ENGLISH TRANSLATION

THREE-DIMENSIONAL MULTICHANNEL STEREOPHONIC SOUND SYSTEM FOR PROGRAMME PRODUCTION

ARIB STANDARD

ARIB STD-B59 Version 2.0

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Association of Radio Industries and Businesses

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Foreword

The Association of Radio Industries and Businesses (ARIB) investigates and summarizes the basic technical requirements for various radio systems in the form of "ARIB Standards". These standards are developed with the participation of and through discussions amongst radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

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This ARIB Standard is developed for the three-dimensional multichannel stereophonic sound system, beyond the 5.1 channel stereophonic sound system, for the programme production in production studios. In order to ensure fairness and transparency in the defining stage, the standard was set by consensus at the ARIB Standard Assembly with the participation of both domestic and foreign interested parties from radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

ARIB sincerely hopes that this ARIB Standard will be widely used by radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and users.

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Although this ARIB Standard contains no specific reference to any essential Industrial Property Rights relating thereto, the holders of such Essential Industrial Property Rights state to the effect that the rights listed in the Attachment 1 and 2, which are the Industrial Property Rights relating to this standard, are held by the parties also listed therein, and that to the users of this standard, in the case of Attachment 1, such holders shall not assert any rights and shall unconditionally grant a license to practice such Industrial Property Rights contained therein,

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Attachment 1 (selection of option 1)

(None)

Attachment 2 (selection of option 2)

PATENT HOLDER	NAME OF PATENT	REGISTRATION NO./ APPLICATION NO.	REMARKS
Sony Corporation	Comprehensive confirmation of ARIB STD-B59 version 1.0 is submitted. (*)		

(*) Effective to ARIB STD-B59 version 1.0 (Received on March 11, 2014)

Contents

Chapter 1: General Terms

1.1 Objective

This standard defines fundamental parameters, audio signals and so on of a three-dimensional multichannel stereophonic sound system, which is beyond the 5.1 channel stereophonic sound system, used in production studios. This standard intends to ensure smooth programme productions and programme exchanges of the three-dimensional multichannel stereophonic sound.

1.2 Scope

This standard applies to the three-dimensional multichannel stereophonic sound system beyond the 5.1 channel stereophonic sound system, and the audio equipment used for Ultra High Definition Television programme productions in production studios.

1.3 References

1.3.1 Normative references

(1) Recommendation ITU-R BS. 2051 Advanced sound system for programme production

(2) SMPTE ST 2036-2:2008 Ultra High Definition Television1 — Audio Characteristics and Audio Channel Mapping for Program Production

(3) SMPTE RP 155:2004 Reference Level for Digital Audio Systems

(4) EBU Technical Recommendation R68-2000 Alignment level in digital audio production equipment and in digital audio recorders

(5) ARIB STD-B32, "Video Coding, Audio Coding and Multiplexing Specifications for Digital Broadcasting"

(6) JIS C 1509-1:2005 Electroacoustics−Sound level meters

(7) JIS C 5532:2014 Loudspeakers for sound system equipment

1.3.2 Informative references

(1) Recommendation ITU-R BS.645 Test signals and metering to be used on international sound programme connections

(2) Recommendation ITU-R BS.775 Multichannel stereophonic sound system with and without accompanying picture

(3) Recommendation ITU-R BS.1116 Methods for the subjective assessment of small impairments in audio systems

(4) International Standard IEC 62574:2011 Audio, video and multimedia systems – General channel assignment of multi-channel audio

(5) International Standard IEC 61672-1:2013 Electroacoustics – Sound level meters

(6) International Standard IEC 60268-5:2003 Sound system equipment – Part 5: Loudspeakers

(7) ARIB TR-B30, "The Technology Guideline of Production for Surround Broadcast Program"

1.4 Definition of Terms

1.4.1 Sound systems, loudspeaker layouts and audio channels

Term	Definition
5.1 channel stereophonic sound system	Sound system with six audio channels. The sound system is denoted as multichannel stereo 3/2.1 in the audio modes specified in ARIB STD-B32. It is also called as 5.1ch surround sound.
7.1 multichannel sound system	Sound system with eight audio channels. The sound system is denoted as multichannel stereo 2/0/0-3/0/2-0/0/0.1 in the audio modes specified in ARIB STD-B32.
22.2 multichannel sound system	Sound system with 24 audio channels. The sound system is denoted as multichannel stereo 3/3/3-5/2/3-3/0/0.2 in the audio modes specified in ARIB STD-B32. It is also called as 22.2ch sound.

Middle layer	Middle layer of vertical three-layered loudspeaker arrangement for the three-dimensional multichannel stereophonic sound system, which is located at a height approximately equal to that of the listener's ears.
Top layer	Top layer of vertical three-layered loudspeaker arrangement for the three-dimensional multichannel stereophonic sound system, which is located at a higher position above the listener (ceiling level).
Bottom layer	Bottom layer of vertical three-layered loudspeaker arrangement for the three-dimensional multichannel stereophonic sound system, which is located at a lower position below the listener (floor level).
Main channel	Audio channel except LFE channel(s), included on Top, Middle and Bottom layers.
LFE channel	Band-limited low-frequency audio channel for Low Frequency Effects.

The following acronyms are used in this standard.

FL	Front left channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-left front on Middle layer.
FR	Front right channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-right front on Middle layer.
FC	Front centre channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the centre front (straight ahead) on Middle layer.
LFE1	LFE channel of the 22.2 multichannel sound system, which is reproduced from a specific low frequency loudspeaker located at the far-left front on Bottom layer.
BL	Back left channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-left back on Middle layer.
BR	Back right channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-right back on Middle layer.
FLc	Front left centre channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the mid-way between the front centre and the front left on Middle layer.
FRc	Front right centre channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the mid-way between the front centre and the front right on Middle layer.

BC	Back centre channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the centre back (straight behind) on Middle layer.
LFE2	LFE channel of the 22.2 multichannel sound system, which is reproduced from a specific low frequency loudspeaker located at the far-right front on Bottom layer.
SiL	Side left channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the left side on Middle layer.
SiR	Side right channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the right side on Middle layer.
TpFL	Top front left channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-left front on Top layer.
TpFR	Top front right channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-right front on Top layer.
TpFC	Top front centre channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the centre front (straight ahead) on Top layer.
TpC	Top centre channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the centre on Top layer just above the seating position.
TpBL	Top back left channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-left back on Top layer.
TpBR	Top back right channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-right back on Top layer.
TpSiL	Top side left channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the left side on Top layer.
TpSiR	Top side right channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the right side on Top layer.
TpBC	Top back centre channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the centre back (straight behind) on Top layer.
BtFC	Bottom front centre channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the centre front (straight ahead) on Bottom layer
BtFL	Bottom front left channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-left front on Bottom layer.
BtFR	Bottom front right channel of the 22.2 multichannel sound system, which is reproduced from a loudspeaker located at the far-right front on Bottom layer
L	Left channel of the 2 channel stereo system, the 5.1 channel stereophonic sound system, or the 7.1 multichannel sound system, which is reproduced from a loudspeaker located at the left front on Middle layer.
R	Right channel of the 2 channel stereo system, the 5.1 channel stereophonic sound system, or the 7.1 multichannel sound system, which is reproduced from a loudspeaker located at the right front on Middle layer.
C	Centre channel of the 5.1 channel stereophonic sound system, or the 7.1

	multichannel sound system, which is reproduced from a loudspeaker located at the centre front (straight ahead) on Middle layer.
LFE	LFE channel of the 5.1 channel stereophonic sound system, or the 7.1 multichannel sound system, which is reproduced from a specific low frequency loudspeaker.
Ls*1	Left surround channel of the 5.1 channel stereophonic sound system, or the 7.1 multichannel sound system, which is reproduced from a loudspeaker located at the left back on Middle layer.
Rs*1	Right surround channel of the 5.1 channel stereophonic sound system, or the 7.1 multichannel sound system, which is reproduced from a loudspeaker located at the right back on Middle layer.
Ltf	Left top front channel of the 7.1 multichannel sound system, which is reproduced from a loudspeaker located at the left front on Top layer.
Rtf	Right top front channel of the 7.1 multichannel sound system, which is reproduced from a loudspeaker located at the right front on Top layer.

*1 Capital letters LS and RS are used in Recommendation ITU-R BS.775 and ARIB TR-B30, however, Ls and Rs are employed in this standard according to notations of Recommendation ITU-R BS. 2051.

1.4.2 Glossary of Terms

Reference full-scale value	Reference level value of digital audio signal. The reference level value (0 dBFS) of signal corresponds to the maximum amplitude value of digital audio signal representation.
dBFS	Unit symbol for a level representation of digital audio signal. When the reference full-scale level is 0 dBFS, the signal level dBFS is obtained from the following equation: Signal level (dBFS) = $20\log_{10}(A/B)$ A; Amplitude value of digital signal whose level to be determined, B; Reference full-scale value of digital audio signal.
dBFSrms	Unit symbol for a level representation of digital audio signal, whose level is represented by root mean square (r.m.s.) value. The r.m.s. value of 1 kHz square wave with the maximum amplitude value is 0 dBFSrms. The r.m.s. value of 1 kHz sine wave with the maximum amplitude value is −3 dBFSrms. The r.m.s. value of 1 kHz sine wave with the reference level of –18 dBFS or –20 dBFS is −21 dBFSrms or −23 dBFSrms, respectively.
dBC	Widely used unit symbol for a sound level, weighted with the weighting filter curve C, which is specified by JIS C 1509-1 (equivalent with IEC 61672-1).
Band level	Sound level of a frequency band measured through a band-pass filter in an octave or 1/3 octave band frequency analyzer. The measured band levels by a 1/3 octave band frequency analyzer are not even. An average of sound level within each frequency band is defined as “band level”. A calibration of reproduction level is carried out using the band level.
1/3 octave band	One octave is the interval between one musical pitch “note A” and next “note A” with half or double its frequency. An octave band is a frequency range between the lower and upper frequency limit of the octave. A centre frequency of the

