

# MEASUREMENT RESULTS REPORT

## 1. Submission

The following measurement results are submitted as a report on the joint use of research equipment for technical support to small and medium-sized enterprises.

Submission date: February 14, 2023

Submitted by: Yong-Tae Kim

Affiliation: Korea Research Institute of Standards and Science (KRISS), Ultrasound Standards Team

## 2. Equipment Under Test

- Equipment name: MUTI Chip ver. 2.1 module
- Model and serial number: MUTI-B / SN:001
- Manufacturer: MUTi Inc.

Photographs of the actual equipment under test are shown in Figures 1 and 2 below.

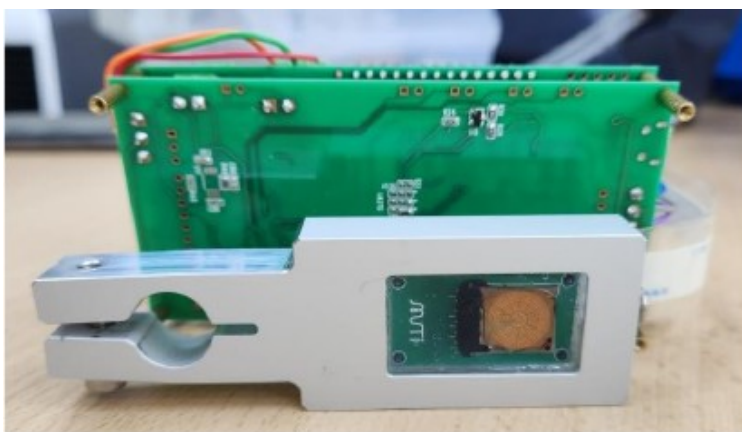


Figure 1. Bottom view of the equipment under test.

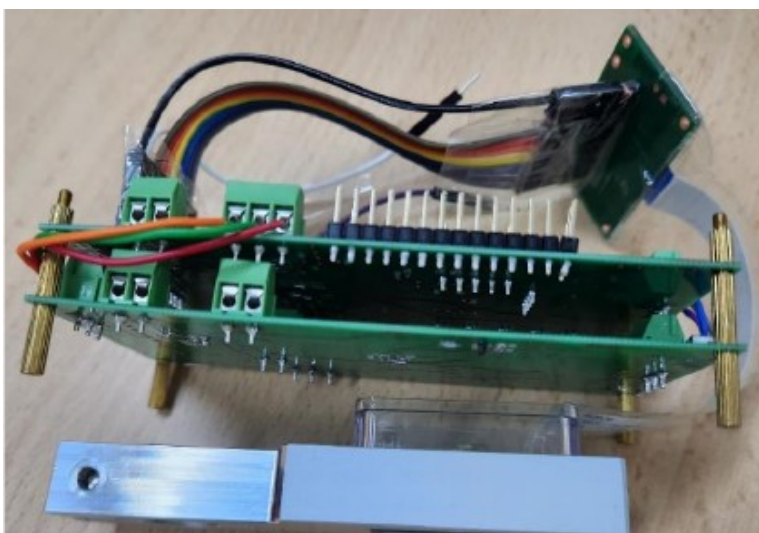
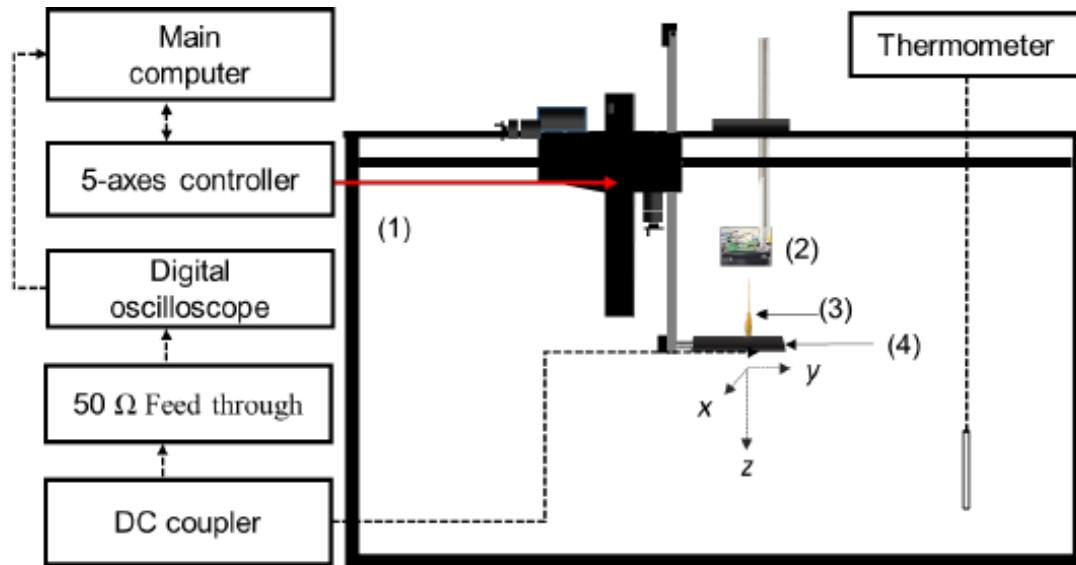


