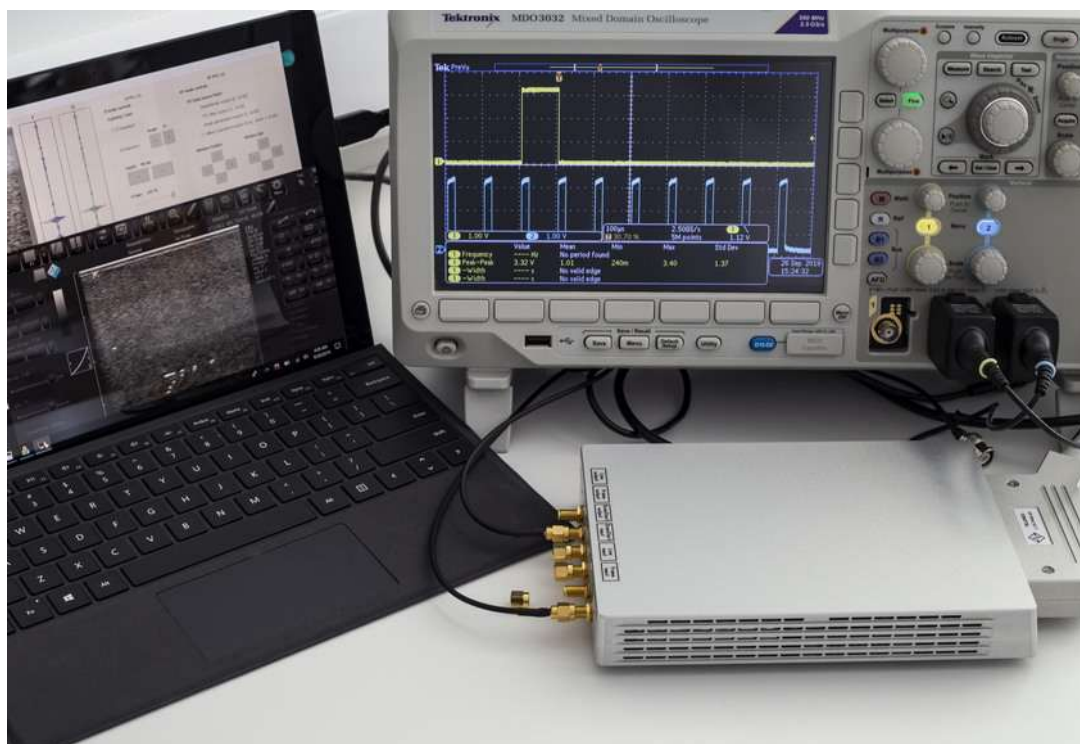


ArtUs EXT-1H/2H

ArtUs OEM-1H/2H

ArtUs OEXT-1H/2H

Ultrasound System



I/O MODULE USER GUIDE



Internet page: <https://www.pcultrasound.com>
Information E-mail: info@pcultrasound.com
Support E-mail: support@pcultrasound.com

Contents

1.	<u>Terms Used In This Guide.....</u>	3
2.	<u>I/O Module Connectors Description</u>	3
3.	<u>I/O Module Triggering Signals Description.....</u>	4
4.	<u>ArtUs Sync Options Utility.....</u>	6
5.	<u>Voltage Levels for Interface Signals</u>	9
6.	<u>Signal Diagrams</u>	10
7.	<u>External Equipment Connection Diagram</u>	12
8.	<u>Return to normal scan mode</u>	12
9.	<u>How to enable/disable I/O signals without ArtUs Sync Options Utility</u>	12
10.	<u>Twin Synchro ArtUs Setup.....</u>	13
	Configuration 1: 2 ArtUs, 2 PCs, Signal Generator for external frame synchronization ..	13
	Configuration 2: 2 ArtUs, PC with 2 Monitors, Signal Generator for external frame synchronization	15
	Setting the highest frame rate	16
11.	<u>Q&A Section.....</u>	17
12.	<u>Revision History.....</u>	18

Introduction

The ArtUs beamformer can be equipped with an optional I/O module that enables control via an external signal source, such as a signal generator.

This I/O module features several coaxial connectors for both input and output signal transmission.

When equipped with the I/O module, ArtUs can support a variety of ultrasound imaging scenarios, which are described in detail later in this document.

1. Terms Used In This Guide

Line (Ultrasound Line) – a set of ultrasound echo signals acquired as a result of one transmission event.

Frame (Ultrasound Frame) – a set of ultrasound lines combined and displayed simultaneously.

ScanStart – a signal that triggers the state of the beamformer between FREEZE and SCAN.

2. I/O Module Connectors Description

ArtUs EXT-1H/2H and **ArtUs OEXT-1H/2H** with I/O module installed look as shown in the picture below (rear view), cooling fans “looking” down; see attached photo. Connectors are of SMA female type and require 50 Ohm coaxial cable equipped with SMA male plug on the beamformer end. More information about connectors/cables can be found in the Q&A Section.



Connectors are labeled as shown in a table:

Line output	Frame output	ScanStart output	ScanStart input	Line input	Frame input
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The names and designations of connectors:

- Ultrasound Line Output** (label **Line output**) signal, a falling edge of the output signal corresponds to the start of ultrasound data acquisition from a tissue for one ultrasound line. The signal stays in the logic level "0" at the end of the line.
- Ultrasound Frame Output** (label **Frame output**) signal, a falling edge of the output signal corresponds to the start of ultrasound data acquisition from a tissue for one ultrasound frame. Signal returns to logic level "1" at the end of the frame.
- ScanStart output** signal, the system generates logic level "0" in FREEZE state and logic level "1" in SCAN state. This signal is not configurable.

- D) **ScanStart input** signal, the system changes state from FREEZE to SCAN and from SCAN to FREEZE at each rising edge of the input signal (works like the FREEZE button). This signal is not configurable.
- E) **Ultrasound Line Input** (label **Line input**) signal, upon receiving a rising edge of the input signal, the system starts acquiring ultrasound data from tissue for one ultrasound line with a delay of approximately 20 microseconds.
- F) **Ultrasound Frame Input** (label **Frame input**) signal, upon receiving a rising edge of the input signal, the system starts acquiring ultrasound data from a tissue for one ultrasound frame with a delay of approximately 20 microseconds.

