



R&D: Ultrasonic Technology / Fingerprint Recognition

Przedsiębiorstwo Badawczo-Produkcyjne

OPTEL Sp. z o.o.

ul. Otwarta 10a

PL 50-212 Wrocław

tel.: +48 (71) 329 68 54 fax: 329 68 52

NIP 898-10-47-033

e-mail: optel@optel.pl <http://www.optel.pl>

Guide to Ultrasonic test system - USTS-011 Software Revision 1.0 / 2002

Hardware

OPBOX-01/100 is particularly well suited for ultrasonic measurements as well as other kinds of measurements which employ mechanical scanning elements or multiplexed channels (the card is capable of controlling such devices). Together with the pulser & receiver unit and an ultrasonic probe it could be used as complete ultrasonic testing device.

Technical data:

A/D converter:

- Resolution: 8 bits
- Sampling frequency: 2 MHz

Analog parameters:

- Input channels: 1 (BNC)
- Input amplifier gain: 0dB, 6dB, 14dB, 20dB, 26dB, 34dB, 40dB
- Attenuator: -20dB
- Input preamplifier gain: 20dB, 30dB, 40dB, 50dB, 60dB, 70dB, 80dB
- preAttenuator: -20dB
- Input voltage: AC, max. 20mVpp
- Input impedance: 700Ohm

Data buffer:

4K

Triggering:

external (TTL Signal)

Signals on the external connectors:

DB9

- Uin - measured input signal;
- Ntrig - pulse generator control;
- Kreg (out) - software controlled preamplifier gain

BNC

Uin

- measured input signal

Ext_trg

- external trigger

Software:**System Requirements:**

In order to use the Ultrasonic Testing Card OPBOX-01/100, the following equipment is:

Computer System: IBM PC

Display Adapter: SVGA Adapter working in mode 640x480 or higher (recommended 800x600)

Operations System: Windows 95, Windows 98, ME, XP and Windows NT or 2000.

Overview of Hotkey Selection:

Hotkey	Function	Description
[F1]	Open	Load in a previously saved data file and restore the capture settings as they were when the data was saved
[F2]	Save as	This option creates one file that contains both the current settings and the current data. The setting saved are the same in the Save Settings option.
[F3]	Print	This option will create a hardcopy of the screen into IBM Graphics mode compatible printers. The printout will include everything currently on the screen.
[F4]	About us...	Short information about OPTEL
[F5]	Select port	From the settings window it is possible to change a board address, and rs232 port.
[F6]	Help	a general help screen is available that shows most hotkeys of the program
[F7]	RUN / STOP	enables / disables selected acquisition mode
[F8]	Zoom / Spectrum	choose between Zoom and Spectrum display in bottom window (Zoom - zoom for timing display; Spectrum - A set of functions which perform transformations between the time domain and the frequency domain, and perform analysis in the frequency domain. These functions are based on

		the discrete implementation of the Fourier Transform. Several rely on frequency domain transformations to obtain the results indirectly).
[F9]	RF Signal / Detector	Choose between RF Signal and Detector display in upper and bottom window.
[F10]	Exit	Exit to system
[F11]	Show diagram	Show diagram of $U_{reg}=f(N)$
[F12]	Transition [on/off]....	close and open of RS232 transmission from sender.

On the scope screen:

Memory	three memories for the measured signals
Grid ON/OFF	toggle on/off the display of the division grid

Measuring - Cells:

Markers from Signal screen and Zoom / Spectrum screen.

Time of flight [us]: It is necessary to prepare the signal, that will be compared (correlated) with the actually measured signal. If the transducer sends a short signal, it is no problem with choosing a proper signal, but it is also possible to choose any other signal. After the chosen signal is visible on the Singal screen, and the markers positioned on the left and right limit of the chosen signal, it is necessary to switch the "Pattern". After it, the bottom screen shows the chosen signal with the comment: "Correlation Pattern". This step can be repeated until the chosen signal is perfect. In the second step the measurement should be started ("Measure").

$U_{reg}[V]$.: sender signal amplitude

Description of software for measurement of time of flight.

