan result by decreasing the **Damping** value. Note that you may need to increase the **Gain** when decreasing the **Damping**.
- **Energy**: Changing from **Low** to **High** will increase the length of the high-voltage pulse applied to the transducer, and successively increase the amplitude of the acquired waveform. You should try with your specific transducer whether **Low** or **High Energy** will result in a better signal-to-noise ratio. In general, low-frequency transducers may benefit from **High Energy**, while high-frequency transducers will show better results with **Low Energy**.
- **Mode**: Take care to correctly choose between **Echo** and **Through**-transmission, depending on your system setup.
- **Gain**: The values correspond to the electronic gain applied to the received waveform. Noise and signal are amplified simultaneously; therefore, the gain has no influence on the signal-to-noise ratio. However, you should optimize the gain such as the amplitude of the acquired waveform (A-scan) is close to 60-80% of the maximum amplitude which can be visualized on your oscilloscope. Take care to avoid saturation.
- **Low pass filter - LPF**: All frequencies above **LPF** will be filtered out of the original signal by the DPR before the filtered signal is sent to the A/D converter. The lower the **LPF** value is, the stronger the signal will be filtered (including potential partial suppression of the signal).
- **High pass filter - HPF**: All frequencies below **HPF** will be filtered out of the original signal by the DPR before the filtered signal is sent to the A/D converter. The higher the **HPF** value is, the stronger the signal will be filtered (including potential partial suppression of the signal).

6.2. Signal Acquisition

For easy signal acquisition and optimization, a numerical oscilloscope is integrated in the InsightScan software. You may switch on the oscilloscope corresponding to the acquisition channel (A or B) that you are currently using in the **Scopes** window as shown in Figure 6-2. An oscilloscope as shown in Figure 6-3 will be displayed, which will visualize the voltage vs. time characteristics (the A-scan) of the selected channel.

To obtain the first signal, use the manual motor control to place your transducer above the sample, at some mm distance. The aim should be to obtain a reflected signal similar to the one shown in Figure 6-3. For adjusting the signal representation on the oscilloscope, the following functions exist:

- **Moving the trackball of the mouse back or forth**: This will stretch or compress the time scale.
- **Keep right mouse button pressed and move mouse**: This will move the time axis to the left or to the right.

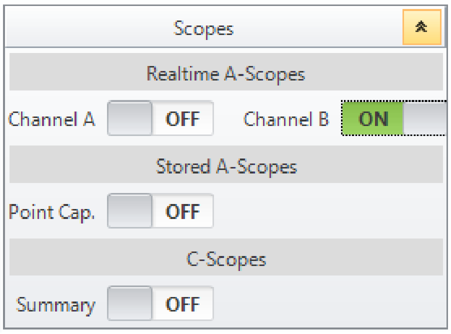


*Figure 6-2: Select **Channel B** ON and **Channel A** OFF to display the A-scan acquired on channel B.*

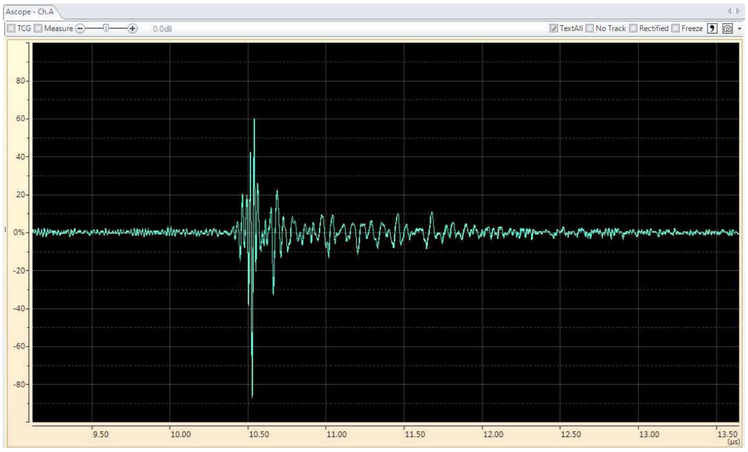


Figure 6-3: Representation of the acquired signal on the A Scope – CH. B

Above the oscilloscope graph, some tick boxes and other elements give access to further control functions:

- **TCG**: Switches on or off the **Time Controlled Gain**. For more details see Section 6.4.
- **Measure**: Switches on or off a set of two measurement cursors in the A-scan graph. Moving the cursors with the mouse onto two selected events on the scan allows precise measurement of the time delay between the selected events.
- **Slider symbol (0.0dB):** The slider symbol gives access to additional digital gain which you might use to optimize the representation of the signal on the scope.
- **Text**: There are three options for this switch box:
  - **NoText** (box empty): No text information displayed.
  - **TextAll** (box ticked): Text information concerning all gates (Section 6.3) is supplied.
  - **TextSelected** (box filled): Only for selected gates text information will be supplied.
- **Tracking**: There are three options for this switch box:
  - **No Track** (box empty): The time scale on the oscilloscope's z-axis is fixed. This means, that when you change the height of your transducer above the sample (z-axis), the signal will travel across the oscilloscope, either from left to right or from right to left, due to the fact that the time of flight of the acoustic impulse increases with the distance of the transducer from the sample.

- **Tracking** (Box ticked): In case of a displacement of the transducer along the z-axis, the displacement in z-direction is converted into the corresponding change of the first sound echo's round-trip time from the transducer to sample and back. The time axis of the oscilloscope is then incremented or decremented by this amount. As a result, when scanning in z-direction, the time axis is now moving, and the first echo signal stays fixed on the screen.
- **Reversed Tracking** (Box filled): Like tracking, but with an inversed sign in the travel-to-time conversion. Replaces the simple Tracking function in case the sample is mounted above the transducer instead of below.

- **Rectified:** The negative part of the voltage (y-) axis of the scope is mirrored into the positive part, and only the positive part of the axis is displayed.
- **CSV-symbol ( ) :** Click here for CSV export of the data.
- **Safe-symbol( )** : Click here to save the oscilloscope as an image file.

The *y*-axis of the oscilloscope is scaled in %, and always shown on full scale from -100% to +100%. The absolute value corresponding to 100% is the **Input Range (mV)** value defined in Figure 5-8. For adapting the signal amplitude to the oscilloscope screen, you mainly should vary the **Gain** of the DPR, as shown in Figure 6-1. You may also adjust the DPR's **Voltage** in the same window. Keep in mind the voltage limitation considerations given in Section 6.1.

Once the signal is well visualized on the screen, carefully move up and down the transducer (scanning along the z-axis). The first aim is to maximize the amplitude of the very first part of the signal, which corresponds to the reflection on the surface of your sample. When you reach the maximum, your acoustic beam is focused on the sample surface. Then carefully move downwards the transducer. Take great care not to crash the transducer into the sample while doing so. Observe the waveform while moving the transducer downwards. The very first part of the signal will become weaker, but in the tail of the signal the amplitude will increase due to the fact that the focus of the acoustic wave is no longer on the sample surface, but somewhere inside the volume. Place your transducer so that the signal part corresponding to the depth inside the sample that you are interested in is maximized. Your system is now correctly set for measurements.

6.3. Gate Settings

The gates are the primary tool for data analysis based on the waveform. Information concerning the inner volume of the sample is only contained within a relatively small part of the full waveform. By setting the gates you may define which part of the waveform should be analyzed for your specific application.

For setting the various gates, first, make sure that you are in the **No Track** mode (Section 6.2), otherwise, gate setting is not possible. Then visualize the **Gate** tab corresponding to the Channel (A or B) you are currently working with, as shown in Figure 6-4. In this tab, the various Gates are accessible by clicking on one of the sub-tabs **FSF1**, **FSF2**, **DATA1**, **… DATA4**, **WF**, **FFT** or **Misc**.

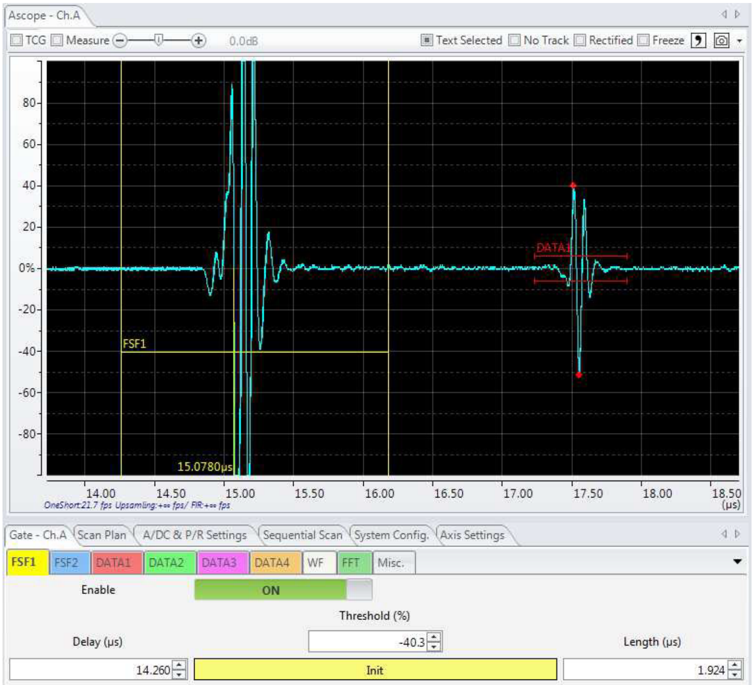


*Figure 6-4: Acoustic signal and gate setting menus for Ch. A. On the signal, a front surface follower **FSF** and a **Data1** gate are set.*

6.3.1. Front Surface Follower

The **Front Surface Follower** (**FSF**) provides a kind of trigger signal marking the instant when the part of the acoustic wave which is reflected on the sample surface ("front surface reflection") reaches the transducer again. If the sample is not placed perfectly horizontally in the tank, then the time delay between sending the pulse and receiving the front surface reflection is not constant over the sample surface (because for tilted samples the water path before hitting the sample is not constant). For the same reason, reflections coming from a different given depth inside the sample volume will need different time spans for reaching the transducer again if the sample is tilted.

The **Front Surface Follower** allows suppressing the uncertainty in signal runtime, by setting a trigger mark at the moment when the front surface reflection arrives back at the transducer. Therefore, even for a tilted sample, two signals acquired at different locations, but arriving back at the transducer after the same time delay relative to the Front Surface Follower trigger signal can be attributed to be emitted from the same depth level inside the sample.

For setting a Front Surface Follower, click on the **FSF1** tab in the **Gate** menu (see Figure 6-4) and toggle the **Enable** slider to *ON*. A yellow horizontal line will be displayed in the A-scope, as shown in Figure 6-4. The height of the line (y-axis value) indicates the voltage level at which the **FSF1** will be triggered. The length of the line (on the time scale) indicates the period during which the **FSF1** is active. The **FSF1** will trigger when for the first time during its active period the voltage of the signal is higher (if **FSF1** is in the positive voltage range) or lower (if **FSF1** is in the negative voltage range) as the threshold indicated by the **FSF1**.

By manipulating the yellow line with the mouse, you can set its length and its height (threshold) to adapted values. The threshold should be high enough in order not to be triggered by noise, but low enough in order to be reliably triggered by the front surface reflection signal. The length needs to be selected so that for all positions on your sample the front of the reflected signal is inside the active period of the **FSF1**. You should test this condition in several positions of your sample.

In total two different Front Surface Followers (**FSF1** and **FSF2**) can be activated. **FSF2** can be used in the same way as **FSF1**, with other voltage and/or timing settings for example. In this case, the **Sub Surface** switch present in the **FSF2** menu needs to be *OFF*. With the **Sub Surface** switch set to *ON*, the start of the **Delay (µs)** of **FSF2** will be triggered by the **FSF1**. That means **FSF2** follows **FSF1**, with a user-adjustable delay.

6.3.2. Data Gate

A total number of four **DATA** gates is available. They are all identical and may serve to acquire four sets of data following different criteria simultaneously. A **DATA** gate can be a *single data gate* or a *sliced data gate*.

Single Data Gate

A single data gate is shown in Figure 6-5, depicted as a red rectangle in the A-scan. It is activated by setting the **Enable** switch in the **DATA1** tab to *ON*.

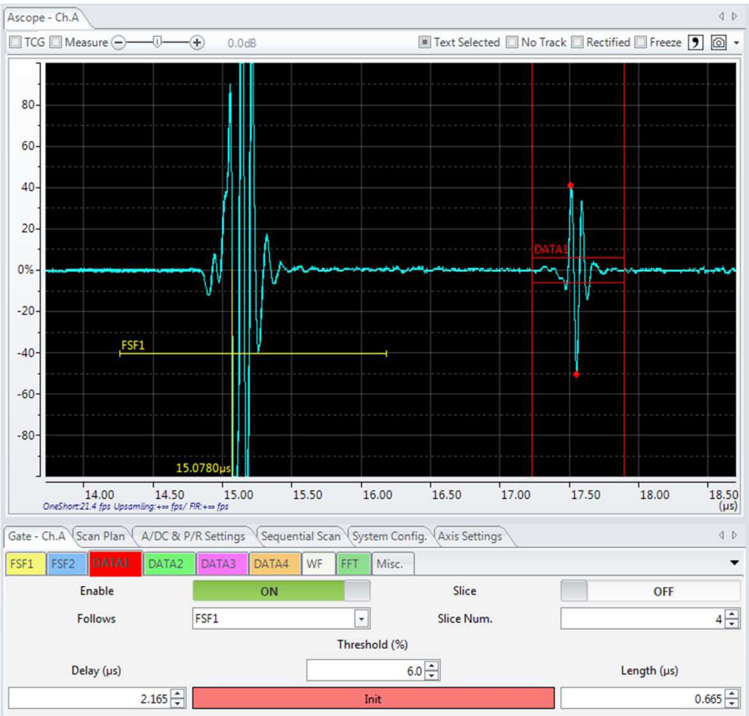


Figure 6-5: Parameter setting for a single ***DATA1*** *gate, triggered by the* ***FSF1****.*

As for the **FSF**; the horizontal extension of the red rectangle defines the **Length (µs)** of the time-period during which the data gate is active, i.e. only during this period valid signal will be generated. The height of the rectangle defines the voltage **Threshold (%)**: only when the voltage of the A-scan signal is larger than the defined threshold, this voltage will be considered a signal. Otherwise, it will be considered as noise and disregarded. As for the **FSF**, the **Delay**, **Length** and **Threshold** of the data gate can be obtained by manipulation of the rectangle with the mouse.

Finally, you need to set the trigger mode of the data gate, by choosing either *NONE*, *FSF1*, or *FSF2* in the **Follows** selector in each **DATA** menu. When *NONE* is chosen, the data gate will stay fixed in time. With *FSF1* or *FSF2* either one of these two front surface followers will trigger the start of the data gate, as described above.

The three parameters **Delay**, **Length** and **Threshold** in the **DATA** pull-down menu are automatically filled in when manipulating the data gate in the A-scan by the mouse. Alternatively, you may type in numbers here and see the result on the oscilloscope.

For working with a *Single Data Gate*, the **Slice** selector needs to be set to *OFF*. This selector will be introduced later, together with the **Slice Num**. Parameter, for working with *Sliced Data Gates*.

