## 2． 項目簡介

(*項目所屬科學技術領域、主要技術內容、授權專利情況、技術經濟指標及應用推廣情況*)
Due to the ZTE and Huawei events, the importance of integrated circuits (IC), commonly known as Chips, has risen as a major concern not only in the China IC industry but also in the whole Nation. Such chips not only are the key to enable emerging technologies, such as IoT, 5G mobile communication, Big Data etc., but also to self-sustain the industrial support chain and national level security. China, as the world's largest IC consumer, still heavily relies on imports with an annual amount of >US$300 billion in 2018 (1st among importing items and the trade deficit on IC is close to the triple).

In this project, through various IC innovations, our team of Data Converter and Signal Processing from the State-Key Lab of Analog and Mixed-Signal VLSI has achieved performances breakthroughs on the key hardware technologies, especially emphasizing on energy-efficient high-speed data converters and energy-efficient power converters for emerging systems. The major technological breakthroughs of this project are the following 4:

1) Energy-Efficient Robust-to-Environmental-Change Nyquist ADCs: In the emerging systems such as IoT and 5-6G mobile communication, except energy efficiency, the robustness of the integrated circuit indeed is also a critical concern. While the devices in these systems may work under various environments, which causes temperature drift and supply voltage change, the circuits should still function well. In this project, our group proposed several innovative techniques to tackle the issue of robustness in several converters while maintaining a good energy-efficiency simultaneously.

2) Wideband Sigma Delta Modulator (SDM) in Low Cost and Low Power: SDM is a very promising candidate to increase the resolution and thus allowing a more complex modulation scheme for emerging communication systems. However, the necessary calibration often leads to a large area and the wideband implies power-hungry modulators. In this project, our group focus on architectural level innovation and quantizer to enable low power and calibration-free wideband SDMs that are suitable to the next generation communication systems.

3) Highly-Efficient Power Conversion: As various DC levels are often required in the emerging systems for energy-efficient designs, they place a burden on the power conversion. Such power converter needs to support a heavy load and/or a fast transient that draws significant design challenges under high efficiency. In this project, we have developed several novel power converters that can lead the whole system to a higher level of efficiency.

4) Peripheral Circuits and Digital-Assisted Scheme Enabling Energy Efficient Conversion: While the converter core can be energy-efficient, its peripheral circuits also need to match up. In this project, we explore several low-power peripheral circuits, such as clock generation and power management circuit to support our energy-efficient converters. At the same time, we also introduce calibration techniques to take advantage from

the technology scaling.

The results from this project lead to a significant breakthrough on energy efficiency in data and power conversions. They led to 1 book, 36 IEEE journal papers (including 11 in the prestigious IEEE J. Solid-State Circuits), and 9 papers in the Int. Solid-State Circuits Conf. (ISSCC) 2019-2020, maintaining our group as No.1 in China and enabling our State-Key Lab as No. 2 in worldwide in 2019 in terms of ISSCC paper contributions. 12 awards granted to our projects, researchers or students in international conferences or local funding agencies. In addition, we successfully conducted or are undergoing four industrial projects that attracted more than 2 million MOP funding to the State Key Lab. Our leadership position in the field is also well recognized by the world most renowned experts, such as M.C. Frank Chang (Fellow, National Academy of Engineering, UCLA) and 黃如院士(北京大學) etc.

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