FocusPC
UT and Phased Array Data Acquisition and Analysis Software

Advanced User’s Manual

Software Version 1.0

DMTA-20093-01EN — Rev. D
September 2022

This instruction manual contains essential information on how to use this Evident product safely and effectively. Before using this product, thoroughly review this instruction manual. Use the product as instructed.

Keep this instruction manual in a safe, accessible location.

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This document was prepared with particular attention to usage to ensure the accuracy of the information contained therein, and corresponds to the version of the product manufactured prior to the date appearing on the title page. There could, however, be some differences between the manual and the product if the product was modified thereafter.

The information contained in this document is subject to change without notice.

Software version 1.0
Part number: DMTA-20093-01EN
Rev. D
September 2022

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List of Abbreviations

ED	electronic delay
EMAT	electro-magnetic acoustic transducer
FT	flight time
GD	global delay
ID	inside diameter
LD	law delay
OD	outside diameter
OPD	optical path difference
PA	phased array
PRF	pulse repetition frequency
SAFT	synthetic aperture focusing technique
SNR	signal-to-noise ratio
TCG	time-corrected gain
TOFD	time-of-flight diffraction
UT	ultrasonic testing
VC	volume corrected
WD	wedge delay

Important Information — Please Read Before Use

Intended Use

FocusPC is designed to perform nondestructive inspections on industrial and commercial materials.

Instruction Manual

This instruction manual contains essential information on how to use this Evident product safely and effectively. Before using this product, thoroughly review this instruction manual. Use the product as instructed.

Keep this instruction manual in a safe, accessible location.

IMPORTANT

Some of the details of screen images shown in this manual may differ from the screen images displayed in your software. However, the principles remain the same.

Software Compatibility

FocusPC is only compatible with the FOCUS PX instrument. For a list of models, refer to the FocusPC *User's Manual*.

Safety Symbols

The following safety symbols might appear on the instrument and in the instruction manual:

 General warning symbol

This symbol is used to alert the user to potential hazards. All safety messages that follow this symbol shall be obeyed to avoid possible harm or material damage.

 Shock hazard caution symbol

This symbol is used to alert the user to potential electric shock hazards. All safety messages that follow this symbol shall be obeyed to avoid possible harm.

Safety Signal Words

The following safety symbols might appear in the documentation of the instrument:

 **DANGER**

The DANGER signal word indicates an imminently hazardous situation. It calls attention to a procedure, practice, or the like that if not correctly performed or adhered to will result in death or serious personal injury. Do not proceed beyond a DANGER signal word until the indicated conditions are fully understood and met.

 **WARNING**

The WARNING signal word indicates a potentially hazardous situation. It calls attention to a procedure, practice, or the like that if not correctly performed or adhered to could result in death or serious personal injury. Do not proceed beyond a WARNING signal word until the indicated conditions are fully understood and met.

CAUTION

The CAUTION signal word indicates a potentially hazardous situation. It calls attention to a procedure, practice, or the like that if not correctly performed or adhered to may result in minor or moderate personal injury, material damage, particularly to the product, destruction of part or all of the product, or loss of data. Do not proceed beyond a CAUTION signal word until the indicated conditions are fully understood and met.

Note Signal Words

The following symbols could appear in the documentation of the instrument:

IMPORTANT

The IMPORTANT signal word calls attention to a note that provides important information, or information essential to the completion of a task.

NOTE

The NOTE signal word calls attention to an operating procedure, practice, or the like, which requires special attention. A note also denotes related parenthetical information that is useful, but not imperative.

TIP

The TIP signal word calls attention to a type of note that helps you apply the techniques and procedures described in the manual to your specific needs, or provides hints on how to effectively use the capabilities of the product.

Warranty Information

Evident guarantees your Evident product to be free from defects in materials and workmanship for a specific period, and in accordance with conditions specified in the Terms and Conditions available at https://www.olympus-ims.com/en/terms/.

The Evident warranty only covers equipment that has been used in a proper manner, as described in this instruction manual, and that has not been subjected to excessive abuse, attempted unauthorized repair, or modification.

Inspect materials thoroughly on receipt for evidence of external or internal damage that might have occurred during shipment. Immediately notify the carrier making the delivery of any damage, because the carrier is normally liable for damage during shipment. Retain packing materials, waybills, and other shipping documentation needed in order to file a damage claim. After notifying the carrier, contact Evident for assistance with the damage claim and equipment replacement, if necessary.

This instruction manual explains the proper operation of your Evident product. The information contained herein is intended solely as a teaching aid, and shall not be used in any particular application without independent testing and/or verification by the operator or the supervisor. Such independent verification of procedures becomes increasingly important as the criticality of the application increases. For this reason, Evident makes no warranty, expressed or implied, that the techniques, examples, or procedures described herein are consistent with industry standards, nor that they meet the requirements of any particular application.

Evident reserves the right to modify any product without incurring the responsibility for modifying previously manufactured products.

Technical Support

Evident is firmly committed to providing the highest level of customer service and product support. If you experience any difficulties when using our product, or if it fails to operate as described in the documentation, first consult the user’s manual, and then, if you are still in need of assistance, contact our After-Sales Service. To locate the nearest service center, visit the Service Centers page on the Evident Scientific Web site.

Introduction

FocusPC is a powerful and flexible ultrasonic and phased array acquisition and analysis software that can be used to build high speed inspection systems and perform high-end data analysis. The objective of the FocusPC *User's Manual* is to give a good overview of the software and its essential features. The current manual focuses on describing the FocusPC advanced features and also provides detailed menu descriptions.

1. Detailed FocusPC User Interface

This chapter details the FocusPC user interface elements.

1.1 Main Window

The main window (refer to the FocusPC *User's Manual*) contains the following elements.

Title bar

Displays the program icon, the program identification, and the name of the active file, as well as control buttons on the right end of the bar.

Menu bar

Displays the names of the various menus.

Toolbar

Displays command buttons, which can be clicked to carry out various commands.

Document windows

There is a document window, or shell window, for each file opened. Document windows provide a primary view of file content. The windows can be overlapping, in which case, the topmost window is the active one. The document windows can also be arranged as tiles or in a cascade. The active window is always identified by a highlighted title bar.

1.2 Menu Bar

This section describes the FocusPC menu bar. The menu bar (see Figure 1-1 on page 18) is the horizontal bar displayed at the top of the main window, below the title bar, and it provides access to commands. To open a menu, click the menu name. To activate a menu command, click its name in the menu, or type the keyboard shortcut if there is one indicated.

Figure 1-1 The menu bar

The following subsections describe the commands available in each menu. Note that, depending on the operation mode and the type of hardware connected, the content of the menus could differ from what is presented in this manual.

1.2.1 File Menu

The **File** menu (see Figure 1-2 on page 18) contains the commands that manage data files and the general preferences of the software.

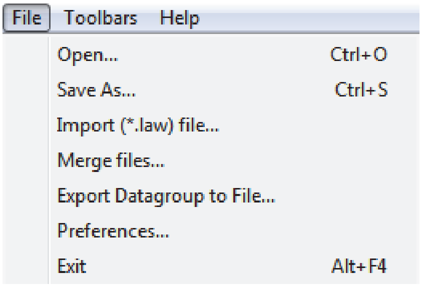

Figure 1-2 The File menu

The **File** menu contains the following commands:

Open

Opens a standard **Open** dialog box, from which you can select and load a setup or a data file.

Save As

Opens a standard **Save As** dialog box, from which you can browse through folders, and save the active setup.

Import (*.law) file

Opens a dialog box (see Figure 1-3 on page 19) from which you can select and load a *.law file used to configure the beam parameters for either the current group or a new one.

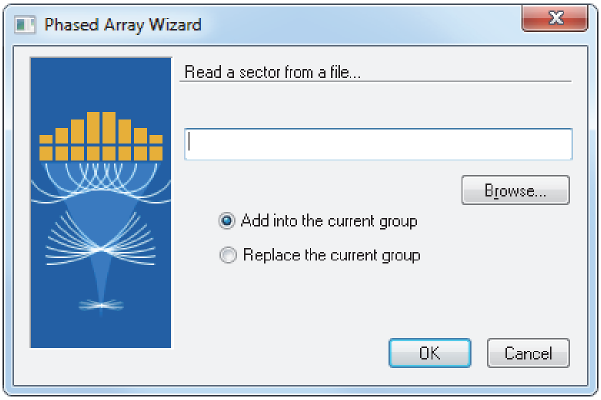

Figure 1-3 Importing a .law file

Merge Files

Opens the dialog box shown in Figure 1-4 on page 20, from which different data files can be selected and merged into a single data file. Refer to the FocusPC *User's Manual* for more information.

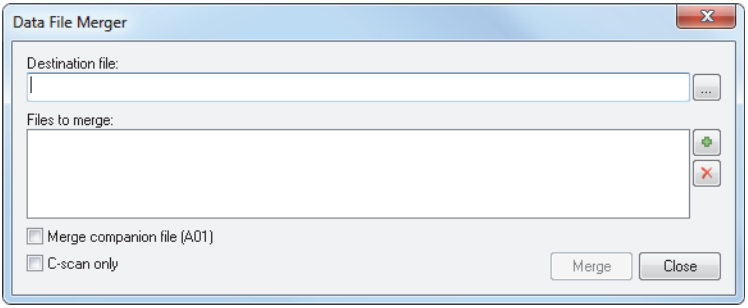

Figure 1-4 The Data File Merge dialog box

Export Datagroup to File

Opens the dialog box shown in Figure 1-5 on page 20, which can be used to export an A-scan or a C-scan to a *.txt file. See "Export Data Utility" on page 163 for more information.

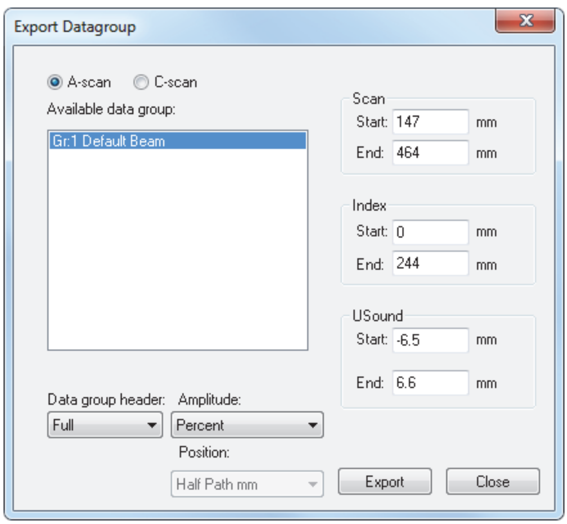

Figure 1-5 The Export Datagroup dialog box

Preferences

Opens the **Preferences** dialog box, used to set various basic parameters related to general use of the software (see “Preferences Dialog Box” on page 90 for details).

Exit

Closes opened data files and exit FocusPC.

1.2.2 Toolbars Menu

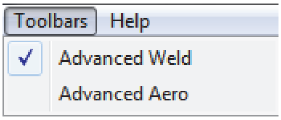

Figure 1-6 The Toolbars menu

The **Toolbars** menu (see Figure 1-6 on page 21) contains commands relating to the display of toolbars. The **Toolbar** menu commands are the following:

Advanced Weld

Alternately displays and hides the **Advanced Weld** toolbar.

Advanced Aero

Alternately displays and hides the **Advanced Aero** toolbar.

1.2.3 Help Menu

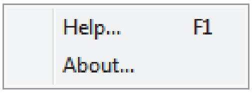

Figure 1-7 The Help menu

The **Help** menu (see Figure 1-7 on page 21) contains commands that provide access to information about FocusPC.

Help

Opens a window providing access to complete FocusPC documentation.

About

Opens a dialog box indicating which version and edition of FocusPC you are running. See Figure 1-8 on page 22.

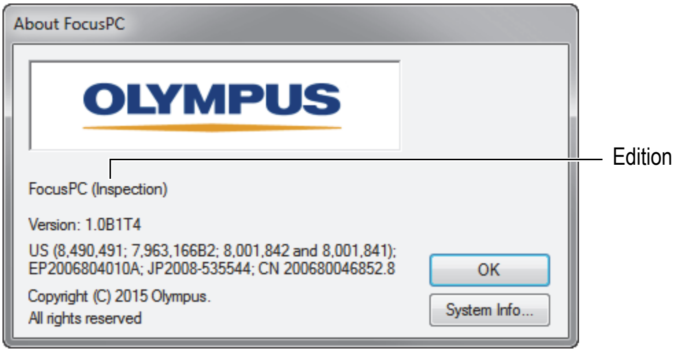

Figure 1-8 The About FocusPC dialog box

1.3 Status Bar

The status bar appears at the bottom of the document windows (see Figure 1-9 on page 22).

Figure 1-9 The status bar

The status bar displays the following information relative to the state of the system:

Scan

Position on the scan-axis from the encoder or from the 1-axis internal clock.

Index

Position on the index-axis from the encoder or from the 2-axis internal clock.

Set Encoders

Sets the encoder position of the **Scan** and **Index** axes to the **Preset** values defined in the **Scan and Mechanical Settings** dialog box.

Acq. speed

Maximum acquisition speed with the current settings, directly related to current PRF value as specified by the following equation:

$$\text{Acq. speed} = \text{PRF} \cdot \text{Scan resolution}$$

where:

PRF:

The pulse repetition frequency is set in the **UT Settings** dialog box > **Digitizer** tab > **PRF** group > **Current** parameter.

Scan resolution:

The scan resolution is set in the **UT Settings** dialog box > **Digitizer** tab > **Data** group > **Resolution** parameter.

TIP

You can adjust the **Acq. speed** by changing the **PRF** value (in the **Digitizer** tab of the **UT Settings** dialog box) and the **Resolution** value (in the **Scan** tab of the **Scan and Mechanical Settings** dialog box). Note, however, that a too high **Acq. speed** value can generate ghost echoes. For example, with a scanner that can move a probe up to 100 mm/s and a scan resolution of 2 mm, in the Dashboard, set the **Acq. speed** to 100 mm/s. FocusPC automatically sets the **PRF** value to 50 Hz. For manual encoder inspections, set the **Acq. speed** value between 50 mm/s and 100 mm/s.

Mode

Current mode (Setup, Inspection, or Analysis).

Al.

Alarm indicator state for the Alarm 1, Alarm 2, and Alarm 3 (from left to right) described in Table 1 on page 24. The alarm indicators only appear when you define at least one alarm in the **Alarms** tab of the **UT Settings** dialog box.

Table 1 Alarm (Al.) indicator states

Indicator color	Alarm state
	Active
	Not active
	Not defined

Link

Indicator color reporting the state of the communication with the acquisition instrument as given in Table 2 on page 24.

Table 2 Link indicator states

Indicator color	Communication with acquisition instrument
	Correctly established
	Not established
	No attempt

Acq. Unit

Internal temperature of the acquisition instrument. The FOCUS PX automatically will shut down if the internal temperature reaches 76 °C.

2. Dialog Box Descriptions

This chapter describes how to use the FocusPC dialog boxes.

2.1 UT Settings Dialog Box

Clicking the UT Settings button () on the Component toolbar toggles the visibility of the **UT Settings** dialog box (see Figure 2-1 on page 25). The **UT Settings** dialog box contains nine basic tabs: **General**, **Gates**, **TCG**, **Digitizer**, **Pulser/Receiver**, **Position**, **Alarms**, **Transmitter**, and **Receiver**.

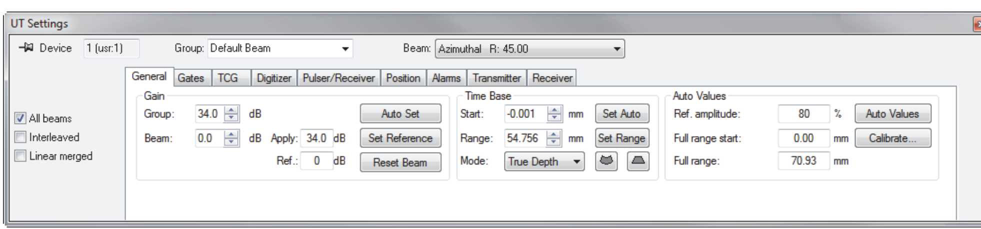

Figure 2-1 The UT Settings dialog box

All beams

When this check box is selected, modifying a parameter causes all focal laws to be affected by the modification. If this check box is clear, modifying a parameter causes only the active focal law to be affected by the modification.

Interleaved

Used to change the firing order of the different focal laws (refer to the FocusPC *User's Manual* for more information on using this function).

Linear merged

Selecting this check box activates the Linear Merged mode, which performs the dynamic merging of the individual firings. (For proper data display, this mode should only be used with 0° linear focal laws).

2.1.1 General Tab

The **General** tab (see Figure 2-2 on page 26) contains options that are used to configure the basic ultrasonic parameters.

Description of the General tab

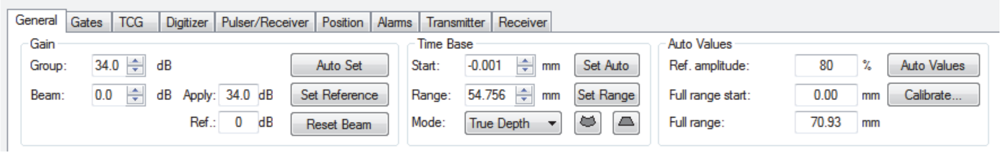

Figure 2-2 The General tab

The **General** tab is subdivided into the **Gain**, **Time Base**, and **Auto Values** areas.

Gain parameters

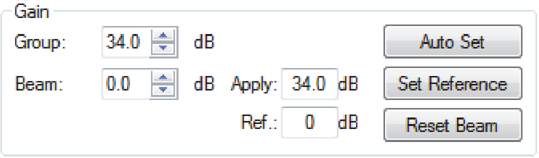

Figure 2-3 The Gain parameters

Group

Sets the gain value in decibels (dB) for the receiver of the active group. The group gain is added to the beam gain (when a phased array unit is connected to the system). See Figure 2-3 on page 26.

When the TCG (time-corrected gain) function is used, the gain programmed in the TCG curve (see “TCG Tab” on page 35) is added to this gain value to produce the total input gain.

Beam

Sets the gain value in decibels (dB) for the active beam’s receiver.

Apply

This box displays the applied gain, considering the sum of the group and focal law gain.

Ref.

This box displays the reference gain that you have set by using the **Set Reference** button.

Auto Set

This button automatically sets the amplitude of the echo between the cursors to the value specified in the **Ref. amplitude** box.

Set Reference

This button transfers the **Apply** value into the **Ref.** box.

Reset Beam

This button resets the gain of the active beam to 0 dB.

Time Base parameters

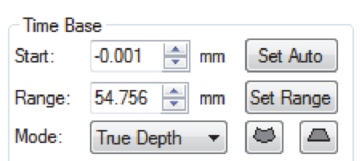

Figure 2-4 The Time Base parameters

Start

Sets the delay in the material at which the acquisition starts. This value can be displayed in distance or time units, according to the unit chosen in the **Mode** list. See Figure 2-4 on page 27.

Range

Sets the acquisition range in the material (according to the unit set in the **Mode** list).

NOTE

The maximum range value is determined by the maximum number of samples allowed for an A-scan.

Mode

Selects the unit mode used to set the time base:

- **Time**: Time base values are expressed in ultrasonic time-of-flight units: **µs** (microseconds).
- **Full path**: Time base values are expressed in distance units: **in.** (inches) or **mm** (millimeters). The value entered is equal to the time of flight multiplied by the ultrasonic velocity in the material.
- **Half path**: Time base values will be expressed in distance units: **in.** (inches) or **mm** (millimeters). The values are equal to half the total distance traveled by the ultrasonic wave (**Full path** divided by 2).
- **TOFD**: Time base values will be expressed in distance units, in function of the TOFD calibration: **in.** (inches) or **mm** (millimeters).
- **True depth**: Time base values will be expressed in distance units: **in.** (inches) or **mm** (millimeters). The calculated true depth is a function of the beam angle in the material.

This button appears in a phased array setup when **True depth** is selected in the **Mode** list. Clicking this button takes the true depth **Start** and **Range** values of the *active focal law* and applies the corresponding half path **Start** and **Range** values to all focal laws in the active group.

This button appears in a phased array setup when **True depth** is selected in the **Mode** list. Clicking this button takes the true depth **Start** and **Range** values of the active focal law and applies them to *focal laws in the active group*.

Set Auto

This button sets the ultrasonic scale (**Start** and **Range** under **Time base**) according to the values specified in the **Full Range Start** and **Full Range** boxes of the **Auto Values** dialog box.

Set Range

This button sets the ultrasonic scale (**Start** and **Range** under **Time base**) according to the positions of the reference and measurement cursors in an A-scan view.

Auto Values parameters

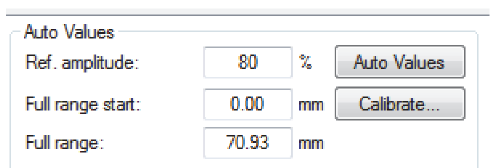

Figure 2-5 The Auto Values parameters

Ref. amplitude

Indicates the reference amplitude that has been specified in the **Auto Values** dialog box (opened with the **Auto Values** button). See Figure 2-5 on page 29.

Full range start

Indicates the full range start on the ultrasonic axis, according to the value specified in the **Auto Values** dialog box.

Full range

Indicates the distance on the ultrasonic axis corresponding to the full range, according to the value specified in the **Auto Values** dialog box.

Auto Values

This button opens the **Auto Values** dialog box, used to define the automatic values. See Figure 2-6 on page 30.

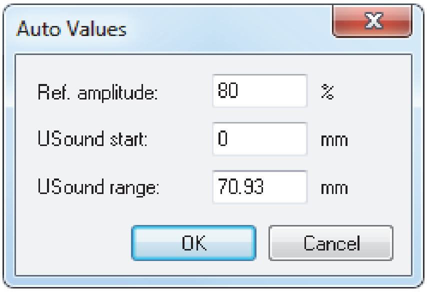

Figure 2-6 The Auto Values dialog box

In this dialog box, enter the **Ref. amplitude**, **Ultrasound start**, and **Ultrasound range** values that should be programmed when the **Set Auto** button is clicked. Click **OK** to accept values, or **Cancel** to return to previous values.

Calibrate

This button opens a dialog box, used to calibrate the ultrasonic velocity or delay according to the reference cursor position. See Figure 2-7 on page 31.

To use this function, select a side view (corrected for the angle), place the cursors on two reflectors at known positions, and then click the **Calibrate** button. In the calibration dialog box that pops up, enter the know depths of the two selected reflectors, and the values shown in the **Results** section of this dialog box will be calculated automatically. To accept these values, click **OK**. FocusPC will program the calculated values.

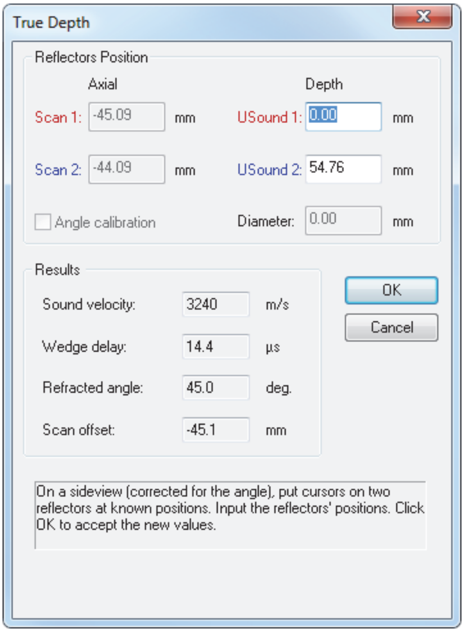

Figure 2-7 The calibration dialog box in True Depth mode

2.1.2 Gates Tab

The **Gates** tab (see Figure 2-8 on page 32) contains options that are used to define the detection gate parameters. Detection gates are used to extract information from the A-scan and to form the C-scan data groups.

Whenever a gate is enabled, it is represented on the corresponding A-scan view by a horizontal line with small vertical lines on both ends. In addition, each time a detection gate is defined and enabled, a new data group is added in the left section of the **Contents** dialog box.

You can define four detection gates for each channel, in addition to the synchronization gate. Gate I is the synchronization gate, and gates A, B, C, and D are the acquisition gates. The A-scan signal that is viewed and acquired can be synchronized on pulse or on echo in the main gate. Each gate is defined by a starting position, a gate length, a threshold level, and an alarm level. Detection occurs when a portion of the signal exceeds the threshold level during the time interval specified by the starting position and gate length.

The setting of the gates can be done either by filling the **Start** and **Length** boxes for each gate, or interactively by positioning both cursors (reference and measurement) on the A-scan and clicking the set button of the gate. The basic procedure to follow for the definition of the gates is described later in this section. For the procedure to define gates, refer to the FocusPC *User's Manual*.

Description of the Gates tab

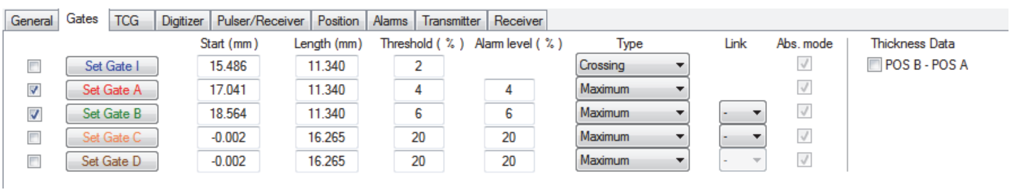

Figure 2-8 The Gates tab

The **Gates** tab contains the following parameters:

Set Gate buttons

> Sets the start position, the length, and the threshold of synchronization of the selected gate according to the position of the reference cursor and the measurement cursor in time, and the reference cursor in level.

Check boxes to the left of the **Set Gate** buttons

> When selected (enabled), the position and amplitude data of the corresponding gate will be recorded.

Start

> Sets the start position of the corresponding gate. The position is expressed in the unit chosen in the **Mode** list of the **General** tab.

Length

> Sets the length of the corresponding gate. The length is expressed in the unit chosen in the **Mode** list of the **General** tab.

Threshold

> Sets the threshold level of the corresponding gate. The level is expressed as a percentage (%) of the full-screen height.

Alarm level

Sets the alarm level of the corresponding gate. The level is expressed as a percentage (%) of the full-screen height.

POS B - POS A

When enabled, a differential-position data group in which the position of a signal above the gate A threshold is subtracted from the position of a signal above the gate B threshold will be recorded.

Type

Use this box to select one of the following detection types according to the detection gate:

Maximum

The position and amplitude data of the detected maximum signal peak inside the gate is recorded (respectively P1 and A1 in Figure 2-9 on page 33).

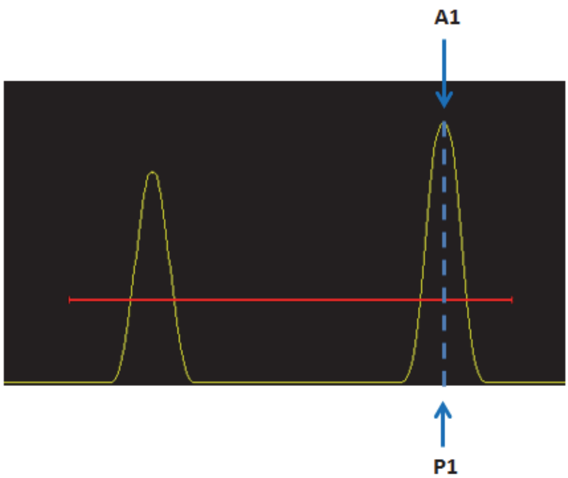

Figure 2-9 Maximum gate detection

Crossing

The position data of the first peak crossing the gate and the amplitude data of the maximum detected signal peak inside the gate are recorded. (respectively P1 and A1 in Figure 2-10 on page 34).

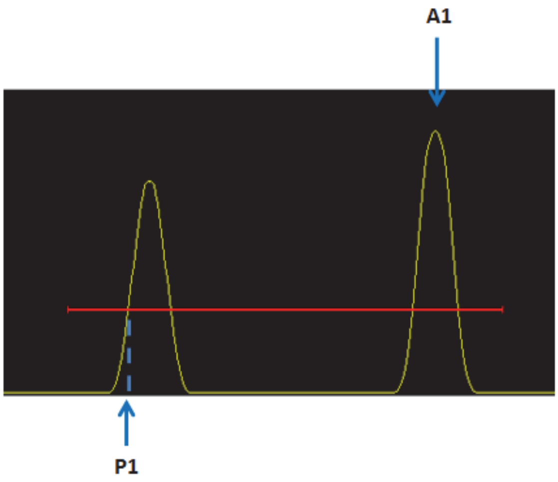

Figure 2-10 Crossing gate detection

First Peak Maximum

The position and amplitude data of the first signal peak detected inside the gate is recorded (respectively P1 and A1 in Figure 2-11 on page 34).

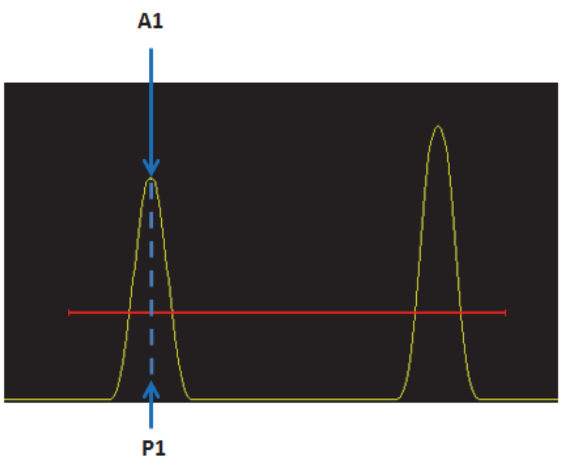

Figure 2-11 First peak maximum gate detection

First Peak Crossing

The position data of the first peak crossing the gate and the amplitude data of the first detected signal peak inside the gate are recorded (respectively P1 and A1 in Figure 2-12 on page 35).

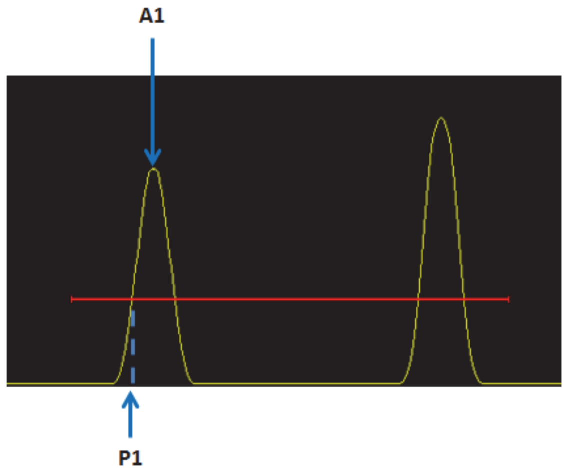

Figure 2-12 First peak maximum gate detection

Link

This box can be used to synchronize the start of the corresponding gate with respect to the previous gate.

Abs. mode

When enabled, the absolute maximum amplitude value is kept. This option is only available when the A-scan signal rectification (available in the **Pulser/Receiver** tab) is set to **RF**.

2.1.3 TCG Tab

The **TCG** tab (see Figure 2-13 on page 36) contains the options that can be used to set the time-corrected gain (TCG) for the current group. The TCG function operates by modifying the receiver gain during data acquisition to compensate for the attenuation of the ultrasonic wave in the material. The TCG curve defines the gain values that are added to the group gain.

Description of the TCG tab

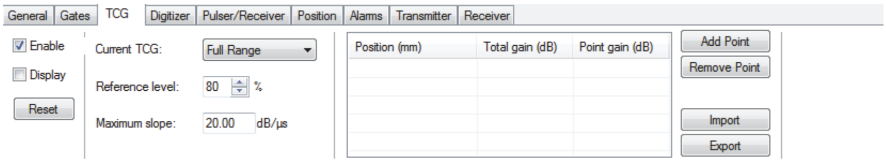

Figure 2-13 The TCG tab

The **TCG** tab contains the following parameters:

Enable

This check box alternately activates and deactivates the TCG function according to the values set on the **TCG** tab.

Display

This check box alternately displays and hides the TCG curve in an area covering 25 % of the A-scan view.

Reset

This button resets the TCG curve by clearing all currently defined points.

Current TCG

This box allows you to choose between **High Resolution** and **Full Range**.

High Resolution TCG is designed to optimize subsurface coverage:

— Points can be placed very close to the A-scan synchronization position
— Maximum slope of 40 dB/10 ns
— Maximum TCG gain of 40 dB

Full Range TCG is designed to optimize signal-to-noise ratio:

— Points can be placed 640 ns after the A-scan synchronization position
— Maximum slope of 20 dB/µs
— Maximum TCG gain of 80 dB

Reference level

Sets the wanted reference level, in percent, for the next point.

Maximum slope

Displays the maximum slope between two TCG points.

Position

Indicates the position of the TCG points on the ultrasonic axis. These points are represented by red dots when the TCG curve is displayed at the top of the corresponding A-scan view.

Gain

Indicates the gain level for the TCG points.

Add Point

This button adds a new point to the TCG curve, and it is placed in a position corresponding to the maximum amplitude that is read between the reference and measurement cursors. The gain associated with the TCG point corresponds to the theoretical gain required to reach the reference level.

Remove Point

This button removes the selected point from the grid. The TCG curve is then recalculated according to the remaining points. The gain and slope parameters are updated for the current position.

Import/Export

These buttons allow the user to export the TCG curve applied to the current group or import a TCG curve from a .csv file. For more information on the TCG curve import/export function, refer to the FocusPC *User's Manual*.

2.1.4 Digitizer Tab

The **Digitizer** tab (see Figure 2-14 on page 37) contains options that are used to set the basic digitizer and data-acquisition parameters. The **Digitizer** tab is subdivided into the **Digitizing**, **PRF**, **Data Sample Size**, **Data**, and **Multipeak** areas.

Description of the Digitizer tab

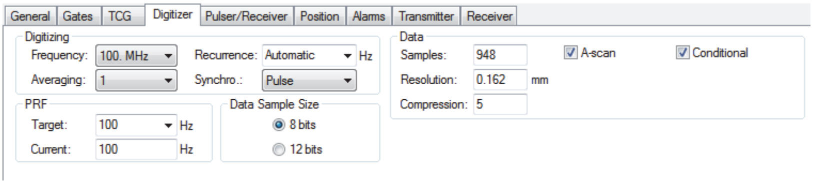

Figure 2-14 The Digitizer tab

The **Digitizing** parameters are shown in Figure 2-15 on page 38.

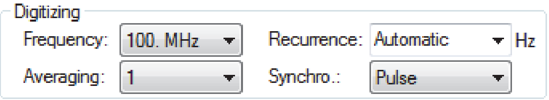

Figure 2-15 The Digitizing parameters

Frequency

Allows the user to select the digitizer frequency, specified in megahertz (MHz).

Recurrence

The recurrence is the firing recurrence frequency (pulse repetition frequency, or PRF) which is defined independently for every group. The effective recurrence is the number of ultrasonic pulses generated per second.

Averaging

Indicates the number of A-scans acquired for each A-scan that is returned. The returned A-scan is obtained by calculating, for each sample, the average value over all the acquired A-scans.

The averaging can be used to reduce the effect of noise; however, using a great number of acquisitions for the averaging will decrease the maximum acquisition rate.

Synchro

Selects the synchronization mode:

— **Pulse**: the acquisition is synchronized on the ultrasonic firing pulse.

— **Echo**: the acquisition is synchronized on the echo crossing gate 1.

The **PRF** parameters are shown in Figure 2-16 on page 38.

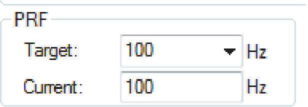

Figure 2-16 The PRF parameters

Target

This box can be used to select whether the PRF should be set to the maximum possible value in hertz or to a custom defined value that FocusPC will try to match as closely as possible.

Current

Indicates the current PRF value in hertz.

The **Data Sample Size** area is shown in Figure 2-17 on page 39.

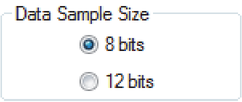

Figure 2-17 The Data Sample Size setting

The selected data sample size indicates the resolution of the amplitude digitalization. This resolution influences the size of an elementary data sample and therefore the size of the resulting data file.

The **Data** area (see Figure 2-18 on page 39) contains the following choices:

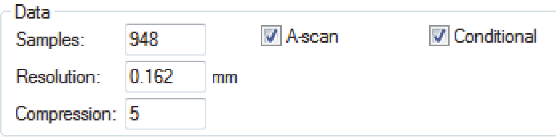

Figure 2-18 The Data parameters

Samples

Indicates the number of samples per data acquisition, that is, the number of points that compose the A-scan. This number is directly related to the **Range** (**General** tab) and **Digitizing frequency** values. If the **Units** parameter is in time (microseconds), multiplying the **Range** value (in seconds) by the **Digitizing frequency** value (in hertz) gives the number of points. This has an effect on the **Compression**.

Resolution

Indicates the digitizer resolution in the UT scale unit.

Compression

This box is used to set the digitizer compression ratio. You can reduce the sample quantity, and thus the data file size, by keeping the position of the first sample with the maximum amplitude (see example shown in Figure 2-19 on page 40). This box is only available for certain acquisition units.

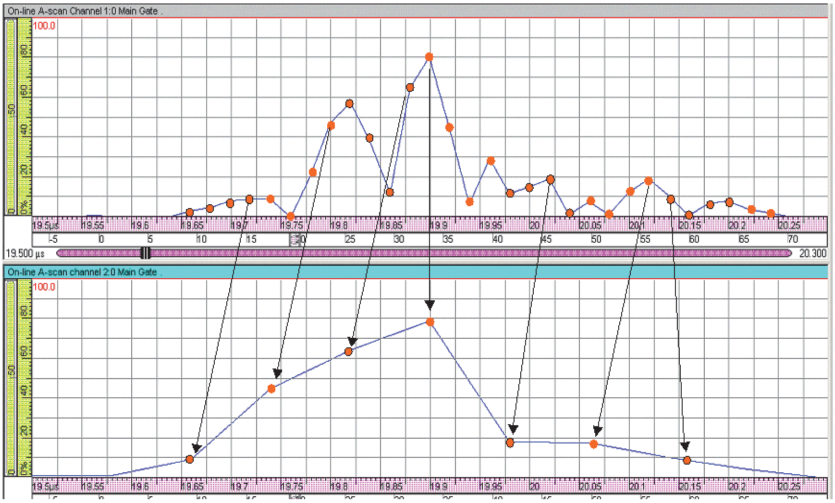

Figure 2-19 Example of a compression ratio of 4

A-scan

Creates the A-scan data group.

Conditional

When you select this option, the A-scan is only recorded when an alarm is triggered. For more details about this function, refer to the FocusPC *User's Manual*.

2.1.5 Pulser/Receiver Tab

The **Pulser/Receiver** tab (see Figure 2-20 on page 41) contains options that you can use to configure the pulser and receiver used for the inspection.

Description of the Pulser/Receiver tab

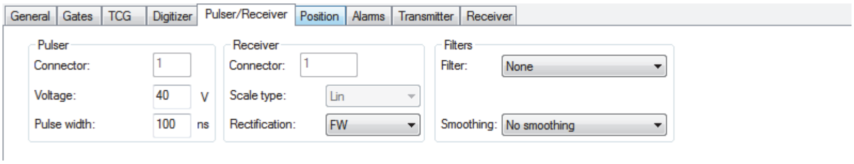

Figure 2-20 The Pulser/Receiver tab

The **Pulser/Receiver** tab is subdivided into the following sections: **Pulser**, **Receiver**, and **Filter** (see Figure 2-20 on page 41).

Pulser parameters

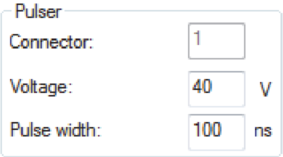

Figure 2-21 The Pulser parameters

Connector

For a conventional UT group, you can use this box to select the connector to use for the pulser. For a phased array group, it indicates the number of the first element used in emission.

Voltage (all groups)

Sets the pulse voltage of the pulser, which is the same for all groups, in volts (V).

Pulse width

Sets the pulse width of the pulser in nanoseconds.

Receiver parameters

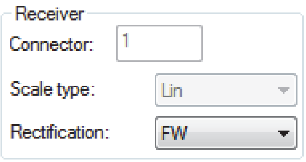

Figure 2-22 The Receiver parameters

Connector

For a conventional UT group, you can use this box to select the connector to use for the receiver. For a phased array group, it indicates the number of the first element used in reception.

Scale Type

Indicates the receiver type: **LIN** (linear receiver).

Rectification

Allows you to choose the rectification type: **RF** (the A-scan signal is displayed without any rectification), **HW+** (only the positive part of the signal is kept), **HW-** (only the negative part of the signal is kept), or **FW** (the negative part of the signal is brought back to the positive part).

Filters parameters

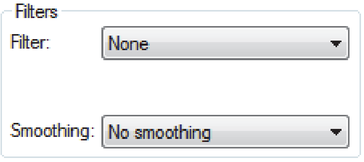

Figure 2-23 The Filters parameters

Filter

Allows you to select the frequency of the filter used on the group signal. Several high-pass, low-pass, and band-pass filters are available.

Smoothing

Selects the video filtering of the rectified signal in order to smooth the curve. The smoothing function creates an envelope on the rectified signal to eliminate the effects of the original RF signal (alternating positive and negative amplitudes).

2.1.6 Position Tab

The **Position** tab (see Figure 2-24 on page 43) contains options that are used to set the parameters of the groups and beams used for the inspection.

Description of the Position tab

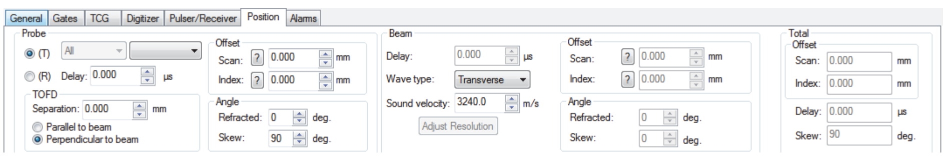

Figure 2-24 The Position tab

The **Position** tab contains **Probe**, **Beam**, and **Total** parameters.

Probe parameters

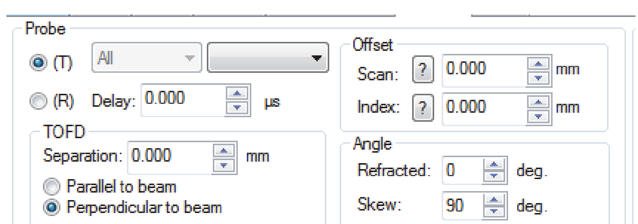

Figure 2-25 The Probe parameters

Probe selection boxes

Two boxes are available to choose the probe category (type) and model for conventional UT probes.

T/R buttons

When a pulse-echo group is selected, the **T** button transfers the pulse-receiver probe parameters. When a pitch-and-catch or a TOFD group is selected, the **T** button transfers the pulser probe parameters and the **R** button transfers the receiver probe parameters.

Delay

Sets the probe delay.

TOFD

Separation

Specifies the distance between the probes (available only with an active TOFD group).

Parallel/perpendicular to beam buttons

Specifies the beam orientation as parallel or perpendicular to the scan direction (available only with an active TOFD group).

Offset

Scan

Specifies the probe offset on the scan axis.

Index

Specifies the index offset (distance on the index axis between two consecutive scan lines).

Angle

Refracted

Specifies the refracted angle of the probe.

Skew

Specifies the skew angle of the probe.

Beam parameters

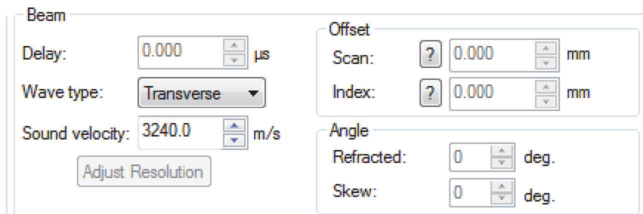

Figure 2-26 The Beam parameters

Delay

Sets the total wedge delay of the probe. The wedge delay is calculated as follows:

$$\text{Wedge delay} = \frac{\text{Ultrasound path in wedge}}{\text{Sound velocity in wedge}}$$

Wave type

Allows you to select the wave type: **Longitudinal** or **Transverse**.

Sound velocity

Sets the sound velocity in the inspected material for each wave type. This value must be determined with precision as it is used to convert time units into distance units.

Adjust Resolution

This button opens the dialog box shown in Figure 2-27 on page 46, which can be used to adjust the data group resolution.

(1) **Min.**

Sets the minimal offset difference, ensuring that there will be no data fusion among the data groups, although acquisition gaps may occur.

(2) **Max.**

Sets the maximal offset difference, ensuring that there will be no acquisition gaps among the data groups, although data fusion may occur.

(3) Average

Sets an average of the offset difference, therefore providing a good compromise between acquisition gaps and data fusion among data groups.

(4) **User**

This option enables you to define the offset difference. In the box, enter the desired data group resolution between the minimum and maximum offset differences.

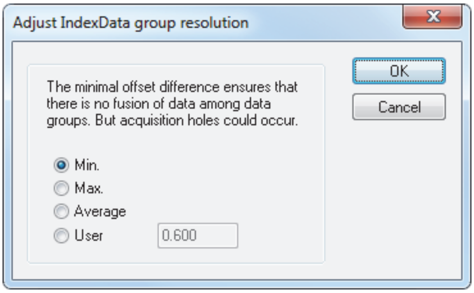

Figure 2-27 The Adjust Index Data group resolution dialog box

Offset

Scan

The scan offset represents the distance between the scan origin and the beam; this value can be positive or negative. Click the  button to view a graphical representation of this offset.

Index

The index offset represents the distance between the index origin and the beam; this value can be positive or negative. Click the  button to view a graphical representation of this offset.

Angle

Refracted

Defines the refracted angle of the beam.

The refracted angle (β) [see Figure 2-28 on page 47] is calculated from the probe incidence angle (α), sound velocity in wedge, and sound velocity in material according to the following formula (Snell's law):

$$\frac{\sin\alpha}{\sin\beta} = \frac{\text{Sound velocity in wedge}}{\text{Sound velocity in material}}$$

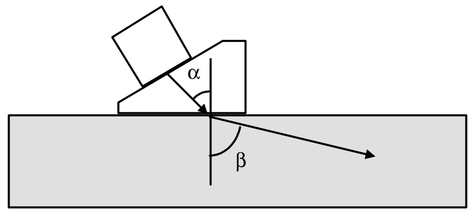

Figure 2-28 Refracted angle

Skew

Sets the skew angle of the beam, which is defined as the angle between the primary axis of the probe and the scan axis. For more details on the probe orientation convention, refer to the FocusPC *User's Manual*.

Total

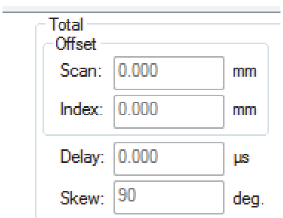

Figure 2-29 The Total parameters

The boxes under **Total** display the combination of the defined probe and beam parameters (**Scan**, **Index**, **Delay** and **Skew**).

2.1.7 Alarms Tab

The **Alarms** tab (see Figure 2-30 on page 48) contains options that are used to define the alarms. For more information on defining the alarms, refer to the FocusPC *User's Manual*.

Description of the Alarms tab

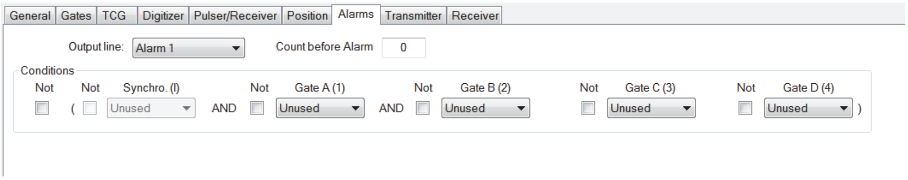

Figure 2-30 The Alarms tab

The **Alarms** tab contains the following parameters:

Output line

Selects the alarm output line to be used when the alarm condition is met.

Count before Alarm

Set the number of consecutive times the alarm condition must be exceeded before the alarm is triggered.

Conditions parameters

Not

When selected, these check boxes apply the logical operator “NOT” to the next condition to the right.

Synchro

This box is used to select the condition relative to the synchronization gate (**Gate I**): **Unused** or **Detect**.

Gates A, B, C, and D

These boxes are used to select the conditions relative to gates A, B, C, and D: **Unused** or **Detect**.

NOTE

Alarm conditions are defined independently for each channel.

2.1.8 Transmitter Tab

The **Transmitter** tab (see Figure 2-31 on page 49) is used to specify the parameters of each element of a focal law in transmission.

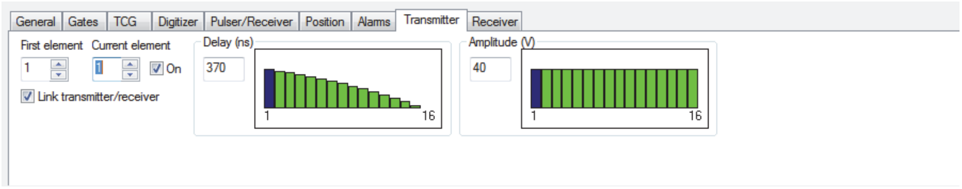

Figure 2-31 The Transmitter tab

The **Transmitter** tab contains the following parameters:

First element

Specifies the first active element of the transmitter in the considered focal law.

Current element

Selects an element of the probe as the current element. You can also select an element by clicking the corresponding bar on the **Delay** or **Amplitude** graphs.

On

Selecting or clearing this check box respectively turns on or off the element in transmission.

NOTE

Holding down the SHIFT key while clearing the **On** check box simultaneously turns off all the elements in transmission.

Link transmitter/receiver check box

When this check box is selected, modifying the **First Element** value for the transmitter also sets the same value for the receiver.

Delay (ns)

The **Delay** box is used to specify the transmission delay applied to the current element in nanoseconds (ns).

The bar graph represents the transmission delay law for the different elements. The blue bar shows the delay for the element that is being modified, that is, the one for which the parameters are displayed. The green bars indicate the delays of the other active elements. The inactive elements are left blank.

Amplitude (V)

The **Amplitude** box is used to specify the pulse amplitude applied to the element in volts (V).

2.1.9 Receiver Tab

The **Receiver** tab (see Figure 2-32 on page 50) is used to specify the parameters of each element of a focal law in reception.

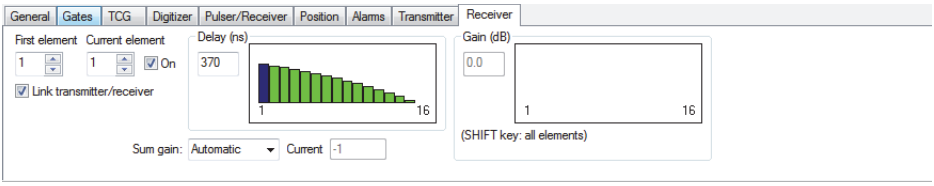

Figure 2-32 The Receiver tab

The **Receiver** tab contains the following parameters:

First element

Specifies the first active element of the receiver in the considered focal law.

Current element

Selects an element of the probe as the current element. You can also select an element by clicking the corresponding bar on the **Delay** or **Gain** graphs.

On

Selecting or clearing this check box respectively turns on or off the element in reception.

NOTE

Holding down the SHIFT key while clearing the **On** check box simultaneously turns off all the elements in reception.

Link transmitter/receiver check box

When this check box is selected, modifying the **First Element** value for the receiver also sets the same value for the transmitter.

Insert

Used to insert an element to be used as a receiver in the active focal law. The new element is inserted before the currently selected element.

Delete

Deletes the currently selected receiver element from the active focal law.

Sum gain

This box allows you to select whether the **Sum gain** should be automatically set or manually defined.

Current

Indicates the current hardware **Sum gain** value.

Delay (ns)

This box is used to specify the reception delay applied to the element in nanoseconds (ns).

The bar graph represents the reception delay law for the different elements. The blue bar shows the delay for the element that is being modified, that is, the one for which the parameters are displayed. The green bars indicate the delays of the other active elements. The inactive elements are left blank.

Gain (dB)

This box is used to specify the gain applied to the element in decibels (dB).

The bar graph represents the amplitude law in reception for the different elements. The blue bar shows the delay for the element that is being modified, that is, the one for which the parameters are displayed. The green bars indicate the amplitudes of the other active elements. The inactive elements are left blank.

2.2 Part Definition Dialog Box

You can access the **Part Definition** dialog box (see Figure 2-33 on page 52) by clicking the **Part and Material** button () on the Component toolbar.

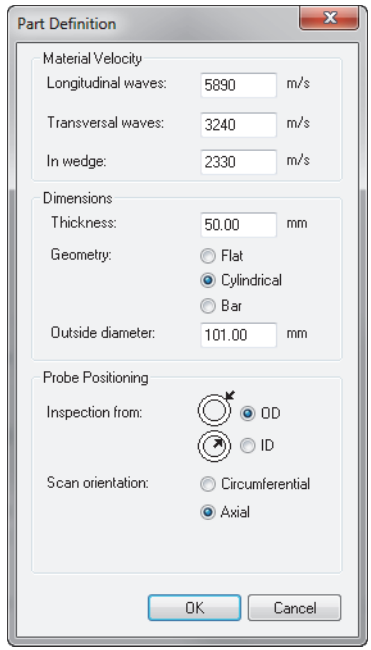

Figure 2-33 The Part Definition dialog box

The **Part Definition** dialog box is subdivided into the **Material Velocity**, **Dimensions**, and **Probe Positioning** areas.

Material Velocity parameters

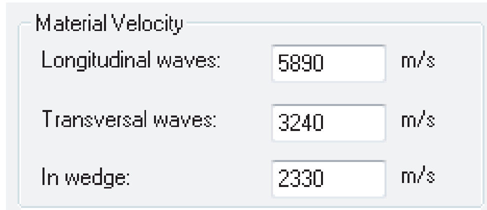

Figure 2-34 The Material Velocity parameters

The **Material Velocity** area (see Figure 2-34 on page 53) contains the following parameters:

Longitudinal/transversal waves

Sets the velocity of the longitudinal and transversal waves inside the part material.

In Wedge

Sets the velocity inside the wedge.

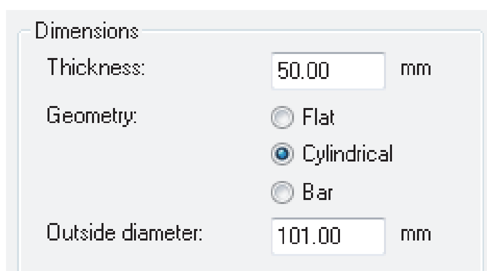

Figure 2-35 The Dimensions parameters

The **Dimensions** area (see Figure 2-35 on page 53) contains the following parameters:

Thickness

Defines the thickness for flat and cylindrical part types.

Geometry

Option buttons used to select the geometry of the inspected part: **Flat**, **Cylindrical**, or **Bar**.

Probe Positioning parameters

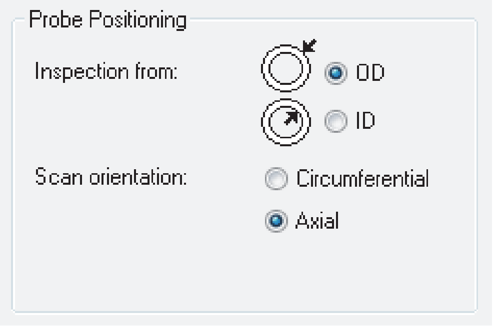

Figure 2-36 The Probe Positioning parameters

The **Probe Positioning** area (see Figure 2-36 on page 54) contains the following parameters:

Inspection from

Defines whether the probe is positioned on the outside diameter (**OD**) or inside diameter (**ID)** for the inspection of cylindrical parts.

Scan orientation

Defines whether the orientation of the scan axis is **Circumferential** or **Axial** during the inspection.

NOTE

If the part type is defined as cylindrical or bar, the Polar view type is added to the **Contents** dialog box when performing the analysis (see Figure 2-37 on page 55).

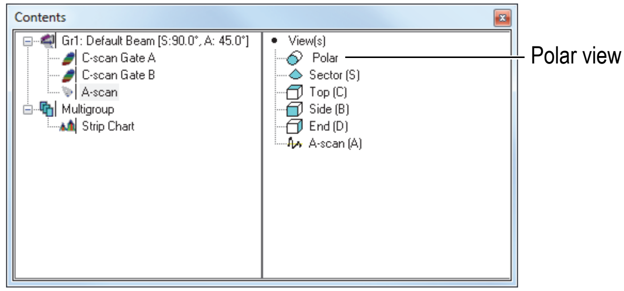

Figure 2-37 The Contents dialog box with the Polar view

2.3 Scan and Mechanical Settings Dialog Box

This section describes the **Scan and Mechanical Settings** dialog box.

2.3.1 Scan Tab

Clicking the Scan Settings button ( ) on the Component toolbar toggles open and close the **Scan and Mechanical Settings** dialog box. The **Scan and Mechanical Settings** dialog box contains four tabs: **Scan**, **I/O**, **Encoders**, and **Data** (see Figure 2-38 on page 55).

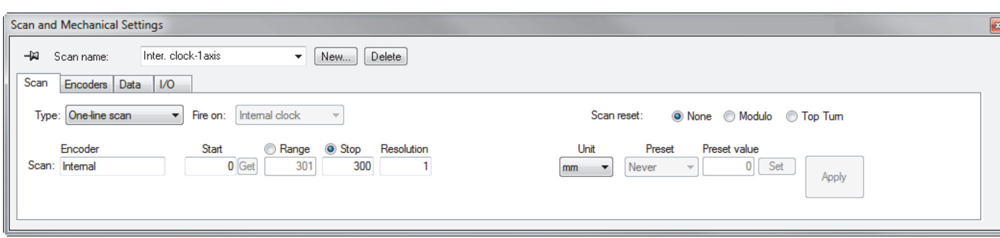

Figure 2-38 The Scan tab for one-line scan type

Type

This list allows you to select the scan type to be used for the inspection: **One-line scan**, **Free running**, **Bidirectional**, **Unidirectional**, **Helicoidal**, **Angular**, or **Custom**.

These inspection types are described in the FocusPC *User's Manual*.

Fire on

Select the trigger signal used to fire the ultrasonic pulses from the list: **Encoder**, **External signal**, **Internal clock**, or **Absolute** position.