ArtUs OEM-1H/2H with I/O module has the same set of connectors labeled as shown in the table below:



Line output	Frame output	ScanStart output	ScanStart input	Line input	Frame input
-------------	--------------	------------------	-----------------	------------	-------------

3. I/O Module Triggering Signals Description

Signal	Trigger	SCAN state	FREEZE state	Final State
Line Input	Rising Edge	Acquire one line delay 20 us	n/a	Logical 0
Line Output	Falling Edge	Acquired one line	n/a	Logical 0
Frame Input	Rising Edge	Acquire a set number of frames delay 20 us	n/a	Logical 0
Frame Output	Falling Edge	Acquired a set number of frames	n/a	Logical 1
ScanStart Input Unconfigured (FREEZE button simulation)	Rising Edge	To FREEZE	To SCAN	Logical 0
ScanStart Input Configured	n/a	Logical 1	Logical 0	n/a
ScanStart Output	Device state	Logical 1	Logical 0	n/a

Ultrasound Line input and **Ultrasound Frame input** signals need to be configured by **ArtUs Sync** utility:

- **Ultrasound Line input** - system starts acquiring ultrasound data for one ultrasound line, approximately 20 us after the rising edge of the input signal.
- **Ultrasound Frame input** - system starts acquiring ultrasound data for one ultrasound frame, approximately 20 us after the rising edge of the input signal.

Note: When using an external generator to synchronize ArtUs, the jitter of launches and signal reception by ArtUs can be up to 25 ns, i.e., the period of the “system” clock.

Ultrasound Line output and **Ultrasound Frame output** work automatically, and do not require additional configuration:

- **Ultrasound Line output** - the falling edge of the output signal corresponds to the start of ultrasound data acquired for one ultrasound line. The signal stays in the logic level "0" at the end of the line.
- **Ultrasound Frame output** - the falling edge of the output signal corresponds to the end of the first ultrasound line of the ultrasound frame. The signal returns to logic level "1" at the end of the frame.

ScanStart input and **ScanStart output** without additional configuration:

- **ScanStart input** - the system switches its state from FREEZE to SCAN and from SCAN to FREEZE at each rising edge of the signal (functions like the FREEZE button). The delay of the state change depends on the PC hardware and software configuration and may be on the order of several tens of milliseconds. The first frame may be corrupted in this synchronization mode. Not recommended when precise timing requirements are critical.
- **ScanStart output** - the system generates logic level "0" in Freeze mode and logic level "1" in Scan mode

ScanStart input and **ScanStart output** with additional configuration:

- **ScanStart input** - the system starts scanning when the signal is at logic level “1” and pauses scanning (not equivalent to FREEZE) when the signal is at logic level “0”, with a delay of approximately 20 μs after the input signal level changes.
- **ScanStart output** – does not depend on the ScanStart input signal level. The system outputs logic level “0” in FREEZE mode and logic level “1” in SCAN mode.

4. ArtUs Sync Options Utility

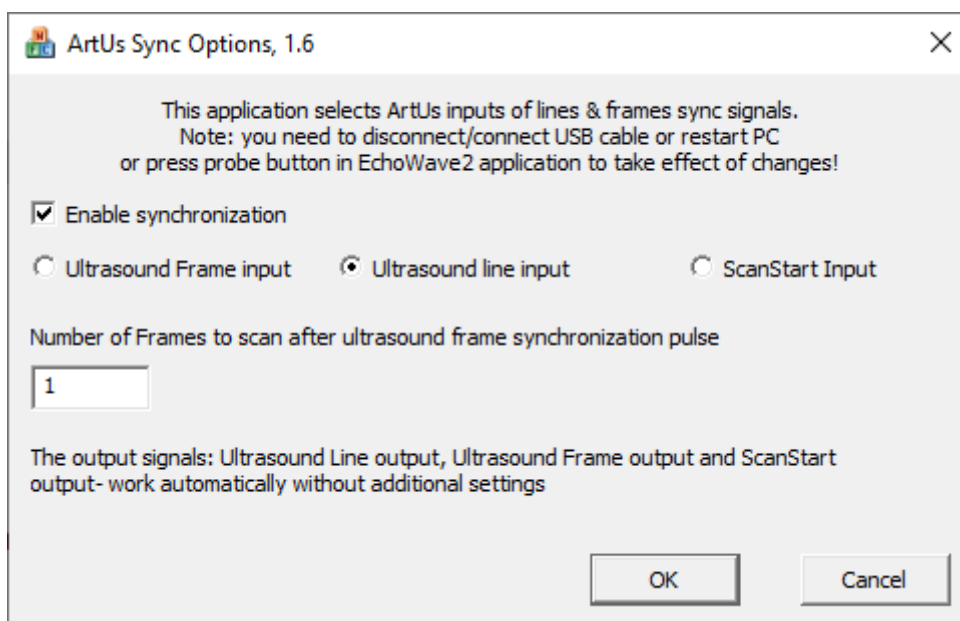


NOTE: If you have installed Echo Wave II 64-bit application only, then you may be required to install additional Microsoft Visual C++ 2005 libraries. For additional instructions, please see Q&A Section.

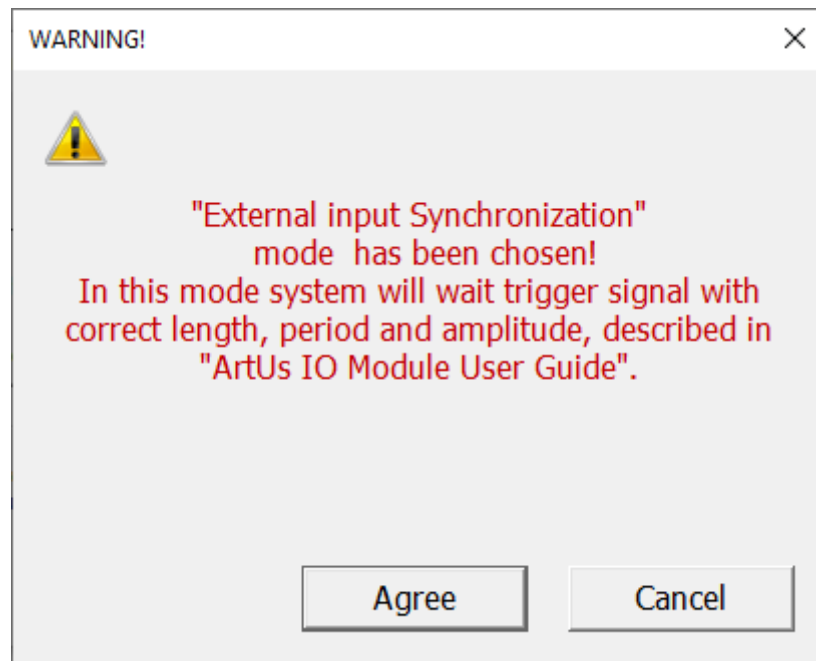


NOTE: Always run the **ArtUs Sync Options** utility in Administrator mode to allow changes to be saved to the Windows Registry.

1. Run the **ArtUs Sync Options** utility, and select **Ultrasound Line input** synchronization mode, see the picture below.



