Instructions Manual

SonixDAQ – Gdaq

Summary

1. Introduction

The *SonixDAQ* is a research add-on for *Sonix* ultrasound systems that consists of parallel acquisition of pre-beamformed radiofrequency data. In a simplified way, the *SonixDAQ* hardware can be understood as four RAM memory of 4GB (total of 16GB) connected to an Analog-to-Digital Converter (ADC) where each RAM memory stores data from 32 elements of transducer. The internal clock of *SonixDAQ* has 40 MHz, however, images can be acquired with a sampling frequency of 80 MHz using an external clock. The analog-to-digital conversion has 12 bits for 40 MHz and 10 bits for 80 MHz. The *SonixDAQ* supports external trigger pulses for sync data acquisition.

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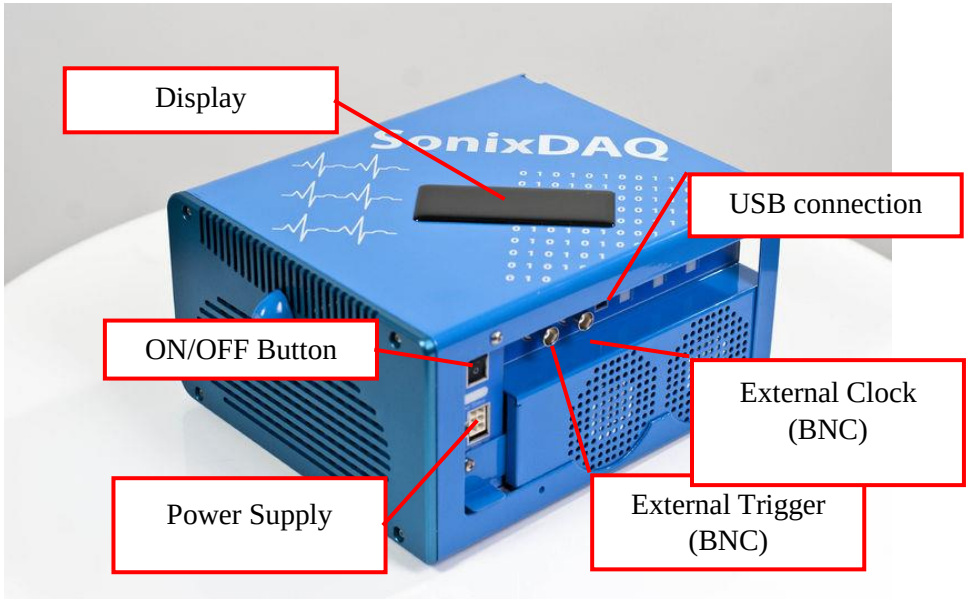
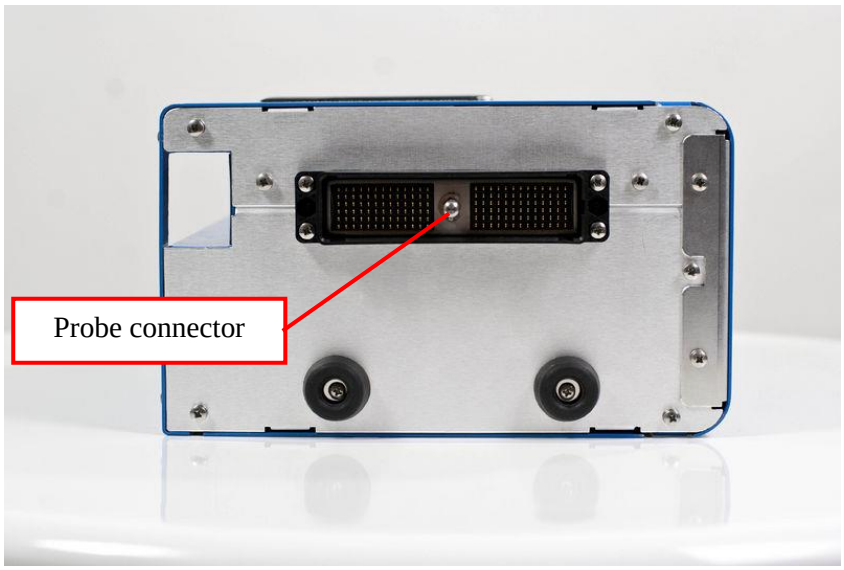




The advantage of a parallel acquisition system in comparison with a conventional ultrasound machine is the possibility to reach a greater pulse repetition frequency (PRF), increasing the temporal resolution of ultrasound imaging. In photoacoustic modality, the parallel acquisition makes possible the image formation using a single pulse of light.