Figure 2. Side view of the equipment under test.

## Measurement System Configuration

The measurement system configuration is shown in Figure 3.



(1) Water, (2) DUT, model: Muli-Chip ver. 2.1 module /SN: 001, (주)무티, (3) Hydrophone, model: NH-0250 SN: 098, Precision Acoustics Co. (4) Hydrophone mount

Figure 3. Measurement system configuration: (1) degassed triple-distilled water, (2) equipment under test, model: MUTI-Chip ver. 2.1 module, serial no.: 001, (3) hydrophone used for measurement, model: NH0025, SN:098, and (4) hydrophone mount.

## 3. Notes for Presentation of the Measurement Results

- Voltage square integral

$$VII(t) = \int_{t_0}^t V(t') dt'$$

- Pulse width

$$pw = 1.25(\tau_{90} - \tau_{10})$$

- $\tau_{90}$ : time at which  $VII(t)$  reaches 90% of the maximum value of  $VII(t)$
- $\tau_{10}$ : time at which  $VII(t)$  reaches 10% of the maximum value of  $VII(t)$
- Coordinate correction equation for the z-axis (acoustic radiation axis)

$$z_{cor} = z_m - (z_{tf-ref} - \sqrt{(z_{tf-ref}^2 - r_{ch8}^2)})$$

- $z_m$ : coordinate provided by the equipment
- $z_{tf-ref}$ : coordinate based on flight time (coordinate of one find-pulse point)
- $r_{ch8}$ : lateral distance to Channel 8, which provided the trigger signal (customer-provided value: 5 mm)

## 4. Measurement Results - 4-1. Transducer System Setting 1 (Nominal Focus: 6 mm) (February 3, 2023)

### 4. 측정결과

#### 4-1. 변환기 시스템 설정 1 (공칭초점 6 mm)의 측정 결과. (2/3/2023)

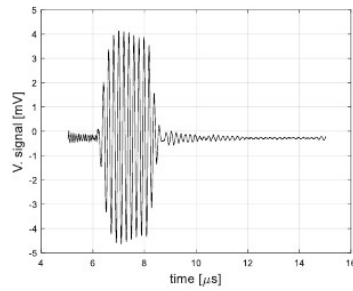


그림 4. 수중 청음기 수신 신호.

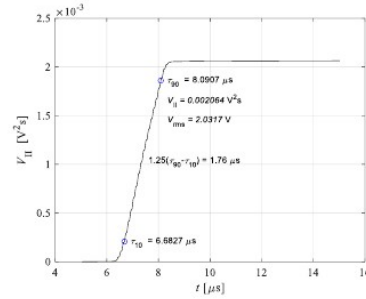


그림 5. V-제곱 적분 및 펄스 폭.

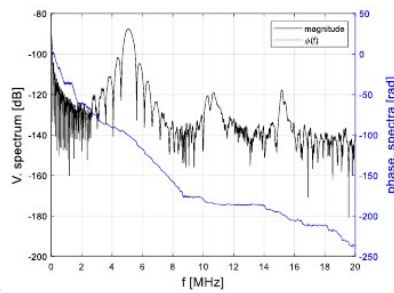


그림 6 수중 청음기 수신 신호의 스펙트럼.

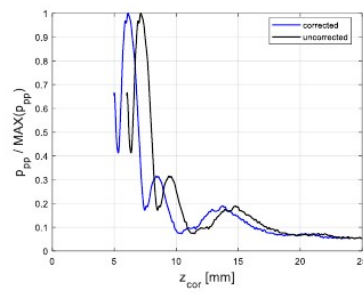


그림 7. 음향 방사 축상 주사 결과.

