USER MANUAL

Rev. 1 (ENG)

ALPINION
MEDICAL SYSTEMS
www.alpinion.com

Copyright and License

Reproduction, adaptation, or translation without prior written permission is prohibited, except as allowed under the copyright laws.

The information contained herein is subject to change without notice.

The only warranties for ALPINION products and services are set forth in the express warranty statements accompanying such products and services. Nothing herein should be construed as constituting an additional warranty. ALPINION shall not be liable for technical or editorial errors or omissions contained here in.

Prepared by:
ALPINION MEDICAL SYSTEMS Co., LTD.
1FL and 6FL, Verdi Tower,
72, Digital-ro (St) 26-gil (Rd),
Guro-gu, Seoul, Republic of Korea

1316~1320 room, ACE HIGH-END Tower 1st,
5, Digital-ro (St) 26-gil (Rd),
Guro-gu, Seoul, Republic of Korea 152-848

T: +82 2 3282 0907 F: +82 2 851 5591 www.alpinion.com
Copyright © 2012 ALPINION MEDICAL SYSTEMS Co., LTD, All rights reserved.

CE 0470

Revision Log

The following is a list of major changes and additions that have been made to this manual since it was first released.

Rev	Date	Description
Rev. 0	June, 2014	User manual first released
Rev. 1	Feb 10, 2015	Updated for Rev.1 release

Table of Contents

1. System Basics 1-1

Introduction 1-2
System Components 1-6
Image Display 1-19
Control Panel 1-21
QWERTY Keyboard. 1-24
Touch Screen 1-26
Transducers 1-27

2. Getting Started 2-1

Operating Requirements. 2-2
Powering On/Off 2-4
Adjusting the Monitor and Touch Screen 2-5
Connecting/Disconnecting the Transducer 2-8
Activating/Deactivating the Transducer 2-10

3. Starting a Study 3-1

Patient Registration Screen 3-2
Entering Patient Information 3-3
Quick ID 3-10
Starting a New Study with an Existing Patient 3-11
Retrieving Patient Information via Worklist 3-12
Deleting a Patient or Study 3-13
Locking a Patient or Study. 3-14
E-view 3-16
Image History 3-19

4. Imaging Modes 4-1

2D Mode 4-2
M Mode 4-15
Color Flow Mode 4-19
Power Doppler (PD) Mode 4-25
Pulsed Wave Doppler (PWD) Mode 4-28

5. Imaging Functions. 5-1

Freezing Images 5-2
Screen Split 5-4
CINE Images 5-5
Annotating Images 5-6
Exporting Data 5-12

6. Managing Patient Information and Image 6-1

Clipboard 6-2
Patient Browser 6-5

7. Measurements and Reports. 7-1

Basics 7-2

8. Executing E-CUBE 12R. 8-1

Executing E-CUBE 12R System. 8-2

9. Using Research Tool 9-1

Research Tool 9-2
Image Optimization Tool 9-6
Exporting Data 9-17
Saving Data 9-19
Analyzing Data 9-20
AWG (Arbitrary Waveform Generation). 9-30

10. Creating a Script 10-1

Creating a Script 10-2
Script Objects 10-3
Custom Filters 10-37
Exercise Script 10-55

11. Transducer and Biopsy 11-1

Transducer Overview 11-2
Biopsy Special Concerns 11-5
Preparing for Biopsy 11-6

12. Preset 12-1

System Preset 12-2
Image Preset 12-35

13. Care and Maintenance 13-1

System Care and Maintenance 13-2
Transducer Care and Maintenance 13-7

14. Safety and Regulatory Information 14-1

Safety Summary 14-2
Important Safety Warnings 14-3
Patient Safety Information 14-4
Electrical Safety Information 14-5
Transducer Safety Information 14-6
System Symbols and Labels 14-8
Peripherals and Accessories 14-12
Regulatory Information 14-15
Electromagnetic Compatibility (EMC) 14-17
Diagnostic Ultrasound Indications for Use 14-29
Acoustic Output 14-35

1

System Basics

This chapter introduces the followings:

Introduction 2

System Components..... 6

Image Display 19

Control Panel..... 21

QWERTY Keyboard 24

Touch Screen 26

Transducers 27

Introduction

System feature

The E-CUBE 12R ultrasound system provides excellent quality and reliability as well as these specific features:

Table 1-1 System feature

Physical Dimensions	• Weight: 128.5 kg (system only) • Width: 580 mm • Depth: 895 mm • Height: 1413/1848 mm
Image Processing Technology	• FullSRI™ • Spatial Compounding • Frequency Compounding
Clinical Applications	• Fetal • Abdominal (renal & GYN/pelvic) • Pediatric • Small Organ (breast, testes, thyroid) • Adult Cephalic • Musculo-skeletal (conventional) • Musculo-skeletal (superficial) • Cardiac (adult & pediatric) • Peripheral Vascular (PV) • Urology (including prostate)
Operable Transducers	• L3-12 • L3-12H • SC1-4H • SC1-6 • SP1-5
Available Imaging Modes	• 2D mode • M mode • Color flow (CF) mode • Power doppler (PD) mode • Pulsed wave doppler (PWD) mode

Available Measurements	• Distance • Ellipse • Trace • Spline • Time • Slope • Velocity • Acceleration
Connectivity	• Verification • DICOM storage • DICOM print • DICOM storage commitment • DICOM media • DICOM worklist • DICOM MPPS • DICOM Structured Report

Contraindication

Using the system for certain purposes such as gender determination is severely restricted by law.

Do not operate the system for an ophthalmic purpose or any use affecting the patient's eye by the acoustic beam.

Prescription device

United States law restricts this device to sale by or on the order of a physician.

Intended User Profile

The E-CUBE 12R is intended for use by a qualified physician or sonographer for ultrasound evaluation.

Table 1-2 Intended User

User	Role	Expected Experience and Other user characteristics
Sonographer (RDMS, RDCS, RVT)	• Acquires diagnostic views of anatomy, blood flow and related pathology • Performs measurement and analysis of those images • Prepares the exam for review and interpretation by a qualified physician (“sonologist”, or reading physician).	• Ranges from Novice (i.e. student) to Master (i.e advanced practitioner) with certification in multiple subspecialties • Educated in anatomy, physiology, patient care and in pathology identifiable by ultrasound images • Many sonographers have a Bachelor’s degree; some sonographers have advanced degrees in related health care fields
Cardiologist/ Internist	• Performs invasive and non-invasive ultrasound exams • Interprets diagnostic imaging studies, including echocardiography, and rendering a report of findings.	• Medical Doctor • Expert in diagnostic imaging, including CT, MRI, X-Ray, Ultrasound and Nuclear Medicine • Well trained in imaging physics with typically four to six years of post-doctoral training in the field of cardiology
Maternal Fetal Medicine/ Perinatologist	• Performs ultrasound exams • Interpret exam data	• Medical Doctor • Manages high risk obstetrical cases to a successful and safe delivery of the fetus • Skilled in interpreting ultrasound exam findings.

Radiologist/ Internist	• Performs ultrasound exams • Interpret exam data	• Medical Doctor • Expert in diagnostic imaging, including CT, MRI, X-Ray, Ultrasound and Nuclear Medicine. • Well trained in imaging physics with typically two to six years of post-doctoral training in the field of radiology
System Administrator / Customer Service Engineer	• Configures the ultrasound system for use in a networked environment.	• A system administrator is a person assigned within the department, or from IT, to set up the system parameters for networking to a PACS server. • Customer Service Engineers are called upon to configure the system upon initial installation and for troubleshooting inquiries. • The system administrator may be a sonographer or a physician within the department or might be assigned to someone in the IT department.

System Components

Front view

There are the main components of your system:

Figure 1-1 Front view

No.	Component	No.	Component
1	Monitor (21.5-inch wide display)	**8**	Up/Down lever
2	LED lamp	**9**	QWERTY keyboard
3	Touch screen	**10**	DVD-RW
4	Gel warmer	**11**	Cable hook
5	Transducer holder	**12**	ECG port
6	Control panel	**13**	Transducer port
7	Rotate lever		

Rear view

Figure 1-2 Rear view

No.	Component	No.	Component
14	Monitor buttons	**18**	System on/off switch
15	LED lamp button	**19**	AC inlet
16	I/O panel	**20**	Voltage selector- output
17	AC outlet		

NOTE

When connecting an external monitor to your system, use the monitor with 1366 x 768 or higher resolution.

Side view

Figure 1-3 Side view

No.	Component	No.	Component
1	Monitor arm	4	Body base
2	Rear handle	5	Caster lock
3	Body cover	6	Caster

Peripheral area

In the middle of the system, you can place optional peripherals such as black and white printer and color printer.

CAUTION

The peripheral area is only for peripheral devices. Do not place transducers or the footswitch in the peripheral area to prevent damaging them from accidentally falling off.

I/O panel

I/O panel located on the rear side of a system includes video input and output, audio input and output, Ethernet, power and control connections for a printer. See **Figure 1-4** below for more details.

CAUTION

- Each outer (case) ground line of peripheral/accessory connectors are earth grounded. Signal ground lines are not isolated.
- For compatibility reasons, use only ALPINION approved transducers, peripherals or accessories.
- Be sure to plug the power supply cable of the peripherals to the connector panel of the system to avoid unexpected electrical shock.
- Do not connect any transducer or accessories without approval from ALPINION.

Figure 1-4 I/O panel

1 Trigger ports for Research
2 Audio In/Out port
3 Remote control port for a B/W printer
4 Video port for printer port
5 S-video output port for a DVR
6 HDMI extend port
7 VGA port
8 HDMI duplication port
9 USB 3.0 port
10 DVI duplication port
11 USB 2.0 port
12 Ethernet port

CAUTION

- The connection of equipment or transmission network other than as specified in these instructions can result in electric shock hazard.
- Connected peripherals must meet IEC standard (An equipment that processes data: IEC60950/EN60950, a medical equipment: IEC60601-1/EN60601-1). For product configuration, it must meet the safety requirements of product standard IEC/EN60601-1 or system standard IEC60601-1-1/EN60601-1-1.
- The operator shall not contact the parts (SIP/SOP) and the patient simultaneously.
- When connecting a cable to the ethernet (LAN) port, always use the optional LAN isolator (EN-20G by EMO system or any similar isolator complying with IEC/EN 60601-1) to protect your system from electrical damage.

Footswitch (Option)

The optional tri-pedal footswitch that is connected with the rear panel of your system performs specific functions easily instead of pressing function keys on the control panel.

The each pedal of the footswitch may have different functions depending on the assigned settings such as **Freeze**, **Print**, **P1**, **P2**, and **Rec/Pause**.

To assign the footswitch functions, press the **System Preset** key and go to **User Setting** > **Print/Foot Switch**.

Figure 1-5 Footswitch

CAUTION

Do not place or store the footswitch in the peripheral area on the system to prevent damaging the footswitch from accidently falling off.

Monitor and touch screen

Figure 1-6 Monitor buttons

1 Up (∧) button
2 Mode/Select (◇) button
3 Down (∨) button
4 USB port (2 ports)
5 LED lamp button
6 LED lamp
7 Brightness dial

CAUTION

The LED lamp may overheat. Be careful not to directly touch it to avoid injury.

Moving and transporting the system

Before moving the system

CAUTION

- For your safety, you must follow the precautions carefully before moving or transporting the system.
- Before moving the system, make sure that the peripherals in the storage area are installed securely.

Before you move the system, use the following steps.

1. Power off the system using the **Power On/Off** key on the control panel.
2. Unplug the power cord from the power outlet.
3. Disconnect all peripheral devices (e.g. printers or DVD) and the footswitch from the system.
4. Secure all cables.
5. Store all transducers or accessories in the proper spaces carefully.
6. Lock the monitor arm. Depending on the type of monitor arm you use, you need to follow the steps below.

To lock the monitor arm,

(1) Remove the lock cover cap.

(2) Insert the lock cover cap to the cap housing.

(3) Align 3 rotatable parts of the arm to each slotted hole.

(4) Lower the arm hook.

(5) Pull down the arm hook and insert it into the arm hook slot.

(6) Push the locking knob and rotate it clockwise.

Figure 1-7 Locking the monitor arm

7 If necessary, push the **Up/Down** lever and adjust the height.

8 Push the **Rotate** lever and adjust the location of the control panel.

1. Rotate lever
2. Up/Down lever

Figure 1-8 Rotate and Up/Down levers

9 Fold up the monitor.

Figure 1-9 Folding up the monitor

10 Unlock the front and rear casters by stepping on the lock levers.

Figure 1-10 Front and rear casters

When moving the system

CAUTION

- For your safety, follow the precautions carefully when moving the system.
- Do not use the system cables to move the system.
- When you move the system with another person, take extra precaution not to injure feet.

When moving the system, use the following procedure.

1. Move the system by using the front or rear handle grip.
2. Take extra care when moving the system for long distances and on inclines. Ask for help, if necessary.
3. Use extra care to move the system when crossing door or elevator thresholds.
4. When you reach the destination, lock the front and rear casters.

When transporting the system

When transporting the system with vehicles, use the following procedure.

1. Only use vehicles that are capable of transporting your E-CUBE 12R system.
2. Load and unload the system to a vehicle parked on a level surface.
3. Ensure that the transporting vehicle can handle the weight of the system plus the passengers.
4. Ensure that the load capacity of the lift is capable of handling the weight of the system.
5. Ensure that the lift is in good working order.
6. Secure the system while it is on the lift so that it cannot roll. Use wood chocks, restraining straps, or other similar types of constraints. Do not attempt to hold it in place by hand.
7. Employ two to three persons to load and unload safely from a vehicle.
8. Load the unit aboard the vehicle carefully and keep its center of gravity. Keep the unit still and upright. (Do not lay the unit down on its side.)
9. Ensure that the system is firmly secured while inside the vehicle. Any movement, coupled with the weight of the system, could cause it to break loose.
10. Secure the system with straps or as directed otherwise to prevent motion during the transport.
11. Prevent vibration damage by driving cautiously. Avoid unpaved roads, excessive speeds, and erratic stops or starts.

Image Display

The image display consists of an US image, application information, patient information, and indicators.

Figure 1-11 Image display

1 Company logo
2 Hospital logo
3 Hospital name
4 Operator ID, Current date & time
5 Labeled measurement menu
6 Mechanical index, Thermal index
7 Depth scale bar
8 Focus mark
9 Image parameter
10 Gray scale bar
11 The location of transducer
12 Symbol lock, caps lock, USB connection, network connection
13 Clipboard icons (Recycle bin, Single layout format, Dual layout format)

Screen saver

Screen saver mode automatically activates to save the system power when you do not operate the system and the system stays in idle for a specified time. To deactivate this mode and return to normal operating mode, press any key on the control panel.

NOTE

To configure the screen saver settings, press the **System Preset** key and go to **System** > **General** > **Monitor**.

Control Panel

Figure 1-12 Control panel layout

Table 1-2 Key description

No	Controls	Description
1	Power on/off	Use this control to turn on and off the system.
2	User (1~6)	Use these controls to access user-defined functions.
3	Patient	Use this control to display the ***Patient Registration*** screen. You can enter patient data.
4	Transducer	Use this control to select the desired transducer, application, and preset.
5	Report	Use this control to create a report based on the exam result and edit it.
6	E-view	Use this control to activate image management with end of study options.
7	Select	Use this control to select the desired function from the context menu on the screen.
8	Soft keys	Use these controls to select or adjust the functions in the soft menu at the bottom of the touch screen. • Press to select the corresponding soft menu. • Rotate to adjust the function of the corresponding soft menu.
9	TGC slides	Use these controls to adjust TGC values on images.
10	Imaging mode	Use these controls to activate 2D, PD, M, PW, or CF modes.
11	Depth	Use this control to adjust the scanning depth of an image.
	Zoom	Use this control to turn Zoom mode on. • Rotate to activate Read zoom. • Press to activate Write zoom in Read zoom mode.
12	Image layout keys	Use these controls to view an image in dual or single screen.
13	TDI	Use this control to activate the tissue doppler imaging.
14	Opt1	Use this control to access a user-defined optional function.

No	Controls	Description
15	Exit	Use this control to exit current screen (mode) and return to the previous screen (mode).
	Text	Use this control to annotate images.
	Body Pattern	Use this control to display the body pattern images.
	Update	Use this control to update a 2D image in real time based on the specified time or freeze a 2D image.
	PDI	Use this control to activate Power doppler mode.
	Harmonic	Use this control to turn harmonic imaging on and off.
	Xpeed	Use this control to automatically optimize image parameters on the live screen.
16	Rec	Use this control to record images.
17	Cursor	Use this control to show the cursor on the screen. You can select a menu on the screen using this cursor.
	Clear	Use this control to delete the arrow, comment, and measurement.
	Measure	Use this control to perform measurement.
	Priority	Use this control to adjust the priority of Trackball. • In 2D mode, press to select the priority between the width and tilt functions. • In Duplex or Triplex mode, press to select the priority between ROIs of the activated imaging modes.
	Set	Use this control to set the current function.
19	P1, P2	Use this control to print out images.
20	Trackball	Use this control to scroll through menus or options on the screen by moving the cursor.
21	Freeze	Use this control to start and stop scanning.
22	Print	Use this control to print out images.

QWERTY Keyboard

Under the control panel, the QWERTY keyboard is available which you can enter text or perform special functions.

Using the QWERTY keyboard

To open the keyboard,

Push the edge of the keyboard. The keyboard smoothly slides out.

To close the QWERTY keyboard,

Slide the edge of the keyboard into the console, and then push it

Figure 1-13 QWERTY keyboard

Using the special keys

- **Quick ID**: access the ***Quick ID*** screen.
- **Patient Browse**: access the **Patient Browser** menu.
- **Image Preset**: access the **Image Preset** menu.
- **System Preset**: access the **System Prese**t menu.
- **DICOM Spool**: access the **DICOM Spooler** menu.
- **DVR**: access the **DVR** menu.
- **Help**: access Quick guide information.
- **Eject**: eject a medium (CD, DVD, or USB).
- **Hide**: hide the current menu screen.
- **Clear All**: clear your input or cancel your selection.
- **Biopsy**: Show the biopsy guideline.
- **Initial**: restore the default settings of the current function.
- **End Exam**: end the current study.

Touch Screen

Your ultrasound system has the touch screen that enables you to easily access menus or adjust options on the current monitor display. With the touch screen, you can also enter text instead of using the QEWRTY keyboard. Simply touch the menu or option you want.

Figure 1-14 Touch screen

Transducers

The E-CUBE 12R ultrasound system provides the following transducers: L3-12, L3-12H, SC1-4H, SC1-6, SP1-5. Most of them have a state of art in transducer technology: single crystal transducers, composite transducers, and extreme fine pitch transducer, and real-time mechanical 4D transducers

Moving and storing transducers

Transducers should be placed inside their holders for moving short distances. For shipping or moving considerably a long distance, storing transducers in their carrying cases are strongly recommended. Storing them in carrying cases is not only to protect the transducers from physical damage such as shock or vibration, but also it will protect them from environmental damages such as humidity and temperature.

NOTE

For more information about transducer, see ***Transducer Overview*** on page 11-2.

2

Getting Started

This chapter shows you how to get started using your system. It includes these topics:

Operating Requirements 2

Powering On/Off 4

Adjusting the Monitor and Touch Screen..... 5

Connecting/Disconnecting the Transducer 8

Activating/Deactivating the Transducer..... 10

Operating Requirements

Before using your system, you should consider the following requirements.

NOTE

Only qualified sonographers or physicians should perform scanning with the system.

WARNING

Do not install the system by yourself. Only ALPINION MEDICAL SYSTEMS service engineer should install the system.

Electrical requirements

You should use a system with the specified power outlet as follows:

- 100 - 120 VAC, 900 VA, 50 - 60 Hz
- 200 - 240 VAC, 900 VA, 50 - 60 Hz

WARNING

Using the system in a wrong voltage range causes damages on the system.

Environmental requirements

You should use this system in proper environment to prevent it from radio wave interference, dust and gas.

WARNING

Using the system in an inappropriate environment might cause unexpected problems.

Make sure the area, which your system is installed, is well-ventilated, with a temperature, humidity, and pressure requirements. If the system is exposed to inappropriate temperature, humidity, or pressure, adapt your system to normal range of environment for a few hours.

Table 2-1 Environmental requirements

	Temperature	Humidity	Pressure
Operation	10 °C ~ 40 °C	30 % ~ 75 %	700 ~ 1060 hPa
Storage	-25 °C ~ 60 °C	20 % ~ 90 %	700 ~ 1060 hPa
Transportation	-25 °C ~ 60 °C	20 % ~ 90 %	700 ~ 1060 hPa

CAUTION

Before powering the system on, make sure that the system meets the operational conditions in temperature and humidity.

Powering On/Off

Power on

1. Make sure that the power cord is plugged into the power outlet.

CAUTION

Make sure that the system power is supplied from a separate and properly rated power outlet.

2. Push the **System On/Off** switch to turn on the system power on the bottom rear of the system.
3. Press the **Power On/Off** key on the control panel.

Power off

1. Press the **Power On/Off** key on the control panel.
2. When the shutdown dialog box appears, select **Shutdown** by using **Trackball**.

NOTE

Depending on the power-off setting, you can activate Sleep mode or turn the system off immediately. To change the power-off setting, press the **System Preset** key and go to **System** > **General** > **Power Off**.

CAUTION

Do not unplug the power cord during the system operation. Do not turn off the **System On/Off** switch before pressing the **Power On/Off** key. This may lead to data loss or system software damage.

Adjusting the Monitor and Touch Screen

Rotate, tilt, pan, and fold the monitor

The position of monitor can be easily adjusted to fit your viewing by help of the professional arm. This monitor can be adjusted in following positions:

- Rotating: the monitor with the professional arm provides three pivot points for rotation (covers considerably wide rotation area).
- Tilting: the monitor can be tilted around its pivot point to both forward and backward.
- Panning: the monitor can be panned forward and backward by the rotation on the rear rotation pivot point on the professional arm. The distance of monitor from user can be easily adjusted.
- Folding: the monitor can be folded down close to the control panel to provide a stability when moving the system.
- Adjusting height (up/down): the height of monitor can be adjusted without handling the control panel height.

Figure 2-1 Adjusting the monitor

Contrast, brightness, and dim brightness

To adjust the contrast,

1. Press the **Mode/Select** (◇) button on the monitor once.
2. To increase the contrast, press the **Up** (∧) button. Press the **Down** (∨) button to decrease the contrast. Repeat step 2 until desired value reached.

NOTE

Current contrast value is shown on the display.

To adjust the brightness of the monitor,

1. Press the **Mode/Select** (◇) button on the monitor twice.
2. To increase the brightness, press the **Up** (∧) button. Press the **Down** (∨) button to decrease the brightness. Repeat step 2 until the desired value is reached.

NOTE

Current brightness value is shown on the display.

To adjust the brightness of the touch screen,

1. Push up **Brightness dial** to increase the brightness.
2. To decrease the brightness, push down **Brightness dial**.

To adjust the dim brightness,

1. Press the **Mode/Select** (◇) button on the monitor three times.
2. To increase the dim brightness, press the **Up** (∧) button. Press the **Down** (∨) button to decrease the dim brightness. Repeat step 2 until the desired value is reached.

NOTE

Current dim brightness value is shown on the display.

LED lamp

The LED lamp is adapted to offer proper light at a dark room to see the chart or readings. To turn the light on, press the **LED Lamp** button. Press this button once again to turn this lamp off.

Connecting/Disconnecting the Transducer

Connecting the transducer

You can connect the transducer to the transducer port when the system is powered off or on. Make sure that you press the **Freeze** key on the control panel before connecting the transducer.

CAUTION

Do not touch the patient when connecting or disconnecting a transducer.

1 Check if you press the **Freeze** key on the control panel.

2 Slide the shutter down to open the transducer port.

Figure 2-2 Connecting the transducer

3 Insert the transducer connector into the transducer port.

CAUTION

Do not forcibly insert the transducer connector to the system. Improper connection may cause damages to the system and transducer.

4 Turn the connector locking handle clockwise.

Figure 2-3 Connecting the transducer

NOTE

After connecting the transducer to the system, you need to activate the desired transducer by selecting it from the screen.

Disconnecting the transducer

You can disconnect the transducer from the transducer port when the system is powered off or on. Make sure that you press the **Freeze** key on the control panel before disconnecting the transducer.

CAUTION

Do not touch the exposed surface of the transducer connector when the transducer is removed.

1 Check if you press the **Freeze** key on the control panel.

2 Turn the connector locking handle counter-clockwise.

3 Pull out the transducer connector from the transducer port.

4 Slide the shutter up to close the transducer port.

Activating/Deactivating the Transducer

Activating the transducer

Use the following procedure to activate the transducer and application.

1. On the control panel, press the **Transducer** key.
2. The dialog box for transducer and application selection appears.
3. Move the cursor to select the desired transducer, application and preset using **Trackball** on the control panel. Press the **Set** key on the control panel.

   NOTE

   Default transducer for the selected preset or default preset for the selected transducer is selected automatically.

4. Click **Exit** to exit and save your selections.

   NOTE

   Selecting the **Automatic Preset selection when changes the Transducer** check box shows the default application and preset for the selected transducer.

Deactivating the transducer

NOTE

Before deactivating the transducer, press the **Freeze** key on the control panel. An error may occur when you deactivate the transducer while the system is running.

Use the following procedure to deactivate the transducer.

1. Press the **Freeze** key on the control panel.
2. Clean the gel from the transducer.
3. Gently wipe the excess gel on the transducer surface.
4. Place the transducer in its holder.

3

Starting a Study

This chapter describes:

Patient Registration Screen 2

Entering Patient Information..... 3

Quick ID 10

Starting a New Study with an Existing Patient 11

Retrieving Patient Information via Worklist 12

Deleting a Patient or Study 13

Locking a Patient or Study..... 14

E-view 16

Image History 19

Patient Registration Screen

You can enter patient information on the ***Patient Registration*** screen. When the patient information is entered, you can perform measurement and calculation, save images to the image archive, and send the images to a DICOM device. You can also identify the patient information on the patient banner and report screen.

To enter the ***Patient Registration*** screen,

- Press the **Patient** key on the control panel, or select **Patient** on the touch screen.

The following components are shown on the screen:

Figure 3-1 Patient Registration screen

1 Menu selection

2 Function selection

3 Patient information

4 Application information

5 Transducer and application selection

6 Patient search (Switch to the study list)

7 Exit

8 HDD capacity indicator

Entering Patient Information

1 On the ***Patient Registration*** screen, enter patient information using the QWERTY keyboard. You can also select and use the virtual keyboard on the touch screen.

2 The cursor positions on the ***Patient ID*** field. Enter patient information using the alphanumeric keyboard. The ***Patient Registration*** screen includes the following patient information fields.

Table 3-1 Patient information

Field name	Description	Remarks
Patient ID	Identification code for a patient	Maximum 64 characters are supported. Use a unique ID for each patient.
Name	Patient's last, first, and middle name	Each of last name, middle name, and first name supports maximum 62 characters and the total name supports maximum 62 characters.
Birth Date	Patient's birth date	Click the calendar icon and select a date on the calendar. You can also manually enter a date.
Age	Patient's age	Automatically calculated when birth date is entered.
Sex	Female, male, other	

NOTE

- Using the **TAB** or **Enter** key on the QWERTY keyboard allows you to navigate through each field on the ***Patient Registration*** screen. You can use **Trackball** and the **Set** key on the control panel to move and fix the cursor.
- To automatically generate a patient ID with current date and time,
  - Press the **System Preset** key and go to **Patient Info**. Select the **Auto ID Generation** check box.
  - Press the **Quick ID** key on the QWERTY keyboard and select the **Auto ID Generation** check box on the ***Quick ID*** screen.

3 Enter required application information for the selected application.

To change application, select the ***Application*** drop-down list and then select an application (e.g. Abdomen, OB, GYN, Cardiology, Vascular, Urology, Pediatrics, Small Parts, EM). All possible information needs to be entered.

Figure 3-2 Selecting an application

ABD application

No specific application data

OB and EM application

Table 3-2 OB and EM application

Field	Descriptions
LMP/IVF	Select LMP or IVF first to calculate EDD and enter the date of the last menstrual period (or In Vitro Fertilization).
EDD	Estimated Date of Delivery. The system automatically calculates and displays EDD after entering LMP or IVF. When you enter or change EDD, the system calculates and displays values for LMP/IVF and GA. EDD = LMP + 280 days
GA	GA is automatically calculated when you enter LMP, IVF or EDD. GA = Current date - LMP
Fetus #	Select the fetus number (up to 4 fetuses)
Gravida	Enter the number of pregnancy.
Para	Enter the number of childbirth.
Ectopic	Enter the number of ectopic pregnancy.
Aborta	Enter the number of abortion.

GYN application

Table 3-3 GYN application

Field	Descriptions
LMP	Enter the date of the last menstrual period using the selected date format (ex – MM/DD/YYYY).
Expected Ovulation Date	Enter an expected ovulation date.
Day of Cycle	Enter a menstrual cycle.
Gravida	Enter the number of pregnancy.
Para	Enter the number of childbirth.
Ectopic	Enter the number of ectopic pregnancy.
Aborta	Enter the number of abortion.

Cardio application

Table 3-4 Cardio application

Field	Descriptions
BSA	Body Surface Area (Calculated, No input data)

Vascular application

Table 3-5 Vascular application

Field	Descriptions
Left BP	Blood pressure of left arm, using the systole over diastole measurement in mmHg
Right BP	Blood pressure of right arm, using the systole over diastole measurement in mmHg
ABI	Ankle Brachial Index

Urology application

Table 3-6 Urology application

Field	Descriptions
PSA	Enter the value of the Prostate-specific antigen.
PPSA Coefficient1	Enter the first value of the predicted PSA coefficient.
PPSA Coefficient2	Enter the second value of the predicted PSA coefficient.

Pediatrics application

No specific application data

Small Part application

No specific application data

4 Enter the general application information.

Table 3-7 Application information

Field	Descriptions
Height	Enter the patient's height using selected dimension (cm, ft, inch)
Weight	Enter the patient's weight using selected dimension (kg, lb, oz)
BP	Blood pressure in mmHg
Accession #	Maximum 16 characters Identification code indicating the sequence of the current study as related to other studies for this patient. Usually generated by a HIS or RIS server.
Comments	Maximum 144 characters
Indication	Maximum 72 characters
Performing MD	The name of performing MD
Referring MD	The name of referring MD
Operator	The name of operator

NOTE

- To configure the measurement unit, press the **System Preset** key and go to **System** > **General** > **Location** > **Unit**.
- When you change the operator ID on the ***Patient Registration*** screen, the ***Log in*** dialog box appears on the screen. Select a desired operator ID from the ***Operator ID*** field and enter a valid password into the ***Password*** field, and then click **OK**.

5 Click **Register** or select **Register** on the touch screen to enter patient and application information into the database prior to examination.

6 Click **Exit** or select **Register** on the touch screen to register patient and application information and exit from the ***Patient Registration*** screen. The scan screen appears.

CAUTION

Always verify the identification with the patient to avoid patient identification errors. Make sure that the correct patient identification appears on all screens before printing out the patient information.

Quick ID

With the Quick ID feature, you can quickly register a patient by entering basic patient information. This feature is useful when you do not have enough time to register all patient information.

1 Press the **Quick ID** key on the QWERTY keyboard. The ***Quick ID*** screen appears.

Figure 3-2 Quick ID screen

2 Enter Patient ID, Name, Birth Date, and Sex. Only OB application shows the LMP field.

NOTE

Using the **TAB** or **Enter** key on the QWERTY keyboard allows you to navigate through each field on the ***Quick ID*** screen. You can use **Trackball** and the **Set** key on the control panel to move and fix the cursor.

To enter more information including application information, go to the ***Patient Registration*** screen by pressing the **Patient** key on the control panel or selecting **Patient** on the touch screen.

3 Click **OK** to save the patient.

CAUTION

Do not register a patient ID using the Quick ID feature while scanning an image or performing measurement or calculation with no patient ID. The current image or measurement data may be lost.

Starting a New Study with an Existing Patient

NOTE

When you register a patient, the study list appears on the display. If the patient is not registered, the patient list appears instead.

1. Press the **Patient** key on the control panel, or select **Patient** on the touch screen. The ***Patient Registration*** screen appears.
2. Select a search criteria (Patient ID, Patient Name, Birth Date, Sex, Exam Date, and Locked) from the ***Search*** drop-down list and enter a search keyword.

   To view all registered patients while entering a search keyword, click **Clear**.
3. When the search results appear, select a desired patient from the patient list.

   For example, when you select **Exam Date**, you can select a desired period (Today, Last Week, Last Month, and Last 3 Months) and a specific date from the drop-down list.
4. Click **New Study** on the function selection to create a new study.
5. Enter or edit the patient information.
6. Click **Register**.
7. Click **Exit** to return to the ***Scan*** screen.

Retrieving Patient Information via Worklist

1. Press the **Patient** key on the control panel, or select **Patient** on the touch screen. The ***Patient Registration*** screen appears.
2. Select **Worklist** on the function selection to view patient data from the default worklist server.
3. To change the worklist server, select a source from the ***Source*** drop-down list.

NOTE

Before connecting to the worklist server, you need to configure worklist settings in **System Preset** > **Connectivity** > **Worklist**.

4. Select **Worklist** to retrieve patient data from the worklist server.

The search results appear on the list.

5. Select the patient you want to start a study.
6. Select **Transfer** on the touch screen to transfer the selected study to the patient archive. The progress bar appears on the screen while transferring.

NOTE

Destination for transfer is always Local Archive HDD.

Deleting a Patient or Study

CAUTION

Before deleting a patient or study, make sure you have already backed up the patient data using Backup Patient Archive or export function. After deleting the patient or study, you CANNOT recover it.

NOTE

To select multiple patients from the patient list, press the **Set** key while the **Ctrl** or **Shift** key is pressed.

Deleting a patient

NOTE

To switch between the patient list and the study list, use **Patient List** or **Study List**.

1. Search and select a patient from the patient list.
2. Select **Delete** on the touch screen.
3. When the ***Message*** dialog box appears, click **Yes** to delete the selected patient.

NOTE

When the patient you want to delete is locked, you cannot delete the patient by using **Delete**. You have to unlock the locked patient before deleting it.

Deleting a study

1. Select a study from the study list.
2. Touch **Delete** on the touch screen.
3. When the ***Message*** dialog box appears, click **Yes** to delete the selected study.

NOTE

When the study you want to delete is locked, you cannot delete the study by using **Delete**. You have to unlock the locked study before deleting it.

Locking a Patient or Study

To prevent deleting or moving patient data, use Lock functionality.

Locking the existing patient

1. Search and select a patient from the patient list.
2. Select **Lock** on the touch screen.
3. You can see the locked patient with the lock icon in the patient list.

NOTE

When you select a locked patient, you can see all of the studies are locked.

Locking the existing study

1. Select a study from the study list.
2. Select **Lock** on the touch screen.
3. You can see the locked study with the lock icon in the study list.

NOTE

To unlock the locked patient or study, select **Unlock** on the touch screen.

Sorting the list

Sort the patient or study information by clicking the column names (e.g. Lock, Patient ID, Last Name, First Name, Birth Date, Sex, Image Size, Last Exam, Exam Date, and Study #) of the patient or study list in ascending or descending order.

Ending a study

When you end a study, all images of the current study are saved in the local hard disk.

- Press the **E-view** key on the control panel and select **End Study** on the context menu of the ***E-view*** screen.
- You can also end a study by selecting **New Patient** on the ***Patient Registration*** screen.

E-view

The E-view feature allows you to review the current study images or saved study images. While reviewing, you can print an image, send an image to a DICOM device, or save an image to a removable media.

To activate the E-view feature,

- Press the **E-view** key on the control panel, or select **E-View** on the touch screen.
- On the ***Patient Registration*** or ***Image History*** screen, select **E View** to switch to E-view mode.

Figure 3-3 E-view

Reviewing an image

Select an image and touch **Review** on the touch screen. The image is shown on the scan screen.

Ending a study

To end a study immediately,

- Press the **End Exam** key on the QWERTY keyboard.

- Select **End Study** on the context menu.

Printing an image

On the ***E-view*** screen, you can print images via the standard printer.

1. Select an image or multiple images by pressing the **Set** key.
2. Select **Print** on the context menu.

   The ***E-View Print*** window appears.
3. Select a standard (default) printer and set up the printing options.
4. When you are finished, click **Print**.

   The selected printer prints out the selected image(s).

NOTE

To invert color between images and background, select the **Invert Image** check box.

Sending an image to a DICOM device

You can transfer image data to a DICOM device such as DICOM storage or DICOM print.

NOTE

To configure the destination device, press the **System Preset** key and go to **Connectivity**.

1. Select an image or multiple images by pressing the **Set** key.
2. Select **Send** on the function selection. The ***Send To*** dialog box appears.
3. Select a destination from the drop-down list.
4. Click **Send**. The progress bar appears while files are being transferred.

Saving an image to a removable media

You can save images to a removable media. The supported file formats are PC friendly formats such as BMP, JPEG, AVI, and WMV.

1. Insert your removable media to the media tray properly.
2. Select an image or multiple images by pressing the **Set** key.
3. Select **Save As** on the function selection. The ***Save*** dialog box appears.
4. Select a media from the ***Device*** drop-down list.
5. The system automatically creates a file name. To change the file name, enter a file name.
6. Select an image format in the ***Type*** drop-down list.
7. Click **Save**.

Image History

Image History allows you to review all previous studies for the selected patient. When you access Image History, the study information with the study date and location appears in a table.

While scanning an image, you can compare the active image with the saved images in the dual or quad screen.

Figure 3-4 Image history

To review an image,

1. Put a removable medium (CD or DVD) to the media tray, if necessary.
2. Press the **Patient** key on the control panel.
3. Select a desired patient in the patient list.
4. Select **Image History** on the menu selection. All of the studies for the selected patient are listed by chronological order.
5. Select an image in the desired study by using **Trackball**. The blue-colored frame appears on the selected image.

   To review multiple images between different studies, select desired images of the studies you want. You can select up to 4 images at one time.

   NOTE

   You can compare images by changing the image layout to dual imaging or quad imaging. Press the Dual key or Quad key on the control panel.

6. Select **Review** on the touch screen to review the image.
7. To delete the imaget, select **Delete** on the touch screen.
8. When you are finished, press the **2D** key to move to the ***Scan*** screen.

   To use the E-view function, select a desired study and then select **E View** on the menu selection. You can also select **E View** on the touch screen.

4

Imaging Modes

The system provides the four imaging (scanning) modes:

2D Mode..... 2

M Mode..... 15

Color Flow Mode..... 19

Power Doppler (PD) Mode 25

Pulsed Wave Doppler (PWD) Mode 28

2D Mode

In 2D mode ultrasound, your transducer simultaneously scans a plane through the body that can be viewed as a two-dimensional image on the screen.

In 2D mode, two-dimensional images and measurements of the anatomical structures of soft tissues such as internal organs and vascularities can be determined.

General workflow

To start a scan in 2D mode,

1. Press the **2D** key on the control panel to start 2D mode.
2. Use the following controls for image optimization:
   - **2D** key (rotate to adjust 2D mode gain)
   - **Depth** and **Focus** keys
   - **TGC** slide controls

   NOTE

   To reset the current image settings, press the **Initial** key on the QWERTY keyboard.
3. Use additional soft keys, if necessary.
4. To enter another imaging mode, press the corresponding mode key.
5. Press the **2D** key to return to 2D mode from another imaging mode.

Image optimization controls

Soft key menus

Select an option on the touch screen, or rotate the corresponding soft key to select the following imaging functions:

- Frequency
- Dynamic Range and Gray Map
- Rejection and Colorize
- Up/Down

Gain

Increase or decrease in the amount of echo information displayed in an image. It may have the effect of brightening or darkening the image if sufficient echo information is generated.

Adjusting the gain

Increase or decrease the sensitivity of the instrument. You can use two controls to adjust gain: The overall gain control and TGC. To decrease or increase overall gain, rotate the **2D** key.

Gain values

Gain is shown as **Gn** on the display. Gain values may vary depending on the transducer, application, and frequency setting.

Gain values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Remarks

Commonly, you need to decrease the gain when you increase the Power Output; To increase the gain, decrease the power output. Gain and TGC interact by adding together.

Depth

Increasing the depth enables the deeper structures to be visualized. You can decrease the depth if you do not need the bottom portion of the display.

Adjusting the depth

Increase or decrease the depth by rotating the **Depth** key clockwise or counter-clockwise on the control panel. You can see the display and image parameters are automatically changed.

Depth values

Maximum and minimum depth selections are dependent on the frequency of the transducer you are currently using.

NOTE

- You might adjust TGC and focus with depth adjustment. Adjusting depth erases real-time calculations of the graphic on the screen (but not the completed results on the worksheet page).
- Incrementing depth depends on what transducer and application you use. When you change the transducer, application, preset, or click **New Patient** on the ***Patient Registration*** screen, depth parameters are set to the factory or user preset settings.

Focus

Curved array, linear array, and phased array transducers support multiple transmit focus zones, which you can select in 2D-mode images. Focal zone markers display on the left side of the image screen.

Adjusting the focus

On the touch screen, select **<** or **>** of **Focus Num** to adjust the number of focal zones.

NOTE

To move the focal zone to the near/far field, adjust the focus position by rotating the **Focus** key.

Focus values

Focal zone number and position may vary depending on the depth, zoom, transducer, application, and selected frequency setting.

Remarks

Using multiple focal zones causes a reduction in the frame rate. The amount of frame rate reduction depends on the depth of view and the transducer.

Harmonic

Tissue Harmonic Imaging (THI) is a system feature that can enhance the contrast resolution with fine tissue differentiation, benefiting patients with poor images. THI creates images from received signals using the harmonics of the transmitted frequency.

For certain applications, Filtered THI (FTHI) can be used to optimize temporal resolution. The frame rate of FTHI is higher than THI between similar images. To use the FTHI function, you need an additional request to your local agent.

Adjusting THI

To adjust THI,

1. Press the **THI** (**Harmonic**) key. **2D HAR** appears next to 2D image parameters.
2. To change the frequency of THI, select **Frequency** on the touch screen.
3. To exit THI, press the **THI** (**Harmonic**) key.

To adjust FTHI,

1. Press the **THI** (**Harmonic**) key. **2D HAR** appears next to 2D image parameters.
2. If **INV** appears next to 2D image parameters, rotate the **Frq** soft key one level to switch to FTHI (HAR).
3. To change the frequency of FTHI, rotate the **Frq** soft key.
4. To exit FTHI, press the **THI** (**Harmonic**) key.

Harmonic values

Changing multi-frequency resets those parameters which are presettable by frequency to their preset values for the current harmonic frequency. Multi frequency values are returned to the factory or user preset value when you change one of the followings: Transducer, application

Xpeed™

Xpeed™ is an auto-optimizing technology that enables you to easily adjust an image's the contrast resolution and brightness uniformity. For using this feature, you need an additional request to your local agent.

Adjusting Xpeed

To activate or deactivate Xpeed, press the **Xpeed** key on the control panel.

Time Gain Compensation (TGC)

To compensate for weak signals or over-bright signals at various depths, you can adjust Time Gain Compensation (TGC) using the TGC slide controls. The 2D control adjusts the overall receiver gain and compensates for the brightness of the image.

Adjusting the TGC

TGC slide control selectively adjusts the sensitivity (brightness) in depth.

- Slide the slide control to the left to decrease the gain in the corresponding specific 2D depth.
- Slide the slide control to the right to increase the gain in the corresponding specific 2D depth.

TGC values

TGC compensates for attenuation in tissue by increasing the receiver gain as a function of time following each transmit pulse.

Dual imaging

Using dual imaging, you can position two images side by side on the display. Dual imaging is available in all 2D live imaging modes, M mode, Color Flow mode, and TDI mode.

To change the image layout,

1. In 2D mode, Color flow mode, or M mode imaging, press the **Dual** key on the control panel. The image is shown on the left of the display.
2. Press the**Dual** key again to activate the second image.
3. To switch between the two images, press the **Dual** key.
4. Press the **2D** key to exit the dual imaging.

Priority

The priority function has the following two options: Width, Tilt

Width

Control the size or angle width of the 2D image sector. A smaller angle generally produces an image with a higher frame rate.

You can widen or narrow the size of the sector angle to maximize the image's region of interest (ROI).

- **Adjusting the width**

  To narrow or widen the ROI, press the **Priority** key on the control panel. **Width** is highlighted in the message line. Move **Trackball** left or right to decrease or increase the angle size. Then, press the **Priority** key to set the region of interest (ROI).

- **Width values**

  Width values may vary depending on the transducer (not applicable for linear transducers) and application.

Tilt

After the size or angle width of the 2D image sector is set, you can steer the image sector by using the tilt option. Press the **Priority** key to select the tilt function. Then move **Trackball** to tilt the angle.

NOTE

The priority function may not be available with the transducer models L3-12 and L3-12H.

Angle steer

In 2D mode, you can tilt an image left or right by using a linear transducer.

Adjusting the angle steer

On the touch scree, select **<** or **>** of **Angle Steer**. The each level of the angle increment/decrement is 5 degrees.

NOTE

This function is not available when the virtual convex function is applied to the current image.

Frequency

You can adjust the operating frequency of the transducer. The selected frequency is displayed in the Image Parameter.

Changing the frequency value on the display is selecting different transmit patterns associated with that value, including transmit pulse shape, frequency and transmit sequence.

Adjusting the frequency

On the touch screen, select **<** or **>** of **Frequency** to adjust the frequency.

NOTE

Changing the frequency is not available when the image is frozen.

Frequency values

Frequency values may vary depending on the transducer and application.
The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Dynamic range

Dynamic range is useful for optimizing tissue texture in different anatomy. Dynamic range should be adjusted so that the highest amplitude edges appear as white while lowest levels (such as blood) are just visible.

Adjusting the dynamic range

To increase or decrease, rotate the **DR** soft key clockwise or counter-clockwise.

NOTE

When the dynamic range is set high, the image is softer and more low-level data is visible.

