No more discharged batteries – Azoteq Wear&Play™ intelligent wear detection for Auto ON/OFF
Capacitive sensing technology to detect wearable usage and provide intuitive control.

1 Introduction
All wearable devices contain rechargeable battery units that need to last long periods.
This document describes the application of Azoteq ProxSense® capacitive sensors in wearables for:
- Auto ON/OFF – Wear detection
- Proximity alert and movement detection
- Capacitive sensing buttons
- Trackpad/touchscreen with gestures
Capacitive sensing eliminates the need for mechanical ON/OFF switches. Auto-OFF after a fixed period is not practical in all applications. Motion sensors may deactivate during passive periods – like traveling in a car or an airplane.
Azoteq ProxSense® provides a range of low cost and low current, touch and proximity sensors manufactured in compact packages.

2 Typical application
2.1 Wireless Headphones
Figure 2.1 depicts typical wireless headphones. Capacitive sensing can be used for:
- On-head detection
- Gesture control

Figure 2.1 Typical wireless headphones

2.2 Bluetooth earphones
- Small/compact design
- Limited battery life
- Auto ON/OFF saves power when not in use.
2.3 Fitness trackers
- Robust designs (water/dust-proof)
- Need extended battery life
- Intuitive user interface

Figure 2.2 A Bluetooth headset

Figure 2.3 Typical fitness trackers

2.4 Smart watches and other wearables
- Capacitive touchscreen
- On-wrist detection
- Functional gesture control

Figure 2.4 A modern smart watch

2.5 Toys & remote controllers
- Proximity detection
- Auto ON/OFF
- Capacitive touch control

Figure 2.5 A children’s toy example

Figure 2.6 Remote controller

2.6 Medical wearables
- Monitor the health of a person
- Heart rate monitors, ECG’s, glucose level monitoring (Figure 2.7), pain relievers, and respiratory- and neuro-monitoring devices
- Human detection is crucial
- Require extended battery life

Figure 2.7 Wearable glucose monitoring system
3 Advantages of capacitive sensing

3.1 Low power

Azoteq Wear&Play™ solutions provide current consumptions below 80μA in activation mode and as less as 3.5μA in a low power state while still sensing.

3.2 Robust design possibilities

Using capacitive sensors:
- No mechanical switches
- Saves space (small device packages)
- Robust designs (waterproof)
- Custom finishes possible

Figure 3.1 A robust wearable device for fitness tracking

3.3 Intuitive use

Azoteq ProxSense® sensors can detect:
- Proximity,
- Touch,
- Movement,
- Gestures (tap, double tap, tap-and-hold, swipe, swipe and hold),
- Tilt sensing (require hardware design)

Figure 3.2 Swipe gesture on a smart watch display

Also refer to Figure 5.18 for a complete gesture illustration available regarding headphone trackpads.

3.4 Intelligent detection algorithms

Proven sensing algorithms:
- Touch late release. Hysteresis based threshold adjustment.
  Firm touch → activation
  Relaxed over time → keeps activation
- Movement detection. Senses small capacitive changes when moving.
  Distinguish between:
  - A trigger from a person (continuous movement afterwards)
  - A false trigger with an inanimate object (stationary).

Figure 3.3 Wireless headphones stored on a metal stand

Figure 3.3 gives an example of no movement although proximity triggered.
3.5 Low cost

Azoteq provides low cost capacitive sensing solutions with a wide range of sensors for every application. With limited external components, capacitive functionality can be added to a device at a price comparing to tactile switches.

4 Azoteq WEAR&PLAY™ applicable sensors

Azoteq’s range of wearable IC and package details are given in Table 4.1.

