

## Dual-mode Bluetooth Silicon IP in 22 nm CMOS

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For years, CSEM's icyTRX BLE silicon IP has led the race towards the lowest power consumption, highest sensitivity, resilience to interferers, and maximum integration. It is available in several process flavors and foundries in the 65 and 55 nm technology nodes. icyTRX-DM is the successor and brings performances improvement, reduced size and 50% power-savings (RX mode) for longer battery life. It is also fully backward-compatible with Bluetooth Classic, including the EDR mode, which makes it the ideal versatile candidate for applications requiring audio streaming.

Bluetooth Low Energy (BLE) has become omnipresent in our daily lives, enabling low-power connectivity with our smartphones, from simple temperature sensors to sophisticated smartwatches. Today even a rice steamer can log its cooking temperature profile to a smartphone through a BLE connection.

Before the introduction of BLE in 2010, in version 4.0 of the Bluetooth standard, Bluetooth (BT) Classic could be found in nearly all cellphones, starting with the Ericsson T39 in 2001, but was mostly used for audio streaming for hands-free headsets. With its drastically reduced power requirement, BLE was the trigger enabling a variety of new applications such as mice, keyboards and remote controls.

The Bluetooth SIG (Special Interest Group) finally added audio functionality to the BLE standard in January 2020 with the announcement of LE Audio, allowing portable audio devices to also benefit from the more efficient BLE. Nevertheless, to ensure backward compatibility audio streaming will require for the foreseeable future support of the power-hungry legacy Bluetooth classic mode (see Figure 1).

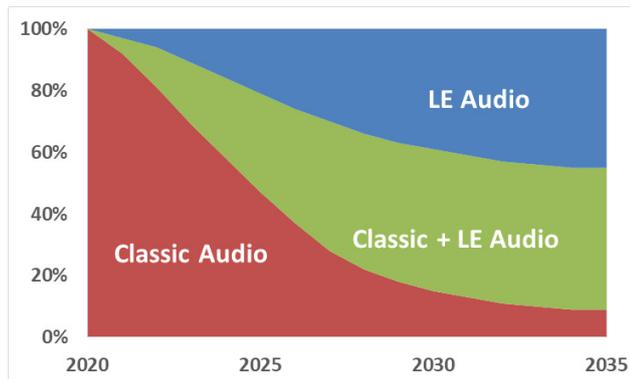


Figure 1: Expectation of Bluetooth Audio market.

In order therefore to address the immediate and growing need for low-power audio-enabled applications, and in particular the market of hearables, CSEM rearchitected and fully redesigned its existing IP, baptised icyTRX-DM, to simultaneously support dual-mode operation (classic and LE) audio streaming, while limiting the energy penalty associated with BT Classic. With less than half of the power consumption of the best BLE products, and up to 8x less than standard BT Classic products, icyTRX-DM offers a clear value proposition for portable audio products such as hearing aids and earbuds.

CSEM selected Global Foundries' 22 nm FD-SOI (Fully-Depleted Silicon-On-Insulator) as the first target for integration, benefitting from the outstanding performances at extremely low

power and ultra-low standby leakage. Other 22 nm CMOS options are planned to follow shortly.

The choice of such a high-performance target process allowed a design without compromise on the radio performances (budget link and interferers immunity among others). The increased complexity and more demanding modulation required by the Enhanced Data Rate (EDR) scheme in BT classic mode is offset by the capabilities of the lower-geometry node, which allow much more digital processing while minimizing both the silicon footprint and the power consumption. The architecture includes a newly designed flexible digital frequency synthesizer and modem. It supports a fallback BLE mode which provides all-round improved performances, including a higher power output capability, reduced spurious emissions and better blocking performances, for the best error-free audio streaming experience.

More than just a replacement, LE Audio promises attractive new features and new use cases, such as audio sharing, multi-stream, broadcasting and improved audio quality with the LC3 (Low Complexity Communication Codec). For instance, hearing-aid manufacturers had so far to support proprietary solutions like Apple's MFI [1], in order to stream efficiently a stereo audio signal from a smartphone. With LE Audio (Figure 2), True Wireless Stereo (TWS) audio streaming across all software platforms and smartphone manufacturers is finally possible, instead of using workaround with BT Classic.

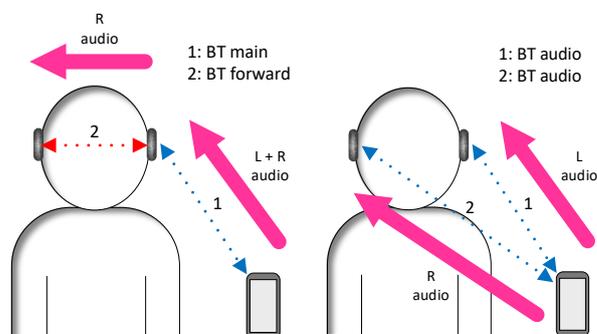


Figure 2: TWS Bluetooth Classic (left) vs TWS LE Audio (right).

icyTRX-DM provides unparalleled benefits, including low-overhead backward compatibility and, in line with previous generations, best-in-class RF performances.

In addition to an overall improved robustness, it boasts a sensitivity @ 1 Mbps of -98 dBm (-95 dBm @ 2 Mbps) for half of the power consumption (3 mW) of previous solutions, and an output power scalable up to +10 dBm, all this with a low footprint of 0.65 mm<sup>2</sup> and no external component required besides the quartz reference.

[1] <https://developer.apple.com/programs/mfi/>