Dynamic Range values

The dynamic range values are 30 dB to 170 dB. Dynamic range operates in real-time, Freeze, CINE, and CINE Timeline, but is not available during the VCR playback. It also affects Gain.

Rejection

Low echo information will not be displayed on the screen below the adjusted rejection level.

The rejection function determines the amplitude level below which echoes are suppressed (rejected). Rejection set to high leads to bad tissue display.

Adjusting the rejection

On the touch screen, select **<** or **>** of **Rejection** to adjust the rejection values.

NOTE

When you increase the rejection, low-level echoes are rejected and appear in the 2D image.

Rejection values

The rejection values are 0 to 10.

Up/Down

Adjusting up/down

On the touch screen, select or to flip the image vertically.

Up/Down values

The Up/Down values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

NOTE

To flip the image horizontally, select on the touch screen or press the key on the QWERTY keyboard.

Gray map

The Gray map provides you with the system maps for 2D, M, and Doppler modes.

Adjusting the gray map

On the control panel, rotate the **Gray Map** soft key to clockwise or counter-clockwise.

Gray map values

Gray maps gradually change from the least contrasty or softest to the most contrasty. The gray map values are 0 to 13.

Colorize

Colorize is the colorization of a conventional 2D mode image or Doppler Spectrum to enhance the user's ability to discern 2D mode, M mode, and Doppler mode intensity valuations. Colorize is NOT a Doppler mode.

Adjusting the Colorize

On the control panel, rotate the **Colorize** soft key clockwise or counter-clockwise.

Colorize values

The colorize values are 0 to 13.

Persist

Persistence provides a visible smoothing effect to the 2D-mode image by persisting lines of image data for each frame of imaging.

Adjusting the persist

On the touch screen, select **<** or **>** of **Persist** to adjust the persist function.

Persist values

The persist values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Full SRI™

Full SRI™ is a more powerful SRI feature that allows you to adjust the SRI level according to your image condition or imaging mode. The full SRI feature is available in 2D, 3D, and 4D modes. For using this feature, you need an additional request to your local agent.

Adjusting the full SRI

On the touch screen, select **FullSRI** to adjust the full SRI.

Full SRI values

The full SRI values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Spatial compound

Spatial compound allows you to combine different steering frames to form a single frame at real-time frame rates.

Adjusting the spatial compound

On the touch screen, select **<** or **>** of **Spt.Comp** to adjust the spatial compound.

Spatial compound values

The spatial compound values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

NOTE

The spatial compound function may not be available with phased array transducers.

Line density

Line density optimizes 2D mode frame rate or spatial resolution for the best possible image. A lower line density is useful in fetal heart beat, adult cardiac applications and in clinical Radiology applications requiring significantly higher frame rates. A higher line density is useful in obtaining very high resolution (e.g. thyroid, testicles).

Adjusting the line density

Line density changes the vector density and frame rate.

1. Select **Line Density** on the context menu.
2. Increase the resolution or increase the frame rate.

Line density values

The line density values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient. A lower line density is useful in fetal heart beat, and adult cardiac.

M Mode

The M mode display is formed by using a stationary ultrasound beam, yielding distance/motion versus time information for reflections along a single ultrasound beam line. M mode provides a display format and measurement capability that represents tissue displacement (motion) occurring over time along a single vector.

In M mode, you can learn the movement of an area of anatomy. First, you position the M-line in the 2D image on the anatomy of Interest. Then you can display information about movement along that line in M mode trace. M mode trace can be helpful when you perform measurements, especially measuring the heart rate.

General workflow

1. On the control panel, press the **M** key to activate M mode.
2. Move the M-line to the anatomy of interest by using **Trackball**.
3. Rotate the **M** key to change the initial gain for M mode.
4. To change the sweep speed, select **<** or **>** of **Sweep** on the touch screen.
5. To review the M mode trace, press the **Freeze** key, and use **Trackball** to scroll forward or backward.
6. To exit M mode, press the **2D** key.

Image optimization controls

Soft key menus

Select an option on the touch screen, or rotate the corresponding soft key to select the following imaging functions:

- Dynamic Range and Gray Map
- Rejection and Colorize
- Sweep and Full M
- Anatomical M

Gain

With the Gain control, you can adjust the brightness of M mode image. The adjustment of the Gain control determines the amount of amplification applied to the received echoes. All received echoes are amplified with the same gain value regardless of the scan depth. The M Gain function influences the M trace only.

To adjust the brightness of the entire image, rotate the **M** key on the control panel.

- Rotate the **M** key clockwise to increase the brightness.
- Rotate the **M** key counter-clockwise to decrease the brightness.

Frequency

In Multi-frequency mode, you can change the frequency of the transducer. The frequency function is the same as the one in 2D mode. For adjusting the frequency and frequency values, see ***Frequency*** on page 4-9.

TGC slider controls

In M mode, the TGC slide controls have the same functions in 2D mode. See ***Time Gain Compensation (TGC)*** on page 4-7 for more information.

Depth

In M mode, the depth function is the same as the one in 2D mode. See ***Depth*** on page 4-4 for more information.

CINE

In M mode, image trace information can be recalled. When freezing an image, a certain time frame (M information of the last examination sequence) is stored in the loop memory. The sequence can be reviewed second by second.

Sweep speed

During M mode imaging, you can adjust the sweep speed of the display.

There are six levels for the sweep speed: 0, 1, 2, 3, 4, and 5. The sweep speed is displayed on the touch screen.

Adjusting the sweep speed

To increase or decrease the sweep speed, select **<** or **>** of **Sweep** on the touch screen.

Sweep speed values

The medium sweep speed is suitable for normal use, but the fast sweep speed may be useful to show the shape of some flow information.

Remarks

You can speed up or slow down the timeline to see more or fewer occurrences over time.

Full timeline

Expand the display to full timeline display.

Adjusting the full timeline

On the touch screen, select **Full M**.

Full timeline values

The Full timeline values are On and Off.

Anatomical M mode

Anatomical M mode allows you to move or rotate an M line and review an image on the desired region. For using this feature, you need an additional request to your local agent.

To activate Anatomical M mode,

1. In M mode, select **Anatomical M** on the touch screen.

   The cursor line of the Anatomical M mode appears in the middle of a 2D image.

2. Use **Trackball** to move the cursor line (left/right/up/down).

3. Rotate the **AMM Angle** soft key to rotate the angle.

Color Flow Mode

Color flow mode is useful when you see the flow in a broad area. Color flow allows visualization of the flow in the CF ROI whereas Doppler mode provides spectral information in a smaller area.

Color flow mode is also used as a stepping stone to Doppler mode. Use Color flow mode to locate flow and vessels before activating Doppler mode.

General workflow

1. Press the **CF** key on the control panel. The CF window appears over the 2D mode image.
2. Move the cursor to the CF window by using **Trackball**.
3. Use **Trackball** to change the position of the color box.
4. Press the **Set** key and use **Trackball** to change the size of the color box.
5. Press the **Set** key to move the color box left or right.
6. Press the **Freeze** key to hold the image in the memory.
7. Record color flow images, if necessary.
8. To exit Color flow mode, press the **CF** or **2D** key.

The combination imaging modes of Color flow mode and Power doppler mode

The following combination imaging modes are available:

- 2D mode with Color Flow or Power Doppler
- 2D mode with color and zoom
- 2D/Doppler mode with Color Flow or Power Doppler

Color flow imaging parameters

Use the ultrasound system controls and soft key selections to change the settings for imaging parameters. The system increases the lighting intensity of the control or key associated with the active function.

Positioning, sizing, and steering the ROI

When you press the **CF** key in 2D mode, the color window or ROI appears on the image.

The initial location and the shape of the window depend on the active transducer and default imaging depth.

Changing the size and position of the color ROI

1. Press the **CF** key on the control panel. The system places the ROI, outlined in solid yellow, on the image.
2. Use **Trackball** to reposition the ROI.
3. To resize the ROI, press the **Set** key and move **Trackball**. The system outlines the ROI with a dotted yellow line with solid corners.
4. Press the **Set** key to set the size.
5. To exit Color flow mode, press the **CF** or **2D** key.

Image optimization controls

Soft key menus

Select an option on the touch screen, or rotate the corresponding soft key to select the following imaging functions:

- Frequency
- PRF and Wall Filter
- Threshold and Persist
- Color Map
- Baseline and Invert
- Ensemble and Smooth
- Line Density and Persist
- Angle Steer

Gain

Gain amplifies the overall strength of echoes processed in the Color Flow window or spectral Doppler timeline.

Adjusting the Gain

- Rotate the **CF** key clockwise to increase the gain; rotate the key counter-clockwise to decrease the gain.
- Rotate the **CF** key to adjust the receive gain for color without affecting the 2D mode image gain.

Gain values

Gain values may vary by transducer, application, and multi-frequency setting. Gain value is shown as Gn on the display. Gain values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Pulse repetition frequency (PRF)

Increase or decrease the PRF on the color bar. The PRF is established by the depth of the color ROI. Before a pulse is transmitted, the pulse transmitter must wait until the echoes from the previously transmitted pulse return from the color ROI.

Adjusting the PRF

To adjust the PRF up or down, rotate the **PRF** soft key.

PRF values

The PRF values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient. PRF is in kHz.

Threshold

Threshold assigns the grayscale level at which color information stops.

Adjusting Threshold

Increase or decrease the grayscale threshold.

Threshold values

The threshold values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Baseline

Change the Color Flow or Doppler spectrum baseline to accommodate higher velocity blood flow. Minimize aliasing by displaying a greater range of the forward flow with respect to the reverse flow, or vice versa.

Baseline adjusts the alias point. The default baseline is at the midpoint of the color display and at the midpoint of the color bar reference display.

Adjusting the baseline

To adjust the baseline, rotate the **Baseline** soft key.

Baseline values

Zero velocity follows the baseline. The total PRF range remains the same. Values may vary by transducer and application. Baseline values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Wall filter

Wall filter allows you to filter out clutter signals caused from vessel movement.

Adjusting the wall filter

To raise or lower the wall filter, select **<** or **>** of **WF** on the touch screen.

Wall filter values

The wall filter values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change the following: Transducer, application, new patient

Invert (Color Invert)

Invert allows you to view blood flow from a different perspective, e.g., red away (negative velocities) and blue toward (positive velocities). You can invert a real-time or frozen image.

NOTE

- Invert reverses the color map, NOT the color PRF.
- While viewing an inverse image, be careful not to confuse over scan direction or left/right image reversal.

Adjusting the invert

To reverse the color flow, select **Invert** on the touch screen.

In Triplex mode, both Color flow and Doppler mode velocity scales are inverted.

Invert values

The invert values are On and Off.

Power Doppler (PD) Mode

Power doppler imaging is another way of color flow mapping technology which maps the strength of the doppler signal from the blood flow. Power doppler mode, unlike Color flow mode, displays color flow imaging by using the number of reflectors that are moving. Therefore, this mode has no aliasing and is able to measure the slow blood flow.

General workflow

1. Press the **PDI** key on the control panel. The Power doppler window appears over the 2D mode image.
2. Use **Trackball** to change the position of the color box.
3. Press the **Set** key and use **Trackball** to change the size of the color box.
4. Press the **Set** key.
5. Press the **Freeze** key to hold the image in the memory.
6. Record color flow images, if necessary.
7. To exit Power doppler mode, press the **PDI** key or the **2D** key.

Image optimization controls

Soft key menus

Select an option on the touch screen, or rotate the corresponding soft key to select the following imaging functions:

- Frequency
- PRF and Wall filter
- Threshold and Persist
- Color map
- Angle steer
- Line Density
- Ensemble and Smooth

Gain

Gain amplifies the overall strength of echoes processed in the Color Flow window or spectral Doppler timeline.

Adjusting the Gain

- Rotate the **CF** key clockwise to increase the gain; rotate the key counter-clockwise to decrease the gain.
- Rotate the **CF** key to adjust the receive gain for color without affecting the 2D mode image gain.

Gain values

Gain values may vary by transducer, application, and multi-frequency setting. Gain value is shown as Gn on the display. Gain values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Pulse repetition frequency (PRF)

Increase or decrease the PRF on the color bar. The PRF is established by the depth of the color ROI. Before a pulse is transmitted, the pulse transmitter must wait until the echoes from the previously transmitted pulse return from the color ROI.

Adjusting the PRF

To adjust the PRF up or down, rotate the **PRF** soft key.

PRF values

The PRF values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient. PRF is in kHz.

Threshold

Threshold assigns the grayscale level at which color information stops.

Adjusting Threshold

On the touch screen, select **<** or **>** of **Threshold** to adjust the threshold.

Threshold values

The threshold values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Wall filter

Wall filter allows you to filter out clutter signals caused from vessel movement.

Adjusting the wall filter

On the touch screen, select **<** or **>** of **WF** to adjust the wall filter.

Wall filter values

The wall filter values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change the following: Transducer, application, new patient

Angle steer

In Power doppler mode, you can tilt an image left or right by using a linear transducer.

Adjusting the angle steer

Rotate the **Angle Steer** soft key clockwise or counter-clockwise. The each level of the angle increment/decrement is 3 or 5 degrees depending on the linear transducer type.

NOTE

This function is not available when the virtual convex function is applied to the current image.

Pulsed Wave Doppler (PWD) Mode

Pulsed Wave Doppler (PWD) is a Doppler mode that measures velocity in a PW sample volume and displays that information in a spectral trace with an audio output.

Doppler is intended to provide measurement data concerning the velocity of moving tissues and fluids. PW Doppler lets you examine the blood flow data selectively from a small region called the sample volume.

Doppler equipment is commonly used for detecting and evaluating the blood flow in arteries and veins. The Doppler effect is used in medical ultrasound to detect moving reflectors and to measure and characterize the blood flow.

General workflow

1. In 2D mode, press the **PW** key on the control panel.
2. Adjust the position and the size of the sample volume.
3. To change the sample volume size, select **SV** on the touch screen.
4. To adjust the angle-to-flow correction, rotate the **Angle Correct** soft key.
5. To change the sweep speed, select **Sweep** on the touch screen.
6. To exit PW doppler mode, press the **PW** or **2D** key.

Image optimization controls

Soft key menus

Select an option on the touch screen, or rotate the corresponding soft key to select the following imaging functions:

- Sample Volume (SV) and Frequency
- PRF and Wall Filter
- Angle Correct and Angle Steer
- Baseline and Invert
- Sweep and Full D
- Gray Map and Colorize
- Reject and Auto Angle
- Update and TimeForRes

PW doppler angle

Angle between the direction of reflector motion and the direction of propagation of the ultrasound beam.

PW doppler effect

Phenomenon whereby there is a change in the perceived frequency of a sound source relative to the transmitted frequency when there is a relative motion between a sound source and the listener.

Doppler sample volume length

Size the sample volume gate.

Adjusting the sample volume length

To increase or decrease the gate size, select **SV** on the touch screen.

You can adjust the sample volume gate length whenever the sample volume gate appears on the display.

NOTE

Adjustments to the sample volume gate size are made from the center point of the sample volume position.

Sample volume length values

Values may vary depending on the transducer and application. Sample volume gate size values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Pulse repetition frequency (PRF)

Adjust the velocity scale to accommodate faster/slower blood flow velocities. Velocity scale determines the pulse repetition frequency. If the sample volume gate range exceeds single gate PRF capability, the system automatically switches to the high PRF mode. When multiple gates appear, HPRF is indicated on the display.

Adjusting the PRF

To raise or lower the PRF, rotate the **PRF** soft key.

PRF values

Velocity scale values may vary depending on the transducer and application. In Triplex, when you change the velocity scale in Color flow, the Doppler mode velocity scale is also updated if Triplex is on. Velocity scale values are returned to the factory or user preset value when you change one of the followings: Transducer, application, or new patient

Baseline

Adjust the baseline to accommodate faster or slower blood flows to eliminate aliasing.

Adjusting the baseline

Baseline adjusts the point in the spectrum where the velocity trace is at zero. The default baseline is at the midpoint of the spectrum. To shift the baseline, rotate the **Baseline** soft key.

The baseline is shown as a solid line running across the spectrum. The baseline is raised and lowered in equal increments, depending on the current Doppler scale factor. The control does not work when the maximum baseline shift (in either direction) has been reached.

Baseline values

The baseline values are -8 to 8.

Update (B pause)

In simultaneous mode of 2D and Doppler modes, you can pause a doppler image and move the image to the 2D live screen by adjusting the doppler gate.

Adjusting the update

1. In 2D mode, press the **PW** key on the control panel.
2. Press the **Update** key to freeze the doppler image (2D mode remains live).
3. Use **Trackball** to adjust the doppler gate.
4. Press the **Update** key. The doppler image is moved to the 2D mode screen.

Wall filter

Wall filter allows you to filter out clutter signals caused from vessel movement.

Adjusting the wall filter

To increase or decrease the wall filter, select **WF** on the touch screen.

Wall filter values

The wall filter values may vary depending on the transducer and application. The values are returned to the factory or user preset value when you change the following: Transducer, application, new patient

Angle correct

Estimate the flow velocity in a direction at an angle to the Doppler vector by computing the angle between the Doppler vector and the flow to be measured.

NOTE

When the Doppler mode cursor and angle correct indicator are aligned (the angle is 0), you cannot see the angle correct indicator.

Adjusting the Angle correct

Flow toward the transducer is mapped above the baseline and vice versa.

To adjust the angle relative to the transducer face, rotate the **Angle Correct** soft key. The velocity scale changes when you adjust angle correct.

Angle correct values

The angle correct values are -89 to 89.

Invert

Vertically invert the spectral trace without affecting the baseline position.

Adjusting Invert

To invert the spectral trace, select **Invert** on the touch screen. The plus (+) and minus (-) signs on the velocity scale are reversed when the spectrum is inverted. Positive velocities display below the baseline.

Invert values

The invert values are On and Off.

5

Imaging Functions

This chapter provides the following imaging functions:

Freezing Images 2

Screen Split..... 4

CINE Images 5

Annotating Images 6

Exporting Data..... 12

Freezing Images

Condition in which 2D, M, Doppler, and Color flow image data are retained in a scan converter's memory for examination and/or photograph as well as for video recording.

Freezing an image

1. While scanning an image, press the **Freeze** key on the control panel to freeze the image.

   You can also freeze an image with the right pedal of the footswitch, if supported.

2. To reactivate the image, press the **Freeze** again.

   To start CINE mode, use **Trackball**.

NOTE

- Deactivating the **Freeze** key allows you to erase all measurements including calculations from the screen (Not from the worksheet).
- Selecting a new transducer unfreezes the image.
- To configure the each pedal of the footswitch, press the **System Preset** key and go to **User Setting** > **Print/Foot Switch**.
- To configure the **Freeze** key function after freezing an image, press the **System Preset** key and go to **System** > **Control Panel** > **Key** > **Active Function on Freeze**.

Processing an image

In Frozen mode, you can process 2D mode image. The following controls are available:

- Zoom
- Reverse
- Gain
- Dynamic range
- Up/Down
- Colorize
- Gray map

In Frozen mode, you can process Color flow (CF) or Doppler mode image. The following controls are available:

CF mode	PD mode	PW mode
Threshold	Threshold	Baseline
Baseline	Color map	Sweep speed
Invert		Invert
Color map		Color map
Gain		Gray map

Screen Split

Screen Split allows you to view active images as the dual display view.

1. Press the **Dual** key on the control panel.
2. To display other active images, press the **Dual** key again.

CINE Images

The CINE function is available in all imaging modes. During the real-time imaging, the system places the most recently acquired images as well as the image currently on the screen into a CINE memory buffer.

CINE image review functions as a storage and enables you to review the sequence of images in the system memory. CINE review is available by pressing the **Freeze** key. Moving **Trackball** to the left or right scrolls through the CINE sequence.

Images from a CINE sequences can be measured and annotated. You can play back CINE images to simulate a real-time motion, or review an image at one time.

NOTE

CINE is useful for focusing on images during a specific part of the heart cycle or to view short segments of a scan session.

General workflow

To activate CINE mode,

1. Press the **Freeze** key on the control panel.
2. Use **Trackball** to scroll through the CINE sequences.

   To move the CINE sequence by frame, rotate the **Frame by Frame** soft key.
3. On the touch screen, select **Move First Frame** to take the first frame.
4. Select **Move Last Frame** to take the last frame.
5. To exit CINE mode, press the **Freeze** or **2D** key on the control panel.

Annotating Images

You can place text labels and arrows on an image to identify anatomical structures and positions. You can also annotate an image with a body marker image that indicates the part of the anatomy that you are scanning.

The annotation feature allows you to add text to the display by entering text manually or by using the control on the Annotations. The annotation feature is available in live-acquisition mode and in frozen modes.

The annotation feature allows you to add text to the display by typing labels are initially placed in the home location, but you can move them anywhere in the image area. You can also add an image display title, a specific type of annotation that appears in a fixed location near the top of the screen.

General workflow

1. Press the **TEXT** key on the control panel to activate Annotating mode.

   The system displays the General, Anatomy and Position. The highlighted tab corresponds to the displayed **Select** key.

2. To configure the default position of the annotation cursor, use **Trackball** to place the annotation cursor to a desired location of the image screen and press the **Set Home** soft key on the control panel.

3. The system automatically searches for the word you want in the text bar.

4. After activating the text mode, a vertical bar type cursor appears on the screen. Use **Trackball** to move the cursor.

   NOTE

   The default text color is yellow. The color selection can be changed to any of the colors available on the system.

5 When a specific comment or text group is selected, the color turns to green. Once the comment is set or fixed, the color returns to yellow or to the user-selected color.

6 Delete characters or the entire text, if necessary.

- To delete text by character, press the **Backspace** key.

- To delete text by word, press the **Word Delete** soft key.

- To delete all text and arrow marks, press the **Clear** twice, or press the **Clear All** key.

7 Select **Word Grab** to move a group of words on the screen.

8 To deactivate Annotating mode, press the **TEXT** key.

Inserting directional arrows

1 Press the **Arrow** soft key on the control panel. The system displays an arrow on the image screen. The green-colored pointer indicates that it is active and movable.

2 Use **Trackball** to move the pointer to a desired position of the screen. The pointer head direction can be controlled as you move **Trackball**.

3 To readjust the length, thickness, or the angle of the pointer, use the **Arrow Size**, **Arrow Type**, or **Arrow Angle** soft key.

NOTE

Changing the pointer size may not be available.

4 Press the **Set** key to fix the place of the pointer and the direction of the pointer head. The GREEN color turns to YELLOW (or the default color if changed).

5 To delete the arrow marks, press the **Clear** or **Clear All** key.

Annotating images using the library

To reduce the amount of time spent annotating an image, store frequently-used comments in the text library. As many as 11 libraries are available per study. One of the selected libraries is designated as the default and its entries shall be displayed on the top/sub menu when the comment mode is activated for that study.

1. Press the **TEXT** key.
2. Select a comment in the text library menu.

Annotating images with typed words

1. Press the **TEXT** key.
2. Enter text to add comments.
3. To place the comment cursor to another location, use **Trackball**.
4. Press the **Enter** key to move to the next line and continue entering the text.

Moving text

You can move the entered text to a desired place.

1. Place the cursor on the desired text or text group and press the **Set** key.

   The selected text color turns to green.
2. Press the **Word Grab** soft key.
3. Use **Trackball** to move the selected text.
4. When you are finished, press the **Set** key to fix the location.

Editing a comment

1. Use the **Backspace** key over any error(s) made. Blank spaces take the place of the letter(s) that were there. Continue typing the comment after backspacing over all incorrect letters.
2. To delete the previous character(s):

   - Press the **Backspace** key as many as you need to delete characters.

   - Once all text within the selected text group is deleted, the cursor will find another text group to delete to the upper left direction.

   - If there is no text to delete, the cursor will be located at the home position.
3. To move through the text at a time,

   - Press the **Select** key to move to the right by text group.
4. To increase or decrease the area of the highlighted selection, use the **HIGHLIGHT** rotary.
5. Press the **Word Grab** soft key to highlight the selected comment.

Body pattern

Body patterns are small graphic images represent the anatomy being examined. Using Body Patterns, the user can indicate the position of the transducer during the examination.

Figure 5-1 Body pattern

Inserting a body pattern

1. To activate body patterns, press the **Body Pattern** key on the control panel.

   The Body Patterns menu is displayed showing a selection of Body Patterns relative to the selected preset category.

2. To change the body pattern, press the **Select** key. Continue with step 3.

3. Move **Trackball** to a desired body pattern and press the **Set** key.

   The body pattern with a transducer marker is shown on the scanning screen.

4. Select a desired body pattern on the context menu.

   The selected body pattern appears on the display.

5. Use **Trackball** to adjust the position of the transducer marker.

6. Rotate the **Select** key to adjust the transducer marker orientation and press the **Set** key.

Deleting a body pattern

Press the **Clear All** key.

Exporting Data

Saving Data

The method for saving the acquired data is explained below. The E-CUBE 12R system can save the acquired data in CINE memory and export the saved data in MAT format.

To save data,

1. Select the type of data to acquire using the **CineDataType** on the touch screen.
   - **Channel**: RF data of each channel
   - **Beamformed**: Beamformed RF data
   - **IQ**: IQ data
   - **S.C.**: Scan conversion image data
2. After acquiring data, press the **Freeze** key on the control panel to enter Cine mode.
3. In order to save the acquired data or save the new image data in Cine memory, press the **Freeze** key to enter the Live mode, then select the **CineDataType** or press the **Freeze** key.
4. Set the beginning section of frame to export by selecting < or > of **Edit Start Frame** on the touch screen.
5. In order to set the end section of frame to export, select < or > of **Edit End Frame**.
6. In order to select the current frame, select < or > of **Frame by Frame**.

   When you operate the system, you may check that the selected image will be renewed on the screen.
7. The number of saved frames, selected section and the current frame are displayed on CINE status (bar) as graphics.

8 Select the **Export Selected Frames** to save the frames in the selected section. The file is saved in the default storage location of output data, and you can set the location of output data in the Python script as below;

```
System['Parameters']['exportFolderPath'] = r'D:\'
```

9 To save the frames in the other section, select the **Export Selected Frames (Save As)**.

10 To save the current frame, select the **Export Current Frame**.

11 To save the current frame in the other directory, select the **Export Current Frame (Save As)**.

NOTE

Data is saved in MAT format so you may analyze it using MATLAB or Python Spyder.

The saved data is saved in the relevant folder according to its type.

RND sub folder	Description
Export_Data	Default storage location of output data
RES_Data	Storage location of parameter files created from each script (ATGC, DTGC, Apodization Window, etc)
SEQ_Data	Storage location of sequence script files

NOTE

Default path of RND folder: D:\COSMOS\v1\RND

Information of Data

Data is divided and saved as files for each frame. Each file includes the following information:

ScanlineNum	Int	The number of scanlines.
SampleNum	Int	The number of samples.
AlignedSample	Int	Size of memory for one scanline.
EnsembleNum	Int	The number of ensemble.
ThiNum	Int	The number of frame for Tissue Harmonic Imaging. It is two in case of Pulse-Inversion THI.
MultiBeamNum	Int	The number of beams when the Multi-Beam function is used.
SyntheticApertureNum	Int	The number of low resolution images to be synthesized.
AcqChannelNum	Int	The number of acquisition channel on Plane Wave Image
FrameNum	Int	The number of frames saved.
DecimationNum	Int	Decimation Ratio
ElementNum	Int	Number of elements of transducer
ScData	Array(float) : 2dim.	Post-Scan conversion data 3 Rank (WidthxHeight)
iqData	Array(float) : 3dim.	IQ data AlignedSample x Scanline x 2(I,Q)
BfData	Array(float) : 2dim	Post-beamformed RF data AlignedSample x Scanline
AdcData_scanline###	Array(float) : 3dim.	Pre-beamformed RF 64 channel data 32chx# x AlignedSample x 2(32ch block)

To analyze the data more easily, the context information of generated data is saved as the following structures:

Transducer =		
name	String	Name of transucer ex.) L3-12H
elementCnt	Int	The number of transducer elements
spacing	float	Space between elements
radiusCm	float	Length of radius (Convex, Sector Only)
maxLateralDeg	float	Maximum angle of transducer (Convex, Sector Only)

Roi =		
lateralStart	Float	Start position of lateral direction on a display area In case of Convex/Sector array Probe type, the unit of value is degree. In case of Linear Probe type, the unit of value is Cm.
lateralLength	Float	Length of lateral direction on a display area In case of Convex/Sector array Probe type, the unit of value is degree. In case of Linear Probe type, the unit of value is Cm.
axialStartCm	Float	Start position of axial direction on a display area. The unit of value is Cm.
axialLengthCm	Float	Length of axial direction on a display area. The unit of value is Cm.

Tw =		
burstCount	Float	The number of pulse-burst (1~32)
freqMHz	Float	Transmit frequency. The unit of value is MHz. This parameter is not available in case of AWG. You can set frequency value by changing sample values of a waveform memory.

The following figure shows the screen that frame data file using transmitted and connected frame data and plane wave is loaded to MATLAB.

Workspace

Name	Value	Min	Max
ScanlineNum	256	256	256
SampleNum	2304	2304	2304
AdcData_scanline255	<2304x64 int16>	-558	528
AdcData_scanline254	<2304x64 int16>	-558	528
AdcData_scanline253	<2304x64 int16>	-558	528
AdcData_scanline252	<2304x64 int16>	-558	528
AdcData_scanline251	<2304x64 int16>	-558	528
AdcData_scanline250	<2304x64 int16>	-558	528
AdcData_scanline249	<2304x64 int16>	-558	528
AdcData_scanline248	<2304x64 int16>	-558	528
AdcData_scanline247	<2304x64 int16>	-558	528
AdcData_scanline246	<2304x64 int16>	-558	528
AdcData_scanline245	<2304x64 int16>	-558	528
AdcData_scanline244	<2304x64 int16>	-558	528
AdcData_scanline243	<2304x64 int16>	-558	528
AdcData_scanline242	<2304x64 int16>	-558	528
AdcData_scanline241	<2304x64 int16>	-558	528
AdcData_scanline240	<2304x64 int16>	-558	528
AdcData_scanline239	<2304x64 int16>	-558	528
AdcData_scanline238	<2304x64 int16>	-558	528
AdcData_scanline237	<2304x64 int16>	-558	528
AdcData_scanline236	<2304x64 int16>	-558	528
AdcData_scanline235	<2304x64 int16>	-558	528
AdcData_scanline234	<2304x64 int16>	-558	528
AdcData_scanline233	<2304x64 int16>	-558	528
AdcData_scanline232	<2304x64 int16>	-558	528

Figure 5-2 Focused frame

Focused frame data contains one frame information in each MAT file, and saves scanline data which composes the relevant frame on **AdcData_scanlineXXX_thiX_saX** variable. AdcData_scanlineXXX_thiX_saX variable is 2D array of SampleNum * ChannelNum which has 16 bit sized elements and it is saved in the system channel order.

Workspace

Name	Value	Min	Max
ScanlineNum	192	192	192
SampleNum	2304	2304	2304
FrameNum	186	186	186
ElementNum	192	192	192
AdcData_frame185	<2304x192 int16>	-2048	2047
AdcData_frame184	<2304x192 int16>	-2048	2047
AdcData_frame183	<2304x192 int16>	-2048	2047
AdcData_frame182	<2304x192 int16>	-2048	2047
AdcData_frame181	<2304x192 int16>	-2048	2047
AdcData_frame180	<2304x192 int16>	-2048	2047
AdcData_frame179	<2304x192 int16>	-2048	2047
AdcData_frame178	<2304x192 int16>	-2048	2047
AdcData_frame177	<2304x192 int16>	-2048	2047
AdcData_frame176	<2304x192 int16>	-2048	2047
AdcData_frame175	<2304x192 int16>	-2048	2047
AdcData_frame174	<2304x192 int16>	-2048	2047
AdcData_frame173	<2304x192 int16>	-2048	2047
AdcData_frame172	<2304x192 int16>	-2048	2047
AdcData_frame171	<2304x192 int16>	-2048	2047
AdcData_frame170	<2304x192 int16>	-2048	2047
AdcData_frame169	<2304x192 int16>	-2048	2047
AdcData_frame168	<2304x192 int16>	-2048	2047
AdcData_frame167	<2304x192 int16>	-2048	2047
AdcData_frame166	<2304x192 int16>	-2048	2047
AdcData_frame165	<2304x192 int16>	-2048	2047
AdcData_frame164	<2304x192 int16>	-2048	2047

Figure 5-3 Planewave frame

Planewave frame data saves frame data as **AdcData_frameXXX** variable, as many times as the number of frame compounded in each MAT file. AdcData_frameXXX variable is 2D array of SampleNum * ElementNum, which has 16 bit sized elements, and each channel data is saved in the element order of transducer. The number compounded can be controlled using the 'Spt.Comp' menu on the touch screen and the sequence script.

The followings are parameters that influence the acquisition of RF data.

Parameter	Description	Value	Acquisition Number
SyntheticApertureNum	Make the electrical channel number is doubled	1 : No S.A. 2 : S.A. Mode	x Value
ThiNum	Pulse inversion	1 : Default 2 : Pulse Inversion	x Value
MultibeamNum	Support dual / quad beam imaging to speed up temporal resolution	1 : No MultiBeam 2/4/8 : 2/4/8 MultiBeam	/ Value

The saved data can be checked from MATLAB or Python Spyder environment with the following command.

```
plot(AdcData_scanline064(:, 4)); % MATLAB
plot(AdcData_scanline064[:, 4]); # Python
```

Figure 5-4 Checking Data (MATLAB)

In the connection structure between the transducer and the system, EL0 ~ EL191 (192Elements) of the transducer are connected to TX0 ~ TX127 (128 Channels) of the Transmitter through HVMUX. EL0 ~ EL127 and TX0 ~ TX127 are connected directly, and EL128 ~ EL191 are connected to TX0 ~ TX63 through HVMUX. Also, TX0 ~ TX127 are connected to RX0 ~ RX63 (64 Channels).

In other words, TX0 ~ TX63 are connected to RX0 ~ RX63, and TX64 ~ TX127 are connected to RX0 ~ RX63 through LVMUX.

Figure 5-5 Connection structure between the transducer and the system

In scanline mode, the number of transmission channels is different from the number of reception channels, so the reception aperture should be placed at the center of transmission aperture as shown in the figure below.

Figure 5-6 FocusedWave transmission and reception

In plane-wave mode, the reception aperture is compounded after a number of transmission and reception, to control the position of reception aperture so that the size of reception aperture is same as the size of transmission aperture. The following figure shows the operation at 128 elements transducer and 192 elements transducer.

Figure 5-7 UnfocusedWave transmission and reception (128, 192 Elements)

6

Managing Patient Information and Image

This chapter describes how to capture images.
It includes these topics:

Clipboard 2

Patient Browser 5

Clipboard

The clipboard shows captured ultrasound images for a quick review. Pressing the **Print** key captures an active image and displays a preview image on the clipboard. When reloading the previous study, the images belong to that study are shown on the clipboard.

Capturing onto the clipboard

Press the **Print** key to capture images onto the clipboard. You can see thumbnail images on the clipboard.

NOTE

The **Print** key is programmable. You can assign the Print, P1, and P2 key functions in **User Setting** > **Print/Foot Switch**.

Reloading images from the clipboard

1. Press the **Cursor** key to obtain the cursor.
2. Move the cursor over the image you want to reload by using **Trackball** and press the **Set** key.
3. Press the **Set** key to reload the selected image on the full screen image.

   You can also double-click a thumbnail image to reload an image. To scroll the page, click the arrow mark of the scroll bar to move up and down.

Deleting images from the clipboard

1. Press the **Cursor** key to obtain the cursor.
2. Move the cursor over the image you want to delete by using **Trackball** and press the **Set** key.
3. Click the trash can icon ( ) on the bottom right.
4. When the confirmation dialog appears, click **Yes** to delete the image.

Saving images permanently

1. Press the **E-view** key on the control panel, or select **E-View** on the touch screen. The images on the clipboard appear expanded.
2. Use **Trackball** to select an image or multiple images and press the **Set** key.

   To select all images, select **Select All**. To select inverse images, select **Select Inverse**.
3. Select **Archive** on the touch screen to save the image(s).

Indices

- The number on the top left corner denotes the consecutive order for saving.
- Film symbol on the bottom right side denotes the CINE loop that is possible to post processing.
- On the top of the clipboard, the clipboard indicators show the total capacity and number of images.
- To delete the selected thumbnail image, click the trash can icon ( ) on the bottom right.
- To change the clipboard window layout, click the single layout icon ( ) or dual layout icon ( ) on the bottom right.

Patient Browser

The system provides a patient browser that allows fast and easy image management. Patient Browser allows you to view the whole patient from local database or removable media, export/ import, save as with PC friendly format and send DICOM images to remote server over the network.

Figure 6-1 Patient browser

1 Menu selection

2 Function selection

3 Search area

4 Source drop-down list

5 List view (switch to Image view)

6 Image area

7 Layout selection

8 Select All/Unselect All

9 Memory capacity indicator (local HDD/removable media)

List view

List view allows you to search and quick view for patients and studies from the local hard disk drive (HDD) or a removable media.

1. Select a source from the ***Source*** drop-down list.
2. To search patients by using the searching filter, select a search method from the ***Search*** drop-down list. Or, you can manually enter a keyword in the search area.
3. Select a desired patient from the list.
4. Use the following options:

   - **Image View**: View the saved images for the selected patient.
   - **Export**: Export the patient information.
   - **Save As**: Save the image as a different file format. The supported file formats are JPEG, BMP, DCM, AVI, and WMV.
   - **Send**: Send the saved images through the network.

Image view

Image view allows you to view the selected patient from list view. You can change the display layout.

Figure 6-2 Image view

Save as

Save as allows you to save images or studies from your PC to a removable media. Before saving, make sure that the removable media is in the appropriate tray.

1. Select images or studies by using the **Cursor** key.

   NOTE

   In List view, you can select single patient or study.

2. Select **Save As** on the context menu. The dialog box appears.
3. Select a media from the ***Device*** field.
4. The system automatically creates a file name. To change the file name, enter a file name.

5 Select an image format in the ***Type*** field.

To save CINE images as a video file, skip to step 8.

Table 6-1 Image format

Format	Function
DCM	Save a still image as standard DICOM format.
BMP	Save a still image as BMP format.
JPEG	Save a still image as JPEG format. It is possible to specify compression type and quality.

NOTE

To view a DICOM format image on your PC, you need a dedicated DICOM viewer.

6 Select a compression type in the ***Compression*** field.

7 If you selected **JPEG** in step 7, select an image quality in the ***Quality*** field.

8 Select a video file format.

- **2D Cine(*WMV)**: Save 2D CINE images as WMV format.
- **4D Volume Cine(*AVI)**: Save 4D volume CINE images as AVI format.

9 When you are finished, click **Save**.

Import/Export

To move patient(s) between compatible systems or to back up and retrieve, use **Import** and **Export** menu. You can use the following types of medium for importing and exporting: CD, DVD, USB HDD, USB flash drive, Network storage

NOTE

Make sure that your medium is appropriate for exporting or importing images. If any problem occurs, eject the medium and retry the task.

To export from the local HDD to a removable medium,

1. Select ***Local HDD*** from ***Source*** drop-down list.
2. Select patient(s) from the patient list.
3. Insert a blank medium on the tray.
4. Click **Export**.
5. When the export dialog box appears, you can use the following options:
   - **Finalization of CD/DVD**: Finalize the CD or DVD to prevent from further writing.
   - **Verification after CD burning**: Verify your patient data in a CD or DVD after burning the CD or DVD.
   - **Generate DICOMDIR file when export**: Save the patient data as DICOMDIR file.

To import from a removable medium to the local HDD,

1. Place a medium that contains patient data.
2. Select a removable medium from the ***Source*** drop-down list.
3. Select patient(s) from the patient list.
4. Click **Import**. The progress bar appears while importing files.
5. To eject the removable medium (for CD or DVD), press the **Eject** key on the QWERTY keyboard.

7

Measurements and Reports

This chapter provides the following measurements and report functions:

Basics 2

Basics

Basic measurement operations

To begin the measurement,

1. On the control panel, press the **Measure** key.
2. Use **Trackball** to move the point.
3. Press the **Set** key to fix the point.

To modify a measurement,

1. Click the result value you want to change from the ***Result*** window. The caliper is activated.
2. Use **Trackball** to change the measurement value and press the **Set** key.
   - To switch the caliper mark of the current value, press the **Measure** key when the caliper is active.
   - To activate the caliper of another value, press the **Priority** key repeatedly until the desired value is highlighted.

To delete a measurement,

1. Click the result value you want to delete from the ***Result*** window. The caliper is activated.
2. Press the **Clear** key on the control panel.

To change a measurement preset, click the measurement preset you want to change.

To exit, press the **Exit** or **2D** key on the control panel.

Measurement menu display

Figure 7-1 Measurement menu display

1 **Basic measurement**: The basic measurement menus appear on the soft key menu. Displaying the list of basic measurement depends on an active preset and imaging mode.

NOTE

To configure the basic measurements, press the **System Preset** key and go to **Measurement** > **Basic MEAS**.

2 **Labeled measurement**: Labeled measurement menus appear on the context menu. Displaying the list of labeled measurement depends on an active preset and imaging mode.

① Performed measurement

② Pre-selected measurement

③ Package measurement

NOTE

- The result for basic measurement is shown on the ***Result*** window (not on the ***Mini report*** and ***Report*** pages).
- The result for labeled measurement is shown on the ***Result*** window, ***Mini report*** page, and ***Report*** page.
- After performing basic measurement, you can assign the measurement data to the **Labeled measurement** menu.
- To configure the labeled measurements, press the **System Preset** key and go to **Measurement** > **Labeled MEAS**.

Direct key

With the Direct key feature, you can quickly access measurement menus by simply pressing alphanumeric keys on the QWERTY keyboard. There are total of 16 available keys: A, S, D, F, G, H, J, K, L, Z, Y, C, V, B, N, M

1 Press the **Measure** key on the control panel.

2 From the **Labeled measurement** menu, press an alphanumeric key to access the menu you want. You can see the corresponding direct key on the right side of the menu.

3 Repeat step 2 until the desired menu appears.

Measurement result window

The ***Result*** window displays the measurement result. You can change the window status by selecting one of the following icons:

Table 7-1 Measurement result window

Icon	Description
	Change the background type (e.g. transparent or opaque) of the ***Result*** window.
	Change the position of the ***Result*** window.
	View the mini report.

Basic measurement unit

Table 7-2 Basic measurement unit

Mode	Measurement	Unit	Abbreviation
2D mode	Distance	centimeters	cm
	Area	centimeters^2	cm^2
	Circumference	centimeters	cm
	Angle	degree	deg
	%Stenosis	percent	%
	Volume	milliliter	ml
	Disk Volume	milliliter	ml
M mode	Distance	centimeters	cm
	Time	milliseconds	ms
	Slope	centimeters per second	cm/s
	%Stenosis	percent	%
	HR	beats per minute	bpm
D mode	Velocity	centimeters per second	cm/s
	PG	millimeters mercury	mmHg
	Time	millisecond	ms
	VTI	centimeters	cm
	Acceleration	centimeters per second^2	cm/s^2
	HR	beats per minute	bpm
	Volume Flow	Volume liter per minute	l/min

Measurement formula

Table 7-3 Measurement formula

Mode	Measurement	Method	Formula
2D	Circumference	Ellipse	$C = 2\pi \times \sqrt{\frac{D1^2 + D2^2}{2}}$
	Area	Ellipse	A= π(D1)(D2)/4
	%Stenosis	2 Diameter 2 Area	%Steno= (1- min(D1,D2)/max(D1,D2))X100 %Steno= (1- min(A1,A2)/max(A1,A2)X100
	Volume	1 Distance 2 Distance 3 Distance Ellipse Distance + Ellipse	V= $\pi D1^3/6$ V= D1X D2Xmin(D1, D2)Xπ/6 V= πD1XD2XD3/6 V= D1XD2Xmin(D1, D2)Xπ/6 V= πD_1XD2XD3/6
	Disk Volume		$V = \sum_{m=1}^{20} \frac{\pi}{4} l_m^{\ 2} \times (\frac{D}{20})$
M	Slope		S= (D1-D2)/ΔT
	HR		HR= Cycle number/ΔT*60
D	Acceleration		Accel= (V1-V2)/ΔT
	PI		PI= (PS-ED)/Vmean
	RI		RI= (PS-ED)/PS
	HR		HR= Cycle number/ΔT*60
	Volume Flow	Distance	Vol. Flow=AXTAmax (or TAmean)X60/ 1000 (A=π/4XD^2)
		Ellipse	Vol. Flow=AXTAmax (or TAmean)X60/1000 (A=π/4XD1XD2)
		Trace	Vol. Flow=AXTAmax (or TAmean)X60/1000

Basic measurements

The basic measurements are available in the following imaging modes:

- 2D mode
- M mode
- Doppler mode

2D mode measurements

The basic 2D mode measurements include the following measurement parameters:

- Tissue depth
- Distance
- Circumference and area
- Angle
- Volume
- Stenosis
- Ratios
- Histogram

Tissue depth

Selecting this option in the system preset enables depth to be automatically measured when the first measurement marker appears on the image.

The ***Result*** window shows the distance from a point on the transducer-skin interface to the marker until the first marker is anchored.

NOTE

To configure the tissue depth, press the **System Preset** key and go to **Measurement** > **General** > **Tissue Depth display(2D,M)**.

Distance

- 1 Distance
- 3 Lengths
- Trace Length

NOTE

Measurement error is within 5% of the distance you measured for all transducers.

1 Distance

1. Press the **Distance** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point.
3. Press the **Set** key to fix the point. The end point, overlapping the start point, appears.
4. Use **Trackball** to move the marker to the end point, and press the **Set** key.
5. The measured value is fixed, and the distance (**D**) is shown on the ***Result*** window.

3 Lengths

1. Press the **Distance** soft key. The start point appears.
2. Draw three straight lines using **Trackball**, and press the **Set** key.
3. Move the forth point, and then press the **Set** key.
4. The measured value is fixed, and three distances (**D1**, **D2**, **D3**) are shown on the ***Result*** window.