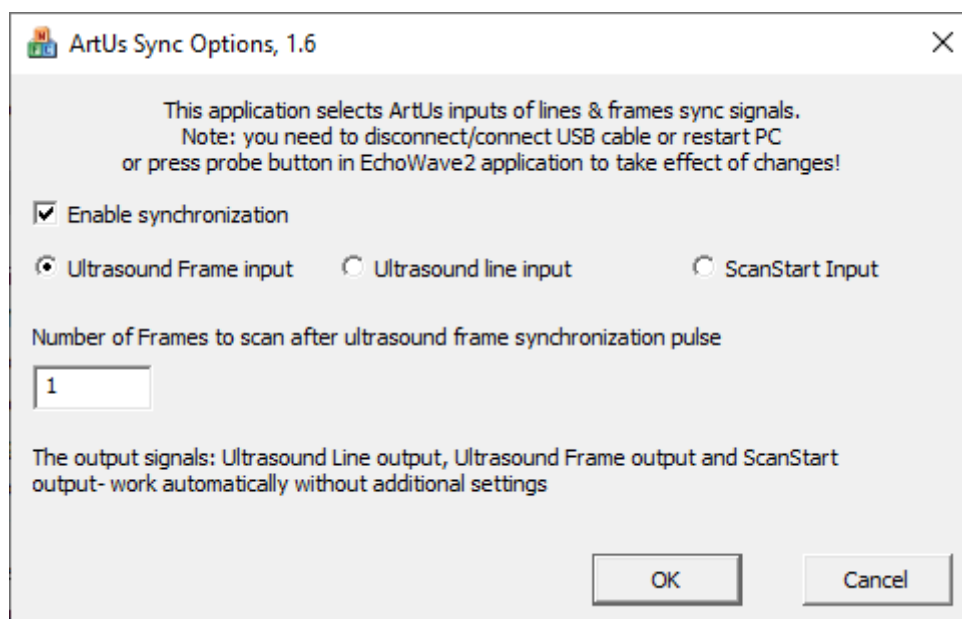
Please note, that after clicking the “OK” button user gets a warning message as shown below.



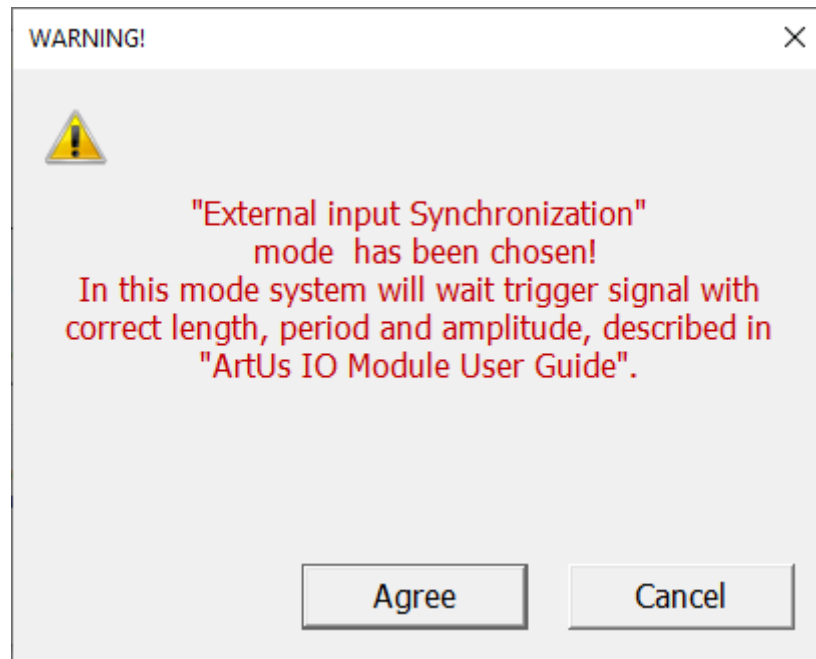
To activate device settings, the user needs to run the Echo Wave II program or, if Echo Wave II is already running, push the “Probe” button.

The output signals: Ultrasound Line output, Ultrasound Frame output, and ScanStart output — work automatically without additional settings.

2. Run the **ArtUs Sync Options** utility and select **Ultrasound Frame input** synchronization mode; see the picture below. “Number of Frames to scan after synch pulse” defines how many frames will be received after each “Ultrasound Frame Input” signal. Set “0” to start non-stop scanning after the rising edge of the “Ultrasound Frame Input” signal.

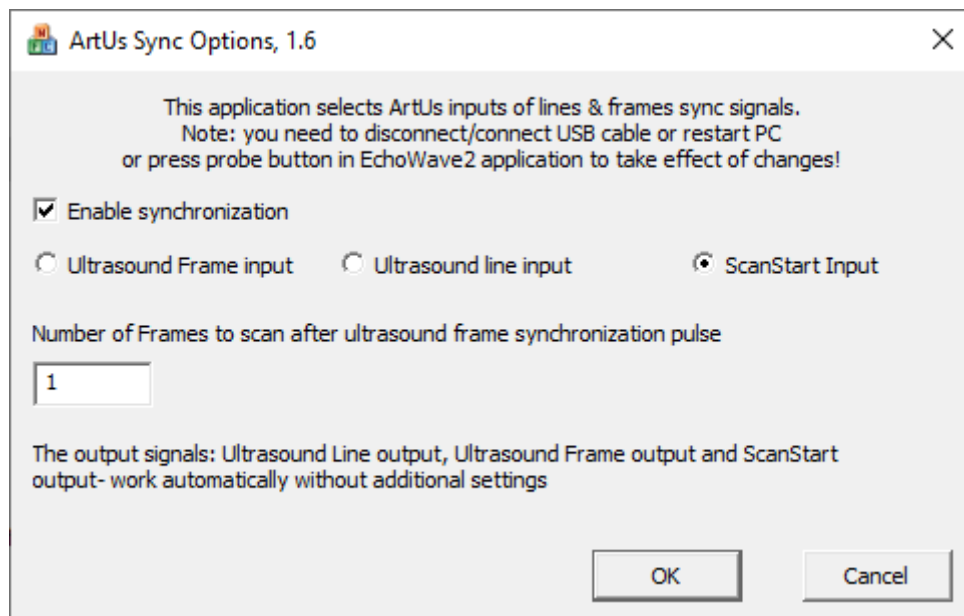


Please note that after clicking the “OK” button, the user gets a warning message as shown below.

