Requirement Specification

Acoustic Shock Protection

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Version	Date	Editor	Status	Description
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1.0 / 002	2005-04-07	T. Schertler	In work	Add comments by B. Tramblay and M.Schoenle
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1.0 / 005	2005-04-20	T. Schertler	Released	Apply comments of review. Released without change of version number.
2.0 / 001	2005-06-15	J. Siegel	In Review	Generalization to all Products: changes only in 'scope'; 'already realized in' removed no changes in requirements it selves
2.0 / 002	2005-07-13	R.E. Jensen	In work	Special view to QualComm platform
2.0 / 003	2005 -07-15	J. Siegel	In Review	Adaptions to get the general view
2.0 / 004	2005-07-22	J.Siegel	In Review	Adaptions during the review
2.0 / 005	2005-07-25	J.Siegel	In Review	Corrections according to the review record
2.0 / 006	2005-07-28	J.Siegel	In Review	Updated references to new locations in IMS
2.0 / 007	2005-08-04	J.Siegel	In Review	Update abbreviations according to review record
2.0 / 008	2005-08-30	J.Siegel	Released	Update according to remarks of the release team and change of status to released.

Table of Content

1Introduction

1.1Purpose

This document describes the acoustic shock protection requirements to Siemens cellular phones. The purpose of these requirements is to avoid damaging the customers hearing. As different measurement methods result in different values of sound pressure level, the method which is used by Siemens is described in an appendix. It is not a requirement to use this method as far as the measured values of sound pressure level are not less than the ones measured by the described method.

For single speaker solutions and in some cases dual speaker solutions, very high sound pressure levels at the earpiece can occur in order to make e.g. ring tones audible in noisy environments. In these cases ramping of the audio signal is one possible solution to avoid acoustic shock. Since ramping is the default solution for Siemens built mobile devices, it is described in this document. In 2-speaker-concepts the HW and stack-up concept shall secure that no critical level of sound pressure occurs at ear!

Furthermore this document is the basis for deriving test cases to validate the functionality.

1.2Scope

This shock protection concept is valid for all sound playbacks (with the sound player). This includes formats such as SRT (DSP tone generator only), AMR, ADPCM, PCM, MIDI, 3GP (video), MP3, AAC, etc. for applications such as voice memo, video playback, MIDI playback, Java applications etc.

All speech signals within a GSM call are not subject of this shock protection concept.

All accessories (headsets carkits, Bluetooth devices, Mobile Music Set) are not subject of this shock protection concept.

This document holds on all platforms (and products) no matter how many loudspeakers are built in.

All digital signal entities refer to signals scaled at 0dB (FS). If diagrams contain sound signals, these diagrams show loudest possible sound signals.

1.3Terms and Abbreviations

Term	Definition
Req. ID	Every requirement must be unambiguously identifiable by means of a requirement ID prefix.
Req. Title	Every requirement must be assigned an abbreviated title. The requirement title is used for communication and tracking.
Req. Body	Every requirement must be assigned a requirement text - the body. The body contains the exact performance characteristic documented by the requirement.
Req. Explanation	Scenarios are used to describe complex applications. An explanation may be assigned to a requirement. The explanation may contain an example, a use case or any other information which will help make the requirement better understood. If desired, background information or the motivation for a requirement may be added.
Req. Type	Every requirement is assigned a type, e.g. functional requirement, non-functional requirement, etc.
Req. Originator	The originator of a requirement must be specified. This can be network operator, end customer, market trends, competition (strengths and weaknesses of own product compared to rival products), manufacturer, technological environment, etc.