Trace Length

1. Press the **Distance** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point, and press the **Set** key.

   The end point appears.
3. Move the end point gradually along the circumference of the target object using **Trackball**.
4. Press the **Set** key. The end point appears.
5. When the start point and the end point are connected with a line, press the **Set** key to complete the measurement.
6. The measured value is fixed, and the distance (**D**) is shown on the ***Result*** window.

NOTE

To configure the distance, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **Distance** > **Default method**.

Circumference and Area

- Ellipse
- Trace
- Spline

Ellipse

1. Press the **Ellipse** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point, and press the **Set** key.

   The first point is fixed, and the second point appears.
3. Use **Trackball** to move the marker to the second point, and press the **Set** key. The ellipse appears.
4. Use **Trackball** to adjust the height of the ellipse, and press the **Set** key again.

   - To increase the height, move **Trackball** up and right.

   - To decrease the height, move **Trackball** down and left.
5. The measured value is fixed. The two diameters (**D1**, **D2**), the circumference (**C**), and the area (**A**) are shown on the ***Result*** window.

Trace

1. Press the **Trace** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point, and press the **Set** key.

   The end point appears.
3. Use **Trackball** to move the end point gradually along the circumference of the target object.
4. When the start point and the end point are connected with a line, press the **Set** key to complete the measurement.
5. The measured value is fixed. The circumference (**C**) and the area (**A**) are shown on the ***Result*** window.

Spline

1. Press the **Spline** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point, and press the **Set** key.

   The second point appears.
3. Set the third and subsequent points in the same way.
4. Press the **Set** key twice at the same point to fix the end point.
5. The measured value is fixed. The circumference (**C**) and area (**A**) are shown on the ***Result*** window.

Angle

- Angle 3 Points
- Angle 2 Lines
- Angle 3 Lines

Angle 3 Points

1. Press the **Angle** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point, and press the **Set** key.

   The first point is fixed, and the second point appears.
3. Use **Trackball** to move the marker to the second point.
4. Press the **Set** key. The third point appears.
5. Use **Trackball** to move the third point to the end point of the angle measurement.
6. Press the **Set** key. The angle between the two lines appears.
7. The angle (**Angle**) is shown on the ***Result*** window.

Angle 3 Lines

1. Press the **Angle** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point, and press the **Set** key.

   The first point is fixed, and the second point appears.
3. Use **Trackball** to move the marker to the second point.
4. Draw the baseline, and press the **Set** key to fix the baseline.

   The third point appears.
5. Draw two straight lines to cross the baseline as the same way. The α angle and β angle appear.
6. Press the **Set** key at the end point to fix the measured value.

   The two angles (**Alpha**, **Beta**) are shown on the ***Result*** window.

NOTE

To configure the angle, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **Angle** > **Default method**.

%Stenosis

- 2 Distances
- 2 Ellipses
- 2 Traces
- Trace + Ellipse
- Ellipse + Trace

Two diameters percent stenosis calculation

1. Press the %**Stenosis** soft key. The start point appears.
2. Measure the larger diameter (**D1**) of the stenosis using **Trackball**, and press the **Set** key.
3. Measure the smaller diameter (**D2**) of the stenosis using **Trackball**, and press the **Set** key.
4. The two diameters (**D1**, **D2**) and the diameter percent stenosis (**%Steno(Diam)**) are shown on the ***Result*** window.

Two ellipses percent stenosis calculation

1. Press the **%Stenosis** soft key. The start point appears.
2. Measure the outer area (**A1**) of the stenosis using **Trackball**, and press the **Set** key.
3. Measure the inner area (**A2**) of the stenosis using **Trackball**, and press the **Set** key.
4. The two ellipses (**A1**, **A2**) and the diameter percent stenosis (**%Steno(Area)**) are shown on the ***Result*** window.

NOTE

To configure the %Stenosis, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **%Stenosis** > **Default method**.

Volume

- 1 Distance
- 2 Distances
- 3 Distances
- Ellipse
- Distance + Ellipse

3 Distance volume

1. Press the **Volume** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point, and press the **Set** key.

   The first point is fixed, and the second point appears.
3. Use **Trackball** to move the marker to the second point, and press the **Set** key again.

   The first distance is measured.
4. Measure the second and third distances in the same manner.

   When the three distances are measured, the volume is calculated.
5. The measured value is fixed. The three distances (**D1**, **D2**, **D3**) and the volume (**Vol**) are shown on the ***Result*** window.

NOTE

When you measure one distance (D1) and press the **Clear** key, the volume for D1 is calculated and shown on the ***Result*** window. For the volume of two distance (D2), measure one and two distances (D1, D2) and press the **Clear** key.

Ellipse

1 Press the **Volume** soft key. The start point appears.

2 Use **Trackball** to move the marker to the start point, and press the **Set** key.

The first point is fixed, and the second point appears.

3 Use **Trackball** to move the marker to the second point and press the **Set** key. The ellipse appears.

4 Use **Trackball** to adjust the height of the ellipse, and press the **Set** key again.

- To increase the height, move **Trackball** up and right.
- To decrease the height, move **Trackball** down and left.

5 The measured value is fixed. The two distances (**D1**, **D2**) and the volume (**Vol**) are shown on the ***Result*** window.

NOTE

To configure the volume, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **Volume** > **Default method**.

Disk Volume

- Trace
- Spline

Trace

1. Press the **Disk Volume** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point, and press the **Set** key.

   The first point is fixed, and the second point appears.
3. Use **Trackball** to create a trace of the structure with the second point.
4. Press the **Set** key to complete the trace.

   The start and end points of the trace are connected, and a line representing the long axis appears.
5. Press the **Set** key again. The volume is calculated.
6. The area (**A**), the circumference (**C**), the diameter (**D**), and the volume (**Vol**) are shown on the ***Result*** window.

Spline

1. Press the **Disk Volume** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point, and press the **Set** key. The second point appears.
3. Set the third and subsequent points in the same manner.
4. Press the **Set** key twice to complete the trace.

   The start and end points of the trace are connected, and a line representing the long axis appears.
5. Press the **Set** key again. The volume is calculated.
6. The area (**A**), the circumference (**C**), the diameter (**D**), and the volume (**Vol**) are shown on the ***Result*** window.

NOTE

To configure the disk volume, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **Disk Volume** > **Default method**.

A/B Ratio

- 2 Distances
- 2 Ellipses
- 2 Traces
- Ellipse + Trace
- Trace + Ellipse

Two diameters ratio

1. Press the **A/B Ratio** soft key. The start point appears.
2. Measure the first diameter (**D1**) of the ratio using **Trackball**, and press the **Set** key.
3. Measure the second diameter (**D2**) of the ratio using **Trackball**, and press the **Set** key.
4. The ratio is calculated. The two distances (**D1**, **D2**) and A/B ratio (**A/B Ratio**) are shown on the ***Result*** window.

Two ellipses ratio

1. Press the **A/B Ratio** soft key. The start point appears.
2. Measure the first area (**A1**) of the ratio using **Trackball**, and press the **Set** key.
3. Measure the second area (**A2**) of the ratio using **Trackball**, and press the **Set** key.
4. The ratio is calculated. The two ellipses (**A1**, **A2**) and A/B ratio (**A/B Ratio**) are shown on the ***Result*** window.

NOTE

To configure the A/B ratio, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **A/B Ratio** > **Default method**.

Histogram

1. Press the **Histogram** soft key.
2. Use **Trackball** to move the caliper to the corner of the area where you want to measure histogram.
3. Press the **Set** key.
4. Use **Trackball** to move the caliper diagonally to the opposite side of the area.
5. Press the **Set** key. The measured value is shown in the ***Result*** window.
6. To view the histogram, go to the ***Histogram*** window.

NOTE

To configure the histogram, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **Histogram**.

CAUTION

Do not change the gain control of the 2D image after performing the histogram measurement. Your change may not be applied on the histogram.

M mode measurements

The basic M mode measurements include the following measurement parameters:

- Distance
- Time
- Slope
- Stenosis
- Heart rate
- Ratios

Distance

- 1 Distance
- 3 Lengths

1 Distance

1. Press the **Distance** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Use **Trackball** to move to the point of intersection, and press the **Set** key.

   The start point is fixed, and the end point appears.

3. Use **Trackball** to move the point, and press the **Set** key again.

4. The measured value is fixed, and the distance (**D**) is shown on the ***Result*** window.

3 Lengths

1. Press the **Distance** soft key. The start point appears.

2. Draw three straight lines using **Trackball**, and press the **Set** key.

3. Move the fourth point and press the **Set** key.

4. The measurement value is fixed, and three distances (**D1**, **D2**, **D3**) are shown on the ***Result*** window.

NOTE

To configure the distance, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **Distance** > **Default method**.

Time

1. Press the **Time** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Use **Trackball** to move to the point of intersection, and press the **Set** key.

   The start point is fixed, and the end point appears.

3. Use **Trackball** to move the point, and press the **Set** key again.

4. The time interval between the two points appears. The time (**T**) is shown on the ***Result*** window.

Slope

1. Press the **Slope** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Use **Trackball** to move to the point of intersection, and press the **Set** key.

   The start point is fixed, and the end point appears.

3. Use **Trackball** to move the point, and press the **Set** key again.

4. The oblique line is displayed, and the slope is calculated. The distance (**D**), time (**T**) and slope (**Slope**) are shown on the ***Result*** window.

%Stenosis

Two diameters percent stenosis calculation

1. Press the **%Stenosis** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Measure the larger vertical diameter (**D1**) of the stenosis using **Trackball**, and press the **Set** key.

3. Measure the smaller vertical diameter (**D2**) of the stenosis using **Trackball**, and press the **Set** key.

4. The diameters (**D1**, **D2**) and the diameter percent stenosis (**%Steno(Diam)**) are shown on the ***Result*** window.

NOTE

For diameter calculation, do not take a distance measurement from a longitudinal view. This may lead to an inaccurate assessment of %stenosis.

A/B Ratio

- Distance
- Time

Distance ratio

1. Press the **A/B Ratio** soft key. The start point appears.

   The vertical line and the horizontal line are perpendicular to each other.

2. Measure the first vertical diameter (**D1**) of the ratio using **Trackball**, and press the **Set** key.

3. Measure the second vertical diameter (**D2**) of the ratio using **Trackball**, and press the **Set** key.

4. The ratio is calculated. The two distances (**D1**, **D2**) and A/B ratio (**Distance Ratio**) are shown on the ***Result*** window.

Time ratio

1 Press the **A/B Ratio** soft key.

The vertical line and the horizontal line are perpendicular to each other.

2 Measure the first vertical diameter (**T1**) of the ratio using **Trackball**, and press the **Set** key.

3 Measure the second vertical diameter (**T2**) of the ratio using **Trackball**, and press the **Set** key.

4 The ratio is calculated. The two distances (**T1**, **T2**) and A/B ratio (**Time Ratio**) are shown on the ***Result*** window.

NOTE

To configure the A/B ratio, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **A/B Ratio** > **Default method**.

Heart Rate (HR)

1. Press the **HR** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Use **Trackball** to move to the point of intersection, and press the **Set** key.

   The start point is fixed, and the end point appears.

3. Use **Trackball** to move the point, and press the **Set** key again.

4. The heart rate between the two points is calculated. The heart rate (**HR**) and time (**T**) are shown on the ***Result*** window.

NOTE

To configure the HR cycle, press the **System Preset** key and go to **Measurement** > **Advanced MEAS.** > **HR cycle**.

D mode measurements

The basic D mode measurements include the following measurement parameters:

- Velocity
- Time
- Acceleration
- Resistivity Index
- Pulsatility Index
- VTI
- Heart Rate
- Ratios
- Auto/Manual Cals.

Velocity

1. Press the **Velocity** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Use **Trackball** to move to the point of intersection, and press the **Set** key.

3. The measured value is fixed. The velocity (**Vel**) and pressure gradient (**PG**) are shown on the ***Result*** window.

Time

1. Press the **Time** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Use **Trackball** to move to the point of intersection, and press the **Set** key.

   The start point is fixed, and the end point appears.

3. Use **Trackball** to move the point, and press the **Set** key again.

4. The time interval between the two points appears. The velocity (**Vel**) and time (**T**) are shown on the ***Result*** window.

Acceleration

1. Press the **Acceleration** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Use **Trackball** to move to the point of intersection, and press the **Set** key.

   The start point is fixed, and the end point appears.

3. Use **Trackball** to move the point, and press the **Set** key again.

4. The oblique line is displayed, and the acceleration is calculated. The acceleration (**Accel**), the acceleration time (**AT**), and maximum velocity (**Vmax**) are shown on the ***Result*** window.

Resistivity Index (RI)

1. Press the **RI** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Use **Trackball** to move to the point of intersection, and press the **Set** key.

   The start point is fixed, and the end point appears.

3. Use **Trackball** to move the point and press the **Set** key again.

4. The end point is fixed, and the resistive index is calculated. The peak systolic velocity (**PS**), end diastolic velocity (**ED**), and resistivity index (**RI**) are shown on the ***Result*** window.

Pulsatility Index (PI)

1. Press the **PI** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Move the marker to the start point of the waveform using **Trackball**, and press the **Set** key.

   The end point appears.

3. Use **Trackball** to manually trace the waveform, and press the **Set** key.

4. The pulsatility index is calculated.

5. The peak systolic velocity (**PS**), end diastolic velocity (**ED**), minimum diastolic velocity (**MD**), the maximum time-average velocity (**TAmax**), the resistivity index (**RI**), the pulsatility index (**PI**), and systole/diastole ratio (**S/D Ratio**) are shown on the ***Result*** window.

Velocity-Time Integral (VTI)

1. Press the **VTI** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Move the marker to the start point of the waveform using **Trackball**, and press the **Set** key.

   The end point appears.

3. Use **Trackball** to trace one cycle of the waveform, and press the **Set** key.

4. The velocity-time integral is calculated. The minimum, maximum, mean velocities (**Vmin**, **Vmax**, **Vmean**) and maximum and mean pressure gradients (**PGmax**, **PGmean**) are shown on the ***Result*** window.

A/B Ratio

- Velocity
- Time

Velocity ratio

1. Press the **A/B Ratio** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Measure the first point (**V1**) of the ratio using **Trackball**, and press the **Set** key.

3. Measure the second point (**V2**) of the ratio using **Trackball**, and press the **Set** key.

4. The ratio is calculated. The two velocities (**V1**, **V2**) and A/B ratio (**Velocity Ratio**) are shown on the ***Result*** window.

Time ratio

1. Press the **A/B Ratio** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Measure the first time interval (**T1**) of the ratio using **Trackball**, and press the **Set** key.

3. Measure the second time interval (**T2**) of the ratio using **Trackball**, and press the **Set** key.

4. The ratio is calculated. The two time values (**T1**, **T2**) and A/B ratio (**Time Ratio**) are shown on the ***Result*** window.

NOTE

To configure the A/B ratio, press the **System Preset** key and go to **Measurement** > **Basic MEAS.** > **A/B Ratio** > **Default method**.

AC/DC

1. Press the **AC/DC** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Measure the first oblique line (**Accel**) of the slope using **Trackball**, and press the **Set** key.

3. Measure the second oblique line (**Decel**) of the slope using **Trackball**, and press the **Set** key.

4. The ratio is calculated. The acceleration index (**Accel**), the acceleration time (**AT**), the deceleration index (**Decel**), and deceleration time (**DT**) are shown on the ***Result*** window.

Heart Rate (HR)

1. Press the **HR** soft key.

   The vertical line and the horizontal line are perpendicular to each other.

2. Use **Trackball** to move to the point of intersection, and press the **Set** key.

   The start point is fixed, and the end point appears.

3. Use **Trackball** to move the point, and press the **Set** key again.

4. The heart rate between the two points is calculated. The heart rate (**HR**) and time (**T**) are shown on the ***Result*** window.

NOTE

To configure the heart rate cycle, press the **System Preset** key and go to **Measurement** > **Advanced MEAS.** > **HR cycle**.

Auto/Manual calculations

- Auto trace
- Manual trace

Auto trace

1. In PW mode, select **Auto Calc** on the context menu.
2. Select **Frozen** or **Live**.
3. If you select **Live**, the caliper and waveform trace automatically appear.

   If you select **Frozen**, press the **Set** key to show the caliper and the waveform trace.
4. The calculated value is shown on the ***Result*** window.

NOTE

To configure the auto trace options, press the **System Preset** key and go to **Measurement** > **Advanced MEAS.** > **Modify Calc** > **Auto Trace**.

Auto trace options

- **Method**: Select a trace method for Doppler spectrum.
- **Direction**: Select a trace direction for Doppler spectrum.

NOTE

- To configuTo configure the auto trace options, press the **Image Preset** key and go to **General**.
- To measure the maximum velocity, select **Below** or **Above** for the trace direction.
- To edit the trace, use **Trackball**.

Figure 7-2 Doppler

Manual trace

1. Press the **Trace** soft key. The start point appears.
2. Use **Trackball** to move the marker to the start point of the waveform and press the **Set** key.

   The end point appears.
3. Use **Trackball** to trace one cycle of the waveform, and press the **Set** key.
4. The measured value is calculated.

NOTE

To configure the manual trace, press the **System Preset** key and go to **Measurement** > **Advanced MEAS.** > **Modify Calc** > **Manual Trace**.

Volume Flow

- Distance + TAmax
- Distance + TAmean
- Ellipse + TAmax
- Ellipse + TAmean
- Trace + TAmax
- Trace + TAmean

1. In simultaneous mode of 2D and PW modes, scan an image.
2. Press the **Freeze** key to freeze the image.
3. Use **Trackball** to scroll through the section that you want to trace.
4. Press the **Measure** key.
5. In PW mode, press the **Vol. Flow** soft key.

   The 2D mode screen appears.
6. Use **Trackball** to move the marker to the first point, and press the **Set** key.
7. Use **Trackball** to move the marker to the end point, and press the **Set** key.
8. When the 2D mode measurement is completed, the system moves to the PW mode screen and shows a vertical bar.
9. Use **Trackball** to set the first point of the trace, and press the **Set** key. Another vertical bar appears.
10. Use **Trackball** to set the end point of the trace, and press the **Set** key.
11. The measured value is calculated and the volume flow is shown on the ***Result*** screen.

Report operations

Viewing a report

1. Press the **Report** key on the control panel. You can also select **Report** on the context menu.
2. To view a report by application or measurement mode, select an application or a mode from the corresponding list or field on the top left of the display.

   NOTE

   To view a report in a particular mode, select a mode (**2D**, **M**, or **PW**) in the context menu. To view a report for more than one mode, select **All**.

3. When a report appears on the display, view the report information.
4. To view the next page of the report, press the **Select Page** soft key.
5. To exit the report, press the **Report** or **2D** key on the control panel. You can also select **Exit** on the context menu.

Editing a report

To change the report data,

1. Move the cursor to the field that you want to change.
2. Press the **Set** key. The field is highlighted.
3. Enter a new data. You can enter data in the blank field.

   The entered data is changed to green and changed data is shown with an asterisk mark.

To erase measurement results,

1. Move the cursor to the field that you want to erase. The field is highlighted.
2. Press the **Delete Value** soft key to delete the data.

To exclude or include measurement results,

1. Move the cursor to the field that you want to exclude. The field is highlighted.
2. Press the **Exclude Value** soft key to exclude the data. The excluded data is displayed in white.
3. Press the **Exclude Value** soft key again to include a value that you previously excluded.

To change the value type,

1. Move the cursor to the **Method** column.
2. Press the **Set** key.
3. Select a value type of the measurement from the drop-down list (Last, Average, Maximum, and Minimum).

Adding a comment

1. Press the **Comment** soft key.

   You can view comments in the ***Summary Statements*** screen and ***Comment*** screen.

2. On the ***Summary Statements*** screen, enter text by using the QWERTY keyboard.

3. To exit the comment, click **OK** or press the **Comment** soft key.

NOTE

On the ***Patient Registration*** screen, you can edit text in the ***Comments*** field.

Previewing a report

- Select **Preview** on the context menu.

  You can preview the report to be printed.

NOTE

In Preview mode, you can add thumbnailed images.

Printing a report

- Press the **Print** soft key to print a report via standard printer.
- Press the **Print**, **P1**, or **P2** key on the control panel to capture the report screen.

NOTE

- To configure a standard printer, press the **System Preset** key and go to **System** > **Peripheral** > **Standard Printer**.
- The supported paper size for report is A4 only.

Transferring a measured data

You can transfer a measured data via the RS232C port. This function is only available for OB and GYN reports, and anatomical survey.

1. Press the **System Preset** key and go to **System** > **Peripheral** > **RS232C** > **COM** > **Transfer Measurement**.
2. From the ***Report*** screen, select **Transfer** on the context menu.

   When the data is being transferred, the progress bar indicating the transfer appears on the display.

Measurement accuracy

The measurement values should always be accurate according to measuring caliper and point.

Despite the high technical accuracy of the scan geometry and the measuring system of the E-CUBE 12R expert equipment, one must, however, be aware of inaccuracies caused by the ultrasound beam properties and the physiological properties of the scanned structures, tissues and fluids.

For the reason of improved lateral resolution you should choose the proper scan head for the depth range of the structure to be measured.

Table 7-4 Measurement accuracy

Mode	Measurement	Accuracy
2D	Depth	±5% or 1mm
	Distance Axial Lateral (Linear) Lateral (Convex) Lateral (Sector)	 ±5% or 1mm ±5% or 2mm ±5% or 4mm ±5% or 4mm
	Circumference Ellipse Trace	 ±5% or 1mm ±10% or 1mm
	Area 2 Distance Ellipse Trace	 ±5% or 1mm^2 ±5% or 1mm^2 ±5% or 1mm^2
M	Time	±5% or 10ms
	Slope	±5% or 1mm/s
D	Velocity 0~100 cm/s 100~130 cm/s	 ±10% or 1cm/s ±5% or 1cm/s
	Time	±5% or 10ms
	Doppler SV Position	±2mm
	Doppler Angle Correction 0~60deg 60~80deg	 ±5% ±12%
CF	Velocity	±50%

Calculation accuracy

Estimate the overall inaccuracy of a combined measurement and calculation by including the stated inaccuracy from the basic measurement accuracy statements.

Calculation formulas and databases are provided as a tool to assist the user, but should not be considered an undisputed database, in making a clinical diagnosis. The user is encouraged to research the literature and judge the equipment capabilities on an ongoing basis in order to asses its utility as a clinical tool.

8

Executing E-CUBE 12R

This chapter provides the preset features that you can configure the default settings of your system.

Executing E-CUBE 12R System 2

Executing E-CUBE 12R System

Starting/Shutting down E-CUBE 12R System

After booting up Windows, double click the E-CUBE 12R icon on the desktop to start the E-CUBE 12R system.

Click the Power icon on the Window toolbar to shut down the E-CUBE 12R system.

Figure 8-1 E-CUBE 12R shut down icon

NOTE

When you shut down Windows, the E-CUBE 12R system will also turn off.

Exporting Data

In order to export data in the E-CUBE 12R system, follow the procedure below.

1. Start the E-CUBE 12R system.
2. Set the image acquired by using the research tool and image optimization tool.
3. Check live image and save the image on the buffer using the Freeze function.
4. Save ADC, BeamFormed and IQ data of saved image in MatLab format, using the Export function.

Figure 8-2 Exporting data

Tutorial for Exporting Data

1. Turn on the system and start the E-CUBE 12R system.
2. Apply the sequence file to the system using the research tool.
3. Adjust the set value using the image optimization tool.

NOTE

The E-CUBE 12R system saves as much live images as allowed by buffer capacity. The time to store images varies according to the set value and data format specified in **CineDataType** menu of the touch panel. If the buffer memory becomes full, it will start deleting old frame and then add a new frame.

Figure 8-3 2D mode touch panel

4 In 2D mode, select **Cine Data Type** on the touch panel and set the data type.

5 Press the **Freeze** key on the control panel to enter Cine mode

Figure 8-4 CINE mode touch panel

6 In order to save an image in Cine mode, follow the following steps:

a. If you want to save currently set image (frame) only, select **Export Frame** on the touch panel.

b. If you want to save all the images (frames) in the set range, select **Export Range Frames**.

NOTE

Exported data is saved in the following directory.
D:\COSMOS\v1\RND\Export_Data

7 Reconstruct an image from the saved data file.

9

Using Research Tool

This chapter provides the preset features that you can configure the default settings of your system.

Research Tool 2

Image Optimization Tool 6

Exporting Data..... 17

Saving Data..... 19

Analyzing Data..... 20

AWG (Arbitrary Waveform Generation)..... 30

Research Tool

The followings are the methods applied to E-CUBE 12R system for research purpose:

- Method to create a sequence script, create and apply sequence data
- Method to control the image parameter using the image optimization tool
- Method to acquire and export data

NOTE

For creating a sequence script, refer to ***Creating a Script*** on page 10-2.

Figure 9-1 Execution sequence of research tool scripts

In order to apply a Python script file to the E-CUBE 12R system, follow the following steps

1. Create a script file using the Python IDE Tool (Spyder).
2. Execute the Python script file to acquire the sequence file.
3. Apply the sequence file to the E-CUBE 12R system from the research tool.

NOTE

The research tool can be executed from the COSMOS touch screen.

Creating and Modifying a Script File

1. Select **E-Tool** menu.
2. Click **Ext.Editor** on top of the touch panel.
   You may run Spyder which is set as the default editor.
3. Select an item from the Python Script List and click **Ext.Editor**.
   You may open and modify the selected file from Spyder directly.

In order to create a new file, follow the following steps:

1. Press the shortcut key **Ctrl** + **N** or select **File > New File** from the menu and create a script.
2. After creating the script, save it on the default path of E-CUBE 12R by pressing the shortcut key **Ctrl** + **S** or **File** > **Save** on the menu bar.
3. In order to review the list, press the **Refresh** key.

NOTE

- When you run the Spyder program for the first time, the files in "C:\Users\Administrator\.spyder2\.temp.py" are loaded by default. This path is different from the path used in E-CUBE 12R.
- Default path for script files of E-CUBE 12R research tool: D:\COSMOS\v1\RND\SEQ_Data

Creating Sequence Data

In order to create sequence data, run the script user created. You may execute the script from Spyder and the research tool.

In order to execute the script in Spyder, follow the following steps:

1. Save the script file created in the Spyder program.
2. Press the **F5** key to execute the script.
   The message "**Success: Sequence Data File Create**" will be displayed on the Python consol screen
   The created sequence data can be confirmed from the **Variable Explorer** screen.

NOTE

- If the script code has an error, the error message will be displayed on the Python consol screen.
- Sequence files are saved in Mat format in the same directory as script files.

Applying Sequence Data to E-CUBE 12R

In order to apply sequence data to the research tool, follow the following steps:

1. Select an item from the sequence script list.
2. Click **RUN**.
   E-CUBE 12R will enter the research mode, and sequence data will be applied.

User may check whether or not to enter the research mode and the sequence data file name from the bottom left side of the image.

Figure 9-2 Result after applying the sequence data to E-CUBE 12R

Image Optimization Tool

You may execute the image optimization tool by using the **Ctrl** + **F8** key. You may control all parameters of E-CUBE 12R in the image optimization tool. You may operate the image optimization tool by using the Select knob on the controller, and the data types are as follows:

Change menu and submenu	Change value	Change value 2 - Select from array	Edit popup (chart)

The function of each button in the image optimization tool is as follows:

Pre. ,Next 	Changes the sub mode of image optimization tool. The image optimization tool filters and shows appropriate items according to the status of E-CUBE 12R.
Save 	It is activated when a change has been made. Saves the changed value of image optimization tool. You may import the last change later only after saving it.

The description regarding the parameters that can be controlled in the image optimization tool is as follows. BNOR is the default, and only items to be added for each mode are summarized.

Table 9-1 B parameter list

Sub mode	Caption	Description	Note
Tx	BTxRealFreq	Adjusts the actual transmission frequency.	Hz > 0
	BTxBurstCount	Executes Tx as many times as the Burst Count and performs Rx.	1 ~ 32
	BTxHv1MaxVoltage	High Voltage : B mode	1 ~ 80v
	BTxHv2MaxVoltage	High Voltage : C / D mode	1 ~ 50v
AR	ATgc	Calls a chart that can create ATGC data	
Rx	RxApod	Calls a chart that can create Rx Apodization data	
	RxApodA	RxAprd Mat file list for each mode	
	RxFNumberValue	As the value of focal length/aperture, f number indicates the beam width from the focus. The beam width and the depth of focus are proportional to each other.	fnum > 0
	BLineDensity2D	Adjusts the number of scan lines in B mode image.	128~512
	BLineDensity2DSC	(Use when applying spatial compounding)	128~512
	BBMultiBeam	Generates a signal from 2 or more elements at a time to acquire data. The frame rate increases and the resolution lowers.	1, 2, 4, 8
MID	Demod	Calls a chart that can create Demodulation and LowPassFilter data	
	DemodA	Demodulation Mat file list for each mode	
	DTgc	Calls a chart that can create DTGC data	
	RFInterpolationF	If True is selected, read doubled BScanlineSize.	true/false

POST	**BBSPCDIndex**	Interpolate an image with slightly tilted tx to improve the quality of the image.	0 ~ 7 0 ~ 31 (PWI)
	BDynamicRangeDb	Adjusts the dynamic range. The smaller the dynamic range, the clearer the difference in the brightness value between bright and dark.	30 ~ 170 (dB)
	BGainDbDP	Amplifies the received echo signal to adjust the overall image brightness.	0 ~ 90 (dB)
	BBPersistence	Calculate the average of frames to reduce white noise. As the afterimage removal ratio is higher, the number of frames to interpolate increases.	0 ~ 4
	BBPersistenceSC	(Use when applying spatial compounding)	0 ~ 4
	BRejectLevel	Removes the echo signal which is lower than the rejecting level.	0 ~ 10
	BColorMap	Adjusts the color of image through the Color map Look-up table.	0 ~ 12
	BGrayMap	Adjusts the brightness (shading) of image through the Gray map Look-up table. BGrayMapValue: Gray map file name	0 ~ 13

Table 9-2 Common parameter list

Sub mode	Caption	Description	Note
Common	PitchCm	Space between elements in probe	
	MaxDepthCm	Rx max depth	min:0cm
	MinDepthCm	Rx min depth	max:30cm
	VelocityUS	Ultrasonic wave velocity (us)	default 1540 (us)

Also, the charts (Atgc, Dtgc, Demod, RxApdo) of image optimization tool create data in MATLAB format and the contents of this data can be confirmed from Spyder.

The points for a chart in the image optimization tool can be adjusted using the function button on the graph as well as the combination of the following short cut keys.

Shortcut key	Function	Note
Alt + Left Click	Remove Point	
Left Click (on Curve)	Add Point	

Also, Continuous Apply is the function to manipulate the graph and apply to E-CUBE 12R automatically as soon as you release the mouse button. If a check mark is removed, you need to click Apply to apply changes to the image.

ATGC

Figure 9-3 Atgc Graph

X axis represents the depth and has the value between 0 cm and 30 cm, and Y axis represents the level and has the value between 0 and 255. If the value exceeds this range, the relevant part is automatically saved as maximum value.

MAT Data Structure

Data created in Atgc chart of image optimization tool is configured as follows:

MAT Variable Name	Type	Size	Note
Atgc	uint8	(256L,)	
Atgc_RawPoints	Float64	(2L, (Point Count) L)	

Atgc data is divided into 256 sub data based on 30 cm. When using a probe where the depth is shorter than 30 cm, the total data length is constant, but only part of data corresponding to the length will apply to E-CUBE 12R. The remaining data, except for valid data, is handled as Dummy. Copy the very last part of valid data and fill the remaining data with it.

Atgc_RawPoints is storing points that form a chart. It is made of 2D arrays, and the first column (No. 0 column) corresponds to X coordinate and the second column (No. 1 column) corresponds to Y coordinate.

DTGC

Figure 9-4 Dtgc Chart

X axis represents the depth and has the value between 0 cm and 30 cm, and Y axis represents the level and has the value between -60 dB and 60 dB.

MAT Data Structure

Data created in Atgc chart of image optimization tool is configured as follows.

MAT Variable Name	Type	Size	Note
Dtgc	Float32	(16384L,)	A/B (voltage ratio)
Dtgc_RawPoints	Float64	(2L, (Point Count) L)	

dB is displayed on the chart for convenience, but in order to apply it to E-CUBE 12R, data is converted into A/B (voltage ratio) for storage. dB and A/B have the following relationship:

$$dB = 2 * 10 * \log_{10} \frac{A}{B}$$

Dtgc is divided into 16384 sub data based on 30 cm. Just as Atgc, the part corresponding to the length is applied, and the remaining part is filled with the last part of valid data or handled as dummy.

Dtgc_RawPoints is storing points that form a chart. It is made of 2D arrays, and the first column (No. 0 column) corresponds to X coordinate and the second column (No. 1 column) corresponds to Y coordinate.

Demodulation, Low Pass Filter

Figure 9-5 Demodulation, LowPassFilter Chart

X axis represents the depth and has the value between 0 cm and 30 cm, Y-axis demodulation can have the value between 0 Mhz and 15 Mhz and the Low Pass Filter can have the value between 0 Mhz and 8 Mhz.

MAT Data Structure

Demodulation table data created in Demod chart of image optimization tool is configured as follows.

MAT Variable Name	Type	Size	Note
Demod	Float32	(32768L,)	Reference Table
Demod_RawPoints	Float64	(2L, (Point Count) L)	

Demod table consists of Sin and Cos values for 16384 USSpeed(mm/s) / 2.0 * Frequency(Mhz) * 1000000.0(mm) so that it has a total of 32768 data.

LowPassFilter data created in Demod chart of image optimization tool is configured as follows.

MAT Variable Name	Type	Size	Note
LowPassFilter	Int32	(128L,)	Index
LowPassFilter_RawPoints	Float64	(2L, (Point Count) L)	

The effective range of data and RawPoints are same as Atgc and Dtgc.

Rx Apodization

Figure 9-6 Rx Apodization Chart

Shortcut key	Function	Note
Alt + Left Click (on GreenBar)	Remove Point	
CTRL + Left Click (on GreenBar)	Add Point	

In Rx Apodization charts, you may divide the Depth using the green pole in the middle of the chart and assign the Window Function for each section. The offset can be adjusted between 0 and 0.9 by 0.1, and the scale can be adjusted between 0.1 and 1.0 by 0.1.

Also, the Window functions that can be applied to RxApod Chart are Rectangular, Hamming, Bartlett and BlackMan.

MAT Data Structure

Rx apodization Data created in RxApod chart of image optimization tool is configured as follows.

MAT Variable Name	Type	Size	Note
RxApod_128	Float32	(128L, 574L,)	Abridged data
RxApod_64	Float32	(64:, 543L)	Abridged data
RxApod_Delta	Int	1	
RxApod_DepthPoint	Float64	(0L)	Total Cnt - 1
RxApod_Max	Int32	(2L,)	{ 128, 64 }
RxApod_Min	Int	1	
RxApod_SampleRate	Int	1	
RxApod_Velocity	Float	1	
RxApod_WindowFunc_FuncName	Unicode	1	
RxApod_WindowFunc_Offset	Float	1	
RxApod_WindowRunc_RangeIndex	Int	1	
RxApod_WindowFunc_Scale	float	1	

RxApod_128 has 16384 samples. However, data becomes too large, so the first 128 samples are saved, and remaining data is saved after every 32 samples are skipped. RxApod_64 is created through the same calculation step with RxApod_128 except for 64 numbers of channels.

RxApod_DepthPoint is the criteria for storing classifying the depth.

Exporting Data

The method for saving the acquired data is explained below. The E-CUBE 12R system can save the acquired data in CINE memory and export the saved data in MAT format.

To export data,

1. Select the type of data to acquire using **CineDataType** on the touch screen.
   - **Channel**: RF data of each channel
   - **Beamformed**: Beamformed RF data
   - **IQ**: IQ data
   - **S.C.**: Scan-conversion image data
2. After acquiring data, press the **Freeze** key on the control panel to enter Cine mode.
3. In order to save the acquired data or save the new image data in Cine memory, press the **Freeze** key to enter the Live mode, then select **CineDataType** or press the **Freeze** key.
4. Set the beginning section of frame to export by selecting < or > of **Edit Start Frame** on the touch screen.
5. In order to set the end section of frame to export, select < or > of **Edit End Frame**.
6. In order to select the current frame, select < or > of **Frame by Frame**.

   When you operate the system, you may check that the selected image will be renewed on the screen.
7. The number of saved frames, selected section and the current frame are displayed on CINE status (bar) as graphics.
8. Select **Export Selected Frames** to save the frames in the selected section. The file is saved in the default storage location of output data, and you can set the location of output data in the Python script as below;

   ```
   System['Parameters']['exportFolderPath'] = r'D:\'
   ```
9. To save the frames in the other section, select **Export Selected Frames (Save As)**.
10. To save the current frame, select **Export Current Frame**.
11. To save the current frame in the other directory, select **Export Current Frame (Save As)**.

NOTE

Data is saved in MAT format so you may analyze it using MATLAB or Python Spyder.

The saved data is saved in the relevant folder according to its type.

RND sub folder	Description
Export_Data	Default storage location of output data
RES_Data	Storage location of parameter files created from each script (ATGC, DTGC, Apodization Window, etc)
SEQ_Data	Storage location of sequence script files

NOTE

Default path of RND folder: D:\COSMOS\v1\RND

Saving Data

The method for saving the acquired data is explained below. The E-CUBE 12R system can save the acquired data in CINE memory and export the saved data in MAT format.

To save data,

1. Pres the **System Preset** key and go to **User Setting** > **Print/Foot Switch** and select **RawMatlab** to assign this function onto specific **Print** key.
2. Select the type of data to acquire using **CineDataType** on the touch screen.
   - **Channel**: RF data of each channel
   - **Beamformed**: Beamformed RF data
   - **IQ**: IQ data
   - **S.C.**: Scan-conversion image data
3. After acquiring data, press the **Print** key on the control panel in Cine mode or Live mode. You can see the thumnail on the right side of the screen.
4. Double click the thumnail on the right side of the screen, or select **Review** on the touch screen after selecting specific thumnail on the E-View screen to review the image in Cine mode. Also you can export the data as a Mat file during reviewing the image in Cine mode.
5. Press the **E-View** key on the control panel and select **End study** to store the all saved images as the study information.
6. Press the **Patient** key on the control panel or select **Patient** on the touch screen. You can load the images stored as the study information as thumnail list and review the selected thumnail in Cine mode.

Analyzing Data

Data is divided and saved as files for each frame. The file name of this frame data is saved in the form of <Num1>_idx<Num2>_layer<Num3>_<Mode>DATA_<DataType>.mat. Here, <Num1> means Cine Bar Index in the layer selected when executing export. In Dual Live mode, always 2 frames exist at the same time, so 2 files which have the same <Num1> value will be created. <Num2> means Cine Bar Index in the layer where the frame is saved. <Num3> is the layer number where the frame is saved. The default number is No. 0, the left layer in Dual Live mode is recorded as No. 0 and the right layer is recorded as No. 1. <Mode> is the mode of the relevant frame. <DataType> is the type of frame data saved in Cine and it is indicated as Channel/BF/IQ. The following information is saved in each file.

ScanlineNum	Int	The number of scanlines.
SampleNum	Int	The number of samples.
AlignedSample	Int	Size of memory for one scanline.
EnsembleNum	Int	The number of ensemble.
ThiNum	Int	The number of frame for Tissue Harmonic Imaging. It is two in case of Pulse-Inversion THI.
MultiBeamNum	Int	The number of beams when the Multi-Beam function is used.
SyntheticApertureNum	Int	The number of low resolution images to be synthesized.
AcqChannelNum	Int	The number of acquisition channel on Plane Wave Image
FrameNum	Int	The number of frames saved.
DecimationNum	Int	Decimation Ratio
ElementNum	Int	Number of elements of transducer
ScData	Array(float) : 2dim.	Post-Scan conversion data 3 Rank (WidthxHeight)
iqData	Array(float) : 3dim.	IQ data AlignedSample x Scanline x 2(I,Q)
BfData	Array(float) : 2dim	Post-beamformed RF data AlignedSample x Scanline
AdcData_scanline###	Array(float) : 3dim.	Pre-beamformed RF 64 channel data 32chx# x AlignedSample x 2(32ch block)

To analyze the signal data, you should understand the system structure such as the connection structure between the transducer and the system.

In the connection structure between the transducer and the system, EL0 ~ EL191 (192Elements) of the transducer are connected to TX0 ~ TX127 (128 Channels) of the Transmitter through HVMUX. EL0 ~ EL127 and TX0 ~ TX127 are connected directly, and EL128 ~ EL191 are connected to TX0 ~ TX63 through HVMUX. Also, TX0 ~ TX127 are connected to RX0 ~ RX63 (64 Channels).

In other words, TX0 ~ TX63 are connected to RX0 ~ RX63, and TX64 ~ TX127 are connected to RX0 ~ RX63 through LVMUX.

Figure 9-7 Connection structure between the transducer and the system

Scanline mode

In scanline mode, the number of transmission channels is different from the number of reception channels, so the reception aperture should be placed at the center of transmission aperture as shown in the figure below.

Figure 9-8 FocusedWave transmission and reception

The following figure shows the screen that frame data file using focused frame data is loaded to MATLAB.

Workspace

Name	Value	Min	Max
ScanlineNum	256	256	256
SampleNum	2304	2304	2304
AdcData_scanline255	<2304x64 int16>	-558	528
AdcData_scanline254	<2304x64 int16>	-558	528
AdcData_scanline253	<2304x64 int16>	-558	528
AdcData_scanline252	<2304x64 int16>	-558	528
AdcData_scanline251	<2304x64 int16>	-558	528
AdcData_scanline250	<2304x64 int16>	-558	528
AdcData_scanline249	<2304x64 int16>	-558	528
AdcData_scanline248	<2304x64 int16>	-558	528
AdcData_scanline247	<2304x64 int16>	-558	528
AdcData_scanline246	<2304x64 int16>	-558	528
AdcData_scanline245	<2304x64 int16>	-558	528
AdcData_scanline244	<2304x64 int16>	-558	528
AdcData_scanline243	<2304x64 int16>	-558	528
AdcData_scanline242	<2304x64 int16>	-558	528
AdcData_scanline241	<2304x64 int16>	-558	528
AdcData_scanline240	<2304x64 int16>	-558	528
AdcData_scanline239	<2304x64 int16>	-558	528
AdcData_scanline238	<2304x64 int16>	-558	528
AdcData_scanline237	<2304x64 int16>	-558	528
AdcData_scanline236	<2304x64 int16>	-558	528
AdcData_scanline235	<2304x64 int16>	-558	528
AdcData_scanline234	<2304x64 int16>	-558	528
AdcData_scanline233	<2304x64 int16>	-558	528
AdcData_scanline232	<2304x64 int16>	-558	528

Figure 9-9 Focused frame

Focused frame data contains one frame information in each MAT file, and saves scanline data which composes the relevant frame on **AdcData_scanlineXXX_thiX_saX** variable. AdcData_scanlineXXX_thiX_saX variable is 2D array of SampleNum * ChannelNum which has 16 bit sized elements and it is saved in the system channel order.

Planewave

In plane-wave mode, the reception aperture is compounded after a number of transmission and reception, to control the position of reception aperture so that the size of reception aperture is same as the size of transmission aperture. The following figure shows the operation at 128 elements transducer and 192 elements transducer.

Figure 9-10 UnfocusedWave transmission and reception (128, 192 Elements)

The following figure shows the screen that frame data file using planewave frame data is loaded to MATLAB.

Workspace

Name	Value	Min	Max
ScanlineNum	192	192	192
SampleNum	2304	2304	2304
FrameNum	186	186	186
ElementNum	192	192	192
AdcData_frame185	<2304x192 int16>	-2048	2047
AdcData_frame184	<2304x192 int16>	-2048	2047
AdcData_frame183	<2304x192 int16>	-2048	2047
AdcData_frame182	<2304x192 int16>	-2048	2047
AdcData_frame181	<2304x192 int16>	-2048	2047
AdcData_frame180	<2304x192 int16>	-2048	2047
AdcData_frame179	<2304x192 int16>	-2048	2047
AdcData_frame178	<2304x192 int16>	-2048	2047
AdcData_frame177	<2304x192 int16>	-2048	2047
AdcData_frame176	<2304x192 int16>	-2048	2047
AdcData_frame175	<2304x192 int16>	-2048	2047
AdcData_frame174	<2304x192 int16>	-2048	2047
AdcData_frame173	<2304x192 int16>	-2048	2047
AdcData_frame172	<2304x192 int16>	-2048	2047
AdcData_frame171	<2304x192 int16>	-2048	2047
AdcData_frame170	<2304x192 int16>	-2048	2047
AdcData_frame169	<2304x192 int16>	-2048	2047
AdcData_frame168	<2304x192 int16>	-2048	2047
AdcData_frame167	<2304x192 int16>	-2048	2047
AdcData_frame166	<2304x192 int16>	-2048	2047
AdcData_frame165	<2304x192 int16>	-2048	2047
AdcData_frame164	<2304x192 int16>	-2048	2047

Figure 9-11 Planewave frame

Planewave frame data saves frame data as **AdcData_frameXXX** variable, as many times as the number of frame compounded in each MAT file. AdcData_frameXXX variable is 2D array of SampleNum * ElementNum, which has 16 bit sized elements, and each channel data is saved in the element order of transducer. The number compounded can be controlled using the 'Spt.Comp' menu on the touch screen and the sequence script.

The followings are parameters that influence the acquisition of RF data.

Parameter	Description	Value	Acquisition Number
SyntheticApertureNum	Make the electrical channel number is doubled	1 : No S.A. 2 : S.A. Mode	x Value
ThiNum	Pulse inversion	1 : Default 2 : Pulse Inversion	x Value
MultibeamNum	Support dual / quad beam imaging to speed up temporal resolution	1 : No MultiBeam 2/4/8 : 2/4/8 MultiBeam	/ Value

The saved data can be checked from MATLAB or Python Spyder environment with the following command.

```
plot(AdcData_scanline064(:, 4)); % MATLAB
plot(AdcData_scanline064[:, 4]); # Python
```

Figure 9-12 Checking Data (MATLAB)

For easier data analysis, context information where the relevant data is created is saved as a separate file. Context information file is saved under the file name in the form of Layer<Num1>_ContextInfo.mat, and <Num1> here is the layer index.

