Sound Source Visualization System

- System example
  - Sound Source Visualization Probe Microphone*1
  - 4ch Beam Forming software
  - OS-2000 series FFT Analysis package
  - OS-2000 series video playback function (option)
  - OS-2000 series IIR filter (option)*2
  - Data Station (4ch), signal output (option)
  - Personal Computer

- Product name
  - MI-5420
  - BF-3100
  - OS-2720
  - OS-0281
  - OS-0261
  - DS-3204, DS-0371

- Model name
  - Sound Source Visualization System using MI-6420 3D SI probe
  - BF-3100 4ch Beam Forming software can be used with the MI-6420
  - Using MI-6420 has advantages of supporting wide range of sound visualization measurement methods including BF, EI*, and SI*.

- Specification of MI-6420 (60 mm)
  - Grip undersurface mounting screw hole × 1
    - 1/4-20UNC depth 6 mm

- Distance between microphones
  - 60 mm (regular tetrahedron)*3

- Analysis frequency range
  - 1 kHz to 5 kHz

- Length
  - 560 mm

- Mass (excluding a cable)
  - Approx. 300 g

- Connection cable
  - BF-3100
  - OS-2720
  - OS-0281
  - DS-3204/DS-0371
  - MI-6420
  - MX-101
  - CF-0610
  - Others

- Operating temperature range
  - 0 to +40 °C

- Storage temperature range
  - -10 °C to +60 °C

- Approx. 5 m

- Camera kit (Camera, USB cable (3 m), synchronization cable (5 m))

- Personal Computer

- *EI: Envelope Intensity   SI: Sound Intensity

*1 Two types of probe microphone (120 mm and 60 mm), camera, combined cable exclusive for camera microphone (3 m) are included.

*2 Required when IIR filter which is added to the real-time monitor is used in offline analysis.

*3 The probe microphone of 20 mm-interval is also included to MI-640. Mainly used for sound visualization measurement by EI, SI.
Evolved probe microphone meets the demands you want to see, and you want to know.
Small and lightweight
Use it anytime, anywhere

► Achieves wide analysis frequency range
  Sound source visualization from 500 Hz to 8 kHz* of frequency range

► Visualizing sound source using only 4 microphones
  4ch Beam Forming System localizes sound source position with minimum microphones by “Beam Forming” and new calculation method.

► Monitors sound source in real-time (5 times/sec.)
  You can monitor sound occurring and confirm the sound source position in the field.

► Enables detailed analysis even transient/impulsive sound
  As for sounds changing very quickly, offline analysis is effective. It enables further analysis of transient/impulsive sound by recorded sound and video.

Sound source visualization method: Beam Forming
Beam forming is one of the sound visualization techniques that calculates the distribution of sound pressure and sound intensity from the data recorded with microphone array system, and superimposes the resulting view with the video through the camera.
This technique produces an easily understandable result because it shows the result in a color map. The microphone array size has been apt to become large. This is because the number of microphones used in beam forming occasionally exceeds 100 and they are randomly positioned so that they can handle wide range of sounds.
Ono Sokki’s 4ch Beam Forming System has achieved sound visualization in real-time by minimum number of microphones.
Evolved probe microphone meets the demands you want to see, and you want to know. Small and lightweight, use it anytime, anywhere. Enables detailed analysis even for transient/impulsive sound. As for sounds changing very quickly, offline analysis is effective. It enables further analysis of transient/impulsive sound by recorded sound and video. Visualizing sound source using only 4 microphones, 4ch Beam Forming System localizes sound source position with minimum microphones by "Beam Forming" and new calculation method. Monitors sound source in real-time (5 times/sec.). You can monitor sound occurring and confirm the sound source position in the field. Achieves wide analysis frequency range. Sound source visualization from 500 Hz to 8 kHz* of frequency range. *Recommended frequency. Refer to [Specification] in page 7.

Beam forming is one of the sound visualization techniques that calculates the distribution of sound pressure and sound intensity from the data recorded with microphone array system, and superimposes the resulting view with the video through the camera. This technique produces an easily understandable result because it shows the result in a color map. The microphone array size has been apt to become large. This is because the number of microphones used in beam forming occasionally exceeds 100 and they are randomly positioned so that they can handle wide range of sounds. Ono Sokki’s 4ch Beam Forming System has achieved sound visualization in real-time by minimum number of microphones.

Sound Source Visualization
Probe Microphone MI-5420
System example

The measurement system includes DS-3200 series as a measurement unit, MI-5420 as microphones. Two types of microphone array (120 mm/60 mm-interval) are available according to analysis frequency. BF-3100 and OS-2000 series software are used for measurement and analysis. Other than 4 channels connected to MI-5420, 4 more channels can be added. You can connect an accelerometer and a rotation detector to see vibration waveform and rotation speed.

