May 2022

Wearable Device Mic Corrosion Mitigation

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ABSTRACT

Metallic components within a device may be subject to corrosion due to moisture entering the device. The corrosion of these components may be mitigated by including an additional, or sacrificial, anode. The sacrificial anode may be added to a substrate, such as a printed circuit board, within the device.

BACKGROUND

Devices, such as wearable devices, include many components that are subject to corrosion from ambient moisture. Wearable devices include smart watches, AR/VR headsets, earbuds, etc. The devices typically include processors, microphones, speakers, and sensors, amongst other components. There are typically ports, or openings, at the location of the microphones and speakers, which allow the microphones to better pick up audio signals and the speakers to output audio signals. Moisture can enter the device through these ports and lead to corrosion of the metallic components within the device. Due to the presence of the ports, the size and location limitations, moisture protection with conventional methods are either costly or infeasible.

BRIEF SUMMARY

As described in this paper, a sacrificial anode can be added to a printed circuit board of a device. The sacrificial anode can be part of a circuit such that a voltage can be applied to the sacrificial anode. The sacrificial anode may be placed near components that have a corresponding opening, such as microphones or speakers. For example, the sacrificial anode may be part of the microphone circuit such that the sacrificial anode is near the microphone port.

The microphone circuit may include a ground, voltage supply pins, such as Vdd pins, data line(s), clock line(s), and sacrificial anode(s). The sacrificial anode may be positioned within the circuit to have a positive voltage applied such that the sacrificial anode is anode and, therefore subject to corrosion. By positioning the sacrificial anode to have a positive voltage applied, the sacrificial anode will be subject to corrosion rather than the components surrounding the sacrificial anode.

DESCRIPTION

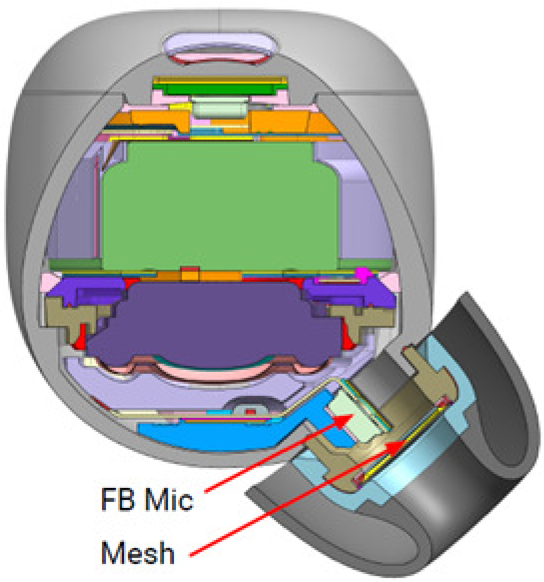

Fig. 1

Figure 1 illustrates an example device with metallic components subject to anode corrosion. As shown in Figure 1, the device may be an earbud from a pair of earbuds. The earbud may include a feedback ("FB") microphone as well as additional sensors and processing units to provide for active noise cancellation ("ANC"). Corrosion may occur on the circuitry at or near the FB microphone as the FB microphone may be located in a flood zone at or near a sound output port. The port may be open to the ambient surroundings. In some examples, the port may be covered with a moisture permeable mesh. Thus, the components at or near the output port may be subject to moisture. The metallic components, therefore, may be subject to corrosion due to the moisture. To mitigate the corrosion from damaging components required for the device to function properly, a sacrificial anode may be added to circuits at or near the ports. For example, a sacrificial anode may be added to the microphone circuitry such that the sacrificial anode will be subject to corrosion while mitigating any corrosion to the nearby circuit components. This may extend the life of the device as circuitry components subject to moisture will be less likely to corrode and, therefore, become defective.

