

Robustness of Pure and Ace micon

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Abstract:

This paper describes the design features of the Siemens Pure and Ace micon hearing instruments, which have been developed to enhance perspiration, water, dirt, and debris-resistance. Both products feature an effective protection from environmental effects via special sealing, and by encapsulation of the electronics.

In this version, we also describe the results of a field test conducted to validate the perspiration resistance of Pure and Ace micon in challenging real-life conditions.

I. General Information

Robustness, especially perspiration and water resistance is an important product property for all hearing instruments. Survey results show that one out of six hearing aid users restricts their activities due to the concern that the hearing instrument might become damaged [1].

The Pure and Ace micon housings feature several technical improvements, which impact significantly the water and dirt resistance, according to IP67 [2]. This IP rating substantiates that these hearing systems are very robust against rigorous indoor and outdoor activities.



Figure 1: Pure micon and Ace micon hearing instruments

The enhancements we have introduced for perspiration and water resistance for the Pure and Ace micon were achieved by combining the following:

- A housing concept that minimizes the entry of water and debris
- Protection of the inner components to avoid damage from moisture

II. Housing concept minimizing water / perspiration entry

The housing concept of the Ace and Pure is specially designed to minimize the chances for water and perspiration to enter. First, the connector to the mini-Receiver 2.0, the charging contacts and user controls are hermetically sealed using silicone rubber parts.

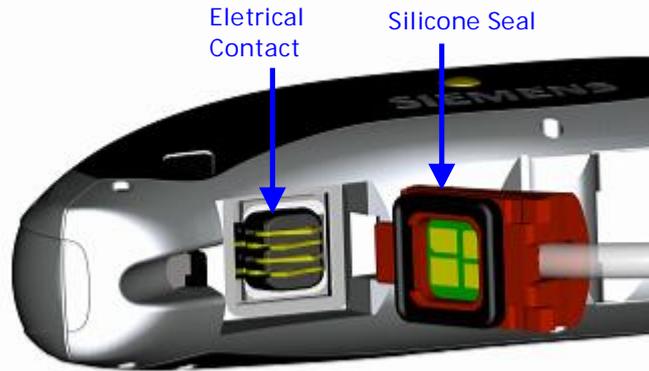


Figure 2: Sealed connection to external receivers “mini-Receiver 2.0”

Additionally, the silicone seal included in the miniReceiver 2.0 plug (Figure 2) completely encloses the electrical contacting part inside the hearing instrument. Moisture is kept away from the electronic contacts and as a result, corrosion over time is avoided.

To further enhance the robustness, the miniReceiver 2.0 contacts utilize the principle of SIM connectors. These are the connectors that have been reliably used in billions of cell phones over the years, consisting of large gold plated areas on the one side and spring contacts on the other side. This ensures a secure connection of the receiver to the instrument.

Silicone seal around control element and charging contacts

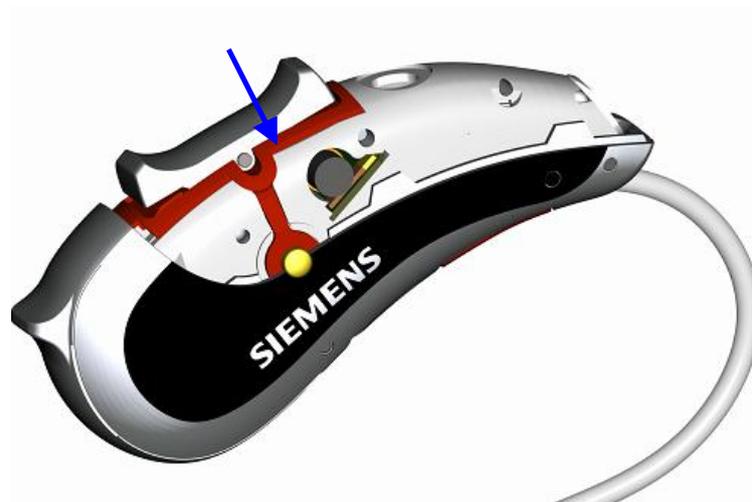


Figure 3: Sealed user controls and charging contacts on Pure micon

Required openings in the housing for features such as charging or exchangeable control elements are protected in a similar fashion. A silicone flap on the top of the frame completely seals the control element against the top shell and encircles the charging contacts (See Figure 3).