For each Data Gate, up to eight specific values are extracted, which may then be displayed as area scans (called C-scans, see Section 6.5) over the entire sample surfaces. These values are (Figure 6-6):

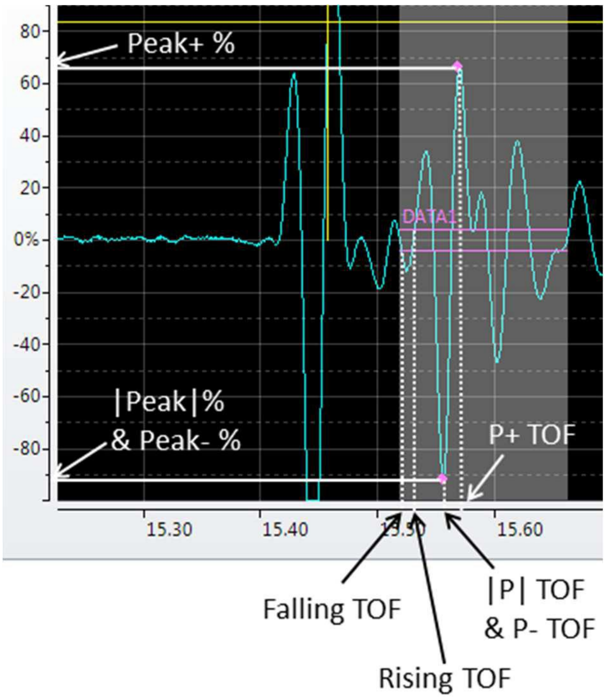


Figure 6-6: Potential data obtained within a data gate.

- **|Peak|%:** The voltage (in %, 100% being full scale on the A-scan oscilloscope) at the peak which has the highest absolute voltage of all peaks within the data gate, and which overpasses the data gate voltage threshold.
- **|P| TOF**: The time at which the signal crosses the data gate voltage threshold the last time before arriving at **|Peak|%** (note: TOF = Time of Flight).
- **Peak+%**: Same as **|Peak|%**, but ONLY peaks in the positive voltage range are considered.
- **P+ TOF**: Same as **|P| TOF**, but ONLY peaks in the positive voltage range are considered.
- **Peak-%**: Same as **|Peak|%**, but ONLY peaks in the negative voltage range are considered.
- **P- TOF**: Same as **|P| TOF**, but ONLY peaks in the negative voltage range are considered.
- **Rising TOF**: The time at which the signal crosses the data gate voltage threshold the last time before arriving at the very first positive peak within the data gate.

- **Falling TOF**: The time at which the signal crosses the data gate voltage threshold the last time before arriving at the very first negative peak within the data gate.

Sliced Data Gate

Each data gate can be divided into smaller sub-data gates by setting the toggle switch **Slice** to *ON* (Figure 6-7). The number of slices can be selected in the **Slice Num.** selection field.

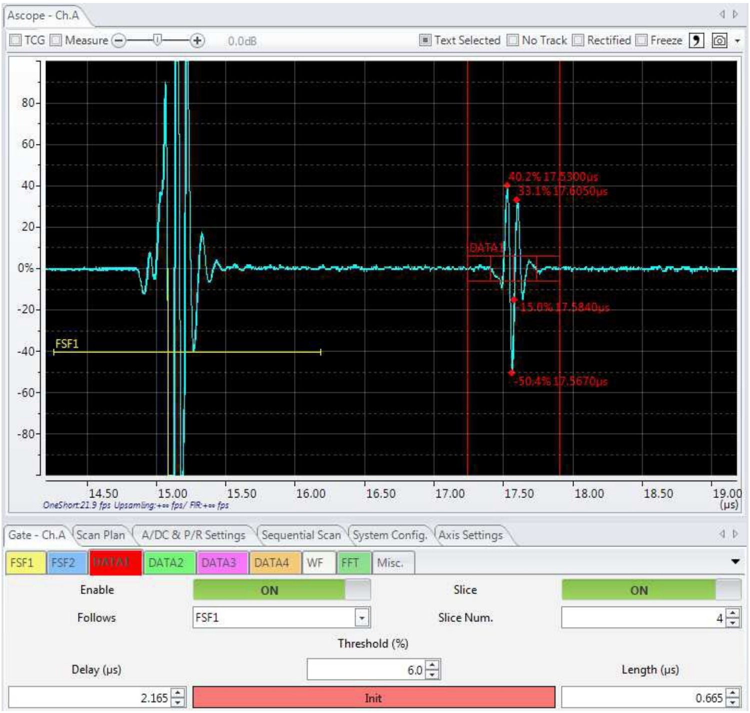


Figure 6-7: View of a data gate divided into 4 slices.

The slices of the data gate are visualized on the screen. When an acquisition is started, each slice is then treated as a single gate on its own, i.e. for each slice the full set of data as described in the *Single Gate Section* can be acquired, independently of the other gates. As a result, a data set corresponding to a tomographic view of the sample is obtained.

6.3.3. Wave Form Acquisition

The **Enable** *ON*/*OFF* toggle switch in the **Gate – WF** section (Figure 6-8) allows to select whether or not the entire waveform (**WF**) of the signal should be acquired and stored on the hard disk.

In case the **WF** acquisition is disabled, only up to eight numerical values extracted from the waveform as shown in Figure 6-6 are acquired and stored.

When **WF** is enabled, a window formed by white lines is displayed in the A-scan oscilloscope. The start and end of the **WF** are indicated by vertical lines, spaced on the oscilloscope by a **Length (µs)** which can be set by the user. Similar to the data gates, the start point of the waveform acquisition can be defined relatively to the *FSF1* or *FSF2* event, by choosing either of these in the **Follows** menu. Or it might be defined on the absolute time scale, which starts running with the emission of the sound wave by the transducer, by setting **Follows** to *NONE*. The **Delay (µs)** parameter allows moving the WF window back and forth with respect to its trigger event. Note that the **WF** gate can start before the FSF trigger happens, even in case its beginning is defined with respect to the FSF event.

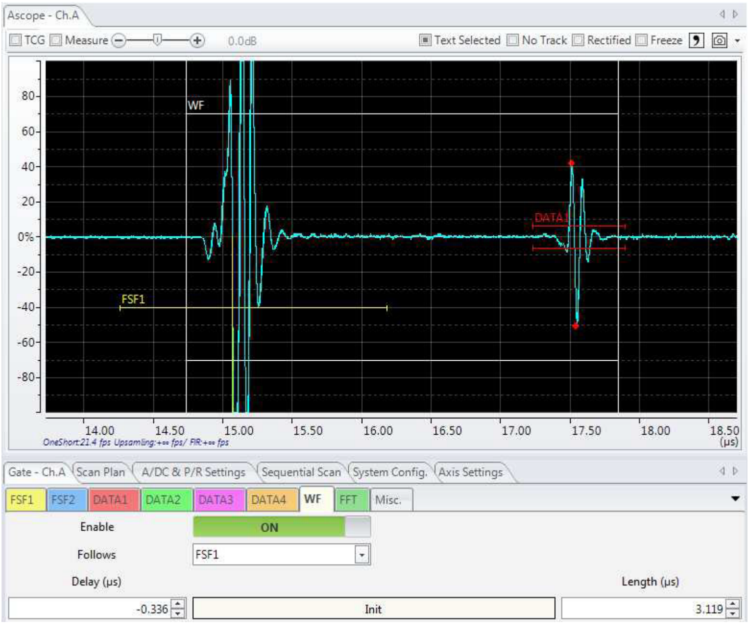


Figure 6-8: Set-up of a wave form acquisition window.

The horizontal limitation lines of the **WF** gate do not have any significance; they can be moved to a location where they do not hinder the view to the other elements on the oscilloscope.

Waveform acquisition does not influence the acquisition speed. However, the size of stored result files may drastically increase, depending on the length of the stored waveform.

6.3.4. FFT Analysis

By **Enabling** the **FFT** (Fast Fourier Transformation) analysis in the corresponding tab (Figure 6-9) a second graph shows up on your screen. This graph displays the FFT of your signal's A-scan.

In the **A-Scope** a set of two vertical green lines will be shown. Use the mouse to move these lines in order to define a certain time interval on the A-Scan. The **FFT** graph will then show the frequency distribution of the A-Scan signal within the selected time interval. This function allows for example to analyze selectively the frequency distribution of a signal which has been reflected inside the volume of a sample, by excluding the contributions due to surface reflection from the selected time interval.

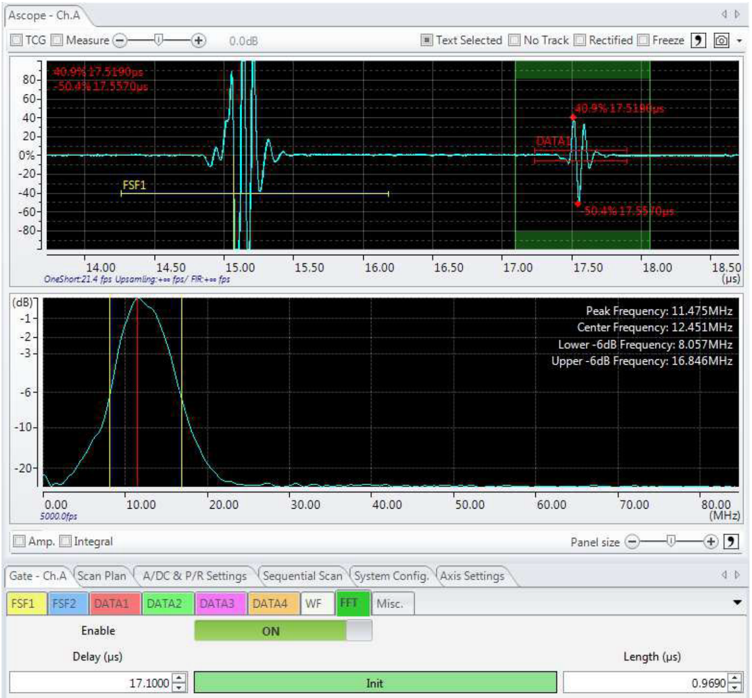


Figure 6-9: Frequency analysis of the signal by using the FFT function.

6.3.5. Miscellaneous Data Settings

The ordinate of the A-scan oscilloscope can be scaled either in **µs** (standard) or in **mm**. A switch in the **Misc.** tab of the Gate settings area allows toggling between these settings (Figure 6-10). When the mm representation is chosen, then the conversion from µs to mm is done by using the sound velocity in water until the triggering of FSF1. For later instances on the time scale, the conversion is done by using a **Vel. Material (m/s)** speed, which needs to be set by the user depending on the material of the sample. If FSF1 is not set or not triggered, the entire time-to-length conversion will be done by using the sound velocity in water.

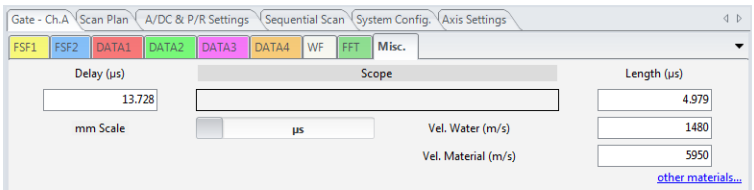


Figure 6-10: The ordinate of the A-scan oscilloscope can be scaled in µs or in mm.

The Misc. section also allows control of the A-scopes time axis purely by indicating numerical values in the **Delay (µs)** and the **Length (µs)** fields, which might be useful if precise, predefined values are needed for some reasons.

6.4. Time Gain Control

The sliced data scan is used to obtain acoustic data from different depth levels inside the sample. The deeper a given slice is situated inside the sample volume, the lower the received signal will be, due to sound reflection and absorption in the higher-lying levels. To overcome this issue, the IS-350 is equipped with a **Time Controlled Gain** (**TCG**) function. It allows controlling the gain of the signal as a function of its receiving time (Figure 6-11).

For setting up the time-controlled gain, click the **TCG** box on top of the A-scan oscilloscope. A **TCG** control area will appear on the right of the oscilloscope. There, you first need to switch **TCG** *ON*. Then, by the toggle switch, you need to select if the time scale for the time-dependent gain control should be *Absolute*, or *Gated*. In the *Absolute* mode, the time scale for gain control starts with the emission of the ultrasonic pulse from the transducer. In the *Gated* mode, the time scale for gain control is triggered by the **FSF1** front surface follower. This latter method makes it possible to synchronize the variation of the gain with any data gate (single or sliced) which is triggered by the **FSF1**. Note that no synchronization is possible with **FSF2** and that the *Gated* mode for time-controlled gain necessarily needs **FSF1** to be active.

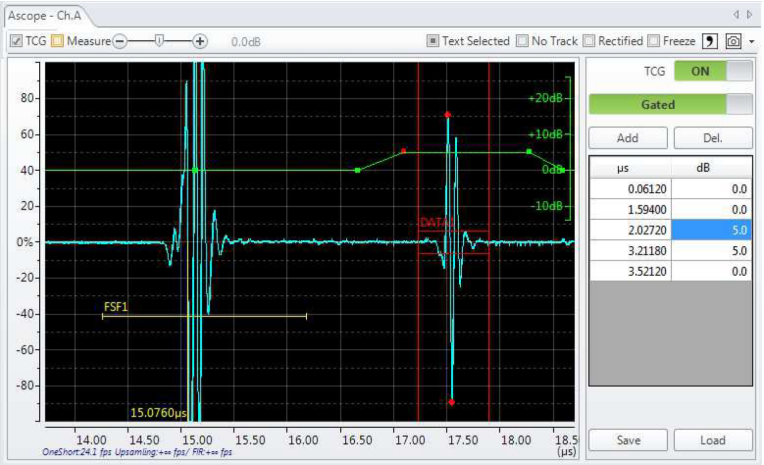


*Figure 6-11: Use of the **Time Controlled Gain** (**TCG**) for varying the Gain with Time.*

The gain vs. time characteristics is controlled by at least two user-defined (*time*; *gain*) data points as shown in Figure 6-11. The number of data points in the table can be increased or decreased with the **Add** and **Del.** Buttons. The resulting **gain** vs. **time** characteristics are shown in green within the A-scan oscilloscope. The **gain** values should be understood as additional gain values, adding/subtracting to/from the gain currently selected in the respective DPR tab (see Figure 6-1). The data points defined in the table are shown as small dots on the green graph. These dots might be dragged and dropped by the mouse for easy gain adjustment. The resulting effect on the signal is immediately visible as the signal curve is permanently updated with the current gain values. Defining an increasing gain as shown in Figure 6-11 allows to homogenize the amplitudes of the signal corresponding to different depths inside the sample.

6.5. Setting up a Scan Plan

6.5.1. Linear Scan

A scan plan defines the way an entire sample is scanned.
Before setting up a scan plan, the signal needs to be found, correct focusing needs to be done, and the gates of interest need to be set. *If you want to store your scan plan, for using it again for the inspection of identical samples in future, you need to* ***Initialize*** *the motor positions before setting up the scan plan.*

Go to the **Scan Plan** tab and click on **Recipe -> New -> Linear scan** (Figure 6-12). A certain number of scans are suggested for selection. With the standard IS-350 system, only the **Linear scan** and the **Array scan** are available. All other suggested scans need additional control axes and motors and are not detailed in this manual.

