



# Speech Performance Test Plan

**Revision 1.0**

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## TABLE OF CONTENTS

<b>SECTION 1 INTRODUCTION.....</b>	<b>1</b>
1.1 PURPOSE.....	1
1.2 SCOPE.....	1
1.3 APPLICABLE DOCUMENTS .....	1
1.4 ACRONYMS AND DEFINITIONS.....	2
<b>SECTION 2 TEST CASES .....</b>	<b>3</b>
2.1 TEST CASES FOR 3GPP AND 3GPP2 METHODS.....	3
2.2 ADDITIONAL TEST CASES, HANDSET AND HEADSET, FOR 3GPP METHODS .....	6
2.3 RADIO NETWORKS AND CODECS .....	6
2.4 DEVICE POSITIONING.....	7
2.5 TEST METHODS FOR QUALITY IN THE PRESENCE OF AMBIENT NOISE .....	9
<b>APPENDIX 1 VERIFICATION METHOD FOR BACKGROUND NOISE SIMULATION 10</b>	
<b>APPENDIX 2 CHANGE HISTORY .....</b>	<b>12</b>

## Section 1 Introduction

### 1.1 Purpose

The purpose of this document is to define the CTIA Certification Program test requirements for measuring the performance of 3GPP and 3GPP2 speech capable wireless devices.

### 1.2 Scope

This document defines a set of standard test measurements, with associated test setup and test signal conditions, for narrowband mode. Devices designed for GSM/UMTS or CDMA will be tested per the respective standard contained herein. Results are informative at this point.

### 1.3 Applicable Documents

The following documents are referenced in this test plan:

- [1] 3GPP TS26.132 v11.4.0 (2014-01) 3<sup>rd</sup> Generation Partnership Project; Technical Specification Group Services and System Aspects; Speech and video telephony terminal acoustic test specification (Release 11)
- [2] ETSI TS 103 106, v1.3.1 (2014-04) Speech and multimedia Transmission Quality (STQ): Speech quality performance in the presence of background noise: Background noise transmission for mobile terminals – objective test methods.
- [3] ETSI ES 202 396-1, v1.5.1 (2014-01) Speech and multimedia Transmission Quality (STQ): Speech quality performance in the presence of background noise: Part 1: Background noise simulation technique and background noise database
- [4] 3GPP2 C.S0056-A v.1.0 (2013-03) Electro-Acoustic Recommended Minimum Performance Specification for cdma2000 mobile stations
- [5] ITU-T P.57 Ed. 6 (2011-12) Artificial Ears
- [6] ITU-T P.58 Ed. 4 (2013-05) Head and torso simulator for telephony
- [7] ITU-T P.64 Ed. 8 (2007-11) Determination of sensitivity/frequency characteristics of local telephone systems
- [8] ITU-T P.380 Ed. 1 (2003-11) Electro-acoustic measurements on headsets
- [9] ITU-T P.581 Ed. 3 (2014-02) Use of head and torso simulator (HATS) for hands-free and handset terminal testing

- [10] IEEE 269-2010: IEEE Standard Methods for Measuring Transmission Performance of Analog and Digital Telephone Sets, Handsets, and Headsets
- [11] 3GPP TS26.131 v11.4.0 (2014-01) 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Terminal acoustic characteristics for telephony; Requirements (Release 11)

#### **1.4 Acronyms and Definitions**

DRP – Drum Reference Point

ERP – Ear Reference Point

HATS – Head and Torso Simulator

HFRP – Hands Free Reference Position

ID – Independent of Direction

MECRP – Manufacturer Ear Cap Reference Position

MRP – Mouth Reference Point

RCV – Receive direction

RFR – Receive Frequency Response

RLL – Receiving Loudness Rating

SFR – Send Frequency Response

SLR – Sending Loudness Rating

SND – Sending or Transmit direction

STMR – Sidetone Masking Rating

TCLw – Terminal Coupling Loss, Weighted

## Section 2 Test Cases

### 2.1 Test Cases for 3GPP and 3GPP2 Methods

Harmonization of 3GPP and 3GPP2 standards permits a common set of test methods, as listed in the tables below.

