Introduction to ProCheck SC5 UTAS

The Broadsound ProCheck SC5 Ultrasound Transducer Analysis System (UTAS) is a specialty measurement instrument for the R&D, design, manufacturing, recurrent test, and repair of acoustic transducers. Its features are as follows:

A) Analysis Apps (applications) that involve the following five measurements:
  1. Capacitance measurement
  2. Axial characteristic loop sensitivity S_{LC} measurement
  3. Intrinsic characteristics measurement
  4. Transmission crosstalk measurement with optimum drive waveform signal $B(t)$
  5. Echo measurement with optimum drive waveform signal $B(t)$

B) $B(t)$ Generator / Receiver Apps (applications)

C) Pulser / Receiver Apps (applications)

D) Product Configuration

E) “Innovator” software

F) Compliance

A) Analysis Apps (applications)

The Analysis Apps of ProCheck SC5 UTAS involve five measurements; please refer to the attached file “**2019-01-15_Broadsound ProCheck SC5 UTAS_Analysis Apps.pdf”** for details, and the summary of which is listed as following:

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.

2. Axial characteristic loop sensitivity S_{LC} measurement

   2.1 Curve of characteristic loop sensitivity S_{LC} along axial distance L is measured; the curve Indicates elevation focus and divergence in far-field zone of acoustic beam which are determined by acoustic membrane / acoustic lens.

   2.2 Supporting acoustic transducers with center frequency ranging from 0.5 MHz to 40 MHz

3. Intrinsic characteristics measurement

   3.1 Characteristic loop sensitivity S_{LC}
   - The most representative parameter of acoustic performance

   3.2 Normalized loop time response $X(t)$
   - t_d: Temporal duration of $X(t)$
   - t_{-x}: Temporal length of $-x$ dB ring-down of $X(t)$, wherein $-x$ dB = −12, −20, or −26 dB

   3.3 Wideband loop sensitivity $S_L(f)$
   - f_{c-x}: Center frequency of $-x$ dB limit of $S_L(f)$, wherein $-x$ dB = −6, −10, −20, or −30 dB
   - BW_{-x}: Fractional bandwidth of $-x$ dB limit of $S_L(f)$, wherein $-x$ dB = −6, −10, −20, or −30 dB

   3.4 Optimum drive waveform signal $B(t)$ [i.e., $B(t)$ Signal]
   - The $B(t)$ signal is derived from the self-deconvolution of normalized loop time response $X(t)$

   3.5 Supporting acoustic transducers with center frequency ranging from 0.5 MHz to 40 MHz

   3.6 Intrinsic characteristics S_{LC}, $X(t)$ and $S_L(f)$ are measurement system independent

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

3.8 SNR (signal-to-noise ratio) evaluation for the measurement available
3.9 Application of intrinsic characteristics $X(t)$: DIY drive-echo computer simulation with given $X(t)$ and various reference drive signals

4. Transmission crosstalk measurement with $B(t)$ signal
4.1 The pre-determined $B(t)$ signal is written into a $B(t)$ generator that supports $B(t)$ with center frequency ranging from 0.5 MHz to 15 MHz
4.2 Transmission Crosstalk XT across adjacent elements up to ± 5 elements could be measured

5. Echo Measurement with $B(t)$ signal
5.1 The pre-determined $B(t)$ signal is written into a $B(t)$ generator that supports $B(t)$ with center frequency ranging from 0.5 MHz to 15 MHz
5.2 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}.

5.3 Echo signal in time domain
- t_{de}: Temporal duration of echo
- t_{-xe}: Temporal length of $-x$ dB ring-down of echo, wherein $-x$ dB = −12, −20, or −26 dB

5.4 Relative echo energy spectrum
- 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

5.5 SNR (signal-to-noise ratio) evaluation for the measurement available

B) $B(t)$ Generator / Receiver Apps (applications)
1. The hardware “optimum drive waveform signal $B(t)$ generator” of ProCheck SC5 ultrasound transducer analyzer PCSC5TA/PCSC5T available for external use
2. The hard ware “receiver” of ProCheck SC5 ultrasound transducer analyzer PCSC5TA/PCSC5T available for external use and receiver output to external oscilloscope
3. ECHO mode & THRU mode
4. 50-ohm for the source impedance of $B(t)$ generator and the input impedance of receiver in both ECHO mode & THRU mode
5. Software “Innovator” provides with software control panel