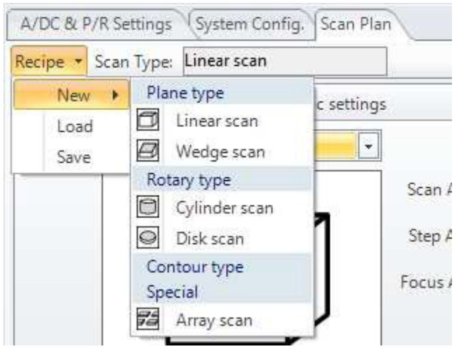


*Figure 6-12: The **Linear scan** and the **Array scan** correspond to the standard scan plans included in the IS-350 hard- and software. All other scan plans need optional hardware items.*

For setting up a linear scan of a single sample click on **Linear scan**. The table shown in Figure 6-13 needs to be completed to define a scan plan.

In the **Basic settings** section, the functions of the three axes *x*, *y*, and *z* need to be attributed. *Note that except your system is equipped with specific, optional capabilities, you need to select the **X-Y Scan***, which means that the *x*-axis is the scan axis, the *y*-axis is the step axis, and the *z*-axis is the focus axis.

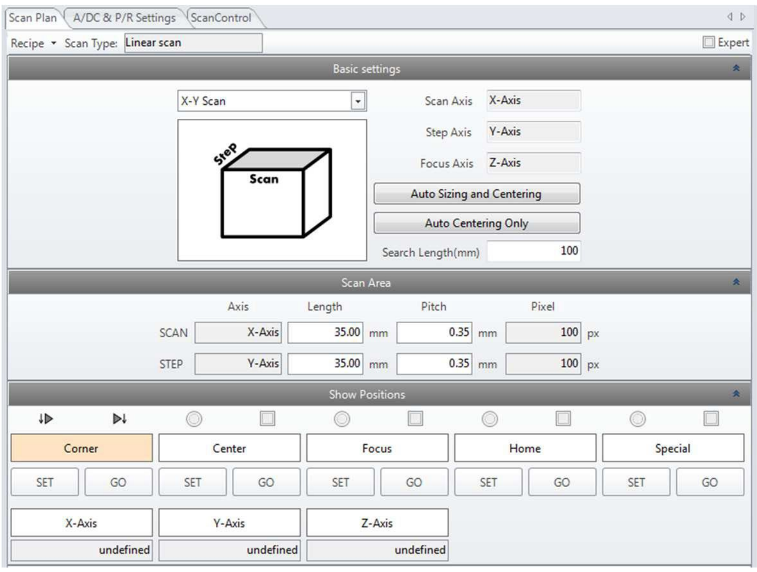


*Figure 6-13: Setting up a **Linear scan** plan.*

The two buttons **Auto Sizing and Centering** and **Auto Centering Only** may help you define the scan area. Before using them, the sample needs to be placed in the tank, and the complete acquisition chain needs to be correctly set up (transducer, remote pulser, DPR, etc.). The transducer needs to be placed above the sample, and the FSF1 needs to be active and correctly triggered at this transducer position.

The **Auto Sizing and Centering** tool will move the transducer in the four directions +/-x and +/-y, and will detect for each direction the position at which the FSF1 is no longer triggered. This position will be considered as the edge of the sample in the corresponding direction. The **Search Length (mm)** should be set by the user under consideration of the sample size. **Auto Centering Only** will only detect the sample center position, but will not influence the **SCAN** and **STEP LENGTH** parameters. **Auto Sizing and Centering** will additionally determine adapted values for the **SCAN** and **STEP LENGTH**.

In the **Scan Area** section, you need to define the dimension of the scan area, its width (i.e. the **Length** in the **SCAN** direction) and its depth (i.e. the **Length** in the **STEP** direction). In general, these dimensions should be slightly larger than the area of the sample you are interested in. The **Pitch** defines the distance between two successive data points, in either direction. The number of resulting pixels in each direction is calculated by the software.

In the **Show Positions** section, you need to define the absolute position of the sample in the tank, and by this teach this position to the scan control software.

- First, make sure the transducer is correctly focused on the sample depth you are interested in. With the transducer at that height, click on the **SET** button under the **FOCUS** field. This *z-height* is now stored as a focus position.
- Then, by using the manual motor control (Section 4.2) move the transducer in *x*- and in *y*-direction until it is positioned just above the front left corner of the area to be scanned. At this position, click on the **SET** button under the **CORNER** field. This (*x*,*y*) position is now stored as the front left corner position of the area to be scanned. Alternatively, you may also manually position the transducer over the centre of the area to be scanned, and then click on the **SET** button under the **CENTER** field. The **CENTER** and the **CORNER** positions are related one to the other by the two Length parameters set before. They are therefore equivalent, and setting either one is sufficient to define the position of the area to be scanned on the (*x,y*) plane. If you used the **Auto Sizing and Centering** tool then the **CENTER** position is already defined. *Note that you should re-**SET** either the **CORNER** or the **CENTER** after each modification of one or both **LENTGH** parameter(s).*

Note that **Corner** and **Center** only store the (*x,y*) position of the transducer, and **Focus** only stores the *z-position*.

Home and **Special** represent two other positions which might be defined by manually moving the transducer to an arbitrary (*x,y,z*) position within its full range, and then clicking the respective **SET** button. These two positions include the *z* height of the transducer.

When clicking on the **Go** button under each of the previously defined fields, then the transducer is moved to the (*x,y*) position (for **Corner** and **Center**), to the *z*-position (for **Focus**), or to the (*x,y,z*)-position (for **Home** and **Special**) defined for these locations. Note that when clicking on **Corner** or **Center**, the z-position of the transducer stays unchanged, and when clicking on **Focus** the (x,y) position remains the same.

The round and the square above each position field allow to define to which position the transducer should be moved before (round) and after (square) a scan. Thus, when starting a scan, the movement sequence of the transducer will be the following:

1. Go to the position indicated by the marked circle above one of the **Corner**, **Center**, **Focus**, **Home**, and **Special** fields (in Figure 6-13 this would be the **Corner** position);
2. Move to the front left **Corner** of the area to be scanned;
3. Scan the area defined by the two **Length** values. The scan ends in the back right corner of the area to be scanned;
4. Move to the position indicated by the marked square above one of the **Corner**, **Center**, **Focus**, **Home**, and **Special** fields (in Figure 6-13 this would again be the **Corner** position).

The movement sequence of the motors is the *x*-axis, then the *y*-axis, then the *z*-axis. Therefore, depending on the particular configuration, you need to make sure that the transducer can do all the programmed movements without colliding with a sample, or with any other object which might be inside the sample tank.

The entire **Scan Plan**, including the scan settings, but also the used DPR pulser/receiver settings, gates, timings, etc. can be stored in the **Recipe** pull-down menu. Previously established scan plans can be reloaded here. *Note that it is essential that the IS-350 is* ***Initialized*** *for use and storing each time you are going to work with scan plans.*

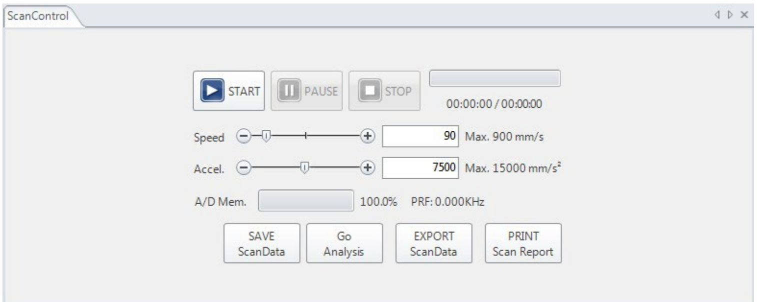


Figure 6-14: The ***Scan Control*** *tab.*

The **Scan Control** tab (Figure 6-14) allows to **Start**, **Pause**, or **Stop** the scan. By moving the respective sliders, you can influence the scan **Speed** and the transducer **Acceleration**. Settings can be adjusted while a scan is running. The sliders allow to set all technically possible values. However, note that a too-high scan speed might cause problems due to wave formation in the water tank. For information, the total and the elapsed scan time are indicated, as well as the used level of the A/D memory. You should limit the scan speed and acceleration to such values that the A/D memory charge stays at 50% or less. In case of too high memory use, decrease the scan speed.

The IS-350's Pulse Repetition Frequency (PRF) is limited to 20 kHz. For best performance, a maximum PRF of 15 kHz should be respected during measurements. The PRF is related to the scan speed and the pitch in the x-direction by the formula

$$\text{PRF} = \text{Scan speed (x)} / \text{Pitch (x)}.$$

In general, the pitch in the x-direction is determined by the spatial resolution that you need. For this given pitch, the maximum scan speed can therefore be calculated. Some examples are summarized in Table 6-3.

Table 6-3: Recommended and maximum scan speeds as a function of the pitch in x-direction. Note that the limitation of the scan speed to 1000 mm/sec for large pitch values is due to the speed limitation of the motor.

Pitch in x-direction	Max. recommended scan speed (PRF ≤ 15 kHz)	Maximum scan speed (PRF = 20 kHz)
10 µm	≤ 150 mm/sec	200 mm/sec
20 µm	≤ 300 mm/sec	400 mm/sec
50 µm	≤ 750 mm/sec	1000 mm/sec
100 µm	**≤ 1000 mm/sec**	1000 mm/sec

When the scan is finished, various possibilities for saving or analyzing the results are available in the **Scan Control** tab:

- **SAVE ScanData**: Save the full set of acquired data. All images are saved in binary and image format. The binary file can be used for detailed image analysis by InsightView. The file in image format allows to easily visualize the resulting image with every standard type image viewer. The image format used when saving the data can be defined in the **System Config** tab (see Chapter 7.1). If the acquisition of the **Wave Form** (**WF**) has been selected (see Section 6.3.3) then the entire waveform is automatically saved in the binary file.
- **Go Analysis:** When clicking on this button the currently active image will be opened in InsightView for detailed analysis. The path of the InsightView software needs to be indicated in the **System Config**. tab in order to make this shortcut work properly.
- **EXPORT ScanData**: This button allows to export of a selected set of images in a format pre-defined in the **System Config**. tab (Chapter 7.1). No binary file will be created.
- **PRINT ScanReport**: Fast and simple generation of a standardized scan report in *.xps format.

6.5.2. Array Scan

The **Array Scan** is a linear scan during which multiple identical samples which are arranged in the sample tank in the form of an array are scanned during one single scan. Therefore, in addition to the size of a unique sample also the way the individual samples are arranged to an array needs to be specified.

For setting up an array scan click on **Recipe -> New -> Array scan** in the **Scan Plan** tab. The window shown in Figure 6-15 will open. The meaning of the different parameters is similar to the **Linear Scan** described above.

In the **Basic settings** section, the dimensions of the individual samples (or the individual areas to be scanned) as well as the array dimensions need to be declared. The meaning of the different parameters is visualized by a sketch. In most cases an acquisition in the **Individual** mode is faster than an acquisition in the **Line-by-line** mode. For standard Array Scans please do not touch the **Sequential Scan** button. This button is reserved for large arrays scanned with very high resolutions, and will be introduced in the next Chapter.

In the **Scan Area** section, the total **Lengths** (in both directions) of the scan area are calculated based on the array characteristics, and only the **Pitches** in both directions need to be set by the user.

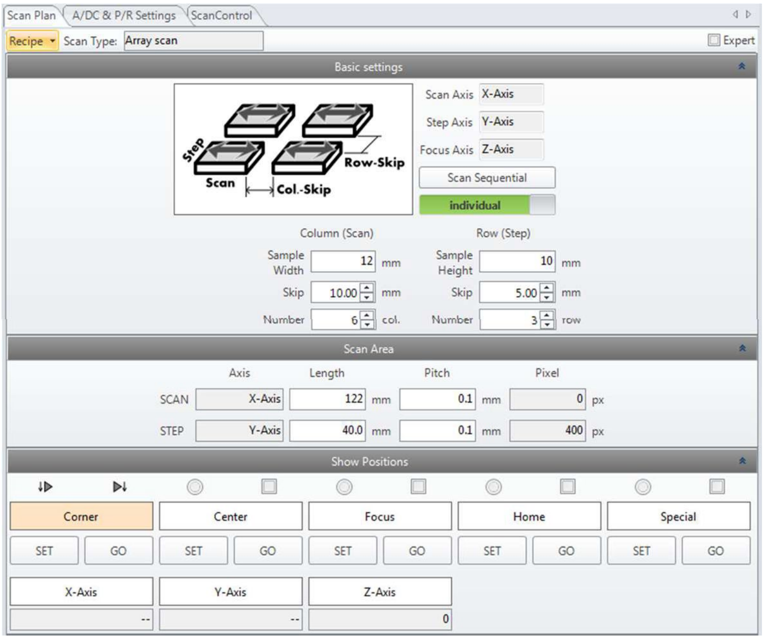


*Figure 6-15: Setting up an **Array scan** plan.*

The **Show Positions** section is equivalent to the one in case of a Linear Scan. Note that **Corner** and **Center** now refers to the corner and center of the entire array, and not of an individual sample.

The **Scan Control** is equivalent to the one concerning the **Linear Scan**. Please refer to Table 6-3 for considerations concerning an adapted scan speed.

6.5.3. Array Scan for Large Arrays

The “basic” **Array Scan** as introduced in the previous Chapter is particularly suited for scanning small and medium size arrays. We consider small or medium size all arrays with a scan pitch of 50 µm or larger, or those which are limited to a small number of samples. If the number of samples becomes important, and/or if the scan pitch is less than 50 µm, then the total size of the result matrix becomes too large for fast and reliable numerical handling. In this case, a more adapted solution consists in considering the total array as a composition of individual, small images, with identical acquisition conditions for each of these images. In the acquisition software, this change of consideration can be obtained by converting the **Array Scan** into a **Sequential Scan**.

In the case of a large array, you first need to define a “basic” **Array Scan**, as introduced in Chapter 6.5.2. In particular, you need to define the **Sample Width** and **Height**, the distances to **Skip**, the **Number** of columns and rows, and the **Pitch** in both directions. The scan mode has to be **Individual**. Set an adapted scan **Speed** in the **Scan Control** tab (Figure 6-14). All these parameters will be used in the **Sequential Scan**. If all parameters are well set you need to run at least partially the “basic” Array Scan by clicking on the **Start** button in **Scan Control**. It might be useful to wait until the array scan skips to the second sample, in order to validate the correct dimension of the programmed scan matrix. Then stop the scan by clicking the **STOP** button in **Scan Control**. Then click on **Sequential Scan** in the **Scan Plan** tab (Figure 6-15). The “basic” **Array Scan** will then be converted into a **Sequential Scan**, and the characteristics of this scan will be shown in the **Sequential Scan** tab (Figure 6-16).

During the execution of the **Sequential Scan**, the scan of each individual sample is considered as an independent measurement. As a consequence, the 6 x 3 samples defined in the **Array Scan** in Figure 6-15 will be handled as 18 independent scans in the **Sequential Scan**. These individual scans are indicated as Recipe_001, Recipe_002, …, and Recipe_018 in the upper right area of the **Sequential Scan** window shown in Figure 6-16.