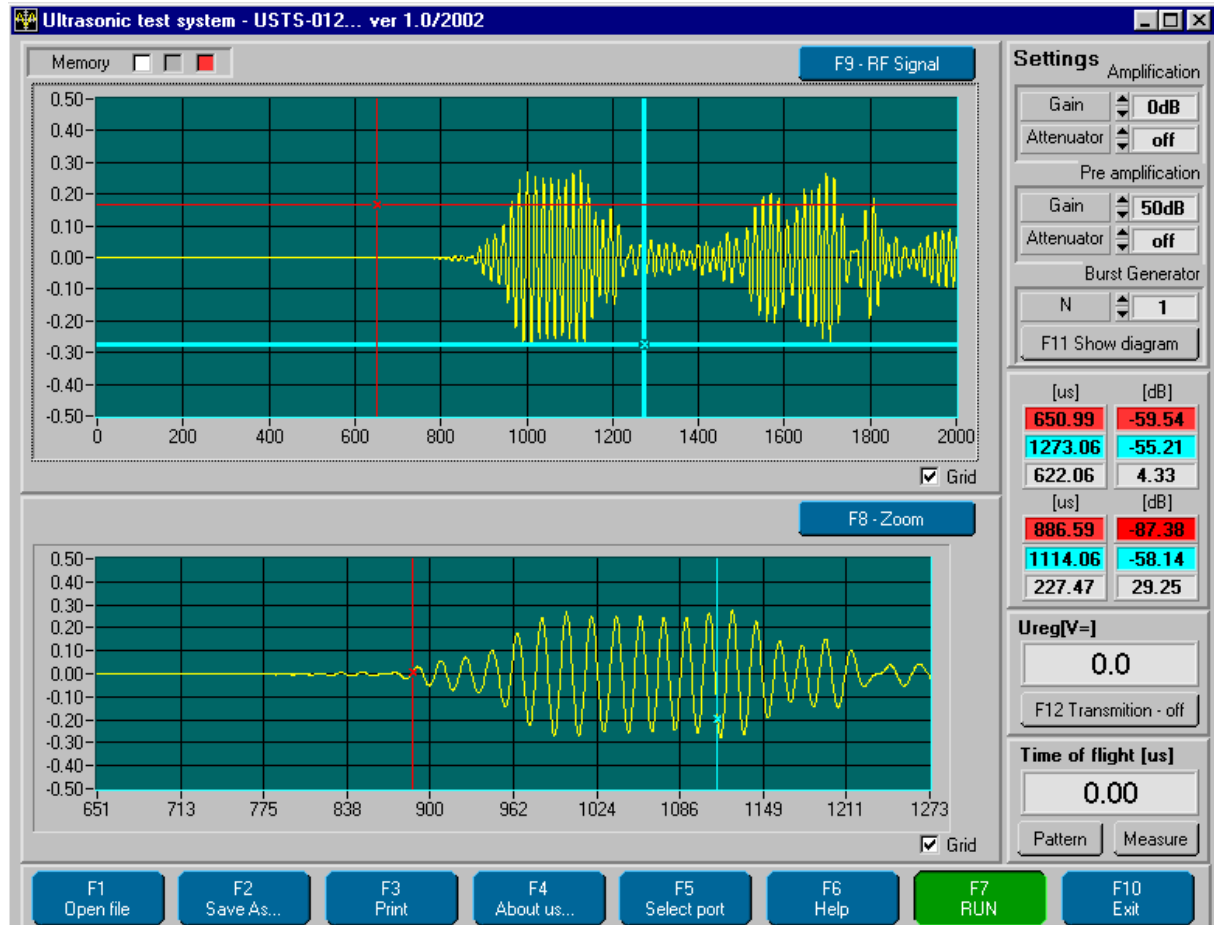
This software package allows to measure time of flight.

For each measurement it is necessary to choose reference signal and compare it with the signal, coming from the measured medium (reflected or transmitted through it). This allows to use this software with almost any kind of samples, containments etc. For people using this software it is necessary to have some knowledge about such kind of measurements, physics of ultrasounds etc