<table>
<thead>
<tr>
<th>Controller</th>
<th>Description</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQS211</td>
<td>Touch, Prox, Movement, Touch late release</td>
<td>TSOT23-6</td>
</tr>
<tr>
<td>IQS213A</td>
<td>SwipeSwitch™</td>
<td>MSOP-10</td>
</tr>
<tr>
<td>IQS263</td>
<td>Touch, Prox, SAR, Movement, Slider, Scroll wheel</td>
<td>MSOP-10</td>
</tr>
<tr>
<td>IQS333</td>
<td>Touch, Prox, 2 sliders</td>
<td>QFN32</td>
</tr>
<tr>
<td>IQS360</td>
<td>Trackpad controller</td>
<td>QFN32</td>
</tr>
<tr>
<td>IQS525</td>
<td>Trackpad/Touchscreen</td>
<td>QFN28</td>
</tr>
<tr>
<td>IQS572</td>
<td>Trackpad/Touchscreen</td>
<td>QFN28</td>
</tr>
</tbody>
</table>

For any further details regarding a specific ProxSense® controller kindly consult the appropriate datasheet available on the Azoteq website (www.azoteq.com/design/datasheets).
5 IQS572 trackpad implementation: Wireless headphone gesture control

An Azoteq IQS572 trackpad module (AZP584A01) was fitted in a SoundBot® SB420-BLU headphone (Figure 5.1) for on-head touch and gesture recognition. User gestures will emulate tactile button presses.

Figure 5.1 SoundBot® SB240-BLU headphones

The integration steps follows (guideline):

- Disassemble the headset module.
- Fit a trackpad module into the design.
- Apply an appropriate overlay to the trackpad and ear piece.
- Program the IQS572 IC.
- Interface connections towards the controller inputs. Assemble the headset.
- Evaluate the gesture recognitions and sensitivity of the trackpad.

5.1 Disassemble the headset

a. Remove the cushions over ear pieces.

Figure 5.2 Ear cushions removed

b. Open the controller ear piece (right hand side) by loosening the screws (3).

Figure 5.3 Controller-side ear piece opened

c. Remove the controller PCB from the plastic ear piece structure.

Figure 5.4 Control PCB removed
d. Separate the ear piece structure from its individual plastic buttons.
5.2 Fit a trackpad module

a. Select an appropriate size trackpad module (developed by Azoteq). A 40mm diameter circular trackpad (1mm thick FR4) was used.

b. The trackpad is fitted close to the controller for interfacing. Figure 5.7 and 5.8 shows annotated pictures of the retrofit.

c. The trackpad was fixed on the outside of the earpiece. Placed with top indication indent in upright position for correct directional gesture recognition.

5.3 Trackpad overlay

a. Design an overlay to cover the trackpad:
   - Cover completely and around edges
   - 1.2mm thickness used for ESD protection (1mm – 3mm suggested)
   - 45mm diameter (slightly bigger than trackpad)
   - Perspex material. Can use non-conductive materials with high dielectric permittivity (ε) value.
b. A double sided adhesive tape (3M) was used (Figure 5.11). Ensure that:
   - Surfaces is clean and level
   - Properly stick trackpad PCB to overlay.
   - No air pockets.
   This guarantee equal and consistent sensitivity over the trackpad surface.

Figure 5.11 Double sided adhesive contact tape over trackpad

Figure 5.12 Trackpad with overlay on ear piece

5.5 Interface the trackpad to the headphone’s controller

a. Provide wire connections to the trackpad solder pads (Table 4.1).

Figure 5.13 Trackpad interfaced with programming wires

5.4 Program the trackpad module

This section is omitted due to its complexity. The reader is referred to the Application note AZD070 IQS5xx programming and data streaming for more detail.

Figure 5.14 Connection wires soldered on the trackpad PCB

b. Table 5.1 summarises all wire connections towards button inputs to control their functions.