Scan reset

Use to select the scan axis reset options from among the following options:

None

The scan axis is never reset.

Modulo

The scan axis is reset when the Scan encoder reaches the **Stop** position.

Top Turn

The scan axis is reset when an external signal is received on the corresponding instrument I/O connector.

Index preset

Use to select the Index axis preset options from among the following options:

None

No preset at acquisition end.

At acquisition end

When the acquisition is stopped, the **Start** value for the index axis is set to the current index axis encoder position.

Angle

If an **Angular** scan type is chosen, the angle between the mechanical axis and the scan axis can be defined.

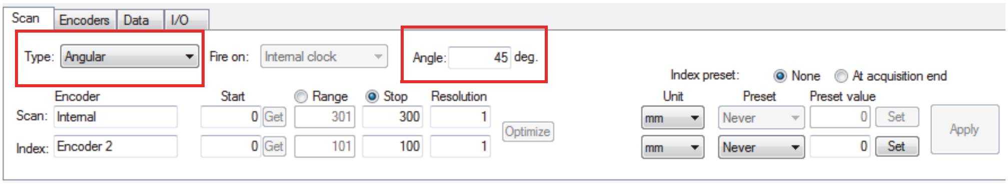

Figure 2-39 The Scan tab with Angular scan type

Deg./Index

If a **Helicoidal** scan type is chosen, this box indicates the number of degrees of rotation for every index position.

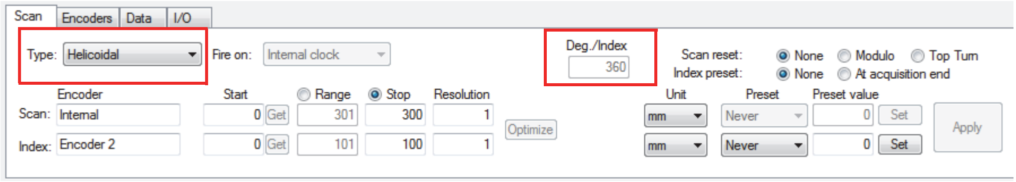

Figure 2-40 The Scan tab with Helicoidal scan type

Encoder

These boxes indicate the name of the encoder associated with each axis. The encoder names can be changed in the **Encoder** tab.

Start

These boxes are used to set the position on the scan and index axes where the inspection is to start. These values can be positive or negative.

Get

These buttons set the start value to the current encoder position for the associated axis.

Range

If the **Range** option button has been selected, these boxes are used to set the range on the scan and index axes.

Stop

If the **Stop** option button has been selected, these boxes are used to set the stop position on the scan and index axes.

NOTE

In the case of an encoded scan, all acquisitions for which the position is outside the inspection surface defined by the **Start** values and **Stop** values are ignored.

Resolution

These boxes are used to set the acquisition resolution for the scan and index axes. The resolution of the scan axis determines the spacing between the acquisitions. The resolution of the index axis, in the case of a surface scan, determines the separation between the scan lines.

Optimize

This button is enabled when, in the **UT Settings** dialog box, the **Linear merged** mode option is selected. Depending on the selected skew angle, the optimal resolution for the relevant axis is automatically calculated (0° and 180° = scan axis resolution, 90° and 270° = index axis resolution).

Speed

Indicates the maximum allowable inspection speed that can be used without missing data.

Unit

These boxes are used to select the unit of the corresponding axis in **mm**, **in.**, or **deg (°)**.

Preset

These boxes allow you to select when the corresponding encoder is to be reset during the inspection:

Never

The corresponding encoder is never reset.

On start

The corresponding encoder is reset when the acquisition is started.

External

The corresponding encoder is reset when an external signal is received on the corresponding instrument’s I/O connector.

Preset value

These boxes specify the encoder positions to be used with the **Preset** option or the **Set** button.

Set

These buttons set the encoder positions to the **Preset value** positions for the associated axis.

Apply

This button applies the current tab settings to the scan that is selected in the **Scan name** list.

2.3.2 I/O Tab

The **I/O** tab contains options and indicators related to the inspection sequence (see Figure 2-41 on page 59)

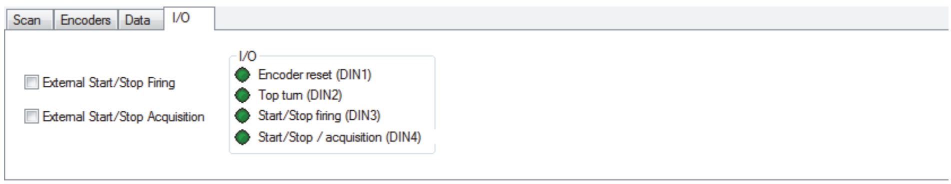

Figure 2-41 The I/O tab

The **I/O** tab contains the following parameters:

External Start/Stop Firing

Activates the usage of DIN3 for the Start/Stop firing function.

External Start/Stop Acquisition

Activates the usage of DIN4 for the Start/Stop acquisition function.

I/O section

The indicators in this section give the user the current status of the **Rot. synchro, External reset**, **Pause acquisition**, and **External acquisition** input/output signals.

2.3.3 Encoders Tab

The **Encoders** tab contains options related to the configuration of the encoders (see Figure 2-42 on page 60).

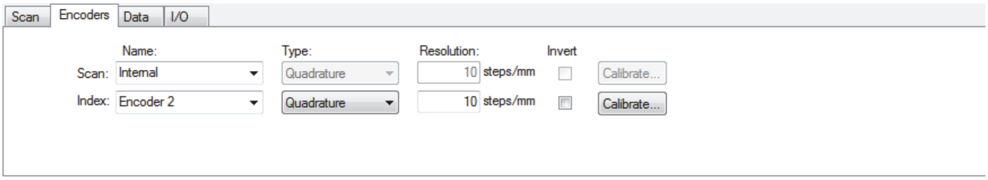

Figure 2-42 The Encoders tab

The **Encoders** tab contains the following options:

Name

These boxes are used to select the encoder associated with the **Scan** and the **Index** axes, and the **Alternate** encoder.

You can edit the default encoder names but not when **Internal** is selected.

Type

These boxes are used to select the encoder type: **Pulse** + (positive pulse) **Pulse** – (negative pulse), **Quadrature**, or **Clock Dir**. (clock direction).

Resolution

This box is used to set the encoder resolution, that is, the number of encoder steps needed to move 1 mm (or 1 in.) in linear units, or 1° in angular units.

Invert

When one of these check boxes is selected, the sign of the corresponding encoder data is automatically inverted.

Calibrate

This button displays the **Calibration of Encoder** dialog box, used to calibrate the encoder resolution for the corresponding axis (see Figure 2-43 on page 61).

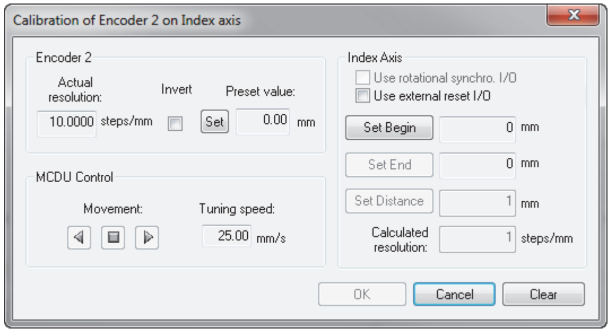

Figure 2-43 The Calibration of Encoder dialog box

The **Calibration of Encoder** dialog box is subdivided into **Encoder**, **MCDU Control**, and **Scan Axis** areas:

Encoder area

Actual resolution

This box indicates the actual encoder resolution set in the **Resolution** box of the **Encoders** tab of the **Scan and Mechanical Settings** dialog box.

Invert

This check box, when selected, inverts the count direction of the encoder.

Set

This button is used to set the encoder position to the value indicated in the **Preset value** box.

Preset value

This box displays the value entered in the **Preset value** box on the **Scan** tab.

Scan Axis

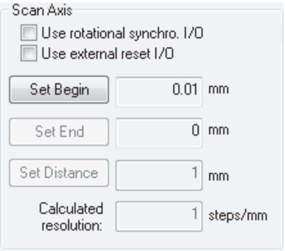

Figure 2-44 The Scan Axis area

Use rotational synchro I/O

Select this check box to use an external rotation synchronization input/output signal to set the beginning and end of motion used for the calibration (see Figure 2-44 on page 62).

Use external reset I/O

Select this check box to use an external reset input/output signal to set the beginning and end of motion used for the calibration.

Set Begin

This button sets the current position as the beginning of the motion used for the calibration.

Set End

This button sets the current position as the end of the motion used for the calibration.

Set Distance (box)

This box indicates the distance covered by the motion on the axis to perform the calibration. When the motion is done, enter the appropriate distance value.

Set Distance (button)

This button is used to calculate the encoder resolution so that the actual position matches the expected distance you specify in the box.

NOTE

The units for the scan and index axes are the same as the ones used on the **Encoders** tab, which are defined on the **Scan** tab.

Calculated resolution

This box gives the encoder resolution calculated with the calibration.

OK

This button applies the calculated resolution in the **Resolution** box of the **Encoders** tab of the **Inspection Scan and Mechanical Settings** dialog box, and closes the dialog box.

Cancel

This button closes the dialog box without applying the calculated resolution.

Clear

This button resets the parameters of the dialog box to the default values.

2.3.4 Data Tab

In the **Data** tab (see Figure 2-45 on page 63) you can set the automatic file saving options.

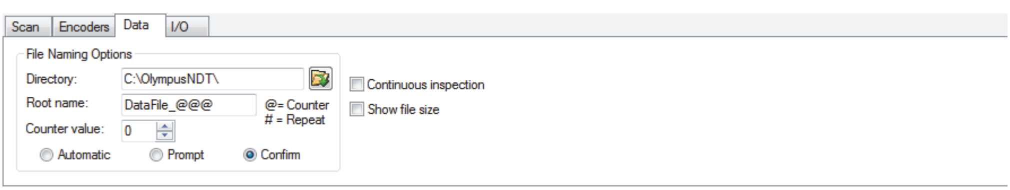

Figure 2-45 The Data tab

The **Data** tab contains the following parameters:

File Naming Options parameters

Directory

Using this box, you can specify the directory, with its complete path, that is then used for the automatic file naming. You can enter the directory name either by typing it directly into the box, or by clicking and selecting the directory in the **Browse for Folder** dialog box that appears.

Root name

Using this box, you can specify the root name that is to be used for the automatic file naming.

- The @ character inserts a counter, which will be automatically incremented in the file names. For example, typing **test@** will produce test0.fpd, test1.fpd, test2.fpd, and so on.
- The # character adds the desired number of digits for repeats. For example, typing **test@##** will produce test000.fpd, test100.fpd, test200.fpd, and so on.
- If a file already exists (for example, test000.fpd), then the new file will be saved with the following name: test001.fpd (first repeat of the test000.fpd file name).

Counter value

This box sets the start value of the counter that is inserted in the file name with the @ character.

Automatic

Selecting this option button activates automatic file naming that does not require your confirmation.

Prompt

Selecting this option button deactivates the automatic file naming. With this option, the **Save As** dialog box appears at the end of the inspection, prompting you to enter the file name you want.

Confirm

Selecting this option button activates automatic file naming that requires your confirmation. With this option, the **Save As** dialog box appears at the end of the inspection, prompting you to confirm the file name defined in the **Root name** box.

Continuous inspection

Activates the continuous inspection mode.

The continuous inspection mode lets you avoid interruptions of the inspection sequence during the inspection of very large parts. It enables automatic data file saving, which permits data files to be continuously produced during inspection, resulting in significant time savings.

Show file size

Activates the display of the data file size when an inspection is started.

When the continuous inspection mode is activated, the following data files are generated during the inspection process:

— A series of 700 MB data files containing the A-scan and C-scan data for each subsection of the inspected part

— A data file containing the C-scan data of the fully inspected part

To optimize the offline data visualization, the subsections are divided using the following logic:

— If you are working in **One-line scan** or **Helicoidal scan** modes, the subsections are only divided along the index axis of the inspected part (see Figure 2-46 on page 65).

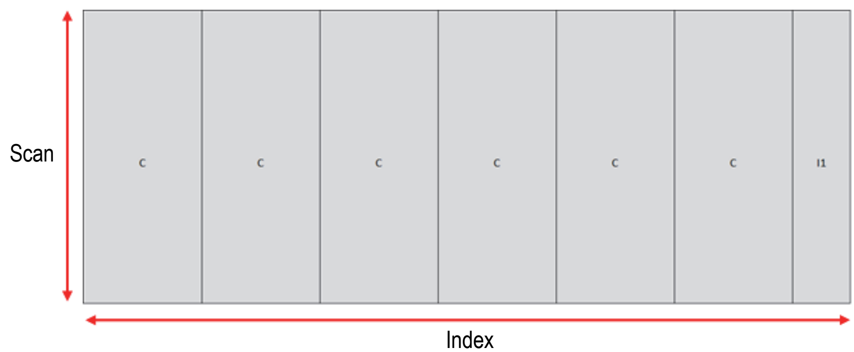

Figure 2-46 The subsections for One-line scan and Helicoidal scan modes

— If you are working in **Bidirectional scan** mode, the subsections are divided along both the index and the scan axes of the inspected part, which lets you avoid smaller parts next to the inspected part (see Figure 2-47 on page 66).

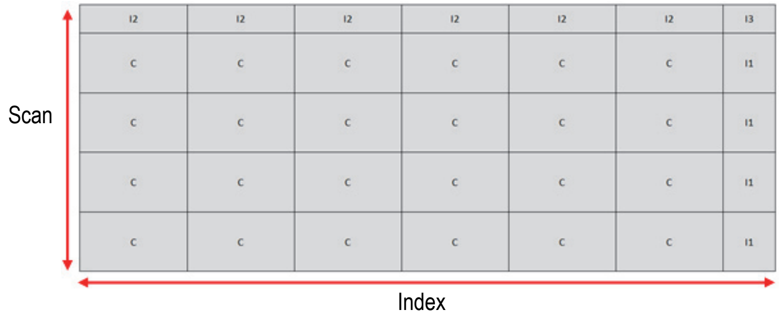

Figure 2-47 The subsections for Bidirectional scan mode

2.4 View Properties Dialog Box

Clicking the View properties button () on the toolbar toggles open and close the **View Properties** dialog box (see Figure 2-48 on page 66). The appearance of tabs depends on the data type in the active view. If the tab parameters are not applicable to a selected view, the tab does not appear in the **View Properties** dialog box.

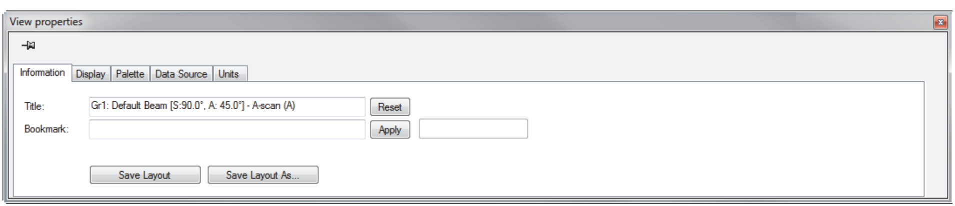

Figure 2-48 The View Properties dialog box

2.4.1 Information Tab

The **Information** tab (see Figure 2-49 on page 67) contains commands that can be applied to the active view or layout.

Figure 2-49 The Information tab

The **Information** tab contains the following parameters:

Title

This box identifies the title of the active view and can be used to change titles.

Bookmark

This box can be used to define the text to be displayed inside a pane when a view isn't available on the current data file.

Reset

Clicking on the **Reset** button resets the **Title** to its original value, and also removes any defined **Bookmark**.

Apply

When the bookmark contains code for advanced layout association, clicking this button applies the bookmark code. This button is disabled by default for standard users.

Save Layout

Saves the modifications made to the current layout.

Save Layout As

Opens the **Save Current Layout As** dialog box, used to save the current layout under the number and name of your choice.

2.4.2 Display Tab

The **Display** tab contains various options to modify the active view display and will change depending on the active view type (see Figure 2-50 on page 68).

Figure 2-50 The Display tab for an A-scan view

The **Display** tab is subdivided into **Cursors**, **Zooms and Rulers**, **Grid**, **Group Gates**, and **Configuration** areas.

Cursors parameters

This area contains check boxes used to select display options related to the cursors (see Figure 2-51 on page 68).

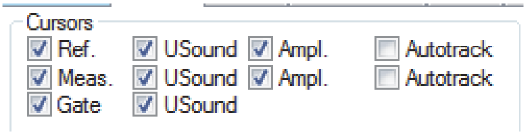

Figure 2-51 The Cursors parameters

Ref., Meas, and Gate

Selecting one of these check boxes adds the **Reference**, **Measurement**, or **Gate** cursors to the view. Depending on the active view, these cursors can include:

Scan

Cursor for the scan axis.

Index

Cursor for the index axis.

USound

Cursor for the ultrasonic axis.

Ampl.

Cursor for the amplitude axis.

Autotrack

Autotracking measurement cursor that displays the amplitude of the ultrasonic cursor position.

TOFD

Hyperbolic cursor for time-of-flight diffraction.

Polar coordinates

Polar cursors (available only when Polar view is active).

Meas.

Adds the measurement cursors to the view (see previous **Ref.** check box).

Gate

Adds the gate cursors to the view (see previous **Ref.** check box). The gate cursors are black cursors showing the position of the gate selector.

Zooms and Rulers parameters

Figure 2-52 The Zooms and Rulers parameters

The **Zooms and Rulers** area has the following check boxes (see Figure 2-52 on page 69):

Ultrasound Enabled/Amplitude Enabled

This check box enables the zoom bar on the ultrasound/amplitude axis.

Zoom bar

Adds a zoom bar to the corresponding axis in the active view.

Ruler

Adds a ruler to the corresponding axis in the active view.

Grid parameters

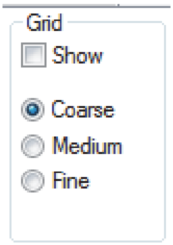

Figure 2-53 The Grid parameters

The **Grid** area has the following check box (see Figure 2-53 on page 70):

Show

The **Show** dialog box enables the grid on the active A-scan view, and the **Coarse**, **Medium**, and **Fine** options are used to customize the grid density.

Polar View Image Processing parameters

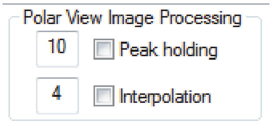

Figure 2-54 The Polar View Image Processing parameters

Depending on the resolution on the scan or index axis, there might be positions where no data is shown because of the limited size of the color-coded A-scan line. You can use the **Peak holding** or **Interpolation** image processing algorithms to fill these gaps (see Figure 2-54 on page 70).

Peak holding

This algorithm looks for a maximum in amplitude and spreads this value over the selected number of samples (must be less than or equal to 50). This algorithm is optimized for Polar views constructed from C-scan data.

Interpolation

This algorithm improves the visual representation of a view by filling the gaps between the selected number of samples (must be less than or equal to 50), until recorded data of a higher amplitude sample is detected. This algorithm is optimized for Polar views constructed from A-scan data.

Auto-Scroll Zoom parameters

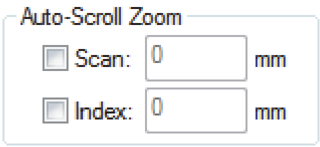

Figure 2-55 The Auto-Scroll Zoom parameters

The **Auto-Scroll Zoom** area has the following check boxes (see Figure 2-55 on page 71):

Scan/Index

This activates the Auto-Scroll Zoom function for the selected axis, which dynamically zooms in on the active view within the specified range.

Smooth

Adds a display smoothing function to the active view.

Configuration parameters

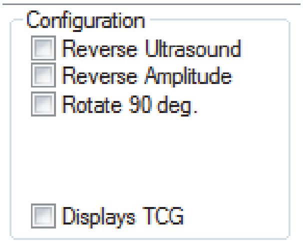

Figure 2-56 The Configuration parameters

The **Configuration** area has the following check boxes (see Figure 2-56 on page 71):

Reverse Ultrasound

Reverses the data along the ultrasonic axis (horizontal or vertical flip).

Reverse Amplitude

In an A-scan view selecting this check box reverses the data along the amplitude axis (vertical flip).

Rotate 90 deg

Rotates the data so that the two axes interchange.

Display TCG

Enables the time-corrected gain (TCG) display on the active A-scan view.

Reverse Horizontal/Vertical

Reverses the horizontal/vertical axis on an active Polar view.

Show part

Enables the display of the defined part on an active Polar view.

Gate selector

Adds the gate selector to the active view.

Keep 1:1 ratio

Displays the view in a way that maintains the 1:1 sample ratio of both displayed axes.

Reverse scan

Reverses the data along the scan axis (horizontal or vertical flip).

Reverse index

Reverses the data along the index axis (horizontal or vertical flip).

Group Gates parameters

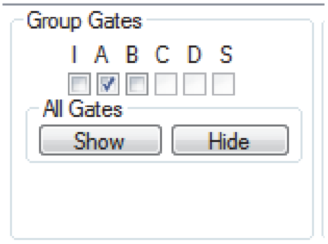

Figure 2-57 The Group Gates parameters

The **Group Gates** area has the following check boxes and buttons (see Figure 2-57 on page 72):

I, A, B, C, D, and S

These check boxes enable the display of the corresponding gates on the active A-scan.

All Gates

Show/Hide

Enables or disables the display of gates on the active A-scan view.

The **Display** tab for a Polar view contains additional options that are specific to this view (see Figure 2-58 on page 73).

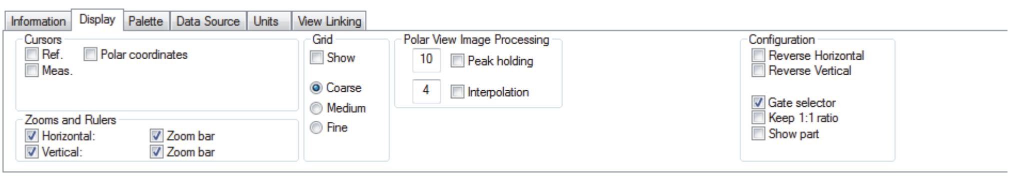

Figure 2-58 The Display tab for a Polar view

The part-definition setting that is needed in order to obtain a Polar view is described in "Part Definition Dialog Box" on page 52.

2.4.3 Echo Dynamics Tab

An echo dynamics curve is a 2-D curve resulting from the projection of the data under a cursor or between cursors. The **Echo Dynamics** tab (see Figure 2-59 on page 73) is used to set the echo dynamic curve parameters.

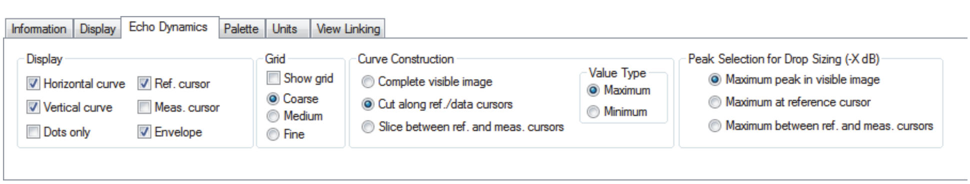

Figure 2-59 The Echo Dynamics tab

The **Echo Dynamics** tab is subdivided into the **Display**, **Grid**, **Curve Construction**, and **Peak Selection for Drop Sizing** (−X dB) areas.

Display area

This area encloses the display options of the echo dynamic curves (see Figure 2-60 on page 74).

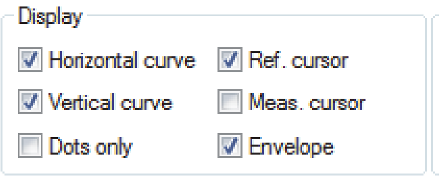

Figure 2-60 The Display area

Horizontal/vertical curve

When this check box is selected, a horizontal echo dynamic curve is displayed at the top or right side of the active view.

Dots only

When this check box is selected, echo dynamic curves are displayed with dots.

Ref./Meas. cursor

Enables the display of the reference/measurement cursors on the echo dynamic curves.

Envelope

When this check box is selected, the echo dynamic curves are displayed as an envelope of all the curves between the cursors or the complete visible image.

Grid area

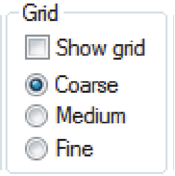

Figure 2-61 The Grid area

The **Grid** area contains the following parameters (see Figure 2-61 on page 74):

The **Show grid** check box enables the grid on the echo dynamic curves of the active view. The **Coarse**, **Medium**, and **Fine** options can be used to customize the grid density.

Curve Construction area

The **Curve Construction** area contains the following option buttons used to select one of three curve construction types (see Figure 2-62 on page 75):

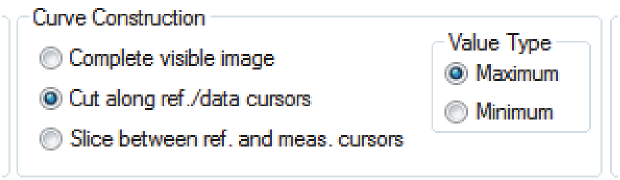

Figure 2-62 The Curve Construction area

Complete visible image

With this option, the echo dynamic curve is constructed with the complete visible image of the inspected part.

Cut along ref./data cursors

With this option, the echo dynamic curve is constructed with the cross section that is specified by the reference cursor.

Slice between ref. and meas. cursors

With this option, the echo dynamic curve is constructed with the slice that is specified by the reference and measurement cursors.

Value type

Select to build the echo dynamic curve using the **Maximum** or the **Minimum** value of the current area.

Peak Selection for Drop Sizing (–X dB)

The **Peak Selection for Drop Sizing (–X dB)** area contains three option buttons (see Figure 2-63 on page 76).

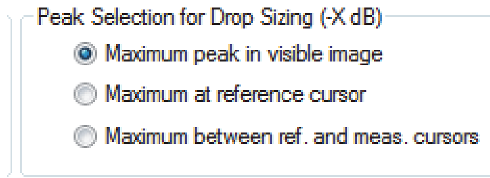

Figure 2-63 The Peak Selection for Drop Sizing (-X dB) area

This area allows you to select the option that will be used for the −X dB drop sizing measurements on echo dynamic curves: **Maximum peak in visible image**, **Maximum at reference cursor**, or **Maximum between ref. and meas. cursors**.

2.4.4 Overlay Tab

The **Overlay** tab (see Figure 2-64 on page 76) is used to set the display of overlay drawings on the active volume-corrected view.

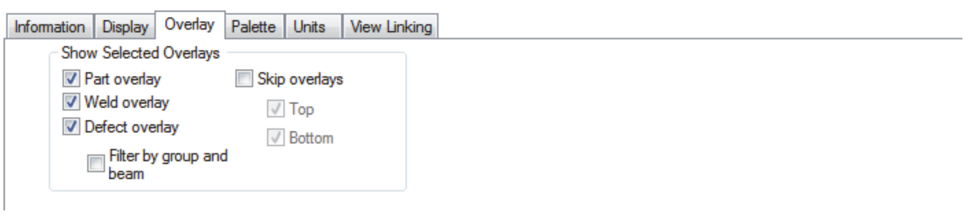

Figure 2-64 The Overlay tab

Show Selected Overlays

The **Show Selected Overlays** area contains the following parameters (see Figure 2-65 on page 77):

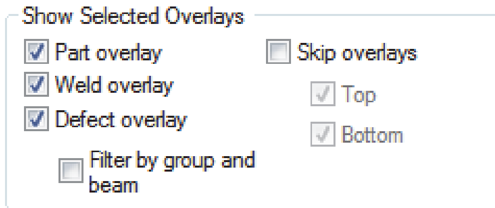

Figure 2-65 The Show Selected Overlays area

Part/Weld/Defect Overlays

Enables the display of the selected overlay on the active volume-corrected view.

Filter by group and beam

Selecting this check box ensures that only the defects created on the current group for the active view are displayed.

Skip Overlays

Enables the display of the skips on the current view for the corrected volume and sector (S) views. Clearing the **Top** or **Bottom** check boxes removes the corresponding skips from the active view.

2.4.5 Palette Tab

The **Palette** tab (see Figure 2-66 on page 77) is used to set the color palette of the active view.

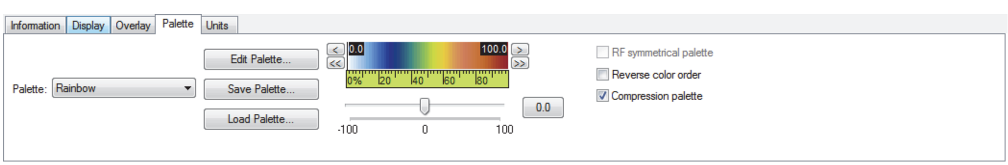

Figure 2-66 The Palette tab

The **Palette** tab contains the following items: the **Palette** list, **Edit Palette**, **Save Palette**, and **Load Palette** buttons, the color palette, the cursors, left- and right-arrow buttons, the software gain slider, **RF symmetrical**, **Reverse color order**, and **Compression palette**.

Palette

This list is used to select a predefined color palette. A zone displays the selected color palette.

Edit Palette

Opens the **Palette Editor** dialog box, used to define color palettes.

Save Palette

Opens a standard **Save As** dialog box, used to name and save a color palette (.col file). The saved color palette replaces the selected palette in the **Palette** list.

Load Palette

Opens a standard **Open** dialog box, used to select and load a color palette (.col file). The loaded color palette replaces the currently selected palette in the **Palette** list.

Color palette

Displays the current color palette for the active view (see Figure 2-67 on page 78).

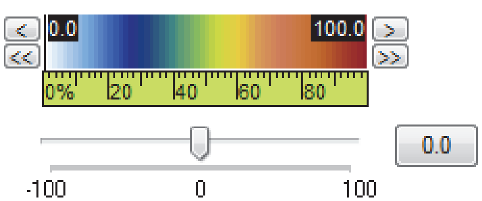

Figure 2-67 The Color Palette dialog box

Double-clicking between the cursors divides the current palette range by two and double-clicking outside the cursors restores the full palette range default.

Double-clicking outside the cursors restores the default full palette range, which goes from −100 % to +100 %.

Left and right arrow buttons

Clicking the left- and right-arrow buttons, respectively, shifts the color palette range by a fine increment to the left and to the right.

Left and right double-arrow buttons

Clicking the left- and right-double-arrow buttons, respectively, shifts the color palette range to the left and to the right by a coarse increment.

Color palette left/right cursors

Dragging the left/right cursor sets the lower and upper limits of the color palette range as a percentage (linear data), or in decibels (logarithmic data).

Dragging the color palette itself sets the lower and upper limits of the color palette range simultaneously.

Software gain slider

Dragging the slider, or using the arrow keys, sets the software gain, which ranges from −100 dB to +100 dB. Clicking on the gain slider moves the slider by 6 dB or 6 % increments, depending on the case.

The software gain you set appears in a box to the right of the software gain slider. Clicking this box restores the default software gain, which is 0 dB or 0 %.

NOTE

The software gain slider is used to set a software-calculated amplitude gain, which leaves the acquisition data unchanged.

RF symmetrical palette

Selecting this check box makes the selected color palette symmetrical relative to the zero value.

Reverse color order

Selecting this check box reverses the color order in the color palette.

Compression palette

When enabled, the full color palette range is compressed between the left and right color palette.

2.4.6 Data Source Tab

Using the **Data Source** tab (see example in Figure 2-68 on page 80), you can set the data source used to compute the projection displayed in a view. The contents of the **Data Source** tab changes, depending on the current type of view selected.

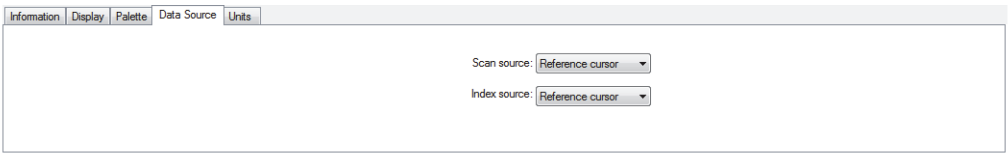

Figure 2-68 The Data Source tab

The **Data Source** tab may contain the following parameter options:

Single plane

In this mode, the view displays a single plane crossing the inspection volume. A single gate selector selects the cross section to display in the inspected part.

Projection, using gate selectors

In this mode, FocusPC uses all data contained between two gate selectors to generate the displayed image. When many samples of data must use the same display pixel, the highest value is used.

Link to reference cursor

This check box, when selected, links the gate selector position to the corresponding reference and measurement cursors. Dragging these cursors then causes gate selectors of other views to react accordingly.

Set gate selectors range to max.

When this check box is selected, the gate selectors are set at lower and higher values to display the volume of data. When this check box is selected, it is not possible to adjust the gate selector values at the bottom of the pane.

Scan source

Using this list, you can select the cursor (**Reference cursor**, **Measure cursor**, or **Data cursor**) that is to be used to select the A-scan along the scan axis.

Index source

Using this list, you can select the cursor (**Reference cursor**, **Measure cursor**, or **Data cursor**) that is to be used to select the A-scan along the index axis.

2.4.7 Units Tab

The **Units** tab (see Figure 2-69 on page 81) is used to set the units for the four data dimensions, for all views displaying the same data group as the active view.

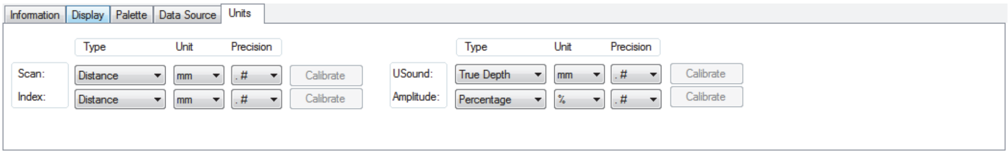

Figure 2-69 The Units tab

The **Units** tab contains the following parameters:

Scan/Index/USound/Amplitude

Set the scan/index/ultrasonic axis/amplitude units.

Type

This column contains the lists used to select the unit type for each parameter. According to the dimension, the possible unit types are the following:

Scan: **Distance**, **Samples**, **Rotation**.

Index: **Distance**, **Samples**, **Rotation**.

USound: **True Depth**, **Half Path**, **Full Path**, **Time**, **Time/2**, **Samples**, **TOFD**.

Amplitude: **Samples**, **Percentage**, **Decibels**.

Unit

This column contains the lists used to select the measurement unit for each parameter. According to the unit type, the possible units are the following:

Distance: **True Depth**, **Half Path**, **Full Path**: **m**, **mm**, **in.**, **mils**.

Samples: **smpl**.

Rotation: **deg**, **rad**.

Time, **Time/2**: **s**, **µs**.

TOFD: **m**, **mm**, **in.**, **mils**.

Percentage: **%**.

Decibels: **dB**.

Precision

This column contains the lists used to select the measurement precision:

. = 0 digits after the decimal

.# = 1 digit after the decimal

.## = 2 digits after the decimal

.### = 3 digits after the decimal

Calibrate

Clicking on the **Calibrate** buttons opens the **Mechanical Axis**, **Time/Full Path** and **Time/Half Path**, **TOFD**, **True Depth**, or **Translation/Rotation** calibration dialog boxes.

Mechanical Axis Calibration dialog box

The **Mechanical Axis Calibration** dialog box (see Figure 2-70 on page 82) is used to calibrate the distance value on the scan or index axes.

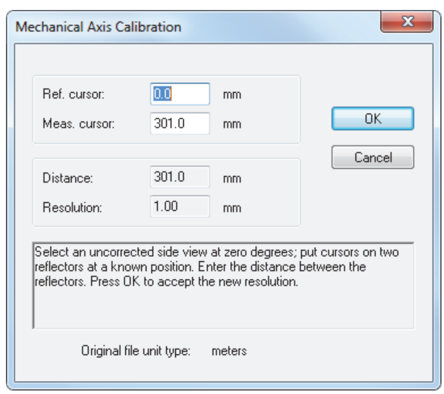

Figure 2-70 The Mechanical Axis Calibration dialog box

The **Mechanical Axis Calibration** dialog box contains the following parameters:

Reference cursor/Measurement cursor

These boxes are used to set the reference and measurement cursor positions.

Distance/Resolution

These boxes indicate the distance between reference and measurement cursor positions along with the measurement resolution.

Original file unit type

This line displays the original unit used in the data file.

Time / Full Path and Time / Half Path dialog boxes

The **Time / Full Path** and **Time / Half Path** dialog boxes (see Figure 2-71 on page 83) are used to calibrate the time value relative to the full path value and the half path value.

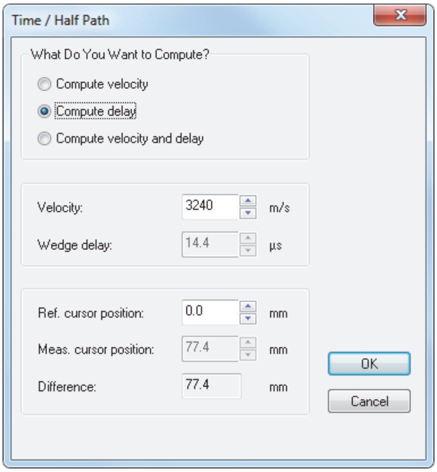

Figure 2-71 The Time / Half Path dialog box

The **Time / Full Path** and the **Time / Half Path** dialog boxes contain the following parameters:

What do you want to compute?

This area allows you to select which parameter should be calculated.

Velocity, Wedge Delay

These boxes indicate the sound velocity and wedge delay inside the material.

Ref. cursor position, Meas. cursor position

These boxes indicate the current reference and measurement cursor positions.

Difference

This box indicates the difference between the reference and measurement cursor positions.

TOFD dialog box

The **TOFD** dialog box (see Figure 2-72 on page 84) is used to calibrate the ultrasonic axis when you use the TOFD method.

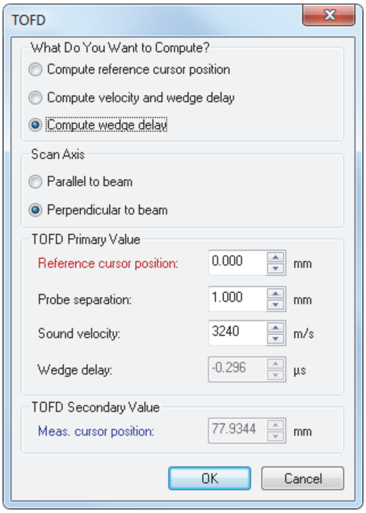

Figure 2-72 The TOFD dialog box

The **TOFD** dialog box contains the following parameters:

What do you want to compute?

This area contains option buttons used to select the parameter that is to be calculated:

Compute reference cursor position

This option is used to adapt the TOFD ruler, setting it to its zero position at the reference cursor position. Position the reference cursor on the first echo signal and then click **OK**.

Compute velocity and wedge delay

This option is used to calculate both the material sound velocity and the probe wedge delay by using two reference signals, typically the lateral wave and the back wall echo.

Compute wedge delay

This option is used to calculate the probe wedge delay by using a fixed value of the sound velocity and one reference signal, typically the lateral wave or the back wall echo.

Scan axis

This area contains option buttons that can be used to select whether the scan axis orientation relative to the ultrasonic beam projection should be defined as **Parallel to beam** or **Perpendicular to beam**.

TOFD Primary Value

Reference cursor position

This box defines the real (true depth) reference cursor position in millimeters (mm) or inches (in.).

Probe separation

This box defines the distance between the probes in millimeters (mm) or inches (in.).

Sound velocity

This box defines the material sound velocity in meters per second (m/s) or inches per microsecond (in./µs).

Wedge delay

This box defines the probe wedge delay in microseconds (µs).

TOFD Secondary Value

Meas. cursor position

This box defines the real (true depth) measurement cursor position in millimeters (mm) or inches (in.).

NOTE

For details on using the calibration function with the **TOFD** dialog box, see “Performing TOFD Calibration in Analysis Mode” on page 113.

True Depth dialog box

The **True Depth** dialog box (see Figure 2-73 on page 86) is used to calibrate the ultrasonic axis in true depth units.

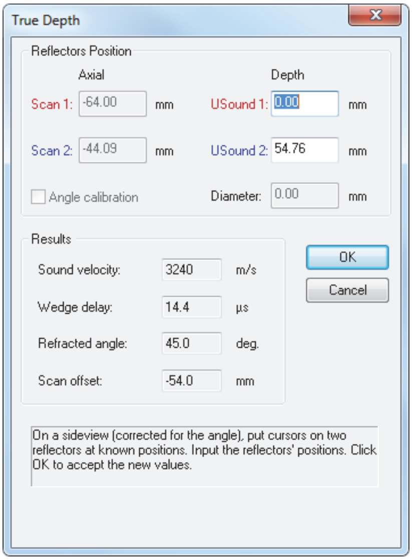

Figure 2-73 The True Depth dialog box

The **True Depth** dialog box contains text boxes (on white background) for the values that can be changed, or display boxes (appearing dimmed) for the values that are calculated from other values. The dialog box contains the following parameters:

Reflectors position

This area contains parameters used to calibrate the ultrasonic axis.

Scan 1/Scan 2

These boxes define the real scan axis position of the reference and measurement cursor positions in millimeters (mm) or in inches (in.).

USound 1/USound 2

These boxes defines the real (true depth) reference cursor position in millimeters (mm) or in inches (in.).

Diameter

This box defines the diameter of the hole used for calibration.

Angle calibration

This check box, when selected, enables the calibration of the refracted angle.

Results

The **Sound velocity**, **Wedge delay**, **Refracted angle**, and **Scan offset** values displayed in this section give the values calculated from the defined parameters.

Translation/Rotation dialog box

The **Translation/Rotation** dialog box (see Figure 2-74 on page 87) is used to calibrate the translation value relative to the rotation value.

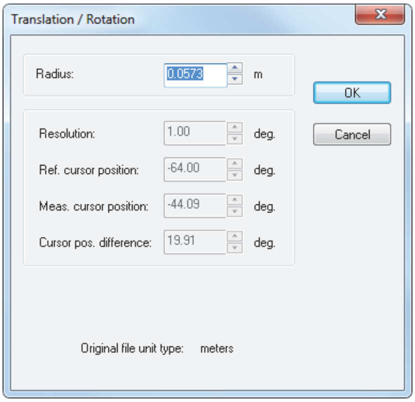

Figure 2-74 The Translation/Rotation dialog box

The **Translation/Rotation** dialog box contains the following parameters:

Radius

This box indicates the radius of the rotary motion.

Resolution

This box indicates the measurement resolution.

Ref. cursor/Meas. cursor

These boxes indicate the reference and measurement cursor positions.

Cursor pos. difference

This box indicates the difference between reference and measurement cursor positions.

Original file unit type

This line displays the original unit used in the data file.

2.4.8 View Linking Tab

The **View Linking** tab (see Figure 2-75 on page 88) is used to set linking cursors types, rulers, palette ranges, and other settings for the active view. The particular linking types set for the active view override the default links set in the **Linking** tab of the **Preferences** dialog box.

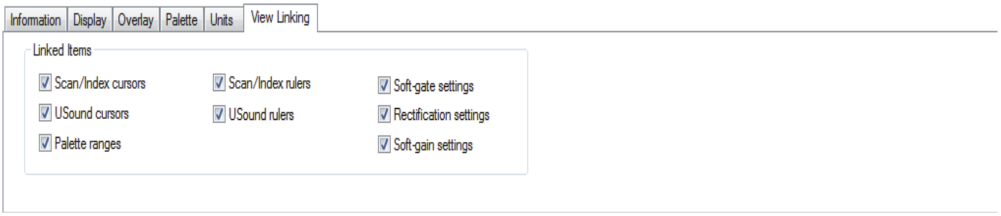

Figure 2-75 The View Linking tab

Linked Items

The **Linked Items** area contains the various objects and settings that can be linked to the graphical tools of the other views. Selecting a check box activates the linking of the corresponding object or setting.

2.4.9 Rebounds Tab

The **Rebounds** tab (see Figure 2-76 on page 88) is used to set the skip processing parameters.

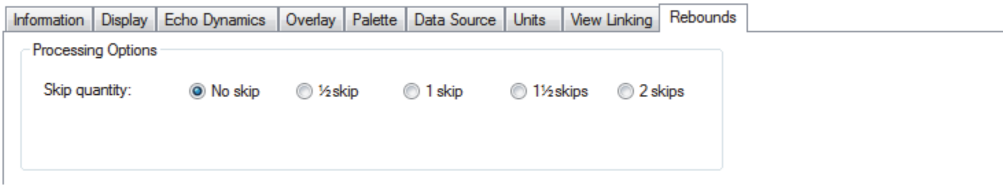

Figure 2-76 The Rebounds tab

The **Rebounds** tab contains the following items:

Processing options

This area encloses options that are selected for the skip processing.

Skip quantity

Using these option buttons, you can select the number of skips used in the processing from the following: **No skip**, **½ skip**, **1 skip**, **1½ skips**, or **2 skips**.

2.4.10 Strip Tab

The **Strip** tab (Figure 2-77 on page 89) is used to set options and parameters related to the strip views. The **Strip** tab is only available when the active view is a strip view.

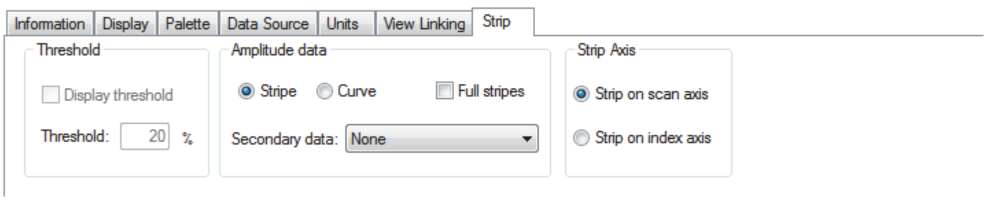

Figure 2-77 The Strip tab

The **Strip** tab is subdivided into **Threshold**, **Amplitude/Position data**, and **Strip Axis** areas.

Threshold area

This area encloses the threshold options of the strip views.

— **Display threshold**

When this check box is selected, the **Threshold** value is displayed as a black line in the active strip view. When the **Secondary data** is displayed, if the secondary data is below the **Threshold** value at a defined position, the associated stripe of the strip view becomes green. If the secondary data is above the **Threshold** value at a defined position, the associated stripe of the strip view becomes red.

— **Threshold**

Indicates the threshold level in amplitude or as percentage of gate length.

Amplitude/Position data area

This area encloses the amplitude/position data options for the strip views.

— **Stripe**

When this option is selected, the data is represented by a colored stripe. The color and the length of the stripe are indicative of the amplitude or the position of the indication within the associated gate.

— **Curve**

When this option is selected, the data is represented by a curve.

— **Full stripes**

When this check box is selected, the data is represented by a colored stripe with its length at full-view height. The color of the stripe is indicative of the amplitude or position of the indication within the associated gate.

— **Secondary data**

Using this list, you can choose secondary data to be displayed in the active strip view. Depending on the number of gates, the data type recorded, and the active strip view, the **Secondary data** and the different gate's amplitude and position data.

Strip axis area

This area allows you to select whether the strip view should be constructed along the scan or index axis (available in Analysis mode only).

2.5 Preferences Dialog Box

You can customize various FocusPC parameters using the **Preferences** dialog box (see Figure 2-78 on page 91). You can access the **Preferences** dialog box by selecting **File > Preferences** on the menu.

NOTE

The **Preferences** dialog box is not available in the FocusPC Viewer edition.

2.5.1 General Settings Tab

This section contains descriptions of the parameters in the **General Settings** tab of the **Preferences** dialog box (see Figure 2-78 on page 91).

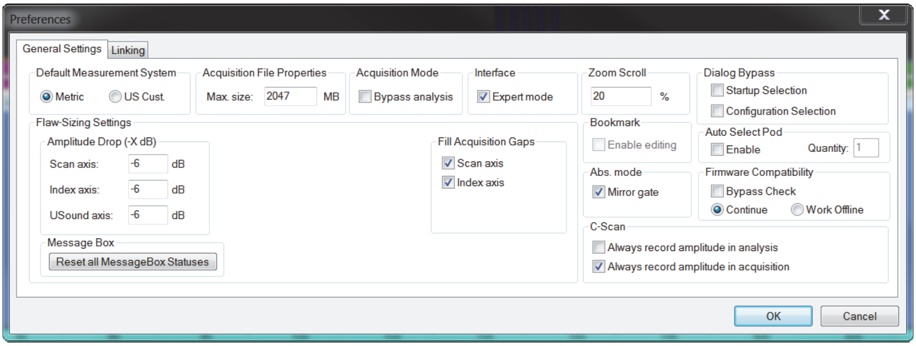

Figure 2-78 The General Settings tab of the Preferences dialog box

Default Measurement System

Select **Metric** or **US Cust.** to respectively use the metric or the US customary measurement systems for all FocusPC parameters and views. You can configure units in more detail for each view in the **Properties** dialog box, in the **Units** tab.

Acquisition File Properties

Use **Max Size** to set the maximum size of the acquisition file. The maximum size of a data file that can be recorded with FocusPC is 2 GB.

Acquisition Mode

Select the **Bypass analysis** check box to bypass the online Analysis mode so that you immediately go to the Setup mode at the end of the acquisition.

Interface

Select the **Expert mode** check box to activate advanced features (refer to the FocusPC *User's Manual* for details).

Zoom Scroll

You can scroll the vertical zoom bars on the selected view using the wheel of the mouse. Holding the CTRL key while moving the wheel scrolls the horizontal zoom bar. The axis range percentage value indicates the magnitude of the zoom bar displacement for one tick of the mouse wheel.

Dialog Bypass

Select the check box for the dialog boxes (**Startup Selection** or **Configuration Selection**) that you want to bypass at startup. These options may be useful when you always use the same setup and want to avoid acknowledging the default setup, or when you remotely control FocusPC and you cannot respond to the dialog boxes.

Amplitude drop

Set the amplitude-drop negative value for the three axes to be used for flaw sizing with the Zone tool.

Peak Holding Algorithm

Set the number of samples to be used in the peak holding algorithm for the three axes for flaw sizing with the Zone tool. A setting of n samples means that the algorithm ignores an amplitude drop below $-x$ dB along the axis if it is smaller than n samples.

Reset all Message Box Status

Click this button to reactivate all messages for which the **Do not show again** check box was selected.

Fill Acquisition Gaps

Select the check box to activate the function that fills data acquisition gaps when performing amplitude-drop sizing measurements for each of the two axes.

Bookmark

The **Enable editing** check box is disabled because its use is reserved for Evident.

Auto Select Pod

The **Auto Select Pod** feature can be used to automatically boot FocusPC when the selected number of instruments have been detected.

Abs. Mode

Select the **Mirror Gate** check box to activate a positive and negative A gate in RF mode.

C-Scan

On an amplitude C-scan, FocusPC normally does not show signal amplitudes that are below the gate level, replacing these values by **no detection** codes.

Select the **Always record amplitude in analysis** check box when you want to configure FocusPC to show this signal in Analysis mode, after moving the gate. Select **Always record amplitude in acquisition** if you want the amplitude data to be shown whether or not the signal has crossed the gate (thereby ignoring the **no detection** codes).

2.5.2 Linking Tab

The **Linking** tab of the **Preferences** dialog box (see Figure 2-79 on page 93), accessible from the **File > Preferences** menu selection, contains parameters to customize the linking features in FocusPC.

When an element is linked, changing it in one context (view, group, gate) automatically changes it identically in the other linked contexts. For example, with the **Scan cursors** set to **Fully linked**, moving the reference cursor on the scan axis in one view, moves it to the same position in all the other views. The linking feature can save you a large number of tedious adjustments when you work with multiple views, multiple groups, and multiple gates. You can set the cursor and ruler linking behavior differently for uncorrected and corrected views.

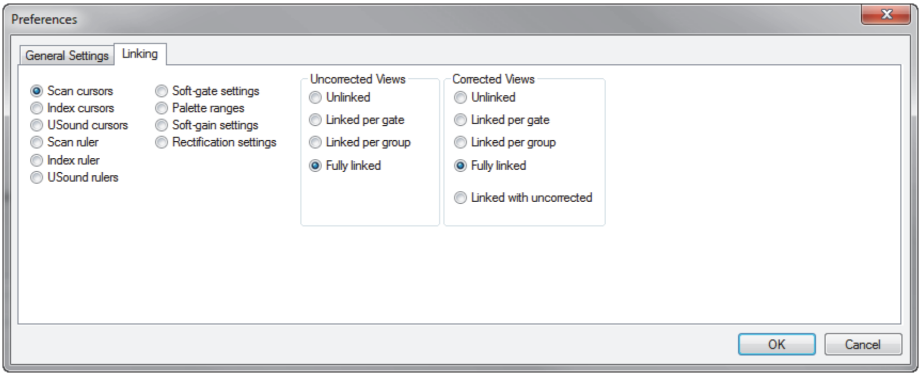

Figure 2-79 The Linking tab of the Preferences dialog box

The following linking behaviors are available with other views:

Unlinked

The selected item is not linked.

Linked per gate

The selected item is linked per gate.

Linked per group

The selected item is linked per group.

Fully linked

The selected item is linked for all gates and all groups.

Linked with uncorrected

The selected item is linked as defined under **Uncorrected Views**.

NOTE

FocusPC classifies an A-scan as an uncorrected view, even when the ultrasound axis is set to True Depth mode.

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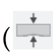
3. Advanced Analysis Using FocusPC

This chapter describes how to use the multiple advanced analysis features available in FocusPC.

3.1 Thickness C-Scan Process

A thickness C-scan is a part thickness color illustration used to highlight thickness variations. This view is useful for the monitoring of part wear or corrosion.

To create a thickness C-scan

1. On the Component toolbar, click the **Thickness C-scan** button ().
2. In the **Create Thickness C-scan** dialog box (see Figure 3-1 on page 960), proceed as follows:
   a) In the **Groups** list, select the group to create a thickness C-scan.
   b) In the **Thickness types** list, for example, select **A ^ - I/**.
   c) To customize the color palette limits, in the **Thickness gate** area, select **Override with user values**, and then set **Min.** and **Max.** parameters to the desired values.
   d) Click **Create**.
   e) Click **Done**.
3. Choose a view in a layout to be configured as a thickness C-scan.
4. On the Component toolbar, click the **Add View Content** button ().
5. In the **Contents** dialog box, select a thickness C-scan view (see Figure 3-2 on page 96).

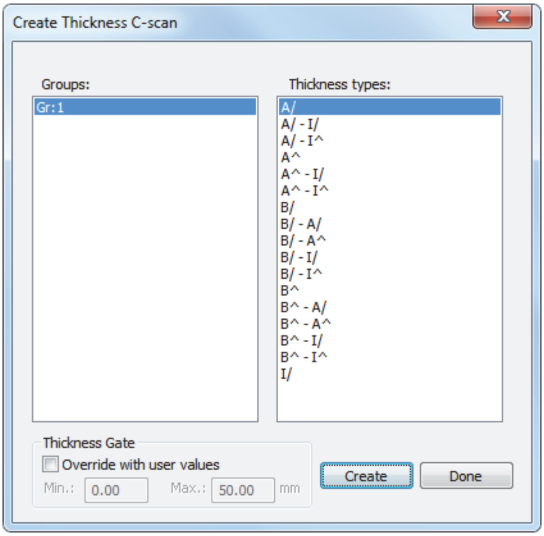


Figure 3-1 The Create Thickness C-scan dialog box

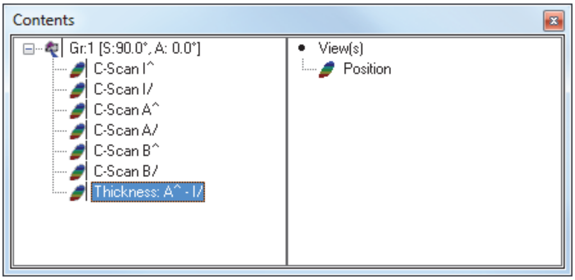


Figure 3-2 Selecting a thickness C-scan view

The thickness C-scan illustration appears in the view (see example in Figure 3-3 on page 97).

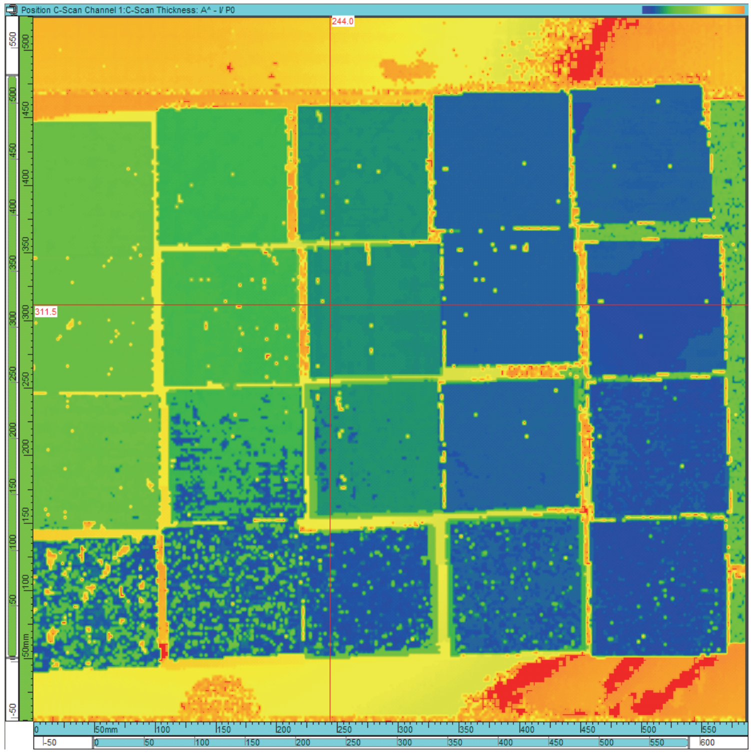


Figure 3-3 Example of a thickness C-scan

3.2 Volumetric Merge Process

A FocusPC view can only display the data of one data group. The volumetric merge function condenses the information of several groups into one group, so that you can view more information in a single view.

In Analysis mode, you can use the volumetric merge function to perform a merge of the ultrasonic data acquired with various groups. The merging process compares the amplitude obtained at each point of the inspected volume by the considered groups, and creates a new data group with the maximum amplitude observed at each position in the inspected volume.

