Standards for safe listening devices : situation analysis

As part of the Make Listening Safe initiative of the World Health Organization and the International Telecommunications Union

World Health Organization

ITU

Situation analysis

for

safe listening devices' standards

Compiled by Mr Christian Bertin, in collaboration with WHO and ITU

Contents

Glossary

Dosimetry: in the context of safe listening, dosimetry is the measurement and monitoring of the dose of acoustic signals (noise or otherwise) over a period of time (e.g. a day or week) to which an individual has been exposed. A noise dose is the combination of listening level (that is, "exposure level") and listening time ("exposure time"), expressed in percentage of a maximum pre-defined amount.

Personal audio system: a personal audio system refers to the complete listening system which consists of two parts: 1) the personal music player and 2) the headphones/earphones used with it.

Personal music player: a *personal music player* refers to portable equipment intended for use by an ordinary person, that:

- Is designed to allow the user to listen to audio or audiovisual content/material; and
- Uses a listening device, such as headphones or earphones that can be worn in or on or around the ears; and
- Has a player that can be body worn (of a size suitable to be carried in a clothing pocket) and is intended for the user to walk around while in continuous use (for example, on a street, in a subway, at an airport, etc.).

Examples include portable CD players, MP3 audio players, mobile phones with MP3 type features, personal digital assistants (PDAs) or similar equipment.
(Excluded from the definition are rehabilitative and medical devices (Hearing aids, FM loops) as well as personal sound amplification devices.)

Transducer: in the context of this document, a transducer refers to a earphone/headphone used along with a personal music player for purpose of listening.

Acronyms

CEA: Consumer Electronics' Association

CENELEC: European Committee for Electrotechnical Standardization

dB(A): A-weighted decibels

HATS: Head and torso simulator

ICT: Information and communication technology

IEC: International Electrotechnical Commission

PDA: Personal digital assistant

PLD: Personal listening device

PMP: Personal music player

QoE: Quality of experience

QoS: Quality of service

SPL: Sound pressure level

SDO: Standards development organizations

1 Executive Summary

In March 2015, WHO launched its initiative to Make Listening Safe, based on the estimate that over 1 billion young people across the world are at a risk of hearing loss due to their unsafe listening habits http://www.who.int/pbd/deafness/news/safe_listening/en/. Following the WHO-ITU Joint Stakeholders' Consultation and Expert Meeting on Safe Listening Devices in October 2015, it was agreed to conduct an analysis of gaps in current standards, by studying existing literature in this field.

This report is a compilation of available information on standards for safe listening devices. The key points from the report are summarized as below:

- Standards have been put in place by the CENELEC and IEC which measure sound pressure levels in personal music players (PMPs).
- There is no uniformity in implementation of safe listening standards across the world. In Europe, the EN 50332 standards have been in effect since January 2013. Their use is mandatory in the countries of the European Union and Switzerland.
- There is variable provision of information and warnings by different device manufacturers through their interface or websites.
- Based on the current situation, the need for safe listening, and user preferences, it is important that parameters should be identified that assist users to make listening safe whilst maintaining the quality of their listening experience.
- There is a possible benefit in including dosimetry in the new standards. Such dosimetry would have the ability to measure time, signal energy, information and would allow the provision of feedback to the user in order to promote behaviour change.
- There is a need for harmonization amongst all existing measurement methods, and for definition of reference signals.
- There are currently no exiting standards with respect to headphones and earphones used with the personal music players.
- Such standards should be developed through a collaborative effort of all stakeholders (including all standardization organizations with expertise in the field), and implemented globally by manufacturers and governments.

2 Background and methodology

Taking cognisance of the risk posed to hearing by listening to loud sounds in recreational settings, WHO launched its initiative to Make Listening Safe in March 2015 http://www.who.int/pbd/deafness/news/safe_listening/en/.

Joint WHO-ITU Joint Stakeholders' Consultation and Expert Meeting on Safe Listening Devices were held in Geneva on 1 and 2 October 2015 respectively. During these meetings, it was agreed that there is a need to define standards for personal audio systems which can minimize the risk of hearing loss among users. During the meeting, which had representation from other standardization organizations, it was agreed to conduct an analysis of gaps in current standards, by studying existing literature in this field.

This report provides a review and analysis of the standards related to hearing protection for the recreational use of personal audio systems defined by different standardization organizations, and the results of a gap analysis based on the outcomes of the WHO-ITU Joint Expert Consultation on Safe Listening Devices.

The review focusses mainly on personal music players as sources of recreational sound and does not include sources such as concerts, sporting venues nor personal sound amplifiers. Among the personal music players are the CD players, MP3 players, MP3 players in mobile phones or PDAs and tablets.

Search methodology

1. Review of all documents produced by WHO and ITU in the area of safe listening devices.

2. Identification of the different international standardization bodies with activities related to sound exposure, their working groups and existing standards in this area.

3. Information was collected about the implementation of these standards in different countries.

4. Information was collected from the major smartphone and music player vendors on standards implementation and recommendations related to safe listening.

5. A summary of the current situation was produced and proposals were made to improve protection of hearing when personal audio systems are used.

3 Standards Development Organizations

This section lists the major standards development organizations (SDOs) with activities related to sound measurement and user hearing protection when a personal audio system is used.

Only SDOs from America and Europe have been found to have activities in this area.

They are listed in alphabetical order.

3.1 ANSI: American National Standards Institute

ANSI *inter alia* develops safety standards for ladder safety, fall protection, construction safety, clothing and equipment, workplace surfaces, and occupational health and safety.

In particular, ANSI develops hearing protection standards to guide noise safety at workplaces when noise cannot be sufficiently reduced due to the intrinsic properties of a particular action or environment.

No specific activity related to recreational use of personal audio systems has been identified.

3.2 ASA: Acoustical Society of America

Founded in 1929, ASA has published noise safety standards but they relate solely to noise safety in the workplace.

3.3 CENELEC: European Committee for Electrotechnical Standardization

CENELEC is the European Committee for Electrotechnical Standardization. Officially recognized by the European Commission as the competent European Standardization Organization in this field, CENELEC creates both voluntary and harmonized standards (supporting the guidelines of the New Approach Directives[1]).

CENELEC ensures that the majority of its standards are identical to the standards developed by the International Electrotechnical Commission (IEC). This is achieved through cooperation between both organizations, and through the participation of CENELEC members directly in IEC work.

[1] https://www.cenelec.eu/aboutcenelec/whatwestandfor/supportlegislation/newapproachdirectives.html

Its technical committee TC 108X[2] develops standards for safety of electronic equipment within the fields of audio/video, information technology and communication technology. It has developed the following relevant European standards: EN 50332[3], EN 60065[4] and EN60950-1[5].

3.4 IEC: International Electrotechnical Commission

IEC develops International Standards and conformity assessment for electrical, electronic and related technologies.

Accordingly, its technical committee TC 108 (Safety of electronic equipment within the field of audio/video, information technology and communication technology) has adopted (transposed) at the international level several EN standards produced by CENELEC TC 108X: IEC/EN 60065[6], 60950[7], 62368[8].

3.5 ISO: International Standardization Organization

ISO is an independent, non-governmental international organization with a membership of 162 national standards bodies.

