# 4ch BEAM FORMING Sound Source Visualization System

# ονοζοκκι

# Where does this sound come from?

Advanced 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 \*Recommended frequency. Refer to [Specification] in page 11.

### 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 status in the field in real-time (20 times/sec.)

Having good performance of follow-up, you can visualize various sounds including transient sound as well as stationary sound.

### Short-distance object can be measured by a camera with a wider viewing angle

The measurement from close to a target produces less reflection waves and less environmental influences including noise, making it easier to detect the sound and vibration signals. You can grasp sound source position with this system, even in an environment where sound source visualization has been difficult up to now.

# Sound source visualization method: Beam Forming

Beam Forming is one of the sound visualization techniques that obtains the sound pressure distribution from the phase difference information of the sound source to the microphone, and makes it visualized with the color map. This technique provides easy-to-understand results by superimposing on the image of the camera, so you can intuitively grasp the position of the sound source in real time, which is displayed in red for high sound pressure. This technique often requires a lot of microphones to cover a wide area and generally tends to increase the size of the system. By Beam Forming system, Ono Sokki achieved real-time sound source visualization with just 4 microphones.

# 4ch BEAM FORMING SYSTEN Sound Source Visualization

Probe Microphone MI-5420A

	0:00.000
	Center MIC POA 44.18 dB Recording time (s) 30 b Brightness -¢- 10 + 10 + 10 + 10 + 10 + 10 + 10 +
	Unit is dB, but not SPL MAX: 93 Span: 3 MIN=MAX-Span MIN: 96 Auto scale
	1/3octave band (Hz)
We Microphone Mission	

# System example

The measurement system includes DS-3200 series as a measurement unit, MI-5420A as microphones. Two types of microphone array (120 mm/60 mm-interval) are available according to analysis frequency.

BF-3200/0310 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-5420A 4ch Beam Forming System



#### **OS-2000** series

#### Time-series Data Analysis Software OS-2000 series Software

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

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

FFT analysis screen

\*For more information on DS-3200 series, OS-2000 series, and other measuring instruments, please refer to each brochure.

# Anywhere, any sound

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

Easy installation (Example) Vehicle sound while driving









Compact and lightweight microphone array flexibly measures sound in various situations.

### BF-3200 BF monitor

This software performs sound source visualization processing of sound being generated from the measurement object in real-time (more than 20 times/sec.), and displays the results.

Simultaneous recordings of camera image and time data of microphones are also available. You can replay those data and reanalyze with different frequency band on this software. Even when you do not know the frequency band at which abnormal noise is generated, you can easily check and specify it while listening to the sound applied the band pass filter.

### BF-0310 BF Offline analysis

This software which is an option for the BF-3200 plugged in the OS-2000 series Time series data anaylsis software is effecive for further analysis of the recorded sound. You can make more detailed setting for time resolution and frequency resolution to the recorded data than the BF monitor.

Making it coorperated with the OS-2000, you can analyze the result of sound source visualization using tracking analysis and sound quality evaluation as well as FFT analysis.

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

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





BF monitor screen

BF offline analysis screen

# Applications

### Operating sound of desktop printers

Reduction of printer operation sound directly leads to improvement of product value.

For taking countermeasures against noise, grasping the timing and the position where the noise is generated is necessary.

This system can find the source position of sound generated by parts being hit each other by using decomposing with frequency band filter. Even when various sounds are mixed behind during printing, you can easily find the sound source position.



### Detection of operating sound of power seats

As automobiles get quieter, small sounds that have never disturbed have come to be recognized as "noise". The operating sound of electric power seats, which are often used for sound proofed luxury cars, is required to be quiet.

helps to find the sound source position inside of cars for making countermeasures for operating sound reduction.

and lightweight handy type, you can search the sound source from various angles while holding with a hand, even when the sound source position is changing at every moment according to the motion of the power seat.



## Applications

### Noise detection inside air conditioners

Typical examples of air conditioner noise are rattling at the beginning of operation and squeak of the frame. Those noises can be visualized by using the threshold setting function of this system. You can grasp the abnormal sounds being generated irregularly with the data which is obtained only when the noise exceeds a certain level of the sound pressure.