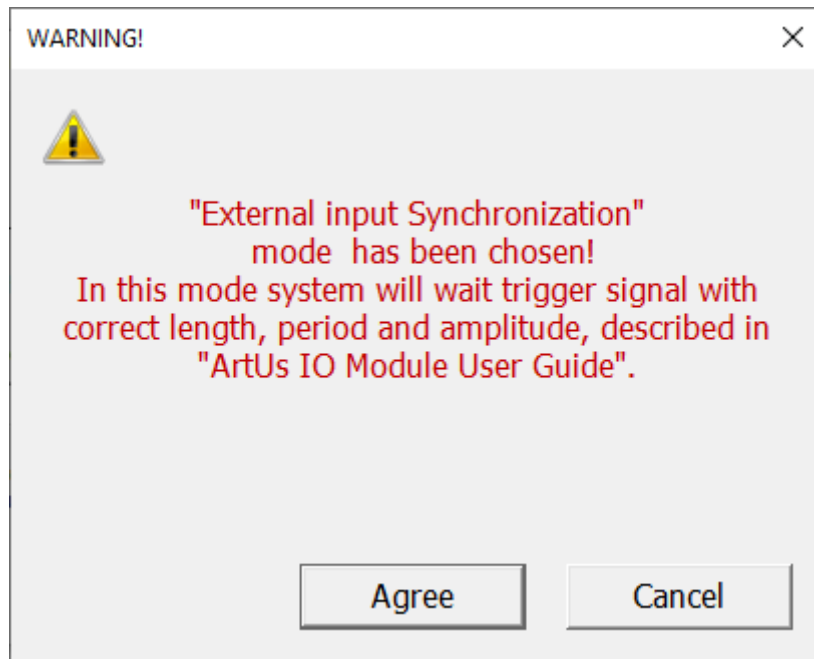


To activate device settings, the user needs to run the Echo Wave II program or, if Echo Wave II is already running, push the “Probe” button.

3. Run the **ArtUs Sync Options** utility in Administrator mode, and select **ScanStart Input** synchronization mode, see the picture below.



Please note that after clicking the “OK” button, the user gets a warning message as shown below.



To activate device settings, the user needs to run the Echo Wave II program or, if Echo Wave II is already running, push the “Probe” button.

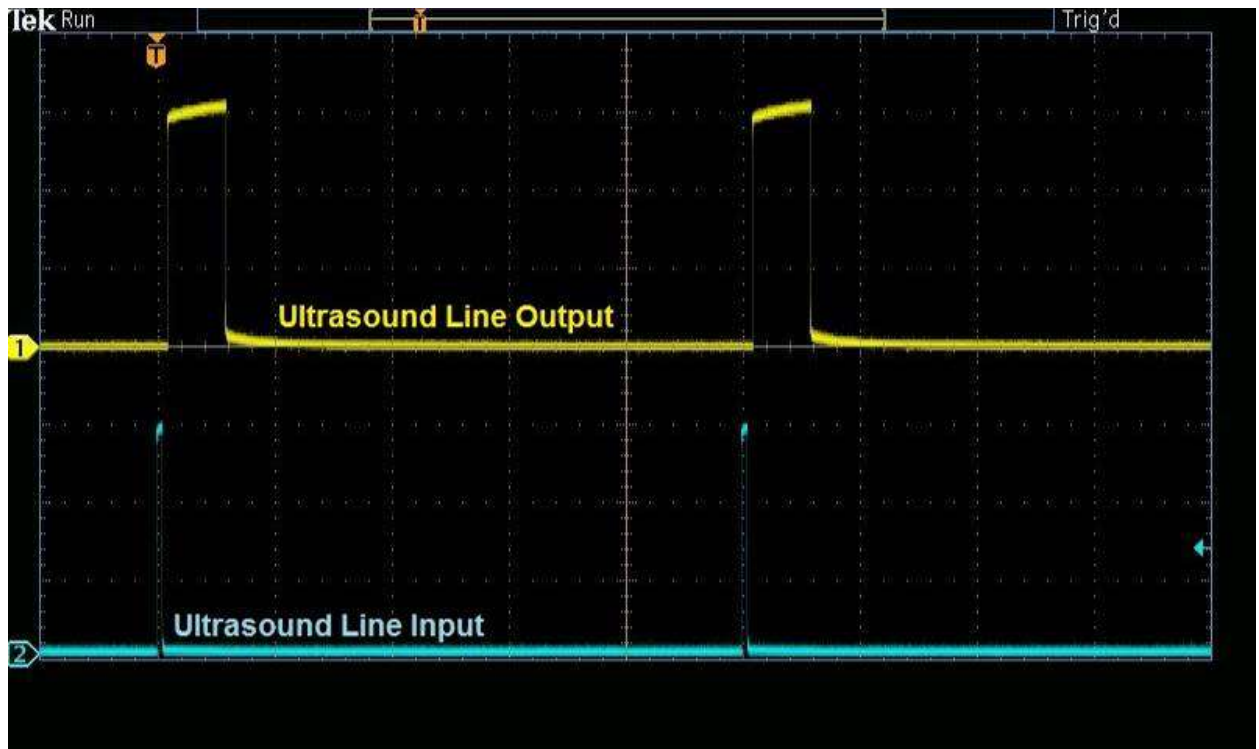
Note: Ultrasound Frames have one additional “passive” ultrasound line when any input is chosen in the **ArtUs Sync Options** utility.

5. Voltage Levels for Interface Signals

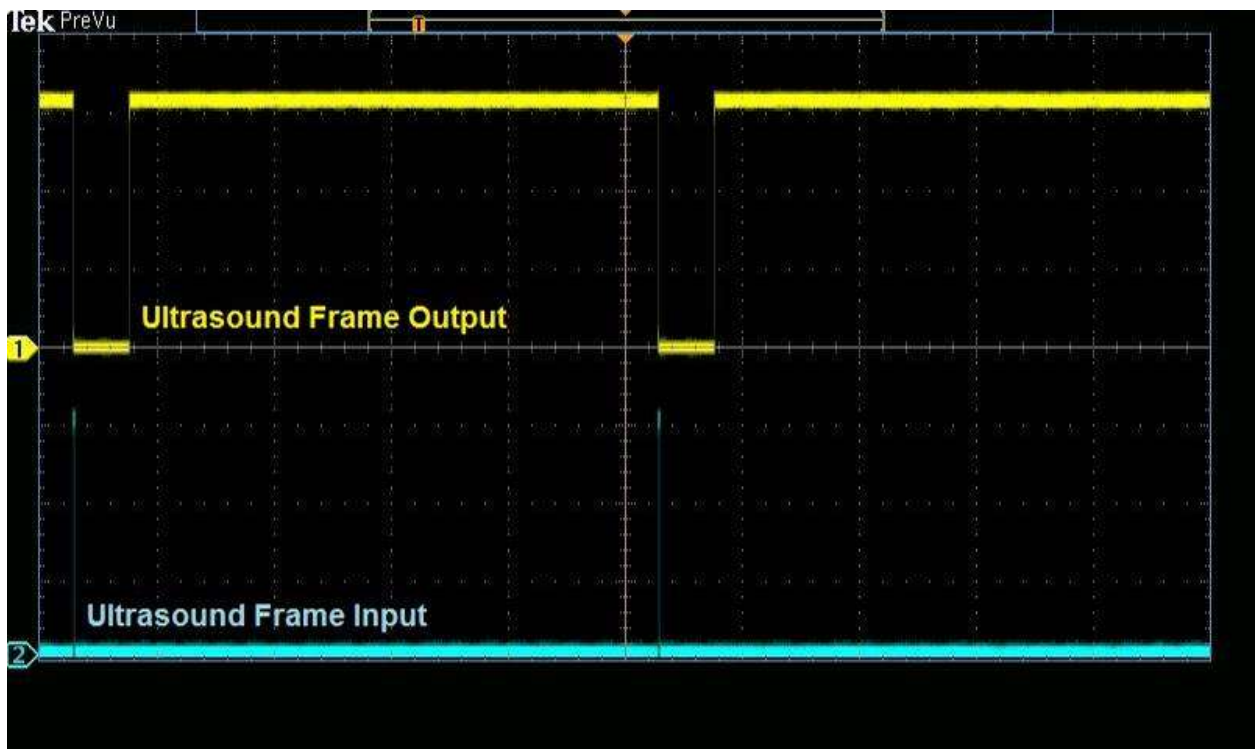
- **Input signals** – 2,5V or 3,3V CMOS level (5V logic tolerance)
- **Output signals** – 3,3V CMOS level