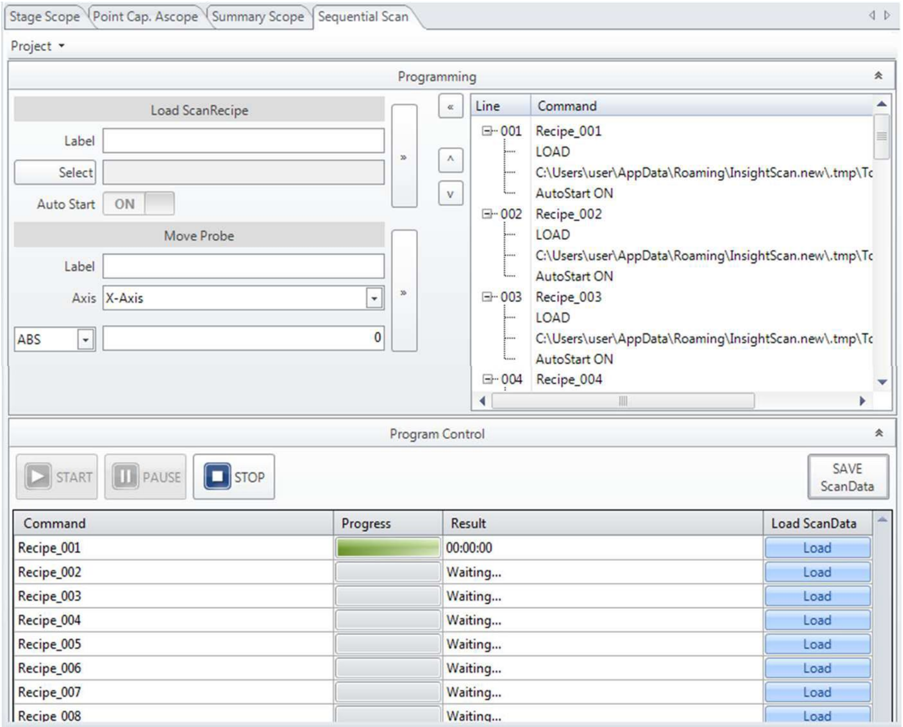


*Figure 6-16: View of a **Sequential Scan** as defined by clicking on the **Sequential Scan** button in the **Array Scan** window shown in Figure 6-15.*

In the upper left area of the **Sequential Scan** tab (Figure 6-16) additional movements of the transducer can be added to the succession of sample scans. *However, in case the **Sequential Scan** is used as a special kind of **Array Scan** for large arrays, no other element (scan recipe, transducer movement, …) as those automatically generated should be added to the list of operations. Otherwise, the failure-free function of the entire **Sequential Scan** might be compromised. Programming a completely flexible **Sequential Scan** will be introduced in Section 6.6.5.*

For executing a Sequential Scan, you have to use the START, PAUSE and STOP buttons present within the Sequential Scan tab as shown in Figure 6-16. The equivalent buttons in the Scan Control tab (Figure 6-14) are not active for Sequential Scans. When the scan is finished the acquired data can be saved by clicking on the SAVE ScanData button. Each single image of the Sequential Scan will be saved as an individual file, thus keeping the file size reasonable even in case of a very large scan matrix.

6.6. Data Acquisition and Representation

6.6.1. C-Scan Visualization

When a scan is started, by clicking **Start** in the **Scan control** section in either Figure 6-14 or 6-16, then the obtained results are successively represented in the **Stage Scope** as shown in Figure 6-17. The resulting image is known as the acoustic *C-Scan* of the sample.

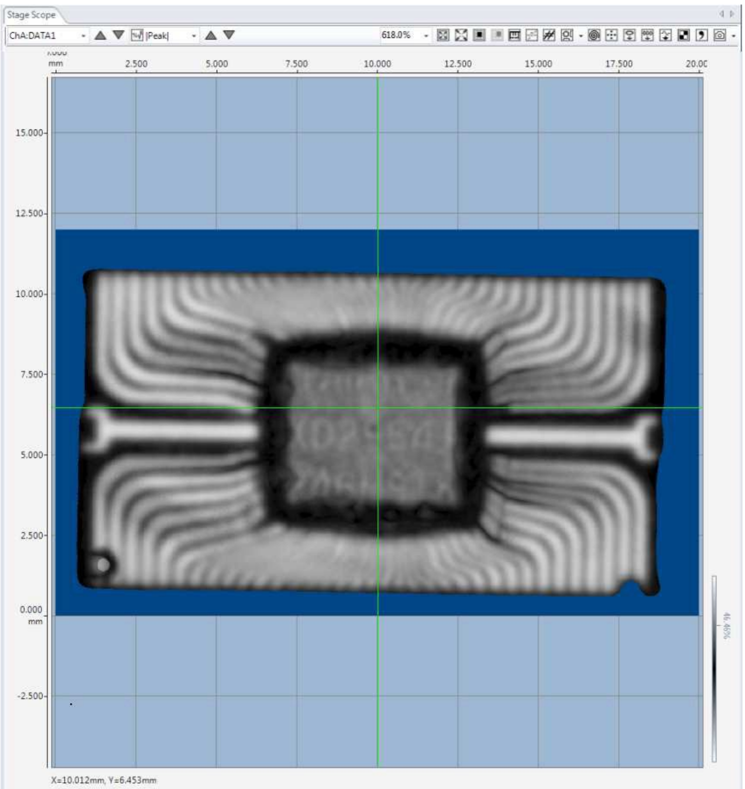


*Figure 6-17: The **Stage Scope** visualizes the data obtained during a scan.*

The content of the stage scope can be controlled by using the small control elements on its top side:

- The first control element (on the left) allows the selection of the source of data to be shown. If only one *Single Data Gate* has been active, then only one source of data is available. If a *Sliced Data Gate* has been used, then each slice can be selected separately for representation. Finally, if several different data gates (out of the four which are possible) have been used, some of them eventually sliced, then all these different slices out of different gates can be chosen as the source of the data to be visualized.
- The second control element allows selecting which data out of those introduced in Figure 6-6 will be visualized.
- The next element allows scaling of the data representation. The image can also be scaled by rotating the trackball of the mouse. The image can be moved by keeping the right mouse button pressed and moving the mouse.

The other control elements have the following functions:

- **Zoom on Image**: Zoom on the image in such a way that the scan area fills out the available space for image representation.
- **Zoom on Stage**: Zoom on the sample stage in such a way that the maximum available scan area (in general 400 x 400 mm) fills out the available space for image representation. In this case, the image of the part under study in general only fills out a small part of the space which is available in InsightScan for image representation.
- By the **Stage Coordinates** and **Image Coordinates** buttons you may select if the indicated coordinate system should be the one of the stage or the one relative to the scanned area.
- **Measure**: Click on any point of the sample image, and its coordinates in the currently selected coordinate system are shown. Draw a line on the image by keeping the left mouse button pressed and the coordinates of the two endpoints will be shown, together with their distance.
- **Probe**: If this icon is active (click on it to activate it), then moving the cursor to any point on the sample image and clicking there will move the transducer to the respective position. Then the received signal at this point can be seen in real time on the A-scan oscilloscope.
- **ScanArea**: You may redefine the scan area by using the current image as a source for the new scan length and depth. When **ScanArea** is activated, draw a rectangle representing the new scan area on the **StageScope** image, with the left mouse button kept pressed. When you release the mouse button, the dialogue shown in Figure 6-18 will open.
  Selecting one out of the two first items will make you either keep the current recipe and create a new one with the new scan area, or replace the current one. In either case, starting the next scan will delete the former one. If you select **Patch Scan**, the former scan result will be kept, and the result of the next scan with the newly defined scan area will be patched into the former result taken on a larger area. You may thus replace sections of the scan result where errors occurred (like a water bubble on the sample surface), without doing again the full scan on the large initial scan area.

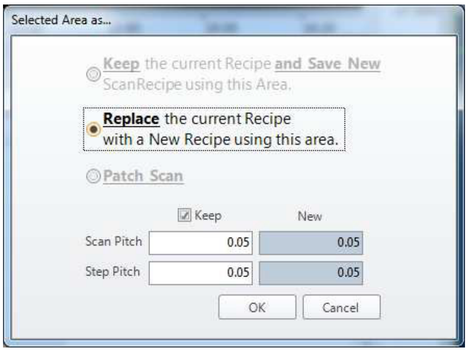


*Figure 6-18: The **ScanArea** dialog window.*

- **BScope**: Adds **BScope** visualization to the lower and the right-hand side of the **Stage Scope**. To use this tool, the **BScope** tick box needs to be ticked. Refer to Section 6.6.4 for details.
- **Polar**: In the case of rotational scans clicking on this button allows to show polar coordinates.
- **Cursor**: Adds/removes a cursor to the image.
- **Save one image**: Saves the current image in the *.png format.
- **Save all images**: Saves a selection of images (selected by the user within all currently available images) in one of the following formats: png, TIFF, TIFF_UNCOMP, jpeg, bmp, DICONDE. The format needs to be defined before saving in the **System Config** tab (Chapter 7.1).

- **Point Cap. AScan**: Click here to extract a point capture A-scan at the current cursor position (see Section 6.6.3).
- **Smooth**: Operates a virtual smoothing operation on the C-Scan image, which might generate a visually "nicer" impression.
- **Export CSV**: Click here for *.csv export of the C-Scan data.
- **Image capture**: Click here to save the Stage Scope as an image file.

6.6.2. The Summary Scope

The Summary Scope offers the possibility to visualize up to four C-scan images simultaneously. To activate this scope set the **Summary** switch in the **Scopes** selection area (Figure 6-2) to *ON*. An additional scope area as shown in Figure 6-19 will open.

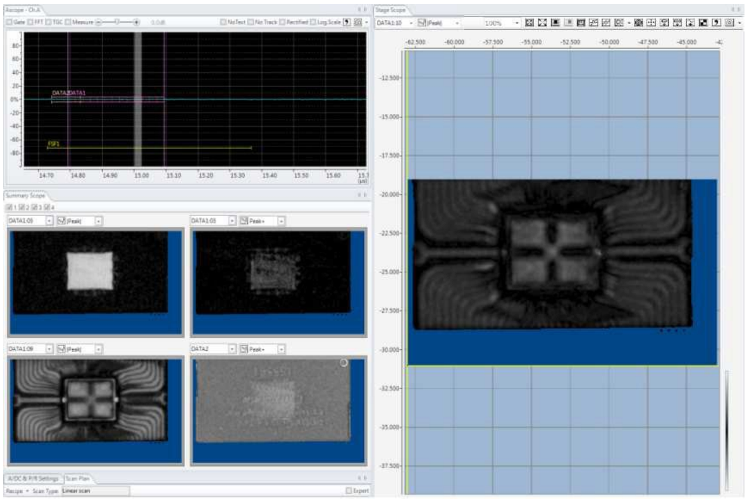


*Figure 6-19: The **Summary Scope** can visualize up to four C-scan images simultaneously. These C-scans can be selected out of all current available C-scan data in the software.*

In the upper left corner of the Summary Scope window, you may open up to four representation areas, by clicking the check boxes numbered 1 … 4. In each of these representation areas, the specific data to show can be selected by the pull-down menus.

6.6.3. The Point Capture AScope

The Point Capture Ascope can visualize A-scan images on selected locations of a previously obtained C-Scan. It may serve for example to compare the A-Scan at a location where a defect is visualized on the C-scan with the A-Scan at a location where no defect is seen. To activate this scope set the **Point Cap.** switch in the **Scopes** selection area (Figure 6-2) to *ON*. A scope as shown in Figure 6-20 will open.

At the end of a scan acquisition use the **Probe** tool of the **Stage Scope** (Section 6.6.1) to mark a point on the C-scan image. Then click on the **Point Cap. AScan** button (Section 6.6.1) to extract the A-scan at this point. It will be visualized on the **Point Cap. AScope**, and added to the list of available A-scans on the left-hand side of this scope. With the aid of this list, you may turn selected A-scans visible or invisible, and you may delete those you no longer need.

The A-scans present in the list can be activated by clicking on the respective line. The activated A-scan can be moved horizontally on the Point Capture scope, which allows the superposition of different

Scans which slightly shifted in time. The activated A-scan can be analyzed by the FFT tool. The portion of the A-scan to be FFT-analyzed can be determined by moving the green selector tool in the A-scan onto the portion of interest.

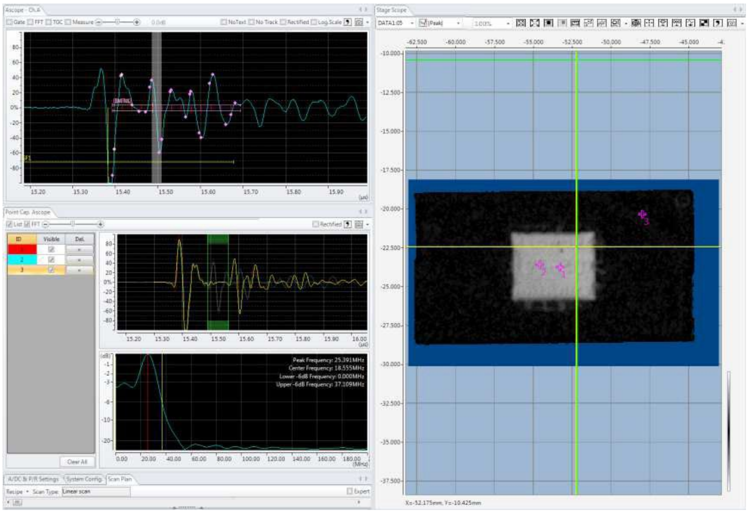


Figure 6-20: The Point Capture AScope may be used to compare A-Scan images at different selected locations within a C-scan.

6.6.4. The BScope Tool

Figure 6-21 shows the Stage Scope with the **BScope** tool active (the **BScope** tick box is ticked). Two additional visuals are added to the bottom and the right-hand side of the main screen. Different options are available by using the **BScope** tool.

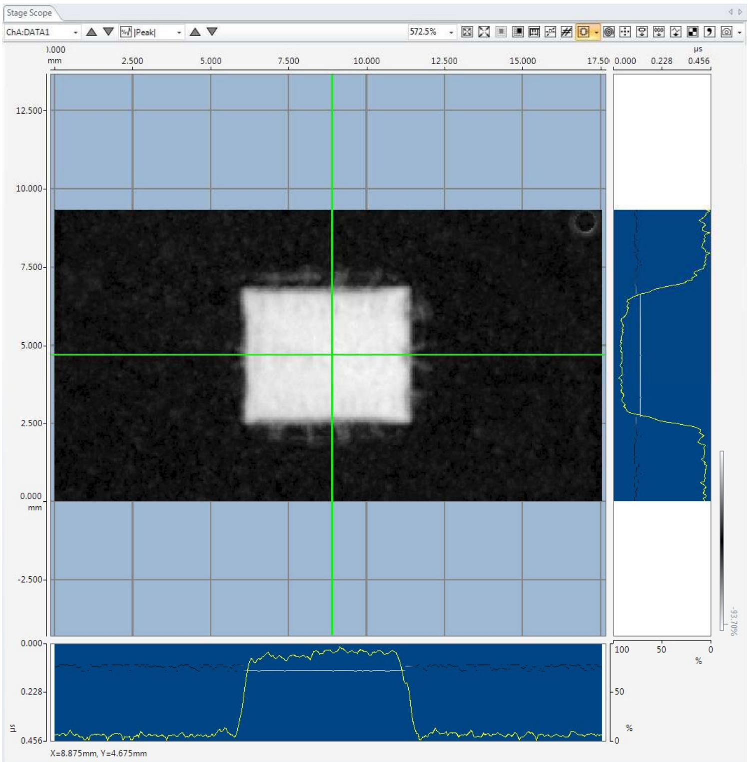


*Figure 6-21: The Stage Scope, with the **BScope** tool active. The **Cross Section** representation is chosen, and the **Profile** option is active.*

Figure 6-21 shows the **BScope** when the **Cross Section** function is chosen. Move the mouse on the C-scan image. Then in each of the lower and right **BScan** images a grey scale line will be drawn. The colour and the position of the line are determined by the amplitude and the time of flight of the highest peak within the data gate represented in the C-Scan image.