ISO/PC 283 deals with occupational health and safety management systems for workers.

ISO TC 43 Acoustics develops international standards in the field of acoustics, including methods of measuring acoustical phenomena, their generation, transmission and reception, and all aspects of their effects on people and their environment. In particular, it has developed the two-part standard ISO 11904 with reference to determination of sound immission from sound sources placed close to the ear.

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[2] Safety of electronic equipment within the fields of Audio/Video, Information Technology and Communication Technology https://www.cenelec.eu/dyn/www/f?p=104:7:0::::FSP_ORG_ID:1257189

[3] https://www.head-acoustics.de/downloads/eng/standards/D6789_EN_50332_e.pdf

[4] http://standards.globalspec.com/std/1387913/cenelec-en-60065

[5] http://www.itesafety.com/en_e3.pdf

[6] https://webstore.iec.ch/preview/info_iec60065%7Bed8.0%7Db.pdf

[7] https://webstore.iec.ch/preview/info_iec60950-1%7Bed2.0%7Den_d.pdf

[8] http://pes-spdc.org/sites/default/files/guide-to-iec-tc108-safety-standards-parameters.pdf

3.6 ITU-T: International Telecommunication Union – Telecommunication Standardization Sector

ITU is an intergovernmental organization and the United Nations specialized agency for information and communication technologies (ICTs). Its members comprise 193 member states, the private sector and academia. Its Telecommunication Standardization Sector (ITU-T) develops international standards (called *Recommendations*) in various ICT fields, there comprised multimedia, quality of experience, e-health, accessibility and human factors. The most relevant groups and standardization work to this report are listed below.

3.6.1 JCA-AHF (Joint Coordination Activity for Accessibility and Human Factors)

The JCA-AHF is an ITU-T wide coordination group that aims at raising awareness and contributing to better collaboration and cooperation amongst groups developing standards considering accessibility and human factors. It does not develop standards.

3.6.2 Study Group 2 on Operational aspects

Question 4/2: is an experts group developing human factors and related work items for the improvement of the quality of life through international telecommunications.

Currently, Q4/2 does not have specific standardization work applicable to safe listening, although messaging of safe listening information to users can be dealt with from a human factors aspect.

3.6.3 Study Group 12 on Performance, Quality of Service (QoS) and Quality of Experience (QoE)

Question 5/12: Telephonometric methodologies for handset and headset terminals (QoS for terminals).

Question 6/12: Analysis methods use complex measurement signals and their application for speech enhancement techniques and hands-free telephony (QoS for terminals).

Question Q13/12: QoE, QoS, performance requirements and assessment methods for multimedia (multimedia quality assessment).

Question Q14/12: Development of parametric models and tools for multimedia quality assessment (multimedia quality assessment).

These include Recommendations (i.e. international standards) ITU-T P.310, P.311, P.360, P.380, and P.381.

3.6.4 Study Group 16 on Multimedia

Question 26/16: Accessibility to multimedia systems and services for persons with disabilities.

Question 28/16: Multimedia framework for e-health applications.

Q28/16 has now started work on an integrative standard providing technical guidance on safe listening devices (draft Recommendation ITU-T F.SLD).

3.7 ITU-R: International Telecommunication Union – Radiocommunication Sector

The ITU Radiocommunication Sector (ITU-R) is responsible for allocation of bands of the radiofrequency spectrum and for coordinating elimination of interference across Radiocommunication systems, as well as to produce Recommendations intended to assure the necessary performance and quality in operating radiocommunication systems.

ITU-R Study Group 6 works on radiocommunication broadcasting, including vision, sound, multimedia and data services principally intended for delivery to the general public.

Amongst its developed standards of interest, we have Recommendation ITU-R BS.1770-4.

4 Existing standards for personal audio systems with respect to safe listening

There are standards about hearing protection devices for workers in real-world occupational settings. They specify methods to measure noise reduction, noise attenuation, and sound pressure level of hearing protectors. They are not listed here.

Only standards related to recreational use of personal audio systems are listed below.

Standards are voluntary and only made mandatory when included in legislation or regulations; for example, in Europe and France.

4.1 EN 50332 – Sound system equipment: Headphones and earphones associated with personal music players (PMPs) – Maximum sound pressure level measurement methodology

EN 50332 applies only to battery-operated portable consumer audio entertainment equipment with mono or stereo headphones or earphones, intended for presenting broadcast or recorded sound or video, for example CD players, MP3 players, MP3 players in mobile phones, or PDAs and tablets. This standard does not cover mains-operated hi-fi or audio equipment, nor does it cover headphones used to aid the hard of hearing.

This standard also does not apply to headphones or headsets used at work, e.g. headsets used with two-way radios or headsets in call centres, control rooms, or broadcasting. Headphones used at work are covered separately by the requirements of the Control of Noise at Work Regulations 2005[9].

In order to minimise the risk of hearing impairment, this European standard has been issued which specifies test procedures for measuring the sound levels from the headphones and earphones of personal music players and similar consumer equipment.

[9] Control of Noise at Work Regulations 2005: http://www.legislation.gov.uk/uksi/2005/1643/pdfs/uksi_20051643_en.pdf

EN 50332 has two parts:

- Part 1 covers “one package equipment”, where the headphones and the music player are supplied together as a unit.
- Part 2 covers the matching of headphones and players that are sold separately.

CENELEC TC 108X is currently working on a Part 3, on dosimetry.

4.1.1 EN 50332-1:2013[10]

EN 50332 Part 1 requires a specified test signal to be replayed from the device being tested. The test signal, or “programme simulation noise” is a pink noise signal which has been filtered to change the spectrum shape and then soft-clipped to reduce the crest factor. The test signal is recorded or uploaded to the player at a specified level.

The test signal is played from the player at the maximum volume setting and the sound levels from the attached headphones are measured using a Head and Torso Simulator (HATS).

PMPs must be equipped with user protection if they are capable of delivering an Sound Pressure Level (SPL) of 85 dB(A) when playing a static test signal including:

- an active warning when SPL (of the test signal) is above 85 dB(A);
- a maximum SPL no higher than 100 dB(A).

The 2013 version of EN 50332 specifies a test method. The actual limits are specified in other standards (EN 60065 or EN60950-1).

4.1.2 EN 50332-2:2013[11]

EN 50332 Part 2 uses the same programme simulation test signal as Part 1. When testing a player without headphones, the signal is replayed at the player’s maximum volume setting and the voltage at the player’s headphone socket is measured across a 32 Ω load.

[10] From http://www.isvr.co.uk/labtests/en50332.htm

[11] From http://www.isvr.co.uk/labtests/en50332.htm

Figure 1 – The Kemar mannequin (HATS)

When testing headphones without a player, the test signal is replayed from a source through an amplifier to the headphones being tested. The headphones are placed on the HATS or mannequin as in Part 1, and the sound level is measured. The voltage required to produce a sound level of 94 dB(A) is measured.

When a player producing 150 mV or less is combined with headphones which require 75 mV or more to produce a sound level of 94 dB(A), the sound level of the combination must be 100 dB(A) or less.

The 2013 version of EN 50332 specifies the test method. The actual limits are specified in other standards (EN 60065 or EN 60950-1).

