Application Note: AZD034 Release2
Wear&Play™: Auto ON/OFF for portable devices

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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.

Automatic device activation when wearable detects body contact

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.

Figure 2.2 A Bluetooth headset

2.3 Fitness trackers

- Robust designs (water/dust -proof)
- Need extended battery life
- Intuitive user interface

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

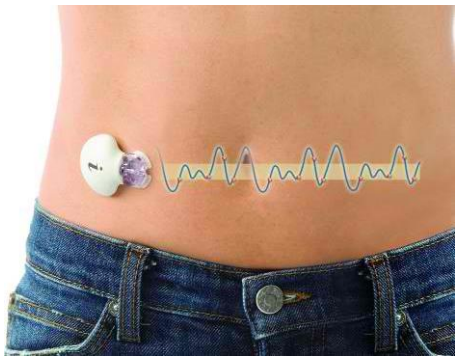

Figure 2.7 Wearable glucose monitoring system

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 shows an example of a swipe gesture on a smart watch's display.

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 gives an example of no movement although proximity triggered.

Figure 3.3 Wireless headphones stored on a metal stand

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 4.1 Azoteq wearable IC's

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

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.

Figure 5.5 Ear piece structure and buttons disassembled

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.

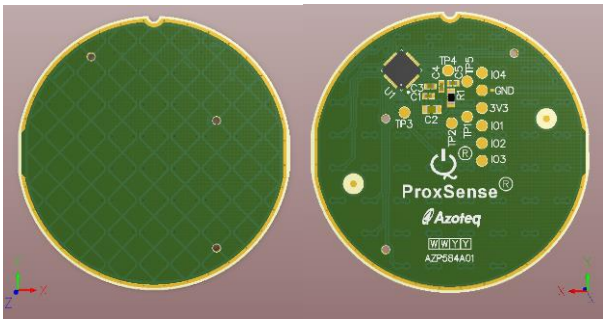

Figure 5.6 IQS572 trackpad PCB (40mm diameter)

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

Figure 5.7 Top view of proposed trackpad layout (in white) on ear piece structure

Figure 5.8 Side profile of proposed trackpad layout on ear piece structure

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

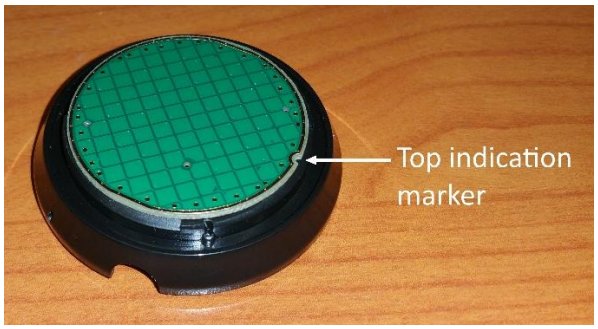

Figure 5.9 Trackpad fixed on ear piece structure

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.

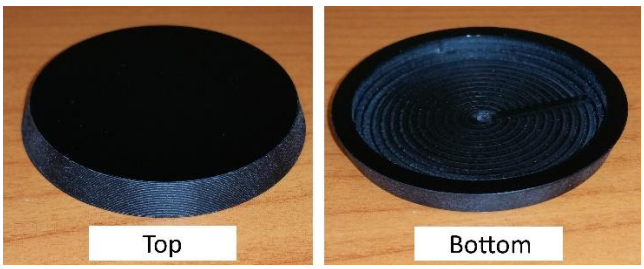

Figure 5.10 Illustration of the Perspex overlay used

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

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

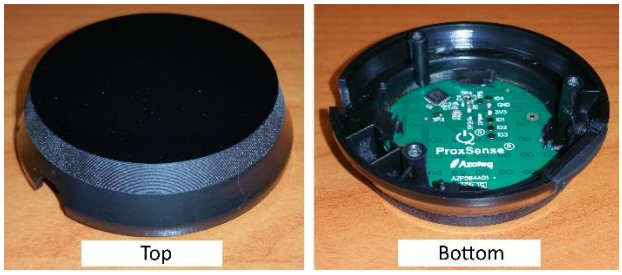

Figure 5.12 Trackpad with overlay on ear piece

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 5.13 Trackpad interfaced with programming wires