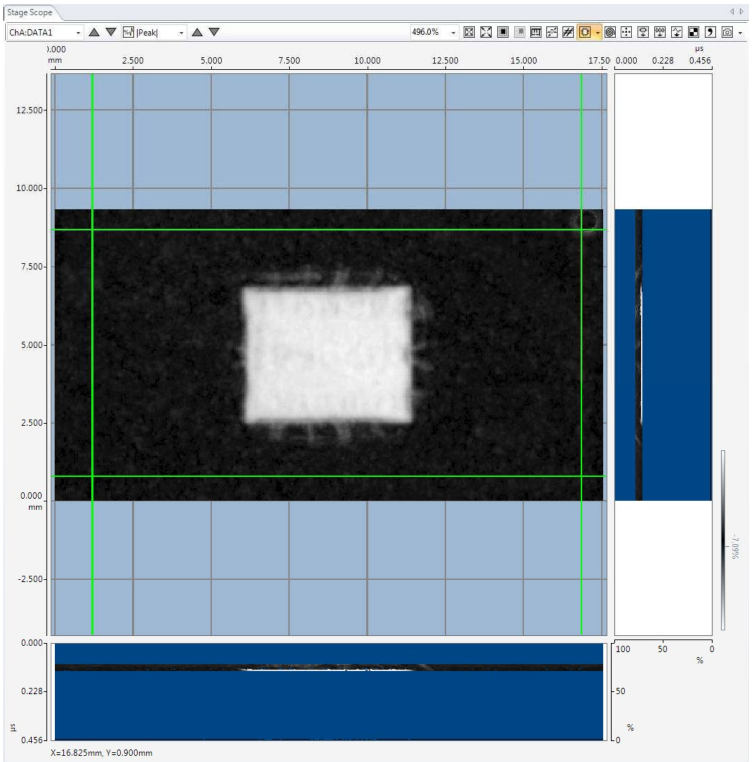


*Figure 6-22: The Stage Scope, with the **BScope** tool active. The **Volume** representation is chosen,* but *the **Profile** option is not active.*

Figure 6-22 shows the **Volume** representation of the **BScope**. For this representation, you have to drag the green rectangle on the C-scan image, while keeping the left mouse button pressed. This rectangle will define the volume to be analyzed. Then the software will extract **Cross Sections** as described above, for all pixel lines and rows present in the green rectangle you defined. These will be represented simultaneously in the lower and right BScope areas.

Additionally, in Figure 6-21 the optional **Profile** function is activated. This function adds the yellow line to the **BScope** images, which represents, at each point, the sum of all amplitudes. In case it is used with the **Cross Section** function, the **Profile** corresponds just to another way of representing the color (= amplitude) of the **BScope** line. However, if used with the **Volume** function, **Profile** will build the sum of all amplitudes present at a given location.

Finally, the **BScope** can be used in the **RF BScope** mode. In this mode, the “classical” B-scan images are shown below and on the right-hand side of the C-scan images: For each pixel, the pixel position corresponds to the time of flight, and the pixel colour to the amplitude measured at this position and time, independently if there is a maximum or not in the A-scan. Note that using the RF mode is only possible if a **WF** gate is present in the scan. The **RF BScope** will be generated for all events which are located within the **WF** gate limits.

6.6.5. Sequential Scan

The **Sequential Scan** allows combining different **Linear Scans** and/or **Array Scans** into one scan operation. Each of the combined scans needs to be set up preliminarily, and its scan plan needs to be saved on the PC. To create a **Sequential Scan**, click on the tick box in the upper right corner of the InsightScan window. A Sequential Scan definition area as shown in Figure 6-23 opens.

Open a **New** Project in the pull-down menu in the upper left corner. In the upper left area of the **Sequential scan** window, you may load existing **Scan Recipes**, and move them to the right-hand side of the window where the sequence of scans to be done is built. You may also define **Probe** (i.e. transducer) movements in between the different scans. This might be useful if when passing from one scan area to the next the transducer has to pass a zone where high obstacles hinder the movement of the transducer. In this case, you might program an elevation of the z-axis in between these successive scans, so that the transducer passes above the obstacle. **Labels** of your choice can be attributed to both recipes and probe movements.

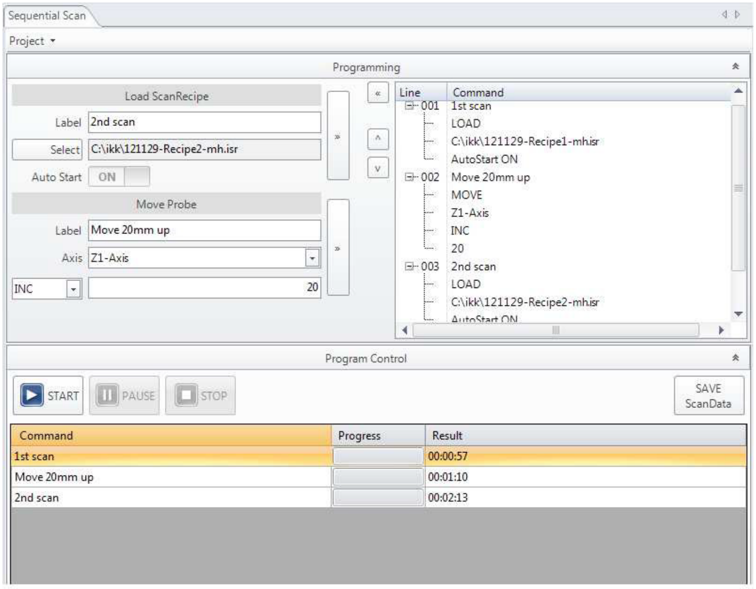


Figure 6-23: Setting up a ***Sequential Scan*** *plan.*

The specific interest of the **Sequential Scan** is that each of the scans it is built from can have its own focal position, gain, gate setting, etc. Therefore, this scan is particularly adapted for analyzing physically different samples within on single run. When setting up the different single scan recipes to be combined into a sequential scan care needs to be taken concerning the position the transducer will move to before starting the single scan, and after its termination. In the case of the sequential scan, due to potentially different geometries of the analyzed samples, it might be interesting to define the **Corner** position as the initial and final transducer position for each single scan. Then, the movement from one sample to the next might be programmed within the **Sequential Scan** by adding **Move Probe** commands.

Press the **Start** button in the **Sequential Scan** window to start the **Sequential Scan**. The scan progress will be indicated in the lower part of the window. You may save the scan results by pressing the **SAVE ScanData** button.

6.6.6. The Scan Data Explorer

The **Scan Data Explorer** is a tool that allows to rapidly get information concerning previously acquired scans: scan conditions and parameters, recipes, C-scan images and notes. The **Scan Data Explorer** is located on the right-hand side of the InsightScan window (see Figure 3-4). During the time you use it, you might pin it to the InsightScan window by clicking on the drawing pin in its upper right corner.

For assessing a previously obtained scan, mark the result file of this scan in the **Scan Data** section in the lower part of the **Explorer**. The C-scan images of the scan are then accessible in the **ScanInfo** tab, as shown in Figure 6-24. On the top of the **Explorer**, you may select every available data from the scan for representation in the **Explorer**'s data screen. Clicking on **Compare** under the **Explorer**'s screen will copy the currently open data file from the Explorer into the InsightScan main window. There it might be used e.g. for real-time comparison with the currently acquired data.

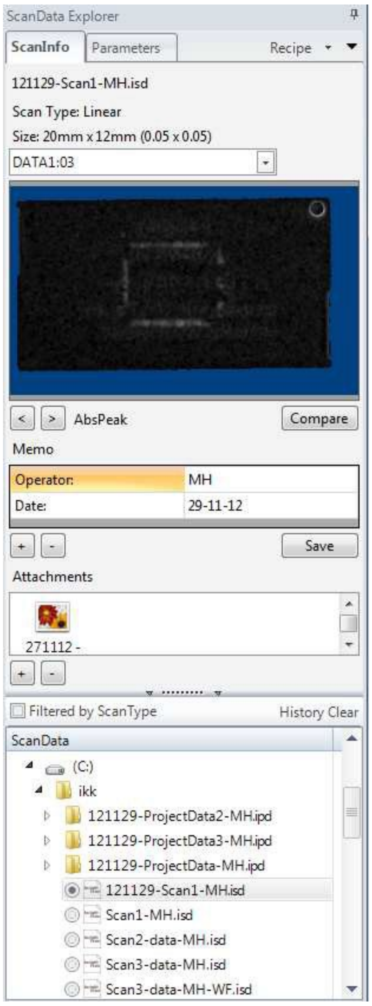


Figure 6-24: View of the Scan Data Explorer.

In the **Memo** section, you may add additional information to the file which is active in the **ScanData Explorer**. Click on the **+** sign underneath the memo to add new lines. You may add text to these lines. When click on **Save**, the created **Memo** will be added to the active file, and you will keep this information for the next time you open the file. Similarly, you may attach other files to the currently active file. Click on the **+** sign under the **Attachments** area, and select any file from your PC. This file will be permanently attached to your currently active InsightScan data file, until you remove it by clicking the **–** sign.

By activating the **Filtered by ScanType** box above the **ScanData** selection area you may restrict the previously acquired data files present in the **ScanData** area to those which have been acquired under similar conditions as the one your IS-350 scanner is currently in. For example, if your scanner is currently set up for doing a linear scan, all rotational scan data results eventually present on your computer will not be shown in the **ScanData** area.

On top of the **Scan Data** area the recently acquired scans are shown separately. You may clear these scans from the Scan Data area by clicking on **History Clear**.

The **Parameters** tab of the **ScanData Explorer** shows the acquisition parameters like scan area details and pulser/receiver settings.

6.6.7. The Color Palette

As default, C-scan images are represented with a grey-scale color palette. You may change the palette by doing a right mouse click on the color scale of the **Color Palette** tool present in the **Tool Box**. The menu shown in Figure 6-25 appears. Some predefined color palettes are present in the **System Palettes** menu. Others can be created and stored as **User Palettes**. The different color steps you defined are represented on the color scale. There, the color steps can be moved up and down the scale by moving them with the mouse and keeping the left mouse button pressed.

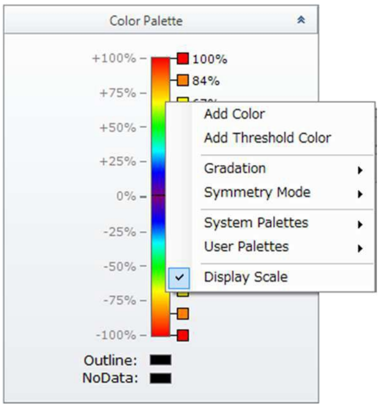


Figure 6-25: The Color Palette tool in the Tool Box. The menu opens by doing a right mouse click on the current color scale.

7. Options

Some optional items are available for the IS-350 acoustic scanner. These will be introduced in the present Chapter. Note that these items are non-standard items. Therefore, you will not find them on your system except you explicitly ordered them.

7.1. 500 MHz Pulser/Receiver

Your IS-350 system may be equipped with a pulser/receiver with a frequency range up to 500 MHz, replacing the 300 MHz standard pulser/receiver.

In this case, you may use ultrasonic transducers with frequencies up to 500 MHz. No special attention or action is required from the user, the variation between this option and the standard system is limited to internal electronic modifications. You may also use the same remote pulsers as in the case of the standard system: RP-L2, RP-H4 and RP-U4.

In the case of a dual channel system with channel A used for LOW frequencies (up to 50 MHz) and channel B for VERY HIGH frequencies (up to 500 MHz), the set of adjustable DPR parameters is summarized in Tables 7-1 and 7-2.

Table 7-1: Possible values for DPR channel A in case of a dual channel (50MHz/500MHz) IS-350 system.

Channel A	with RP-L2	with RP-H4
Pulse	On, Off	
Voltage (negative)	275, 276, 277, ... 499, 500 V	330, 331, 332, ... 379, 380 V
Damping	330, 104, 44, 34 Ω	100, 50, 33, 25 Ω
Energy	Low, High	
Mode	Echo, Through	
Gain	-13, -12, -11, ... +65, +66 dB	
Low Pass Filter LPF	3, 7.5, 10, 15, 22.5, 50 MHz	
High Pass Filter HPF	0.001, 1, 2.5, 5, 7.5, 12.5 MHz	

Table 7-2: Possible values for DPR channel B in case a dual channel (50MHz/500MHz) IS-350 system.

Channel B	with RP-L2	with RP-H4	with RP-U4
Pulse	On, Off		
Voltage (negative)	275, 276, ... 499, 500 V	330, 331, ... 379, 380 V	143 V
Damping	330, 104, 44, 34 Ω	100, 50, 33, 25 Ω	100, 50, 21, 17 Ω
Energy	Low, High		
Mode	Echo, Through		
Gain	-22, -21, -20, ... +49, +50 dB		
Low Pass Filter LPF	300, 500 MHz		
High Pass Filter HPF	5, 30 MHz		

7.2. Turntable Sample Stage

The IS-350-TT system is equipped with a turntable sample holder, allowing for a fourth scan axis. A typical mechanical setup is shown in Figure 7-1. However, depending on the special configuration, the size of the turntable plate might vary. The rotation of the turntable around its vertical axis adds to the sample scan capabilities given by the x-, y, and z-axis.