2. Getting started with *SonixDAQ*

2.1.SonixDAQ install

The *SonixDAQ* install in ultrasound system should be done following the steps:

- Connect the probe cable to the specified probe connector in the ultrasound system and to the probe connector of *SonixDAQ*.
- Connect the ultrasound transducer to the first probe connector of the ultrasound machine.
- The external trigger should be connected to the BNC connector of *SonixDAQ* **and** to the "sync in" BNC connector of the ultrasound system. (In *SonixRP*, the external trigger can be connected to the "sync in" connector and the *SonixDAQ* connected to the "sync out" connector)
- Connect the power supply
- Connect the USB cable to the *SonixDAQ* and to the ultrasound system. Turn on the *SonixDAQ*. If the *SonixDAQ* is not recognized by *Windows* the USB driver should be installed.

2.2. Control Software of SonixDAQ (GDaq)

The *GDaq* is a multimodal platform for data acquisition using the *SonixDAQ*. This software was developed in C++ using the software development kits (SDK) *Texo* and *Daq* version 5.7. The *Texo* controls the transmission and the receive parameters of ultrasound system and the *Daq* controls the receive parameters of *SonixDAQ*. The *SonixDAQ* is a receive module, then the transmission of acoustic waves is done by the ultrasound system using *Texo*. Some limitations of version 5.7 of SDK are listed below:

- The memory buffer size is defined as:

$$Buffer = \frac{16GB}{2^{divisor}} \quad (1)$$

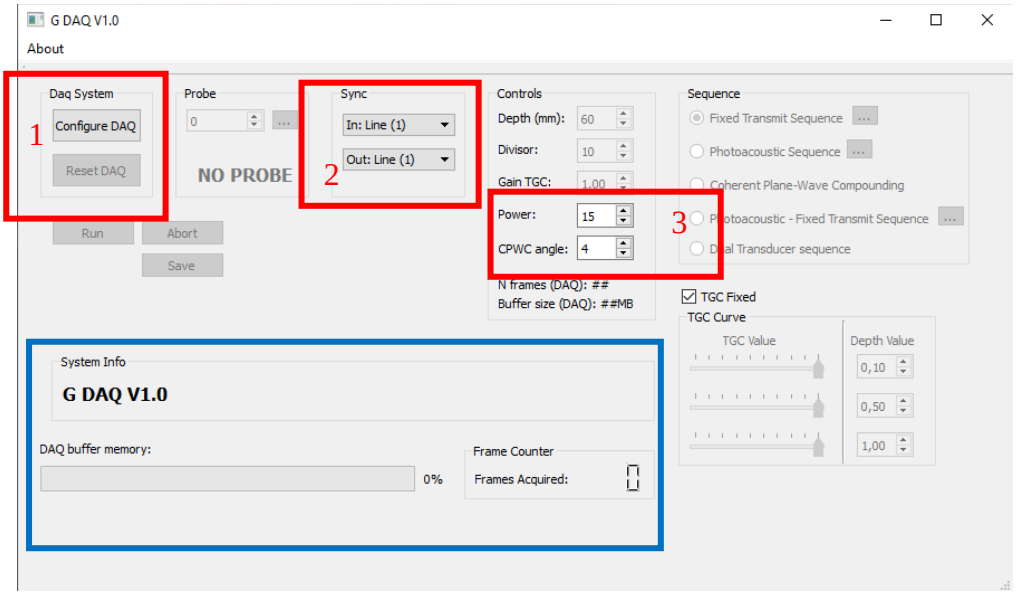
  Where *divisor* is an **integer** value that can be defined by the user.

