**Source: HEAD acoustics GmbH**

**Title: Method for determining ECRP for HaNTE-devices**

**Document for: Discussion, Agreement**

# Introduction

The 3GPP work item HanTE [1] is intended to work on possible new test methods and requirements in 3GPP TS 26.131 [2] and TS 26.132 [3] for Handsets featuring Non-Traditional Earpieces. A round robin test with several devices and across different labs was conducted [4], which provides a comprehensive analysis of the obtained measurement results. During the discussions at SA#116-e, many different views on possible changes resulting from this round robin test and the work item in general were raised:

* Which measurements to include (from "none" to "all"),
* If they should be mandatory or optional,
* If they should apply also for non-HaNTE devices.

However, the original WID [1] also mentioned the following aspects:

 *Establish guidelines for mounting of HaNTE devices to ensure a repeatable and reproducible measurement method in 3GPP TS 26.132.*

*- Investigate testing RFR/RLR at a single position and at different positions, and report the results; based on those results, and if judged necessary by SA4, new requirements/test methods may be specified.*

Especially the first item is important for the actual measurements in case no manufacturer-defined ECRP is provided (MECRP). This issue was not considered so far in the discussions listed above. Therefore, a repeatable method for determining a suitbale ECRP is proposed in the present document. To verify

NOTE: Some of these aspects and text proposals were already addressed in the initial draft CR for TS 26.132 [5].

# Method for determining ECRP

For non-HaNTE-devices, in most cases the default ECRP according to ITU‑T P.64 [6] (geometric centre of the acoustic outlet) is used and typically provides the optimum performance when testing according to 3GPP TS 26.131 [2] and TS 26.132 [3]. Also from the user's perspective, it seems obvious to use this position. In many cases, manufacturers do not even provide an explicit MECRP to test houses and just indicate to use the default ECRP as test position.

For HaNTE-devices it is much more crucial to use a suitable ECRP. As seen from the round robin test results [7], the performance of a device may strongly vary for different positions. In contrast to non-HaNTE-devices, it is also not obvious for the user how the device should be hold to the ear to obtain best performance. It can be assumed that due to the form factor and the experience over the last years, users will position it in a similar way as for devices with an acoustic outlet (e.g., towards the upper edge).

For these reasons, manufacturers should define and provide MECRP to test operators. However, from the source's experience as a test house, it is expected that not all manufactorers are always able to provide this information. In such cases, a method for determining a generic, but also suitable ECRP seems necessary.

The round robin test included measurements with averages across different positions/shifts around a center position. Even though these tests were mainly intended to investigate the variation in performance, the principle of "grid measurements" can be used for determining a reasonable ECRP. A detailed description of the proposed method can be found in Annex A.

# Example Measurements

The iterative procedure was applied to three commercially available HaNTE-devices from three different manufacturers. Note that in advance to the test, the number of volume steps were manually determined.

## DUT1

Table 1 shows RLR results across shifts for decreasing volume control of DUT1, which provides 7 volume steps. At volume setting 3, six shifts provide nominal RLR and is considered for the next step of the analysis. In Table 2, the distances to the average RFR curve are provided in dB. The highlighted row indicates the selected volume setting (3). Here shift **S8** provides the lowest difference and is selected as the ECRP for testing. To illustrate this result, Figure 1 shows all shift and average RFR curves at this volume setting, the selected shift/ECRP is marked in bold.

Table 1: RLR (in dB) vs shifts and volume settings (DUT1)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Volume** | **S0** | **S1** | **S2** | **S3** | **S4** | **S5** | **S6** | **S7** | **S8** | **Valid** |
| **7** | -14.7 | -14.4 | -15.6 | -4.5 | -3.6 | -15.4 | -15.1 | -4.6 | -13.9 | 0 |
| **6** | -11.0 | -10.9 | -11.8 | -1.1 | 0.0 | -11.8 | -11.5 | -1.2 | -10.2 | 1 |
| **5** | -7.2 | -6.9 | -8.1 | 3.5 | 4.6 | -7.8 | -7.7 | 4.1 | -6.1 | 3 |
| **4** | -3.8 | -3.3 | -4.6 | 8.2 | 8.6 | -4.1 | -3.8 | 8.2 | -2.7 | 0 |
| **3** | **1.0** | **1.1** | **-0.1** | **13.1** | **13.2** | **0.4** | **0.7** | **12.8** | **1.8** | **6** |
| **2** | 5.4 | 5.6 | 4.0 | 18.1 | 18.1 | 4.8 | 4.9 | 17.6 | 6.4 | 3 |
| **1** | 9.0 | 9.0 | 7.6 | 21.8 | 21.8 | 8.3 | 8.5 | 21.4 | 9.9 | 0 |