	octave band is an octave band centre frequency. A 1/3 octave band is a frequency range equal to one third of an octave.
Pink noise	Broadband noise signal used for a level alignment. The energies of the signal within octave bands are equal.
Sound level meter	Level meter specified as JIS C 1509-1, these specifications are identical to that of International Standard IEC 61672. It is united to the “sound level meter”, which is used world-widely, followed by a suppression of JIS C 1502/1505 (Sound level meters) along 2005-year JIS revisions. The meter has frequency-weighting modes of A-, C-, and Z-frequency-weighting and time-weighting modes of Fast- (0.125 s), Slow- (1 s), and Impulse- (35ms/ 1.5 s) time-weighting. Some meters can measure time averaged sound levels. The Slow-time-weighting mode is used for measurements of sound levels as usual. The sound meter has two performance levels, Class 1 and 2. Guaranteed frequency ranges of Class 1 and 2 are 16 Hz -16 kHz and 20 Hz- 8 kHz, respectively. For a calibration of reference reproduction level, the C-frequency-weighting and Slow-time-weighting modes should be selected. As the sound level meter indicates an integrated value of full-bandwidth, the meter indicates lesser values if band-limited signals such as LFE channels are measured. Even if pink noise signals with an identical level are reproduced, the measured values of large and compact loudspeakers may be different by the above-mentioned reason. A sound calibrator specified by JIS should be used to calibrate a sound level meter. If a sound level meter meets the type certification and inspection of sound level meter regulated by Measurement Act, the meter is qualified to represent as the “sound level meter”.

Chapter 2: Three-dimensional multichannel stereophonic sound system

2.1 Loudspeaker arrangement

Recommendation ITU-R BS.2051 specifies reference loudspeaker layouts (Note 1) for an advanced sound system (a three-dimensional multichannel stereophonic sound system), beyond the 5.1 channel stereophonic sound system specified in Recommendation ITU-R BS.775. Reference loudspeaker layouts used in digital broadcasting in Japan for the three-dimensional multichannel stereophonic sound system are specified as follows.

(Note 1) Loudspeaker positions of the sound system are defined by a spherical arrangement. Arrival times and levels of sounds from each loudspeaker are identical at a centre of sphere, if loudspeakers are located on the sphere surface. Therefore, a reference adjustment position is defined as the centre of the spherical loudspeaker arrangement. A reference listening position is defined as the reference adjustment position located at the centre between both ears of a sound mixing engineer and where the engineer directs to the centre front (straight ahead) loudspeaker which is located at the azimuth of 0 degree in the spherical loudspeaker arrangement. For other loudspeaker arrangements such as a rectangular solid or a cylindrical arrangement used in production studios, it may be necessary to introduce compensation of sound levels and time delays corresponding to the differences of distance between the reference adjustment position and loudspeakers. If compensations of sound levels and time delays are implemented, the differences of physical distances are canceled, so there is no need to compensate sound levels and time delays even when post-processing such as down-mix is carried out. Examples of time delay compensations for the rectangular solid or cylindrical arrangement in production studios should be referred to Appendix 1. Calibrations of reproduction levels should be referred to Section 2.3.

2.1.1 Vertical three-layered loudspeaker layout

Fig. 2-1 illustrates a vertical three-layered loudspeaker layout for the three-dimensional multichannel stereophonic sound system. The sound system has three vertical layers, which are termed Middle layer, Top layer, and Bottom layer. Middle layer (Note 3) is located at a height approximately equal to that of the listener's ears (Note 2). Top layer is located at a higher position above the listener (ceiling level). Bottom layer is located at a lower position below the listener (floor level).

(Note 2) The normal height of listener's ear from a floor level is assumed to be 120 cm in Recommendation ITU-R BS.775.

(Note 3) Sometimes loudspeakers on Middle layer are located at the vertical centre of the television screen.

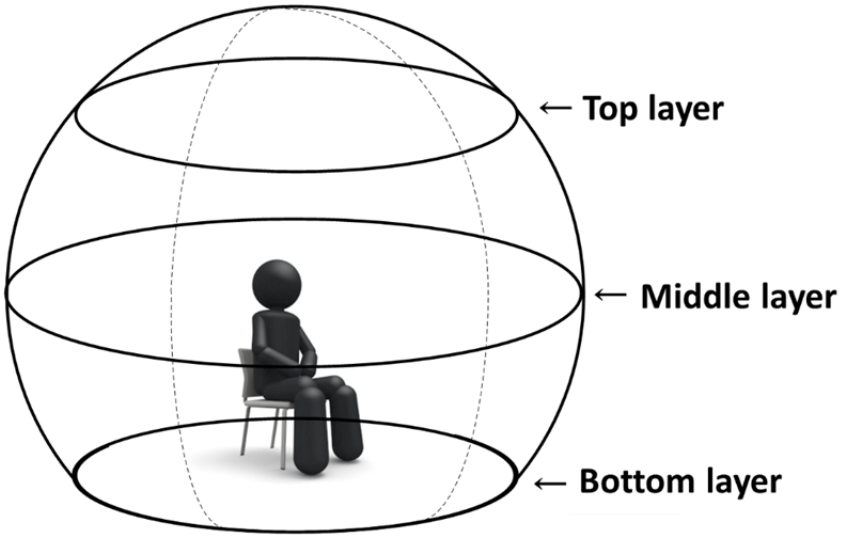


Fig. 2-1 Vertical three-layered loudspeaker layout

The loudspeaker arrangements consisting of each layer are illustrated in Fig. 2-2, Fig. 2-3 and Fig. 2-4. Middle layer is shown in Fig. 2-2. Top layer is shown in Fig. 2-3, and Bottom layer is shown in Fig. 2-4. Labels of loudspeakers for main channels are denoted as the combination of acronym of each layer (Middle layer: M, Top layer: U / UH / T, and Bottom layer: B) and azimuth angle of loudspeaker position (straight ahead 0 degree: +000, left side 60 degree: +060, right side 110 degree: -110, and so on) (Note 4). Labels of loudspeakers for LFE channels are denoted as LFE1, LFE2 by the number of loudspeakers for LFE channels. A loudspeaker located at the far-left front is denoted as LFE1, if two loudspeakers for LFE channels are arranged.

(Note 4) Loudspeaker labels M+SC and M-SC are loudspeakers located at both sides of the television screen. Loudspeaker label T of Top layer indicates a loudspeaker at just above the seating area (elevation angle of 90-degree), and UH of Top layer indicates a loudspeaker located at the upper position than U of Top layer (elevation angle of 45-degree).

It is expected that each loudspeaker is arranged so that the directivity axis directs to the reference adjustment position (Note 5). Even for Top and Bottom layers, loudspeakers (except sub-woofer loudspeakers for LFE channels) should also be arranged so that the directivity axis directs to the reference adjustment position. This implementation should be applied for a rectangular solid or a cylindrical arrangement.

(Note 5) It is no need that the directivity axis directs to the reference adjustment position, if the directivity axis directed to the reference adjustment position influences on the frequency response, for instance, in the case that a sound-transparent screen is used, and so on.