6. Signal Diagrams

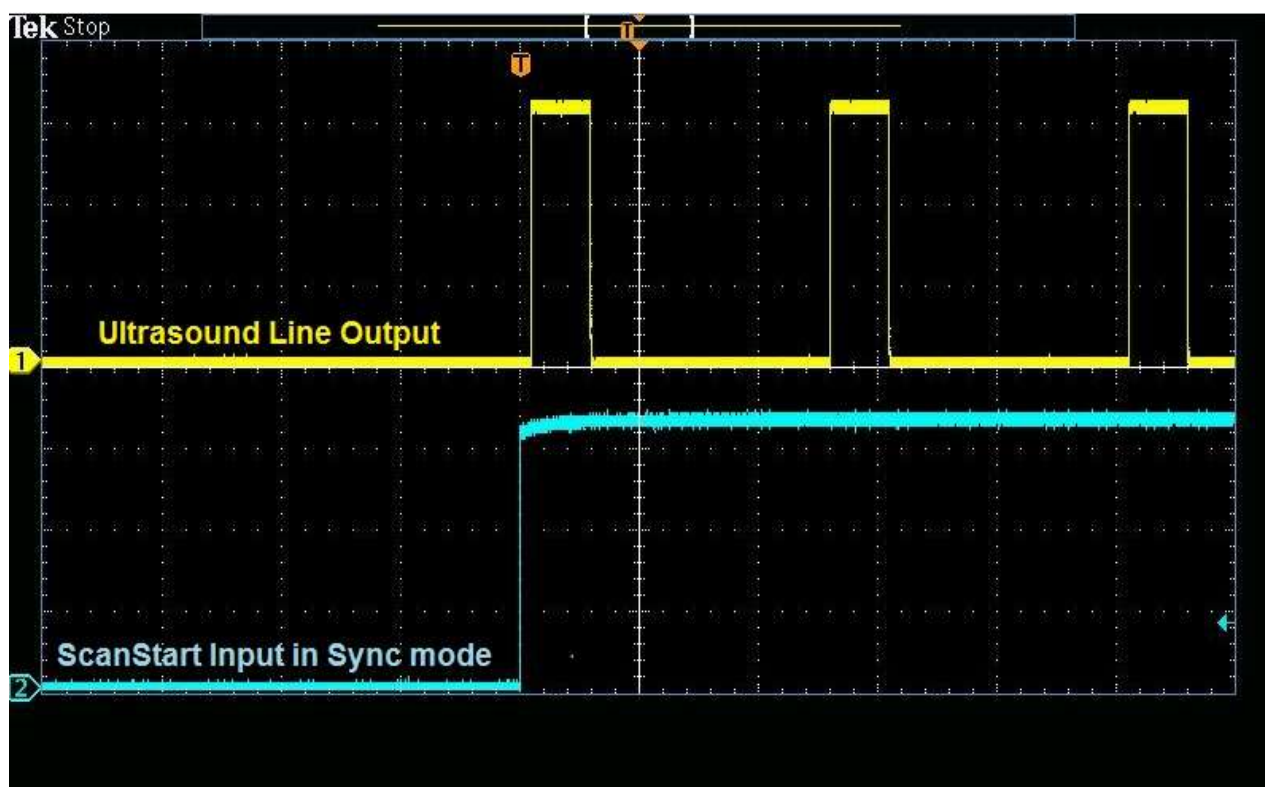
Diagrams show external equipment input signals and corresponding outputs.



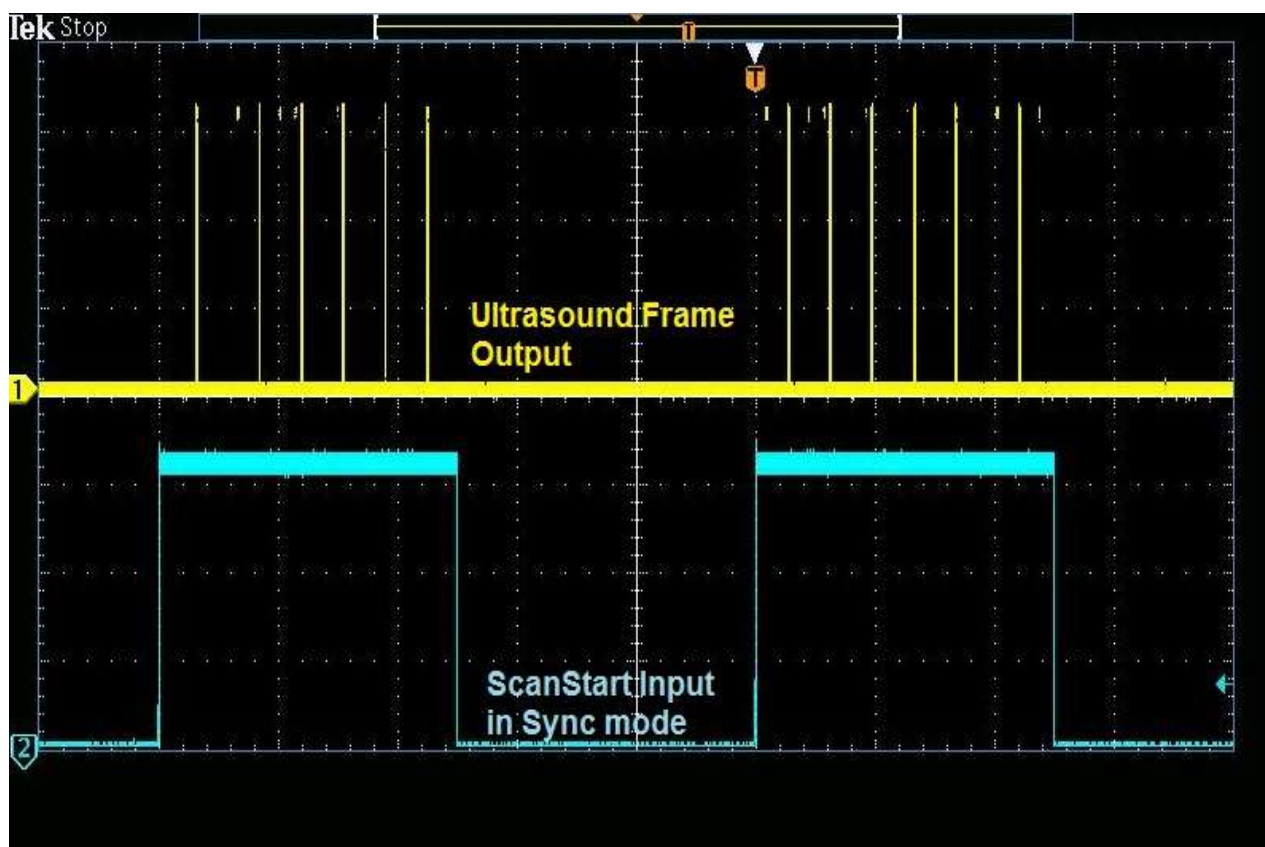
Ultrasound Line Input vs Ultrasound Line Output