Context information is saved in the following structure.

Transducer

```
System["Transducer"] =
     name                          Transducer name (Ex. L3-12H)
     Type                Int       0 = Linear, 1=Convex, 2=Sector
     elementCnt          Int       The number of transducer elements
     elementPitchCm      float     Width of element
     radiusCm            float     Length of radius (Convex, Sector Only)
     maxLateralDeg       float     Maximum angle of transducer (Convex,
                                   Sector Only)
```

System Parameter

```
System["Parameters"] =
   transmitNum          Int       Default : 128 (Fixed)
   receiveNum           Int       Default : 64 (Fixed)
   cineDataType         Int       Default: 0(0:Channel, 1:Beamformed,
                                  2:IQ)
   multiLiveModeF       Int       Default: 0(0:disable, 1:enable)
   SpatialCompoundAng   [1 * N]   Enter an odd number of arrays.
   le                   Int       Start angle: 0
                                  Symmetry of + angle and - angle
   FrequencyCompoundN   Int       The number of Frequency Compound
   um
```

Parameter

```
Parameter =
   dtgc                [1 * N]          dtgc object
                       Parameter.dtgc
   demod               [1 * N]          demod object
                       Parameter.demo
                       d
   Lpf                 [1 * N]          lpf object
                       Parameter.lpf
   rxApod              [1 * N]          rxApod object
                       Parameter.rxAp
                       od
Parameter.dtgc =
   dtgc_file           String           Path for a file containing the dtgc
                                        value
Parameter.demod =
   demod_file          String           Path for a file containing the demod
                                        value
Parameter.lpf =
   lpf_file            String           Path for a file containing the lpf
                                        value
Parameter.rxApod =
   rxApod_file         String           Path for a file containing the
                                        rxApod value
```

ROI

```
Roi =
    datatype                String      Display type
                                        B, C, E
    type                    String      Display type
                                        ('2D': B mode method, '2D Overlay':
                                        CF mode method)
    layoutNo                Int         Index of layout object where the
                                        frame is displayed
    steerAngle              Float       Angle of the display area
                                        Default: 0
    lateralStart            Float       Start location for the lateral axis
                                        of display area
                                        Convex/phased probe's angle is set
                                        to zero at the center. Linear
                                        probe's length is set to zero at
                                        the left end and it is expressed in
                                        cm.
    lateralLength           Float       Length of lateral axis for the
                                        display area
                                        Convex/phased probe is expressed in
                                        degrees. Linear probe is expressed
                                        in cm.
    axialStartCm            Float       Start location for the axial axis
                                        of display area
                                        Cm
    axialLengthCm           Float       Length of the axial axis for the
                                        display area
                                        Cm
    dtgcNo                  Int         Index of dtgc object for the
                                        parameter reflected in the signal
                                        data of the area
    demodNo                 Int         Index of demod object for the
                                        parameter reflected in the basic
                                        signal data of the area
    lpfNo                   Int         Index of lpf object for the
                                        parameter reflected in the basic
                                        signal data of the area
    rxApodNo                Int         ndex of rxApod object for the
                                        parameter reflected in the basic
                                        signal data of the area
    modeName                String      Mode names for the display area
    mapTypeIndex            Int         Color map type for the display area
                                        (0: Power, 1: Velocity, 2:
                                        Variance,
                                        3: VelVar, 4: PowVar, 5: PowVel,
                                        6: BGrayColorize, 7:SWE)
    mapFilePath             String      Path of the map file
                                        file path
    srcFilterNo             Int         Index of the first filter
```

bfProc	String	Process method of built-in BeamformingFilter [FOCUSED | PWI | PWI_SPCD | SWEI | PAI]
bfDelayOffsetUsec	Float	Correction value of DelayOffset using for built-in BeamformingFilter Default: 0
cineFilterNo	Int	Filter index for saving Cine data index
cineDataTypeName	String	Names of data type for saving Cine data

Tw

TW['i'] =

burstCount	float	It indicates the pulse count.(1 ~ 32))
freqMHz	float	It indicates the transmit frequency in the conventional E-CUBE 12R system. It is not valid in AWG, and the frequency can be adjusted with the value of samples saved in the waveform memory.

Hv

Hv =

highVoltage	int	highVoltage: High voltage setting (Voltage). The high voltage range for Hv 0 is 1 to 80 and it must be greater than the range for Hv 1. The high voltage range for Hv 1 is 1 to 50 and it is not used in AWG.

Filter

Filter =

name	String	Filter names, Filter name should not use duplicate filter names.
class	String	C++ class that implements a filter
type	String	Filter class type 'Embedded': system's built-in filter class, 'Custom': filter class developed by a user
filepath	String	Absolute path for the physical module file that provides the filter class. Ex) r'D:\CustomFilter.dll'

outputMemory	String	Type of output data memory for the filte ('Host': general memory mounted in the Host main board 'CUDA': built-in memory that can be accessed from a CUDA graphic card 'Texture': Texture memory of DirectX3D)
nextFilterNo	Int	Index of next filter that output data will be sent to

Mode

Mode =

BActiveF	Int	Activate B mode (0: False, 1: True)
BPwiF	Int	Activate Planewave Imaging for B mode (0: False, 1: True)
BSubmode	Int	Submode index for Bmode (0: Normal, 1: Tissue Harmonic Imaging)
CActiveF	Int	Activate C mode (0: False, 1: True)
CPwiF	Int	Activate Planewave Imaging for C mode (0: False, 1: True)
CSubmode	Int	Submode index for C mode (0: Color Flow, 1: Power Doppler)
EActiveF	Int	Activate E mode (0: False, 1: True)
ESubmode	Int	Submode index for E mode (0: ????, 1: ????)
PriorityMode	Int	Selected Priority Mode (0: BNormal, 1: BTHI, 2:CF, 3:PD)

AWG (Arbitrary Waveform Generation)

The method of using the AWG (Arbitrary Waveform Generation) function provided in the COSMOS system is explained next. By using the AWG function, you may create an arbitrary waveform, perform Tx/Rx, acquire and analyze RF data. For example, when you create, transmit and receive Chirp signal and perform pulse compression, you can obtain an image with improved SNR.

When Chirp waveform is used, it has a longer waveform than the previous pulse but the transmission may be carried out with a lower voltage than the previous pulse and it is very helpful for improving SNR and noise.

Figure 9-13 Previous pulse method and Chirp pulse

AWG System Basics

The AWG system has 128 memory where an arbitrary waveform can be saved for each channel, and the memory of each channel can save 2048 8 bit data. When you save (writes) a desired waveform in AWG memory space and transmits the waveform, the waveform saved by you are transmitted at every PRT.

Figure 9-14 AWG System Block diagram

The characteristics of AWG system are as follows.

- Possible to save and operate different waveform memory for each channel
- Possible to set different weight for each channel
- Possible to inverse for each channel
- Possible to update memory at the same time or update a desired channel only
- Memory loop function available (generate the waveform saved in the memory repeatedly)
- Possible to save memory for each channel as a different form of waveform
- Possible to adjust Pulse Initial Delay

Creating AWG

1. Create desired waveform using Matlab or another tool. Make sure that the number of arrays to be created does not exceed 2048. (The maximum memory capacity (depth) of each channel is 2048.)
2. Create a script file using the created array.
3. Execute the script file to display the set waveform.

NOTE

- Each memory can be saved as a different form of waveform.
- freqMHZ or duty in a script are not actually applied and only waveform value saved in the array is valid, so that Tx waveform is displayed.
- The maximum voltage is (set) based on highVoltage1.

Specifications and Constraint Conditions of AWG

The specifications and constraint conditions of AWG system are as follows:

- Since the resolution of AWG TX waveform is 160MHz sampling 8bit DAC output, you may create a waveform at intervals of 6.25ns.
- In case of setting 80 V for High voltage1 of script, the unit voltage of DAC is 0.656 V, and DAC can be set between -120 and +120. At this time, the analog output of actual pulse will change between -78.71 V and +78.71 V.
- Cautions should be taken when considering setting weight to only one decimal point and should be used as the effective value.
  For example, when the weight of 1.85 is given to the original signal, the signal will be multiplied only by 1.8.
- Array should be set in the way that the value after applying weight to the original signal exists between -120 and +120.
  For example, if the original signal is DAC 100 and the weight of 1.5 is applied, DAC output is 128, not 150 (100*1.5). Therefore, the maximum value of original signal is 100, the maximum value of weight should be adjusted to 1.2.

10

Creating a Script

This chapter provides the preset features that you can configure the default settings of your system.

Creating a Script 2

Script Objects 3

Custom Filters 37

Exercise Script 55

Creating a Script

Setting Script Default

The script default setting refers to the part where you should include a script file for creating sequence data.

Import “TransLib” library in order to call the functions provided for transducers in a script..

```
import TransLib          #Import E-CUBE 12R related TransLib.
```

Import “SysLib” library in order to call the functions provided for the system in a script.

```
import SysLib            #Import E-CUBE 12R related SysLib.
```

Import “FilterLib” library in order to call the functions provided for the filter in a script.

```
import FilterLib         #Import E-CUBE 12R related FilterLib.
```

Sets the number of system transmit channel and receive channel. The number of default transmit channel is 128 and the number of default receive channel is 64. It should not be changed by the user.

```
System['Parameters']['transmitNum'] = 128

System['Parameters']['receiveNum'] = 64
```

Script Objects

Script objects are objects required for creating script files. Script objects are divided into system objects related to E-CUBE 12R system setting; and transducer and sequence objects should be set to execute in consecutive order.

Figure 10-1 Object diagram

System Objects

System objects include the system setting parameters and the transducer information. This object's attributes are referred to when creating other objects included in the script, so these attributes should be specified on the top level of script file. This method uses the predefined structure so that it provides a natural method for you to create a script.

Example: Creating a System Objects

Using the init_object function in SysLib, you can create a system object.

```
System = SysLib.init_object("System")
```

Transducer Objects

Transducer objects include information regarding the geometry and property of transducer elements.

```
System[“Transducer”] =
     Type            Int        0 = Linear, 1=Convex, 2=Sector
     elementCnt      Int        The number of transducer elements, Ex) 128
                                or 192
     frequencyMHz    Int        MHz, Center frequency of transducer
     elementPitchC
     m               float      cm
     radiusCm        float      cm
     maxLateralDeg   float      Degree
```

Property

- Type : Transducer type
- elementCnt : The number of transducer elements
- frequencyMHz : Center frequency of transducer
- elementPitchCm : Width of element
- radiusCm :Length of radius (Convex, Sector Only)
- maxLateralDeg : Maximum angle of transducer (Convex, Sector Only)

Example: Loading the Transducer Objects

You may load the relevant information by entering the name of transducer using loadTransducer function in TransLib.

```
System['Transducer'] = TransLib.loadTransducer("L3-12")
```

System Parameter Objects

A system parameter object contains other setting information such as a system built-in filter settings. A “Parameters object” under the system includes the following attributes.

```
System["Parameters"] =
     transmitNum          Int        Default : 128 (Fixed)
     receiveNum           Int        Default : 64 (Fixed)
     cineDataType         Int        Default: 0(0:Channel, 1:Beamformed,
                                     2:IQ)
     MultiLiveModeF       Int        Default: 0(0:disable, 1:enable)
     SpatialCompoundAng   [1 * N]    Enter an odd number of arrays.
     le                   Int        Start angle: 0
                                     Symmetry of + angle and - angle
```

Property

- transmitNum: System Transmit Channel Number
- receiveNum: System Receive Channel Number
- cineDataType: Define type of data saved in Cine
- MultiLiveModeF: Define whether to use the DualLive function that simultaneously displays two frames on the monitor
- SpatialCompoundAngle: Angle used for Spatial Compounds

Example: Defining System Parameter Objects

System[‘Parameters’] defines the properties of other parameters used in the system.

```
System['Parameters']['transmitNum'] = transNumElement
System['Parameters']['receiveNum'] = 64
System['Parameters']['cineDataType'] = 1
```

① 128 (system value, cannot be modified) defined above will be applied to 'transmitNum', and 64(system value, cannot be modified) will be applied to 'receiveNum'.

```
System['Parameters']['transmitNum'] = transNumElement
System['Parameters']['receiveNum'] = 64
```

② 'cineDataType' specifies data(Channel/BeamFormed/IQ) to store on the buffer in Cine mode.

```
System['Parameters']['cineDataType'] = 1
```

Parameter Objects

A parameter object contains the parameter information delivered to the built-in filter or customer filter. A parameter object is a dictionary type. If necessary, you can additionally define arbitrary data in key/value type for use. A parameter object basically includes the following parameters.

```
Parameter =
    speedOfSoundUsec    Int             Ultrasonic speed (m/s) (default :
                                        1540 m/s)
                                        Varies depending on the medium.
    PTHI                Int             Pulse Inversion Tissue Harmonic
                                        Imaging (Y/N)
    dtgc                [1 * N]         dtgc object
                        Parameter.dtgc
    demod               [1 * N]         demod object
                        Parameter.demo
                        d
    Lpf                 [1 * N]         lpf object
                        Parameter.lpf
    rxApod              [1 * N]         rxApod object
                        Parameter.rxAp
                        od
Parameter.dtgc =
    dtgc                [1 * 16384]     Digital Time Gain Compensation Raw
                        Float           Value
                                        dtgcDb converted into the data used
                                        in the system.
    dtgcDb              [1 * 8] Int     Digital Time Gain Compensation
                                        Compensates attenuation according to
                                        the tissue.Used at the digital
                                        circuit.
                                        8 points in the direction of depth.
                                        (-20 - 20 dB)
    dtgc_file           String          Path for a file containing the dtgc
                                        value
Parameter.demod =
    demod               [1 * 32768]     Demodulation Raw Value
                        Float           demodMHz converted into the data
                                        used in the system.
    demodMHz            [1 * 8] Int     Enter the frequency value to
                                        demodulate as a curve in the
                                        direction of depth
                                        8 points in the direction of depth
                                        (0 - 15 MHz)
    demod_file          String          Path for a file containing the demod
                                        value
Parameter.lpf =
    lpf                 [1 * 128] Int   Low Pass Filter Raw Value
                                        lpfMHz converted into the data used
                                        in the system.
```

```
    lpfMHz              [1 * 8] Int      Low Pass Filter
                                         8 points in the direction of depth
                                         (0 - 15 MHz)
    lpf_file            String           Path for a file containing the lpf
                                         value
Parameter.rxApod =
    rxApod              [128 * 574]      Rx Apodization Raw Value
                        Int
    WindowFunc_FuncNa   String           Rx Apodization
    me                                   Select among Rectangular, Hamming,
                                         Bartlett and Blackman
                                         When '' is set, the default value of
                                         the system is selected
    rxApod_file         String           Path for a file containing the
                                         rxApod value
```

dtgc, demod, lpf, rxApd create data based on 30 cm. When creating data, interpolation is carried using all 8 values, so in case of creating data for the probe with depth shorter than 30 cm, all 8 values should be filled. Also, you may execute the script to apply the created sequence data to E-CUBE 12R and check it from the chart in the image optimization tool. (Refer to ***Image Optimization Tool*** on page 9-6.)

For example:

- Input: Atgc = [38, 112, 167, 210, 238, 253, 255, 255]
- Result of matching data entered for the following depths:

0.0 cm	4.3 cm	8.6 cm	12.9 cm	17.0 cm	21.3 cm	26.0 cm	30.0 cm
38	112	167	210	238	253	255	255

- Chart showing interpolated data in the graph

- Format and path of data storage:
  D:\COSMOS\v1\RND\RES_Data\L3-12_Focused_Atgc.mat

NOTE

- Created data is saved as "Script Name + Attribute.mat".
- Default path: D:\COSMOS\v1\RND\RES_Data

Example: Defining Parameter Objects

Define a parameter used in the system and the filter.

```
Parameter = SysLib.init_object("Parameter", 1)

Parameter[0]['speedOfSoundUsec'] = 1540

Parameter[0]['dtgc'][0]['dtgcDb'] =
[127,127,127,191,255,255,255,255]
SysLib.convertToDtgc(Parameter[0])

Parameter[0]['demod'][0]['demodMHz'] = [10.0, 10.0, 10.0, 10.0, 9.5, 9.5,
9.5, 9.5]
SysLib.convertToDemod(Parameter[0], "L3-12")

Parameter[0]['lpf'][0]['lpfMHz'] = [1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0,
1.0]

SysLib.convertToLpf(Parameter[0], "L3-12")

Parameter[0]['rxApod'][0]['WindowFunc_FuncName'] = "Hamming"
SysLib.convertToRxApod(Parameter[0], 128)
```

① Create 1 Parameter object.

```
Parameter = SysLib.init_object("Parameter",1)
```

② ‘speedOfSound’ sets the ultrasonic wave velocity, and the default value is 1540(µs).

```
Parameter[0]['speedOfSoundUsec'] = 1540
```

③ ‘dtgcDb' is set at 8 point away in the direction of depth. Using the system helper function called converToDtgc, a Raw Value is created.

```
Parameter[0]['dtgc'][0]['dtgcDb'] =
[127,127,127,191,255,255,255,255]

SysLib.convertToDtgc(Parameter[0])
```

④ 'demod' is set at 8 point away in the direction of depth. Using the system helper function called converToDemod, a Raw Value is created.

```
Parameter[0]['demod'][0]['demodMHz'] = [10.0, 10.0, 10.0, 10.0, 9.5,
9.5, 9.5, 9.5]
```

```
SysLib.convertToDemod(Parameter[0], "L3-12")
```

⑤ 'lpf' is set at 8 point away in the direction of depth. Using the system helper function called converToLpf, a Raw Value is created.

```
Parameter[0]['lpf'][0]['lpfMHz'] = [1.0, 1.0, 1.0, 1.0, 1.0, 1.0,
1.0, 1.0]
```

```
SysLib.convertToLpf(Parameter[0], "L3-12")
```

⑥ rxApod' Window function of 'rxApod' is set to Hamming Window. Using the system helper function called converToRxApod, a Raw Value is created. In this case, the number of channels is set to 128.

```
Parameter[0]['rxApod'][0]['WindowFunc_FuncName'] = "Hamming"
```

```
SysLib.convertToRxApod(Parameter[0], 128)
```

TGC Objects

A TGC object contains the Analog Time Gain Compensation Data. The attributes of TGC objects are as follows.

```
Tgc =
    atgc                [1 * 256]
                        Int
    atgc_RawPoints      [1 * 8]     0~255; 40dB
                        Int
    atgc_file           String      Specify the Path automatilcally
```

Property

- atgc: Analog Time Gain Compensation Raw Value
  atgc_RawPoints converted into data type used in the system.
- atgc_RawPoints: Analog Time Gain Compensation

  Compensates attenuation according to the tissue.
  Used at the analog circuit.
  8 points in the direction of depth. (0~255; 40dB)
- atgc_file: Path for a file containing the atgc value

Example: Defining TGC Objects

TGC object is used to define the Analog Time Gain Compensation data received.

```
Tgc = SysLib.init_object("Tgc",1)
Tgc[0]['atgc'] = SysLib.convertToAtgc(Tgc[0],
array([127,127,127,191,255,255,255,255])
```

① Create 1 Tgc object.

```
Tgc = SysLib.init_object("Tgc",1)
```

② Using the system helper function called convertToAtgc, you can set the atgc value.

```
Tgc[0]['atgc'] = SysLib.convertToAtgc(Tgc[0],
array([127,127,127,191,255,255,255,255])
```

HV(High Voltage) Objects

A HV object contains the high voltage information. The attributes of HV objects are as follows.

```
Hv =
    highVoltage         int         High voltage setting (Voltage)
```

Property

highVoltage: High voltage setting (Voltage). The high voltage range for Hv 0 is 1 to 80 and it must be greater than the range for Hv 1.
The high voltage range for Hv 1 is 1 to 50 and it is not used in AWG.

Example: Defining HV Objects

Max two High voltage objects, HV can be set.

```
Hv = SysLib.init_object("Hv", 1)

Hv[0]['highVoltage'] = 40
```

① Create as many `High Voltage` as the number of High Voltages to be used.

```
Hv = SysLib.init_object("Hv", 1)
```

② The first HV object's `'highVoltage'` is the voltage used in B mode. Set it to 40v. (max 80v)

ex) 40v * 80%(power percent) = 32v

```
Hv[0]['highVoltage'] = 40
```

The second `HV` object's `'highVoltage'` is not used in the AWG equipment. It is the voltage used in C, D modes. (max 50v)

ROI Objects

An ROI object contains the information about areas and types of frames displayed. Using multiple ROI objects, you can display complex ultrasonic frames in a single layout. The attributes of ROI objects are as follows:

```
Roi =
    datatype            String      B, C, E
    type                String      '2D': B mode method, '2D Overlay': CF
                                    mode method
    layoutNo            Int         Default: 0 (0-1)
    steerAngle          Float       Degree, Default: 0 (0-1)(- or +)
    lateralStart        Float       Convex/phased probe's angle is set to
                                    zero at the center. Linear probe's
                                    length is set to zero at the left end
                                    and it is expressed in cm.
    lateralLength       Float       Convex/phased probe is expressed in
                                    degrees. Linear probe is expressed in
                                    cm.
    axialStartCm        Float       Cm
    axialLengthCm       Float       Cm
    dtgcNo              Int         Default: 0 (available to the number of
                                    dtgc)
    demodNo             Int         Default: 0 (available to the number of
                                    demod)
    lpfNo               Int         Default: 0 (available to the number of
                                    lpf)
    rxApodNo            Int         Default: 0 (available to the number of
                                    rxApod)
    modeName            String      name
    displayParam        String      string
    mapTypeIndex        Int         (0: Power, 1: Velocity, 2: Variance,
                                    3: VelVar, 4: PowVar, 5: PowVel,
                                    6: BGrayColorize, 7:SWE)
    mapFilePath         String      file path
    srcFilterNo         Int         Default: 0
    bfProc              String      [FOCUSED | PWI | PWI_SPCD | SWEI | PAI]
    bfDelayOffsetUsec   Float       usec, Default: 0
    cineFilterNo        Int         index
    cineDataTypeName    String      name
    acqTimeUsec         Int         usec
```

Property

- datatype: Display type
- type: Display type
- layoutNo: Index of layout object where the frame is displayed
- steerAngle: Angle of the display area
- lateralStart: Start location for the lateral axis of display area
- lateralLength: Length of lateral axis for the display area
- axialStartCm: Start location for the axial axis of display area
- axialLengthCm: Length of the axial axis for the display area
- dtgcNo: Index of dtgc object for the parameter reflected in the signal data of the area
- demodNo: Index of demod object for the parameter reflected in the basic signal data of the area
- lpfNo: Index of lpf object for the parameter reflected in the basic signal data of the area
- rxApodNo: Index of rxApod object for the parameter reflected in the basic signal data of the area
- modeName: Mode names for the display area
- displayParam: Parameter information for the display area
- mapTypeIndex: Color map type for the display area
- mapFilePath: Path of the map file
- srcFilterNo: Index of the first filter
- bfProc: Process method of built-in BeamformingFilter
- bfDelayOffsetUsec: Correction value of DelayOffset using for built-in BeamformingFilter
- cineFilterNo: Filter index for saving Cine data
- cineDataTypeName: Names of data type for saving Cine data
- acqTimeUsec: Data acquisition time.

Defining ROI Objects

ROI is used to define the various information such as types, size, location, layout and angle of area to display a frame.

```
Roi = SysLib.init_object("Roi", 1)

Roi[0] = SysLib.computeRoi("B", "2D", System['Transducer'],
[roiStartElement, roiEndElement], [0, depthCm], steerAngle)
```

① By considering the type of frame displayed on the screen and the number of layouts, you can create an ROI object.

```
Roi = SysLib.init_object("Roi", 1)
```

② Using the system helper function called `computeRoi` , you can set the `ROI` information.

```
Roi[0] = SysLib.computeRoi("B", "2D", System['Transducer'],
[roiStartElement, roiEndElement], [0, depthCm], steerAngle,
layoutNo)
```

- The first argument is a data type.
- The second argument is a type of ROI.
- The third argument is the information about transducer to be applied.
- The fourth argument is the index of element indicating the start/end of lateral used to alculate the area size.
- The fifth argument is used to calculate the height. It means the start/end of axial and it is expressed in cm.
- The sixth argument is the adjustment angle. By default, it is 0.

Layout and Filter Objects

A layout object implies an individual frame displayed on the monitor. You can define a total of two layout objects. Using them, you can check two sets of frames on the monitor. The attributes of layout objects are as follows:

```
Layout =
     filter                    [1 * N]    Multiple filter objects that process
                               Filter     the signal data
```

Using the RX object, you can pass the received signal data through many different filters and then create frames to check the frame displayed on the system monitor. In a script, you can define the relationships among various filter names. To implement the filter that processes the actual data, you can use a tool provided by the system or you can use your own created tool. Each filter is connected to each other. An output from the previous filter is entered to the next filter. The connection structure of entire filter should start with the HostSource filter provided by the system and terminate with the Render2D filter provided by the system. The filters connected like this do not exist independently unlike other objects but they are defined as sub objects to the layout object. The attributes of filter objects are as follows:

```
Filter =
     name                      String      Filter name Should not use duplicate
                                           filter names.
     class                     String      Name
     type                      String      'Embedded','Custom'
     filepath                  String      File path
     outputMemory              String      'Host', 'CUDA', 'Texture': Texture
                                           memory of DirectX3D
     param                     Dictionary
     nextFilterNo              Int         Index
```

Property

- name: Filter names
- class: C++ class that implements a filter
- type: Filter class type
  'Embedded': system's built-in filter class, 'Custom': filter class developed by a user
- filepath: Absolute path for the physical module file that provides the filter class.
  Ex) r'D:\CustomFilter.dll'
- outputMemory: Type of output data memory for the filter

  'Host': general memory mounted in the Host main board
  'CUDA': built-in memory that can be accessed from a CUDA graphic card

- param: Parameter delivered to a filter class Composed of a key and value pair. Arbitrary input is allowed.
  Ex) Filter[0]['param']['UsSpeed'] = 1540
- nextFilterNo: Index of next filter that output data will be sent to.

Example: Creating Layout and Filter Objects

By passing the received signal data through many different filters, you can create frames to be displayed on the monitor. Now, you can define two layouts and filters with different configurations in order to simultaneously display two different frames on the monitor.

```
Layout = SysLib.init_object("Layout", 1 )

Layout[0]['filter'] = SysLib.init_object("Filter", 11)
Layout[0]['filter'][0]['name'] = 'BHostSource0'
Layout[0]['filter'][0]['class'] = 'HostSource'
Layout[0]['filter'][0]['type'] = 'Embedded'
Layout[0]['filter'][0]['outputMemory'] = 'Host'
Layout[0]['filter'][0]['nextFilterNo'] = 1

Layout[0]['filter'][1]['name'] = 'BBeamformingFilter0'
Layout[0]['filter'][1]['class'] = 'BeamformingFilter'
Layout[0]['filter'][1]['type'] = 'Embedded'
Layout[0]['filter'][1]['outputMemory'] = 'CUDA'
Layout[0]['filter'][1]['nextFilterNo'] = 2
.
Omitted
.
Layout[0]['filter'][10]['name'] = 'Render0'
Layout[0]['filter'][10]['class'] = 'Render2D'
Layout[0]['filter'][10]['type'] = 'Embedded'
Layout[0]['filter'][10]['outputMemory'] = 'Host'
```

① Create as many layout objects as the number of frames simultaneously displayed on the screen.

```
Layout = SysLib.init_object("Layout", 1 )
```

② Create as many filter objects in 'filter' of layout object as necessary.

```
Layout[0]['filter'] = SysLib.init_object("Filter", 11)
```

③ Enter the filter name without duplication.

```
Layout[0]['filter'][0]['name'] = 'BHostSource0'
```

④ Enter the class name that implements the filter.

```
Layout[0]['filter'][0]['class'] = 'HostSource'
```

⑤ Enter the type of class that implements the filter. If you use a filter class provided by the system, then enter 'Embedded' and if you use your own filter class, enter 'Custom'.

```
Layout[0]['filter'][0]['type'] = 'Embedded'
```

⑥ Enter the type of output memory for the filter. If you use the CUDA memory that can be only accessed from the GPU, enter 'CUDA' and if the memory is accessible from the CPU, enter 'Host'.

```
Layout[0]['filter'][0]['outputMemory'] = 'Host'
```

⑦ Enter the index of next filter that will receive an output from the filter.

```
Layout[0]['filter'][0]['nextFilterNo'] = 1
```

It may take long time and heavy efforts to define filters used to create frames. Thus, if you use the filter structure as provided by the system, you can use the helper method provided in advance to easily define the filter information.

```
Layout = SysLib.init_object("Layout", 1 )

Layout[0]['filter'] = FilterLib.createFilterGraph('Focused_B')
```

Receive Buffer Objects

Receive buffer objects specify the location to save RF data, and these objects have "index" attribute. `RcvBuffer["index"]` specifies index for butter to save, and a number of RcvBuffer can be specified.

```
RcvBuffer =
      index           Int          index. (0 ~ )
      acqNo           Int          index. (0 ~ acqNum-1)
      frameNo         Int          index. (0 ~ frameNum-1)
      ensembleNo      Int          index. (0 ~ ensembleNum-1)
      interleaveNo    Int          index. (0 ~ interleaveNum-1)
```

Property

- index: Index of receive buffer
- acqNo: Data index required for composing a frame. Determined according to acqNum of Rx object.
- frameNo: Index of frame
- ensembleNo: Index of ensemble
- interleaveNo: Index of interleave in CF mode

Example: Defining Receive Buffer Objects

The system can have a number of "RcvBuffer" which are receive buffer objects.

```
for i in range(0,numFrames,1):
   for j in range(0,acqNum,1):
      RcvBuffer[index]['index'] = index
      RcvBuffer[index]['acqNo'] = j
      RcvBuffer[index]['frameNo'] = i
      index = index + 1
```

① `'index'` indicates the position of buffer where RF data will be saved.

② `'acqNo'` indicates the position number (sequence) to be transmitted within one frame.

③ `'frameNo'` indicates the frame number.

When acqNo increases as many as acqNum sequentially, it configures the buffer of one frame, and the next frame is also configured in the same way.

Example: Defining BC Mode Receive Buffer objects

In case of BC, B mode is same with B only mode, and the buffer configuration varies according to interleave in C mode

```
for i in range(0,numFrames,1):
    for j in range(0,acqNumB,1):
        RcvBuffer[index]['index'] = index
        RcvBuffer[index]['acqNo'] = j
        RcvBuffer[index]['frameNo'] = i
        index = index + 1
    for j in range(0,acqNumC,interleaveNum):
        for e in range(0,ensembleNum,1):
                    for int_i in range(0,interleaveNum,1):
                            RcvBuffer[index]['index'] = index
                            RcvBuffer[index]['acqNo'] = j
                            RcvBuffer[index]['frameNo'] = i
                            RcvBuffer[index]['ensembleNo'] = e
                            RcvBuffer[index]['interleaveNo'] = int_i
                            index = index + 1
```

① 'index' indicates the position of buffer where RF data will be saved.

② 'acqNo' indicates the position number (sequence) to be transmitted within one frame.

③ 'frameNo' indicates the frame number.

④ 'interleaveNo' is used by entering a number of acqNo in one ensemble in order to increase the frame rate in CF.

⑤ 'ensembleNo' indicates the ensemble position.

One ensemble is configured while acqNo increases as many as the number of interleave, and the next ensemble is also filled in the same way. When the number of ensemble is filled, ensembles are filled again from ensemble 0 to the last ensemble after acqNo increases as many as the number of interleave. This process is repeated as many times as the number of ceil(acqNum_c/Interleave) to configure CF buffer.

Example: Defining SWEI Mode Receive Buffer objects

In case of SWEI, the first ensemble is obtained as reference and the following ensembles are obtained as many as the number of ensembleNum * acqNum.

```
for i in range(0,numFrames_B,1):
    for j in range(0,acqNum_B,1):
        RcvBuffer[index]['index'] = index
        RcvBuffer[index]['acqNo'] = j
        RcvBuffer[index]['frameNo'] = i
        index = index + 1

for i in range(0,acqNum_SWE,1):
    for j in range(0,ensembleNum_SWE,1):
        RcvBuffer[index]['index'] = index
        RcvBuffer[index]['acqNo'] = i
        RcvBuffer[index]['frameNo'] = 0
        RcvBuffer[index]['ensembleNo'] = j
        index = index + 1
```

① 'index' indicates the position of buffer where RF data will be saved.

② 'acqNo' indicates the position number (sequence) to be transmitted within one frame.

③ 'frameNo' indicates the frame number.

④ 'ensembleNo' indicates the ensemble position.

Tw Objects

The transmit waveform for each transmitter of the system is set using Tw objects. Various types of transmit waveform can be set through Tw objects that have an index. The attributes of Tw objects are as follows:

```
TW['i'] =
    type              String         'Parameter', 'Waveform
    waveA             [128*2048]     (-127 ~ +127)
                      int]
    burstCount        float          pulse count. (1 ~ 32))
    freqMHz           float          MHz
    hvNo              Int            (0, 1) - AWG : 0 only
    pulseLengthUsec   Int            micro sec
    pulseLengthDuty   Int            percent, Default: 50 (0 ~ 100)
```

Property

- type: It indicates the type of transmit waveform.

  - Parameter : Creates a waveform using waveA(Waveform array) in AWG system

  - Waveform : It is used in the digital mode. Waveforms created in the system are used. (Option for AWG)

- waveA: It indicates the DAC value of Waveform array. (Optin for AWG)
- burstCount: It indicates the pulse count.
- freqMHz: It indicates the transmit frequency in the conventional E-CUBE 12R system. It is not valid when the value of type property is 'Waveform', and the frequency can be adjusted with the value of samples saved in the waveform memory.
- hvNo: Index of HV object used for transmission.
- pulseLengthUsec: Length of the long burst pulse. Used for pulse pushing.
- pulseLengthDuty: Duty of the long burst pulse. You should be careful of the pulse lenth, duty, and the repeat count when using the long burst. If you use the long burst continuously, it may damage the transducer.

Example: Defining Tw Objects

"Tw", which is the transmit waveform, defines a waveform generated in an element. A number of waveform types can be specified (by creating a number of Tw Objects) and the waveform is determined according to `'waveformType'`. (AWG Only).

```
Tw[0]['waveformType'] = "Parameter"
Tw[0]['freqMHz'] = 6.0
Tw[0]['burstCount'] = 1
Tw[0]['hvNo'] = 0
```

① `'freqMHz'` is the Tx frequency. Set 6.0 MHz.

```
Tw[0]['freqMHz'] = 6.0
```

② `'burstCount'` indicates the pulse length (pulse of one cycle * count).

```
Tw[0]['burstCount'] = 1
```

③ `'hvNo'` represents the index of HV object.

Tx Objects

Tx objects are used for defining transmission, and Tx objects define required transmit waveforms for each Tx channel. N is same as the system transmit number. (The default value is 128, and it cannot be changed.)

```
Tx =
     fNum                Int          (0 ~ )
     focalPosCm          int          Cm
                                      Linear Array : min 1 ~ Max 10
                                      Convex Array : min 1 ~ Max 30
                                      Phased Array : min 1 ~ Max 30
     twNo                Int          Index (Should be set to less than the
                                      number of Tw objects)
     apod                [1 * 128]    AWG Only. (-255 ~ +255)
                         Float
     steerAngleDeg       Int          Degree (-180 ~ 180)
     originElement       Float        Index
     delay               [1 * N]      US
                         Float
     apertureCtrlF       Int          0:default, 1:manual (0 ~ 127 manual
                                      control)
     aperture            [1 * 128     (0: on, 1: off)
                         Int]
     inversion           [1 * 128     (0: normal, 1: inversion)
                         Int]         Not used in AWG
     ampMode             Int          Only for the AWG. (0: off, 1: digital,
                                      2: analog, 3:  elastography), Default is
                                      0.
     hvMuxCtrlF          Int          0:auto, 1:manual
     hvMuxSelection      Int          0 ~ 191
```

Property

- fNum: F-Number
- focalPosCm: Focal position
- twNo: Tw ObjectIndex
- apod: TX Apodizaition Window. (AWG Only)
- steerAngleDeg: SteerAngle of beam
- originElement: Focal position(lateral) is defined by an element index.
- delay: Transmit delay time for elements
- apertureCtrlF: Tx Aperture control
- aperture: Defines aperture on/off.

- inversion: Define whether the connected waveform is inverted.
- ampMode: Define the status of linear amp chip for the AWG board
- hvMuxCtrlF: hv Mux control. When setting the value 0, hv Mux selection is activated automatically following the scanline.
- hvMuxSelection: hv Mux of the element is set when the value of hvMuxCtrlF is 1.

Tx.waveform attribute defines the index number of Tw objects showing the transmit waveforms generated by each activated transmitter. It can be controlled by setting Tx.Apod attribute if all transmitters are not required for transmit sequence. 0 (not use) or 1 (use) can be set and used for the relevant transmitter value in Tx.Apod.

Tx.OriginElement, Tx.focus and Tx.SteerAngle attributes are used for defining the attribute for transmit beam. Tx.Focus means the distance from the transducer's basic element plane(X) and Tx.OriginElement means the location on the element plane(X). Tx.SteerAngle sets the angle to be bent from the basic beam's direction and Θ means the degree to be bent toward X and Z surfaces of transducer.

If you designate the Tx.focus, Tx.SteerAngle and Tx.OriginElement attributes, you can use the SysLib.computeTXDelay function to calculate the transmission delay. In order to use this function, you need to access the system [“Transducer”] and Parameter attributes defined previously. This function calculates Tx.delay value for all elements of which Tx.Apod value is not 0.

Example: Defining Tx Objects

Tx, which is the transmit object, defines the properties of each transmission used while scanning. Attributes such as transmit waveform, focus point, steering angle and apodization are included. A single sequence is required for scanning L3-12, and flat transmit wave occurs.

```
Tx = SysLib.init_object("Tx",acqNum)
for i in range(0,acqNum,1):
   Tx[i]['twNo'] = 0
   Tx[i]['steerAngleDeg'] = 0
   Tx[i]['focalPosCm'] = 4
   Tx[i]['fNum'] = 5.0
   Tx[i]['apod'] = ones(transNumElement)
   Tx[i]['originPosCm'] = np.array([((-elementCnt/2) +
float(elementCnt)/acqNum*i)*spacing, 0.0, 0.0])
   Tx[i]['originElement'] = float(elementCnt) / acqNum * i
   Tx[i]['delay'] = SysLib.computeTXDelay(Tx[i],System,Parameter[0])
```

① Create one Tx object.

```
Tx = SysLib.init_object("Tx",acqNum)
```

② Specify the index of Tw object to be used in transmission.

```
Tx[i]['twNo'] = 0
```

③ Set the steer angle of beam used for transmission. The steer angle refers to θ which indicates the steering of beam in X and Z planes.

```
Tx[i]['steerAngleDeg'] = 0
```

④ Specify the transmit focal point. Set 4 cm.

```
Tx[i]['focalPosCm'] = 4 (If you set value to 0 for 'focalPosCm', it
will operate as Planewave.)
```

⑤ Specify F-Number.

```
Tx[i]['fNum'] = 5.0
```

⑥ It refers to the transmit apodization used for transmission. In a transmit event which uses E-CUBE 12R, Tx['apod'] value is 0 or 1. It means that the transmitter is on or off. Set the Tx apodization value to 1

```
Tx[i]['apod'] = ones(transNumElement)
```

⑦ Enter the start location of transmission focusing.[X, Y, Z]

```
Tx[i]['originPosCm'] = np.array([((-elementCnt/2) +
float(elementCnt)/acqNum*i)*spacing, 0.0, 0.0])
```

⑧ Enter the element index where transmission focusing starts.

```
Tx[i]['originElement'] = float(elementCnt) / acqNum * i
```

Example: Creating a Script which uses arbitrary Tx channels only

The following contents are prepared based on L3-12_Focused_ApertureControl.py. You can control No. 0 ~ No. 127 Tx channels by setting 1 for `'apertureCtrlF'` in Tx objects. 0 means on, and 1 means off. The following is the exercise that only No. 32 ~ No. 95 channels in the middle are set on and the remaining channels are set off.

```
Tx[0]['apertureCtrlF'] = 1
Tx[0]['aperture'] = ones(128)
Tx[0]['aperture'][32:96] = zeros(64)
```

① Set 1 for `'apertureCtrlF'` in order to control tx channels discretionally.

```
Tx[0]['apertureCtrlF'] = 1
```

② Assign values to a total of 128 arrays. Turn on/off the corresponding channels.

- Set the total array value to 1. All the channels will be off.
- Turn on No. 32 - No. 95 channels by setting its array value to 0.

In this exercise, computeTXDelay which is the system help function can be used. computeTXDelay is used for calculating the transmit delay time for each transmission. This delay time is created in us units.

```
Tx[i]['delay'] = SysLib.computeTXDelay(Tx[i],System,Parameter[0]
```

Rx Objects

Rx objects are objects which set the processing of receiver.

```
Rx =
     acqNum                  Int        (min 1)
                                        Conventional - 128,192,256,384,512
                                        (Number of scanlines)
                                        Planewave - 2 (128 elements), 3 (192
                                        elements)
                                        -> Transducer Element Number /
                                        64(RxCh.)
     numFrames               Int        (min 1)
     tgcNo                   Int        Index. (TGC object - 1)
     originElement           Float      0 ~ transducer element-1)
     apertureCtrlF           Int        0: default, 1: manual
     aperture                [1 * 64]   0: 0~63, 1: 64~127
                             Int
     roiNo                   Int        Index (0 ~ ROI object - 1)
```

Property

- acqNum: 1 Number of acquired images per frame.
- numFrames: Number of acquired frames
- tgcNo: Index of TGC object to be applied
- originElement: Focal position(lateral) is defined by an element index.
- apertureCtrlF: Low Voltage Mux Control
- aperture: Low Voltage Mux Settings
- roiNo: Index of ROI object that helps you check the imaging depth information.

You can designate the Rx.OriginElement attribute using SysLib.computeRXAperture function to calculate the received aperture. In order to use this function, you need to access the system [“Transducer”] attribute defined previously.

Example: Defining Rx Objects

Rx objects define the properties of receiver at each sequence.

```
Rx = SysLib.init_object("Rx",acqNum)
for i in range(0,acqNum,1):
 Rx[i]['acqNum'] = acqNum
 Rx[i]['numFrames'] = numFrames
 Rx[i]['tgcNo'] = 0
 Rx[i]['roiNo'] = 0
```

① Create 1 Rx object.

```
Rx = SysLib.init_object("Rx",acqNum)
```

② Sets the acquisition number for one frame.

```
Rx[i]['acqNum'] = acqNum
```

③ Set the number of frames to acquire.

```
Rx[i]['numFrames'] = numFrames
```

④ After acquisition, set the index of TGC object to which atgc will be applied.

```
Rx[i]['tgcNo'] = 0
```

⑤ Set the index of ROI object that already has the imaging depth information.

```
Rx[i]['roiNo'] = 0
```

Sequence Item Objects

Sequence objects are the objects that contain all the attributes and sequences required for processing or obtaining ultrasonic data. The sequence defines the sequence to proceed in consecutive order when obtaining data. Each sequence object contains the information regarding other objects for processing ultrasonic data, and a number of sequence objects may exist in the script, such as index. Sequence objects can be used for obtaining one or more frames of ultrasonic data. For example, it is possible to carry out the operation to return to the beginning of sequence at the end of sequence, through this operation, the sequence can be operated repeatedly.

The product of sequence object is MAT structure created in the research tool or Spyder. This file is delivered to the E-CUBE 12R system and then executed.

```
SeqItem =
     txNo              Int         Index. (0~Tx object - 1)
     rxNo              Int         Index. (0~Rx object - 1)
     bufNo             Int         Index. (0~RcvBuffer object - 1)
     ctrlNo            int         Index. (0~SeqControl object - 1)
     layoutNo          Int         Index. (0~Layout object - 1)
     roiNo             Int         Index. (0~ROI object - 1)
```

Property

- txNo: Tx Object Index number used for transmission
- rxNo: Receive Object Index number used for reception
- bufNo: Buffer No. to be saved
- ctrlNo: Index of sequence control object
- layoutNo: Index of layout object where the frame is displayed
- roiNo: Object index

All attributes of event objects match Tx, Rx, RcvBuffer and SeqControl objects to be entered on the script. Therefore, the required objects should be defined in advance before the sequence object is defined. SeqControl objects are used for setting sequence flow commands such as sequence branch and pause.

Event objects determine whether the operations to be carried out in consecutive order. The initial operation is data acquisition, which is the transmission and reception of ultrasound signal. Beamforming operation processes acquired data again and creates the outcome. SeqControl commands such as pause of sequence and extTrigger are executed for SeqControl operation. A sequence object which sets the sequence operation used for SeqControl operation should be created in advance.

In order to determine the sequence, a number of sequence objects which have index are created (Ex. Sequence [“1”], Sequence[“2”], Sequence[“3”], …. Sequence [“n”]). n number of sequence objects are executed in the E-CUBE 12R system in consecutive order. It is also possible to carry out the operation continuously as many times as you want according to the command defined to SeqControl object matched to the sequence item object.

