icyTRX-55, an Evolution of the Bluetooth Low Energy (BLE) RF IP

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As a direct derivative of the 65 nm version, the icyTRX-55 transceiver benefits from all of the previous successful achievements and the know-how gained previously. The new technology node (CMOS ULP 55 nm) offers the huge advantage to provide access to an EFLASH memory, which opens new opportunities for SoC developers. Due to the newly implemented features, together with the benefits of the shrink to 55 n, this new version of the icyTRX has already triggered substantial interest from major semiconductor major players and is foreseen to remain among the most attractive BLE IP's available on the market.

Compared to the icyTRX-65 silicon, which achieved last year state-of-the-art sensitivity at minimal current consumption and supply voltage, the 55 n IP version does not claim to improve those transceiver performance characteristics dramatically. Rather, the choice of the CMOS ULP 55 nm process (TSMC and Global Foundries) is based on the intrinsic access to the EFLASH memory offered by those technology nodes. This process option together with the outstanding transceiver performance opens the door for the icyTRX-55 IP to enter the huge IoT (Internet of Things) market. In order to increase icyTRX attractiveness, a reduced 7 metal stack (5 thin, 1 think and 1 ultra-thick) was chosen for the porting to the 55 nm technology, lowering the fabrication cost significantly.

SoC (System on Chip) assemblers are looking for low cost reliable high performance IPs available in an EFLASH capable technology node, which makes the icyTRX-55 a perfect candidate. At the same time, they also need a robust IP with silicon proven characteristics. Based on the experience obtained with the 65 nm version of the IP and the large amount of measurements performed, several major enhancements have then been made to the icyTRX-55 IP. First of all, a new carrier recovery algorithm has been designed. It is based on the correlation over the access address in order to have a precise estimation of the carrier offset. The results are impressive; the maximum frequency offset tolerance of the receiver, i.e. the maximum deviation of the transmitter center frequency tolerated by the receiver, covers a range of ±250 kHz around the nominal value without observable degradation on the Packet Error Rate (PER). In other words, icyTRX can comply with a ±50 ppm error on both the receiver and the transmitter reference clocks, as often seen in the case of low cost BLE (Bluetooth Low Energy) devices.

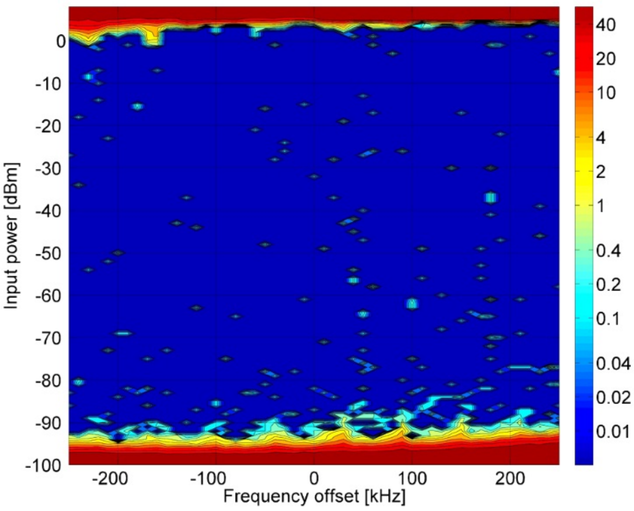

Figure 1: PER in % versus frequency offset and versus input power.

The second major enhancement is a new algorithm for the sub-band selection to overcome the problems of temperature dependence and selection ambiguity observed in the previous version. The new algorithm is faster, more accurate and even provides fractional information on the sub-band to be selected. The finer algorithm allows narrowing of the margins previously taken to accommodate the extreme PVT (process, voltage, temperature corner) cases, hence reducing, for example, the PLL bandwidth and thus the emitted noise at a given frequency offset from carrier. Compared to the BLE 4.2, ETSI EN 300 328 and FCC CFR47 part 15 certified 65 nm version, this modification provides more margin with respect to the spurious emission characteristics required by these standards.

The robustness against close interferers was also improved thanks to an interferer detector (called "peak detector") located in parallel with channel filter. In the presence of a strong interferer, an attenuation step will be triggered by the AGC (Automatic Gain Control) algorithm, reducing the Rx gain, thus preventing the saturation of the receiver blocks. An improvement of up to 7 dB is expected on the interferer rejection characteristics (at <10 MHz offset).

In parallel with these enhancements, several other features have been added, such as new interfaces (AMBA APB and AHB light 32-bit) and the inclusion of the AES CCM coding for the BLE. Although the encryption algorithm is not mandatory and can be implemented in software, internal tests have shown that calculations required to encrypt packets can take as long as 30 ms. By comparison, hardware implementation of the algorithm does not generate any latency and is completely transparent with respect to the upper layers of the BLE stack.

For customers interested in ultra-low-cost solutions, the integrated oscillator circuit is now capable of addressing low cost crystals (XTAL) with high ESR (equivalent series resistance of up to 200Ω) thanks to a special operation mode, if at the cost of a higher power consumption for this block.

Last but not least, icyTRX-55 is foreseen to be "out of the box" BLE 2 Mb/s compliant, as soon as the Bluetooth 5.0 is released in 2016. All tests conducted so far show that changing a few configuration registers will be sufficient to switch from the original BLE data-rate of 1 Mbps to the enhanced BLE data-rate (2 Mbps). The attractiveness of the icyTRX-55 IP is thus reinforced and its success assured for the years to come.