Introduction

The ProCheck SC5 Ultrasound Transducer Analysis System (UTAS) is a specialty measurement instrument designed for the following five sectors of relevance for ultrasound transducers:

I. Recurrent test,
II. Repair,
III. Manufacturing,
IV. Design, and
V. R&D of ultrasound systems.

The features of Broadsound ProCheck SC5 UTAS are as follows:

A) Apps (Applications)

A.1 XDCR (Transducer) Analysis Apps
- A.1.1 Capacitance Measurement
- A.1.2 Intrinsic Characteristics Measurement
- A.1.3 Transmission Crosstalk Measurement with Optimum Drive Waveform Signal $B(t)$
- A.1.4 Echo Measurement with Optimum Drive Waveform Signal $B(t)$
- A.1.5 Probe Lens Focusing Characteristics Measurement / Axial Characteristic Loop Sensitivity Measurement
- A.1.6 Sector of Relevance Related Measurement & Report Format in the XDCR Analysis App

A.2 $B(t)$ Generator & Receiver Apps

A.3 Pulser & Receiver Apps

B) Software "Innovator"

C) Product Configurations

D) Compliance

E) Relevant Patents of Broadsound ProCheck SC5 UTAS

F) Product List

A) Apps (Applications)

A.1 XDCR (Transducer) Analysis Apps

- The XDCR Analysis App involves five measurements for ultrasound transducers; the summary of which is listed as following:

A.1.1 Capacitance Measurement

- Total capacitance C_T of each channel/element including capacitance of transducer element, capacitance of coaxial cable, and capacitance of HVSW (high voltage switch) ICs if existed is measured at low frequency ≤ 30 kHz.

A.1.2 Intrinsic Characteristics Measurement

A.1.2.1 Characteristic Loop Sensitivity S_{LC}

- The most representative parameter of electrical-acoustical performance

A.1.2.2 Normalized Loop Time Response $X(t)$

- t_d : Temporal duration of $X(t)$
- t_{-y}: Temporal length of $-y$ dB ring-down of $X(t)$, wherein $-y$ dB = −12, −20, or −26 dB

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A.1.2.3 Wideband Loop Sensitivity $S_L(f)$
- f_{c-x}: Center frequency of $-x$ dB limit, wherein $-x$ dB = −6, −10, −20, or −30 dB
- BW_{-x}: Fractional bandwidth of $-x$ dB limit, wherein $-x$ dB = −6, −10, −20, or −30 dB

A.1.2.4 Optimum Drive Waveform Signal $B(t)$ (i.e., $B(t)$ signal)
- Derived from the self-deconvolution of normalized loop time response $X(t)$

A.1.2.5 Supporting acoustic transducers with center frequency ranging from 0.5 MHz to 40 MHz

A.1.2.6 Intrinsic characteristics of XDCR, such as S_{LC}, $X(t)$, $B(t)$, and $S_L(f)$, are measurement system independent; that is, the S_{LC}, $X(t)$, $B(t)$, and $S_L(f)$ are not bundled with any test system parameter such as drive pulse or receiver gain etc.

A.1.2.7 One-shot wideband measurement of $S_L(f)$ vs. monotonic measurement of insertion loss

A.1.2.8 SNR (signal-to-noise ratio) evaluation for the measurement available

A.1.2.9 Application of normalized loop time response $X(t)$
- DIY drive-echo computer simulation with given $X(t)$ and various reference drive signals

A.1.3 Transmission Crosstalk Measurement with Optimum Drive Waveform Signal $B(t)$

A.1.3.1 The pre-determined $B(t)$ signal is loaded into a programmable $B(t)$ generator that supports $B(t)$ with center frequency ranging from 0.5 MHz to 15 MHz.

A.1.3.2 Transmission Crosstalk XT across one of adjacent elements up to ± 5 elements could be measured.

A.1.4 Echo Measurement with Optimum Drive Waveform Signal $B(t)$

A.1.4.1 The pre-determined $B(t)$ signal is loaded into a programmable $B(t)$ generator that supports $B(t)$ with center frequency ranging from 0.5 MHz to 15 MHz.

A.1.4.2 Insertion Gain of Echo IG_e
- With the $B(t)$ signal, the insertion gain of echo IG_e would tightly comply with the characteristic loop sensitivity S_{LC}.

