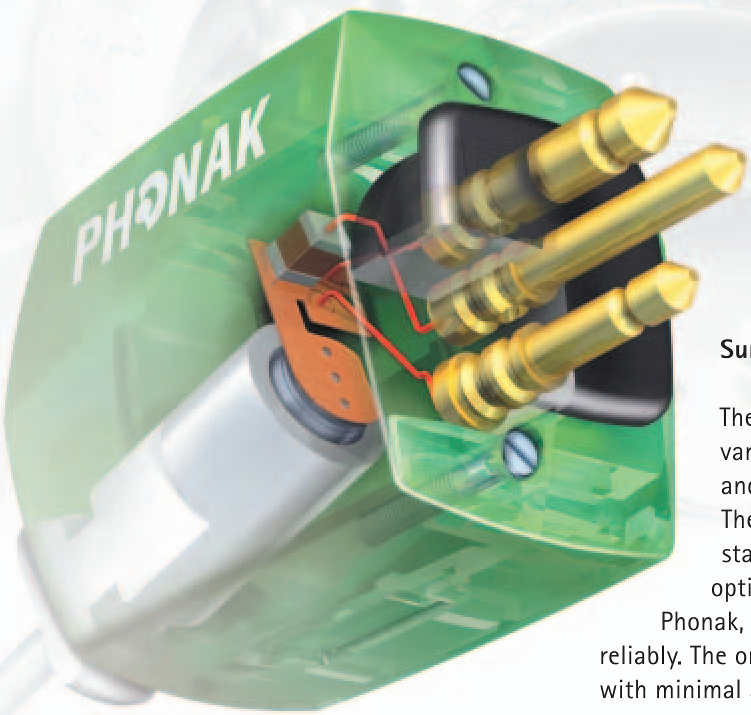
RECDdirect for Supero™



Summary

The acoustic properties of the auditory canal may vary widely according to the auditory canal's shape and size, especially in children but also in adults. These variations can impair fitting accuracy if standard RECD values are used. RECDdirect is an optional fitting tool for Supero, developed by Phonak, that measures individual RECD quickly and reliably. The one-step procedure allows more accurate fitting with minimal active wearer cooperation. RECDdirect measurement is built into the fitting software, and facilitates the best possible acoustic fitting – simply, quickly, and with very little additional equipment.

PHONAK
hearing systems

Every auditory canal is different

The auditory canal varies considerably in size and shape, both in children and adults. These size and shape differences affect the sound level that a hearing instrument produces at the eardrum. In a smaller auditory canal with correspondingly less cubic volume, the sound level is correspondingly higher. As a result, there may be considerable discrepancies between the hearing instrument's response measured in a 2cc coupler, and the sound level effectively reaching the eardrum. For best results, therefore, hearing instrument fitting should account for individual variations in the auditory canal's acoustic properties.

What is RECD measurement – and why is it so important?

RECD (Real-Ear-To-Coupler Difference) measurement determines the deviation between the hearing system's coupler response vs. the response at the eardrum when the hearing instrument or earmold is actually inserted in the ear.

Individualized RECD measurement offers three-fold benefits. Firstly, initial hearing instrument pre-calculated settings take auditory canal characteristics into account, which reduces the need for subsequent fine-tuning. Secondly, it allows the hearing instrument to be adjusted and verified in the coupler, which is a particularly important consideration for pediatric fittings. Thirdly, it reduces the risk of over- or under-amplification.

RECD measurement requires special hardware (2cc coupler, insert earphone or hearing instrument, in-situ measurement equipment) and additional RECD software. To incorporate RECD measurement in the hearing instrument pre-calculation, the fitting software needs data import or manual data entry facilities.

RECD measurement is a two-step procedure. First, the insert earphone or the hearing instrument itself is used as the reference sound source for measuring the response in a 2cc coupler. Next, the response from the same sound source is measured at the eardrum with the ear closed. The difference between the two response curves is the individual RECD. Figure 1 shows an individually measured RECD for an adult ear.