The volumetric merge function is a wizard that takes you step by step through the merging configuration process. You can save the configuration defined with the wizard in a volumetric merge configuration file (.vmc), and recall the file to quickly perform a similar volumetric merge. See “Performing a Volumetric Merge” on page 98 for details on the volumetric merge configuration file format.

FocusPC saves the created merged data in the attributes file (.A01) that is saved as part of the data file (.fpd).

You can also use the automatic volumetric merge that uses the default volumetric merge parameters, thus bypassing the steps of the volumetric merge wizard. All groups (except TOFD groups) are merged together, but the original data is always preserved (see “Performing an Automatic Volumetric Merge” on page 100).

3.2.1 Performing a Volumetric Merge

The volumetric merge function is a wizard that takes you step by step through the merging configuration process.

To perform a volumetric merge

1. Open a data file containing more than one beam or more than one data group.
2. On the Component toolbar, click the **Volumetric Merge** button ().

   The **Volumetric Merge** wizard starts.
3. Under **Available Data Groups** (see Figure 3-4 on page 99), select which beams or groups to merge:
   a) In the type selection box, select the beam or group type to be displayed in the **Available Data Groups** list.

   b) In the **Available Data Groups** list, select the beams and groups you wish to merge, and then click **Add**.

   The selected beams or groups appear in the **Selected Data Groups** list.

   c) Click **OK**.

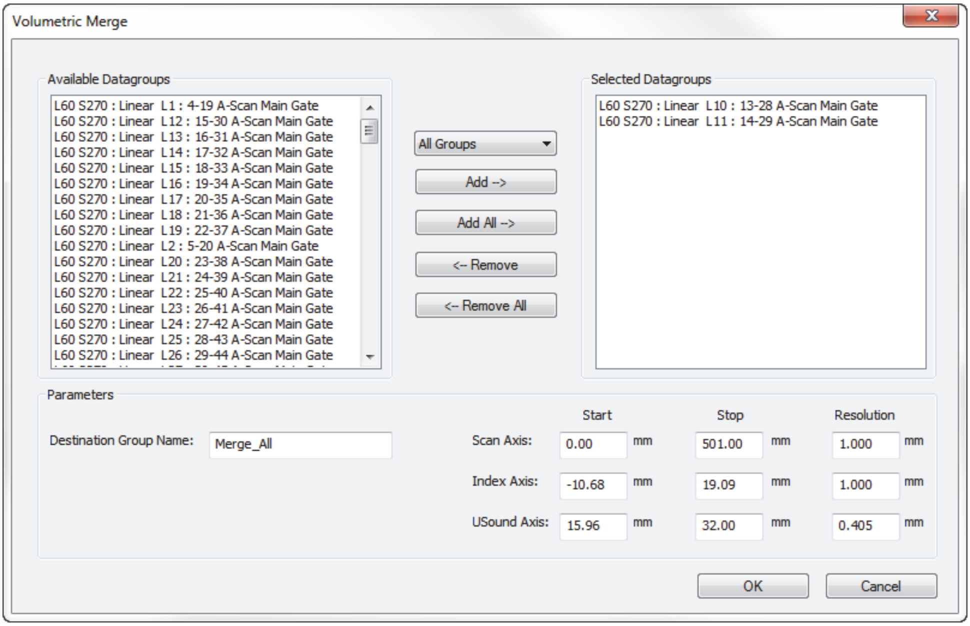


Figure 3-4 The Volumetric Merge dialog box

NOTE

The volumetric merge function does not work when a cylindrical specimen is defined. Also, it is impossible to merge different data types together (for example, A-scan with C-scan).

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4. Type a name in the **Destination Group Name** box.
5. If necessary, modify the merge dimensions (**Start**, **Stop**, and **Resolution**) for the three axes.
6. Click **OK**.

   The merged group is added to the contents (see Figure 3-5 on page 100).

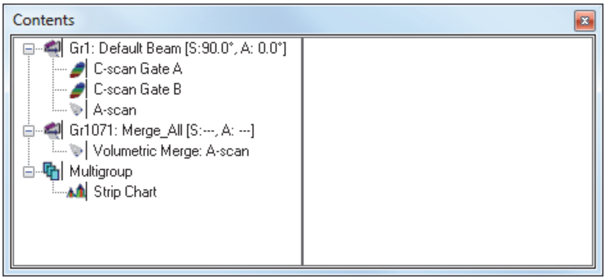

Figure 3-5 Example of the volumetric merge group created

3.2.2 Performing an Automatic Volumetric Merge

The automatic volumetric merge function performs the volumetric merge of all beams in the currently selected file using the default values of the **Volumetric Merge** dialog box (see “Performing a Volumetric Merge” on page 98). The merge process transforms the sectorial group data into bitmap images of end-view slices.

To perform an automatic volumetric merge

1. Open the file on which you wish to perform a volumetric merge.
2. On the Component toolbar, click the **Automatic Volumetric Merge** button ().
   The merged data groups are added to the view **Contents** list.

3.2.3 Performing an Automatic Volumetric Merge by Group

The automatic volumetric merge by group function performs the volumetric merge of all beams for each group using the default values of the **Volumetric Merge** dialog box (see “Performing a Volumetric Merge” on page 98) and creates one merged data group per group.

To perform a volumetric merge by group

1. Open the file on which you wish to perform a volumetric merge.
2. On the Component toolbar, click the **Automatic Volumetric Merge by Group** button ().
   The merged data groups are added to the view **Contents** list.

3.3 Customizing Readings

Readings can be customized in Analysis mode in the same way as in Setup mode. For details on how to customize readings, refer to the FocusPC *User's Manual*.

3.4 Amplitude Drop Sizing Utility

You can use FocusPC to display the various readings related to the active data file and the data views (see "Customizing Readings" on page 101). With user-defined flaw sizing settings, you can use some of these parameters to get information on the position and the size of a flaw indication.

3.4.1 Defining or Modifying Flaw Sizing Settings

The **View Information** parameters, related to indication sizing, allow for −X dB amplitude-drop sizing of a flaw indication in its three dimensions simultaneously (scan, index, and ultrasonic axes). The value of X can be defined independently for each axis.

To define or modify the flaw sizing settings

1. On the menu, select **File > Preferences**.
2. In the **Flaw sizing settings** area of the **General Settings** tab (see Figure 3-6 on page 102), perform the following steps:
   a) In the **Amplitude drop (−X dB)** area, enter the -X value for each axis independently (only negative values are accepted).
   b) In the **Peak holding algorithm** area, enter the number of samples to be used for the peak holding algorithm for each axis independently.
   The default value is 0, but if for a given axis a value *n* larger than 0 is entered, the sizing algorithm, along this axis, "ignores" an amplitude drop below -X dB that is smaller than *n* samples. This tool can be used to group several flaws, or to avoid the problems related to the use of nonsmoothed A-scan signals.
   c) If the check boxes are selected in the **Fill acquisition gaps** area, the sizing algorithm ignores the missing acquisition points or lines along the considered axis by interpolating between the adjacent valid acquisition points or lines.

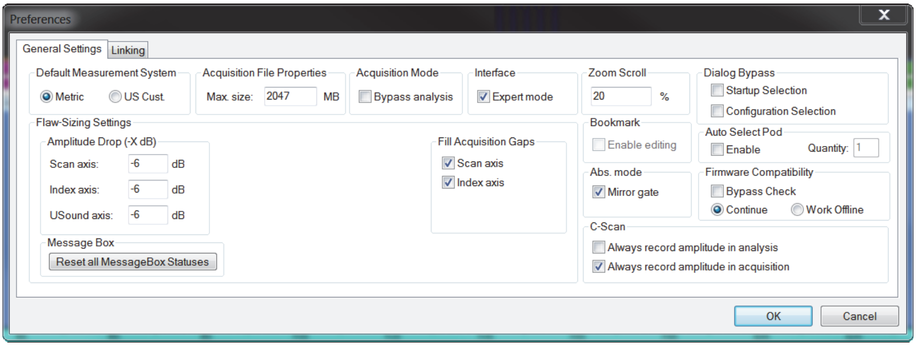

Figure 3-6 The General Settings tab

NOTE

Applying the peak holding algorithm, for a given axis, can oversize the indication by $2 \times n$ samples for this axis.

3.4.2 Determining the Location and Dimensions of Flaw Indications

The **View Information** parameters can be used not only to determine the dimensions of a flaw indication using –X dB amplitude-drop sizing, but also to determine the location of the flaw indication in the inspected volume. The following procedure uses the **Zone** tool of the FocusPC software.

To determine the location and dimensions of a flaw indication in 3-D

1. Create a suitable display layout, showing at least the Top (C), Side (B), or the End (D) views.
2. In one of the displayed views display the parameters (as shown in Table 3 on page 102).

Table 3 Parameters for flaw indication

Parameter	Description
Z. Max. Ampl.	Zone maximum amplitude

Table 3 Parameters for flaw indication *(continued)*

Parameter	Description
Z. Max. Scan Pos.	Zone maximum amplitude position on the scan axis
Z. Max. Index Pos.	Zone maximum amplitude position on the index axis
Z. Max. UT Path Pos.	Zone maximum amplitude position on the ultrasonic axis
Z. Scan1 –X dB	Position 1 along the scan axis of “maximum amplitude –X dB” position
Z. Scan2 –X dB	Position 2 along the scan axis of “maximum amplitude –X dB” position
Z. Index1 –X dB	Position 1 along the index axis of “maximum amplitude –X dB” position
Z. Index2 –X dB	Position 2 along the index axis of “maximum amplitude –X dB” position
Z. USound1 –X dB	Position 1 along the ultrasonic axis of “maximum amplitude –X dB” position
Z. USound2 –X dB	Position 2 along the ultrasonic axis of “maximum amplitude –X dB” position
Z. Scan2 – Scan1 –X dB	Length of the flaw indication at –X dB along the scan axis
Z. Index2 – Index1 –X dB	Length of the flaw indication at –X dB along the index axis
Z. USound2 – USound1 –X dB	Length of the flaw indication at –X dB along the ultrasonic axis

These readings can be found in the **Statistics > Zone** category of the **Information Groups** dialog box (see Figure 3-7 on page 104). Note that the Expert mode must be activated for these readings to be available (refer to the FocusPC *User's Manual*).

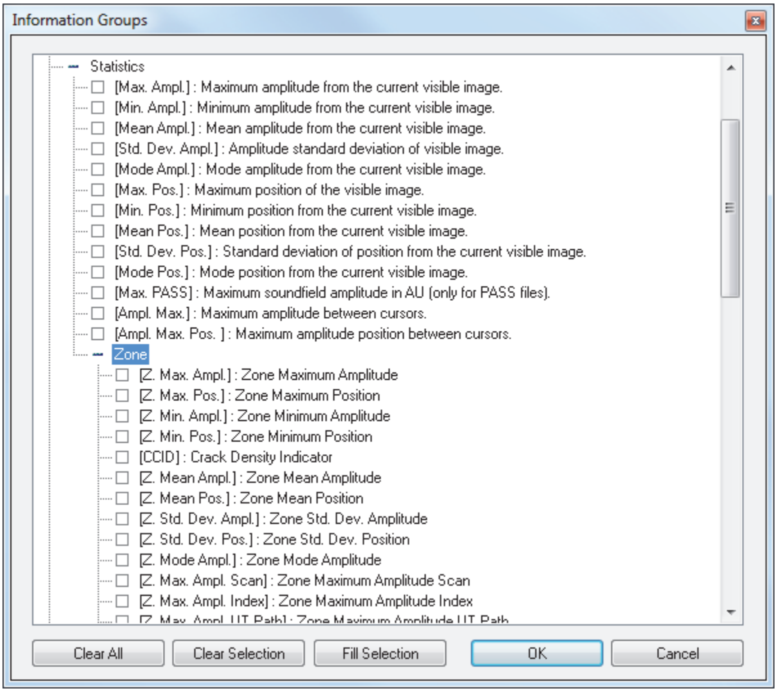

Figure 3-7 Statistics parameter category of the Information Groups dialog box

3. Display and examine the area of recorded data that is of interest (see Figure 3-8 on page 105).

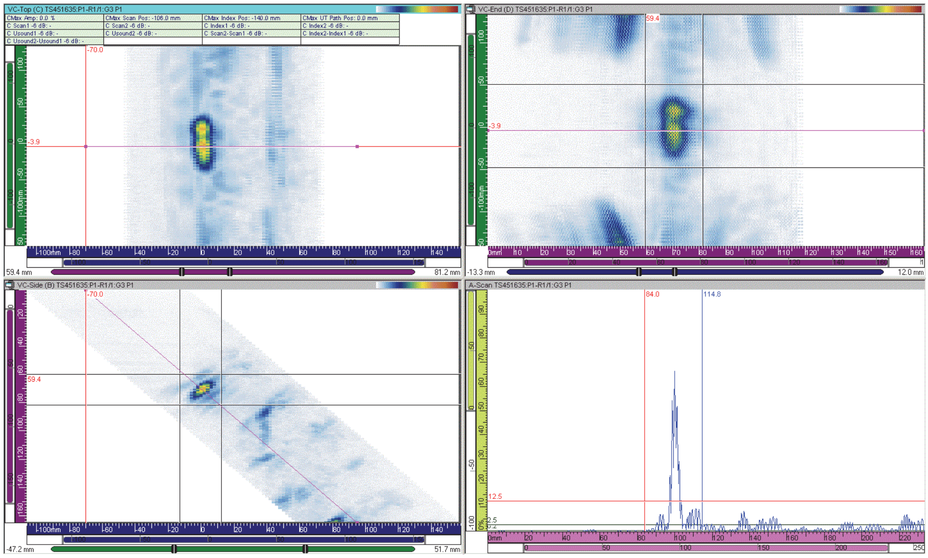

Figure 3-8 Data display examples

4. Position the gate selectors for the ultrasonic axis so that the flaw indication to be sized is located between the gate selectors.
5. Create a zone in the Side (B) view [or End (D) view] containing the considered flaw indication.
6. Create a zone in the Top (C) view containing the considered flaw indication.
7. The zone in the Side (B) or End (D) view is automatically adjusted to the gate selector limits. You have now created a volumetric zone defined by the contour in the Top (C) view and the gate selectors in the ultrasonic axis (see Figure 3-9 on page 106). The parameters in the **Information Groups** dialog box give the maximum amplitude of the flaw indication, its position along each axis, and its size along each axis, with the user-defined amplitude drop value.

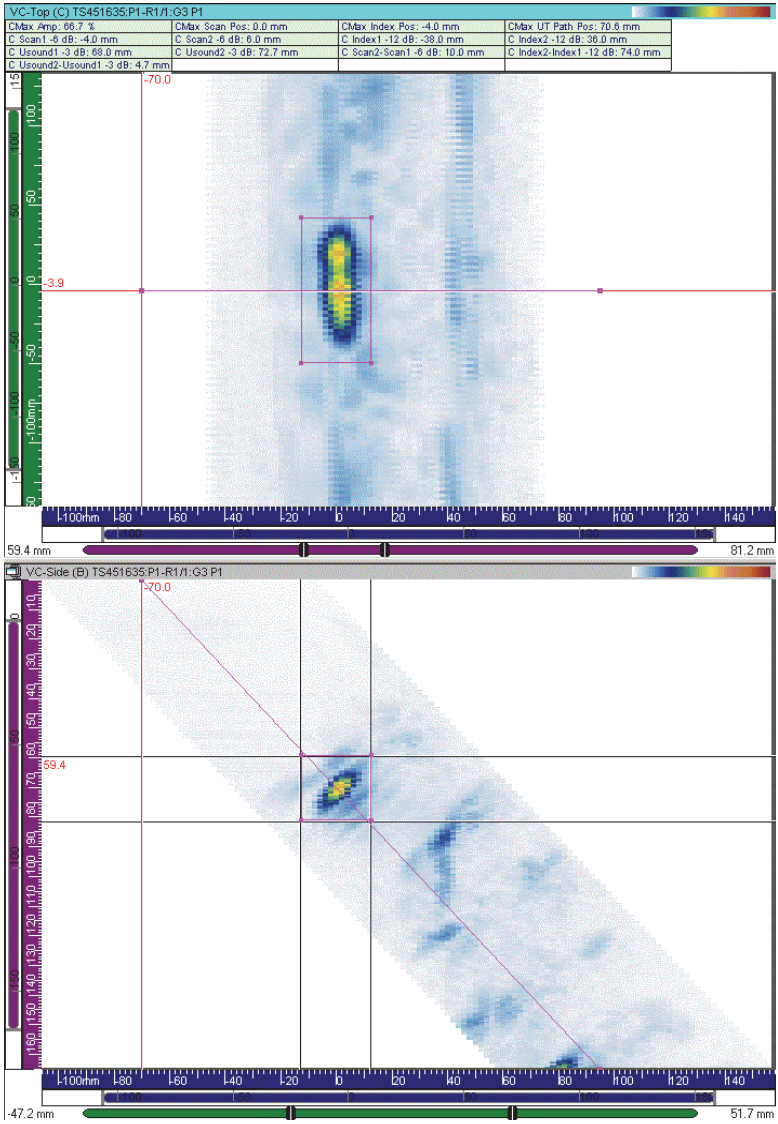

Figure 3-9 Examples of flaw indication sizing with the zone tool

3.5 Gain Information Component

The **Gain Information** dialog box (see Figure 3-10 on page 107) is used to monitor the different gain settings, and to adjust the software gain applied to the signal and/or the color palette settings in either Setup or Analysis mode.

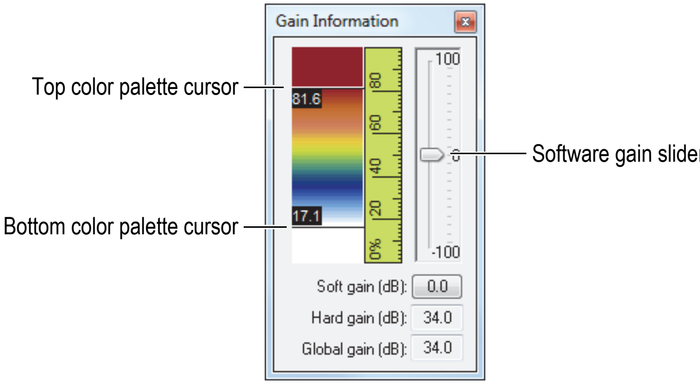

Figure 3-10 The Gain Information dialog box

The **Gain** dialog box displays the current color palette. Double-clicking between the top and bottom cursors reduces the current palette range by a factor of two. Double-clicking outside the cursors restores the default full-palette range.

Dragging the top or bottom color palette cursors, respectively, sets the upper and lower limits of the color palette range in percentage (linear data), or in decibels (logarithmic data). Dragging the color palette itself sets the lower and upper limits of the color palette range.

Dragging the slider, or using the arrow keys, sets the software gain, which ranges from −100 dB to +100 dB. The software gain slider sets a software-calculated amplitude gain that is applied to both the displayed images and the amplitude values in the readings, but leaves the raw acquisition data unchanged.

When negative software gain is applied to ultrasonic data, pixels over 100 % FSH keep applicable color code for saturation and the corresponding information view keeps returning 100 % for the signal amplitude.

To add or remove software gain

1. Select the view for which you want to modify the gain information.
2. On the Component toolbar, click the **Soft Gain Tool** button ( ).
   The **Gain Information** dialog box appears (see Figure 3-10 on page 107).

NOTE

The **Hard Gain (dB)** information box indicates the applied hardware gain. This information can be modified in the **UT Settings > General** dialog box.

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3. Use one of the following methods to modify the software gain:
   — Move the software gain slider cursor up or down using the mouse.
   — Click in the **Gain Information** dialog box and use the up and down keyboard arrow keys to increase or decrease the software gain in 0.1 dB increments.
   — Click above or below the slider cursor ( ) to increase or decrease the software gain in 6 dB increments.
   — Click on the **Soft Gain (dB)** button to set the software gain.
   — On the color palette, double-click between the cursors to divide the current palette range by two, or outside the cursors to restore the default full palette range.

3.6 TOFD Manager Component

The TOFD Manager is a complete tool for time-of-flight diffraction (TOFD) inspections that performs both basic and advanced analysis of TOFD examination data. Using the TOFD Manager, you can perform online and offline TOFD calibrations with either conventional or phased array probes.

You can also use the TOFD Manager to perform advanced analysis using typical TOFD cursors, algorithms for both lateral wave synchronization (straightening) and lateral wave removal, and a synthetic aperture focusing technique (SAFT) algorithm. All processing algorithms are developed to leave the raw inspection data unaffected. However, all processed data can be saved in separate data groups in the attributes file (.A01).

You can open the TOFD Manager by clicking the **TOFD Manager** button (TOFD) on the Component toolbar. The **TOFD Manager** dialog box is shown in Figure 3-11 on page 109.

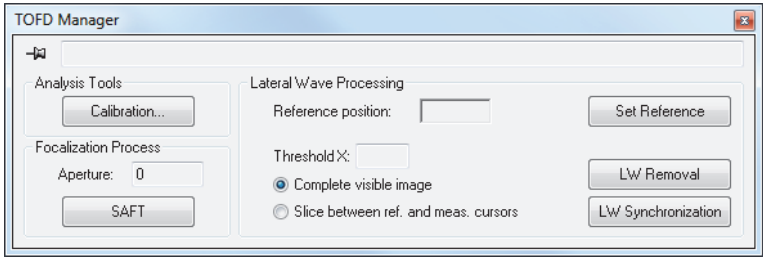


Figure 3-11 The TOFD Manager dialog box

In the **Information Groups** dialog box, when the Expert mode is active, a **TOFD** group of readings is available (see Figure 3-12 on page 109) for fast and easy length and through-wall sizing of indications in combination with the indication table (refer to the FocusPC *User's Manual*).

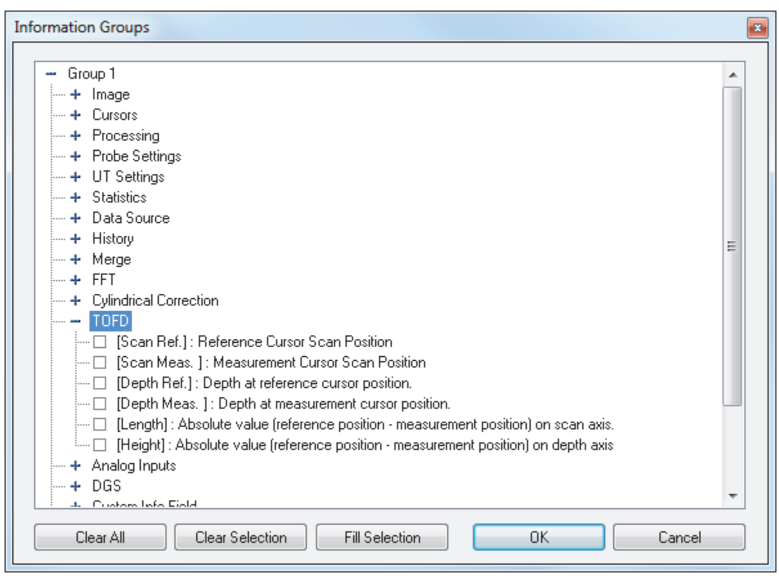


Figure 3-12 The TOFD readings in the Information Groups dialog box

3.6.1 TOFD Manager Dialog Box

This section describes the parameters in the **TOFD Manager** dialog box (see Figure 3-13 on page 110).

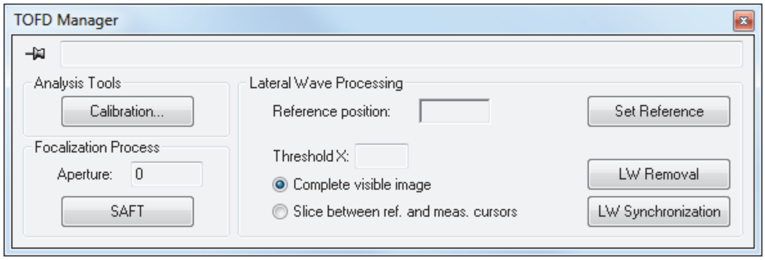


Figure 3-13 The TOFD Manager dialog box

Analysis Tools
Specifies parameters for the calibration of the ultrasonic axis (depth) for TOFD data.

Focalization Process
Allows the operator to use the SAFT algorithm on TOFD data.

Lateral Wave Processing
Specifies parameters for lateral wave processing (synchronization and removal).

3.6.1.1 Analysis Tools Parameters

The **Analysis tools** area contains the following button:

Calibration
Opens the **TOFD** dialog box in order to perform TOFD calibration (see Figure 3-14 on page 111).

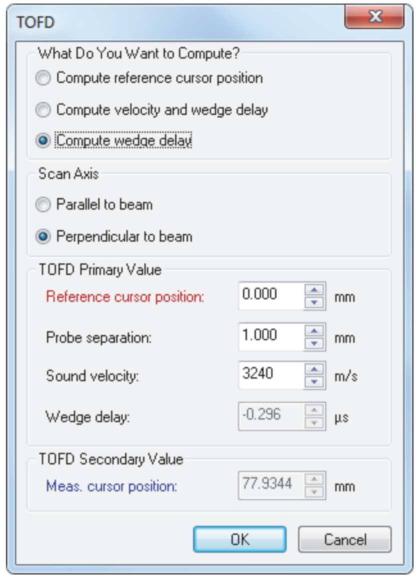


Figure 3-14 The TOFD dialog box

The **TOFD** dialog box contains boxes (on a white background) for the values that can be changed, or display boxes (appearing dimmed) for the values that are calculated from the other values. The dialog box contains the following elements:

What Do You Want To Compute?

This area contains option buttons used to select the parameter that is to be calculated from the other parameters.

Compute reference cursor position

This option is used to adapt the TOFD ruler to set its zero position at the reference cursor position. Position the reference cursor on the first echo signal, and then click **OK**.

Compute velocity and wedge delay

This option is used to calculate both the material sound velocity and the probe wedge delay, by using two reference signals, typically the lateral wave and the back wall echo.

Compute wedge delay

This option is used to calculate the probe wedge delay, by using a fixed value of the sound velocity and one reference signal, typically the lateral wave or the back wall echo.

Scan Axis

This area contains option buttons used to select the scan axis orientation relative to the ultrasonic beam projection: **Parallel to beam** or **Perpendicular to beam**.

TOFD Primary Value

Reference cursor position

This box defines the real (true depth) reference cursor position in millimeters (mm) or inches (in.).

Probe separation

This box defines the distance between the probe exit points in millimeters (mm) or inches (in.). This distance is always measured along the component surface.

Sound velocity

This box defines the material sound velocity in meters per second (m/s) or inches per microsecond (in./µs).

Wedge delay

This box defines the probe wedge delay in microseconds (µs).

3.6.1.2 Lateral Wave Processing Parameters

The **Lateral wave processing** area (see Figure 3-13 on page 110) contains the following options:

Reference position

This box indicates the position, on the scan axis, of the selected reference A-scan.

Set Reference

This button sets the reference A-scan defined by the reference cursor position.

Complete visible image

When this option is selected, the processing is done on the complete image.

Slice between ref. and meas. cursors

When this option is selected, the lateral wave synchronization, or lateral wave removal, is performed on the A-scans enclosed between the reference and the measurement cursors on the displayed Side (B) view.

LW Removal

This button performs the lateral wave (LW) removal process on the data group in the active view, and creates a new data group containing the processed data.

LW Synchronization

This button performs the lateral wave synchronization process on the data group in the active view, and creates a new data group containing the processed data.

3.6.1.3 Focalization Process Parameters

The **Focalization process** area contains the following elements:

Aperture size

This box indicates the aperture of the SAFT algorithm, which is the total number of A-scans used to calculate the processed A-scan. The value is always odd, and is determined by the position of the cursors on the active Side (B) view.

SAFT

This button performs the SAFT (synthetic aperture focusing technique) algorithm.

3.6.2 Performing TOFD Calibration in Analysis Mode

This section provides a description on how to use the TOFD calibration of the TOFD Manager component in Analysis mode. For information on how to perform TOFD calibration in Setup mode, refer to the FocusPC *User's Manual*.

To perform a TOFD calibration in Analysis mode

1. Open a data file (.fpd).
2. Display a Side (B) view.
3. Position the reference cursor at the start of the lateral wave signal.
4. Position the measurement cursor at the start of the back wall signal.
5. On the **View Properties > Units** dialog box, in the **Type** list of the **USound** axis, select **TOFD**.
6. On the Component toolbar, click the **TOFD Manager** button (
).

7. In the **TOFD Manager** dialog box (see Figure 3-13 on page 110), select the appropriate options, and then enter the appropriate values (see "TOFD Manager Dialog Box" on page 110).

NOTE

If you select the **Compute velocity and wedge delay** option button in the **What do you want to compute** area of the **TOFD** dialog box, the measurement cursor has to be positioned on a second reference signal (for example, a lateral wave).

---

8. Click **OK**.

   The ultrasonic axis is now calibrated in Analysis mode.

3.6.3 Performing Data Processing of TOFD Files

IMPORTANT

Although the functionality and mathematical correctness of all processing algorithms have been thoroughly checked and validated, no guarantees in terms of flaw detection and sizing performances can be given. The performance enhancement provided by a processing algorithm is definitely related to the specificity of each application, and is therefore the responsibility of the user.

3.6.3.1 Lateral Wave Synchronization

This section describes how to synchronize the lateral wave of a TOFD group.

IMPORTANT

Calibrate the TOFD group prior to applying the lateral wave synchronization algorithm.

To synchronize the lateral wave of a TOFD group

1. Open a data file (.fpd).

2. Select the Side (B) view on which you want the lateral wave synchronization to be applied.
3. In the Side (B) view, position the reference (red) cursor to select a reference A-scan in an unflawed zone (see Figure 3-15 on page 115).
4. In the Side (B) view, position the ultrasonic reference cursor and the ultrasonic measurement (blue) cursor on either side of the lateral wave signal (see Figure 3-15 on page 115). Appropriate setting of the cursors determines the result of the operation.

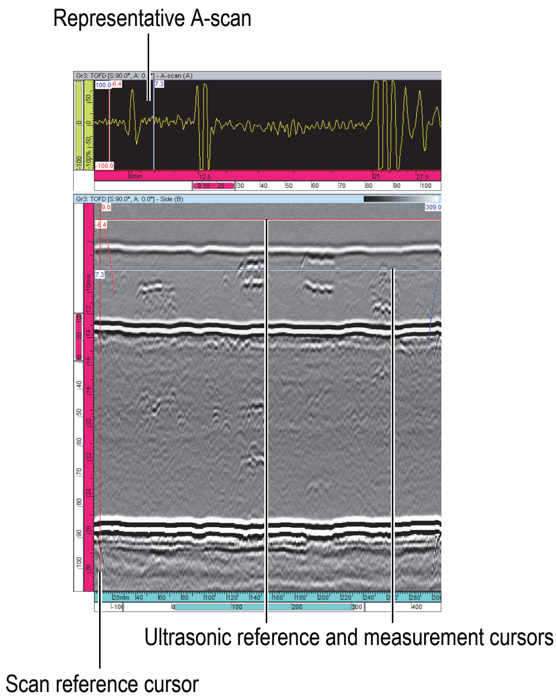


Figure 3-15 Selection of a reference A-scan

5. In the **TOFD Manager** dialog box, in the **Lateral Wave Processing** area, click **Set Reference**.

   By default, the lateral wave synchronization is applied to the **Complete visible image**, but alternatively, the **Slice between Ref. and Meas. cursors** option can be selected if appropriate for the considered TOFD data.

6. Click **LW Synchronization**.

7. Click (Add View Content) and display the newly created **LWS**. The lateral wave is now synchronized (see Figure 3-16 on page 116).

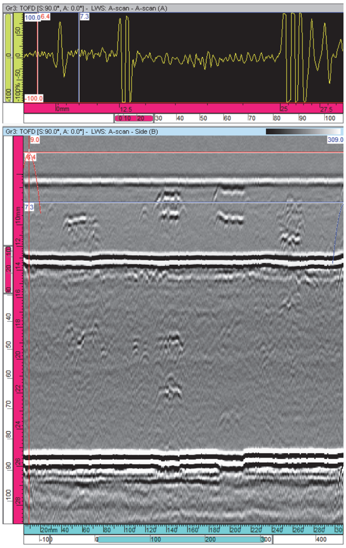


Figure 3-16 TOFD data after lateral wave synchronization

3.6.3.2 Lateral Wave Removal

This section describes how to remove the lateral wave of a TOFD group.

IMPORTANT

In order to obtain usable results from the lateral wave removal algorithm, it is mandatory to apply the algorithm to previously synchronized data.

To remove the lateral wave of a TOFD group

1. Click (Add View Content) and display the lateral wave synchronized data.

2. In the Side (B) view, position the scan reference (red) cursor to select a reference A-scan in an unflawed zone (see Figure 3-17 on page 117). If the selection of the reference A-scan is correctly performed prior to the lateral wave synchronization, this operation does not need to be repeated.
3. In the Side (B) view, position the ultrasonic reference cursor (red) and the ultrasonic measurement cursor (blue) on either side of the lateral wave (see Figure 3-17 on page 117). If the lateral wave signal shows a lot of variation, it is important to position the cursors around the first oscillation of the lateral signal.

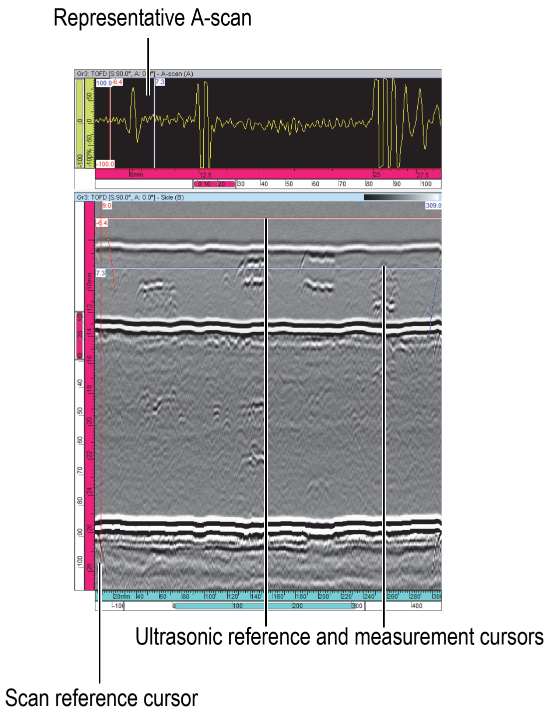


Figure 3-17 Selection of reference A-scan

4. In the **TOFD Manager** dialog box, in the **Lateral wave processing** area, click **Set Reference**.

By default, the lateral wave removal is applied to the **Complete visible image**, but alternatively the **Slice between Ref. and Meas. cursors** option can be selected if appropriate for the considered TOFD data.

5. Click **LW Removal**.

6. Click  (Add View Content) and display the newly created LWR. The lateral wave is now removed (see Figure 3-18 on page 118).

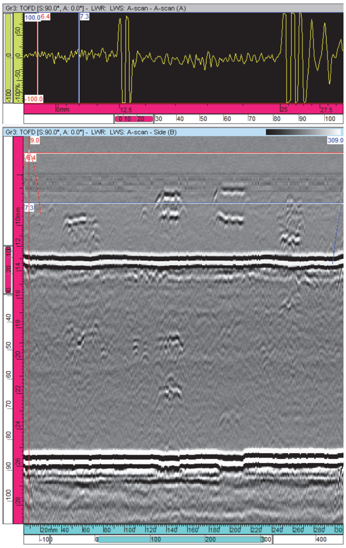


Figure 3-18 TOFD data after lateral wave removal

3.6.3.3 SAFT Processing

The synthetic aperture focusing technique (SAFT) is a computer enhanced imaging technique for the detection and characterization of discontinuities. The technique takes advantage of the nonlinear phase shift of a reflection as a discontinuity is linearly scanned. Improved lateral resolution and a higher signal-to-noise ratio are achieved by using this phase shift, mathematically simulating the focusing of an ultrasonic lens that is focused on every point in an inspected part.

IMPORTANT

The SAFT algorithm can be applied either to raw TOFD data or to processed TOFD data. It is the responsibility of the data analyst to select the best combination for a given application.

To apply the SAFT algorithm

1. Select the Side (B) view on which you want to apply the SAFT algorithm.
2. In this Side (B) view, perform the following procedure in order to select the adequate aperture to be used for the SAFT algorithm:
   a) Zoom in on a zone of interest containing a punctual TOFD indication (see Figure 3-19 on page 120), showing the typical parabolic shape.
   b) Position the reference and measurement cursors on either side of the flight-time minimum of the indication, so that the indication remains clearly visible at the selected scan axis positions; the SAFT algorithm tends to smooth out and eventually erase indications if too large an aperture is used.

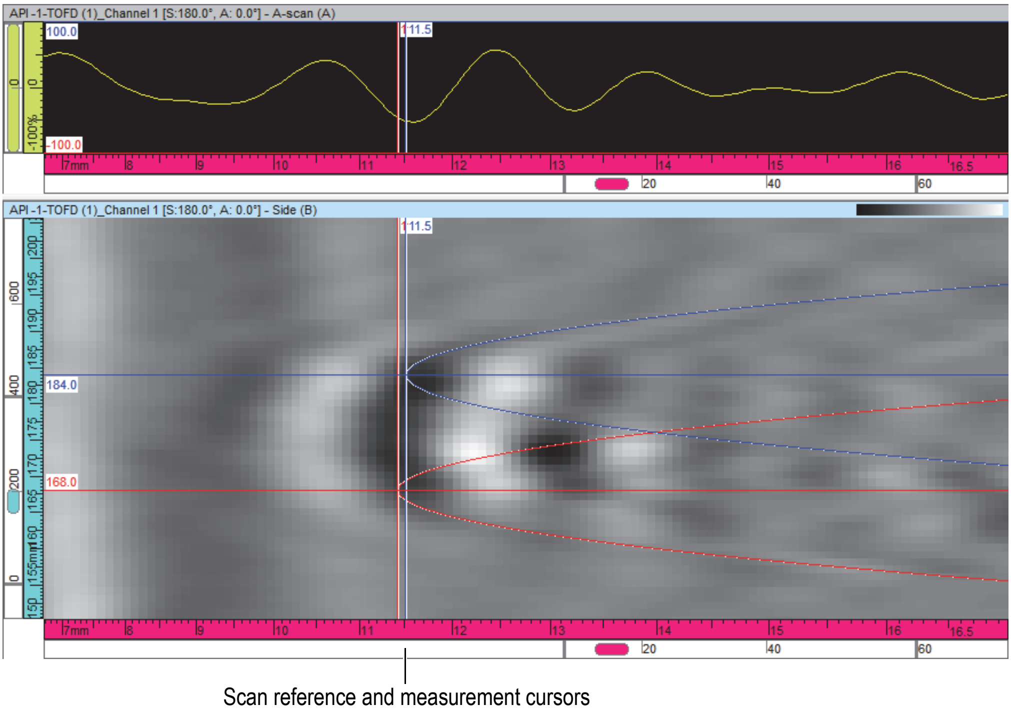


Figure 3-19 Definition of the aperture

3. The SAFT aperture as defined by the positions of the cursors is displayed in the **TOFD Manager** dialog box, in the **Focalization process** area.
4. In the **TOFD Manager** dialog box, in the **Focalization process** area, click **SAFT**.
5. Click (Add View Content) and display the newly created SAFT.
   The SAFT algorithm has been applied (see Figure 3-20 on page 121).

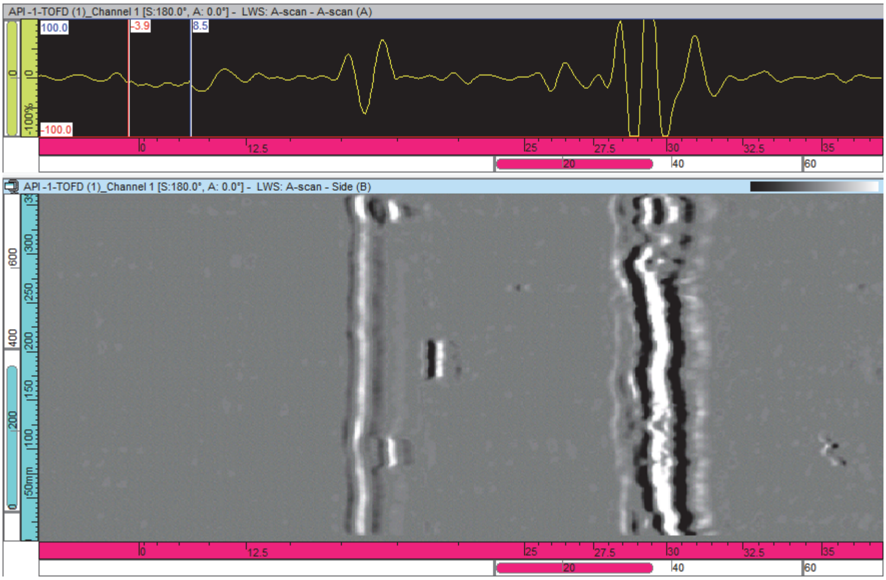


Figure 3-20 Overview of a SAFT ultrasonic image

As the SAFT algorithm involves averaging, which tends to smooth out high amplitudes, the use of a higher **Software Gain** value could be helpful to optimize the visualization of the processed data.

3.7 C-Scan Merge Process

In the Analysis mode, you can use the C-scan merge component to merge C-scan data acquired with various groups and/or beams.

The merge process compares the minimum amplitude, the maximum amplitude, or the minimum position obtained at each point of the inspected part acquired by the considered groups and/or beams. It then creates a new data group with the above mentioned criterion. FocusPC also saves the created merged data in the Attributes file (.A01).

With the C-scan merge component, you can do the following:

- Merge multiple C-scan images from different data files (see Figure 3-21 on page 122).
- Merge C-scan images from different gates (even if you modified the gate position and length). This can be used for multilayered parts with bonding (see Figure 3-22 on page 123).
- Merge Amplitude C-scans and preserve maximum amplitude (for indication detection) or minimum amplitude (for back wall attenuation monitoring).
- Merge minimum position C-scans.

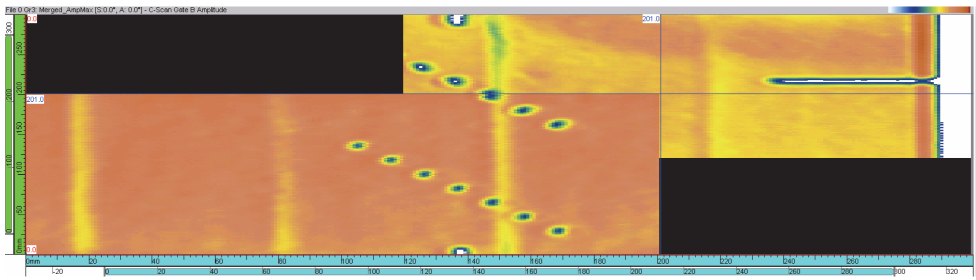


Figure 3-21 Example of two merged files

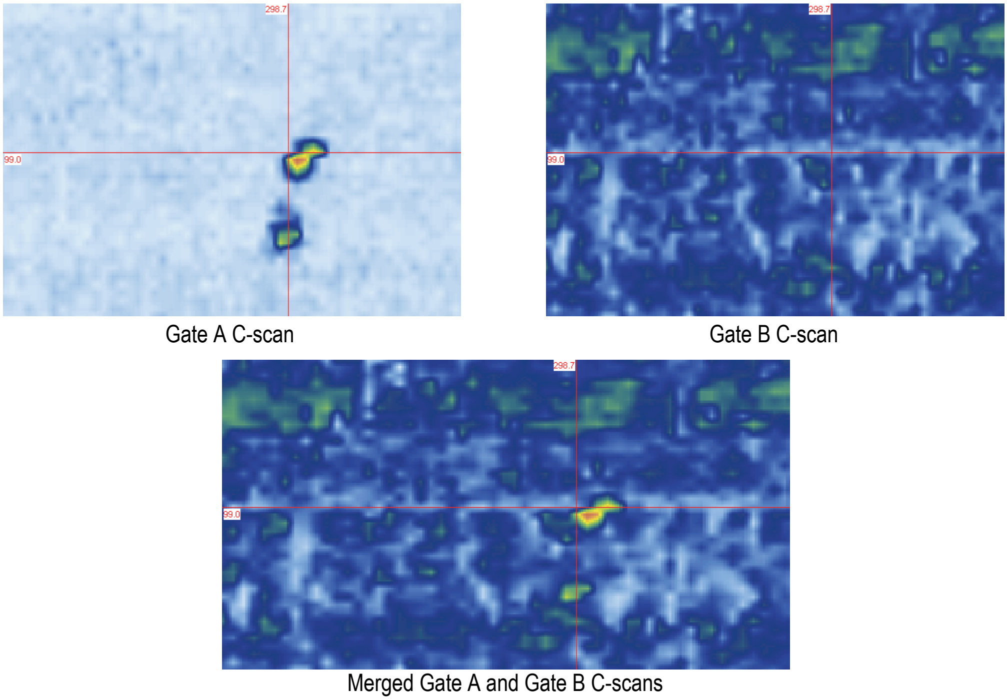


Figure 3-22 Gate A and Gate B C-scan merging example

To merge C-scan data

1. Open the file containing the data that you want to merge.
2. On the Component toolbar, click the **C-Scan Merge** button ( ).
3. In the **C-Scan Merge** dialog box (see Figure 3-23 on page 124), select the data groups:
   a) In the **Data Selection** box, select the data that you want to preserve in the merge.
   b) In the **Available data groups** list, hold down the SHIFT key (or CTRL key) and click to select the groups that you want to merge, and then click **Add**.
   The selected groups appear in the **Selected data groups** list.

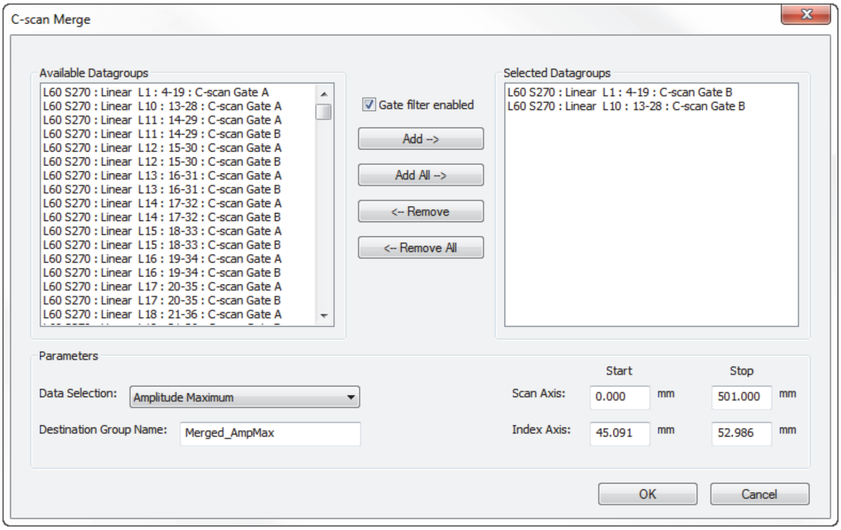


Figure 3-23 Example of the C-Scan Merge dialog box

4. Complete the merge settings:
   a) In the **Scan Axis** and **Index Axis** areas, set the **Start** and **Stop** dimensions for the merge.
   b) In the **Destination Group Name** box, type the desired group name for the merged data.
   c) Click **OK**.
   The merged group is added to the contents.
5. To display the merged group (see Figure 3-24 on page 125), do the following:
   a) Select the view where you want to display the merged C-scan.
   b) On the Component toolbar, click the **Add View Content** button ().
   c) In the **Contents** dialog box, in the list on the left, select the created C-scan merged group.
   d) In the list on the right, double-click the corresponding view to display.
   The selected data appears in the view.
   e) Close the **Contents** dialog box.

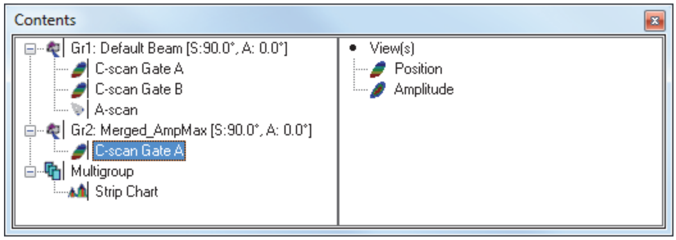


Figure 3-24 Example of the C-scan merge group created

3.8 SNR Analysis Component

FocusPC includes a signal-to-noise ratio (SNR) function. You can use the SNR Analysis Utility to calculate the indication surface area above the noise level.

The SNR function is available in Analysis mode. The SNR function is used for 0-degree inspections, often for aerospace industry parts. You can use the function on Top (C), amplitude C-scan, and position C-scan views.

3.8.1 Using the SNR Analysis Utility

This section contains a step-by-step procedure for using the SNR function in FocusPC.

To use the SNR Analysis Utility

1. Start the SNR Analysis Utility by clicking the **SNR Analysis** button (SNR).

2. On the Component toolbar, select the **Zone** tool ( ), and then draw a rectangle over a zone representing a noise reference area (see Figure 3-25 on page 126).

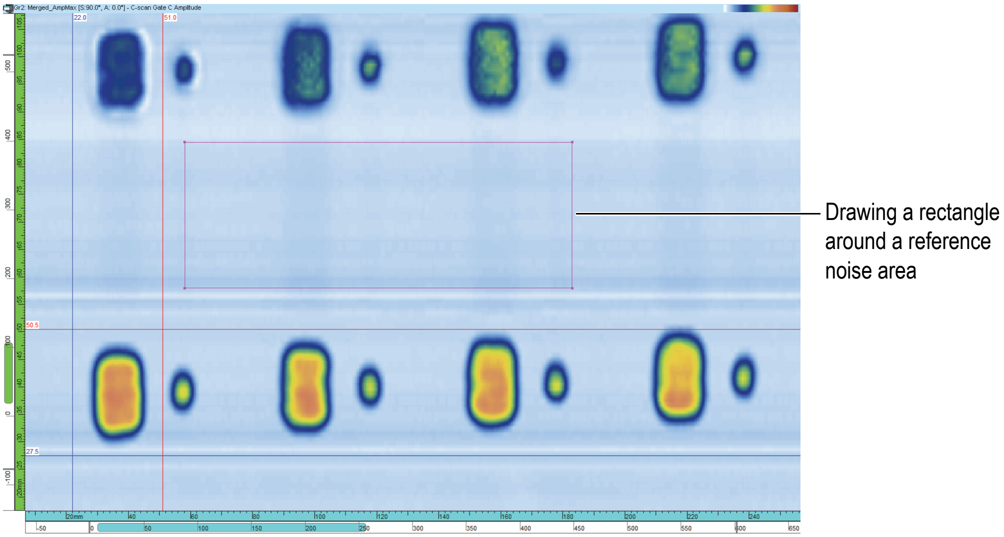


Figure 3-25 Selecting the noise reference area with the Zone tool

3. In the **SNR Analysis Utility** dialog box, click **Retrieve** (see Figure 3-26 on page 127).

   FocusPC calculates the mean and the standard deviation value for the reference area, and displays a distribution chart of the number of pixels as a function of the signal amplitude.

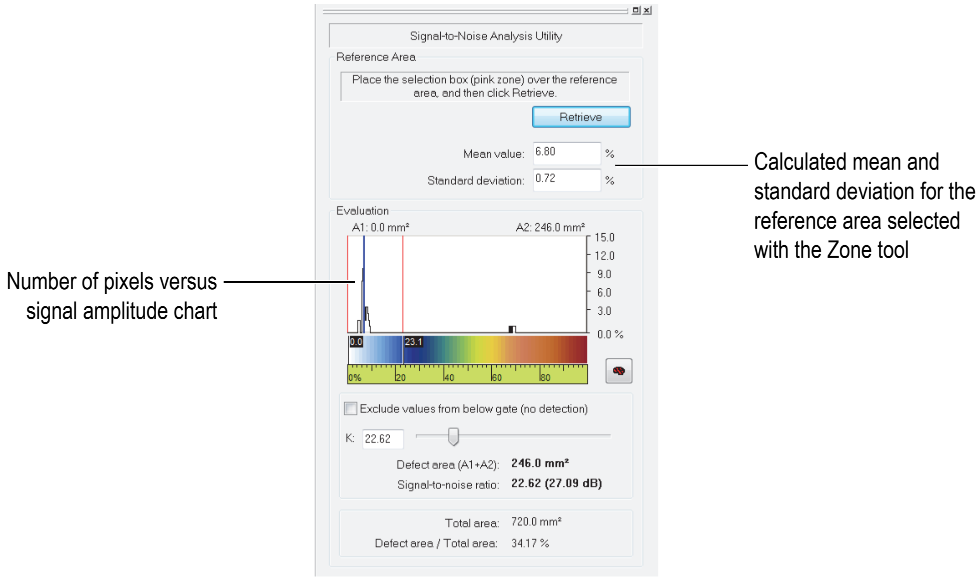


Figure 3-26 Example of reference area analysis results

4. On the C-scan view, move the reference cursor and the measurement cursors around an indication for which you know the area (see Figure 3-27 on page 128).

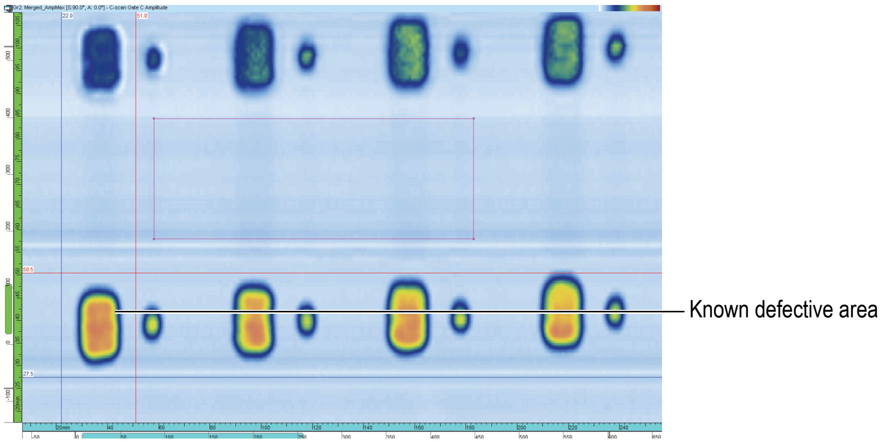


Figure 3-27 Positioning the cursors around the defect area

5. In the **SNR Analysis Utility** dialog box, use the **K** parameter slider to adjust the defect area value so that it corresponds with the known area of the defect (see Figure 3-28 on page 129).

   For this example, if the reference defect area is 246 mm², the *K* value must be **22.62**.

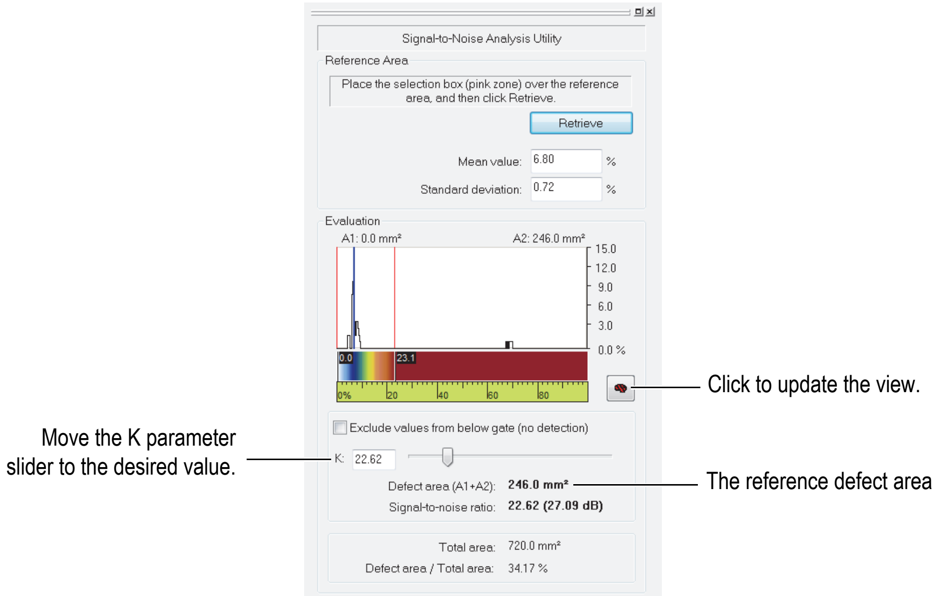


Figure 3-28 Adjusting the *K* value

6. Now that the *K* value has been set on a reference defect, move the cursors to size other indications.

   The defect area value is represented by the set of pixels above the amplitude of the lower threshold or the higher threshold (see Figure 3-30 on page 131).

7. To quickly visualize the defect area, click  to update the C-scan view (see Figure 3-29 on page 130).

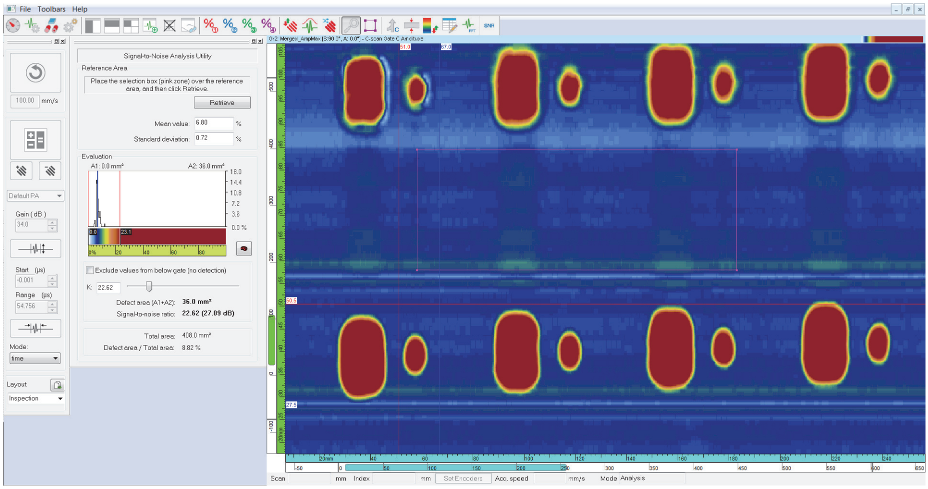


Figure 3-29 Example of SNR analysis

3.8.2 SNR Analysis Conventions

The parameters involved in the SNR calculations are presented in Table 4 on page 130 and are illustrated in Figure 3-30 on page 131.