- In SDK 5.7, **the storage of acquired data can only be done after the total fill of memory buffer**. If the acquisition is interrupted before fill the memory buffer all data will be lost.
- The parameters *Power*, *CPWC angle* and *Sync* should be configured before the *SonixDAQ* initialization. To change these parameters after initialization the *SonixDAQ* should be reset.
- It is possible to use the internal clock of the ultrasound machine as sync of *SonixDAQ* to acquire data without an external trigger source. However, this configuration only can be used in *SonixRP*. Connect the "Sync out" BNC connector of the ultrasound system to the *SonixDAQ* external trigger connector and select *Sync In: None(0)* in software.
- The *SonixDAQ* initialization and the data storage to disk are critical processes. If *SonixDAQ* initialization takes too long or the display lights do not come on, turn off the *SonixDAQ*, close the *GDaq* software, turn

on the *SonixDAQ* and open *GDaq* again. The best practice is avoiding interaction with *GDaq* during data storage.

3. Configuring the *SonixDAQ*

3.1.SonixDAQ initialization



Box 1 shows the *Configure DAQ* button that initializes the *SonixDAQ*. The parameters of boxes 2 and 3 should be defined before the *SonixDAQ* initialization. After *SonixDAQ* initialization, these parameters no longer can be changed. Using the *Reset DAQ* button the software finishes the *SonixDAQ* making possible changes in boxes 2 and 3.

Power: Is the power of acoustic waves transmitted. The maximum value is 15 and the minimum value is 0.

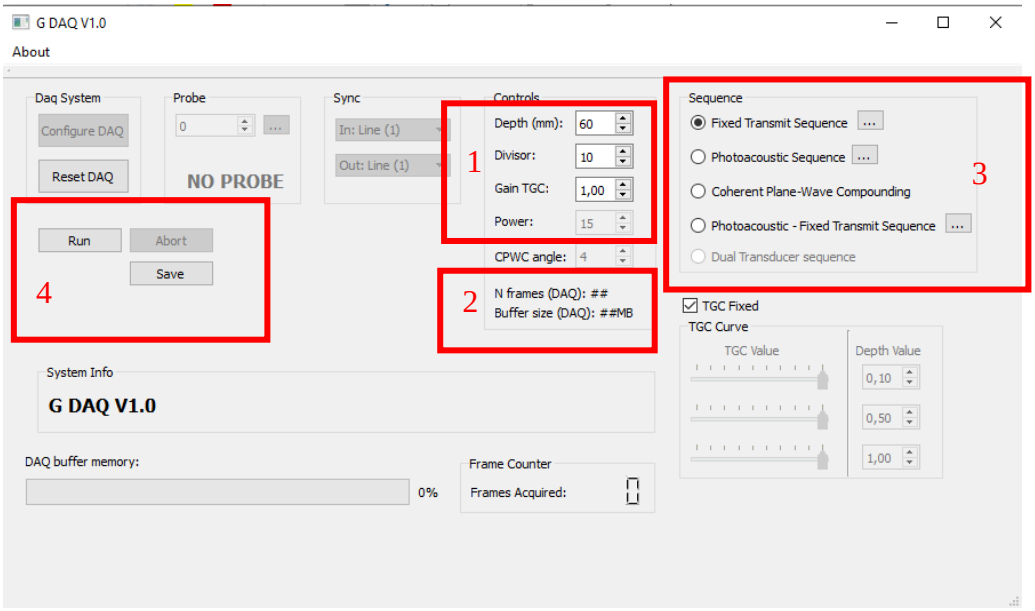
CPWC Angle: Is the maximum angle of the plane-wave emitted, used in Coherent Plane-Wave Compound (CPWC) sequence. The maximum value is 24 and the minimum value is 2. This parameter only affects CPWC sequence and does not cause any effect in other sequences.

The *System Info* box (blue rectangle) shows the information about *SonixDAQ*, the status bar of the memory buffer and the number of image frames acquired.

The *Probe* box shows the selected probe connector of the ultrasound system and information about the connected ultrasound transducer.

3.2. Configuring parameters and acquiring data

After *SonixDAQ* initialization, the box of image control, buffer, and gain, the box of sequences and the buttons of acquisition control become active.