Figure 4: Microphone Protection of Pure and Ace

In designing the housing parts, the capillary action of liquids was taken into consideration. Capillarity action is the ability of liquids to flow into narrow spaces due to the intermolecular attractive forces between liquids and solid surfaces. Unfortunately, this effect also causes water or perspiration to enter into the devices along the housing separation lines. The housings, therefore, are nano-coated to reduce the capillary effect. Interestingly, reducing the size of the housing partition lines can be actually counterproductive as the capillary effect increases with decreasing opening size. Therefore, the edges of the housing shells are rounded to reduce this effect.

III. Protection of the inner components

While both Pure and Ace micon have been awarded the IP67 rating [2] for *water-resistance*, a minimal chance still remains for water to enter the hearing instrument*. Therefore, the inner parts of the Pure and Ace micon still need to be well protected against moisture. All electrical components such as the chip, battery contacts, microphones and coils of the amplifier are machined together in a fully automated way. This guarantees precise and consistent quality standards with very low failure rates. A thick encapsulation material, which is layered on top of the electronics, further protects them from environmental effects such as moisture and perspiration.

*Siemens Aquaris is the only *waterproof* instrument on the market with an IP68 rating.

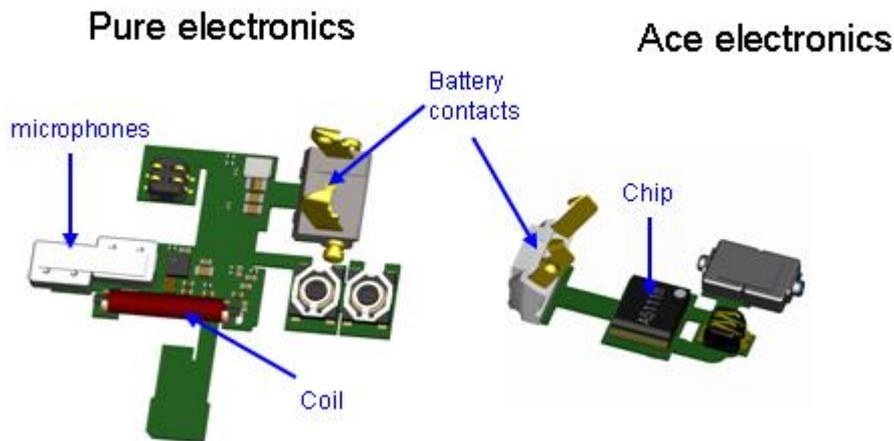


Figure 5: Fully automatically produced Pure and Ace electronics.

The electronics are assembled in a frame holder. Additionally, the frame itself is nanocoated as a further measure against moisture.

IV: Laboratory and Field Test Result

To assess the effectiveness of the moisture and debris protection engineering, stress tests simulating extreme conditions were performed on the Ace and Pure instruments. Both instruments successfully passed tests which included the long-term exposure of the hearing instrument to moisture.

Additionally, the instruments passed an internationally standardized test, IP67. With this test, the instruments are immersed into water that is one meter deep for 30 minutes, and in a separate test, are put into a dust chamber for eight hours. This rigorous test was first applied to a hearing system with the Aquaris model [3]. With the Pure and Ace, no functional failures could be observed after removing the hearing instruments from the test chamber.

To further ensure perspiration resistance in challenging real-life conditions, a field test was conducted during the hot and humid summer months in a coastal area of South Africa between December 2012 and April 2013. Ten subjects with significant histories of hearing instrument problems due to moisture participated in the test. As an example, one subject was chosen because he was wearing his previous hearing instruments only for an average of 1 hour per day due to concerns of moisture-associated damage. These subjects were fit bilaterally with Pure micon or Ace micon hearing instruments. During the testing period, subjects typically wore the hearing instruments the entire day, participating in outdoor activities such as camping, and regular exercise workouts. One subject even forgot that he was wearing the instruments and took showers wearing them on several occasions.