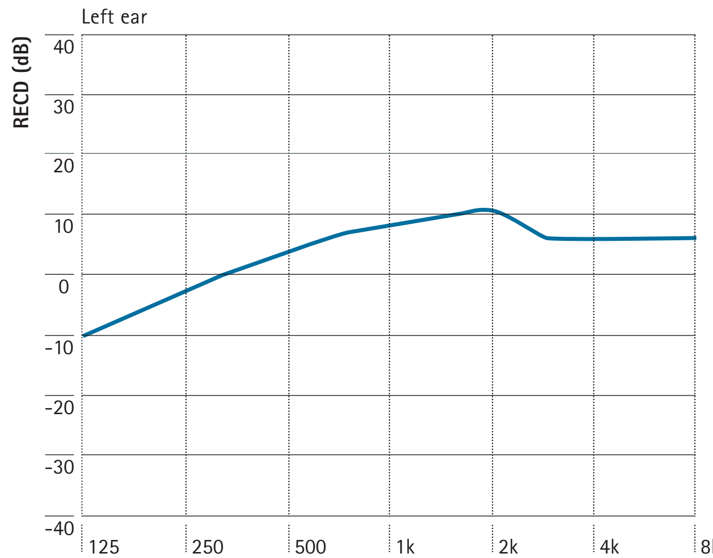


Figure 1
An individually measured RECD for an adult ear. Deviations above or below the 0 dB SPL difference line indicate higher or lower average levels in the ear compared to the coupler.

Modern hearing systems factor average RECD figures into precalculated settings. These average values are age-dependent, because the auditory canal is much smaller in children than in adults and exhibits correspondingly greater deviations from coupler measurements. This means considerably higher real-ear signal levels than in a 2cc coupler.

Individual adult RECDs often conform closely to the average. Children, even of similar age, frequently have very different RECDs. Therefore, RECD measurement is vital to achieving the best possible hearing instrument fitting, especially in children.

The example for an 8-month-old infant in Figure 2 reveals the full importance of RECD measurement in pediatric fittings: there is up to 17 dB SPL difference between the coupler measurement and the predicted sound level at the eardrum, based on the individual RECD profile. At 2 kHz, the maximum sound pressure level is 147 dB SPL, not the expected 130 dB SPL (Seewald, 1995).

Numerous studies have revealed the great extent by which the auditory canal's acoustic properties change during the first year of life (e.g. Feigin et al., 1989; Keefe et al., 1993; Scollie et al., 1998; Westwood & Bamford, 1995). As a child grows, the auditory canal likewise increases in length and cubic volume. Such growth has a big effect on the cubic volume of the closed ear. It is this volume, together with the input impedance of the middle ear, which determines RECD. The impedance of the auditory canal wall is an additional factor in babies. Figure 3 shows variations in individual RECD measurements for various age groups. The results tend to converge with increasing age. At 5 years old or thereabouts, average RECD approximates the adult characteristic.

Tympanostomy tubes (grommets) are another factor affecting the auditory canal's acoustic properties. Studies have shown that 24–35% of children with sensorineural hearing loss had tympanostomy tubes implanted because of middle-ear infections (Das, 1990; Broockhouser, 1993).

Martin et al. (1997) studied the effect of tympanostomy tubes on RECD. Sixteen children aged 4–7 years were examined, along with a control group of 16 similarly aged children without middle-ear complaints.

Figure 4 clearly shows that in comparison to children with normal middle ears, average RECD in children with tympanostomy tubes is 10–15 dB lower at 750 Hz. It follows that children with tympanostomy tubes require fittings with considerably greater low frequency amplification than children without.

The example further underlines the need to account for the auditory canal's acoustic properties using individual RECD measurement.

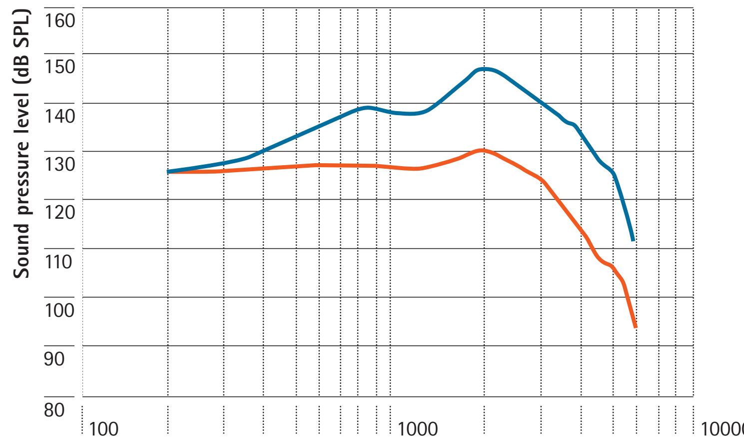


Figure 2
The SSPL90 of a hearing aid as a function of frequency fitted to an eight-month-old child as measured in a HA-2-2cc coupler (red line). Also shown is the predicted real ear saturation response (RESR) of this hearing aid (blue line). (Seewald, 1995)

