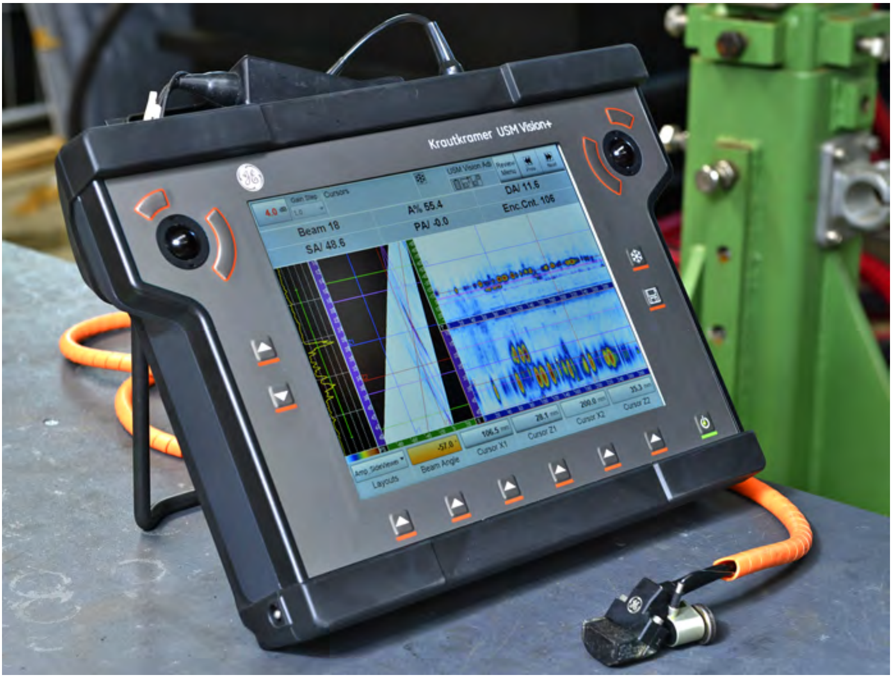
GE
Measurement & Control

Ultrasonic Inspection

Krautkramer USM Vision+

User's Manual



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110N1532 Rev. 3
July 2015

Krautkramer USM Vision+

Portable Phased Array Ultrasonic Testing

User's Manual

110N1532 Rev. 3

(Software Version 9.4.1)

July 2015

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Important Notice

The information in this section must be read and understood by all users of GE Measurement & Control ultrasonic test equipment. Failure to follow these instructions can lead to errors in measurements or other test results. Decisions based on erroneous results can, in turn, lead to property damage, personal injury or death.

General Warnings

Proper use of ultrasonic test equipment requires three essential elements:

- Selection of the correct test equipment
- Knowledge of the specific “test application requirements”
- Operator training about welds

This operating manual provides instruction in the basic setup and operation of the GE equipment. There are, however, additional factors which affect the use of ultrasonic test equipment. Specific information regarding these additional factors is beyond the scope of this manual. The operator should refer to textbooks on the subject of ultrasonic testing for more detailed information.

Operator Training

Operators must receive adequate training before using ultrasonic test equipment. Operators must be trained in general ultrasonic testing procedures and in the setup and performance required by a particular test. Operators must understand:

- Sound wave propagation theory
- Effects of the velocity of sound in the test material
- Behavior of the sound wave where two different materials are in contact
- Areas covered by the sound beam

More specific information about operator training, qualification, certification, and test specifications is available from various technical societies, industry groups, and government agencies.

Testing Limitations

In ultrasonic testing, information is obtained only from within the limits of the sound beam. Operators must exercise great caution in making inferences about the test material outside the limits of the sound beam. For example, when testing large materials, it may be impossible or impractical to inspect the entire test piece.

When a less-than-complete inspection is to be performed, the operator must be shown the specific areas to inspect. Inferences about the condition of areas not inspected, based on data from the evaluated areas, should only be attempted by personnel fully trained in applicable statistical and probability techniques. In particular, materials subject to erosion or corrosion, in which conditions can vary significantly in any given area, should only be evaluated by fully trained and experienced operators.Sound beams reflect from the first interior surface encountered. Because of part geometry and overlapped flaws or overlapped surfaces, thickness gauges may measure the distance to an internal flaw rather than to the back wall of the material. Operators must take steps to ensure that the entire thickness of the test material is being examined.

Operators must be familiar with the use of ultrasonic couplants. Testing skills must be developed so that couplant is used and applied in a consistent manner to minimize variations in couplant layer thickness and errors in test results. Calibration and actual testing should be performed under similar coupling conditions, using a minimum amount of couplant and applying consistent pressure on the transducer.

Safety Information

ATTENTION! This instrument is designed only for materials testing. Any use for medical applications or other purposes is not allowed.

This instrument may only be used in industrial environments.

This instrument can be operated with batteries or while plugged into an electrical outlet using the AC charger. The power supply unit has the electrical safety class II.

Only authorized personnel should open the unit.

This product is not rated for use in an explosive atmosphere / environment.

Use caution when using the harness while climbing — there is a risk of strangulation.

The neck strap is not intended to be used when climbing with the instrument.

If a support stand closes on a user's fingers, it can cause injury.

Software

According to the current state of the art, software is never completely free from errors. Before using any software-controlled test equipment, please make sure that the required functions operate perfectly in the intended application.

Defects, Errors and Exceptional Stresses

If you have reason to believe that safe operation of your instrument is no longer possible, you have to disconnect the instrument and secure it against unintentional re-connection. Remove the batteries if necessary.

A safe operation is no longer possible if:

- The instrument shows visible damage
- The instrument no longer operates perfectly
- The instrument has been subjected to prolonged storage under adverse conditions like exceptional temperatures, especially high air humidity or corrosive environmental conditions
- The instrument has been subjected to heavy stresses during transportation

Battery Safety Information

ATTENTION! The power for this ultrasonic instrument can be supplied by lithium-ion batteries. Read these safety instructions and the product operating manual carefully.

Do not open or dismantle batteries.

Do not expose batteries to heat above 80°C or fire. Avoid storage in direct sunlight.

Do not short-circuit a battery.

Do not store batteries haphazardly in a box or drawer where they may short-circuit each other or be short-circuited by other metal objects.

Do not remove a battery from its original packaging until required for use.

Do not subject batteries to mechanical shock.

In case of a battery leaking, do not allow the liquid to come in contact with the skin or eyes. If contact has been made, wash the affected area with copious amounts of water and seek medical advice.

Charge only with the charger provided with the equipment.

Follow the instructions in the operating manual for inserting the batteries into the instrument, and the note indicating the charging of the batteries in the instrument.

Observe the plus (+) and minus (-) marks on battery and equipment and ensure correct use.

Do not mix batteries of different manufacture, capacity, size or type within this instrument.

Keep batteries out of the reach of children.

Keep batteries clean and dry.

Battery Safety Information (cont.)

ATTENTION! The power for this ultrasonic instrument can be supplied by lithium-ion batteries. Read these safety instructions and the product operating manual carefully.

Use the battery only in the application for which it was intended.

When possible, remove the battery from the equipment when not in use.

Do not store batteries longer than 1 month in discharged state.

Do not store batteries longer than 6 month without recharge.

The battery must be recycled or disposed of properly, according to the national and local regulations. If you have any questions, contact your local dealer.

The batteries must be disposed of only in the discharged state to the collection point. In case of not fully discharged batteries, there is a short-circuit risk. Short-circuits can be prevented by isolation of contacts with adhesive tape.

FCC Compliance Statement

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.

2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Service

The ultrasonic flaw detector USM Vision+ is manufactured by:

GE Sensing & Inspection Technologies GmbH
Robert-Bosch-Straße 3
50354 Hürth
Germany
T +49 (0) 22 33 601 111
F +49 (0) 22 33 601 402

The USM Vision+ is manufactured according to the state-of-the-art methods using high-quality components. Thorough in-process inspections or intermediate tests and a quality management system certified to DIN EN ISO 9001 ensure an optimum quality of conformance and workmanship of the instrument.

Should you nevertheless detect an error on your instrument, power the instrument off and remove the batteries. Inform your local GE customer service and support, indicating the error and describing it.

Keep the shipping container for any repairs possibly required which cannot be made on the spot.

If there is anything special that you would like to know about the use, handling, operation, and specifications of the instruments, please contact your nearest GE representative or contact one of the service centers listed on the rear cover of this manual.

Typographical Conventions

Note: *These paragraphs provide additional information about the topic which is helpful but is not essential to proper completion of the task.*

Important: *These paragraphs provide emphasis to instructions that are essential to proper setup of the equipment. Failure to follow these instructions carefully may cause unreliable performance.*

WARNING! These paragraphs indicate a potentially hazardous situation which can result in serious personal injury or death, if it is not avoided.

CAUTION! These paragraphs indicate a potentially hazardous situation which can result in minor or moderate injury to personnel or damage to the equipment, if it is not avoided.

Chapter 1. USM Vision Overview

1.1 Introduction

The USM Vision+ phased array inspection system (see *Figure 1* below) combines phased array and conventional ultrasonic testing (UT) for imaging testing results and encoded data recording plus on-screen evaluation. The system works in 16/128 configuration; that is, it offers 16 physical channels, where, in multiplex mode, probes with a maximum of 128 elements can be driven. An intuitive menu structure and layout simplify operation, even when multiple groups were chosen (up to a maximum of 12).

Users enter data via either a touchscreen, or through six soft buttons (F1-F6) located below the screen, and two trackballs.

Figure 1: The USM Vision+

Note: *This manual is subject to revision to reflect product updates and additions. Please contact your local sales agent or visit our web page, www.ge-mcs.com, to find the most recent revision.*

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Chapter 2. Initial Startup and Operation

2.1 Instrument Overview

Figure 2 below outlines the controls available on the USM Vision+ front panel.

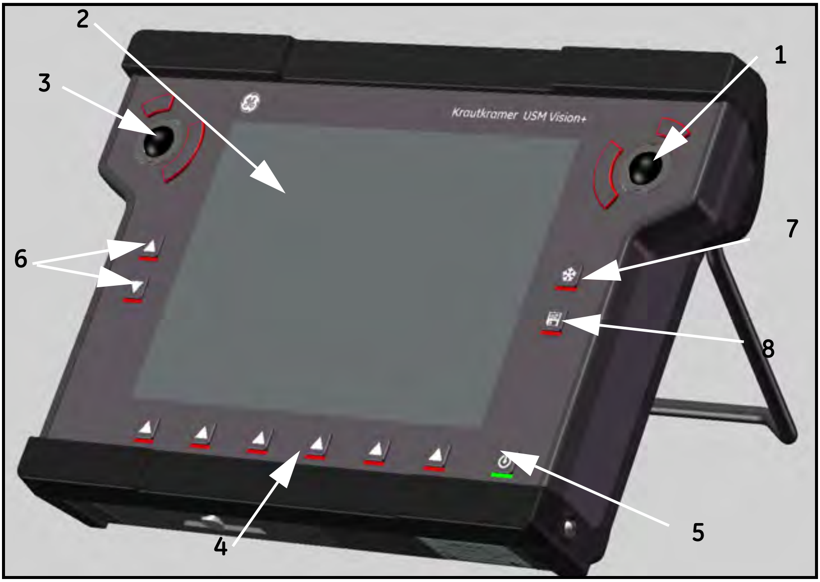


Figure 2: USM Vision Front Panel

Table 1: Key to USM Vision+ Front Panel (see *Figure 2* above)

Number	Front Panel Control
1	Trackball with two keys to control the focus in the user interface
2	Touch-sensitive screen (touchscreen), for direct operation of the graphic interface
3	Trackball with two keys, for direct access to values in controls having focus
4	Function keys, assignment programmable via software
5	Power key (for switching the meter ON and OFF)
6	Gain increase and decrease keys
7	Image freeze
8	Data storage, report generation

2.1 Instrument Overview (cont.)

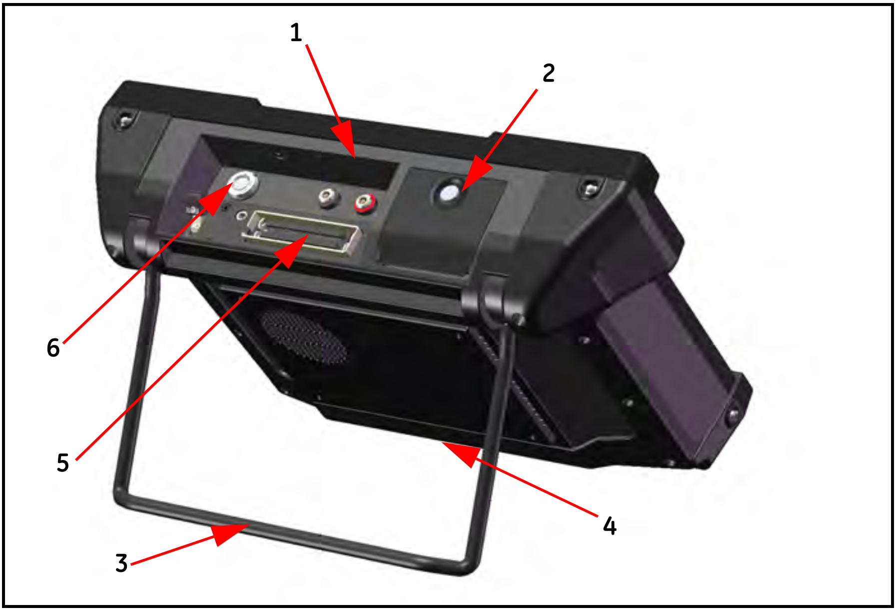


Figure 3: USM Vision Back Panel

Table 2: Key to USM Vision+ Back Panel (see *Figure 3* above)

Number	Front Panel Control
1	LEMO 00 COAX sockets, for conventional UT use in single and T/R mode
2	PC interfaces: Ethernet, USB, Lemo 0S for connecting VGA and Power Supply
3	Prop-up stand and handle, for transportation and inclined installation
4	Battery compartment at the bottom, for holding one or two lithium-ion batteries
5	Phased array probe connector
6	I/O connector, encoder input

2.2 Setting up the USM Vision+

The USM Vision+ has a prop-up stand and handle at the rear that locks into place in different positions.When completely folded out, it becomes a transport handle for the instrument. You can set up the USM Vision+ at different angles to have the best possible view of the screen.

Important: *Place the USM Vision+ on a stable flat surface. When operating on a stable flat surface, make sure that the stand is secure, and do not touch the instrument on its back. Due to the applied force, the prop-up stand might move and could either snap to the back or the instrument could drop on the surface. When opening the handle, be sure to grasp it firmly to avoid unwanted movements.*

The device is intended for indoor or outdoor use. Select a suitable location for installation that guarantees meeting the environmental conditions. The ambient temperature must be between 0 and +45°C. The relative humidity must not exceed 95%.

Because the USM Vision+ generates heat during operation, ensure that there is adequate ventilation and enough clearance between the unit and heat-sensitive objects or equipment.

Avoid direct heat, heat accumulation and overheating by direct sunlight or other heat sources. Ensure that there is adequate and unhindered circulation of air.

Ensure that no dirt or only dry, nonconducting dirt accumulates on the instrument, in particular at the connectors.

The following condition must be met for safe operation:

- No iron or steel dust must penetrate into the instrument, in particular at the connectors. Apply protective caps on any connectors that are not in use.

2.3 Connecting a Probe

A wide range of probes manufactured by GE may be used in combination with the USM Vision+, provided the suitable connecting cable is available.The connector sockets for one or more probes are located on the top side of the USM Vision+.

When connecting probes having only one transducer element, you can use either connector socket. The connectors for transmitter and receiver are marked with a red ring (= receiver) and a black ring (= transmitter).

2.4 Power Supply

the USM Vision+ can be powered using an external power supply or by up to two lithium-ion batteries. You can connect the USM Vision+ to the mains supply system when the battery is in the instrument. A discharged battery will be charged in this situation, while the instrument remains in operation.

The power supply unit provided is intended only for indoor operation.

2.4.1 Operation Using the External Power Supply

The external power supply automatically adjusts to any AC input voltage between 90 V and 240 V nominal voltage.

Connect the USM Vision+ to the mains socket-outlet using the external power supply with the appropriate power cable. The socket connector is under the cover on the top side of the USM Vision+. Proceed as follows:

- Loosen the knurled screw in the cover on the top side of the instrument and open the cover completely.
- Plug the Lemo connector of the external power supply unit into the socket connector +15V until it snaps into place with a clearly-audible click.
- When pulling off the Lemo plug, withdraw the metal bushing on the plug first in order to release the lock.
- When transporting the USM Vision+, always shut the cover and fasten the knurled screw.

Note: *When powering from mains operation, it is recommended that you use a battery in the USM Vision+ in order to prevent a system failure and data loss in case of a power failure.*

2.4.2 Operation Using Batteries

Use either one or preferably two lithium-ion batteries for the optional battery operation mode. These batteries each have a high capacity. Consequently, two lithium-ion batteries ensure a long operating time for the instrument.

2.4.2a Inserting Batteries

The battery compartment is located at the bottom of the instrument and the cover is fixed with one knurled screw. To install a battery, proceed as follows:

- Loosen the knurled screw in the cover on the bottom side of the instrument.
- Fold the cover down, and you will see two battery compartments.
- Insert a battery into either the left-hand or the right-hand battery compartment. Be sure to position the battery so that the contacts point back and downwards.
- Close the cover and fasten the knurled screw.

2.4.3 Checking the Battery Charge Level

The lithium-ion battery is equipped with a battery charge indicator, which is located on the front of the battery. Five LCD segments indicate the battery charge level, with the number of filled LCD segments showing the charging level as follows:

- 5 segments – battery charge level 100... 81%
- 4 segments – battery charge level 80... 61%
- 3 segments – battery charge level 60... 41%
- 2 segments – battery charge level 40... 21%
- 1 segments – battery charge level 20... 1%

2.4.4 Exchanging Batteries

Important: *If you remove both batteries during operation and the instrument is not connected to the mains supply, all unsaved data will be lost.*

You can exchange one battery during operation as follows:

- First, insert a fully charged battery into an empty compartment.
- Then, remove the other battery.

2.4.5 Charging Batteries

You can charge the lithium-ion battery either directly in the instrument or by means of an external battery charger. Several batteries are charged in succession.

If there is a battery in the instrument, the charging process starts automatically as soon as you connect the external power supply. You can carry out ultrasonic tests and charge a battery at the same time.

The charging time is approximately 6 hours per battery. Charging time is independent of operation. The charging time applies to ambient temperatures from 25 °C to 30°C. Please keep in mind that the batteries are not charged to their full capacity at high temperatures.

Charging lithium-ion batteries is also possible with the external battery charger recommended and provided by GE Measurement & Control.

Note: *You will find information on how to handle the external battery charger in the documentation supplied with the charger.*

2.5 Interfaces

Three USB sockets, a VGA socket and one network interface are located behind the cover on the top side of the USM Vision+.

2.5.1 USB Sockets

The three USB Type A sockets offer multifunctional connection possibilities for items such as a mouse, keyboard, printer or external data carriers.

Important: *Do not use the USB Type B connector, as it may damage the USM Vision+ or your computer.*

Note: *You will find information on the relevant software in the documentation provided by the device manufacturer.*

2.5.2 Network

For data transfer, you can connect the USM Vision+ with to Ethernet network. The basic network functions are already set up, but have to be adapted and configured to specific local network requirements.

2.6 The Trackballs and Touchscreen

2.6.1 Trackballs

The USM Vision+ features two trackballs to operate the graphical software interface. The two trackballs work independently of each other.

Each trackball has a large button and a small button. Buttons on both sides of the trackball have the same function. The big button confirms any selection or performs the action of the button having the focus, while the small button cancels an action.

You can operate both trackballs simultaneously, such as moving the focus with the right trackball while triggering functions with the buttons of the left trackball.

2.6.2 Touchscreen

The USM Vision+ is equipped with a touchscreen, enabling direct operation of the menus appearing on the screen. This operation by direct touch replaces operation by means of a mouse (selecting and clicking). A mouse pointer is therefore not necessary. To select or to mark an element of the user interface, just touch the corresponding point of the screen briefly.

CAUTION! Do not touch the touchscreen with any hard or sharp-edged objects (e.g., ball-point pen or screwdriver). They might severely damage the touch-sensitive surface. Do not apply high pressure to the screen, as the touchscreen needs only slight pressure to react.

2.7 Software Installation

The USM Vision+ is delivered completely configured and ready for operation.

2.8 Preparing the USM Vision+ for Use

When you unpack the USM Vision+, carefully remove the instrument, the probe, the power supply and the cables from the shipping containers. Before discarding any of the packing materials, account for all components and documentation listed on the packing slip. If anything is missing or damaged, contact GE Measurement & Control immediately for assistance

After you first receive the USM Vision+, you must insert the batteries into the battery compartment on the bottom of the unit. You must then charge the batteries, using the power supply included with the unit. When you start the USM Vision+, you will need a user name and password from your system administrator to log onto the system. Before beginning an inspection, you must also import an inspection plan into the unit from a linked PC or USB memory stick and attach the probe to the port at the top of the USM Vision+.

2.9 Starting the USM Vision+

To start the USM Vision+, press the **Power** button in the lower right corner of the front panel (see *Figure 2 on page 3*). The instrument is switched ON and the USM Vision+ software boots up.The initialization screen appears similar to *Figure 4* below.

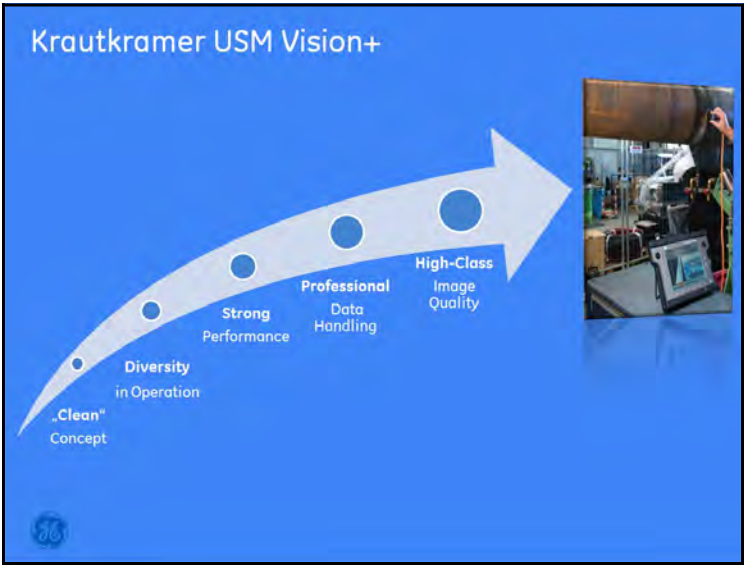


Figure 4: USM Vision Initialization Screen

Once loaded, the screen displays two security levels: Inspector and Administrator (complete access), as shown in *Figure 5 on page 12*. For additional entry levels please refer to Appendix A of this manual.

2.9 Starting the USM Vision+ (cont.)

Figure 5: Login Screen

When you press the Admin option, you will need to enter a password, as shown in Figure 6 below. If you press the Inspector option, you will be asked to enter your user name via the keyboard.

Figure 6: Entering the Password

2.9 Starting the USM Vision+ (cont.)

To enter the password, press the keyboard icon in the upper left corner of the screen. The onboard keyboard opens (Figure 7 below).

Figure 7: The On-screen Keyboard

The default password is “1234”. (To change the user password, refer to Appendix A.) Once the system has confirmed your password, the Windows screen opens (Figure 8 below) providing access to all functions and applications.