Table 4 SNR parameters

Parameter	Symbol
Mean value inside reference area	m
Standard deviation inside reference area	σ
Lower threshold	S_{-}
Upper threshold	S_{+}
Lower area (area of amplitude below S_{-})	$A_{-} = A1$
Upper area (area of amplitude above S_{+})	$A_{+} = A2$
Adjustable factor	K

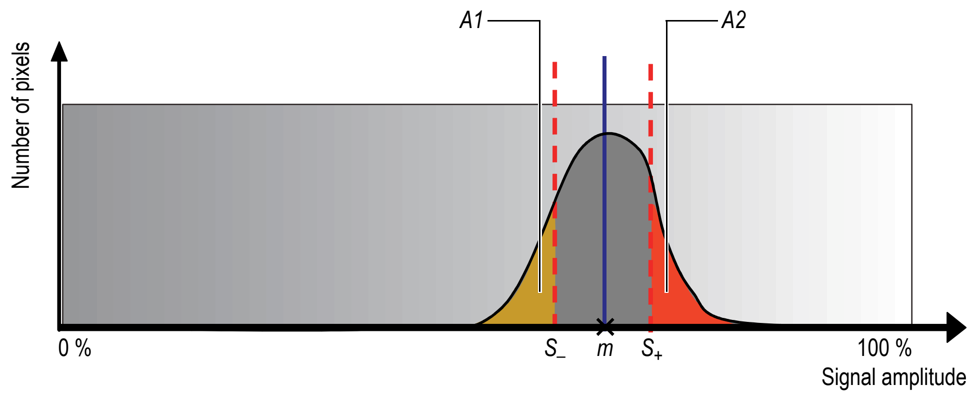


Figure 3-30 The SNR distribution

In Figure 3-30 on page 131, S_- and S_+ are calculated as follows:

$$S_- = m - K \times \sigma$$

$$S_+ = m + K \times \sigma$$

The mathematical expression for the SNR is:

$$\mathrm{SNR} = 20 \times \log(K)$$

The defect area value represents the set of pixels with values above the SNR ratio. The mathematical expression for the defect area is:

$$\text{Defect Area} = A_+ + A_-$$

When the **K** slider is at the maximum left position, the following aspects apply:

- $K = 0$
- The defect SNR is not applicable.
- The defect area is equal to the total area between the reference and measurement cursor positions.

When the **K** slider is at the maximum right position, the following aspects apply:

- The K value is defined as follows:

$$K = max\left[\log\left(\frac{|A_{max} - m|}{\sigma}\right), \log\left(\frac{|m|}{\sigma}\right)\right]$$

where:

A_{max} = 100 % (for an amplitude C-scan)

A_{max} = End of gate position (for a TOF C-scan)

- The defect SNR is defined as follows:

$$\text{Defect SNR} = 20 \times max\left[\log\left(\frac{|A_{max} - m|}{\sigma}\right), \log\left(\frac{|m|}{\sigma}\right)\right]$$

- Defect Area = 0

3.9 Color Palettes

Depending on the application, it can be very helpful to modify the color palette associated with the specific view types in order to make certain types of indications easier to see. This section shows how the FocusPC color palette can be edited.

3.9.1 Modifying Color Palettes

To modify a color palette

1. To open the **Palette Editor** dialog box (see Figure 3-31 on page 133):
   - ◆ In the **View Properties > Palette** dialog box, click **Edit Palette**.

     OR

     Right-click on the active view color palette, and select **Edit Color Palette**.

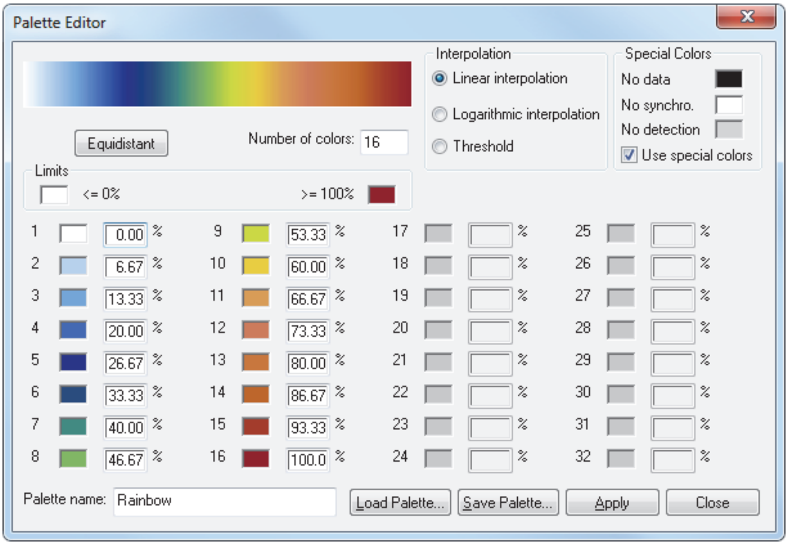


Figure 3-31 The Palette Editor dialog box

2. In the **Palette Editor** dialog box, make the necessary adjustments:
   a) To open an existing palette, click **Load Palette**.
   b) To distribute the thresholds evenly between the colors, click **Equidistant**.
   c) Enter the desired number of colors in the palette in the **Number of colors** box. The number of active boxes will increase or decrease accordingly.
   d) In the **Interpolation** area, select the desired interpolation type from the colors.
   e) To have specific colors highlighted on the display, select the **Use special colors** check box and select colors to be associated with the **No data**, **No synchro**, and **No detection** boxes.
      - **No data** corresponds to locations where no data was acquired because of missed encoder steps, or because the location was outside the inspected volume.
      - **No synchro.** corresponds to locations where no signal crossed gate I (synchronization gate). This color is only effective for synchronization set up on echo.
      - Click the **No detection** box to define the color assigned to locations where no signal crossed the considered gate.

f) To change a color, click on it and select an alternative color using the **Color** dialog box (see Figure 3-32 on page 134).

g) To save the current palette to a **.col** file, click **Save Palette**.

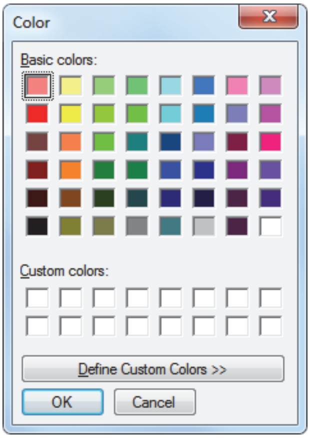


Figure 3-32 The Color dialog box

NOTE

In Setup mode, **Special colors** functions are not applied to the Scrolling B-scan view, Scrolling Strip View (Amp), and Scrolling Strip View (Pos).

---

3. Click **Apply**, and then **Close**.

3.9.2 Optimizing a Color Palette for Corrosion Visualization

Corrosion inspection is a good example of an application where an appropriate color palette configuration can be very useful. This section describes the steps to optimize a color palette for corrosion.

To optimize a color palette for corrosion visualization

1. Select the C-scan view with which you want to visualize the corrosion.
2. In the **Palette Editor**, do the following:

a) Set **Number of colors** to **4**.

b) In the **Interpolation** area, select **Threshold**.

c) Clear the **Use special colors** check box.

d) In the **Limits** area, set the < = **0 %** color to gray and the > = **0 %** color to red.

e) Set **color 1** to green, **color 2** to yellow, **color 3** to orange, and **color 4** to red.

f) Click **Save Palette** and save the current color palette to a **.col** file.

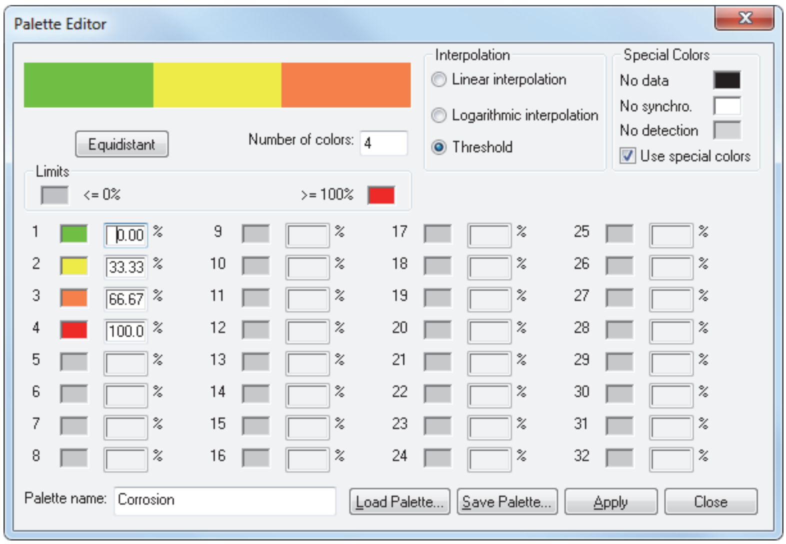


Figure 3-33 Color palette optimized for corrosion visualization

3. In the **View properties > Palette** dialog box, select the **Reverse color order** check box.

4. Click  to open the **Gain Information** dialog box:

   - Adjust the top and bottom color palette cursors to match, respectively, the maximum and minimum corrosion thicknesses of your specimen (see the example in Figure 3-35 on page 136).

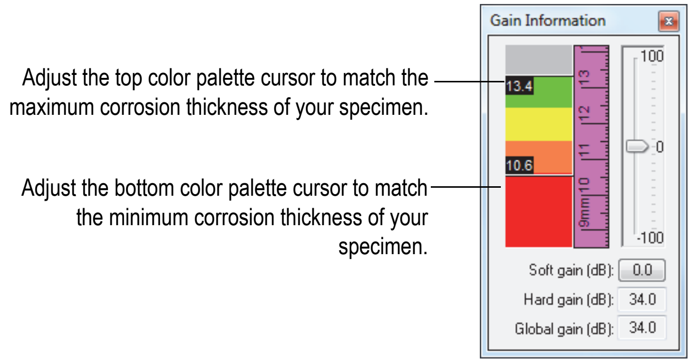


Figure 3-34 Example of palette limits adjusted to specimen corrosion limits

The C-scan pane view should now highlight the corrosion of the specimen, such as in the example in Figure 3-35 on page 136.

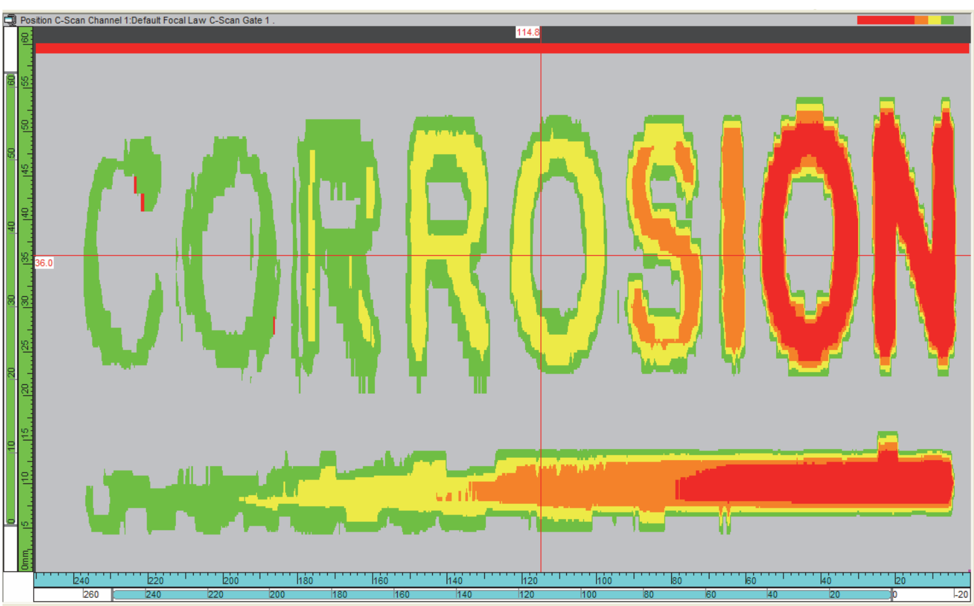


Figure 3-35 Example of corrosion visualization on a demonstration specimen

3.10 Image Analysis Tools

This section provides information on the cursor and zone tools as well as on the display of rebound and overlays.

FocusPC offers powerful tools to facilitate advanced data analysis. Table 5 on page 137 provides a list of these image analysis tools along with their associated buttons and their descriptions.

Table 5 Summary of image analysis tools

Icon	Name	Function
	Split view vertically	Divides the active view into two views with the same vertical dimension
	Split view horizontally	Divides the active view into two views with the same horizontal dimension
	Split view in four	Divides the active view into four views with the same horizontal and vertical dimensions
	Add view content	Opens the **Contents** dialog box, used to select the data view types to be displayed in the active pane
	Delete view	Deletes the active view
	View properties	Opens the **View Properties** dialog box, used to configure the parameters of the active view
	Zoom tool	Select and zoom in a specific region on a view
	Zone tool	Select a region on a top, side, end, or C-scan view by clicking and dragging **Tip**: When the Zone tool is not selected, press and hold the CTRL key, and then click and drag on a view to perform the same task.
	Readings 1	Toggles the display of information group 1 in the active view (by default, readings related to reference cursors)

Table 5 Summary of image analysis tools *(continued)*

Icon	Name	Function
	Readings 2	Toggles the display of information group 2 in the active view (by default, readings related to measurement cursors)
	Readings 3	Toggles the display of information group 3 in the active view (by default, readings related to reference and measurement cursors)
	Readings 4	Toggles the display of information group 4 in the active view (by default, readings related to the Zone tool)
US	US customary units	FocusPC Viewer edition only; changes length measurement units to US customary when pressed.

As shown in the example in Figure 3-36 on page 138, the reference and measurement cursors appear on the various views as horizontal and vertical colored lines on each of the three axes (index, scan, and ultrasonic) to mark a specific data point. The Zone tool appears as a pink rectangle and the 3-D cursor appears as a pink line.

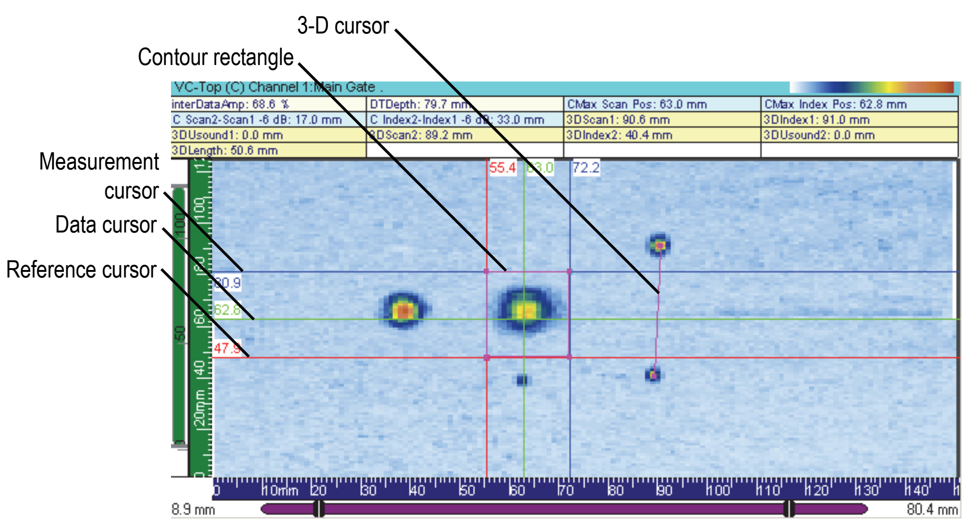


Figure 3-36 Example of cursor and zone tools

3.10.1 Measurement Cursors and Measures

With FocusPC, you can use the reference and measurement cursors on a view to measure the distance along the various axes. Each cursor has a label indicating the current coordinate on the view. You can display cursor parameters values at the top of the view (see “Displaying Cursor Parameters” on page 140).

3.10.1.1 Relationship between Cursors

Two types of relationships can exist between cursors: a fixed gap or a link.

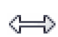
A *fixed gap* is a relationship created between the reference and the measurement cursors for a given view. You can use it to simultaneously move both cursors with a fixed gap between them.

A *link* is a relationship created between cursors of a same type in different views. You can use it to simultaneously move either the reference or the measurement cursors to the same coordinate in two different views.

3.10.1.2 Moving a Cursor with the Mouse

To move a cursor with the mouse

1. Place the mouse pointer over the reference or measurement cursor you want to move.

   The pointer shape changes to  or .
2. Click, drag, and release the cursor onto the new position.

   OR

   Double-click using the left or right mouse button on the desired position to move the reference or measurement cursor directly to the new position.

3.10.1.3 Moving a Cursor with the Keyboard

To move a cursor with the keyboard

1. Select the view on which you want to move the reference or measurement cursors.
2. Use the arrow keys to move the reference cursor.

   OR

Use the arrow keys while holding down the SHIFT key to move the measurement cursor.

The cursors only move on the active view, unless they are linked to other views.

3.10.1.4 Moving Cursors with a Fixed Gap

To move the reference and measurement cursors with a fixed gap

1. Place the reference cursor on a given position.
2. Place the measurement cursor at a distance from the reference cursor corresponding to the gap you want to create.
3. Place the mouse pointer over one of the cursors you want to move with a fixed gap (the pointer shape will change to ⇔ or ⇕).
4. Press the mouse button while holding down the CTRL key and drag the cursors to the new position.

Both reference and measurement cursors will follow each other with the specified gap. The cursors will only move on the active view, unless they are linked to other views.

3.10.1.5 Creating a Link between Cursors

To create a link between cursors

1. Click on the view where you want to create a cursor link.
2. Open the **View Properties > View Linking** dialog box.
3. In the **Linked items** area, select the **Scan/Index cursors** check box.

   The scan and index cursors will automatically move to the same position as will any linked cursor in another view.

3.10.1.6 Displaying Cursor Parameters

As the reference and measurement cursors are often used to take measurements inside the different views, it is very convenient to display the various readings related to these cursors.

To display the cursor parameters

1. Click on the view where you want to display the cursor parameters, and then activate the readings by clicking a Reading button ( ) on the Component toolbar.
2. Double-click on the readings area in the view.
3. In the **Information Groups** dialog box, proceed as follows:
   a) Select the **Group *n* > Favorite Readings** category.
   b) Select the **Reference Cursor (r)**, **Measurement Cursor (m)**, and **Cursors** readings that you want to display.
   c) Click **OK**.

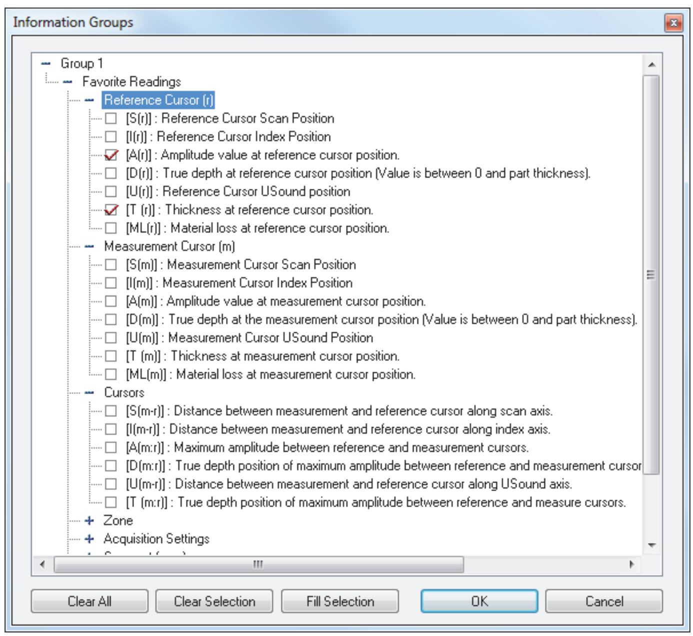


Figure 3-37 The cursor parameters

4. On the View toolbar, click to activate the readings that you have defined for the current view.

3.10.2 Zone Tool

You can use the Zone tool to select a part of an image. A zone is a rectangular shape that can be used on volume-corrected volumetric views (only one zone can be active at a time).

NOTE

Because contours are 3-D measurement tools, they are always linked from one volumetric view to another.

3.10.2.1 Creating a Zone

To create a zone

1. Click on the view where you want to create a zone.
2. On the Component toolbar, click  .
3. Drag and release the mouse button on a view to create the zone, which appears as a magenta-colored rectangle.

3.10.2.2 Resizing a Zone

To resize a zone

1. Click on the view where you want to resize a zone.
2. Place the mouse pointer over the zone corner to be resized until the pointer changes to an oblique arrow ( or ).
3. Drag and release the zone corner using the mouse button until it has reached its arrival point.

   The other zone corners can similarly be moved to resize the zone as desired.

3.10.2.3 Moving a Zone

To move a complete zone

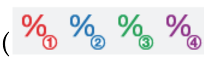
1. Click on the view where you want to move the zone.

2. Place the mouse pointer over one of the zone lines until the pointer changes to a cross ().
3. Drag and release the mouse button to move the zone to its new position.

3.10.2.4 Displaying Zone Parameters

No information group displays the coordinates related to the zone. To display zone parameters, you must first edit an information group.

To display the zone parameters

1. Click on the view where you want to display the zone parameters, and then activate the readings by clicking a Reading button () on the Component toolbar.
2. Double-click on the readings area in the view.
3. In the **Information Groups** dialog box, proceed as follows:
   a) Select the **Group *n* > Favorite Readings** category.
   b) Select the **Zone** readings that you want to display (see Figure 3-38 on page 143).
   c) Click **OK**.

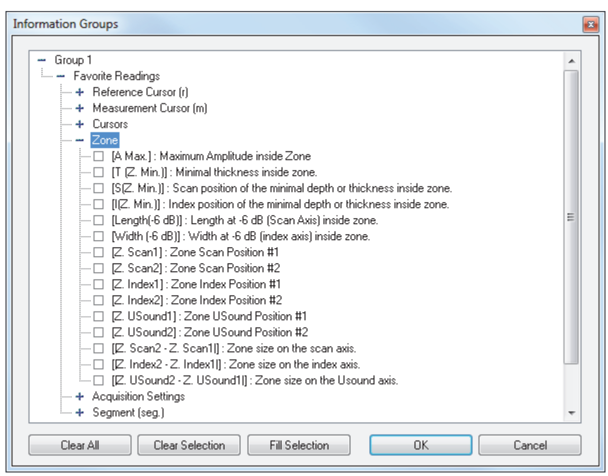
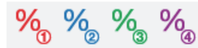


Figure 3-38 The Statistics zone parameters

4. On the View toolbar, click  to activate the readings that you have defined in the current view.

3.11 Cylindrical Correction

This section describes the cylindrical correction tool provided in FocusPC. This section provides details on *Volume Corrected* views (called the **VC-X View**). To set a volumetric view as a Volume Corrected view, right click in the View bar, and select **Set Volume Corrected Display Mode** (see Figure 3-39 on page 144).

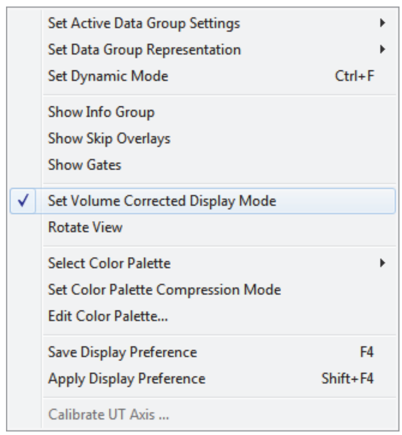


Figure 3-39 The shortcut menu for Set Volume Corrected Display Mode

3.11.1 Description of the Cylindrical Correction Tool

FocusPC software can display various types of information about the active data file and the data views. View information consists of the various view-related parameters, which can be displayed in the upper part of the pane. The information to be displayed is defined in the **Information Groups** dialog box. In FocusPC, all information about the position of indications in a user-defined cylindrical geometry has been organized in the **Cylindrical Correction** group (see Figure 3-40 on page 145).

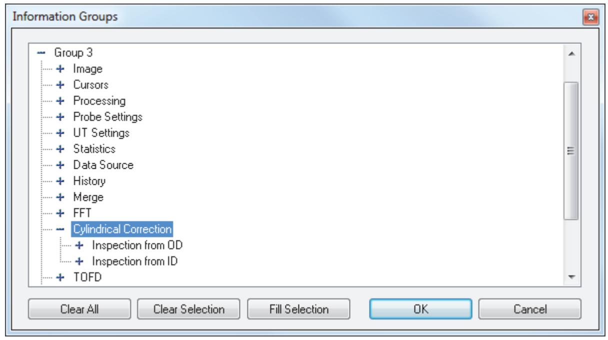


Figure 3-40 The Cylindrical Correction information group

This information group contains the parameters shown in Figure 3-41 on page 145. These parameters provide the position, in the user-defined cylindrical geometry, of a point indicated by the reference cursor and/or the measurement cursor, or by the zone tool.

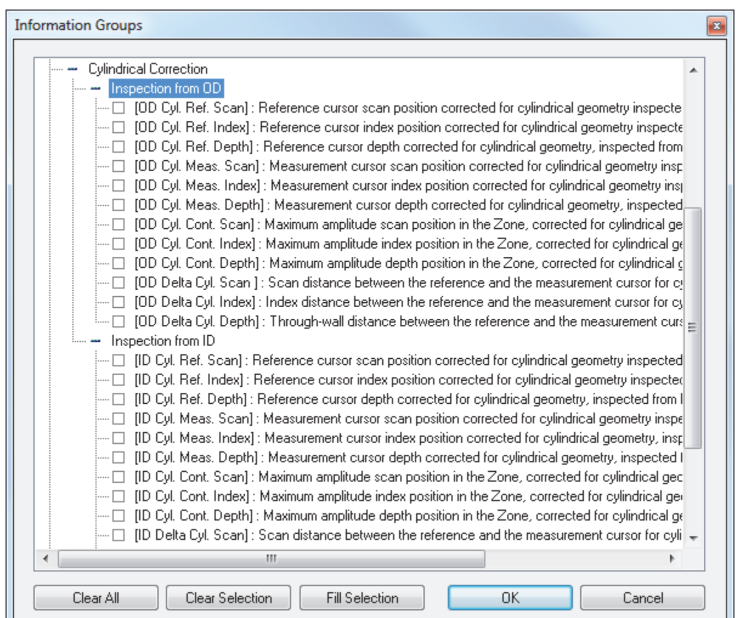


Figure 3-41 The cylindrical correction parameters

Cylindrical correction parameters are available for an inspection conducted from the outside diameter (OD) or from the inside diameter (ID). The feature is applicable for data files that are acquired with scan or index axes calibrated in distance units (millimeters or inches) or rotation units (degrees). In addition, you can convert the units in Analysis mode.

The position of the points is determined by the two cursors, and the distance between the cursors in the user-defined cylindrical geometry can be calculated along the considered axes.

The position of the maximum amplitude within a user-defined zone can be calculated in the user-defined cylindrical geometry.

IMPORTANT

The feature is not relevant for merged views resulting from various focal laws, as the data might be deduced from different refracted angles.

3.11.2 Case of a Skew Angle of 0° or 180°

The cylindrical correction for probe skew angles of 0° or 180° is applicable for all inspection configurations where both the scanning axis and the probe beam are oriented circumferentially, for instance:

- Raster scanning a longitudinal pipe weld to find defects parallel to the weld axis
- Raster scanning a circumferential pipe weld to find defects perpendicular to the weld axis

To obtain the cylindrical correction for the points determined by the reference and measurement cursors

1. Make sure that the reference (red) cursor is present in the Volume Corrected Side (B) view before activating the cylindrical correction.
2. In the VC-Side (B) view, select the applicable information fields (either OD- or ID-related) as follows:
   a) Click to activate the VC-Side (B) view.
   b) Click %③ to display information group 3 in the upper part of the pane.
   c) Double-click the readings area to open the **Information Groups** dialog box.

d) Click **Group 3**, and then **Cylindrical correction**.

e) From the **Cylindrical correction** group, click to select the applicable information check boxes (see example in Figure 3-42 on page 147 showing a selection of OD-related parameters).

f) Click **OK**.

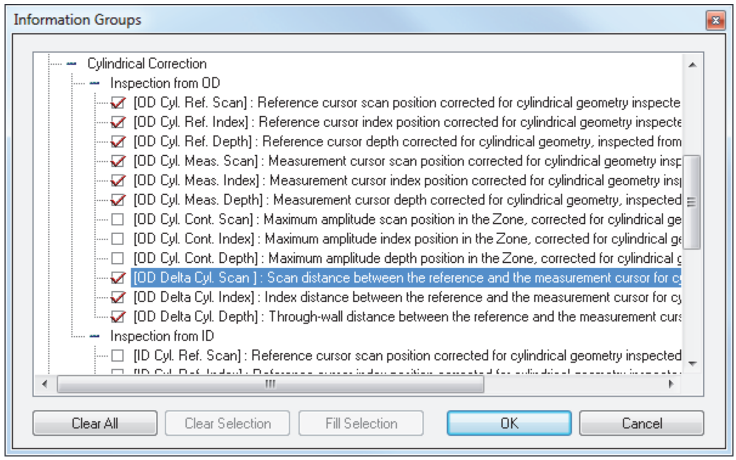


Figure 3-42 Selection of OD-related parameters

3. Click the Part and Material button ().
4. In the **Part Definition** dialog box that appears (see Figure 3-43 on page 148), define the specimen as follows:

a) Click **Cylindrical**.

b) In the **Thickness** box, type the thickness of the considered cylindrical geometry.

c) In the **Outside diameter** box, type the appropriate value for the outside diameter.

d) Under **Cylindrical geometry**, click the **OD** or **ID** option button to specify whether the inspection is performed from the outside diameter or from the inside diameter.

e) Click **OK**.

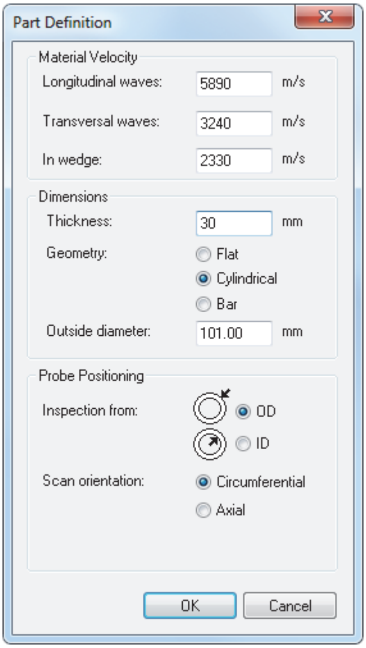


Figure 3-43 The Part Definition dialog box

When the specimen has been defined for one channel or one focal law, it is also applied to all channels or focal laws contained in the considered data file, and it can be saved in the .A01 file upon closing the data file.

- The **OD Cyl. Ref. Scan** and **OD Cyl. Ref. Depth** information fields provide the position (scan and depth axes), in the user-defined cylindrical geometry, of the point determined by the intersection of the horizontal reference (red) cursor and the angled reference (pink) cursor in the VC-Side (B) view, or by the horizontal and the vertical reference (red) cursors in the Side (B) view.
- The **OD Cyl. Meas. Scan** and **OD Cyl. Meas. Depth** information fields provide the position (scan and depth axes), in the user-defined cylindrical geometry, of the point determined by the intersection of the horizontal measurement (blue) cursor and the angled measurement (cyan) cursor in the VC-Side (B) view, or by the horizontal and the vertical measurement (blue) cursors in the Side (B) view.
- The **OD Delta Cyl. Scan** and **OD Delta Cyl. Depth** information fields provide the distance (scan and depth axes), in the user-defined cylindrical geometry, between the points determined by the reference and measurement cursors.

- The provided position information in the cylindrical geometry takes into account multiple rebounds of the ultrasonic beam from both the OD and ID, considering the wall thickness entered by the operator in the **Part Definition** dialog box (see Figure 3-44 on page 149).

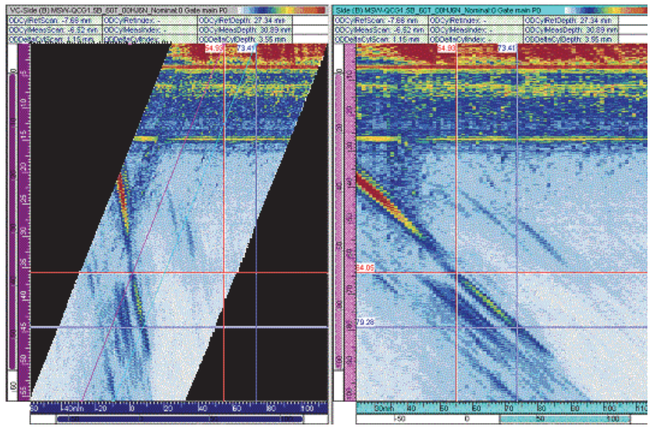


Figure 3-44 Cylindrical correction: example 1

- The provided position information in the cylindrical geometry is displayed in millimeters (or inches) if the scan axis is in distance units, and in degrees (or radians) if the scan axis is in rotation units.

To obtain the cylindrical correction for the position of the maximum amplitude within a user-defined zone

1. Make sure that the reference (red) cursor is present in the VC-Side (B) view before activating the cylindrical correction.
2. In the VC-Side (B) view, select the applicable information fields (either OD- or ID-related) as follows:

   a) Click in the VC-Side (B) view to make it the active view.

   b) Click to display information group 3 in the upper part of the pane.

   c) Double-click the readings area to open the **Information Groups** dialog box.

   d) Click **Group 3**, and then **Cylindrical correction** (see Figure 3-45 on page 150).

e) From the **Cylindrical correction** group, click to select the applicable information check boxes (see example in Figure 3-45 on page 150 showing a selection of OD-related parameters).

f) Click **OK** to close the dialog box.

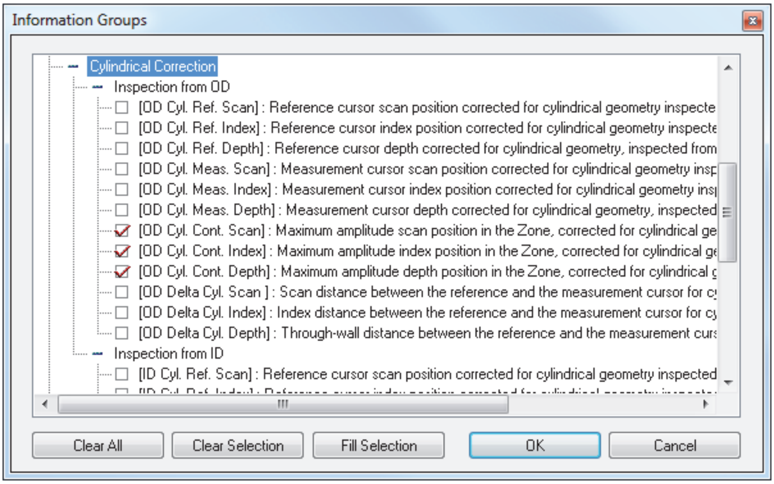


Figure 3-45 Selection of OD-related parameters

3. Position the gate selectors for the ultrasonic axis so that the flaw indication to be sized is located in the gate. (It might also be useful to display the gate cursors in the volume-corrected views.)
4. In the VC-Side (B) view, create a zone containing the considered flaw indication.
5. In the VC-Top (C) view, create a zone containing the considered flaw indication.

   You have now created a volumetric zone defined by the zone created in the top view and the gate selectors on the ultrasonic axis (see Figure 3-46 on page 151). Additionally, the selected parameters in the information group give the position of the maximum amplitude in the zone along the scan and depth axes. The position of the maximum amplitude along the index axis (flat geometry) can be obtained by using the standard parameter **Z. Max. Ampl. Index** from the **Statistics** information group.

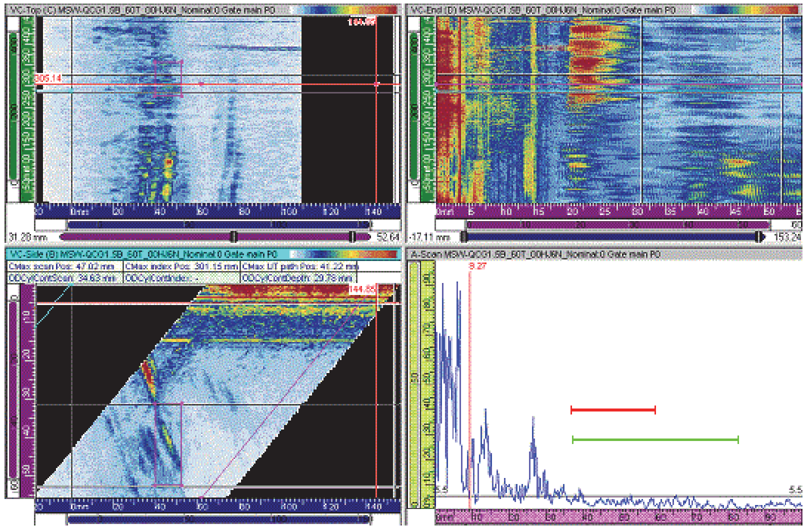


Figure 3-46 Cylindrical correction: example 2

3.11.3 Case of a Skew Angle of 90° or 270°

The cylindrical correction for probe skew angles of 90° or 270° is applicable for all inspection configurations where both the index axis and the probe beam are oriented circumferentially, for instance:

- Raster scanning or line scanning a longitudinal pipe weld to find defects parallel to the weld axis
- Raster scanning or line scanning a circumferential pipe weld to find defects perpendicular to the weld axis

To obtain the cylindrical correction for the points determined by the reference and measurement cursors

1. Make sure that the reference (red) cursor is present in the VC-End (D) view before activating the cylindrical correction.
2. In the VC-End (D) view, select the applicable information fields (either OD- or ID-related) as follows:
   a) Click in the VC-End (D) view to make it the active view.

   b) Click  to display information group 3 in the upper part of the pane.

c) Double-click the readings area to open the **Information Groups** dialog box.

d) Click **Group 3**, and then **Cylindrical correction**.

e) From the **Cylindrical correction** group, click to select the applicable information check boxes (see example in Figure 3-47 on page 152 showing a selection of ID-related parameters).

f) Click **OK**.

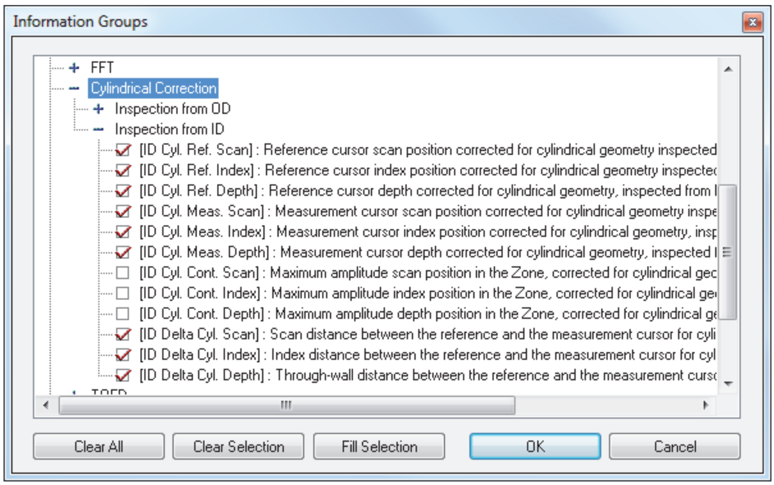


Figure 3-47 Selection of ID-related parameters

3. Click the Part and Material button ().
4. In the **Part Definition** dialog box that appears (see Figure 3-48 on page 153), define the specimen as follows:

a) Click **Cylindrical**.

b) In the **Thickness** box, type the thickness of the considered cylindrical geometry.

c) In the **Outside diameter** box, type the appropriate value for the outside diameter.

d) Under **Cylindrical geometry**, click the **OD** or **ID** option button to specify whether the inspection is performed from the outside diameter or from the inside diameter.

e) Click **OK**.

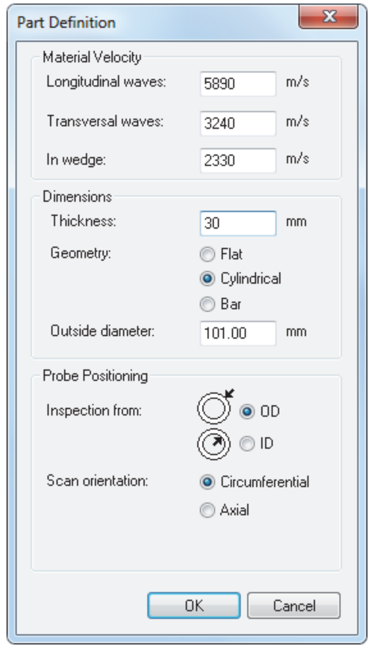


Figure 3-48 The Part Definition dialog box

When the specimen has been defined for one channel or one focal law, it is also applied to all channels or focal laws contained in the considered data file, and it can be saved in the .A01 file upon closing the data file.

- The **ID Cyl. Ref. Index** and **ID Cyl. Ref. Depth** information fields provide the position (index and depth axes), in the user-defined cylindrical geometry, of the point determined by the intersection of the horizontal reference (red) cursor and the angled reference (pink) cursor in the VC-End (D) view, or by the horizontal and the vertical reference (red) cursors in the End (D) view.
- The **ID Cyl. Meas. Index** and **ID Cyl. Meas. Depth** information fields provide the position (index and depth axes), in the user-defined cylindrical geometry, of the point determined by the intersection of the horizontal measurement (blue) cursor and the angled measurement (cyan) cursor in the VC-End (D) view, or by the horizontal and the vertical measurement (blue) cursors in the End (D) view.
- The **OD Delta Cyl. Scan** and **OD Delta Cyl. Depth** information fields provide the distance (index and depth axes), in the user-defined cylindrical geometry, between the points determined by the reference and measurement cursors.

- The provided position information in the cylindrical geometry takes into account multiple rebounds of the ultrasonic beam from both the OD and ID, considering the wall thickness entered by the operator in the **Part Definition** dialog box (see Figure 3-49 on page 154).

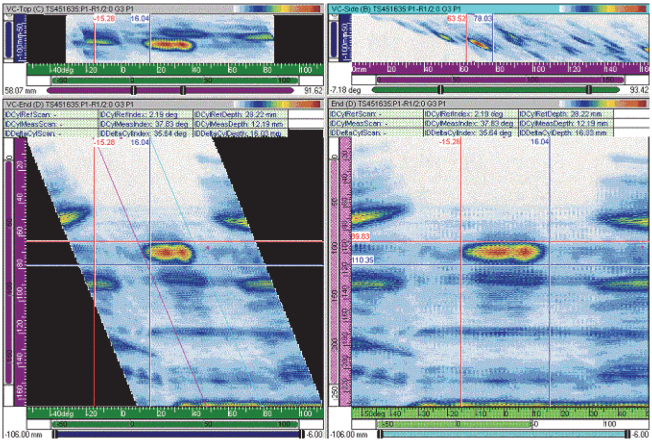


Figure 3-49 Cylindrical correction: example 3

- The provided position information in the cylindrical geometry is displayed in millimeters (or inches) if the index axis is in distance units, and in degrees (or radians) if the index axis is in rotation units.

To obtain the cylindrical correction for the position of the maximum amplitude within a user-defined zone

1. Make sure that the reference (red) cursor is present in the VC-End (D) view before activating the cylindrical correction.
2. In the VC-End (D) view, select the applicable information fields (either OD- or ID-related) as follows:
   a) Click to activate the VC-End (D) view.
   b) Click  to display information group 3 in the upper part of the pane.
   c) Double-click the readings area to open the **Information Groups** dialog box.
   d) Click **Group 3**, and then **Cylindrical correction**.

e) From the **Cylindrical correction** group, click to select the applicable information check boxes (see example in Figure 3-50 on page 155 showing a selection of ID-related parameters).

f) Click **OK**.

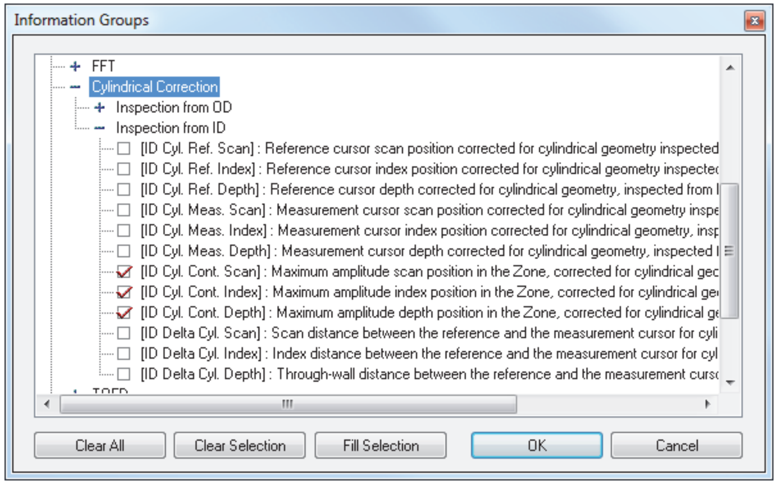


Figure 3-50 Selection of ID-related parameters

3. Position the gate selectors for the ultrasonic axis so that the flaw indication to be sized is located in the gate. (It might also be useful to display the gate cursors in the volume-corrected views.)
4. In the VC-End (D) view, create a contour containing the considered flaw indication.
5. In the VC-Top (C) view, create a contour containing the considered flaw indication.

   You have now created a volumetric contour defined by the contour created in the top view and the gate selectors in the ultrasonic axis (see Figure 3-51 on page 156); the selected parameters in the information group give the position of the maximum amplitude in the contour along the index and depth axes. The position of the maximum amplitude along the scan axis (flat geometry) can be obtained by using the standard parameter **Z. Max. Ampl. Scan** from the **Statistics** information group.

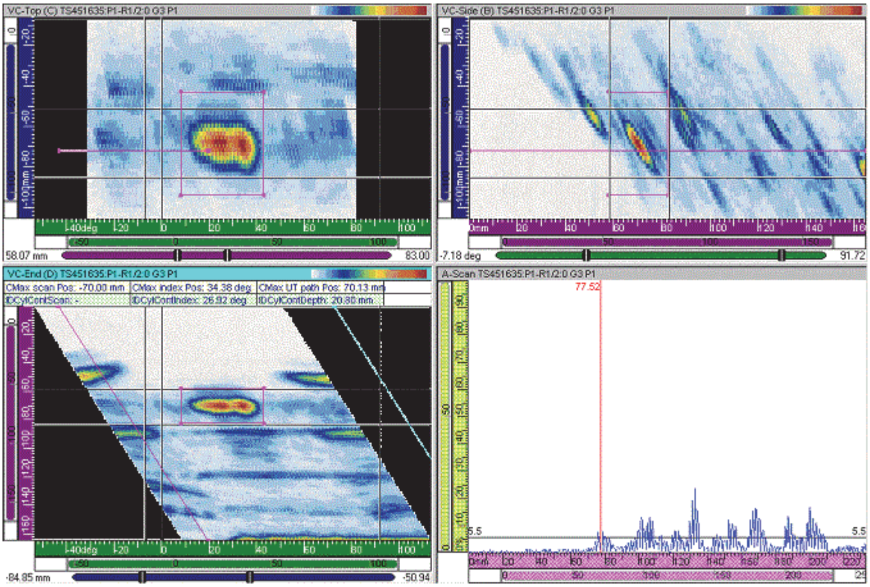


Figure 3-51 Cylindrical correction: example 4

3.11.4 Using Cylindrical Corrections

For the inspection of cylindrical parts, the Calculator takes into account the cylindrical corrections of the beams so that the readings of depth and index values are valid. The reading of depth (ODCylRefDepth) is taken perpendicularly to the tangent external surface of the part, and the reading of the index (ODCyRefIndex) is taken along the circumference of the external surface of the part (see Figure 3-52 on page 157).

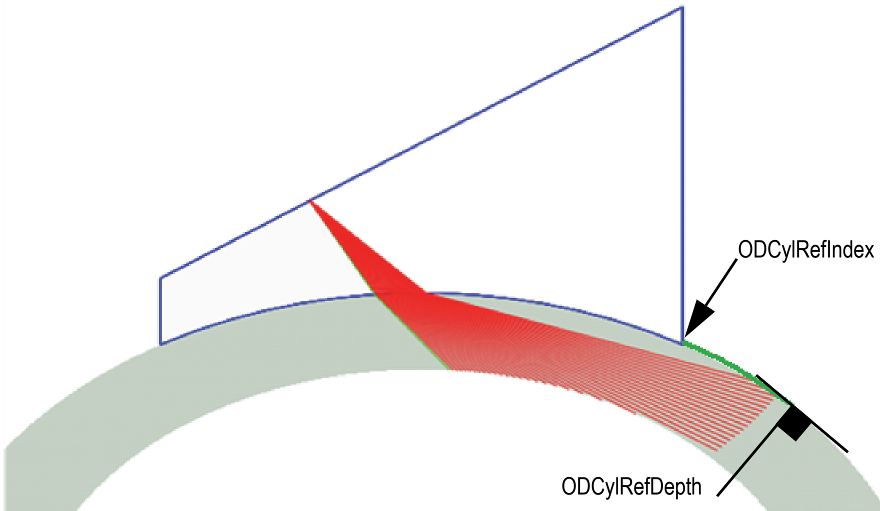


Figure 3-52 Reading of depth and index for a cylindrical part

3.11.5 Calibrating the Wedge

Before performing the inspection of a cylindrical part, you need to configure the Calculator with the appropriate part and wedge dimensions. To achieve this, you need to calibrate both the height of the first element of the probe and the wedge angle. This calibration compensates for inaccurate nominal wedge dimensions or wedge wear. Calibrate the wedge using a linear scan at 0 degrees, oriented towards the center of the cylinder. The interface echo of a correctly calibrated wedge appears at 0 mm depth anywhere along the probe.

To calibrate the wedge

1. On the **1-D Linear array** tab of the Calculator (see Figure 3-53 on page 158), perform the following configuration steps:
   a) In the **Scan Type** box, select **Linear**.
   b) In the **Beam angles selection** area, select **Refracted angle (deg)**, and then set the **Start** value to 0.0.
   c) In the **Elements Selection** area, set the **Stop** parameter to the following value:

   Number of elements on primary axis value − **Primary axis aperture** value + 1 *d)* In the **Wedge** area, set the nominal values specified for your wedge.

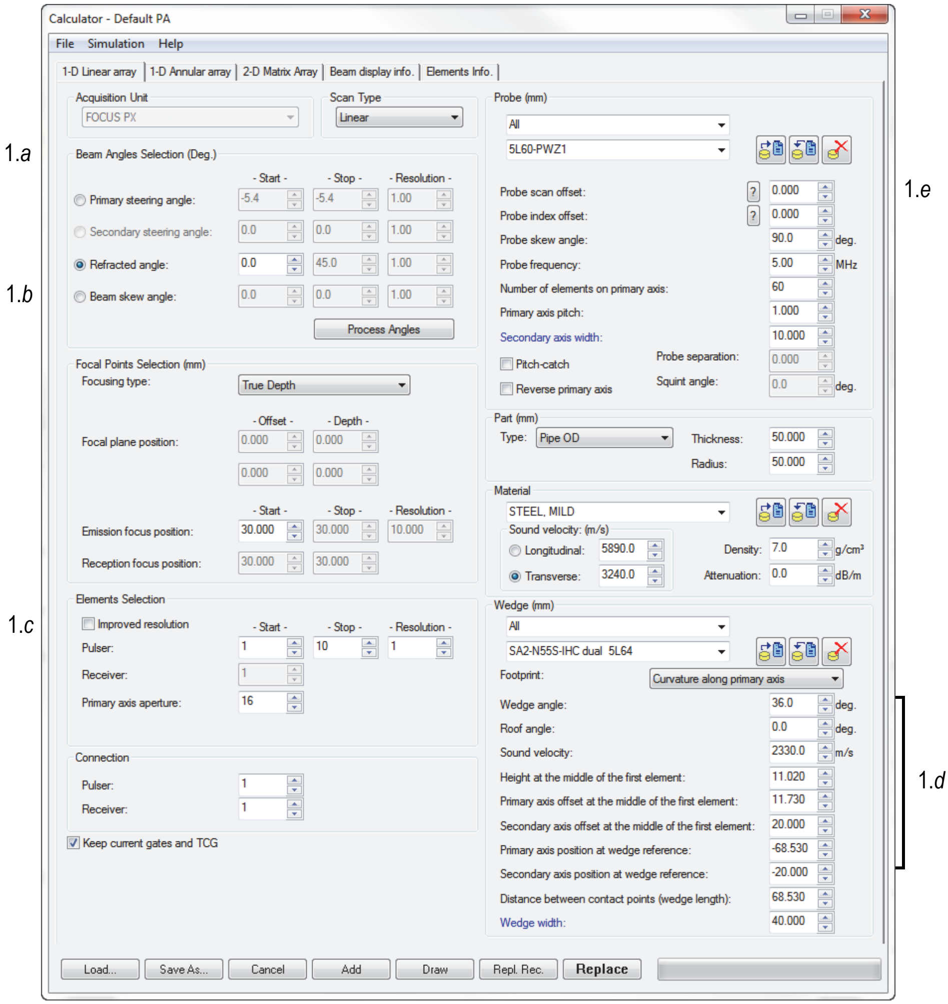


Figure 3-53 Parameters for wedge calibration

e) In the **Probe** area, set the **Probe index offset**.

Measure the probe index offset along the circumference of the outside diameter of the part, as shown in Figure 3-54 on page 159, not along a straight line. The **Probe index offset** value is negative when the **Probe skew angle** is 90°, and is positive when the **Probe skew angle** is 270°.

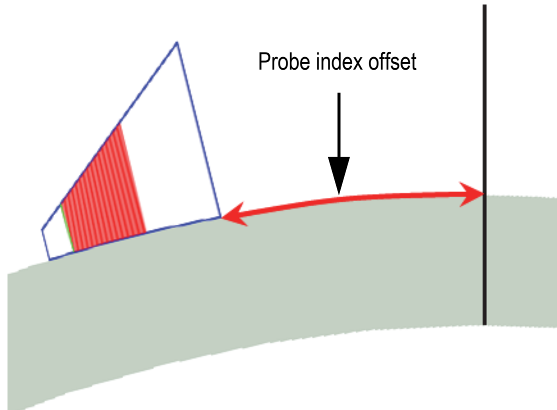


Figure 3-54 Measurement of the probe index offset

2. Click **Save As** to save the focal laws.
3. In FocusPC, load the focal law that you just saved, and examine the interface echo.

   A interface echo of correctly calibrated wedge should appear exactly at 0 mm depth anywhere along the probe, as shown in the example of Figure 3-55 on page 160. If this is the case for your application, you do not need to continue this procedure.

   If the wedge needs calibration, the interface echo does not appear exactly at 0 mm depth anywhere along the probe (as shown in the example of Figure 3-56 on page 160), and the echo line around 0 mm in the sectorial scan is not horizontal.

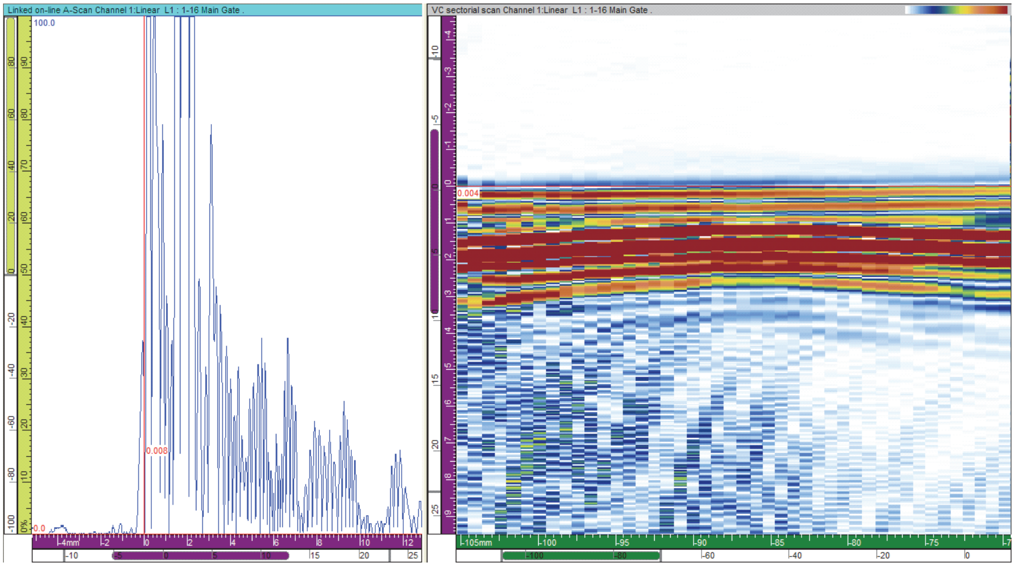


Figure 3-55 Example of the interface echo for a correctly calibrated wedge

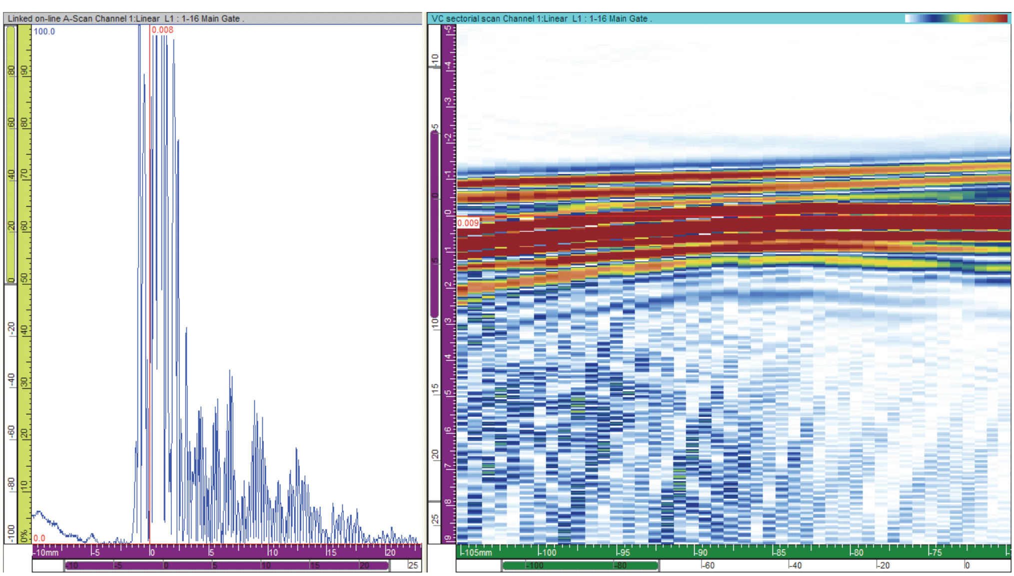


Figure 3-56 Example of the interface echo for a wedge needing calibration

4. If your wedge needs calibration, select the **1-D Linear array** tab in the Calculator.
5. In the **Wedge** area, adjust the values for both the **Wedge angle** and the **Height at the middle of the first element** to better represent the real dimensions of the wedge.
6. Repeat steps 2 to 5 until the interface echo line is exactly at 0 mm depth anywhere along the probe as shown in the example of Figure 3-55 on page 160.