Example: Creating SeqItem Objects

Creating a sequence item object is the step to create the sequence using the objects created above.

```
SeqItem = SysLib.init_object("SeqItem", acqNum*numFrames )
for i in range(0,numFrames,1):
     for j in range(0,acqNum,1):
         SeqItem[index]['txNo'] = 0
         SeqItem[index]['rxNo'] = 0
         SeqItem[index]['bufNo'] = acqNum*i+j
         if j == acqNum-1:
             SeqItem[index]['ctrlNo'] = 1
         else:
             SeqItem[index]['ctrlNo'] = 0
         index = index + 1
```

① Create sequence item objects as many as the number of `acqNum * numFrames`.

```
SeqItem = SysLib.init_object("SeqItem", acqNum*numFrames )
```

② Enter Tx and Rx object indexes to use.

```
SeqItem[index]['txNo'] = 0
SeqItem[index]['rxNo'] = 0
```

③ Designate RcvBuffer object.

```
SeqItem[index]['bufNo'] = acqNum*i+j
```

④ Use SeqControl[1] at the end of frame to use the input trigger ('pause'). The output trigger ('triggerOut') is used for each section except for the last acquisition section.

```
if j == acqNum-1:
   SeqItem[index]['ctrlNo'] = 1
else:
   SeqItem[index]['ctrlNo'] = 0
```

Sequence Control Objects

Sequence control objects provide sequence flow control used in sequence events.

```
SeqControl =
     waitTimeToNext     Int         (0:disable) (?)
                                    - If the time is less than the delay
                                    time (PRF) calculated in the system, the
                                    system PRF will be applied.
     jump               Int         No (-1:disable)
     loopCount          Int         (0:infinite)
     stop               Int         (0:disable, 1:enable)
     pause              Int         (0:disable, 1:enable)
     triggerOut         Int         (0:disable)
                                    bit9 : activeHighLow, bit8 : level_edge,
                                    bit7~0 : trigger width count
     noRx               Int         (0: Rx, 1: no Rx)
     display            Int         (0: no display, 1: display)
     dummy              Int         (0: no dummy, 1: dummy)
     noTx               Int         (0: Tx, 1: no Tx)
```

Propety

- waitTimeToNext: Enter the delay time until the next sequence.
- jump: Moves to the relevant Sequence.
- loopCount: Sets the count of sequence.
- stop: Stops the sequence operation.
- pause: Stops the sequence operation temporarily and waits for input trigger. Trigger may occur or the sequence may return to normal mode.
- triggerOut: Output trigger occurs.
- noRx: Do not receive.
- display: Do not display on the screen.
- dummy: Dummy ensemble
- noTx: Do not Do not transmit.

Example: Defining SeqControl Objects

You may set Trigger, PRF and the number of repeats through the sequence control objects.

```
SeqControl = SysLib.init_object("SeqControl", 2)

SeqControl[0]['waitTimeToNext'] = 0
SeqControl[0]['jump'] = -1
SeqControl[0]['loopCount'] = 0
SeqControl[0]['stop'] = 0
SeqControl[0]['pause'] = 0
SeqControl[0]['triggerOut'] = 0x320
SeqControl[1]['waitTimeToNext'] = 0
SeqControl[1]['jump'] = -1
SeqControl[1]['loopCount'] = 0
SeqControl[1]['stop'] = 0
SeqControl[1]['pause'] = 1
SeqControl[1]['triggerOut'] = 0
```

① Two SeqControl objects are created in order to be selected and used for creating an event object.

```
SeqControl = SysLib.init_object("SeqControl", 2)
```

② 0 is assigned for the time to be taken until the next data acquisition. (If 0 is assigned, the value calculated in the system is set, and if any value other than 0 other is assigned, the value is set in μs unit, and if it is smaller than the system calculation value, it will be replaced with the system value.)

```
SeqControl[0]['waitTimeToNext'] = 0
```

③ `'jump'` is ignored when -1 is set, and the sequence operates repeatedly. If you want to move to a specific sequence, set the sequence index.

```
SeqControl[0]['jump'] = -1
```

④ You may set the number of sequence repeat through 'loopCnt'. When you set value to 0, the sequence will be repeated endlessly.

```
SeqControl[0]['loopCount'] = 0
```

⑤ If you wishe to stop, set 1.

```
SeqControl[0]['stop'] = 0
```

⑥ You may set the input trigger, and when you set value to 0, the input trigger is ignored.
`'pause'` in SeqControl[1] is set as 1 so that the system stops at the event which uses the relevcant sequence control and waits for a trigger signal.

```
SeqControl[0]['pause'] = 0
SeqControl[1]['pause'] = 1
```

⑦ You may set the output trigger.
Set 32 count (x25ns), level trigger and active high for the trigger width.

```
SeqControl[0]['triggerOut'] = 0x320
```

Event Handler Objects

An event handler object receives a user's event and jumps to a specific sequence item object.

```
EventHandler =
     seqJumpEvent           Int        index. (0 ~ SeqItem object - 1)
     link                   Int        index
```

Property

- seqJumpEvent: Index of event object to jump to
- link: Button Index

When a sequence is executed in the system, the touch screen will display as many event buttons as the number of event handler objects defined. When you press the event button, a flow will start from the sequence item object.

Custom Filters

Separately from basic filter modules provided by default, the system provides the function to apply a filter module (custom filter) created by the user. The user can add or change a custom filter module to the system path as well as configure a new signal path such as PAI (Photo Acoustic Imaging) or SWEI (Shearwave Elastography Imaging). The custom filter modules can be created using GPGPU(CUDA) or CPU, and can replace all filter modules including the beamformer in the signal path (excluding the scan conversion filter).

Signal Path

The signal path for each mode provided by the E-CUBE 12R systemare as follows.

Scanline mode - B mode

Figure 10-2 B mode

Scanline mode - B+C mode

Figure 10-3 B+C mode

Planewave - B mode

Figure 10-4 Planewave-B mode

The system provides several embedded modules(embedded filters) by default for creating a signal path promptly and easily. The user can define and use a signal path easily using the embedded filter modules provided by the system.

The memory used for filter modules is classified into CUDA memory, Host memory and Texture memory. Here, CUDA memory is the memory loaded on GPU, Host memory means normal memory stored in DRAM, and Texture memory is similar to Host memory but it means memory which is converted into Texture form of DirectX. The following figure shows the basic memory structure.

Figure 10-5 Memory structure

The description on the embedded filter modules provided by the system, input and output memory type and structure are as follows.

Class and description	Input memory		Output memory	
	Type	Structure	Type	Structure
HostSource Initial starting point of signal path as the source filter which receives and delivers Host memory to the next filter	Host	Disable	Host	Decided by the sequence
BBeamformingFilter Convert RF signals collected from each B mode scanline into one RF frame data through Rx beamforming	Host	TypeSize(2) * ChannelBlock(32) * RF_Stride * 2 * Acquistion_Count * Frame_Count	CUDA	TypeSize(2) * RF_Stride * Scanline_Count
BDemodulationFilter Convert RF data in B mode into IQ data	CUDA	TypeSize(2) * RF_Stride * Scanline_Count	CUDA	TypeSize(4) * IQ_AlignedSample * Scanline_Count
BEnvelopDetection Convert IQ data in B mode into signal data	CUDA	TypeSize(4) * IQ_AlignedSample * Scanline_Count	CUDA	TypeSize(2) * IQ_AlignedSample * Scanline_Count
SpatialCompound Perform SpatialCompounding and Persist process	CUDA	TypeSize(2) * IQ_AlignedSample * Scanline_Count	CUDA	TypeSize(2) * IQ_AlignedSample * Scanline_Count
BLogCompression Log compression of B mode signal	CUDA	TypeSize(2) * IQ_AlignedSample * Scanline_Count	CUDA	TypeSize(2) * IQ_AlignedSample * Scanline_Count
DeviceToHost Convert CUDA memory into Host memory	CUDA	Same with the input memory structure of the preceding filter	Host	Same with the input memory structure of the preceding filter (Pitch may change)
HostToDevice Convert Host memory into CUDA memory	Host	Same with the input memory structure of the preceding filter	CUDA	Same with the input memory structure of the preceding filter (Pitch may change)

HostToTexture Convert Host memory into Texture memory	Host	Same with the input memory structure of the preceding filter	Texture	Same with the input memory structure of the preceding filter (Pitch may change)
TextureToHost Convert Host memory into Texture memory	Texture	Same with the input memory structure of the preceding filter	Host	Same with the input memory structure of the preceding filter (Pitch may change)
BFilter Perform post-processing such as SRI using B mode signals	Host	TypeSize(2) * Pitch * Scanline_Count	Host	TypeSize(2) * Pitch * Scanline_Count
BScanConversion Convert B mode signals into data which can be displayed on the screen	Texture	TypeSize(2) * Pitch * Scanline_Count	Texture	Decided dynamically according to the size of BRoi area
Render2D Display texture on the screen	Texture	Decided dynamically according to the size of BRoi area	Texture	Disable
CBeamformingFilter Convert RF signals collected from each C mode scanline into one RF frame data through Rx beamforming	Host	TypeSize(2) * ChannelBlock(32) * RF_Stride * 2 * Ensemble_Count * Acquistion_Count * Frame_Count	CUDA	TypeSize(2) * RF_Stride * Ensemble_Count * Scanline_Count
CDemodulationFilter Convert RF data in C mode into IQ data	CUDA	TypeSize(2) * RF_Stride * Ensemble_Count * Scanline_Count	CUDA	TypeSize(4) * IQ_AlignedSample * Ensemble_Count * Scanline_Count
CClutter Remove clutter signals and perform autocorrelation using C mode IQ data	CUDA	TypeSize(4) * IQ_AlignedSample * Ensemble_Count * Scanline_Count	CUDA	TypeSize(4) * IQ_AlignedSample * 3 * Scanline_Count

ColorFlow	Host	TypeSize(4) * Pitch * 3 * Scanline_Count	Host	TypeSize(4) * Pitch * Scanline_Count
Perform post-processing of C mode signals such as persist and calculate variance, power and velocity				
CScanConversion	Texture	TypeSize(4) * Pitch * Scanline_Count	Texture	Decided dynamically according to the size of CRoi area
Convert C mode signals into data which can be displayed on the screen				
BCMerge	Texture	TypeSize(4) * Pitch * Scanline_Count	Texture	Decided dynamically according to the size of BRoi area
Combine B mode texture and C mode texture to form one texture				

Operation of custom filter

The following shows the system operation relating to the custom filter. The system loads a created script. The system reads information on the defined layout and filter object from the script and configures a signal path. At this time, each filter is connected using graph data structure. Each filter may be a built-in module (embedded filter) or a module (custom filter) created by the user. It is classified by “type” field in the filter object.

The custom filter can be implemented through the IFilter interface and it is connected to the signal path in the system internally through CustomFilterAdapter. CustomFilterAdapter connects each filter in the signal path, allocates input and output memory, delivers information and delivers system information (Global Parameter, Custom Parameter, etc.) to the user's custom filter. The user can then focus on implementation of process and setting of the IFilter interface.

When signal path connection and setting are complete, data processing becomes possible and data is processed in order of filter modules set in a graph structure.

Configuring the signal path

Signal path configuration is provided in the FilterLib.py file in the $SCRIPT_DIR\Lib path by default. The user can access the signal path through FilterLib.createFilterGraph (string mode) which is the help function defined in FilterLib.py or can configure it directly as needed.

```
Layout = SysLib.init_object("Layout", 1)
# Focused_B | Focused_BC | Unfocused_B | Unfocused_BC
Layout[0]['filter'] = FilterLib.createFilterGraph('Focused_B')
```

In order to configure the signal path, each filter object is connected to the list.

Defining Filters

The method to define each filter is as follows.

```
Filter_base = {
                'name'     : '', # instance name
                'class'    : '', # class name of filter
                'type'     : '', # type of filter / 'Embedded' or 'Custom'
                'filepath' : '',
                'outputMemory': '', # output Memory Type / 'CUDA' or 'Host'
                'param'    : {'none':'none',},
                'nextFilterNo': '',
            }
```

The ‘name’ field is the instance name of the filter, and should be unique in the filter definition of the script. The ‘class’ field is the filter type. For embedded filters, a defined value should be entered, while custom filters have no such restriction and the same name as in the ‘name’ field can be used. The ‘type’ field distinguishes between embedded filters and custom filters. Either 'Embedded' or 'Custom' can be used. The ‘outputMemory’ field distinguishes whether the filter’s output memory is GPU memory or Host Memory. The “nextFilterNo” field indicates the index of the next filter. The ‘filepath’ field is the absolute path of custom filter .dll files. It is ignored if ‘type’ field is 'Embedded'. ‘The ‘param’ field is any parameter list which the user intends to deliver to the custom filter. Each parameter is composed of a pair of “name–value” fields. It is ignored if ‘type’ field is 'Embedded'. The “nextFilterNo” field indicates the index of the next filter.

Implementing Custom Filter

When you need to define filter objects, you can use your own implemented filter classes.

```
Layout[0]['filter'][1]['name'] = 'BCutomBeamformingFilter0'
Layout[0]['filter'][1]['class'] = 'CustomBeamformingFilter'
Layout[0]['filter'][1]['type'] = 'Custom'
Layout[0]['filter'][1]['filepath'] = r'D:\CustomFilter.dll'
Layout[0]['filter'][1]['outputMemory'] = 'CUDA'
Layout[0]['filter'][1]['nextFilterNo'] = 2
```

① Enter the filter name without duplication.

```
Layout[0]['filter'][1]['name'] = 'BCutomBeamformingFilter0'
```

② Enter the class name that implements the filter.

```
Layout[0]['filter'][1]['class'] = 'CustomBeamformingFilter'
```

③ To acknowledge that the filter implementation class is directly provided by a user, enter 'Custom' for 'type'.

```
Layout[0]['filter'][1]['type'] = 'Custom'
```

④ Enter the location of module file that provides the filter class that is developed by a user.

```
Layout[0]['filter'][1]['filepath'] = r'D:\CustomFilter.dll'
```

⑤ Enter the type of output memory for the filter.

```
Layout[0]['filter'][1]['outputMemory'] = 'CUDA'
```

⑥ Enter the index of next filter that will receive an output from the filter.

```
Layout[0]['filter'][1]['nextFilterNo'] = 2
```

Connecting Filters

The following shows how to configure a signal path by connecting defined filter objects.

- Create as many filter objects as necessary;
- The signal path should begin with 'HostSource' class filter and end with 'Render2D' class filter;
- It is advisable to configure the 'outputMemory' field in filter objects in order of GPGPU (CUDA) -> Host -> Texture;
- In case the type of ‘outputMemory’ changes, 'DeviceToHost' or 'HostToTexture' class filter is necessary.

Let's consider ‘Unfocused’ defined in FilterLib for example.

```
def createUnfocusedB():
     Filter =                                Create 9 filter objects.
     SysLib.init_object("Filter", 9)


     Filter[0]['name'] =BHostSource0'        Non-functional filter which
     Filter[0]['class'] = 'HostSource'       indicates signal path input.
     Filter[0]['type'] = 'Embedded'          All signal paths should begin
     Filter[0]['outputMemory'] = 'CUDA'      with ‘HostSource’ filter.
     Filter[0]['nextFilterNo'] = 1           Embedded type
                                             Output to GPU memory.
                                             Connect to the next filter.
     Filter[1]['name'] =                     Handle Beamforming.
     'BBeamformingFilter0'
     Filter[1]['class'] =
     'BBeamformingFilter'                    Output to GPU memory.
     Filter[1]['type'] = 'Embedded'          Connect to the next filter.
     Filter[1]['outputMemory'] = 'CU
     Filter[1]['nextFilterNo'] = 2
     Filter[2]['name'] =                     Output to GPU memory.
     'BEnvelopDetection0'                    Connect to the next filter.
     Filter[2]['class'] =
     'BEnvelopDetection'
     Filter[2]['type'] = 'Embedded'
     Filter[2]['outputMemory'] = 'CUDA'
     Filter[2]['nextFilterNo'] = 3
     Filter[3]['name'] =                     Output to GPU memory.
     'BLogCompression0'                      Connect to the next filter.
     Filter[3]['class'] =
     'BLogCompression'
     Filter[3]['type'] = 'Embedded'
     Filter[3]['outputMemory'] = 'CUDA'
     Filter[3]['nextFilterNo'] = 4
```

```
Filter[4]['name'] = 'DeviceToHost0'
Filter[4]['class'] = 'DeviceToHost'
Filter[4]['type'] = 'Embedded'
Filter[4]['outputMemory'] = 'Host'
Filter[4]['nextFilterNo'] = 5

Filter[5]['name'] = 'BFilter0'
Filter[5]['class'] = 'BFilter'
Filter[5]['type'] = 'Embedded'
Filter[5]['outputMemory'] = 'Host'
Filter[5]['nextFilterNo'] = 6
Filter[6]['name'] =
'BHostToTexture0'
Filter[6]['class'] =
'HostToTexture'
Filter[6]['type'] = 'Embedded'
Filter[6]['outputMemory'] = 'Host'
Filter[6]['nextFilterNo'] = 7
Filter[7]['name'] =
'BScanConversion0'
Filter[7]['class'] =
'BScanConversion'
Filter[7]['type'] = 'Embedded'
Filter[7]['outputMemory'] =
'Texture'
Filter[7]['nextFilterNo'] = 8
Filter[8]['name'] = 'Render0'
Filter[8]['class'] = 'Render2D'
Filter[8]['type'] = 'Embedded'
Filter[8]['outputMemory'] =
'Texture'
return Filter
```

Non-functional filter which copies from GPU memory to Host memory: It is necessary because the ''OutputMemory'' field on the next filter is the host.

Connect to the next filter.

Output host memory.

Connect to the next filter.

Non-functional filter which copies from Host memory to texture memory.

It is necessary because the next filter handles GPU shader.

Connect to the next filter.

Handle ScanConversion. Process with Pixel shader.

The pixel shader processing filter does not support custom filters.

Connect to the next filter.

Non-functional filter which indicates end of signal path.

Connect to the next filter.

Creating Custom filter

The method to implement a custom filter class is defined in a script is as follows.

① Run Visual Studio to create a new C++ project.

② Create an arbitrary class. Include the CustomFilterAPI.h file provided by the header file in the system.

```
#include "CustomFilterAPI.h"
```

③ The class will inherit the IFilter defined in the CustomFilterAPI.h filter to implement a virtual function.

```
class CustomFilter : public IFilter
{
public:
CustomFilter();

void initialize();
void uninitialize();

void setting(PARAM_MAP& param);

CUSTOM::FilterMemInfo processing(const DataAttribute& attr
                      , const CUSTOM::FilterMemInfo& inputMemInfo
                      , CUSTOM::FilterMemInfo& outputMemInfo
                      );
}
```

- `initialize()`

  The script will be run and called when the filter is created.

- `uninitialize()`

  Script execution is stopped and it will be called when the filter is removed in the system.

- `setting(PARAM_MAP& param)`

  It will be called each time when the filter is called after the initialize() method is called. The param variable contains the parameters sent from the script and the system status information. You can refer to it to renew the filter status. The general method to acquire specific information from the param variable is as follows.

  ```
  float soundSpeedMmSec = param_cast<float>(param[L"SoundSpeedMmSec"]);
  ```

- `CUSTOM::FilterMemInfo processing(const DataAttribute& attr, const CUSTOM::FilterMemInfo& inputMemInfo, CUSTOM::FilterMemInfo& outputMemInfo)`

  Depending on a sequence object, it will be called each time a frame is created as the signal is received. attr contains the meta information about the data received. inputMemInfo contains the output data memory information delivered from the preceding filter. A custom filter also can be a preceding filter for another filter. So, when a custom filter developer

implements the processing method, they must enter the output data memory information for the filter in outputMemInfo.

④ In the header file for the class, declare and implement the getFilter(void) function that delivers a class instance.

```
extern "C" __declspec( dllexport ) LPVOID getIFilter(void) { return
new CustomFilter(); }
```

⑤ In the header file for the class, declare and implement the following function.

```
extern "C" __declspec( dllexport ) int getVersion_Major(void) {
return int(API_VERSION_MAJOR); }
extern "C" __declspec( dllexport ) int getVersion_Minor(void) {
return int(API_VERSION_MINOR); }
extern "C" __declspec( dllexport ) int getVersion_Revision(void) {
return int(API_VERSION_REVISION); }
```

⑥ Compile the Visual Studio project.

We provide implementation examples to help you develop customized filters more easily and conveniently. Using the examples, you can easily develop customized filter classes without going through complex settings.

Using Custom Parameters

The system provides the function to deliver an arbitrary user parameter to a custom filter module in the script.

The user delivers user parameters to a pair of [variable name] = value through the “param” field of filter object instance. The delivered parameters can be accessed through the "param" of setting (PARAM_MAP& param) interface.

When accessing parameter values in the custom filter module, the type of values should match exactly, otherwise an error will occur. Therefore, using python built-in type functions such as int() and float32() is recommended in order to clarify the type when delivering the parameter.

```
Filter[2]['type'] = 'Custom'
Filter[2]['filepath'] = 'D:\\Products\\COSMOS\\v1\\BIN\\SWEIRec
Filter[2]['outputMemory'] = 'CUDA'
Filter[2]['param']['frameindex'] = int(0)
Filter[2]['param']['txFreqHz'] = int(5500000)
Filter[2]['param']['nSwpLen'] = int(1)
Filter[2]['param']['numFrames'] = int(numFrames-1)
Filter[2]['param']['prfHz'] = int(prfHz)
Filter[2]['param']['numScanlines'] = int(64)
Filter[2]['param']['firstArrTime_px'] = float32(firstArrTime)
Filter[2]['param']['increment'] = float32(increment)
Filter[2]['param']['halfTimeMg_px'] = float32(20.0)
Filter[2]['param']['nSWSWinSizeZ'] = int(7)
Filter[2]['param']['nSWSWinSizeX'] = int(7)
Filter[2]['param']['lowTimeLim_px'] = float32(5.0)
Filter[2]['param']['uppTimeLim_px'] = float32(numFrames-10.0)
Filter[2]['param']['nLeaveLeft'] = 0
```

Figure 10-6 Example: Delivering custom filter parameters in the script

The following explains how to obtain the parameter value from a custom filter module. The parameters are delivered to the structure of map<string, AnyParameter> through "param" of setting(PARAM_MAP& param) interface.

AnyParameter is a container for all types of utilities. It can be used for the purpose after being casted into a proper type of parameter delivered through param_cast<T>.

```
param_.nFirstArrTime_px = param_cast<float> (param[L"firstArrTime_px"]);
param_.nIncrement       = param_cast<float> (param[L"increment"]);
param_.nHalfTimeMg_px   = param_cast<float> (param[L"halfTimeMg_px"]);
param_.nSWSWinSizeZ     = param_cast<int>   (param[L"nSWSWinSizeZ"]);
param_.nSWSWinSizeX     = param_cast<int>   (param[L"nSWSWinSizeX"]);
param_.lowTimeLim_px    = param_cast<float> (param[L"lowTimeLim_px"]);
param_.uppTimeLim_px    = param_cast<float> (param[L"uppTimeLim_px"]);
int nLeaveLeft          = param_cast<int>   (param[L"nLeaveLeft"]);
param_.bLeaveLeft       = (0==nLeaveLeft) ? false : true;
```

Figure 10-7 Example: Accessing a parameter delivered from IFilter::setting(PARAM_MAP& param) interface

Using Global Parameters

The same parameter information can be delivered to a number of custom filter modules using the Global Parameter function in the script. Global Parameter can be defined using the Parameter object, and it can be delivered to map<string, AnyParameter> structure in customer filter modules through param of setting (PARAM_MAP& param) interface.

```
Parameter = SysLib.init_object("Parameter", 1)
Parameter[0]['speedOfSoundMps'] = int(1540)
```

Figure 10-8 Example of delivering global parameters of custom filter in the script

AnyParameter which can be accessed under the name of "global" always exists in param which is delivered through setting method of custom filter module, and AnyParameter object obtained in this way can be converted into PARAM_MAP type. globalParam object which is type-casted with PARAM_MAP includes a parameter which is set through the parameter object, and a parameter value can be obtained with the same method with the custom parameter.

```
PARAM_MAP& globalParam = *param_cast<PARAM_MAP*>(param[L"global"]);
int speedOfSoundMps = param_cast<int> (globalParam[L"speedOfSoundMps"]);

printMapInfo(globalParam);
```

Figure 10-9 Example of accessing a global parameter delivered from IFilter::setting(PARAM_MAP& param) interface

The global parameter includes parameter information provided by the system besides the parameter set through the parameter object. The parameter information which the system delivers through the global parameter is as follows, and it can be confirmed also from Debug window of Visual Studio using printMapInfo method provided through IFilter class.

Name	Data type	Description
DCRCoefficient	Float*	Filter coefficient data for DC rejection
DCRCoefficient_Tabs	Int	Tab size of DCRCoefficient
IQSampleSize0	Int	Number of IQ samples obtained from one scanline which corresponds to the first Roi object of the relevant layout

IQAlignedSampleSize0		Int	Size of memory allocated for saving data obtained from one scanline which corresponds to the first Roi object of the relevant layout
IQDecRatio0		Int	Decimation Ratio information used while converting a signal corresponding to the first Roi object of the relevant layout into IQ data
IQSampleMaxSize0		Int	Maximum size of IQ sample which could be obtained from one scanline which corresponds to the first Roi object of the relevant layout
IQSampleSize1		Int	Number of IQ samples obtained from one scanline which corresponds to the second Roi object of the relevant layout
IQAlignedSampleSize1		Int	Size of memory allocated for saving data obtained from one scanline which corresponds to the second Roi object of the relevant layout
IQDecRatio1		Int	Decimation Ratio information used while converting a signal corresponding to the second Roi object of the relevant layout into IQ data
IQSampleMaxSize1		Int	Maximum size of IQ sample which could be obtained from one scanline which corresponds to the second Roi object of the relevant layout
System_Spec		Int	Structure including system settings
Gain		Float	Gain value
DR		Int	Dynamic Range value
	speedOfSoundMeterSec	System_Spec	Velocity value of ultrasound applied to the system Unit is m/s.
	sampleFreqHz	Int	Frequency value of sampling applied to the system Unit is Hz.
	rx_fnumber	Int	Rx FNumber applied to the system
Probe_Spec		Float	Structure including transducer information
	probe_type	Probe_Spec	Type of transducer (Linear Array = 0, Convex = 1, Phased Array = 2)
	elementCnt	PROBE_TYPE	Number of elements
	maxLateralDeg	Float	Maximum angle
	radiusCm	Float	Radius
	elementPitchCm	Float	Width of element
	maxSteerDeg	Float	Maximum steering angle

Custom Filter Interface

Strucrture		Description
PROBE_TYPE		Refer to ***Using Global Parameters*** on page 10-50.
System_Spec		Refer to ***Using Global Parameters*** on page 10-50.
Probe_Spec		Refer to ***Using Global Parameters*** on page 10-50.
DataAttribute		It includes meta information on the ultrasound signal information entered into the filter.
	Data_Type	Indicates the mode which data corresponds to (0 = B, 1 = C, 2 = D, 3 = M, 4 = SWE)
	Aquisition_Count	Number of Rx executed for obtaining one frame information
	Focus_Count	Number of Tx Focus
	Element_Count	Number of elements in transducer
	Ensemble_Index	Ensemble index of current data
	Ensemble_Count	Number of total ensembles
	Frame_Count	Number of frames included in current data
	Tx_Element_Count	Number of Tx channels
	Tx_FNumber	FNumber used in Tx Aperture calculation
	Tx_FrequencyHz	Tx frequency; Unit is Hz
	FocalPosCm	Focal position; Unit is Cm
	SteerAngles	Arrangements of steer angle; The number of arrangements matches with the number of frames.
	IsPlanewave	Data status for plane wave Tx
	Scanline_Start	Index of Scanline Start; Starts from 0
	Scanline_End	Index of Scanline End; flexible according to the line density
	Scanline_Count	Number of Scanlines
	Scanline_MAX_Count	Maximum number of scanlines
	Rx_Channel_Count	Number of Rx channels
	RF_Stride	Memory allocation size of RF data which corresponds to one scanline
	RF_Sample	Size of RF data which corresponds to one scanline
	RF_DummySample	Size of dummy data in RF data which corresponds to one scanline

	RF_DataSize	Size of RF data; Unit is Byte
	BufferOffsets	initial memory address of RF data; The number of arrangements matches with the number of frames.
	BF_SampleRatio	The ratio of beamforming samples
	BF_Sample	Size of beamformed data which corresponds to one scanline
	IQ_DecimationRate	Decimation Ratio used when converting RF data into IQ data
	IQ_Sample	Size of IQ data which corresponds to one scanline
	IQ_AlignedWidth	Memory allocation size of IQ data which corresponds to one scanline
	IQ_DummySample	Size of dummy data in IQ data which corresponds to one scanline
	Multibeam_Count	Number of beams when processing multi-beam
	HarmonicImage_Count	Number of images required for completing one frame in harmonic imaging
	SyntheticAperture_Count	Number of low resolution images used for synthetic aperture image
	SpatialCompound_Count	Number of images used for the spatial compound image
	SpatialCompound_Index	Spatial compound image index of current data
	FrequencyCompound_Count	Number of images used in frequency compound image
FilterMemInfo		FilterMemInfo contains information regarding input and output memory delivered to the filter. The whole memory has a size of pitch * height * typeSize, and significant data length in the pitch is saved in the width.
	eMemoryOwnerDevice	Memory type; (0 = Host, 1 = CUDA, 2 = Texture)
	width	Length of continuous data which corresponds to one scanline
	pitch	Size of memory allocated for saving one width. It is always same with or larger than the width.
	height	Number of width existing in the memory
	typeSize	Size of one data (Unit is Byte)
	mem	Initial memory address

AnyParameter - AnyParameter is a class which can abstract and process various data type objects, and parameters delivered through PARAM_MAP are delivered after being wrapped with AnyParameter class. Therefore, in order to obtain actual parameter value, AnyParameter should be converted into the data type of actual parameter using param_cast.

param_cast - param_cast is the casting method to convert a custom parameter delivered as the AnyParameter type into actual data type. It can be used by casting in the following method.

- nt intParam = param_cast<int> (param[L"ValueParamName"]); - Value type
- int* intPointerParam = param_cast<int*> (param[L"PointerParamName"]); - Pointer type
- System_Spec system = param_cast<System_Spec> (param["System_Spec"]); - Structure type

Exercise Script

The following explains how to use Focused Wave, Photo Acoustic Imaging and Data Acquisition Only Mode through 3 types of exercise scripts (SC1-6_Focused.py, L3-12_BPAI.py, L3-12_Unfocused_AcqOnly.py).

Creating Focused Mode(B) Script

The script is created based on SC1-6_Focused.py.

```
import sys
sys.path.append("..\Lib")

from numpy import *
import TransLib
import SysLib
import FilterLib
```

This is where to import libraries required for creating a script for research, and an additionally required python library can be added.

```
① System['Parameters']['transmitNum'] = 128
  System['Parameters']['receiveNum'] = 64

② System['Parameters']['cineDataType'] = 0
```

Set the system parameters.

① Place to set transmission and reception channels (Fix to Tx 128 channels and Rx 64 channels for E-CUBE 12R)

System['Parameters']['transmitNum'] = 128

```
System['Parameters']['receiveNum'] = 64
```

② The user can select a data type when exporting the received data through 'cineDataType' setting.

Set 0 for the channel data, 1 for beamformed data and 2 for IQ data.

```
System['Parameters']['cineDataType'] = 0
```

```
System = SysLib.init_object("System")
① System['Transducer'] = TransLib.loadTransducer("SC1-6")
```

Load Transducer Geometry information.

① It should be created as same as the Transducer name.

```
System['Transducer'] = TransLib.loadTransducer("SC1-6")
```

```
Parameter = SysLib.init_object("Parameter", 1)
Parameter[0]['dtgc'] = SysLib.init_object("Parameter.dtgc", 1)
① Parameter[0]['dtgc'][0]['dtgcDb'] = [0,0,0,0,0,0,0,0]
SysLib.convertToDtgc(Parameter[0])

Parameter[0]['demod'] = SysLib.init_object("Parameter.demod", 1)
② arameter[0]['demod'][0]['demodMHz'] = [3.5, 3.5, 3.5, 3.0, 3.0, 3.0, 2.5,
2.5]
SysLib.convertToDemod(Parameter[0], System, "SC1-6")

Parameter[0]['lpf'] = SysLib.init_object("Parameter.lpf", 1)
③ Parameter[0]['lpf'][0]['lpfMHz'] = [1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0]
SysLib.convertToLpf(Parameter[0], System, "SC1-6")

Parameter[0]['rxApod'] = SysLib.init_object("Parameter.rxApod", 1)
④ Parameter[0]['rxApod'][0]['WindowFunc_FuncName'] = "Hamming"
SysLib.convertToRxApod(Parameter[0], 128)

⑤ Parameter[0]['speedOfSoundUsec'] = 1540
```

Place to set DTGC, Demod, LPF, RxApod, and ultrasonic wave velocity.

① Set dtgc. 8 points are applied separately to the maximum depth of SC1-6 (30cm).

```
Parameter[0]['dtgc'][0]['dtgcDb'] = [0,0,0,0,0,0,0,0]
```

② Set demod. The user can set a proper value according to Tx Frequency. Just as dtgc, 8 points are applied separately based on 30cm.

```
Parameter[0]['demod'][0]['demodMHz'] = [3.5, 3.5, 3.5, 3.0, 3.0, 3.0,
2.5, 2.5]
```

③ Set 1MHz for low pass filter.

```
Parameter[0]['lpf'][0]['lpfMHz'] = [1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0]
```

④ Set Apodization Window as Hamming window.

```
Parameter[0]['rxApod'][0]['WindowFunc_FuncName'] = "Hamming"
```

⑤ Set 1540m/s for ultrasonic wave velocity. It can be changed according to medium.

```
Parameter[0]['speedOfSoundUsec'] = 1540
```

```
depthCm = 16
roiStartElement = 0
roiEndElement = System['Transducer']['elementCnt']-1

① Roi = SysLib.init_object("Roi", 1)
② Roi[0] = SysLib.computeRoi("B", "2D", System['Transducer'],
[roiStartElement, roiEndElement], [0, depthCm])
```

Set ROI information.

① Create 1 ROI object. In case of multi mode, the number of ROI can be 2 or more.

```
Roi = SysLib.init_object("Roi", 1)
```

② Set 16cm for the depth and set the number of Transducer elements for the width.

(In case of B mode, Line Density only for the number of elements is applied, so the number of scan lines should be set as same as the number of elements.)

Roi[0] = SysLib.computeRoi("B", "2D", System['Transducer'], [roiStartElement, roiEndElement], [0, depthCm])

```
① Hv = SysLib.init_object("Hv", 1)
② Hv[0]['highVoltage'] = 40
```

Set the high voltage value.

① Create 1 Hv object. Up to 2 Hv objects can be set, and when creating an object, Hv Voltage value should be entered.

Hv 0 can be set between 0 and 80v and Hv 1 can be set between 0 and 50v.

```
Hv = SysLib.init_object("Hv", 1)
```

② Set 40v for Hv0.

Hv`[0]['highVoltage'] = 40`

```
① Tw = SysLib.init_object("Tw",1)
② Tw[0]['waveformType'] = "Parameter"
③ Tw[0]['freqMHz'] = 3.6
④ Tw[0]['burstCount'] = 1
⑤ Tw[0]['pulseLengthDuty'] = 50
⑥ Tw[0]['hvNo'] = 0
```

Setting section for transmission waveform.

① Create 1 Tw object.

```
Tw = SysLib.init_object("Tw",1)
```

② In E-CUBE 12R, only “Parameter” can be set for the waveformType. (In case of AWG equipment, both Waveform and OCI can be set.)

```
Tw[0]['waveformType'] = "Parameter"
```

③ Enter 3.6MHz for Tx Frequency. (min and max vary according to the transducer.)

```
Tw[0]['freqMHz'] = 3.6
```

④ Set 1 for the se repeat count. (1~32 possible)

```
Tw[0]['burstCount'] = 1
```

⑤ Set the duty of pulse. In case of E-CUBE 12R, it is fixed to 50 except in case of using long-term pulse.

```
Tw[0]['pulseLengthDuty'] = 50
```

⑥ Select the High Voltage (hv0 or hv1). Set 0 since Hv0 is only used here.

```
Tw[0]['hvNo'] = 0
```

```
① acqNum = 128
elementCnt = System['Transducer']['elementCnt']
maxLateral = System['Transducer']['maxLateralDeg']
radiusCm = System['Transducer']['radiusCm']
probe_pitch = maxLateral / (elementCnt - 1)

② Tx = SysLib.init_object("Tx",acqNum)
for i in range(0,acqNum,1):
③ Tx[i]['twNo'] = 0
④ Tx[i]['steerAngleDeg'] = 0
⑤ Tx[i]['focalPosCm'] = 12
⑥ Tx[i]['fNum'] = 5.0
⑦ Tx[i]['apod'] = ones(transNumElement)

⑧ originAngle = (-acqNum / 2 + i) * (probe_pitch * elementCnt / acqNum)
    originPosX = radiusCm * np.sin( originAngle * np.pi/180.)
    originPosZ = radiusCm * np.cos( originAngle * np.pi/180.) - radiusCm
    Tx[i]['originPosCm'] = np.array([originPosX, 0.0, originPosZ])
    Tx[i]['originElement'] = float(elementCnt) / acqNum * i
⑨ Tx[i]['delay'] = SysLib.computeTXDelay(Tx[i],System,Parameter[0])
⑩ Tx[i]['aperture'] = SysLib.computeTXAperture(Tx[i],System['Transducer'])
```

Setting section for Tx objects.

① Set the number of probe elements for the acquisition number in B mode. (128 in case of SC1-6)

```
acqNum = 128
```

② Create as many Tx objects as the number of acqNum.

```
Tx = SysLib.init_object("Tx",acqNum)
```

③ Enter 0 since there is 1 tw object to be used in Tx object.

```
Tx[i]['twNo'] = 0
```

④ Set the steering angle. It is the form of float, and it is entered as a degree value. (+ and - are possible.)

```
Tx[i]['steerAngleDeg'] = 0
```

⑤ Set 12cm for the focal position.

```
Tx[i]['focalPosCm'] = 12
```

⑥ Set 5.0 for f-number.

```
Tx[i]['fNum'] = 5.0
```

⑦ Tx Apodization is not supported in E-CUBE 12R.

```
Tx[i]['apod'] = ones(transNumElement)
```

⑧ Obtain the origin position (x, y and z coordinates) and the origin element values according to the scan line.

⑨ Calculate Tx delay using computeTXDelay function with the calculated values in ⑧ and focalPosCm as input.

Output is μs value and it consists of 128 arrays.

It is provided in form of function to calculate delay automatically according to the type of transducer by default.

```
Tx[i]['delay'] = SysLib.computeTXDelay(Tx[i],System,Parameter[0])
```

⑩ Calculate Tx Aperture value using the computeTXAperture function with the value calculated in ⑧ as input.

Output value is 128 arrays of 1(close) or 0(open) value.

```
Tx[i]['aperture'] = SysLib.computeTXAperture(Tx[i],System['Transducer'])
```

```
① numFrames = 10
index = 0

② RcvBuffer = SysLib.init_object("RcvBuffer", acqNum*numFrames)
③ for i in range(0,numFrames,1):
    for j in range(0,acqNum,1):
        RcvBuffer[index]['index'] = index
        RcvBuffer[index]['acqNo'] = j
        RcvBuffer[index]['frameNo'] = i
        index = index + 1
```

Setting for the receive buffer.

① Set the number of frames to be acquired.

```
numFrames = 10
```

② Create as many RcvBuffer objects as the number of acqNum * numFrames.

```
RcvBuffer = SysLib.init_object("RcvBuffer", acqNum*numFrames)
```

③ Enter frame index and acquisition index on RcvBuffer object.

```
① Tgc = SysLib.init_object("Tgc", 1)
② Tgc[0]['atgc'] = SysLib.convertToAtgc(Tgc[0], array([128,192,228,255,255,255,255,255]))
```

Enter Time Gain Compensation value.

① Create 1 TGC object. In case of multi mode or for applying a different TGC value, a number of TGC objects can be created.

Tgc = SysLib.init_object("Tgc", 1)

② When 8 points are entered, they are entered and processed as curve based on Max Depth (30cm in case of SC1-6) as shown in the figure below.

```
Tgc[0]['atgc'] = SysLib.convertToAtgc(Tgc[0],
array([128,192,228,255,255,255,255,255]))
```

```
① Rx = SysLib.init_object("Rx",acqNum)
for i in range(0,acqNum,1):
    Rx[i]['acqNum'] = acqNum
② Rx[i]['tgcNo'] = 0
    Rx[i]['numFrames'] = numFrames
③ Rx[i]['originElement'] = float(elementCnt) / acqNum * i
    Rx[i]['aperture'] = SysLib.computeRXAperture(Rx[i],System['Transducer'])
④ Rx[i]['roiNo'] = 0
```

Setting section for Rx objects.

① Create as many Rx objects as the number of acquisitions.

```
Rx = SysLib.init_object("Rx",acqNum)
```

② Enter index of TGC object to be used. Set 0 since there is only 1 TGC here.

```
Rx[i]['tgcNo'] = 0
```

③ Part which calculates aperture according to the scan line.

Aperture is calculated as 64 LV Mux array values consisting of 0(0-63) and 1(64-127) using computeRXAperture function wiith originElement obtained by entering the scan line as input value.

```
Rx[i]['originElement'] = float(elementCnt) / acqNum * i
   Rx[i]['aperture'] =
SysLib.computeRXAperture(Rx[i],System['Transducer'])
```

```
① SeqControl = SysLib.init_object("SeqControl", 1)

② SeqControl[0]['waitTimeToNext']= 0
③ SeqControl[0]['jump']= -1
④ SeqControl[0]['loopCount']= 0
⑤ SeqControl[0]['stop']= 0
⑥ SeqControl[0]['pause']= 0
⑦ SeqControl[0]['triggerOut']= 0
```

Sequence control section.

① Create 1 SeqControl object.

```
SeqControl = SysLib.init_object("SeqControl", 1)
```

② Use the set time interval (PRF) in the system.

```
SeqControl[0]['waitTimeToNext']= 0
```

③ Set not to jump the sequence.

```
SeqControl[0]['jump']= -1
```

④ Set to repeat the sequence.

```
SeqControl[0]['loopCount']= 0
```

⑤ Set not to stop the sequence.

```
SeqControl[0]['stop']= 0
```

⑥ Set not to wait for the input trigger. Set 1 in case input trigger setting is required.

```
SeqControl[0]['pause']= 0
```

⑦ Do not set the output trigger. In case the setting is required, enter a value other than 0.
(e.g. 0x320 – active high, level trigger, 32*25ns length)

```
SeqControl[0]['triggerOut']= 0
```

```
① SeqItem = SysLib.init_object("SeqItem", acqNum*numFrames )

index = 0 # Seq number
for i in range(0,numFrames,1):
    for j in range(0,acqNum,1):
② SeqItem[index]['txNo'] = j
         SeqItem[index]['rxNo'] = j
SeqItem[index]['bufNo'] = acqNum*i+j
SeqItem[index]['ctrlNo'] = 0
          index = index + 1
```

Set the sequence items.

① Create as many SeqItem objects as the number of acqNum * numFrames.

```
SeqItem = SysLib.init_object("SeqItem", acqNum*numFrames )
```

② Set index of tx, rx, rcvBuffer and SeqControl to be used in the sequence.

```
SeqItem[index]['txNo'] = j
SeqItem[index]['rxNo'] = j
SeqItem[index]['bufNo'] = acqNum*i+j
SeqItem[index]['ctrlNo'] = 0
```

```
① Layout = SysLib.init_object("Layout", 1)
② Layout[0]['filter'] = FilterLib.createFilterGraph('Focused_B')
```

Set the layout.

① Create one layout object to be used. In case of dual live, up to two layout objects can be created.

```
Layout = SysLib.init_object("Layout", 1)
```

② In case of B mode, enter the predefined ‘Focused_B’ to create a filter using createFilterGraph function.

```
Layout[0]['filter'] = FilterLib.createFilterGraph('Focused_B')
```

```
savedict = dict(
                SeqItem = SeqItem,
                RcvBuffer = RcvBuffer,
                Parameter = Parameter,
                Roi = Roi,
                Hv = Hv,
                Tw = Tw,
                Tx = Tx,
                System = System,
                Tgc = Tgc,
                Rx = Rx,
                SeqControl = SeqControl,
                Layout = Layout
                )

SysLib.saveMat("SC1-6_Focused",savedict)
```

Create set objects as output files (.mat format) so that they can be used in E-CUBE 12R.

Creating BPAI(Photo Acoustic Imaging) Script

The script is created based on L3-12_BPAI.py, and only a part which is different from 1) Creating Focused Mode (B) is explained.

```
① Roi = SysLib.init_object("Roi", 2)


②
# B ROI
depthCm0 = 6
roiStartElement0 = 0
roiEndElement0 = System['Transducer']['elementCnt']-1


Roi[0] = SysLib.computeRoi("B", "2D", System['Transducer'], [roiStartElement0,
roiEndElement0], [0, depthCm0])
Roi[0]['dtgcNo']= 0
Roi[0]['demodNo'] = 0
Roi[0]['lpfNo'] = 0
Roi[0]['rxApodNo'] = 0
```

Setting ROI

① Create 2 ROI to overlap basic B mode and PAI image.

```
Roi = SysLib.init_object("Roi", 2)
```

② Set RIO for B mode.

```
# PAI ROI
depthCm1  = 4
roiStart1 = 32
roiEnd1   = roiStart1+64-1

③ [1] = SysLib.computeRoi("E", "2D_Overlay", System['Transducer'], [roiStart1, roiEnd1], [0.5, depthCm1])
Roi[1]['dtgcNo'] = 0
Roi[1]['demodNo'] = 0
Roi[1]['lpfNo'] = 0
Roi[1]['rxApodNo'] = 0
④ Roi[1]['srcFilterNo'] = 10
⑤ Roi[1]['bfProc'] = 'PAI' # FOCUSED | PWI | PWI_SPCD | SWEI | PAI
⑥ Roi[1]['mapFilePath'] = r'C:\Program Files\Alpinion\COSMOS\v1\RES\PPC\_Resource\SWEMap\ElastoMapG.map'
⑦ Roi[1]['mapTypeIndex'] = 7
```

Set ROI for PAI.