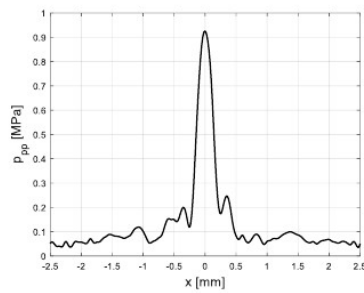


그림 8. x-축상 주사 결과.

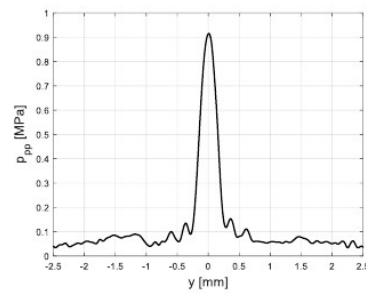


그림 9. y-축상 주사 결과.

**Table 1. Data for each measurement parameter under Condition 1.**

표 1. 조건 1의 측정 파라미터 별 데이터.

| Waveform results                                           | Measurement | Std. uncertainty |
|------------------------------------------------------------|-------------|------------------|
| Z Distance [mm]                                            | 7.29        | 0.03             |
| Z_cor Distance [mm]                                        | 5.96        | 0.03             |
| Temperature [°C]                                           | 28.06       | 0.01             |
| Peak Positive Pressure [MPa]                               | 0.481       | 0.004            |
| Peak Negative Pressure [MPa]                               | 0.472       | 0.003            |
| Peak-to-Peak Pressure [MPa]                                | 0.953       | 0.007            |
| Peak Positive Pressure (derated) [MPa]                     | 0.423       | 0.004            |
| Peak Negative Pressure (derated) [MPa]                     | 0.415       | 0.003            |
| Peak-to-Peak Pressure (derated) [MPa]                      | 0.838       | 0.006            |
| Pulse Average Intensity [W/cm <sup>2</sup> ]               | 6.18        | 0.24             |
| Temporal Average Intensity [mW/cm <sup>2</sup> ]           | 21.70       | 0.85             |
| Pulse Average Intensity (derated) [W/cm <sup>2</sup> ]     | 4.78        | 0.18             |
| Temporal Average Intensity (derated) [mW/cm <sup>2</sup> ] | 16.79       | 0.63             |
| Pulse duration [us]                                        | 1.76        | 0.00             |
| Center Frequency [MHz]                                     | 5.09        | 0.00             |
| -3dB Bandwidth [MHz]                                       | 0.470       | 0.007            |
| -3dB Bandwidth percent [%]                                 | 9.23        | 0.14             |
| Mechanical Index                                           | 0.18        | 0.00             |
| x-scan results                                             | Measurement | Std. uncertainty |
| Beam Width (mm)                                            | 0.341       | 0.009            |
| Center (mm)                                                | 0.006       | 0.003            |
| y-scan results                                             | Measurement | Std. uncertainty |
| Beam Width (mm)                                            | 0.322       | 0.004            |
| Center (mm)                                                | 0.000       | 0.001            |
| z-scan results                                             | Measurement | Std. uncertainty |
| Focal depth (mm)                                           | 1.55        | 0.03             |
| Focal length (mm)                                          | 5.96        | 0.03             |

# MEASUREMENT RESULTS REPORT

## 1. Submission

The following measurement results are submitted as a report on the shared use of research equipment for technical support to small and medium-sized enterprises.

Submission date: October 15, 2025  
Submitted by: Kyung-Min Baek  
Participating researchers: Yong-Tae Kim, Hyo-Sung Lee  
Affiliation: Korea Research Institute of Standards and  
Science (KRISS),  
Acoustics, Vibration and Ultrasound Metrology Group

## 2. Measurement Request

### 2.1 Overview

- Request: Measurement of maximum focal acoustic pressure and intensity of a novel semiconductor ultrasound chip.
- Equipment: MUTI semiconductor ultrasound chip module for skin beauty and wellness applications.
- Model / Serial No.: MUTI-Thera-Vhead / SN:001
- Manufacturer: MUTi Inc.
- Measurement: Maximum acoustic pressure (kPa), intensity (W/cm<sup>2</sup>), and 3D beam profile at each focal point of the low-intensity focused ultrasound semiconductor chip. Requested focal intensity range:  $1 < I_{\text{sppa}} < 20 \text{ W/cm}^2$ .