3.11.6 Analyzing Cylindrical Readings in FocusPC

In FocusPC, you can analyze the cylindrical readings for sectorial and linear scans.

To analyze cylindrical readings for sectorial scans

1. Open the data file to be analyzed.
2. See Figure 3-57 on page 162 and perform the following actions:
   a) In the **VC sectorial scan** view, select the desired focal law to display and position the reference cursor.
   b) In the **Linked VC-END (D)** view, read the cylindrical correction values.

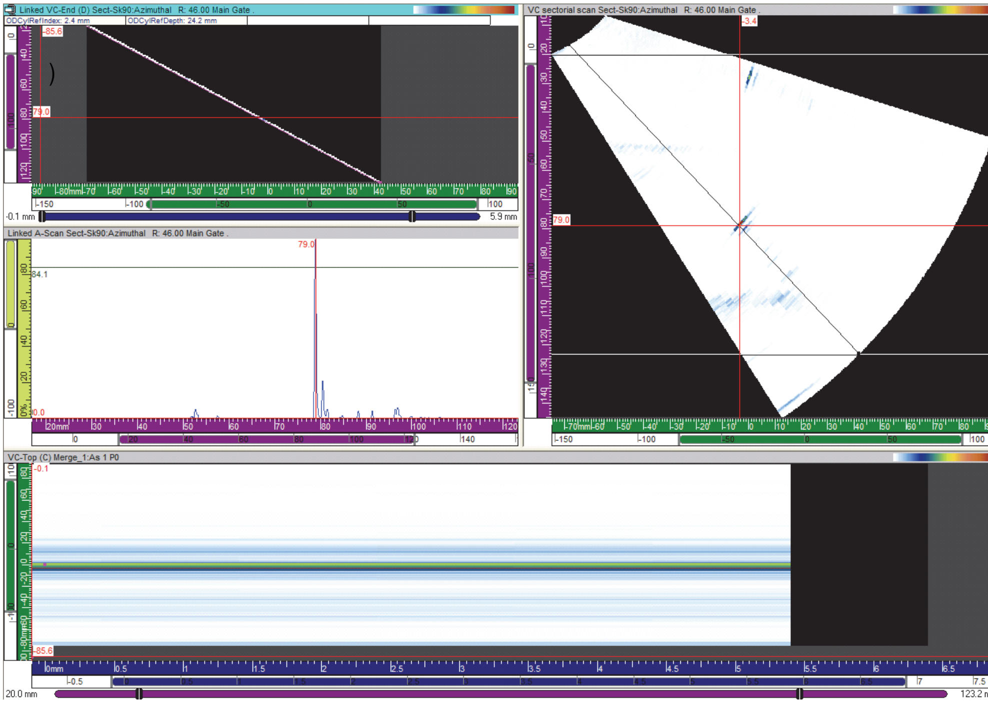


Figure 3-57 Analyzing cylindrical readings for a sectorial scan

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NOTE

Do not use merged or Polar views to measure cylindrical values.

To analyze cylindrical readings for linear scans

1. Open the data file to be analyzed.
2. See Figure 3-58 on page 163 and perform the following actions:
   a) Set the reference cursor at the probe index position to correctly display the A-scan.
   b) In the **VC-END (D)** view, read the cylindrical correction values.

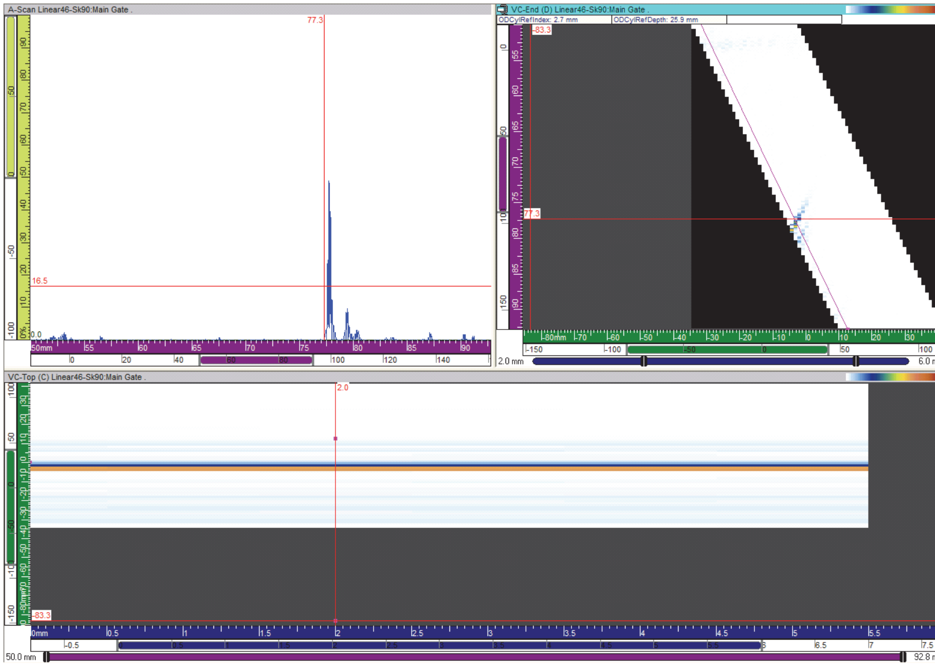


Figure 3-58 Analyzing cylindrical readings for a linear scan

NOTE

Do not use merged or Polar views to measure cylindrical value.

3.12 Export Data Utility

This section describes how to use the **Export Datagroup** features to export A-scan and C-scan data to a simple text file format, which can be read with Microsoft Excel.

To export a data group

1. Open a data file.

2. Position the reference and measurement cursors on views to determine the volume of the recorded data to be exported.
3. In the menu, select **File > Export Datagroup to File** (see Figure 3-59 on page 164).

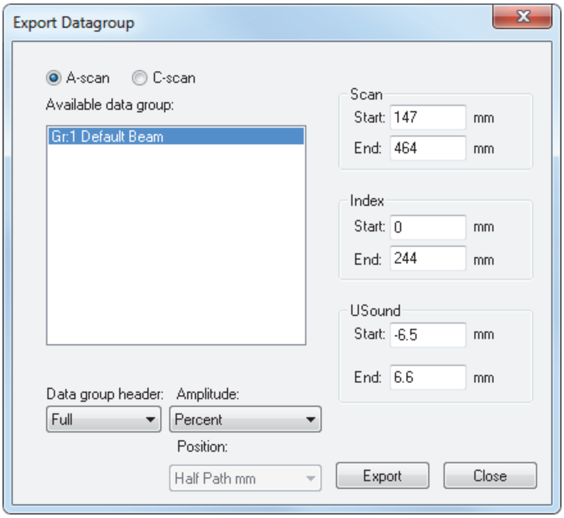


Figure 3-59 The Export Datagroup dialog box

4. In the **Export Datagroup** dialog box, select from **A-scan** or **C-Scan** data, depending on what you want to export (this will modify the **Available data group** list according to contents of the data file).
5. Select the data that you want to export in the **Available data group** list.
6. Adjust the **Start** and **End** values of the **Scan**, **Index**, and **USound** parameters to determine the data volume to export.
7. Set the **Data group header** to determine the header format that will be added to the exported data.
8. Select if you want to have the **Amplitude** data exported as **Percent** or as **Raw** data.
9. If exporting C-scan data, select the format of the **Position** data.
10. Click **Export**.
11. Select a name and location for the exported file and click **Save**.

The data is exported in the following formats:

For A-scan

- 1st line

  A-scan amplitude data at **Scan Start**, **Index Start** position

- 2nd line

  A-scan amplitude data at **Scan Start** + 1, **Index Start** position

- 3rd line

  A-scan amplitude data a **Scan Start** + 2, **Index Start** position

  IndexQTY + 1st line

  A-scan amplitude data at **Scan Start**, **Index Start** + 1 position

  IndexQTY + 2nd line

  A-scan amplitude data at **Scan Start** + 1, **Index Start** + 1 position

For C-scan

- 1st line

  C-scan data of line along the scan axis, at index position **Index Start**

- 2nd line

  C-scan data of line along the scan axis, at index position **Index Start** + 1

- 3rd line

  C-scan data of line along the scan axis, at index position **Index Start** + 2

NOTE

The values are delimited by the TAB key (ASCII character code: 9).

3.13 Configuring Links between FocusPC Elements

With FocusPC, you can link the behavior of elements. For example, moving a cursor in one view automatically moves the same linked cursor in another view.

You can set the general link configuration for all views in the **Link** tab of the **Preferences** dialog box (see “Linking Tab” on page 93). You can also customize the link configuration for a specific view.

To set the general link preferences

1. On the menu, select **File > Preferences**.
2. Select the **Linking** tab.
3. In the two-column list on the left, select the element for which you want to configure the linking behavior.
4. For cursor and ruler items, choose the following settings:
   a) Under **Uncorrected Views**, select the desired linking behavior to be applied for all uncorrected views.
   b) Under **Corrected Views**, select the desired linking behavior to be applied for all corrected views.
5. For the other elements, select the desired linking behavior to be applied for all views.

TIP

You can press the F4 shortcut key to save view preferences to the display setup (.rst) file or SHIFT+F4 to load view preferences from the display setup file.

3.14 Fast Fourier Transforms (FFT) Component

The Fast Fourier Transform (FFT) tool can be used to determine the spectral components of the signal received by an ultrasonic transducer. The FFT tool can be used at any time. However, to use the FFT tool in Analysis mode, it requires data files that have been acquired using the settings detailed below (see Figure 3-60 on page 167).

To configure a setup for the FFT component

1. On the **Pulser/Receiver** tab of the **UT Settings** dialog box, set **Rectification** to **RF**.
2. On the **Digitizer** tab of the **UT Settings** dialog box, set **Compression** to **1**.
3. In the **Scan and Mechanical Settings** dialog box, in the **Scan** tab's **Type** box, set the Scan mode to **Free running**.
4. On the Component toolbar, click  (FFT).
5. In an A-scan view, place the reference and measurement cursors around the portion of the signal that you want to analyze.

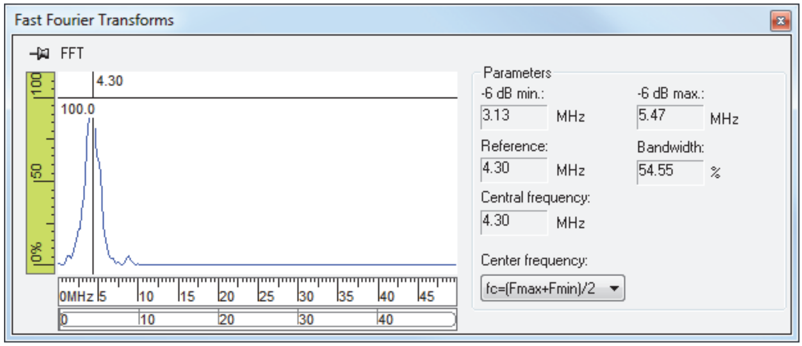


Figure 3-60 The Fast Fourier Transforms dialog box

4. Shortcut Keys

Table 6 on page 169 provides a list of the keyboard shortcuts that you can use with FocusPC. You can use the shortcut keys to activate certain commands without going through all the menus or clicking a toolbar button.

Shortcut keys available for menu commands appear on the menu to the right of the command that they activate.

Table 6 Shortcut keys

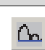
Shortcut key	Toolbar button — Menu command function description
CTRL+[n]	**Layout > Layout[n]** With [n] equal to 1, 2, 3,...,9, or 0, activates the n^{th} layout as when you select one of the ten layouts from the Dashboard under **Layout**. CTRL+0 activates the tenth layout.
CTRL+SHIFT+[n]	**Layout > Save Current Layout > Save as layout**[n] With [n] equal to 1, 2, 3,..., 9, or 0, opens the **Save Current Layout as** dialog box, allowing you to name and to save the n^{th} layout.
CTRL+C	Copies the selected text onto the Clipboard.
CTRL+E	**Tools > Clear Envelope** Resets the envelope mode.
CTRL+SHIFT+E	 **— Tools > Envelope** Toggles the Envelope mode.
CTRL+F	**Tools > Freeze** Alternately freezes and resumes the display update of the active A-scan view.

Table 6 Shortcut keys *(continued)*

Shortcut key	Toolbar button — Menu command function description
CTRL+SHIFT+F	**Tools > Freeze All** Alternately freezes and resumes the display update of all views.
CTRL+H	Hides the menu and the toolbars.
CTRL+M	 — **View > Maximize/Minimize** Alternately maximizes and restores the size of the active view.
CTRL+N	**File > Load Default Configuration** In Inspection mode, creates a new configuration using the default values.
CTRL+O	**File > Open** Opens the **Open** dialog box to select a file to load.
CTRL+S	**File > Save Configuration As** Opens the **Save As** dialog box to select the path, name, type, and content of the file to save.
CTRL+V	Pastes the text previously copied onto the Clipboard into a text box.
CTRL+X	Cuts the selected text and copies it onto the Clipboard.
CTRL+ click and drag	On a C-scan, draws a rectangular zone, independently from the selected tool. On a cursor, moves two cursors together. For a zoom bar, changes the bar start and end values.
CTRL+SHIFT	On a cursor, moves the cursor label.
ALT+C	**Processing > Automatic Volumetric Merge by Group** Performs an automatic volumetric merge by group on the opened data file containing more than one beam per group and more than one group.
ALT+V	**Processing > Automatic Volumetric Merge** Performs an automatic volumetric merge on the opened data file containing more than one beam.
F1	**Help > Help** Opens the User's Manual

Table 6 Shortcut keys *(continued)*

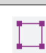
Shortcut key	Toolbar button — Menu command function description
F2	 — **View > Splitting > Split Horizontally** Horizontally splits the active view into two views.
F3	 — **View > Splitting > Split Vertically** Vertically splits the active view into two views.
F4	**View > Save as Preference** Saves the current view properties as the default property settings.
SHIFT+F4	**View > Apply Preference** Applies the default settings view properties.
ALT+F4	**File > Exit** Terminates the execution of FocusPC after validating if you want to save unsaved data.
F5	**Tools > Previous Group** Selects the previous group.
F6	**Tools > Next Group** Selects the next group.
F7	**Tools > Previous Beam** In a view containing more than one beam, selects the previous beam.
F8	**Tools > Next Beam** In a view containing more than one beam, selects the next beam.
CTRL+F8	**Tools > Change Group** Opens the **Change Group** dialog box where you can select one of the groups.
F9	 — **Tools > Zoom** Enables the zoom tool.
F11	 — **Tools > Zone** Enables the zone tool (see also "CTRL+ click and drag" on page 170).

Table 6 Shortcut keys *(continued)*

Shortcut key	Toolbar button — Menu command function description
F12	— **Tools > Move** Enables the move tool.
ALT+ENTER	— **View > Properties** Alternately opens and closes the **Properties** dialog box.
SHIFT+ENTER	— **View > Contents** Alternately opens and closes the **Contents** dialog box.
DELETE	**Layout > Delete Active Note** Eliminates the active note from the view.
CTRL+DELETE	— **View > Delete** Deletes the active view.
CTRL+SHIFT+DELETE	— **View > Empty** Clears the content of the active view.
PAGE UP	Selects the next gate selection.
PAGE DOWN	Selects the previous gate selection.
TAB	Selects the next box or option in a dialog box.
SHIFT+TAB	Selects the previous box or option in a dialog box.
CTRL+TAB	Selects the next tab in a dialog box.
CTRL+SHIFT+TAB	Selects the previous tab in a dialog box.
ALT+Up, Down, Left, or Right	Moves the reference (red) cursor.
SHIFT+ALT+Up, Down, Left, or Right	Moves the measurement (blue) cursor.

5. Troubleshooting

To function correctly, FocusPC requires a HASP key and a properly configured computer and acquisition instrument connection.

Security hardware key

If no security hardware key (HASP key) is connected to the computer, only the FocusPC **Viewer** option is available in the **Startup Selection** dialog box.

If you expect to start FocusPC in one of the other editions, ensure that the security hardware key is connected to the computer before starting FocusPC. For details, refer to the FocusPC *User's Manual*.

Computer configuration

The FocusPC installation procedure includes steps to correctly configure your computer. Additionally, FocusPC must be correctly started up in order to correctly function. Make sure that you have followed all installation and start-up steps, as detailed in the FocusPC *User's Manual*.

Connection to FOCUS PX acquisition instrument

Your computer must be correctly connected and configured for the acquisition instrument. The FOCUS PX Configuration Tool is needed to configure the connection. The FOCUS PX Configuration Tool contains a **Troubleshooting** section with a list of possible causes of problems. For connection details, refer to the FocusPC *User's Manual*.

6. Calculator — Overview

The Calculator is designed to calculate phased array probe element delays. This manual includes guidelines on how to use the Calculator to generate ultrasonic beams for various typical phased array (PA) probe configurations. The Calculator saves the individual element delays in text file formats. You can import these files into FocusPC for use with supported acquisition instruments.

The Calculator is launched by clicking  in the FocusPC Dashboard.

6.1 Calculator User Interface

The Calculator user interface includes a menu bar and a selection of tabs at the top of the screen (see Figure 6-1 on page 175). The menu bar provides file-related commands. The first three tabs regroup parameters related to a specific type of probe. The last two tabs present graphically rendered illustration and probe element information.

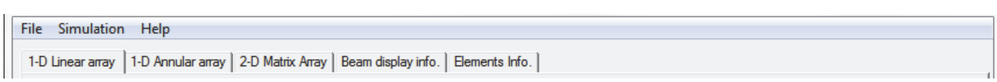


Figure 6-1 The menu bar and the available tabs

A button bar is available at the bottom of the Calculator window (see Figure 6-2 on page 176).

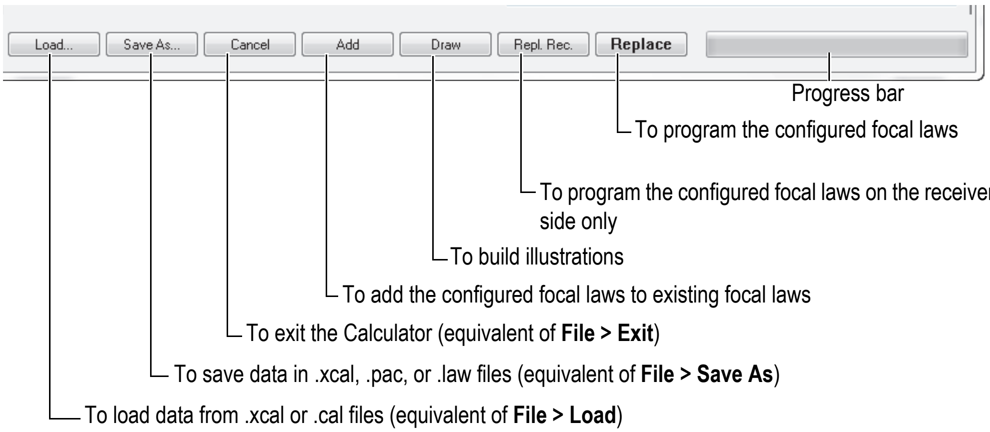


Figure 6-2 The button bar

6.2 File Menu Commands

The **File** menu in the Calculator menu bar contains the following commands:

Load

Used to open the **Open** dialog box in which you can select a calculator setup file to load (.cal or .xcal format).

Save As

Used to open the **Save As** dialog box in which you can select the name, location, and format (.xcal, .pac, or .law) of the file to which you save the calculator data. This creates one .law file for each group. The file contains delays to be applied for all ultrasonic beams.

Export elementary beam

This command includes a submenu with two items (**Delay** and **No Delay**). Both submenu commands are used to open the **Save As** dialog box in which you can select the name and location of a .law file in which to save ultrasonic beam data, respectively, with or without the delay data. This creates one .law file for each ultrasonic beam in the current group. Each .law file contains one beam per element used in the aperture.

Preferences

Used to open the **Preferences** dialog box in which you can select the measurement units (**Metric** or **US Cust**.) used in the Calculator user interface.

Exit

Used to close the Calculator program.

6.3 Supported File Formats

The Calculator can open and save data using the file formats described in Table 7 on page 177.

Table 7 File formats supported by the Calculator

File type	Extension	File content
Calculator setup	.cal	Calculator setup file
Calculator setup	.xcal	Calculator extended setup file
Calculator setup	.law	Calculated ultrasonic beam parameters. See “Description of the .law File Format” on page 285 for details.
Calculator setup	.pac	Calculated ultrasonic beam parameters.

7. Calculator — Phased Array Technique

This section describes the main concepts of phased array inspection and the phased array data views.

Phased array technology allows the generation of an ultrasonic beam with the possibility of modifying the ultrasonic beam parameters such as angle, focal distance, and focal spot size with software. Furthermore, this ultrasonic beam can be multiplexed over a large array, thus creating movement of the ultrasonic beam along the array. These capabilities open a series of new possibilities. For example, it is possible to electronically vary the angle of the ultrasonic beam to scan a part or weld without moving the probe itself. Phased array capabilities also allow the replacement of multiple probes and mechanical scanning devices. Inspecting a part or weld with a variable-angle ultrasonic beam also improves detection, regardless of the defect orientation, while optimizing signal-to-noise ratio.

7.1 Physical Principles

To generate an ultrasonic beam, the various elements of the probe are pulsed at slightly different times. By precisely controlling the delays between the probe elements, ultrasonic beams of various angles, focal distances, and focal spot sizes can be produced. As shown in Figure 7-1 on page 180, the echo from the desired focal point hits the various transducer elements with a computable time shift. The echo signals received at each transducer element are time-shifted before being summed together. The resulting sum is an A-scan that emphasizes the response from the desired focal point and attenuates various other echoes from other points in the material.

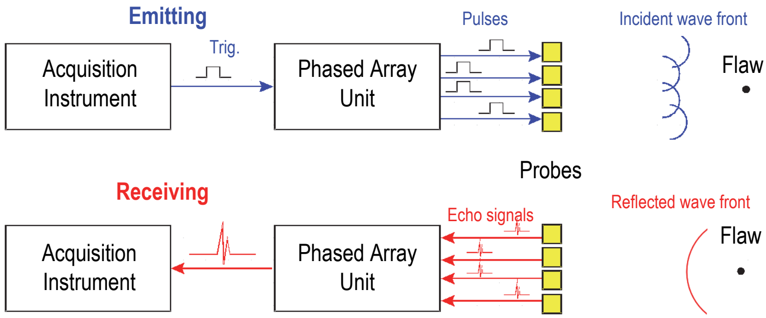


Figure 7-1 Emitting and receiving in a phased array system

A phased array probe is typically a one- or two-dimensional array of small transducer elements. To control the ultrasonic beam characteristics, the excitation pulse is applied at different times to the various elements of the probe.

The multielement composition of the phased array probe enables ultrasonic beam angle control (see “Beam Angle Control” on page 180) and ultrasonic beam focus control (see “Beam Focus Control” on page 182).

7.1.1 Beam Angle Control

Beam angle control involves the production of a wave front. As shown in Figure 7-2 on page 181, simultaneous firing of all elements of a linear multielement probe produces a series of circular arc waves, one from each transducer element. As all wave fronts are at the same distance from their respective emitter, the resulting wave front, or envelope, is parallel to the transducer plane. This is very similar to pulsing a single element transducer of the same size.

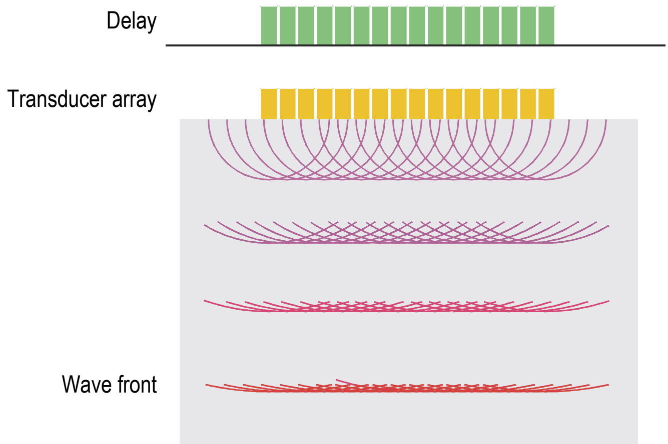


Figure 7-2 Ultrasonic wave front of a linear array

A phased array instrument pulses the various elements in a sequential manner with a small and precisely controlled time delay between each element. Sequential firing of the various transducer elements produces a series of circular arc waves. The resulting envelope is a wave front that is no longer parallel to the transducer surface but propagates at an angle (see Figure 7-3 on page 181). It is possible to adjust the pulse delays to produce any desired wave-front angle.

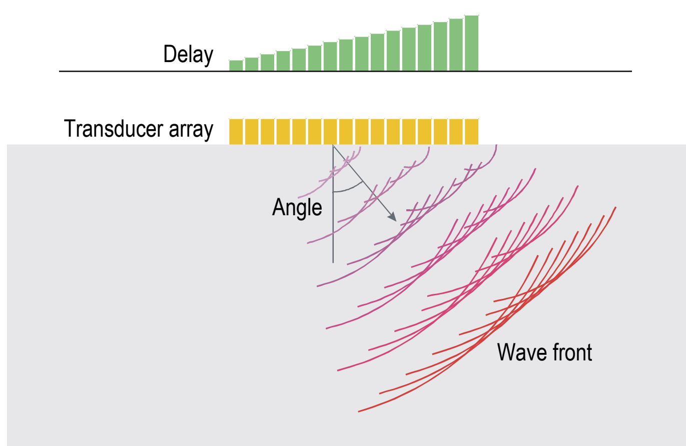


Figure 7-3 Ultrasonic beam angle control of a linear array

7.1.2 Beam Focus Control

When generating a focused beam, the delays are adjusted so that all individual wave fronts stay in phase along the path leading to the desired focal point while canceling each other out at all other points. By accurately controlling the pulse delays, it is possible to focus the beam at a desired point (see Figure 7-4 on page 182).

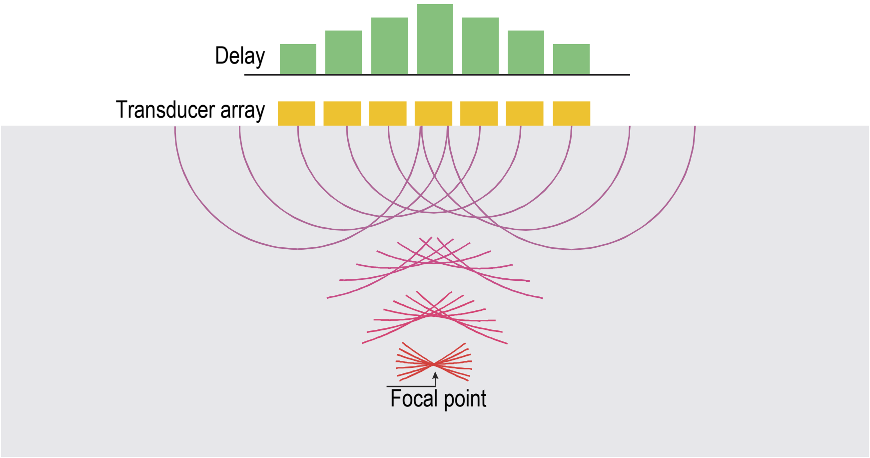


Figure 7-4 Ultrasonic beam focusing of a linear array

For beam angle control and beam focus control, signals received by every element are time-synchronized by the phased array instrument prior to summing the various responses.

7.2 Phased Array Applications

The ultrasonic beam generated by a phased array probe is treated as an ordinary ultrasonic beam by the FocusPC ultrasonic visualization and analysis software, and, as such, phased array can be used to generate all the regular data views (A-scan views, B-scan views, volumetric views, etc.).

Phased array also offers the possibility of performing inspections with various angles and focal lengths. It provides hardware and software tools for different application types.

The application types that you can select in the Calculator dialog box are:

- Sectorial scanning
- Depth scanning
- Linear electronic scanning

7.2.1 Sectorial and Depth Scanning

Sectorial scanning of the phased array signal is obtained by applying several beams in sequence at each x-y coordinate of the inspected area.

At each x-y coordinate of the inspection sequence, an array of elements is used to deflect the ultrasonic beam without moving the probe. Scanning can be conducted along a horizontal axis (see Figure 7-5 on page 183), at different depths in the material (see Figure 7-6 on page 184), or for a combination of these two modes.

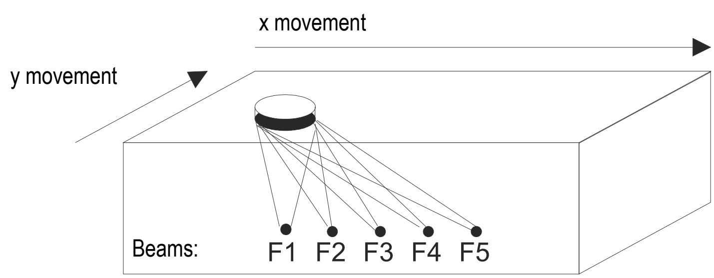


Figure 7-5 Sectorial scanning of x-axis using phased array deflection

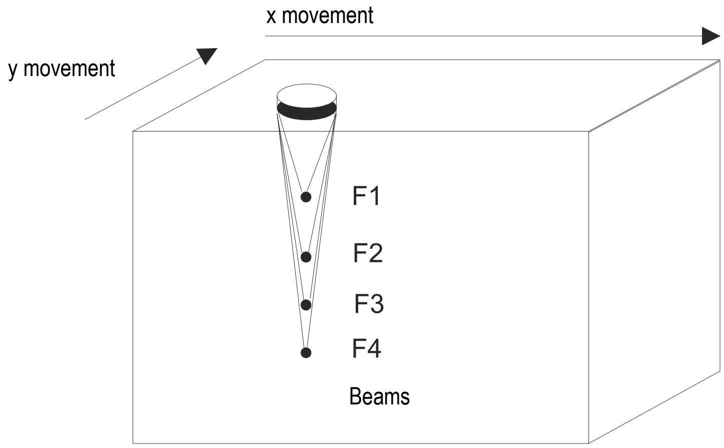


Figure 7-6 Scanning at different depths

For certain applications, a conventional UT inspection would require a number of different transducers. A single phased array probe can be made to sequentially produce the various angles and focal points required by the application (see Figure 7-7 on page 184).

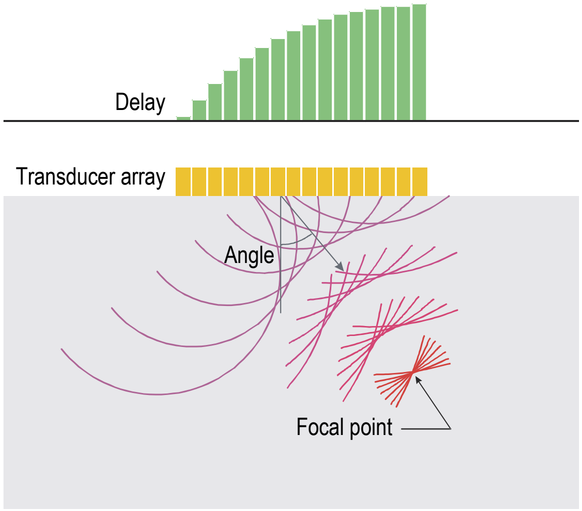


Figure 7-7 Ultrasonic beam angle control and focusing of a linear array

7.2.2 Linear Electronic Scanning

For large phased array probes containing a high number of elements, a phased array instrument can apply the same beam to different sets of elements. By moving the beam along a probe array, the scanning of an inspection axis is realized electronically without any need for physical displacement of the probe (see Figure 7-8 on page 185).

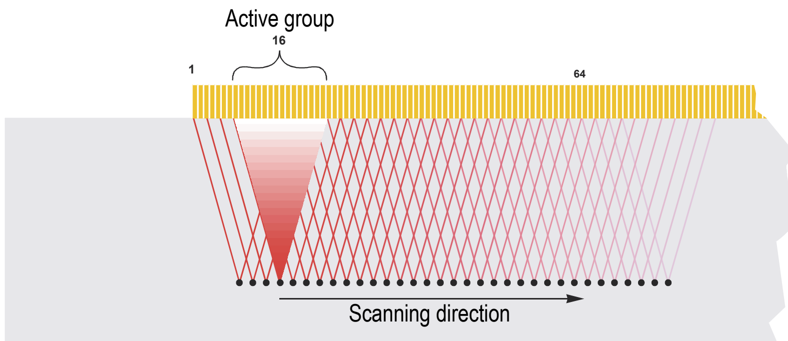


Figure 7-8 Electronic scanning along an axis

In Figure 7-8 on page 185, a focused beam is created using a few of the many probe elements of a long phased array probe. The beam is then shifted (or multiplexed) to the other elements to perform a high-speed scan of the part with no probe movement along scanning axis. More than one scan can be performed with various inspection angles.

8. Calculator — 1-D Linear Arrays Tab

This section presents 1-D linear arrays and describes the Calculator's **1-D Linear array** tab.

8.1 Generic Conventions

You should consider generic conventions regarding probe, wedge, and part geometry to generate beams for 1-D linear arrays in the most efficient and accurate way. Generic conventions exist on aspects such as orientations and positive directions of axes, reference points and signs of offsets, and definition and signs of angles.

8.1.1 Probe Conventions

Axis definition

The axis convention for a **1-D Linear array**, as described in "Tab Description" on page 204 (see **Probe** area), is illustrated in Figure 8-1 on page 188.

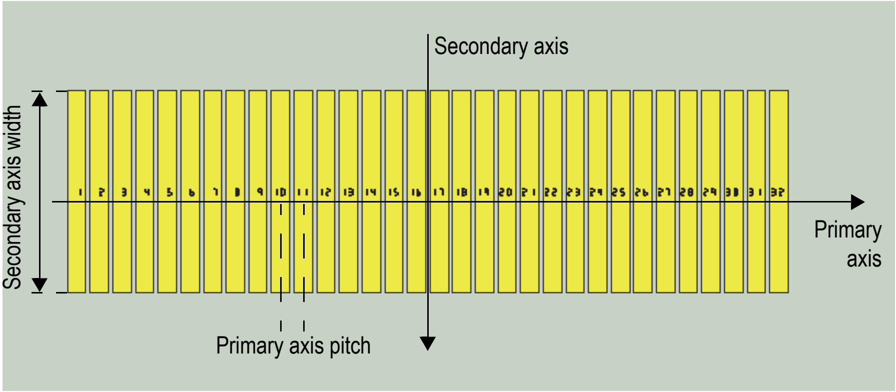


Figure 8-1 Probe axis definition

Refracted angle

The *refracted angle* of the ultrasonic beam is the angle between the central ray of the ultrasonic beam in the material and the normal on the surface at the entrance point of the central ray (see Figure 8-2 on page 188 and Figure 8-3 on page 189). The refracted angle can have values between –89.9° and 89.9°.

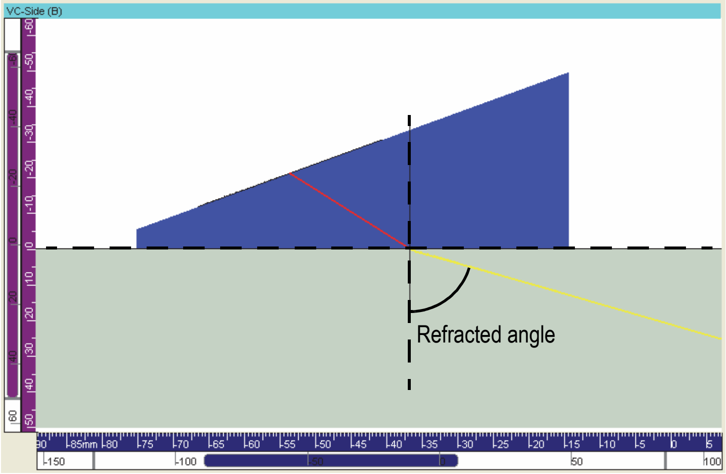


Figure 8-2 Refracted angle on flat part

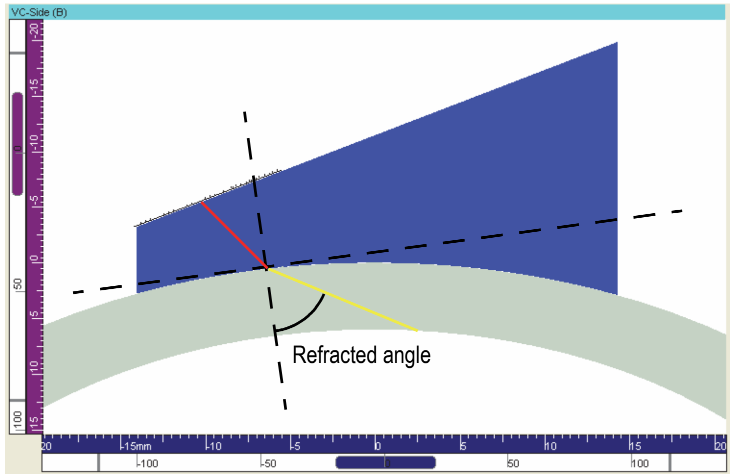


Figure 8-3 Refracted angle on pipe part

Skew angle

The *total skew angle* is the sum of two components: the *beam skew angle* (for definition, see “Beam Angles Selection Area” on page 206) and the *probe skew angle* (for definition, see “Probe Area” on page 214). In both cases, the FocusPC conventions are used. The skew angle can have values between 0° and 359.9°.

Beam skew angle

Because the 1-D linear array has no skewing capability, only a beam skew angle different from 0° can be obtained when using a wedge with a roof angle.

The *beam skew angle* is the angle between the ultrasonic beam (central ray) projection on the scanning surface and the primary axis of the array. The beam skew angle can have values between −179.9° and 179.9°, and it has a positive value when turning from the positive primary axis towards the positive secondary axis.

An example of a beam skew angle going from 70° to 110° with a resolution of 10° is illustrated in Figure 8-4 on page 190.

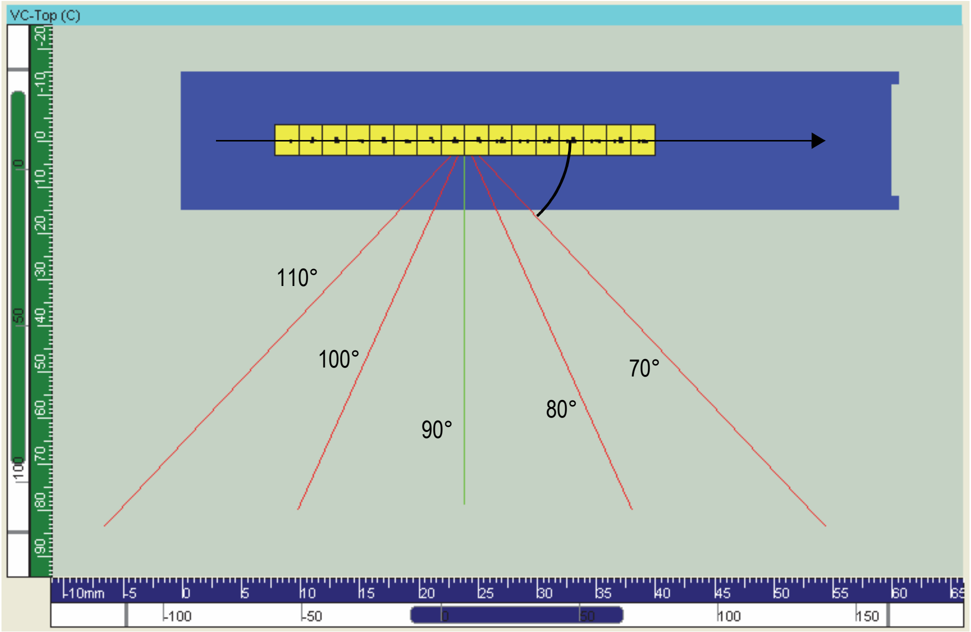


Figure 8-4 Example of a beam skew angle

Probe skew angle

The *probe skew angle* is the angle between the primary axis of the probe and the scan axis. It can have values between 0° and 360°, and it is positive when turning from the positive scan axis towards the positive index axis.

Examples of different probe skew angles, ranging from 0° to 135°, are illustrated in Figure 8-5 on page 191 to Figure 8-8 on page 192.

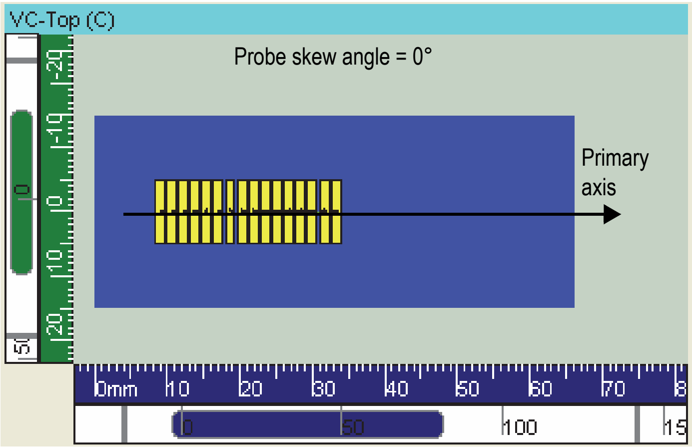


Figure 8-5 Example of a probe skew angle equal to 0°

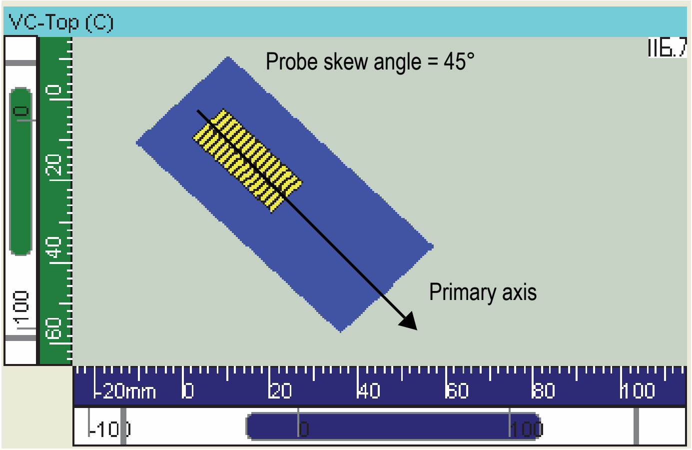


Figure 8-6 Example of a probe skew angle equal to 45°

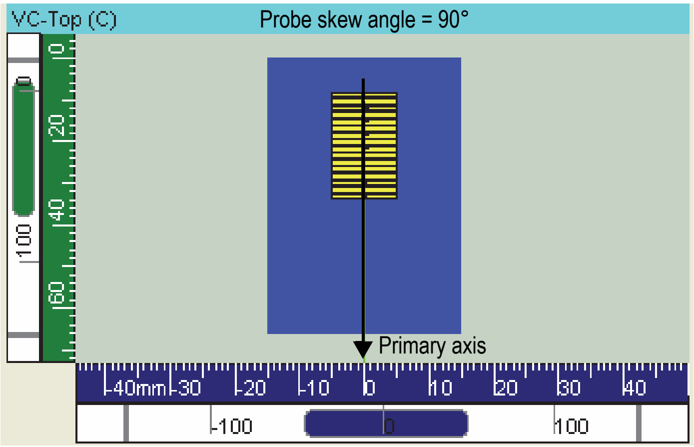


Figure 8-7 Example of a probe skew angle equal to 90°

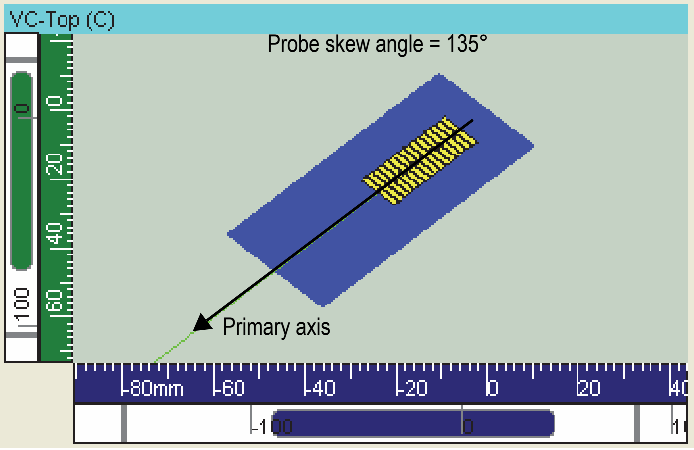


Figure 8-8 Example of a probe skew angle equal to 135°

Total skew angle

The combination of a probe skew angle of 90° and a beam skew angle of 15°, resulting in a *total skew angle* of 152.51°, is illustrated in Figure 8-9 on page 193.

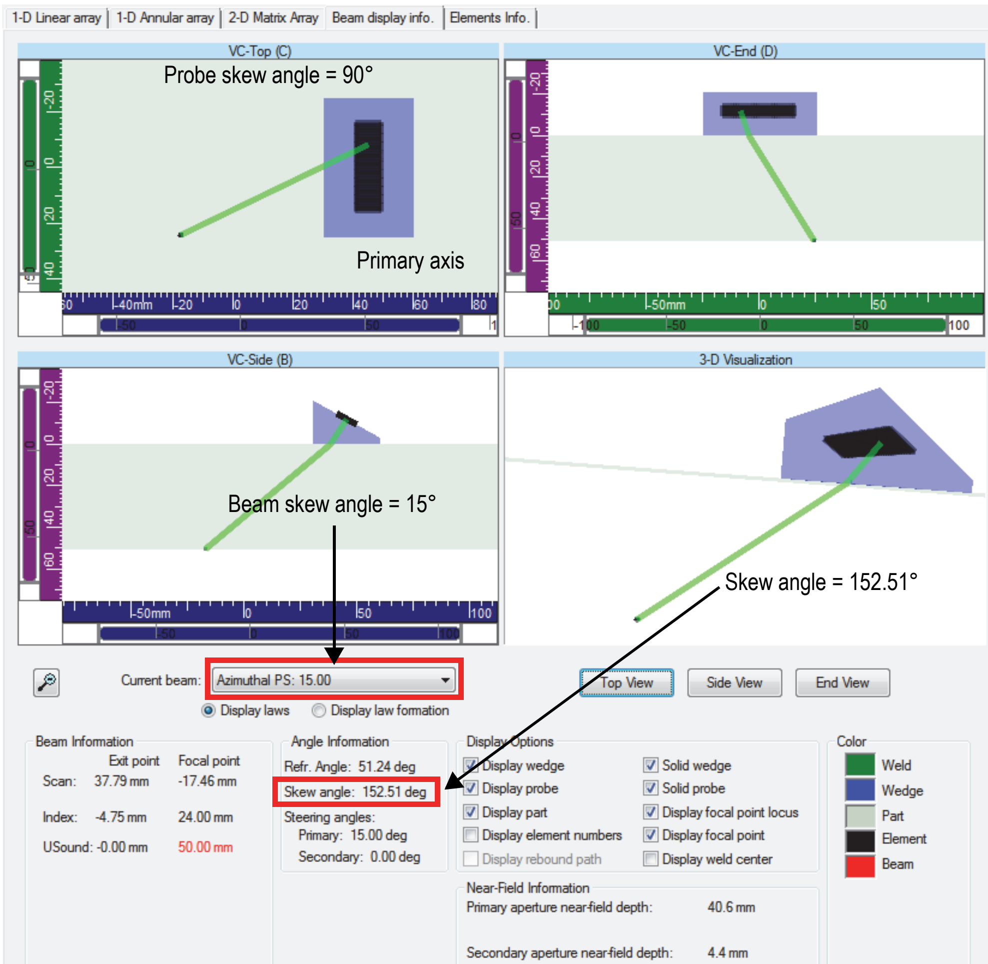


Figure 8-9 Total skew angle

8.1.2 Wedge Conventions

In the Calculator, the different rotations, which define the *wedge*, *roof*, and *squint* angles, are performed in such a way that they are independent. This is mathematically possible because the rotations are performed around adequate axes (not necessarily Scan, Index, and Usound). Consequently, the chronology of the rotations is not important. The value specified for each angle will be correctly applied.

Wedge angle

The *wedge angle* is the angle between the primary axis of the probe (when it is fixed on the wedge) and the surface of the component (or the tangential plane to the surface of the component in the case of cylindrical geometry). It is obtained by a rotation around the secondary axis of the probe, and it can have values between 0° and 89.9°.

Figure 8-10 on page 194 gives an example of a wedge with a wedge angle and no roof angle.

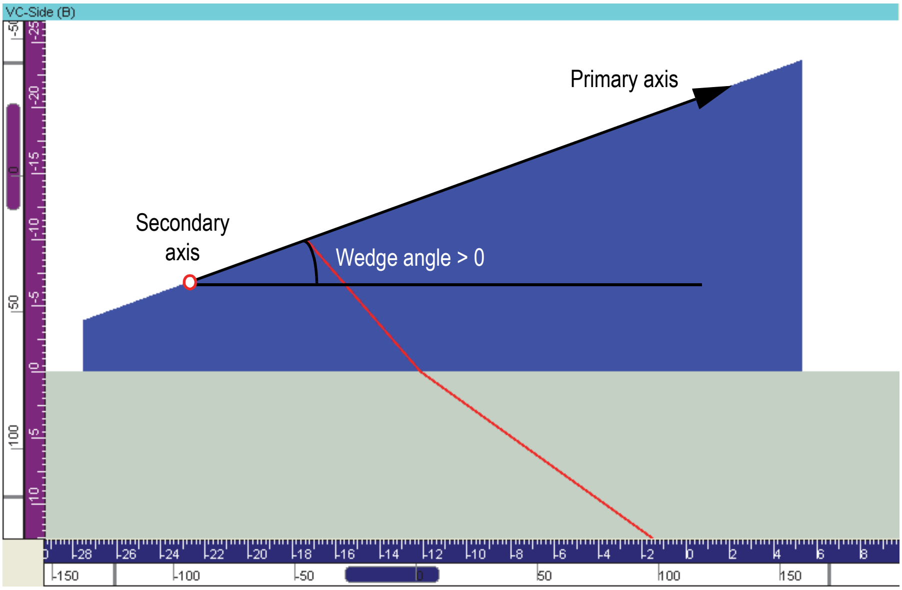


Figure 8-10 Wedge angle definition

Roof angle

The *roof angle* is the rotation angle around the primary axis of the probe, and it can have values between −89.9° and 89.9°. For a probe skew of 0°, a positive roof angle generates beams with total skew angles between 0° and 180°.

Figure 8-11 on page 195 gives an example of a wedge with a positive roof angle and no wedge angle.

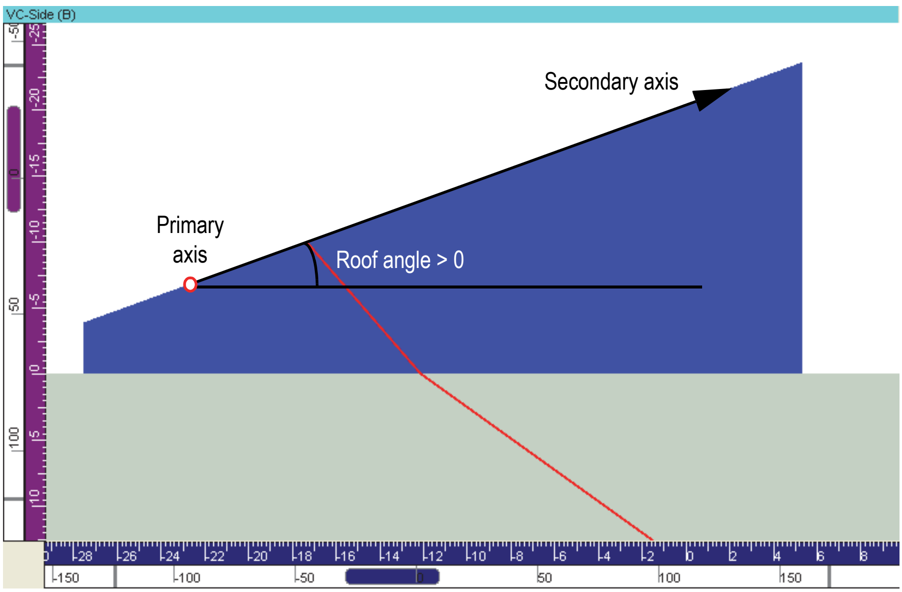


Figure 8-11 Roof angle definition

For pitch-catch configurations, the *probe separation* and the *squint angle* parameters must be appropriately set.

Probe separation

The *probe separation* defines the spacing (center-to-center distance) between the first element of the transmitter array and the first element of the receiver array (see Figure 8-12 on page 196).

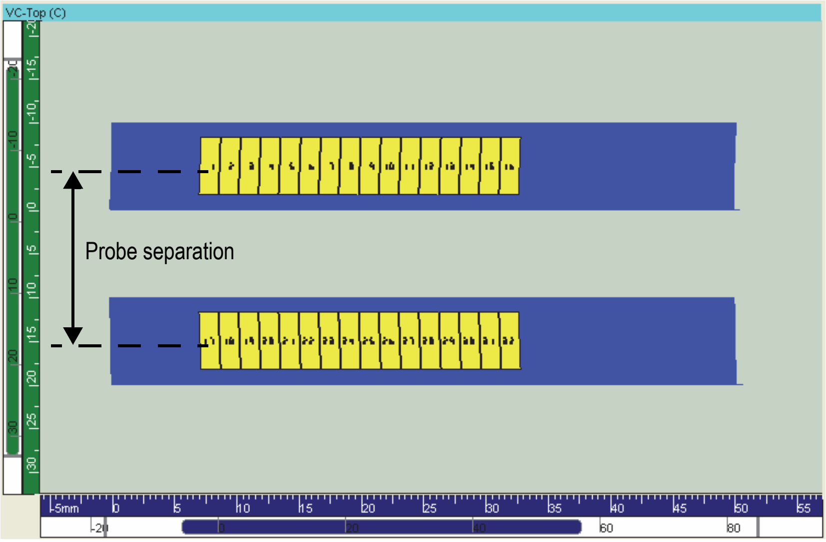


Figure 8-12 Probe separation

Squint angle

The *squint angle* is half the angle between the primary axes of transmitter and receiver arrays. A symmetrical rotation is automatically applied to the receiving array. The squint angle can have values between −89.9° and 89.9°, and a positive squint angle means that the primary axes of the arrays cross in front of the arrays (see Figure 8-13 on page 197).

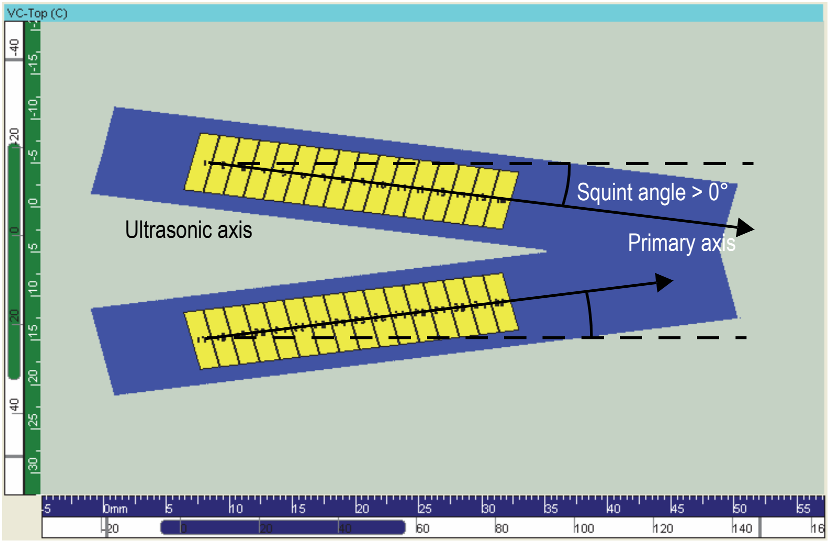


Figure 8-13 Squint angle definition

Position of the probe relative to the wedge

In the **Wedge** area of the Calculator, the values for the **Primary axis position of wedge reference** (mm) and **Secondary axis position of wedge reference** (mm) parameters are adjusted so that the probe is correctly positioned relative to the wedge. In the example shown in Figure 8-14 on page 198, the front of the wedge is at zero on the index axis and the center of the wedge is at zero on the scan axis.

