Apple is ahead of its competitors in many applications, most obviously imaging and display – and is now also adopting innovative technology in the radio-frequency (RF) area. Having usually depended on well-proven solutions, the company is now using the latest and most advanced filter and packaging technology from Broadcom, formerly Avago Technologies, in two of the three versions of the iPhone X. The versions dedicated to the Japanese and SIM-free markets feature a two-in-one Long Term Evolution (LTE) Front-End Module (FEM), covering the mid- and high-frequency RF bands. This FEM is the first to include advanced Electro-Magnetic Interference (EMI) shielding, allowing frequency band sharing in the same System-in-Package (SiP).

Located on the main Printed Circuit Board (PCB) substrate underneath the SIM card slot, the RF Front-End (RFFE) has different configurations depending on the transceiver chipset. The AFEM-8072 from Broadcom was found in the Japanese and SIM-Free versions of the Apple iPhone X, the A1865 and A1902 respectively. In the European version, two separate modules from Avago share the RFFE area with Qorvo, Skyworks, and TDK-Epcos.

The AFEM-8072 is a mid- and high-band LTE FEM. As usual, it features several dies, including power amplifier, silicon-on-insulator switch and filters. The last ones still use Avago’s Microcap bonded-wafer Chip Scale Packaging (CSP) technology with Through-Silicon Vias (TSVs) enabling electrical contacts and scandium-doped aluminum nitride (AlScN) as a piezoelectric. However, for this special version, Broadcom has integrated two advanced features: An RF integrated circuit (IC) featuring several integrated passive devices (IPDs) for antenna matching; and an EMI shield inside the FEM to reduce interference between the dies. Moreover, Broadcom has chosen Sony to supply low power SOI switches.

Thanks to all these innovations, Broadcom is able to supply a cost effective two-in-one component with fewer interconnections.

This report analyzes the full FEM SiP, including the RF IC and its IPDs, the filtering dies and the internal and external EMI shielding. It also features a cost analysis and a price estimation of the component. Finally, it also includes a physical comparison with the single and the dual module for the mid and high band LTE FEM in the Apple iPhone X model A1901.
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