### 2.2 Operating Protocol

- Operating frequency: 5.2 MHz

- PRF: 2 kHz
- Ultrasound output: 10-pulse burst cycle
- Analog drive voltage: 62 Vpp (drive circuit supplied by MUTi; battery powered)
- Water-tank temperature: 28 deg C
- Triggering: wired trigger signal

## 2.3 Beam-Focus Profile Measurement Volume (Maximum Focal Pressure and Intensity)

- 1st) Focused pressure at  $z \sim 10$  mm using one semiconductor ultrasound chip  
x:  $(-2 \sim 2)$  mm / y:  $(-2 \sim 2)$  mm / z:  $(6 \sim 12)$  mm (resolution: 50 ~ 100  $\mu$ m)
- 2nd) Focused pressure at  $z \sim 22$  mm using one semiconductor ultrasound chip  
x:  $(-2 \sim 2)$  mm / y:  $(-2 \sim 2)$  mm / z:  $(18 \sim 24)$  mm (resolution: 50 ~ 100  $\mu$ m)
- 3rd) Crossed focusing pressure at  $z \sim 21$  mm using two semiconductor ultrasound chips  
x:  $(-2 \sim 2)$  mm / y:  $(-2 \sim 2)$  mm / z:  $(18 \sim 24)$  mm (resolution: 50 ~ 100  $\mu$ m)

## 2.4 Measurement Overview and Photographs

The measurement overview and photographs are shown in Figures 1 and 2.

## 3. Measurement System Configuration

The equipment used in the measurement system is listed below.

- Degassed triple-distilled water: provided by KRISS
- Equipment under test: MUTI semiconductor ultrasound chip module (model: Muti-thera S/N001), provided by MUTi
- Hydrophone: NH0040, SN:1099, provided by KRISS

## Measurement Results for Transducer System Setting (Focus: 6 mm) (September 23, 2025)

The transducer system was set to a focal distance of 6 mm. The hydrophone received signal and spectrum, and the scan results along the acoustic radiation axis (z-axis), x-axis, and y-axis are shown in Figures 15-18.

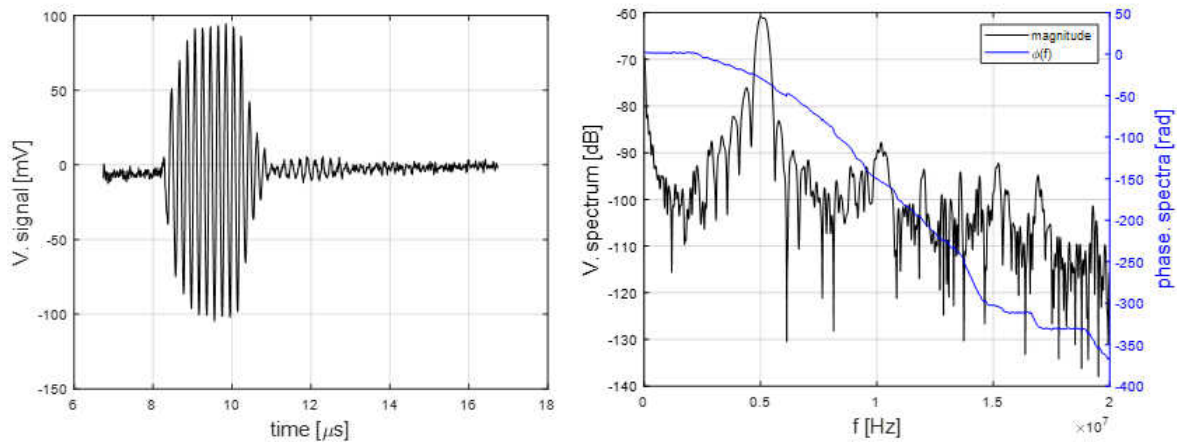


Figure 15. Hydrophone received signal and spectrum.