5.5 Interface the trackpad to the headphone's controller

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

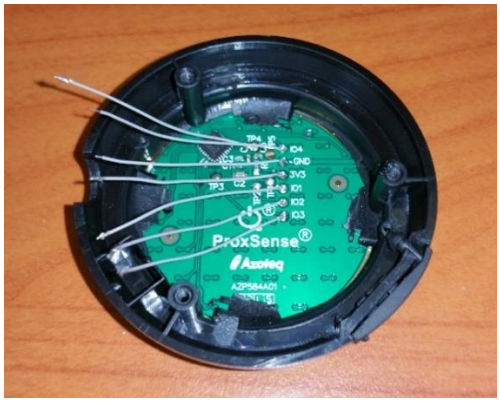

Figure 5.14 Connection wires soldered on the trackpad PCB

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

Headphone	Trackpad
AUX 1V8	3V3
Ground (G)	GND
Volume increase (+)	IO1
Call/Play/Pause (>ll)	IO2
Volume decrease (-)	IO3
Skip backward (<<)	IO4
Skip forward (>>)	RDY

Table 5.1 Headphone control interface towards trackpad

Figure 5.15 Connection wires soldered and tucked into earpiece

c. Assemble the headphone completely. Ensure that all wire connections are securely fastened.

Figure 5.16 Headset completely assembled

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 5.17 The original tactile button solution vs. the new gesture trackpad implementation