Figure 8: The Windows Desktop Screen

2.9 Starting the USM Vision+ (cont.)

To enter the USM Vision+ application, press on the icon “EchoLoader”. The next screen is the USM Vision+ boot screen.

Figure 9: USM Vision+ Boot Screen

Once confirmed, you will view the boot screen shown in Figure 9, then go to the option selection screen in Figure 10 below. The available options are PA (phased array) and conventional. This manual will describe all functions for the PA application (see Chapter 3); subsequent revisions will cover future applications.

Figure 10: Option Selection Screen

2.10 Establishing Base Settings

To establish base settings (language, date and time, measurement units) for the USM Vision+, press the Main Menu button and then the **Settings** option (Figure 11 below).

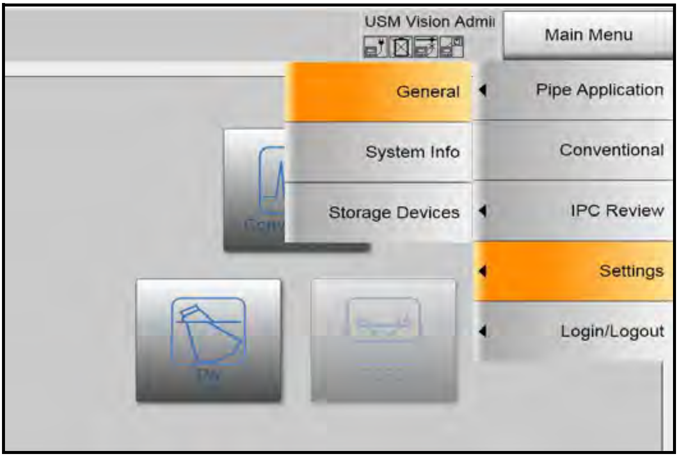


Figure 11: The Main Menu Button

Then press **General**. The General Settings option (shown in Figure 12 below) opens.

Figure 12: The General Settings Window

2.10 Establishing Base Settings (cont.)

- To change the language, press the Language drop-down menu and then press the desired language: English, Japanese, Chinese, Portuguese, Deutsch (German), Italian, Francais (French), Espanol (Spanish), Russian and Arabic.

Note: *The first release will have only the English and German GUIs; GUIs for other languages will follow shortly.*

- To change the date, press the Month drop-down menu and select the current month. For the Day and Year, press the associated drop-down menu and use the keypad to enter the day.
- To change the time, press the Hour or Minute drop-down menu. Then use the associated keypad to enter the hour (up to 23) and the minute (up to 59).
- To select the unit of measurement, press the Unit drop-down menu. You can choose either millimeters or inches.
- To select the decimal point style, press the Decimal option button for a period (.) or a comma (,).
- To alter the color of the screen, press the Color Scheme drop-down menu. You can select from standard, light and dark options.
- The Startup Option determines the startup of the conventional channel. You can select either the default setting or the startup with the last used setting.

When you have completed entering settings, press **Close.** the USM Vision+ returns to the Main Menu.

2.11 Checking System Information

The System Information screen contains basic data about your USM Vision+, such as serial number, hardware and software version, and the most recent calibration date. To access this data from the Main Menu, press Settings and then System Information. The screen appears similar to *Figure 13* below. Press Close to return to the Main Menu.

Figure 13: System Information Window

Note: *If you are contacting GE for service, please have all system information data ready to simplify remote assistance.*

2.12 Exiting the Software and Shutting Down

Important: *Always exit the software first before shutting down the instrument. Not following this sequence may result in a loss of data.*

From the Main Menu, you have two options to close the USM Vision+: Logout or Shutdown.

- Selecting Shutdown will shut down the entire system.
- Selecting Logout will log off the current user.

Note: *To switch off the USM Vision+ without shutting down the software or the operating system, keep the* **Power** *button on the front panel depressed for at least 4 seconds.*

Switching off without shutting down the software may be required as an extreme exception to this procedure (e.g., if the instrument no longer responds). In this case, all unsaved data is lost.

Chapter 3. Phased Array (PA) Mode

3.1 The Phased Array Menu

Figure 14 below illustrates the phased array menu.

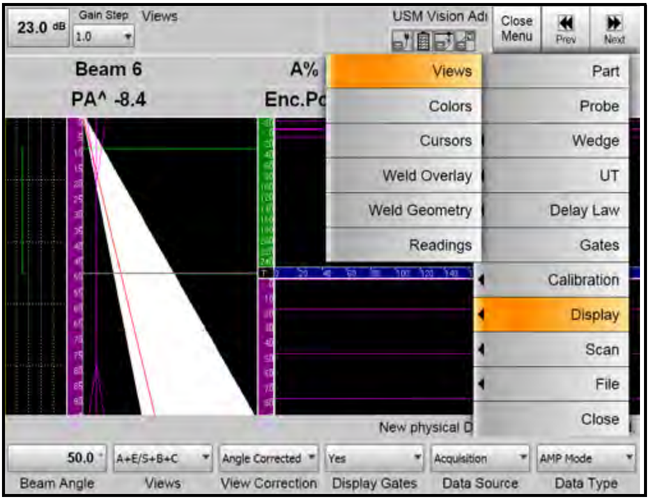


Figure 14: The Phased Array Menu

The available menus are presented sequentially in this chapter, but you may proceed directly to any specific menu. To do so, see the *Menu Map* in *Figure 15 on page 20* and follow the instructions in the appropriate section:

3.1 The Phased Array Menu (cont.)

Main	Sub menus					
Part						
Probe						
Wedge	Geometry	Curvature				
UT	Range	Pulser	Receiver			
Delay Law	Aperture	Electronic Scan	Groups			
Gates						
Calibration	Delay - Setup	Delay - Record	TCG - Setup	TCG - Record	TCG - Verify	TCG – Levels
Display	Views	Colors	Cursors	Weld Overlay	Weld Geometry	Readings
Scan	Encoder Cal.	Scan Setup	Run			
File	Load/Store Pass	Import/Delete				
Close						

Figure 15: PA Mode Menu Map

3.1 The Phased Array Menu (cont.)

Table 3: Menu Layout and Readings

Main Menu	Sub Menu	Function	Values	Dim	Comment
PART					
		Material Vel.	100 - 15000 m/s	m/s, in/ms	Currently used sound velocity of the test object
		Thickness		mm, in	Thickness of the test object
		Shape	flat, convex, concave		Shape of the test object
		Beam into curv.	no, yes		Sound beam directed to the direction of curvature
		Outer Diam.		mm, in	Outer diameter of the test object
		Calc Delay Law	execute		Start the delay law calculation
PROBE					
		Probe Name		alpha num.	Name of the probe in use
		Probe SN		alpha num.	Serial number of the probe in use
		Probe Freq.	0.5 - 20	MHz	Frequency of the probe in use
		No. of Elements	1 - 128	integer	Element count of the probe in use
		Pitch		mm, in	Element pith of probe in use
		Elevation		mm, in	Element length of the probe in use

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
WEDGE					
	GEOMETRY	Wedge Name		alpha-num.	Name of the wedge / delay in use
		Wedge Angle	0 - 45	°	Wedge angle
		Wedge Velocity	500 - 6000 m/s	m/s, in/ms	longitudinal sound velocity in the wedge / delay
		Wedge Front		mm, in	Distance from center of the array to the wedge (probe) front
		Z-Offset		mm, in	Distance from center of the array to the coupling surface
		1st Elem. Pos.			Position of the 1st element
	CURVATURE	Wedge Name		alpha-num.	Name of the wedge / delay in use
		Shape	flat, convex, concave		Shape of the wedge / delay
		Radius		mm, in	Radius of the wedge / delay in primary axis
		Beam Dir.	To left, to right		Direction of the beam
		Calc Delay Law	execute		Start the delay law calculation

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
UT	RANGE	Range Start			Start of the range (A-scan and frame)
		Range Mode	Auto, Manual		automatic range setting related to no. of legs
		Range End		mm, in	End of the range (A-scan and frame)
		Legs	1 - 10		Number of legs to be displayed in the frame
		Range Trigger	IP, IF		Trigger of range and gates form IP of IE
	PULSER	Pulser Voltage	30 - 150	volts	Voltage of the initial pulse
		IP Width Mode	Auto, Manual		Pulse width automatically calculated form the probe frequency
		Pulser Width	30 - 1260	ns	Pulse width
		PRF Mode	Auto, Manual		Pulse repetition frequency automatically calculated
		PRF	15 - 10000	Hz	Pulse repetition frequency
		Range Trigger	IP, IF		Trigger of range and gates form IP of IE
	RECEIVER	Rectification	full, pos, neg, RF		Signal rectification
		Filter		MHz	Frequency filter
		Video Filter	off, on		Signal smoothing
		Auto 80%	execute		adjust gain to get echo in gate A to 80% FSH

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
DELAY LAW	APERTURE	Start Element	1 - 128		Defines the 1st element to be used in current setup
		Aperture	1 - 16		Number of elements used in the virtual probe
		Focal Depth		mm, in	Depth of the focal point
		Pin Offset	0 - 127		Physical pin number for first element in current group
		Calc Delay Law	execute		Start the delay law calculation
	ELECTRONIC SCAN	Type	Sector linear TR TOFD		Defines type of electronic scan Dual mode Through transmission mode for TOFD
	Sector: *linear:* *TR:* *TOFD:*	Angle Start Angle Angle	-86 '-86 to 86 '-86 to 86	°	Beam angle (start)
	Sector: *linear:* *TR:* *TOFD*	Angle Stop Receiv. Offset Receiv. Offset	86 1 - 127 1 - 127	°	Beam angle stop
	Sector: *linear:* *TR:* *TOFD:*	Angle Step Receiv. Order	0.1 - 5 parallel, turned	°	Angle increment from shot to shot with TR-probes the order of elements

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
	Sector: *linear:* *TR:* *TOFD*	PCS		mm/in	Probe Center Separation
		Calc Delay Law	execute		Start the delay law calculation
	GROUPS	Group Name		alpha num.	Name of the current group
		Group Display	current, all		Type of display for more than one group
		Copy	execute		Copy current group to create a new one with similar parameters
		Rename		alpha num.	Rename duplicated group
		Delete	execute		delete current group
GATES					
		Gate Select	A, B, I		Select gate for parameter change
		Gate Start		mm, in	Start of selected gate
		Gate Width		mm, in	Width of selected gate
		Gate Thresh.	0 - 95	%	Threshold of selected gate
		TOF Mode	Peak, Flank, J-Flank		TOF measurement mode of selected gate
		Gate Logic	off, positive, negative		Logic of selected gate

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
CALIBRATION					
	DELAY SETUP	Reference Refl.	Depth, Radius, SDH		Type of reference reflector to be used for calibration
		SDH Dia.	1 - 25		Diameter of the SDH, if selected
		Ref. Distance		mm, in	Sound path or depth of selected reference reflector
		Tolerance		mm, in	wanted calibration tolerance
		Clear Cal.	execute		delete an existing calibration
	DELAY RECORD	Gate A Start		mm, in	Start of selected gate
		Gate A Width		mm, in	Width of selected gate
		Tolerance		mm, in	wanted calibration tolerance
		Start (Record)	execute		Start the calibration procedure, or record the reference signals
		Store	execute		Store the calibration values
		Clear Cal.	execute		delete an existing calibration

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
	TCG SETUP	Reference Refl.	Depth, SDH		Type of reference reflector to be used for calibration
		SDH Dia.		mm, in	Diameter of the SDH, if selected
		Reference Ampl.	10 - 100	%	Wanted screen height of the reference reflector
		Tolerance		mm, in	wanted calibration tolerance
		Clear TCG	execute		Delete an existing TCG calibration
		TCG	execute		Toggle TCG ON/OFF
	TCG RECORD	Reference No.	1 - 16	integer	current number of the TCG reference (point)
		Target Depth		mm, in	depth or sound path of the current reference reflector
		Gate A Start		mm, in	Start of selected gate
		Beam Section		°	Angular range for TCG recording
		Start (Record)	execute		Start the TCG recording procedure, or record the reference amplitudes
		End (Store)	execute		finalize the TCG recording and store the TCG parameters

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
	TCG VERIFY	Check TCG Finish	execute		Start TCG verification procedure (envelope of TCG references) or finish the verification
		Beam Angle Beam Select		° integer	Shot number or angle for TCG verification
		TCG Curve	off, on		TCG level display
	TCG LEVELS	TCG Level 1		dB	additional TCG line
		TCG Level 2		dB	additional TCG line
		TCG Level 3		dB	additional TCG line
		TCG Level 4		dB	additional TCG line
		TCG Curve		off, on	display TCG lines or not
		Transfer Corr.		dB	apply transfer correction

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
DISPLAY					
	VIEWS	Beam Angle, Beam Select	relates to Angle Start and Stop		Shot number or beam angle
		Views	A+E/S, E/S, A+E/S+C, A+E/S+B, A+E/S+B+C		selects screen views, e.g., A-Scan, A-Scan + E- or S-Scan, etc.
		View Correction	angle corr./ volume corr.		type of display for inclined scanning in the electronic scan (frame)
		Display Gates	no, yes		Gate display (still active, even when switched off)
		Data Source	Gate A, B, Acquisition		Data to be used for scanning
		Data Type	AMP, TOF		Type of data to be used with scanning
	COLORS				
		Amp Palette			Color palette for echo amplitudes
		TOF Palette			Color palette for TOF values
		Cursor Display	show, hide		Display of the measurement cursors

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
	CURSORS	View Select	Top, Side, Frame		Select view for image evaluation
		Beam Angle Beam Select	relates to Angle Start and Stop		Shot number or beam angle
	Top+Side *Side+Frame*	Cursor X1 Cursor Y1		mm, in	X = mechanical scanning coordinate Y = transverse coordinate (parallel to primary axis)
	Frame+Side *Top+Frame*	Cursor Z1 Cursor Y1		mm, in	Z = depth coordinate
	Top+Side *Side+Frame*	Cursor X2 Cursor Y2		mm, in	
	Frame+Side *Top+Frame*	Cursor Z2 Cursor Y2		mm, in	
	WELD OVERLAY	Show Overlay	yes, no		Display overlay in the electronic scan (Frame)
		Origin Offset X		mm, in	Start position of the mechanical scan
		Origin Offset Y		mm, in	Distance between Y-origin (e.g. weld center) and front of probe
		Flip Weld Side	execute		Change probe position to the other side of the weld
		Beam Dir.	to Left, to Right		Direction of the beam
		Weld Type		V, X, J	Type of the weld to be overlaid

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
	WELD GEOMETRY	Dimension A		mm, in	specific weld parameter
		Dimension B		mm, in	specific weld parameter
		Dimension C		mm, in	specific weld parameter
		Dimension D		mm, in	specific weld parameter
		Dimension E		mm, in	specific weld parameter
		Dimension F		mm, in	specific weld parameter
	READINGS	Reading 1	see reading list		Reading no. 1 to be displayed on screen
		Reading 2			Reading no. 2 to be displayed on screen
		Reading 3			Reading no. 3 to be displayed on screen
		Reading 4			Reading no. 4 to be displayed on screen
		Reading 5			Reading no. 5 to be displayed on screen
		Reading 6			Reading no. 6 to be displayed on screen

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
SCAN					
	ENCODER CAL.	Scan Mode	timed, positional		Type of mechanical scanning
		Encoder Dir.	clockwise, counter clockwise		Count direction of wheel encoder
		Encoder Counts		mm/ Tick, in/Tick	Distance between two encoder ticks
		Scan Increment		mm, in	Distance between two consecutive data acquisitions with encoded scanning
		Cal. Distance		mm, in	Distance for encoder calibration
		Start Calibrate Stop Calibrate			Start or stop encoder calibration
	SCAN SETUP	Scan Mode	timed, positional		Type of mechanical scanning
		Scan vs. Array	Perpendic-ular, parallel		mechanical scan perpendicular or parallel to primary (array) axis
		Origin Offset X		mm, in	Start position of the mechanical scan
		Scan Length		mm, in	Length of current mechanical scan
		Views	A+E/S, E/S, A+E/S+C, A+E/S+B, A+E/S+B+C		selects screen views, e.g., A-Scan, A-Scan + E- or S-Scan, etc.

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
	RUN	Scan Start Scan Stop	execute		Start or stop the mechanical scan
		Auto Name	off, on		use given name with sequential no. with consecutive storage of scans or setups
		Store	execute		Start storage
		Store as	execute		Start store a file with name editing
		Flip Weld Side	execute		Change probe position to the other side of the weld
		Clear Data	execute		clear current scan data

Table 3: Menu Layout and Readings (cont.)

Main Menu	Sub Menu	Function	Values	Dim	Comment
FILE	LOAD/ STORE PASS	Name		alpha-num.	Group (file) name
		Auto Name	off, on		use given name with sequential no. with consecutive storage of scans or setups
		Store	execute		Start storage
		Store as	execute		Start store a file with name editing
		Load	execute		Load selected file
		Delete	execute		Delete selected file
	IMPORT/ DELETE	Name			Group (file) name
		Export One	execute		export selected file
		Export All	execute		export all files containing mechanical scan data
		Target Drive			specifies target drive
		Eject	execute		ejects specified drive
		Import	execute		imports all files containing mechanical data form target drive to the system memory

3.2 The Gates Menu

A typical screen for the *Gates Menu* is shown in *Figure 16* below.

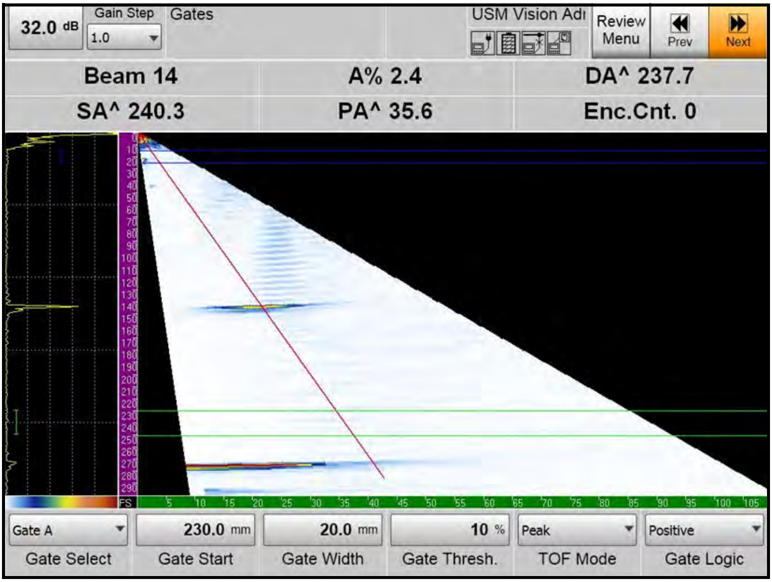


Figure 16: Gates Menu

The available options for this menu are listed in *Table 4* below.

Table 4: Gates Menu Options

Function	Description
Gate Select	Select desired gate
Gate Start	Sets gate start value
Gate Width	Sets gate width value
Gate Thresh.	Sets gate threshold
TOF Mode	Selects point for TOF measurement
Gate Logic	Selects the way of gate threshold violation

3.3 Weld Geometry in the Display Menu

The weld geometry is set according to the type of weld, as listed in *Table 5* below. Figure 17 below shows examples of the three weld types, with the locations of the dimensions.

Table 5: Weld Geometry

	Dimension A	Dimension B	Dimension C	Dimension D	Dimension E	Dimension F
Single V	Root Height	—	Half Root Width	Half Cap Width	—	—
Double V	—	Top Height	Bottom Height	Half Top Cap Width	Half Root Width	Half Bottom Cap Width
J Weld	Prep. Angle	Root Height	Half Root Width	Shoulder Width	Radius	—

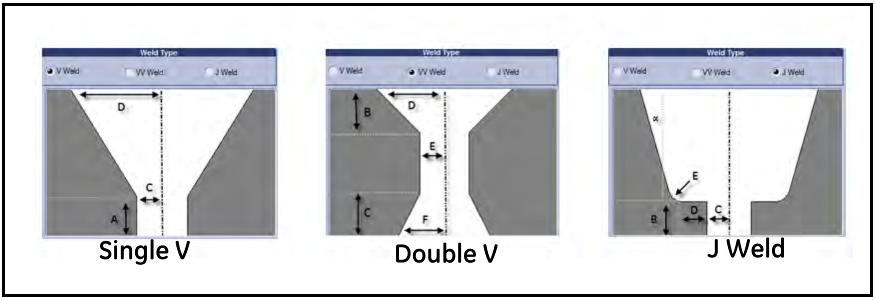


Figure 17: Weld Types

3.3.1 The Readings Sub-Menu

A typical screen for the *Readings* sub-menu is shown in *Figure 18* below.

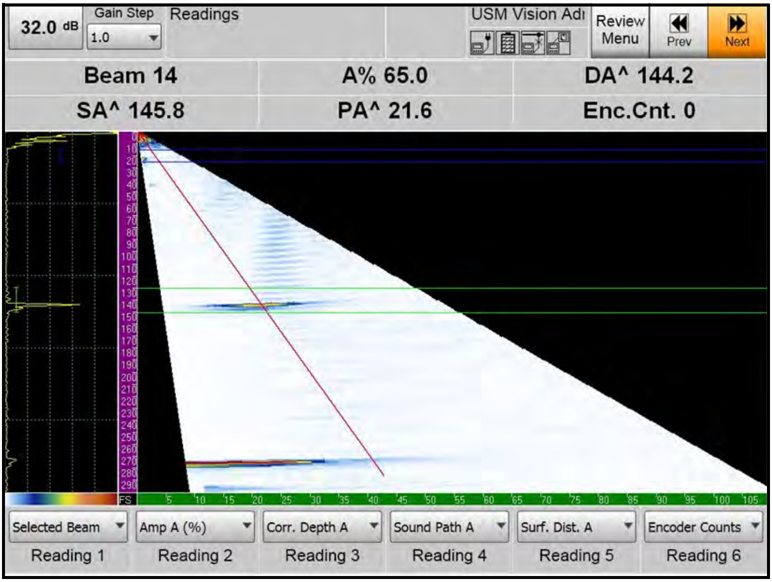


Figure 18: Display-Readings Sub-Menu

You can select up to six readings (each from 20 parameters) for display on the screen. The available options for this menu are listed in *Table 6* below.

Table 6: Options for Readings Sub-Menu

Reading	Description
None	Reading empty
Selected Beam	Beam number
Amp A (%)	Amplitude of echo in Gate A in % FSH
Amp A to TCG (%)	Amplitude of echo in Gate A in % compared to TCG
Amp A to TCG (dB)	Amplitude of echo in Gate A in dB compared to TCG
Sound Path A	Sound Path of echo in Gate A
Surf. Dist. A	Surface (projected) distance of echo in Gate A, relative to Origin Offset Y
Corr. Depth A	Corrected depth relating to echo in gate A (part thickness considered)

Table 6: Options for Readings Sub-Menu (cont.)

Reading	Description
Uncorr. Depth A	Uncorrected depth relating to echo in gate A
Amp B(%)	Amplitude of echo in Gate B in % FSH
Sound Path B	Sound Path of echo in Gate B
Surf. Dist. B	Surface (projected) distance of echo in Gate B, relative to Origin Offset Y
Corr. Depth B	Corrected depth relating to echo in gate B (part thickness considered)
Uncorr. Depth B	Uncorrected depth relating to echo in gate B
S-Diff B-A	Sound path difference between echoes in gate A and B
Amp A/B (dB)	Ratio of amplitudes in Gate A and B in dB
Amp I (%)	Amplitude of echo in gate I (Interface gate)
Scan Pos.	Scan position
Scan Pos. (°)	Scan position related to circumference of a round object (rod, pipe)
Encoder counts	actual encoder value
Missing Lines (%)	Missing scan lines in a scan recording

3.4 The File Menu

3.4.1 The Load/Store Pass Sub-Menu

A typical screen for the *Load/Store Pass* sub-menu is shown in *Figure 19* below.

