Common tests from ANSI S3.22-2003

Abbreviations	o HFA: High-Frequency Average - the average of values at 1000, 1600 and 2500 Hz. In all tests, HFA may be replaced by SPA: Special Purpose Average - the average of values at three frequencies specified by the hearing aid manufacturer that are at 1/3 octave frequencies separated by 2/3 octave. o RTS: Reference Test Setting - setting of the gain control (i.e. volume control, master or overall gain control) required to produce an HFA-gain within +/- 1.5 dB of the HFA-0SPL90 minus 77 dB for a 60 dB input SPL or, if the full-on HFA gain for a 60 dB input SPL is less than the HFA 0SPL90 minus 77 dB, the full-on setting of the gain control. o AGC: Automatic Gain Control - means for controlling gain as a function of signal level. It includes expansion and various forms of compression.
Notes	o This standard is for quality control purposes. The results are valid only for the test signals, test conditions, hearing aid settings, hooks, tips, filters, wax guards and accessories employed when they were obtained. Unless specified in this standard, these are to be specified by the manufacturer. o All test signals are sinusoidal (pure tones). o Output SPL is measured in a 2cc coupler. BTE hearing aids which use an earhook and earmold are tested using the HA-2 coupler. ITE, ITC,CIC and other hearing aids which place the receiver in the ear canal or which use a thin tube and ear tip are tested using the HA-1 coupler. Vents are plugged at the outer (faceplate) end. o There is no standard coupler for open-fit hearing aids. Most are specified as BTE aids using an earhook. If the thin tube cannot be replaced by an earhook, the eartip is removed and the thin tube sealed to the HA-1 coupler, or an adapter may be provided by the manufacturer. o The hearing aid should be set to omnidirectional mode, its widest frequency response range, greatest HFA-OSPL90, greatest HFA-FOG. o All adaptive features (noise reduction, feedback suppression) should be disabled. o Except for input-output and attack and release time tests, all tests are performed with the AGC set for minimum effect. If test settings are not provided by the manufacturer, this may be accomplished by disabling AGC or by setting all gain and MPO to maximum which should result in a compression ratio near 1 and a compression threshold above 60 dB SPL. o Input-output and attack and release time tests are performed with the AGC set to have maximum effect. If test settings are not provided by the manufacturer, this may be accomplished by setting low-level gain to maximum and high level gain and MPO to minimum. Expansion is set for maximum effect. This will typically show the extremes of what is attainable, producing very flat, input-output curves and maximum values for attack and release times. o Interpretation of tolerances. When checking a hearing aid against manufacturers' specifications, the tolerances given in the table must be increased by the accuracy of the measuring equipment being used. For example, if measurement equipment accuracy is ±1 dB, and the tolerance given in the table for a particular test is ±3 dB, a measured value within ± 4 dB of the value listed by the manufacturer would be considered to be within specification.

Test	Explanation of Test Result	Gain Setting	AGC	Input (dB SPL)	Frequency	Measure or Calculate	Tolerance
OSPL90 curve	Coupler SPL as a function of frequency for a 90 dB input SPL	Full on	Min	90	200 - 5000 Hz	Coupler SPL	unspecified
Maximum OSPL90	The maximum value of the OSPL90 curve	Full on	Min	90	Frequency of maximum	Maximum of OSPL90 curve	+ 3 dB
HFA-OSPL90	Average of the OSPL90 values	Full on	Min	90	HFA	Average coupler SPL at HFA frequencies	± 4 dB
HFA full-on gain (HFA-FOG)	Average of the full-on gain at the HFA frequencies	Full on	Min	50	HFA	Average gain at HFA frequencies	± 5 dB