③ Set PAI area smaller than B mode. Set 4 cm for the depth and 64 scan lines for the width.

```
[1] = SysLib.computeRoi("E", "2D_Overlay", System['Transducer'], [roiStart1, roiEnd1], [0.5, depthCm1])
```

④ Set 10 for the index of the beginning filter to be used in PAI. Set to begin with Filter 10 for PAI when entering the filter item into the Layout object.

```
Roi[1]['srcFilterNo'] = 10
```

⑤ Set ‘PAI’ for the beamforming type.

```
Roi[1]['bfProc'] = 'PAI' # FOCUSED | PWI | PWI_SPCD | SWEI | PAI
```

⑥ Set the map file to be used. Here, ElastoMapG.map file used in SWEI is specified.

```
Roi[1]['mapFilePath'] = r'C:Program Files\Alpinion\COSMOS\v1\RES\PPC\_Resource\SWEMap\ElastoMapG.map'
```

⑦ Set the map type. 7 is SWEI.

```
Roi[1]['mapTypeIndex'] = 7
```

```
acqNum_B = 128
acqNum_PA = 1

① Tx = SysLib.init_object("Tx",acqNum_B+acqNum_PA
```

① Create as many Tx objects as the number of acqNum in B mode and acqNum in PAI.

```
Tx = SysLib.init_object("Tx",acqNum_B+acqNum_PA)
```

```
for i in range(0,acqNum_B,1):
    Tx[tx_idx]['twNo'] = 0
    Tx[tx_idx]['steerAngleDeg'] = 0
    Tx[tx_idx]['focalPosCm'] = 3
    Tx[tx_idx]['fNum'] = 5.0
    Tx[tx_idx]['apod'] = ones(transNumElement)
① Tx[tx_idx]['originPosCm'] = np.array([((-elementCnt / 2) + float(elementCnt)/
    acqNum_B*i) * spacing, 0.0, 0.0])
    Tx[tx_idx]['originElement'] = float(elementCnt) / acqNum_B * i
    Tx[tx_idx]['delay'] = SysLib.computeTXDelay(Tx[tx_idx],System,Parameter[0])
    tx_idx = tx_idx + 1
```

Set Tx objects for B mode.

① Since the transducer type is linear, set x-axis for originPosCm as shown above.

```
Tx[tx_idx]['originPosCm'] = np.array([((-elementCnt / 2) +
float(elementCnt)/acqNum_B*i) * spacing, 0.0, 0.0])
```

```
Tx[tx_idx]['twNo'] = 1
Tx[tx_idx]['steerAngle'] = 0
Tx[tx_idx]['focalPosCm'] = 0
Tx[tx_idx]['fNum'] =1.0
Tx[tx_idx]['apod'] = ones(transNumElement)
Tx[tx_idx]['delay'] = SysLib.computeTXDelay(Tx[tx_idx],System,Parameter[0])
① Tx[tx_idx]['apertureCtrlF'] = 1
Tx[tx_idx]['aperture'] = ones(128)
tx_idx = tx_idx + 1;
```

Set Tx objects for PAI mode.

① Close all Tx Apertures since only Rx is performed.

```
Tx[tx_idx]['apertureCtrlF'] = 1
Tx[tx_idx]['aperture'] = ones(128)
```

```
Tgc = SysLib.init_object("Tgc", 2)
Tgc[0]['atgc'] = SysLib.convertToAtgc(Tgc[0], array([128,192,228,256,256,256,256,256]))
Tgc[1]['atgc'] = SysLib.convertToAtgc(Tgc[1], array([200,200,200,256,256,256,256,256]))
```

Set a different TGC value for B mode and PAI.

```
① Rx = SysLib.init_object("Rx",acqNum_B+acqNum_PA)
②
for i in range(0,acqNum_B,1):
    Rx[index]['acqNum'] = acqNum_B
    Rx[index]['tgcNo'] = 0
    Rx[index]['numFrames'] = numFrames
    Rx[index]['roiNo'] = 0
    Rx[index]['originElement'] = i
   Rx[index]['aperture'] = SysLib.computeRXAperture(Rx[index],System['Transducer'])
    index = index + 1
```

① Create Rx objects for B mode and PA mode.

```
Rx = SysLib.init_object("Rx",acqNum_B+acqNum_PA)
```

Set ② same as setting Rx objects in B mode.

```
for i in range(0,acqNum_PA,1):
    Rx[index]['acqNum'] = acqNum_PA
    Rx[index]['tgcNo'] = 1
    Rx[index]['numFrames'] = numFrames
    Rx[index]['roiNo'] = 1
① Rx[index]['originElement'] = 32 + (64*i)
  Rx[index]['aperture'] = SysLib.computeRXAperture(Rx[index],System['Transducer'])
    index = index + 1
```

Set Rx objects in PA mode.

① In case of PA, set the position of No. 32 element where data is acquired once to set aperture (lv mux).

```
Rx[index]['originElement'] = 32 + (64*i)
```

```
seqControlCnt = 2
SeqControl = SysLib.init_object("SeqControl", seqControlCnt)
SeqControl[0]['waitTimeToNext']= 0
SeqControl[0]['jump']= -1

① SeqControl[1]['waitTimeToNext']= 20000
SeqControl[1]['jump']= -1
② SeqControl[1]['pause']= 1
SeqControl[1]['triggerOut']    = 0
SeqControl[1]['display']= 1
③ SeqControl[1]['noTx']= 1
```

Set 2 SeqControl since an external trigger should be received and processed in PA mode.

SeqControl[0] is SeqControl for normal B mode.

① Set to acquire PA image and then operate the next sequence after 20ms.

```
SeqControl[1]['waitTimeToNext']= 20000
```

② Set 1 for pause to receive data after shooting laser, receive external trigger and operate.

```
SeqControl[1]['pause']= 1
```

③ Set 1 for noTx not to perform Tx for ultrasonic wave.

```
SeqControl[1]['noTx']= 1
```

```
for i in range(0,numFrames,1):
    for j in range(0,acqNum_B,1):
        SeqItem[index]['txNo'] = j
        SeqItem[index]['rxNo'] = j
        SeqItem[index]['bufNo'] = (acqNum_B+acqNum_PA)*i+j
① SeqItem[index]['ctrlNo'] = 0
        index = index + 1
    for j in range(0,acqNum_PA,1):
        SeqItem[index]['txNo'] = j + acqNum_B
        SeqItem[index]['rxNo'] = j + acqNum_B
                SeqItem[index]['bufNo']  =  (acqNum_B+acqNum_PA)*i+acqNum_B+j
#acqNum_PA*i+j +(acqNum_B*numFrames)
② SeqItem[index]['ctrlNo'] = 1
        index = index + 1
```

Set SeqItem.

① Use SeqControl No. 0 in B mode.

```
SeqItem[index]['ctrlNo'] = 0
```

② Set to use SeqControl No. 1 in PA mode.

```
SeqItem[index]['ctrlNo'] = 1
```

```
Layout = SysLib.init_object("Layout", 1)
① Layout[0]['filter'] = SysLib.init_object("Filter", 20)
Filter = Layout[0]['filter']
```

Set the filter arbitrarily for imaging B mode and PA mode.

① Set 20 for the number of filters. Filter objects should be filled as many as the set number of filters.

```
Layout[0]['filter'] = SysLib.init_object("Filter", 20)
```

```
Filter[0]['name'] = 'BHostSource0'
Filter[0]['class'] = 'HostSource'
Filter[0]['type'] = 'Embedded'
Filter[0]['outputMemory'] = 'CUDA'
Filter[0]['nextFilterNo'] = 1

Filter[1]['name'] = 'BBeamformingFilter0'
Filter[1]['class'] = 'BBeamformingFilter'
Filter[1]['type'] = 'Embedded'
Filter[1]['outputMemory'] = 'CUDA'
Filter[1]['nextFilterNo'] = 2
…
…

Filter[7]['name'] = 'BFilter0'
Filter[7]['class'] = 'BFilter'
Filter[7]['type'] = 'Embedded'
Filter[7]['outputMemory'] = 'Host'
Filter[7]['nextFilterNo'] = 8

Filter[8]['name'] = 'BHostToTexture0'
Filter[8]['class'] = 'HostToTexture'
Filter[8]['type'] = 'Embedded'
Filter[8]['outputMemory'] = 'Host'
Filter[8]['nextFilterNo'] = 9

Filter[9]['name'] = 'BScanConversion0'
Filter[9]['class'] = 'BScanConversion'
Filter[9]['type'] = 'Embedded'
Filter[9]['outputMemory'] = 'Host'
Filter[9]['nextFilterNo'] = 18
```

Filter 0~9 are filters for B mode.

```
Filter[10]['name'] = 'PAHostSource0'
Filter[10]['class'] = 'HostSource'
Filter[10]['type'] = 'Embedded'
Filter[10]['outputMemory'] = 'CUDA'
Filter[10]['nextFilterNo'] = 11

Filter[11]['name'] = 'PABeamformingFilter0'
Filter[11]['class'] = 'BBeamformingFilter'
Filter[11]['type'] = 'Embedded'
Filter[11]['outputMemory'] = 'CUDA'
Filter[11]['nextFilterNo'] = 12

Filter[12]['name'] = 'PAEnvelopDetection0'
Filter[12]['class'] = 'BEnvelopDetection'
Filter[12]['type'] = 'Embedded'
Filter[12]['outputMemory'] = 'CUDA'
Filter[12]['nextFilterNo'] = 13
…
…
Filter[18]['name'] = 'BCMerge0'
Filter[18]['class'] = 'BCMerge'
Filter[18]['type'] = 'Embedded'
Filter[18]['outputMemory'] = 'Host'
Filter[18]['nextFilterNo'] = 19

Filter[19]['name'] = 'Render0'
Filter[19]['class'] = 'Render2D'
Filter[19]['type'] = 'Embedded'
Filter[19]['outputMemory'] = 'Host'
```

Filter 10 to the last filter are filters in PA mode. Set to combine images in B mode and PA mode at Filter 18 and print images at Filter 19.

Creating Acq Only Script

The script is created based on L3-12_Unfocused_AcqOnly.py. This is the script to acquire data as longer as possible at once.

```
System['Parameters']['transmitNum']      = transNumElement
System['Parameters']['receiveNum']       = 64
System['Parameters']['cineDataType']     = 0 #Channel=0, BeamFormed=1, IQ=2
① System['Parameters']['dataAcqOnlyMode'] = 1
```

① Set 1 for dataAcqOnlyMode only to acquire. If you set in this way, only channel data is acquired without carrying out beamforming, post-processing and imaging.

```
System['Parameters']['dataAcqOnlyMode'] = 1
```

```
Roi = SysLib.init_object("Roi", 1)
Roi[0]      =      SysLib.computeRoi("B",      "2D",      System['Transducer'],
[roiStartElement, roiEndElement], [0, depthCm])
① Roi[0]['acqTimeUsec'] = 400000
```

① Set to acquire data for 0.4 second. (The available time to acquire data continuously at once is up to 0.41 second.)

```
Roi[0]['acqTimeUsec'] = 400000
```

```
acqNum = 1
Rx = SysLib.init_object("Rx",acqNum)
for i in range(0, acqNum):
    Rx[i]['acqNum'] = acqNum
    Rx[i]['tgcNo'] = 0
    Rx[i]['numFrames'] = recordNum
    Rx[i]['roiNo'] = 0
    Rx[i]['apertureCtrlF'] = 1
    Rx[i]['aperture'] = zeros(64) # 0~63 element receive
```

Since data is acquired continuously by once, 1 is set for acqNum, and it is set to acquire data from 64 elements on the left.

```
seqControlCnt = 1
SeqControl = SysLib.init_object("SeqControl", seqControlCnt)

SeqControl[0]['waitTimeToNext']  = 0
SeqControl[0]['jump']      = -1
SeqControl[0]['noTx']      = 1
SeqControl[0]['pause']      = 0
SeqControl[0]['display']      = 1 #interrupt
```

SeqControl only acquires data so it is set not to perform Tx.

Creating Long burst(pushing pulse) Script

The script is created based on C1-6_Long_Burst.py. This is the script to perform Tx for setting time when pressing the button.

NOTE

To maintain the safety and funtionality of the ultrasound system and the transducer, you must use Long burst carefully.

- You must have a beak before starting Long burst when you use Long burst continuously.
- You cannot use Hv, Tx Aperture, Duty, Pushing Pulse Length, and Frequency at the same time.
- When the limit value is exceeded, the sequence is stopped or controlled and operated appropriately.

```
① Tw = SysLib.init_object("Tw",2)
Tw[0]['waveformType'] = "Parameter"
Tw[0]['freqMHz'] = 3.3
Tw[0]['burstCount'] = 1
Tw[0]['pulseLengthDuty'] = 50
Tw[0]['hvNo'] = 0

Tw[1]['waveformType'] = "Parameter"
Tw[1]['freqMHz'] = 2.3
② Tw[1]['pulseLengthUsec'] = 50000
③ Tw[1]['pulseLengthDuty'] = 70
Tw[1]['hvNo'] = 0
```

Setting section for transmission waveform.

① Create 2 Tw objects. Tw[0] is for common imaging, and Tw[1] is for Long burst.

```
Tw = SysLib.init_object("Tw",2)
```

② Set the Long burst time. The unit of value is μs. Set 50㎳.

```
Tw[1]['pulseLengthUsec'] = 50000
```

③ Set the duty of Long burst. Set 70 for duty of Long burst. (The duty may be limited according to pulseLengthUsec, Freq, Hv, Aperture

Tw[1]['pulseLengthDuty'] = 70

```
#pushing pulse
push_sc = 64
① Tx[tx_idx]['twNo'] = 1
Tx[tx_idx]['steerAngleDeg'] = 0
Tx[tx_idx]['focalPosCm'] = 10.0
Tx[tx_idx]['fNum'] = 3.3
Tx[tx_idx]['apod'] = ones(transNumElement)
originAngle = (-acqNum / 2 + push_sc) * (probe_pitch * elementCnt / acqNum)
originPosX = radiusCm * np.sin( originAngle * np.pi/180.)
originPosZ = radiusCm * np.cos( originAngle * np.pi/180.) - radiusCm
Tx[tx_idx]['originPosCm'] = np.array([originPosX, 0.0, originPosZ])
Tx[tx_idx]['originElement'] = float(elementCnt) / acqNum * push_sc
Tx[tx_idx]['delay'] = SysLib.computeTXDelay(Tx[tx_idx],System,Parameter[0])
② Tx[tx_idx]['apertureCtrlF'] = 1
③ Tx[tx_idx]['aperture'] = ones(128)
④ Tx[tx_idx]['aperture'][0:64] = zeros(64)
```

Set Tx objects for Long burst.

① It means Tw[1] object for Long Burst.

```
Tx[tx_idx]['twNo'] = 1
```

② Set 1 to control Tx Aperture manually.

```
Tx[tx_idx]['apertureCtrlF'] = 1
```

③ Initialize Tx Aperture(128 channel). (1 : off, 0: on)

```
Tx[tx_idx]['aperture'] = ones(128)
```

④ Turn on the 0 ~ 63 Tx channel.

```
x[tx_idx]['aperture'][0:64] = zeros(64)
```

```
① SeqControl[0]['jump']= -1
② SeqControl[1]['jump']= 0
③ SeqControl[2]['waitTimeToNext']= Tw[1]['pulseLengthUsec'] + 30000
④ SeqControl[2]['jump']= 0
SeqControl[2]['loopCount']= 0
SeqControl[2]['stop']= 0
SeqControl[2]['pause']= 0
SeqControl[2]['triggerOut']          = 0x320   # level trigger & high active
& 32 clk length
⑤ SeqControl[2]['noRx']= 1
```

Set seqControl objects for Long burst.

①② Use 'jump' to skip Long burst sequence. Long burst only performed when you press the button. -1 means moving to next sequence, and 0 means moving to Sequence 0.

```
SeqControl[0]['jump']= -1
SeqControl[1]['jump']= 0
```

③ Set waitTimeToNext to have a break after performing Long burst. If you do not have a beak, transducer may be damaged.

```
SeqControl[2]['waitTimeToNext']= Tw[1]['pulseLengthUsec'] + 30000
```

④ Perform Long b and jump to Sequence 0.

```
SeqControl[2]['jump']= 0
```

⑤ Set not to use Rx because only Tx is perfomed.

```
SeqControl[2]['noRx']= 1
```

```
# imaging sequence
for i in range(0,numFrames,1):
    for j in range(0,acqNum,1):
        SeqItem[index]['txNo'] = j
        SeqItem[index]['rxNo'] = j
        SeqItem[index]['bufNo'] = acqNum*i+j
① if j == acqNum - 1 :
            SeqItem[index]['ctrlNo'] = 1  # move to first event
        else:
            SeqItem[index]['ctrlNo'] = 0  # move to next event
        index = index + 1

# push seq
SeqItem[index]['txNo'] = acqNum
SeqItem[index]['rxNo'] = 0
SeqItem[index]['bufNo'] = 0
② SeqItem[index]['ctrlNo'] = 2  # move to first event & no RX
```

Set SeqItem.

① Perform the sequence as the number of acqNum to move to sequence 0.

```
if j == acqNum - 1 :
            SeqItem[index]['ctrlNo'] = 1  # move to first event
    else:
            SeqItem[index]['ctrlNo'] = 0  # move to next event
```

② Set SeqControl[2] for Long burst. You can move to imaging sequence(0) without Rx.

```
SeqItem[index]['ctrlNo'] = 2  # move to first event & no RX
```

```
EventHandler = SysLib.init_object("EventHandler", 1 )
① EventHandler[0]['seqJumpEvent'] = acqNum*numFrames      # event index
```

Create Button event handler objects.

① Assign SeqJumpEvent as the default menu on the **Research** tab. You can jump assigned index when selecting **SeqJumpEvent**. In this script, Ling burst sequence is assigned as the index. You can perform Long burst when selecting **SeqJumpEvent**.

```
EventHandler[0]['seqJumpEvent'] = acqNum*numFrames      # event index
```

Creating AWG Script

The script is created based on SC1-6_non_Chirp_Harmonic.py. This is the script using nonlinear chirp.

```
① chirp = sp.io.loadmat('DATA\\H_chirp_2p6_non_bw5.mat') #non-chirp 2M
② tx_seq = chirp['Chirp_seq'].transpose();
③ rx_seq = chirp['matched_filter'].transpose();

Tw = SysLib.init_object("Tw",1)
④ Tw[0]['waveformType'] = "Waveform"
Tw[0]['freqMHz'] = 3.3
Tw[0]['burstCount'] = 1
Tw[0]['pulseLengthDuty'] = 50
Tw[0]['hvNo'] = 0
⑤ Tw[0]['apod'] = ones(128)
⑥ Tw[0]['waveA'] =tx_seq
```

Set Tw objects to use Waveform.

① Load matlab file of nonlinear chirp wave.

```
chirp = sp.io.loadmat('DATA\\H_chirp_2p6_non_bw5.mat') #non-chirp 2M
```

② Acquire the waveform data from loading chirp data.

```
tx_seq = chirp['Chirp_seq'].transpose();
```

③ Acquire the value of filter coefficient from chirp demodulation.

```
rx_seq = chirp['matched_filter'].transpose();
```

④ Set waveformType as “Waveform” to use waveform.

```
Tw[0]['waveformType'] = "Waveform"
```

⑤ Set all Tx apodization to 1 for 128 channels. Multiply waveform by each channel.

```
Tw[0]['apod'] = ones(128)
```

⑥ Enter the acquired waveform for waveA. The value of arrays is up to ±127 ~ 128. If you set 1 x SampleNumber array, same waveform is applied to all channels. You can apply different waveform by channels when you set 128 x SampleNumber array. Other arrays except 1 and 128 array are not performed.

```
Tw[0]['waveA'] =tx_seq
```

```
Filter[2]['name'] = 'BDemodulation0'
Filter[2]['class'] = 'BDemodulation'
Filter[2]['type'] = 'Custom'
① Filter[2]['filepath'] = r'c:\Program Files\Alpinion\SDK\1.0\bin\ChirpDemodFilter.dll'
Filter[2]['param']['NumberOfFRCD'] = int(1)
② Filter[2]['param']['MatchedFilterCoeff0'] = array(float32(rx_seq))
Filter[2]['param']['MatchedFilterCoeff1'] = array(float32(rx_seq))
Filter[2]['param']['MatchedFilterCoeff2'] = array(float32(rx_seq))
Filter[2]['param']['BlendingCoeff'] =""
Filter[2]['outputMemory'] = 'CUDA'  # CUDA or Host
Filter[2]['nextFilterNo'] = 3
```

Use the CustomFilter to perform nonlinear chirp imaging.

① Designate the path of ChirpDemodFilter.dll.

```
Filter[2]['filepath'] = r'c:\Program Files\Alpinion\SDK\1.0\bin\ChirpDemodFilter.dll'
```

② Enter the value of Coefficient acquired from the chirp matlab file.

```
Filter[2]['param']['MatchedFilterCoeff0'] = array(float32(rx_seq))
```

11

Executing E-CUBE 12R

This chapter provides the transducer overview and biopsy preparations.

Transducer Overview 2

Biopsy Special Concerns 5

Preparing for Biopsy 6

Transducer Overview

The E-CUBE 12R ultrasound system supports the following types of transducers: Most of them have a state of art in transducer technology.

Type	Trasducer	Frequency	Elements	Key feature	Intended Application
Linear array	L3-12	8.5 MHz	128	Short pulse length and high sensitivity transducer	Breast, Musculoskeletal (MSK), Emergency Medicine (EM), Vascular, Small Parts
	L3-12H	8.5 MHz	192	Short pulse length and high sensitivity transducer	Breast, Musculoskeletal (MSK), Emergency Medicine (EM), Vascular, Small Parts
Convex array	SC1-4H	3.5 MHz	192	Broadband and high sensitivity single crystal transducer	Abdomen, OB/GYN, Emergency Medicine (EM)
	SC1-6	4.0 MHz	128	Broadband and high sensitivity single crystal transducer	Abdomen, OB/GYN, Emergency Medicine (EM)
Phased array	SP1-5	3.0 MHz	64	Broadband and high sensitivity single crystal transducer	Abdomen, Cardiac, Emergency Medicine (EM)

Transducer features

Table 8-1 Transducer feature

Feature / Model	Harmonics (THI)	Speckle Reduction Imaging (SRI)	Multi-beam	Biopsy	4D	Easy 3D	Virtual Convex	Spatial Compounding
L3-12	o	o	o	o	x	x	o	o
L3-12H	o	o	o	o	x	x	o	o
SC1-4H	o	o	o	o	x	x	x	o
SC1-6	o	o	o	o	x	x	x	o
SP1-5	o	o	o	x	x	x	x	x

Transducer applications

Table 8-2 Transducer application

Feature / Model	Abdomen	Obstetrics (OB)	Gynecol -ogy (GYN)	Cardiac	Urology	Vascular	Breast	Musculoskel-etal(MSK)	Small Parts	Emergency Medicine (EM)
L3-12						o	o	o	o	o
L3-12H						o	o	o	o	o
SC1-4H	o	o	o							o
SC1-6	o	o	o							o
SP1-5	o			o						o

Biopsy Special Concerns

Precautions concerning the use of biopsy procedure

WARNING

- Do not freeze the image during a biopsy procedure. The image must be live to avoid a positioning error. Biopsy guidezones are intended to assist the user in determining optimal transducer placement and approximate the needle path. However, actual needle movement is likely to deviate from the guideline. Always monitor the relative positions of the biopsy needle and the subject mass during the procedure.
- Biopsy procedures should not be used for In vitro fertilization (IVF), Chronic villus sampling (CVS), and Percutaneous umbilical blood sampling (PUBS).

CAUTION

- The use of biopsy devices and accessories that have not been evaluated for use with this equipment may not be compatible and could result in injury.
- The invasive nature of biopsy procedures requires proper preparation and technique to control infection and disease transmission. Equipment must be cleaned as appropriate for the procedure prior to use.
  - Follow the transducer cleaning and disinfection procedures and precautions to properly prepare the transducer.
  - Follow the manufacturer's instructions for the cleaning of biopsy devices and accessories.
  - Use protective barriers such as gloves and transducer sheaths.
  - After use, follow proper procedures for decontamination, cleaning, and waste disposal.
- Improper cleaning methods and the use of certain cleaning and disinfecting agents may cause damage to the plastic components that will degrade imaging performance or increase the risk of electric shock. For details, see ***Transducer Safety Information*** on page 14-6.
- A biopsy must only be performed by physicians with adequate experiences under all circumstances the necessary safety precautions and sterility measures have to be respected.

Preparing for Biopsy

The biopsy guidezone display

The biopsy guidezone represents a path of the needle. Colored markers in each dotted guideline show the actual increments in the area of the anatomy.

- Yellow marker is represented by 1 cm increment of the needle depth.
- Blue marker is represented by 5 cm increment of the needle depth.

NOTE

When **Enable 0.5cm markers** in Image Preset is selected, each yellow maker represents 0.5 increment.

The display should be carefully monitored during a biopsy for any needle deviation from the center line and the guidezone. The biopsy guidezone appears along with image adjustments such as image invert, rotation, zoom, and depth change.

Figure 8-17 Biopsy guidezone

Preparing the biopsy guide attachment

The each transducer (Convex, sector, and linear transducers) has the optional biopsy guide attachment. The guide consists of a non-disposable bracket to attach to the transducer, disposable needle clip to attach to the bracket, sheath, coupling gel, and disposable needle guide. The disposable needle guides are available for a variety of needle sizes.

NOTE

Please refer to the manufacturer's instructions included in the biopsy kit.

The following table shows the multi-angle biopsy guide availability for transducers.

Table 8-3 Multi-angle biopsy guide

Transducer	Multi-angle support	Angle 1 (Target depth)	Angle 2 (Target depth)	Angle 3 (Target depth)
L3-12	O	1.5 cm	2.5 cm	3.5 cm
L3-12H	O	1.5 cm	2.5 cm	3.5 cm
SC1-4H	O	4 cm	7 cm	10 cm
SC1-6	O	4 cm	7 cm	10 cm

Assembling the multi-angle biopsy guide

WARNING

DO NOT attempt to use the biopsy bracket and needle guide until the manufacturer's instructions, provided with the biopsy bracket and needle guide in the kit, have been read and thoroughly understood.

1. Scan the patient and identify the target for biopsy. Move the transducer to locate the target to the center of the image. Enable the system biopsy guidezone and try guidezone angles 1 to 3 to decide the best angle setting for the needle path.
2. Prepare the appropriate biopsy guide bracket by matching the transducer label on the bracket with the transducer to be used.

3 Orient the guide bracket toward the orientation mark of the transducer, and then attach the bracket by sliding it over the end of the transducer until it clicks in place.

Convex transducer

Linear transducer

NOTE

Depending on the transducer you are using, attaching the guide bracket may be different. Refer to the manufacturer's instruction included in the biopsy kit.

4 Pull out the knob to release the needle guide attachment.

5 Move the needle guide attachment to a desired angle position (angle 1, 2, or 3) and push the knob down to secure the angle position.

CAUTION

Hold the bracket in place on the transducer when pushing the knob to secure the angle position of the needle guide attachment. Excessive force may cause the bracket to release from the transducer.

6 Spread the coupling gel thoroughly on the transducer surface.

7 Cover the transducer and biopsy bracket with a sanitary sheath. Use the rubber bands to tighten the sheath.

8 Snap the needle clip onto the biopsy guide bracket.

9 Push the locking mechanism towards the bracket to secure the lock. Make sure that the needle guide is firmly attached to the bracket.

10 Select a desired size of the needle barrel from the plastic tree. Twist the needle barrel back and forth to remove it.

11 Place the needle barrel into the needle clip until it clicks into place.

CAUTION

Before performing a biopsy, ensure that all guide parts are seated properly.

Biopsy procedure

WARNING

- Biopsy procedure must be performed on a live image to avoid positioning error.
- Before starting a biopsy, make sure that all patient information is entered and the study is saved.

When the biopsy guide assembly is completed, perform the following biopsy procedure.

1 Scan an image. When you find a target image, place the target in the middle of the guidezone.

NOTE

Enabling Color flow mode would allow for visualization of vascular structure around the area to take a biopsy.

2 When the target image is prepared, press the **Biopsy** key once, twice, or three times on the QWERTY keyboard that corresponds to the selected angle. The biopsy guidezone appears on the display.

- Press the key once for angle 1.

- Press the key twice for angle 2.

- Press the key three times for angle 3.

CAUTION

Ensure that the selected angle on the biopsy guide corresponds to the selected guide line of the guidezone.

3 Place the needle in the guide line between the needle barrel and the needle clip. Direct it into the area of interest.

NOTE

To configure the biopsy guidezone settings, press the **Image Preset** key and go to **General**.

Releasing the needle

After performing a biopsy, release the needle from the attached biopsy guide of the transducer by following the procedure.

1 Push down the sleeve of the needle clip.

The needle is released from the assembly.

2 Pull out the needle from the needle clip of the transducer.

12

Preset

This chapter provides the preset features that you can configure the default settings of your system.

System Preset 2

Image Preset 35

System Preset

In each preset menu, you can configure different default settings for its submenus.

Table 9-1 System preset menu

Preset menu	Description
System	Customize the system configurations such as general settings, control panel, peripheral, patient info, and monitor calibration.
Annotation	Customize the comment and body pattern settings.
Measurement	Customize the labeled measurement for each study and create a new measurement and OB table.
User Setting	Customize the user-defined settings.
Connectivity	Customize the DICOM device and service.
Administration	Create a user ID, activate the service browser, and view the option information.
Advanced Cardiac	Customize the settings for the Stress echo and Cube strain™ functions.

NOTE

After changing some preset menus, you may need to reboot the system.

General usage

To enter the **System Preset** menu,

1. Select **E-Tool** on the touch screen, or press the **System Preset** key on the QWERTY keyboard.
2. To scroll though the current page, press the **Navigate** soft key.
3. To exit the menu, press the **System Preset** or **2D** key. You can also click **Exit**.

To change the settings in System Preset,

1. Select **E-Tool** on the touch screen, or press the **System Preset** key on the QWERTY keyboard. The **General** screen appears.
2. Select a desired menu from the left side of the display.
3. Use **Trackball** to select the menu tab you want.
4. Change the settings for the selected menu.
5. When you are finished, press the **Save** soft key and then click **Yes** to save the changes.
6. Click **Exit** to return to Scan mode.

NOTE

- To restore the settings on the current menu screen, click **Factory Default**.
- To restore all settings of the system preset, click **Factory Default All**.

System

The **System** menu contains the following submenus:

- General
- Control Panel
- Peripheral
- Patient Info
- Monitor

General

The **General** menu allows you to configure the general system settings such as hospital, time and date, and screen saver.

Organization

- **Hospital**: Enter a hospital name.
- **Department**: Enter a department name.
- **Logo Path**: Import a hospital logo to be shown on the top of the display.

To import a hospital logo from a USB drive,

1. Insert a USB driver that stores a hospital logo to the system.
2. Click **...** to find the file path.
3. When the file selection dialog box appears, select the logo file you want.
4. Click **OK**.

NOTE

- The supported file formats are BMP, PNG, and JPG only.
- You may not import a hospital logo from a CD or DVD.

Location

- **Language**: Change the display language.

  NOTE

  After changing the language, you need to reboot the system.

- **Unit**: Select a measurement unit, **Metric** or **US**. When you select **US**, all units are changed from centimeter to inch.

Power Off

- **Power Off**: Set how the system powers off when you press the **Power On/Off** key.
  - **Shutdown dialog**: Set to show the shutdown dialog box.
  - **Immediately**: Set to power off immediately.

Monitor

- **Enable screen saver**: Set to activate Screen saving mode.
- **Delay**: Specify the time of inactivity.

Date / Time

- **Date Format**: Select a desired date format.
- **Time Format**: Select a desired time format.

To change the current date and time,

1. Click **Date / Time** under **Time Format**.
2. Click the **Date & Time** tab and change the current date and time.

Figure 9-1 Date & Time

3 Click the **Time Zone** tab and select your time zone.

To set Daylight Savings Time (DST), select the **Automatically adjust clock for daylight saving changes** check box.

Figure 9-2 Time zone

4 Click **OK** to save the changes.

Transducer

- **Default Port**: Select a default transducer port when the system powers on.

Monitor Info

- **Size**: Set the monitor size to use.

Touch Screen Volume

- **Volume**: Adjust the volume of the touch screen.

Control Panel

The **Control Panel** menu provides options for trackball and the control panel keys.

Trackball

- **Trackball Travel Speed**: Change the trackball speed (Slow, Medium, Fast).
- **Trackball Cine Speed**: Change the speed for scrolling through CINE sequences (Slow, Medium, Fast).

Key

- **Application**: Select a default application that is used for the selected function on freezing.
- **Active Function on Freeze 2D**: Select a function (Cine, Measurement, Body pattern, Arrow) to be activated after freezing an image in 2D mode. The selected function automatically activates when you press the **Freeze** key.
- **Active Function on Freeze M**: Select a function (Cine, Measurement, Body pattern, Arrow) to be activated after freezing an image in M mode. The selected function automatically activates when you press the **Freeze** key.
- **Active Function on Freeze D**: Select a function (Cine, Measurement, Body pattern, Arrow) to be activated after freezing an image in Doppler mode. The selected function automatically activates when you press the **Freeze** key.
- **Backlight Intensity**: Set the brightness of the key backlight (High, Low, Off).
- **CCW Depth Control**: Set to operate the **Depth** key when you rotate the key counter-clockwise.
- **Switch the Cursor and Set Keys**: Switch the key function between the **Cursor** key and **Set** key.
- **Switch Single(Dual) and P1(P2)**: Switch the key function between the **Single** key and **P1** key, or between the **Dual** key and **P2** key.

Audio

- **'Beep' sound only when the 'Print, P1, P2'key are Pressed**: Set to play a beep when you press the **Print**, **P1**, and **P2** keys.

Patient Info

The **Patient Info** preset provides useful options related to patient management and E-view, and allows you to configure the patient banner display option.

Patient Information

- **Hide Patient Information**: Select to hide patient information on patient banner.
- **Patient Banner Line1**: Select the patient information to display patient banner line1 from the drop-down list.
- **Patient Banner Line2**: Select the patient information to display patient banner line2 from the drop-down list.

Patient Package Option

- **Auto ID Generation**: Set the system to automatically create a new patient ID when you select **New Patient**.
- **Auto Search for Patient**: Set the system to automatically search for the patient data when you enter the first letter of a patient ID in the ***Patient ID*** field.
- **Auto Logon**: Set the system to log on automatically.
- **Auto Archiving Patient Data**: Set the system to save the current patient data to archive automatically.
- **Use Birthdate**: Set the system automatically to enter an age when you enter a patient's birthdate.
- **Default Layout**: Select a default image layout.

Archive Option

Select an archive to be used for saving data when you select **End Study**. You can also add and remove a DICOM service such as DICOM storage and DICOM print.

NOTE

The default archive "**Local Archive**" cannot be deleted.

Monitor

You can adjust the display pattern using gray bars and color bars. After the monitor adjustment, you need to check your peripherals. To adjust the monitor, see ***Adjusting the Monitor*** on page 2-5.

Figure 9-3 Gray & Color bars

NOTE

After adjusting the monitor settings, you may need to verify the peripheral functions, such as standard printer and DVR.

Annotation

The **Annotation** menu allows you to specify body pattern/text options and to define body pattern/text libraries on the context menu. The following menus are available: General, Body Pattern, and Text.

General

The **General** menu allows you to configure the text and body options.

Text Preset

- **Font Color**: Select a font color for comment.
- **Font Size**: Select a font size (Small, Medium, or Large).
- **Arrow Size**: Select an arrow size (Small, Medium, Large, or X Large).
- **Keep arrow's head position when trackball is moving**: Set to fix the arrow's head position when you move **Trackball**. When this option is not selected, the arrow's head position changes with the movement of **Trackball**.
- **Erase Text when image is unfrozen**: Set to erase all comments on the display when you press the **Freeze** key to return to Scan mode.
- **Erase Text when changing Transducer or Exam**: Set to erase all comments on the display when you change the transducer or study.
- **Erase Text when entering M mode or PW mode**: Set to erase all comments on the display when you enter M mode or PW mode.
- **Add Text in a row before complete**: Set to add comments in a row until you press the **Set** key.
- **Erase Text when entering Dual mode**: Set to erase all comments on the screen when the display is changed to the dual layout screen.
- **Select the 'Word Grab' to move a group of words in the screen**: Set to select text by a group of words. When this option is not selected, text is selected by a word.
- **Keep the Arrow mode when Set button is pressed**: Set to leave an arrow mark at the position where you press the **Set** key.
- **Turn off Auto-Complete when entering Text mode**: Set to automatically deactivate Auto-Complete function when you enter Text mode.

Body Pattern Preset

- **Erase bodypattern when image is unfrozen**: Set to erase the body pattern on the display when you press the **Freeze** key to return to Scan mode.
- **Erase body pattern when changing Transducer or Exam**: Set to erase the body pattern on the display when you change the transducer or study.
- **Copy to active side in multiple image**: Set to copy the body pattern on the selected image in the dual or quad layout screen.
- **Set as default position when Bodypattern is moved**: Set to show the last position movement of the body pattern when you press the **Move Pattern** soft key.
- **Activate Probe marker when Bodypattern is selected**: Set to activate the transducer marker when you enter the **Body Pattern** menu.
- **Erase bodypattern when pressing Clear key**: Set to erase the saved body patterns when you press the Clear key in Scan mode.

Body Pattern

The **Body Pattern** menu allows you to define and change body pattern libraries. The left side of the body pattern menu shows all available body pattern libraries, and the right side shows the specific body patterns for the selected library.

Once you have defined body patterns for a library, they are shown on the context menu of the Body Pattern menu.

NOTE

To specify the default library per each preset, go to **User Setting** > **Annotation**.

To add a body pattern,

1. Select the library you want to add a body pattern from the library list.
2. Use **Trackball** to select a body pattern, and press the **Set** key twice or click **Add**.

   The body pattern is shown on the bottom of the library.
3. To change the position of the body pattern, select the body pattern and click **Up**/**Down**/**Left**/**Right**.
4. Press the **Save** soft key and then click **Yes** to save the changes.

To delete a body pattern,

1. Select the library you want to delete a body pattern from the library list.
2. Use **Trackball** to select a body pattern, and press the **Set** key.
3. Click **Delete** to delete the body pattern.
4. Press the **Save** soft key and then click **Yes** to save the changes.

To change the location of a body pattern,

1. Select the library you want from the library list.
2. Use **Trackball** to select a body pattern, and press the **Set** key.
3. Click **Up**, **Down**, **Left**, or **Right** to change the location of the body pattern.
4. Press the **Save** soft key and then click **Yes** to save the changes.

Text

The **Text** menu allows you to change and define the text libraries. The left side of the Text menu shows all available text libraries, and the right side shows the specific text for the selected library. For each library, you can define up to one column with twenty three rows. The defined text is shown on the context menu of Text mode.

To add a text,

1. Select the library you want from the library list.

   The system shows all texts saved in the library.

2. Use **Trackball** to select a text, and press the **Set** key.

   The text is shown on the bottom of the library.

3. Click **Add** to add the selected text.
4. To change the text position, select the text and click **Up** or **Down**.
5. Press the **Save** soft key and then click **Yes** to save the changes.

To create a new text,

1. On the ***New Text*** field, press the **Set** key.
2. Enter a new text and click **Add**.

   The new text is shown on the bottom right of the library.

To delete a text,

1. Select the library you want from the library list.
2. Use **Trackball** to select a text and press the **Set** key.
3. Click **Delete** to delete the text.
4. Press the **Save** soft key and then click **Yes** to save the changes.

To change the text location,

1. Select the library you want from the library list.
2. Use **Trackball** to select a text and press the **Set** key.
3. Click **Up** or **Down** to change the text location.
4. Press the **Save** soft key and then click **Yes** to save the changes.

Measurement

The **Measurement** menu allows you to specify measurement and calculation preset.

General

The **General** menu allows you to define the cursor and result window settings.

General

- **Repeat Measurement**: Set to repeat the measurement.
  - **Repeat**: The selected measurement on the context menu is repeated.
  - **None**: The measurement is not repeated.
  - **Default Measurement**: The basic measurement is repeated (e.g. Distance).
- **Tissue Depth display(2D,M)**: Set to show the tissue depth (depth from the transducer surface) when moving the measurement cursor in 2D or M mode.

Caliper

- **Caliper Type**: Select a caliper type (Number or Symbol).
- **Caliper Size**: Select a caliper size (Normal or Large).
- **Caliper Color**: Select a color for the fixed measurement cursor.
- **Caliper Line Width**: Select a line width of the caliper (Thin, Normal, or Thick).
- **Ellipse cross line display**: Set to show the cross line for ellipse.
- **Caliper line display**: Set to show the caliper line when measurement is completed.
- **D mode caliper cross line display**: Set to show the cross line of the caliper in D mode.
- **M mode caliper cross line display**: Set to show the cross line of the caliper in M mode.

Result Window

- **Format**: Select a window format (Wide or Narrow).
- **Direction**: Select a window direction (Top down or Bottom up).
- **Font Size**: Select a font size (Small, Medium, or Large).
- **Font Color**: Select a font color.
- **Position 2D**: Select a default position of the result window in 2D mode (Left Top, Left Bottom, Right Top, or Right Bottom).
- **Position TimeLine**: Select a default position of the result window in M and PW modes (Left Top, Left Bottom, Right Top, or Right Bottom).
- **Transparency**: Set to show the window background transparent or opaque.

Basic MEAS.

The basic measurement preset shows all settings for the basic measurement in each application. Depending on the application, available settings may vary. You can define the basic measurement and default method for each basic measurement. You can control basic measurement by using the soft keys in each measurement mode.

1 Select a measurement application.

2 Select a measurement mode (2D, M, or Doppler mode). The basic measurement entries of the selected measurement mode appear on the table.

NOTE

The order of the basic measurement is the same as on the soft key menu.

3 Specify **Default Measure Key Sequence**.

For example) OB1, M mode: Select 2 Sequences (Distance, Time) or 3 Sequences (Distance, Time, Slope).

4 When you select **Distance**, **Time** for 2 Sequences, the distance caliper will be shown by pressing the **Measure** key once. The time caliper will be shown by pressing the **Measure** key twice.

Labeled MEAS.

This preset menu shows all settings for the labeled measurement. You can control labeled measurement using the context menu in the measurement mode.

1. Select a measurement application from the drop-down list.
2. Select a measurement mode (2D, M, or Doppler mode).
3. All of the available measurement lists appears on the left of the measurement window. The default measurements are shown on the context menu.
4. To add a measurement to the context menu, select a measurement from the **Available Measurement** list and click **Add**.
5. To delete a measurement from the context menu, select a measurement from the **Default Measurement** list and click **Delete**.
6. To change the order of a measurement from the context menu, select a measurement from the **Default Measurement** list and click **Up** or **Down**.
7. To enable automatic sequence measurement, select **Auto Sequence**.

NOTE

You can change the author in the OB measurement.

Creating a new measurement

To create a new measurement entry,

1. Click **New Measurement**.
2. Specify the following measurement information.
   - **Measurement Name**: Enter a measurement name. Make sure that the measurement name is unique.
   - **Measurement Type**: Select a measurement type among Distance, Area, Angle, Volume, and Disk volume from the drop-down list.
   - **Caliper Type**: Select a caliper type from the drop-down list.
   - **Parameter**: Set to show Parameter, Parameter Type, Unit, Precision and Method. You can modify Unit, Precision and Method by changing them from the drop-down list.

NOTE

Depending on the measurement mode, available measurement types and caliper types may differ.

3 After creating a new measurement, the **Available Measurement** window appears.

Creating a new calculation

To create a new calculation on a defined measurement,

1 Click **New Calculation**.

2 Enter a calculation name.

3 Select an operator from the **Operator** list and click **<<** to add. You can see your operator on the ***Formula*** field.

4 Select a parameter from the **Parameter** list and click **<<** to add. You can see your parameter on the ***Formula*** field.

NOTE

Use only available parameters and operators to make your own formula.

5 When you complete the formula, click **Check** to verify that the syntax is correct.

6 Select **Display Unit** and **Display Precision** on the list for the output.

7 To save the settings and return to the previous window, click **OK** and then **Yes**.

Editing a measurement

To edit the customized measurement,

1. Select a measurement from the list and click **Edit** or double-click the measurement.

   The **Edit Measurement** window appears on the screen.

2. Add or change the calculation by using **New Calculation** and **Edit Calculation**, and then change Unit, Precision and Method for report.

3. Click **OK** and then **Yes** to save your changes.

NOTE

The default measurements cannot be edited.

Editing a calculation

To edit the customized calculation,

1. Select a caluation and click **Edit Calculation**.

   The ***Edit Calculation*** window appears on the screen.

2. Change the formula and output format such as Method, Unit, and Precision.

3. Click **OK** and then **Yes** to save your changes.

Deleting a measurement

To delete a measurement entry,

1. Select a created measurement from the **Available Measurement** window.
2. Click **Del.Measurement**.

Deleting a calculation

To delete a calculation,

1. Select a measurement from the list.
2. Click **Del.Calculation**.

NOTE

The default measurements cannot be edited or deleted.

Setting up the automatic sequence for EFW

The automatic sequence feature allows you to perform EFW measurements in sequence.

1. Press the **System Preset** key and go to **Measurement** > **Labeled MEAS.**
2. Select an OB application from the **Available Measurement** list.
3. Select an EFW folder and click **Add**.
4. Double-click the selected measurement.
5. Select the **Auto Sequence** check box on the top of the **Default Measurement** list.

OB MEAS.

This menu allows you to define default OB presets such as OB type and OB graph. You can also register a user-defined OB table.

General

- **OB Type**: Select an OB type (USA, Europe, Tokyo, Osaka or ASUM) from the drop-down list for the measurement and calculation. The default measurement list may differ depending on the selected OB type.
- **Default US Age Type(Hadlock)**: Select CUA (Composite Ultrasound Age) or AUA (Average Ultrasound Age).
- **Table Type (Hadlock)**: Select Hadlock82 or Hadlock84 for OB table.
- **OB Graph Single**: Select EFW or Last for displaying OB graph as default.
- **Add 1 Week to EDD**: Set to add additional week to estimated the date of delivery.

