

The Need for Masking

When stimulating one ear for the acquisition of evoked potentials, it is possible that the response from the non-test ear may be inadvertently considered to be the response from the test ear. The effects and contribution of the non-test ear response will depend on the level of stimulation it receives. White noise may be delivered to the non-test ear to eliminate, or mask, any possible contributions from the non-test ear to the test ear response. Eliminating these non-test ear components is only needed when using air conduction testing in patients that show asymmetrical hearing loss, or while using bone conduction testing.

Each stimulator type has an inherent Interaural Attenuation (IA) associated with it. This is the level difference between the perception level of the test signal at the test ear, and the perception level of the same test signal at the non-test ear.

To create a general calculation for the needed masking we will define the following items:

- **SI:** Stimulus Intensity. This is the stimulus level applied to the test-ear.
- **IA:** Interaural Attenuation. Is the perceived level difference between the test and non-test ears.
- **RM:** Required Masking. This is the masking level required to mask the stimulus level and therefore eliminate the contribution from the non-test ear.
- **EMC:** Effective Masking Correction Value. This is the conversion value for white noise from SPL to nHL. (Estimated to be -40dB). This value is needed because masking is output in SPL, while stimuli are usually presented in nHL.

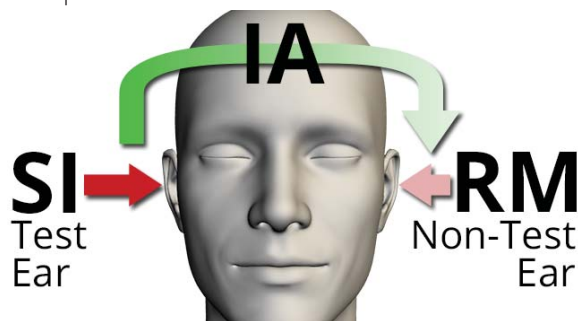


Fig.1 - Stimulus perception levels

Calculating the Required Masking

In order to mask the stimulus signal, an equal level sound, to the one perceived by the non-test ear, should be presented. Given that, the Required Masking (RM) needed is equal to the Stimulus Intensity (SI) minus the Interaural Attenuation (IA):

$$RM \text{ (dB nHL)} = SI \text{ (dB nHL)} - IA \text{ (dB nHL)}$$

This equation provides a value for residual masking given in nHL; however, the signal output of IHS equipment for masking noise is entered and output in dB SPL, so the resulting value needs to be converted. Using the Effective Masking Correction value as follows, we can obtain a converted value:

$$RM \text{ (dB nHL)} = RM \text{ (dB SPL)} + EMC$$

Then solving for RM in dB SPL, the equation becomes:

$$RM \text{ (dB SPL)} = RM \text{ (dB nHL)} - EMC$$

Replacing the value of RM (dB nHL) using the first formula, and given an effective masking correction value for white noise from SPL to nHL of -40 dB, we have a final equation:

$$RM \text{ (dB SPL)} = \{SI \text{ (dB nHL)} - IA \text{ (dB nHL)}\} - (-40)$$

or:

$$RM \text{ (dB SPL)} = SI \text{ (dB nHL)} - IA \text{ (dB nHL)} + 40$$

Masking Levels in SmartEP

The masking level and modality in SmartEP can be set by using the options at the bottom left hand side of the Auditory Stimulus Generation window. To open this window, click the **[Stim]** button on the SmartEP control panel, or use the options under Stimulus in the main menu.

The selected masking levels are always output in SPL. The options allow selection of either a specific masking level or an intensity tracking level.

- **Specific:** When this option is selected, SmartEP will output the value entered in the masking intensity field. Entering a value of '70' in the field will result in a masking level of 70 dB SPL, regardless of the stimulus intensity level.

Masking: Level: ☒ Specific ☐ Tracking

☒ Contralateral ☐ Ipsilateral

dB SPL: 70 dB SPL: 0

☐ SAL Freq: 500Hz

Fig.2 - Specific masking at 70 dB SPL

- **Tracking:** When this option is selected, SmartEP will output a masking level equal to the sum of the stimulus intensity value, regardless of scale, plus the offset value entered in the masking intensity field. Entering a negative number in the field will result in a subtraction; e.g. Entering a value of '20' in the field, while the stimulus intensity is 50 dB (either SPL or nHL), will result in a masking level of 70 dB SPL. Entering a value of '-20' in the field, while the stimulus intensity is 50 dB (either SPL or nHL), will result in a masking level of 30 dB SPL. Modifying the intensity of the stimulus will modify the intensity of the masking by the same amount.