A.1.4.3 Echo signal $V_e(t)$
- t_{de}: Temporal duration of $V_e(t)$
- t_{-ye}: Temporal length of $-y$ dB ring-down of $V_e(t)$, wherein $-y$ dB = −12, −20, or −26 dB

A.1.4.4 Relative Energy Spectrum of Echo $RE_e(f)$
- f_{c-xe}: Center frequency of $-x$ dB limit, wherein $-x$ dB = −6, −10, −20, or −30 dB
- BW_{-xe}: Fractional bandwidth of $-x$ dB limit, wherein $-x$ dB = −6, −10, −20, or −30 dB

A.1.4.5 SNR (signal-to-noise ratio) evaluation for the measurement available

A.1.5 Probe Lens Focusing Characteristics Measurement / Axial Characteristic Loop Sensitivity Measurement

A.1.5.1 Axial characteristic loop sensitivity S_{LC} measurement reveals probe lens focusing characteristics, such as near-field focusing and far-field divergence slope, which affect spatial resolution within ultrasound image; more specifically, the probe lens focusing characteristics determines the spatial resolution in elevation direction.

A.1.5.2 Supporting acoustic transducers with center frequency ranging from 0.5 MHz to 40 MHz

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A.1.6 Sector of Relevance Related Measurement & Report Format in the XDCR Analysis Apps

Measurement & Report Format in XDCR Analysis Apps of ProCheck SC5 UTAS						
Sector of Relevance / XDCR Analysis Apps		I Recurrent Test	II Repair	III Manufacturing	IV Design	V US System R&D
1	Capacitance Measurement	R❶	R	R	R	R
2	Intrinsic Characteristics Measurement	R	R	R	R	R
3	Transmission Crosstalk Measurement with Optimum Drive Waveform Signal $B(t)$	O❷	O	R	R	R
4	Echo Measurement with Optimum Drive Waveform Signal $B(t)$	O	O	O	R	R
5	Probe Lens Focusing Characteristics Measurement / Axial Characteristic Loop Sensitivity Measurement	O / R	O / R	S❸	R	R
Measurement & Report Format		A		B	C	
Note: ❶ R: recommended; ❷ O: optional; ❸ S: Sampling						

A.2 $B(t)$ Generator & Receiver Apps

A.2.1 The hardware "Programmable $B(t)$ Generator" inside the Ultrasound Transducer Analyzer PCSC5TA/PCSC5T is available for external use.

A.2.2 The hardware "Receiver" inside the Ultrasound Transducer Analyzer PCSC5TA/PCSC5T is available for external use and the receiver outputs to external oscilloscope.

A.2.3 ECHO mode & THRU mode

A.2.4 50-ohm for both the source impedance of programmable $B(t)$ generator and the input impedance of receiver in ECHO mode & THRU mode

A.2.5 Software "Innovator" provides with software control panel

A.2.6 The pre-determined $B(t)$ signal is loaded into the programmable $B(t)$ generator inside the Ultrasound Transducer Analyzer PCSC5TA/PCSC5T that supports $B(t)$ with center frequency ranging from 0.5 MHz to 15 MHz.

A.3 Pulser & Receiver Apps

A.3.1 The hardware "Unipolar Pulser" with 9 sets of unipolar pulses inside the Ultrasound Transducer Analyzer PCSC5TA/PCSC5T is available for external use.

A.3.2 The hardware "Receiver" inside the Ultrasound Transducer Analyzer PCSC5TA/PCSC5T is available for external use and the receiver outputs to external oscilloscope.

A.3.3 ECHO mode & THRU mode

A.3.4 50-ohm for both the source impedance of unipolar pulser and the input impedance of receiver in ECHO mode & THRU mode

A.3.5 Software "Innovator" provides with software control panel

A.3.6 Supporting acoustic transducers with center frequency ranging from 0.5 MHz to 40 MHz

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B) Software “Innovator”

The software “Innovator” of ProCheck SC5 UTAS provides all the user interfaces and calculations for the measurements in the XDCR Analysis Apps. The Innovator also provides with software control panels for the $B(t)$ Generator / Receiver Apps and Pulser / Receiver Apps.

C) Product Configurations

C.1 ProCheck SC5 UTAS for multiple-element array assembly and single-element transducer assembly comprises the following components, as shown in Fig. 1:

C.1.1 Ultrasound Transducer Analyzer PCSC5TA;

- Contemporary housing design with multiple layouts: level, tilt, & wall-mounting

C.1.2 Diagnosis Kit PCSC5DK;

C.1.3 Probe Adaptor;

- Dual-receptacle and triple-receptacle probe adaptors available

C.1.4 Probe Holder & Positioner;

C.1.5 Acoustic Mirror Assembly;

- Flat, concave, and bowl type acoustic mirrors
- Acoustic mirror for specialty TEE & 3D probes available

C.1.6 Tank with Degassed Water Bath;

C.1.7 Software “Innovator”; and,

C.1.8 Microsoft Windows-based PC.