4.1.3 EN 50332-3 (ongoing work)

Part 3 is ongoing work on estimation of an individual's audio dose, its management and alerts. This concerns sound system equipment, i.e. headphones and earphones associated with portable audio equipment. This takes into account the maximum sound pressure level measurement methodology.

Dose estimation is expected to reduce false warnings (given by part 1 and 2) and to help protect music integrity by not requiring absolute reduction of music levels of recorded content, but rather managing exposure over time.

TC108X/WG3 is making progress on dose estimation and expects to finalize Part 3 in 2016.

4.2 IEC/EN 60065:2014: Audio, video and similar electronic apparatus - Safety requirements

This IEC international standard specifies the sound level limits for “one package equipment” tested to EN 50332-1 and for combinations of player and headphones not supplied as a package, tested to EN 50332-2.

Some of the features in the first edition in 2011 are:

- standard acoustic output level LAeqT[12] not greater than 85 dB(A)
- actively inform user of increased sound pressure – higher output level has to be acknowledged by user every 20 hours
- maximum output from player and listening device not greater than 100 dB(A)
- warning on equipment
- distinction is made for usage by children and adults

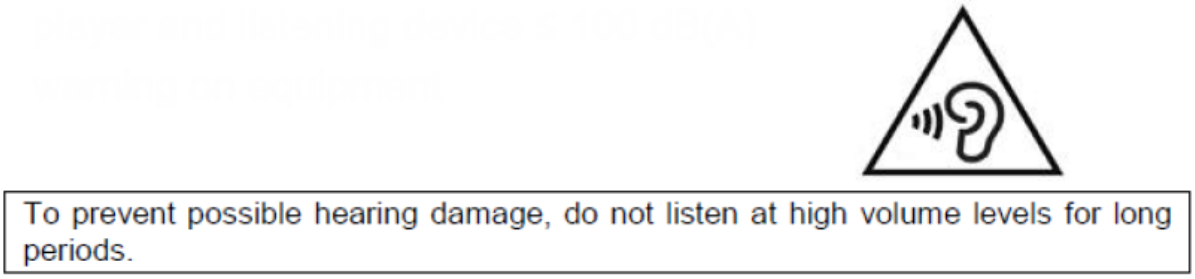


Figure 2. Hearing damage warning

4.3 IEC/EN 60950-1:2011[13] – Information technology equipment - Safety - Part 1: General requirements

EN 60950-1:2006/A1:2010 has been superseded by EN 60950-1:2006/A12:2011 on 24 January 2013.

Hence, from this date, all information technology equipment for use in the EU must be tested and certified for conformity with EN 60950-1:2006/A12:2011.

[12] LAeqT: Equivalent continuous A-weighted sound pressure level. LpA: A-weighted sound pressure level; LpCpeak: C-weighted peak sound pressure level.

[13] https://webstore.iec.ch/preview/info_iec60950-1%7Bed2.0%7Den_d.pdf

4.4 IEC/EN 62368-1:2014 – Audio/video, information and communication equipment – Part 1: Safety requirements

IEC 62368-1 replaces two standards currently in use – EN 60065 for audiovisual equipment, and EN 60950-1 for IT and communication technology equipment. It applies to new and existing products.

Additionally, the US and Canada adopted a national version of IEC 62368-1 titled CSA/UL 62368-1.[14]

Phases 1 and 2 of EN 50332 are implemented in IEC 62368-1, clause 10.6.

4.5 IEC HD 483-1 S2:2003 – Sound System Equipment – Part 1: General

This standard applies to noise tests of sound systems of any kind, and to the parts of which they are composed or which are used as auxiliaries to such systems.

This standard deals with the determination of the performance of sound system equipment, the comparison of these types of equipment and the determination of their proper practical application by listing the characteristics which are useful for their specification and laying out uniform methods of measurements for these characteristics.

The standard is confined to a description of the different characteristics and the relevant methods of measurement; it does not in general specify performance (except in Part 10).

4.6 ITU-T P.360 (07/2006)[15] – Efficiency of devices for preventing the occurrence of excessive acoustic pressure by telephone receivers and assessment of daily noise exposure of telephone users

It is known that an excessive acoustic pressure level may produce auditory damage to the user. To prevent the occurrence of excessive acoustic pressure generated by the earphones of handset or headset, the telephony terminal equipment needs to integrate devices to limit the acoustic pressure level. This ITU-T Recommendation proposes limits to the acoustic pressure generated by the handset and headset earphones and some guidance on how to measure it. It also provides guidance on how to assess acoustic sound exposure of telephone users. In addition, ITU-T P.360

[14] http://industries.ul.com/blog/edition-no-2-of-csaul-62368-1-published-in-canada-u-s-on-december-1-2014

[15] http://www.itu.int/rec/T-REC-P.360

includes some guidance on how to avoid speech degradation due to the use of devices implemented in the terminal to prevent the occurrence of excessive acoustic pressure.

4.7 ITU-T P.311 (03/2011)[16] Transmission characteristics for wideband digital handset and headset telephones

Recommendation ITU-T P.311 provides audio performance requirements for wideband (8000 Hz) handset and headset telephones.

Requirements and test methods are specified for the major audio transmission parameters affecting wideband audio, including sending and receiving levels, frequency response, noise, distortion, sidetone, stability, echo path and delay. Wideband audio represents a considerable departure from traditional narrow-band telephony, offering significantly improved quality.

Major changes over the previous version of this recommendation (2005) are as follows:

- In addition to sinusoidal and noise signals, speech-like stimulus signals as described in Recommendation ITU-T P.50 and Recommendation ITU-T P.501 are also recommended for the measurements.
- HATS method is used for better simulation of real telephone communication.
- Specific headset requirements are incorporated.
- Some technical requirements and related test methods have been modified based on the latest research, e.g. frequency response, distortion, STMR, D-factor, and delay.

4.8 ITU-T P.380 (11/2003)[17]– Electroacoustic measurements on headsets

This recommendation provides testing methods for headsets using the head and torso simulator. The recommendation addresses the following topics:

- selection of artificial ears,
- classification of headsets,
- positioning of headsets on HATS,

[16] http://www.itu.int/rec/T-REC-P.311

[17] http://www.itu.int/rec/T-REC-P.380

– test repeatability, and

– contents of the measurement report.

4.9 ITU-T P.381 (02/2014)[18] – Technical requirements and test methods for the universal wired headset or headphone interface of digital mobile terminals

Recommendation ITU-T P.381 specifies critical physical and electrical-acoustical characteristics for the universal headset interface and provides corresponding test methods. Both 3.5 mm and 2.5 mm diameter headset/headphone interfaces have been widely used in digital mobile terminals in recent years. Nowadays, the consumer is free to choose either the headset/headphone originally provided by the terminal manufacturer or others that are offered separately. However, the quality of service (QoS)/quality of experience (QoE) perceived by users is influenced by both the electrical performance of the interface and the compatibility between the terminal and the connected headset/headphone.

4.10 ITU-R BS.1770-4 (10/2015)[19] Algorithms to measure audio programme loudness and true-peak audio level

This Recommendation contains a specification of the objective multichannel loudness measurement algorithm to be used when an objective measure of the loudness of an audio channel or programme, produced with up to five main channels per Recommendation ITU-R BS.775 (mono source, stereo and 3/2 multichannel sound), is required to facilitate programme delivery and exchange.