IMPORTANT

For standard flat wedges, in the **Wedge** area of the Calculator, do not change the values of the **Primary axis position of wedge reference** and the **Secondary axis position of wedge reference** parameters (see "Wedge Area" on page 219)

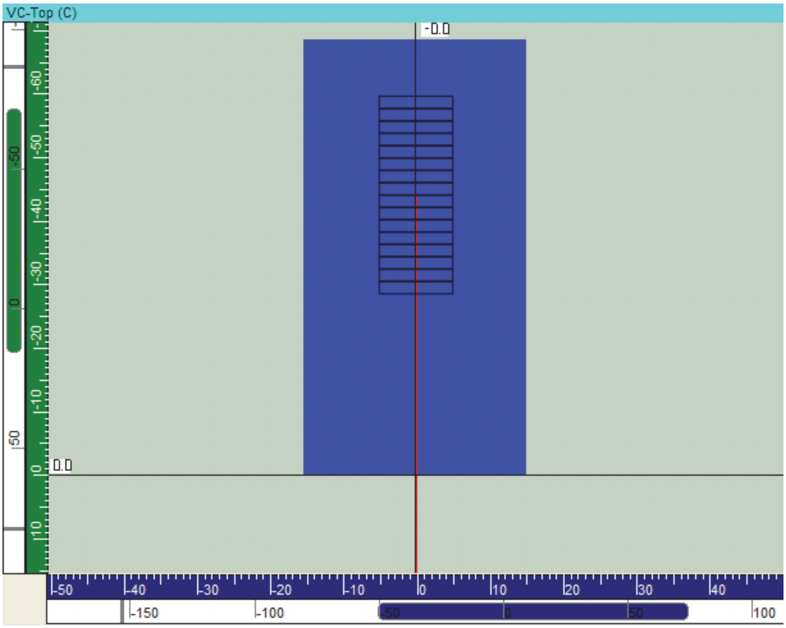


Figure 8-14 Wedge reference positions

8.1.3 Part Conventions

In order to increase the flexibility with regards to selection of reference points, the Calculator considers two different reference points:

- The *wedge reference point* is the intrinsic reference point used by Calculator, and it is always located at the rear-left corner of the wedge. The probe is then positioned with regards to the *wedge reference* by specifying the **Primary axis offset at the middle of the first element** parameter and the **Secondary axis offset at the middle of the first element** parameter (for definition, see "Wedge Area" on page 219).
- The *mechanical reference point* is an arbitrary reference point that you can use to define the position of the intrinsic wedge reference relative to an alternative wedge reference (for example, the front of the wedge) or a reference point on a scanning mechanism. The wedge reference is positioned with regards to the *mechanical reference* by specifying the **Primary axis position of wedge reference** parameter or the **Secondary axis position of wedge reference** parameter (for definition, see "Wedge Area" on page 219). In the visualization of the considered

configurations on the **Beam display info.** tab, the *mechanical reference* is always positioned at the origin.

When using **Primary axis position of wedge reference** and/or **Secondary axis position of wedge reference** values different from zero, the Calculator takes these values into account for the scan and/or index offset values in the **Beam Information** area of the **Beam display info.** tab.

Examples for flat and cylindrical parts are illustrated in Figure 8-15 on page 200, Figure 8-16 on page 201, and Figure 8-17 on page 202.

Flat part

IMPORTANT

For standard probes and wedges, to correctly position the wedge and the probe relative to the part, enter proper values in the **Probe scan offset (mm)** and **Probe index offset (mm)** parameters in the **Probe** area of the Calculator (see "Probe Area" on page 214).

For custom wedges, refer to Figure 8-15 on page 200 to understand the physical meaning of the various Calculator parameters.

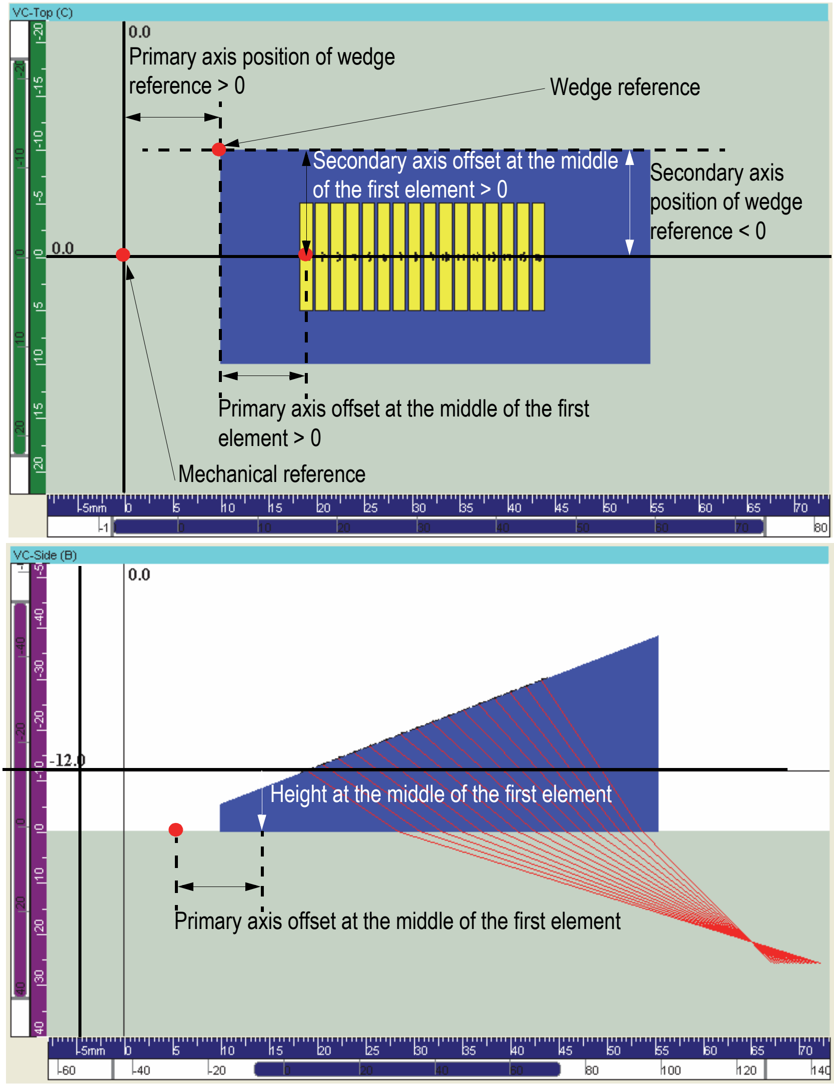


Figure 8-15 Flat part: offset definition

Cylindrical part

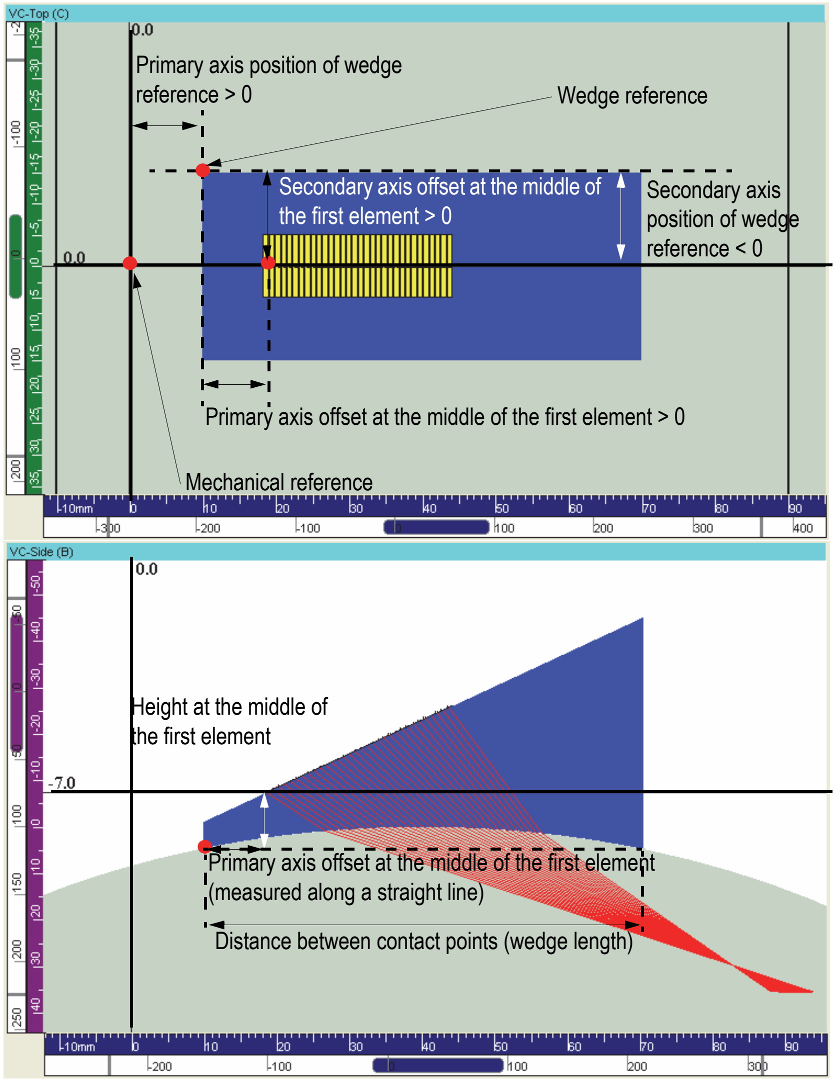


Figure 8-16 Pipe OD with a curvature along the primary axis: offset definition

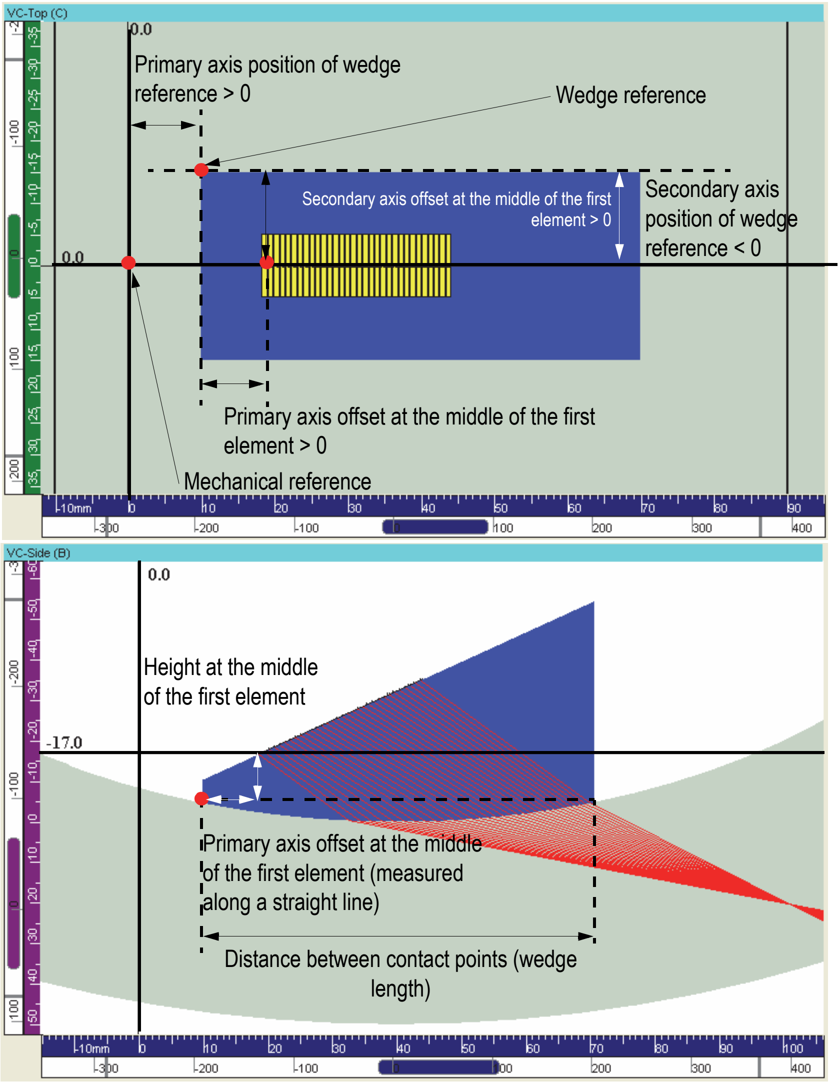


Figure 8-17 Pipe ID with a curvature along the primary axis: offset definition

For cylindrical parts (**Pipe OD** or **Pipe ID**), it is important to note that the wedge is, by definition, considered as centered on the center of the pipe.

Similar conventions apply to a **Pipe OD** and **Pipe ID** with a *curvature along secondary axis* with the difference that the **Distance between contact points** represents the *wedge width*.

8.2 Tab Description

The **1-D Linear array** tab is divided into ten areas (see Figure 8-18 on page 204).

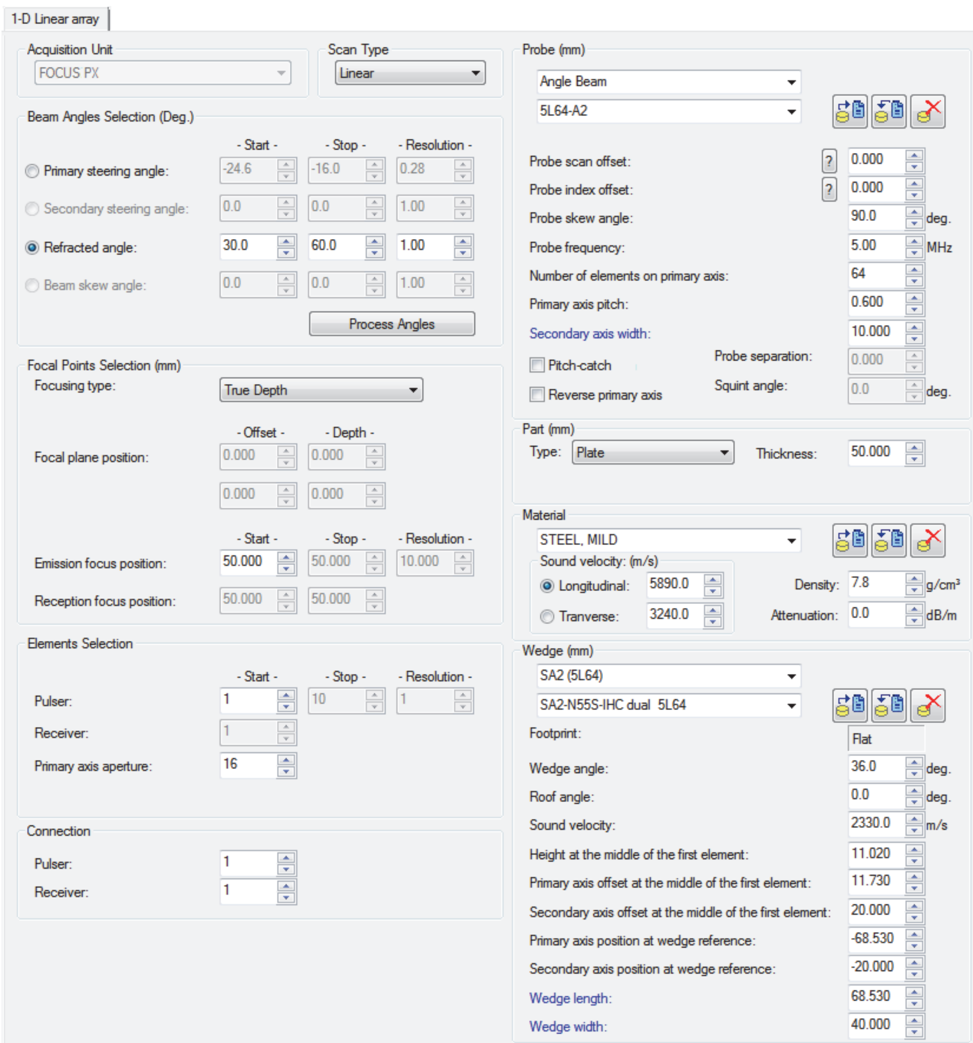


Figure 8-18 The 1-D Linear array tab

8.2.1 Acquisition Unit Area

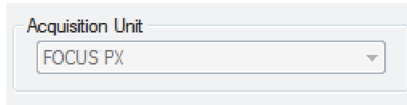


Figure 8-19 The Acquisition Unit area

The **Acquisition Unit** area (Figure 8-19 on page 205) contains only one list used to select the type of acquisition instrument for which you want to create beams. The beam calculation uses a slightly different compensation gain for each acquisition instrument type. The list is available only when no acquisition instrument is connected to the computer. The acquisition instrument is automatically detected when it communicates with the computer.

8.2.2 Scan Type Area

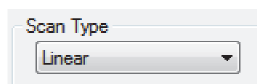


Figure 8-20 The Scan Type area

The **Scan Type** area (Figure 8-20 on page 205) is used to select the type of beams to be generated:

- **Sectorial:** the refracted or inspection angle varies (see “Sectorial and Depth Scanning” on page 183 and “Sectorial Beam Creation” on page 228).
- **Linear:** the primary aperture travels along the array (see “Linear Electronic Scanning” on page 185 and “Linear Beam Creation” on page 240).
- **Depth:** the focusing depth of the ultrasonic beam varies (see “Sectorial and Depth Scanning” on page 183 and “Depth Beam Creation” on page 224).
- **Static:** the refracted angle, the focusing depth, and the primary aperture are fixed values (generates a single beam) [see “Static Beam Creation” on page 221].

8.2.3 Beam Angles Selection Area

Figure 8-21 The Beam Angles Selection (Deg.) area

The **Beam Angles Selection (Deg.)** area (see Figure 8-21 on page 206) contains the following:

Primary steering angle

This is the angle between the central ray of the beam generated at the probe surface and the normal on the wedge surface in contact with the probe. It is generated by electronic steering of the array probe and determines the resulting incident angle (α) in the wedge, used to calculate the refracted angle of the ultrasonic beam to be generated according to Snell's law (see Figure 8-22 on page 207). The **Primary steering angle** can have values between −89.9° and 89.9°, and a "0" value generates the nominal angle defined by the wedge parameters.

For **Sectorial** beams: the **Start**, **Stop**, and **Resolution** boxes next to **Primary steering angle** are used to set the first and last primary steering angles and the angular primary steering angle resolution between two consecutive beams.

For **Linear**, **Depth**, and **Static** beams: only the **Start** box can be modified to set the primary steering angle of the ultrasonic beam to be generated.

Not applicable for pitch-catch configurations.

Secondary steering angle

Not applicable for a 1-D linear array.

Refracted angle

Defines the refracted angle of the ultrasonic beam to be generated. The refracted angle of the ultrasonic beam is the angle between the central ray of the ultrasonic beam in the material and the normal on the incidence plane. The refracted angle (β) is calculated using the probe incidence angle (α), sound velocity in the wedge, and sound velocity in the material according to Snell's law (see Figure 8-22 on page 207).

$$\frac{\sin\alpha}{\sin\beta} = \frac{\text{Sound velocity in wedge}}{\text{Sound velocity in material}}$$

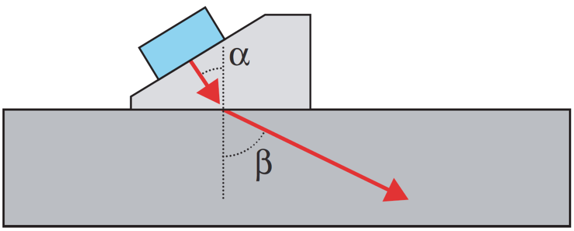


Figure 8-22 Refracted angle

The refracted angle can have values between −89.9° and 89.9°.

For **Sectorial** beams: the **Start**, **Stop**, and **Resolution** boxes next to **Refracted angle** are used to set the first and last refracted angles and the angular refracted angle resolution between two consecutive beams.

For **Linear**, **Depth**, and **Static** beams: only the **Start** box can be modified to select the refracted angle of the ultrasonic beam to be generated.

Beam skew angle

Defines the skew angle of the ultrasonic beam to be generated. This skew angle is the angle between the ultrasonic beam (central ray) projection on the scanning surface and the primary axis of the array. The **Beam skew angle** can have values between −179.9° and 179.9°, and it has a positive value when turning from the positive primary axis towards the positive secondary axis. The **Beam skew angle** value does not take into account the probe skew angle described in the **Probe** area (see Figure 8-4 on page 190).

For **Sectorial** beams: the **Start**, **Stop**, and **Resolution** boxes next to **Beam skew angle** are used to set the first and last skew angles and the angular beam skew angle resolution between two consecutive beams.

For **Linear**, **Depth**, and **Static** beams: only the **Start** box can be modified to set the beam skew angle of the ultrasonic beam to be generated.

Not applicable for pitch-catch configurations.

Process angles button

Calculates the values of the primary steering angle, refracted angle, and/or beam skew angle associated with the beam angle selection.

8.2.4 Focal Points Selection Area

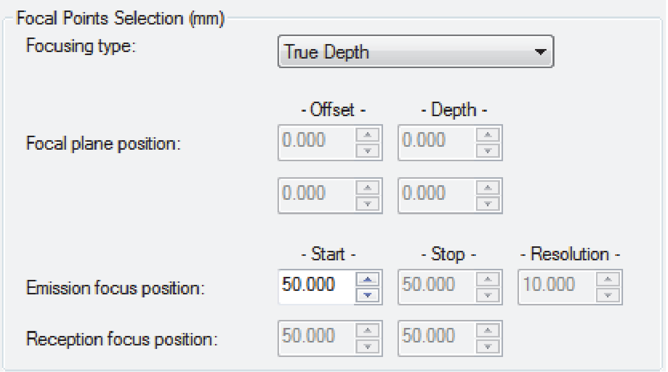


Figure 8-23 The Focal Points Selection (mm) area

The **Focal Points Selection (mm)** area (see Figure 8-23 on page 208) contains the following parameters:

Focusing type

Selects the type of focusing of the beams to be generated:

- **True depth:** all beams are focused at a constant true-depth value (see Figure 8-24 on page 209). For a cylindrical part, the true-depth value is the depth in the cylindrical geometry.
- **Half path:** all beams are focused at a constant half-path (distance) value (see Figure 8-25 on page 210).
- **Projection:** all beams are focused on a given vertical plane (see Figure 8-26 on page 210); this option is not applicable for depth laws or for pitch-catch configurations.
- **Focal plane:** all beams are focused on a user-defined focal plane (see Figure 8-27 on page 211); this option is not applicable for depth laws or for pitch-catch configurations.

— **Auto:** the focalization depth is automatically calculated so that the transmitter and the receiver focus at the same point in space; thus, focalization occurs at the geometrical intersection of the central rays of the transmitter and the receiver (see Figure 8-28 on page 211). This option is only applicable for pitch-catch configurations.

Focal plane position

Defines the focalization plane:

— **Projection:** the first **Offset** box is used to define the position (in scan or in index, depending on the skew angle of the probe) of the vertical focal plane (see Figure 8-26 on page 210).

— **Focal plane:** the **Offset** and **Depth** boxes are used to set the two points (in scan or index, and in depth) defining the focal plane (see Figure 8-27 on page 211).

Emission focus position

Defines the desired focusing position (depth or half-path) of the ultrasonic beams to be generated.

For **Depth** beams: the three boxes are used to set the initial (**Start**) and final (**Stop**) desired focusing position (depth or half-path) of the ultrasonic beams to be generated and the resolution.

Reception focus position

Defines the desired focusing position (depth or half-path) (applied delay) for the received signal.

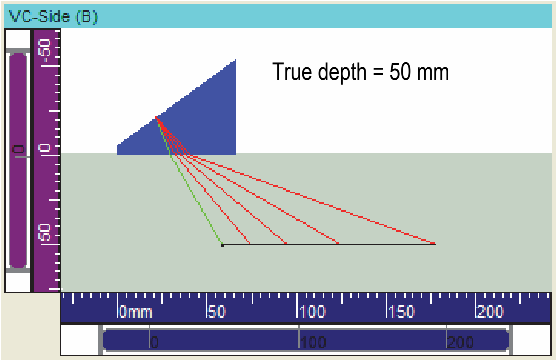


Figure 8-24 True-depth focalization

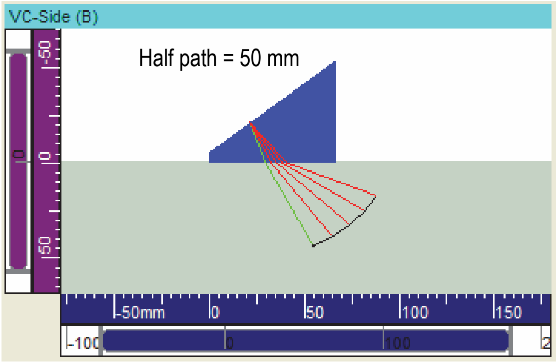


Figure 8-25 Half-path focalization

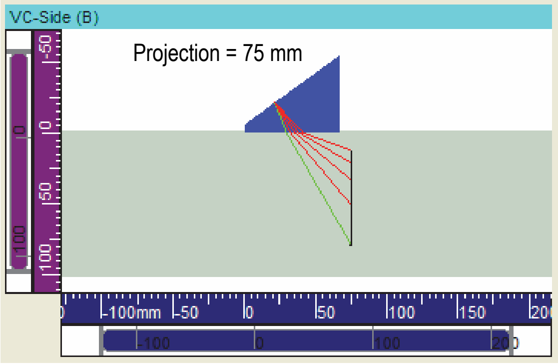


Figure 8-26 Projection focalization

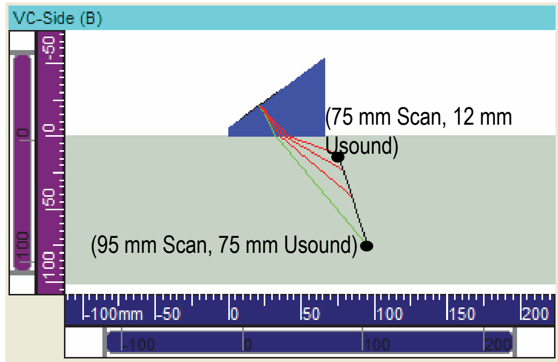


Figure 8-27 Focal plane focalization

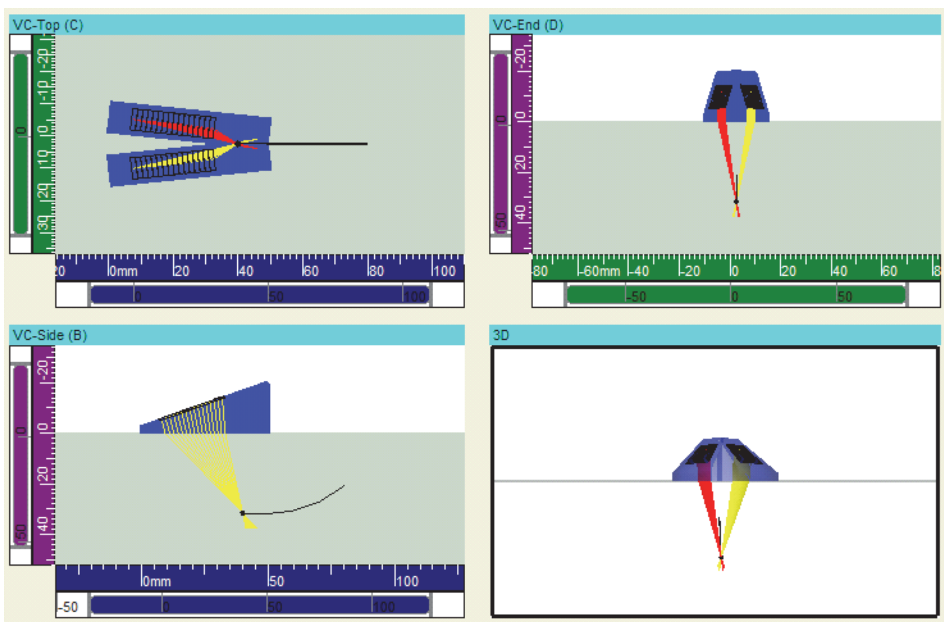


Figure 8-28 Autofocalization for pitch-catch configuration

8.2.5 Elements Selection Area

Figure 8-29 The Elements Selection area

The **Elements Selection** area (see Figure 8-29 on page 212) contains the following:

Improved resolution

This check box appears when **Linear** is selected in the **Scan Type** area and can only be selected when the **Resolution** parameter of the pulser is set to **1**.

When the **Improved resolution** check box is selected, for each beam generated with the defined *active aperture*, another beam is generated with "*active aperture* + 1" elements.

Therefore, the element step (**Resolution**) between two beams is reduced to 1/2 element.

Pulser

Sets the first element of the active pulser group.

For linear beams: the three boxes define the elements that are used during the scan.

Start

Sets the first element of the first group of active elements (aperture).

Stop

Sets the first element of the last group of active elements (aperture).

Resolution

Sets the increment (in number of elements) for linear beams.

Receiver

Sets the first element of the active receiver group.

Primary axis aperture

Sets the number of elements used simultaneously to generate beams.

8.2.6 Connection Area

Figure 8-30 The Connection area

The **Connection** area (see Figure 8-30 on page 213) contains the following parameters:

Pulser and **Receiver**

When using only one probe, always set the value of these parameters to 1.

Use these parameters when connecting two phased array probes to a splitter box (such as the OMNI-A-ADP05 shown in Figure 8-31 on page 214) for measurement in a symmetrical configuration. In this case, you need to separately calculate the beams for each probe using the same values for all parameters of the Calculator except for the **Pulser** and **Receiver** connection parameters. For a given probe, the **Pulser** and **Receiver** connection parameters must have the same value. If you are working with 128-element probes, the value can be between 1 and 64 for the first probe and between 65 and 128 for the second probe (see Figure 8-31 on page 214).

NOTE

In the case of TOFD probes, you need to connect the pulser and receiver on different connectors and note the element numbers used in the respective parameters.

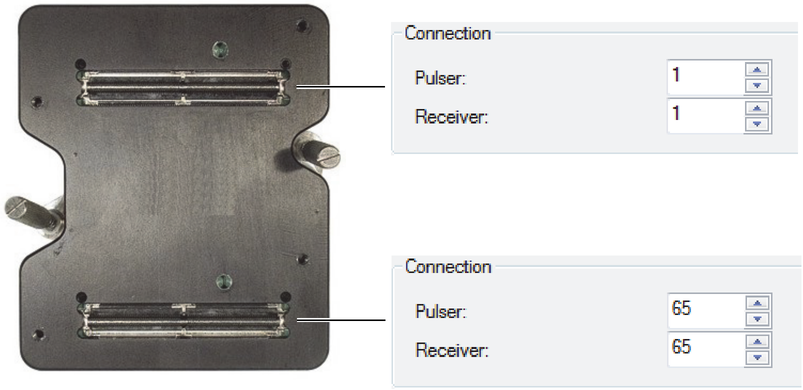


Figure 8-31 Example pulser and receiver configuration for two 128-element probes

8.2.7 Probe Area

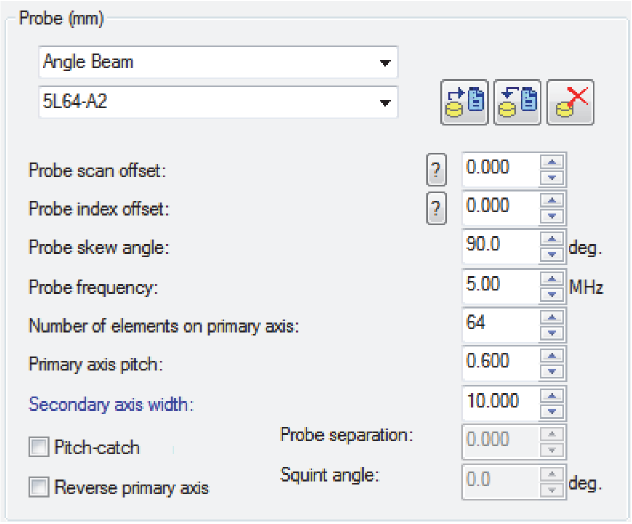


Figure 8-32 The Probe area

The **Probe** area contains the following parameters (see Figure 8-32 on page 214):

Probe database

Use the lists and buttons to select, save, or delete a probe in the probe database.

Load from database button

Use to load a probe configuration from the probe database.

Save in database button

Use to save the active probe configuration in the probe database.

Delete from database button

Use to delete a probe configuration from the probe database.

Probe scan offset

Defines the distance between the center of the first element and the scan-axis origin. Clicking the question mark (?) button on the same line opens the information window shown in Figure 8-33 on page 215.

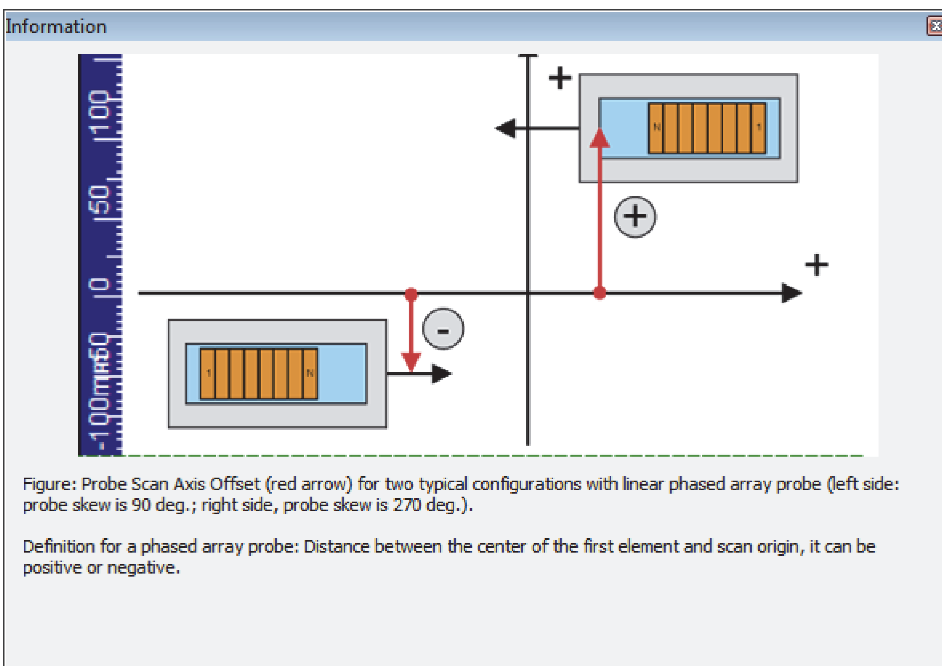


Figure 8-33 Definition of the probe scan offset

Probe index offset

Defines the distance between the front of the wedge and the index-axis origin.

Clicking the question mark (?) button on the same line opens the information window shown in Figure 8-34 on page 216.

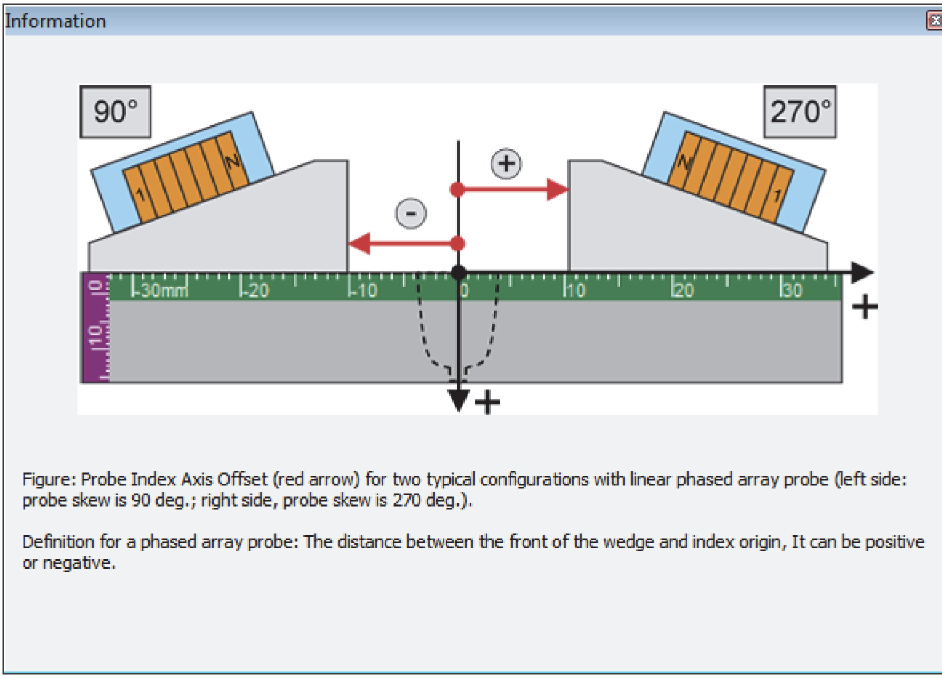


Figure 8-34 Definition of the probe index offset

Probe skew angle

Defines the skew angle of the probe. The **Probe skew angle** is the angle between the primary axis of the probe and the scan axis. It can have values between 0° and 360°, and it is positive when turning from the positive scan axis towards the positive index axis (see Figure 8-8 on page 192).

Probe frequency

Defines the probe frequency.

Number of elements on primary axis

Defines the number of elements on the primary axis of the current probe (see Figure 8-1 on page 188).

Primary axis pitch

Defines the spacing (center-to-center distance) between consecutive probe elements on the primary axis of the probe (see Figure 8-1 on page 188).

Secondary axis width

Defines the width of the elements (see Figure 8-1 on page 188).

Pitch-catch

Allows the creation of a pitch-catch, side-by-side probe configuration.

Reverse primary axis

Inverts the order of the element numbers in the calculation of the beams.

Probe separation

Defines the spacing (center-to-center distance) between the first element of the transmitter array and the first element of the receiver array (see Figure 8-12 on page 196). This option is only applicable for pitch-catch configurations.

Squint angle

Defines the squint angle of the transmitter and the receiver array. The **Squint angle** is half the angle between the primary axes of transmitter and receiver arrays. A symmetrical rotation is automatically applied to the receiving array. The **Squint angle** can have values between −89.9° and 89.9°, and a positive squint angle means that the primary axes of the array cross in front of the arrays (see Figure 8-13 on page 197). Only applicable for pitch-catch configurations.

8.2.8 Part Area

Figure 8-35 The Part area for flat part

The **Part** area (see Figure 8-35 on page 217) contains the following parameters:

Type

Defines the part type supported by the Calculator:

Plate: flat part

Pipe OD: cylindrical part inspected from the outside diameter

Pipe ID: cylindrical part inspected from the inside diameter

Thickness (mm)

Defines the thickness of the part to be displayed on the **Beam display info.** tab.

Radius (mm)

Defines the radius of the cylindrical part. For a **Pipe OD** part, this value represents the outer radius (inner radius + thickness). For **Pipe ID** part, the radius represents the inner radius.

8.2.9 Material Area

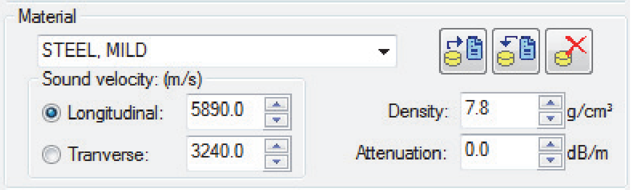


Figure 8-36 The Material area for a flat part

Material database

Use the list and buttons to select, save, or delete a material type from the **Material** database.

 **Load from database** button

Use to load a material configuration from the material database.

 **Save in database** button

Use to save the active material configuration in the material database.

 **Delete from database** button

Use to delete a material configuration from the material database.

Sound velocity area

Defines the sound velocities in the material to be inspected for the available wave types, **Longitudinal** (compression) or **Transverse** (shear) waves, in meters per second.

Density

Defines the density of the selected material.

Attenuation

Use to set the ultrasonic attenuation for the selected material.

8.2.10 Wedge Area

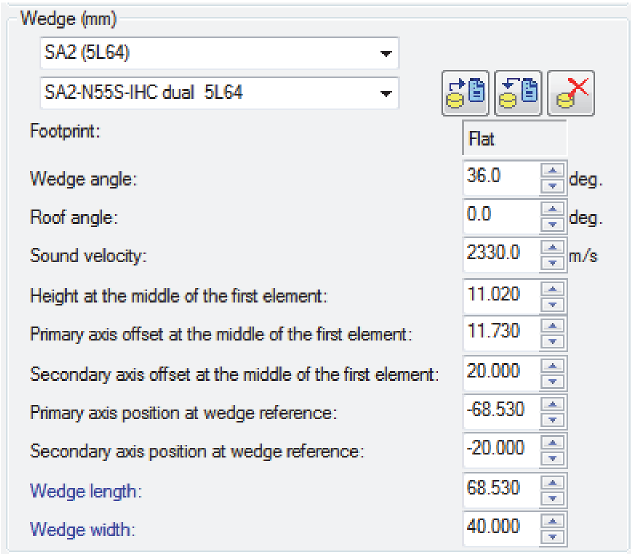


Figure 8-37 The Wedge area

The **Wedge (mm)** area (see Figure 8-37 on page 219) contains the following parameters:

Wedge database

Use the lists and buttons to select, save, or delete a wedge in the **Wedge** database.

 **Load from database** button

Use to load a wedge configuration from the wedge database.

 **Save in database** button

Use to save the active wedge configuration in the wedge database.

 **Delete from database** button

Use to delete a wedge configuration from the wedge database.

Footprint

Defines the footprint of the wedge. For a **Plate** part, the footprint is set to **Flat**. For a cylindrical part, choose one of the following footprints: **Curvature along primary axis** or **Curvature along secondary axis**.

Wedge angle

Defines the wedge angle in degrees. The **Wedge angle** is the angle between the primary axis of the probe (when it is fixed on the wedge) and the surface of the component (or the tangential plane to the surface of the component in the case of a cylindrical geometry). It is obtained by a rotation around the secondary axis of the probe, and it can have values between 0° and 89.9° (see Figure 8-10 on page 194).

Roof angle

Defines the roof angle in degrees. The **Roof angle** is the rotation angle around the primary axis of the probe, and it can have values between −89.9° and 89.9°. For a probe skew of 0°, a positive roof angle generates beams with total skew angles between 0° and 180° (see Figure 8-11 on page 195).

Sound velocity

Defines the sound velocity in the wedge.

Height at the middle of the first element

Defines the height at the middle of the first element, relative to the material surface (see Figure 8-15 on page 200).

For a cylindrical part, the height is measured relative to the flat surface obtained by drawing a line between the contact points of the wedge, and this value is always positive (see Figure 8-16 on page 201, Figure 8-17 on page 202).

Primary axis offset at the middle of the first element

Defines the offset of the middle of the first element along the primary axis, relative to the back of the wedge (see Figure 8-15 on page 200). The offset is always measured along a straight line, and it normally has positive values.

Secondary axis offset at the middle of the first element

Defines the offset of the middle of the first element along the secondary axis, relative to the left side of the wedge (see Figure 8-15 on page 200). The offset is always measured along a straight line, and it normally has positive values.

Primary axis position of wedge reference

Defines the primary axis position of the wedge reference relative to the mechanical reference (see Figure 8-15 on page 200). The offset is always measured along the part surface and is positive along the positive scan-axis direction.

Secondary axis position of wedge reference

Defines the secondary axis position of the wedge reference relative to the mechanical reference (see Figure 8-15 on page 200). The offset is always measured along the part surface and is positive along the positive index-axis direction.

Wedge length or **Distance between contact points (wedge length)**

The **Wedge length** is the actual length of the wedge.

For a cylindrical part with a curvature along primary axis, the wedge length represents the distance between the contact points of the wedge (see Figure 8-16 on page 201, Figure 8-17 on page 202).

Wedge width or **Distance between contact points (wedge width)**

The **Wedge width** is the actual width of the wedge.

For a cylindrical part with a curvature along secondary axis, the wedge width represents the distance between the contact points of the wedge.

8.3 Static Beam Creation

A **Static** beam is an ultrasonic beam generated by a phased array probe that is similar to a beam generated by a conventional probe. The refracted angle, the focusing depth, and the primary aperture cannot be modified; they are fixed. A single beam is generated.

To illustrate the use of the Calculator to create a **Static** beam for a 1-D linear array probe, the following typical application is given as an example:

Example 1: single array, flat part, probe parallel to the scan axis

The following configuration is considered:

- Single 1-D linear array probe with the following characteristics: 5 MHz nominal frequency, 32 elements, 1 mm pitch, and the width of the elements is 10 mm
- A Rexolite wedge with the following characteristics: 36° wedge angle, no roof angle, 2330 m/s wedge velocity, 12 mm height at the middle of the first element, 9 mm primary axis offset of the first element
- A flat carbon steel part with a wall thickness of 50 mm
- The probe is oriented parallel to the scanning axis (skew 0°), and the rear end of the probe is positioned at 75 mm from the scan-axis reference (0 point).
- The probe generates a shear-wave beam in pulse-echo mode at a 60° refracted angle, focusing at a true-depth of 30 mm; all 32 elements of the probe are used to generate the beam.

In order to generate this **Static** beam, the input parameters must be set as shown in Figure 8-38 on page 223.

Attention should be paid to the setting of the following parameters:

- **Height at the middle of the first element:** 12 mm, as previously mentioned
- **Primary axis offset of the first element:** 9 mm, as previously mentioned
- **Secondary axis offset of the first element:** 15 mm, in order to position the probe in the middle of the wedge with a width of 30 mm
- **Primary axis position of wedge reference**: −75 mm, in order to position the rear end of the wedge at a distance of 75 mm from the scan-axis zero reference (mechanical reference point)
- **Secondary axis position of wedge reference**: −15 mm, in order to position the middle of the wedge at the rear end of index-axis zero reference (mechanical reference point)

Also, note that the database has been used to save the probe, wedge, and material parameters (see “Calculator — Using the Databases” on page 275).

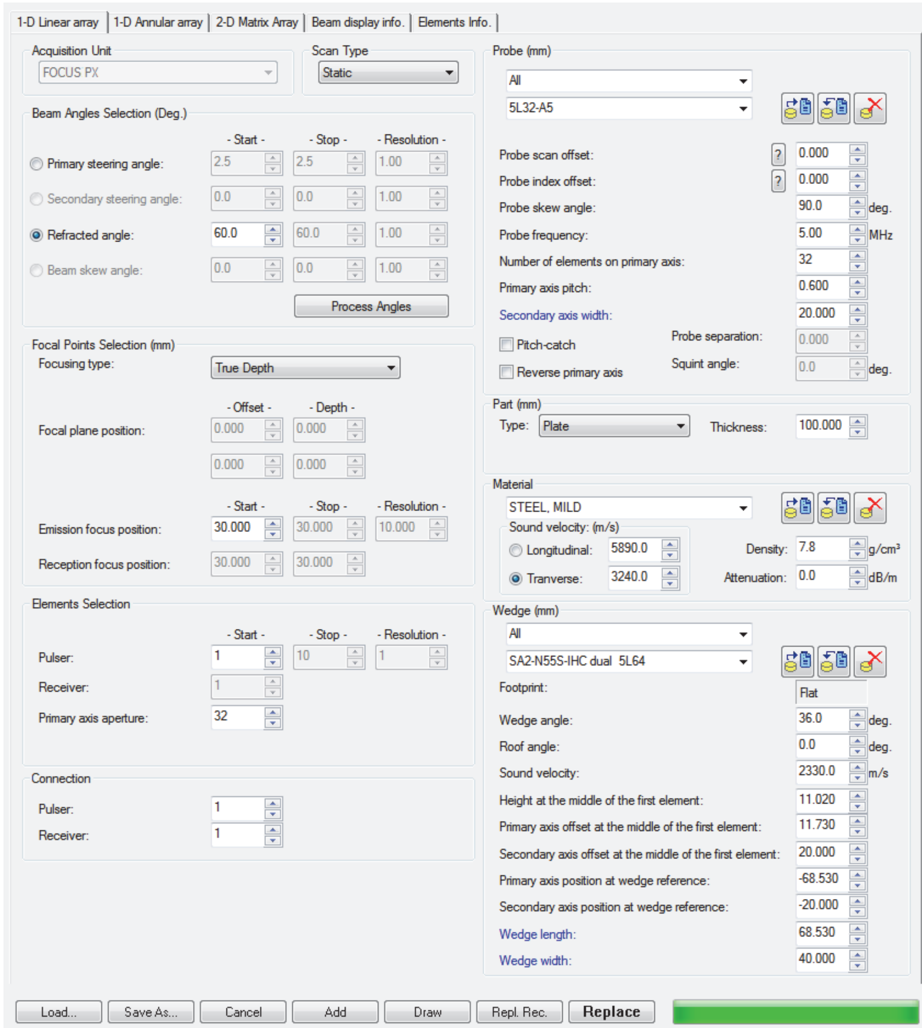


Figure 8-38 Static beam: input parameters

The results can be examined in the graphic representation on the **Beam display info.** tab (see Figure 8-39 on page 224).

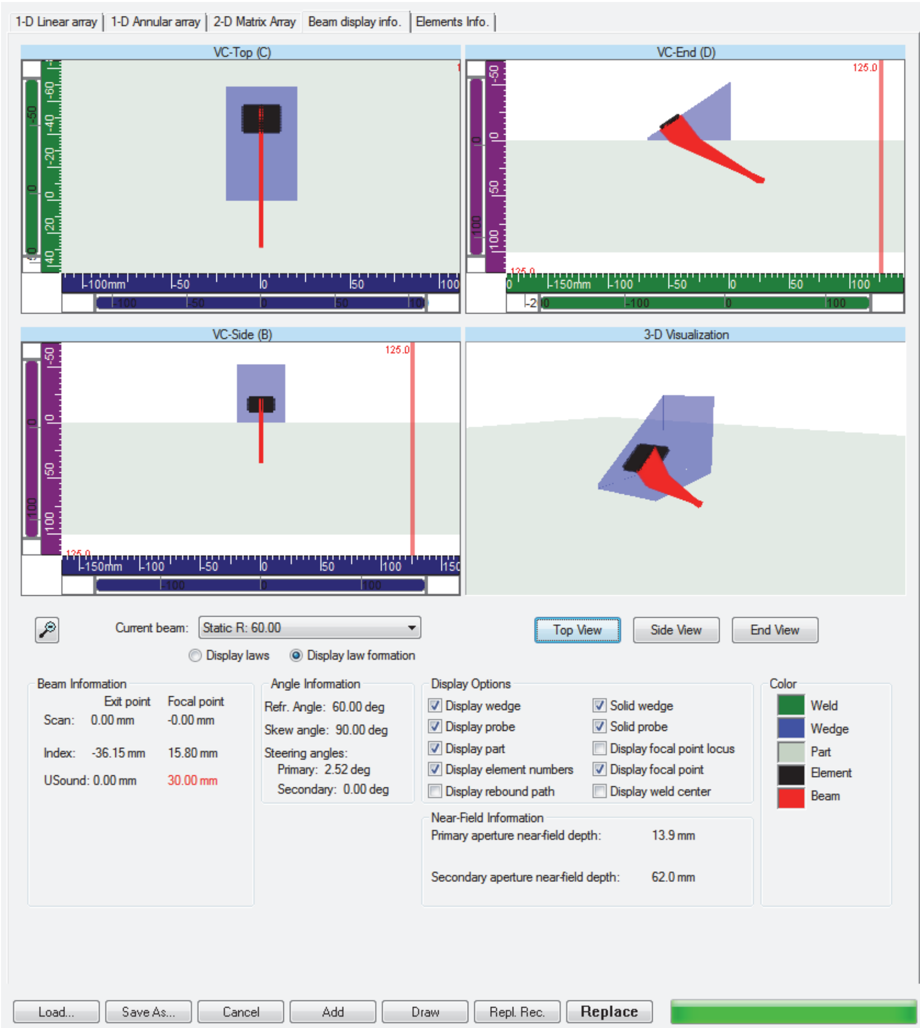


Figure 8-39 Static beam: visualization

8.4 Depth Beam Creation

Depth beams are a set of ultrasonic beams that are generated at a fixed refracted angle and fixed primary aperture, but that focus at different depths.

To illustrate the use of the Calculator to create **Depth** beams for a 1-D linear array probe, the following typical application is given as an example:

Example 1: single array, flat part, probe perpendicular to scan axis

The following configuration is considered:

- Single 1-D linear array probe, with the following characteristics: 5 MHz nominal frequency, 32 elements, 1 mm pitch, and the width of the elements is 10 mm
- A Rexolite wedge with the following characteristics: 36° wedge angle, no roof angle, 2330 m/s wedge velocity, 12 mm height at the middle of the first element, 9 mm primary axis offset of the first element
- A flat carbon steel part with a wall thickness of 100 mm
- The probe is oriented perpendicular to the scanning axis (skew 90°), and the rear end of the probe is positioned at 75 mm from the index-axis reference (0 point).
- The probe generates shear-wave beams in pulse-echo mode at a refracted angle of 45°, focusing between a true-depth distance of 20 mm to 80 mm with a depth resolution of 10 mm; all 32 elements of the probe are to be used to generate the beam.

In order to generate this set of **Depth** beams, the input parameters must be set as shown in Figure 8-40 on page 226.

Attention should be paid to the setting of the following parameters:

- **Height at the middle of the first element:** 12 mm, as previously mentioned
- **Primary axis offset of the first element:** 9 mm, as previously mentioned
- **Secondary axis offset of the first element:** 15 mm, in order to position the probe in the middle of the wedge with a width of 30 mm
- **Primary axis position of wedge reference:** −75 mm, in order to position the rear end of the wedge at a distance of 75 mm from the index-axis zero reference
- **Secondary axis position of wedge reference:** −15 mm, in order to position the middle of the wedge at the rear end of scan-axis zero reference

Also, note that the database has been used to save the probe, wedge, and material parameters (see “Calculator — Using the Databases” on page 275).

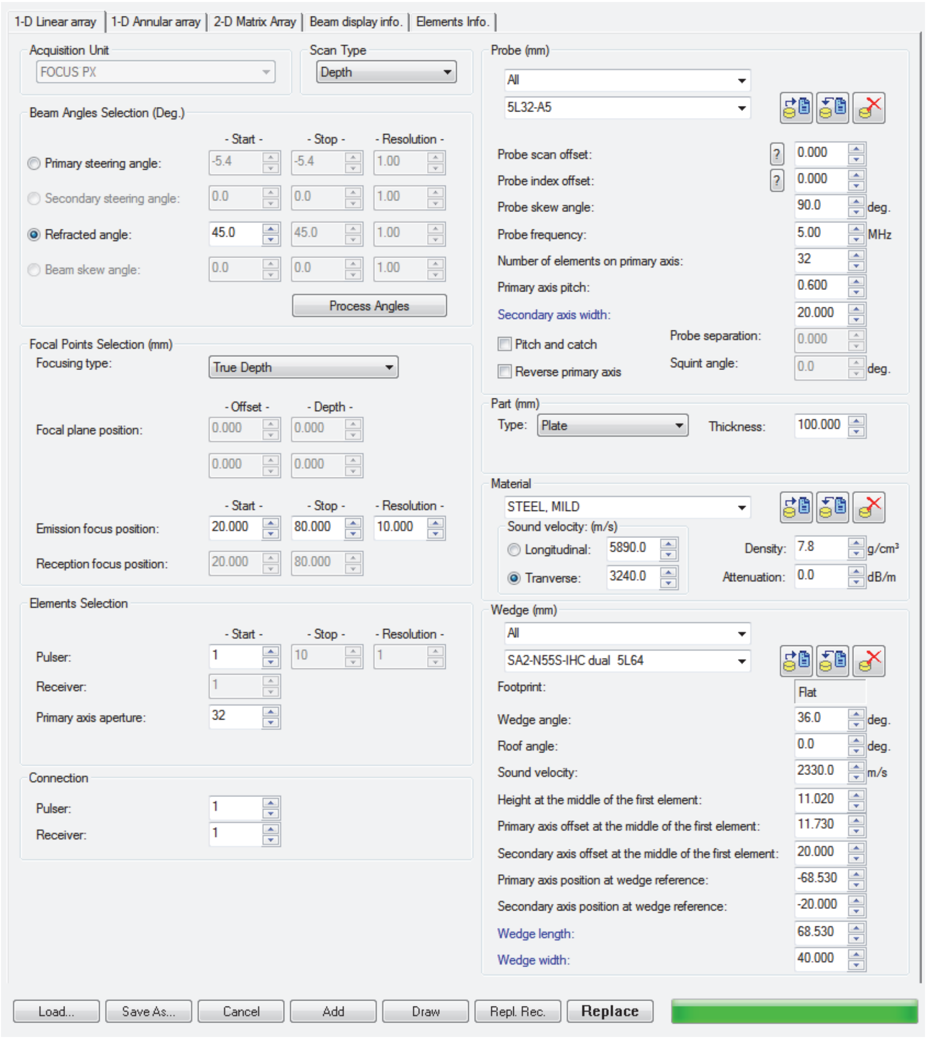


Figure 8-40 Depth beams: input parameters

The results can be examined in the graphic representation on the **Beam display info.** tab (see Figure 8-41 on page 227).

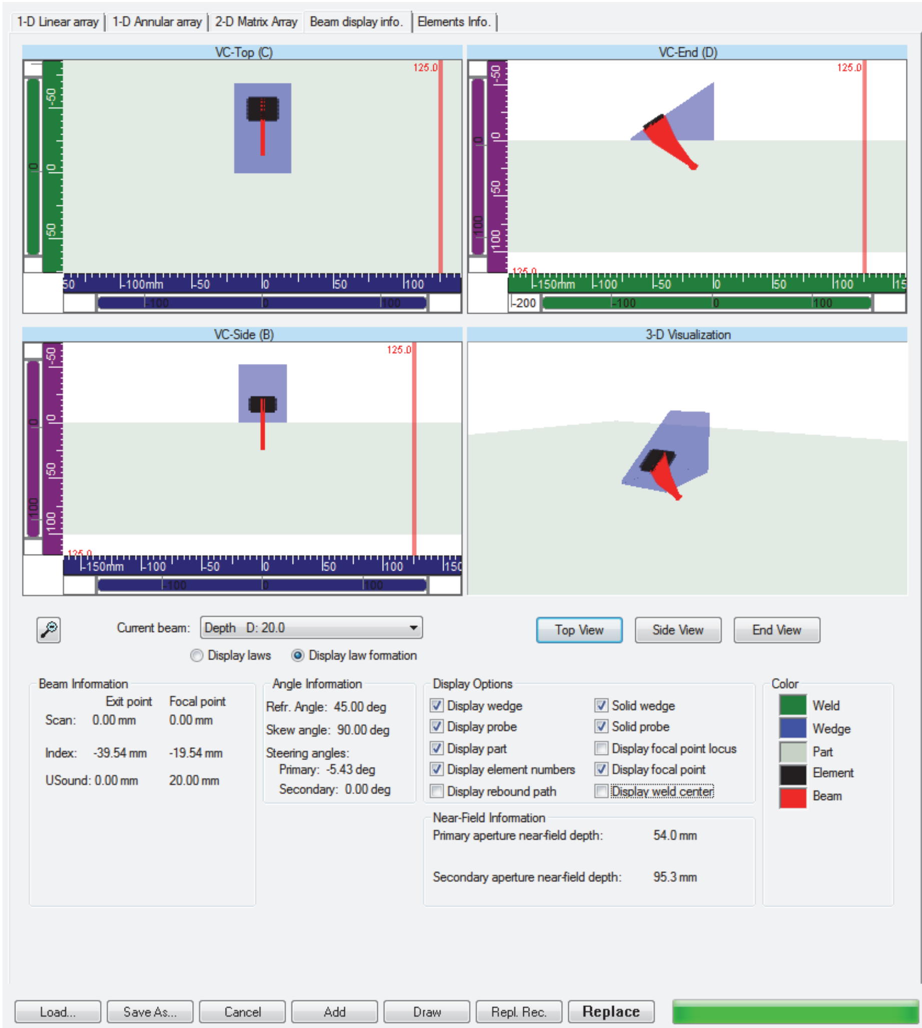


Figure 8-41 Depth beams: visualization

8.5 Sectorial Beam Creation

Sectorial beams are a set of ultrasonic beams that are generated at a fixed focusing distance and fixed primary aperture, though at different inspection angles (refracted angles and/or skew angles).