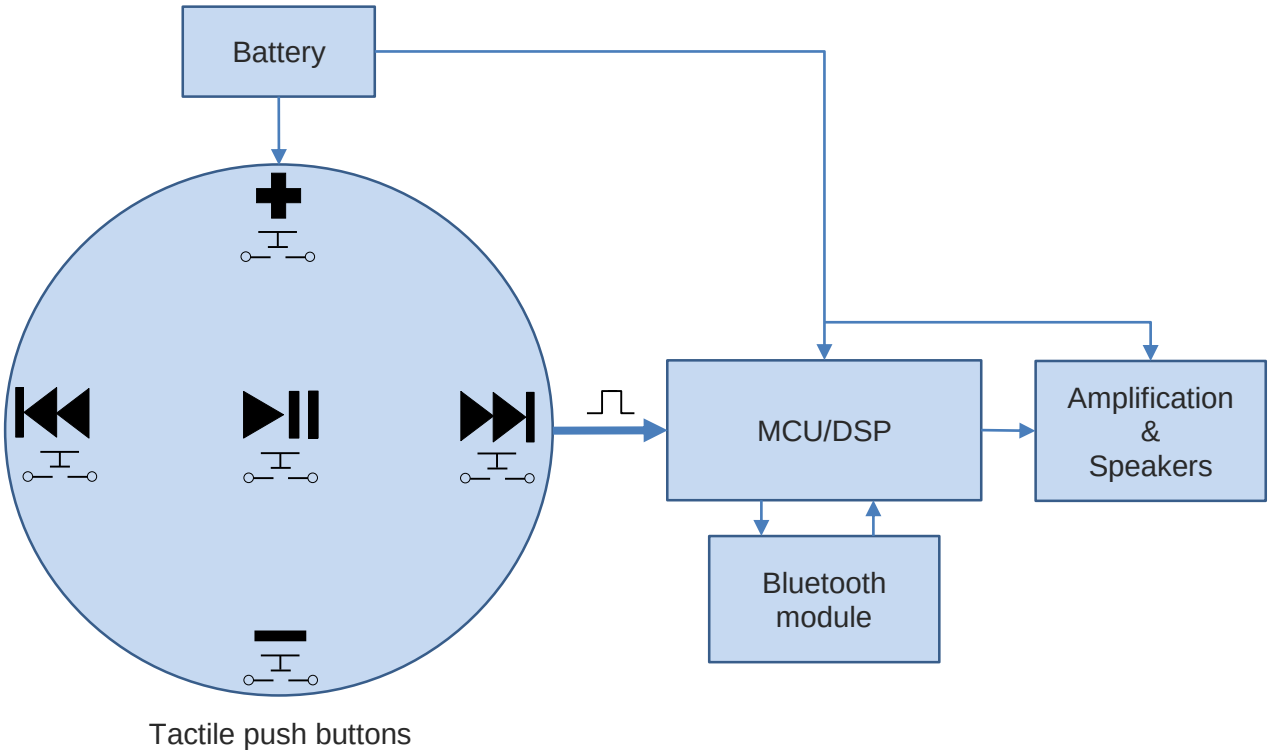

Figure 5.18 Block diagram of original wireless headphones

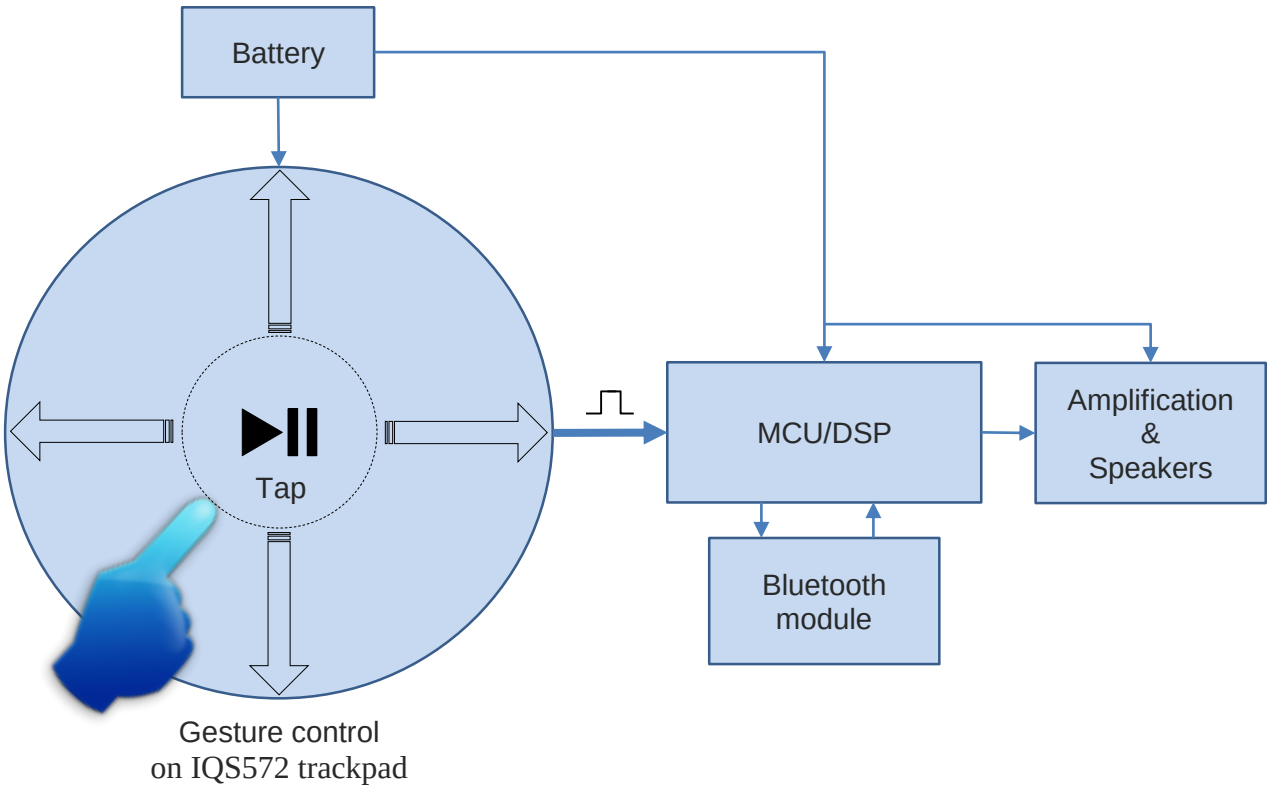

Figure 5.19 Block diagram of a IQS572 trackpad fitted wireless headphones

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