Term	Definition
Req. Priority	Every requirement must be assigned a priority. Possible values are constraint (C), high (H), middle (M), or low(L).
Req. Stability	Every requirement must be assigned a stability class. Stability designates the probability that a requirement will remain unchanged until the finished product is rolled out. Possible values are high (H) middle (M), or low (L).
Target Parameters	Requirements with performance parameters must be assigned targets/intervals as applicable.
Standards	The relevant standards to be complied with.
Interworking	Interworking with other functions or applications. For conflict handling see chap.2.4.
Audio event	An audio event is the time between the start and the end of an audio playback. Start and end of an audio playback can be seen by switching on/off the audio path (e.g. DAC, amplifier, multiplexers, et al.). From the user point of view, an audio event is the playback of a sound file with the media player from pressing “start” to pressing “stop”. A pause within a sound file does not introduce two audio events.
DRP	Drum Reference Point: Place in the acoustical artificial head, where the drum of the ear is supposed to “hear” the recorded sound. See also ERP.
Earpiece	The part of the mobile device’s chassis which has direct mechanical contact with the ear in handset mode.
ERP	Ear Reference Point: Place in the acoustical artificial head, where the ear entry is supposed to be. Sound, which was recorded at ERP, can be corrected to be recorded at DRP by mathematical means.
FS	Full Scale. Used as suffix for digital levels given in decibels (dB FS). As reference for RMS and peak measurement (0dB FS peak and 0dB FS RMS, respectively) a sine wave with maximum possible non-distorted amplitude is used. Note: According to this definition a rectangular signal with maximum level will result in +3dB FS RMS and 0dB FS peak, respectively. Caution: In literature two different definition of FS RMS can be found. The other definition (which shall never be used within this document) uses a rectangular wave with maximum amplitude. Both definitions lead to different levels and therefore shall not be confused.
Handset mode	Standard telephone mode where the mobile device is pressed against the ear.
Idle mode	The time where no speech connection and no application is running at the mobile device.
Receiver	The loudspeaker which has direct acoustical contact with the ear in handset mode.
Signal sound	The term 'signal sound' comprises all kind of sounds emitted by any speaker of the phone expect for the GSM- or UMTS-coded downlink speech signal.
Speaker	The loudspeaker in a dual speaker mobile device, which is placed at the opposite side of the earpiece.
SPL	Sound Pressure Level: **Sound pressure level** (SPL) or sound level L_p is a logarithmic measure of the energy of a particular noise relative to a reference noise source. It is almost always expressed in decibels compared to a reference source of 20 µPa (micropascal) sound pressure. **Sound pressure** (or acoustic pressure) is the measurement in pascals of the Root Mean Square (RMS) pressure deviation (from atmospheric pressure) caused by a sound wave passing through a fixed point. (Source: encyclopedia.laborlawtalk.com)

Abbreviation	Definition
AAC	Advanced Audio Codec

Abbreviation	Definition
ADPCM	Adaptive Differential Pulse Code Modulation (audio compression format)
AMR	Adaptive Multi Rate (audio compression format)
APS	Audio parameter settings
DAC	Digital Analog Converter
DTMF	Dual Tone Multi-Frequency
FBT	Functional Block Team
FS	Full Scale
GPRS	General Packet Radio Service
MIDI	Musical Instrument Digital Interface
MPEG	Moving Picture Expert Group (video compression format)
MP3	MPEG2 Layer 3 (audio compression format)
PaT	Push and Talk (Walkie-Talkie like conversation mode based on GPRS)
PCM	Pulse Code Modulation (audio format)
PWM	Pulse Width Modulation
SPL	Sound Pressure Level
SRT	Siemens Ringer Tone

1.4References

[BGV] Unfallverhütungsvorschrift Lärm, Berufsgenossenschaftliche Vorschrift für Sicherheit und Gesundheit, Ausgabe 2001.
Link to IMS

[TÜV] Stellungnahme TÜV Immissionsschutz und Energiesystem GmbH, 2003-08-27
Link to IMS

[FBT] L55- and Future Generation Requirements to prevent Acoustic Shock, FBT Acoustics, Version 1.4
Link to IMS

[ETSI] Acoustic safety of Terminal Equipment (TE); An investigation on standards and approval documents; ETSI TR 101 800 V1.1.1, July 2000 Link to IMS

2Product Definition

2.1Product Description

These requirements deal with measures that limit the SPL of the signal at the earpiece. These measures can include ramping of the audio signals. A third section lists requirements which lead to keeping an appropriate sound quality and it gives the possibility to limit the power of the signal in the loudspeaker path.