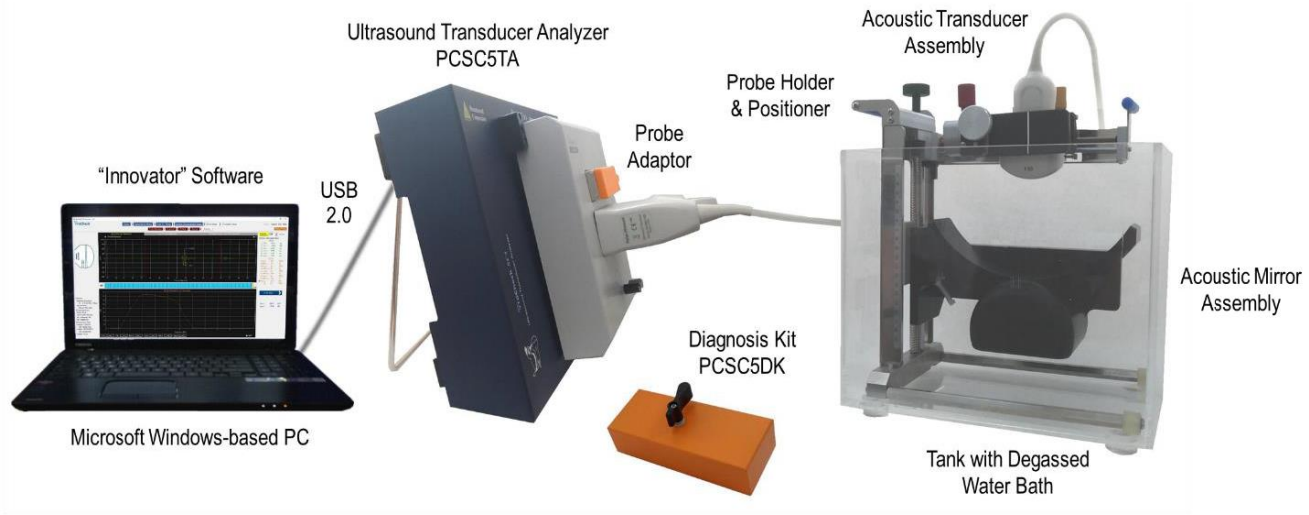

Fig. 1 shows the ProCheck SC5 UTAS for multiple-element array assembly and single-element transducer assembly, which consists of Ultrasound Transducer Analyzer PCSC5TA, Diagnosis Kit PCSC5DK, Probe Adaptor, Probe Holder & Positioner, Acoustic Mirror Assembly, Tank with Degassed Water Bath, Software “Innovator”, Microsoft Windows-based PC, and a given acoustic transducer assembly under test.

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C.2 ProCheck SC5 UTAS for single-element transducer assembly comprises the following components, as shown in Fig. 2:

C.2.1 Ultrasound Transducer Analyzer PCSC5T;

C.2.2 Probe Holder & Positioner;

C.2.3 Acoustic Mirror Assembly;

C.2.4 Tank with Degassed Water Bath

C.2.5 Software “Innovator”; and,

C.2.6 Microsoft Windows-based PC.