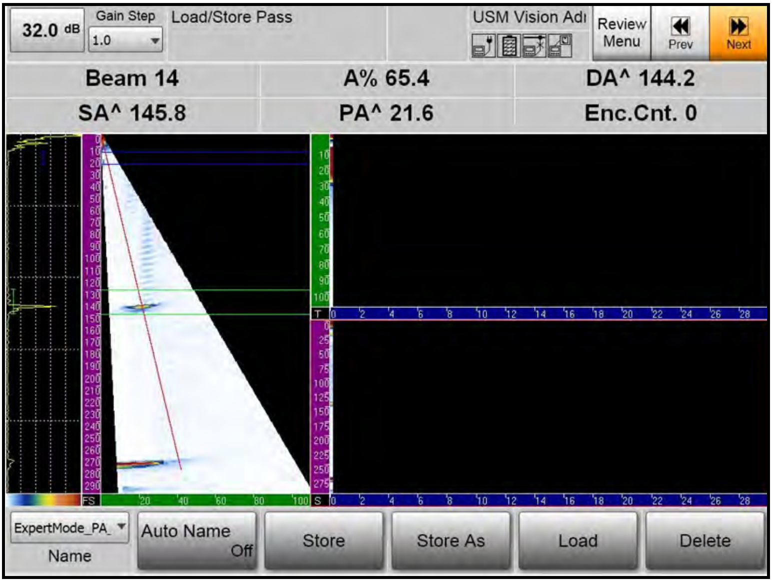


Figure 19: File—Load/Store Pass Sub-Menu

The available options for this sub-menu are listed in *Table 7* below.

Table 7: Load/Store Pass Sub-Menu Options

Function	Description
Name	Name of currently loaded file; opens data base to search for the wanted file
Auto Name	Selects manual file name editing or automatic file name editing with "Store"
Store	Stores the current data with the current name, or adds incremental number
Store as	Stores the current data with a new name (on-board keyboard)
Load	Loads file entered in Name
Delete	Deletes current file

3.5 Color Palette Editor (Amplitude and True Depth)

3.5.1 User Interface

3.5.1a Predefined Color Palettes

Color Palettes that come with the instrument are predefined and cannot be changed by the operator. The operator can only choose from the given list for Amplitude and Depth.

3.5.1b Custom Color Palettes

Unlike predefined palettes, the “Custom” Color palettes can be changed by the operators. They can specify the number of colors and specify, for each color, at which value it will end and the color value. There will be a selector for predefined colors, but they can also access the RGB values for each color.

3.5.1c Color Interpolations

Some of the predefined Color Palettes support a linear interpolation between colors. This option is not available for custom colors, which will be limited to colors that switch on a threshold.

3.5.1d Function Bar: Color Selection

In the Color Selection menu, users can switch between the Amplitude or Depth Mode Palettes, and select which palette should be used for the selected mode. For a custom palette, they can set the number of colors.

Figure 20: Color Selection Menu

3.5.1e Function Bar: Color Ranges

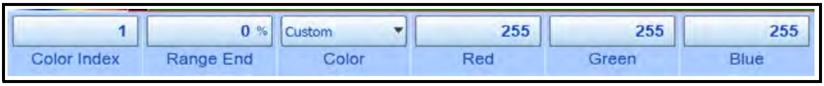


Figure 21: Color Range Menu

In the Color Range menu, the operator can specify the upper value for the selected color range, select a predefined color for it, or modify the RGB value of the color in the selected range.

Range End [% LSH] will be replaced by Range End [%Depth displayed] for predefined depth palettes and changes Range End [mm] for the "Custom" depth palette. Range End [mm] is valid from 0.0 to 6000.0 (as is RangeEnd in UT->Range).

Color Index value is limited from 1 to "Number of Colors". With color control, the user selects from a list of seven predefined colors: black, red, green, blue, yellow, white and gray. Changing any of the red, green or blue values will set Color to Custom. Values for red, green and blue controls range from 0 to 255.

3.5.1f Grey Out Logic

Predefined Color Palettes cannot be modified. Parameters allowing the operator to inspect the current palette settings are operable (like Color Index). Custom Color Palettes can only be modified while the USM Vision + is not scanning and not analyzing.

3.5.1g Storage

The selected Color Palette Names, along with their characteristics, will be stored in the settings file. Thus, after loading an instrument setting or a scan, the color definitions remain as they were when the file was stored.

3.6 Color Rulers

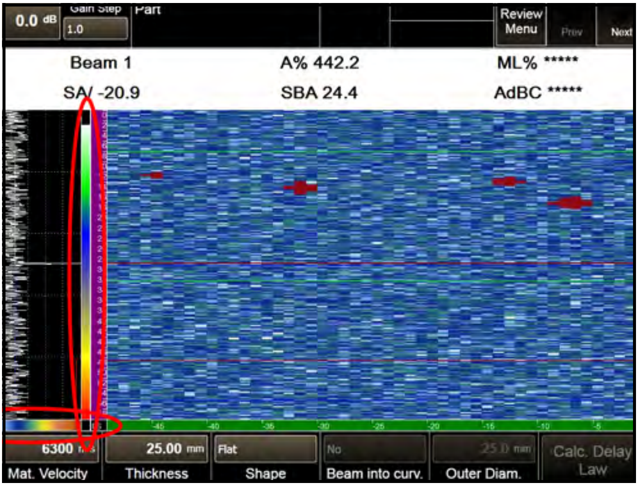


Figure 22: Color Ruler

3.6.1 Amplitude Color Bars

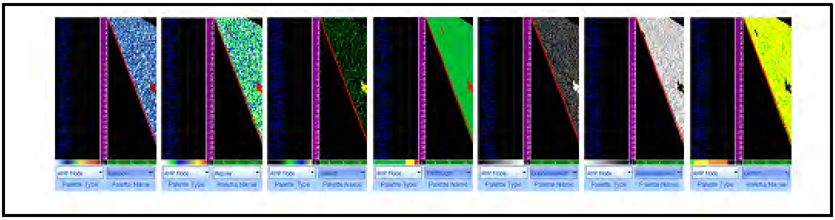


Figure 23: Predefined Amplitude Color Bars

The predefined color bars in the instrument are displayed in Figure 23 above. The "Custom" color palette is displayed as it is initially set before the operator has started to change it.

3.6.2 Amplitude Color Palette for RF

If Rectification is set to "RF," the A-Scan displays the range between -100% LSH and +100% LSH. The amplitudes in the Frame-View are always displayed rectified. Therefore the Amplitude Color palette in RF repeats the positive color values for the negative amplitude range.

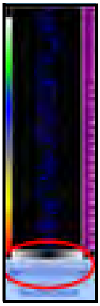


Figure 24: RF Amplitude Color Palette

3.6.3 Depth Color Bars

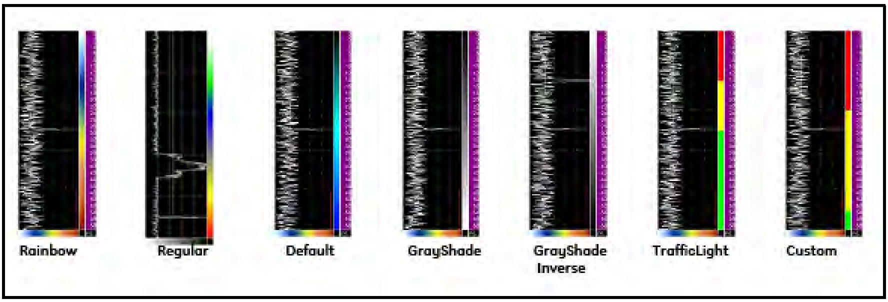


Figure 25: Depth Color Bars

The Color Palette for Depth values (Figure 25) appears at the right side of the A-Scan. On any signal peak (or flank event) in the A-Scan, the color that will be displayed within the Top-View will show up at the same horizontal position in the color bar. The Depth Color Bar is only displayed when "Depth Mode" is selected as Data Type for the Top-View. Depth Color Palette is not displayed at all when calibrating Delay or TCG.

3.7 Step Control Functionality

The linear and T/R pattern describe an aperture sequence of sending and receiving a beam with the same angle and focal depth from different elements of a phased array probe.

In USM Vision+ ver. 9.4.0, users could specify the first probe element where the first beam aperture should start. The pattern contained all apertures starting at the first element and the following probe elements, until the last element of the aperture reached the last element of the probe. Therefore the first element of the aperture increased by one from beam to beam.

With version 9.4.1, the operator can set the increment to a value other than one.The pattern can thus contain a lower number of beams, because the USM Vision + reaches the last probe element more quickly.

3.7.1 Valid Value Range

The minimum value for this control is 1 the maximum is (No of channels - 1) which calculates to 127 for the current USM Vision+ hardware.

3.7.2 Number of Beams in Pattern

The number of beams in a linear or T/R pattern is:

Number of Beams =
(Number of Probe Elements - (Start Element -1) - Aperture) / Linear Step + 1

3.7.3 Grey Out Logic

Control is greyed out during any calibration and when the USM Vision + is in scan or analyze mode.

3.7.4 User Interface

An additional control has been added for Linear as well as for T/R pattern selected.

Figure 26: User Interface Control

3.8 Sound Velocity Measurement

Figure 27: Sound Velocity Measurement

Sound velocity measurement is the topmost calibration menu. The interface appears similar to Figure 27 above.

The operator enters backwall, radius, side drilled hole or flat bottom hole as Ref. Type, and the distances /depths of the two reference reflectors as **Ref. Dist D1** and **Ref. Dist D2.** In addition, if the scan is other than sector, the operator needs to select the beam for the measurement in the Display Views menu.

The instrument will set the natural beam angle when the operator presses the START-button. Beam selection will be grayed out while sound velocity measurement is active. The operator can choose the threshold of gate A as well as the TOF measurement mode for gate A. Peak-mode is the typical setting for sound velocity measurement.

In the example on the following pages, the linear probe 115-000-766 has been used on a 10 mm aluminum plate, started with 6400 m/s as material velocity in menu Part. When pressing the START-button, the instrument switches gate A on, and sets it around the first reference distance (Start = D1 - 2 mm, if possible, and width = 4 mm).

3.8 Sound Velocity Measurement (cont.)

The instrument activates the A-Scan + Frame - layout, and displays the envelope curve in the A-Scan. An inverted V-icon is displayed while sound velocity measurement is active. At any time the gain may be changed, and the envelope curve will be generated again.

Figure 28: Envelope Curve in A-Scan

At any time the sound velocity measurement can be canceled by pressing the **CANCEL** button. In this case, the former layout, start and width of gate A are restored.

The **Set UT range** button enables users to quickly set a UT range around the two reference distances / depths, when the current display does not show them:
Range start = (D1 - 2mm) - 0.25 * ((D2 + 2mm) - (D1 - 2mm))
Range end = (D2 + 2mm) + 0.25 * ((D2 + 2mm) - (D1 - 2mm)).

The operator now maximizes the first reference echo, and presses the **STORE D1** button: The instrument will display the message “Measured TOF is invalid”, when no echo has been detected in Gate A (This should only occur when the echo does not intersect the gate bar in case of gate TOF measurement mode = flank, or in case of “loss of echo in interface gate”, when range trigger = IF in menu range, which are not typical settings for sound velocity measurement).

3.8 Sound Velocity Measurement (cont.)

Figure 29: Recording TOF

The instrument records the TOF of the highest echo of the envelope curve, within the TOF range given by gate A start to gate A end, when the measured TOF value is valid and positions gate A around the value of 'Ref Dist. D2' (Start = D2 - 2 mm, if possible, and Width = 4 mm).

The operator now maximizes the second reference echo, and presses the **STORE D2** button: The instrument will display the message “Measured TOF is invalid”, when no echo has been detected in Gate A (for the same reasons as mentioned in D1 above).

The instrument records the TOF of the highest echo of the envelope curve, within the TOF range given by gate A start to gate A end, when the measured TOF value is valid, and calculates the sound velocity according to formula (2) of M. Berke related document, and displays it as grayed out as **Sound Velo** (see Figure 30 on the next page).

3.8 Sound Velocity Measurement (cont.)

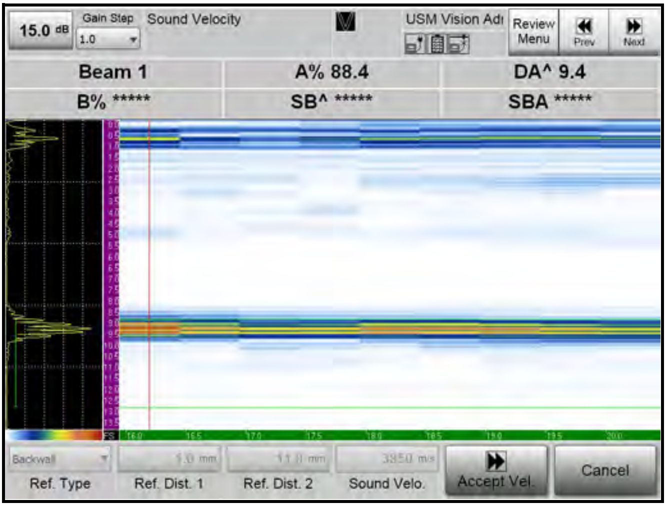


Figure 30: Sound Velocity Calculation

The operator can now accept the measured sound velocity or cancel the value to repeat the steps as desired.

With **ACCEPT** the measured sound velocity is confirmed and assigned to the actual part's material velocity. The delay law calculation is then automatically applied, and the sound velocity measurement is complete. The former layout, start and width of gate A are restored, and a V-icon, which is not inverted, will be shown.

3.8 Sound Velocity Measurement (cont.)

Figure 31: Return to Former Layout

The V-icon will be shown as long as the delay law calculation will not be called again. As a result, the part material velocity is stored, but the state "sound velocity was measured" is not stored, so that the V-icon will not be shown after re-load.

3.9 Range Trigger: IP Acquisition and IF Gate

The parameter “Range Trigger” in the UT Range menu has an additional mode, “IP Acquisition and IF Gate.” In this mode, the A-Scan starts with the initial pulse (IP), while gates A and B, and the TCG are triggered by the echo in the interface gate. Thereby, the area between initial pulse and echo in the interface gate is displayed in A-Scan and frame view, when the Range Start is set up accordingly.

To enable this mode, operators must select a linear scan with phasing angle = 0 degree, and the interface gate must be switched on.

Gate A and B are dynamically displayed in the A-Scan, which means that their gate bars move as the echo in the interface gate moves. Gate A and B are not displayed in frame view or side view. Frame view, side view and A-Scan are related to initial pulse and are in sync.

When the top view will be generated from gated data (Gate A or B), it will be relative to the echo in the interface gate. The readouts of gate A and B are also relative to the echo in the interface gate.

As the start value of gate A or B must be a positive value, and gate A and B are triggered by the echo in the interface gate, it is not possible to position gate A or B before the echo in the interface gate.

3.10 New Viewer Display Options

Some additional viewer functions are available in version 9.4.1. These options appear highlighted in light green in Figure 32 on the next page, while the options available in version 9.4.0 are in white.

3.10 New Viewer Display Options (cont.)

Settings Scheme 9.4.0 Layout	Data Source	Data Tpe	Settings Scheme 9.4.1 Layout	Top View Config	Screen Appearance	Viewer 1
A+E/S	ignored	ignored	Frame	---		Frame Amplitude
A+E/S+C (a)	Amp	Acquisition	Frame + Top	Amp Acquisition	A-Scan / Viewer 1 / Viewer 2	Frame Amplitude
				Amp Gate A		Frame Amplitude
				Amp Gate B		Frame Amplitude
A+E/S+C (d)	Depth	Acquisition		Depth Acquisition		Frame Amplitude
A+E/S+C (d)	Depth	Gate A		Depth Gate A		Frame Amplitude
A+E/S+C (d)	Depth	Gate B		Depth Gate B		Frame Amplitude
				Depth Gate B-A		Frame Amplitude
A+E/S+B	ignored	ignored	Frame + Side	---		Frame Amplitude
A+E/S+B+C (a)	Amp	Acquisition	Frame + Side + Top	Amp Acquisition	A-Scan / Viewer 1 / Viewer 2 / Viewer 3	Frame Amplitude
				Amp Gate A		Frame Amplitude
				Amp Gate B		Frame Amplitude
A+E/S+B+C (d)	Depth	Acquisition		Depth Acquisition		Frame Amplitude
A+E/S+B+C (d)	Depth	Gate A		Depth Gate A		Frame Amplitude
A+E/S+B+C (d)	Depth	Gate B		Depth Gate B		Frame Amplitude
				Depth Gate B-A		Frame Amplitude
			Frame + 2* Top	Amp & Depth Acquisition		Frame Amplitude
				Amp & Depth Gate A		Frame Amplitude
				Amp & Depth Gate B		Frame Amplitude
			Frame + Side + 2 * Top	Amp & Depth Acquisition	A-Scan / Viewer 1 / Viewer 2 / Viewer 3 / Viewer 4	Frame Amplitude
				Amp & Depth Gate A		Frame Amplitude
				Amp & Depth Gate B		Frame Amplitude

Figure 32: Viewer Display Options

[no content intended for this page]

Chapter 4. Calibration

Successful calibration is vital to accurate weld inspection. The USM Vision+ can perform both linear and sector scan calibration, as well as sensitivity, ACG, TCG and encoder calibration.

4.1 Calibrating a 0° Linear Scan

This procedure calibrates a linear scan of 0° with probe 115-500-016 in direct coupling.

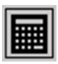
1. The first step is to set the Part, Probe, Wedge, UT and Delay Law menus. Table 8 below lists the appropriate settings for the menus.

Table 8: Menu Settings for Linear Scan 0°

Menu	Sub-Menu	Parameter	Value
Part		Mat. Velocity	5920 m/s
Part		Thickness	100 mm
Part		Shape	Flat
Part		Beam into curve.	No
Probe		Probe Name	115-500-016
Wedge	Geometry	Wedge Name	Custom
Wedge		Wedge Angle	0°
Wedge		Wedge Velocity	2730 m/s
Wedge		Wedge Front	0 mm
Wedge		Z-Offset	1 mm
Wedge		1st Elem. Pos.	Low
Wedge	Curvature	Shape	Flat
Wedge		Beam Dir.	To Right
UT	Range	Range Start	0 mm
UT		Range Mode	Manual
UT		Range End	100 mm

Table 8: Menu Settings for Linear Scan 0° (cont.)

Menu	Sub-Menu	Parameter	Value
UT		No. of Legs	1
UT		Range Trigger	IP
UT	Pulser	Pulser Voltage	90 V
UT		IP Width Mode	Auto
UT		PRF Mode	Manual
UT		PRF	2000 Hz
UT	Receiver	Rectification	Full Wave
UT		Filter	0.5 –11.5 MHz
UT		Video Filter	Off
Delay Law	Aperture	Start Element	1
Delay Law		Aperture	16
Delay Law		Focal Depth	100 mm
Delay Law		Pin Offset	0
Delay Law	Electronic Scan	Electronic Scan	Linear
Delay Law		Angle	0°

2. The symbol  indicates that element delays need to be calculated. Press the **Calc. Delay Law** icon**.** The system now calculates the individual element delays for the current setup and stores the values.

IMPORTANT: *As long as the Delay Law Calculation is pending, many functions of the instrument are blocked!*

Since all entered values are correct related to the probe and part, the system should show almost correct signals, when coupled to the 25 mm K1. Gate parameters have been set to measure the two echoes from 25mm and 50 mm using gate A and B.

4.1 Calibrating a 0° Linear Scan (cont.)

The current readings for the setup shown in Figure 33 below are:

- Beam = 10 (shot number)
- SA^ = sound path for max. echo in gate A
- SB^ = sound path for max. echo in gate B
- SBA = Sound path difference
- A% = echo height in gate A
- B% = echo height in gate B

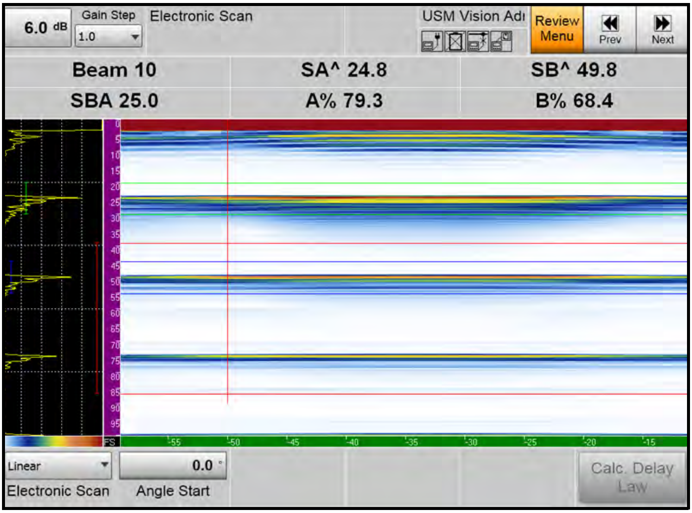


Figure 33: Menu Setup for Calibration

Gate parameters have been set to measure the two echoes from 25 mm and 50 mm using gate A and B.

3. Now you must set up the calibration itself, according to the parameters in Table 9 on the next page.

4.1 Calibrating a 0° Linear Scan (cont.)

Table 9: Calibration Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	Delay - Setup	Reference Refl.	Depth
Calibration		Ref. Distance	25 mm
Calibration		Tolerance	1mm

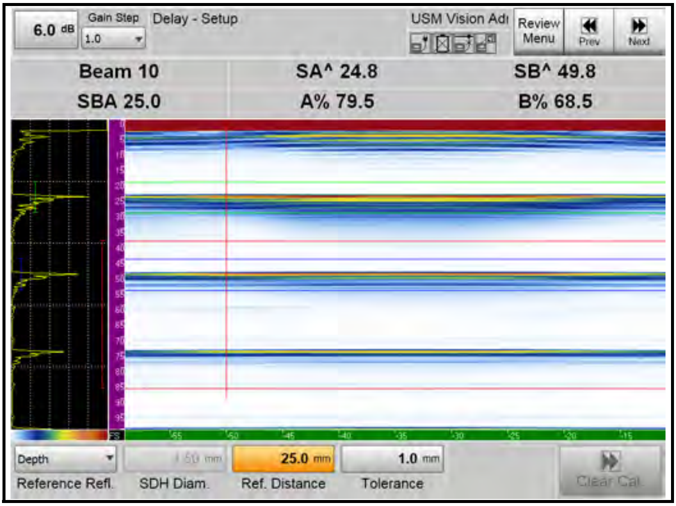


Figure 34: Calibration Setup

Note: *GE recommends setting the gain so that the optimized 25mm echo is at ~80% FSH.*

4. Press **Start** to start recording the calibration echo.

Table 10: Calibration Recording

Menu	Sub-Menu
Calibration	Delay - Record

4.1 Calibrating a 0° Linear Scan (cont.)

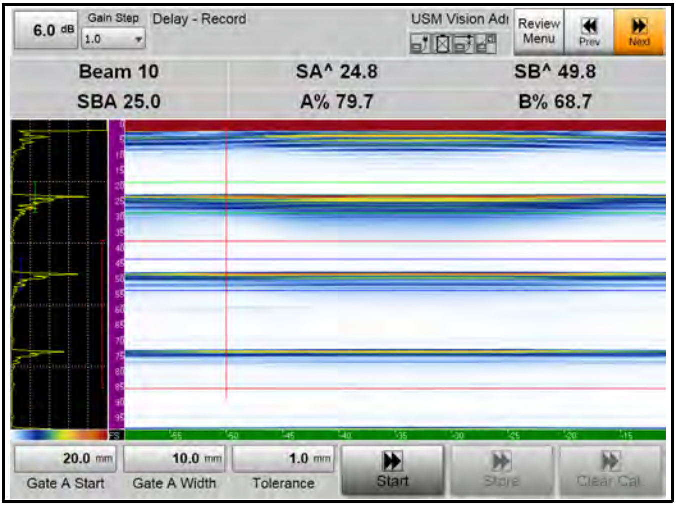


Figure 35: Start Recording

5. As calibration begins, the **Start** icon changes to **Record.** A new window shows the measured distances for all shots versus the beam number. The red curve shows the measured sound paths for the current probe position. Move the probe slowly to reach a constant coupling over the probe coupling area. The red curve may change slightly. The gate measurement point should be set to **Peak**.