MI-5420 4ch Beam Forming System

Sound Source Visualization Probe Microphone MI-5420
- 120 mm (500 Hz to 4 kHz)
- 60 mm (1 kHz to 8 kHz)

Wide variety of sensor connection*

Rotation
- Optical detector LG-9200
- Digital Engine Tachometer CT-6700
- Signal cable MX-7100 series

Vibration
- Accelerometer with built-in amplifier NP-3000 series
- Signal cable NP-0120/0130/0150/0170 series
- Miniature/BNC conversion adapter NP-0021

Acoustic
- Sound Level Meter LA-1411/1441/4441 (Integrated type)
- Signal cable AX-501

OS-2000 series

Time-series Data Analysis Software

OS-2000 series edits and analyzes the time-series data which is too long to be used on Microsoft® Excel® flexibly and freely. It supports a wide variety of data formats, not only general formats such as CSV and WAV files, but also unique format of each recording device.

OS-2000 series has many useful functions including overlay of waveforms of different formats, division, moving, and zooming in and out. Smooth linking to Microsoft® Excel® is also available. Various other functions, such as video playback function, FFT analysis function, filter functions and sound quality evaluation are available.

*For more information on DS-3200 series, OS-2000 series, and other measuring instruments, please refer to each brochure.
4ch BEAM FORMING SYSTEM

Anywhere, any sound

Enables measurement very close to a target
(Example)
Opening/closing sound of door mirror

Easy installation
(Example)
Vehicle sound while driving

Can be used in a narrow space
(Example)
Sliding sound of power sheet

Compact and lightweight microphone array flexibly measures sound in various environment.
Two types of software support analysis regardless of the kind of sound.

Real-time monitor software

This software performs and displays sound source visualization processing of a sound occurring from the measurement object in real-time (5 times/sec.). Simultaneous record (25 times/sec) and playback are also available. You can find a sound source position while moving probe microphone and changing analysis frequency band. The frequency band of abnormal sound can be confirmed by hearing the sound with the Bandpass filter applied.

Offline analysis software

This is software which is plugged in the OS-2000 series. Offline analysis is effective for the sound that is difficult to reproduce or changing very quickly. By recording the sound and images, the analysis of those sound can be performed repeatedly. Because there is no data loss, it is surely possible to analyze and visualize the sound source position of an unexpected sound, such as transient or impulsive sound.

- Offline analysis processing: 25 times/sec or more of time resolution
- OS-2000 series (Time-series data analysis software) OS-2720 (FFT analysis package) and OS-0281 (video playback option) are required.
- The addition of the OS-0261 (IIR filter) option is recommended.
The following shows each example of before and after measures by using 4ch Beam Forming Sound Source Visualization System.

1. Operating sound of a multifunctional printer

[Measurement procedure]
- Record the sound from central open area of the multifunctional printer during paper feeding.
- Decide the place to take noise reduction measures referring to the recorded sound data (finding the place from which the sound is occurring).
- Paste shielding tapes and record the sound during paper feeding again.
- Analyze the recorded data by offline analysis software (BF-3100), and compare the result before and after the noise reduction measures (without or with the shielding tape).

[Analysis result]
Color maps and sound pressure levels measured by a Sound Level Meter tell the change of the sound radiated from open area. Compare the sound source position (red area) on color maps Fig.1 and Fig.2. After that the shielding tapes are pasted, there is no red area in Fig.2. The sound pressure level (A-weighting) has been reduced about 10 dB compared to the noise before measures, from 72.2 dB to 62.6 dB.

Fig.1 Before measures (without shielding tapes) A-weighting sound pressure level: 72.2 dB
Fig.2 After measures (with shielding tapes) A-weighting sound pressure level: 62.6 dB

2. Time Sequence Analysis of Vehicle Door Closing Sound

[Analysis result]
When a door is closed, various noises are generated from various positions in a short period.
As shown in the following time series graph, it contains two crests (A, B). Frequency analysis shows each sound pressure becomes large at the 1.6 kHz band. Visualizing the sound by focusing upon this band, you can see that A is the waveform of door-hitting sound from the lower part of the door, and B is the waveform of which contains both the door-hitting sound and reflection sound on the ground.

BF-3100 can visualize and check that several sounds are occurring along with the time series even though it is heard as one sound with human ears.
Time Sequence Analysis of Vehicle Door Closing Sound

A B can see that A is the waveform of door-hitting sound. Visualizing the sound by focusing upon this band, you sound pressure becomes large at the 1.6 kHz band. Two crests (A, B). Frequency analysis shows each from various positions in a short period.

Analyze the recorded data by offline analysis software (BF-3100), and

Analyze the recorded data during paper feeding again.

Sound is occurring (After measures (with shielding tapes))

Record the sound from central open door hitting sound

Composite sound of door-hitting sound and reflection sound on the ground.

Vertical axis:

Operating sound of a multifunctional printer

Sound pressure (Pa) Horizontal axis:

Time (s)

compared to the noise before measures, from 72.2 dB to 62.6 dB.

After that the shielding tapes are pasted, there is no red area in Fig. 2.

Color maps and sound pressure levels measured by a Sound Level Meter tell the change of the sound radiated from open area.