Table 2: Distance to average RFR (in dB) vs shifts at nominal volume setting (DUT1)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Volume** | **S0** | **S1** | **S2** | **S3** | **S4** | **S5** | **S6** | **S7** | **S8** |
| **7** | 1.78 | 1.99 | 2.49 | 6.68 | 7.36 | 2.47 | 2.03 | 6.57 | 1.66 |
| **6** | 1.79 | 1.99 | 2.33 | 6.44 | 7.29 | 2.28 | 2.05 | 6.28 | 1.66 |
| **5** | 1.88 | 2.05 | 2.48 | 6.77 | 7.53 | 2.33 | 2.17 | 7.07 | 1.73 |
| **4** | 2.08 | 2.01 | 2.57 | 7.43 | 7.85 | 2.32 | 1.96 | 7.37 | 1.78 |
| **3** | **1.80** | **2.21** | **2.56** | **7.79** | **7.82** | **2.34** | **1.97** | **7.38** | **1.79** |
| **2** | 1.81 | 1.96 | 2.81 | 8.10 | 8.00 | 2.33 | 2.20 | 7.78 | 1.86 |
| **1** | 1.77 | 2.24 | 2.84 | 8.20 | 8.07 | 2.52 | 2.07 | 7.88 | 1.93 |



Figure 1: RFR per shift and average at volume setting 3/7 (DUT1)

## DUT2

Table 3 shows RLR results across shifts for decreasing volume control of DUT2, which provides 15 volume steps. Since for volume step 4 no nominal RLR could be determined, steps 1-3 were skipped. At volume settings 7-9, four shifts provide nominal RLR and are considered for the next step of the analysis. In Table 4, the distances to the average RFR curve are provided in dB. The highlighted rows indicate the selected volume settings (7-9). Here shift **S0** provides the lowest difference at volume setting 9 and is selected as the ECRP for testing. To illustrate this result, Figure 2 shows all shift and average RFR curves at this volume setting, the selected shift/ECRP is marked in bold.

Table 3: RLR (in dB) vs shifts and volume settings (DUT2)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Volume** | **S0** | **S1** | **S2** | **S3** | **S4** | **S5** | **S6** | **S7** | **S8** | **Valid** |
| **15** | -11.0 | -11.5 | -15.9 | -1.6 | 4.9 | -13.7 | -12.9 | 0.3 | -8.4 | 2 |
| **14** | -9.3 | -9.8 | -14.3 | 0.2 | 6.6 | -12.0 | -11.3 | 2.1 | -6.8 | 2 |
| **13** | -7.4 | -7.8 | -12.0 | 2.3 | 8.7 | -10.0 | -9.1 | 4.4 | -4.6 | 2 |
| **12** | -4.9 | -5.9 | -10.1 | 4.5 | 10.9 | -8.1 | -6.7 | 6.5 | -2.4 | 1 |
| **11** | -2.9 | -3.8 | -8.2 | 6.7 | 13.4 | -5.8 | -4.4 | 8.8 | -0.1 | 1 |
| **10** | -0.1 | -2.2 | -6.7 | 8.1 | 15.0 | -4.4 | -3.0 | 10.0 | 1.4 | 2 |
| **9** | **2.2** | **-0.2** | **-5.0** | **10.5** | **17.4** | **-2.2** | **-0.8** | **12.4** | **3.7** | **4** |
| **8** | **4.7** | **1.8** | **-2.8** | **13.5** | **20.0** | **0.0** | **1.5** | **14.8** | **5.8** | **4** |
| **7** | **6.8** | **4.0** | **-0.7** | **15.6** | **22.0** | **2.1** | **3.6** | **17.0** | **7.9** | **4** |
| **6** | 9.0 | 6.1 | 1.2 | 18.4 | 24.1 | 4.0 | 5.9 | 19.2 | 10.2 | 2 |
| **5** | 11.3 | 8.1 | 3.3 | 20.9 | 26.6 | 6.0 | 8.2 | 21.6 | 12.3 | 1 |
| **4** | 13.4 | 10.2 | 5.9 | 23.4 | 29.4 | 8.3 | 10.4 | 24.1 | 14.6 | 0 |