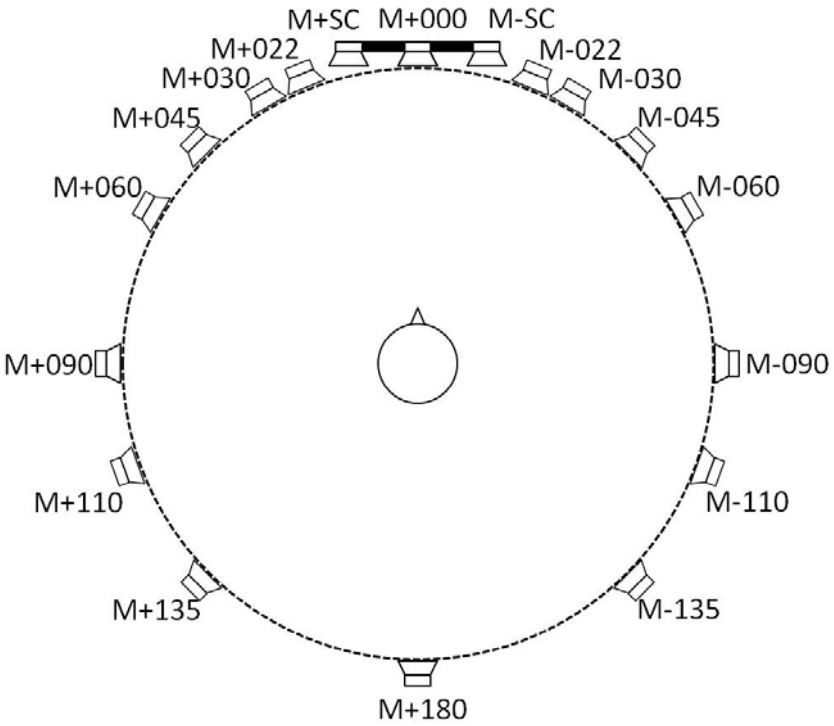


Fig. 2-2 Loudspeaker arrangement of Middle layer

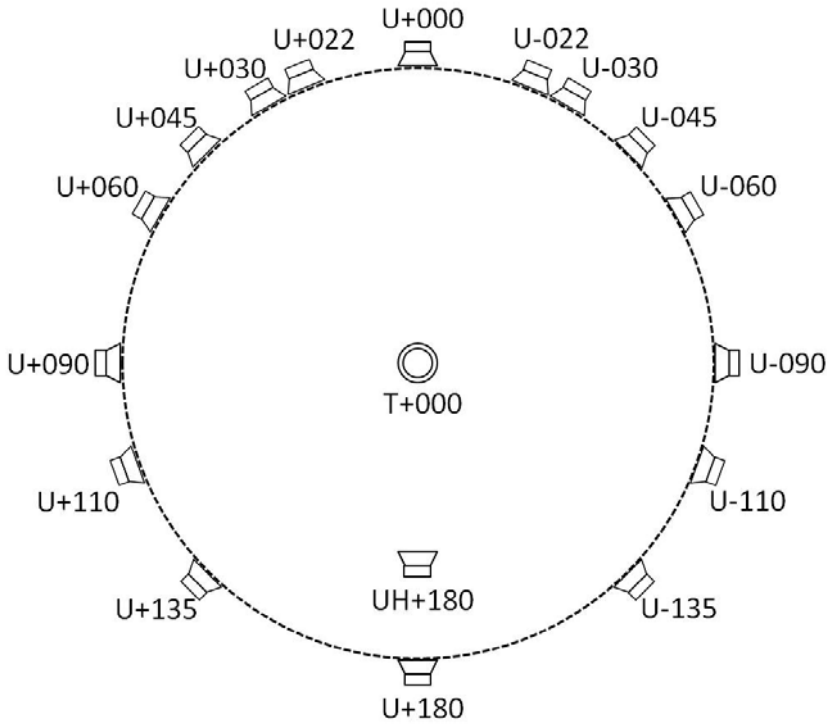


Fig. 2-3 Loudspeaker arrangement of Top layer

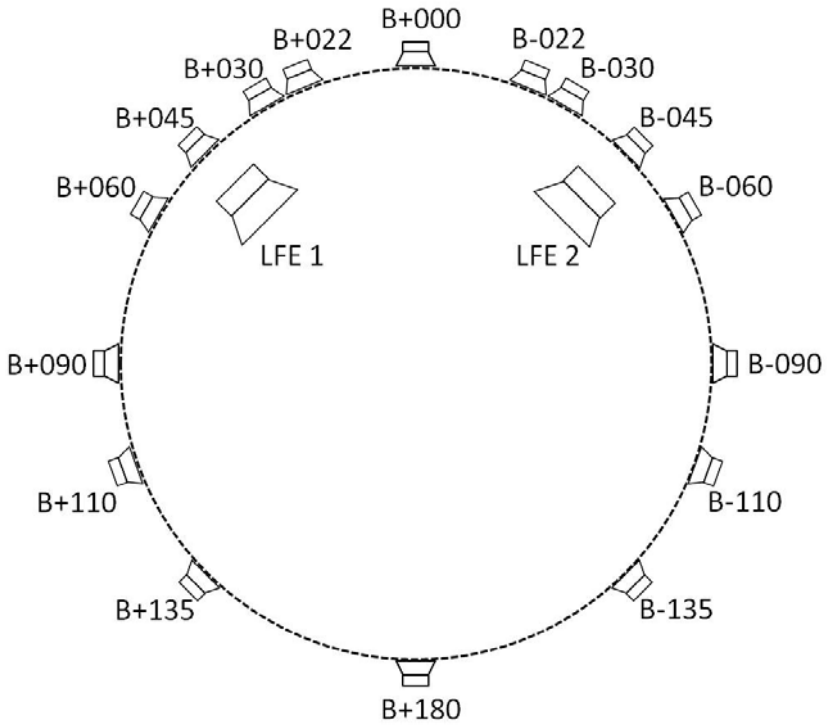


Fig. 2-4 Loudspeaker arrangement of Bottom layer

2.1.2 Reference loudspeaker arrangement for 22.2 multichannel sound system

Reference loudspeaker arrangement for the 22.2 multichannel sound system is shown in Fig. 2-5, Fig. 2-6, Fig. 2-7, and Fig. 2-8. Middle layer is shown in Fig. 2-5. Top layer is shown in Fig. 2-6, and Bottom layer is shown in Fig. 2-7. The vertical three-layered loudspeaker layout of the system is shown in Fig. 2-8.

The reference loudspeaker arrangement of Middle layer is as follows:

- the front centre loudspeaker M+000 is placed at the front of the reference listening position, i.e. at an azimuth angle of 0°; the front left loudspeaker M+060 and front right loudspeaker M-060 are placed bisymmetrically at the extremities of an arc subtending an azimuth angle of 45° - 60° at the reference listening position (α_1); the front left centre loudspeaker M+030 and front right centre loudspeaker M-030 are placed bisymmetrically at the extremities of an arc subtending an azimuth angle of 22.5° - 30° at the reference listening position (α_2). The azimuth angle α_2 is normally a half of α_1;
- the side left loudspeaker M+090 and side right loudspeaker M-090 are placed bisymmetrically at the side of the reference listening position, that is the extremities of an arc subtending an azimuth angle of 90° at the reference listening position;
- the back centre loudspeaker M+180 is placed at the back of the reference listening position, at an azimuth angle of 180°; the back left loudspeaker M+135 and back right loudspeaker M-135 are placed bisymmetrically at the extremities of an arc subtending an azimuth angle of 110° - 135° at the reference listening position (α_3).

Loudspeakers of Top layer are placed at the same distance as those of Middle layer from the reference listening position. The reference loudspeaker arrangement of Top layer is as follows:

- the top front centre loudspeaker U+000 is placed at the upper front of the reference

listening position, i.e. at an azimuth angle of 0°; the top front left loudspeaker U+045 and top front right loudspeaker U-045 are placed bisymmetrically at the extremities of an arc subtending an azimuth angle of 45° - 60° at the reference listening position (α_4);

– the top side left loudspeaker U+090 and top side right loudspeaker U-090 are placed bisymmetrically at the upper side of the reference listening position, that is the extremities of an arc subtending an azimuth angle of 90° at the reference listening position;

– the top centre loudspeaker T+000 is placed at the upper centre of the reference listening position;

– the top back centre loudspeaker U+180 is placed at the upper back of the reference listening position, i.e. at an azimuth angle of 180°; the top back left loudspeaker U+135 and top back right loudspeaker U+135 are placed bisymmetrically at the extremities of an arc subtending an azimuth angle of 110° - 135° at the reference listening position (α_5).

Loudspeakers of Bottom layer are placed at the same distance as those of Middle layer from the reference listening position. The reference loudspeaker arrangement of Bottom layer is as follows:

– the bottom front centre loudspeaker B+000 is placed at the lower front of the reference listening position, i.e. at an azimuth angle of 0°; the bottom front left loudspeaker B+045 and bottom front right loudspeaker B-045 are placed bisymmetrically at the extremities of an arc subtending an azimuth angle of 45° - 60° at the reference listening position (α_6);

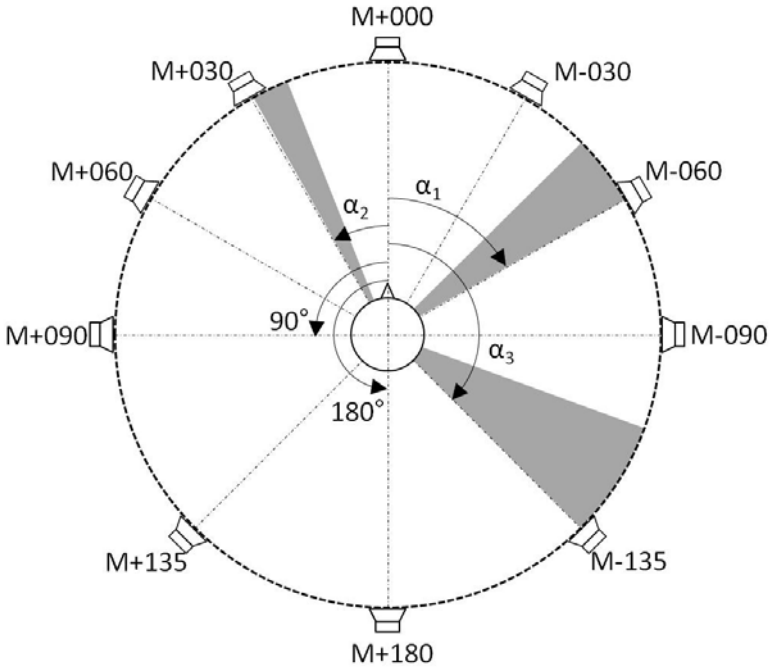
– the sub-woofer loudspeakers for LFE1 and LFE2 channels are placed bisymmetrically at the extremities of the lower front of an arc subtending an azimuth angle of 30°-90° at the reference listening position (α_7).

Regarding the elevation angles of Middle layer, Top layer, and Bottom layer at the reference listening position, the reference arrangement is as follows:

– the front loudspeakers of Middle layer M+000, M+030, M-030, M+060, and M-060 are placed at the extremities of an arc subtending an identical elevation angle of 0° - 5° at the reference listening position (β_1); the side and back loudspeakers M+090, M-090, M+135, M-135, and M+180 are placed at the extremities of an arc subtending an identical elevation angle of 0° - 15° at the reference listening position (β_2).

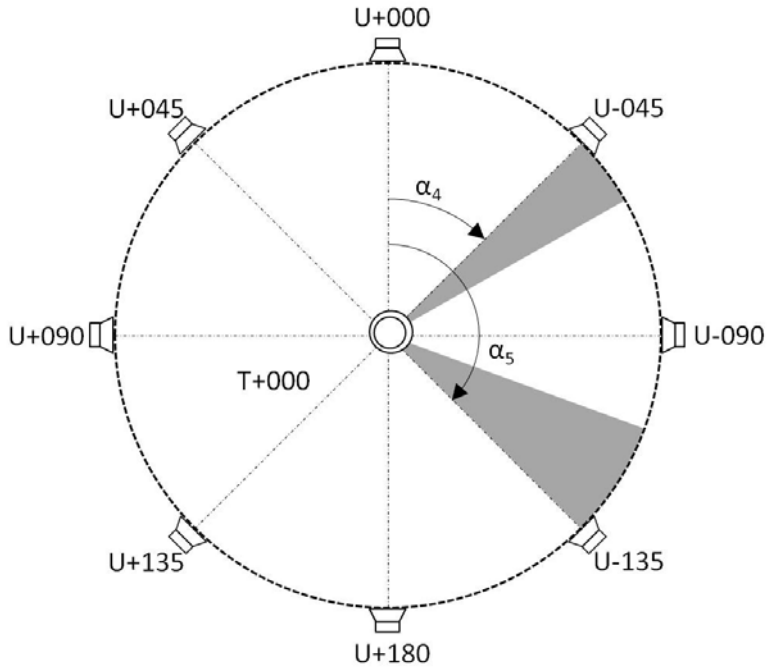
– the loudspeakers of Top layer except the loudspeaker T+000 are placed at the extremities of an arc subtending an identical elevation angle of 30° - 45° at the reference listening position (β_3); the loudspeaker T+000 are placed at the extremities of an arc subtending an elevation angle of 90° at the reference listening position.

