Waterproof phones: What challenges lie ahead?

Bob Jones - July 08, 2014

Take a look down the 3.5-mm headphone jack connection of the iPhone 4/4S and you should see a little spot. This is a hydrochromic paint that permanently changes colour to red once you get it wet. As you might expect, it has been added to the phone to prevent fraudulent warranty or insurance claims: "My phone just stopped working... I did nothing out of the ordinary, so I want a new one."

This all seems a little excessive until you see the statistics. A survey undertaken by GoodMobilePhones.co.uk suggests that over 30% of people in the UK have damaged their phone by getting it wet. Nearly half (47%) of these phones are drowned in the toilet. And a fifth (21%) have a drink spilled on them.

Indeed, Japanese consumers now place waterproofing as a key feature with most handsets - even the high-end ones need this feature if they are to sell well.

It's therefore no wonder that manufacturers, including Sony and Samsung, are beginning to make waterproof handsets. Independent testing by Strategy Analytics gives Sony's first water-resistant phone, the Xperia Z1, an ingress protection rating of IP58 (the highest liquid protection rating), meaning it can be submerged in fresh water to 1.5 m for up to 30 minutes.

With the new generation of wearable devices hitting the market - such as smart watches - the need for waterproof technologies are going to be all the more essential.

To achieve the IP58 rating, Sony uses a combination of tight seals and an "adhesive bonding" layer on the back cover that sticks with the body closely, preventing water and dust from entering the componentry. This can be seen in Witrigs teardown blog.
Figure 1: Sony's flagship phone – the Xperia Z2, is water resistant for 30 minutes in shallow water. But how do we improve on this? © Sony 2014

Alternative methods have also been developed, but have not caught on, for example Ion-Mask, which was developed in 2007 by UK military scientists and uses a plasma to bond a watertight layer.

But, as anyone who has taken a waterproof watch in for a new battery will know, a seal or waterproof layer is only temporary. Therefore, to build a permanently watertight handset, we need to develop a casing with no holes; how can this be properly achieved without compromising the handset's functionality?

A quick look at a high-end phone will show nine key areas for concern. The battery compartment, the flash memory, the SIM card slot, the USB port for data transfer and charging, as well as the speaker, the microphone, any physical buttons, and, of course, the headphone jack.

**Headphone jack**
The first Bluetooth headset appeared on the market at the turn of the century. Bluetooth headsets are now ubiquitous and can stream both standard voice for calls and high-quality audio to a home's stereo system.

**Battery**
This is a relatively easy fix. Neither the iPhone nor the Google Nexus ranges allow you to change the battery or add additional memory. Consumers are happy (enough) to accept this as batteries rarely fail within the two-year life span of the phone and this would, therefore, be covered by warranty.

**Flash memory card**
Another relatively easy fix. As per the battery, neither the iPhone nor the Google Nexus ranges allow the addition of a flash memory card. The Nexus 5, for example, offers 16- or 32-GB options, and the iPhone offers these and a 64-GB handset.
One of the reasons for this is the cost of memory, which has come down to a point where it's possible to integrate enough storage to ensure a premium handset will not be overfilled within the two-year phone cycle - and without pricing the handset out of the market. At the same time, cloud storage reduces the need for excessively large hard drives; Google, for example, lets you store 20,000 songs on its music servers, and platforms such as Netflix and LoveFilm means you can stream video to the phone rather than storing it.

But this does present a problem, how do you deliver the content at high speed if you eliminate a USB cable port?

![iPhone](image)

**Figure 2:** A quick look at the iPhone reveals several points where water can get in. If we want a truly waterproof phone, these must be eliminated.

**Data transfer**

USB, especially USB 3.0 - which transmits at speeds up to 5 Gbps - provides a quick way of enabling high-speed data transfer, and these speeds would need to be matched by any wireless alternative. Handsets typically include just three wireless standards, Wi-Fi (802.11n is the most common, and typically transmits at 130 Mbps or below), Bluetooth (typically 1 Mbps) and NFC (424 kbps maximum, and requires contact).