4.1 Calibrating a 0° Linear Scan (cont.)

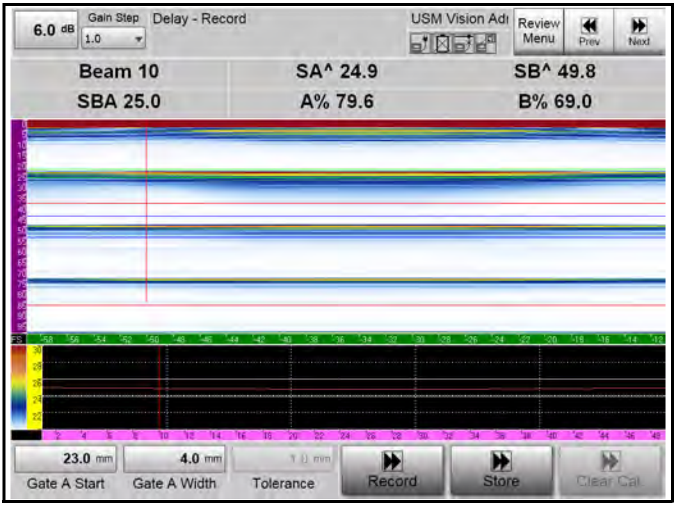


Figure 36: Window with Measured Distances

6. When you have found all sound paths, press **Record** to let the system calculate the necessary delay line correction for each shot (beam).

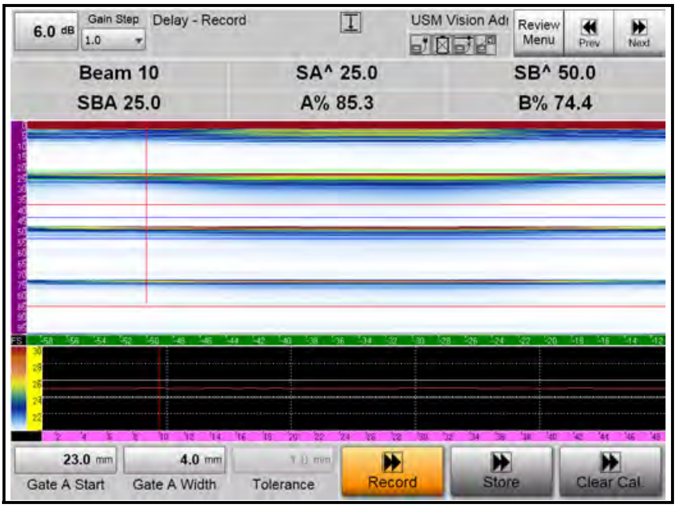


Figure 37: Start Recording

4.1 Calibrating a 0° Linear Scan (cont.)

7. Press **Store** if all measured sound paths are within the tolerance band.

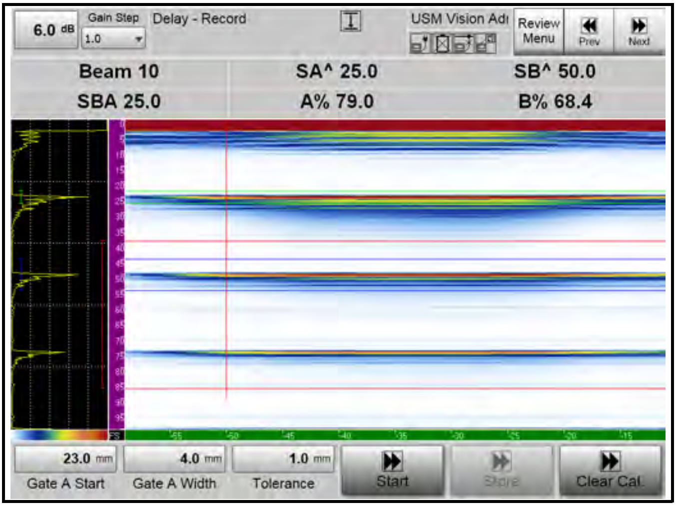


Figure 38: Storing the Calibration

8. The system is now calibrated, confirmed by the calibration symbol . You can perform a calibration check using K1/100 mm.

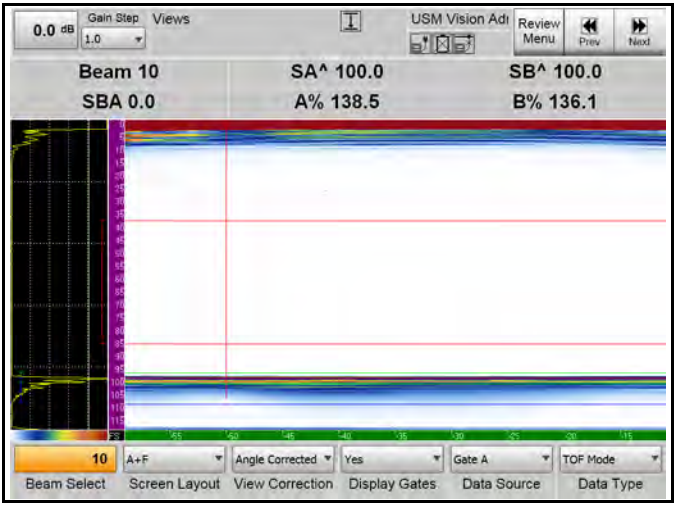


Figure 39: Calibration Check

4.2 Calibrating a 20° Linear Scan

This procedure calibrates a linear scan of 20° with probe 115-500-016 in direct coupling.

Calibration block: DAC vertical
Thickness: 105 mm
Reference: 3 mm SDHs
Sound velocity: 5920 m/s

1. The first step is to set the Part, Probe, Wedge, UT and Delay Law menus. Table 11 below lists the appropriate settings for the menus.

Table 11: Menu Settings for Linear Scan 20°

Menu	Sub-Menu	Parameter	Value
Part		Mat. Velocity	5920 m/s
Part		Thickness	105 mm
Part		Shape	Flat
Part		Beam into curve.	No
Probe		Probe Name	115-500-016
Wedge	Geometry	Wedge Name	Custom
Wedge		Wedge Angle	0°
Wedge		Wedge Velocity	2730 m/s
Wedge		Wedge Front	0 mm
Wedge		Z-Offset	1 mm
Wedge		1st Elem. Pos.	Low
Wedge	Curvature	Shape	Flat
Wedge		Beam Dir.	To Right
UT	Range	Range Start	0 mm
UT		Range Mode	Manual
UT		Range End	120 mm
UT		No. of Legs	1

Table 11: Menu Settings for Linear Scan 20° (cont.)

Menu	Sub-Menu	Parameter	Value
UT		Range Trigger	IP
UT	Pulser	Pulser Voltage	90 V
UT		IP Width Mode	Auto
UT		PRF Mode	Manual
UT		PRF	2000 Hz
UT	Receiver	Rectification	Full Wave
UT		Filter	0.5 - 11.5 MHz
UT		Video Filter	Off
Delay Law	Aperture	Start Element	1
Delay Law		Aperture	16
Delay Law		Focal Depth	50 mm
Delay Law		Pin Offset	0
Delay Law	Electronic Scan	Electronic Scan	Linear
Delay Law		Angle	20°

2. The symbol  indicates that element delays need to be calculated. Press the **Calc. Delay Law** icon**.** The system now calculates the individual element delays for the current setup and stores the values.

IMPORTANT: *As long as the Delay Law Calculation is pending, many functions of the instrument are blocked!*

Since all entered values are correct related to the probe and part, the system should show almost correct signals, when coupled to the DAC block.

4.2 Calibrating a 20° Linear Scan (cont.)

The current readings for the setup shown in Figure 40 below are:

- Beam = 10 (shot number)
- SA^ = sound path for max. echo in gate A
- SB^ = sound path for max. echo in gate B
- SBA = Sound path difference
- A% = echo height in gate A
- B% = echo height in gate B

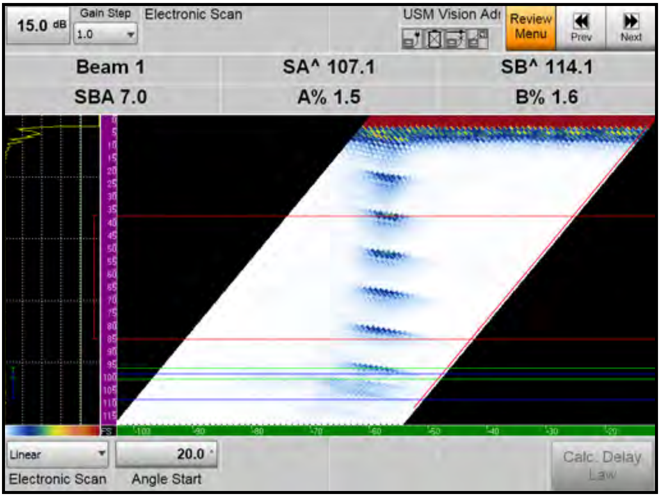


Figure 40: Menu Setup for Calibration

3. Set up the calibration according to the parameters in Table 12 below.

Table 12: Calibration Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	Delay - Setup	Reference Refl.	SDH
Calibration		SDH Diam.	3 mm
Calibration		Ref. Distance	55 mm
Calibration		Tolerance	1 mm

4.2 Calibrating a 20° Linear Scan (cont.)

Figure 41 below shows the echo from the SDH in 55 mm.

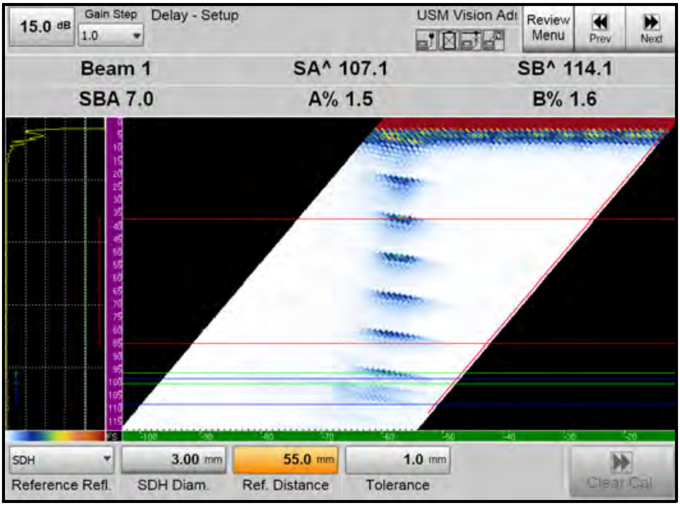


Figure 41: SDH Echo

4. Press **Start** to begin recording.

Table 13: Calibration Recording

Menu	Sub-Menu
Calibration	Delay - Record

4.2 Calibrating a 20° Linear Scan (cont.)

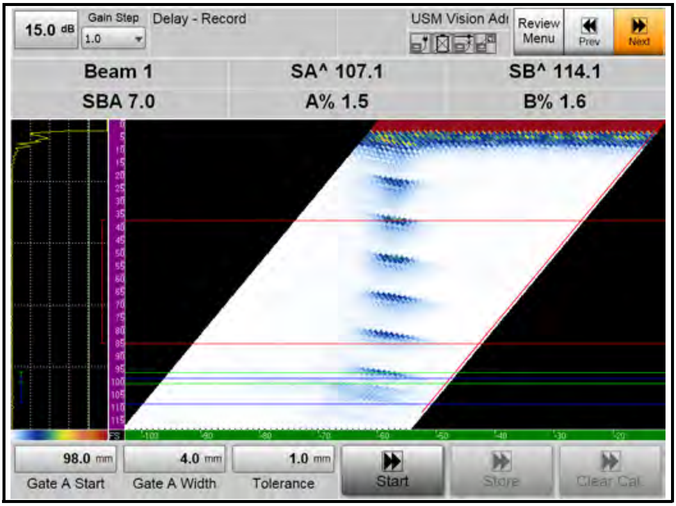


Figure 42: Start Recording

Note: *After you press* ***Start,*** *Gate A will automatically be set to cover the reference reflector (here the SDH in 55 mm).*

5. As calibration begins, the **Start** icon changes to **Record.** A new window shows the measured distances for all shots versus the beam number. The red curve shows the measured depths for the current probe position.

   Move the probe slowly to hit the SDH with every shot (beam). The red curve will change to correspond.

4.2 Calibrating a 20° Linear Scan (cont.)

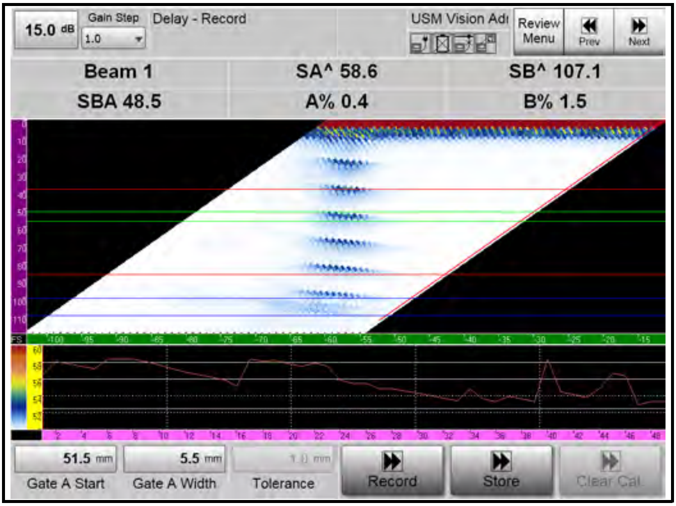


Figure 43: Window with Measured Distances

6. When you have found all depths, press **Record** to let the system calculate the necessary delay line correction for each shot (beam).

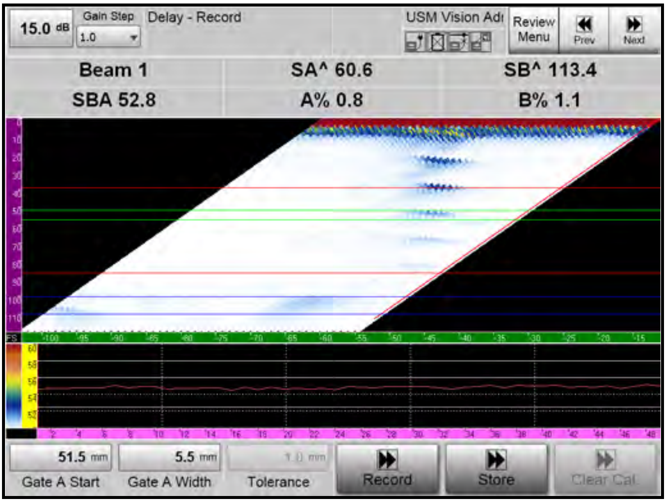


Figure 44: Start Recording

4.2 Calibrating a 20° Linear Scan (cont.)

7. Press **Store** if all measured depths are within the tolerance band.

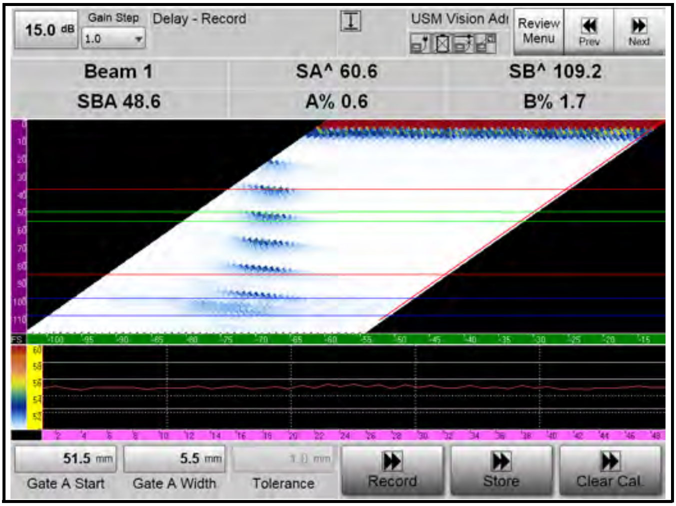


Figure 45: Storing the Calibration

8. The system is now calibrated, confirmed by the calibration symbol. You can perform a calibration check using a 105 mm corner.

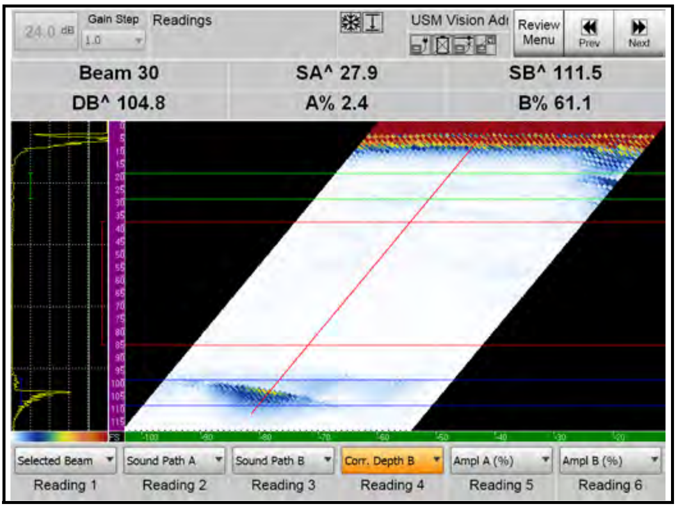


Figure 46: Calibration Check

4.2 Calibrating a 20° Linear Scan (cont.)

9. Sensitivity linearization uses the same procedure as with 0°. Instead of the back wall echo at constant depth, you use the 3 mm SDH at 55 mm in the DAC block.

Table 14: Amplitude Linearization (1-Point TCG)

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Setup	Reference Refl.	SDH
Calibration		SDH Diam.	3 mm
Calibration		Reference Ampl.	80%
Calibration		Tolerance	1 mm

4.3 Calibrating a -20° to 20° Sector Scan

This procedure enables calibration of a -20° to 20° sector scan with probe B2SPA.

Calibration block: Half cylinder
Radius: 50 mm
Sound velocity: 5840 m/s

1. The first step is to set the Part, Probe, Wedge, UT and Delay Law menus. Table 15 below lists the appropriate settings for the menus.

Table 15: Menu Settings for -20° to 20° Sector Scan

Menu	Sub-Menu	Parameter	Value
Part		Mat. Velocity	5840 m/s
Part		Thickness	100 mm
Part		Shape	Flat
Part		Beam into curve.	No
Probe		Probe Name	Custom *
Probe		Probe Frequency	2 MHz
Probe		No. of Elements	16
Probe		Pitch	1.5 mm
Probe		Elevation	24 mm
Wedge	Geometry	Wedge Name	Custom
Wedge		Wedge Angle	0°
Wedge		Wedge Velocity	2730 m/s
Wedge		Wedge Front	0 mm
Wedge		Z-Offset	2.3 mm
Wedge		1st Elem. Pos.	Low
Wedge	Curvature	Shape	Flat
Wedge		Beam Dir.	To Right

Table 15: Menu Settings for -20° to 20° Sector Scan (cont.)

Menu	Sub-Menu	Parameter	Value
UT	Range	Range Start	0 mm
UT		Range Mode	Manual
UT		Range End	120 mm
UT		No. of Legs	1
UT		Range Trigger	IP
UT	Pulser	Pulser Voltage	90 V
UT		IP Width Mode	Auto
UT		PRF Mode	Manual
UT		PRF	2000 Hz
UT	Receiver	Rectification	Full Wave
UT		Filter	0.5 –11.5 MHz
UT		Video Filter	Off
Delay Law	Aperture	Start Element	1
Delay Law		Aperture	16
Delay Law		Focal Depth	100 mm
Delay Law		Pin Offset	0
Delay Law	Electronic Scan	Electronic Scan	Sector
Delay Law		Angle	0°
Delay Law		Angle Start	-20°
Delay Law		Angle Stop	20’
Delay Law		Angle Step	1°

2. The symbol  indicates that element delays need to be calculated. Press the **Calc. Delay Law** icon**.** The system now calculates the individual element delays for the current setup and stores the values.

4.3 Calibrating a -20° to 20° Sector Scan (cont.)

IMPORTANT: *As long as the Delay Law Calculation is pending, many functions of the instrument are blocked!*

Since all entered values are correct related to the probe and part, the system should show almost correct signals, when coupled to the 50 mm half-circular block, and optimizing the echo from radius 50 mm. Gate values have been set to measure the two echoes from 50 mm and 100 mm using gate A and B.