NOTE: For testing compliance of meters according to this Recommendation, test material from the set described in Report ITU-R BS.2217 may be used.

EN 50332 does not work with ITU-R BS 1770.

[18] http://www.itu.int/rec/T-REC-P.381

[19] http://www.itu.int/rec/R-REC-BS.1770

4.11 ISO 11904 Acoustics [20]– Determination of sound immission from sound sources placed close to the ear

ISO 11904[21] is a standard in two parts which specify methods for the determination of sound immissions from sources located close to the ear in which situations the sound pressure level measured at the position of the exposed person (but with the person absent) does not adequately represent the sound exposure.

In order to make it possible to assess the exposure by means of well-established criteria, the exposure of the ear is measured and subsequently converted into a corresponding free-field or diffuse-field level. The result is given as a free-field related or diffuse-field related equivalent continuous A-weighted sound pressure level, LFF, H, Aeq or LDF, H, Aeq when ISO 11904-1 is used; or LFF, M, Aeq or LDF, M, Aeq when ISO 11904-2 is used.

ISO 11904-1:2002 "*Acoustics -- Determination of sound immission from sound sources placed close to the ear -- Part 1: Technique using a microphone in a real ear (MIRE technique)*" describes measurements carried out using miniature or probe microphones inserted in the ears of human subjects (microphones in real ear, MIRE technique).

ISO 11904-2:2004 "*Acoustics — Determination of sound immission from sound sources placed close to the ear — Part 2: Technique using a manikin*" describes measurements carried out using a manikin equipped with ear simulators including microphones (HATS technique).

ISO 11904 may, for instance, be applied to equipment tests and the determination of noise exposure at the workplace, where, in the case of exposure from sources close to the ears, the sound pressure level measured at the position of the exposed person (but with the person absent) does not adequately represent the sound exposure. Examples of applications are headphones and earphones used to reproduce music or speech (whether at the workplace or during leisure), nail guns used close to the head, and combined exposure from a close-to-ear sound source and an external sound field.

When specific types of equipment are to be tested (e.g. portable cassette players or hearing protectors provided with radio receivers), test signals suitable for this particular type of equipment

[20] http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=33944

[21] From https://www.iso.org/obp/ui/#iso:std:iso:11904:-2:ed-1:v1:en.

have to be used. Neither such test signals nor the operating conditions of the equipment are included in ISO 11904, but might be specified in other standards.

When workplace situations are measured, the various noise sources contributing to the emission should be identified. Operating conditions for machinery and equipment used might be specified in other standards.

Both parts of ISO 11904 strive for the same result: a mean value for free-field or the diffuse-field related level. ISO 11904-1 does this by specifying the mean of measurements on a number of human subjects; ISO 11904-2 does this by using a mannequin, which aims at reproducing the acoustic effects on an *average* human adult. However, the two methods yield different measurement uncertainties which can influence the choice of method. Only the method described in ISO 11904-1 gives results which indicate the variance in a human population. Information on the uncertainties is given in its Annexes A and B.

When using the MIRE technique for measurement of sound from earphones of insert and stethoscopic types, practical problems can occur with the positioning of microphones in the ear canal. When using the mannequin technique, the headphone or earphone has to be coupled to the pinna simulator and ear canal extension as far as possible in the way it is coupled to the human ear. In cases where head- or earphones or other objects touch the pinna, a possible deviation in stiffness or shape of the artificial pinna from human pinnae has a significant impact on the result and can even make the results invalid.

5 Implementation of existing standards

5.1 Implementation by countries

The adoption of standards is by nature voluntary. When standards are available, their adoption can be mandated by laws or regulation at country or regional level, or by inclusion in contracts or procurement requirements. This section provides an overview of the information identified during this study on use of regulations and related issues for recreational use of personal audio systems safe listening.

5.1.1 European Union

EN 50332 standards have been in effect in Europe since January 2013. Their use is mandatory in the countries of the European Union and Switzerland.

"One package equipment" capable of generating more than 85 dB(A), or any player providing a headphone socket with more than 27 mV output, must be accompanied by a warning either on the equipment, packaging or instructions. The warning comprises a symbol, as shown below, with a minimum height of 5 mm, and the following, or similar, wording:

To prevent possible hearing damage, do not listen at high volume levels for long periods.

Figure 3. Hearing damage warning symbol

In France, the maximum sound level from headphones and earphones used with personal music players is limited by law to protect hearing. It has been reported that, as of February 2013, all personal music players sold in the EU must restrict headphone sound levels; whereas at the moment this is not a legal requirement in EU Member States apart from France. However, to avoid country-specific modifications of software and to sell the same model of music players or headphones throughout the EU, it is likely the players will need to comply with French law.

Conforming to the recommended noise limits is also a precautionary measure against personal injury claims for hearing loss allegedly caused by personal music players and similar devices.

5.1.2 Switzerland

Same list of standards as in EU:

- SNEN 60065:2014 (transposition of EN 60065:2014)
- SNEN 50332:2013 (transposition of EN 50332:2013)

5.1.3 United States

ANSI deals with the control of conditions and factors that may affect the health and safety of persons in the workplace, not limited to employees.

Nothing related to recreational use of personal audio systems was found in this study.

However, in 2010, the U.S. Court of Appeals for the Ninth District[22] affirmed a 2008 decision by a California district court to dismiss a long-running lawsuit that claimed Apple iPods endangered users' hearing. The original 2006 lawsuit (which eventually boasted three plaintiffs and sought class-action status), claimed that iPods were defective because they could play music at unsafe volumes above 115 decibels (dB).

The district court disagreed, saying that any dangers of hearing loss from playing music too loud were "obvious" and "unavoidable."

5.1.4 Other parts of the world

The research in this study was unable to identify specific regulation or related issues concerning the recreational use of personal audio systems in other parts of the world.