Air conditioners installed indoors are indispensable to our daily lives. As they are used in various environments, sometimes it is required to have very small and quiet operation sounds depending on the situation used. Even very small sound will be emphasized as "noise" in a quiet environment such as a bedroom.



### Noise detection in head-up displays

With the spread of EV and HEV, environment of For the countermeasures, this sound source automobile inside becomes quieter. Along with this, the visualization system is effective. You can record all sounds made by motion of automobile parts are also sounds that pass in an instant, and analyze the recorded data afterward. increasingly required to be guieter.

A head up display, installed often near the driver and may You can visualize the sound changing from moment to bother the driver, is one of the parts that countermeasures moment, and grasp even the position of transient sound against noise such as chatter or squeak may be strictly which is irregularly generated. required.



# 4ch BEAM FORMING SYSTEM

# Applications

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### Noise detection in hydraulic pumps

The following example shows the detection of abnormal rattling sound generated around hydro pressure pump built in large construction equipment outside. To find the reason and position of the sound occurrence, the sound source visualization system is used. This simple system does not take much time for setting,

only a PC, DS-3000 series Data Station, and compact and lightweight microphone probe.

Furthermore, if you cannot spend much time for on-site measurement, you can deeply analyze the recorded data afterward offline with OS-2000 series secondary processing software.

#### Captures the rattling sound generated from a hydraulic pump



#### Visualization of wiper rubbing sound 6

This application shows how to visualize the fricative sound that is generated from operating car wipers. To grasp the position where irregularly the squeaky sound is generated, this sound source visualization system is helpful. You can see the target noise in both a color map and a video. The threshold setting function of this system can visualize sound in color map according to the level. You can check it only when fricative sound is generated.



# Applications

### Noise detection of outdoor units

For an outdoor unit, the operation sound is required to be quiet because sometimes it may be the reason of complaints from neighborhood.

To achieve quieter operation sound, it is necessary to grasp locations of sound source, generated from various components including compressor, and take

#### Detection of the noise generated from a compressor



#### 8 Noise detection in power windows

This is an example of detecting abnormal sound (rubbing noise) hidden in an operating sound of power windows. The sound source visualization system helps to find where on the rail the rubbing sound comes from when the power window is operated, that is required to take countermeasures for noise reduction.



# 4ch BEAM FORMING SYSTEM

countermeasures for noise reduction at each position. This system can visually check where and which amount of sound is generated by the video. Further, you can check the effectiveness of countermeasures by video output of both before and after.

You can capture how the sound source position moves with color map and video. As it also can record the trajectory of moving sound, you can also check where the sound source position is concentrated and the frequency of noise occurrence.

# Applications -Analysis Example-

The following examples show how to take countermeasures for noise reduction by using 4ch Beam Forming Sound Source Visualization system. You can easily see the effect by checking before and after countermeasures in color map.

### Operating sound of a multifunction photocopier



result before and after the noise

(with or without 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 the shielding tapes are affixed, there is no red area in Fig.2.

The sound pressure level (A-weighting) has been reduced about 10 dB from 72.2 dB to 62.6 dB compared to the noise before measures.







# Time Sequence Analysis of Vehicle Door Closing Sound

#### [Analysis result]

eduction measures

When a door is closed, various noises are generated from various positions in a short period.

As shown in the following result of time waveform and frequency analysis, the sound pressure is increased at the timings of A and B, in a frequency band between 1 kHz to 2.5 kHz.

Visualizing the sound by focusing upon this band, it shows that A is the waveform of latching sound, and B is that of door-hitting sound.

Beam Forming system can visualize the sound which is heard as a single sound with human ears, but actually generated from multiple places with time series.