The current readings for the setup shown in Figure 47 below are:

- Beam = 21 (beam number, here 0°)
- SA^ = sound path for max. echo in gate A
- SB^ = sound path for max. echo in gate B
- SBA = Sound path difference
- A% = echo height in gate A
- B% = echo height in gate B

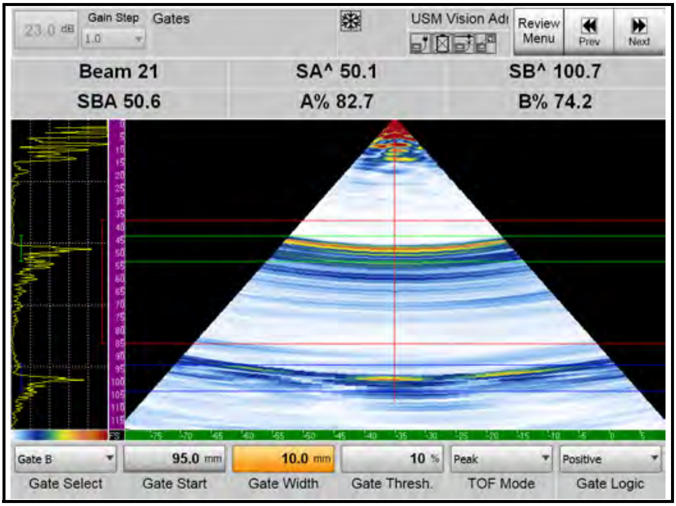


Figure 47: Menu Setup for Calibration

4.3 Calibrating a -20° to 20° Sector Scan (cont.)

3. Set up the calibration according to the parameters in Table 16 below.

Table 16: Calibration Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	Delay - Setup	Reference Refl.	Radius
Calibration		Ref. Distance	50 mm
Calibration		Tolerance	1mm

Note: *GE recommends selecting an angle of 0° (at the center of the angular range) and setting the gain so that the optimized 50 mm echo is at ~80% FSH.*

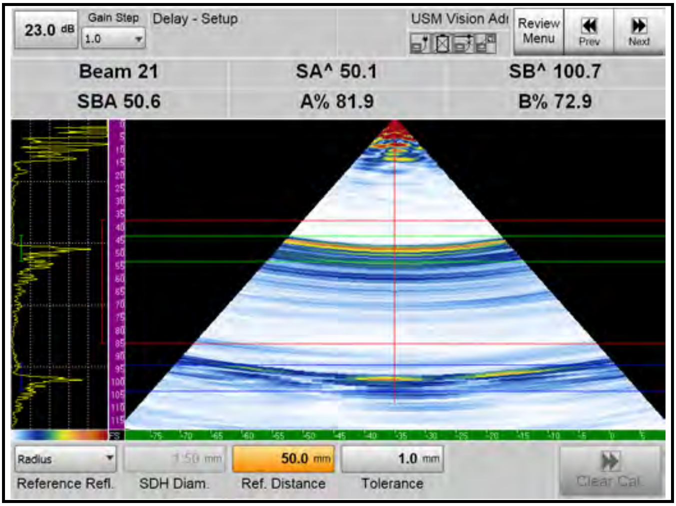


Figure 48: Calibration Setup

4. Press **Start** to begin recording.

Table 17: Calibration Recording

Menu	Sub-Menu
Calibration	Delay - Record

4.3 Calibrating a -20° to 20° Sector Scan (cont.)

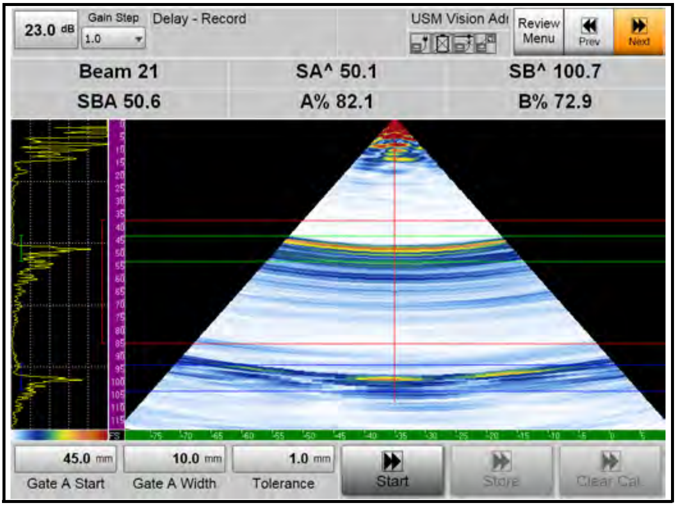


Figure 49: Recording Setup

Note: *The probe's primary (active) axis is in the radial direction (cable in axial direction).*

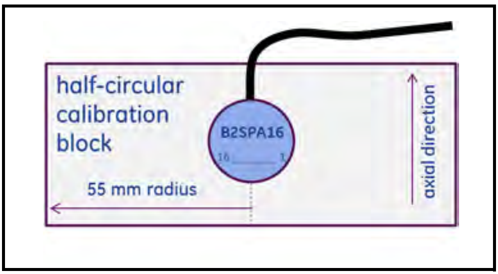


Figure 50: Probe Direction

5. As calibration begins, the **Start** icon changes to **Record.** A new window shows the measured distances for all shots versus the beam number. The red curve shows the measured sound paths for the current probe position.

   Move the probe slowly to collect the maximum amplitude for every angle. The red curve will change to correspond.

4.3 Calibrating a -20° to 20° Sector Scan (cont.)

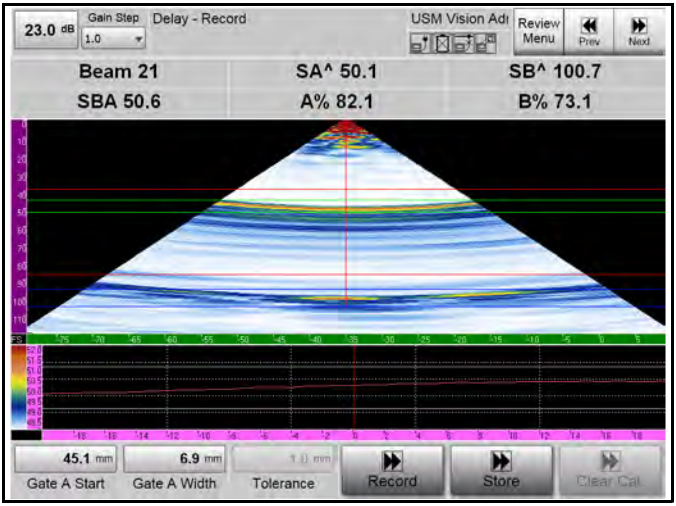


Figure 51: Window with Measured Sound Paths

6. When you have found all maximum amplitudes, press **Record** to let the system calculate the necessary delay line correction for each angle.

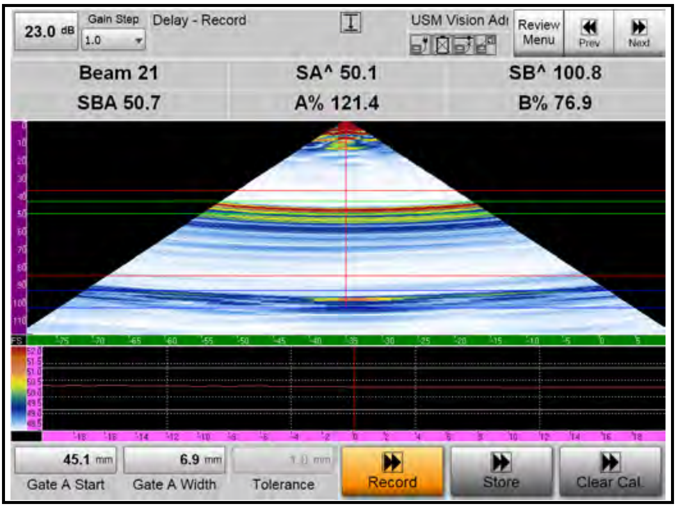


Figure 52: Start Recording

4.3 Calibrating a -20° to 20° Sector Scan (cont.)

7. Press **Store** if all measured sound paths are within the tolerance band.

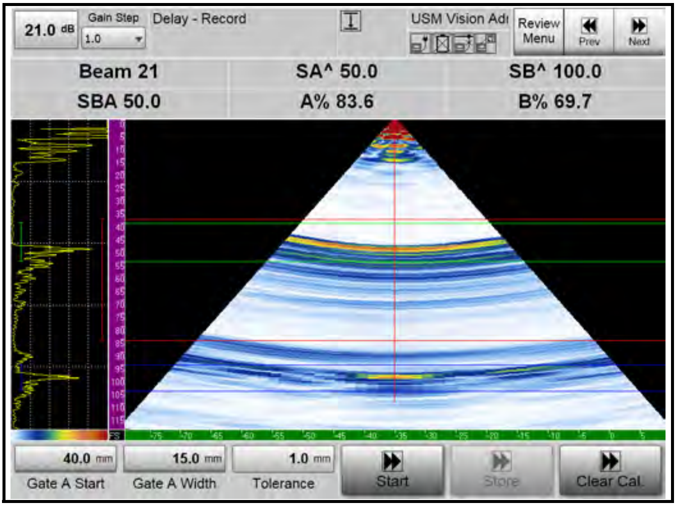
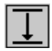


Figure 53: Storing the Calibration

8. The system is now calibrated, confirmed by the calibration symbol . You can perform a calibration check using a SDH in 65 mm or an SDH full screen (Figure 54).

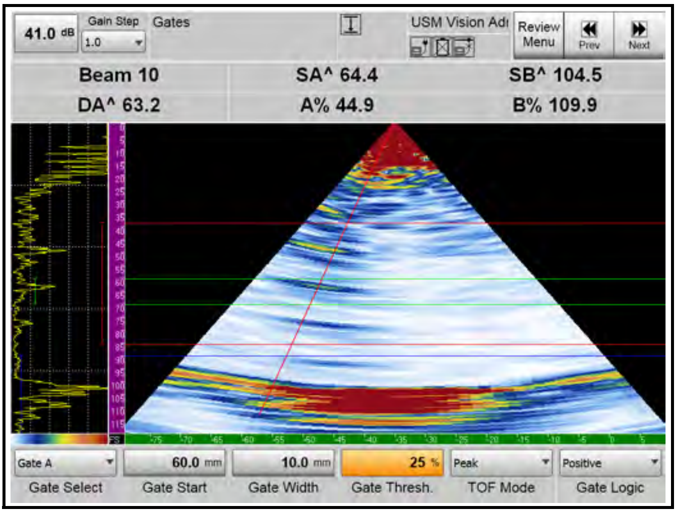


Figure 54: Full Screen Calibration Check

4.4 Calibrating a 40° to 70° Sector Scan

This procedure enables calibration of a 40° to 70° sector scan with probe MWB4PA (built-in wedge).

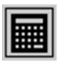
1. The first step is to set the Part, Probe, Wedge, UT and Delay Law menus. Table 18 below lists the appropriate settings for the menus.

Table 18: Menu Settings for 40° to 70° Sector Scan

Menu	Sub-Menu	Parameter	Value
Part		Mat. Velocity	3250 m/s
Part		Thickness	100 mm
Part		Shape	Flat
Part		Beam into curve.	No
Probe		Probe Name	69142
Wedge	Geometry	Wedge Name	Custom
Wedge		Wedge Angle	43.2°
Wedge		Wedge Velocity	2730 m/s
Wedge		Wedge Front	16.1 mm
Wedge		Z-Offset	5.3 mm
Wedge		1st Elem. Pos.	Low
Wedge	Curvature	Shape	Flat
Wedge		Beam Dir.	To Right
UT	Range	Range Start	0 mm
UT		Range Mode	Manual
UT		Range End	100 mm
UT		No. of Legs	1
UT		Range Trigger	IP
UT	Pulser	Pulser Voltage	90 V
UT		IP Width Mode	Auto

Table 18: Menu Settings for 40° to 70° Sector Scan (cont.)

Menu	Sub-Menu	Parameter	Value
UT		PRF Mode	Manual
UT		PRF	2000 Hz
UT	Receiver	Rectification	Full Wave
UT		Filter	0.5 –11.5 MHz
UT		Video Filter	Off
Delay Law	Aperture	Start Element	1
Delay Law		Aperture	16
Delay Law		Focal Depth	100 mm
Delay Law		Pin Offset	0
Delay Law	Electronic Scan	Electronic Scan	Sector
Delay Law		Angle Start	40°
Delay Law		Angle Stop	70’
Delay Law		Angle Step	1°

2. The symbol  indicates that element delays need to be calculated. Press the **Calc. Delay Law** icon**.** The system now calculates the individual element delays for the current setup and stores the values.

IMPORTANT: *As long as the Delay Law Calculation is pending, many functions of the instrument are blocked!*

Since all entered values are correct related to the probe and part, the system should show almost correct signals, when coupled to K2, and optimizing the echo from radius 25 mm. Gate values have been set to measure the two echoes from 25 mm and 100 mm using gate A and B. The part thickness must be equal or larger than the sound path related to the calibration distance! After calibration, the thickness can be set to the real value of the test object.

4.4 Calibrating a 40° to 70° Sector Scan (cont.)

The current readings for the setup shown in Figure 55 below are:

- Beam = 21 (beam number, here 60°)
- SA^ = sound path for max. echo in gate A
- SB^ = sound path for max. echo in gate B
- SBA = Sound path difference
- A% = echo height in gate A
- B% = echo height in gate B

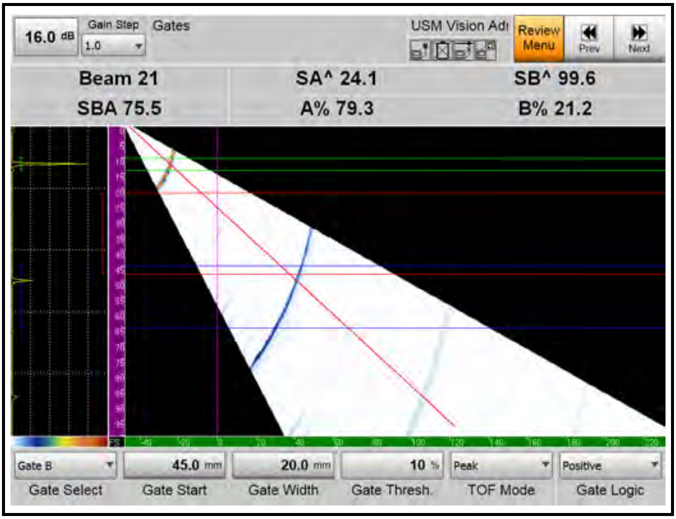


Figure 55: Menu Setup for Calibration

4.4 Calibrating a 40° to 70° Sector Scan (cont.)

3. Set up the calibration according to the parameters in Table 19 below.

Table 19: Calibration Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	Delay - Setup	Reference Refl.	Radius
Calibration		Ref. Distance	25 mm
Calibration		Tolerance	1mm

Note: *GE recommends selecting an angle of 55° (at the center of the angular range) and setting the gain so that the optimized 25 mm echo is at ~80% FSH.*

Figure 56: Calibration Setup

4. Press **Start** to begin recording.

Table 20: Calibration Recording

Menu	Sub-Menu
Calibration	Delay - Record

4.4 Calibrating a 40° to 70° Sector Scan (cont.)

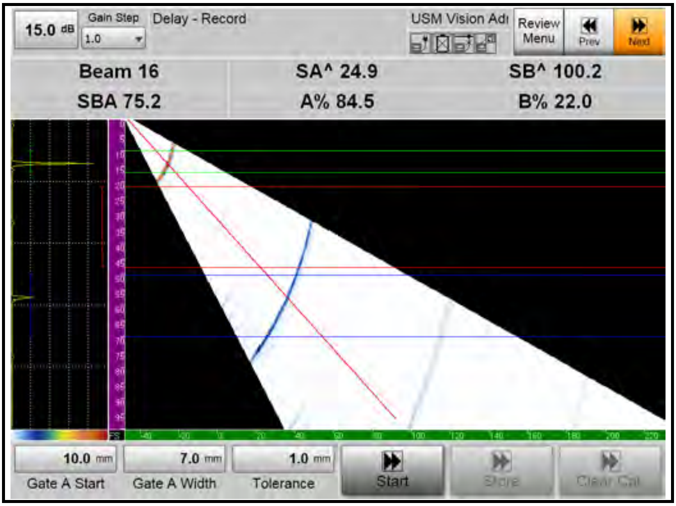


Figure 57: Recording Setup

5. As calibration begins, the **Start** icon changes to **Record.** A new window shows the measured distances for all shots versus the beam angle. The red curve shows the measured sound paths for the current probe position. Move the probe slowly to collect the maximum amplitude for every angle. The red curve will change to correspond.

Figure 58: Window with Measured Sound Paths

4.4 Calibrating a 40° to 70° Sector Scan (cont.)

6. When you have found all maximum amplitudes, press **Record** to let the system calculate the necessary delay line correction for each angle.

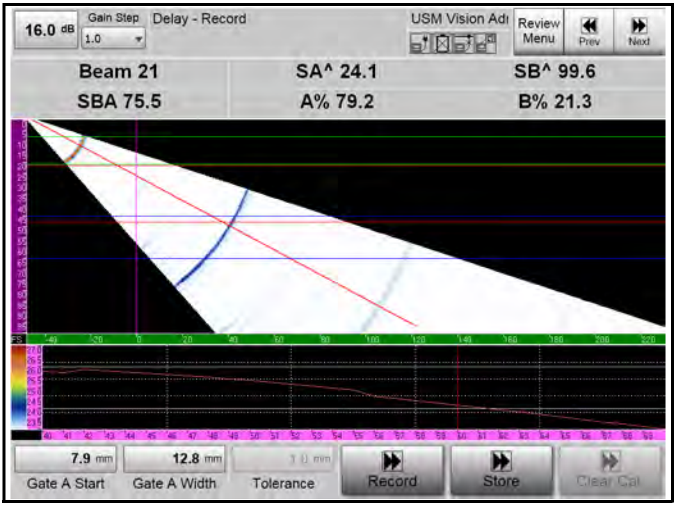


Figure 59: Start Recording

7. Press **Store** if all measured sound paths are within the tolerance band.

Figure 60: Storing the Calibration

4.4 Calibrating a 40° to 70° Sector Scan (cont.)

8. The system is now calibrated, confirmed by the calibration symbol . You can perform a calibration check using K1 at 40° (Figure 37) 55° (Figure 38) or 70°.

Figure 61: Calibration Check at 40° (99.9 mm)

Figure 62: Calibration Check at 55° (99.9 mm)

4.4 Calibrating a 40° to 70° Sector Scan (cont.)

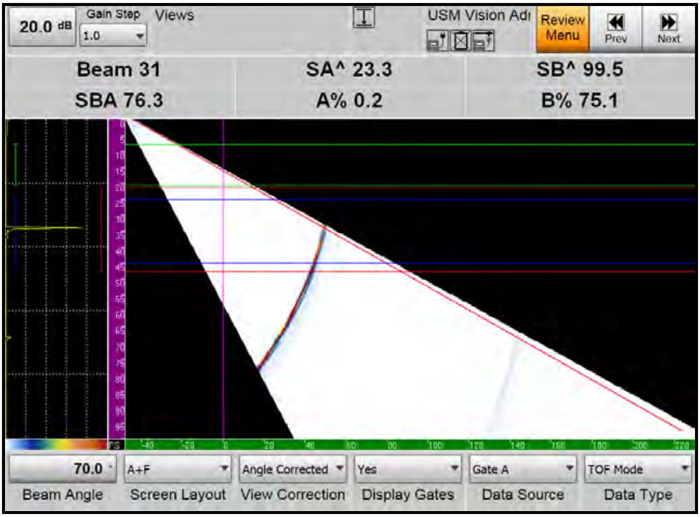


Figure 63: Calibration Check at 70° (99.5 mm)

4.4.1 Creating a Dual Sector Scan for Weld Inspection

Once you have correctly set up and calibrated the first group, you can then “clone” a second group from the first, e.g., for a double side simultaneous scan (dual scan). You must use a so-called “Y-probe” (two probes sharing one connector). This example uses the “Y-version” of the probe used for the single sector scan calibration, as described in section 4.4, order number P/N 115-500-013.

Here, the two 16 element probes are connected via the Y-cable with one socket. On the socket, probe #1 (left) uses pins 1 – 16, probe #2 (right) uses pins 33 – 48. Pin Offset for probe #2 is 32.

Set up the 115-500-013 probe on 36° wedge (69438) with:

- Calibration on K2
- TCG recording with 4 points (10, 25, 40, 55mm)
- Sector from 40° - 70°, stored to file “2Sector_left”

Figure 64 below shows the setup for probe #1 on the DAC block to verify the correct calibration and probe position.

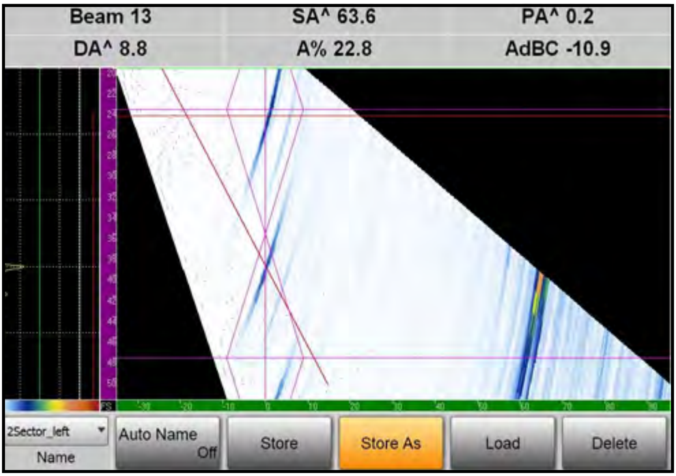


Figure 64: Setup for Probe #1

4.4.1 Creating a Dual Sector Scan for Weld Inspection (cont.)

1. Set the parameters as shown in Table 21 below.

Table 21: Menus and Actions for Dual Sector Scan

Menu	Action / Function	Action	Comment
Delay Law: Groups	Copy		The system creates a second group having exactly the same parameters as group #1.
	Rename	Enter: sector right Ok	The new group is now called “sector right”.
Delay Law: Aperture	Pin Offset	= 32	Probe #2 (right) starts now at pin 33 on the combined socket.
Display: Weld Overlay	Beam dir.	= To Left	The beam direction of probe #2 now looks to the left.
	Origin Offset Y	= +40 mm	The probe offset to the weld center is now equal to probe #1, but opposite.
Delay Law: Groups	Group Name	Select previous group	
	Rename	Enter: sector left Ok	The first (original) group has now been renamed to “sector left”.
File: Load/Store	Store As	Enter: 2Sector	The setup including 2 groups is now stored with the name “2Sector”.

2. Set up the dual sector scan in the following sequence, shown in Figure 65 on the next page:

- Weld geometry: Double V
- Dimensions: A = E = 0 mm, B = C = 12 mm, D = F = 9 mm, T = 24 mm
- UT Range: 20 mm - 52 mm, 3 Legs, Probe offset to weld center = 40 mm

4.4.1 Creating a Dual Sector Scan for Weld Inspection (cont.)

Figure 65: Weld Overlay with Flip Button

The scan result appears as shown in Figure 66 below. The scan data is stored in the file: "2Sector_weld scan" The current position (blue cursor) displays a root defect.

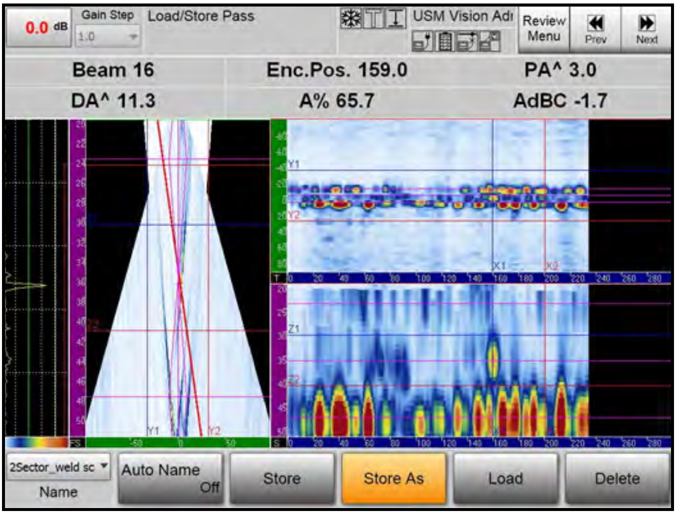


Figure 66: Scan Result with Root Defect

4.5 Sensitivity Calibration

Sensitivity calibration is used to compensate any differences in sensitivity for every shot (beam) of the current group, based on a known reference reflector in a given depth.

Sensitivity differences are related to:

- Production differences for the individual elements in the Phased Array probe
- Beam steering
- Changes of delay line length due to shifting the virtual probe along the array (electronic linear scan)

Sensitivity calibration is achieved by using the TCG calibration for just one single given reference reflector (→ 1-Point TCG).

Before the TCG calibration can be started, the Delay Law Calculation (DLC) and the Delay calibration must have been completed successfully. The examples in this section are for a linear scan 0° with probe 115-500-016 in direct coupling and for a sector scan 40° to 70° with MWB4PA.

4.5.1 1-point TCG (0° Linear Scan)

TCG recording for just one reflector will linearize the sensitivity for all shots (beams) of the current group.

1. Set the calibration parameters as described in Table 22 below.

Table 22: Calibration Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG- Setup	Reference Refl.	Depth
Calibration		Tolerance	5%

4.5.1 1-point TCG (0° Linear Scan) (cont.)