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Test	Explanation of Test Result	Gain Setting	AGC	Input (dB SPL)	Frequency	Measure or Calculate	Tolerance
reference test gain (RTG)	Average of the gain at the HFA frequencies for a 60 dB input SPL, with gain control at RTS	RTS	Min	60	HFA	Average gain at HFA frequencies	unspecified
Frequency range	Range between the lowest and the highest frequency at which the frequency response curve is 20 dB below its HFA value	RTS	Min	60	From the lowest frequency (f1) to the highest frequency (f2) at which the frequency response curve is 20 dB below its HFA average		unspecified
Frequency response curve	Coupler SPL as a function of frequency for a 60 dB input SPL, with gain control at RTS	RTS	Min	60	From the higher of f1 or 200 Hz to the lower of f2 or 5000 Hz. Wider range may be shown.	Coupler SPL or Gain	±4 dB from the lesser of 1.25 f1 or 200 Hz to 2kHz. ±6 dB from 2kHz to the lesser of 4kHz or 0.8 f2.
Total harmonic distortion (THD)	Ratio of sum of the powers of all the harmonics to the power of the fundamental	RTS	Min	70 except 65 @ highest frequency	500, 800, 1600 Hz (HFA) or ½ the SPA frequencies		+ 3%
Equivalent input noise (EIN)	SPL of an external noise source at the input that would result in the same coupler SPL as that caused by all the internal noise sources in the hearing aid	RTS	Min	OFF and 50	(Coupler SPL with no input) - (HFA gain with a 50 dB input SPL)		+3 dB
Battery current	Electrical current drawn from the battery when the input SPL is 65 dB at 1000 Hz and the gain control is at RTS	RTS	Min	65	1000 Hz	Battery current	+20%
SPL for an inductive telephone simulator (SPLITS)	For hearing aids with an inductive input coil (T-coil), the coupler SPL as a function of frequency when the hearing aid, with gain control at RTS, is oriented for maximum output on a telephone magnetic field simulator (TMFS)). BTE is as flat as possible on test surface. ITE or ITC with faceplate as close as possible and parallel to test surface.	RTS	Min	Telephone magnetic field simulator (TMFS)	200 - 5000 Hz	Coupler SPL.	unspecified
HFA-SPLITS	Average of the SPLITS at the HFA frequencies	RTS	Min	TMFS	HFA	Average SPLITS values at the HFA frequencies	± 6 dB
RSETS	Relative simulated equivalent telephone sensitivity	RTS	Min	TMFS	HFA	HFA-SPLITS minus (RTG + 60)	unspecified
Input-output curves	For hearing aids with AGC, the coupler SPL as a function of the input SPL, at one or more of 250, 500, 1000, 2000, 4000 Hz, with the gain control at RTS	RTS	Max	50 - 90 in 5 dB steps	One or more of 250, 500, 1000, 2000, 4000 Hz	Coupler SPL vs Input SPL	± 5 dB at 50 and 90 dB input SPL when matched at 70 dB input SPL

Test	Explanation of Test Result	Gain Setting	AGC	Input (dB SPL)	Frequency	Measure or Calculate	Tolerance
Attack time	For hearing aids with AGC, the time between an abrupt change from 55 to 90 dB input SPL and the time when the coupler SPL has stabilized to within 3 dB of the steady value for a 90-dB input SPL, at one or more of 250, 500, 1000, 2000, 4000 Hz, with the gain control at RTS	RTS	Max	Step from 55 to 90	Same frequencies used for input-output curves.	Time from input step until coupler SPL settles within 3 dB of its steady value for 90 dB input SPL	± 5 ms or 50%, whichever is greater
Release time	For hearing aids with AGC, the time between an abrupt change from 90 to 55 dB input SPL and the time when the coupler SPL has stabilized to within 4 dB of the steady value for a 55 dB input SPL, at one or more of 250, 500, 1000, 2000, 4000 Hz, with the gain control at RTS	RTS	Max	Step from 90 to 55	Same frequencies used for input-output curves.	Time from input step until coupler SPL settles within 4 dB of its steady value for 55 dB input SPL	± 5 ms or 50%, whichever is greater