A Door-hitting sound





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



# Specification of 4ch Beam Forming System

MI-5420/	A					
Sound pressu	ure sensitivity	-38 dB ±3 dB (0 dB = 1 V/Pa, 1 kHz)	Composite	Screw hole for grip installation	1/4-20UNC 6 mm (on the bottom surface and the back	surface)
Max. sound p	pressure level	110 dB (1 kHz, THD=3 %)	cable	Screw hole for accessory installation*3	1/4-20UNC 6 mm (on the top surface × 2)	
Self-noise lev	vel	39 dB (A weighting)		Length	Full length approx. 3 m	
Operating ter	mperature range	0 °C to 50 °C		Diameter	Approx. Ø20 mm*4	
Operating hu	midity range	80 % RH or less (with no condensation)		Minimum bending radius	Approx. 70 mm	
Storage temp	perature range	-10 °C to 60 °C		Covering	Resin mesh sleeve*5	
Storage humi	idity range	90 % RH or less (with no condensation)		•		
Weight*1 with 120 mm probe head		Approx. 785 g	Accessory	Microphone Acoustic Corr	orrection File CD 1	
with 60 mm probe head		Approx. 655 g		Microphone position chec	n checking plate 1	
Applicable standard (CE marking)		EMC Directive 2014/30/EU EN61326-1 Class A		Placing platform for camera*6		1
		RoHS Directive 2011/65/EU EN50581		BNC cable (0.2 m)		1
Power source Supplying method		CCLD		BNC-JPJ adapter		1
Voltage 24 VDC		24 VDC		Instruction manual		1
	Current	4 mA/ch		Carrying case		1
Camera*2		CMOS USB camera	*1 When inclu	ding probe head, main body, g	arin (not including cables.)	
		Interface: USB 3.0	*2 Camera·len	ises are not exchangable.	grip (not moldaling babies.)	
		Power source: USB Bus power	*3 Using grips / lighting made by other company may affect on the measurement results.			

#### BF-3200 / BF-0310 Software

BF-3200 BI	F Monitor		BF-0310	<b>BF Offline Analysis (op</b>	otior	ו) <sup>*11</sup>	
Beam	Applicable microphone	MI-5420A/MI-5420/MI-6420	Analysis	Number of color map display divisions	33 ×	25 to 161 × 121	
Forming	Number of color map display divisions	41 × 31 (fixed)	setting	Frame length	40 n	ns (2048 points: fixed)	
Calculation	Visualization frequency	120 mm probe head: 500 Hz to 4 kHz		Window function	Rec	tangular / hanning window / force*13	
	band*7	60 mm probe head: 1 kHz to 8 kHz		Visualization frequency	Ever	ry 1/3 octave band	
	Visualization frequency setting band	315 Hz to 16 kHz (every 1/3 octave band)		setting band	cust	com (specified frequency section)	
	Frame rate*8	20 fps or more		Output function	AVI ,	/ BMP / CSV / OC-1300 series*12	
	Angle of view used for calculation	Horizontal 78° × Vertical 63° (TYP value)					
	Number of pixels used for calculation	1024 × 768	Accessory	Installation manual	1	Instruction on the installation procedure	
	Window function	Rectangular (fixed)		BF-3200 / BF-0310	1	CD for installation of BF-3200/BF-0310	
FFT monitor	Frame length	40 ms (2048 points: fixed)		Installation CD		software and camera driver	
	Display frequency band*9	250 Hz to 20 kHz		DS-3200 Installation CD	1	CD for updating the DS series DSP	
Recording	Sampling frequency	51.2 kHz	*7 Definition	of visualization frequency band	4		
function*10	Recording frequency range	20 kHz (fixed)	· Definitio	n 1 In the free acoustic field, wh	nen th	e distance between the sound source and the	
	A/D conversion	24 bit (fixed)		microphone is 1 m, the spatia	al reso	olution until attenuation by -6 dB from the sound	
Number of input channels		Max. 8ch: for microphone (1 to 4ch) for general purpose (5 to 8ch)	<ul> <li>source center is within the wavelength or within 30 cm.</li> <li>Definition 2 The target scope size can secure 1/3 or more of the camera angle of view.</li> <li>Also available to analyze the center fragmency of 1/3 or taxe band from 315 Hz to 16 kHz ever</li> </ul>				
	Internal trigger	Setting of slope and level Pretrigger up to 2 seconds	when it is out of range of the visualization frequency band. *8 When within the visualization frequency band.				
	External sampling	Used for display and recording of rotation speed	*9 It is differ	ent from the beam forming visua	alizati	ion frequency band.	
	Max. recording time	600 seconds	*10 Depending on the play mode, bfm files recorded in Ver. 1.3 or later can be played.				
	Frame rate for video recording	25 fps	*11 OS - 200	D series Basic or more, and mov	vie op	otions are required.	
	Recording file format	bfm file (Ono Sokki original format)	*12 For output to the OC-1300 series, OC-1300 ver. 3.6 (sold separately) is required.				