Masking while using Headphones

When using headphones as the stimulator, the estimated Interaural Attenuation has been estimated to be 40 dB. Inserting that value into the previous formula:

$$RM \text{ (dB SPL)} = SI \text{ (dB nHL)} + 0$$

Therefore, the offset value is 0. Then:

- **When the level is set to Specific:** enter the same value as the stimulus level being used. So if the intensity of the stimulus was 70 dB nHL, since the value offset is 0, then the masking should be set to 70 dB SPL.

Masking: Level: ☒ Specific ☐ Tracking

☒ Contralateral ☐ Ipsilateral

dB SPL: 70 dB SPL: 0

☐ SAL Freq: 500Hz

Fig.3 - Specific masking for headphones

Note that when using the Specific option, you must remember to change the value of the masking when changing the intensity value of the stimulus.

- **When the level is set to Tracking:** enter "0" for the offset value.

Masking: Level: ☐ Specific ☒ Tracking

☒ Contralateral ☐ Ipsilateral

dB SPL: 0 dB SPL: 0

☐ SAL Freq: 500Hz

Fig.4 - Tracking masking for headphones

Masking while using Inserts

When using insert earphones as the stimulator, the estimated Interaural Attenuation has been estimated to be 60 dB. Given the formula we previously deducted:

$$RM \text{ (dB SPL)} = SI \text{ (dB nHL)} - 20$$

Therefore the offset value is - 20. Then:

- **When the level is set to specific:** enter stimulus value minus 20. E.g if the stimulation is set to 90 dB nHL, then the masking level should be set to 70 dB SPL, as shown on Fig.5.

Masking: Level: ☒ Specific ☐ Tracking

☒ Contralateral ☐ Ipsilateral

dB SPL: 70 dB SPL: 0

☐ SAL Freq: 500Hz

Fig.5 - Specific masking for inserts

Note that when using the Specific option, you must remember to change the value of the masking when changing the intensity value of the stimulus.

- **When the level is set to tracking:** enter "-20" as the offset value.

Masking: Level: ☐ Specific ☒ Tracking

☒ Contralateral ☐ Ipsilateral

dB SPL: -20 dB SPL: 0

☐ SAL Freq: 500Hz

Fig.6 - Tracking masking for inserts

Masking for Bone Conduction

When using a bone conductor as the stimulator, the estimated Interaural Attenuation has been estimated to be 0 dB. Inserting that value into the previous formula:

$$RM \text{ (dB SPL)} = SI \text{ (dB nHL)} + 40$$

Therefore, the offset value is 40. Then:

- **When the level is set to specific:** enter the stimulus value plus 40. E.g. if the stimulation value for the bone conductor is set to 55 dB nHL, then the masking level should be set to 95 dB SPL, as shown on Fig.7.

Masking: Level: ☒ Specific ☐ Tracking

☒ Contralateral ☐ Ipsilateral

dB SPL: 95 dB SPL: 0

☐ SAL ☐ Freq: 500Hz

Fig.7 - Specific masking for bone conduction

Note that when using the Specific option, you must remember to change the value of the masking when changing the intensity value of the stimulus.

- **When the level is set to tracking:** enter "40".

Masking: Level: ☐ Specific ☒ Tracking

☒ Contralateral ☐ Ipsilateral

dB SPL: 40 dB SPL: 0

☐ SAL ☐ Freq: 500Hz

Fig.8 - Tracking masking for bone conduction

General Usage Tips

- Since interaural attenuation is 0 for bone conduction, it is recommended to always use masking when using that stimulus delivery method.
- Masking for air conduction is only recommended when unilateral hearing loss is suspected, when wave I is not present, or when wave V is abnormally delayed.
- Tracking is the recommended masking method.
- If using Specific, remember to change the value along with the stimulation intensity. Otherwise you could end up under or over-masking.
- Over-masking may lead to elevated thresholds.
- Under-masking may lead to contralateral response contributions.
- Masking over extended periods may lead to temporarily shifted thresholds.
- Masking may contribute to patient fatigue.
- Instruct the patient about masking as it may be confusing or uncomfortable.
- Values in this note are taken from various articles and books. Values may vary between authors.

References

Additional information about masking can be found in:

- Hall, James W. "New Handbook of Auditory Evoked Responses." Contralateral Masking in AER Measurements Boston: Pearson, 2007. 75-78.
- Hall, James W. and H. Gustav Mueller. "Audiologists' Desk Reference: Volume I" San Diego: Singular Pub. Group, 1997.