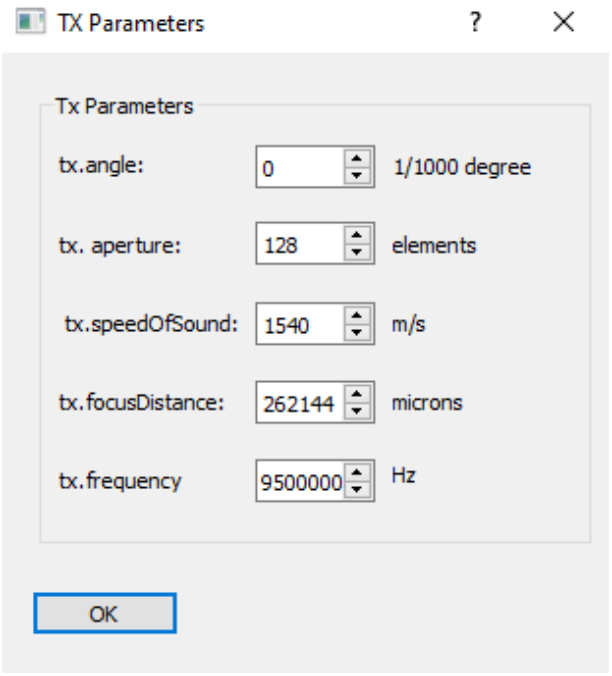
Box 1 shows the depth control, divisor, and TGC gain. The *divisor* parameter controls the size of memory buffer which can be visualized in box 2 (*Buffer size (DAQ)*) and the number of frames needed to fill the memory buffer (*N frames (DAQ)*). **Note: The number of frames needed to fill the memory buffer is a function of divisor (size of allocated memory) and image depth (size of image frame in bytes)**

Depth: Defines the image depth. The minimum value is 10 mm and the maximum value is 149 mm.

Divisor: Defines the parameter of equation (1). The minimum value is 0 (allocating all memory available) and the maximum value is 15 (allocating 512KB).

Gain TGC: Defines the value of *Time Gain Compensation* (TGC). The minimum value is 0 and the maximum value is 1.

Box 3 shows the image sequences. Clicking in ... opens a new window where the transmission parameters can be configured:



tx.angle: Plane-wave angle (1/1000)º. The minimum value is -80000 (80º) and the maximum value is 80000 (80º).

tx.aperture: Number of elements used in plane-wave transmission. The minimum value is 1 and the maximum value is 128.

tx.speedOfSound: Speed of Sound.

tx.focusDistance: Focus distance. This parameter does not affect data acquisition and is only used in software processing.

tx.frequency: Frequency of emitted acoustic wave.

Box 4 shows the buttons for run *SonixDAQ*, save data, and abort acquisition. The acquisition automatically stops when memory buffer is filled and the data storage can be done clicking in the *Save* button. All data are discarded when the acquisition is aborted.

4. Acquisition sequences

Fixed Transmit

The fixed transmit sequence consists of the emission of a plane-wave and acquisition of an image frame, for each trigger pulse. The maximum PRF in this sequence is 4000 frames per second (fps).

Photoacoustic

The photoacoustic sequence consists of acquiring an image frame without the emission of acoustic waves, for each trigger pulse applied. The frame size of the photoacoustic image is half of pulse-echo image size, needing twice the frames number to fill the memory buffer (this value is automatically updated in *N Frames (DAQ)*). The maximum PRF in this sequence is 4000 fps.

Coherent Plane-Wave Compound

This sequence emits angulated plane-waves with angles from – *CPWC angle* to *CPWC angle* with a step of 2º. It is necessary a trigger pulse for emitting each angulated plane-wave. The minimum value of *CPWC angle* is 2º representing a sequence of 3 image frames [-2 0 2] and the maximum value is 24º representing a sequence of 25 image frames [-24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24].

The maximum PRF in this modality is $\frac{4000}{CPWC\ angle\ +1}$ fps.

Photoacoustic + Fixed Transmit

The combination of photoacoustic and pulse-echo modalities. The first trigger pulse acquires an image frame without acoustic wave emission and the second trigger pulse performs a pulse-echo image.

5. Fixed TGC and TGC curve

The TGC gain can be configured as a fixed value to the entire axial direction of the image or as a curve defined by 3 points with coordinates (TGC value, depth). To define a TGC curve, uncheck the *Fixed TGC* option, choose depth value in scroll boxes, and TGC values in slide buttons. The depth values are configured as a percent of depth defined in control box.