#### 2.1.1. Handset Mode

TABLE 2.1-1 HANDSET MODE TEST CASES AND APPLICABLE SETTINGS

Handset Narrowband Test Cases		Measurement Setup				Standards Reference for each Test ID		
Test ID	Parameter (Metric)	Test Signal	Level	DUT Volume Control	Appl. Force [N]	Document	Rev.	Sect.
NB-001 <sup>1</sup>	RLR (dB) - Receive Loudness Rating	P.501 real speech	-16 dBm0	nominal	8	3GPP TS 26.132	11.4.0	7.2.2.2
						3GPP2 C.S0056-A	1.0	2.1.2.2
NB-002 <sup>1</sup> NB-018	RLR (dB) - Receive Loudness Rating	P.501 real speech	-16 dBm0	maximum	8 13	3GPP TS 26.132	11.4.0	7.2.2.2
						3GPP2 C.S0056-A	1.0	2.1.2.2
NB-003 <sup>1</sup>	SLR (dB) - Sending Loudness Rating	P.501 real speech	-4.7 dBPa	nominal	8	3GPP TS 26.132	11.4.0	7.2.2.1
						3GPP2 C.S0056-A	1.0	2.2.2.2
NB-004 <sup>1</sup>	Idle Channel Noise SND	n/a <sup>2</sup>	n/a	nominal	8	3GPP TS 26.132	11.4.0	7.3.1
						3GPP2 C.S0056-A	1.0	2.2.4.2
NB-005 <sup>1</sup>	Idle Channel Noise RCV	n/a <sup>2</sup>	n/a	maximum	8	3GPP TS 26.132	11.4.0	7.3.2
						3GPP2 C.S0056-A	1.0	2.1.3.2
NB-006	RFR - Receive frequency response	P.501 real speech	-16 dBm0	nominal	8	3GPP TS 26.132	11.4.0	7.4.2
						3GPP2 C.S0056-A	1.0	2.1.1.2
NB-007	SFR - Send frequency response	P.501 real speech	-4.7 dBPa	nominal	8	3GPP TS 26.132	11.4.0	7.4.1
						3GPP2 C.S0056-A	1.0	2.2.1.2
NB-008 <sup>1</sup>	TCLw (weighted terminal coupling loss)	P.501 compressed speech	-10 dBm0	maximum	2	3GPP TS 26.132	11.4.0	7.7.3
						3GPP2 C.S0056-A	1.0	2.2.3.2
NB-009	Quality in presence of ambient noise: SMOS, NMOS, GMOS	real speech	-1.7 dBPa	nominal	8	3GPP TS 26.132	11.4.0	7.12
		ETSI TS 103 106				3GPP2 C.S0056-A	1.0	2.7.2
NB-010 <sup>1</sup>	Round-trip Delay (ms)	single word	-4.7 dBPa	nominal	8	3GPP TS 26.132	11.4.0	7.10.3
NB-011						3GPP2 C.S0056-A	1.0	2.6.2
NB-012 <sup>1</sup>	Max acoustic pressure	PeakLevel	+3 dBm0	maximum	13	IEEE 269	2010	8.6
NB-013 NB-014	STMR (Sidetone Masking Rating)	P.501 real speech	-4.7 dBPa	nominal, F = 8		3GPP TS 26.132	11.4.0	7.5.1.2
				maximum, F = 13		3GPP2 C.S0056-A	1.0	2.5.1.2
NB-015	Sidetone delay	P.501 real speech	-4.7 dBPa	nominal	8	3GPP TS 26.132	11.4.0	7.5.4
						3GPP2 C.S0056-A	1.0	2.5.2.2
<p><b>Note 1:</b> If Device supports both UMTS and GSM mode, the Test IDs (marked with <sup>1</sup>) are to be performed and documented for both modes.</p> <p><b>Note 2:</b> A test signal, such as CSS bursts, may have to be intermittently applied to prevent 'silent mode' operation of the MS. Such a test signal should be documented by the tester, if used.</p>								