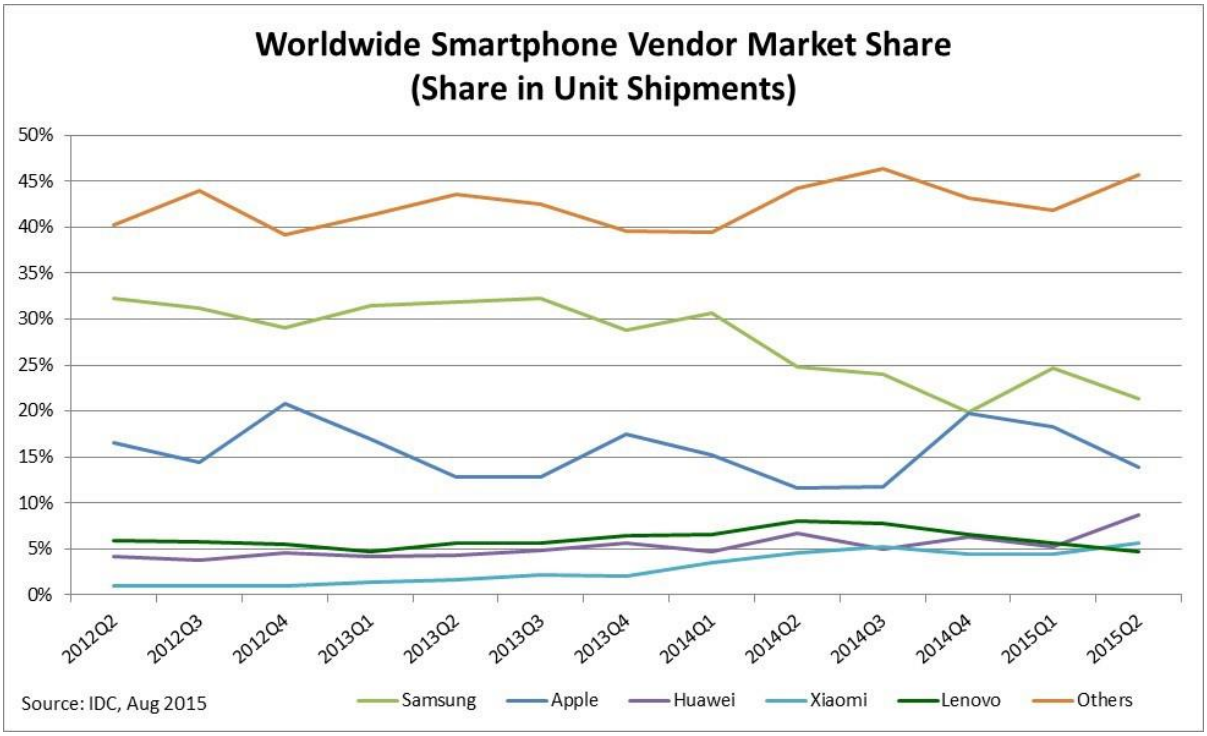
5.2 Implementation by vendors

5.2.1 Smartphones

For the second quarter of 2015, the top five smartphone vendors are Samsung, Apple, Huawei, Xiaomi and Lenovo as shown in Figure 4[23]

[22] From http://www.macworld.co.uk/news/apple/apple-wins-appeal-ipod-hearing-loss-case-28170/.

[23] From http://www.idc.com/prodserv/smartphone-market-share.jsp



Period	Samsung	Apple	Huawei	Xiaomi	Lenovo	Others
2015Q2	21.4%	13.9%	8.7%	5.6%	4.7%	45.7%
2014Q2	24.8%	11.6%	6.7%	4.6%	8.0%	44.3%
2013Q2	31.9%	12.9%	4.3%	1.7%	5.7%	43.6%
2012Q2	32.2%	16.6%	4.1%	1.0%	5.9%	40.2%

Figure 4. Worldwide smartphone market share. Source: IDC, Aug 2015

* Motorola figures have been captured under Lenovo.

This section provides a sample of information found on how different manufacturers approach safe listening.

5.2.1.1 *Apple*

On the Apple web site, a page on “Sound and Hearing” (see
Safe listening from Apple web site) provides general information about the risk of recreational exposure to loud sound.

5.2.1.2 *Huawei*

On phone "Huawei Ascend P6", one can get this warning:

WARNING: Making your volume or music louder can damage your hearing.

This suggests that some standards have been implemented, albeit none is indicated.

5.2.1.3 *Lenovo*

Lenovo displays a warning message as confirmed by a user request on the Internet to remove this message:

A user with a Lenovo P70 asks if there is some way to remove the ANNOYING android warning that my volume is too high which I have to confirm EVERY time?[24]

This suggests that some standards have been implemented, albeit none is indicated.

5.2.1.4 *Microsoft*

On Windows phone, there is a warning message:

Figure 5. Microsoft hearing damage warning

Such a warning message is also available on PCs and tablets with Microsoft Windows OS.

This suggests that some standards have been implemented, albeit none is indicated.

5.2.1.5 *Samsung*

No indication of compliance with existing standards was found but the following information suggests that some have been implemented. As with other manufacturers, no reference is made to specific standards.

[24] From https://forums.lenovo.com/t5/P-Series-Smartphones/p70-increasing-the-volume-bypassing-volume-threshold/td-p/2152622.

When listening to music using the default Music Player app on the Samsung Galaxy S5, you will get a music volume warning when attempting to turn the volume up while earphones are plugged into the device.

The warning says “Raise volume above safe level? Listening at high volume for long periods may damage your hearing.”

On the Samsung Galaxy S6, you may see:

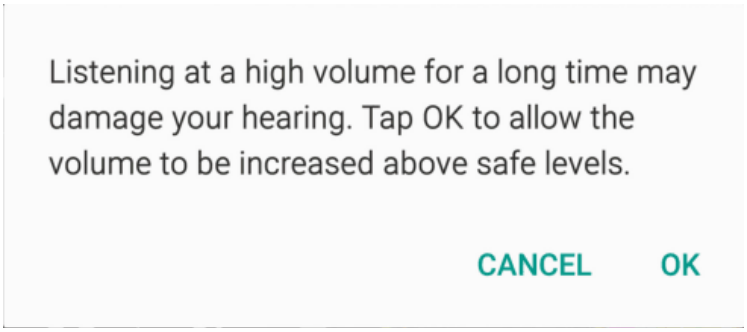


Figure 6. Samsung Galaxy S6 hearing damage warning

5.2.1.6 *Xiaomi*

Here is a message you can see on Mi 2/2S smartphone:

Are you sure you want to raise your volume to unsafe levels?

This suggests that some standards have been implemented, albeit none is indicated.

5.2.2 MP3 Players

Concerning the MP3 player market, Apple's iPod continues to lead an ever-shrinking market of portable music players with a staggering 72 percent of the market, though the overall size of that market continues to contract amidst cannibalization from smartphones[25].

From “pcmag.com” web site, based on the number of products, the major vendors of MP3 players are as follows: Apple (with 37 products), Creative (28), Samsung (27), Sony (25), Archos (22), iriver (20), Cowon (13), SanDisk (13).

Hearing loss warnings are mandatory for personal music players sold in Europe but it is not confirmed that these warnings are available globally.

[25] From http://appleinsider.com/articles/13/12/19/apples-ipod-continues-to-lead-an-ever-shrinking-market-of-portable-media-players.

5.2.2.1 *Apple*

On the Apple web site, recommendations for the safe use of MP3 players are available (see Safe listening from Apple web site) but there is no indication about compliance of their MP3 products with international standards.

Apple includes a warning on all iPods that reads in part, "Permanent hearing loss may occur if earphones or headphones are used at high volume."

5.2.2.2 *Archos*

No information was found on the Internet about hearing loss warning.

5.2.2.3 *Creative*

No information was found on the Internet about hearing loss warning.

5.2.2.4 *Samsung*

Very simple safety warnings are present in user manuals. For example in the Samsung MCD-SM45 Instruction Manual you can read:

> *In order to protect your hearing*
>
> – *Do not wear the earphones with the volume set too high.*
>
> *Doctors state that listening to music at high volume for prolonged periods is harmful to hearing.*
>
> – *If you experience a ringing in your ears, reduce the volume or stop listening*

No indication on the internet of warning message for safe listening to be displayed when sound level is too high.