– the loudspeakers of Bottom layer are placed at the extremities of an arc subtending a depression angle of 15° - 30° at the reference listening position (β_4). The height of loudspeakers corresponds to a floor level.



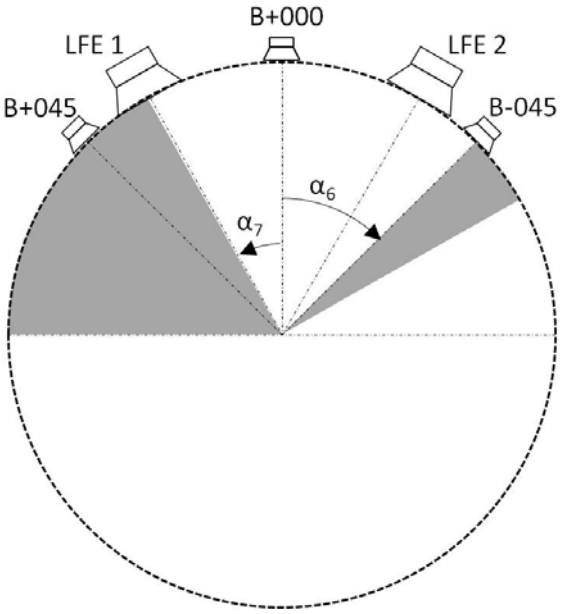
$$45° \le \alpha_1 \le 60°, \quad 22.5° \le \alpha_2 \le 30°, \quad 110° \le \alpha_3 \le 135°$$

Fig. 2-5 Reference loudspeaker arrangement of Middle layer for 22.2 multichannel sound system



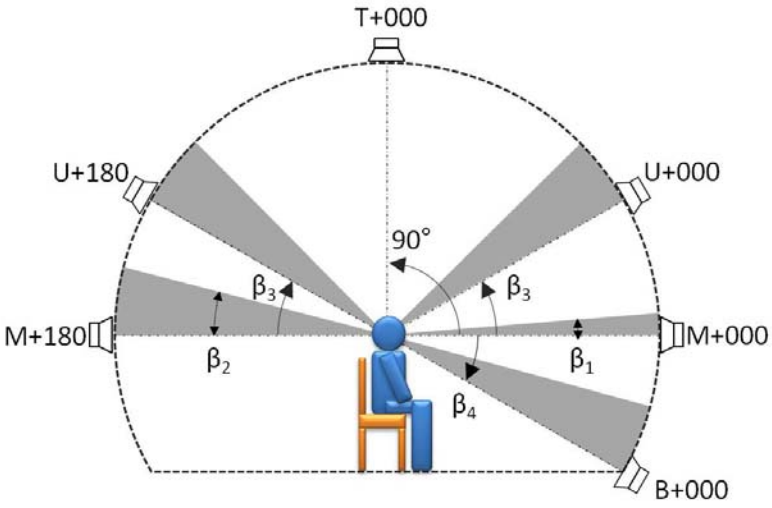
$$45° \le \alpha_4 \le 60°, \ 110\ ° \le \alpha_5 \le 135\ °$$

Fig. 2-6 Reference loudspeaker arrangement of Top layer for 22.2 multichannel sound system



$45° \le \alpha_6 \le 60°,\ 30° \le \alpha_7 \le 90°$

Fig. 2-7 Reference loudspeaker arrangement of Bottom layer for 22.2 multichannel sound system



elevation angles of Middle layer β1, β2: $0° \le \beta_1 \le 5°, 0° \le \beta_2 \le 15°$

elevation angle of Top layer β3: $30° \le \beta_3 \le 45°$

depression angle of Bottom layer β4: $15° \le \beta_4 \le 30°$

Fig. 2-8 Vertical three-layered loudspeaker layout for 22.2 multichannel sound system

2.1.3 Reference loudspeaker arrangement for 7.1 multichannel sound system

Reference loudspeaker arrangement for the 7.1 multichannel sound system is shown in Fig. 2-9, Fig. 2-10, Fig. 2-11 and Fig. 2-12. Middle layer is shown in Fig. 2-9. Top layer is shown in Fig. 2-10, and the sub-woofer loudspeaker for LFE channel is shown in Fig. 2-11. The vertical three-layered loudspeaker layout of the system is shown in Fig. 2-12.

The reference loudspeaker arrangement of Middle layer is as follows:

– the front centre loudspeaker M+000 is placed at the front of the reference listening position, i.e. at an azimuth angle of 0°; the front left loudspeaker M+030 and front right loudspeaker M-030 are placed bisymmetrically at the extremities of an arc subtending an azimuth angle of 30° at the reference listening position;

– the left surround loudspeaker M+110 and right surround loudspeaker M-110 are placed bisymmetrically at the extremities of an arc subtending an azimuth angle of 100° - 120° at the reference listening position (α_8).

Loudspeakers of Top layer are placed at the same distance as those of Middle layer from the reference listening position. The reference loudspeaker arrangement of Top layer is as follows:

- the top front left loudspeaker U+030 and top front right loudspeaker U-030 are placed bisymmetrically at the extremities of an arc subtending an azimuth angle of 30° at the reference listening position.

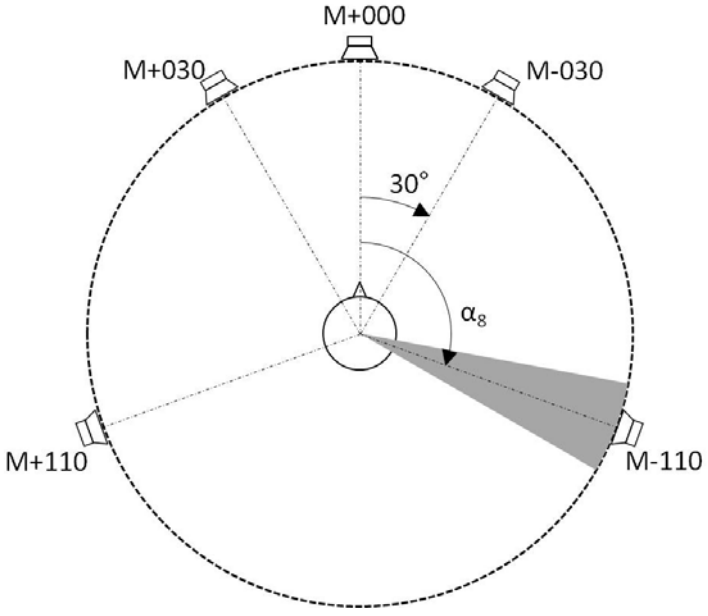
A sub-woofer loudspeaker for LFE channel is placed at the same distance as those of Middle layer from the reference listening position. The reference loudspeaker arrangement for LFE channel is as follows:

– the position of sub-woofer loudspeaker LFE1 for LFE channel is not specified. However, the loudspeaker is commonly placed at the lower front on a floor.

Regarding the elevation angles of Middle layer and Top layer at the reference listening position, the reference arrangement is as follows:

– the front loudspeakers of Middle layer M+000, M+030, and M-030 are placed on the horizontal level of the reference listening position, i.e. an elevation angle of 0°; the surround loudspeakers M+110 and M-110 are placed at the extremities of an arc subtending an identical elevation angle of 0° - 15° at the reference listening point (β_5).

– the loudspeakers of Top layer U+030 and U-030 are placed at the extremities of an arc subtending an identical elevation angle of 30° - 45° at the reference listening position (β_6).



$$100° \le \alpha_8 \le 120°$$

Fig. 2-9 Reference loudspeaker arrangement of Middle layer for 7.1 multichannel sound system

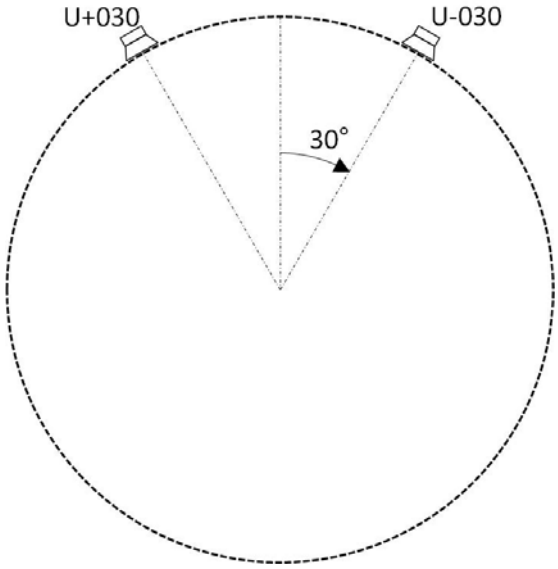
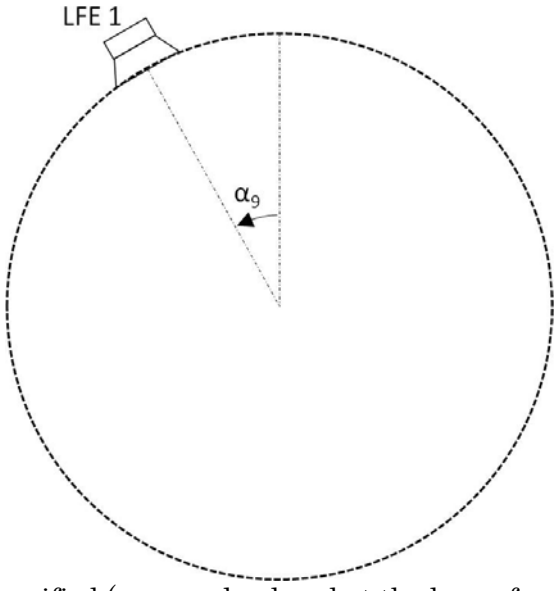
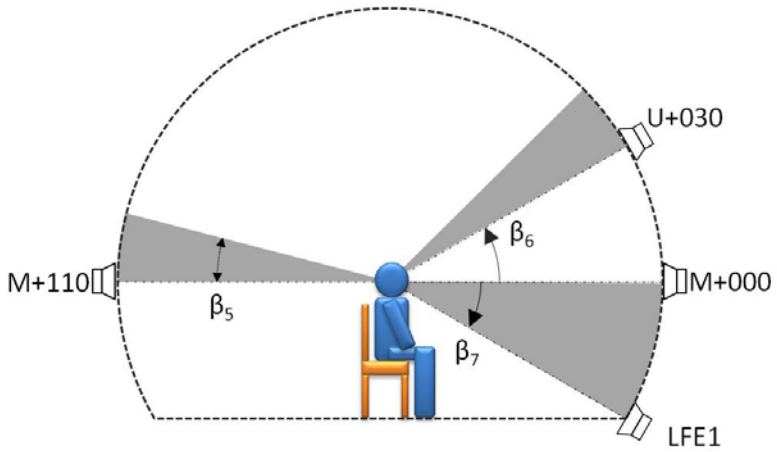