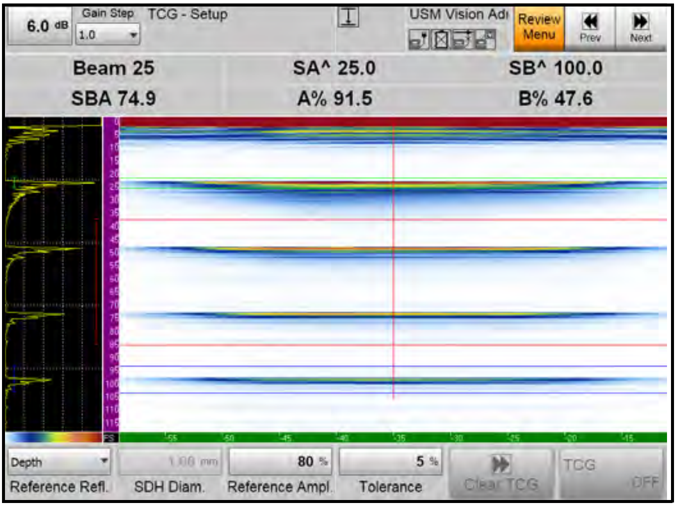


Figure 67: TCG-Setup Sub-Menu

2. Press **Start.** Gate A will automatically be set to cover the reference reflector: here, the BE in 25 mm.

Table 23: Recording Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG- Record	Reference Distance	25 mm

4.5.1 1-point TCG (0° Linear Scan) (cont.)

Figure 68: Start Recording

3. The **Start** icon changes to **Record**. A new window shows the measured amplitudes for all shots versus the beam number. The red curve shows the measured sound amplitudes for the current probe position. Move the probe slightly to reach a constant coupling over the probe coupling area. The red curve will change slightly.

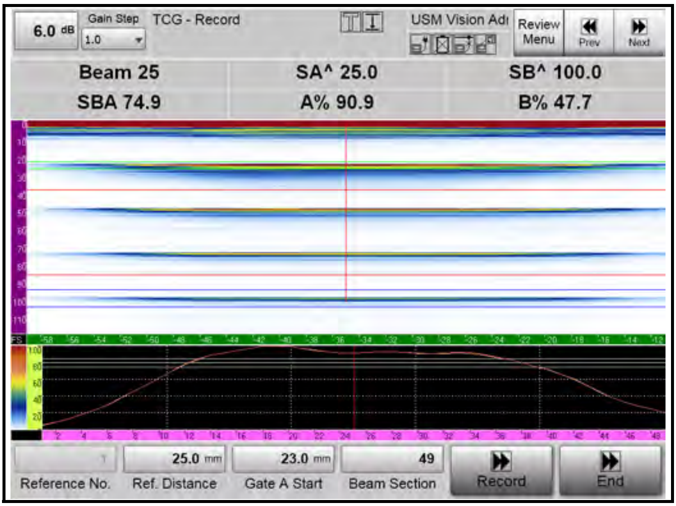


Figure 69: Window with Measured Amplitudes

4.5.1 1-point TCG (0° Linear Scan) (cont.)

4. When you have found all maximum amplitudes, press **Record** to let the system calculate the necessary amplitude correction for every shot (beam).

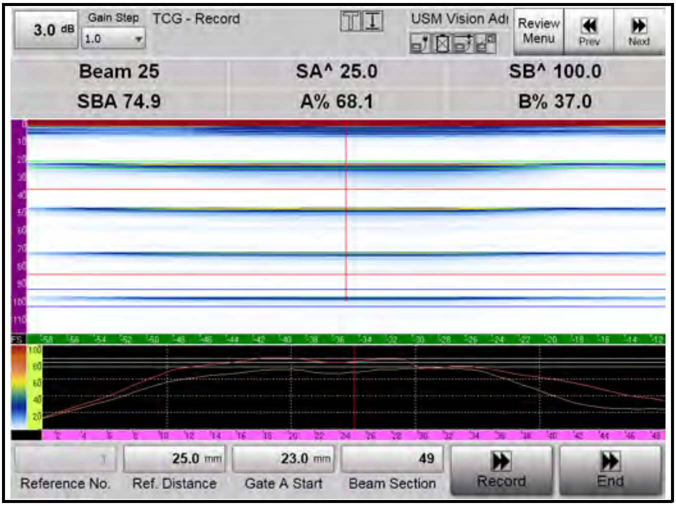


Figure 70: Amplitude Recording

5. Press **Store** if all measured amplitudes are within the tolerance band. The electronic scan now performs an equal sensitivity for all 49 shots (beams).

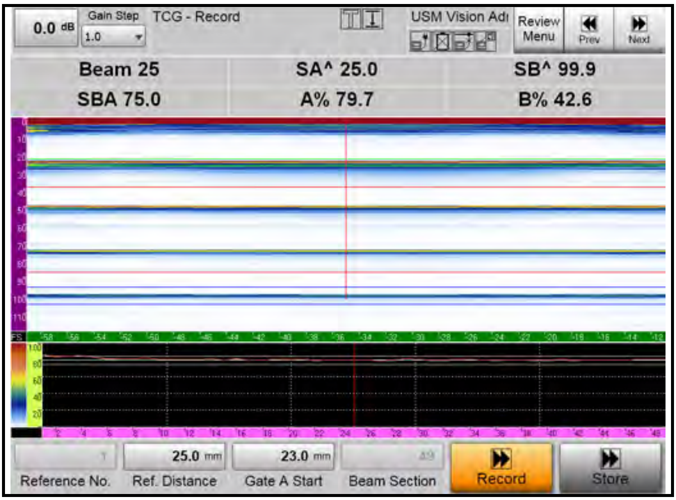


Figure 71: Store Recording

4.5.1 1-point TCG (0° Linear Scan) (cont.)

6. Press **End** to finalize TCG calibration and store the amplitude correction values. The **End** button turns grey, and the system is ready for use.

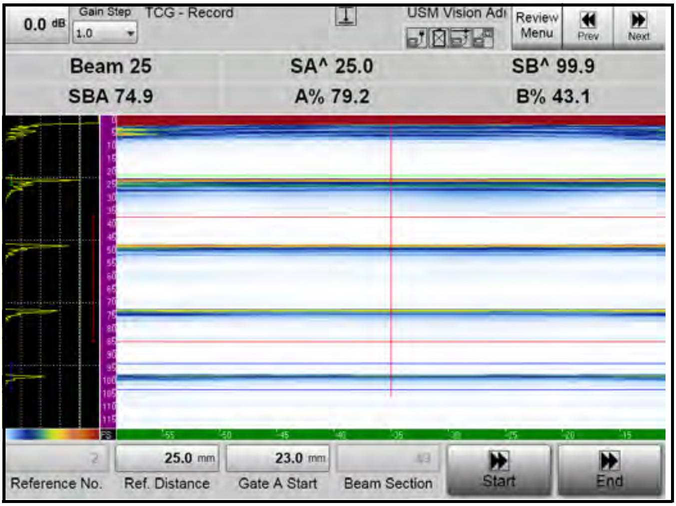


Figure 72: End Calibration

4.5.2 1-point TCG = ACG (40° to 70° Sector Scan)

TCG recording for a single reflector— here, the 1.5 mm SDH in the K1 calibration block—will linearize the sensitivity for all angles (beams) of the current group → ACG = Angle Corrected Gain.

1. Set the calibration parameters as described in Table 24 below.

Table 24: Calibration Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Setup	Reference Refl.	SDH
Calibration		SDH Diam.	1.5 mm
Calibration		Tolerance	5%

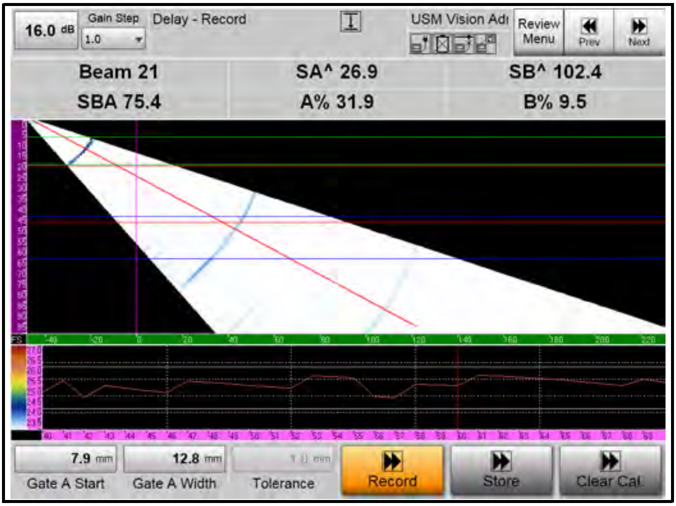


Figure 73: TCG Setup Sub-Menu

2. Press **Start.** Set the gain to receive an echo amplitude of ~80%.

Note: *Gate A will automatically be set to cover the reference reflector (here the SDH in 15 mm) after you press **Start.***

4.5.2 1-point TCG = ACG (40° to 70° Sector Scan) (cont.)

Table 25: Calibration Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Record	Ref. Distance	15 mm

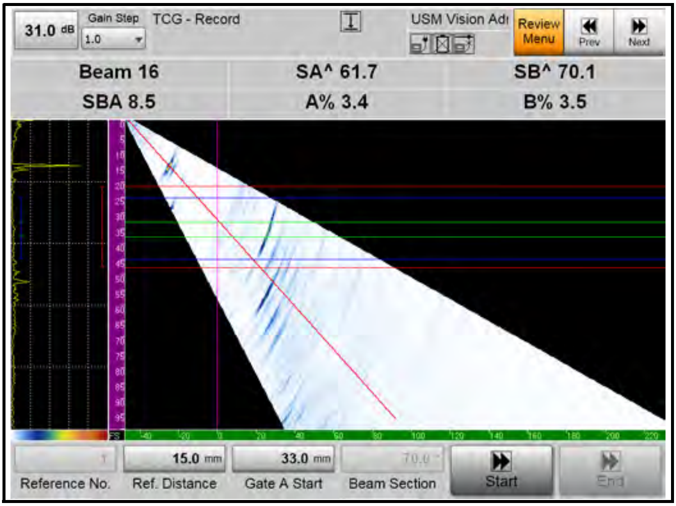


Figure 74: Recording Setup

3. **Start** changes to **Record.** A new window shows the measured amplitudes for all shots versus the beam angle. The red curve shows the measured echo amplitudes for the current probe position. Move the probe slowly to record the maximum reference amplitude for every angle. The red curve will change correspondingly. Reduce the gain if the amplitude exceeds 100% FSH.

4.5.2 1-point TCG = ACG (40° to 70° Sector Scan) (cont.)

Figure 75: Window with Measured Amplitudes

4. When you have found all maximum amplitudes, press **Record** to let the system calculate the necessary amplitude correction for every angle (beam). Re-check the amplitudes by recording the amplitudes again, and press **Record** repeatedly.

Figure 76: Recording Underway

4.5.2 1-point TCG = ACG (40° to 70° Sector Scan) (cont.)

5. Press **Store** if all measured amplitudes (red curve) are finally within the tolerance band.

Figure 77: Store Calibration

6. Press **End** to finalize TCG calibration and store the amplitude correction values. The electronic scan now performs an equal sensitivity for all 31 angles (beams)⟶ ACG = Angle Corrected Gain. The **End** button turns grey.

4.5.2 1-point TCG = ACG (40° to 70° Sector Scan) (cont.)

Figure 78: End Calibration

The following screens illustrate amplitude verification at 40°, 55° and 70°.

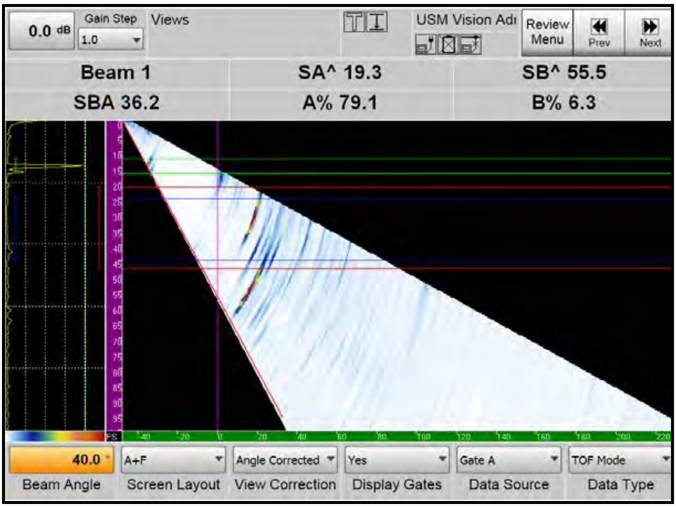


Figure 79: Amplitude Verification at 40°

4.5.2 1-point TCG = ACG (40° to 70° Sector Scan) (cont.)

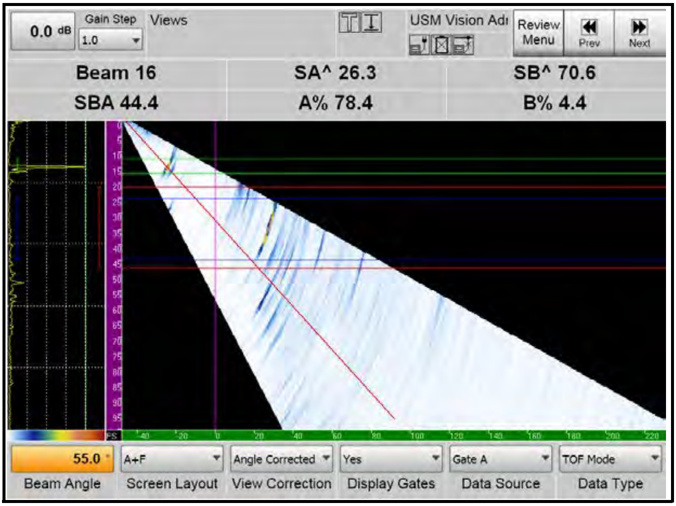


Figure 80: Amplitude Verification at 55°

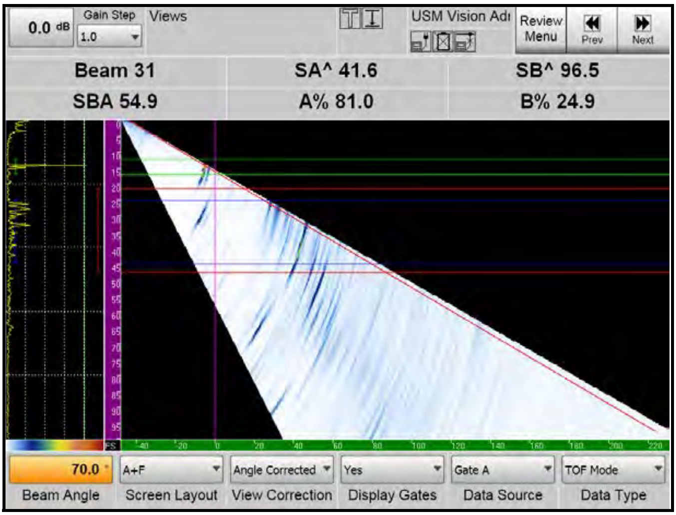


Figure 81: Amplitude Verification at 70°

4.6 Sector Scan TCG Recording

TCG recording is used to compensate any differences in sensitivity for every shot (beam) of the current group, based on several known reference reflectors of the same size, but at different known depths. Apart from ACG (Angle Corrected Gain), the losses due to beam divergence and sound attenuation will be compensated within the range defined by the distances of the reference reflectors.

Before the TCG calibration can be started, the Delay Law Calculation (DLC) and the Delay calibration must have been completed successfully.

In case one TCG point has already been recorded (e.g., for ACG), recording may be continued by adding new reference reflectors in other depths.

IMPORTANT: *You must continue an already existing TCG with the same reflector type and size! If you cannot, clear the existing TCG and start a completely new one.*

1. Set up the TCG according to Table 26 below. In this example, 3mm SDHs will be used for TCG recording. No TCG has been stored before.

Table 26: Calibration Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Setup	Reference Refl.	SDH
		SDH Diameter	3mm
		Reference Ampl.	8-%
		Tolerance	5%

2. Enter the distance to the first reference reflector, then press **Start**.

Note: *Gate A will automatically be set to cover the reference reflector (here the SDH in 10 mm) after you press **Start.***

Table 27: Recording Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Record	Reference Distance	10 mm

4.6 Sector Scan TCG Recording (cont.)

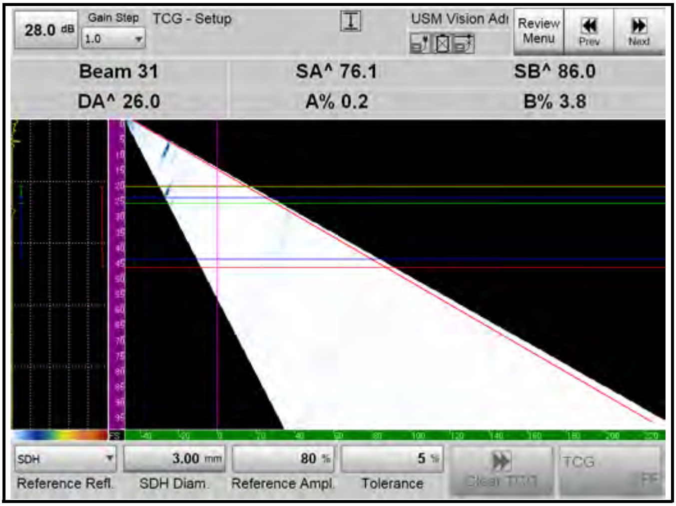


Figure 82: TCG Setup

3. **Start** changes to **Record.** A new window shows the measured amplitudes for all shots versus the beam angle.The white curve shows the measured echo amplitudes for the current probe position. Move the probe slowly to record the maximum reference amplitude for every angle (the red curve). The red curve will change to correspond as the SDH is hit by the different beams.

4.6 Sector Scan TCG Recording (cont.)

Figure 83: Recording Amplitudes

When you have found all maximum amplitudes, press **Record** to let the system calculate the necessary amplitude correction for every angle (beam).

Figure 84: Calculating Amplitudes

4.6 Sector Scan TCG Recording (cont.)

4. Re-check the amplitudes by recording the amplitudes again, and press **Record** repeatedly, until all measured amplitudes (red curve) are finally within the tolerance band. Then press **Store**.

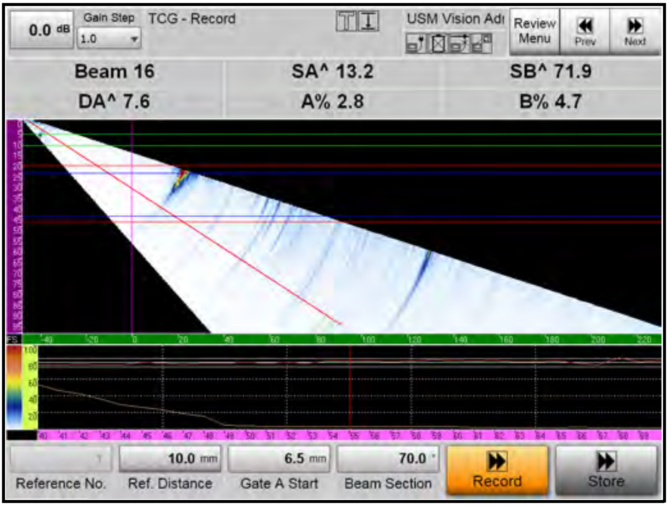


Figure 85: Storing Amplitude Corrections

5. If one or more amplitudes have amplitudes outside the specified tolerance band, the system will prompt an error message. If you press **Yes**, the system will store the amplitude corrections even with values out of the tolerance. If you select **No**, the system returns to the previous screen to let you record the amplitudes of the last reference target again.
   The system stores all dB-compensation values and returns to normal operation. The reference number has incremented to 2.

4.6 Sector Scan TCG Recording (cont.)

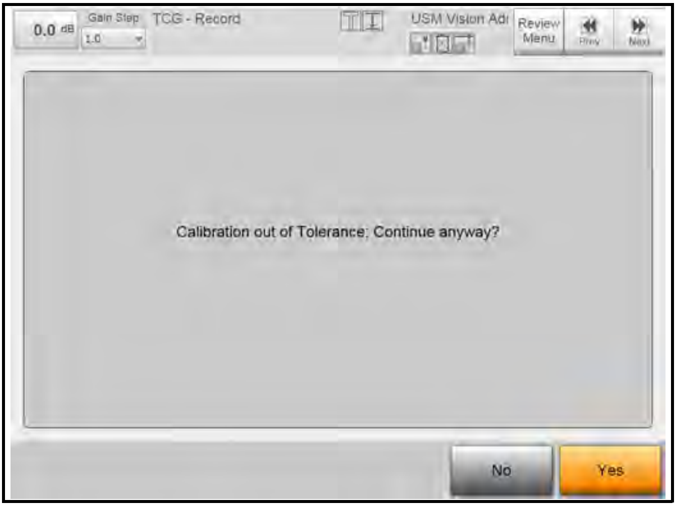


Figure 86: Out of Tolerance Message

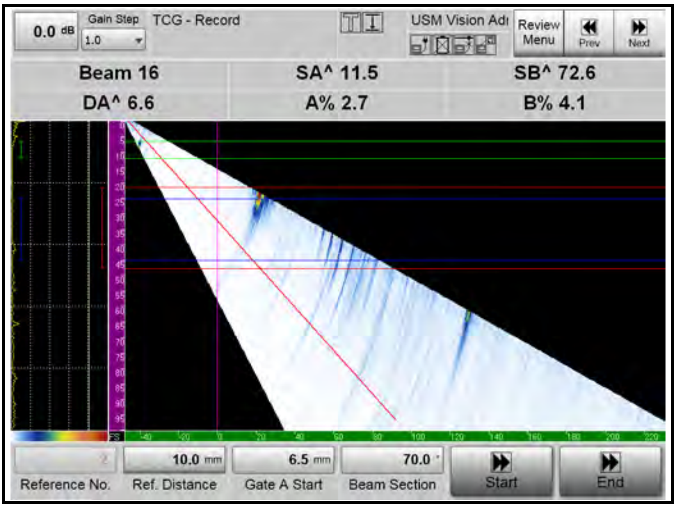


Figure 87: Storing Compensation Values

4.6 Sector Scan TCG Recording (cont.)

6. Enter the next reference distance — here, 25 mm. Press **Start.**

Note: *Gate A will automatically be set to cover the reference reflector (here the SDH in 25 mm) after you press **Start.***

Table 28: Recording Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Record	Reference Distance	25 mm

Figure 88: TCG Setup for 25 mm

7. As with the first reference reflector, move the probe to pick up all maximum echo amplitudes of the second reference reflector.

4.6 Sector Scan TCG Recording (cont.)

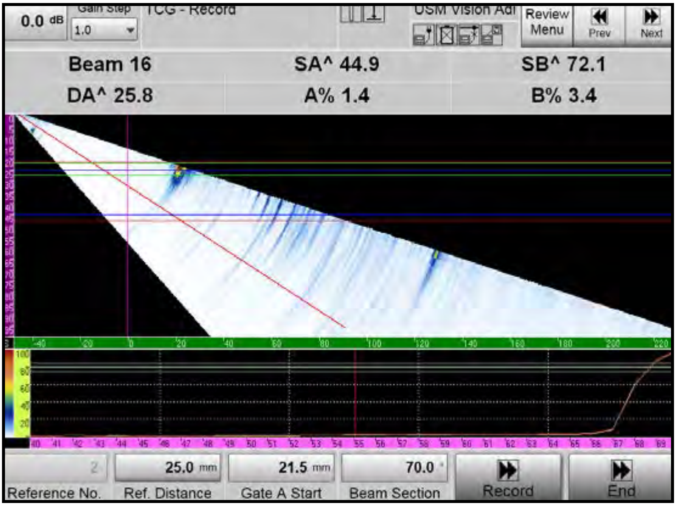


Figure 89: Recording 25 mm Amplitudes

8. Press **Record** repeatedly to adjust all maximum amplitudes into the tolerance band.
9. Finally, press **Store** to apply the measured amplitude corrections for the second reference reflector.