Ultrasound Frame Input vs Ultrasound Frame Output



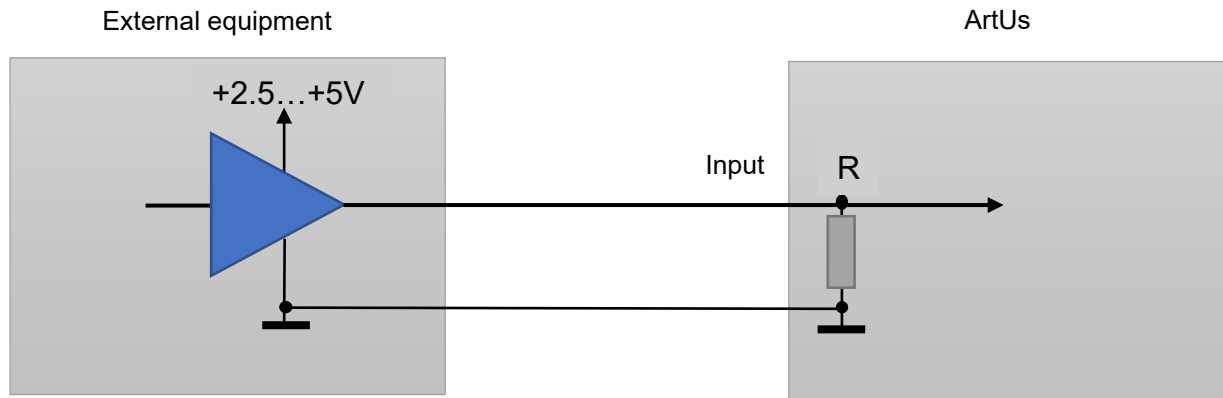
ScanStart Input in Sync Mode vs Ultrasound Line Output



ScanStart Input in Sync Mode vs Ultrasound Frame Output

7. External Equipment Connection Diagram

Block schematics below demonstrate how ArtUs inputs must be connected to external equipment outputs.



8. Return to normal scan mode.

To switch the ArtUs scanner back to normal scan mode, do not forget to run the **ArtUs Sync Options** utility in Administrator mode, clear the checkbox **Enable synchronization**, and click the "OK" button. Please note that after clicking the "OK" button, the user needs to disconnect and reconnect the USB cable or reboot the PC.

9. How to enable/disable I/O signals without ArtUs Sync Options Utility

Run the Registry Editor utility (regedit.exe)

Locate the Registry path:

„HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\ArtUs\Parameters“.

To **enable synchronization** and **Ultrasound Frame input**

Write value **1** to the "External synch mode" register

To **enable synchronization** and **Ultrasound Line input**

Write value **2** to the "External synch mode" register

To **enable synchronization** and **ScanStart input**

Write value **4** to the "External synch mode" register.

To define the **Number of Frames to scan after the ultrasound frame synchronization pulse**

Write the number of frames to the "Synch frames number" register.

10. Twin Synchro ArtUs Setup

Some ultrasound applications require synchronous work of two or more beamformer devices. You can use the ArtUs system in such scenarios. There can be several possible configurations, which are described below.

To use the external hardware Freeze/Run button, edit a line shown below and save the options2.txt file (located in C:\Program Files (x86)\TELEMED\Echo Wave II\Config\Options directory):

```
accept_ultrasound_keyboard_commands_when_window_is_not_focused;1
```

Configuration 1: 2 ArtUs, 2 PCs, Signal Generator for external frame synchronization