To illustrate the use of the Calculator for creating a set of **Sectorial** beams for 1-D linear array probes, various typical applications are given as examples.

Example 1: single array, flat part, probe perpendicular to the scan axis

The following configuration is considered:

- Single 1-D linear array probe, with the following characteristics: 5 MHz nominal frequency, 32 elements, 1 mm pitch, and the width of the elements is 10 mm
- A Rexolite wedge with the following characteristics: 36° wedge angle, no roof angle, 2330 m/s wedge velocity, 12 mm height at the middle of the first element, 9 mm primary axis offset of the first element
- A flat carbon steel part with a wall thickness of 50 mm
- The probe is oriented perpendicular to the scanning axis (skew 90°), and the rear end of the probe is positioned at 70 mm from the index-axis reference (0-point).
- The probe generates shear-wave beams in pulse-echo mode at refracted angles from 40° to 70° with a resolution of 5°, focusing at a constant half-path distance of 40 mm; all 32 elements of the probe are to be used to generate the beam.

In order to generate this set of **Sectorial** beams, the input parameters must be set as shown in Figure 8-42 on page 229.

Attention should be paid to the setting of the following parameters:

- **Height at the middle of the first element:** 12 mm, as mentioned previously.
- **Primary axis offset of the first element:** 9 mm, as mentioned previously.
- **Secondary axis offset of the first element:** 15 mm, in order to position the probe in the middle of the wedge with a width of 30 mm
- **Primary axis position of wedge reference:** −70 mm, in order to position the rear end of the wedge at a distance of 70 mm from the index-axis zero reference
- **Secondary axis position of wedge reference:** −15 mm, in order to position the middle of the wedge at the rear end of scan-axis zero reference

Also, note that the database has been used to save the probe, wedge, and material parameters (see “Calculator — Using the Databases” on page 275).

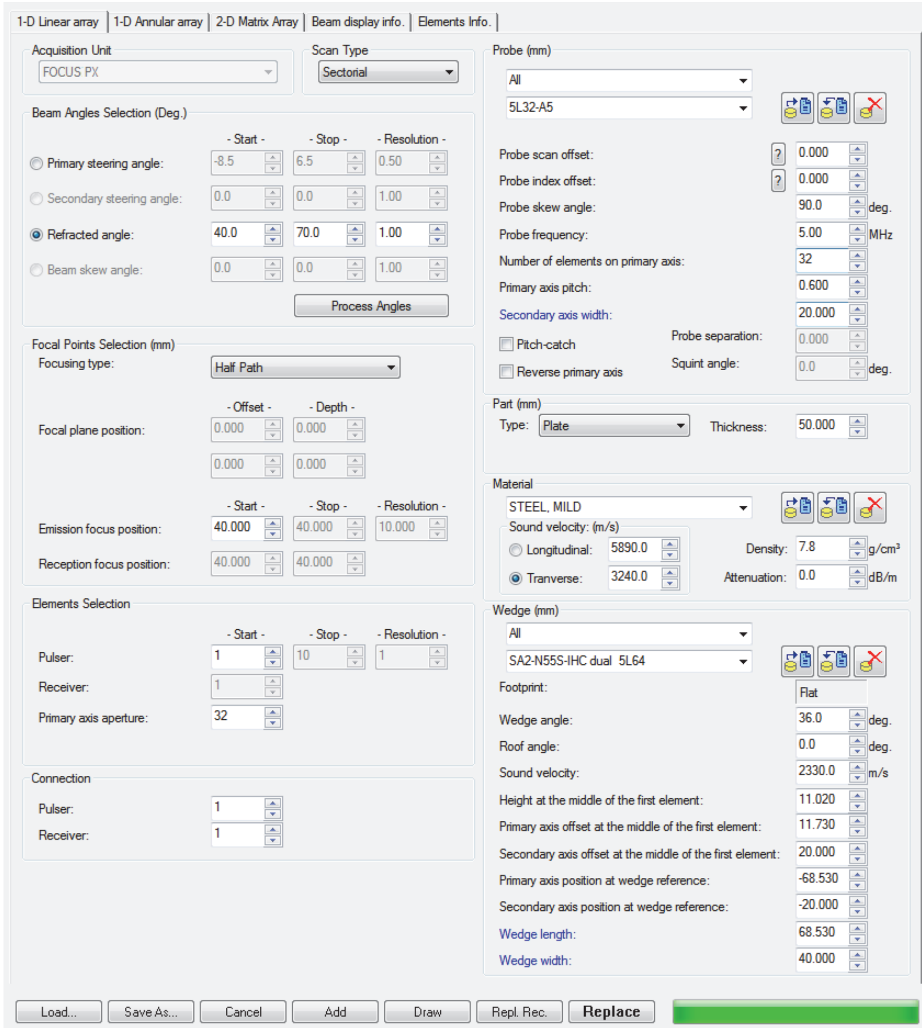


Figure 8-42 Sectorial beams: input parameters for sectorial sweep on a flat part

The results can be examined in the graphic representation on the **Beam display info.** tab (see Figure 8-43 on page 230).

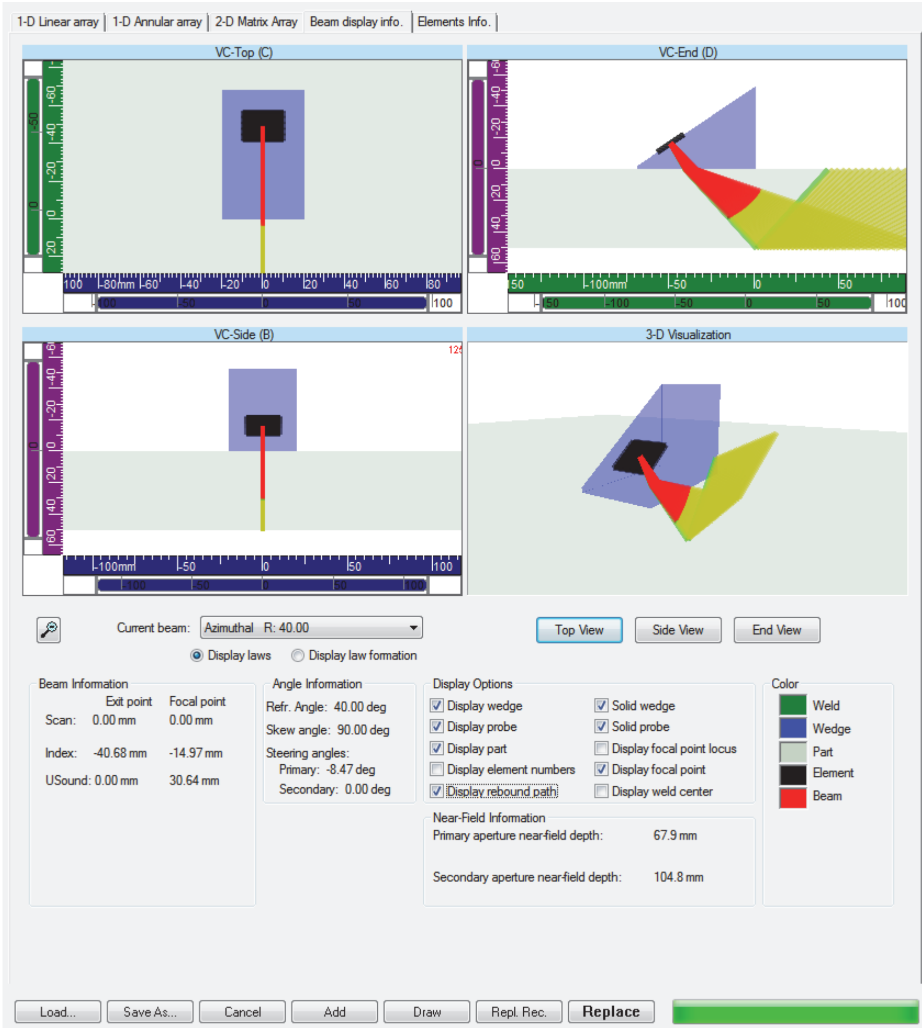


Figure 8-43 Sectorial beams: visualization of sectorial sweep on a flat part

Example 2: single array, flat part, probe parallel to scan axis, “lateral scan”

The following configuration is considered:

- Single 1-D linear array probe, with the following characteristics: 5 MHz nominal frequency, 32 elements, 1 mm pitch, and the width of the elements is 10 mm
- A Rexolite wedge with the following characteristics: no wedge angle, 31° roof angle, 2330 m/s wedge velocity, 12 mm height at the middle of the first element, 9 mm primary axis offset of the first element
- A flat carbon steel part with a wall thickness of 50 mm
- The probe is used to generate shear-wave beams at refracted angles of approximately 45°, skewed from at least −30° to +30° relative to the orientation perpendicular to the scan axis, and focusing at a constant depth of 35 mm; all 32 elements of the probe are to be used to generate the beams.
- The probe itself is oriented parallel to the scanning axis (skew 0°), and the probe is positioned so that the focal points coincide approximately with the index-axis reference (0 point), and so that the center beam is aimed at the scan-axis reference.
- This type of configuration is often called a "lateral scan" technique, and can be used to improve detection of misoriented (skewed) flaws.

In order to generate this set of **Sectorial** beams, the input parameters must be set as shown in Figure 8-44 on page 232.

Attention should be paid to the following parameters:

- The beam angles are selected using the **Primary steering angle** as the input parameter. In the case of a lateral scan with a linear array probe, this is the most efficient way to define the angles, since the refracted angle changes from 53.4° down to 45.6° and back to 53.4°.
- **Height at the middle of the first element:** 12 mm, as previously mentioned
- **Primary axis offset of the first element:** 9 mm, as previously mentioned
- **Secondary axis offset of the first element:** 15 mm, in order to position the probe in the middle of the wedge with a width of 30 mm
- **Primary axis position of wedge reference:** −25 mm, in order to position the center beam focal point end at the scan-axis reference
- **Secondary axis position of wedge reference:** −60 mm, in order to position the focal point locus at the index-axis reference

Also, note that the database has been used to save the probe, wedge, and material parameters (see "Calculator — Using the Databases" on page 275).

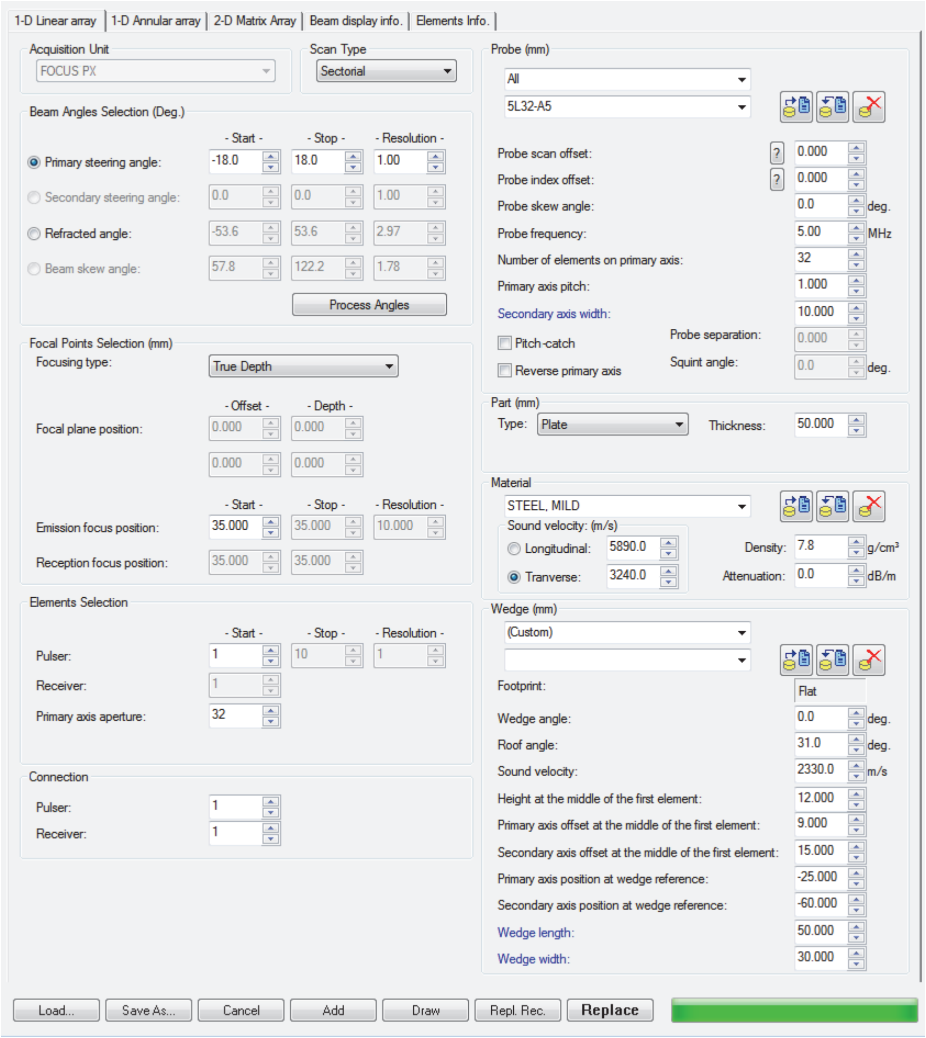


Figure 8-44 Sectorial beams: input parameters for "lateral scan" on a flat part

The results can be examined in the graphic representation on the **Beam display info.** tab (see Figure 8-45 on page 233).

Figure 8-45 Sectorial beams: visualization of "lateral scan" on a flat part

Example 3: dual array, flat part, probe parallel to scan axis

The following configuration is considered:

- Dual 1-D linear array probe (pitch-catch), with the following characteristics: 2.25 MHz nominal frequency, 2 × 16 elements, 1.7 mm pitch, and the width of the elements is 6.6 mm
- The probe contains two identical Rexolite wedges with the following characteristics: 19.2° wedge angle, 4.7° roof angle, 2330 m/s wedge velocity, 5.4 mm height at the middle of the first element, 7.9 mm primary axis offset of the first element; 15 mm probe separation, 6° squint angle
- A flat carbon steel part with a wall thickness of 50 mm
- The probe is oriented parallel to the scanning axis (skew 0°), and the rear end of the probe is positioned at 50 mm from the scan-axis reference (0-point).
- The probe generates compression wave beams in pitch-catch mode at refracted angles from 45° to 70° with a resolution of 5°; all 16 elements of the transmitter and receiver arrays are used to generate the beams. The focalization depth is automatically calculated to focus the transmitter and the receiver at the same position. The focalization is therefore made at the geometrical intersection of the transmitter and the receiver.

In order to generate this set of **Sectorial** beams, the input parameters must be set as shown in Figure 8-46 on page 235.

Attention should be paid to the setting of the following parameters:

- **Height at the middle of the first element:** 5.4 mm, as previously mentioned
- **Primary axis offset of the first element:** 7.9 mm, as previously mentioned
- **Secondary axis offset of the first element:** 5 mm, in order to position the probe in the middle of the wedge with a width of 10 mm
- **Primary axis position of wedge reference:** −50 mm, in order to position the rear end of the wedge at a distance of 50 mm from the scan-axis zero reference
- **Secondary axis position of wedge reference**: −12.5 mm, in order to position the symmetrical line between the transmitter and the receiver arrays at the index-axis zero reference

Also, note that the database has been used to save the probe, wedge, and material parameters (see “Calculator — Using the Databases” on page 275).

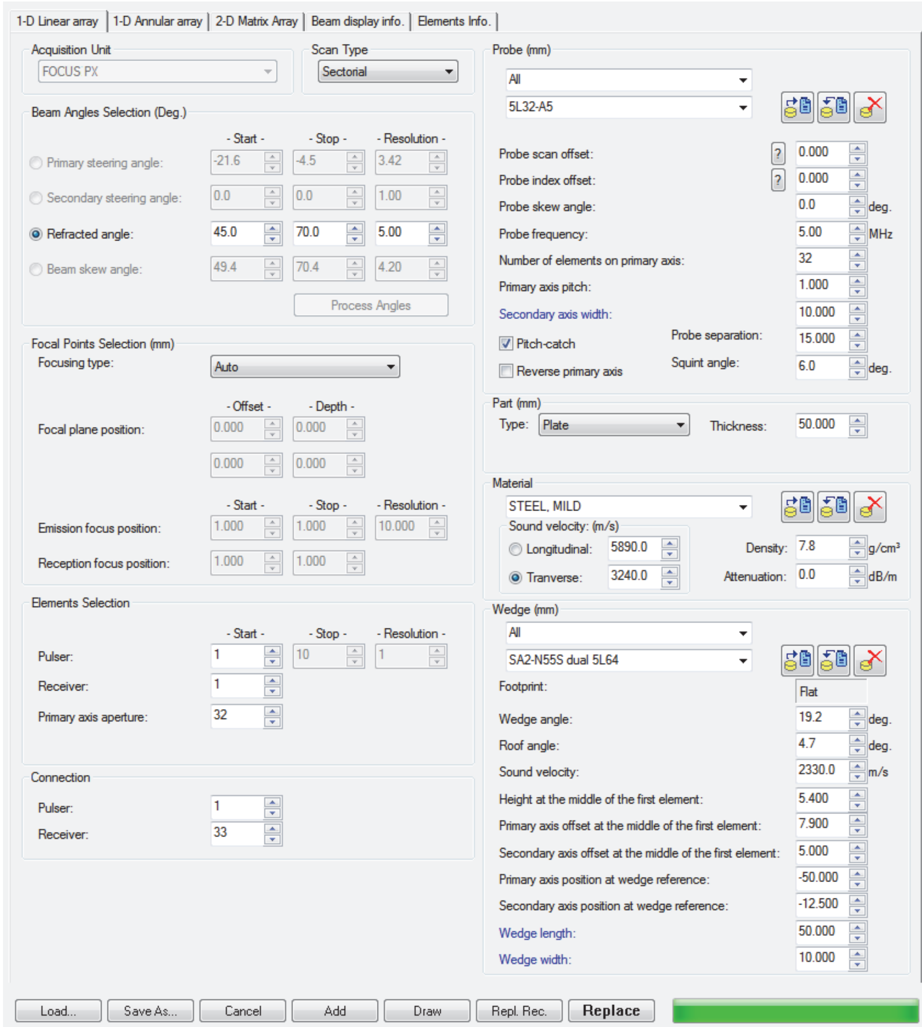


Figure 8-46 Sectorial beams: input parameters for a pitch-catch configuration

The results can be examined in the graphic representation on the **Beam display info.** tab (see Figure 8-47 on page 236).

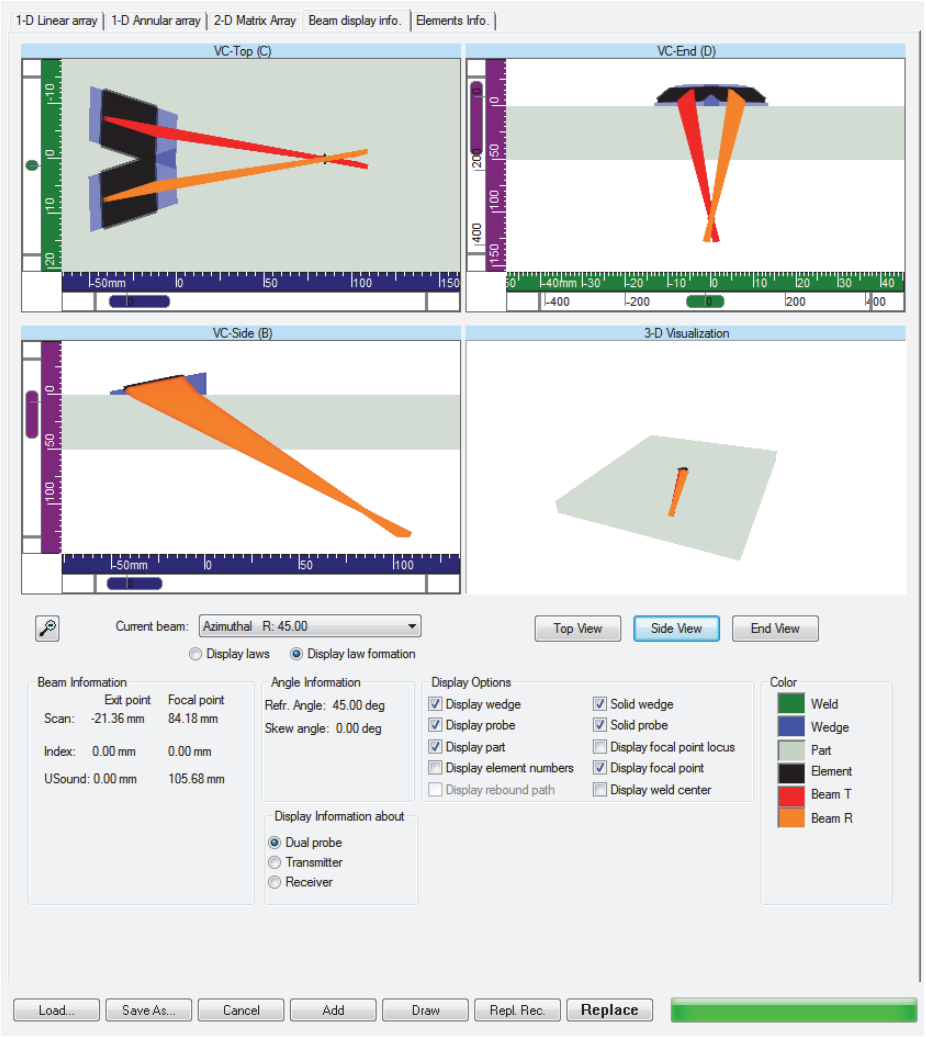


Figure 8-47 Sectorial beams: visualization of a pitch-catch configuration

Example 4: single array, pipe OD, probe perpendicular to the pipe axis

The following configuration is considered:

- Single 1-D linear array probe, with the following characteristics: 5 MHz nominal frequency, 32 elements, 1 mm pitch, and the width of the elements is 10 mm
- A Rexolite wedge with the following characteristics: 36° wedge angle, no roof angle, 2330 m/s wedge velocity, 9 mm height at the middle of the first element, 7 mm primary axis offset of the first element, a curvature along primary axis with an 80 mm distance between contact points
- A pipe inspected from the outside diameter (Pipe OD) in carbon steel with an outside radius of 150 mm and a wall thickness of 25 mm
- The probe is oriented parallel to the scanning axis (skew 0°) and perpendicular to the pipe axis. The rear end of the probe is positioned at 40 mm from the scan-axis reference (0 point).
- The probe generates shear-wave beams in pulse-echo mode at refracted angles from 35° to 55° with a resolution of 5°, focusing at a constant cylindrical depth of 25 mm (focusing on the back wall of the pipe); all 32 elements of the probe are to be used to generate the beam.

In order to generate this set of **Sectorial** beams, the input parameters must be set as shown in Figure 8-48 on page 238.

Attention should be paid to the setting of the following parameters:

- **Height at the middle of the first element:** 9 mm, as previously mentioned
- **Primary axis offset of the first element:** 7 mm, as previously mentioned
- **Secondary axis offset of the first element:** 20 mm, in order to position the probe in the middle of the wedge with a width of 40 mm
- **Primary axis position of wedge reference:** −40 mm, in order to position the rear end of the wedge at a distance of 40 mm from the scan-axis zero reference and to position the center of the pipe at the scan-axis zero reference
- **Secondary axis position of wedge reference:** −20 mm, in order to position the middle of the wedge at the index-axis zero reference

Also, note that the database has been used to save the probe, wedge, and material parameters (see “Calculator — Using the Databases” on page 275).

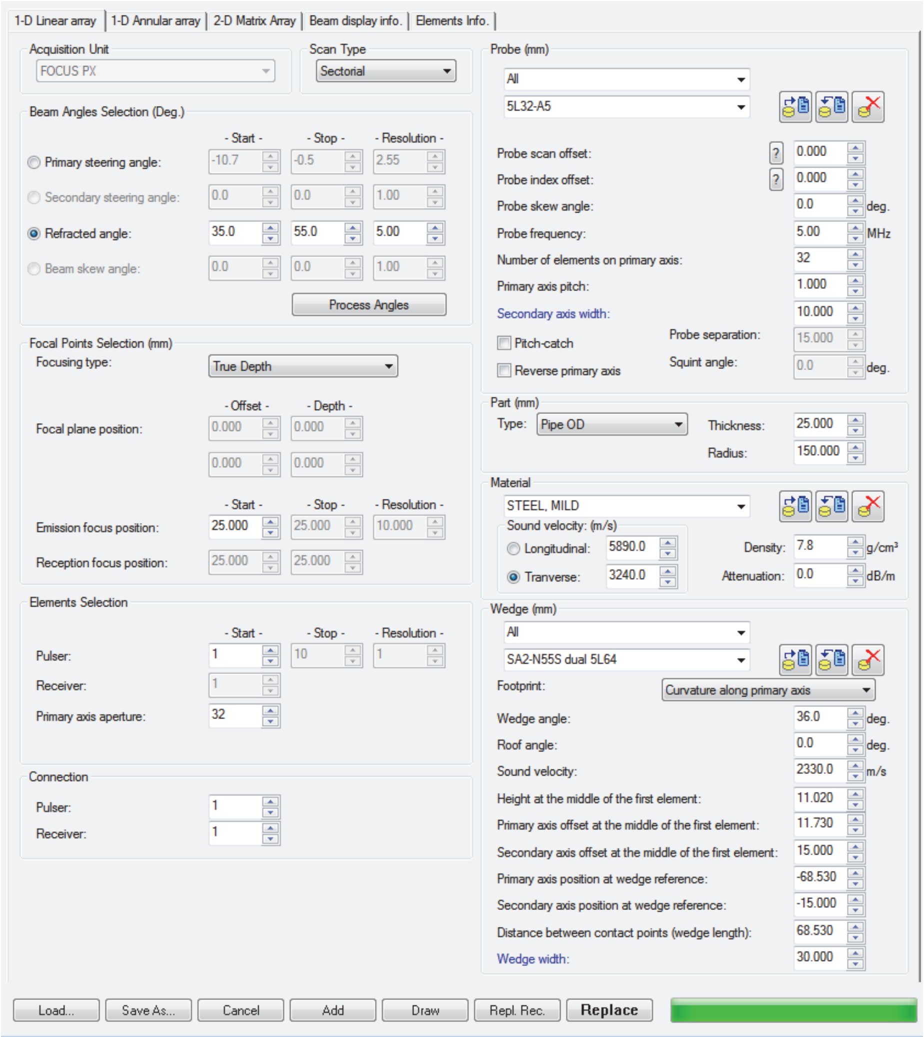


Figure 8-48 Sectorial beams: input parameters for sectorial sweep on a pipe part

The results can be examined in the graphic representation on the **Beam display info.** tab (see Figure 8-49 on page 239).

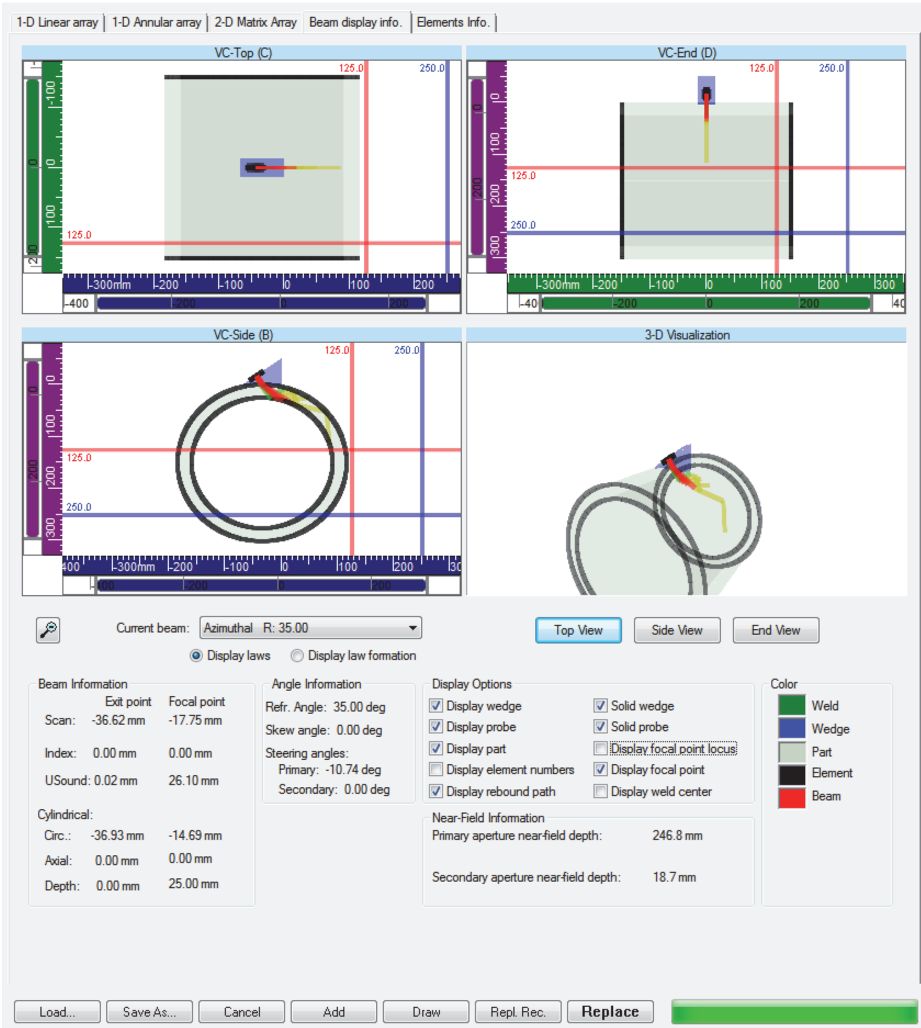


Figure 8-49 Sectorial beams: visualization of sectorial sweep on a pipe part

8.6 Linear Beam Creation

Linear beams are ultrasonic beams that are generated at a fixed refracted angle and a fixed focusing distance, but with a primary aperture traveling along the array, thus generating the same beams with a different set of active elements. By moving the beam along a transducer array, scanning along an inspection axis is achieved electronically without physically displacing the transducer (see Figure 8-50 on page 240).

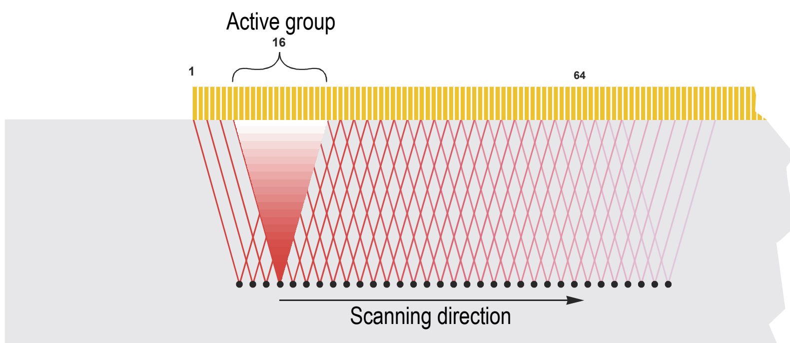


Figure 8-50 Electronic scanning along an axis

To illustrate the use of the Calculator for creating **Linear** beams for a 1-D linear array probe, the following typical application is given as an example.

Example 1: single array, flat part, probe perpendicular to scan axis

The following configuration is considered:

- Single 1-D linear array probe, with the following characteristics: 5 MHz nominal frequency, 64 elements, 1 mm pitch, and the width of the elements is 10 mm
- A Rexolite wedge with the following characteristics: 36° wedge angle, no roof angle, 2330 m/s wedge velocity, 12 mm height at the middle of the first element, 9 mm primary axis offset of the first element
- A flat carbon steel part with a wall thickness of 50 mm
- The probe is oriented perpendicular to the scanning axis (skew 90°), and the rear end of the probe is positioned at 100 mm from the index-axis reference (0 point).

- The probe generates shear-wave beams in pulse-echo mode at a refracted angle of 55°, focusing at a constant half-path distance of 50 mm. 16 elements of the probe are used to generate the beams.

In order to generate this set of **Linear** beams, the input parameters must be set as shown in Figure 8-51 on page 242.

Attention should be paid to the setting of the following parameters:

- **Height at the middle of the first element:** 12 mm, as previously mentioned
- **Primary axis offset of the first element:** 9 mm, as previously mentioned
- **Secondary axis offset of the first element:** 15 mm, in order to position the probe in the middle of the wedge with a width of 30 mm
- **Primary axis position of wedge reference:** −100 mm, in order to position the rear end of the wedge at a distance of 100 mm from the index-axis zero reference
- **Secondary axis position of wedge reference:** −15 mm, in order to position the middle of the wedge at the rear end of scan-axis zero reference

Also, note that the database has been used to save the probe, wedge, and material parameters (see “Calculator — Using the Databases” on page 275).

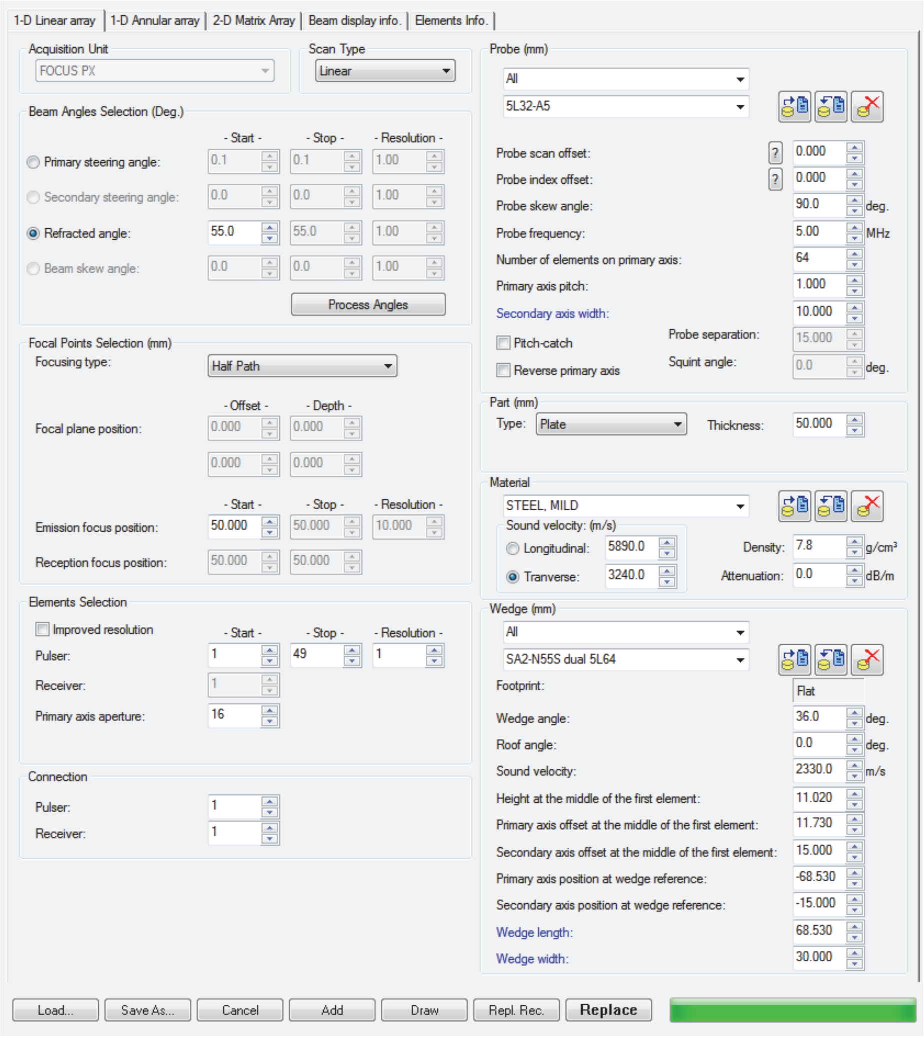


Figure 8-51 Linear beams: input parameters

The results can be examined in the graphic representation on the **Beam display info.** tab (see Figure 8-52 on page 243).

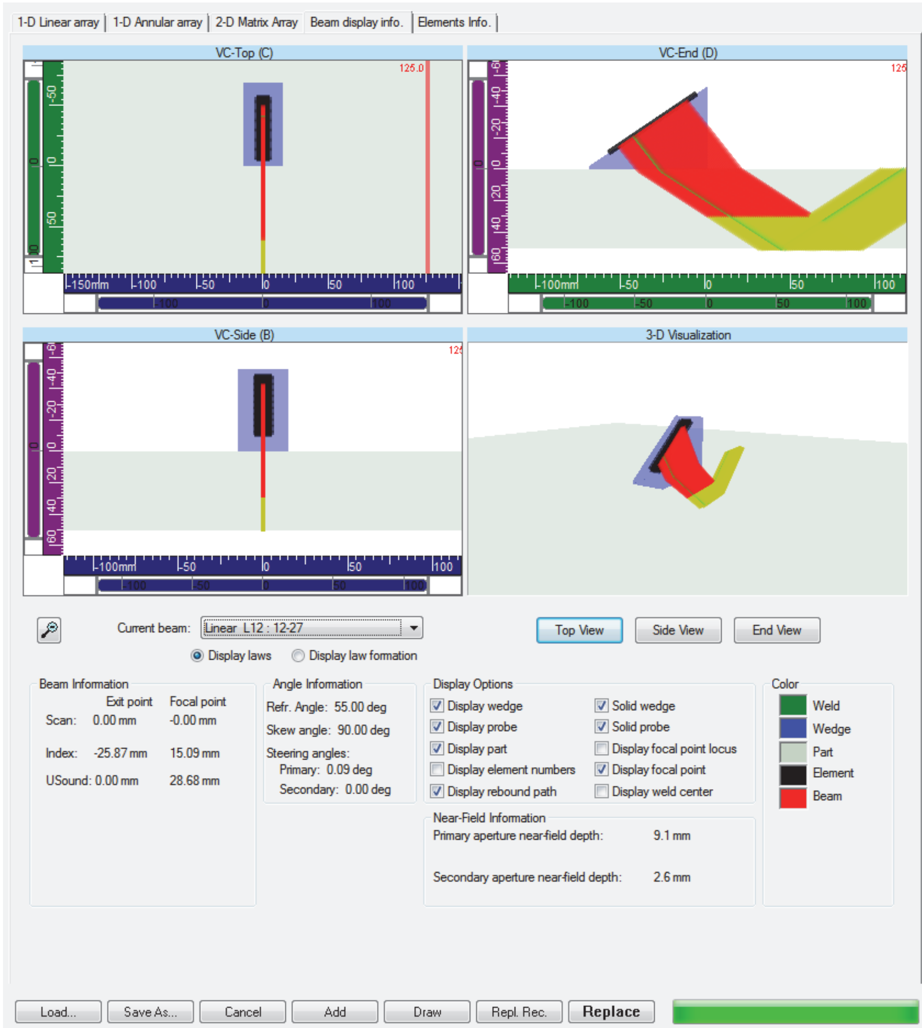


Figure 8-52 Linear beams: visualization

8.7 Saving a Calculator Setup File (.xcal)

To save a Calculator setup file (.xcal)

1. Enter the parameters of the beams to be generated.
2. On the menu, select **File > Save As** or click **Save As** at the bottom of the Calculator dialog box.
3. In the **Save As** dialog box, do the following:
   a) Select the folder where you want to save the .xcal file.
   b) Enter an appropriate file name.
   c) In the **Save as type** box, select **Extended Calculator Setup Files (*.xcal)**.
   d) Click **Save** (see Figure 8-53 on page 244).

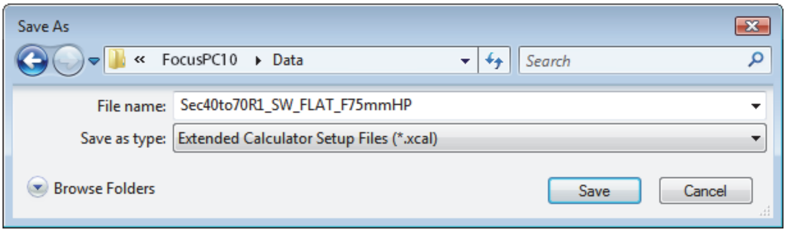


Figure 8-53 The Save As dialog box

NOTE

The Calculator Setup File contains only the parameter values and settings entered in the Calculator; it does not contain the generated beams (the delays to be programed in the instrument).

8.8 Saving a Beam File (.law)

You can save the Calculator configuration to a beam file (.law) that can later be imported.

To save a beam file (.law)

1. Enter the parameters of the beams to be generated
2. On the menu, select **File > Save As** or click **Save As** at the bottom of the Calculator dialog box.
3. In the **Save As** dialog box, do the following:
   a) Select the folder where you want to save the .law file.
   b) Enter an appropriate file name.
   c) In the **Save as type** box, select **Law Files (*.law)**.
   d) Click **Save** (see Figure 8-54 on page 245).

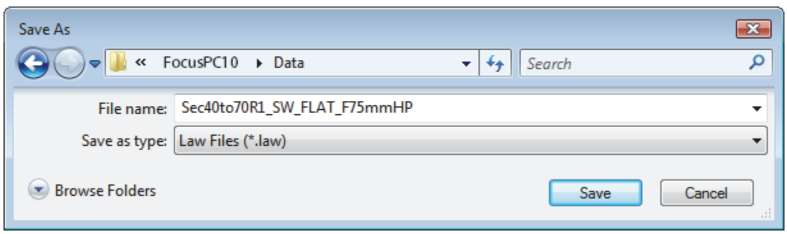


Figure 8-54 The Save As dialog box

9. Calculator — 1-D Annular Arrays Tab

This section presents 1-D annular arrays and describes the Calculator's **1-D Annular array** tab.

9.1 Generic Conventions

To generate beams for 1-D annular arrays in the most efficient and accurate way, you should take into account the generic conventions regarding the probe wedge.

9.1.1 Probe Conventions

Fresnel annular array

When a **Fresnel** type annular array is used, only the **First radius** (**R_1**) and the **Spacing between elements** (**S**) must be specified (see "Probe Area" on page 254). Based on these values, the internal and external radii of the successive elements are calculated according to the following formula:

$$R_1^2 = R_1^{\text{ext}^2} - R_1^{\text{int}^2} = R_N^{\text{ext}^2} - R_N^{\text{int}^2}$$

A **Fresnel** type annular array is characterized by the fact that all elements have the same surface area, and they are separated by a constant distance (see Figure 9-1 on page 248).

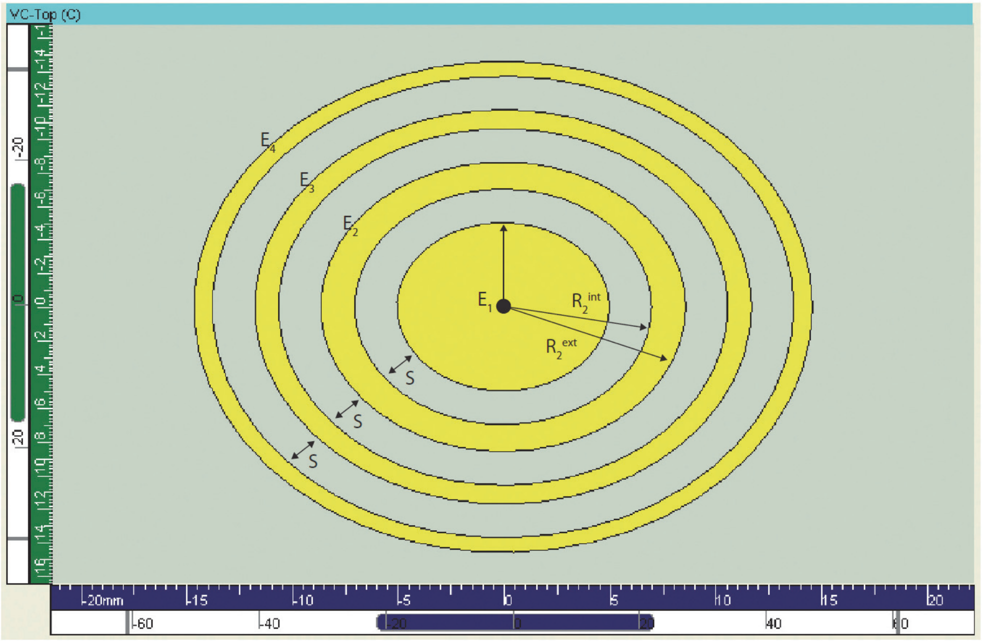


Figure 9-1 Fresnel annular array

The central element is always positioned at the zero point of the scan axis and of the index axis.

Custom annular array

When a **Custom** type annular array is used, the **Internal Radius** (R_n^{int}) and the **External Radius** (R_n^{ext}) of each element must be specified (see "Probe Area" on page 254). Based on these values, the distance between each element is calculated.

A **Custom** type annular array can have different radii and variable spacing between consecutive elements (see Figure 9-2 on page 249).

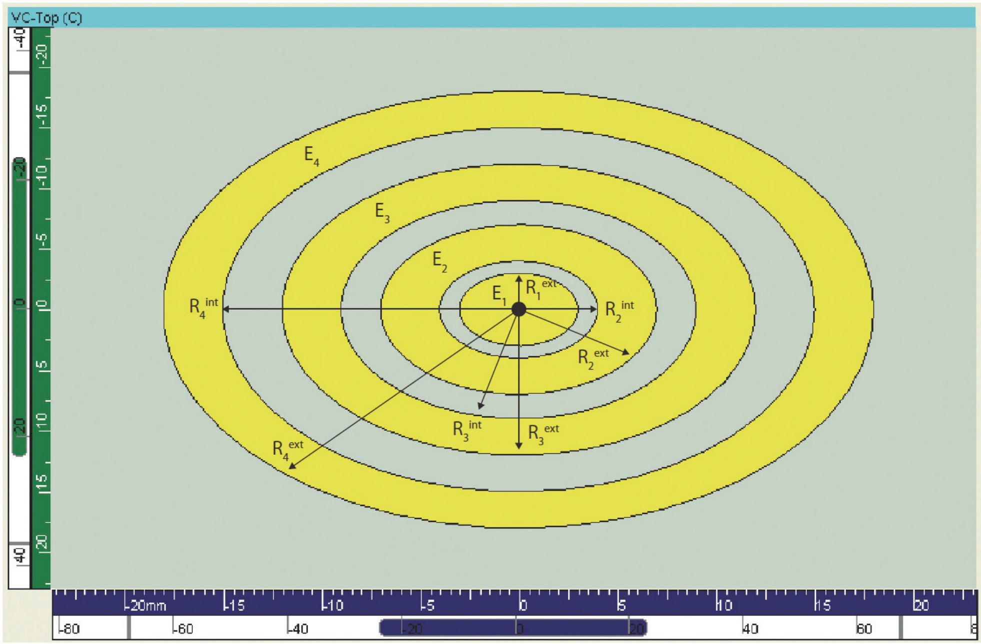


Figure 9-2 Custom annular array

The central element is always positioned at the zero point of the scan axis and of the index axis.

9.1.2 Important Details on the Delay Calculation

For both **Fresnel** type and **Custom** type annular arrays, the delay for each element is calculated at the radius R_i^{calc}, for which the following statement is true: half of the surface of the element is within this radius and half of the surface of the element is outside of this radius. Mathematically, this is expressed as follows:

$$R_i^{\text{ext}^2} - R_i^{\text{calc}^2} = R_i^{\text{calc}^2} - R_i^{\text{int}^2}$$

9.2 Tab Description

The **1-D Annular array** tab is divided into seven areas (see Figure 9-3 on page 250).

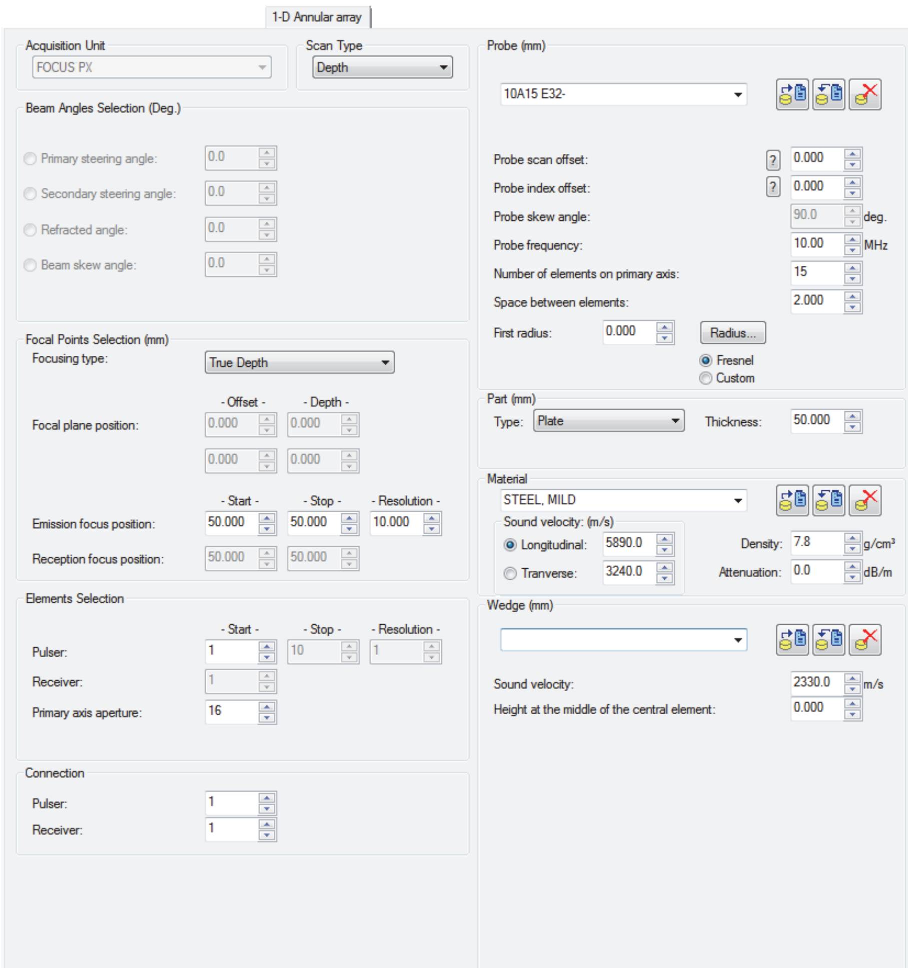


Figure 9-3 The 1-D Annular array tab

9.2.1 Acquisition Unit Area

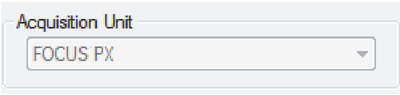


Figure 9-4 The Acquisition Unit area

The **Acquisition Unit** area (Figure 9-4 on page 251) contains only one list for the selection of the type of acquisition instrument for which you want to create beams. The beam calculation uses slightly different compensation gain for each acquisition instrument type. The list is available only when no acquisition instrument is connected to the computer. The acquisition instrument is automatically detected when it communicates with the computer.

9.2.2 Scan Type Area

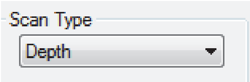


Figure 9-5 The Scan Type area

The **Scan Type** area (see Figure 9-5 on page 251) is used to select the type of beams to be generated:

- **Depth:** the focusing depth of the ultrasonic beam varies.
- **Static:** the focusing depth of the ultrasonic beam is fixed (generates a single beam).

9.2.3 Beam Angles Selection Area

Figure 9-6 The Beam Angles Selection area

The **Beam Angles Selection** area (see Figure 9-6 on page 252) is not applicable for the 1-D annular array option, because only ultrasonic beams at 0° (longitudinal waves) are considered.

9.2.4 Focal Points Selection Area

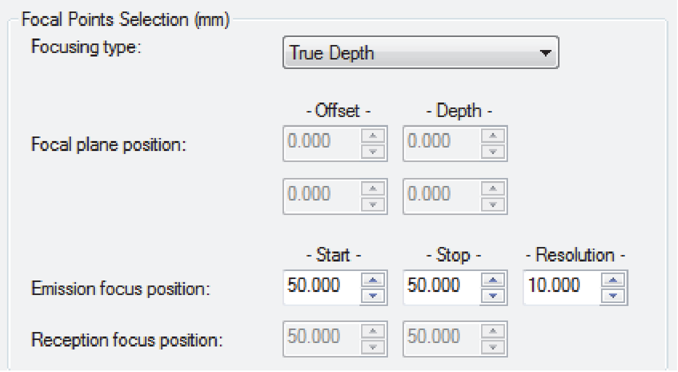


Figure 9-7 The Focal Points Selection area

The **Focal Points Selection (mm)** area (see Figure 9-7 on page 252) contains the following parameters:

Focusing type

Selects the type of focusing of the beams to be generated:

— **True depth:** all beams are focused at a constant true-depth value. For a cylindrical part, the true-depth value is the depth in the cylindrical geometry.

— **Half path:** all beams are focused at a constant half-path (distance) value.

— **Projection:** all beams are focused on a given vertical plane; this option is not applicable for depth laws or pitch-catch configurations.

— **Focal plane:** all beams are focused on a user-defined focal plane (see Figure 8-27 on page 211); this option is not applicable for depth laws or for pitch-catch configurations.

Focal plane position

Not applicable for a 1-D annular array.

Emission focus position (depth)

Defines the desired focusing depth of the ultrasonic beam to be generated.

For **Depth** beams: the three boxes are used to set the desired initial (**Start**) and final (**Stop**) focusing depth of the ultrasonic beam to be generated and to set its resolution.

Reception focus position (depth)

Defines the desired focusing depth (applied delay) for the received signal.

9.2.5 Elements Selection Area

Figure 9-8 The Elements Selection area

The **Elements Selection** area (see Figure 9-8 on page 253) contains the following parameters:

Pulser

Use to set the first element of the active pulser group.

Receiver

Use to set the first element of the active receiver group.

Primary axis aperture

Use to set the number of elements used simultaneously to generate beams.

9.2.6 Probe Area

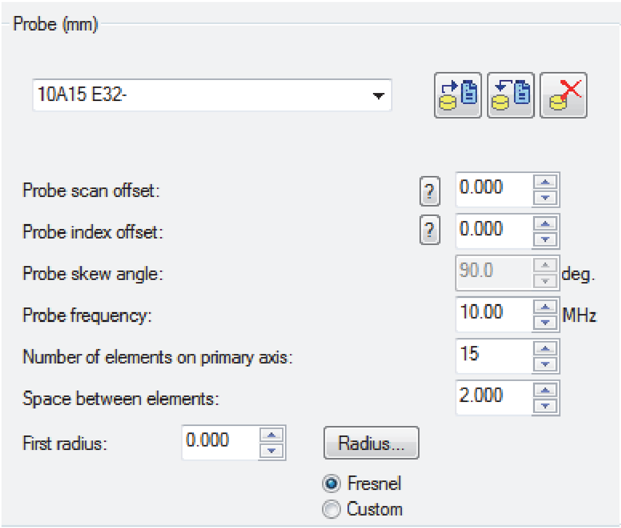


Figure 9-9 The Probe area for annular arrays

The **Probe** area (see Figure 9-9 on page 254) contains the following parameters:

Probe database

Use the list and the buttons to select, save, or delete a probe in the **Probe** database.

 **Load from database**

Use to load a probe configuration from the probe database.

Save in database

Use to save the active probe configuration in the probe database.

Delete from database

Use to delete a probe configuration from the probe database.

Probe skew angle (deg)

Defines the skew angle of the probe. The probe skew angle is always 0° for a 1-D annular array since it only generates ultrasonic beams at 0°.

Probe frequency (MHz)

Defines the probe frequency.

Number of elements on primary axis

Defines the number of elements on the primary axis (radial) of the current probe.

First radius (mm)

Defines the radius of the central element. This parameter is only applicable for Fresnel type annular arrays (see Figure 9-1 on page 248).

Space between elements (mm)

Defines the space between two consecutive elements; that is, the distance between the external radius of the n^{th} element to the internal radius of the $(n+1)^{th}$ element. Only applicable for Fresnel type annular arrays (see Figure 9-1 on page 248).

Radius button

Opens the **Annular Array Radius** dialog box (see Figure 9-10 on page 256), which enables the creation of a **Custom** annular array.

When a **Fresnel** type annular array is used, the dialog box provides the possibility to verify the radius of each element.

Fresnel option button

Defines a **Fresnel** type annular array characterized by the fact that each element has the same surface (same area) and is separated by a constant distance (see Figure 9-1 on page 248).

Custom option button

Defines a **Custom** type annular array with arbitrary radii and a variable spacing between consecutive elements (see Figure 9-2 on page 249).

9.2.7 Annular Array Radius Dialog Box

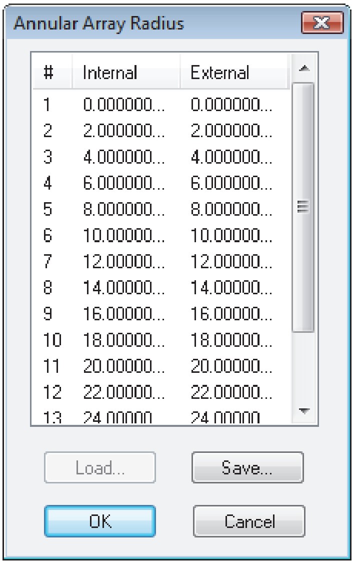


Figure 9-10 The Annular Array Radius dialog box

The **Annular Array Radius** dialog box (see Figure 9-10 on page 256) contains the following parameters:

Load button

Opens a standard **Open** dialog box, which enables you to load a text file (.txt file) containing the internal and external radius of each element.