Fig. 2-10 Reference loudspeaker arrangement of Top layer for 7.1 multichannel sound system



α_9 is not specified (commonly placed at the lower front on a floor)

Fig. 2-11 Reference loudspeaker arrangement of sub-woofer loudspeaker for LFE channel for 7.1 multichannel sound system



elevation angle of Middle layer β5: $0° \le \beta_5 \le 15°$

elevation angles of Top layer β6: $30° \le \beta_6 \le 45°$

Fig. 2-12 Vertical three-layered loudspeaker layout for 7.1 multichannel sound system

2.2 Digital audio signals

2.2.1 Fundamental characteristic of digital coding

When audio signals are encoded to digital signals, the sampling frequency, sampling timing, and number of quantization bits shall be identical for all audio signals including LFE channels.

2.2.2 Sampling frequency (fs)

The sampling frequency for audio signals shall be 48 kHz. The sampling frequency of 96 kHz can be used optionally.

2.2.3 Number of quantization bits

The number of quantization bits for audio signals shall be 16 bits, 20 bits or 24 bits.

2.2.4 Emphasis

The audio coding system shall be emphasis free.

2.2.5 Bandwidth of LFE channel

The bandwidth of audio signals for LFE channels shall be 20-120 Hz.

2.2.6 Reference level

The reference level (Note 6) shall be either –18 dBFS or –20 dBFS, where a reference full-scale value (0 dBFS) is set to the maximum digital signal code value. The level of –18 dBFS is compliant with the European Broadcasting Union (EBU) Technical Recommendation R68-2000. The level of –20 dBFS is compliant with the Society for Motion Picture & Television Engineer (SMPTE) RP 155 – 2004.

(Note 6) Recommendation ITU-R BS.775 specifies that the level of LFE channel is reproduced with positive offset gain of 10 dB relative to the main channels through a gain setting of reproduction equipment, when the LFE channel is recorded with the reference level.

2.3 Reference reproduction level

A reference reproduction level is specified at a reference adjustment position. The reference adjustment position is defined as a centre of a spherical reference loudspeaker arrangement described in Section 2.1.1 (Note 7). The reference reproduction level is calibrated using a broadband pink noise signal, which is reproduced from each loudspeaker of audio channel, and a

sound level meter with C-frequency-weighting and Slow-time-weighting setting specified in JIS C 1509 (Note 8). As the sound level meter indicates an integrated value within overall measured bandwidth, the frequency characteristics is not given. Therefore, the measurement using a sound level meter is employed for regular managements of reproduction level. A detailed calibration of reproduction level for each frequency band is carried out using a 1/3 octave band frequency analyzer. For the calibration of reference reproduction level, the alignment signal should be a digital sound source signal (Note 10) with broadband pink noise (Note 11), whose characteristic is specified in JIS C 5532 (Note 9) and whose r.m.s. value is informed. The r.m.s. value of broadband pink noise signal is −21 dBFSrms for a -18 dBFS reference level system, −23 dBFSrms for a -20 dBFS reference level system (Note 12).

(Note 7) In case of a cylindrical or rectangular solid loudspeaker arrangement, the reference adjustment position is defined as a centre of Middle layer. The reference reproduction level for each loudspeaker should be calibrated to be identical, taking the distance between the loudspeaker and the reference adjustment position into consideration.

(Note 8) Specifications of JIS C 1509 standard are identical to those of International Standard IEC 61672.

(Note 9) Specifications of JIS C 5532 standard are identical to those of International Standard IEC 60268-5.

(Note 10) For an alignment signal for the reproduction level calibration, analogue pink noise signals are conventionally used, whose level corresponds to 0 VU, that is equivalent to 0 dBu0s specified in Recommendation ITU-R BS. 645. A VU meter is also conventionally used for the measurement. By contrast, the digital alignment signal with broadband pink noise is specified in this standard because the r.m.s. value of the alignment signal is calculated exactly.

(Note 11) The broadband pink noise signal specified in JIS C 5532 has a wider bandwidth than that of a measured loudspeaker system. A value of Crest Factor is recommended to be 3 - 4.

(Note 12) The r.m.s. values of sine waves of the reference level with −18 dBFS or −20 dBFS are calculated to −21 dBFSrms or −23 dBFSrms, respectively. The r.m.s. value of broadband pink noise signal used for the alignment should be identical to that of sine wave signal with the reference level.

2.3.1 Loudspeaker for main channel

Each reference reproduction level for main channels except LFE channels should be calibrated to 79 dBC using a sound level meter with a reproduced broadband pink noise alignment signal (Note 13, and Note 14). A detailed calibration of reproduction level for each frequency band is carried out using a 1/3 octave band frequency analyzer. After the calibration is carried out, reproduction levels of frequency bands should be flat (Note 15), and each reproduction level of frequency band should be as equal to that of other main channels (Note 16) as possible. If the reference reproduction level is set to 79 dBC, the reproduction level for each frequency band corresponds to 65 dB (Note 17). Even omnidirectional microphones, which are commonly used for the level calibration, have directivity in high-frequency bands. Therefore, for the reproduction level calibration of main channels, the measurement microphone should be directed to the measured loudspeaker. If the microphone is not directed to the measured loudspeaker such as the microphone is fixed uprightly, a compensation of reproduction level is necessary for each frequency band, taking the loudspeaker angle and microphone main axis for each frequency band into consideration.

(Note 13) The reproduction level 79 dBC is based on an inquiry to broadcasting sound engineers, which was examined by the Association of Radio Industries and Businesses (ARIB). The 79 dBC is a mean value of reproduction levels during mixing operations. However, variations of reproduction level are allowed if some problems arise when sound mixings are operated at the reproduction level 79 dBC; for example average loudness values of programmes are quite loud (i.e. the recoding levels are overloud). For example, to control average loudness of programmes, if a monitor loudspeaker reproduces sounds with 3 dB offset gain, the

recoding level is relatively decreased. In this case, despite that a reproduction level is calibrated to 82 dBC using the alignment signal such as a broadband pink noise, mixing operations are carried out with a reproduction level corresponds to 79 dBC. Refer Appendix 3 for reproduction level specifications in foreign countries.

(Note 14) Recommendation ITU-R BS.1116 recommends that the reference reproduction level should be calibrated within a tolerance of ± 0.25 dB. In the beginning, a calibration of reference reproduction level should be done using a broadband pink noise signal, then a calibration for each frequency band should be carried out. As the calibration for each frequency band may cause an alteration of reference reproduction level, the reference reproduction level should be measured once again using the broadband signal, and it should be confirmed that the reference reproduction level is within the tolerance.

(Note 15) Recommendation ITU-R BS.1116 recommends that reproduction levels for frequency bands should be aligned to a flat response with a tolerance of ± 3 dB for 250 Hz - 2 kHz, with a tolerance of upper limit 3 dB and lower limit 3dB + 2 dB/Oct for below 250 Hz, and with a tolerance of upper limit 3 dB and lower limit 3dB + 1.5 dB/Oct for above 2 kHz.

(Note 16) Recommendation ITU-R BS.1116 recommends that reproduction levels for frequency bands between other loudspeakers should be aligned to a target level within 2 dB as much as possible. Especially the alignment between frontal loudspeakers of Middle layer is most important, i.e. five loudspeakers of FL, FLc, FC, FRc, and FR channels for the 22.2 multichannel sound system, and three loudspeakers of L, C, and R channels for the 7.1 multichannel sound system, because essential sound elements are arranged for these loudspeakers.

(Note 17) The reproduction level 65 dB for each frequency band is an ideal value, where the reproduction level is 79 dBC, assuming that loudspeakers with a flat frequency response are arranged for studio equipment. However, loudspeakers with different frequency responses may be installed, in the case in which compact loudspeakers are used only for Top layer. If the reproduction levels of full-bandwidth are aligned to an identical value, side effects may be caused, such as difference of sound impressions between loudspeakers. In this case, a reproduction level alignment of each frequency band, instead of full-bandwidth, improves the sound impressions between loudspeakers to be comparable.

2.3.2 Loudspeaker for LFE channel

A calibration of reproduction level for LFE channels is carried out using a 1/3 octave band frequency analyzer. The reproduction level of LFE channel for frequency bands should be aligned to have a positive offset gain of 10 dB relative to the main channels (Note 18). For an alignment signal, a broadband pink noise signal with 120Hz low-pass filter (24 dB/oct) or a narrowband pink noise signal with 20 – 120 Hz bandwidth is used.