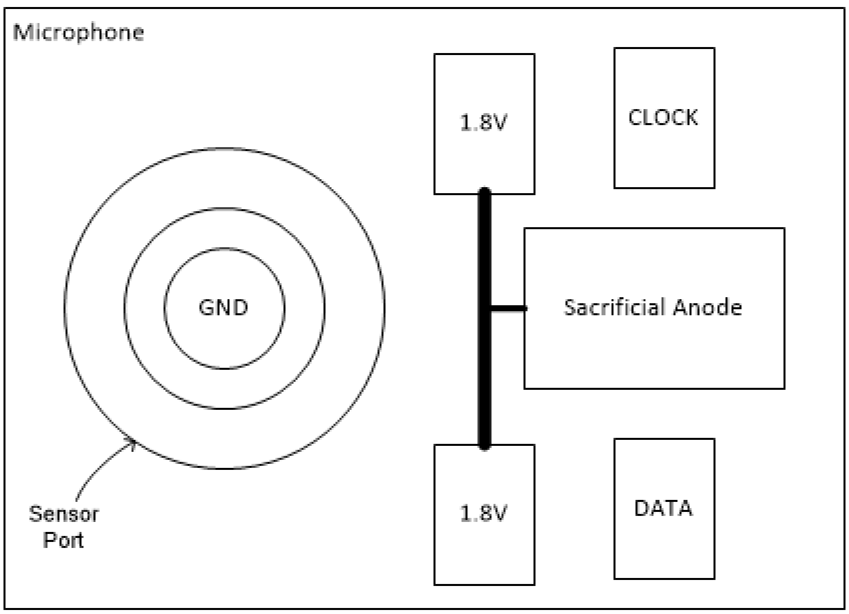

Fig. 2

Figure 2 depicts a block diagram of a component within a device. The device may be, for example, a wearable device such as a pair of earbuds, a smart watch, glasses, AR/VR headset, smart helmet, etc. The device may include a plurality of components, such as a microphone, output, processors, inputs, etc. The component depicted in Figure 1 may be, for example, a microphone. The microphone may include a sensor port, which may connect the microphone to a system on a chip ("SOC"). The sensor port may be sealed, for example, by applying solder around the sensor port thereby leaving only the internal portion of the sensor port exposed. According to some examples, more than one sensor port may be required such as when a microphone located on the portion of the device that goes within an ear is used for active noise control. In such an example, one additional sensor ports may be required for obtaining feedback signals. For example, a FB microphone may sample audio signals inside the portion of the device within the ear. The audio signals may be the audio output from a speaker in the device and traveling toward the ear canal. In such an example, the microphone and, therefore, the sensor ports, may be exposed. Moisture may corrode the microphone and/or other metallic components on a microphone circuit.

The microphone circuit can include the sensor port, a ground (GND), clock lines ("CLOCK"), data lines ("DATA"), and a sacrificial anode. According to some examples, the CLOCK and DATA lines may be powered by the SOC, which has a connection to the microphone. However, the CLOCK and DATA lines may be subject to anode corrosion due to the applied voltage and exposure to moisture.

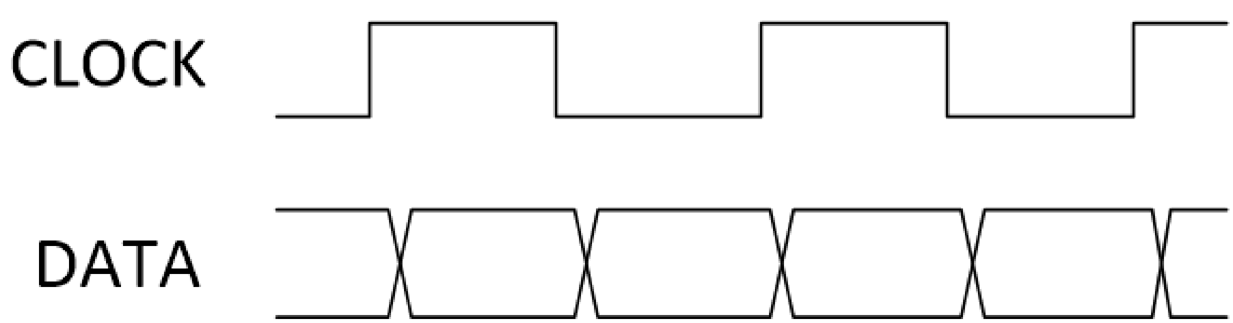

Fig. 3

The circuit may be exposed to moisture via one or more ports in the housing of the device. For example, the device may include ports, or openings, at or near the location of the microphone to better allow the microphone to capture audio signals. Moisture may enter the device through the ports. The moisture may cause corrosion of the components on the circuit and/or within the device. To mitigate the corrosion of components on the circuit, such as the CLOCK lines and DATA lines, the sacrificial anode may be positioned in the circuit such that a positive voltage is applied to the sacrificial anode by the SOC. A positive voltage may be applied to the sacrificial anode by including PCB traces also carrying a positive voltage. The positive voltage may be an amount greater than the voltage applied to the CLOCK and DATA lines. For example, the SOC may apply a constant 1.8Volts to the sacrificial anode while the CLOCK and DATA lines have a voltage less than 1.8Volts applied at least half of the time. For example, the interface of the microphone may be 1.8Volts pulse density modulation (“PDM”), with DATA and CLOCK lines. The CLOCK and DATA lines may be higher than ground voltage level. As shown in Figure 3, the CLOCK line may be fifty percent duty (50%), such that a voltage is applied fifty percent (50%) of the time, at 1.8Volts. The DATA line may toggle between 1.8Volts and 0Volts. By having the positive voltage applied to the sacrificial anode, the sacrificial anode may be subject to corrosion before the other components within the circuit.

In some examples, the sacrificial anode may have a size, e.g. a length, width, and height, and/or shape based on the type of device. For example, the size and/or shape of the sacrificial anode may be determined based on the projected annual failure rate of the device. The annual failure rate may be the estimated product life of the device. The size and/or shape of the sacrificial anode, therefore, may be chosen in order to last the estimated life of the device.