Differences between ANSI S3.22-1996 and ANSI S3.22-2003

ANSI S3.22-1996	ANSI S3.22-2003	Significance of Change
Terms HFA and SPA repeated in many definitions & procedures	Term HFA is used in definitions & procedures. SPA may be substituted for HFA wherever it appears.	Simplifies definitions
Gain control: a user-operated gain adjustment	Gain control: a manual or electronic adjustment for overall gain	o Accommodates hearing aids without user volume controls. o Allows gain to be set by software for easier testing.
HFA full-on gain (FOG): gain with gain control at maximum. For linear aid, input SPL = 50 or 60 dB. For AGC aid, input SPL= 50 dB	HFA full-on gain (FOG): gain with gain control at maximum and an input SPL of 50 dB	Eliminates confusion due to the possibility that linear aids could be measured at 50 or 60 dB input SPL.
Basic settings of controls: for linear aids and AGC aids without AGC controls, set controls to provide the widest frequency range, greatest HFA OSPL90 and greatest HFA FOG. For AGC aids having AGC controls, the setting of controls shall be specified by the manufacturer.	Basic settings of controls: set hearing aid for widest frequency range, greatest HFA-OPSL90 and greatest HFA-FOG. Set AGC to have minimum effect for setting RTS and for all tests except input-output curves and attack and release times. For these set AGC for maximum effect. Disable adaptive features. Settings used shall be specified by the manufacturer.	o Performing response, distortion and noise tests free of the effects of AGC provides a clearer indication of transducer and amplifier integrity. o Specifying settings for AGC aids ensures that they are testable in the field without relying on manufacturers to provide test settings. o Specifying input-output curves and attack-release times with AGC set for maximum effect shows the available range for these characteristics - potentially more useful than a “typical” curve.
Reference test gain (RTG): Gain when gain control is set to amplify a 60 dB input SPL to (HFA-OSPL90 minus 17dB OR full-on gain OR HFA OSPL90 minus 77 dB.	Reference test gain (RTG): Gain for an input SPL of 60 dB with the gain control at RTS.	o Eliminates conflicting definitions o Eliminates confusion between a calculated RTG (the target) and the measured RTG.

ANSI S3.22-1996	ANSI S3.22-2003	Significance of Change
Reference test position (RTP) - Setting of the gain control to achieve RTG. *Setting performed with AGC enabled and set as specified by the manufacturer or for maximum effect. Input SPL of 60 dB, unless RTG = FOG; then it could be 50 or 60 dB SPL.*	Reference test setting (RTS) - Setting of gain control to produce an HFA gain with a 60 dB input SPL that is within 1.5 dB of the HFA OSPL90 minus 77 dB. *Setting performed with AGC disabled or set for minimum effect.*	o With AGC active, gain depends on input SPL. Slight changes in hearing aid or test setup could change input SPL from 50 to 60 making a large difference in RTP. This is solved by setting RTP with AGC off. o Provides tolerance on setting RTP/RTS
Frequency response curve - gain or coupler SPL at RTP as a function of frequency for an input SPL of 60 dB (linear) or 50 dB (AGC)	Frequency response curve - gain or coupler SPL at RTS as a function of frequency for an input SPL of 60 dB.	o Eliminates artifacts caused by the test signal activating AGC at some frequencies and not at others (“blooming”). o Eliminates dependence on choice of input SPL or AGC settings because AGC is off. o All types of hearing aids are tested at the same input SPL making testing and comparison easier.
Equivalent input noise - the difference between the coupler SPL with no input signal and the HFA gain for a 60 dB input SPL. *User gain control at RTP. For AGC aids a 50 dB input SPL may be used. Ambient noise + equipment noise is low enough if noise measurement drops more than 6 dB when aid is switched off.*	Equivalent input noise (EIN) - the difference between the coupler SPL with no input signal and the HFA gain for a 50 dB input SPL. *Gain control at RTS. Ambient noise is low enough if noise measurement drops less than 1 dB when mic. inlet is blocked. Equipment noise is low enough if noise measurement drops more than 6 dB when hearing aid, with mic. inlet sealed, is switched off. Manufacturer shall report use of low level expansion*	o Eliminates high EIN values resulting from the gain used in the calculation being depressed by the test signal used to measure it. o Corrects error in note for checking ambient and equipment noise levels. o In the 1996 version, it was possible to test EIN with the expansion active. In the 2003 version, expansion should be set for minimum effect for the EIN measurement and this should be stated
Simulated telephone sensitivity (STS) - the difference between the HFA or SPA-SPLITS and (RTG + 60).	Relative simulated equivalent telephone sensitivity (RSETS) - the difference between the HFA or SPA-SPLITS and (RTG + 60).	Only the name has changed