(Note 18) As LFE channels are band-limited, the measured value using a sound level meter is different from the value with positive offset gain of 10 dB relative to the main channels. Therefore, the calibration of reproduction level for LFE channels should be carried out using a 1/3 octave band frequency analyzer. However, a sound level meter can be employed for regular managements of reproduction level. The reproduction level using a sound level meter is calculated as follows:

LFE (dBC) = main channel (dBC) + 4 dBC

Therefore, the reproduction level for LFE channel should be calibrated to be 83 dBC, where the reproduction level for main channel is 79 dBC.

2.4 Audio channel name and assignment

2.4.1 Audio channel assignment

A channel mapping between a channel number, an audio channel and a reference loudspeaker location is specified to ensure that any user can easily and unambiguously transmit and receive audio channels between audio equipment in production studios for the three-dimensional

multichannel stereophonic sound system. Channel assignments are also specified, considering that multiple sound systems are exchanged simultaneously.

2.4.2 Channel assignments for 22.2 multichannel sound system

Channel assignments for the 22.2 multichannel sound system are shown in Table 2-1, between the channel number, the audio channel name, the corresponding loudspeaker label and the loudspeaker location specified in Section 2.1.2.

Table 2-1 Channel assignments for 22.2 multichannel sound system

Channel number	Channel label	Channel name	Loudspeaker label	Range of loudspeaker location			
				Azimuth angle		Elevation angle	
1	FL	Front Left	M+060	+45°	+60°	0°	+5°
2	FR	Front Right	M-060	-45°	-60°	0°	+5°
3	FC	Front Centre	M+000	0°		0°	+5°
4	LFE1	Low Frequency Effects -1	LFE1	+30°	+90°	-15°	-30°
5	BL	Back Left	M+135	+110°	+135°	0°	+15°
6	BR	Back Right	M-135	-110°	-135°	0°	+15°
7	FLc	Front Left Centre	M+030	+22.5°	+30°	0°	+5°
8	FRc	Front Right Centre	M-030	-22.5°	-30°	0°	+5°
9	BC	Back Centre	M+180	+180°		0°	+15°
10	LFE2	Low Frequency Effects -2	LFE2	-30°	-90°	-15°	-30°
11	SiL	Side Left	M+090	+90°		0°	+15°
12	SiR	Side Right	M-090	-90°		0°	+15°
13	TpFL	Top Front Left	U+045	+45°	+60°	+30°	+45°
14	TpFR	Top Front Right	U-045	-45°	-60°	+30°	+45°
15	TpFC	Top Front Centre	U+000	0°		+30°	+45°
16	TpC	Top Centre	T+000	0°		+90°	
17	TpBL	Top Back Left	U+135	+110°	+135°	+30°	+45°
18	TpBR	Top Back Right	U-135	-110°	-135°	+30°	+45°
19	TpSiL	Top Side Left	U+090	+90°		+30°	+45°
20	TpSiR	Top Side Right	U-090	-90°		+30°	+45°
21	TpBC	Top Back Centre	U+180	+180°		+30°	+45°
22	BtFC	Bottom Front Centre	B+000	0°		-15°	-30°
23	BtFL	Bottom Front Left	B+045	+45°	+60°	-15°	-30°
24	BtFR	Bottom Front Right	B-045	-45°	-60°	-15°	-30°

Table 2-2 Channel assignments for multiple sound systems including 22.2 multichannel sound system

Number	Channel label	Sound system		Channel label	Sound system
1	FL	22.2 multichannel sound system		L	2 channel stereophonic sound system
2	FR			R	
3	FC			L	5.1 channel stereophonic sound system
4	LFE1			R	
5	BL			C	
6	BR			LFE	
7	FLc			Ls	
8	FRc			Rs	
9	BC			FL	22.2 multichannel

10	LFE2			FR	sound system
11	SiL			FC	
12	SiR			LFE1	
13	TpFL			BL	
14	TpFR			BR	
15	TpFC			FLc	
16	TpC			FRc	
17	TpBL			BC	
18	TpBR			LFE2	
19	TpSiL			SiL	
20	TpSiR			SiR	
21	TpBC			TpFL	
22	BtFC			TpFR	
23	BtFL			TpFC	
24	BtFR			TpC	
25	L	5.1 channel stereophonic sound system		TpBL	
26	R			TpBR	
27	C			TpSiL	
28	LFE			TpSiR	
29	Ls			TpBC	
30	Rs			BtFC	
31	L	2 channel stereophonic sound system		BtFL	
32	R			BtFR	

2.4.3 Channel assignments for 7.1 multichannel sound system

Channel assignments for the 7.1 multichannel sound system are shown in Table 2-3, between the channel number, the audio channel name, the corresponding loudspeaker label and the loudspeaker location specified in Section 2.1.3.

Table 2-3 Channel assignments for 7.1 multichannel sound system

Channel number	Channel label	Channel name	Loudspeaker label	Range of loudspeaker location			
				Azimuth angle		Elevation angle	
1	L	Left	M+030	+30°		0°	
2	R	Right	M-030	-30°		0°	
3	C	Centre	M+000	0°		0°	
4	LFE	Low Frequency Effects	LFE1	-		-	
5	Ls	Left Surround	M+110	+100°	+120°	0°	+15°
6	Rs	Right Surround	M-110	-100°	-120°	0°	+15°
7	Ltf	Left top front	U+030	+30°		+30°	+45°
8	Rtf	Right top front	U-030	-30°		+30°	+45°

Table 2-4 Channel assignments for multiple sound systems including 7.1 multichannel sound system

Number	Channel label	Sound system		Channel label	Sound system
1	L	7.1 multichannel sound system		L	2 channel stereophonic sound system
2	R			R	
3	C			L	5.1 channel stereophonic sound system
4	LFE			R	
5	Ls			C	
6	Rs			LFE	

7	Ltf			Ls	
8	Rtf			Rs	
9	L	5.1 channel stereophonic sound system		L	7.1 multichannel sound system
10	R			R	
11	C			C	
12	LFE			LFE	
13	Ls			Ls	
14	Rs			Rs	
15	L	2 channel stereophonic sound system		Ltf	
16	R			Rtf	

Appendix1 Examples of cylindrical or rectangular solid loudspeaker arrangements

Chapter 1: General Terms

The loudspeaker locations are defined by a spherical arrangement for the three-dimensional multichannel stereophonic sound system in this standard. Arrival times and levels of sounds from each loudspeaker are identical at the reference adjustment position, if identical signals are reproduced from each loudspeaker. However, cylindrical or rectangular solid loudspeaker arrangements should be considered if production studios with the sound system are practically designed. For the cylindrical or rectangular solid loudspeaker arrangements, it is necessary to compensate the arrival times and levels of sounds to be identical at the reference adjustment position. Examples of time delay compensations are shown below, for cylindrical and rectangular solid loudspeaker arrangements of the 22.2 multichannel sound system.

Let R0 be a distance between the reference adjustment position and the loudspeaker position, which is located most distant from the reference position. Also let R1 - R24 be distances between the reference adjustment position and 24 loudspeakers' positions respectively. For the cylindrical or rectangular solid loudspeaker arrangements, it is necessary to compensate time delays of signals corresponding to the differences of distance $\Delta Rn = Rn - R0$ (n=1, 2…, 24). If compensations of time delays are implemented, there is no need to compensate time delays even when post-processing such as down-mix is carried out.

(Appendix-note 1) A time delay caused by the difference of the distance is calculated as following equations under the standard atmospheric pressure:
delay time (msec) = distant difference (mm) / sound speed (m/s)
where sound speed (m/s) = 331.5 + 0.6t (m/s) ; t = temperature (°C)
In a case that the temperature at room is 20°C, and the differenece of the distance difference is 50cm,
delay time (msec) = 500 (mm) / 343.5 (m/s) =1.456 msec.
The delay time is set up for the below-mentioned time delay compensation devices.

Chapter 2: Cylindrical loudspeaker arrangement

Fig.A1-1 shows an example of cylindrical loudspeaker arrangement for the 22.2 multichannel sound system.

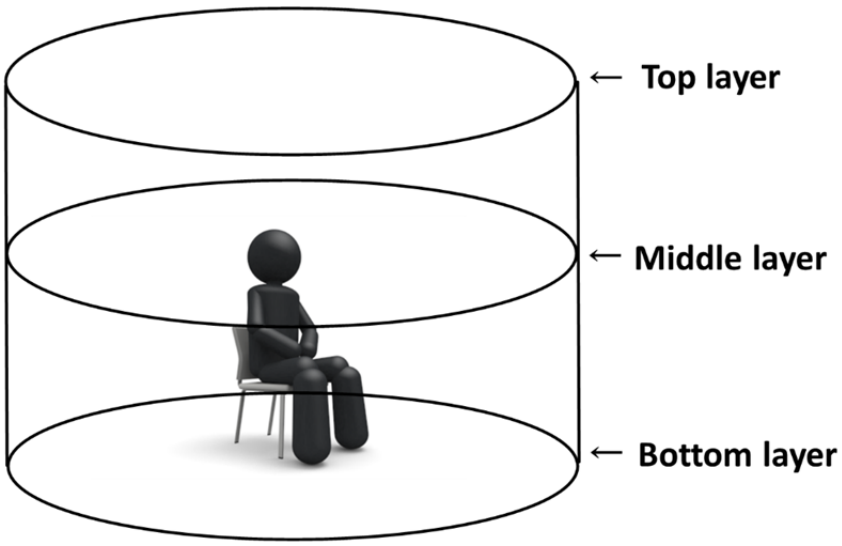


Fig. A1-1 Vertical three-layered cylindrical loudspeaker layout

When a reference adjustment position is assumed to be the centre of Middle layer circle, loudspeakers on Top or Bottom layer circle are most distant from the reference position, for the vertical three-layered cylindrical loudspeaker layout. Let R0 be the largest distance, then Δ Rn (n=1, 2…, 24) are calculated through the above-mentioned equation. For each time delay compensating device, which is inserted in front of a loudspeaker, the delay time Tn should be set to Rn / c (n=1, 2,⋯, 24) depending on Δ Rn (i.e. Tn = Δ Rn / c: where c is a sound speed). Examples of insertion of time delay compensating devices are shown in Fig. A1-2, Fig. A1-3, and Fig. A1-4.