## 2.1.2. Handheld Hands-free/Speakerphone Mode

TABLE 2.1-2 HANDHELD HANDS-FREE/SPEAKERPHONE MODE TEST CASES AND APPLICABLE SETTINGS

HH Hands-free Narrowband Test Cases		Measurement Setup				Standards Reference for each Test ID		
Test ID	Parameter (Metric)	Test Signal	Level	DUT Volume Control	Distance	Document	Rev.	Sect.
NB-040	RLR (dB) - Receive Loudness Rating	P.501 real speech	-16 dBm0	maximum	HFRP <sup>1</sup>	3GPP TS 26.132	11.4.0	7.2.4.2
						3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-041	SLR (dB) - Sending Loudness Rating	P.501 real speech	-4.7 dBPa	nominal	HFRP <sup>1</sup>	3GPP TS 26.132	11.4.0	7.2.4.1
						3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-042	RFR - Receive frequency response	P.501 real speech	-16 dBm0	nominal	HFRP <sup>1</sup>	3GPP TS 26.132	11.4.0	7.4.6
						3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-043	SFR - Send frequency response	P.501 real speech	-4.7 dBPa	nominal	HFRP <sup>1</sup>	3GPP TS 26.132	11.4.0	7.4.5
						3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-044	TCLw (weighted terminal coupling loss)	P.501 compressed speech	-10 dBm0	maximum	HFRP <sup>1</sup>	3GPP TS 26.132	11.4.0	7.7.2
						3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
<p><b>Note 1:</b> See section 2.4.2 (Device positioning Handheld Hands-free / Speakerphone mode for HFRP acceptable value)</p> <p><b>Note 2:</b> For 3GPP2 Test Cases; Handheld Hands-free mode is not in the scope of reference [4], and while testing should be carried out in a similar fashion and methodology as per reference [1], radio system setup shall be in compliance with reference [4].</p>								

### 2.1.3. Headset Mode

TABLE 2.1-3 HEADSET MODE TEST CASES AND APPLICABLE SETTINGS

Headset Narrowband Test Cases		Measurement Setup			Standards Reference for each Test ID		
Test ID	Parameter (Metric)	Test Signal	Level	DUT Volume Control	Document	Rev.	Sect.
NB-060 NB-061	RLR (dB) - Receive Loudness Rating	P.501 real speech	-16 dBm0	nominal	3GPP TS 26.132	11.4.0	7.2.2.2
maximum				3GPP2 C.S0056-A	1.0	Note <sup>2</sup>	
NB-062	SLR (dB) - Sending Loudness Rating	P.501 real speech	-4.7 dBPa	nominal	3GPP TS 26.132	11.4.0	7.2.2.1
					3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-063	Idle Channel Noise SND	n/a <sup>1</sup>	n/a	nominal	3GPP TS 26.132	11.4.0	7.3.1
					3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-064	Idle Channel Noise RCV	n/a <sup>1</sup>	n/a	maximum	3GPP TS 26.132	11.4.0	7.3.2
					3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-065	RFR - Receive frequency response	P.501 real speech	-16 dBm0	nominal	3GPP TS 26.132	11.4.0	7.4.2
					3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-066	SFR - Send frequency response	P.501 real speech	-4.7 dBPa	nominal	3GPP TS 26.132	11.4.0	7.4.1
					3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-067	TCLw (weighted terminal coupling loss)	P.501 compressed speech	-10 dBm0	maximum	3GPP TS 26.132	11.4.0	7.7.3
					3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-068	Round-trip Delay (ms)	single word	-4.7 dBPa	nominal	3GPP TS 26.132	11.4.0	7.10.3
					3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
NB-069 NB-070	STMR (Sidetone Masking Rating)	P.501 real speech	-4.7 dBPa	nominal	3GPP TS 26.132	11.4.0	7.5.1.2
maximum				3GPP2 C.S0056-A	1.0	Note <sup>2</sup>	
NB-071	Sidetone delay	P.501 real speech	-4.7 dBPa	nominal	3GPP TS 26.132	11.4.0	7.5.4
					3GPP2 C.S0056-A	1.0	Note <sup>2</sup>
<p><b>Note 1:</b> A test signal, such as CSS bursts, may have to be intermittently applied to prevent 'silent mode' operation of the MS. Such a test signal should be documented by the tester, if used.</p> <p><b>Note 2:</b>For 3GPP2 Test Cases, Headset mode is not in the scope of reference [4], and while testing should be carried out in a similar fashion and methodology as per reference [1], radio system setup shall be in compliance with reference [4]</p>							



## 2.2 Additional Test Cases, Handset and Headset, for 3GPP Methods

Two additional test cases for each of Handset and Headset have been added to the test plan for 3GPP methods only.

