

# INTERNATIONAL STANDARD

Quality evaluation method for the sound field of directional loudspeaker array systems

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**Quality evaluation method for the sound field of directional loudspeaker array systems**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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## QUALITY EVALUATION METHOD FOR THE SOUND FIELD OF DIRECTIONAL LOUDSPEAKER ARRAY SYSTEMS

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The text of this standard is based on the following documents:

|               |                  |
|---------------|------------------|
| FDIS          | Report on voting |
| 100/2603/FDIS | 100/2637/RVD     |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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## INTRODUCTION

Directional loudspeaker array systems provide focused sound for a person to listen alone without disturbing others. This system is convenient for consumers who want to listen to sound without earphones or headphones.

This system would be widely used in consumer electronics, for example, smart phone or pad, TV, computer, navigator, and game machine. The applicable area for the system could be fitness club, exhibition room, museum, shopping mall, and etc. A simple and easy concept is needed to evaluate the performance of the directional loudspeaker array system for a consumer. It will provide consumers with personalized audio space criteria in order to compare the audio sound field quality between various electronic products that have a directional loudspeaker array system. It is important to specify the quality evaluation method for the personal audio space and the concept of personal audio space.

This standard provides guidelines for general test methods to evaluate the quality of directional loudspeaker array systems.

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# QUALITY EVALUATION METHOD FOR THE SOUND FIELD OF DIRECTIONAL LOUSPEAKER ARRAY SYSTEMS

## 1 Scope

This International Standard applies to directional loudspeaker array systems of any kind, and to the parts of which they are composed or which are used as auxiliaries in such systems.

This standard deals with the determination of the performance of directional loudspeaker array systems, the comparison of these system types, and the determination of their proper practical application, by listing the characteristics which are useful for their specification. It specifies uniform measurement methods for these characteristics.

This standard is restricted to a description of the audio space around a person and the relevant method of measurement. It does not consider characteristics of loudspeakers, which are specified in IEC 60268-5.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60268-1, *Sound system equipment – Part 1: General*

IEC 60268-2, *Sound system equipment – Part 2: Explanation of general terms and calculation methods*

IEC 60268-5, *Sound system equipment – Part 5: Loudspeakers*

IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 3.1

#### **personal acoustic zone**

#### **PAZ**

acoustic space occupied by a person

### 3.2

#### **personal distance**

distance between listeners and a directional loudspeaker array system

### 3.3

#### **sound pressure level at a personal acoustic zone**

$P_{ij}$

sound pressure level measured at the center of the surface  $j$  of the personal acoustic zone  $i$

**3.4****average sound pressure level at a personal acoustic zone** $P_i$ 

mean value of the sound pressure levels measured at the centers of the surfaces of the personal acoustic zone  $i$

**3.5****personal acoustic zone index****PAZI**

ratio of the average sound pressure level of the personal acoustic zone for a listener, to the total average sound pressure levels for listeners around the directional loudspeaker array system located at a specified personal distance

**3.6****personal acoustic zone index-x****PAZI-x**

ratio of the average sound pressure level of the personal acoustic zone of a listener in front of the directional loudspeaker array system to the sum of the average sound pressure levels of listeners at the front, the front-right, and the front-left of the system

**3.7****personal acoustic zone index-y****PAZI-y**

ratio of the average sound pressure level of the personal acoustic zone of a listener located in front of the directional loudspeaker array system to the sum of the average sound pressure levels of listeners at the front and the rear of the system

**3.8****personal acoustic zone index-xy****PAZI-xy**

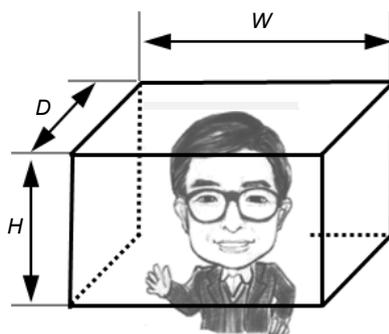
ratio of the average sound pressure level of the personal acoustic zone of a listener located in front of the directional loudspeaker array system to the sum of the average sound pressure levels of listeners at the front, the front-right, the front-left and the rear of the system

**3.9****personal acoustic zone index-xyz****PAZI-xyz**

ratio of the average sound pressure level of the personal acoustic zone of a listener located in front of the directional loudspeaker array system to the sum of the average sound pressure levels of persons at the front, the front-right, the front-left, and the rear, and the front-upper, and the front-lower of the system

**4 Personal acoustic zone and sound pressure level****4.1 Personal acoustic zone**

The personal acoustic zone (PAZ) is defined as an acoustic space occupied by a person as shown in Figure 1. The dimensions of the personal acoustic zone are defined as  $W$  (width),  $D$  (depth), and  $H$  (height). Considering the standard size of a person, the dimensions of the personal acoustic zone shall be stated.