Calculations

- **EFW GP**: Select Hadlock, Brenner, or Williams to calculate EFW GP (Estimated Fetal Weight Growth Percentile).
- **EFW Formula**: Select Hadlock, Campbell, Hansmann, Merz, Osaka, Persson, Schild, Shepard, Shinosuka1, Shinosuka2, Shinosuka3, or Tokyo.
- **EFW (Hadlock Method)**: Select (HC, AC), (AC, FL), (AC, BPD), (AC, BPD, FL), (AC, FL, HC), or (AC, BPD, FL, HC).
- **EFW Unit**: Change the measurement unit for EFW.

Creating a new OB table

1. Click **New Table**.
2. Enter an author name.

> **NOTE**
> Author name always should be unique.

3. Select options in the **Biometry** and **Ref. Author** fields.
4. Select **Fetal Age** or **Fetal Growth**.
5. When you selected **Biometry** and **Ref. Author**, the pre-defined values are shown on the table, and you can edit the table value. When you selected **None** from **Ref. Author**, the table will be reset.
6. Select **SD Format** for a deviation type.
7. Select **Input Unit** for input and **Output Unit** for output.
8. Enter **Min**, **Max**, and **Interval** for range. The system creates default values on the table automatically. For the other options, you can manually enter or edit the values.
9. To enter the value, move the cursor to the desired field and press the **Set** key.
   - To move the row, click ← or →. You can also press the **Enter** key to move to the next row.
   - To move to the column, click ↑ or ↓.
10. To add additional line, click **Insert**.
11. To delete a line, click **Delete**.
12. To clear all values, click **Clear All**.
13. When you are finished, click **OK** and then **Yes** to save your changes.

For example)

To create a table,

1. Select **AC** in the ***Biometry*** field.
2. Select **Hansmann** in the ***Ref. Author*** field.
3. Enter “TEST” in the ***Author*** field.
4. Select **Fetal Age** or **Fetal Growth** for table type.
5. After creating a new table, you can assign “TEST” as the default author on the ***Labeled MEAS***. tab. You can also change TEST author on the report page.

Editing an OB table

Once you have created your own table, you can edit the table by clicking **Edit Table**. You can only edit the table values, not the table type. The editing table procedure is the same as ***New Table***.

NOTE

The default tables and equations cannot be edited.

Creating a new OB equation

1. Click **New Equation**.
2. Enter an author name.

   NOTE

   Author name should always be unique.

3. Select an option in the ***Biometry*** field.
4. Select **Fetal Age** or **Fetal Growth** for equation type.

5 To make a formula, select formula components from the ***Inputs*** and ***Operators*** fields, and enter a formula in the formula field.

6 Click **Check** to test the formula. If there are no errors, the "Syntax OK!" appears. If any error occurs on the formula, an error message appears in the formula field.

7 Specify the input range for the ***Min*** and ***Max*** fields.

8 Click **OK** and then **Yes** to save your changes.

Available operators for equation

The following table shows available operators for using equation.

Table 9-2 Equation operator

Operator	Definition
+	Addition
-	Subtraction
*	Multiplication
/	Division
( )	Parenthesis
^	Caret
sqrt	Square root
pi	Pi
log	Logarithm
ln	Natural logarithm
exp	Exponential
abs	Absolute value

Edit Equation

Once you have created your own equation, you can edit the equation by selecting **Edit Equation**. The editing equation procedure is the same as **New Equation**.

Advanced MEAS.

The **Advanced MEAS.** menu allows you to define application parameters, especially the Doppler measurement.

Measurement Application: select an application to be defined.

Application Settings

- **HR Cycle**: Select a heart rate cycle (1-10).
- **Default Location**: Select a default location for the selected application (Off, Prox, Mid, or Dist).
- **Default Side**: Select a default side (Left or Right).
- **Keep Result Window**: Set to show the previous results of the measurements you performed on the Result window (Auto/On/Off). If you select **Auto**, the previous result for volume measurement is shown on the Result window. If you select **On**, the previous result for labelled measurement is shown on the Result window.
- **PI Calc Method**: Select a parameter (ED or MD) to calculate PI (Pulsaltility Index).
- **RI Calc Method**: Select a parameter (ED or MD) to calculate RI (Resistivity Index).

Modify Calcs

- **Manual Trace**: Select the measurements to perform the manual calculation for the selected application.
- **Auto Trace**: Select the measurements to perform the automatic calculation for the selected application.

NOTE

To set up the Auto trace direction, Auto trace method, and Auto trace sensitivity, go to **Image Preset** > **General**.

User Setting

The **User Setting** menu allows you to configure application specific setting and to configure programmable keys such as Print, P1, P2, user-defined keys, and hot key.

Application

The **Application** menu allows you to specify the default application to be shown when the system starts up. You can also configure the default settings of transducer.

Annotation

The **Annotation** menu allows you to specify the default body pattern library to be shown in the **Body Pattern** menu. You can also specify the default text library to be shown when you use comments.

Measurement

The **Measurement** menu allows you to specify the default package measurement to be shown when you use the measurement.

Administration

The **Administration** menu contains the following submenus:

- Service
- Users
- Options
- System Info

Service

To activate the service browser, click **Service Station**. The Windows login screen appears.

For more information, see the ***Service Manual***.

Users

The **Users** menu allows you to define the user settings.

To create a user ID,

1. Click **New**.
2. Enter a user ID in the ***ID*** field. You can enter up to 16 characters.
3. Click **OK** to save your settings.

NOTE

- Use alphanumeric keys only for the user ID. Do not enter symbols such as asterisk (*), question mark (?), and slash (/).
- After saving, you can edit all information except for the user ID.

To delete a user ID,

1. Select a user ID from the user list by using **Trackball**.
2. Click **Delete**.
3. Click **Yes** to save the changes.

To change the password,

1. Select a user ID from the user list by using **Trackball**.
2. Click **Password**.
3. Enter the current password in the ***Old Password*** field.
4. Enter a new password in the ***New Password*** field.
5. Enter the new password again in the ***Confirm*** field.
6. Click **OK** to save the changes.

Options

The **Options** allows you to view the status of optional functions that require license keys to be installed. The followings show the current status of the selected function.

- **Demo.**: The option is activated for a certain period that the manufacturer specified.
- **Activated**: The option is activated for 3 months after the activation.
- **Invalid**: The option is not installed.
- **Permanent**: The option is installed permanently.

To add or delete a license key, go to **Service Station**.

System Info

You can view the current software and hardware versions of your system.

Backup / Restore

The **Backup / Restore** menu allows you to back up and restore the user data. The following submenus are available:

- User Backup
- Image Backup
- Full Backup

You can select a storage medium (CD, DVD, USB flash drive, USB hard disk, and network storage) to perform the backup.

NOTE

To save images permanently, avoid using the local hard disk. Regularly back up the image archive to a removable media.

CAUTION

Follow the suggested backup procedure in the manual. ALPINION MEDICAL SYSTEMS does not have the responsibility for data recovery caused by the user's carelessness.

User Backup

You can use a CD, DVD, and USB flash drive for user preset backup.

User Backup allows you to back up the each preset data. To select all user-defined presets, select the **User Defined Configuration** check box.

- **Image Preset**: Set to back up or restore the Image preset only.
- **Service**: Set to back up or restore the Service preset only.
- **Measurement**: Set to back up or restore the Measurement preset only.
- **Annotation**: Set to back up or restore the Text and Body Pattern preset only.
- **Connectivity**: Set to back up or restore the Connectivity preset only.
- **Others**: Set to back up or restore other presets such as System and User settings.

To back up the user preset data,

1. Select a media.
2. Insert a blank media properly on your system.
3. Select the user preset you want to back up.
4. Click **Backup** to start backup. The backup procedure begins.
5. After the backup is completed, the last backup time and date appear next to the preset category.

To restore the user preset data,

NOTE

Make sure that the software version of the data is the same as the system's software version. If NOT, you may not perform the restoration.

1. Insert a media on your system.
2. Select the user preset(s) you want to restore.
3. Click **Restore** to start restoring. The restore procedure begins.

Image Backup

You can perform image backup using a storage medium. Select your memory storage such as CD, DVD, USB flash drive, USB hard disk, and network storage.

CAUTION

- While restoring Image Archive data, some existing database may be overwritten on the local hard disk and you may not be able to restore the old data. Make sure that you use the appropriate media before the restoration proceeds.
- Before restoring Image Archive, make sure that the software version is the same or compatible with the current system. The system may not proceed restoring if the version is different.
- Do NOT turn the system off while backup is in progress. You may lose your image data.

NOTE

Use **Import** on **Patient Browser** to restore image data.

Media

- **Media**: Select your default storage medium. Available mediums are CD, DVD, USB flash drive, USB hard disk, and network storage.
- **Media Capacity**: Select the media capacity. The system calculates the number of backup CDs that you need before performing the backup and informs you.

Image Archive Option

- **Backup period**: Specify the starting and ending date to back up patient data for a certain period.
- **Image Move after Backup**: Set to remove the backup image file after backup is completed.
- **Verification after CD burning**: Verify your patient data in a CD or DVD after burning the CD or DVD.
- **Finalization of CD/DVD**: Set to finalize a CD or DVD after backup is completed.
- **Skip the data that has already backed up**: Set to skip the data backup if the data has already been backed up.

NOTE

DICOMDIR is a DICOM file format which provides index and summary information for all the DICOM files on media. If you want to save studies to CD or DVD and view them on the PACS system, you should select this option.

To back up Image Archive,

1. Configure Image Archive.
2. Prepare unformatted CD(s).
3. Click **Backup** to start backup Image archive.

   The media formatting starts and the instructional message appears.

You can view and import backup media via Patient Browser and Patient menu.

To view the backup images,

1. Insert your media.
2. Go to **Patient** or **Patient browser**.
3. Change the source to your medium from the local hard disk.
4. View the backup images of the study you want.

Full Backup

NOTE

The USB hard disk drive is only available for the full preset backup.

This full preset backup is for service purpose only. You can back up the system data such as user preset, image archive, and service configuration.

Image Preset

To enter the Image preset menu, press the **Image Preset** key on the control panel.

To exit from the Image preset menu, press the **Image Preset**, **Exit**, or **2D** key on the control panel.

General workflow

To use Image preset function,

1. Press the **Image Preset** key on the control panel. The ***General Image*** screen appears.
2. Use **Trackball** to select a desired menu tab.
3. Select a desired transducer from the transducer list.
4. Select an option for the menu.
5. Click **Save** to save the changes.
6. Click **Exit** to return to Scan mode.

New preset

You can create a new preset by pressing the **F7** key on the QWERTY keyboard. Once you have added a new preset, it appears in the application list of the transducer selection page, the ***Patient Registration*** screen, and the ***Image Preset*** screen. This function is useful when you want to use user-defined presets easily.

To create a new preset,

1. Adjust the image parameter settings as you want, and then press the **F7** key on the QWERTY keyboard.
2. Select the application that you want to add from the ***Application*** list.
3. Enter a preset name in the ***Preset Name*** field.
4. To show the automatic preset selection when you change the transducer, select the **Automatic Preset selection when changes the transducer** check box.
5. When you are finished, click **OK**.

To overwrite an existing preset,

1. Adjust the image parameter settings as you want, and then press the **F7** key on the QWERTY keyboard.
2. Select the application that you want from the ***Application*** list.
3. Select the preset that you want to overwrite from the ***Preset Name*** list.
4. To show the automatic preset selection when you change the transducer, select the **Automatic Preset selection when changes the transducer** check box.
5. When you are finished, click **OK**.
6. Click **Yes** to confirm.

To delete a preset,

1. Press the **Image Preset** key on the QWERTY keyboard.
2. Select **New Preset**, and then press the **Delete Preset** soft key.
3. Click **Yes** to confirm.

NOTE

The default presets cannot be deleted.

13

Care and Maintenance

This chapter introduces the followings:

System Care and Maintenance..... 2

Transducer Care and Maintenance 7

System Care and Maintenance

It is the responsibility of the user to verify that the ultrasound system is safe for diagnostic operation on a daily basis. Each day, prior to using the system, perform each of the steps in the daily checklist.

All exterior parts of the system, including the control panel, keyboard, and transducers, should be cleaned and/or disinfected as necessary or between uses. Clean each component to remove any surface particles. Disinfect components to kill vegetative organisms and viruses.

The air filter on the ultrasound system must be cleaned regularly to maintain proper system cooling. Remove and check the air filter weekly, and clean as needed.

CAUTION

- The system does not contain any operator serviceable internal components. Ensure that unauthorized personnel do not tamper with the unit.
- When defects or malfunctions occur, do not operate the system until the problems are resolved. Contact your local service representative.

Daily checklist

Perform the following each day before using the ultrasound system:

- Visually inspect all transducers. Do not use a transducer which has a cracked, punctured, or discolored casing or frayed cable.
- Visually inspect all power cords. Do not turn on the power if a cord is frayed or split, or shows signs of wear. If your system's power cord is frayed or split, or shows signs of wear, contact your ALPINION service representative for power cord replacement.
- Visually inspect that the trackball and other controls on the control panel to make sure that they are clean and free from gel or other contaminants.
- Visually inspect the ECG connector and cables. Do not use the ECG connector and cables if they are damaged.

WARNING

To avoid electrical shock, you must visually inspect the transducer prior to use. Do not use the transducer that has a cracked, punctured, or discolored casing or a frayed cable.

Monthly checklist

To inspect the system, examine the following on a monthly basis.

- Connectors on cables for any mechanical defects
- Entire length of electrical and power cables for cuts or abrasions
- Control panel and keyboard for defects
- Casters for proper locking operation

NOTE

To maintain the safety and functionality of the ultrasound system, maintenance must be performed every 12 months. Electrical safety tests must also be performed at regular intervals as specified by local safety regulations. Refer to the service manual for the electrical leakage test.

WARNING

When the LED lamp needs to be replaced, contact the ALPINION service representative.

CAUTION

To avoid electrical shock hazard, do not remove panels or covers from the console. This service must be performed by qualified service personnel. Failure to do so could cause a serious injury.

Weekly maintenance

The system requires weekly care and maintenance to function safely and properly. Clean the following:

- Monitor
- Control panel
- Footswitch

Failure to perform required maintenance may result in unnecessary service calls.

Cleaning the system

Prior to cleaning any part of the system:

- Turn off the system power. If possible, disconnect the power cord.

Cleaning the surface of the ultrasound system

CAUTION

Do not spray any liquid directly into the unit when cleaning the system.

1. Use a clean gauze pad or lint-free cloth, lightly moistened with a mild detergent, to wipe the surface of the ultrasound system. Take particular care to clean the areas near the trackball and the slide controls. Ensure these areas are free of gel and any other visible residue.

   Ensure that cleaning solution does not seep into the control panel, keyboard, or any other openings.

2. After cleaning, use a clean, lint-free cloth to dry the surface.

3. After cleaning, reconnect the power cord of the system into the power outlet.

Cleaning the liners of the transducer holders

1. Use the tab to remove the liner from the transducer holder.
2. Clean the liner under the running water, using a mild detergent and dry with a lint-free cloth.
3. Reinsert the liner into the transducer holder.

Cleaning the trackball

CAUTION

Do not drop or place foreign objects inside the trackball assembly. This may affect the trackball's operation and damage the system. Avoid other solvents that may damage the mechanical parts of the trackball assembly.

1. Remove the front panel bezel by rotating the bezel counter-clockwise.
2. Remove the trackball and the teflon ring.
3. Clean the trackball and the teflon ring with tissue and isopropyl alcohol.
4. Clean the inside of the trackball assembly with a cotton swab and isopropyl alcohol.
5. Allow the assembly parts to completely dry before the reassembly.
6. Replace the trackball and front panel bezel.

Cleaning the monitor face

Use a soft, folded cloth and a glass cleaner solution. Apply the glass cleaner to the cloth. Gently wipe the monitor face.

Do NOT use a glass cleaner that has a hydrocarbon base (such as Benzene, Methyl Alcohol or Methyl Ethyl Ketone) on monitors with the filter (anti-glare shield). Prolonged use of such cleaners will damage the filter (anti-glare shield). Hard rubbing will also damage the filter.

CAUTION

When cleaning the monitor, make sure not to scratch the monitor.

Removing and cleaning the air filter

The air filter on the ultrasound system must be cleaned regularly to maintain the proper system cooling. Remove and check the air filter weekly, and clean as needed.

CAUTION

Do not scrub, stretch, or bend the filter, or apply heat to the filter, as doing so could damage the filter.

1. Power off and unplug the power cord from the power outlet.
2. Grasp the air filter and pull it out of the system.
3. Rinse the air filter with running water and allow the filter to completely dry. To hasten drying, you may gently shake the filter, or blot the filter with a clean, lint-free cloth.
4. Reinsert the filter into the ultrasound system.
5. Plug the power cord into the power outlet.

Transducer Care and Maintenance

It is the responsibility of the user to verify that the transducer is safe for diagnostic operation. After each use, inspect the transducer's lens, cable, and casing. Look for any damage that would allow liquid to enter the transducer. If any damage is found, do not use the transducer until it has been inspected and repaired/replaced by ALPINION Service Representative.

WARNING

- Always place a sterile, non-pyrogenic transducer sheath on a transducer used in procedures requiring sterility.
- To minimize the risk of cross-contamination and infectious diseases, intraoperative transducers must be cleaned and high-level disinfected after each use. A sterile, non-pyrogenic transducer sheath must be in place during procedures requiring sterility.
- There have been reports of severe allergic reactions to medical devices containing latex (natural robber). Health care professionals are advised to identify latex-sensitive patients and to be prepared to treat allergic reactions promptly.
- During neurosurgical procedures, if a transducer becomes contaminated with tissue or fluids of a patient known to have Creutzfeld-Jacob disease, the transducer should be destroyed, as it cannot be sterilized.
- When using an endocavity or intraoperative transducer with a CF type applied part, the patient leakage currents may be additive. Prior to each use, the leakage current test must be done.
- To avoid electrical shock and damage to the system, disconnect the transducer prior to cleaning or disinfecting.
- The list of disinfectants and cleaning methods are recommended by ALPINION for the compatibility with product materials, not for the biological effectiveness. Refer to disinfectant label instructions for the guidance on disinfection efficacy and appropriate clinical uses.

CAUTION

- Transducers are sensitive instruments – irreparable damage may occur if they are dropped, knocked against other objects, cut, or punctured. Do not attempt to repair to alter any part of a transducer.
- To avoid cable damage, do not roll the system over transducer cables.
- To avoid damage to the transducer, do not use transducer sheaths containing on oil-based coating or petroleum-or mineral oil-based ultrasound coupling agents. Use only a water-based ultrasound coupling agent.
- DO NOT place or store the transducer in the side pocket or the storage area on the system to prevent damaging it from accidently falling off.
- To avoid damage to the transducer, observe the immersion levels indicated for each transducer type. Do not immerse or allow the cable or connector of a transducer to become wet. See **Figure 10-1** on page 13-12 for more detailed information.
- The transducer have been designed and tested to be able to withstand high-level disinfection as recommended by the manufacturer of the disinfectant product. Carefully follow the disinfectant manufacturer’s instructions. Do not immerse for more than one hour.

Transducer handling and infection control

This information is intended to increase user awareness of the risks of disease transmission associated with using this equipment and provide guidance in making decisions directly affecting the safety of the patient as well as the equipment user.

Diagnostic ultrasound systems utilize ultrasound energy that must be coupled to the patient by direct physical contact. Depending on the type of examination, this contact occurs with a variety of tissues ranging from intact skin in a routine exam to recirculating blood in a surgical procedure. The level of risk of infection varies greatly with the type of contact.

One of the most effective ways to prevent transmission between patients is with single use or disposable devices. However, ultrasound transducers are complex and expensive devices that must be reused between patients. It is very important, therefore, to minimize the risk of disease transmission by using barriers and through proper processing between patients.

Cleaning and disinfecting transducers

Using cleaning or disinfectant products containing surfactants, methanol, ethanol, benzyl or methyl alcohol, bleach, methyl or ethyl paraben, polyethylene glycol, mineral oil, lubricant oil, oil based lotions, acetone, ammonia, anhydrous ammonia, iodine, iodine compounds, acids with pH5 or greater may damage or discolor your transducer.

See **Table 10-1** on page 13-11 for a list of approved ultrasound gel, cleaning, and disinfectant products.

WARNING

- To avoid electrical shock and damage to the system, disconnect the transducer prio to cleaning and disinfecting.
- Always use protective eyewear and gloves when cleaning and disinfecting transducers.
- Inspect the housing, strain relief, lens and seal for damage, and check for any functional problem after cleaning and disinfecting the transducer.

Cleaning the transducer

Cleaning is an important procedure that is carried out before disinfecting the probe. The probe must be cleaned after each use.

CAUTION

- Do not use a surgical brush when cleaning transducers. Even the use of soft brushes can damage the transducer.
- During cleaning and disinfection, keep the parts of the transducer that must remain dry higher than the other parts during wetting, until all parts are dry.

1. Disconnect the transducer from the system.
2. Moisten a clean gauze pad with water and wipe the transducer to remove any gel or particles remaining on the transducer. If water is not effective, then you can use an approved pre-cleaner or low-level disinfectant.
3. Carefully wipe the entire transducer, including the cable and connector.
4. After cleaning or disinfecting, use a clean cloth to dry the transducer.

Disinfecting the transducer

WARNING

- If a pre-mixed solution is used, be sure to observe the solution expiration date.
- The type of tissue it will contact during use dictates the level of disinfection required for a device. Ensure that the solution strength and duration of contact are appropriate for disinfection.

CAUTION

- Using a non-recommended disinfectant or not following the recommended disinfection method can damage and/or discolor the transducer and will void the transducer warranty.
- Do not immerse transducers for longer than one hour, unless they are sterilizable.

1. Disconnect the transducer from the system.
2. Thoroughly clean, rinse, and dry the transducer.
3. Take care to keep the cable strain relief and the connector of the transducer dry while immersing the transducer in an approved disinfectant to the level indicated in the following illustration.
4. Carefully follow the disinfectant manufacturer's instructions for disinfection or high-level disinfection.
5. After disinfecting or high-level disinfecting, use a clean cloth to dry the transducer.

Approved List of Disinfectant, Pre-Cleaner, and Ultrasound Gel

An appropriate substance should be selected based on the following tables. Refer to Alpinion website for the latest list of compatible disinfectants, pre-cleaners, and gels.

Table 10-1 List of Disinfectant, Pre-Cleaner, and Ultrasound Gel

	Disinfectants								Gel					
	Cidex OPA	Gigasept FF	Virkon	Cidex Plus	Wavicide-01	AIDAL PLUS	Cetylcide-G	Sporicidin	Aquasonic100	Soflean Gel	Care Sonic Gel	ULTRASOUND GEL	Ultrasound Transmission gel	Scan
Type	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**G**	**G**	**G**	**G**	**G**	**G**
SC1-6	O	O	O	O	O	O	O	O	O	O	O	O	Δ	Δ
SC1-4H	O	O	O	O	O	O	O	O	O	O	O	O	Δ	Δ
L3-12	O	O	O	O	O	O	O	O	O	O	O	O	Δ	Δ
L3-12H	O	O	O	O	O	O	O	O	O	O	O	O	Δ	Δ
SP1-5	O	O	O	O	O	O	O	O	O	O	O	O	Δ	Δ

	Gel	Pre-Cleaner												
	Sonogel	T-spray	T-spray II	Enzol	Theracide Plus (S5N)	Transeptic	Septihol	Metrizyme	Klenzyme	McKesson	Cidezyme	Endozyme	Super Sani-Cloth	Cleanisept wpies
Type	**G**	**S**	**S**	**L**	**L**	**S**	**L**	**L**	**L**	**L**	**L**	**L**	**W**	**W**
SC1-6	Δ	Δ	O	O	O	O	O	Δ	Δ	Δ	Δ	O	O	O
SC1-4H	Δ	Δ	O	O	O	O	O	Δ	Δ	Δ	Δ	O	O	O
L3-12	Δ	Δ	O	O	O	O	O	Δ	Δ	Δ	Δ	O	O	O
L3-12H	Δ	Δ	O	O	O	O	O	Δ	Δ	Δ	Δ	O	O	O
SP1-5	Δ	Δ	O	O	O	O	O	Δ	Δ	Δ	Δ	O	O	O

S=Spray; W=Wipes; L=Liquid; P=Powder; G= Gel

O=Approved; X=Not approved (DO NOT USE); Δ= Untested (DO NOT USE)

IPX8 immersion levels

CAUTION

To avoid damage to the transducer, observe the immersion levels indicated for each transducer type. Transducers with the protection level IPX8 are indicated by the presence of the “IPX8” symbol on the connector of the transducer.

Transducers meet Ingress Protection IPX8 of EN 60529 and IEC 60529 to the depth of the immersion line shown in the illustration only for transducers with the “IPX8” symbol on the connector of the transducer.

NOTE

IPX8 level, protected against the effects of continuous immersion in water 1 m depth for 90 minutes.

Figure 10-1 IPX8 immersion level

Cable handling

Take the following precautions with transducer cables:

- Keep free from wheels
- Do not bend the cable acutely
- Avoid crossing cables between transducers

Planned maintenance

The following maintenance schedule is suggested for the transducer to ensure the optimum operation and safety.

- Daily: inspect transducers
- After each use: clean transducers
- After each use: disinfect transducers

14

Safety and Regulatory Information

This chapter introduces the followings:

Safety Summary 2
Important Safety Warnings 3
Patient Safety Information 4
Electrical Safety Information 5
Transducer Safety Information 6
System Symbols and Labels 8
Peripherals and Accessories 12
Regulatory Information 15
Electromagnetic Compatibility (EMC) 17
Diagnostic Ultrasound Indications for Use 29
Acoustic Output 35

Safety Summary

You should make sure the following safety precautions during all phases of operation, service, and repair of the E-CUBE 12R ultrasound system. If you fail to comply with these safety precautions or specific warnings in this manual, you violate safety standards in terms of design, manufacture, and intended use of this system. ALPINION MEDICAL SYSTEMS Co., LTD. does not have liability for your failure to comply with these requirements.

Safety notice

WARNING

A WARNING notice indicates a hazard. You need to observe an operating procedure, practice, or conducts like that. If you do not correctly perform this notice, it could result in personal injury or death.

CAUTION

A CAUTION notice indicates a hazard. You need to observe an operating procedure, practice, or conducts like that. If you do not correctly perform this notice, it could result in damage to the system or loss of important data.

Service document

The service manual supplies block diagrams, lists of spare parts, descriptions, adjustment instructions or similar information to help adequately qualified technical personnel in repairing those parts defined as repairable by the manufacturer.

Important Safety Warnings

WARNING

- Installing the system yourself may cause damage to the system or electrical shock.
- To avoid damage to the system and avoid electrical shock, only qualified ALPINION service engineer must install the system.
- Do not remove the covers of a system yourself to avoid damage to the system and unexpected electrical shock. Only qualified ALPINION service engineer must repair or replace components.
- Before cleaning up and disinfecting the system, always make sure you turn off the system power and unplug the power cord from the power outlet.
- To avoid risk of electric shock, you must connect the system to the supply mains with the protective earth.
- Do not allow water or liquids on or above the system. Dripping water or liquids into the system may cause electrical shock and damage to the system.
- Always use peripherals and accessories approved by ALPINION. You must securely connect peripherals and accessories to the system.
- Do not modify this system such as system components, or software. When you modify the system, it may cause safety hazards. Only qualified ALPINION service engineer must modify the system.
- Always use the system properly to avoid serious injury. Before using the system, you must make sure the instructions and hazards involving ultrasound system. ALPINION provides training assistance, if needed.
- Always use transducers approved or recommended by ALPINION.
- Always use approved ECG cables and recommended electrodes by ALPINION.
- You must follow safety precautions and avoid any situation that causes injury or damage.
- The system voltage may cause serious injury or damage to the system.
- When you observe that the system causes any malfunction, you must stop operating the system and take proper action for patients. After that, contact ALPINION service engineer.
- You must make sure grounded integrity of the power outlet and system regularly.
- Always make sure that you do not use the system in an explosive atmosphere.
- For patient safety, you must locate the system to easily unplug the power cord from the power outlet when a malfunction or an error occurs.
- Your ultrasound system is not intended for diagnosing and monitoring ECG. Do not use the system for cardiac operation.

Patient Safety Information

WARNING

- When you enter patient data, always make sure that you enter correct identification with the patient data.
- Do not use the system until you become familiar with the system operation.
- To avoid the transducer from overheating, you must freeze the system when imaging is not performed.

CAUTION

- Do not allow the system to transmit acoustic output when the transducer is not in use. Otherwise, it could result in overheating of the transducer.
- When not using the system, you should freeze the image or turn off the acoustic output.
- Do not use the system with defibrillator. The system does not include a defibrillation-proof applied part for ECG.
- Do not allow the germicide to contact your patient. Contact to the patient's skin or mucous membrane may cause an inflammation.

Electrical Safety Information

WARNING

- Do not clean or disinfect a system before turning off and unplug the system from the power outlet. Otherwise, it could result in electrical shock and damage to the system.
- Do not place water or liquids on the system. Dripping water or liquids into the system may cause electrical shock and damage to the system.
- Do not remove the panels or covers of a system to prevent system damage and electrical shock.
- Do not use extension cords, adaptors or converters, which are a three-prong to two-prong type, to connect with a power plug.
- The system voltage may cause serious injury or damage to the system. When you observe that the system causes any malfunction, you must stop operating the system and take proper action for patients. After that, contact ALPINION service engineer.
- Do not modify the AC power connector plug of the system to prevent electrical shock.
- You should use the ultrasound system after few hours when the system is in a humidity place.
- Do not connect, disconnect, or replace any part of the system during the scanning of a patient at the same time.
- Do not replace the fuse or power cord by yourself. An ALPINION MEDICAL service engineer or an authorized agent must perform the replacement. Replacing the fuse or power cord by yourself will avoid your warranty.
- Using spray cleaners on the system drips cleaning fluid into the system. It damages components in the system.
- Do not use aerosol spray cleaners on the monitor to prevent electrical shock and damage to the system.
- While using the ECG function, keep ECG cables or patients away from any other electrical conductor to prevent electrical shock.
- Different voltage power between your system and other devices may cause electrical shock. According to the IEC requirements (Refer to IEC 60601-1-1 and clause 16 of the 3 Ed. of IEC 60601-1, respectively), you must use the equipotential cable (equipotential bonding) to connect additional devices to your system. Contact your ALPINION MEDICAL service engineer.

Transducer Safety Information

Damaged transducers or improper use and manipulation of the transducer may result in injury or increase the risk of infection.

Never use excessive force when manipulating intracavity transducers. Become familiar with all instructions and precautions provided with the special purpose transducers.

The use of damaged transducers can result in injury or increase the risk of infection. Inspect transducer often for sharp, pointed, or rough surface damage that could cause injury or tear protective barriers.

WARNING

- Do not use damaged or defective transducer to prevent system damage and serious patient injury.
- Make sure you do not bend or pull the transducer cable to prevent the damage to the transducer.
- Use only approved coupling gels. Using unapproved gels may damage the transducer and void the warranty.
- To reduce the risk of leakage currents and electrosurgical interference, use only isolated output electrosurgical units with an endocavity transducer and disconnect the transducer when it is not in use.
- When an endocavity transducer causes malfunctions, contact ALPINION Service Representative to prevent any safety hazard from the transducer.

CAUTION

- Do not drop the transducer. Always keep the transducer secure when you do not use it.
- Using damaged or defective transducer causes unexpected electric shock. Make sure to use and take care of the transducer accordingly.
- Do not allow the system to transmit acoustic output when the transducer is not in use. Otherwise, it could result in overheating of the transducer.
- When not using the system, you should freeze the image or turn off acoustic output.
- To avoid serious patient injury, always inspect the transducer that you use has sharp edges and rough surfaces. Especially for an endocavity transducer, inspect it exhaustively prior to each use.
- Proper cleaning and disinfecting the transducer prevent disease transmission. You must follow infection control procedures.
- Make sure that you do not use an expired transducer sheath.

CAUTION

- Using pre-lubricated condoms as a sheath might damage the transducer.
- Do not allow your eyes (or patient's eyes) to contact the coupling gel. If there is gel contact to the eyes, flush thoroughly with clean water.
- When the surface temperature of your endocavity transducer reaches a safe level 41 °C, manually freeze the system and stop imaging if the system does not respond automatically.

Transducer surface temperature limits

Transducer	Maximum Temperature (°C)	
	Tissue Mimicking Material (TMM)	Still Air
L3-12	30.5	41.0
L3-12H	30.0	39.6
SC1-6	32.1	43.1
SC1-4H	31.9	43.9
SP1-5	32.9	44.1

System Symbols and Labels

The following is a list of system symbols and labels for safety. They indicate that you must refer to the manual for specific information to avoid personal injury or damage to the product.

Safety symbols/ Labels	Location	Explanation
⏻	On the power button of the control panel	System on/off/stand-by
	On the system rating label for overseas, transducer label, and ECG port	Patient applied part meets the isolation requirements for type BF equipment
IPX8	On the transducer label	This symbol indicates that the transducer meets immersion requirements. Depending on the transducer model, the immersion label may differ.
	On the multi-caution label, rating label for overseas, transducer label, and gel warmer label	This symbol indicates that when the end-user wishes to discard this product, it must be sent to separate collection facilities for recovery and recycling. By separating this product from other household-type waste, the volume of waste sent to incinerators or land-fills will be reduced and natural resources will thus be conserved. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment.
CE 0470	On the multi-caution label, rating label for overseas, and system packing box	This system complies with regulatory requirements of European Directive 93/42/EEC regarding medical device.

Safety symbols/ Labels	Location	Explanation
	On the multi-caution label, gel warmer label, and I/O panel	Consult instructions for use (or consult operating instructions)
	Various locations on labels	Attention (Caution) – consult accompanying documents if complete information cannot be provided on the label
~	On the rating label for overseas: Adjacent to the AC power and the AC power outlet	Alternating current in accordance with IEC60878-01-14
	Adjacent to the AC power outlet	Push-push button
	Adjacent to the AC power	Equipotentiality
	On the right side of the touch screen	Universal Serial Bus
	On the system rating label for overseas and transducer label	Date of manufacture See ISO 8601 for date format
	On the system rating label for overseas and transducer label	Symbol for manufacturer This symbol shall be accompanied by the name and the address of the manufacturer.
SN	On the system rating label for overseas and transducer label	Serial Number
	On the multi-caution label	To ensure safety of user, moving and delivering system shall be performed by at least 2 persons.

Safety symbols/ Labels	Location	Explanation
	On the LCD caution label and multi-caution label	Do not forcibly push the monitor or the system when the casters are locked.
	On the LCD caution label	Do not press or place loads on the monitor when folded. Otherwise, monitor and (or) professional arm could be damaged.
	On the multi-caution label	Do not use mobile transmitter such as mobile phone, radio receiver, broadband power line, etc.
	On the LCD caution label	Be very careful not to injure yourself or damage the system when rotating the monitor arm.
	Rear of the LCD monitor	Caution label
	Top of the monitor arm	Care against pinch shall be taken. (In accordance with IEC60878)
	Rear of the system body	Multi-caution label
	Right cover of the system body	No gender detection label
	Bottom of the control panel	System rating label for overseas

Safety symbols/ Labels	Location	Explanation
	Bottom of the control panel	System rating label for domestics
	On the cable port of the gel warmer	Gel warmer voltage label
	Rear of the gel warmer	Gel warmer label
	Transducer	Name of transducer manufacturer, Authorized EU Representative, Safety, WEEE symbol, indicating separate collection, Certification mark
	Transducer	Transducer name, Serial, IPX Rating, Manufacturer date, Caution mark

Peripheral update for EU countries

The following is intended to provide the users in EU countries with updated information concerning the connection of the E-CUBE 12R to image recording and other devices or communication networks.

The E-CUBE 12R has been verified for overall safety, compatibility and compliance with the following on-board image recording devices:

- Color Printer

  Manufacturer: Sony Corporation

  Model: Sony Digital UP-D25MD, Sony Analog UP-25MD

- B/W Printer

  Manufacturer: Sony Corporation

  Model: Sony Digital UP-D897, Sony Analog UP-897MD

- DVR

  Manufacturer: Sony Corporation

  Model: Sony Digital DVO-1000MD

The E-CUBE 12R may also be used safely while connected to devices other than those recommended above if the devices and their specifications, installation, and interconnection with the system conform to the requirements of IEC/EN 60601-1-1.

Basic accessories

E-CUBE 12R
E-CUBE 12R console
User manual CD/hard copy (English)
Quick guide (English hard copy)
Sonic gel

Optional supplies and accessories

The following tables show optional supplies and accessories that have been verified to be compatible with the system.

Console accessory
Tri-pedal footswitch

Transducer	
• L3-12	• SC1-4H
• L3-12H	• SC1-6
• SP1-5	

Disinfectant	
• Cidex OPA	
• Cidex Plus	

Biopsy kit
L3-12 Biopsy Starter Kit (for L3-12 and L3-12H)
SC1-6 Biopsy Starter Kit (for SC1-4H and SC1-6)

Software
Full SRI
Xpeed
Spatial compounding
FTHI (Filtered Tissue Harmonic)
DICOM
DICOM SR(OB)
CV M&R Standard
CV M&R Professional
Live HQ

Regulatory Information

The E-CUBE 12R ultrasound system conforms to the following classifications, in accordance with the IEC/EN 60601-1:6.8.1:

Classifications:

- Type of protection against electrical shock: Class I
- Degree of protection against electrical shock (Patient connection): Type BF equipment
- Degree of protection against harmful ingress of water: Ordinary equipment and all of applied parts (IPX7, IPX8) except ECG meet ingress protection level according to IEC 60529.
- Degree of safety of application in the presence of a flammable anesthetic material with air or with oxygen or nitrous oxide: Equipment not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide.
- Mode of operation: Continuous operation

The E-CUBE 12R ultrasound system conforms to the following standards:

- EN 55022:2010, Class B (CISPR 22:2008, modified)
- EN55011:2009+A1:2010, Group 1, Class B
- EN 61000-4-2:2009 (IEC 61000-4-2:2008)
- EN 61000-4-3:2006+A1:2008+A2:2010 (IEC 61000-4-3:2006+A1:2007+A2:2010)
- EN 61000-4-4:2004+A1:2010 (IEC 61000-4-4:2004+A1:2010)
- EN 61000-4-5:2006 (IEC 61000-4-5:2005)
- EN 61000-4-6:2009 (IEC 61000-4-6:2008)
- EN 61000-4-8:2010 (IEC 61000-4-8:2009)
- EN 61000-4-11:2004 (IEC 61000-4-11:2004)
- EN 61000-3-2:2006+A1:2009+A2:2009 (IEC 61000-3-2:2005+A1:2009+A2:2009)
- EN 61000-3-3:2008 (IEC 61000-3-3:2008)
- ISO 10993-1:2009
- NEMA/AIUM Acoustic Output Display Standard (NEMA US-3, 1998)
- EN 60601-1:2006 (IEC60601-1:2005)
- EN 60601-1-2:2007 (IEC 60601-1-2:2007)
- EN 60601-2-37 :2008 (IEC 60601-2-37:2007)
- ISO13485:2003
- ISO14971:2007

Authorized EU Representative:

EC REP

Name: Il Ryung KIM
Address: Lilienthalstrasse 17a, 85399 Hallbergmoos, Germany
Phone: +49 (0) 811 99 82 86 0

Authorized US Representative:

Name: Julian Lee
Address: 21312 30th Dr SE Ste 100 Bothell, WA 98021, United States
Phone: +1 (425) 949 1059

Authorized Brazil Representative:

Name: Júlia Zema
Address: CNPJ: 04.967.408/0001-98
SIA Trecho 3, Lotes 2010/2020 1º. Andar, Ed. Myrian - Bairro: Zona Industrial
Brasília – DF - CEP 71200-030
Phone: +55 (61) 3386 3166

Electromagnetic Compatibility (EMC)

This equipment generates, uses, and can radiate radio frequency energy. The equipment may cause radio frequency interference to other medical and non-medical devices and radio communications. To provide reasonable protection against such interference, this product complies with emissions limits for a Group 1, Class Medical Devices Directive as stated in EN 60601-1-2. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment is found to cause interference (which may be determined by turning the equipment on and off), the user (or qualified service personnel) should attempt to correct the problem by one or more of the following measure(s):

- reorient or relocate the affected device(s)
- increase the separation between the equipment and the affected device
- power the equipment from a source different from that of the affected device
- consult the point of purchase or service representative for further suggestions

The manufacturer is not responsible for any interference caused by using other than recommended interconnect cables or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the users' authority to operate the equipment.

Do not use devices which intentionally transmit RF Signals (cellular phones, transceivers, or radio controlled products) in the vicinity of the equipment as it may cause performance outside the published specifications. Keep the power to these type devices turned off when near this equipment.

The medical staff in charge of this equipment is required to instruct technicians, patients, and other people who maybe around this equipment to fully comply with the above requirement.

Recommended separation distances between portable and mobile RF communications equipment and the E-CUBE 12R

The E-CUBE 12R is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the E-CUBE 12R can help Prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the E-CUBE 12R as recommended below, according to the maximum output power of the communications equipment.

Rated maximum output power of transmitter [W]	Separation distance according to frequency of transmitter [m]		
	150 kHz to 80 MHz $d = 1{,}2\sqrt{P}$	80 MHz to 800 MHz $d = 1{,}2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2{,}3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23

For transmitters rated at a maximum output power not listed above, the recommended separation distance *d* in metres (m) can be estimated using the equation applicable to the frequency of the transmitter, where *p* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1) At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.
NOTE 2) These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Immunity and compliance level for system

Immunity test	Frequency of Interest [MHz]	Actual Immunity Level	Compliance Level
Conducted RF IEC 61000-4-6	0.15 MHz to 80 MHz	3 Vrms	0.3 Vrms
Radiated RF IEC 61000-4-3	80 MHz to 800 MHz	3 V / m	1 V / m
	800 MHz to 2.5 GHz	3 V / m	3 V / m

Immunity and compliance level for transducer

Conducted RF IEC 61000-4-6

Transducer: L3-12H, 1 KHz, C mode

Image at Frequency of Interest	Frequency of Interest** [MHz]	Actual Immunity Level
	3.846 MHz to 42.724 MHz	3 Vrms
	4.248 MHz to 36.436 MHz	1 Vrms
	5.131 MHz to 7.869 MHz	0.3 Vrms
	5.970 MHz	0.05 Vrms*
Conducted RF IEC 61000-4-6	6.746 MHz	0.05 Vrms*

* Voltage Level at which the RF Induced Noise is No Longer Discernable from the system ambient background noise.
** Between 0.15 MHz ~ 3.80 MHz and 43.15 MHz ~ 80.00 MHz the level of Immunity is 3 Vrms.

Frequency of Interest [MHz]	F_1 = 5.970	F_1 = 6.746
Image at Frequency of Interest		
Voltage Level at which the RF Induced Noise is No Longer Discernable from the System Ambient Background Noise	0.05 V_{RMS}	0.05 V_{RMS}

Transducer: SC1-4H, 1 KHz, C mode

Image at Frequency of Interest	Frequency of Interest** [MHz]	Actual Immunity Level
Conducted RF IEC 61000-4-6	3.846 MHz to 8.692 MHz	3 Vrms
	20.455 MHz to 35.718 MHz	3 Vrms
	46.265 MHz	3 Vrms
	4.692 MHz to 7.413 MHz	1 Vrms
	27.301 MHz to 35.364 MHz	1 Vrms
	5.446 MHz to 6.846	0.3 Vrms
	5.667 MHz	0.17 Vrms *)
	6.076 MHz	0.17 Vrms*)

* Voltage Level at which the RF Induced Noise is No Longer Discernable from the system ambient background noise.
** Between 0.15 MHz ~ 3.80 MHz, 8.77 MHz to 20.25 MHz, 36.07 MHz to 45.80 MHz and 46.72 MHz ~ 80.00 MHz the level of Immunity is 3 Vrms.

Frequency of Interest [MHz]	F_1 = 5.667	F_1 = 6.076
Image at Frequency of Interest		
Voltage Level at which the RF Induced Noise is No Longer Discernable from the System Ambient Background Noise	0.17 V_{RMS}	0.17 V_{RMS}

Transducer: L3-12, 1 KHz, C mode

Image at Frequency of Interest	Frequency of Interest** [MHz]	Actual Immunity Level
	3.248 MHz to 48.625 MHz	3 Vrms
	3.808 MHz to 37.540 MHz	1 Vrms
	4.646 MHz to 7.869 MHz	0.3 Vrms
	5.667 MHz	0.05 Vrms*
Conducted RF IEC 61000-4-6	6.076 MHz	0.05 Vrms*

* Voltage Level at which the RF Induced Noise is No Longer Discernable from the system ambient background noise.
** Between 0.15 MHz ~ 3.21 MHz and 49.11 MHz to 80 MHz the level of Immunity is 3 Vrms.

Frequency of Interest [MHz]	F_1 = 5.667	F_1 = 6.076
Image at Frequency of Interest		
Voltage Level at which the RF Induced Noise is No Longer Discernable from the System Ambient Background Noise	0.05 V_{RMS}	0.05 V_{RMS}

Transducer: SP1-5, 1 KHz, C mode

Image at Frequency of Interest	Frequency of Interest** [MHz]	Actual Immunity Level
Conducted RF IEC 61000-4-6	3.447 MHz to 39.445 MHz	3 Vrms
	3.733 MHz to 9.227 MHz	1 Vrms
	13.070 MHz to 37.168 MHz	1 Vrms
	4.420 MHz to 7.638 MHz	0.3 Vrms
	5.724 MHz	0.05 Vrms*)
	6.076 MHz	0.05 Vrms*)

* Voltage Level at which the RF Induced Noise is No Longer Discernable from the system ambient background noise.