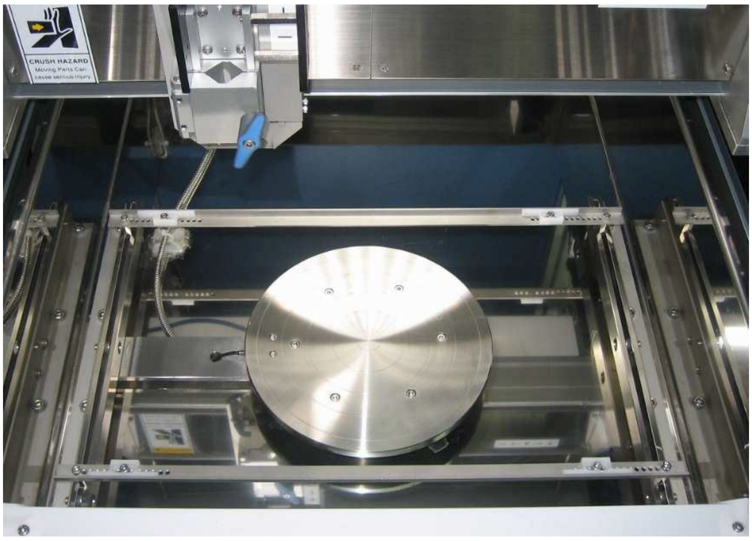
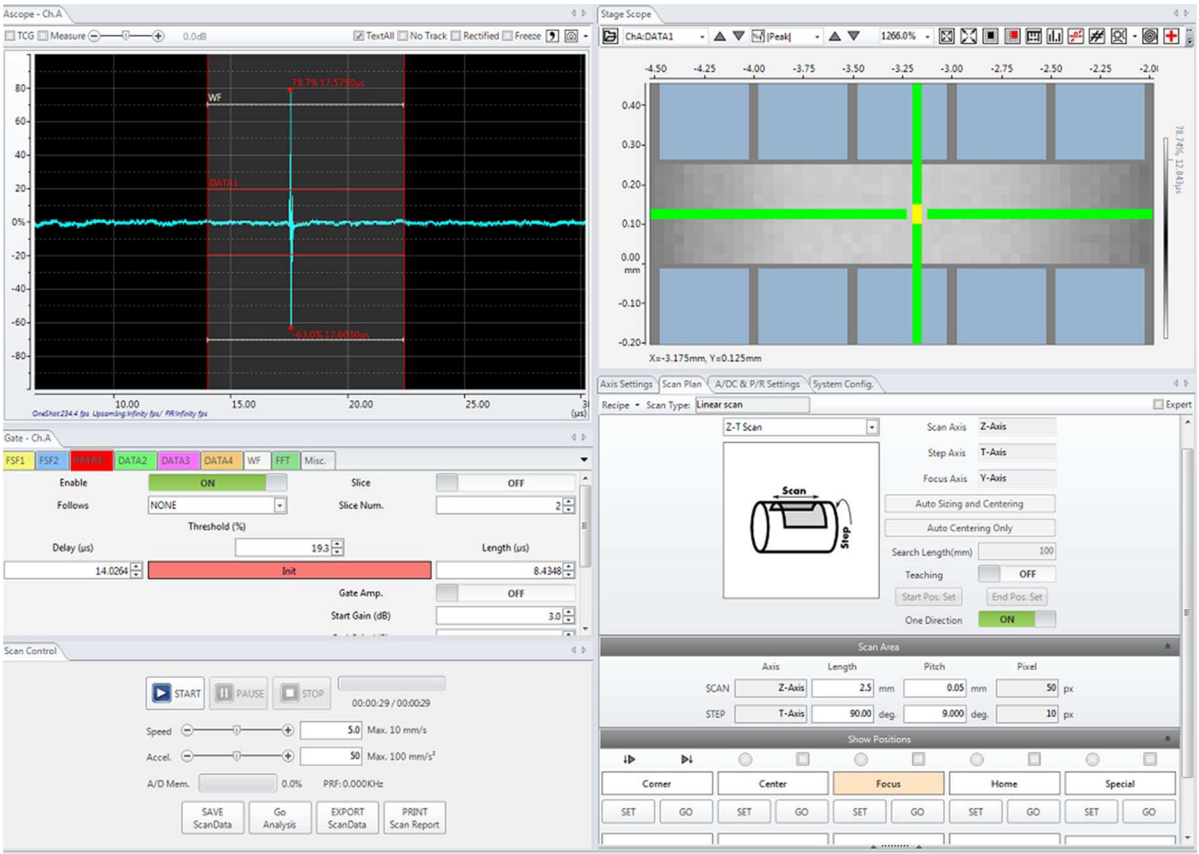


Figure 7-1: View of the turntable type sample holder in the IS-350-TT system.

The control of the turntable rotation is fully integrated in the InsightScan software. Additional scan configurations are therefore possible by using the turntable during scans. A four axis (x,y,z,T)-scan system (*T* meaning *turntable*) is particularly suited for scanning the surface of cylindrical samples. As an example, Figure 7-2 shows the configuration for a *Linear Z-T-scan*.



four-axis

Figure 7-2: InsightScan software configured for a Linear Z-T-Scan.

To configure this type of scan, click on **Linear Scan** in the **Recipe -> New** menu of the *Scan Plan* tab. Then select **Z-T-Scan** in the *Basic Setting* section. In this configuration, the x-axis is the scan axis (the transducer will move up and down while acquiring data), and the rotational axis of the turntable is the step axis. You may select if the data acquisition during the scan along the x-axis will be done in **One Direction** only or in both scan directions. When parametrizing the scan characteristics please note that the standard resolution of the turn table is 50,000 steps/turn. Therefore, a single step of the turn table motor corresponds to a minimum pitch of 0.0072°.

The *Stage Scope* shows the usual result values (such as the **Peak** value of the acoustic signal within the selected gate) projected on a flat 2D square: the horizontal axis of the square represents the scan axis (x-axis) of the scan, the vertical axis of the square represents the step axis (rotation) of the scan.

8. Advanced Settings

The settings and adjustments introduced in the present Chapter are not necessary for the everyday standard work with the IS-350 system. During installation, these parameters will be set by the installation engineer such as trouble-free, high-performance measurements can be done with your instrument. The present Chapter should therefore be considered as expert knowledge, which may help you to further exploit the full potential of your system, beyond the standard use. You should already have accumulated some experience with the system's operation before using them.

8.1. System Configuration

The following general configuration parameters can be set in the **System Config.** Tab (Figures 8-1 and 8-2).

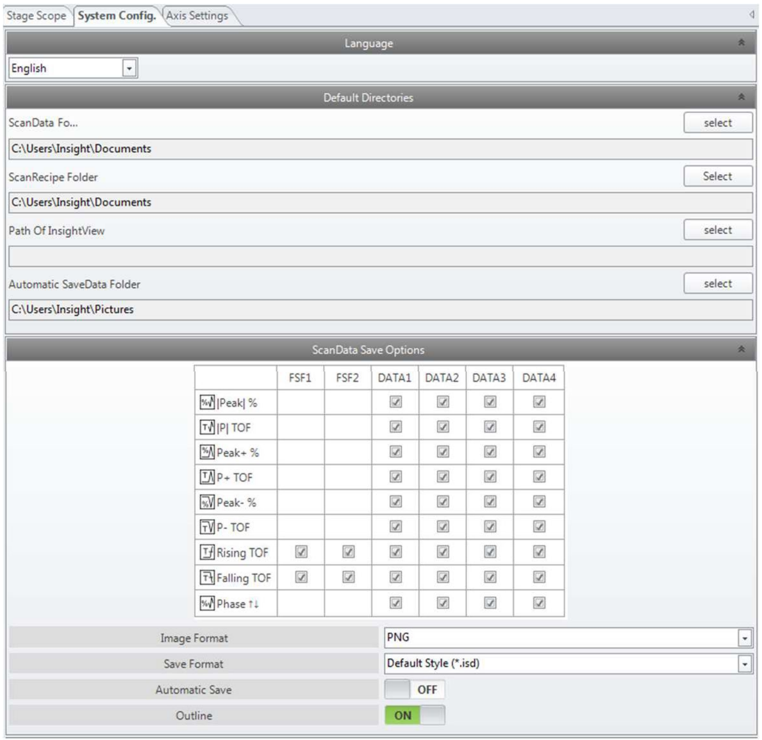


Figure 8-1: System configuration parameters, part 1.

- **Language**: Choose the software's language. You need to restart the software to make your selection effective.
- **Default Directories**: Sets the default directory for data and recipe storage.
- **Path of InsightView**: Indicates the path of the InsightView software. Typically this path should be *C:\Program Files (x86)\Insightkk\InsightView\InsightView.exe*. Indicating this path is mandatory for using the **Analysis** button in the **Scan Control** tab (Figure 6-14).
- **ScanData Save Options**:
    - The **table** in this section allows defining the default data set that will be saved when you hit the **SAVE ScanData** button (Figure 6-14).

- **Image Format:** The format selected here will be used when saving images by clicking either on **Save All Images** in the **C-Scan** tab (Figure 6-17), or by clicking on **Save ScanData** or **Export ScanData** in the **Scan Control** tab (Figure 6-14).
- **Save Format**: All Insight Scan Data are saved in the proprietary *.isd format.
- **Automatic Save**: If automatic saving is active then at the end of each scan the result data are automatically saved in the **Automatic ScanData Folder** defined in the **Default Directories**.
- **Outline:** When **Outline** is *ON*, every pixel of an acquisition where FSF1 is detected, but no data is detected (because the signal stays under the threshold limit within the entire gate) is attributed a specific ‘Outline’ label. With **Outline** *OFF*, these pixels would get the standard ‘NoData’ label attributed. Thus, with Outline ON, pixels without signal at locations where a sample is present (FSF1 detected) can be distinguished from pixels without signal due to the fact that no sample is present (FSF1 not detected). In other words, this function allows outlining the sample surface in cases of very sparse signal.

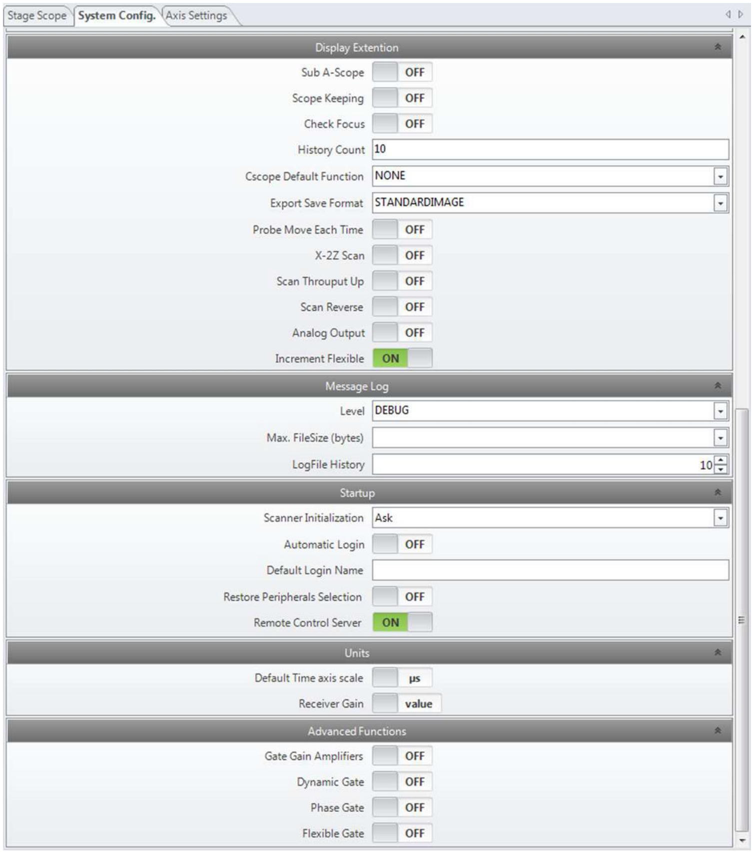


Figure 8-2: System configuration parameters, part 2.

- **Display Extension**:
  - **Sub A-Scope**: Switch *ON/OFF* an additional A-Scope. This scope is a copy of the A-scope integrated in the InsightScan main window.
  - **Scope Keeping**: (prepared for future software upgrades)
  - **Check Focus:** If **Check Focus** is *ON*, then at the beginning of each scan the software checks if the transducer is in the focus position. If this is not the case, a warning message shows up.

    - **History Count:** (prepared for future software upgrades)
    - **Cscope Default Function:** Here you may preselect which function the cursor on a C-Scan image will bear: *NONE*, *MEASURE*, *PROBE*, or *SCAN_AREA*. For details on these functions see Section 6.6.1.
    - **Export Save Format:** The format of saved images can be selected differently for images saved by the **EXPORT ScanData** button compared to those saved by using the **SAVE ScanData** button (Section 6.5.1). The EXPORTED images might be saved in *MULTITIFF* or *DICONDE* format even if the SAVED images are stored in a standard image format.
    - **Probe Move Each Time:** (prepared for future software upgrades)
    - **X-2Z Scan:** Setting the **X-2Z Scan** *ON* allows to acquire simultaneously two C-scans, by using two independent transducers mounted on two independent z-axes. *This function is only available if your scanner is equipped with the corresponding hardware.*
    - **Scan Throughput Up:** Allows to increase the scan speed by reducing the time delay necessary for inverting the transducer direction at each end of a scan line. *Available only if the x-axis is the scan axis.*
    - **Scan Revers:** Reverses the scan direction.
    - **Analog Output:** (prepared for future upgrades)
    - **Increment Flexible:** (prepared for future software upgrades)
- **Message Log:** InsightScan issues messages spanning from debug information over general information to fatal warnings. The minimum **Level** of importance of the messages to be shown can be selected. A log file with a **Max. FileSize** of 1 Mb is created in the folder *UserName*\AppData\Roaming\InsightScan.new\Log. When the log file reaches its 1 Mb size limit, a copy of it is added to the LogFile History, which accumulates up to 10 full LogFiles.
- **Startup**:
    - **Scanner Initialization**: Select if the scanner is initialized every time (*Yes*) or never (*No*) at software start-up, or if you are *asked* what to do. *ONLY choose YES here if you are sure that every time at start-up the measurement head of the system is free to move, without any danger for the transducer.*
    - **Automatic Login:** Selecting *ON* will remove the need for login at software start-up.
    - **Default Login Name:** User administration is not yet implemented; this field is reserved for future software upgrades.
    - **Restore Peripherals Selection**: Selecting *ON* here will automatically restore your peripherals selection at each InsightScan start-up.
    - **Remote Control Server**: Selecting *ON* will allow other Insight kk software, such as the InsightProduction software, to connect to InsightScan and remote control this software. In case *OFF* is selected no other software can take control of InsightScan.
- **Units**:
    - **Default Time axis scale**: Select the units of the x-axis, either µs or mm. See Section 6.3.5.
    - **Receiver Gain**: Chose either *Value* or *Index* for control of the receiver gain. Default: *Value*.
- **Advanced Functions**: In this part you may select available advanced functions for the control of the acquisition gates. Refer to Chapter 7.3 for details.

8.2. Axis Status

Figure 8-3 shows the axis status window in the case of a standard three-axis system. No user interaction is required within this window. However, if you need to ask for support, or report a system failure, it might be useful to include a screenshot of your current axis status window.

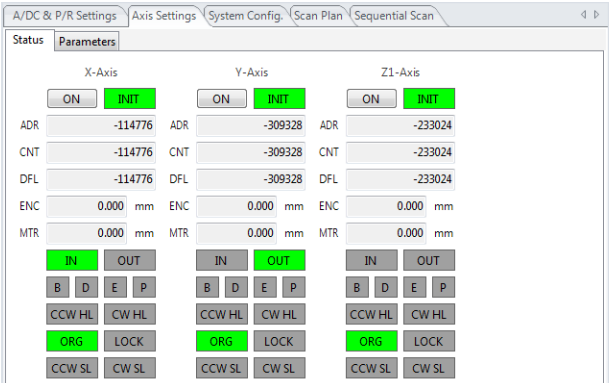


Figure 8-3: View of the axis Status window.

8.3. Advanced Gate Settings

For advanced applications, four additional functions complete the data gate settings introduced in Chapter 6.3. These functions are operational both for single data gates and for sliced data gates. They can be enabled or disabled by using the switches present in the **System Config** tab (see Chapter 8.1).

8.3.1. Gate Gain Amplifiers

The **Gate Gain Amplifiers** allow for change of the gain within a given data gate. To use this function, you first need to enable it in the **System Config** tab (Figure 8-2). Then, some additional parameters are available for the control of the gain within the data gates **DATA1**, …, **DATA4** (Figure 8-4).