TABLE 2.2-1 ADDITIONAL TEST CASES FOR 3GPP METHODS IN HANDSET AND HEADSET MODES

Handset/Headset Narrowband Test Cases		Measurement Setup				Standards Reference for each Test ID		
Test ID	Parameter (Metric)	Test Signal	Level	DUT Volume Control	Appl. Force [N]	Document	Rev.	Sect.
NB-016	Handset Distortion, SND	Sinusoidal	5, 0, -4.7, -10, -15, -20 dBPa	nominal	8	3GPP TS 26.132	11.4.0	7.8.1
NB-017	Handset Distortion, RCV	Sinusoidal + activation	0, -3, -10, -16, -20, -30, -40, -45 dBm0	nominal	8	3GPP TS 26.132	11.4.0	7.8.2
NB-072	Headset Distortion, SND	Sinusoidal	5, 0, -4.7, -10, -15, -20 dBPa	nominal	8	3GPP TS 26.132	11.4.0	7.8.1
NB-073	Headset Distortion, RCV	Sinusoidal+ activation	0, -3, -10, -16, -20, -30, -40, -45 dBm0	nominal	8	3GPP TS 26.132	11.4.0	7.8.2

## 2.3 Radio Networks and Codecs

In a device which supports narrowband functionality, testing shall be performed over UMTS Band II (1900 MHz) on AMR 12.2 kbps. The specific UMTS radio carrier frequency and channel number tested on shall be documented. In a device which supports both GSM and UMTS, Narrowband Test IDs in Table 2.3-1 marked with “1” shall be tested over GSM PCS band 1900 MHz on AMR 12.2 kbps.

Tests shall be performed for one of the channel pairs listed in the tables below.

TABLE 2.3-1 UMTS RX AND TX TEST FREQUENCIES

Band	Channel Pair (UARFCN)	Designation	Frequency (MHz)
UMTS 1900 (3GPP BAND II)	9262	CH4-TX	1852.40
	9662	CH4-RX	1932.40
	9400	CH5-TX	1880.00
	9800	CH5-RX	1960.00
	9538	CH6-TX	1907.60
	9938	CH6-RX	1987.60

TABLE 2.3-2 GSM RX AND TX TEST FREQUENCIES

Band	Channel Pair	Designation	Frequency (MHz)
GSM 1900 (PCS)	512	CH4-TX	1850.20
	512	CH4-RX	1930.20
	661	CH5-TX	1880.00
	661	CH5-RX	1960.00
	810	CH6-TX	1909.80
	810	CH6-RX	1989.80

In a device which supports CDMA, testing shall be performed using **EVRC-S03 8.55 kbps** in Radio Configuration 3 and, if supported, also using **EVRC-B-S068 6.6 kbps** (*Note: This does deviate from the C.S0056 standard*). Either cell band 850 MHz channel 384 or PCS band 1900 MHz channel 600 shall be used and documented accordingly.

**Note:** Test SIMs/PRLs in non-RF shielded environments may be required on any type of device and shall be documented.

## 2.4 Device Positioning

### 2.4.1 Handset Mode

When testing a device in handset mode, it is mounted on the HATS in position and orientation as described in ITU-T P.64 [7] as per Annex E and the Manufacturer Ear Cap Reference Position (MECRP). If no MECRP is declared, the Standard Position per Annex E shall be used. As defined in P.64 Annex E, the Standard Position angles A, B, and C are reproduced in Table 2.4-1 below. Note that the tolerance of these values is to within 0.1°, as given by the precision of the values.

TABLE 2.4-1 HANDSET STANDARD POSITION ANGLES

Angle	Value [degrees]
A	21.2
B	-12.9
C	2.3

For handsets where MECRP is provided, the values must be reported as in Table 2.4-2 below. See the user guide from the specific HATS' manufacturer for relative angle positioning.

TABLE 2.4-2 TABLE FOR REPORTING MECRP POSITIONING VALUES

MECRP (delta from actual ECRP)	
Axis	Delta [mm]
Y <sub>e</sub>	
Z <sub>e</sub>	
Angle Settings	
Angle	Delta from standard angle [°]
A	
B	
C	

The artificial mouth shall conform to ITU-T P.58[6]. The artificial ear shall conform to ITU-T P.57[5]. Type 3.3 artificial ear shall be used. The applied force shall be as indicated in TABLE 2.1-1.