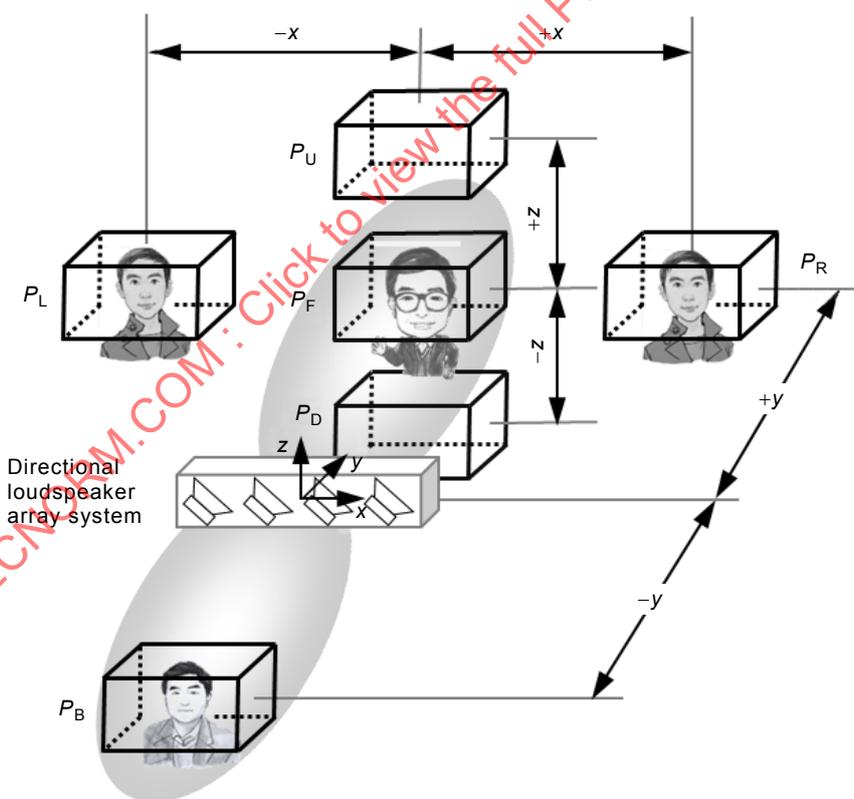


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Figure 1 – Personal acoustic zone

**4.2 Personal distance between listeners**

The personal distance between separate listeners,  $x$  and  $z$ , shall be defined as the distance between the centres of their personal acoustic zones, see Figure 2. Considering the standard size of a person, the dimension of the personal distance between listeners shall be stated.



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Figure 2 – Personal acoustic zone and sound pressure level

**4.3 Personal distance between a directional loudspeaker array system and a listener**

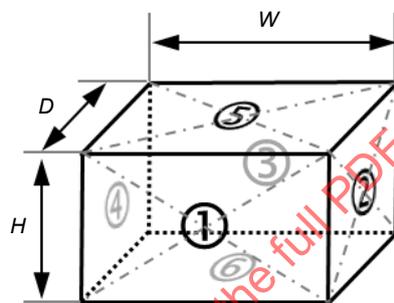
The personal distance between a directional loudspeaker array system and a listener,  $y$ , shall be defined as a distance from the centre of the directional loudspeaker array system to the

listener in front of the system, as shown in Figure 2. The personal distance shall be specified by the target application area of the directional loudspeaker array system.

#### 4.4 Average sound pressure level at a personal acoustic zone

The sound pressure level,  $P_{ij}$ , shall be defined as the sound pressure level measured at the center of the surface  $j$  of the personal acoustic zone  $i$ . The average sound pressure level of the personal acoustic zone,  $P_i$ , shall be the mean value of the sound pressure levels measured at the center of the surfaces of the personal acoustic zone, as shown in Figure 3.

$$P_i = \frac{\sum_{j=1}^6 P_{ij}}{6}$$



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Figure 3 – Measuring points of the personal acoustic zone

The average sound pressure level of the personal acoustic zone,  $P_i$ , at the position of listener, as shown in Figure 2, is defined as follows:

- $P_F$  is the average sound pressure level of the personal acoustic zone in front of the directional loudspeaker array system;
- $P_L$  is the average sound pressure level of the personal acoustic zone at the front-left of the directional loudspeaker array system;
- $P_R$  is the average sound pressure level of the personal acoustic zone at the front-right of the directional loudspeaker array system;
- $P_B$  is the average sound pressure level of the personal acoustic zone at the rear of the directional loudspeaker array system;
- $P_U$  is the average sound pressure level of the personal acoustic zone at the front-upper of the directional loudspeaker array system;
- $P_D$  is the average sound pressure level of the personal acoustic zone at the front-lower of the directional loudspeaker array system.

## 5 Personal acoustic zone index

### 5.1 General

The personal acoustic zone index provides the ratio of the average sound pressure level of the personal acoustic zone of one listener, to the average sound pressure level of another listener at a specified personal distance.