Table 4: Distance to average RFR (in dB) vs shifts at nominal volume setting (DUT1)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Volume** | **S0** | **S1** | **S2** | **S3** | **S4** | **S5** | **S6** | **S7** | **S8** |
| **15** | 1.56 | 2.05 | 5.74 | 7.78 | 13.92 | 3.17 | 2.70 | 9.03 | 2.41 |
| **14** | 1.58 | 2.18 | 5.45 | 7.57 | 13.86 | 3.11 | 2.93 | 8.92 | 2.22 |
| **13** | 1.82 | 2.27 | 5.08 | 7.56 | 13.75 | 3.30 | 2.90 | 9.02 | 2.27 |
| **12** | 1.51 | 2.35 | 5.25 | 7.68 | 13.77 | 3.47 | 2.60 | 9.06 | 2.23 |
| **11** | 1.67 | 2.32 | 5.55 | 7.73 | 14.07 | 3.38 | 2.36 | 9.12 | 2.28 |
| **10** | 1.11 | 2.50 | 5.74 | 7.90 | 14.42 | 3.67 | 2.59 | 9.15 | 2.22 |
| **9** | **1.16** | **2.43** | **6.14** | **8.08** | **14.69** | **3.47** | **2.48** | **9.33** | **2.39** |
| **8** | **1.23** | **2.62** | **6.21** | **8.61** | **14.92** | **3.59** | **2.36** | **9.46** | **2.19** |
| **7** | **1.19** | **2.39** | **6.17** | **8.57** | **14.70** | **3.65** | **2.39** | **9.43** | **2.18** |
| **6** | 1.23 | 2.21 | 6.26 | 9.10 | 14.76 | 3.85 | 2.32 | 9.47 | 2.26 |
| **5** | 1.34 | 2.48 | 6.37 | 9.34 | 14.85 | 3.90 | 2.10 | 9.71 | 2.23 |
| **4** | 1.34 | 2.37 | 6.13 | 9.34 | 15.10 | 3.91 | 2.07 | 9.73 | 2.21 |



Figure 2: RFR per shift and average at volume setting 9/15 (DUT2)

## DUT3

Table 5 shows RLR results across shifts for decreasing volume control of DUT3, which provides 8 volume steps. At volume settings 2, 3 and 5, three shifts provide nominal RLR and are considered for the next step of the analysis. In Table 6, the distances to the average RFR curve are provided in dB. The highlighted rows indicate the selected volume settings (2, 3 and 5). Here shift **S4** provides the lowest difference at volume setting 5 and is selected as the ECRP for testing. To illustrate this result, Figure 3 shows all shift and average RFR curves at this volume setting, the selected shift/ECRP is marked in bold.

Note that shift S7 at volume setting 3 (highlighted in yellow) provides an even better distance value, but RLR is out of nominal range here.

**Table 5: RLR (in dB) vs shifts and volume settings (DUT3)**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Volume** | **S0** | **S1** | **S2** | **S3** | **S4** | **S5** | **S6** | **S7** | **S8** | **Valid** |
| **8** | -14.5 | 8.2 | 10.5 | -7.2 | -8.6 | 12.8 | -15.0 | -9.1 | -12.9 | 0 |
| **7** | -11.8 | 11.2 | 13.6 | -4.1 | -5.6 | 15.9 | -12.0 | -6.2 | -10.0 | 0 |
| **6** | -8.6 | 14.9 | 16.7 | -0.5 | -2.8 | 19.0 | -8.3 | -3.4 | -7.1 | 1 |
| **5** | **-5.5** | **18.2** | **19.6** | **2.1** | **0.2** | **21.9** | **-5.9** | **-0.8** | **-4.2** | **3** |
| **4** | -2.4 | 22.2 | 22.5 | 5.6 | 2.9 | 24.8 | -2.4 | 2.3 | -1.2 | 2 |
| **3** | **0.9** | **26.1** | **26.2** | **9.7** | **6.6** | **27.9** | **0.8** | **6.5** | **1.7** | **3** |
| **2** | **4.3** | **29.4** | **29.3** | **12.3** | **8.7** | **31.4** | **4.1** | **8.4** | **4.8** | **3** |
| **1** | 7.6 | 32.6 | 32.2 | 15.1 | 11.6 | 34.5 | 8.2 | 11.6 | 7.8 | 0 |