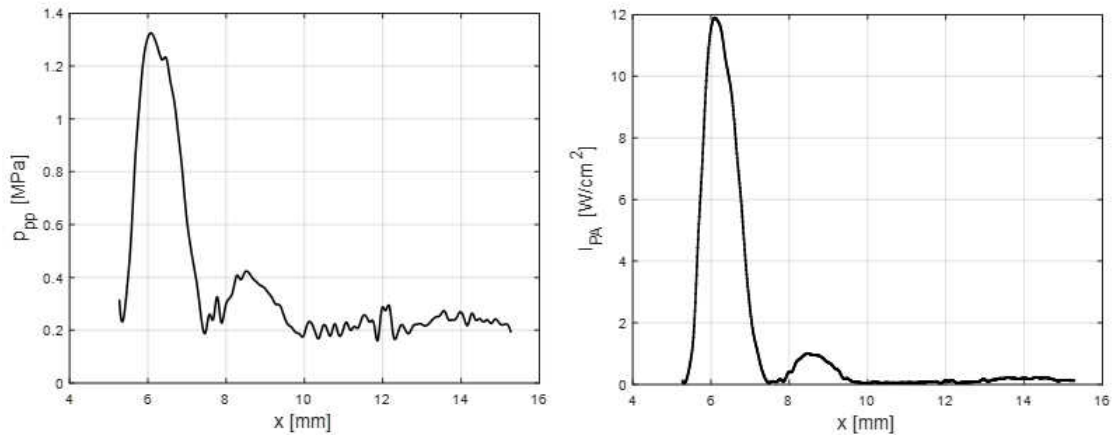


Figure 16. Scan result along the acoustic radiation axis (z-axis).

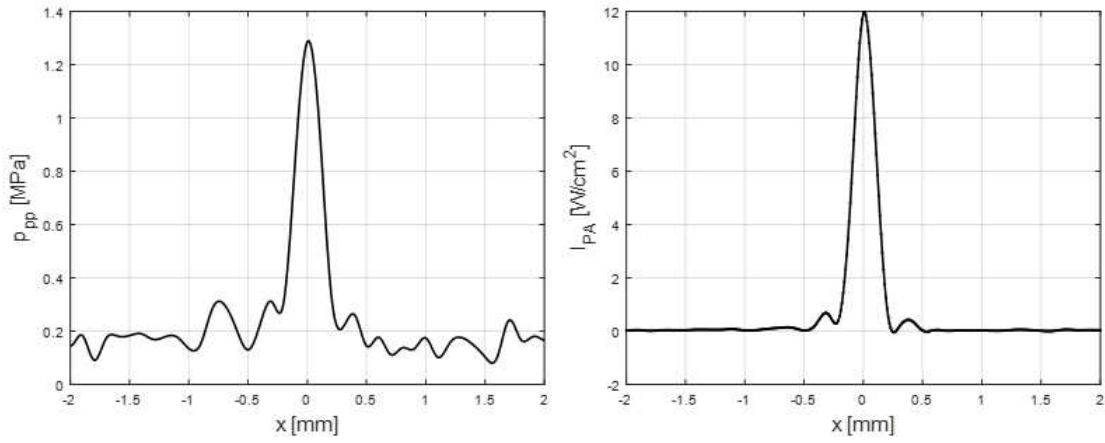


Figure 17. Scan result along the x-axis.

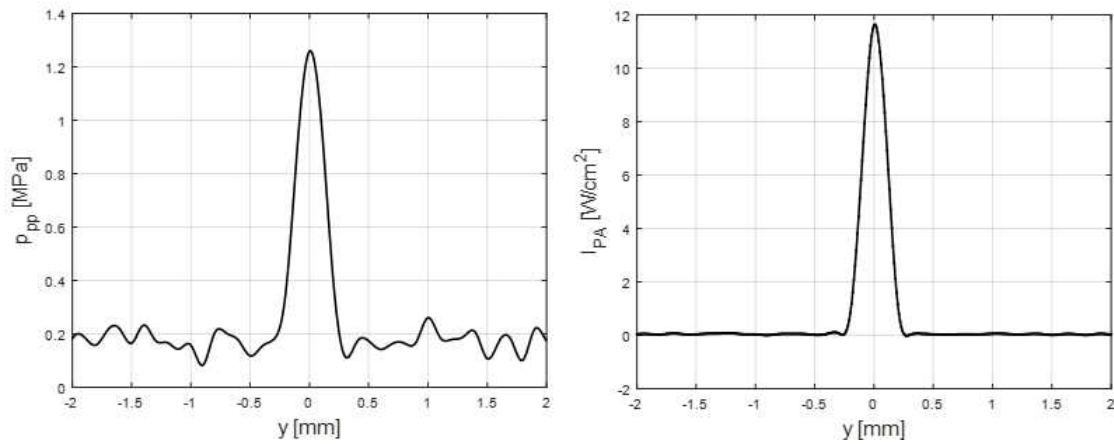


Figure 18. Scan result along the y-axis.