TECHNICAL BRIEF · PROJECT 01

Integrated Wireless Antennas for Wearable Devices

Dual-band (BLE / Wi-Fi) stamped antenna design with hybrid filter-matching network

Project Description

The antenna element must fit inside a 2-inch disk that is 10 mm thick, and must meet the requirements given in the dedicated section below. It must also be suitable for mass production in the US at a unit cost of less than 10 cents (for a minimum order quantity greater than 10,000 units).

Project Requirements

- Tuned antennas fully functional on the wrist.
- Dual-input, dual-band, single-element antenna.
- Stamped, low-cost antenna.
- BLE band: 2.4–2.5 GHz, with return loss better than 10 dB.
- Peak gain of −3 dBi for the BLE antenna.
- Wi-Fi band: 5.5–6 GHz, with return loss better than 10 dB.
- Peak gain of 4 dBi for the Wi-Fi antenna.
- Port-to-port isolation better than 30 dB in both the BLE and Wi-Fi bands.

Models and Details

A simplified design of the system is shown in Figure 1.

Figure 1(a) shows the full enclosure with the desired features and dimensions. The plastic thickness and molds are designed to fit proprietary sensors and chips while housing the wireless antennas and chips. **Figure 1(b)** shows the top view of the model.

Figure 1(c) shows the simplified internal details of the wearable unit. Proprietary implementation details are intentionally omitted from this public technical brief. The rechargeable battery sits in the middle of the unit, behind the main display on top. The stamped antennas are placed around the circumference of the unit, around the main PCBA.

Figure 1(d) shows the main PCB layout with the stamped antennas. Note that one antenna is designed to connect to the Wi-Fi chip and the other to the BLE chip. In the next section, we show how these elements perform on their own and how our hybrid filter-matching network achieves both a good return loss for each antenna and good isolation between the antennas.