**Table 6: Distance to average RFR (in dB) vs shifts at nominal volume setting (DUT1)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Volume** | **S0** | **S1** | **S2** | **S3** | **S4** | **S5** | **S6** | **S7** | **S8** |
| **8** | 5.49 | 15.67 | 20.71 | 1.87 | 1.52 | 21.36 | 5.88 | 1.16 | 3.86 |
| **7** | 5.48 | 15.73 | 20.65 | 1.84 | 1.55 | 21.50 | 5.80 | 1.39 | 4.01 |
| **6** | 5.61 | 16.11 | 20.30 | 2.16 | 1.42 | 21.24 | 5.27 | 1.49 | 4.19 |
| **5** | **5.27** | **16.48** | **20.16** | **2.04** | **1.36** | **21.12** | **5.66** | **1.63** | **4.19** |
| **4** | 5.35 | 17.13 | 19.46 | 2.33 | 1.33 | 20.72 | 5.35 | 1.67 | 4.32 |
| **3** | **5.48** | **17.56** | **19.20** | **3.01** | **1.83** | **20.19** | **5.56** | **1.14** | **4.75** |
| **2** | **5.03** | **17.29** | **19.70** | **2.62** | **1.60** | **20.19** | **5.21** | **1.65** | **4.64** |
| **1** | 4.95 | 17.32 | 18.41 | 2.29 | 1.72 | 19.68 | 4.67 | 1.65 | 4.81 |



Figure 3: RFR per shift and average at volume setting 5/8 (DUT3)

# Conclusion

Based on measurement results from the round robin test, the present document introduced a method for determining a ECRP, which is only applicable in case no manufacturer-defined MECRP is available. The method was validated and shown to work for three commercially available HaNTE-devices.

The source proposes to agree on the proposal and to include it in the upcoming (draft) CR to TS 26.132.

# References

|  |  |
| --- | --- |
| [1]  | 3GPP SP-191212, „New WID on Handsets Featuring Non-Traditional Earpieces (HaNTE)“.  |
| [2]  | 3GPP TS 26.131, „Terminal acoustic characteristics for telephony; Requirements,“ Release-16.  |
| [3]  | 3GPP TS 26.132, „Speech and video telephony terminal acoustic test specification,“ Release-16.  |
| [4]  | 3GPP S4-211633, „HaNTE (Handsets Featuring Non-Traditional Earpieces) Timeplan Document,“ Qualcomm, Inc.. |
| [5]  | 3GPP S4-211629, „Test methods for HaNTE,“ Qualcomm, Inc.. |
| [6]  | Recommendation ITU-T P.64, „Determination of sensitivity/frequency characteristics of local telephone systems,“ 06/2019.  |
| [7]  | 3GPP S4-211092, „Aggregated results of HaNTE round robin test (update),“ HEAD acoustics GmbH. |

# Annex A: Text proposals for (draft) CR

### 5.1.1 Setup for handset terminals

When using a handset UE, the handset is placed on HATS as described in ITU-T Recommendation P.64 Annex E [18]. The handset position for handset UEs featuring non-traditional earpieces is defined in ITU-T Recommendation P.64 Annex D.5 and E.3 [18]. The criteria for determining the ECRP follows this order:

- At the manufacturer defined position (MECRP), if provided.

- If not, at the centre of the earpiece as defined in Annex E of ITU-T P.64, if the handset features a traditional earpiece.

- If not (handset provides a non-traditional earpiece):

- A graphical user interface showing the location of optimal sound radiation, if provided.

- If not, through an objective determination procedure of ECRP as described in Annex H, if possible.

- If not, after a subjective determination by the test operator of the optimal holding position.

The position of the handset positioner forks and support pins shall also be documented by means of dz/dy coordinates according to the definitions in ITU-T Recommendation P.64 Annex D.5 and E.3 [18].

The artificial mouth shall conform to ITU-T Recommendation P.58 [15]. The artificial ear shall conform to ITU-T Recommendation P.57 [14]. Type 3.3 ear shall be used and positioned on HATS according to ITU-T Recommendation P.58 [15].

**Position and calibration of HATS**

The sending and receiving characteristics shall be tested with the HATS. It shall be indicated what application force was used. If not stated otherwise in TS 26.131, an application force of 8 ± 2 N shall be used.

The horizontal positioning of the HATS reference plane shall be guaranteed within ± 2º.