5.2.2.5 *Sandisk*

Audio/video player safety instructions are available on the Sandisk web site (see Sandisk).

Safety instructions are also available in user manuals.

No indication was found on their web site of warning message for safe listening to be displayed when sound level is too high.

5.2.2.6 *Sony*

There is a warning when you try to raise the volume beyond a specific limit as indicated in the on-line Walkman help guide, on the troubleshooting page[26] as follows:

The voice guidance "Check the volume level" is heard.

- *An alarm (beep) and warning "Check the volume level" are meant to protect your ears when you raise the volume setting beyond a specific level (*1) for the first time.*
- *You can cancel the alarm and warning by pressing any button.*
- *You can turn up the volume beyond the specific level[27] after cancelling the alarm and warning.*
- *After the initial warning, the alarm and warning repeat for every 20 cumulative hours that the volume is set beyond the specific level (*1); when this happens, the volume is changed to level [7] automatically.*

NOTE – These instructions are available on a global level for this product.

[26] From http://docs.esupport.sony.com/portable/NWZW273_guide/en/contents/05/02/02/02.html.

[27] Specific level = [18].

6 Gap analysis

6.1 Current situation:

- At present there are standards developed by the CENELEC and IEC which measure sound pressure levels in PMPs.
    - As per these standards, all devices should have a default output limit of 85 dB.
    - The user can choose to override the limit (set by the device), so that the sound level can be increased up to maximum 100dB.
    - If the user overrides the limit, warnings about the risks must be repeated every 20 hours of listening time.
- All personal music players sold in the EU after February 2013 are expected to comply with these standards. No indication of such a limit in other parts of the world was found.
- There is a lack of performance/quality certification of some devices in low- and middle-income countries. This makes it easier for counterfeit and low quality devices to inundate the market.
- The above-mentioned standards do not take into consideration the duration of sound exposure, which is as important as the volume level.
- Evidence suggests that users often consider the limit set as annoying and frequently override it, ignoring the warning message.

6.2 Looking at the future

- It is important to find an effective way to protect hearing which is acceptable to the users of personal audio systems.
- Parameters should be identified that assist users to make listening safe whilst maintaining the quality of their listening experience.

6.2.1 Standards for safe listening

Figure 7. Permissible daily noise exposures[28]

- As illustrated in Figure 7, the sound pressure level is not the only element which should be taken into account; it has to be linked to the duration of exposure.
- Dosimetry would provide the ability to measure time, signal energy, information and would allow the provision of feedback to the user in order to promote behaviour change. A standardized method for measuring sound dose would be beneficial to ensure homogeneity across the personal music players available in the market, as well as to identify that well accepted and reliable methods are being used to monitor dosage.
- In order to customize the listening dose at which warnings are to appear, dose monitoring should also take into consideration:
    - Listening conditions i.e. type of headphone: in-ear, open over-ear, noise cancelling, ear mould, etc.
    - The person using the player i.e. age and hearing capabilities.
- The player should be able to display, at a request from the user or when certain levels are reached, something like the illustration in **Error! Reference source not found.**.

[28] From http://apps.who.int/iris/bitstream/10665/177884/1/WHO_NMH_NVI_15.2_eng.pdf?ua=1&ua=1.

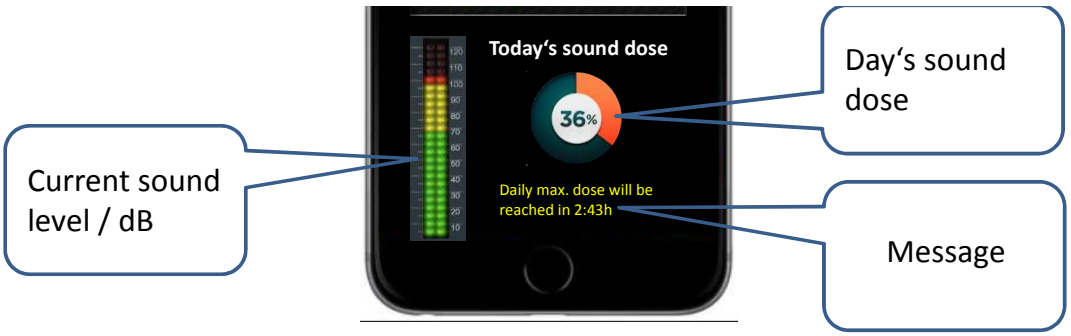


Figure 8 Consumption of daily listening dose

- Personal audio systems should be able to display at any time the remaining safe listening time if the user carries on listening at the current volume level.
- A pre-defined labelling for safe listening devices would be useful. It would be essential to have compliance testing specifications available and a mechanism to verify that they have been properly tested.

6.2.2 Points to consider in the development of global standards for safe listening devices

- Uniform and reliable methods to measure sound output must be applied.
- There must be harmonization among all existing measurement methods, such as those in ISO 11904-1/2 or EN 50332-1/2. Reference signals need to be defined.
- The standards should take into account the sound pressure at the level of the user's ear; it is not sufficient to consider the electrical level at the output of a personal music player as headphones and earphones have transducers with different sensitivities. Standards should consider the complete personal audio system, with different headphones or earphones (e.g. in-ear headphones, open over-ear headphones, noise-cancelling headphones, and their respective sensitivities).
- The standard may include profiles for personal audio systems, covering from basic devices ("low end") to high-end ones. All devices should provide adequate protection; higher end devices can have more plug-and-play functions and customization options, for example.
- The personal music systems should have the ability to recognize the transducer used and be able to configure the output volume level and estimate dose, based on the transducer used. This would allow the PMP to set the warning message according to the transducer used.

- The devices should provide suitable messages to promote safe listening practices among users. Such messages could provide the user with information on the impact of his decision (to raise or reduce the volume).
- Warnings could be complemented with a link to a WHO web page or with a textual document provided by the vendor to clarify what it means. Users should not have to search to get information about the risks of listening at a high volume.
- Technological solutions including noise reduction, isolation or cancellation should be promoted as they help to lower the background sound level in noisy environments and thereby reduce the need to turn up the volume.
- Smartphone application ("apps") to make hearing tests could be provided by vendors with personal audio systems to allow the user to check his hearing. The results could be used to set the threshold at which the warning will appear, making it more relevant to the individual.

7 Suggested actions:

- Safe listening devices should provide information to the user about his/her exposure based on sound level, listening period and signal energy. In order to do so, the personal audio systems should compute listening doses as specified in the relevant standards.
- There should be specification of hourly, daily and a weekly safe listening dose based on listening period, sound level and energy. Personal audio systems should display the listening doses and warn the user when their daily/weekly listening doses are about to reach the recommended maximum values. They should be able to display the remaining safe listening time if the user carries on listening at the current level.
- The PMPs should customize the listening levels according to the transducer used.
- Personal audio systems should suggest safe listening practices.
- Personal audio systems could provide access to WHO's information about risks of hearing above certain limits.
- Hearing tests can also be integrated into personal audio systems to allow users to check their hearing periodically and detect the beginning of hearing loss.
- The threshold at which warnings are to appear could be customizable to take into account the actual listening configuration and user hearing capability.
- The labelling of personal audio systems that monitor the dose or the peak levels should be considered. Different types of labelling can be proposed for devices monitoring dosage and for those monitoring peak levels.
- Such standards should be developed and implemented globally through a collaborative effort of all stakeholders, including all relevant standardization organizations, and be adopted by manufacturers of personal music players and of earphones/headphones.