I. Introduction to the work with the software

First step

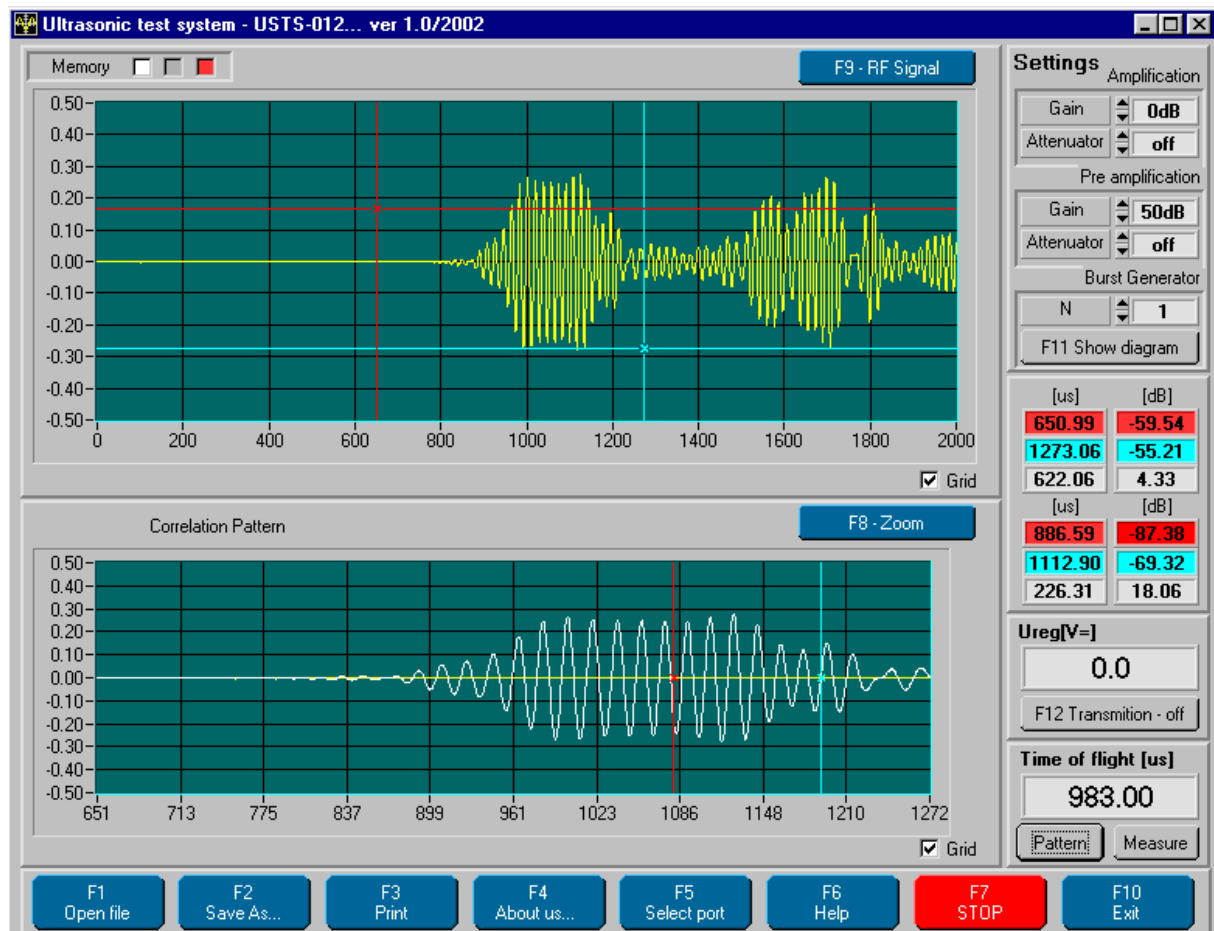
Reference signal should be prepared, the best way to do it is to use pure (distilled) water. Using markers in the upper window most important part of the signal should be chosen. In the bottom window signal between markers from the upper window can be seen - magnified. See picture 1.



Picture 1.

Second step

Button "Pattern" should be used. After pressing this button, chosen signal appears in bottom screen in white color together with information: "Correlation pattern". It means this signal from this moment will be "reference signal". See picture 2.