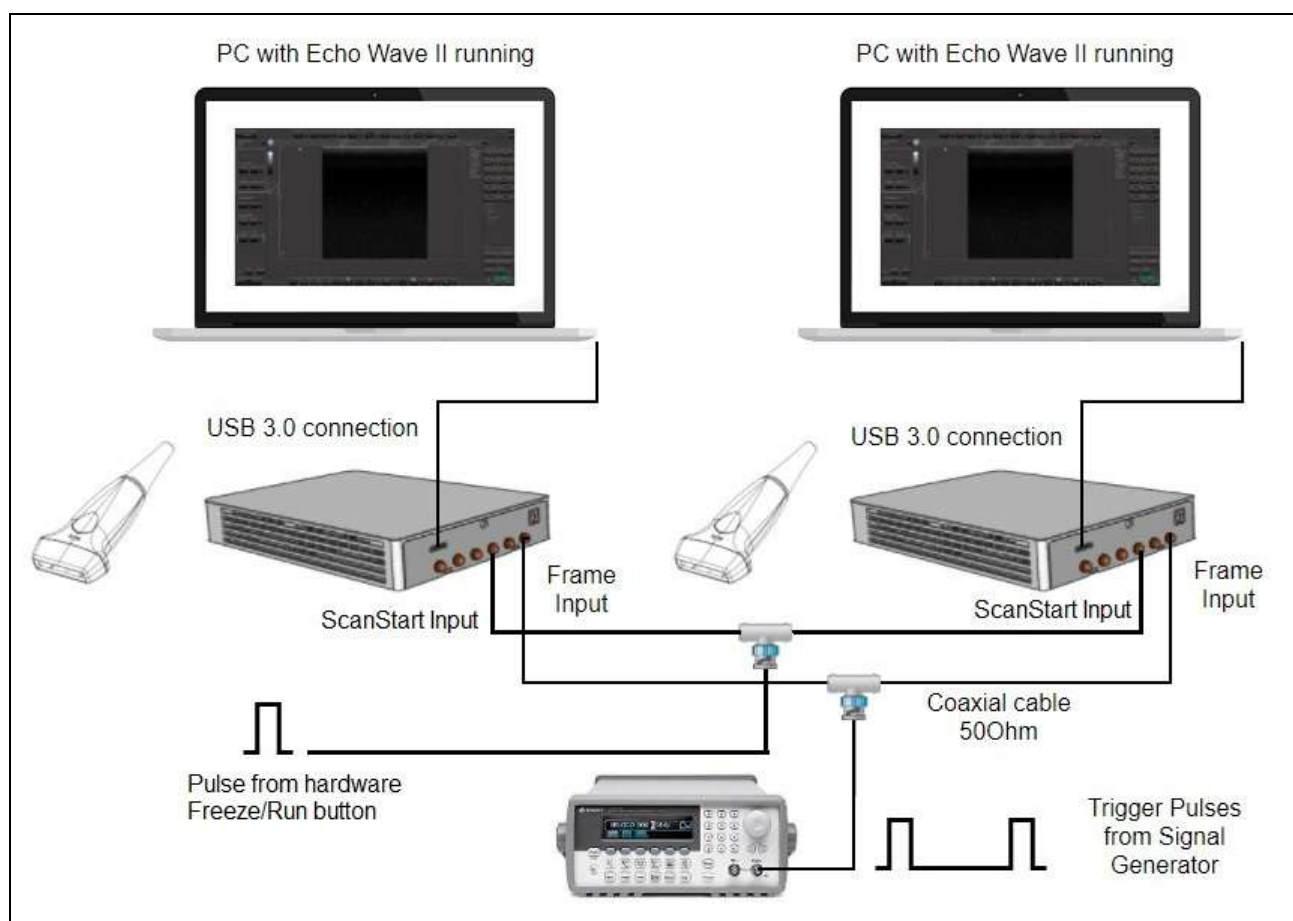


Figure 1. Twin ArtUs with 2 PCs

Configuration 1 setup:

1. Connect both ArtUs beamformers to their respective PCs using USB 3.0 or higher ports.
2. Connect the Signal Generator to both ArtUs devices as shown in **Figure 1. Twin ArtUs with 2 PCs** using 50 Ohm coaxial cables and appropriate connectors. ArtUs has SMA50 connectors for coaxial cable attachment
3. Connect the hardware Freeze/Run button to the ScanStart Inputs of both ArtUs devices, as shown in **Figure 1**
4. Run the **ArtUs Sync Options.exe** utility on each PC
5. Check ☒ Enable Synchronization and select ☒ Ultrasound Frame Input

6. Push the **OK** button. Now both ArtUs devices are in external synchronization mode
7. Set the Signal Generator to pulse triggering with the frequency depending on the probe and scanning parameters (number of probe elements, depth, line density, and others, which fluence on ultrasound frame time)
8. Run the Echo Wave II program on each PC
9. To get synchronous Cine files, do the following steps:
 - 9.1. Turn OFF generator
 - 9.2. Click the Freeze button on Echo Wave II on each PC or press the hardware Freeze/Run button to stop scanning.
 - 9.3. Click the Freeze button on Echo Wave II on each PC or press the hardware Freeze/Run button to start scanning.
 - 9.4. Turn ON generator
 - 9.5. Perform scanning
 - 9.6. Turn OFF generator
 - 9.7. Click the Freeze button on Echo Wave II on each PC or press the hardware Freeze/Run button to stop scanning.
 - 9.8. Save Cine clips as “avi” files on both Echo Wave instances.

Note: The Signal Generator can run continuously. In this case, captured frames from two PCs may be shifted by one or more frames relative to each other.

Configuration 2: 2 ArtUs, PC with 2 Monitors, Signal Generator for external frame synchronization

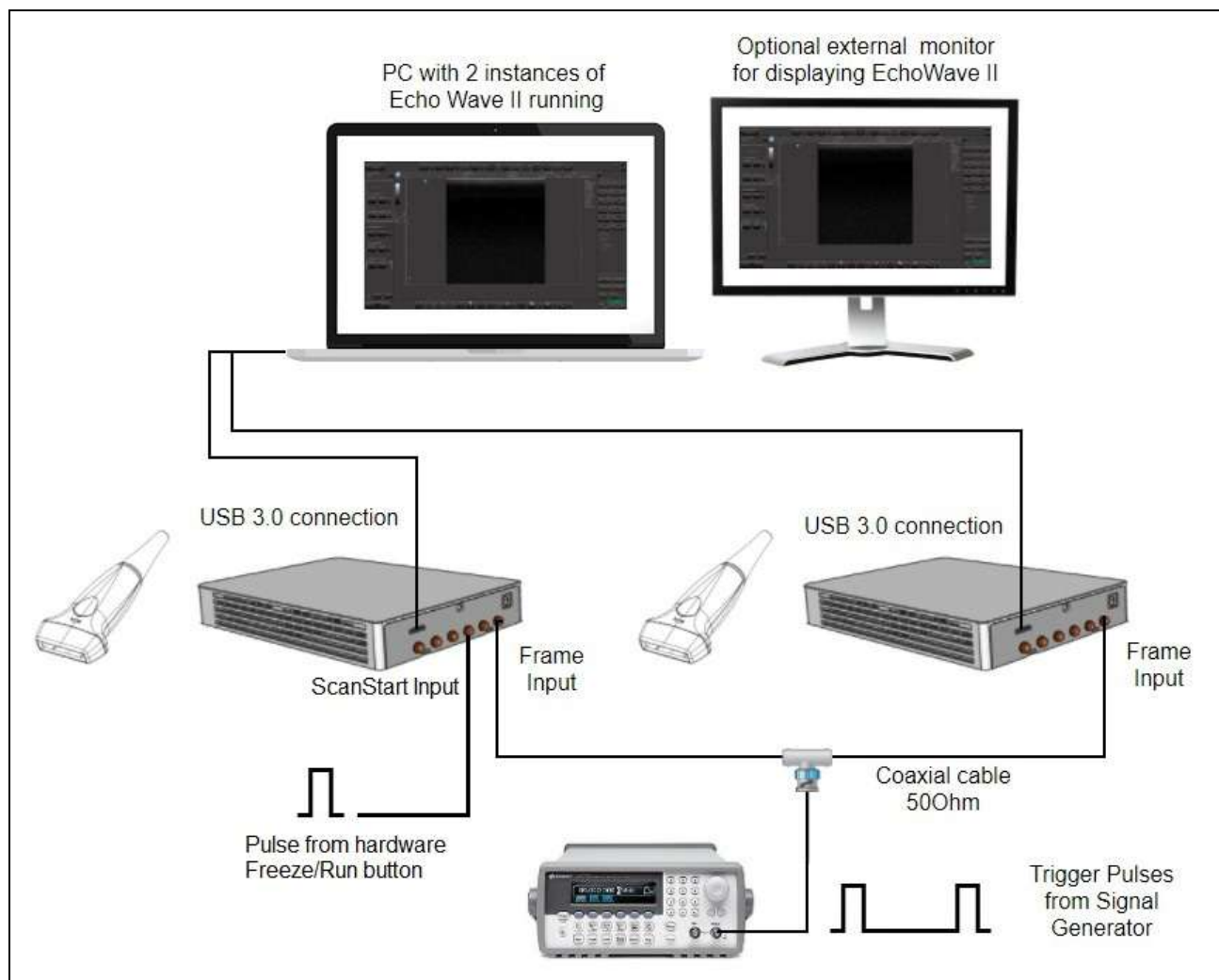


Figure 2 Twin ArtUs with a PC and optional external monitor (Frame Input)