## 5.2 PAZI-x

*PAZI-x* is defined as the ratio of the average sound pressure level of the personal acoustic zone of a listener in front of the directional loudspeaker array system to the sum of the average sound pressure levels of listeners at the front, the front-right, and the front-left of the system. This index means a relative ratio of the average sound pressure level of the listener in front of the directional loudspeaker array system to those of the persons who are at the left side and right side of the listener.

$$PAZI-x = P_F / (P_F + P_R + P_L)$$

## 5.3 PAZI-y

*PAZI-y* is the ratio of the average sound pressure level of the personal acoustic zone of a listener located in front of the directional loudspeaker array system to the sum of the average sound pressure levels of listeners at the front and the rear of the system. This index means a relative ratio of the average sound pressure level of a listener in front of the directional loudspeaker array system to that of the person who is at the rear side of the system.

$$PAZI-y = P_F / (P_F + P_B)$$

## 5.4 PAZI-xy

*PAZI-xy* is the ratio of the average sound pressure level of the personal acoustic zone of a listener located in front of the directional loudspeaker array system to the sum of the average sound pressure levels of listeners at the front, the front-right, the front-left and the rear of the system. This index means a relative ratio of the average sound pressure level of a listener located in front of the directional loudspeaker array system to the sum of those of the persons who are neighboring the listener in a 2-dimensional plane, as shown in Figure 2.

$$PAZI-xy = P_F / (P_F + P_R + P_L + P_B)$$

## 5.5 PAZI-xyz

*PAZI-xyz* is the ratio of the average sound pressure level of the personal acoustic zone of a listener located in front of the directional loudspeaker array system to the sum of the average sound pressure levels of persons at the front, the front-right, the front-left, and the rear, and the front-upper, and the front-lower sides of the system. This index means a relative ratio of the average sound pressure level of a listener located in front of the directional loudspeaker array system to the sum of the average sound pressure levels of the persons who are neighboring the listener in 3-dimensional space.

$$PAZI-xyz = P_F / (P_F + P_R + P_L + P_B + P_U + P_D)$$

## 6 Measurement of the sound pressure level for a personal acoustic zone

### 6.1 General

This standard shall be used in conjunction with IEC 60268-1, IEC 60268-2, IEC 60268-5 and IEC 61672-1.

### 6.2 Characteristics to be specified

The sound pressure level shall be specified as a function of frequency measured under free field condition at a specified constant voltage with sinusoidal signal.

### **6.3 Method of measurement**

#### **6.3.1 Directional loudspeaker array system**

The directional loudspeaker array system shall be brought under normal measuring conditions.

#### **6.3.2 Microphone**

The measuring microphone shall be positioned in the position specified in 4.4.

#### **6.3.3 Test signals**

##### **6.3.3.1 General**

Acoustical measurements shall be made under the following measuring signal condition, and be indicated with the results.

##### **6.3.3.2 Sinusoidal signal**

The sinusoidal test signal shall not exceed the rated voltage at any frequency. The voltage across the input terminals of the directional loudspeaker array system under test shall be kept constant for all frequencies unless otherwise stated.

#### **6.3.4 Sound pressure level curves**

##### **6.3.4.1 General**

One or both of the following ways may be chosen for displaying the sound pressure level curves. A family of frequency responses to be used shall be selected for some frequencies or frequency bands according to the application.

##### **6.3.4.2 Curves at stated frequencies**

A family of sound pressure level curves at stated frequencies shall be displayed.

##### **6.3.4.3 Curves at stated frequency bands**

A family of sound pressure level curves at stated frequency bands shall be displayed.

### **6.4 Test environment condition**

#### **6.4.1 Temperature**

The temperature of the test room shall be a standard room temperature ( $23\text{ °C} \pm 5\text{ K}$ ).

#### **6.4.2 Humidity**

The humidity in the test room shall be a relative humidity (RH) of 30 % ~ 60 %.

## **7 Indication of the characteristics to be specified**

Data that shall be given by the manufacturer are indicated in Table 1 by an "X". Data that the manufacturer should give are indicated by the letter "R" (recommended).

A = data that shall be specified at stated frequencies;

B = data that shall be specified at a stated frequency range.

This table shall be specified in a document available to buyers before purchase of the directional loudspeaker array system.

**Table 1 – Characteristics to be specified**

| Clauses and subclauses |   | System |   |
|------------------------|---|--------|---|
|                        |   | A      | B |
| 4                      | Personal acoustic zone and sound pressure level                                 |        |   |
| 4.1                    | Personal acoustic zone  | R      | X |
| 4.2                    | Personal distance between listeners   | R      | X |
| 4.3                    | Personal distance between a directional loudspeaker array system and a listener | R      | X |
| 4.4                    | Average sound pressure level of the personal acoustic zone                      | X      | X |
| 5                      | Personal acoustic zone index  |        |   |
| 5.2                    | PAZI-x  | R      | X |
| 5.3                    | PAZI-y  | R      | X |
| 5.4                    | PAZI-xy   | R      | X |
| 5.5                    | PAZI-xyz  | R      | X |
| 6                      | Measurement of the sound pressure level for a personal acoustic zone            |        |   |
| 6.4                    | Test environment condition  |        |   |
| 6.4.1                  | Temperature   | R      | X |
| 6.4.2                  | Humidity  | R      | X |

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