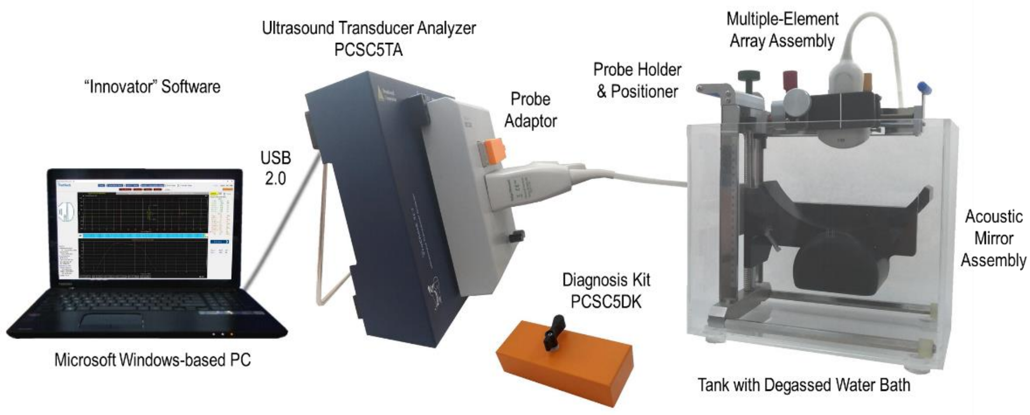
C) Pulser / Receiver Apps (applications)
1. The hardware “unipolar pulser” with 9 sets of unipolar pulses of ProCheck SC5 ultrasound transducer analyzer PCSC5TA/PCSC5T available for external use
2. The hard ware “receiver” of ProCheck SC5 ultrasound transducer analyzer PCSC5TA/PCSC5T available for external use and receiver output to external oscilloscope
3. ECHO mode & THRU mode
4. 50-ohm for the source impedance of unipolar pulser and the input impedance of receiver in both ECHO mode & THRU mode
5. Software “Innovator” provides with software control panel

Please refer to the attached file “**2019-01-15_Broadsound ProCheck SC5 UTAS_Specifications.pdf”** for detailed specifications of ProCheck SC5 UTAS.

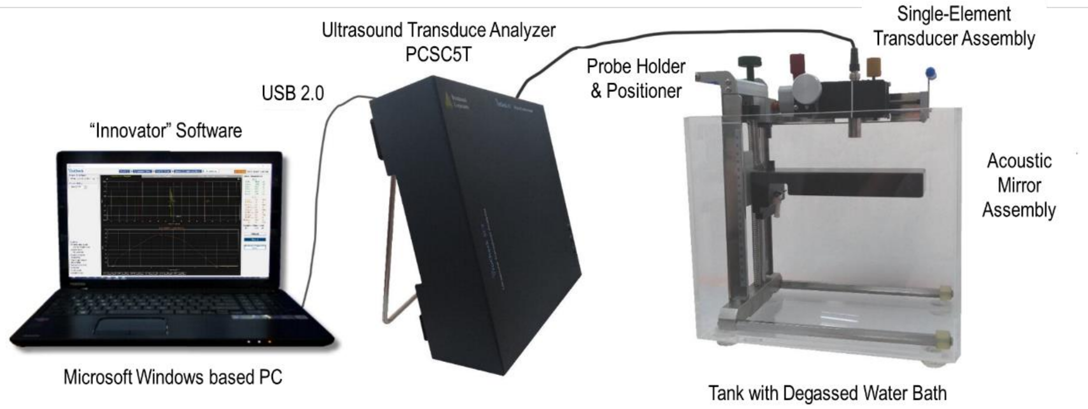
Introduction to ProCheck SC5 UTAS

D) Product Configuration

1. ProCheck SC5 UTAS for multiple-element array assembly and single-element transducer assembly comprises the following components:
   - 1.1 Ultrasound transducer analyzer PCSC5TA
     - Contemporary housing design with multiple layouts: level, tilt, & wall-mounting
   - 1.2 Diagnosis kit PCSC5DK
   - 1.3 Probe adaptor
     - Dual-receptacle and triple-receptacle probe adaptors available
   - 1.4 Probe holder & positioner
   - 1.5 Acoustic mirror assembly
     - Flat, concave, and bowl type acoustic mirrors
     - Acoustic mirror for specialty TEE & 3D probes available
   - 1.6 Tank with degassed water bath
   - 1.7 “Innovator” software
   - 1.8 (Microsoft Windows-based PC)