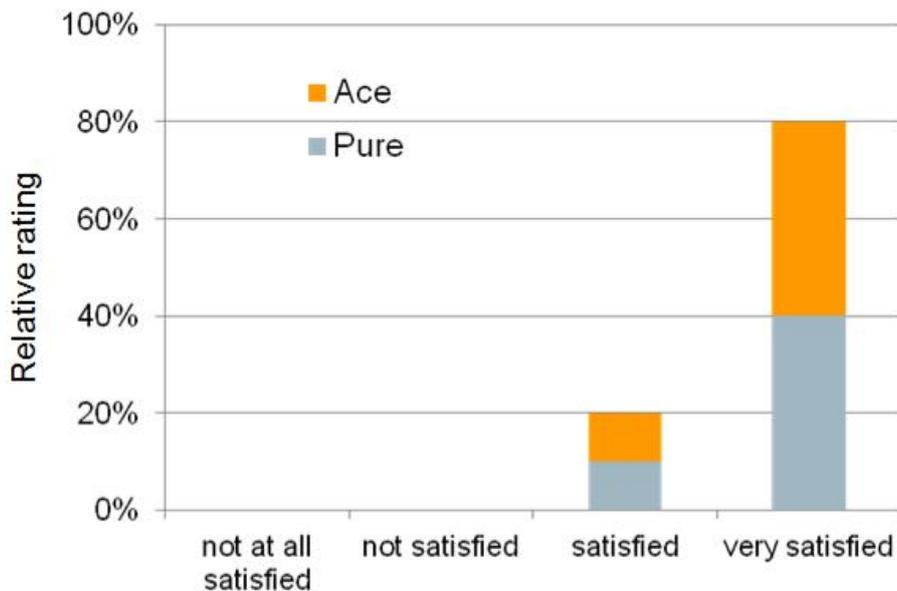


Figure 6: Satisfaction ratings of subjects with the robustness of Pure and Ace micon at the end of the field test.

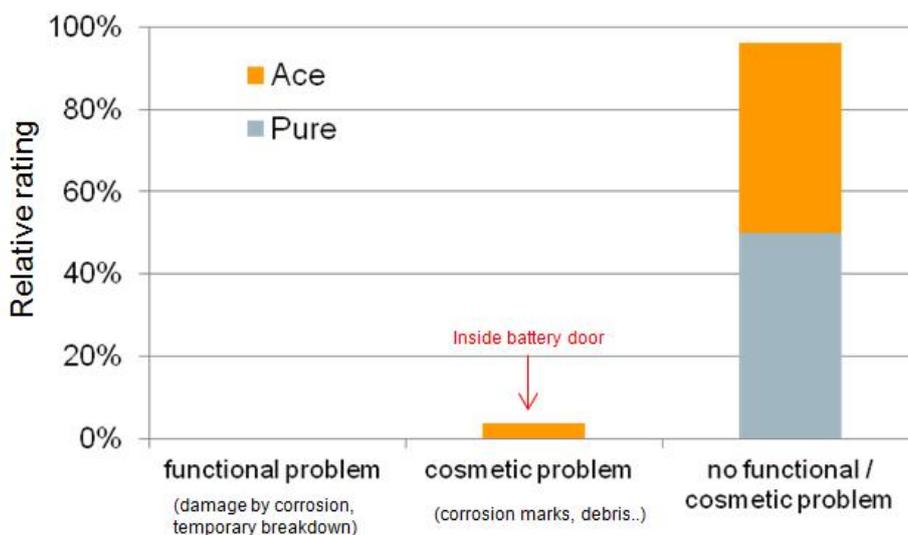


Figure 7: Problems (cosmetic or functional) during the test reported by subject or discovered by the hearing care professional after the test.

Figure 6 shows satisfaction ratings of the subjects with the robustness of Pure and Ace micon. Eight out of the ten subjects reported very high satisfaction with the robustness of the hearing instruments; the other two patients reported to be satisfied.

Figure 7 shows problems that occurred during the field trial or detected after the test by the hearing care professional. Because each participant was fitted bilaterally, these data are taken from 20 instruments. No functional failures or temporary breakdowns occurred during the field trial despite the challenging user profiles and environmental conditions.

None of the hearing instruments showed functional problems such as malfunction due to corrosion or temporary breakdowns. One hearing instrument showed corrosion

stains inside the battery compartment. This is likely due to the chemicals produced by the Zinc-Air battery in highly humid conditions. On all other instruments, no cosmetic problems were detected.

V. Summary

The various technical means newly introduced in the Ace and Pure micon hearing instruments achieve the desired high level of perspiration and water and debris resistance. Moreover, this engineering accomplishment enables patients to wear cosmetically appealing small receiver-in-the-canal hearing instruments without having to worry about robustness problems, even with active lifestyles or in challenging environmental conditions.

VI. References

- [1] Aquaris survey results, June 2011,
http://www.audiologyonline.com/interview/pf_interview_detail.asp?interview_id=594
- [2] IEC 60529: Degrees of protection provided by enclosures (IP Code). [International Electrotechnical Commission](#), Geneva.
- [3] http://www.youtube.com/watch?v=fPgl5PaT_3k