**Note: Measurements of noise suppression performance in alternate positions may be desirable. The test report shall include details of handset position and orientation in accordance with Annex E of ITU-T P.64[7].**

For tests requiring a Nominal volume setting and a user controllable receive volume control is provided on the device, the setting shall be chosen such that the nominal RLR of 2 dB is met as closely as possible. For tests where a Maximum volume setting is required, the user controllable volume control shall be set to the maximum setting.

Device manufacturers strive to meet the receiving frequency response mask at Nominal Receive volume, so in case the Receiving Frequency response is failing, MECRP values should be reconfirmed or the device slightly re-adjusted as the HATS artificial pinna is pliable and the device may seal up the ear concha cavity, resulting in a bass heavy response. Alternatively, the device may not seal well to the pinna and have a weak bass response, a remount or ever so slight adjustment may correct this. Reconfirm the Nominal RLR after any such adjustment and document settings.

#### 2.4.2. Handheld Hands-free/Speakerphone mode

When testing a device in handheld hands-free mode, it is mounted in the HATS HFRP in position and orientation as described in 3GPP TS 26.132 [1] as per Section 5.1.3.3. The distance  $d_{HF}$  and the angle  $\Theta_{HF}$  between the HATS reference point and the device display is defined by the device manufacturer; if no such position is declared a Standard Position of 42-cm and angle of 0° will be used. When HATS is used, testing shall be in compliance with ITU-T P.581[9]. The artificial mouth shall conform to ITU-T P.58[6]. The artificial ear shall conform to ITU-T P.57[5]. A Type 3.3 artificial ear may be used.

### **2.4.3. Headset Mode**

When testing a device including a headset, the headset is mounted in its recommended wearing position as described in 3GPP TS 26.132 [1] per Section 5.1.2 and per ITU-T P.380[8], Clause 6. The device manufacturer should provide at least one headset to be used for this test. For first time tests of headsets; 5 repeat measurements with refit of the headset in the pinna is recommended and the average of at least 3 consistent measurements be reported. The artificial mouth shall conform to ITU-T P.58[6]. The artificial ear shall conform to ITU-T P.57[5]. Type 3.3 artificial ear shall be used.

## **2.5 Test Methods for Quality in the Presence of Ambient Noise**

### **2.5.1. Speech Material**

Appropriate speech material are referenced in Annex C of ETSI TS 103 106 [2]. Only the last 16 sentences are used for individual predictions, then the 16 numbers are averaged into per-condition scores. The first 4 sentences are used to secure a steady voice channel.

### **2.5.2. Background Noise Simulation and Spectral Validation**

Background noise simulation is to be in accordance with ETSI ES 202 396-1 [3], note the test room requirements in section 6.1. If an office type room is used, reverberation time should be in the interval  $0.2 \text{ s} < RT60 < 0.7 \text{ s}$  between 100 Hz and 8 kHz and noise floor should be below 30 dB SPL(A). Background noise types to be used are listed in 3GPP TS 26.132 [1].

In particular, reliable results require accurate simulation of background noise levels and power spectra. It is required to perform spectral validation for each noise type to be used. Spectral validation consists of recording the simulated background noise, and recording at the two HATS artificial ears. After appropriate application of ID equalization to the DRP recordings, the measured power spectra are compared to the power spectra of the source noise signals, in  $1/3^{\text{rd}}$  octave bands. The measured power spectra shall be within  $\pm 3\text{dB}$  of the reference source power spectra in each  $1/3^{\text{rd}}$  octave band.

A final check on the background noise simulation shall be conducted using the method described in Appendix 1 Verification Method for Background Noise Simulation.

### **2.5.3. Measurement Procedure**

Measurements shall follow the requirements in TS 103 106 [2], Section 9, with the background noise setup in accordance to ETSI ES 202 396-1[3].

## Appendix 1 Verification Method for Background Noise Simulation

### Objective

This method is based on 3GPP contribution S4-130400, Reference scores for 3Qest [A1]. The goal is to provide an additional validation of the background noise simulation.