The "primary" gain applied to the signal is the one selected in the parameter section of the DPR (Chapter 6.1). This gain is an electronic "hardware" gain. The signal is then digitized by using the A/D board and analyzed by the Insight software. After digitalization, an additional "software" gain can be applied within the data gate, by activating the **Gate Gain Amplifier** function. The electronic gain of the DPR can thus be decreased or increased numerically at the beginning and the end of the data gate. During the data gate, the gain varies linearly from its initial to its final value.

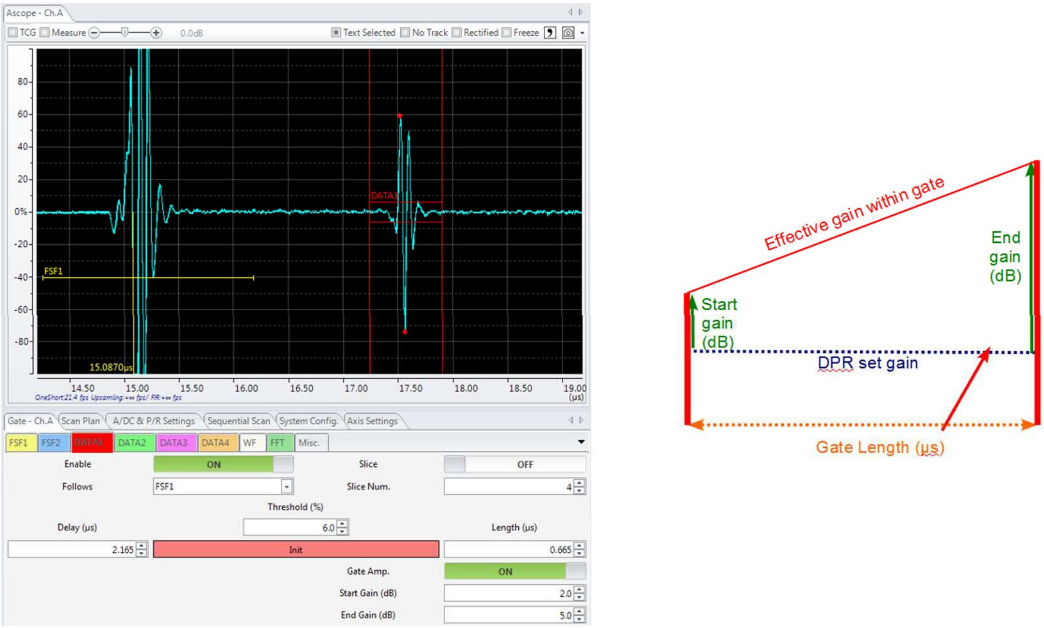


Figure 8-4: Gain variations by using the Gate Gain Amplifiers: The gain applied by the DPR is numerically increased by 2 dB at the beginning of the gate, and by 5 dB at the end of the gate.

8.3.2. Dynamic Gate

The dynamic Gate function, which is present within each of the four data gates DATA1 … DATA4, allows to dynamically increase the length of the data gate during a scan.

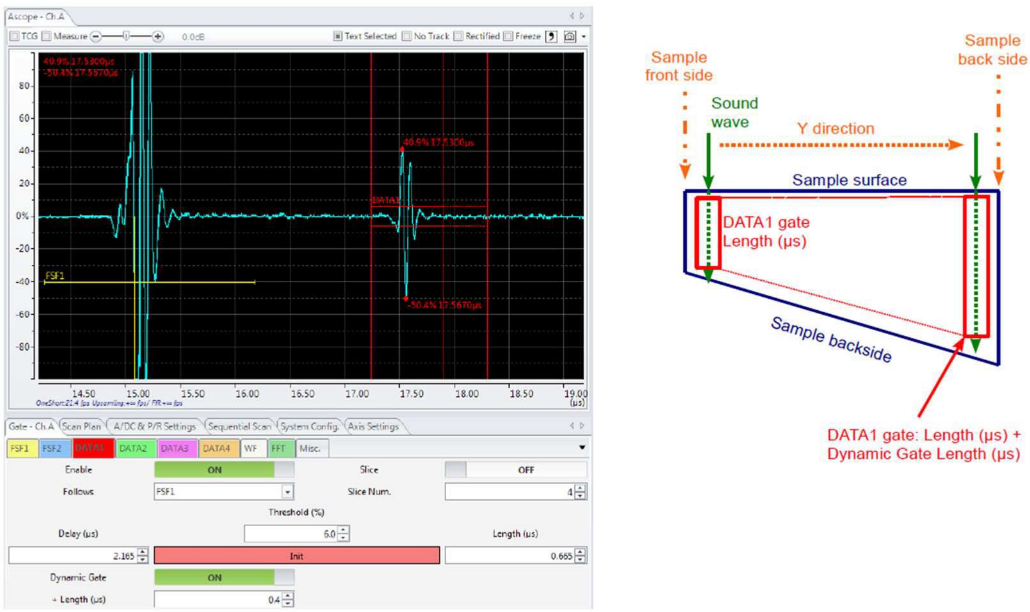


*Figure 8-5: Principle of the **Dynamic Gate** function: At the beginning of the scan (front side of the tank, small y-values) the gate length will correspond to the initially selected gate length (here: 0.665µs). At the end of the scan (back side of the tank, large y-values) the gate length will be equal to the initially selected gate length plus the dynamic length (here: 0.665µs + 0.4µs = 1.005µs).*

If for example a sample has a wedged shape as shown in Figure 8-5, and the length of the data gate should cover the full time that the acoustic wave needs to travel through the sample, then the gate length needs to increase during the scan. To do so, switch **Dynamic Gate** *ON* in the gate settings. Set the **Length(µs)** parameter such as it corresponds to the desired gate length at the front side of the tank (small values on the y-axis), and the **+Length(µs)** parameter such as it corresponds to the increase of gate length during the scan progress along the y-axis.

The Dynamic Gate function also operates on sliced gates. The **+Length (µs)** in this case refers to the increase of the total length of the sliced gate, not the increase of each slice.

8.3.3. Phase Gate

The **Phase Gate** allows to identification of the phase inversion of a reflected ultrasound wave, compared with the incoming wave.

For a correct use of the **Phase Gate,** you first need to know the phase of the emitted wave. This phase depends on the chosen parameters for the DPR, in particular **High** or **Low Energy**, and of the set **High** and **Low Pass Filters**. The phase of the emitted wave therefore needs to be validated for each specific application. For doing so, you may simply acquire the signal generated by the reflection on the sample surface (which in general is used for setting the FSF), or the signal generated by the reflection of the ultrasound wave on the stainless-steel sample holder.

The **Phase Gate** as established in the InsightScan software only applies to the (standard) case of an incident wave which first shows a peak of moderate positive voltage, followed by a peak with high negative voltage (the absolute voltage of the negative peak has to be higher as the absolute voltage of the positive peak). If your incident wave fulfils this requirement, you may use the **Phase Gate**. If your incident wave does not fulfil this requirement you need to change the pulse parameters first, until the phase of your wave fits the requirement.

The phase inversion in the sample is then defined as the fact that the first peak of the reflected wave shows moderate negative voltage, while the second peak shows high positive voltage. The **Phase Gate** has to be configured in a way that allows verifying this condition. For this purpose, Insight scan uses a classical algorithm which is based on three thresholds (see Figure 8-6): **Threshold for Inversion**, **Inversion Threshold+** and **Inversion Threshold-**.

In general phase inversion is tested in order to identify delamination in the sample. During the transition of the ultrasonic wave from resin or silicon into air the phase of the reflected signal is inversed. Additionally, it is known that delamination causes very strong reflections (high amplitude). Therefore, the **Threshold for Inversion** parameter checks if the signal within the **Phase Gate** has a high amplitude. All signals with small amplitude are disregarded. For this reason, the **Threshold for Inversion** parameter should be set at a value of 30 – 50% (default: 30%). Note that here 30 – 50% means *30 – 50% of the full height of the A-Scope's y-axis*.

Then, the algorithm identifies the peak with the highest voltage amplitude within the Phase gate, which might be either of positive or negative voltage. The amplitude of this peak is considered in the following as 100%, which sets a voltage reference. The two parameters **Inversion Thr+** and **Inversion Thr-** are to be considered as relative values compared to the 100% voltage reference of the highest peak. The standard (default) values of these two parameters are 80% (of the reference voltage) for **Inversion Thr+**, and 60% (of the reference voltage) for **Inversion Thr-**. These parameters are valid for a large variety of measurement conditions. **Inversion Thr+** only applies to positive voltage peaks, whereas **Inversion Thr-** applies only to negative voltage peaks.

If, within the **Phase Gate**, the **Inversion Thr-** is triggered first (before **Inversion Thr+** is triggered), then the signal is considered at normal phase (that means: not phase inverted). The corresponding pixel in the C-Scan is shown in *blue* or *green* if the **Threshold for Inversion** has been triggered.

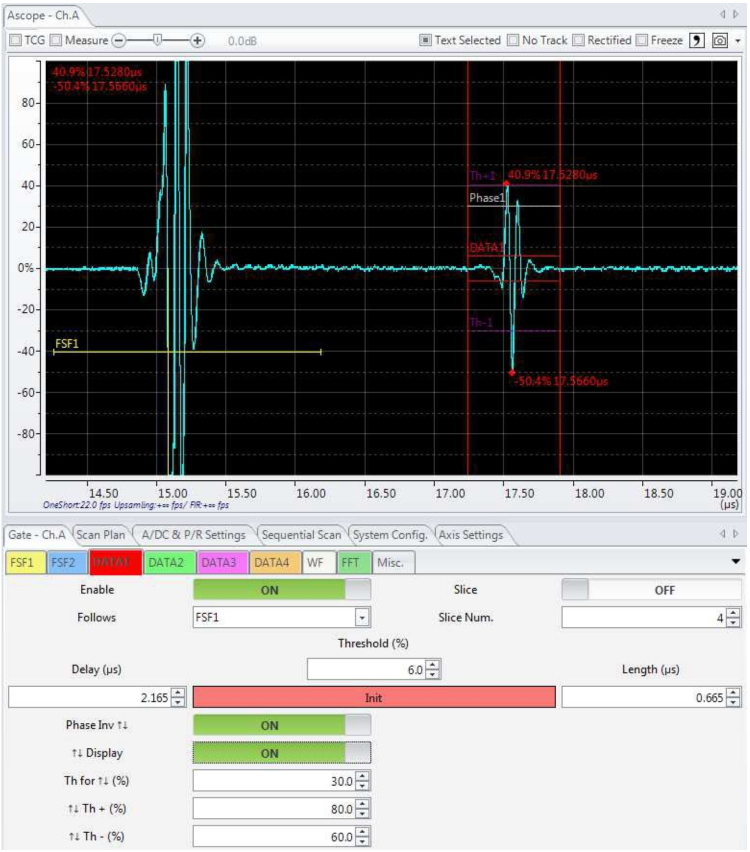


*Figure 8-6: Default configuration of the three **Phase Gate** parameters: **Threshold for Inv.**, **Inversion Thr+** and **Inversion Thr-**.*

If **Inversion Thr+** is triggered first, then the signal is considered as phase inverted. If the **Threshold for Inversion** has been triggered then the corresponding pixel on the C-Scan is shown in *yellow* or *red*, depending on the amplitude of the positive peak.

If the **Threshold for Inversion** is not triggered within the **Phase Gate**, then the corresponding pixel is not specifically colored.

The three parameters can be adapted by the user if needed. However please note that the pre-set values correspond to a reasonable parameter set for a large variety of application cases.

8.3.4. Flexible Gate

The **Flexible Gate** (Figure 8-7) offers the most flexible control of the ultrasound acquisition. It is particularly interesting for an experimental optimization of the acquisition conditions.

When the **Flexible Gate** option is active, the initial **Length(µs)** of the gate can be adjusted in both senses (- or +) by varying the **–Length(µs)** and the **+Length(µs)** parameters. This variation of the gate length is possible during C-Scans, by pressing the PAUSE button for shortly suspending the scan progress.

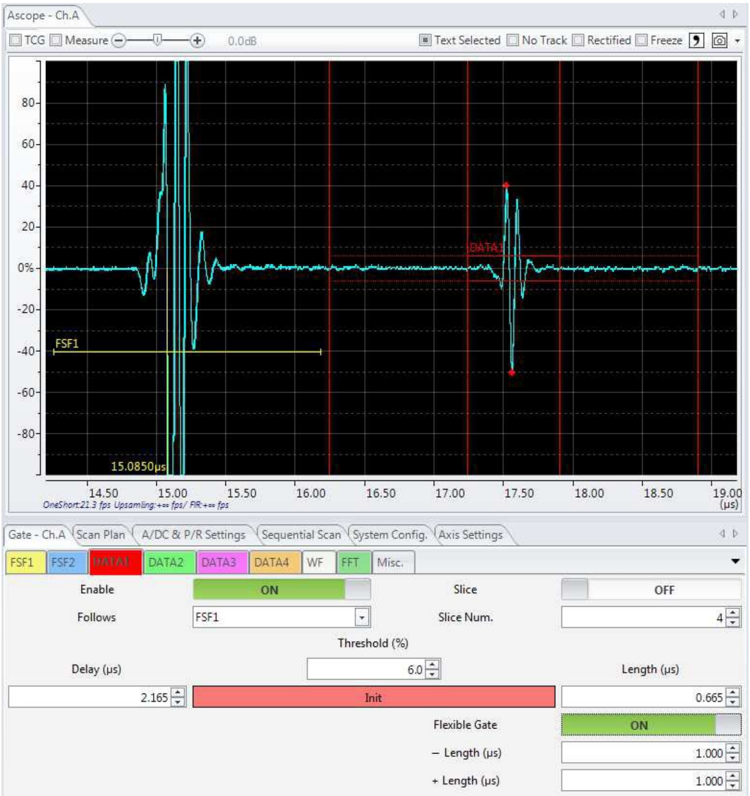


Figure 8-7: The Flexible Gate allows maximum flexibility for defining and rapidly varying gate parameters.

9. Regular User Maintenance Operations

The present maintenance procedure is intended as guidance for preventive system maintenance by the user. Preventive maintenance will contribute to keeping a running system in good working conditions, and minimize system failure due to premature wear of moving components.

However, the present maintenance procedure is not intended for system repair. If your system is not operating, please contact one of Insight's authorized service providers.

9.1. Preventive Maintenance Interval

The preventive maintenance interval depends on the intensity of use of the system, the nature of the inspected parts, and the details of the applied inspection recipes. Systems used on the production floor need more maintenance than pure R&D systems, rusty metal parts will pollute the water faster than clean plastic parts, and fast scans with high acceleration will cause stronger wear of the moving components than slow scans.

Table 9-1 summarizes some recommended maintenance intervals, depending on system use. Please note that these intervals only give a rough indication, and might need to be shortened depending on the application, wear, and condition of your system.

Table 9-1: Recommended preventive maintenance intervals for IS-350 systems. Depending on your specific use and the nature of your samples, the recommended intervals might be shortened or extended upon your personal judgment.

Operating conditions	Screw and slider cleaning and greasing	Tank cleaning and water exchange
Rarely used R&D systems	12 months	3 months
Regularly used R&D systems	6 months	2 months
Production floor systems, 8 hours per day	3 months	2-4 weeks
Production floor systems, > 8 hours per day	1-2 months	1-2 weeks

In the case of new systems, even if they are rarely used, the first preventive maintenance should be done no longer than six months after system installation.