Figure 90: Storing Amplitudes

4.6 Sector Scan TCG Recording (cont.)

10. Enter the next reference distance of 40 mm. Press **Start.**

Note: *Gate A will automatically be set to cover the reference reflector (here the SDH in 40 mm) after you press **Start.***

Table 29: Recording Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Record	Reference Distance	40 mm

Figure 91: TCG Setup for 40mm

Due to the geometry of the DAC block, a false indication runs into the recording gate. Since the system will record the maximum amplitude of all echoes within the gate, some amplitudes will be taken from the false indication, and finally this TCG point will become wrong. Therefore, you must exclude all angles at which false signals occur.

4.6 Sector Scan TCG Recording (cont.)

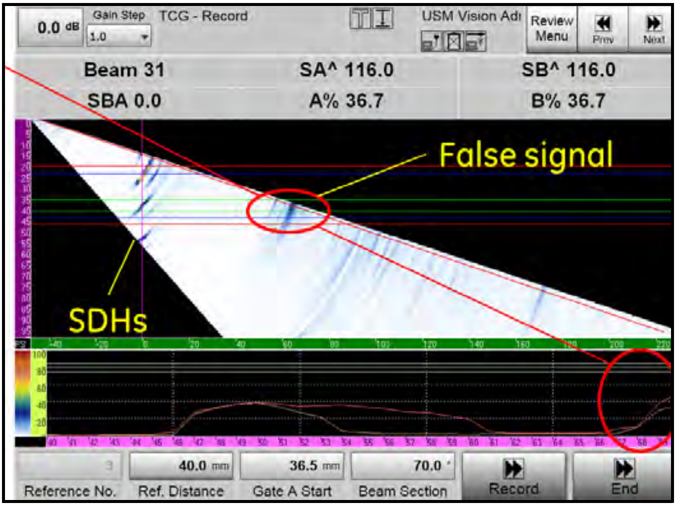


Figure 92: Amplitude Problem

11. Enter 60° to Beam Section. High angles from 61° to 70° will now be excluded from the amplitude recording.

Table 30: Recording Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Record	Reference Distance	40 mm
		Beam Section	60°

4.6 Sector Scan TCG Recording (cont.)

Figure 93: Reducing the Angular Range of the Beam Section

12. As with the previous reference reflector, move the probe to pick up all maximum echo amplitudes of the third reference reflector for the given section. Press **Record** repeatedly to adjust all maximum amplitudes into the tolerance band.

Figure 94: Recording Amplitudes

4.6 Sector Scan TCG Recording (cont.)

13. Press **Store** if all measured amplitudes (the red curve) are finally within the tolerance band. The system is now ready to record the reference signals for the remaining section (61° - 70°).

Figure 95: Storing Amplitudes

Table 31: Recording Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Record	Reference Distance	40 mm
		Beam Section	70°

14. When you have found all maximum amplitudes, press **Record** to let the system calculate the necessary amplitude correction for the angles 61° to 70°. Re-check the amplitudes by recording the amplitudes again, and press **Record** repeatedly.

4.6 Sector Scan TCG Recording (cont.)

Figure 96: Recording Amplitudes

15. Press **Store** if all measured amplitudes (red curve) are finally within the tolerance band.

Table 32: Recording Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Record	Reference Distance	40 mm

4.6 Sector Scan TCG Recording (cont.)

Figure 97: Store Amplitudes

16. Press **End** to finalize the TCG calibration procedure.
The electronic scan now performs an equal sensitivity for all 31 angles (beams), and all three reference reflectors from 10 mm to 40 mm. The **End** button turns grey.

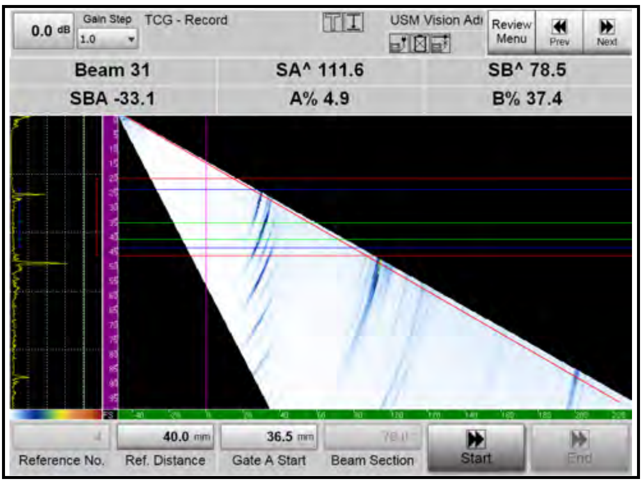


Figure 98: Ending TCG Calibration

4.6.1 Verifying TCG Calibration

Table 33: Recording Parameters

Menu	Sub-Menu	Parameter	Value
Calibration	TCG - Verify	Beam Angle	40° (60°)

1. Press **Check TCG.**
2. Scan all three reference reflectors: The green envelope curve shows proof that all reference echoes reach 80% FSH.
3. Press **Finish** to return to normal operation.

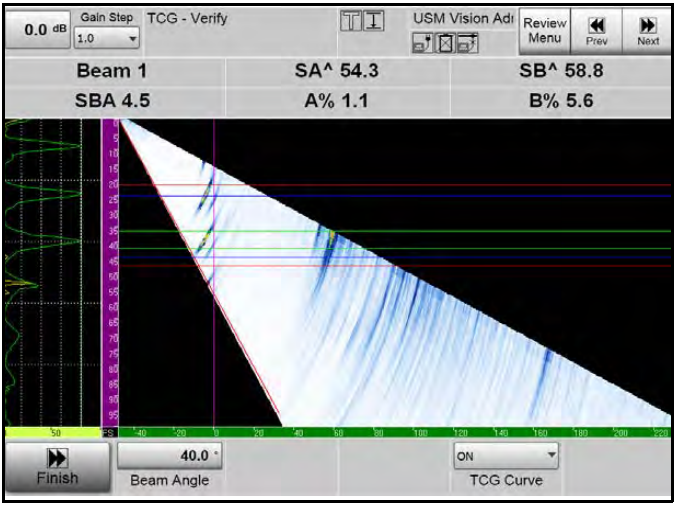


Figure 99: Verifying TCG Calibration at 40°

4.6.1 Verifying TCG Calibration (cont.)

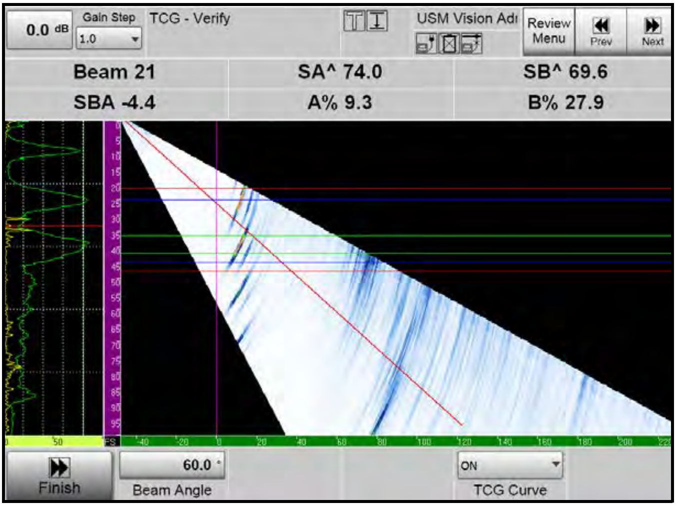


Figure 100: Verifying TCG Calibration at 60°

4.6.2 TCG Amplitude Evaluation Levels

Additional evaluation lines are displayed in the A-scan according to the entered dB-differences to the original reference. The reading AdBC will directly display the dB-difference of the echo in gate A to the reference (here, 80% FSH).

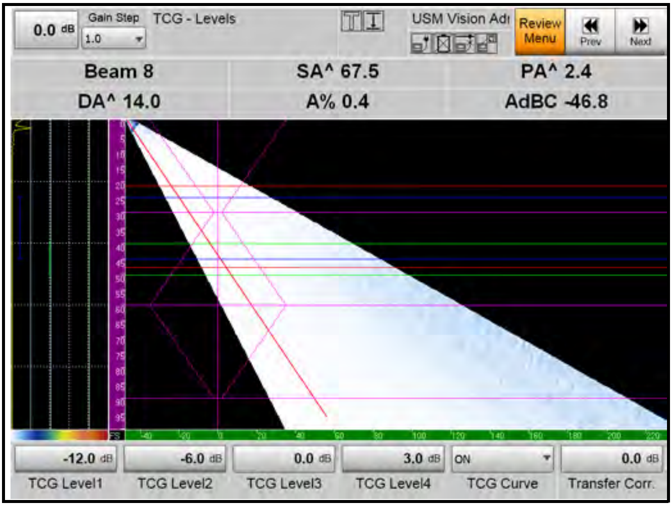


Figure 101: TCG Evaluation Levels

4.6.3 Echo Evaluation

This example shows inspection of a 30 mm thick V-Weld with an inclusion at half thickness. The echo exceeds the reference level by 0.6 dB. Figure 103 shows the same result in volume corrected view: the signals of the inclusion are hit directly with 70° (leg 1), and after one reflection with 47° (leg 2), and with an x-shaped indication in the sector scan.

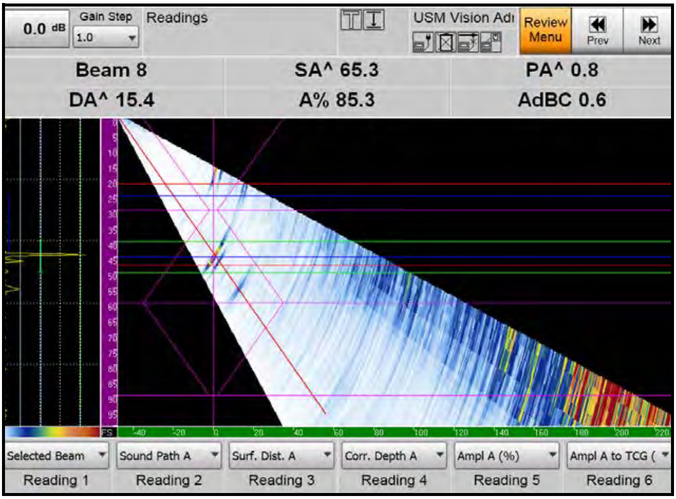


Figure 102: Inspection of 30 mm V-Weld

4.6.3 Echo Evaluation (cont.)

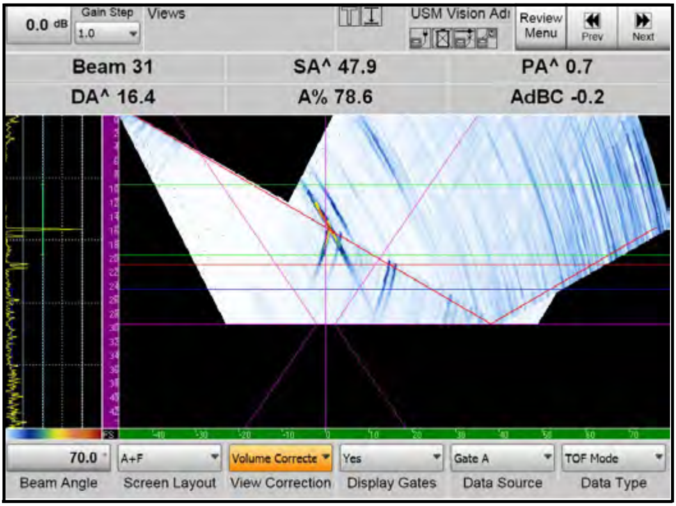


Figure 103: Inspection in Volume Corrected View

4.7 Encoder Calibration

A quadrature wheel encoder provides a certain number of ticks (square wave pulses) per revolution. In order to exactly measure scan distances, the system needs to know the number of ticks per mm (inch). If this value is unknown, the encoder calibration will establish this value.

To establish the number of ticks per mm (or inch), enter the wanted scan length into the system, then move the encoder along this distance, and the system will calculate the characteristic encoder value.

Table 34: Parameters for Encoder Calibration

Menu	Sub-Menu	Parameter	Value
Scan	Encoder Cal.	Scan Mode	Positional
Scan		Encoder Dir.	Clockwise
Scan		Encoder Counts	0.3 mm
Scan		Scan increment	1 mm
Scan		Cal. Distance	300 mm

1. Place the encoder at the Zero position of the calibration distance (here, 300 mm).
2. Press **Start Calibrate**. The button changes to **Stop Calibrate**.
3. Move the encoder along the calibration distance.

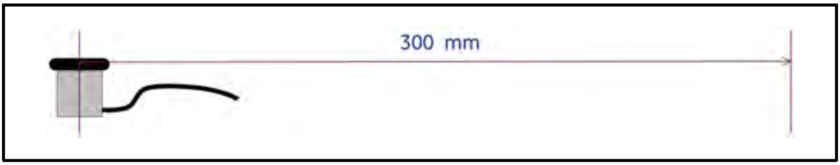


Figure 104: Moving Encoder Along Calibration Distance

4.7 Encoder Calibration (cont.)

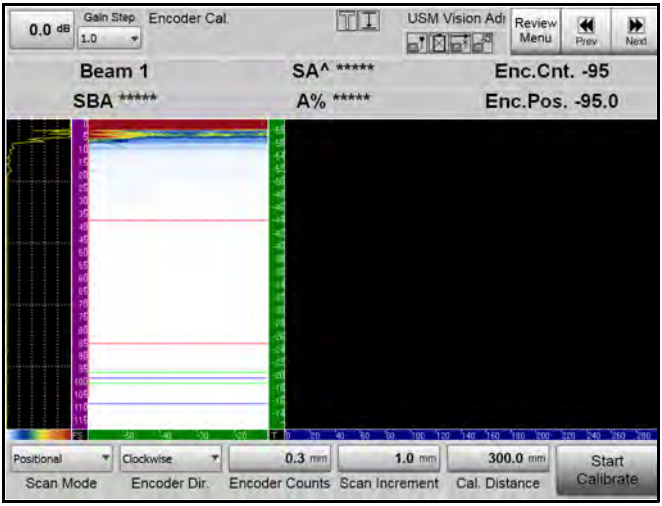


Figure 105: Encoder Calibration Screen

4. Press **Stop Calibrate** at the end of the calibration distance.The system now calculates the encoder counts (mm/tick) and stores the value.

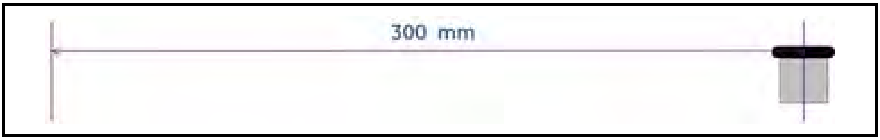


Figure 106: Encoder at End of Calibration

4.7 Encoder Calibration (cont.)

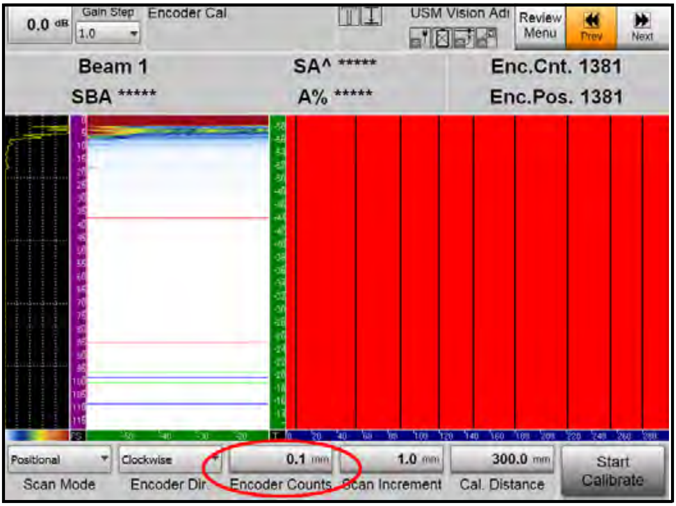


Figure 107: Encoder Calibration Screen, with Value Calculated and Stored

[no content intended for this page]

Chapter 5. Specifications

5.1 General Specifications

Table 35: USM Vision+ Specifications

Information	Values	Unit	Comments
1. Configurations			
Phased array configuration	16/128		number of simultaneously controlled channels and number of available channels
Conventional channel	1		Pulse/Echo or Dual mode
2. General features			
Size, WxHxD	367 (310) x 250 x 100 (60)	mm^3	
Weight	4.6	kg	with one battery
Display size	10.4	inch	
Display resolution	1024x768	pixel	TFT with LED backlight
Power supply, input voltage	100 - 240	VAC	
Power supply, output voltage	15	VDC	
Maximum power consumption	45	W	
Battery operational time	3	h	hot swap possible
Number of batteries	2		Lithium Ion
Operating temperature range	0 - 45	°	
Storage temperature range	-20 - 70	°	
Pulse repetition frequencies (PRF)	0,015 to 10	kHz	depending on settings
Protection grade	IP 54		
Available measurement units	mm, inch		

Table 35: USM Vision+ Specifications (cont.)

Information	Values	Unit	Comments
3. Input/output connectors			
Phased Array Probe	Tyco		
Conventional Probe	Lemo00 coax and triax		
Interface I/O	Lemo 2B 14pin		encoder (quadrature, 5V), SAP; s. table
VGA	Lemo 0 9pin		
Ethernet	RJ 45		1Gb/s
USB 2.0	3		Type A
Power connector	Lemo 0S 4pin		
4. Display			
Range of sound velocities	100 to 15000	m/s	
Time base:			
Delay	0 - 10000	mm	in steel long, IP delay
Width	6 -10000	mm	in steel long
Available views	A, B, C, D, E, S		
Screen refresh rate	50	Hz	depending on setting
5. Beam forming			
Maximum number of channels active simultaneously	16		different configurations
Maximum number of delay laws	256		individual cycles
Maximum time delay	20,000	ns	
Step	5	ns	
6. Phased Array Transmitter			
Number of transmitters available simultaneously	16		depending on configuration
Shape of transmitter pulse	Negative unipolar		

Table 35: USM Vision+ Specifications (cont.)

Information	Values	Unit	Comments
6. Phased Array Transmitter (cont.)			
Transmitter voltage	3 -150	V	in 10V steps, supply voltage 200V
Fall time	<10	ns	
Duration	20 - 1200	ns	20ns steps
Maximum time delay	0 to 20000	ns	
Time delay resolution	5	ns	
7. Conventional Transmitter (not accessible parameter)			
Shape of transmitter pulse	Negative unipolar		
Transmitter voltage	3 -180	V	
Fall time	<10	ns	
Duration	20 - 1200	ns	20ns steps
8. Phased Array Receiver			
Number of receivers available simultaneously	16		
Input voltage at full screen height (FSH)	0.5	Vpp	800% of FSH available for post processing
Maximum input voltage	4	Vpp	
Linearity of vertical display	+/- 2	%	
Frequency response	0,5 - 15	MHz	-3 dB without digital filter
Digital Filters	8		
Dead time after transmitter pulse	<5	us	
Dynamic range	0 to 90	dB	digital gain, 0,1 dB step
Maximum time delay	0 to 20000	ns	
Time delay resolution	5	ns	
Time Corrected Gain	90	dB	16 points/90dB in 20ns steps, 90dB/80ns slope, 220ns delay of start

Table 35: USM Vision+ Specifications (cont.)

Information	Values	Unit	Comments
8. Phased Array Receiver (cont.)			
Linearity of time delays	<1	%	of full range
Gain linearity	+/-2	dB	of full range
Channel gain variation	3	dB	
Maximum digitisation frequency without processing	50	MHz	
Digitisation frequency with processing	200	MHz	with interpolation
Digitiser vertical resolution	20/24	bit	20/channel, 24 on formed beam
Display Start Mode	IP, IF Start display		Display start depending on interface echo in gate I, gate A and B also triggered with interface echo
9. Conventional Receiver			
Number of receivers	1		
Input voltage at full screen height (FSH)	0.5	Vpp	800% of FSH available for post processing
Maximum input voltage	4	Vpp	
Linearity of vertical display	+/- 2	%	
Linearity of the vertical display	+/- 2	%	
Frequency response	0,5 - 15	MHz	-3 dB without digital filter
Digital Filters	8		
Dynamic range	0 to 90	dB	digital gain, 0,1 dB step
DAC	90	dB	16 points/90dB in 20ns steps, 90dB/80ns slope, 220ns delay of start
Maximum digitisation frequency without processing	100	MHz	

Table 35: USM Vision+ Specifications (cont.)

Information	Values	Unit	Comments
9. Conventional Receiver (cont.)			
Digitisation frequency with processing	200	MHz	with interpolation
Digitiser vertical resolution	20	bit	
Display Start Mode	IP		
10. Data acquisition			
Maximum number of A-scans stored per second	4000		A-scan 512 points with 16 bit amplitude
Maximum number of samples per A-scan	1024		16 bit amplitude
11. Gates			
Number of gates	3		incl. IF (A, B, I)
Type of detection	2		coincidence or anticoincidence
Measurement mode	3		flank, J-flank, peak
Synchronisation of gates	2		Initial pulse or with interface echo in gate I
Characteristics of gates:			
Threshold	0 - 95	%	screen height (+/- 95 % in RF mode)
Start	0 to 4000	mm	in steel long
Width	0.1 to 4000	mm	in steel long
Resolution of TOF measurements	5	ns	
Resolution of Amp measurements	1	bit	16 bit signed
Start Mode	IP, IF Start display		

Table 35: USM Vision+ Specifications (cont.)

Information	Values	Unit	Comments
12. Processing			
Rectification	4		pos, neg, RF, full
Averaging	1,2,4,8,16		TOFD: max depth 500mm in steel
Envelope, EchoMax	on/off		
Scan Mode	pulse on position		
Video Filter	on/off		Phased Array mode
13. PC			
PC Module	1		COM Express compact, 1,6GHz
SSD	64	GB	SLC, SATA
Input devices	4		2 Track balls, keypad, touch screen

5.2 I/O Connector (LEMO ECG.2B.314.CLV)

Contact No.	Designation	Function	Signal Control
1	GND-EXT	Ground encoder	
2	+5V_EXT	Supply encoder	Output
3	SAP	Transmitter trigger pulse	Output
4	INDX_Y	Encoder Y index	Input
5	Y_B	Encoder Y phase B	Input
6	PDF	Test data release	Input
7	X_A	Encoder X phase A	Input
8	X_B	Encoder X phase B	Input
9	INDX_X	Encoder X index	Input
10	Y_A	Encoder Y phase A	Input
11	Dig I/O-1	General purpose I/O	In/Output
12	Dig I/O-2	General purpose I/O	In/Output
13	Dig I/O-3	General purpose I/O	In/Output
14	Dig I/O-4	General purpose I/O	In/Output

[no content intended for this page]

Appendix A. Creating User Accounts

To access and operate the USM Vision+, a typical user will need an assigned user name and password. System administrators must create the list of user names and passwords on a PC, and transfer them to the USM Vision+, either directly or from a USB memory stick. For initial setup purposes, system administrators will receive an active *Administrator* account and the USM Vision+ *Guest Account*.

A.1 Setting up User Accounts

1. From the Windows Start Menu on your PC, click on Settings>Control Panel. When the *Control Panel* window (see *Figure 108* below) opens, click on User Accounts.

Figure 108: Windows Control Panel

A.1 Setting up User Accounts (cont.)