### Method

After the background noise simulation has been set up and verified to be in compliance with requirements in ETSI ES 202 396-1 [3], and the HATS properly equalized with speech levels set, recordings are taken using the method of ETSI TS 103 106 [2], but with measurement microphones used to provide the required ‘processed’ and ‘unprocessed’ signals. A measurement microphone placed at HATS MRP is used to provide the ‘processed’ signal (i.e., good SNR), while the HATS ear with ID equalization is used to provide the noisy ‘unprocessed’ signal (i.e., poor SNR).

The speech and noise levels are as referenced for Test Case NB-009 of Table 2.1-1. One additional measurement is taken using speech but no additional background noise.

Reference scores using ETSI TS 103 106 [2] are computed in both wideband and narrowband modes, with the proxy ‘processed’ signal (recorded at MRP) filtered appropriately as in Table A-1. Both high-pass and low-pass filters are applied to simulate the effect of the telephone channel of corresponding bandwidth. No filter (other than ID equalization) is applied to the proxy ‘unprocessed’ signal (recorded at DRP).

TABLE A-1 FILTERS FOR REFERENCE SCORES

Test Case	High-pass filter	Low-pass filter
Narrowband	4 <sup>th</sup> order, at 100Hz	4 <sup>th</sup> order, at 4000Hz
Wideband	4 <sup>th</sup> order, at 100Hz	4 <sup>th</sup> order, at 8000Hz

Reference scores should be within  $\pm 0.2$  MOS of the values for narrowband, Table A-2, and for wideband, Table A-3. Filenames are taken from ETSI ES 202 396-1 [3].

TABLE A-2 REFERENCE SCORES FOR NARROWBAND

Condition	Filename	SMOS	NMOS
Recording in pub	Pub_Noise_binaural_V2	3.1	2.0
Recording at pavement	Outside_Traffic_Road_binaural	3.0	1.9
Recording at pavement	Outside_Traffic_Crossroads_binaural	3.3	2.5
Recording at departure platform	Train_Station_binaural	3.4	2.4
Recording at the drivers position	Fullsize_Car1_130Kmh_binaural	3.8	2.4
Recording at sales counter	Cafeteria_Noise_binaural	3.9	2.5
Recording in a cafeteria	Mensa_binaural	4.1	2.7
Recording in business office	Work_Noise_Office_Callcenter_binaural	4.3	3.1
Quiet	<none>	4.7	3.9

TABLE A-3 REFERENCE SCORES FOR WIDEBAND [FROM A2]

Condition	Filename	SMOS	NMOS
Recording in pub	Pub_Noise_binaural_V2	4.2	2.4
Recording at pavement	Outside_Traffic_Road_binaural	3.3	2.6
Recording at pavement	Outside_Traffic_Crossroads_binaural	4.3	2.3
Recording at departure platform	Train_Station_binaural	4.3	3.0
Recording at the drivers position	Fullsize_Car1_130Kmh_binaural	4.4	2.8
Recording at sales counter	Cafeteria_Noise_binaural	4.4	2.8
Recording in a cafeteria	Mensa_binaural	4.5	3.1
Recording in business office	Work_Noise_Office_Callcenter_binaural	4.6	3.4
Quiet	<none>	4.6	4.3

## References

[A1] S4-130400, Reference scores for 3Quest, Qualcomm, 3GPP SA4#73, 15-19 March 2013, Qingdao, China [[http://www.3gpp.org/ftp/tsg\\_sa/WG4\\_CODEC/TSGS4\\_73/Docs/S4-130400.zip](http://www.3gpp.org/ftp/tsg_sa/WG4_CODEC/TSGS4_73/Docs/S4-130400.zip)].

[A2] S4-131124, Summary of reference scores for ETSI TS 103 106, Qualcomm, 3GPP SA4#75, 23-27 September 2013, Vancouver, CA. [[http://www.3gpp.org/ftp/tsg\\_sa/WG4\\_CODEC/TSGS4\\_75/Docs/S4-131124.zip](http://www.3gpp.org/ftp/tsg_sa/WG4_CODEC/TSGS4_75/Docs/S4-131124.zip)].

## Appendix 2 Change History

Date	Revision	Description
November 2014	1.0	Initial release