2. ProCheck SC5 UTAS for single-element transducer comprises the following components:
   - 2.1 Ultrasound transducer analyzer PCSC5T
   - 2.2 Probe holder & positioner
   - 2.3 Acoustic mirror assembly
   - 2.4 Tank with degassed water bath
   - 2.5 “Innovator” software
   - 2.6 (Microsoft Windows-based PC)



E) "Innovator" software

The software "Innovator" of ProCheck SC5 UTAS provides all the user interfaces and calculations for the measurements in the Analysis Apps. The Innovator also provides with software control panels for the $B(t)$ Generator / Receiver and Pulser / Receiver Apps. Please refer to the attached file "**2019-01-15_Broadsound ProCheck SC5 UTAS_Innovator.pdf"** for details.

F) Compliance

The ProCheck SC5 UTAS complies with the following standards: EN 61326-1, EN 61010-1, EN 55011, EN 61000-3-2, EN 61000-3-3, EN 61000-6-1, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-8, IEC 61000-4-11, FCC part 18.

Patents

USA, China, and worldwide patents pending.

Product List

Please refer to the attached file "**2019-01-15_Broadsound ProCheck SC5 UTAS_Product List.pdf"** for the product list of ProCheck SC5 UTAS.

Question Set of Interest for ProCheck SC5 UTAS

The question set of interest for ProCheck SC5 UTAS is listed below and please refer to the attached file "**2019-01-15_Broadsound ProCheck SC5 UTAS_Q&A.pdf"** for answers. Let us know if you have further questions.

A) About Intrinsic Characteristics Measurement [1 – 3]

Q1: What does it mean by that the normalized loop time response $X(t)$, wideband loop sensitivity $S_L(f)$, and characteristic loop sensitivity S_{LC} are intrinsic characteristics for acoustic transducer assembly itself and do not dependent upon measurement system?

Q2: In the intrinsic characteristics of acoustic transducer assembly, what does the term "loop" stand for?

Q3: What does it mean by that the intrinsic characteristics measurement for obtaining $X(t)$, $S_L(f)$, and S_{LC} is a kind of one-shot wideband measurement?

B) About Axial S_{LC} Measurement [4 – 6]

Q4: What is the significance of the curve of characteristic loop sensitivity S_{LC} along axial distance in the axial characteristic loop sensitivity S_{LC} measurement?

Q5: Should the curve of S_{LC} along axial distance be checked and verified during repair of acoustic lens?

Q6: The intrinsic characteristics measurement and echo measurement are usually performed at a preferable axial distance, and where is the best test region for that?

C) Drive-Echo Computer Simulation [7 & 8]

Q7: The normalized loop time response $X(t)$ could be used in the drive-echo computer simulation and how does it work?

Q8: Are the results of the drive-echo computer simulation reliable?

D) About Optimum Drive Waveform Signal $B(t)$ [9 – 13]

Q9: What is the physical meaning of the optimum drive waveform signal $B(t)$?

Q10: What circumstances would the optimum drive waveform signal $B(t)$ be applicable to?

Q11: Why is the optimum drive waveform signal $B(t)$ the most appropriate drive signal for acoustic transducer assembly in transmit-receive mode?

Q12: Why is the optimum drive waveform signal $B(t)$ the most suitable drive signal for measuring transmission crosstalk?

Q13: Is the optimum drive waveform signal $B(t)$ universal to all acoustic transducer assemblies or it is unique to a given acoustic transducer assembly?

E) SNR (Signal-to-Noise Ratio) Assessment [14]

Q14: Could SNR (Signal-to-Noise Ratio) of measurement be assessed on ProCheck SC5 UTAS?

F) Acceptance Criteria for Multiple-element Transducer Array Assembly [15]

Q15: What are the acceptance criteria for multiple-element transducer array assembly?

G) About Total Capacitance [16 – 18]

Q16: How does the total capacitance C_T reflect the structure of acoustic transducer assembly?

Q17: In the capacitance measurement, why the total capacitance C_T is preferably measured at low frequency such as 30KHz rather than at high frequency like 1 MHz?

Q18: In case there exists HVSW (high voltage switch) IC circuits embedded inside acoustic transducer assembly, could ProCheck SC5 measure the total capacitance C_T?

Please feel free to contact me if you have further questions.

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Shenzhen S&V Acoustic Tech Co., Ltd.

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