But this is changing, and faster Wi-Fi standards are in development. 802.11ac runs in the 5-GHz band and is already being implemented on dual- and tri-band Wi-Fi chipsets to allow typical transfer speeds of 1.7 to 2.5 Gbps. ABI predicts roughly 80% of all Wi-Fi chipsets shipped in 2015 will incorporate 802.11ac functionality.
Beyond this, some of the major players are developing the next generation of Wi-Fi technology, 802.11ad Wi-Fi (more commonly known as WiGig), which uses the unlicensed 60-GHz band and has 7 GHz of bandwidth. This enables speeds of 5 Gbps and over to be delivered wirelessly. And ABI predicts 1.4 billion tri-band Wi-Fi chipsets that incorporate this 60-GHz band will ship by 2018.

However, the complex sampling rate, coupled with the lack of available R&D funding outside the big three – Intel, Qualcomm, Broadcom – means smaller firms would have struggled to compete in this potentially huge market space.

The answer to this market dominance could come from an IP business model with firms – notably Blu Wireless Technology – developing the IP that would allow these vendors to rapidly create and ship chips with this functionality.

Charging
But the USB port is also used to charge the handset, so an alternative charging method would be needed. While wireless charging is nothing new, it is only recently that the technology has been adopted by handset manufacturers – including Nokia, LG, and HTC, but notably not Apple.

Physical buttons
The launch of the first iPhone, just seven years ago, accelerated the move to touchscreen devices. Now we routinely type e-mails and messages on virtual keyboards, yet we’re still often frustrated by miskeyed inputs, accidental touches, and the phone’s attempts to guess what we really meant to type.

In general, this was a move forward, but there should be a subtlety to touch that removes the need to pay close visual attention to how our fingers or hands move. Think back to texting on an old phone’s keypad, when the key selection was perfect every time, even if the phone did turn "fancy a pint" into "fancy a riot."

As a result, almost all phones have a few key buttons. The Nexus 4, for example, has just an on/off and a volume rocker. The iPhone 5, however, implements a physical home key, an off button, two separate volume keys and a mute switch.

The evolution of haptics, from first-generation systems that implemented terrible motorised vibration to shake the entire device to today’s modern third- and fourth-generation systems that can calibrate the response according to a given application, the point of contact, and even how hard we press, means we can implement these subtle sensations once again and cut the need for holes in a handset’s housing.

And, while some of the initial applications – such as Senseg’s E-sense – focused on creating screen textures using the Coulomb effect, other companies are enabling precise, configurable button press sensations. One such company is Redux Labs, a UK-based firm that uses bending wave physics to control sensations delivered to the point of touch and implement a large library of sensations.

Microphones
The microphone presents a challenge: how do you allow airwaves in, but no water, to enter the phone?

However, this solution has been around for many years, as handsets have always needed to waterproof the microphone – albeit from spittle, rather than accidental drownings. The most common way of sealing this compartment is through a Gortex layer. And, provided it’s placed on a breakable seal, this can provide long-term waterproofing for the handset.
The speaker
A speaker clearly needs air to transfer sound clearly. An alternative to the standard micro-speaker technology that is implemented almost universally in today's handsets is therefore needed.

Today's screens, which typically use Corning's rigid Gorilla Glass, provide an unlikely solution. Using precisely calibrated waves it is possible to deliver high-quality audio from the screen. One of the key players here is, again, Redux Labs, which uses its bending wave physics to control sonic waves (as well as sub-sonic haptic waves) across the screen and create a higher-quality speaker.

It is also possible to localise the waves and only emit sound from the standard phone speaker location – ensuring the phone call remains private.

Summary
The high frequency with which we cause water-damage to our phones is leading to waterproofing becoming a significant differentiator for modern handsets.

Many companies – notably Sony – are creating phones that are increasingly water resistant. And while several barriers to creating a truly watertight enclosure lay ahead, today's cutting edge wireless, audio and haptic technologies can be deployed to create a phone that won't die when you drop it in the toilet or spill your drink on it.

More about Bob Jones.