Annex H:
Determination of ECRP for handset providing non-traditional earpiece

# H.1 Overview

The ECRP for handset UEs providing an acoustic outlet is defined according to Annex E.1 and E.2 of Recommendation ITU-T P.64 [18]. This positioning approach cannot be used for handsets without a traditional ear cap. Instead, Annex E.3 of [18] can be used, which specifies ECRP of a handset device in terms of distances from the upper edge (dy) and from a centre/symmetry line (dz). With these definitions, a manufacturer-defined ECRP (MECRP) can be specified for testing such devices.

However, in case MECRP is not available or not provided by the manufacturer, the method described in the following allows at least a suitable and reproducible positioning of a handset.

NOTE: Even though the method described in the following mimics user behaviour, i.e., multiple typical positions, the determination of a custom ECRP may not result in optimal performance. Whenever available, the use of MECRP is preferred.

# H.2 Grid Positions

Several shifts of 1 cm in Ze and Ye direction according to Table H.1 are evaluated around an initial and arbitrarily chosen ECRP at dz=0 mm and dy=20 mm (according to definitions of Annex E.3 of [18]).

Table H.1: Shifts around initial ECRP

|  |  |  |  |
| --- | --- | --- | --- |
| Shift | Offset Ze [mm] | Offset Ye [mm] | Type |
| S0 | 0 | 0 | Mandatory |
| S1 | 0 | -10 | Mandatory |
| S2 | +10 | 0 | Mandatory |
| S3 | 0 | +10 | Mandatory |
| S4 | -10 | 0 | Mandatory |
| S5 | +10 | -10 | Recommended |
| S6 | +10 | +10 | Recommended |
| S7 | -10 | +10 | Recommended |
| S8 | -10 | -10 | Recommended |

The shifts shall be reported. Figure H.1 illustrates the five mandatory (indicated in blue) and four optional (indicated in red) shifts relative to the centre point (indicated in green).



Figure H.1: Evaluation shifts for determination of ECRP

# H.3 Measurement procedure

The measurement to determine ECRP and nominal volume is described in the following and applies for all bandwidths.

1) The handset terminal is setup as described in clause 5 and the volume control is set to maximum. In case a manufacturer-defined nominal volume control setting is provided, this setting shall be used.

2) The test signal to be used for the measurements shall be the British-English single talk sequence described in ITU-T Recommendation P.501 [22]. The test signal level shall be -16 dBm0 measured at the digital reference point or the equivalent analogue point. Level calculation and bandwidth-specific pre-filtering shall be applied according to clause 5.4 on the test signal.

3) Receive loudness rating (RLR) and receive frequency response (RFR) are calculated from the same recording:

- RFR is calculated according to clause 7.4.2 for narrowband, clause 8.4.2 for wideband, clause 9.4.2 for super-wideband and 10.4.2 for fullband.

- RLR is calculated according to clause 7.2.2.2 for narrowband, clause 8.2.2.2 for wideband, clause 9.2.2.2 for super-wideband and 10.2.2.2 for fullband.

4) The measurement shall be carried out for the initial ECRP shift (S0) and for each mandatory shift according to Table H.1 (S1-S4). It is recommended to consider the optional shifts (S5-S8) as well.

5) For the current volume control setting…

a) The repeated RFR measures at each frequency band are linearily averaged across shifts, resulting in an average RFR spectrum.

b) The number of nominal RLR values (2 dB ± 3 dB) are counted.

6) If manufacturer-defined nominal volume control setting is provided:
No further iterations are required.

If no manufacturer-defined nominal volume control setting is provided:
Steps 2) to 5) are repeated for volume control decreased by one step until all RLR values obtained more than 5 dB across all shifts.

7) The maximum number of valid RLR values is determined across all measured volume control settings. Each volume setting providing this amount of valid RLR values are considered for the next step of the analysis. If multiple volume control settings obtain the same amount of nominal RLR values, all of them are considered for the next analysis step.
If nominal volume setting cannot be achieved at any shift and volume setting (i.e., all RLR values are either too high or too low), it is not possible to determine the ECRP with the present method.

8) For each single shift, RFR of the determined nominal volume setting, the absolute difference (in dB) to the average RFR is calculated within the bandwidth-dependent frequency range according to clause 5.4. The shift providing nominal RLR and lowest difference to the average RFR (see step 4) is considered as the ECRP for testing.

NOTE: It is also possible to apply the method in a transposed way, i.e., for each shift, all volume steps are consecutively evaluated. The results obtained this way are equivalent to the ones of the default order. However, due to the non-applicable stop condition (see step 6), in some cases it might be necessary to conduct more measurements than for the default order to obtain the same ECRP result.