8 References

EN 50332-1:2013 *Sound system equipment - Headphones and earphones associated with personal music players - Maximum sound pressure level measurement methodology - Part 1 General method for "one package equipment"* (Identical to BS EN 50332-1:2013 in Britain, NF EN 50332-1:2013 in France or DIN EN 50332-1;2013 in Germany.).

EN 50332-2:2013 *Sound system equipment - Headphones and earphones associated with personal music players - Maximum sound pressure level measurement methodology - Part 2 Matching of sets with headphones if either or both are offered separately, or are offered as one package equipment but with standardised connectors between the two allowing to combine components of different manufacturers or different design.* (Identical to BS EN 50332-2:2013 in Britain, NF EN 50332-2:2013 in France or DIN EN 50332-2:2013 in Germany.).

EN 60950-1:2006 with amendment A12:2011 *Information technology equipment - Safety. Part 1: general requirements.* (NB a later amended version was published in 2013, but EN50332 specifies the 2011 version.).

EN 60065:2002 with amendment A12:2011 *Audio, video and similar electronic apparatus - safety requirements.*

ISO 11904-1: First edition 2002: Acoustics — Determination of sound immission from sound sources placed close to the ear — Part 1: Technique using a microphone in a real ear (MIRE technique)

ISO 11904-2:2004, Acoustics - Determination of sound immission from sound sources placed close to the ear: Part 2: Technique using a manikin (manikin technique)

ISO 4869-1:1990: Acoustics - Hearing protectors - Part 1: Subjective method for the measurement of sound attenuation

ANSI/ASA S12.60-2010/Part 1, American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools

ANSI/ASA S12.60-2009/Part 2, American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors

ANSI/ASA S12.6-2008: Methods for Measuring the Real-Ear Attenuation of Hearing Protectors

CSA Z107.56: Procedures for the Measurement of Occupational Noise Exposure (Canadian Standards Association, 2006).

AS/NZS 1269-1:2005, Occupational noise management Part 1: Measurement and assessment of noise immission and exposure (Standards Australia and Standards New Zealand, 2005). Appendix C: "Recommended procedures for measurement of sound pressure levels from headphones or insert earphones''

Annex 1:

Safe listening from Apple web site[29]

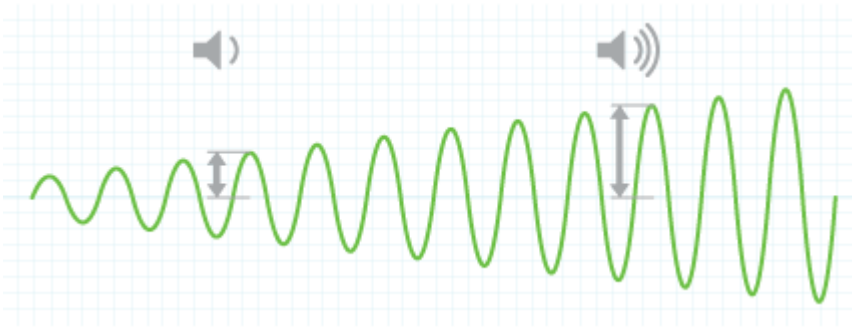
Sound

Sound travels in waves, produced when an object — such as a stereo speaker — pushes on the air around it, causing small changes in air pressure. To describe sound waves, acoustic experts refer to concepts such as frequency and amplitude.

You can easily set a Volume Limit on your iPod and iPhone. Click here to get answers to frequently asked questions about the Volume Limit.

The Science of Sound

The frequency of the waves in the sound determines the sound waves pitch. Frequency is commonly measured in Hertz (Hz) with one Hz being equal to one wave completing a cycle per second. The human ear can detect a wide range of frequencies — from approximately 20 Hz to 20,000 Hz. Amplitude is a description of the sound waves strength. As the amplitude of a sound wave increases, the volume of the sound increases. Music consists of a mixture of different frequencies and amplitudes.



The sound level heard by your ears is commonly measured in decibels. When referring to sound, a decibel is used to measure the amplitude of the sound wave. Decibels are useful in measuring sound because they can represent the enormous range of sound levels the human ear can hear

[29] From http://www.apple.com/sound/

using a more manageable scale. On the decibel scale, the softest sound that can be heard is 0 dB. Each increase of 10 dB represents an approximate doubling of the perceived loudness of the sound.

Sound and Your Ears

You can hear because your ears convert the vibrations of a sound wave in the air into signals that your brain interprets as sound. When the vibrations of a sound wave enter your ear, your eardrum and a set of tiny bones in your ear (the well-known hammer, anvil, and stirrup) amplify those vibrations. In your inner ear, these amplified vibrations move tiny hair cells that then convert the vibrations into nerve impulses sent to your brain. Your brain then interprets these nerve impulses as sound.

If you expose your ears to excessive sound pressure, you can harm those small hair cells in your ears. And if harmed, those hair cells can lose the ability to transmit sound to your brain. As a result, you could experience noise-induced hearing loss. Symptoms can include distorted or muffled sound or difficulty understanding speech.

While you can experience noise-induced hearing loss as a result of a one-time exposure to an extremely loud sound — like a gunshot — noise-induced hearing loss can also occur as a result of repeated exposure to loud sounds over time.

Listen Responsibly

Most research about noise-induced hearing loss has focused on prolonged exposure to loud sounds in industrial workplaces. While not as much research exists regarding the effect of recreational exposure to loud sound, if you listen to music and audio with headphones or earbuds — whether they're connected to your iPod, your computer, or some other audio source — you should follow a few common-sense recommendations.

Think about the volume

There's no single volume setting appropriate for everyone. You may experience a different sound level with different earbuds or headphones and with different EQ settings. Some hearing experts recommend that you set the volume while in a quiet environment, turn the volume down if you can't hear people speaking near you, avoid turning up the volume to block out noisy surroundings, and limit the amount of time that you use earbuds or headphones at high volume.

Keep Track of Time

You should also pay attention to how long you listen to audio at high volume. Remember: you can adapt to higher volume settings over time, not realizing that the higher volume may be harmful to your hearing. Hearing experts warn that noise-induced hearing loss can also occur as a result of repeated exposure to loud sound over time. The louder the volume, the less time required before your hearing may be affected. If you experience ringing in your ears or hear muffled speech, stop listening and have your hearing checked.

Annex 2:

Samsung

Samsung devices display the following warning if you try to raise the volume too much:

“Raise volume above safe level? Listening at high volume for long periods may damage your hearing.”

This is why you get so many posts if you search for « Samsung Raise volume above safe level » as follows:

Raising the volume level without a warning? and Going back a track ...

*forums.androidcentral.com/**samsung**.../274583-**rai**...*

2013-May-02 - 13 messages - authors 11

It seems whenever I plug in the *samsung* headphones that came ... up getting this pesky message asking "*Raise* music *above safe level*, etc..."

What are the ways to disable **Raise volume above safe** ...

2014-Dec-3 - 5 messages

Any way to permanently disable "**Raise volume above** ...