2.1.1SPL limitation requirements

ASP_PL.RQ.01 Limit of the loudspeaker output

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**C**	**H**

The sound pressure level of the audio signal at any sound outlet shall never exceed a maximum output level MAX.

Target Parameters	Maximum output level MAX = 155dB (SPL)
Standards	[FBT]
Interworking	

ASP_PL.RQ.05 Signal sounds in a handset call

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

Signal sounds during a GSM speech call (using the handset mode) shall never exceed 118dB (SPL) measured at the earpiece.

Target Parameters	
Standards	[FBT]
Interworking	

ASP_PL.RQ.06 Signal sounds in idle mode

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

Ramping must be applied to any signal sound in idle mode exceeding 130dB (SPL) measured at the earpiece.

Target Parameters	
Standards	[FBT]
Interworking	Requirements in chapter 2.1.2

2.1.2Ramping requirements

Ramping of the audio event is needed if the sound pressure at the earpiece in idle mode exceeds the one specified in ASP_PL.RQ.06.

2.1.2.1Basic ramping requirements

ASP_RA.RQ.01 Ramping

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

At the start of a sound signal or after long pauses (see section 2.1.2.2) within a sound signal the ramping functionality shall increase the level - beginning from a defined start level - up to a given end level (given by the volume step that has been chosen), using small level increments.

Target Parameters

Standards

Interworking

Remark:

For a graphical example of this requirement, see Figure 1.

For audio playback as well as during a call, the user of a mobile device can choose between a certain number of volume steps (volume step 0: mute, volume step 1: lowest unmuted level; volume step max: highest level).

It has to be taken special care that the maximum output level will not be obtained with volume steps below the maximum volume step.

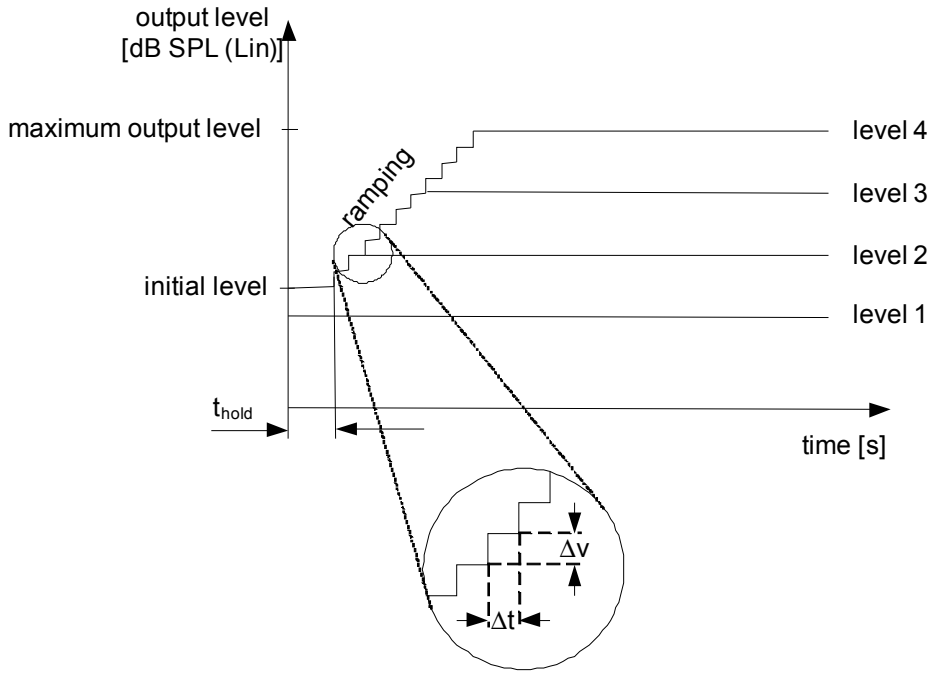

Figure 1: Ramping scheme of audio events (example for four volume steps)

ASP_RA.RQ.02 Initial level of ramping

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**C**	**H**

The initial level MIN shall never exceed 130dB (SPL).

Target Parameters Initial level MIN

Standards

Interworking

ASP_RA.RQ.03 Hold time of initial level

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**CR-PL65-392**	**H**	**H**

The initial level shall be held for t_{hold}=750ms.