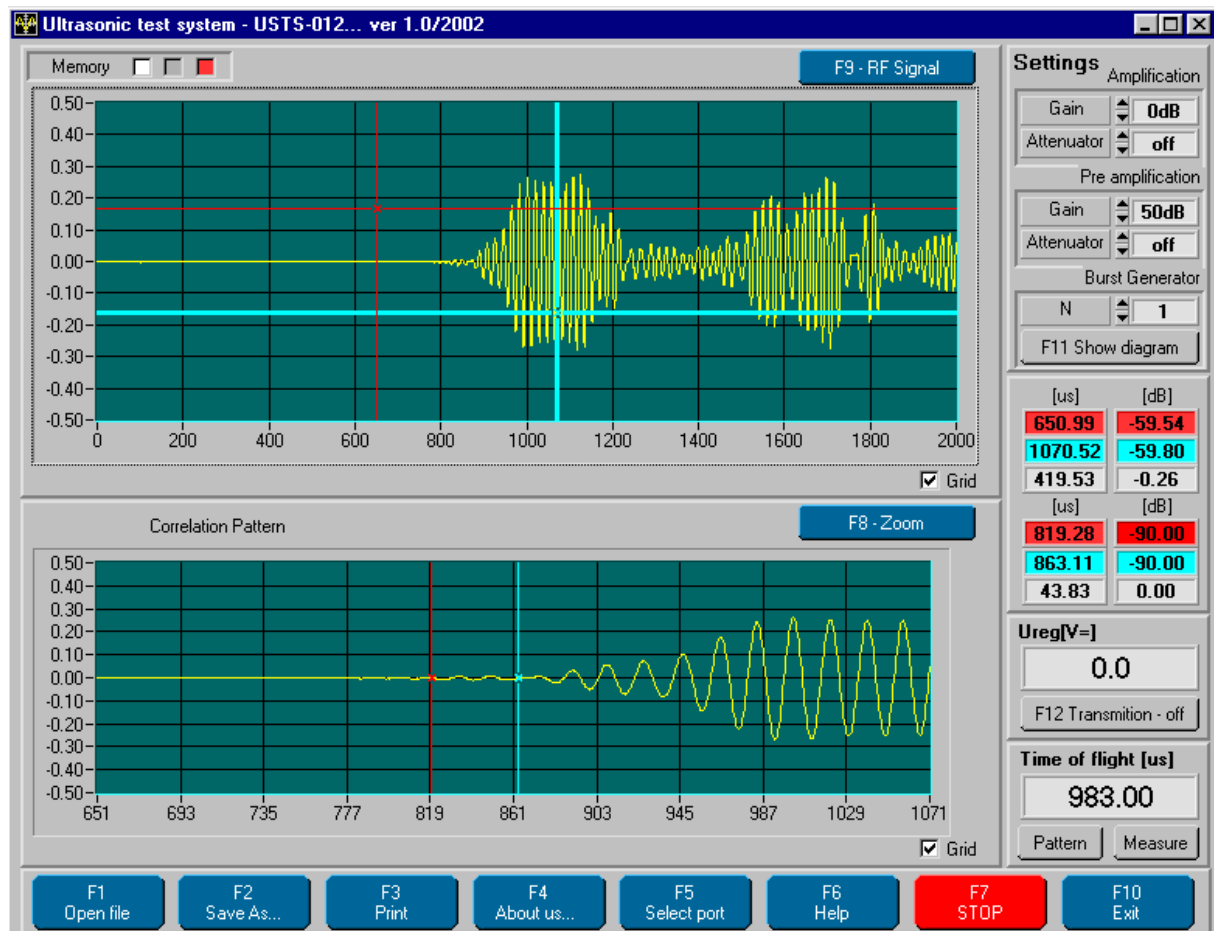


Picture 2.

From this moment key called "Measure" should be used – all subsequent operations will use signal stored before (pattern) as reference for comparison with actually measured signal. See picture 3. For time of flight measurement the display will show 0 – nothing changed.

Third step

In this moment we have to repeat operations described in the first step. In upper window we choose - using markers the most important part of signal we are getting from measured medium. In the bottom window we can see only signal between markers from the upper window. See picture 4. Pay attention on marker position (it is changed now). It means now we have another signal (with time offset for example).



Picture 4.

In this moment we have all information which is necessary for calculation of time of flight (and another functions too), and then the button “Measure” should be used . On the bottom window we can see two earlier prepared signals (white – reference signal; red - measure signal) in this case we receive result different from zero.

II. The time of flight and sound velocity measurement method.

In most cases we can assume, that the signal will change after propagation - simple geometrical comparison of signals won't work properly. This is the reason, why we are using following algorithm for comparison of two signals with different time of flight:

- FFT with Hamming window is made.
- In frequency domain, frequency with maximum amplitude is chosen and using relatively sharp windowing only this frequency and frequencies from its neighborhood are taken.
- Inverse FFT is done.
- Center point of achieved signal is taken as time mark, telling us the moment of “coming” of this signal.

Time of flight can be measured from zero point (start of pulse) or from the time of “coming” of another signal, stored as pattern – as described above.

If the path length is known, it is possible to calculate the sound velocity in the measured material, using comparison with reference fluid – for example water.

If the experimental setup have a containment with measured fluid, where only a part of the sound propagation path is in the measured fluid, we can wrote following formula:

$$T=T_1+T_2$$

Where T_1 is time of propagation outside of measured fluid and T_2 in this medium. We can measure time of flight in the whole system (T) filled with water (T_w , that has velocity C_w), or measured fluid T_x (velocity C_x). If we know the path length (L) in measured fluid, we can calculate the velocity of sound in this medium:

$$T_{2w}=L/C_w$$
$$T_1=T_w-T_{2w}$$

This (T_1) can be obtained after measurement with water, and this measurement must be done only from time to time, since parameters of system doesn't change quickly.

$$C_x \text{ (sound velocity in measured medium)} = L/(T_x-T_1)$$

The user of the software must know the path length (L), and choose appropriate signals (not only direct transmission must be chosen, but also multiple reflections for example).