Configuration 2 setup:

1. Connect both ArtUs beamformers to the PC using two USB 3.0 or higher ports.
2. Connect the Signal Generator to both ArtUs devices as shown above using 50 Ohm coaxial cables and appropriate connectors. ArtUs has SMA50 connectors for coaxial cable attachment.
3. Connect the hardware Freeze/Run button to the ScanStart Input of one of the ArtUs devices, as shown in Figure 2
4. Run the **ArtUs Sync Options.exe** utility
5. Check ☒ Enable Synchronization and select ☒ Ultrasound Frame Input
6. Push the **OK** button. Now both ArtUs devices are in external synchronization mode.
7. Set the Signal Generator to pulse triggering with the frequency depending on the probe and scanning parameters (number of probe elements, depth, line density, and others, which fluence on ultrasound frame time).
8. Run two Echo Wave II instances. Use each monitor to display one Echo Wave II window. Choose an active probe for each instance
9. Run **CopyData.exe** utility (located in C:\Program Files (x86)\TELEMED\Echo Wave II\Config\Plugins\CopyData directory)
10. To get synchronous Cine files, do the following steps:
 - 10.1. Turn OFF generator

- 10.2. Click the Freeze/Run button on the **CopyData.exe** utility window or press the hardware Freeze/Run button to stop scanning.
- 10.3. Click the Freeze button on the **CopyData.exe** utility window or press the hardware Freeze/Run button to start scanning.
- 10.4. Turn ON generator
- 10.5. Perform scanning
- 10.6. Turn OFF generator
- 10.7. Click the Freeze button on the **CopyData.exe** utility window or press the hardware Freeze/Run button to stop scanning.
- 10.8. Save Cine clips as “avi” files on both Echo Wave instances.

Note: The Signal Generator can run continuously. In this case, captured frames from two PCs may be shifted to one frame relative to each other.

Setting the highest frame rate

To set the maximum possible frame rate, raise the triggering frequency on the Signal Generator. At the same time, monitor the frame rate shown in the Echo Wave II ultrasound window. Both frequencies should change accordingly. When you reach the maximum frame rate, you will see a dramatic frame rate drop (approximately 2 times) in Echo Wave II. Adjust the frequency a little to lower the value to regain the frame rate in the Echo Wave II window, as shown on the Signal Generator. Now you have reached the maximum frame rate for the current scanning settings.

Achievable result example:

You can reach up to 150 frames per second with the following settings:

- 128-element transducer
- Scan depth: 40 mm
- Line density: StandardS
- Number of focuses: 1
- iTHI mode: OFF
- Compound mode: OFF

NOTE: If you need other scanning parameters, the achievable frame rate can be different. In this case, you will need to adjust the triggering frequency.

11. Q&A Section

Q: Where can I purchase the needed cables for the I/O module connection?

1. ArtUs rear panel connectors (click link): [Amphenol Connex 132291](#)
2. Recommended cables (click link): [Amphenol Connex](#)
3. Many cable alternatives (click links below):
www.amazon.de
www.amazon.com

Q: Is it possible to achieve higher frame rates than in your example case?

A: Yes, you can. To get higher frame rates, you can:

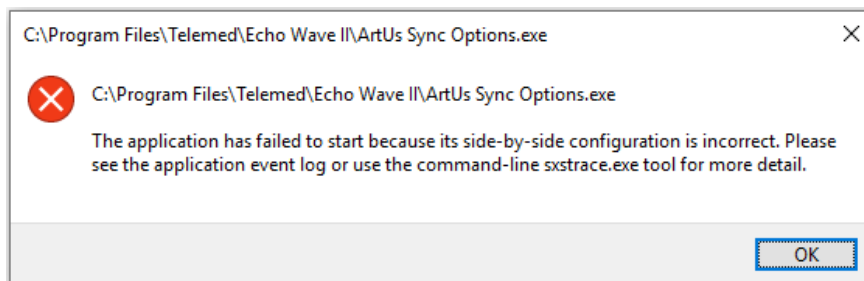
- Lower Line Density
- Make a smaller View Area
- Lower number of Focuses
- Lower Scan Depth

Q: Can I run two EchoWave II instances with two beamformers attached to one computer?

A: Yes, you can. To run two instances of the Echo Wave II application, follow these steps:

1. Find options2.txt file in C:\Program Files (x86)\Telemed\Echo Wave II\Config\Options\
2. Open it with notepad.exe
3. Set parameter: **allow_scanning_by_all_software_instances;1** (replace "0" with "1")
4. Save and close file options2.txt
5. Run the Echo Wave II application
6. Open Menu->Tools->Options
7. Select tab Technical
8. Set checkbox ☒ **Allow to start several software instances**
9. Shut down the Echo Wave II application
10. Attach two beamformers to the same computer using different USB ports
11. Start the Echo Wave II application and allow it to load completely
12. Start another instance of the Echo Wave II application
13. In both instances, you should see live images from one of the attached beamformer/transducer sets. Click the probe button to choose another transducer.

Q: When I run the ArtUs Sync Options utility, I get the error message:



A: This message is caused by the absence of the required 32-bit libraries to run the utility. To fix that, you can do any of the following:

1. Install the "Echo Wave II" 32-bit version. This software will install the MS Visual C++ 2005 libraries.
2. Download and install MS Visual C++ 2005 libraries: <https://www.microsoft.com/en-us/download/details.aspx?id=26347>.

12. Revision History

Revision	Revision Date	Description of Revision	Revision Author
1.0	2018.07.17	Initial Release	A. Prysiazhniuk
1.1	2018.07.19	Added a photo of the rear panel	G. Volkov
1.2	2018.07.24	Added additional description	G. Volkov
1.3	2019.04.10	Added chapter 6.	A. Prysiazhniuk, G. Volkov
1.4	2019.05.07	Fixed mistakes	A. Prysiazhniuk
2.0 – 2.5	2020.02.05 – 2020.12.18	Edited Chapters 9, 10, and 11; small typo fixes	A.Kovalev
2.6	2020.01.12	Edited Chapters 2, 3, and 4; added Chapter 12	A. Prysiazhniuk
2.7	2021.03.18	Updated Sync Options Utility description (Chapter 4)	A.Kovalev
2.8	2021.07.22	Added information to the Q&A section	A.Kovalev
2.9	2022.12.21	Added company information; added jitter note in Chapter 3	A.Kovalev
3.0	2024.03.28	Added information about SMA-type connectors and cables in the Q&A section; small typo fixes	G. Volkov
3.1-3.2	2025-07-17	ArtUs Sync Options 1.6 has been released, and the screenshots have been updated accordingly. Minor corrections were made.	A.Kovalev
3.3	2026-07-15	Small typo corrections. Added ArtUs OEXT-1H/2H models.	A.Kovalev
3.4	2026-08-14	Clarifying information about signal delays has been added to Chapter 3	A. Prysiazhniuk