Operating temperature range

0 to 50 °C

Operating humidity range

85 % RH or less (with no condensation)

Storage temperature range

-10 to 60 °C

Storage humidity range

90 % RH or less (with no condensation)

Applicable standard (CE marking)

EMC Directive 2014/30/EU Standard EN61326−1

Power supply

Supplied from DS-3200/3100/2100A

Supplying system

COLD

Voltage

24 VDC

Current

4 mA x4

*1 When a grip is mounted vertically (not including a cable), not including a protruded section.

*2 Not including a cable.

*3 Definition of visualization frequency band

Definition 1: When the distance of sound source and a microphone is 1m at the free sound field, the space resolution until the frequency is damped 6 db from the center of the sound source should be within ±30 cm.

Definition 2: Vertical sound source does not appear in the camera viewing angle. (Analysis which 1/3 octave band center frequency is from 315 Hz to 16 kHz is possible even though it is out of guaranteed range.)

*4 Refer to the specification of the microphone for more details.

*5 Recommended tightening torque: 0.7 Nm

Main body

Camera*6: CMOS USB camera

Number of pixels: VGA (640×480) (fixed)

Focal point distance: 16 mm

Aperture: F 1.2 to 16

Movie file: btm file format (Ono Sokki original format)

Frame rate: 5 fps (at real-time monitoring)

25 fps (at recording)

Camera viewing angle: Horizontal: 42° vertical: 26 ° (TYP value)

Interface: USB 3.0

Power supply: USB bus-power

Microphone*5:

Diameter: 7 mm

Max. sound pressure level: 110 dB (1 kHz, THD<3 %)

Connection of probe head and main body:

Finger screw (slotted knurling screw) * 2

Main body

Outer Dimensions*1:

Width 140.0 (W) x 174.5 (H) x 349.0 (D) mm

64.3 (W) x 174.5 (H) x 311.0 (D) mm

Mass (probe head + main body + grip) * 12:

Approx. 615 g

Approx. 750 g

Operating temperature range:

0 to 50 °C

Operating humidity range:

85 % RH or less (with no condensation)

Storage temperature range:

-10 to 60 °C

Storage humidity range:

90 % RH or less (with no condensation)

Accessory

4ch Beam Forming Microphone

Acoustic Correction File CD

Microphone position checking plate

Carrying case

Sand * 7

BNK cable (0.2 m) * 1

BNK-JPJ adapter

Instruction manual

BF-3100 Beam Forming Software

BF-3100 Beam Forming Software is used for display and recording of rotation speed.

BF-3100 can be used on the 10ch or more of main unit.

BF-3100 Beam Forming Software can use the 10ch or more of main unit. However, the maximum number of channels to record by real-time monitor is 8.

Operating Environment

Conforming analysis device: DS-3200/3100/2100A (Input: 4ch or more, 8ch max.)* 13

Personal Computer

CPU: Intel® Core™ i5 2.70 GHz or more (Intel® Core™ i7 is recommended.)

Memory: 4 GB or more

Required HDD capacity: 16 GB or more of free space

Optical drive: USB optical drive that can reproduce the installation CD.

Display:

Required 1280 × 768 or more

USB port:

USB 3.0 x 1 (Camera* 17), USB 2.0 or more x 1 (license key), USB 3.0 x 1 (DS-3200**17) or USB 2.0 x 1 (DS-0299/0399)**18

Others:

Sound device

Software:

Required installation of OS-2000 series ver 2.9 or higher version.

*17: USB HUB cannot be used.

*18: Communication error may occur with some personal computers if OS-2099/0399 is connected to the USB 3.0 port.
# 4ch BEAM FORMING SYSTEM

## Outer Dimensions

### MI-5420

- **120 mm**
- **60 mm**

### System example

<table>
<thead>
<tr>
<th>Model name</th>
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</tr>
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<tbody>
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- **Product name**
  - **Sound Source Visualization System using MI-6420 3D SI probe**

### Sound Source Visualization System using MI-6420 3D SI probe

BF-3100 4ch Beam Forming software can be used with the MI-6420 3D SI probe. Using MI-6420 has advantages of supporting wide range of sound visualization measurement methods including BF, EI*, and SI*.

*EI: Envelope Intensity  SI: Sound Intensity

### Specification of MI-6420 (60 mm)

- **Distance between microphones**
  - 60 mm (regular tetrahedron)**

- **Analysis frequency range**
  - 1 kHz to 5 kHz

- **Length**
  - 560 mm

- **Mass (excluding a cable)**
  - Approx. 300 g

- **Operating temperature range**
  - 0°C to +40°C

- **Storage temperature range**
  - -10°C to +60°C

- **Connection cable**
  - approx. 5 m

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<td>Signal cable 1.5 m (BNC-BNC) x 4</td>
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<tr>
<td>CF-0610</td>
<td>Microphone amplifier</td>
</tr>
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### Others

- Camera kit (Camera, USB cable (3 m), synchronization cable (5 m))

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