<table>
<thead>
<tr>
<th>Headphone</th>
<th>Trackpad</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUX 1V8</td>
<td>3V3</td>
</tr>
<tr>
<td>Ground (G)</td>
<td>GND</td>
</tr>
<tr>
<td>Volume increase (+)</td>
<td>IO1</td>
</tr>
<tr>
<td>Call/Play/Pause (&gt;ll)</td>
<td>IO2</td>
</tr>
<tr>
<td>Volume decrease (-)</td>
<td>IO3</td>
</tr>
<tr>
<td>Skip backward (&lt;&lt;)</td>
<td>IO4</td>
</tr>
<tr>
<td>Skip forward (&gt;&gt;)</td>
<td>RDY</td>
</tr>
</tbody>
</table>

Table 5.1 Headphone control interface towards trackpad

c. The outer ear piece was assembled afterwards (excluding the original plastic buttons as shown in Figure 5.5; the three rightmost pieces).
5.6 Test evaluation

1) Power on and connect Bluetooth
2) Swipe up for volume increase
3) Swipe down for volume decrease
4) Swipe forward for skip forward
5) Swipe backwards for skip backward
6) Tap for play/pause/call answer

The definition and timing of IO port’s logic can be custom programmed.

For further information regarding this subject, please contact your local distributor or submit enquiries to Azoteq at: ProxSenseSupport@azoteq.com
Figure 5.18  Block diagram of original wireless headphones

Figure 5.19  Block diagram of a IQS572 trackpad fitted wireless headphones
6 Contact information

<table>
<thead>
<tr>
<th>USA</th>
<th>Asia</th>
<th>South Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Address</td>
<td>6507 Jester Blvd Bldg 5, suite 510G Austin TX 78750 USA</td>
<td>6507 Jester Blvd Bldg 5, suite 510G Austin TX 78750 USA</td>
</tr>
<tr>
<td>Postal Address</td>
<td>Rm2125, Glittery City Shennan Rd Futian District Shenzhen, 518033 China</td>
<td>Rm2125, Glittery City Shennan Rd Futian District Shenzhen, 518033 China</td>
</tr>
<tr>
<td>Tel</td>
<td>+1 512 538 1995</td>
<td>+86 755 8303 5294 ext 808</td>
</tr>
<tr>
<td>Fax</td>
<td>+1 512 672 8442</td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:kobusm@azoteq.com">kobusm@azoteq.com</a> <a href="mailto:linayu@azoteq.com.cn">linayu@azoteq.com.cn</a></td>
<td></td>
</tr>
</tbody>
</table>

Please visit [www.azoteq.com](http://www.azoteq.com) for a list of distributors and worldwide representation.


IQ Switch®, SwipeSwitch™, ProxSense®, LightSense™, AirButton™, ProxFusion™ and the ® logo are trademarks of Azoteq.

The information in this Datasheet is believed to be accurate at the time of publication. Azoteq uses reasonable effort to maintain the information up-to-date and accurate, but does not warrant the accuracy, completeness or reliability of the information contained herein. All content and information are provided on an “as is” basis only, without any representations or warranties, express or implied, of any kind, including representations about the suitability of these products or information for any purpose. Azoteq disclaims all warranties and conditions with regard to these products and information, including but not limited to all implied warranties and conditions of merchantability, fitness for a particular purpose, title and non-infringement of any third party intellectual property rights. Azoteq assumes no liability for any damages or injury arising from any use of the information or the product or caused by, without limitation, failure of performance, error, omission, interruption, defect, delay in operation or transmission, even if Azoteq has been advised of the possibility of such damages. The applications mentioned herein are used solely for the purpose of illustration and Azoteq makes no warranty or representation that such applications will be suitable without further modification, nor recommends the use of its products for application that may present a risk to human life due to malfunction or otherwise. Azoteq products are not authorized for use as critical components in life support devices or systems. No licenses to patents are granted, implicitly, express or implied, by estoppel or otherwise, under any intellectual property rights. In the event that any of the abovementioned limitations or exclusions does not apply, it is agreed that Azoteq's total liability for all losses, damages and causes of action (in contract, tort [including without limitation, negligence] or otherwise) will not exceed the amount already paid by the customer for the products. Azoteq reserves the right to alter its products, to make corrections, deletions, modifications, enhancements, improvements and other changes to the content and information, its products, programs and services at any time or to move or discontinue any contents, products, programs or services without prior notification. For the most up-to-date information and binding Terms and Conditions please refer to [www.azoteq.com](http://www.azoteq.com).

WWW.AZOТЕQ.COM
info@azoteq.com