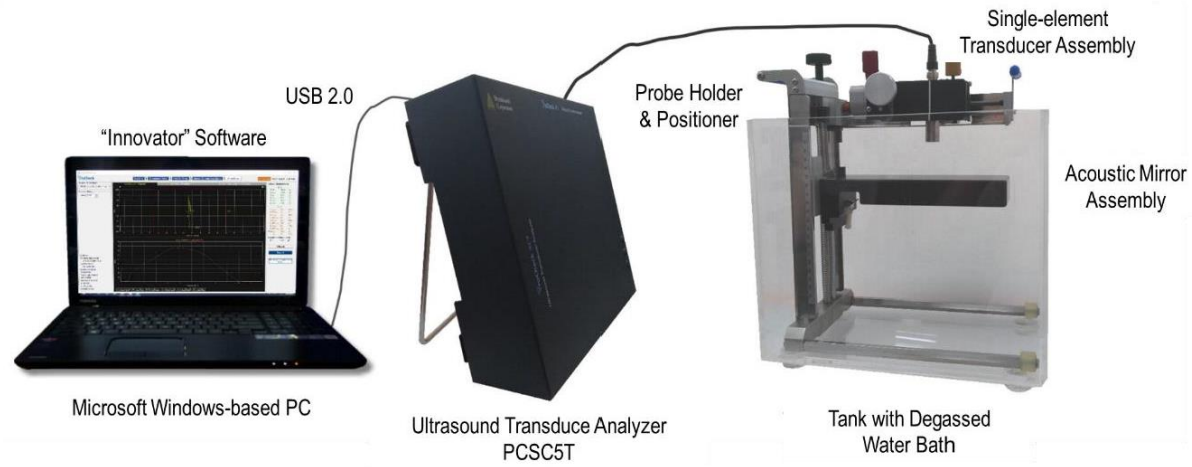

Fig. 2 shows the ProCheck SC5 UTAS for single-element transducer assembly, which consists of Ultrasound Transducer Analyzer PCSC5T, Probe Holder & Positioner, Acoustic Mirror Assembly, Tank with Degassed Water Bath, Software “Innovator”, Microsoft Windows-based PC, and a given single-element transducer assembly under test.

D) Compliance

The ProCheck SC5 UTAS complies with the following 14 standards:

D.1 EN 61326-1,

D.2 EN 61010-1,

D.3 EN 55011,

D.4 EN 61000-3-2,

D.5 EN 61000-3-3,

D.6 EN 61000-6-1,

D.7 IEC 61000-4-2,

D.8 IEC 61000-4-3,

D.9 IEC 61000-4-4,

D.10 IEC 61000-4-5,

D.11 IEC 61000-4-6,

D.12 IEC 61000-4-8,

D.13 IEC 61000-4-11, and

D.14 USA FCC part 18.

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E) Relevant Patents of Broadsound ProCheck SC5 UTAS

1: Method and System for Measuring a Wideband Loop Sensitivity for an Acoustic Transducer 测量声学换能器的宽带环路灵敏度的方法及系统 測量聲學換能器之寬頻環路靈敏度的方法與系統						
Country / Region	Application		Publication		Patent	
	Date	Number	Date	Number	Number	Period
U.S.A.	27-Dec-2017	15/855,677 (System)	27-Jun-2019	US20190195835 A1	US10502717	10-Dec-2019 ~ 26-Dec-2037
U.S.A.	09-Oct-2019	16/596,934 (Method)	06-Feb-2020	US20200041461 A1	US11112387	07-Sep-2021 ~ 08-Oct-2039
China	13-Apr-2018	201810333929.4	05-Jul-2019	CN109974843A	ZL 2018 1 0333929.4	22-Oct-2021 ~ 12-Apr-2038
Taiwan	21-Sep-2018	107133466	16-Jul-2019	201927248	I 678192	01-Dec-2019 ~ 20-Sep-2038
European Union	07-Dec-2018	EP18211186.4	03-Jul-2019	EP3505928A1	(pending)	---

2: Method and System for Measuring a Characteristic Loop Sensitivity for an Acoustic Transducer 测量声学换能器的特征环路灵敏度的方法与系统 測量聲學換能器之特徵環路靈敏度的方法與系統						
Country / Region	Application		Publication		Patent	
	Date	Number	Date	Number	Number	Period
U.S.A.	27-Dec-2017	15/855,710	27-Jun-2019	US20190195995 A1	US10768286	08-Sep-2020 ~ 26-Dec-2037
China	13-Apr-2018	201810333931.1	05-Jul-2019	CN109974844A	ZL 2018 1 0333931.1	29-Oct-2021 ~ 12-Apr-2038
Taiwan	21-Sep-2018	107133467	16-Jul-2019	201927245	I 678191	01-Dec-2019 ~ 20-Sep-2038
European Union	07-Dec-2018	EP18211185.6	03-Jul-2019	EP3505927A1	(pending)	---

3: Method and System for Determining an Optimum Driving Signal for an Acoustic Transducer 测定声学换能器最佳驱动信号的方法与系统 測定聲學換能器最佳驅動信號之方法與系統						
Country / Region	Application		Publication		Patent	
	Date	Number	Date	Number	Number	Period
U.S.A.	27-Dec-2017	15/855,830	27-Jun-2019	US20190195836 A1	US10502718	10-Dec-2019 ~ 26-Dec-2037
China	13-Apr-2018	201810333930.7	05-Jul-2019	CN109982227A	ZL 2018 1 0333930.7	25-Dec-2020 ~ 12-Apr-2038
Taiwan	21-Sep-2018	107133468	16-Jul-2019	201928393	I 667489	01-Aug-2019 ~ 20-Sep-2038
European Union	07-Dec-2018	EP18211184.9	03-Jul-2019	EP3505926A1	(pending)	---

F) Product List

Please refer to the attached file "***Broadsound ProCheck SC5 UTAS_Product List.pdf***" for the product list of ProCheck SC5 UTAS.

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