Save button

Opens a standard **Save As** dialog box, which enables you to save the internal and the external radii of each element in a text file (.txt file).

It is important to note that the internal and external radii of a **Custom** annular array defined in the **Annular Array Radius** dialog box are not saved in the .xcal file.

OK button

Applies the defined radius.

Cancel button

Closes the **Annular Array Radius** dialog box.

9.2.8 Part Area

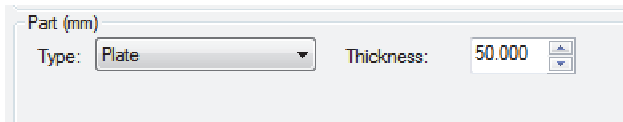


Figure 9-11 The Part area for flat part

The **Part** area (see Figure 9-11 on page 257) contains the following parameters:

Type

Defines the part type supported by the Calculator—for example, **Plate**, which is a flat part.

Thickness (mm)

Defines the thickness of the part to be displayed on the **Beam Display Info** tab.

9.2.9 Material Area

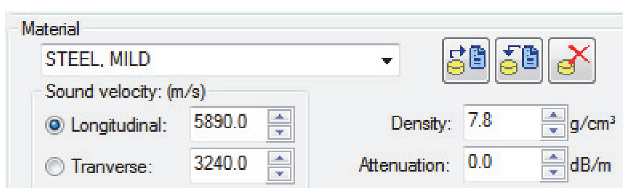


Figure 9-12 The Material area for flat part

Material database

Use the list and the buttons to select, save, or delete a material type in the **Material** database.

 **Load from database** button

Use to load a material configuration from the material database.

 **Save in database** button

Use to save the active material configuration in the material database.

 **Delete from database** button

Use to delete a material configuration from the material database.

Sound velocity area

Defines the sound velocities in the material to be inspected for the available wave types, **Longitudinal** (compression) or **Transverse** (shear) waves, in meters/second.

Density

Defines the density of the selected material.

Attenuation

Used to set the ultrasonic attenuation for the selected material.

9.2.10 Wedge Area

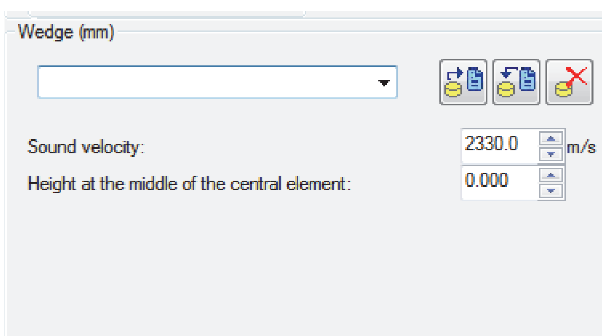


Figure 9-13 The Wedge area for annular arrays

The **Wedge** area (see Figure 9-13 on page 258) contains the following parameters:

Wedge database

Use the list and the buttons to select, save, or delete a wedge in the **Wedge** database.

 **Load from database**

Use to load a wedge configuration from the wedge database.

 **Save in database**

Use to save the active wedge configuration in the wedge database.

 **Delete from database**

Use to delete a wedge configuration from the wedge database.

Sound velocity (m/s)

Defines the sound velocity in the wedge.

Height at the middle of the central element (mm)

Defines the height at the middle of the central element relative to the material surface.

9.3 Creating Depth Beams for Annular Arrays

Depth beams are a set of ultrasonic beams that focus at different depths.

To illustrate the use of the calculator for creating **Depth** beams for a 1-D annular array probe, the following typical application is given as an example.

Example 1: Fresnel annular array

The following configuration is considered:

- Single 1-D annular array probe, Fresnel type with the following characteristics: 5 MHz nominal frequency, 16 elements, 5 mm first radius, and the spacing between elements is 2 mm
- A Rexolite wedge with the following characteristics: 2330 m/s wedge velocity, 10 mm height at the middle of the central element
- A flat carbon steel part with a wall thickness of 100 mm

- The probe generates compression wave beams in pulse-echo mode at 0°, focusing between a true-depth distance of 10 mm to 90 mm with a depth resolution of 10 mm; all 16 elements of the probe are to be used to generate the beam.

In order to generate this set of **Depth** beams, the input parameters must be set as shown in Figure 9-14 on page 261.

Note that the database has been used to save the probe, wedge, and material parameters (see “Calculator — Using the Databases” on page 275).

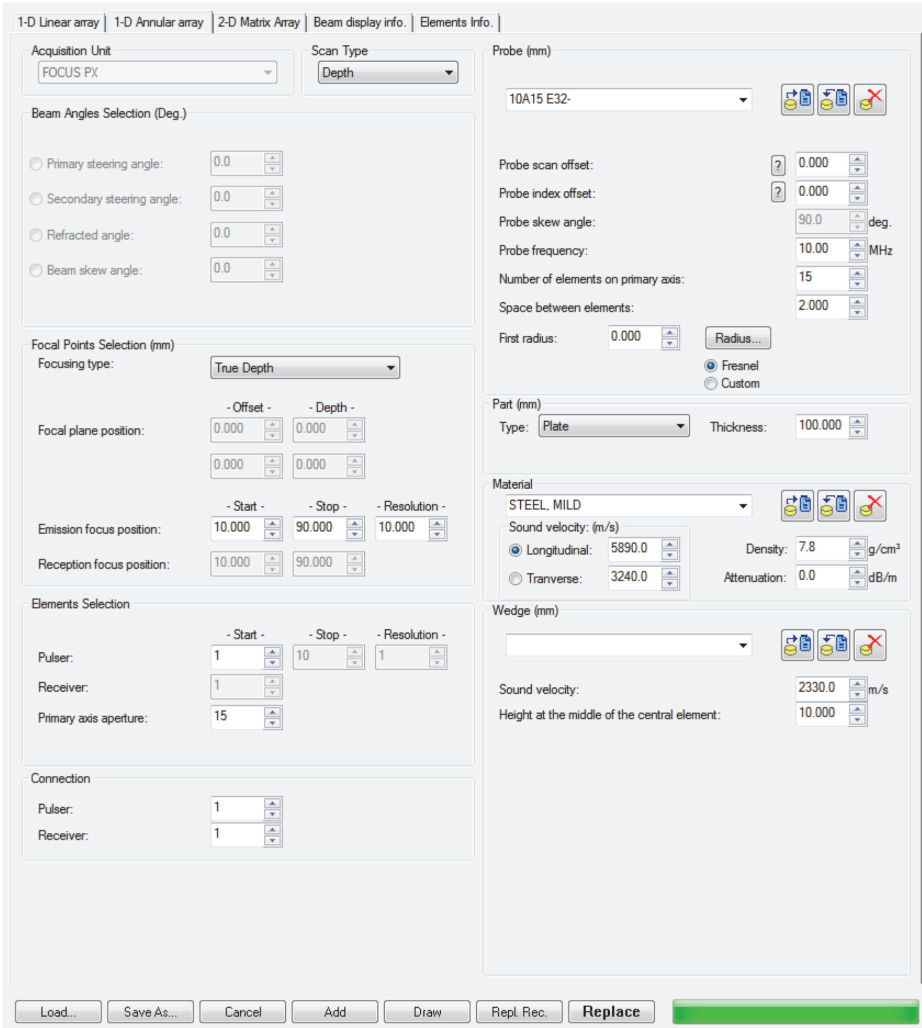


Figure 9-14 Fresnel annular array: Depth beam input parameters

The results can be examined in the graphic representation on the **Beam display info.** tab (see Figure 9-15 on page 262).

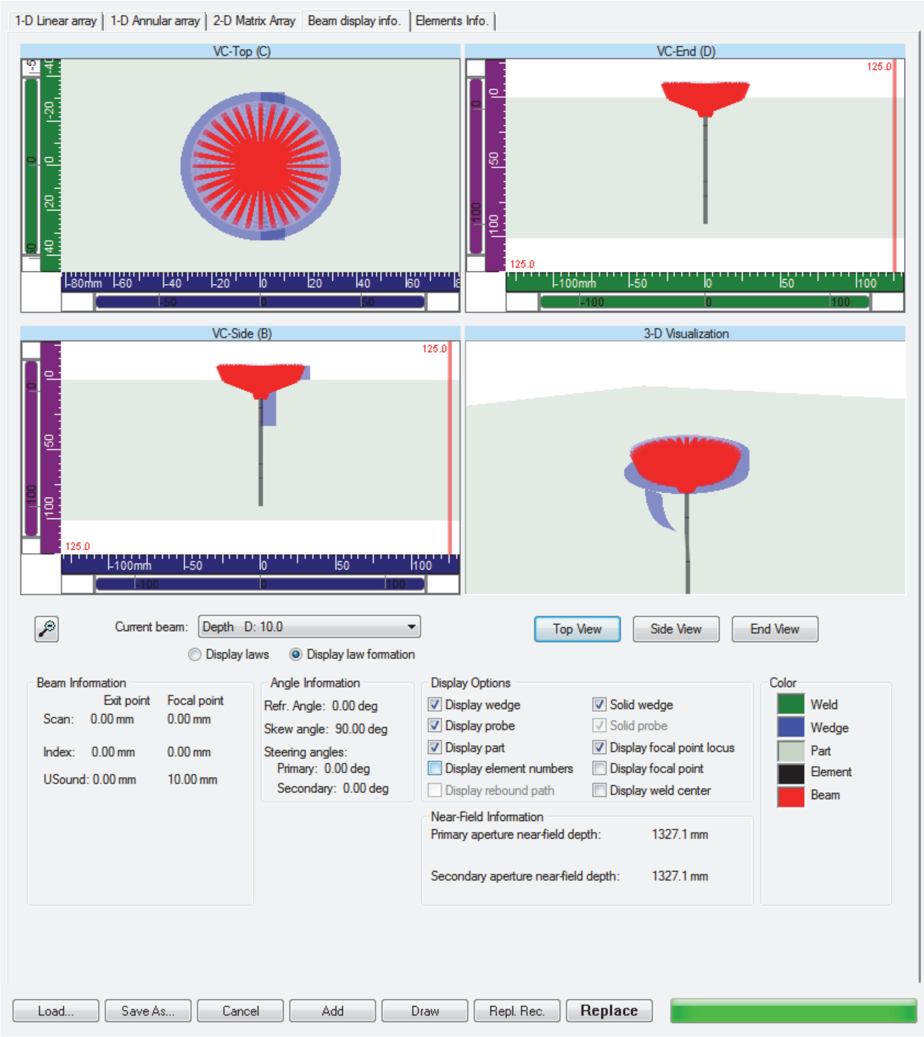


Figure 9-15 Fresnel annular array: Depth beam visualization

10. Calculator — 2-D Matrix Array Tab

This section describes how to create beams when inspecting parts using a 2-D matrix probe.

Sectorial beams are a set of ultrasonic beams that are generated at a fixed focusing distance with a fixed primary aperture, though at different inspection angles (refracted angles and/or skew angles).

The following is an example of configuration of **Sectorial** beams.

The probe, part, and wedge parameters are as follows:

- Two 2-D matrix probe, 5 MHz, 16 elements organized as follows: 4 elements on the primary axis and 4 elements on the secondary axis. The primary and secondary axis pitches are 2 mm. The probe configuration is of the type 1 (as defined in the Calculator).
- The part is a flat steel part with a thickness of 50 mm. The sound velocity in the part is 3200 m/s.
- A wedge, with a 2330 m/s sound velocity, is angled at 30°. The height at the middle of the first element is 4 mm and the primary axis offset of the first element is 3 mm. The secondary axis offset of the first element is also 3 mm. The wedge is 12 mm long and 12 mm wide.

The inspection parameters are as follows:

- The inspection is done in the pulse-echo mode, using longitudinal waves.
- The focusing type is true-depth and the beam is focused at 10 mm.
- The probe motion is parallel to the scanning axis (skew 0°).
- The steering angles ranges from −10° to 10° in steps of 2° on both primary and secondary axes.
- The aperture uses all the elements of the probe.

Figure 10-1 on page 264 presents the parameters to be entered to create the sectorial beams.

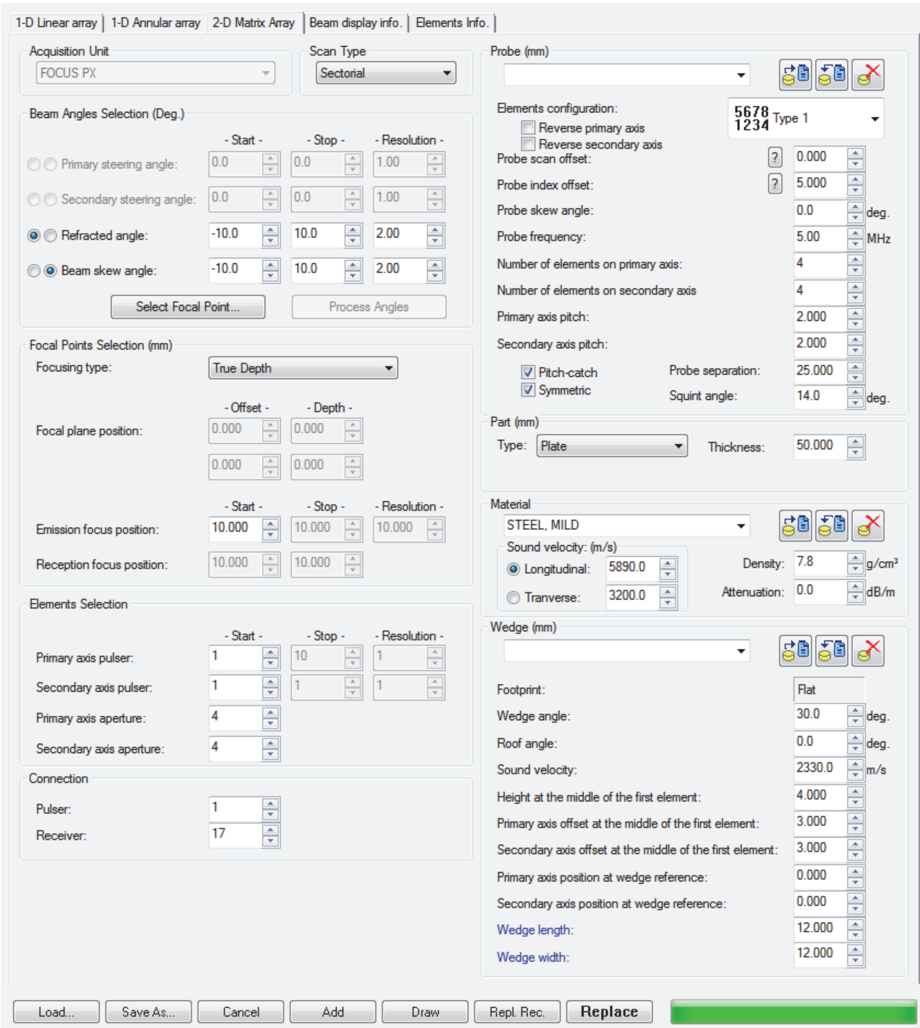


Figure 10-1 Example of parameters of sectorial beams for a 2-D matrix probe

The results can be examined in the graphic representation on the **Beam display info.** tab (see Figure 10-2 on page 265).

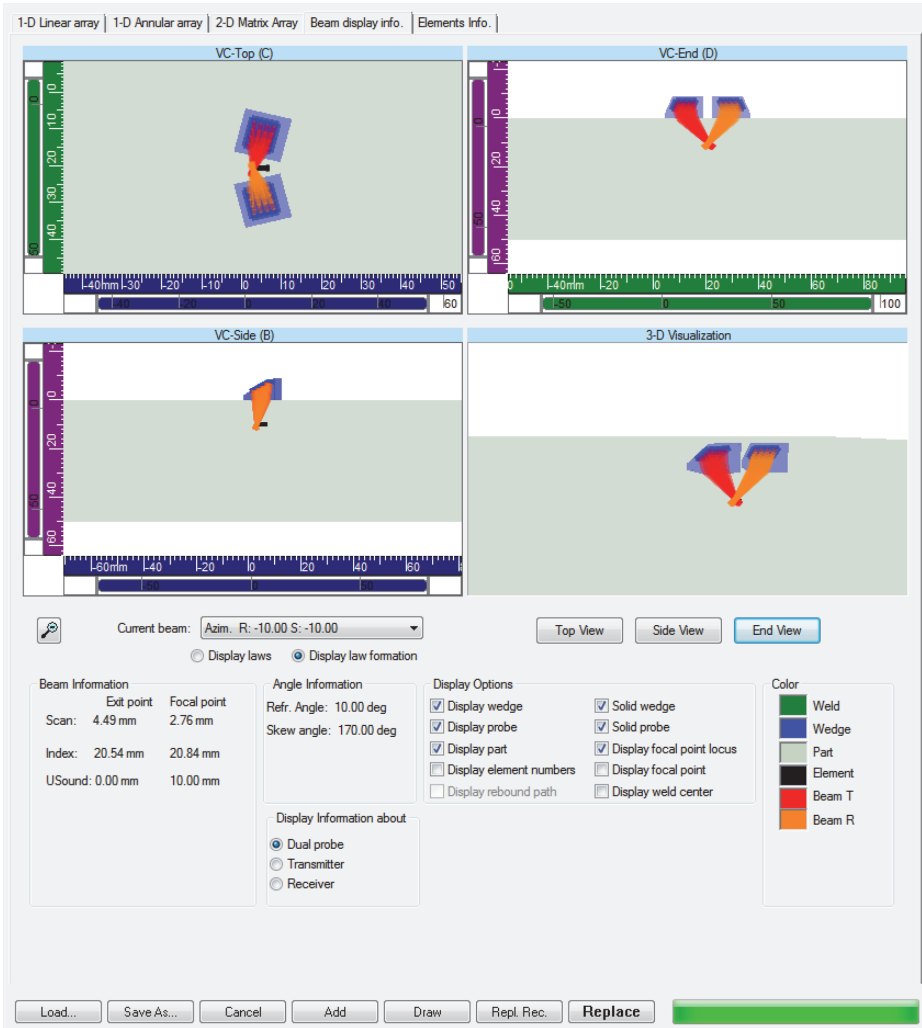


Figure 10-2 Graphic representation of the sectorial beams for a 2-D matrix probe

11. Calculator — Beam Display Info. Tab

The Calculator’s **Beam display info.** tab (see Figure 11-1 on page 268) can be used to verify and validate the inputs and the resulting beams for any of the supported array types. In addition to a graphical representation of the defined probe, wedge, and part, it also provides detailed numerical information for each of the created delay laws: position of beam exit point and focal point, beam refracted angle and skew angle, etc.

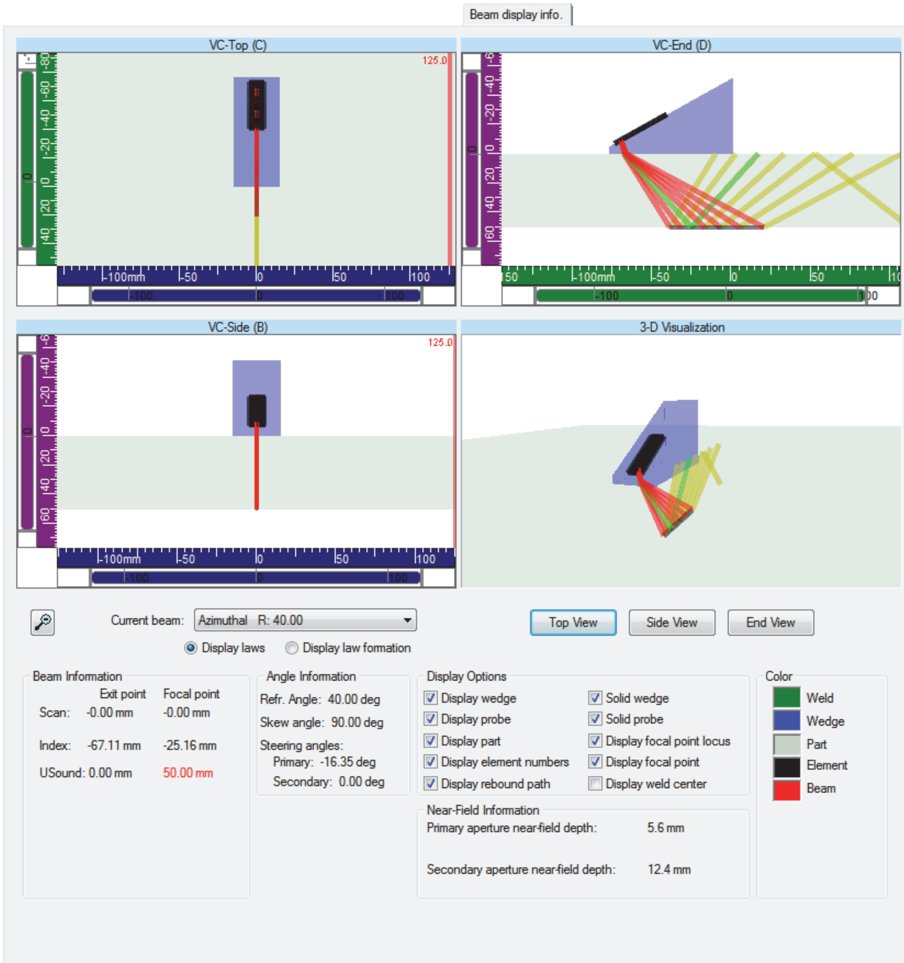


Figure 11-1 The Beam display info. tab

The **Beam display info.** tab (see Figure 11-1 on page 268) contains the following data:

VC-Top (C)

This volume-corrected view is a 2-D graphical representation of the top view of the defined probe and part. One of the axes is the scan axis and the other is the index axis. The defined probe and wedge can be displayed along with the ray tracing of the beams.

VC-Side (B)

This volume-corrected view is a 2-D graphical representation of the side of the defined probe and part. One of the axes is the scan axis and the other is the ultrasonic (**Usound**) axis. The defined probe and wedge can be displayed along with the ray tracing of the beams.

VC-End (D)

This volume-corrected view is a 2-D graphical representation of the end of the defined probe and part. One of the axes is the index axis and the other is the ultrasonic (**Usound**) axis. The defined probe and wedge can be displayed along with the ray tracing of the beams.

3-D

This view is a 3-D representation of the defined probe, wedge, and part.

The **Top View** button automatically readjusts the zoom and repositions the pane content in order to get a representation from the top of the part.

The **Side View** button automatically readjusts the zoom and repositions the pane content in order to get a representation from the side of the part.

The **End View** button automatically readjusts the zoom and repositions the pane content in order to get a representation from the end of the part.

In the **3-D Visualization** view:

— Click and drag to rotate the 3-D model.

— Right-click and drag to move the 3-D model.

— Click the wheel button and drag to zoom in or out the view.

Fit Image to Pane ()

This button simultaneously unzooms the content of the four views.

Current beam

Identifies the current beam.

Sectorial laws, depending on the **Beam angle selection**, are identified as follows:

Sectorial **A:** angle

Sectorial **St:** steering angle

Sectorial **Sk:** skew angle

Linear laws are identified as follows:

Linear L: 1-16, where **1** and **16** represent the first and the last element used to generate the law

Depth laws are identified as follows:

Depth D: 45, where **45** represents the focalization depth

Static laws are identified as follows:

Static A: 30, where **30** represents the refracted angle

Beam information

Indicates the beam **Exit point** and **Focal point** in Cartesian coordinates (**Scan**, **Index**, and **Usound**) and, for cylindrical coordinates (**Circumferential**, **Axial**, and **Depth**) for the current beam.

Angle information

Indicates the **Refr. Angle** (refracted angle), the total **Skew angle** (beam skew angle + probe skew angle), the **Primary**, and the **Secondary Steering angle** of the current beam.

Display options

Use these check boxes to display or hide the following options:

— Wedge (wire frame) or solid wedge
— Probe (wire frame) or solid probe
— Part
— Element numbers
— Focal point
— Focal point locus
— Rebound path
— Weld center

The user-defined options are saved upon closing the Calculator.

Color

Use to define the color of the following components:

— **Wedge**
— **Part**
— **Element**
— **Beam**

The user-defined colors are saved upon closing the Calculator.

Near-Field information

Indicates the **Primary Aperture Near-Field Depth** and the **Secondary Aperture Near-Field Depth.**

12. Calculator — Elements Info. Tab

The Calculator's **Elements Info.** tab presents lists for the pulser and the receiver elements (see Figure 12-1 on page 274). The lists contain the calculated delays for each element number for the beam selected in the **Current Beam** area.

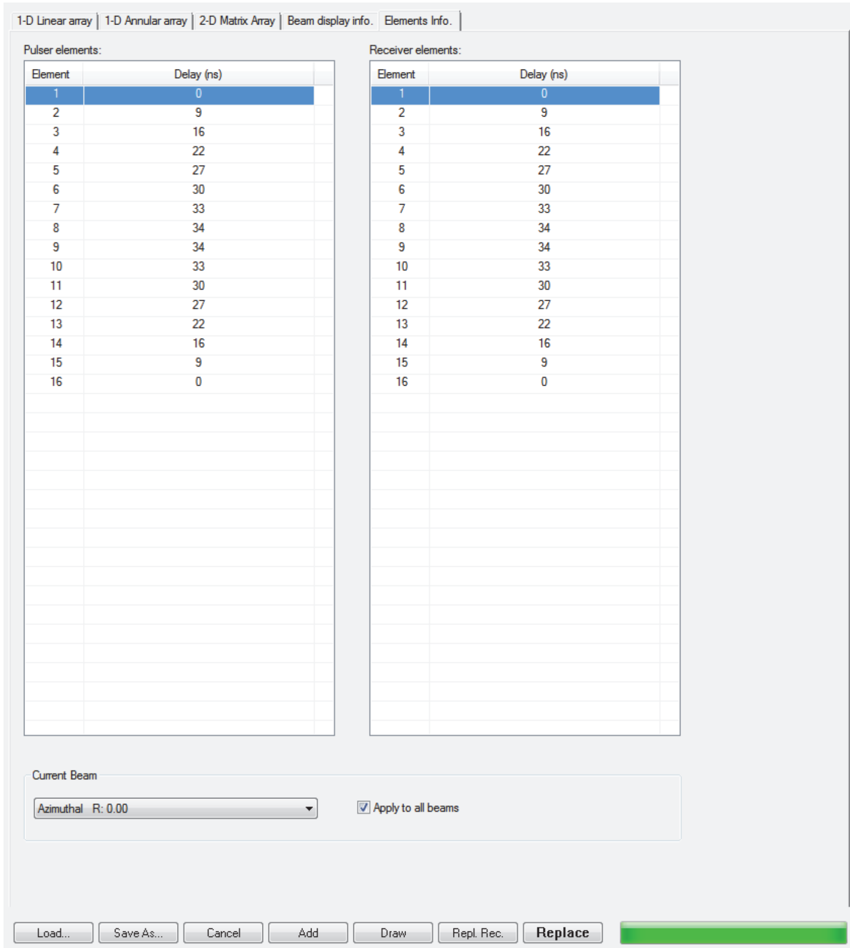


Figure 12-1 Example of the Elements Info. tab

13. Calculator — Using the Databases

The Calculator uses a database to store information related to the probes, the material, and the wedges. The database file is located in a FocusPC folder in the following default location:

C:\EvidentNDT\FocusPC*nnn*

The FocusPC installer creates the following files in the database folder:

UtDatabase.mdb

Active database file containing factory default information used by the Calculator.

UtDatabase-InstallationBackUp-xxxx.tmp.mdb

If a previous version of the Calculator was installed, a copy of the existing UtDatabase.mdb is created with this name, where xxxx is an automatically generated unique ID for the file. Rename this file to `UtDatabase.mdb` if you want to restore the content of the database as it was for the previous version of the Calculator.

13.1 Probe Database

The **Probe** database enables you to save, load, or delete a user-defined probe configuration.

To save a probe configuration in the Probe database

1. Enter the probe parameters with an appropriate probe name (see Figure 13-1 on page 276).

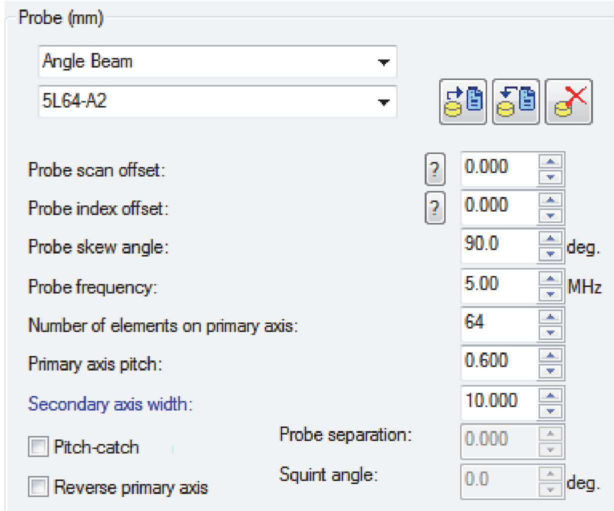


Figure 13-1 Probe parameters

2. Click the **Save in database** button (), and then click **OK** (see Figure 13-2 on page 276).

   The probe configuration is automatically saved in the **Probe** database.

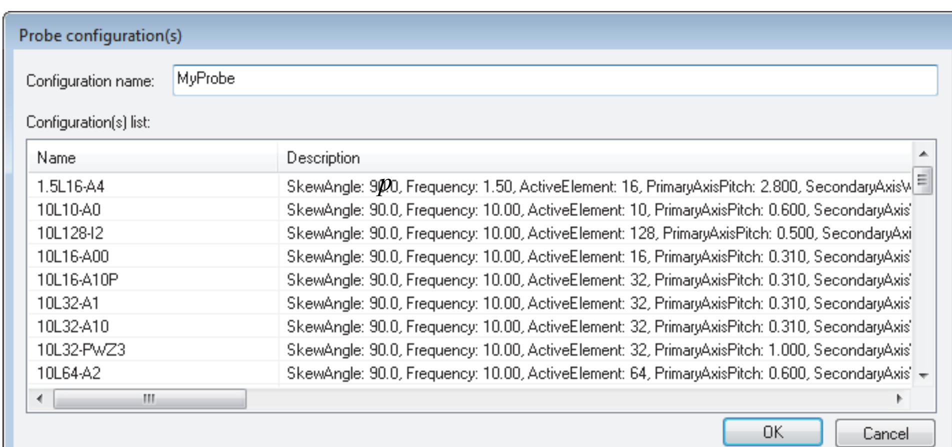


Figure 13-2 Saving a probe using the Probe Configuration dialog box

To load a probe configuration from the Probe database

1. In the Calculator, click the **Load from database button** ( ).
2. In the **Probe Configuration** dialog box, select the desired probe configuration, and then click **OK**.

   The probe configuration is automatically loaded from the **Probe** database.

To delete a probe configuration from the Probe database

1. In the Calculator, click the **Delete from database** button ( ).
2. In the **Probe Configuration** dialog box, select the probe configuration that you want to delete, and then click **Delete**.
3. Click **OK** to close the dialog box (see Figure 13-3 on page 277).

   The probe configuration is automatically deleted from the **Probe** database.

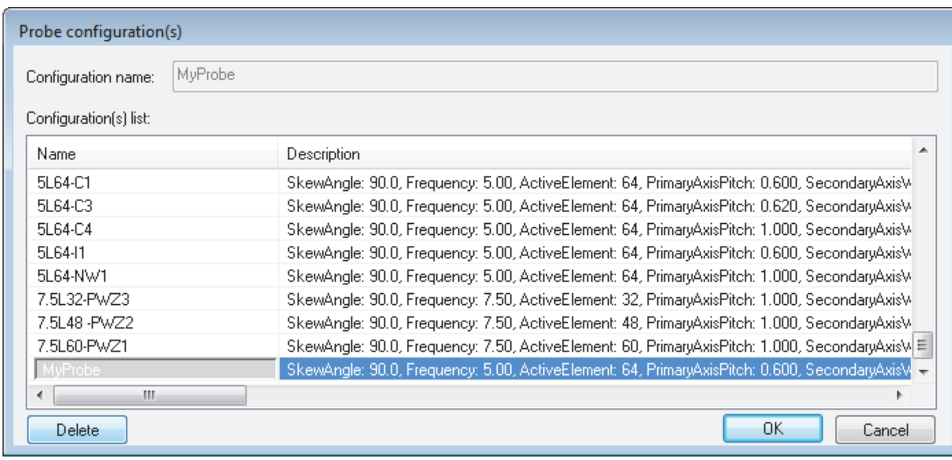


Figure 13-3 Deleting a probe using the Probe Configuration dialog box

13.2 Material Database

The **Material** database enables you to save, load, or delete a user-defined material configuration.

To save a material configuration in the Material database

1. Enter the material parameters with an appropriate material name (see Figure 13-4 on page 278).

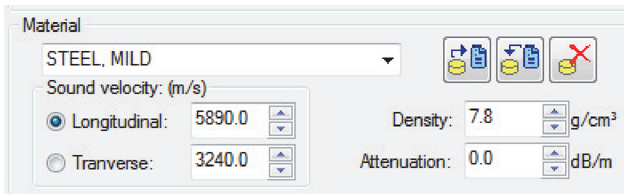


Figure 13-4 Material parameters

2. Click the **Save in database** button (), and then click **OK** (see Figure 13-5 on page 278).
   The material configuration is automatically saved in the **Material** database.

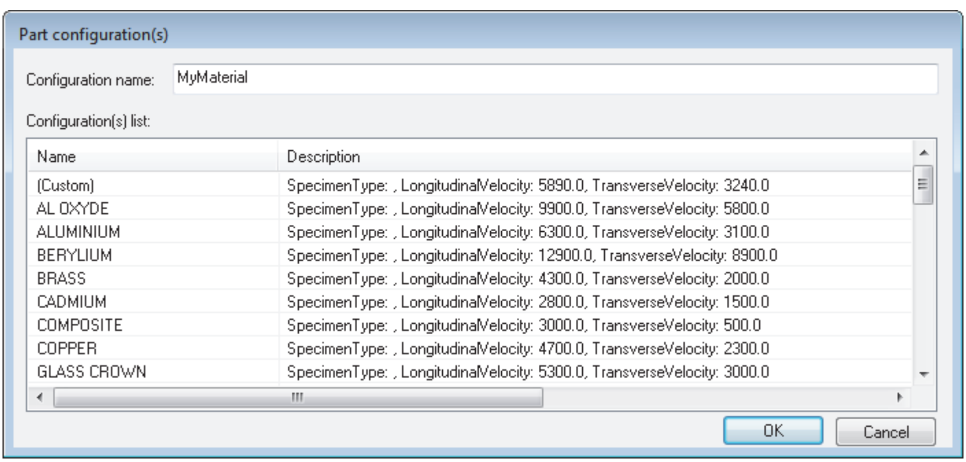


Figure 13-5 Saving a material type using the Material Configuration dialog box

To load a material configuration from the Material database

1. In the Calculator, click the **Load from database button** ().

2. In the **Material Configuration** dialog box, select the desired material configuration, and then click **OK**.

   The material configuration is automatically loaded from the **Material** database.

To delete a material configuration from the Material database

1. In the Calculator, click the **Delete from database** button ( ).
2. In the **Material Configuration** dialog box, select the material configuration that you want to delete, and then click **Delete**.
3. Click **OK** to close the dialog box (see Figure 13-6 on page 279).

   The material configuration is automatically deleted from the **Material** database.

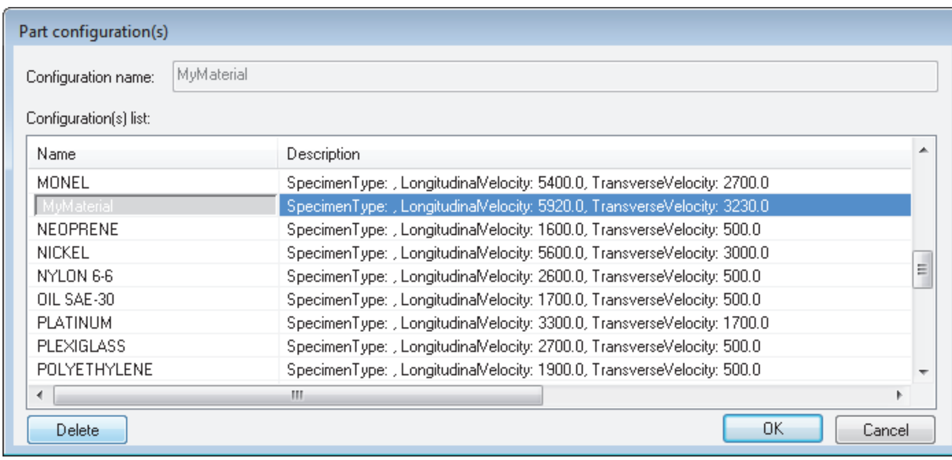


Figure 13-6 Deleting a material type using the Material Configuration dialog box

13.3 Wedge Database

The **Wedge** database enables you to save, load, or delete a user-defined wedge configuration.

To save a wedge configuration in the Wedge database

1. Enter the wedge parameters with an appropriate wedge name (see Figure 13-7 on page 280).

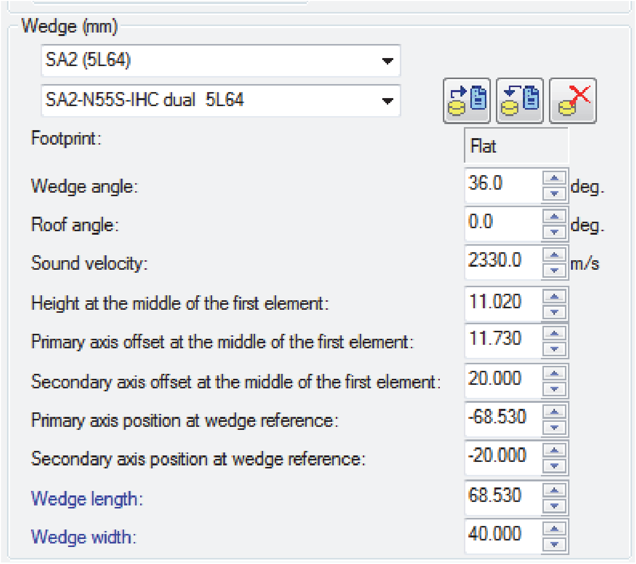


Figure 13-7 Wedge parameters

2. Click the **Save in database** button ( ), and then click **OK** (see Figure 13-8 on page 281).

   The wedge configuration is automatically saved in the **Wedge** database.

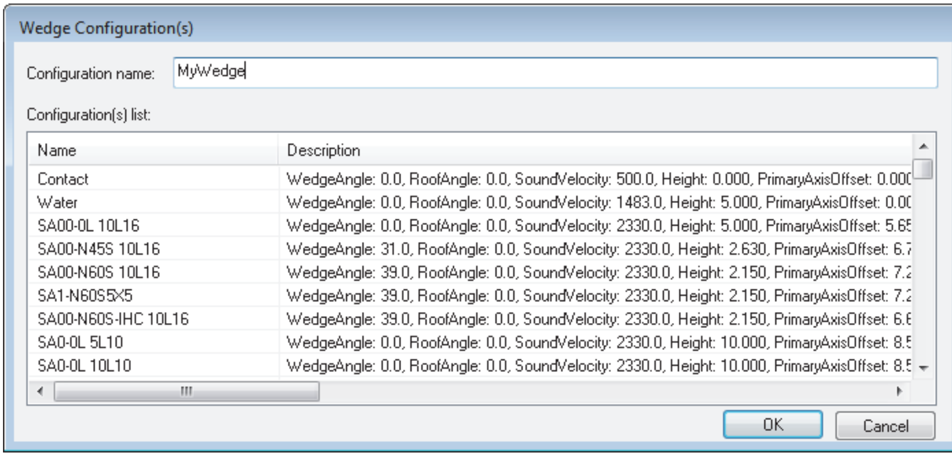


Figure 13-8 Saving a wedge using the Wedge Configuration dialog box

To load a wedge configuration from the Wedge database

1. In the Calculator, click the **Load from database button** ().
2. In the **Wedge Configuration** dialog box, select the desired wedge configuration, and then click **OK**.

   The wedge configuration is automatically loaded from the **Wedge** database.

To delete a wedge configuration from the Wedge database

1. In the Calculator, click the **Delete from database** button ().
2. In the **Wedge Configuration** dialog box, select the wedge configuration that you want to delete, and then click **Delete**.
3. Click **OK** to close the dialog box (see Figure 13-9 on page 282).

   The wedge configuration is automatically deleted from the **Wedge** database.

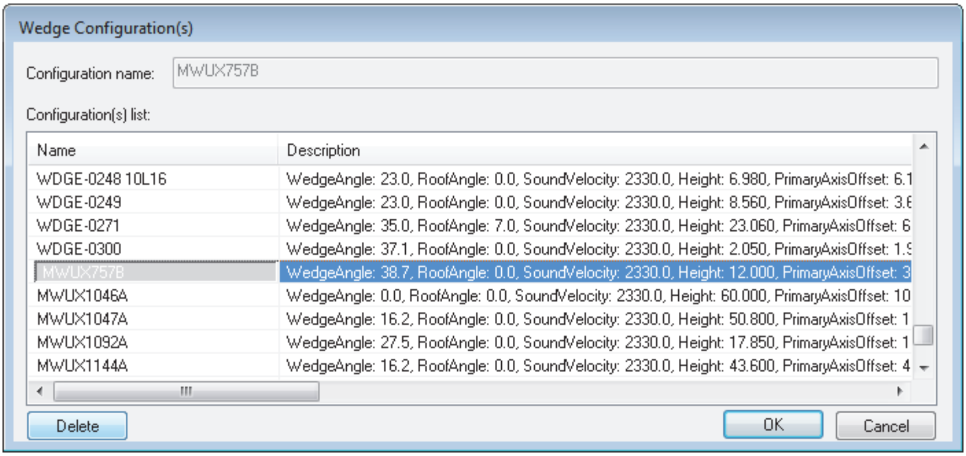


Figure 13-9 Deleting a wedge using the Wedge Configuration dialog box

Appendix A: Theoretical Considerations on Law Delay Accuracy

The Calculator calculates beam delays to electronically generate an ultrasonic probe for which the active surface is a Fermat surface for the considered focal point in the material. This means that the rays from the individual elements (center points) of the probe to the focal point should have equal flight times (FT). The errors are therefore expressed in time units, typically nanoseconds (ns). This approach is very similar to the optical path difference (OPD) parameter, expressed in number of wavelengths, used for quantitative assessment of the quality of optical systems (lenses, etc.).

In optics, it is assumed that a system with a maximum OPD error that is smaller than a quarter of the wave length generates a “sensibly” perfect image (refer to Warren J. Smith, *Modern Optical Engineering*, Chapter 11 “Image Evaluation,” 1966, McGraw Hill). This defined limit is called the Rayleigh criterion, and is used for evaluation of aberrations (errors) in precision optics (microscopes, telescopes, etc.).

When applying this criterion to the calculation of beam delays for ultrasonic array probes, a maximum difference of a quarter of a wavelength can be allowed, compared to an ideal Fermat surface. For typical probe frequencies used in nondestructive testing, the criterion yields the following allowable maximum delay differences:

- For a 10 MHz probe: 25 nanoseconds
- For a 5 MHz probe: 50 nanoseconds
- For a 2.25 MHz probe: 111 nanoseconds

For comparison purposes, a delay difference of 50 nanoseconds is equivalent to a mechanical accuracy of 0.06 millimeters (0.0025 inch) in the fabrication of the wedge, or an accuracy of approximately 0.1 degrees for the wedge angle.

Appendix B: Description of the .law File Format

This appendix describes the .law file format used to create specific beam configurations. The .law file format is contained in text files that can be loaded directly into FocusPC.

To use the .law file format, you must have a good background knowledge of phased array technology in general, and of the hardware and software in particular.

B.1 General Format

This section details the .law file format and example for version 5.0 and version 5.2.

B.1.1 Format

This section describes the .law file format.

Law file version 5.0

The .law file format for version 5.0 is described as follows:

```
<Version> <Number of Laws>

<Number of Active Elements> <Frequency> <Cycles> <Sum Gain> <Mode> <Filter>
    <Refracted Angle> <Beam Skew Angle> <First Pulser> <First Receiver> <Scan
    Offset> <Index Offset> <Global Delay> <Focusing Depth> <Material Velocity>

<Element number> <Beam_Gain> <Transmission Delay> <Reception Delay> <Amplitude>
    <Pulse Width>
```

Law file version 5.2

The .law file format for version 5.2 is described as follows:

```
<Version> <Number of Laws>

<Element Number> <Frequency> <Cycles> <Sum Gain> <Mode> <Filter> <Refracted
    Angle> <First Pulser> <First Receiver> <Scan Exit> <Index Exit> <Global
    Delay> <Focusing Depth> <Material Velocity> <Probe Skew Angle> <Beam Skew
    Angle>

<Element number> <Beam_Gain> <Transmission Delay> <Reception Delay> <Amplitude>
    <Pulse Width>
```

B.1.2 Examples

Law file version 5.0

The following is an example of a .law file containing two beams of 10 elements each, as generated by the Calculator:

```
V5.0 2
16 300 1 -1 1 0 400 900 1 1 0 -46040 13869 50000 3240
1 0 570 570 40 100
2 0 539 539 40 100
3 0 508 508 40 100
4 0 475 475 40 100
5 0 442 442 40 100
6 0 407 407 40 100
7 0 372 372 40 100
8 0 335 335 40 100
9 0 297 297 40 100
10 0 258 258 40 100
11 0 218 218 40 100
12 0 176 176 40 100
13 0 134 134 40 100
14 0 90 90 40 100
15 0 46 46 40 100
16 0 0 0 40 100
16 300 1 -1 1 0 500 900 1 1 0 -44142 14282 50000 3240
1 0 175 175 40 100
2 0 168 168 40 100
3 0 161 161 40 100
4 0 153 153 40 100
5 0 145 145 40 100
6 0 136 136 40 100
7 0 126 126 40 100
8 0 115 115 40 100
```

```
9 0 103 103 40 100
10 0 91 91 40 100
11 0 78 78 40 100
12 0 64 64 40 100
13 0 49 49 40 100
14 0 34 34 40 100
15 0 17 17 40 100
16 0 0 0 40 100
```

Law file version 5.2

The following is an example of a .law file for version 5.2:

```
V5.2 2
16 300 1 -1 1 0 400 1 1 -46040 0 13869 50000 3240 900 0
1 0 570 570 40 100
2 0 539 539 40 100
3 0 508 508 40 100
4 0 475 475 40 100
5 0 442 442 40 100
6 0 407 407 40 100
7 0 372 372 40 100
8 0 335 335 40 100
9 0 297 297 40 100
10 0 258 258 40 100
11 0 218 218 40 100
12 0 176 176 40 100
13 0 134 134 40 100
14 0 90 90 40 100
15 0 46 46 40 100
16 0 0 0 40 100
16 300 1 -1 1 0 500 1 1 -44142 0 14282 50000 3240 900 0
1 0 175 175 40 100
2 0 168 168 40 100
3 0 161 161 40 100
4 0 153 153 40 100
5 0 145 145 40 100
6 0 136 136 40 100
7 0 126 126 40 100
8 0 115 115 40 100
9 0 103 103 40 100
10 0 91 91 40 100
11 0 78 78 40 100
12 0 64 64 40 100
13 0 49 49 40 100
14 0 34 34 40 100
15 0 17 17 40 100
16 0 0 0 40 100
```

B.2 Object Description

The .law file object is defined by general parameters related to the file format and law parameters related to the beams.

B.2.1 General Parameters

The following general parameters are related to the .law file format:

Version

The version of the .law file in the following format: <V> <number> <'.'> <number>.

Number of Laws

The total number of beams defined in the file. This value ranges from 1 to 256.

B.2.2 Law Parameters

This section provides descriptions of the beam-related parameters in the .law file.

Number of Active Elements

The number of active elements used to generate a beam. This value ranges from 1 to 32, and is determined by the limits of the hardware.

Frequency

Pulse train frequency for the given law, in kilohertz. The default value 300 is not used. The value ranges from 300 to 2000. Used only for EMAT (electromagnetic acoustic transducer).

Cycles

The number of cycles in the pulse train for the given law. The default value is 1. The value ranges from 1 to 15. Used only for EMAT.

Sum Gain

The gain working range for a given law, in decibels (dB). Sum gain is an attenuation value that varies according to the number of active elements. This value is dependent on the instrument being used. The value −1 is the Auto Sum gain, which is defined by the hardware. The value ranges from −1 to 30.

In FocusPC, the **Sum gain** can be modified on the **Receiver** tab of the **UT Settings** dialog box (see Figure B-1 on page 289).

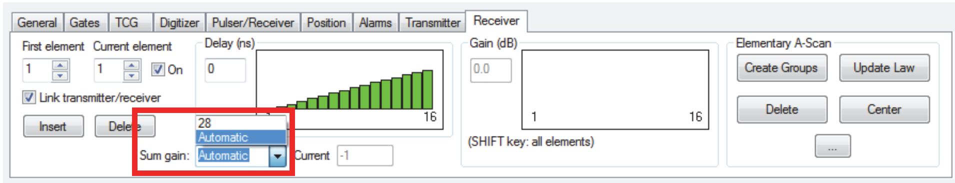


Figure B-1 The Sum gain on the Receiver tab of the UT Settings dialog box

Mode

The inspection mode for the given law:

— 0 = T/R (transmit/receive), which has different pulser and receiver elements

— 1 = Pulse-echo, which has the same pulser and receiver elements

Filter

Specifies the filter applied at reception:

— 0 = no filter (0.5 MHz to 20 MHz)

— 1 = 0.5 MHz to 5 MHz

— 2 = 2.0 MHz to 10 MHz

— 3 = 5.0 MHz to 15 MHz

In FocusPC, the Filter can be modified on the **Pulser/Receiver** tab of the **UT Settings** dialog box (see Figure B-2 on page 289).

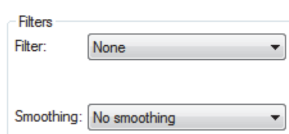


Figure B-2 The Filters area on the UT Settings dialog box's Pulser/Receiver tab

Refracted Angle

The refracted angle for the given law, expressed in tenths of degrees. The parameter-value range is as follows:

— For .law file version 5.0: 0 to 900

— For .law file version 5.2: –900 to 900

In FocusPC, the **Refracted angle** can be modified on the **Position** tab of the **UT Settings** (see Figure B-3 on page 290).

Beam Skew Angle

The skew angle for the given law, expressed in tenths of degrees. The parameter-value range is as follows:

— For .law file version 5.0: 0 to 3599

— For .law file version 5.2: −900 to 900

NOTE

The beam skew angle is defined only for the beam, and initially assumes that the probe skew angle is 0. The probe skew angle (which determines the scan orientation) must be entered after the .law file is downloaded to the acquisition software.

In FocusPC, the **Skew** angle can be modified on the **Position** tab of the **UT Settings** dialog box (see Figure B-3 on page 290).

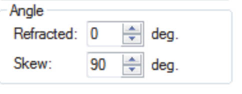


Figure B-3 The Refracted and Skew angles on the Position tab (UT Settings)

Probe Skew Angle (version 5.2)

The probe skew angle for the given law, in degrees. The value ranges from 0 to 3599.

First Pulser[1]

Specifies the number of the first pulser hardware connection used for transmission during focal law formation (whether pulsing or not). The value is a positive integer determined by the hardware (instrument and probe).

In FocusPC, the **First element** can be modified on the **Transmitter** tab of the **UT Settings** dialog box (see Figure B-4 on page 291).

1. It is important to note that if this parameter is redefined in the UT settings of FocusPC, then the wedge delay calculated by the Calculator will be incorrect.

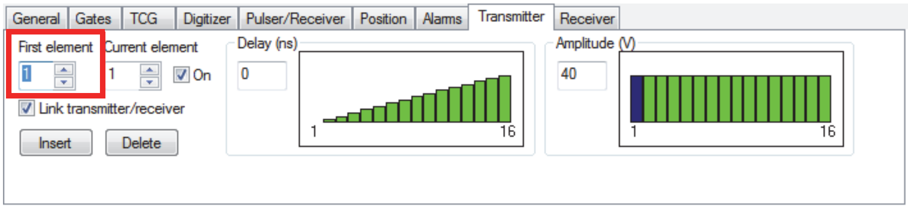


Figure B-4 The First element on the Transmitter tab of the UT Settings dialog box

First Receiver[1]

Specifies the number of the first receiver hardware connection used during focal law formation (whether receiving or not). The value is a positive integer determined by the hardware (instrument and probe).

In FocusPC, the **First element** can be modified on the **Receiver** tab of the **UT Settings** dialog box (see Figure B-5 on page 291).

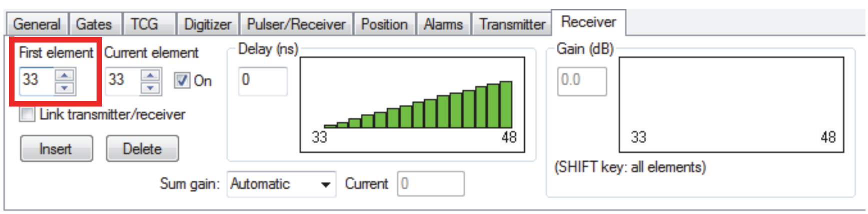


Figure B-5 The First element on the Receiver tab of the UT Settings dialog box

Scan Offset

The offset of the scan-axis exit point (for the given law) relative to the probe set's origin (the mechanical reference point), expressed in micrometers.

In FocusPC, the **Scan** offset can be modified on the **Position** tab of the **UT Settings** dialog box under **Offset** (see Figure B-6 on page 292).

Index Offset

The offset of the index-axis exit point (for the given law) relative to the probe set's origin (the mechanical reference point), expressed in micrometers.

1. It is important to note that if this parameter is redefined in the UT settings of FocusPC, then the wedge delay calculated by the Calculator will be incorrect.

In FocusPC, the **Index Offset** can be modified on the **Position** tab of the **UT Settings** dialog box under **Offset** (see Figure B-6 on page 292).

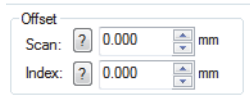


Figure B-6 The Scan axis offset on the Position tab of the UT Settings dialog box

Global Delay

Specifies the global delay (GD) expressed in nanoseconds (ns). The value is a nonnegative integer, and is calculated as follows:

GD = ED + WD + LD

ED: Electronic delay that is determined by the hardware. The value is 0 for FOCUS PX instruments.

WD: Total wedge delay (transmission and reception)

LD: Law delay (global delay introduced by the specified law)

In FocusPC, the **Delay** can be modified on the **Position** tab of the **UT Settings** dialog box (see Figure B-7 on page 292).

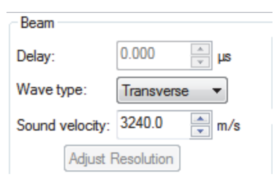


Figure B-7 The Delay on the Position tab of the UT Settings dialog box

Focusing Depth

Focusing distance, which is a true depth expressed in micrometers. The value is a nonnegative integer.

Material (sound) Velocity

Specifies the propagation velocity in the material, in meters per second (m/s). The value is a nonnegative integer.

In FocusPC, the **Sound velocity** can be modified on the **Position** tab of the **UT Settings** dialog box (see Figure B-7 on page 292).

Element parameters

Parameters that are related to the individual elements in a defined beam.

Element Number

The number identifying the individual element of the phased array probe relative to the first pulser and the first receiver (see “First Pulser” on page 290 and “First Receiver” on page 291). The element numbers are consecutive (1, 2, 3, and so on). Inactive elements are disabled by setting the Transmission Delay and Reception Delay to 65535 (see “Transmission Delay” on page 293 and “Reception Delay” on page 293). The value must be less than or equal to the maximum number of hardware elements. The value is a positive integer.

Beam Gain

The gain applied to the considered beam, in decibels (dB). Admissible range: 0–80. Elements of the same beam must have the same focal law gain.

For .law files generated in offline mode (that is, without phased array equipment connected), this parameter has the default value 0.

In FocusPC, the **Beam** gain can be modified on the **General** tab of the **UT Settings** dialog box (see Figure B-8 on page 293). Make sure that **All beams** is cleared before modifying the focal law gain.

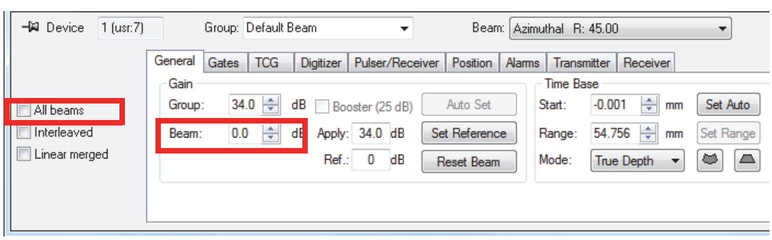


Figure B-8 The Beam gain on the General tab of the UT Settings dialog box

Transmission Delay

Specifies the transmission delay for the specified active element. The delay is expressed in nanoseconds and must be between 0 and 25600. The transmission is deactivated if 65535 is used.

Reception Delay

Specifies the reception delay for the specified active element. The delay is expressed in nanoseconds and must be between 0 and 25600. The reception is deactivated when 65535 is used.

Amplitude

The excitation amplitude for the specified active element, expressed in volts (range: 50–200). The value must be the same for all elements of all beams defined in the current law file.

For .law files generated in offline mode (that is, without phased array equipment connected), this parameter has the default value 180.

In FocusPC, the **Voltage** can be modified on the **Pulser/Receiver** tab of the **UT Settings** dialog box (see Figure B-9 on page 294).

Pulse Width

The pulse width is applied to the specified active element, expressed in nanoseconds (range: 30–500). The value must be the same for all elements of all beams defined in the current law file. Generally, the pulse width value can be confirmed as follows:

Pulse Width (ns) = 500 ÷ Probe Frequency (MHz)

In FocusPC, the **Pulse width** can be modified on the **Pulser/Receiver** tab of the **UT Settings** dialog box (see Figure B-9 on page 294).

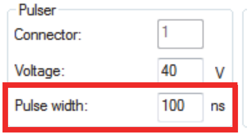


Figure B-9 The Pulse Width on the Pulser/Receiver tab (UT Settings dialog box)

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