Target Parameters Hold time t_{hold}

Standards

Interworking

Remark:

For a graphical example of this requirement, see Figure 1.

ASP_RA.RQ.04 Level after one second

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**[TÜV]**	**C**	**H**

From starting the ramping it shall take at least 1 second (including t_{hold}) to reach levels above 140dB (SPL).

Target Parameters Time threshold, level threshold

Standards

Interworking

ASP_RA.RQ.05 Ramping steps

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

The duration Δt and the height Δv of the steps of loudness increase shall be adjustable by two parameters (see Figure 1).

Target Parameters Duration Δt, Height Δv

Standards

Interworking

ASP_RA.RQ.06 Ramping speed

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

The duration and the height of the ramping steps shall be chosen that the digital level increases by 20dB per second.

Target Parameters Ramping speed

Standards

Interworking

ASP_RA.RQ.07 Initial ramping level dependency

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**CR-PL65-392**	**H**	**H**

The initial level shall depend on the adjusted volume step of the mobile as far as ASP_RA.RQ.02 is not violated.

Target Parameters

Standards

Interworking

Remark:

If the adjusted volume step is higher than the initial level MIN, then the ramping starts at MIN. If the adjusted volume step is below MIN, no ramping needs to be applied.

For a graphical example of this requirement, see Figure 2.

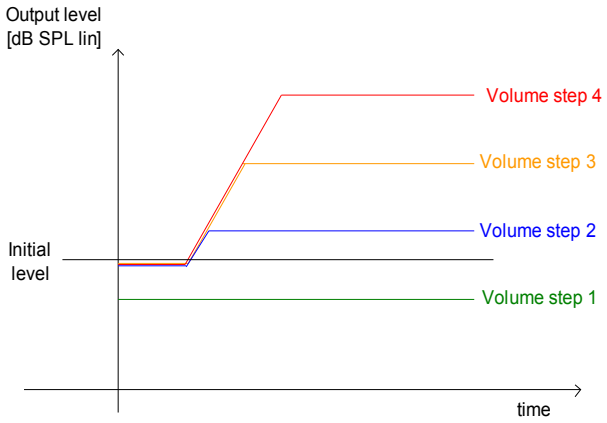

Figure 2: Dependency of initial level to volume step

ASP_RA.RQ.08 Ramping constraint

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**C**	**H**

The ramping functionality shall never amplify the signal.

Target Parameters

Standards

Interworking SetVolume command in audio scheduler

Remark:

The ramping functionality introduces attenuation, only. Amplification of the signal is not allowed.

2.1.2.2Pause detection requirements

ASP_RA.RQ.09 Pause detection

	Req. Type	Req. Originator	Req. Priority	Req. Stability

Value	**Functional**	**FBT Acoustic**	**H**	**H**

The ramping functionality shall detect pauses during an audio event.

Target Parameters

Standards

Interworking

Remark:

A pause is assumed if the estimated power of the audio signal is below a threshold given by a parameter. This parameter can be adapted to the sound format of the audio event.

ASP_RA.RQ.10 Pause detection threshold

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

The pause detection threshold shall be adjustable by a parameter.

Target Parameters

Sound format	Pause detection threshold
SRT	-50 dB (FS)
MIDI / ADPCM / PCM	-40 dB (FS)
AMR	-70 dB (FS) (for S-GOLDlite, S-GOLD2, S-GOLD3) -40 dB (FS) (for EGOLDlite)
MP3 / AAC	-40 dB (FS) (for S-GOLD2, S-GOLD3)

Standards

Interworking

ASP_RA.RQ.11 Differentiation of short pauses and long pauses

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

The ramping algorithm must be able to differ between short pauses and long pauses.

Target Parameters

Standards

Interworking

ASP_RA.RQ.12 Threshold for differentiation of short pauses and long pauses

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**M**	**H**

The threshold that defines the maximum length of a short pause shall be adjustable by a parameter.