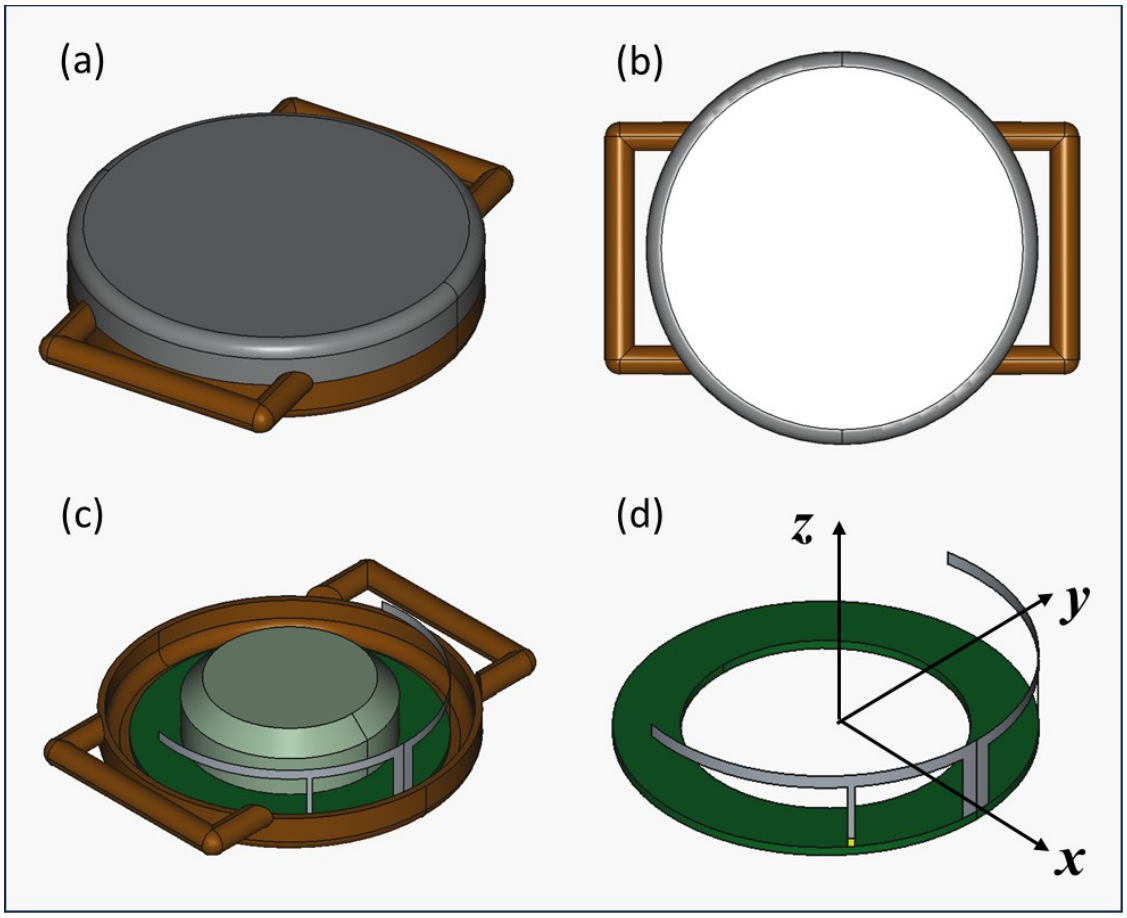


Figure 1 — Wearable enclosure and antenna placement. (a) full enclosure, (b) top view, (c) internal layout, (d) PCB with stamped antennas and coordinate reference.

Results

This section discusses the performance of the modeled antennas.

Figure 2(a) shows the radiation patterns of both antennas in the XZ and YZ cuts (as referenced in Figure 1(d)). The BLE and Wi-Fi antennas have peak gains of 0 dBi and 5 dBi, respectively — both meeting their targets.

Figure 2(b) shows the pre-matched S-parameters of the antennas. The antennas are designed to have acceptable initial return loss in the desired bands; however, the isolation between them is well below the requirement in the Wi-Fi band.