Operat	ing Environmer	ht		
Hardware	Main unit	DS-3200*14, *15	CD or DVD-ROM drive	For software installation
	Interface	USB 3.0	Display	Required 1280 × 768 or more
	Signal output	DS-0371 / DS-0372	USB port*16	USB 3.0 × 2 (camera, DS-3200)
	Remote control	DS-0395		USB 2.0 or more × 1 (license key)*17
OS		Microsoft <sup>®</sup> Windows <sup>®</sup> 7 Professional (64 bit)	Software	For using BF-0310, it requires installation of
		Microsoft® Windows® 10 Pro (64 bit)		OS-2000 series ver. 2.10 or higher.
		(.Net Framework 3.5 Service Pack 1 must be installed.)	*14 The BE-3200 is compatible u	up to 8 channels. Up to 8 channels are operated even 10
CPU		Intel® Core™ i7 or more	channels or more of unit.	
Memory		8 GB or more	*15 BF-3200 is not compatible with DS-2000 series and DS-3100.	
Hard disk 16 GB or more of cap		16 GB or more of capacity	*16 USB hub can not be used.	
DirectX DirectX 9.0c or later (when using BF-0310, OS-0281)		*17 BF-3200 starts without license key. BF-0310 requires a license key because it uses the OS-2000 series.		

#### MI-5420A Outer Dimensions



# 4ch BEAM FORMING SYSTEM

\*4 Please make the diameter of the hole for wiring (through hole etc.) 30 mm or more as there is a connector part.
 \*5 Multiple cables are bundled with polyester and nylon.
 \*6 Used when placing the microphone probe.

13 For adjustment of frame length, use force window

# 4ch BEAM FORMING SYSTEM

■ System example (Full system)			
Model name	Product name		
MI-5420A	Sound Source Visualization Probe Microphone*1		
BF-3200	BF Monitor		
BF-0310	BF Offline Analysis		
DS-3204, DS-0371	Data Station (4ch), Signal output (option)		
OS-2720	OS-2000 series (FFT Analysis package)		
OS-0281	OS-2000 series Video playback function (option)*2		
OS-0261	OS-2000 series IIR filter (option)*3		
PC	-		

#### System example (BF monitor only)

Model name	Product name
MI-5420A	Sound Source Visualization Probe Microphone*1
BF-3200	BF Monitor
DS-3204, DS-0371	Data Station (4ch), Signal output (option)
	Personal computer

\*1: Two kinds of microphone probe head (120 mm, 60 mm), camera, dedicated cable for camera and microphone (3 m) are included.

\*2: Video playback software (option) is required

\*3: Required when performing the function equivalent to BPF function of BF monitor by offline analysis.

### Best solution for sound source visualization below 500 Hz MB-2200M10 Ultraminiature Microphone -



Ultraminiature microphone MB-2200M10



By arranging multiple microphones and measuring sound pressure, a sound pressure map of 500 Hz band or less which is not supported by the MI-5420A can be acquired. The MB-2200M10, light and ultra miniature microphone, is effective for such multi-point detection. Very easy to set even when a lot of microphones are necessary to be installed.

For steady sound	Sound pressure maps can be drawn with several microphones. Recording is performed while moving the microphones.
For transient sound	The number of microphones and input channels for all the measuring points are necessary for simultaneous recording.

#### [Application of multi-point simultaneous detection using MB-2200M10]

The left example shows the measurement of sound pressure distribution using 49 pieces of MB-2200 M10. It is very small and light weighted, you can perform multi-point simultaneous measurement without dropping microphones, even if you open and close the door with those sensors attached. You can see the process of sound attenuation just from the moment the door hits the latch.

#### System example

Model name	Product name
DS-3000	Multichannel Data Station (40 kHz 4ch FFT set)
MB-2200M10	Ultraminiature Microphone
OC-1320	Multi-functioned graph creating software (OC-1300 series standard package)
	Personal computer

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\* Outer appearance and specifications are subject to change without prior notice. URL: https://www.onosokki.co.jp/English/english.htm

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