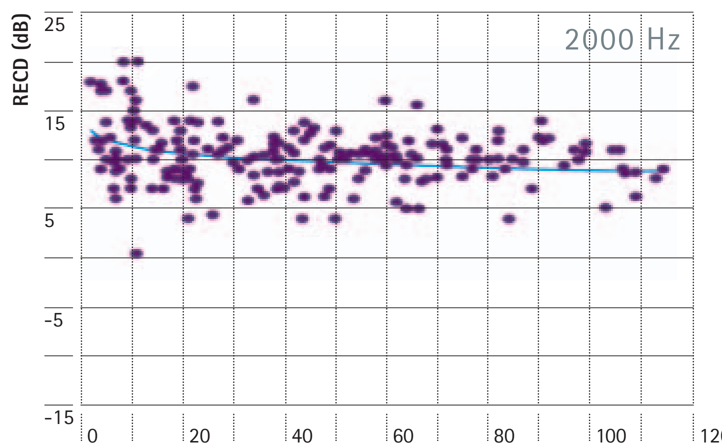


Figure 3
Individual RECD measurements at 2 kHz in children aged 1 to 120 months (Bagatto et al., 2001). Scatter tends to decrease with increasing age.

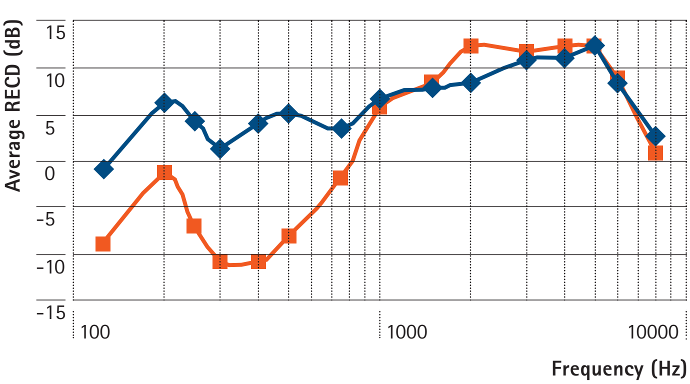


Figure 4
Average RECD comparison of children with tympanostomy tubes (red curve) and without (blue curve).
(Martin et al., 1997)

Control group without tubes
Group with tubes

Figure 5
RECDdirect measurement setup

Although the significance of the RECD is known, routine RECD measurement is seldom performed in current-day practice. The reasons: the need for additional measurement equipment and appropriate software on the one hand and measurement complexity on the other.

Phonak has responded by developing the RECDdirect fitting tool for the Supero hearing system. The objectives were to rationalize the measurement procedure to a one-step process, while minimizing measurement time and the additional equipment necessary.

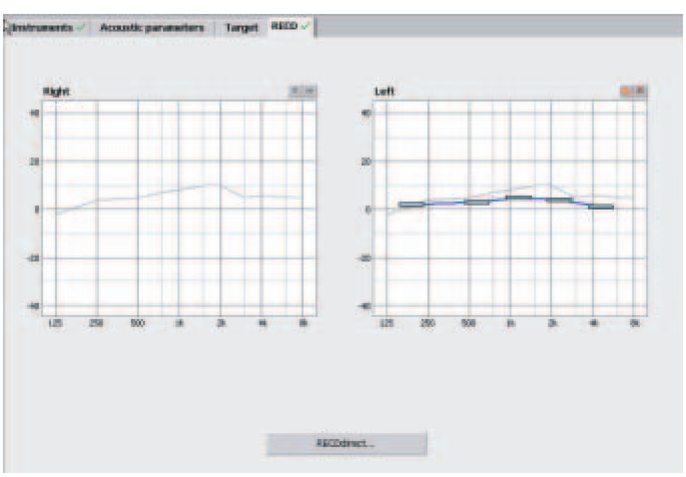


Figure 6
Left ear RECD measurement displayed by PFG fitting software.