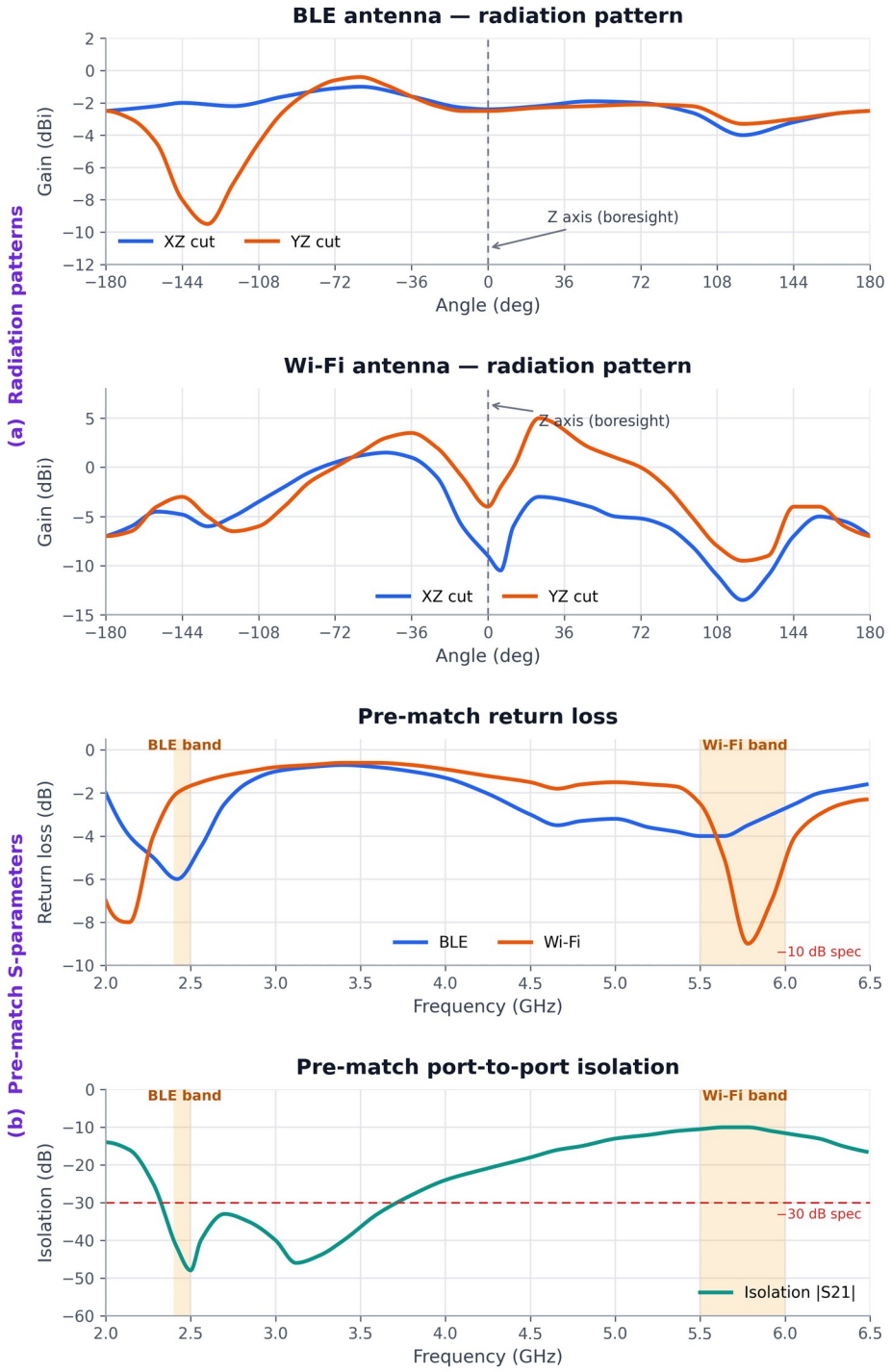
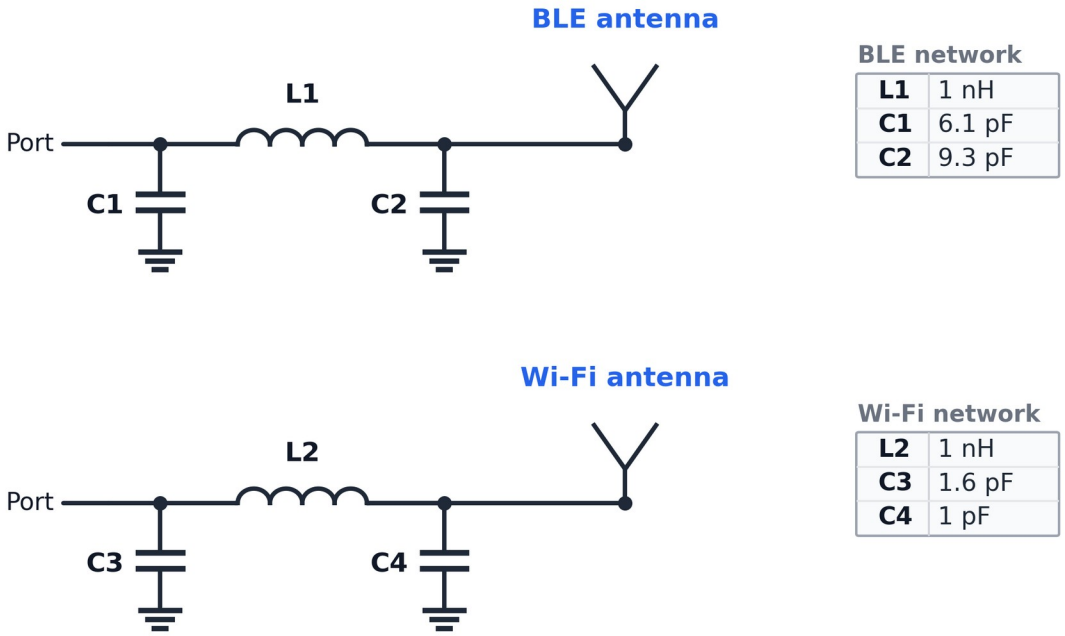


Figure 2 — (a) Radiation patterns of the BLE and Wi-Fi antennas (XZ and YZ cuts). (b) Pre-match S-parameters: return loss and port-to-port isolation.