** Between 0.15 MHz ~ 3.41 MHz and 39.85 MHz ~ 80.00 MHz the level of Immunity is 3 Vrms.

Frequency of Interest [MHz]	F_1 = 5.724	F_1 = 6.076
Image at Frequency of Interest		
Voltage Level at which the RF Induced Noise is No Longer Discernable from the System Ambient Background Noise	0.05 V_{RMS}	0.05 V_{RMS}

Transducer: SC1-6, 1 KHz, C mode

Image at Frequency of Interest	Frequency of Interest** [MHz]	Actual Immunity Level
Conducted RF IEC 61000-4-6	2.797 MHz to 37.168 MHz	3 Vrms
	46.265 MHz	3 Vrms
	3.733 MHz to 9.046 MHz	1 Vrms
	28.409 MHz to 37.168 MHz	1 Vrms
	46.265 MHz	1 Vrms
	4.333 MHz to 7.791 MHz	0.3 Vrms
	5.446 MHz	0.05 Vrms*
	6.076 MHz	0.05 Vrms*

* Voltage Level at which the RF Induced Noise is No Longer Discernable from the system ambient background noise.

** Between 0.15 MHz ~ 2.76 MHz, 37.540 MHz to 45.80 MHz and 46.72 MHz ~ 80.00 MHz the level of Immunity is 3 Vrms.

Frequency of Interest [MHz]	F_1 = 5.446	F_1 = 6.076
Image at Frequency of Interest		
Voltage Level at which the RF Induced Noise is No Longer Discernable from the System Ambient Background Noise	0.05 V_{RMS}	0.05 V_{RMS}

Guidance and manufacturer's declaration–electromagnetic emissions

This system is suitable for use in the following environment. The user must assure that it is used only in the electromagnetic environment as specified.

<table>
<tr><td colspan="3">The E-CUBE 12R is intended for use in the electromagnetic environment specified below. The customer or the user of the E-CUBE 5 should assure that it is used in such an environment.</td></tr>
<tr><td>Emissions test</td><td>Compliance</td><td>Electromagnetic environment - guidance</td></tr>
<tr><td>RF emissions
CISPR 11</td><td>Group 1</td><td>The E-CUBE 12R uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.</td></tr>
<tr><td>RF emissions
CISPR 11</td><td>Class B</td><td rowspan="3">The E-CUBE 12R is suitable for use in all establishments, including domestic establish-ments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.</td></tr>
<tr><td>Harmonic emissions
IEC 61000-3-2</td><td>Class A</td></tr>
<tr><td>Voltage fluctuations / flicker emissions
IEC 61000-3-3</td><td>Complies</td></tr>
</table>

Guidance and manufacturer's declaration - electromagnetic immunity

The E-CUBE 12R is intended for use in the electromagnetic environment specified below. The customer or the user of the E-CUBE 12R should assure that it is used in such an environment.			
Immunity test	**IEC 60601 Test level**	**Compliance level**	**Electromagnetic environment -guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	±6 kV Contact ±8 kV air	±6 kV Contact ±8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30 %.
Electrical fast transient/burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/ output lines	±2 kV for power supply lines ±1 kV for input/ output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1 kV line(s) to line(s) ±2 kV line(s) to earth	±1 kV line(s) to line(s) ±2 kV line(s) to earth	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	< 5 % U_T (> 95 % dip in U_T) for 0.5cycle 40 % U_T (60 % dip in U_T) for 5 cycle, 6 cycle 70 % U_T (30 % dip in U_T) for 25 cycle, 30 cycle <5 % U_T (> 95 % dip in U_T) for 5 s	< 5 % U_T (> 95 % dip in U_T) for 0.5cycle 40 % U_T (60 % dip in U_T) for 5 cycle, 6 cycle 70 % U_T (30 % dip in U_T) for 25 cycle, 30 cycle <5 % U_T (> 95 % dip in U_T) for 5 s	Mains power quality should be that of a typical commercial or hospital environment. If the user of the E-CUBE 12R image intensifier requires continued operation during power mains interruptions, it is recommended that the E-CUBE 12R image intensifier be powered from an uninterruptible power supply.

Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE U_T is the a.c. mains voltage prior to application of the test level.			

Guidance and manufacturer's declaration - electromagnetic immunity

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Conducted RF IEC 61000-4-6 Radiated RF IEC 61000-4-3	3 Vrms 150 kHz to 80 MHz 3 V/m 80 MHz to 2.5 GHz	3 Vrms 3 V/m	Portable mobile RF communications equipment should be used no closer to any part of the E-CUBE 12R, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. **Recommended separation distance** $d = 1{,}2\sqrt{P}$ $d = 1{,}2\sqrt{P}$ 80 MHz to 800 MHz $d = 2{,}3\sqrt{P}$ 800 MHz to 2.5 GHz where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and *d* is the recommended separation distance in meters (m).

			Field strengths from fixed RF transmitters, as deter-mined by an electromagnetic site survey, [a] should be less than the compliance level in each frequency range. [b] Interference may occur in the vicinity of equipment marked with the following symbol :

NOTE 1) At 80 MHz and 800 MHz, the higher frequency range applies.
NOTE 2) These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/ cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the EUT is used exceeds the applicable RF compliance level above, the EUT should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the E-CUBE 12R.

[b] Over the frequency range 150 kHz to 80MHz, field strengths should be less than 3 V/ m.

Diagnostic Ultrasound Indications for Use

E-CUBE 12R Ultrasound System

Indications for Use *(Describe)*

The device is intended for use by a qualified physician for the evaluation of soft tissue and blood flow in the clinical applications; Fetal; Abdominal (renal & GYN/pelvic); Pediatric, Small Organ (breast, testes, thyroid); Adult Cephalic; Musculo-skeletal (Conventional); Musculo-skeletal (Superficial); Cardiac (adult& pediatric); Peripheral Vascular (PV); and Urology (including prostate).

Clinical Application	**Mode of Operation**								
	B	**M**	**PWD**	**CWD**	**Color Doppler**	**Power Doppler**	**Tissue Harmonic Imaging**	**Combined* (Specify)**	**Other** (Specify)**
Ophthalmic									
Fetal	N	N	N		N	N	N	N	
Abdominal	N	N	N		N	N	N	N	
Intra-operative (Specify)									
Intra-operative (Neuro)									
Laparoscopic									
Pediatric	N	N	N		N	N	N	N	
Small Organ (breast, testes, thyroid)	N	N	N		N	N	N	N	
Neonatal Cephalic									
Adult Cephalic	N	N	N		N	N	N	N	
Trans-rectal									
Trans-vaginal									
Trans-urethral									
Trans-esoph. (non-Card.)									
Musculo-skeletal (***Conventional***)	N	N	N		N	N	N	N	
Musculo-skeletal (***Superficial***)	N	N	N		N	N	N	N	
Intravascular									
Cardiac Adult	N	N	N		N	N	N	N	
Cardiac Pediatric									
Intravascular (Cardiac)									
Trans-esoph. (Cardiac)									
Intra-cardiac									
Peripheral vessel	N	N	N		N	N	N	N	
Urology (including prostate)	N	N	N		N	N	N	N	

N = new indication; P = previously cleared by FDA; E = added under appendix

* Combined: B/Color Doppler, B/PWD, B/Color Doppler/PWD; **Other: 3D, 4D

E-CUBE 12R with SC1-6 Transducer

Intended Use: Diagnostic ultrasound imaging or fluid flow analysis of the human body as follows:

Clinical Application	Mode of Operation								
	B	M	PWD	CWD	Color Doppler	Power Doppler	Tissue Harmonic Imaging	Combined* (Specify)	Other** (Specify)
Ophthalmic									
Fetal	P	P	P		P	P	P	P	
Abdominal	P	P	P		P	P	P	P	
Intra-operative (Specify)									
Intra-operative (Neuro)									
Laparoscopic									
Pediatric	P	P	P		P	P	P	P	
Small Organ (breast, testes, thyroid)									
Neonatal Cephalic									
Adult Cephalic									
Trans-rectal									
Trans-vaginal									
Trans-urethral									
Trans-esoph. (non-Card.)									
Musculo-skeletal (***Conventional***)									
Musculo-skeletal (***Superficial***)									
Intravascular									
Cardiac Adult									
Cardiac Pediatric									
Intravascular (Cardiac)									
Trans-esoph. (Cardiac)									
Intra-cardiac									
Peripheral vessel									
Urology (including prostate)	P	P	P		P	P	P	P	

N = new indication; P = previously cleared by FDA K111864; E = added under appendix

* Combined: B/Color Doppler, B/PWD, B/Color Doppler/PWD; **Other: 3D, 4D

E-CUBE 12R with L3-12H Transducer

Intended Use: Diagnostic ultrasound imaging or fluid flow analysis of the human body as follows:

Clinical Application	Mode of Operation								
	B	M	PWD	CWD	Color Doppler	Power Doppler	Tissue Harmonic Imaging	Combined* (Specify)	Other** (Specify)
Ophthalmic									
Fetal									
Abdominal									
Intra-operative (Specify)									
Intra-operative (Neuro)									
Laparoscopic									
Pediatric	P	P	P		P	P	P	P	
Small Organ (breast, testes, thyroid)	P	P	P		P	P	P	P	
Neonatal Cephalic									
Adult Cephalic									
Trans-rectal									
Trans-vaginal									
Trans-urethral									
Trans-esoph. (non-Card.)									
Musculo-skeletal (***Conventional***)	P	P	P		P	P	P	P	
Musculo-skeletal (***Superficial***)	P	P	P		P	P	P	P	
Intravascular									
Cardiac Adult									
Cardiac Pediatric									
Intravascular (Cardiac)									
Trans-esoph. (Cardiac)									
Intra-cardiac									
Peripheral vessel	P	P	P		P	P	P	P	
Urology (including prostate)									

N = new indication; P = previously cleared by FDA K111864; E = added under appendix

* Combined: B/Color Doppler, B/PWD, B/Color Doppler/PWD; **Other: 3D, 4D

E-CUBE 12R with L3-12 Transducer

Intended Use: Diagnostic ultrasound imaging or fluid flow analysis of the human body as follows:

Clinical Application	Mode of Operation								
	B	M	PWD	CWD	Color Doppler	Power Doppler	Tissue Harmonic Imaging	Combined* (Specify)	Other** (Specify)
Ophthalmic									
Fetal									
Abdominal									
Intra-operative (Specify)									
Intra-operative (Neuro)									
Laparoscopic									
Pediatric	P	P	P		P	P	P	P	
Small Organ (breast, testes, thyroid)	P	P	P		P	P	P	P	
Neonatal Cephalic									
Adult Cephalic									
Trans-rectal									
Trans-vaginal									
Trans-urethral									
Trans-esoph. (non-Card.)									
Musculo-skeletal (***Conventional***)	P	P	P		P	P	P	P	
Musculo-skeletal (***Superficial***)	P	P	P		P	P	P	P	
Intravascular									
Cardiac Adult									
Cardiac Pediatric									
Intravascular (Cardiac)									
Trans-esoph. (Cardiac)									
Intra-cardiac									
Peripheral vessel	P	P	P		P	P	P	P	
Urology (including prostate)									

N = new indication; P = previously cleared by FDA K111864; E = added under appendix

* Combined: B/Color Doppler, B/PWD, B/Color Doppler/PWD; **Other: 3D, 4D

E-CUBE 12R with SP1-5 Transducer

Intended Use: Diagnostic ultrasound imaging or fluid flow analysis of the human body as follows:

Clinical Application	Mode of Operation								
	B	M	PWD	CWD	Color Doppler	Power Doppler	Tissue Harmonic Imaging	Combined* (Specify)	Other** (Specify)
Ophthalmic									
Fetal									
Abdominal	P	P	P		P	P	P	P	
Intra-operative (Specify)									
Intra-operative (Neuro)									
Laparoscopic									
Pediatric	P	P	P		P	P	P	P	
Small Organ (breast, testes, thyroid)									
Neonatal Cephalic									
Adult Cephalic	N	N	N		N	N	N	N	
Trans-rectal									
Trans-vaginal									
Trans-urethral									
Trans-esoph. (non-Card.)									
Musculo-skeletal (***Conventional***)									
Musculo-skeletal (***Superficial***)									
Intravascular									
Cardiac Adult	P	P	P		P	P	P	P	
Cardiac Pediatric									
Intravascular (Cardiac)									
Trans-esoph. (Cardiac)									
Intra-cardiac									
Peripheral vessel									
Urology (including prostate)									

N = new indication; P = previously cleared by FDA K111864; E = added under appendix

* Combined: B/Color Doppler, B/PWD, B/Color Doppler/PWD; **Other: 3D, 4D

E-CUBE 12R with SC1-4H Transducer

Intended Use: Diagnostic ultrasound imaging or fluid flow analysis of the human body as follows:

Clinical Application	Mode of Operation								
	B	M	PWD	CWD	Color Doppler	Power Doppler	Tissue Harmonic Imaging	Combined* (Specify)	Other** (Specify)
Ophthalmic									
Fetal	P	P	P		P	P	P	P	
Abdominal	P	P	P		P	P	P	P	
Intra-operative (Specify)									
Intra-operative (Neuro)									
Laparoscopic									
Pediatric	P	P	P		P	P	P	P	
Small Organ (breast, testes, thyroid)									
Neonatal Cephalic									
Adult Cephalic									
Trans-rectal									
Trans-vaginal									
Trans-urethral									
Trans-esoph. (non-Card.)									
Musculo-skeletal (***Conventional***)									
Musculo-skeletal (***Superficial***)									
Intravascular									
Cardiac Adult									
Cardiac Pediatric									
Intravascular (Cardiac)									
Trans-esoph. (Cardiac)									
Intra-cardiac									
Peripheral vessel									
Urology (including prostate)	P	P	P		P	P	P	P	

N = new indication; P = previously cleared by FDA K 121888; E = added under appendix

* Combined: B/Color Doppler, B/PWD, B/Color Doppler/PWD; **Other: 3D, 4D

Acoustic Output

The E-CUBE 12R ultrasound system shows the acoustic output display (e.g. Mechanical Index (MI), Thermal Index (TI)) on the upper right side of the screen. This acoustic output display allows you to monitor the acoustic levels generated by the system.

Two standards for the acoustic output display are as follows:

AIUM/NEMA UD3 Standards for Real-time Display of Thermal and Mechanical Acoustic Output Indices on Diagnostic Ultrasound equipment.

IEC 60601-2-37, Mechanical Electrical Equipment – Part2-37: Particular Requirements for the Safety of Ultrasound Medical Diagnostic and Monitoring Equipment.

WARNING

You should use the E-CUBE 12R ultrasound system at the lowest mechanical/thermal index setting necessary to generate clinically acceptable images.

Acoustic output display (Mechanical/Thermal indices)

The E-CUBE 12R ultrasound system displays Mechanical index (MI) and Thermal index (TI) on the upper right side of the screen as shown below.

The acoustic output display has three values as follows:

- Mechanical Index (MI)
- Thermal Index (TI)
- Power value

MI is used as an indicator of the mechanical bio-effect such as cavitation in the tissue. TI represents the ratio of total power to the power required to raise tissue by 1°C. The power value informs you of where the system is operating within the range of available output power.

One of the following TI values display on the screen based on the application and type of tissue.

- Soft Tissue Thermal Index (TIS)
- Bone Thermal Index (TIB)
- Cranial Bone Thermal Index (TIC)

The TI and MI are displayed all the times. The MI and TI display start at a value of 0.4 and increments in steps of 0.1 (values less than 0.4 are displayed as < 0.4).

WARNING

Be sure to have read and understood control explanations for each mode used before attempting to adjust the power control or any control that can affect Acoustic Output.

Controls affecting acoustic output

The potential for producing mechanical bioeffects (MI) or thermal bioeffects (TI) can be influenced by certain controls. The power control has the most significant effect on Acoustic Output. Indirect effects may occur when adjusting controls.

Controls that can influence MI and TI are detailed under the bioeffects portion of each control in the Image chapter. Always observe the acoustic output display for possible effects.

To minimize exposure time and keep ultrasound levels low, operate your system by using the ALARA (As Low As Reasonably Achievable) principle, increasing output only when you needed to obtain diagnostic image quality. It is recommended that all users receive ALARA training program. The ALARA training program by ALPINION application specialists provides you with basic ultrasound principles, possible biological effects, the derivation and meaning of the indices, ALARA principles, and examples of specific applications of the ALARA principle.

Principle of ALARA

The principle of ALARA, which stands for As Low As Reasonably Achievable, is to keep the radiation exposure at the minimum level necessary to obtain the diagnostic information. This principle is widely practiced in medical x-ray protection where exposure at any level is potentially harmful. Historically, ALARA was initiated as a cautious approach for dealing with uncertain hazards but has since become the principle method for reducing the risk of injury from hazards that do not have safe minimum threshold.

While no minimum thresholds for harmful bioeffects have been established with the use of diagnostic ultrasound, the principle of ALARA can be readily implemented on equipment incorporating an output display. As the operator adjusts the equipment to optimize the image quality, the display interactively updates to indicate the effect on output.

Controls that have no noticeable impact on image quality should be set to minimize the output while controls that improve the image quality and also increase acoustic output should be set no higher than needed to achieve a diagnostic quality image.

Transducer/Mode combination summary

System: E-CUBE 12R

NA: Not Applicable

	Mode of Operation						
Transducer Model	B	M	PWD	CWD	Color Doppler	Combined (Specify)	Other (Specify)
L3-12	O	O	O	NA	O	O	NA
L3-12H	O	O	O	NA	O	O	NA
SC1-4H	O	O	O	NA	O	O	NA
SC1-6	O	O	O	NA	O	O	NA
SP1-5	O	O	O	NA	O	O	NA

Display resolution and measurement accuracy

When a transducer is capable of exceeding a mechanical or thermal index of 1.0, the ultrasound imaging system displays indices starting from 0.4 in increments of 0.1 for all displayed values.

A number of factors contribute to the estimation error for the displayed index. Variation among transducers and systems, approximation for real-time index calculations, and measurement errors contribute to the index display error. Measurement precision for ultrasonic intensities, pressure, center frequency, & power is within 10%, 6%, 7% and 10% respectively. The total estimated display accuracy is +/-15% for MI and +/-30% for TI. Definitions for these parameters can be found in the AIUM/NEMA document entitled Standard for Real-Time Display of Thermal and Mechanical Acoustic Output Indices on Diagnostic Ultrasound Equipment (also known as the Output Display Standard)

Default Displayed MI and TI Values by Transducer
(Per transducer/mode that exceeds default MI or TI value of 0.4)

General Imaging

Transducer Model	Mode of Operation											
	B		M		PW		BC		BCD		THI	
	MI	TI	MI	TI	MI	TI	MI	TI	MI	TI	MI	TI
L3-12	1.2	- - 1.9	1.2	- - 1.9	0.6	- - 0.7	1.3	- - 2.2	1.3	0.5 - 2.6	1.3	- - 2.1
L3-12H	1.0	- - 2.2	1.0	- - 2.2	0.6	- - 0.7	1.1	0.9 - 4.2	0.9	0.7 - 2.8	0.9	- - 0.8
SC1-6	0.9	- - 1.5	0.9	- - 1.5	0.5	0.8 - 1.7	0.8	- - 4.4	0.8	0.4 - 3.2	0.7	- - 1.2
SC1-4H	1.4	- - -	1.4	- - -	0.8	1.8 1.0 2.2	1.3	- - 1.2	1.1	0.4 - 1.4	0.7	- - -
SP1-5	1.0	0.5 0.5 1.2	1.0	0.5 0.5 1.2	0.7	0.6 0.6 1.5	0.7	1.0 1.0 2.0	0.7	0.6 0.5 1.2	0.6	- - 1.6

S: Soft Tissue Index, B: Bone Thermal Index, C: Cranial Thermal Index

Output range summary format

Transducer Model: L3-12

System: E-CUBE 12R

	Mode of Operation						
Global Maximum Output Levels (est.)	B	M	PWD	CWD	Color Doppler	Combined (Specify)	Other (Specify)
Max $I_{SPTA.3}$	92.23	92.23	424.38	NA	195.37	455.36	NA
Min $I_{SPTA.3}$	12.23	12.23	137.62	NA	34.22	119.61	NA
Max MI (or $I_{SPPA.3}$)	1.32	1.32	0.86	NA	1.36	1.23	NA
Min MI (or $I_{SPPA.3}$)	0.70	0.70	0.37	NA	0.47	0.19	NA
Max TIS	0.67	0.67	2.53	NA	1.34	2.83	NA
Min TIS	0.13	0.13	0.22	NA	0.15	0.36	NA
Max TIB	0.67	0.67	1.37	NA	1.34	2.95	NA
Min TIB	0.13	0.13	0.31	NA	0.15	0.45	NA
Max TIC	4.03	4.03	3.76	NA	6.27	7.38	NA
Min TIC	1.52	1.52	0.70	NA	1.99	2.25	NA

NA: Not Applicable

Transducer Model: L3-12H

System: E-CUBE 12R

	Mode of Operation						
Global Maximum Output Levels (est.)	B	M	PWD	CWD	Color Doppler	Combined (Specify)	Other (Specify)
Max $I_{SPTA.3}$	98.83	98.83	591.26	NA	284.13	628.39	NA
Min $I_{SPTA.3}$	12.58	12.58	66.69	NA	37.29	84.97	NA
Max MI (or $I_{SPPA.3}$)	1.38	1.38	1.09	NA	1.52	1.36	NA
Min MI (or $I_{SPPA.3}$)	0.70	0.70	0.16	NA	0.64	0.00	NA
Max TIS	0.85	0.85	5.78	NA	1.57	3.51	NA
Min TIS	0.23	0.23	0.15	NA	0.25	0.28	NA
Max TIB	0.85	0.85	2.20	NA	1.57	1.99	NA
Min TIB	0.23	0.23	0.12	NA	0.25	0.26	NA
Max TIC	4.46	4.46	6.00	NA	5.98	7.06	NA
Min TIC	1.59	1.59	0.33	NA	3.08	1.72	NA

NA: Not Applicable

Transducer Model: SC1-6

System: E-CUBE 12R

	Mode of Operation						
Global Maximum Output Levels (est.)	B	M	PWD	CWD	Color Doppler	Combined (Specify)	Other (Specify)
Max $I_{SPTA.3}$	65.60	65.60	488.60	NA	519.04	419.04	NA
Min $I_{SPTA.3}$	4.59	4.59	34.59	NA	39.24	67.31	NA
Max MI (or $I_{SPPA.3}$)	1.04	1.04	0.64	NA	0.98	0.94	NA
Min MI (or $I_{SPPA.3}$)	0.58	0.58	0.30	NA	0.26	0.25	NA
Max TIS	0.14	0.14	2.71	NA	0.22	2.18	NA
Min TIS	0.01	0.01	0.56	NA	0.02	0.44	NA
Max TIB	0.14	0.14	2.14	NA	0.22	1.77	NA
Min TIB	0.01	0.01	0.46	NA	0.02	0.37	NA
Max TIC	6.00	6.00	4.53	NA	6.16	6.26	NA
Min TIC	1.16	1.16	1.97	NA	4.02	3.69	NA

NA: Not Applicable

Transducer Model: SC1-4H

System: E-CUBE 12R

	Mode of Operation						
Global Maximum Output Levels (est.)	B	M	PWD	CWD	Color Doppler	Combined (Specify)	Other (Specify)
Max $I_{SPTA.3}$	128.94	128.94	472.19	NA	537.27	636.33	NA
Min $I_{SPTA.3}$	4.75	4.75	14.02	NA	18.93	33.02	NA
Max MI (or $I_{SPPA.3}$)	1.46	1.46	0.93	NA	1.38	0.98	NA
Min MI (or $I_{SPPA.3}$)	0.71	0.71	0.22	NA	0.02	0.13	NA
Max TIS	0.03	0.03	6.00	NA	0.27	4.27	NA
Min TIS	0.00	0.00	0.48	NA	0.02	0.37	NA
Max TIB	0.03	0.03	1.72	NA	0.27	1.21	NA
Min TIB	0.00	0.00	0.27	NA	0.02	0.28	NA
Max TIC	1.15	1.15	6.00	NA	6.03	7.43	NA
Min TIC	0.09	0.09	0.72	NA	1.18	0.91	NA

NA: Not Applicable

Transducer Model: SP1-5

System: E-CUBE 12R

	Mode of Operation						
Global Maximum Output Levels (est.)	B	M	PWD	CWD	Color Doppler	Combined (Specify)	Other (Specify)
Max $I_{SPTA.3}$	135.98	135.98	463.37	NA	535.26	642.64	NA
Min $I_{SPTA.3}$	13.50	13.50	62.45	NA	51.81	63.90	NA
Max MI (or $I_{SPPA.3}$)	1.38	1.38	0.96	NA	1.36	0.97	NA
Min MI (or $I_{SPPA.3}$)	0.57	0.57	0.36	NA	0.22	0.14	NA
Max TIS	1.27	1.27	3.36	NA	3.77	3.45	NA
Min TIS	0.28	0.28	0.62	NA	0.60	0.58	NA
Max TIB	1.27	1.27	4.21	NA	3.77	3.39	NA
Min TIB	0.28	0.28	0.65	NA	0.60	0.65	NA
Max TIC	2.54	2.54	6.00	NA	4.90	5.55	NA
Min TIC	0.66	0.66	1.77	NA	1.47	1.53	NA

NA: Not Applicable

Acoustic output reporting table

Transducer Model: L3-12

Operating Mode: B Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.32	0.67	-	-	-	4.03
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	3.20					
	P	W_0	mW		82.3	-		-	81.8
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	1.10					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	5.88	6.45	-	-	-	5.91
	Dim of A_{aprt}	X	cm		1.14	-	-	-	0.45
		Y	cm		0.45	-	-	-	0.45
Other Information	t_d	PD	μsec	0.22					
	prr	PRF	Hz	8192					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	3.84					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		9.00	-	-		3.70
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	286					
Operating Control Conditions	Frequency		MHz	7.50	10.0	-	-	-	7.50
	Focal Zone		cm	2.00	9.00	-	-	-	3.70
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			B	B	-	-	-	B

Transducer Model: L3-12

Operating Mode: THI Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.25	1.09	-	-	-	4.49
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	2.88					
	P	W_0	mW		154	-		-	154
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	1.30					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	5.27	6.05	-	-	-	6.05
	Dim of A_{aprt}	X	cm		1.29	-	-	-	1.29
		Y	cm		0.45	-	-	-	0.45
Other Information	t_d	PD	μsec	0.29					
	prr	PRF	Hz	8192					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	3.53					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		9.00	-	-		9.00
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	287					
Operating Control Conditions	Frequency		MHz	4.00	5.00	-	-	-	5.00
	Focal Zone		cm	2.00	9.00	-	-	-	9.00
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			THI	THI	-	-	-	THI

Transducer Model: L3-12

Operating Mode: BC, BCD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.36	2.83	-	-	-	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	3.26					
	P	W_0	mW		196	-		-	180
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	1.10					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	5.72	6.14	-	-	-	5.15
	Dim of A_{aprt}	X	cm		1.44	-	-	-	0.84
		Y	cm		0.45	-	-	-	0.45
Other Information	t_d	PD	μsec	0.24					
	prr	PRF	Hz	5369					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	4.05					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		9.00	-	-		9.00
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	324					
Operating Control Conditions	Frequency		MHz	6.00	6.00	-	-	-	5.00
	Focal Zone		cm	2.00	9.00	-	-	-	9.00
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			BC	BCD	-	-	-	BC

Transducer Model: L3-12

Operating Mode: D, M Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				0.86	-	2.53	-	1.37	3.76
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	2.00					
	P	W_0	mW		-	137		96.2	137
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					1.30	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	1.10					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					0.49	
	f_{awf}	f_c	MHz	5.36	-	6.14	-	6.14	6.14
	Dim of A_{aprt}	X	cm		-	1.44	-	0.72	1.44
		Y	cm		-	0.45	-	0.45	0.45
Other Information	t_d	PD	µsec	1.40					
	prr	PRF	Hz	930					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.49					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					0.45	
	Focal length	FL_X	cm		-	9.00	-		9.00
		FL_Y	cm		-	0.00	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	158					
Operating Control Conditions	Frequency		MHz	5.50	-	6.00	-	6.00	6.00
	Focal Zone		cm	2.00	-	9.00	-	4.40	9.00
	Sample Volume Size		cm	1.00	-	1.00	-	1.00	1.00
	Power		%	100	-	100	-	100	100
	Mode Type			D Only	-	D Only	-	D Only	D Only

Transducer Model: L3-12

Operating Mode: BD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.37	3.51	-	-	-	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	3.28					
	P	W_0	mW		228	-		-	189
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	1.10					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	5.73	6.14	-	-	-	5.37
	Dim of A_{aprt}	X	cm		1.44	-	-	-	0.72
		Y	cm		0.45	-	-	-	0.45
Other Information	t_d	PD	µsec	0.24					
	prr	PRF	Hz	5369					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	3.81					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		9.00	-	-		4.40
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	331					
Operating Control Conditions	Frequency		MHz	6.00	6.00	-	-	-	5.50
	Focal Zone		cm	2.00	9.00	-	-	-	4.40
	Sample Volume Size		cm	0.00	1.00	-	-	-	1.00
	Power		%	100	100	-	-	-	100
	Mode Type			BD	BD	-	-	-	BD

Transducer Model: L3-12H

Operating Mode: B Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.38	0.85	-	-	-	4.46
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	3.49					
	P	W_0	mW		107	-		-	81.1
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	1.10					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	6.36	6.48	-	-	-	6.00
	Dim of A_{aprt}	X	cm		1.12	-	-	-	0.36
		Y	cm		0.45	-	-	-	0.45
Other Information	t_d	PD	μsec	0.19					
	prr	PRF	Hz	9263					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	4.44					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		9.00	-	-		2.90
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	351					
Operating Control Conditions	Frequency		MHz	10.0	8.50	-	-	-	8.50
	Focal Zone		cm	2.00	9.00	-	-	-	2.90
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			B	B	-	-	-	B

Transducer Model: L3-12H

Operating Mode: THI Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.42	0.40	-	-	-	4.03
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	3.38					
	P	W_0	mW		49.0	-		-	38.6
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	0.90					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	5.70	5.80	-	-	-	5.77
	Dim of A_{aprt}	X	cm		0.90	-	-	-	0.10
		Y	cm		0.45	-	-	-	0.45
Other Information	t_d	PD	µsec	0.26					
	prr	PRF	Hz	9263					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	3.91					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		9.00	-	-		1.00
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	382					
Operating Control Conditions	Frequency		MHz	5.00	5.00	-	-	-	5.00
	Focal Zone		cm	2.00	9.00	-	-	-	1.00
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			THI	THI	-	-	-	THI

Transducer Model: L3-12H

Operating Mode: D, M Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.09	-	5.78	-	2.20	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	2.69					
	P	W_0	mW		-	206		206	143
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					1.00	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	1.10					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					0.62	
	f_{awf}	f_c	MHz	6.16	-	6.17	-	6.17	5.04
	Dim of A_{aprt}	X	cm		-	1.28	-	1.28	0.62
		Y	cm		-	0.45	-	0.45	0.45
Other Information	t_d	PD	µsec	1.23					
	prr	PRF	Hz	930					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	3.48					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					0.58	
	Focal length	FL_X	cm		-	7.80	-		3.70
		FL_Y	cm		-	0.00	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	309					
Operating Control Conditions	Frequency		MHz	6.00	-	6.00	-	6.00	5.00
	Focal Zone		cm	2.00	-	7.80	-	7.80	3.70
	Sample Volume Size		cm	1.00	-	1.00	-	1.00	1.00
	Power		%	100	-	100	-	100	100
	Mode Type			D Only	-	D Only	-	D Only	D Only

Transducer Model: L3-12H

Operating Mode: BC, BCD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.52	3.51	-	-	-	5.98
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	3.79					
	P	W_0	mW		222	-		-	146
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	1.00					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	6.20	6.17	-	-	-	5.46
	Dim of A_{aprt}	X	cm		1.28	-	-	-	0.56
		Y	cm		0.45	-	-	-	0.45
Other Information	t_d	PD	μsec	0.20					
	prr	PRF	Hz	5379					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	4.15					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		9.00	-	-		5.90
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	379					
Operating Control Conditions	Frequency		MHz	8.50	6.00	-	-	-	5.50
	Focal Zone		cm	2.00	9.00	-	-	-	5.90
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			BC	BCD	-	-	-	BC

Transducer Model: L3-12H

Operating Mode: BD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.44	4.23	-	-	-	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	3.57					
	P	W_0	mW		246	-		-	260
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	1.00					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	6.19	6.17	-	-	-	5.37
	Dim of A_{aprt}	X	cm		1.28	-	-	-	1.28
		Y	cm		0.45	-	-	-	0.45
Other Information	t_d	PD	μsec	0.21					
	prr	PRF	Hz	5379					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	4.52					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		9.00	-	-		7.80
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	361					
Operating Control Conditions	Frequency		MHz	8.50	6.00	-	-	-	5.50
	Focal Zone		cm	2.00	9.00	-	-	-	7.80
	Sample Volume Size		cm	0.00	1.00	-	-	-	1.00
	Power		%	100	100	-	-	-	100
	Mode Type			BD	BD	-	-	-	BD

Transducer Model: SC1-6

Operating Mode: B Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.04	0.14	-	-	-	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.56					
	P	W_0	mW		290	-		-	154
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.20					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	2.26	2.29	-	-	-	2.20
	Dim of A_{aprt}	X	cm		2.16	-	-	-	0.24
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	μsec	0.56					
	prr	PRF	Hz	2816					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.14					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		22.0	-	-		2.30
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	100					
Operating Control Conditions	Frequency		MHz	2.50	2.50	-	-	-	2.50
	Focal Zone		cm	6.50	22.0	-	-	-	2.30
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			B	B	-	-	-	B

Transducer Model: SC1-6

Operating Mode: THI Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.05	0.07	-	-	-	5.16
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.53					
	P	W_0	mW		161	-		-	133
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.50					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	2.11	2.11	-	-	-	2.13
	Dim of A_{aprt}	X	cm		2.16	-	-	-	0.24
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	μsec	0.58					
	prr	PRF	Hz	2816					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.14					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		22.0	-	-		2.30
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	95.9					
Operating Control Conditions	Frequency		MHz	2.00	2.00	-	-	-	2.00
	Focal Zone		cm	8.00	22.0	-	-	-	2.30
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			THI	THI	-	-	-	THI

Transducer Model: SC1-6

Operating Mode: D, M Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				0.64	-	-	2.71	2.14	4.53
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	0.91					
	P	W_0	mW		-	-		280	116
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					86.0		
	z_s	z_1	cm				5.00		
	z_{bp}	z_{bp}	cm				2.95		
	z_b	z_{sp}	cm					3.30	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	5.10					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					2.83	
	f_{awf}	f_c	MHz	2.00	-	-	2.96	2.00	2.97
	Dim of A_{aprt}	X	cm		-	-	2.26	2.26	0.24
		Y	cm		-	-	1.35	1.35	1.35
Other Information	t_d	PD	µsec	3.74					
	prr	PRF	Hz	930					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	1.34					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					2.17	
	Focal length	FL_X	cm		-	-	22.0		2.30
		FL_Y	cm		-	-	0.00		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	38.9					
Operating Control Conditions	Frequency		MHz	2.00	-	-	3.00	2.00	3.00
	Focal Zone		cm	8.00	-	-	22.0	22.0	2.30
	Sample Volume Size		cm	1.00	-	-	1.00	1.00	1.00
	Power		%	100	-	-	100	100	100
	Mode Type			D Only	-	-	D Only	D Only	D Only

Transducer Model: SC1-6

Operating Mode: BC, BCD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				0.98	2.18	-	-	-	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.48					
	P	W_0	mW		463	-		-	169
	min of $[P_\alpha(z_s), I_{ta.\alpha}(z_s)]$	min of $[(W_{.3}(Z_1), I_{TA.3}(z_1))$					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.30					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	2.27	2.96	-	-	-	2.96
	Dim of A_{aprt}	X	cm		2.26	-	-	-	0.29
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	μsec	0.55					
	prr	PRF	Hz	2241					
	p_r at max I_{pi}	$P_r@PII_{max}$	MPa	2.00					
	d_{eq} at max I_{pi}	$d_{eq}@PII_{max}$	cm					-	
	Focal length	FL_X	cm		22.0	-	-		2.30
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}@MI_{max}$	W/cm^2	84.1					
Operating Control Conditions	Frequency		MHz	2.50	3.00	-	-	-	3.00
	Focal Zone		cm	6.90	22.0	-	-	-	2.30
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			BC	BCD	-	-	-	BC

Transducer Model: SC1-6

Operating Mode: BD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.03	2.80	-	-	-	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.55					
	P	W_0	mW		458	-		-	319
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.20					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	2.27	2.96	-	-	-	2.49
	Dim of A_{aprt}	X	cm		2.26	-	-	-	1.01
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	μsec	0.55					
	prr	PRF	Hz	2241					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.09					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		22.0	-	-		10.0
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	93.4					
Operating Control Conditions	Frequency		MHz	2.50	3.00	-	-	-	2.50
	Focal Zone		cm	6.90	22.0	-	-	-	10.0
	Sample Volume Size		cm	0.00	1.00	-	-	-	1.00
	Power		%	100	100	-	-	-	100
	Mode Type			BD	BD	-	-	-	BD

Transducer Model: SC1-4H

Operating Mode: B Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.46	0.03	-	-	-	1.15
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	2.26					
	P	W_0	mW		39.0	-		-	22.2
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	3.80					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	2.39	2.36	-	-	-	2.10
	Dim of A_{aprt}	X	cm		2.18	-	-	-	0.14
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	μsec	0.53					
	prr	PRF	Hz	6231					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.97					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		24.0	-	-		1.50
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	235					
Operating Control Conditions	Frequency		MHz	3.20	3.20	-	-	-	2.00
	Focal Zone		cm	5.70	24.0	-	-	-	1.50
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			B	B	-	-	-	B

Transducer Model: SC1-4H

Operating Mode: THI Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.67	0.00	-	-	-	0.29
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	2.37					
	P	W_0	mW		6.19	-		-	5.62
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.40					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	2.02	1.88	-	-	-	2.10
	Dim of A_{aprt}	X	cm		2.18	-	-	-	0.14
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	µsec	0.59					
	prr	PRF	Hz	5363					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	3.03					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		24.0	-	-		1.50
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	266					
Operating Control Conditions	Frequency		MHz	2.20	1.80	-	-	-	1.80
	Focal Zone		cm	8.00	24.0	-	-	-	1.50
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			THI	THI	-	-	-	THI

Transducer Model: SC1-4H

Operating Mode: D, M Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				0.93	-	-	6.00	1.72	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.32					
	P	W_0	mW		-	-		285	154
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					116		
	z_s	z_1	cm				5.50		
	z_{bp}	z_{bp}	cm				2.81		
	z_b	z_{sp}	cm					5.20	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.10					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					0.64	
	f_{awf}	f_c	MHz	2.01	-	-	2.51	2.00	2.00
	Dim of A_{aprt}	X	cm		-	-	2.04	0.85	0.24
		Y	cm		-	-	1.35	1.35	1.35
Other Information	t_d	PD	µsec	3.75					
	prr	PRF	Hz	930					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	1.70					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					0.61	
	Focal length	FL_X	cm		-	-	20.0		1.50
		FL_Y	cm		-	-	0.00		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	122					
Operating Control Conditions	Frequency		MHz	2.00	-	-	2.50	2.00	2.00
	Focal Zone		cm	5.70	-	-	20.0	8.00	1.50
	Sample Volume Size		cm	1.00	-	-	1.00	1.00	1.00
	Power		%	100	-	-	100	100	100
	Mode Type			D Only	-	-	D Only	D Only	D Only

Transducer Model: SC1-4H

Operating Mode: BC, BCD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.38	4.27	-	-	-	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.92					
	P	W_0	mW		556	-		-	152
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.80					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	1.93	2.94	-	-	-	2.93
	Dim of A_{aprt}	X	cm		2.04	-	-	-	0.24
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	µsec	0.65					
	prr	PRF	Hz	2241					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.56					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		20.0	-	-		1.50
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	210					
Operating Control Conditions	Frequency		MHz	2.00	3.00	-	-	-	3.00
	Focal Zone		cm	8.00	20.0	-	-	-	1.50
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			BC	BCD	-	-	-	BC

Transducer Model: SC1-4H

Operating Mode: BD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.46	6.01	-	-	-	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	2.02					
	P	W_0	mW		455	-		-	128
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.70					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	1.92	2.96	-	-	-	2.00
	Dim of A_{aprt}	X	cm		2.18	-	-	-	0.24
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	μsec	0.66					
	prr	PRF	Hz	2241					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.54					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		24.0	-	-		1.50
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	232					
Operating Control Conditions	Frequency		MHz	2.00	3.00	-	-	-	2.00
	Focal Zone		cm	8.00	24.0	-	-	-	1.50
	Sample Volume Size		cm	0.00	1.00	-	-	-	1.00
	Power		%	100	100	-	-	-	100
	Mode Type			BD	BD	-	-	-	BD

Transducer Model: SP1-5

Operating Mode: B Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.38	1.27	-	-	-	2.54
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.92					
	P	W_0	mW		133	-		-	51.7
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.20					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	1.92	2.02	-	-	-	2.53
	Dim of A_{aprt}	X	cm		1.92	-	-	-	0.15
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	μsec	0.70					
	prr	PRF	Hz	1856					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.53					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		23.0	-	-		1.50
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	135					
Operating Control Conditions	Frequency		MHz	2.50	2.50	-	-	-	3.50
	Focal Zone		cm	8.00	23.0	-	-	-	1.50
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			B	B	-	-	-	B

Transducer Model: SP1-5

Operating Mode: THI Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.44	2.36	-	-	-	4.96
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.96					
	P	W_0	mW		238	-		-	110
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	3.70					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	1.85	2.08	-	-	-	2.03
	Dim of A_{aprt}	X	cm		1.92	-	-	-	0.18
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	μsec	0.94					
	prr	PRF	Hz	1856					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.45					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		26.0	-	-		1.50
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	122					
Operating Control Conditions	Frequency		MHz	1.80	2.20	-	-	-	2.20
	Focal Zone		cm	5.60	26.0	-	-	-	1.50
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			THI	THI	-	-	-	THI

Transducer Model: SP1-5

Operating Mode: D, M Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				0.96	-	-	3.36	4.21	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.36					
	P	W_0	mW		-	-		323	172
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					201		
	z_s	z_1	cm				4.20		
	z_{bp}	z_{bp}	cm				2.23		
	z_b	z_{sp}	cm					6.60	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.50					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					0.62	
	f_{awf}	f_c	MHz	2.00	-	-	2.00	2.46	2.00
	Dim of A_{aprt}	X	cm		-	-	1.29	1.92	0.30
		Y	cm		-	-	1.35	1.35	1.35
Other Information	t_d	PD	μsec	3.44					
	prr	PRF	Hz	930					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	1.84					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					0.55	
	Focal length	FL_X	cm		-	-	8.00		1.50
		FL_Y	cm		-	-	0.00		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	145					
Operating Control Conditions	Frequency		MHz	2.00	-	-	2.00	2.50	2.00
	Focal Zone		cm	5.60	-	-	8.00	14.0	1.50
	Sample Volume Size		cm	1.00	-	-	1.00	1.00	1.00
	Power		%	100	-	-	100	100	100
	Mode Type			D Only	-	-	D Only	D Only	D Only

Transducer Model: SP1-5

Operating Mode: BC, BCD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.36	3.77	-	-	-	4.90
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.89					
	P	W_0	mW		356	-		-	356
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.10					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	1.92	2.37	-	-	-	2.37
	Dim of A_{aprt}	X	cm		1.92	-	-	-	1.92
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	μsec	0.69					
	prr	PRF	Hz	2236					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.49					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		26.0	-	-		26.0
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	129					
Operating Control Conditions	Frequency		MHz	2.50	2.50	-	-	-	2.50
	Focal Zone		cm	8.00	26.0	-	-	-	26.0
	Sample Volume Size		cm	-	-	-	-	-	-
	Power		%	100	100	-	-	-	100
	Mode Type			BC	BC	-	-	-	BC

Transducer Model: SP1-5

Operating Mode: BD Mode

System: E-CUBE 12R

Index Label				MI	TIS			TIB	TIC
					scan	non-scan		non-scan	
						A_{aprt}≤1	A_{aprt}>1		
Global Maximum: Index Value				1.33	4.62	-	-	-	6.00
	IEC	FDA	Units						
Associated Acoustic Parameter	p_{ra}	$P_{r.3}$	MPa	1.84					
	P	W_0	mW		532	-		-	259
	min of [$P_\alpha(z_s)$,$I_{ta.\alpha}(z_s)$]	min of [($W_{.3}(Z_1)$, $I_{TA.3}(z_1)$)					-		
	z_s	z_1	cm				-		
	z_{bp}	z_{bp}	cm				-		
	z_b	z_{sp}	cm					-	
	z at max $I_{pi,\alpha}$	z_{sp}	cm	4.30					
	$d_{eq}(z_b)$	$d_{eq}(z_{sp})$	cm					-	
	f_{awf}	f_c	MHz	1.92	1.99	-	-	-	2.00
	Dim of A_{aprt}	X	cm		1.92	-	-	-	0.63
		Y	cm		1.35	-	-	-	1.35
Other Information	t_d	PD	µsec	0.69					
	prr	PRF	Hz	2.236					
	p_r at max I_{pi}	P_r@PII_{max}	MPa	2.46					
	d_{eq} at max I_{pi}	d_{eq}@PII_{max}	cm					-	
	Focal length	FL_X	cm		26.0	-	-		3.80
		FL_Y	cm		0.00	-	-		0.00
	$I_{pa.\alpha}$ at max MI	$I_{PA.3}$@MI_{max}	W/cm^2	125					
Operating Control Conditions	Frequency		MHz	2.50	2.00	-	-	-	2.00
	Focal Zone		cm	8.00	26.0	-	-	-	3.80
	Sample Volume Size		cm	0.00	1.00	-	-	-	1.00
	Power		%	100	100	-	-	-	100
	Mode Type			BD	BD	-	-	-	BD

USER MANUAL

Rev. 1 (ENG)

MEDICAL SYSTEMS

www.alpinion.com