RECDdirect measurement for an individual adult ear
Average adult RECD

RECDdirect – the new fitting tool for Supero

RECDdirect is a simple and very rapid measurement procedure that determines individual RECD for the Supero hearing system. All it needs is the RECDdirect module and a probe tube (see Figure 5). No other test equipment is necessary, which makes the procedure far simpler and more accessible. RECDdirect measurement is built into the fitting software, so it can be incorporated in the fitting procedure. RECD measurement involves inserting a probe tube and the Supero earmold attached to the Supero hearing instrument. Measurement is then started via the fitting software, with the results available on-screen around 5 seconds later. Figure 6 shows how the fitting software displays the RECD measurement.

Integration with the software makes the measured RECD values available in the hearing instrument pre-calculation. The Supero hearing system itself acts as the measurement sound source, generating broadband noise at 70–75 dB SPL and circumventing the need for an insert earphone. The test signal used is independent of hearing loss, but does take age into account. This is especially important with smaller children, where less sound energy is needed to achieve the required in-ear level of 70–75 dB SPL due to the smaller ear canals. With this approach, there is no risk of administering an excessively loud test signal.

Supero coupler response figures are implemented in the fitting software, so hearingcare professionals no longer need to take a coupler measurement. This greatly reduces the time and effort needed to determine individual RECD.

RECDdirect validation

Prescriptive fitting formulas like DSL and NAL specify a certain target gain and MPO that depends on hearing loss. In the absence of an individual RECD measurement, age-dependent average RECD curves are used instead. Depending on individual deviation from the average curve, there may be greater or lesser deviations from the desired target curve. The target gain to compensate for hearing loss is modified according to the measured acoustic characteristics of the individual auditory canal.

A wide-ranging study investigated the extent to which RECDdirect can reduce these deviations from the desired target. A DSL[i/o] fitting (Cornelisse et al., 1995) was chosen as the target. Supero gain calculations took into account both the age-dependent average RECD curve, and individual RECDdirect measurements. Deviation from the target was checked by measuring the respective insertion gain. Deviations from the desired DSL target curve are shown in Figure 7.

It is clearly apparent how RECDdirect measurement reduces deviation from the target, which results in a more accurate fitting. This greatly reduced scatter in the values, means that RECDdirect is always superior to average RECD for fitting accuracy.

In addition to the benefits of straightforward availability, easy handling, modest measurement time and effort already discussed, there is another crucial advantage: to account for acoustic coupling under conditions of everyday use, there is no better approach than to have the personalized earmold in place during RECDdirect measurement.

Given that RECD results depend somewhat on the measurement system used (Munro & Salisbury, 2002), accuracy is greater when the same receiver and earmold are used for both measurement and hearing instrument use.

Average deviations from the DSL target gain curve

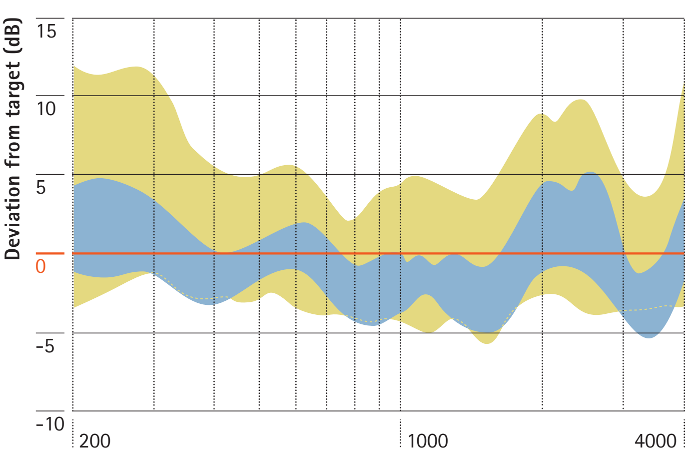


Figure 7 **Frequency (Hz)**

Supero fittings with and without RECDdirect. The graph shows measured deviation from the DSL target (red line) when age-specific average RECD (green) and RECDdirect measurement (blue) are incorporated in the precalculation. Compared with RECDdirect, using average RECD data gives increased scatter and deviation from the target curve. RECDdirect gives a closer fit to the target curve, with much less scatter.

Deviation from the target curve when average data is used
Deviation from the target curve using RECDdirect data.