By the way, time delay compensating devices may not be necessary for all loudspeakers. For the loudspeakers whose distance Rn is equal to R0, time delay compensating devices are unnecessary, as the differences of distance Δ Rn are zero, i.e. the time delays are zero. The example of insertion of time delay compensating devices is shown in Fig. A1-2 for Middle layer. The example for Top layer is shown in Fig. A1-3, and the example for Bottom layer is shown in Fig. A1-4.

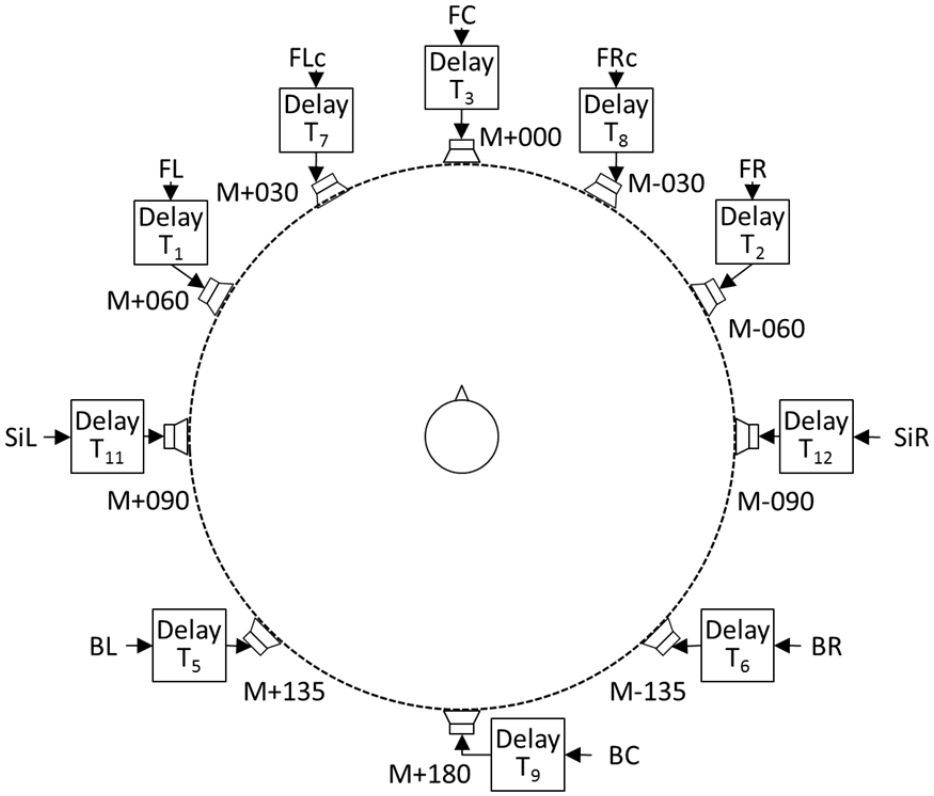


Fig. A1-2 Middle layer (vertical three-layered cylindrical loudspeaker layout)

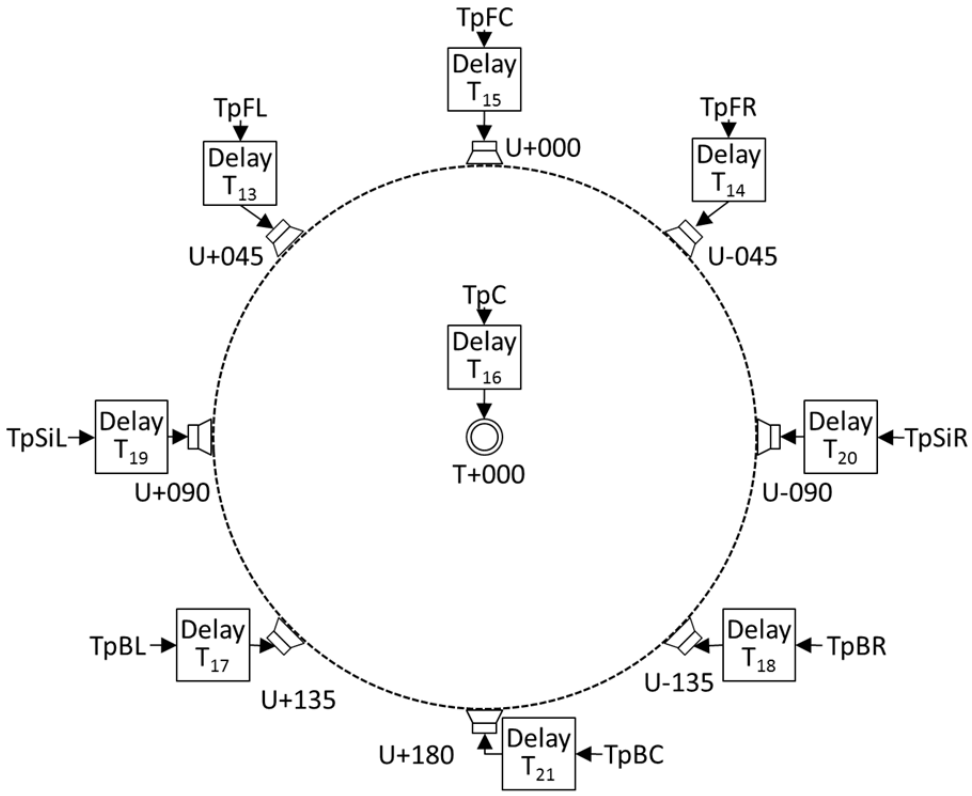


Fig. A1-3 Top layer (vertical three-layered cylindrical loudspeaker layout)

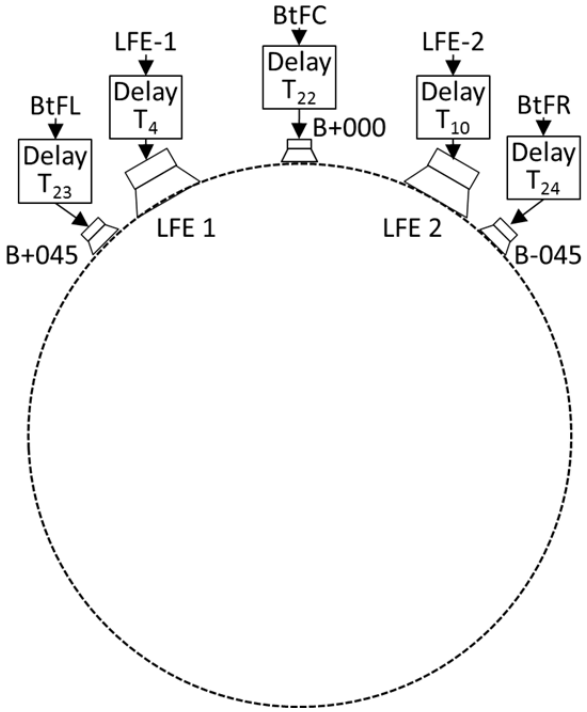


Fig. A1-4 Bottom layer (vertical three-layered cylindrical loudspeaker layout)

Chapter 3: Rectangular solid loudspeaker arrangement

Fig.A1-5 shows an example of rectangular solid loudspeaker arrangement for the 22.2 multichannel sound system.

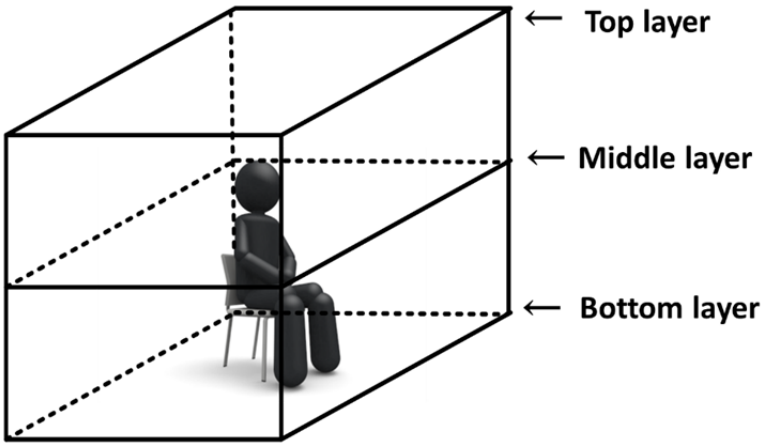


Fig. A1-5 Vertical three-layered rectangular solid loudspeaker layout

When a reference adjustment position is assumed to be the centre of Middle layer, four corners' loudspeakers on Top layer or front corners' loudspeakers on Bottom layer are most distant from the reference position, for the vertical three-layered rectangular solid loudspeaker layout. Let R0 be the largest distance, then Δ Rn (n=1, 2…, 24) are calculated as described in above section. For each time delay compensating device, which is inserted in front of a loudspeaker, the delay time Tn should be set to Rn / c (n=1, 2,⋯, 24) depending on Δ Rn (i.e. Tn = Δ Rn / c). Examples of insertion of time delay compensation devices are shown in Fig. A1-6, Fig. A1-7, and Fig. A1-8.

By the way, time delay compensating devices may not be necessary for all loudspeakers as mentioned above. For the loudspeakers whose distance Rn is equal to R0, time delay compensating devices are unnecessary, as the differences of distance Δ Rn are zero, i.e. the time delays are zero. The example of insertion of time delay compensating devices for Middle layer is shown in Fig. A1-6. The example for Top layer is shown in Fig. A1-7, and the example for Bottom layer is shown in Fig. A1-8.