9.2. Need of Maintenance

Preventive maintenance is most efficient for keeping your system in good working condition when done following a regular time scheme as described above. However, some signs should alarm you that preventive maintenance is necessary immediately. These are:

Axes wear

- Dust and abrasive wear particles that are accumulated in the grease of the x-, y,- and z-axis moving parts.
- When touching the sliding rails and the moving parts of each axis with a finger, you no longer feel an oily film on the parts. Make sure to check the entire length of each axis for the presence of enough grease, including the most often used center part, and also the two outer ends of the axis.

Dirt on the scan axis encoder

- Dust or other foreign matters are sticking to the rubber seal of the x-axis' encoder.
- Oil, water, dirt, or other foreign matters are present between the body and the detection head of the scan axis encoder.

Water tank

- Foreign particles like wear debris, rust, or others are present in the water.
- The water color changes, e.g. to brown (presence of fine dust of rust), green (presence of algae), or other colors.

If one of the above observations holds true on your system, you should proceed to preventive maintenance of your system immediately, and eventually shorten your usual preventive maintenance interval.

9.3. Applicable Grease

Applying the correct grease is essential to keep the moving parts of the IS-350 in good operating conditions, and to avoid corrosion.

Only apply LITHIUM SOAP-based grease systems. Other types of grease or mixtures of different types of grease may cause corrosion and damage to the IS-350 lead screws, linear guides, etc. In particular, NEVER use aluminum-based grease.

For your information: Insight kk uses the following lithium grease:

Product Name: Lithium Universal Grease No. 2

General distributor: Trusco Nakayama Co., Ltd.

Part Number: GCR-25

9.4. Preventive Maintenance Procedure

For all preventive maintenance work, the IS-350 needs to be completely separated from the main power. It is NOT sufficient to switch the system off. You have to pull out the mains cable from the main power outlet.

9.4.1. X-axis Sliding Unit

Remark: Due to the presence of the magnetic field under the cover you should not wear a watch or other precision equipment during your work on this unit.

- Remove the cover from the x-axis sliding unit (Figure 9-1): First remove the cover screws in the center of the x-axis sliding unit cover. Then remove the screws on the outer sides of the cover. Now you may pull the covers away from the unit.

- Use a dry, clean cloth to wipe away dust, deteriorated grease, and other impurities from the slide rails. Then apply fresh grease to the slide. The points where grease should be applied are indicated in Figure 9-2.
- After applying grease to the slide rail, manually make the motor move back and forth along the entire stroke of the axis. Remove the protruding excess grease.
- Use a dry cloth to wipe away dust and other impurities from the shaft.
- Put the cover back on the sliding unit.
- Finally, remove dirt and other foreign objects from the rubber seal and the inner area of the scale by using a clean dry cloth.

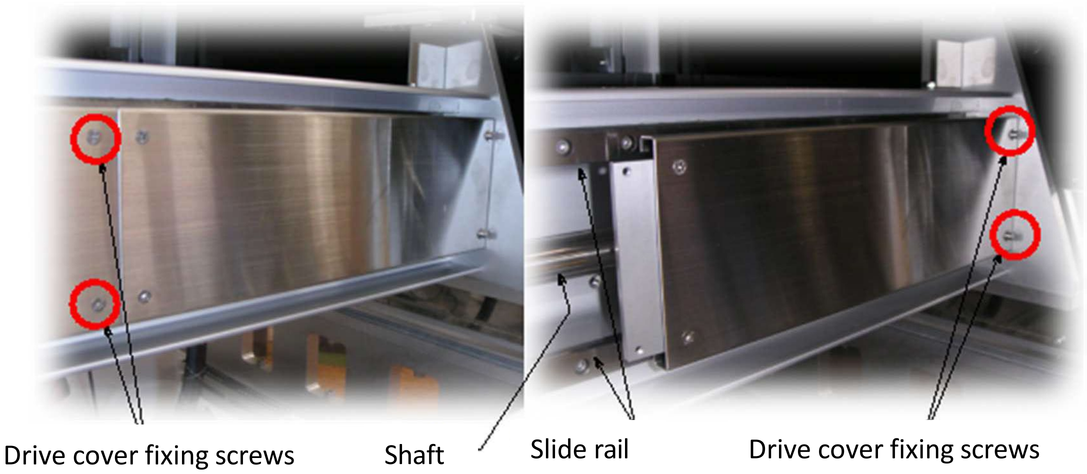


Figure 9-1: Remove these screws for un-mounting the x-axis sliding unit's cover.

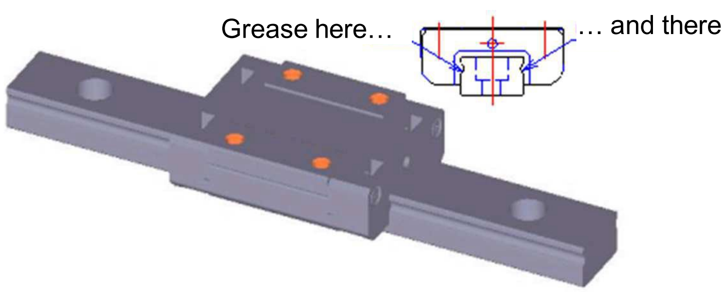


Figure 9-2: Points where grease should be applied on the x-axis sliding unit.

9.4.2. Y-Axis Sliding Unit

- Remove both of the IS-350's side covers, by loosening the screws indicated in Figure 9-3.
- Use a dry cloth to wipe away dust, deteriorated grease and other impurities from the slide rail. Apply fresh grease to the slide. Points where grease should be applied are shown in Fig. 9-4.
- Use a dry cloth to wipe away dust, deteriorated grease and other impurities from the ball screw spindle (Figure 9-5). Then apply fresh grease to the entire spindle.
- Manually move the scanner mechanics back and forth along the entire length of the spindle. Then remove excess grease with a dry cloth.
- Close the IS-350 housing by attaching the covers again.

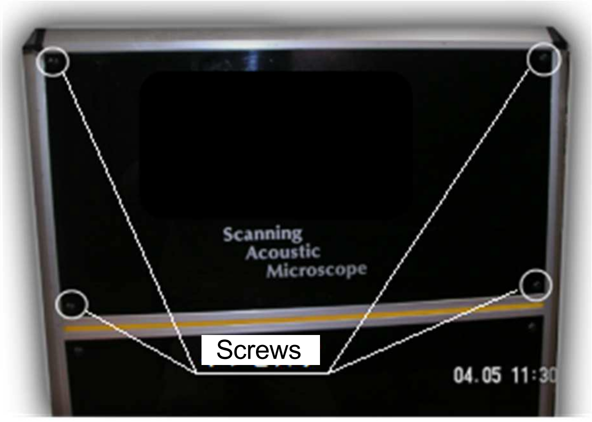


Figure 9-3: Loosen these screws for opening the side cover of the IS-350.

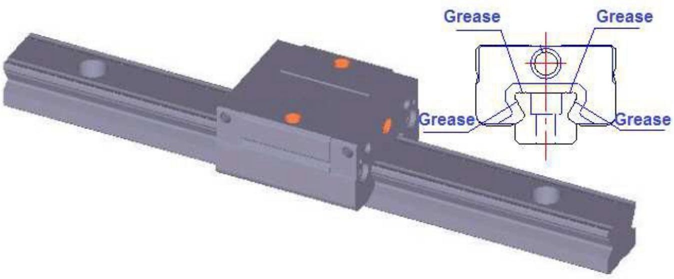


Figure 9-4: Points where grease should be applied on the y-axis sliding unit.

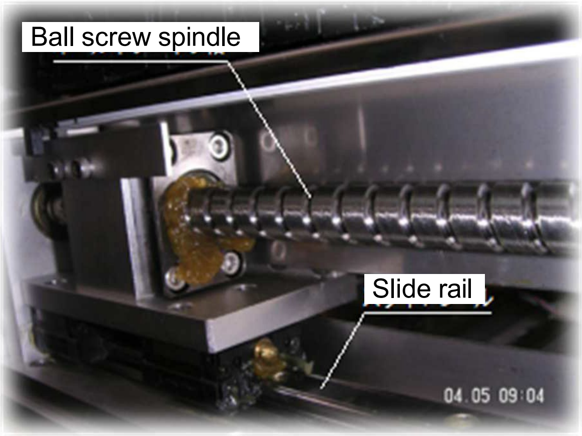


Figure 9-5: Clean and grease the ball grid spindle of the IS-350's y-axis.

9.4.3. Z-Axis Sliding Unit

- Use a dry cloth to wipe away dust, deteriorated grease and other impurities from the slide rail and the ball screw spindle (Figure 9-6).

- Then apply fresh grease to the two slides, one on each side of the measurement. The points where grease should be applied are indicated in Figure 9-7.
- Apply fresh grease to the entire spindle.
- Manually move the z-axis motor back and forth along the entire length of the spindle.
- Remove excess grease with a dry cloth.

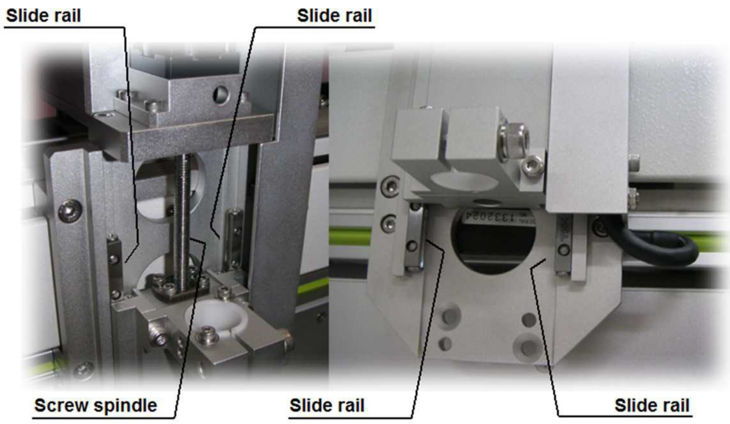


Figure 9-6: Clean and grease the z-axis rails and spindle.

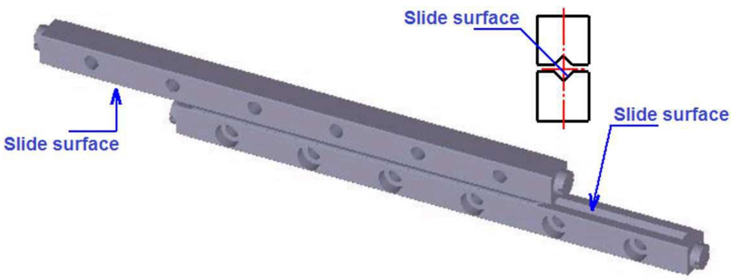


Figure 9-7: Points where grease should be applied on the z-axis sliding unit.

9.4.4. X-Axis Linear Scale

The x-axis linear scale is mounted behind the green-yellow rubber seal along the lower part of the x-axis mechanics (Figure 9-8).

- First remove dirt and other foreign objects from the rubber seal.
- Carefully check the inner part, behind the seal. To do so, carefully tear apart the seal with your fingers. Make sure no dirt is present behind the seal, otherwise carefully clean it with a cloth.

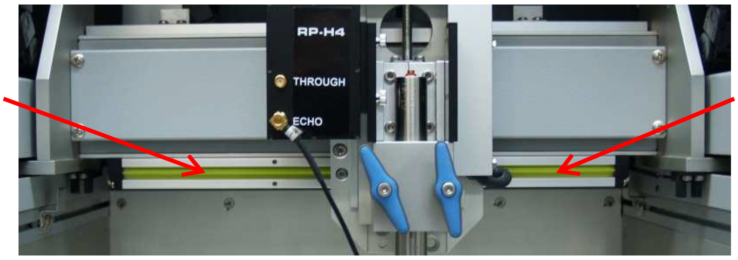


Figure 9-8: The x-axis scale (encoder) is mounted behind the green-yellow rubber seal.

9.4.5. The Sample Tank

- Remove the water from the tank as described in Section 4.2.
- Clean the tank from dust, rust, and all foreign particles.
- If rust remains sticking somewhere use a non-woven cloth (Scotch-Brite™ or similar) to carefully scrape the rust.
- Re-fill the tank with clean tap water and place it back in the system.

9.4.6. Water Filter

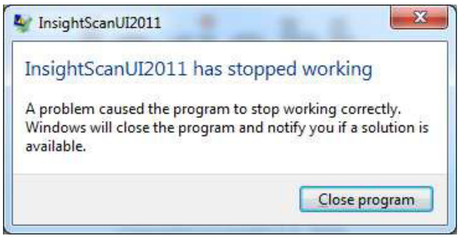
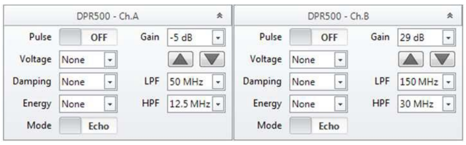
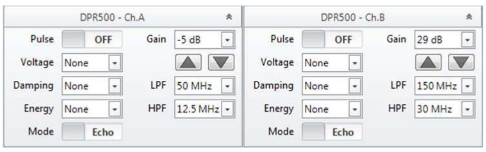
As an option, your IS-350 system may include a water filter, which needs to be changed each time you change the water in the tank. The filter is situated in the lower part of the system's enclosure (Figure 9-9).

Figure 9-9: The water filter housing (unscrewed from its mechanical fixture).

- Remove the water from the tank as described in Section 4.2.
- Unscrew the filter housing from its mechanical fixture (Figure 9-9).
- Unscrew the lower part of the filter housing from its screw cap. It might be interesting to place some recipients under the filter housing when doing so, in order to capture spilled water.
- Replace the filter with a new one. Only use compatible filters as recommended by Insight kk to avoid poor system performance.
- Close the filter housing, and fix it to its mechanical fixture.

- Fill the tank with fresh water, and run the water pump. During the first start-up after filter exchange carefully watch the filter housing in order to identify potential water leakage.

10. Trouble Shooting

Trouble	**Possible Solution**
10.5 Error Message during InsightScan Start-up 	• DPR channel and RP might be incompatible (e.g. RP-U4 used on Channel A). Check the compatibility of the DPR channel and used RP (Table 5-2).
10.10: Empty line during InsightScan start-up: No Pulser/Receiver recognized 	• The DPR is not recognized ○ Check if DPR is powered up ○ Check the serial connection from PC to IS-350 for damage ○ Check the serial port status in the PC's device manager
10.25 After InsightScan start-up, both DPR Channels do not allow Voltage, Damping and Energy settings 	• No contract between DPR and RP. Check connections of pulser cable. • Remote pulser defect. Change RP.
10.105 After DPR initialization, both DPR Channels do not allow Voltage, Damping and Energy settings 	• No contract between DPR and RP. Check connections of pulser cable. • Remote pulser defect. Change RP.

11. Support and Service

For technical assistance, please contact one of Insight's international offices:

Insight k.k. Japan (Head Office)
2-6-7 Hyakunin-cho, Shinjuku-ku, Tokyo
Postal Code: 169-0073
Email: sales@insightkk.co.jp
Web: www.insightkk.co.jp
Tel: 03-5330-6430
Fax: 03-5330-2107

Insight China
Unit316, Lane1,2633, Hunada Road, Pudong New Area Shanghai, China
Postal Code:201305
Email: insight-sales@insight-yuanxi.com.cn
Phone: +86-13641876747