Figure 3 shows the hybrid filter-matching network for each antenna. The components are optimized to achieve a return loss better than 10 dB for both antennas, as well as isolation better than 30 dB between the antennas in both bands. The capacitors are selected from the Murata 0201 library and the inductor from the Murata High-Q 0201 library.



BLE network

L1	1 nH
C1	6.1 pF
C2	9.3 pF

Wi-Fi network

L2	1 nH
C3	1.6 pF
C4	1 pF

Capacitors: Murata 0201 library · Inductors: Murata High-Q 0201 library

Figure 3 — Hybrid filter-matching network and optimized component values for the BLE and Wi-Fi antennas.

Figure 4 shows the S-parameters of the antennas after applying the optimized network from Figure 3. As desired, the return loss of both antennas is better than 10 dB across the entire BLE and Wi-Fi bands, and the isolation between the antennas is better than 30 dB in both bands.

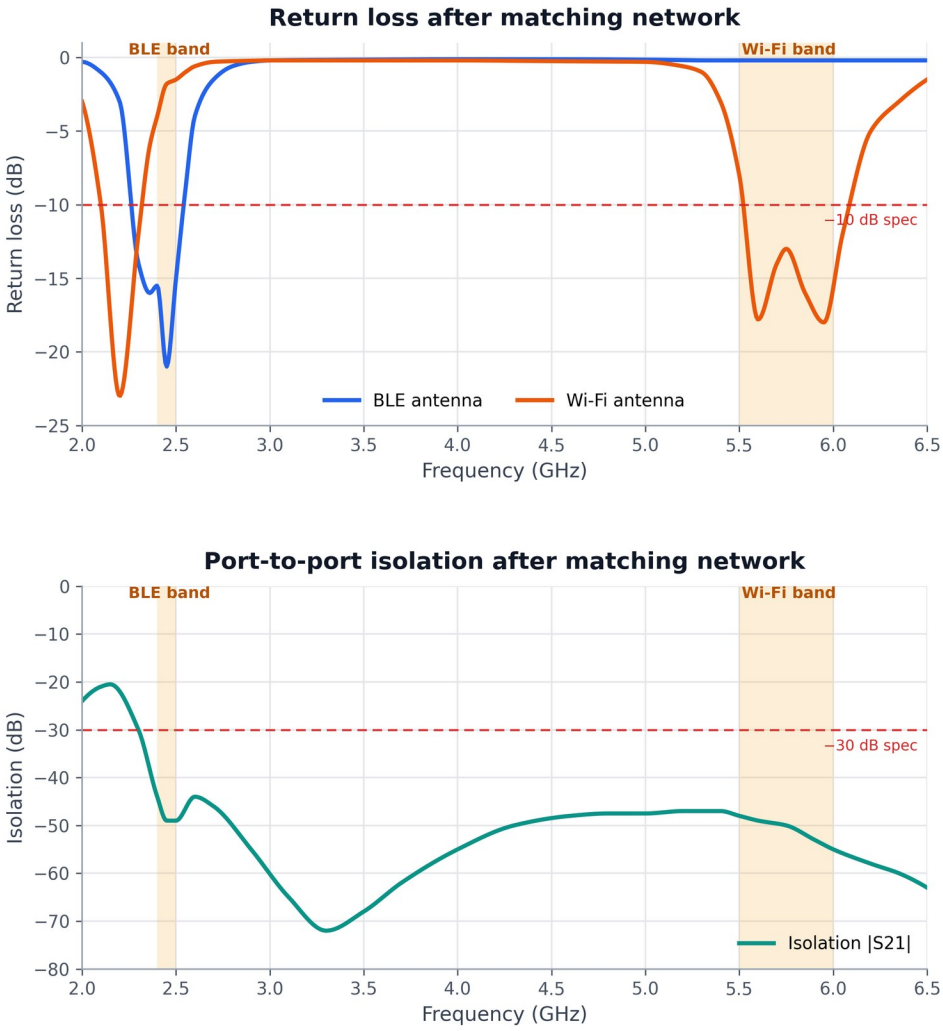


Figure 4 — Post-match S-parameters: return loss of both antennas and port-to-port isolation, meeting the 10 dB and 30 dB targets across both bands.