2014-Dec-2 - 6 messages

Galaxy S4: How to turn off the warning not to listen ...

2013-May-31 - 25 messages

How do I disable the unsafe **volume** warning? - Page ...

2012-Nov-30 - 25 messages

Samsung Galaxy S5: Disable Music Volume Warning

*www.technipages.com/how-to-disable-music-**volu**...*

2014-maj-04 - How to Disable Music *Volume* Warning on *Samsung* Galaxy S5. Tweet ... The warning says “*Raise volume above safe level*? Listening at high ...

Would really like to get rid of the volume warning notification ...

androidforums.com › ... › Samsung Galaxy Note 4

2015-Oct-19 - Its a light weight app and eliminates the issue on *Samsung* phones. I can't .... The warning says “*Raise volume above safe level*?

Warning! You are raising the volume level above safe hearing ...

*www.galaxys4forums.net/.../3066-warning-you-**ra**...*

2013-Sep-14 - 10 messages - authors 5

Hey everybody! I"m sure you've all seen that annoying pop up warning, whenever you *raise* the *volume* on your device. Anyone know how to ...

[Q] How to disable "Raise volume above … | Samsung Galaxy S6 ...

*forum.xda-developers.com/.../how-to-disable-**raise**...*

2015-Jul-01 - 9 messages - authors 6

Hi, How can I disable the"*Raise volume above safe level* warning" and set my *volume* to the loudest *volume*? The problem that I have is that the ...

How to Disable the High Music Volume Warning on Galaxy ...

*www.**samsungs**four.com/.../how-to-disable-the-hig...*

The *volume* will be increased *above safe levels*. This warning is coming only when you connect a headphone to your *Samsung* Galaxy Smartphone....so how to ...

How to Get Rid of the Annoying "High Volume" Alert When ...

*gs4.wonderhowto.com/.../get-rid-annoying-high-**v**...*

2014-jan-11 - This Innocent Calculator Is Really a Secret App *Safe* for Android .... Step 6: Enable The "Disable Loud *Volume* Warning" Setting ... Here's How to *Increase* the *Volume Limits* on Your *Samsung* Galaxy Note 2 · Get .... If you're looking for a little more power *over* your *volume*, you can use an Xposed mod called ...

Disable Android's "High Volume Warning" with an Xposed ...

*lifehacker.com/disable-androids-high-**volume**-war...*

2014-Apr-22 - ... that nags you whenever you turn your *volume up* to a certain *level*. ... I first saw it on a *Samsung* phone which naturally made me hate *Samsung* more, ... Sure makes it easier to play music *over* my car's stereo where I have ...

Issue 40365 - android - Volume warning gets reset every ...

https://code.google.com/p/android/issues/detail?id...

2012-nov-24 - "*Raise volume above safe level*? Listening at high .... gmail.com. Sharing my ghetto fix for the annoying *volume safety* warning using Tasker: 1.

[Cm 10.1] How To Disable Headphone Safety Warning? - Samsung ...

forum.cyanogenmod.org/.../65045-cm-101-how-t...

2013-Jan-20 - 6 messages - authors 4

In this case every time the headphone *safety* warning comes up. ... the best setup for the best sound is to maximize *volume*. ... behaving as described in the link (where you can go *above* 50%, but receive another warning in 24 ...

On the Internet, you can find many articles like the following one:

How to Disable Music Volume Warning on Samsung Galaxy S5

When listening to music using the default Music Player app on the Samsung Galaxy S5, you may get an annoying music volume warning when attempting to turn the volume up while earphones are plugged into the device. The warning says "**Raise volume above safe level? Listening at high volume for long periods may damage your hearing.**"

This is especially annoying when you are listening to music and have the phone in your pocket. Fortunately, you can disable the music volume warning on the Galaxy S5 by following these steps.

1. From within the default **Music Player** app, tap the "**Menu**" button.
2. Choose "**Settings**".
3. Check the "**Smart Volume**" option so that it is turned on.
4. A dialog will appear telling you that "**Smart volume is enabled**". Tap "**OK**".

Now the annoying music volume warning should no longer appear on the screen when you attempt to turn up the volume on your Galaxy S5.

Annex 3:

Sandisk

Audio/Video Player Safety Instructions

Your MP3 player is equipped with a variety of features. To help you maximize your listening pleasure, SanDisk would like to advise you that it is important to use the headphones with your MP3 player at a safe hearing level.

- Exposure or repeated exposure for an extended period of time to music and other sounds that are too loud can cause damage to your hearing resulting in temporary or even permanent "noise induced hearing loss".
- Symptoms of hearing loss increase gradually with prolonged exposure at high levels of loudness.
- Initially, you may not even be aware of the loss unless detected with a hearing test.
- Your hearing may adapt to higher volumes of sound. In order to prevent any harmful impact to your hearing, you must control the sound emanating from your headphones and set the MP3 player's volume to a low setting where you can hear it clearly and comfortably.
- Studies, including one from NIDCD indicate that sounds of less than 80 decibels, even after long exposure, are unlikely to cause a hearing loss.
- Listen to your MP3 player at such a level that you can still hear conversation and other people in your environment without shouting when you attempt to converse.
- It can also be dangerous to play your music with headphones/earphones at high volume while walking or engaged in other activities. You should exercise extreme caution and discontinue use in potentially hazardous situations.
- Do not use headphones or earphones while driving, cycling, or operating any motorized vehicle. This may create a traffic hazard and may be illegal in some areas.

Hearing Levels

To help you understand what may be considered a safe hearing level, the following examples are included for your reference:

Examples of Typical Sounds Levels Approx. Sound Level in Decibels (dB)*

Refrigerator humming 40

Normal conversation 60

City traffic 80

Motorcycles/lawnmowers 90**

Rock concerts 110-120**

Firearms 120-140**

* dB - A decibel (dB) is a unit of relative measurement of the strength sound wave. In decibels (dB), a measured signal level doubles with every additional 3 dB.

** These sound decibel levels are considered harmful under extended exposure. The above information is courtesy of the National Institute of Deafness and Other Communication Disorders (NIDCD): www.nidcd.nih.gov/health/hearing/noise.asp

Annex 4:

Relevant WHO and ITU documents

- WHO-ITU Expert consultation on Safe Listening Devices 2 October 2015 meeting report
- WHO-ITU Stakeholders Consultation on Safe Listening Devices 1 October 2015 meeting revised report
- ITU-T TD 391/WP2, Rapporteur Q28/16, Report from the WHO Safe Listening project, and its attachment 1,
- "Make Listening Safe: a WHO initiative" <http://itu.int/md/T13-SG16-151012-TD-WP2-0391/en>
- WHO-ITU Joint Stakeholders' Consultation on Safe Listening Devices
- WHO Make Listening Safe Campaign factsheet
- WHO Hearing loss due to recreational exposure to loud sounds: A review
- WHO-ITU Expert consultation on Safe Listening Devices 2 October 2015 meeting report
- WHO-ITU Stakeholders Consultation on Safe Listening Devices 1 October 2015 meeting revised report
- WHO-ITU Stakeholders Consultation on Safe Listening Devices 1 October 2015 meeting report revised, Annex 1