Target Parameters

Mobile Device Platform	Maximum length of short pause
EGOLDlite	∞ sec (all pauses are detected as short pauses)
S-GOLDlite	3sec (±0.3 sec)
S-GOLD2	3sec (±0.3 sec)
S-GOLD3	3sec (±0.3 sec)

Standards

Interworking

ASP_RA.RQ.13 Ramping behavior after short pauses

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

After a short pause, the ramping shall resume with the same attenuation as before the pause.

Target Parameters

Standards

Interworking

Remark:

This requirement is also known as “intelligent ramping”. For a graphical example of this requirement, see Figure 3. During a pause, the ramping attenuation is not changed.

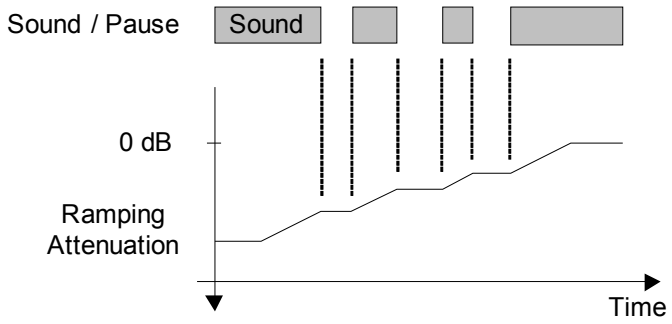

Figure 3: Ramping behavior during pauses

This requirement is especially useful for applications like Push and Talk (PaT) that do not output a single audio stream but numerous separate audio events.

ASP_RA.RQ.14 Pause detection between audio events

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**CR PL-65-410**	**M**	**H**

The pause detection shall also detect pauses between different audio events.

Target Parameters

Standards

Interworking

ASP_RA.RQ.15 Ramping behavior after long pauses

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

After a long pause, the ramping shall restart with an initial level as described in ASP_RA.RQ.02 and ASP_RA.RQ.07

Target Parameters

Standards

Interworking

ASP_RA.RQ.16 Exception from ramping behavior after short pauses

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

If the amplification of the audio path increases from one audio event to another audio event so that the second audio event could exceed a level of 130dB (SPL), the ramping shall restart with an initial level as described in ASP_RA.RQ.02 and ASP_RA.RQ.07 for the second audio event.

Target Parameters

Standards

Interworking

Remark:

As an example, the following use case is considered: the dictation machine plays back a voice memo in handset mode. During this playback, the mobile device alerts an incoming voice call with a ringing tone. This requirement prevents the user from acoustic shock.

2.1.2.3Crescendo mode requirements

ASP_RA.RQ.17 Crescendo mode

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

The ramping functionality shall also work in crescendo mode.

Target Parameters

Standards

Interworking Audio Control µC, SetVolume command

Remark:

In the crescendo mode, the volume of the sound will be successively increased from the lowest volume step to the highest volume step. Every volume step will be held for a certain amount of time (see Figure 4).

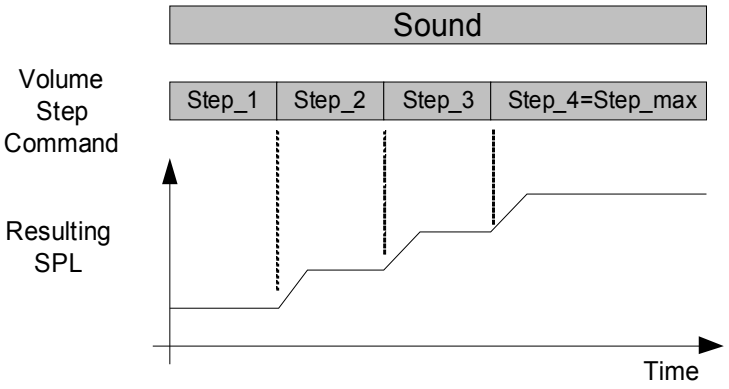

Figure 4: Crescendo mode: behavior for change of volume step

ASP_RA.RQ.18 Stereo mode behavior

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

If the mobile device supports playback of stereo signals, the same ramping parameter set shall be used for left and right channel.