2. When the *User Accounts* window (see *Figure 109* below) opens, click Create a New Account.

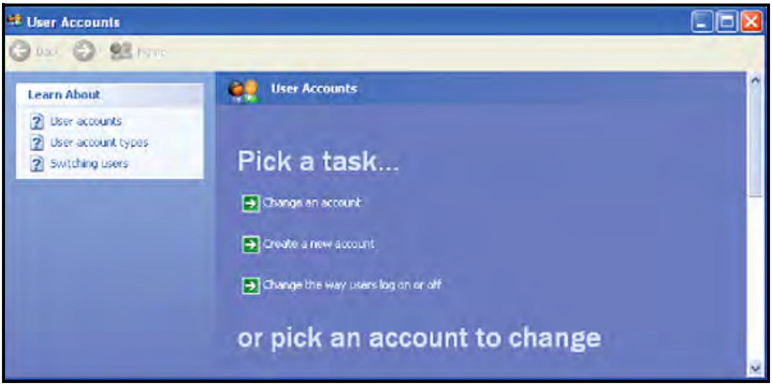


Figure 109: User Accounts Window

3. Select a name for the new account (*Figure 110* below). This name will identify the operator in all inspection tasks, and will be stored with all the user actions on USM Vision+.

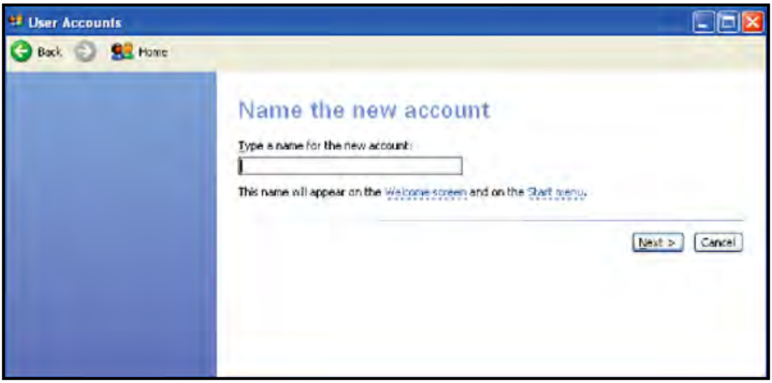


Figure 110: Naming the Account

A.1 Setting up User Accounts (cont.)

4. Select an account type (see *Figure 111* below) and click Create Account.

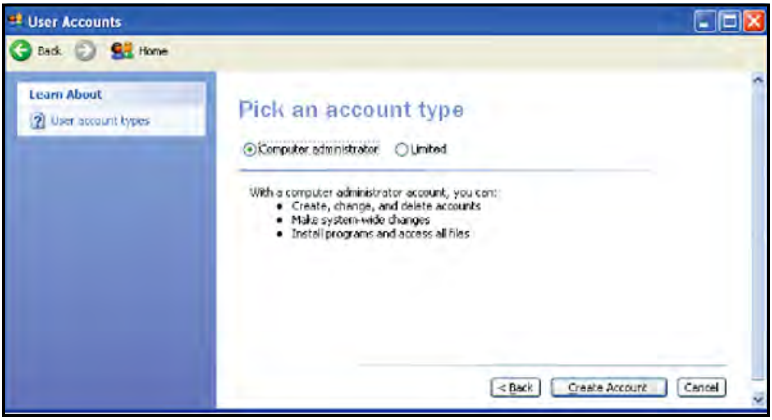


Figure 111: Account Type

5. After creating the account you can create an initial password or change the picture of the account. Detailed instructions are available from *Microsoft* at: http://www.microsoft.com/windowsxp/using/setup/winxp/accounts.mspx

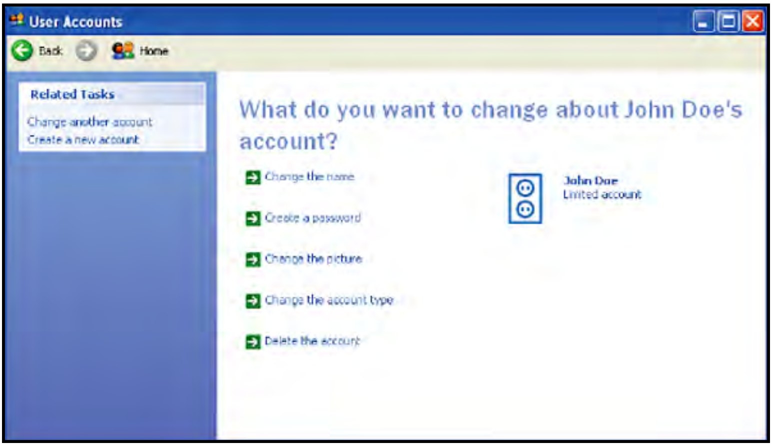


Figure 112: Changing an Account

A.2 Setting up a User's Access Rights

1. To set up a user's access rights, return to the Windows *Control Panel* and click on Administrative Tools (see *Figure 113* below).

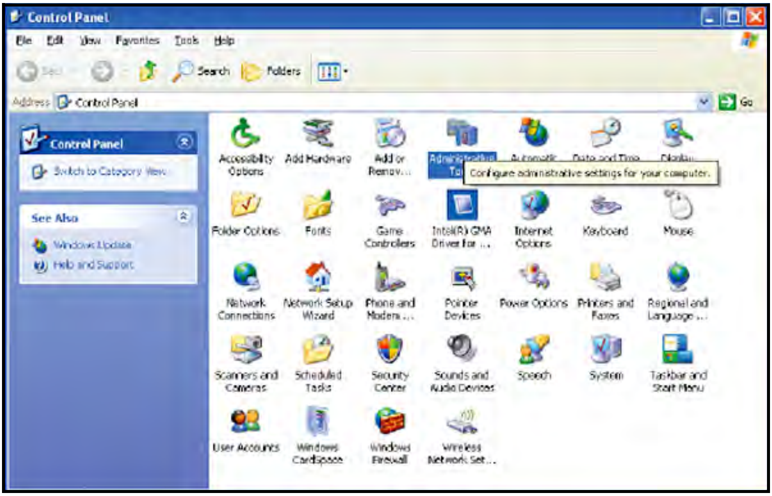


Figure 113: Control Panel (Administrative Tools Icon)

2. From the Administrative Tools window, click on Computer Management (see *Figure 114* below).

Figure 114: Administrative Tools (Computer Management Icon)

A.2 Setting up a User's Access Rights (cont.)

3. In the *Computer Management* option tree, expand the folder Local Users and Groups (see *Figure 115* below).

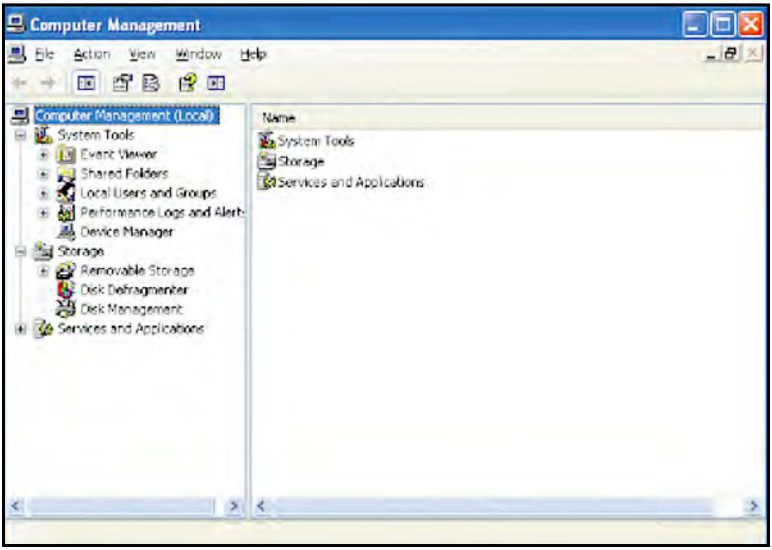


Figure 115: Local Users and Groups in Computer Management

A.2 Setting up a User's Access Rights (cont.)

4. Then, click on the Groups folder (see *Figure 116* below).

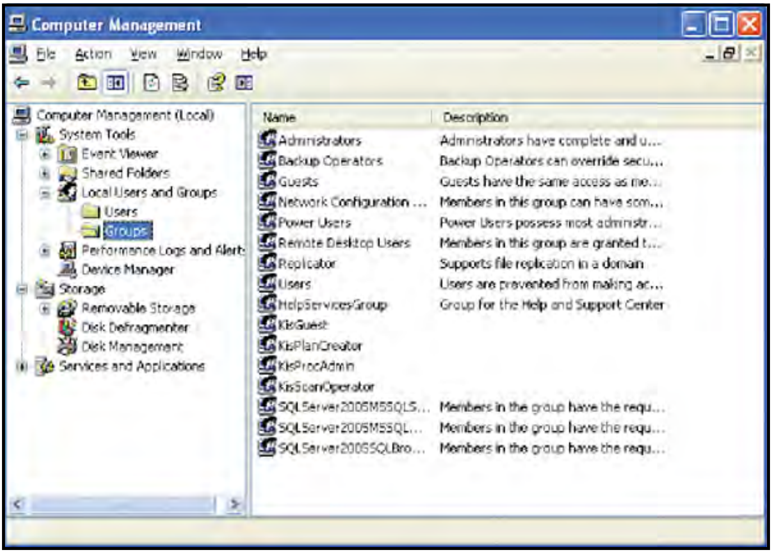


Figure 116: The Groups List

5. From the *Actions Menu*, click New Group. You must create the following groups to set access rights in USM Vision+:

- KisGuest: Guest logon that requires authentication before using the instrument.The access rights are similar to KISScanoperator.
- KisScanOperator: This group is allowed to operate the instrument.
- KisPlanCreator: This group is allowed to create and validate inspection plans as well as operate the instrument.
- KisProcAdmin: Besides operating the USM Vision+ and creating and validating inspection plans, this group is also allowed to create and to revise inspection procedures.

A.2 Setting up a User's Access Rights (cont.)

6. To assign a user to a specific group, return to Local Users and Groups (see *Figure 117* below).

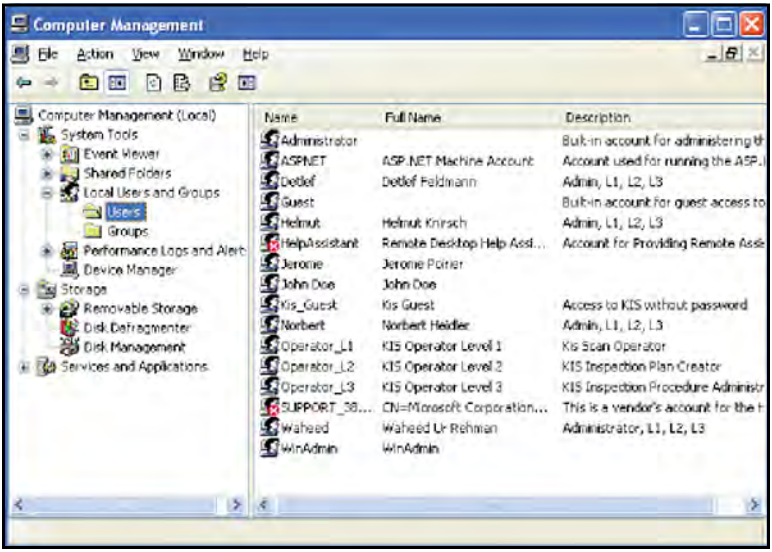


Figure 117: The Users List

7. Select Users and then double-click on the respective user. The *Properties* window (see *Figure 118* below) for that user opens.

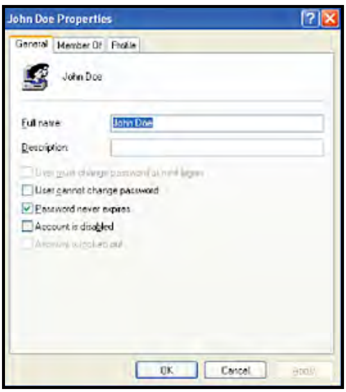


Figure 118: User Properties Window

A.2 Setting up a User's Access Rights (cont.)

8. To change group membership, click on the tab Member Of (see *Figure 119* below). Click the Add button to add the member to a group.

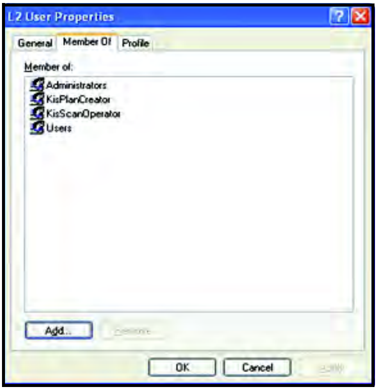


Figure 119: Member Tab

9. When the *Select Groups* window opens (see *Figure 120* below), click the Advanced button.

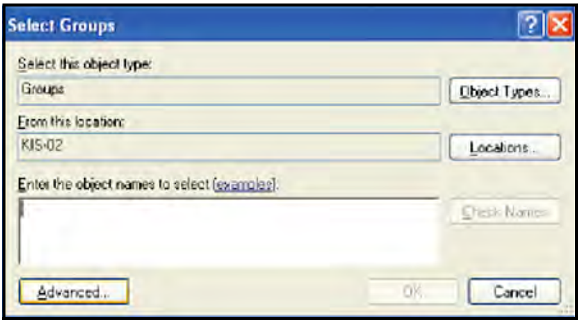


Figure 120: Select Groups Window

A.2 Setting up a User's Access Rights (cont.)

10. Click Find Now and the *Select Groups* window opens (see *Figure 121* below). Then, select the correct group for the user and click OK.

Note: *You can always use* KisGuest *with any account, but it probably makes most sense to associate a user with* KisScanOperator.

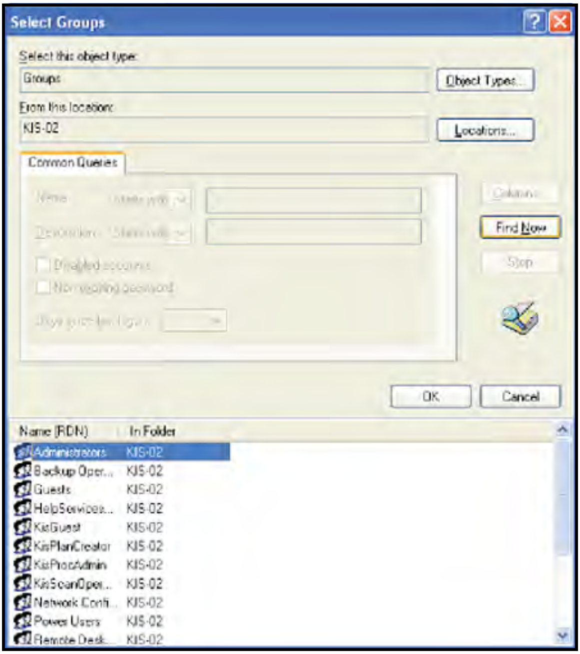


Figure 121: Select Groups with Group Listing

A.2 Setting up a User's Access Rights (cont.)

11. With the appropriate group highlighted in the *Select Groups* window (see *Figure 122* below), click OK. The user is now part of the selected group.

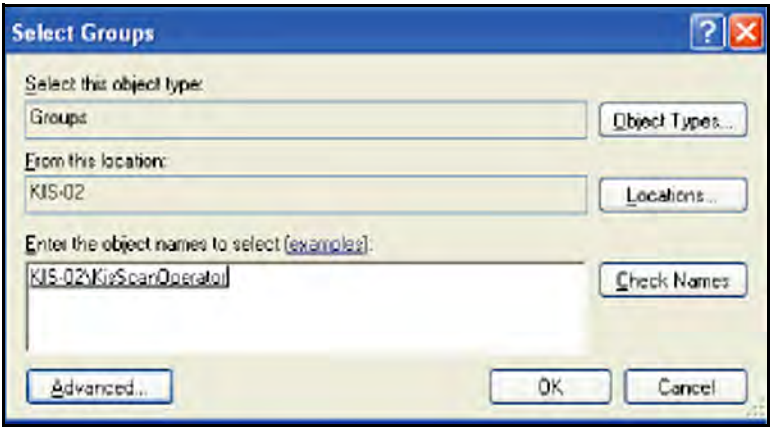


Figure 122: Select Groups Window with Highlighted Group

Appendix B. Calibrating the Touchscreen

When you receive your USM Vision+, the touchscreen is calibrated. However, if you need to recalibrate the touchscreen, complete the steps in this appendix.

B.1 Recalibrating the Touchscreen

1. Start the USM Vision+ as an *Administrator*. From the USM Vision+ *Control Panel*, launch the touch-base control panel applet by double-clicking the Pointer Devices icon, as shown in *Figure 123* below.

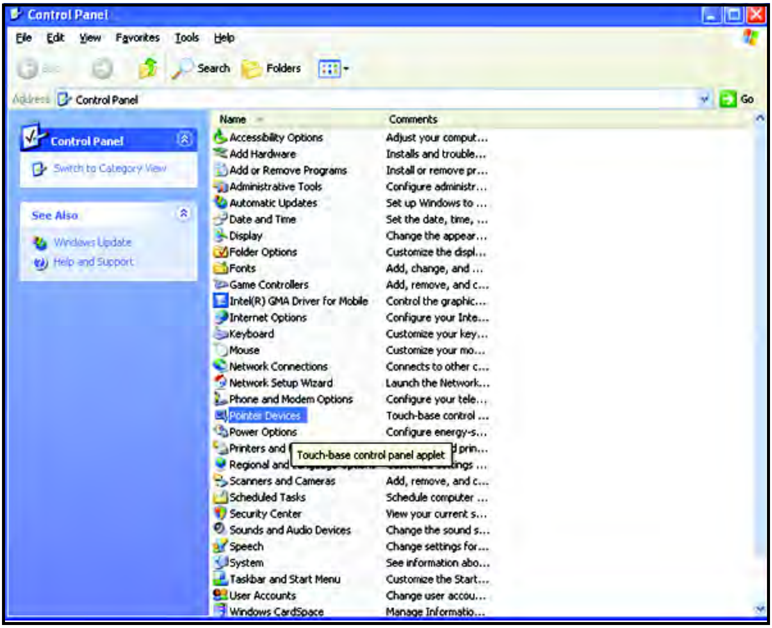


Figure 123: Control Panel with Pointer Devices Icon

B.1 Recalibrating the Touchscreen (cont.)

The window shown in *Figure 124* below opens.

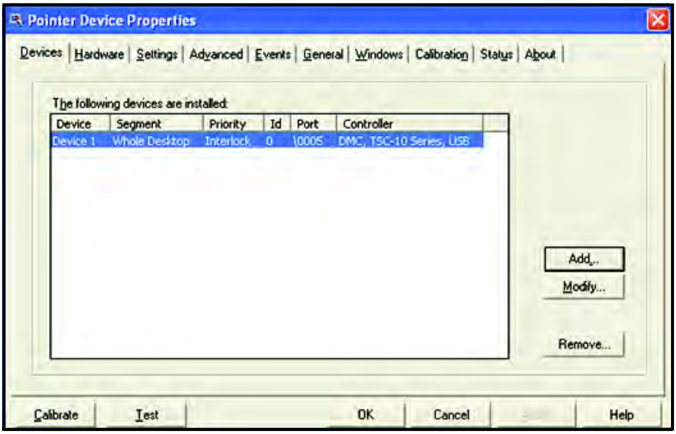


Figure 124: The Pointer Device Properties Window

2. To initiate the calibration, touch the Calibrate button to open the screen shown in *Figure 125* below.

Figure 125: Calibration Screen

B.1 Recalibrating the Touchscreen (cont.)

3. Go through all the points, touching each arrow tip or cross center as it appears. Try to avoid parallax. When you have finished, the window shown in *Figure 126* below opens. Touch OK to confirm your calibration.

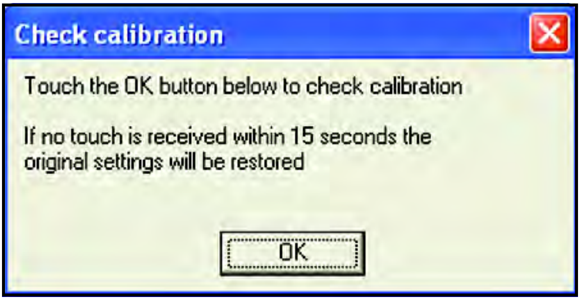


Figure 126: Calibration Confirmation Screen

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Appendix C. Environmental Compliance

C.1 Waste Electrical and Electronic Equipment Directive

GE Measurement & Control is an active participant in Europe's Waste Electrical and Electronic Equipment (WEEE) take-back initiative, directive 2012/19/EU.

The equipment that you bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.

In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end life equipment in a sound way.

The crossed-out wheeled bin symbol invites you to use those systems.

If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.

Visit www.ge.com/inspectiontechnologies for take-back instructions and more information about this initiative.

C.2 Battery Disposal

This product contains a battery that cannot be disposed of as unsorted municipal waste in the European Union. See the product documentation for specific battery information. The battery is marked with this symbol, which may include lettering to indicate cadmium (Cd), lead (Pb), or mercury (Hg). For proper recycling return the battery to your supplier or to a designated collection point.

C.2.1 What do the Markings Mean?

Batteries and accumulators must be marked (either on the battery or accumulator or on its packaging, depending on size) with the separate collection symbol. In addition, the marking must include the chemical symbols of specific levels of toxic metals as follows:

- Cadmium (Cd) over 0.002%
- Lead (Pb) over 0.004%
- Mercury (Hg) over 0.0005%

C.2.2 The Risks and Your Role in Reducing Them

Your participation is an important part of the effort to minimize the impact of batteries and accumulators on the environment and on human health. For proper recycling you can return this product or the batteries or accumulators it contains to your supplier or to a designated collection point.

Some batteries or accumulators contain toxic metals that pose serious risks to human health and to the environment. When required, the product marking includes chemical symbols that indicate the presence toxic metals: Pb for lead, Hg for mercury, and Cd for cadmium.

- **Cadmium** poisoning can result in cancer of the lungs and prostate gland. Chronic effects include kidney damage, pulmonary emphysema, and bone diseases such as osteomalcia and osteoporosis. Cadmium may also cause anemia, discoloration of the teeth, and loss of smell (anosmia).
- **Lead** is poisonous in all forms. It accumulates in the body, so each exposure is significant. Ingestion and inhalation of lead can cause severe damage to human health. Risks include brain damage, convulsions, malnutrition, and sterility.
- **Mercury** creates hazardous vapors at room temperature. Exposure to high concentrations of mercury vapor can cause a variety of severe symptoms. Risks include chronic inflammation of mouth and gums, personality change, nervousness, fever, and rashes.

Visit www.ge.com/inspectiontechnologies for take-back instructions and more information about this initiative.

Appendix D. Glossary

Several acronyms are used throughout this manual. Although these acronyms are commonly used in the ultrasonic flaw detection industry, they are listed in *Table 36* below for convenient reference.

Table 36: Common Acronyms

Acronym	**Meaning**
ACG	Angle Corrected Gain
DAC	Distance Amplitude Correction
DLC	Delay Law Calculator
ERS	Equivalent Reflector Size
FBH	Flat Bottom Hole
IP	Inspection Plan or Initial Pulse
MDI	Menu Directed Inspection
PA	Phased Array
PCF	Probe Center Separation
PRF	Pulse Repetition Frequency
SDH	Side Drilled Hole
SNR	Signal to Noise Ratio
TCG	Time Corrected Gain
TOFD	Time Of Flight Diffraction
UT	Ultrasonic Testing
V, X, J	Three different standard weld types

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ISO 9001
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110N1532 Rev. 3

Printed in USA