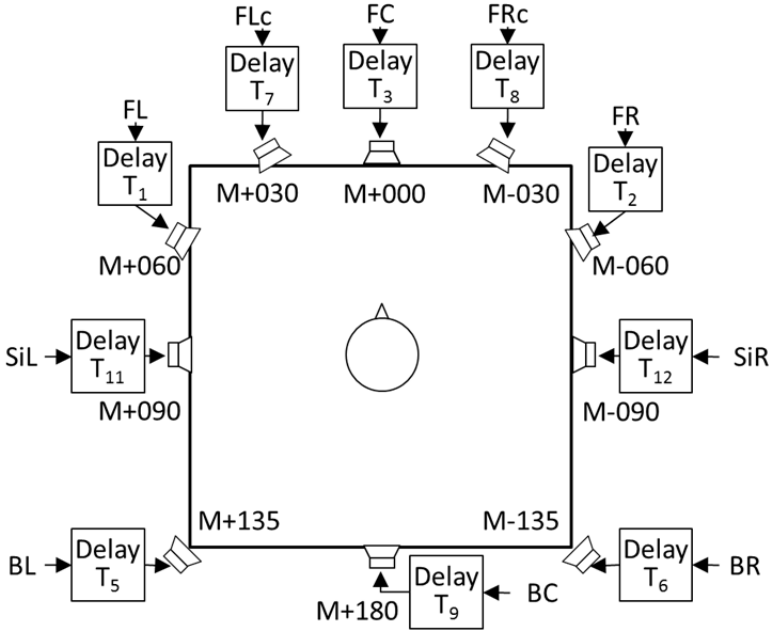


Fig. A1-6 Middle layer (vertical three-layered rectangular solid loudspeaker layout)

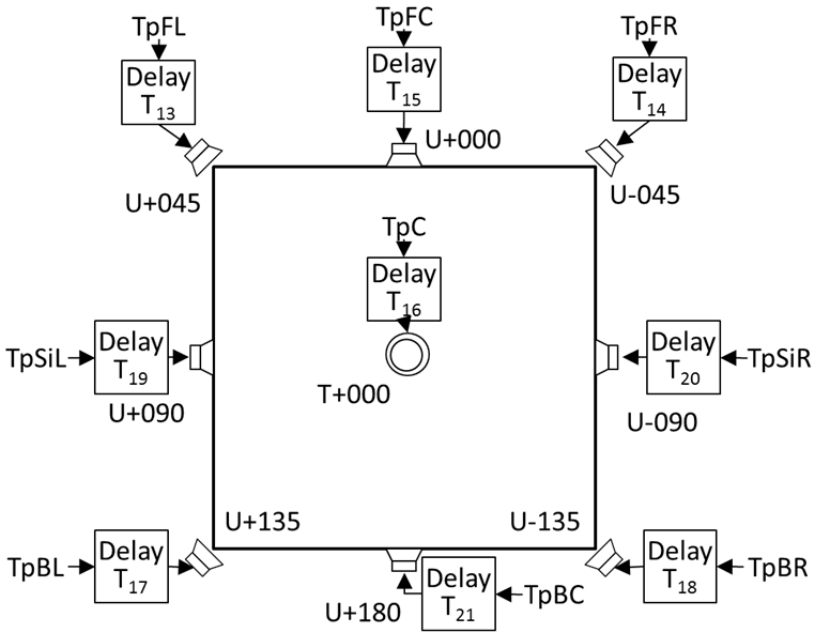


Fig. A1-7　Top layer (vertical three-layered rectangular solid loudspeaker layout)

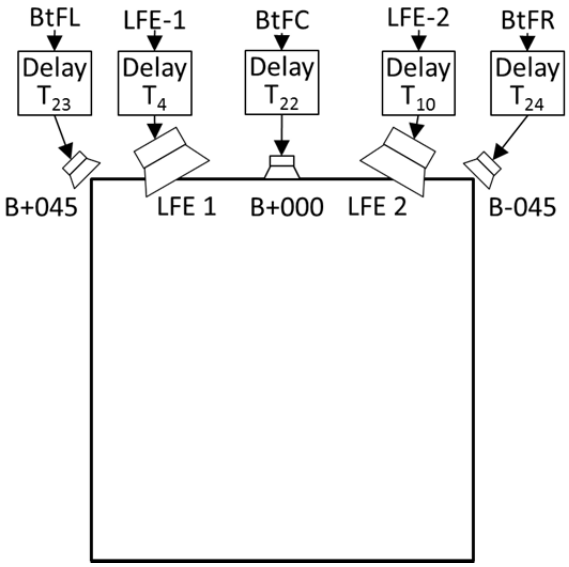


Fig. A1-8　Bottom layer (vertical three-layered rectangular solid loudspeaker layout)

Appendix2 Advanced sound system (three-dimensional multichannel stereophonic sound system) specified in Recommendation ITU-R BS.2051

Chapter 1: General Terms

Loudspeaker arrangements for an advanced sound system (a three-dimensional multichannel stereophonic sound system) specified in Recommendation ITU-R BS.2051, are given below.

Chapter 2: Loudspeaker arrangements for three-dimensional multichannel stereophonic sound system specified in Recommendation ITU-R BS.2051.

Loudspeaker arrangements of sound systems specified in Recommendation ITU-R BS.2051 for the three-dimensional multichannel stereophonic sound system, consist of several loudspeakers from those whose loudspeaker positions are shown in Fig. 2-1. Eight sound systems (which are called Sound System A – H) and possible loudspeaker positions are shown in Table A2-1 (Appendix-note 2). Sound System H (22.2 multichannel sound system) and Sound System C (7.1 multichannel sound system) are specified as a standard of Japan for programme productions in production studios.

Table A2-1 Loudspeaker arrangements for three-dimensional multichannel stereophonic sound system

	Loudspeaker position		Sound system							
Loudspeaker label	Azimuth angle	Elevation angle	A	B	C	D	E	F	G	H
			0+2+0	0+5+0	2+5+0	4+5+0	4+5+1	3+7+0	4+9+0	9+10+3
			stereo	5.1	7.1	9.1	10.1	10.2	13.1	22.2
M+000	0°	0°		✓	✓	✓	✓	✓	✓	✓
M+022	+22.5°	0°								
M-022	-22.5°	0°								
M+SC	Left edge of display	0°							✓	
M-SC	Right edge of display	0°							✓	
M+030	+30°	0°	✓	✓	✓	✓	✓	✓	✓	✓
M-030	-30°	0°	✓	✓	✓	✓	✓	✓	✓	✓
M+045	+45°	0°								
M-045	-45°	0°								
M+060	+60°	0°								✓
M-060	-60°	0°								✓
M+090	+90°	0°						✓	✓	✓
M-090	-90°	0°						✓	✓	✓
M+110	+110°	0°		✓	✓	✓	✓			
M-110	-110°	0°		✓	✓	✓	✓			
M+135	+135°	0°						✓	✓	✓
M-135	-135°	0°						✓	✓	✓
M+180	+180°	0°								✓
U+000	0°	+30°								✓
U+022	+22.5°	+30°								

U-022	-22.5°	+30°								
U+030	+30°	+30°			✓	✓	✓			
U-030	-30°	+30°			✓	✓	✓			
U+045	+45°	+30°						✓	✓	✓
U-045	-45°	+30°						✓	✓	✓
U+060	+60°	+30°								
U-060	-60°	+30°								
U+090	+90°	+30°								✓
U-090	-90°	+30°								✓
U+110	+110°	+30°				✓	✓		✓	
U-110	-110°	+30°				✓	✓		✓	
U+135	+135°	+30°								✓
U-135	-135°	+30°								✓
U+180	+180°	+30°								✓
UH+180	+180°	+45°						✓		
T+000	―	+90°								✓
B+000	0°	-30°					✓			✓
B+022	+22.5°	-30°								
B-022	-22.5°	-30°								
B+030	+30°	-30°								
B-030	-30°	-30°								
B+045	+45°	-30°								✓
B-045	-45°	-30°								✓
B+060	+60°	-30°								
B-060	-60°	-30°								
B+090	+90°	-30°								
B-090	-90°	-30°								
B+110	+110°	-30°								
B-110	-110°	-30°								
B+135	+135°	-30°								
B-135	-135°	-30°								
B+180	+180°	-30°								
LFE1	+45°	-30°		✓	✓	✓	✓	✓	✓	✓
LFE2	-45°	-30°						✓		✓

(Appendix-note 2) The loudspeaker positions listed in Table A2-1 are given as representatives among several implementable positions for each sound system. The specified ranges of loudspeaker locations for sound systems should be referred the main text.

Appendix3 Reproduction level specifications of sound systems in foreign countries

This standard specifies that the reference reproduction level for main channels except LFE channels should be calibrated to 79 dBC. The level 79 dBC is based on an inquiry to broadcasting sound engineers, which was examined by the Association of Radio Industries and Businesses (ARIB). However, there are several guidelines regarding to the reproduction level in foreign countries. Some guidelines are shown below for a reference.

(1) EBU Tech 3276-s1:2004 "Listening conditions for the assessment of sound programme material: Supplement 1 Multichannel sound", recommends that the loudspeaker gains should be adjusted to achieve a reference listening level of 78 dBSPL per loudspeaker.

(2) ATSC Recommended Practice: A/85:2013 "Techniques for Establishing and Maintaining Audio Loudness for Digital Television" of USA, specifies that the standard acoustical reference level is given as 76, 78, 80, 82 or 85 dBC for each category and for various room volumes within the categories.

(3) Standards for cinema sounds in theaters are specified as 85 dBC for dubbing stages (mixing rooms), screening rooms and indoor theaters ((ISO 21727:2004, SMPTE ST 202:2010, and SMPTE RP 200:2012). The sound mixing for cinemas should be carried out under the 85 dBC reproduction level.

(4) "Recommendations for Surround Sound Production" issued by the National Academy of Recording Arts and Sciences, recommends that the recommended reference listening level for surround sound production is in the range of 79 to 85 dBC. It is also stated that it is important to check mixes at varying levels, from very soft (as low as 40dB) to quite loud (not to exceed 92dB).

THREE-DIMENSIONAL MULTICHANNEL STEREOPHONIC SOUND SYSTEM FOR PROGRAMME PRODUCTION

ARIB STANDARD

ARIB STD-B59　Version 2.0-E1

(July　6, 2016)

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