Effect of various probe tube positions on measurement accuracy

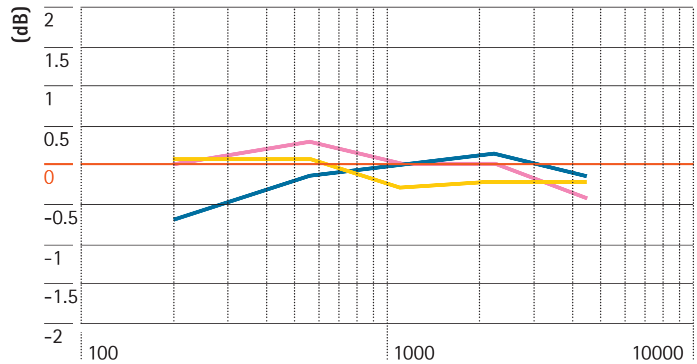


Figure 8 **Frequency (Hz)**

Effect of various probe tube positions on measurement accuracy. The graph shows average deviation from the reference measurement along the 0 dB line (tube end 5mm beyond the tip of the earmold).

2 mm
7 mm
retest 5 mm
5 mm (reference)

The effect of probe tube position

The exact positioning of the probe tube in the auditory canal is not critical to RECDdirect measurement. Figure 8 shows the effect of various probe tube positions on RECDdirect measurement.

The probe tube was set at various positions and an RECDdirect measurement performed each time. In the reference position, the tube end extended 5 mm beyond the tip of the earmold. Comparison measurements were performed at 2 mm and 7 mm, followed by a retest at 5 mm. Figure 8 shows the deviation from the 5 mm reference measurement (0 dB line). With a maximum deviation of 1 dB, probe tube positioning would not appear to be a significant factor in RECDdirect measurement.

Test/retest repeatability, in other words minimum deviation between successive measurements on the same ear, is crucial to straightforward handling. When the earmold and probe tube positions are undisturbed between measurements, deviation is as minor as 0.5 dB. If the earmold and probe tube are repositioned by removal and re-insertion between measurements, there may be up to a 1 dB deviation. Test/retest repeatability is thus very high.

Summary (see front page)

Bibliography

M.P. Bagatto, S.D. Scollie, K.S. Moodie, R.C. Seewald, B. M. Hoover (2002). Development Of Real-Ear-To-Coupler Difference Predictions as a Function of Age for Two Coupling Procedures. Journal of the American Academy of Audiology, 13(8): 407-415

P.E. Brookhouser, D.W. Worthington, J.K. William (1993). Middle ear disease in children with sensorineural hearing loss. Laryngoscope, 103: 371-8

L.E. Cornelisse, R.C. Seewald, D.G. Jamieson (1995). The input/output (i/o) formula: A theoretical approach to the fitting of personal amplification devices. Journal of the Acoustical Society of America, 97(3): 1854-64

V.K. Das (1990). Prevalence of otitis media with effusion in children with bilateral sensorineural hearing loss. Archives of Disease in Childhood, 65: 757-9

H. Dillon (2001). Hearing Aids. New York: Thieme

J. Feigin, J. Kopun, P. Stelmachowicz, M. Gorga (1989). Probe-tube microphone measures of ear-canal sound pressure levels in infants and children. Ear & Hearing, 10(4): 254-258

D. Keefe, J. Bulen, K. Arehart, E.M. Burns (1993). Ear-canal impedance and reflection coefficient in human infants and adults. Journal of the American Academy of Audiology, 94(5): 2617-2638

K.J. Munro and V.A. Salisbury (2002). Is the real-ear to coupler difference independent of the measurement earphone? International Journal of Audiology, 41: 408-413

H.C. Martin, K.J. Munro, D.H. Langer (1997). Real Ear to coupler differences in children with grommets. British Journal of Audiology, 31: 63-69

S. Scollie, R. Seewald, L. Jenstad (1998). DSL questions & answers: Age-appropriate norms for RECDs with ear-molds. DSL Newsletter, 3(1): 2

R.C. Seewald (1995). The Desired Sensation Level (DSL) Method for Hearing Aid Fitting in Infants and Children. Phonak Focus No. 20

G. Westwood and J. Bamford (1995). Probe-tube microphone measures with very young infants: real ear to coupler differences and longitudinal changes in real ear unaided response. Ear & Hearing, 16(3): 263-273

PHONAK hearing systems

www.phonak.com

028-0012-02/0203 • CU/BGS_Supero RECDdirect_GB • Printed in Switzerland © Phonak AG All rights reserved