Target Parameters

Standards

Interworking

2.1.2.4Other requirements

ASP_RA.RQ.19 Pause detection in stereo mode

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

If the mobile device supports playback of stereo signals, the pause shall be detected if both channels contain pauses at the same time.

Target Parameters

Standards

Interworking

ASP_RA.RQ.20 Audio mixing mode behavior

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

If the mobile device supports mixing of two audio signals, the ramping attenuation of the first audio signal shall also be used to attenuate the second audio signal.

Target Parameters

Standards

Interworking

Remark:

Use Case Java Game: first audio signal is background music, second audio signal could be game related sounds (e.g. shots).

ASP_RA.RQ.21 Versatility

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

The ramping functionality shall be tunable for every audio format supported by the mobile device, especially for every sampling frequency and for any dimension of the signal (mono or stereo).

Target Parameters

Standards

Interworking

Remark:
For S-GOLDlite, the ramping parameters are definable for the following groups of sound formats:

- SRT
- MIDI/ADPCM
- AMR

ASP_RA.RQ.22 Error checking of block length parameters

	Req. Type	Req. Originator	Req. Priority	Req. Stability
Value	**Functional**	**FBT Acoustic**	**H**	**H**

A detection mechanism for erroneous block length parameters shall be implemented in the ramping algorithm.
The audio stream shall be muted if erroneous block length parameters are detected, that might cause an acoustic shock.

Target Parameters

Standards

Interworking

Remark:

Not all parameters have to be checked by SW. The following plausibility checks are performed:

- Number of subblocks < 6
- Block length modulus number of sub-blocks = 0

2.1.3Requirements for Keeping Sound Quality at Limitation

Concerning the acoustic shock protection there are no special requirements to the sound quality. On the other hand the sound quality becomes less if the loudspeaker is driven at its highest volume. In this case the crest factor is too high and decreases the audibility of the sound.

1.5Man Machine Interface

Not applicable.

1.6Variants

Not applicable.

1.7Conflict Handling

Not applicable.

2Technical Requirements

Not applicable.

3System Requirement

3.1Memory Requirements

2.1.1RAM

Not applicable.

2.1.2ROM (program code and const data)

Not applicable.

2.1.3Flash File System (Caches, Registry, etc)

Not applicable.

2.1.4EESIMU

3.1.1.1EELITE

Not applicable.

3.1.1.2EEFULL

Not applicable.

2.2Speed Requirements

Not applicable.

2.3Hardware Requirements

Not applicable.

2.4Operating System

Not applicable.

2.5Further Footprint

Not applicable.

2.6Dependencies to Other Components

Not applicable.

4Appendix: Measurement Procedure

4.1Purpose

The purpose of the following chapters is to describe the correct measurement setup for acoustic shock measurement.

4.2References

[ITU-T P57] ITU-T P57 1a, 1b

[ETSI] ETSI TR 101 800, V1.1.1 (2000/07)

[ITU-T P51] ITU-T P.51

[IEC 318] IEC 318

[IEC 711] IEC 711

4.3Acoustic Measurement Setup

This chapter describes the acoustical measurement method used to measure the sound pressure levels mentioned in the acoustic shock requirements.

With regards to the equipment other than the ear (ear types are described in [ITU-T P57]) the equipment must fullfill IEC 651 type 1 (+/-0.7dB).

4.3.1Frequency Weighting

All signals have to be measured with linear weighting (Lin).

4.3.2Frequency Correction

No DRP to ERP correction [ITU-T P57] must be used.

4.3.3Time Constants / Averaging

SPL measurements are done with

- time constant “PEAK” (10…100 µsec.) [ETSI] and
- Max. Hold.

4.3.4Measurement Coupler

SPL value is measured with all of the following measurement couplers:

1. Coupler according to [IEC 318], [ITU-T P51] Type 1
2. Coupler according to [IEC 711] with type 3.2 simplified pinna simulator, [ITU-T P51] low leak
3. Coupler according to [IEC 711] with type 3.2 simplified pinna simulator, [ITU-T P51] high leak

The maximum SPL value is determined by choosing the highest value of these couplers.

4.3.5Mechanical Mounting

The measurement coupler has to be mounted sealed on the mobile phone housing.