SEMICONDUCTOR TIMES
FOCUSED ON EMERGING SEMICONDUCTOR COMPANIES

Kaben Research
Kaben Research was formed in December 2000 to develop mixed-signal IP building blocks for the SoC wireless communications industry. Kaben is funded by its customer contracts and is profitable. The company has 6 full-time and 6 part-time employees.

Kaben develops building blocks for multi-mode cell phones, Bluetooth, multi-mode WLAN 802.11a/b/g, and Cable Modem products. Its IP blocks are optimized to deliver high-performance while maintaining low-power consumption. The company has design experience with ST Microelectronics 0.35µm SiGe BiCMOS, TSMC 0.18 and 0.35µm CMOS, IBM 0.5µm SiGe BiCMOS, and AMS 0.8µm BiCMOS processes. Kaben offers RF Front-End Components, Sampling IF Filters, D/A Converters, Programmable Clock Generators, and Frequency Synthesizers and Local Oscillators.

Kaben's RF Front-Ends target 2.4 and 5GHz wireless communications products such as Bluetooth and WLAN 802.11a/b/g. These cells are designed for receiver systems that require high linearity and low power consumption. The company offers a 5GHz LNA-Mixer, 2.4GHz Upconverter-Mixer, 5GHz Upconverter-Mixer, and a 2.4GHz LNA-Mixer.

Sampling IF Filters are designed for systems that require high dynamic range, high selectivity, and low power consumption. The company offers Narrowband/Wideband Sampling IF Filters. These products combine an anti-alias filter and channel selection filter functions in a single unit, and eliminate expensive off-chip filters and a down-conversion stage. The Sampling IF Filter has been successfully prototyped and is available for system integration.

Kaben's D/A Converters are designed for low power transmitters employing complex modulation formats such as OFDM and high data-rate multi-level QAM. The company offers a Bandpass D/A Converter and a Wideband D/A Converter. These products accept a digital stream, up-convert the signal in frequency, and convert from digital to analog, reducing or eliminating the need for off-chip IF filtering. D/A Converter prototype results are expected in Q4.

Programmable Clock Generators target digital and mixed-signal systems that require a low jitter clock source. The PCG cell has a maximum output frequency of 400MHz.

The Frequency Synthesizer and Local Oscillator product line is designed for systems that require very low phase noise, fine step size, and low power consumption. Kaben's Fractional-N Synthesizer IP blocks feature an output frequency resolution of 100Hz or less and a low phase noise of -90dBc/Hz at 5GHz output. The company offers Integer-N, Fractional-N, Delta-Sigma Fractional-N, and Hybrid Delta-Sigma Fractional-N Frequency Synthesizers, 2.4GHz and 5GHz Local Oscillators, and VCOs.

In a wireless system, frequency synthesizers are used to convert signals up or down in frequency in the receiver and transmitter. Traditional synthesizers are used in systems that have "easy" phase noise (jitter) specifications or large channel spacing. In the transmitter, high phase noise can interfere with nearby wireless systems. High phase noise can also reduce the receiver's ability to detect signals. When narrower

channel spacing is required, traditional synthesizers actually increase the amount of the phase noise in the system.

Emerging systems such as WLAN 802.11a/g, with its error vector magnitude specification, require a low phase noise synthesizer. This stringent specification can be met using a DS Fractional-N synthesizer, however, according to Kaben, to date they have not been widely used on-chip because of the lack of in-house design expertise and the development cost. Kaben's DS Synthesizers feature both low phase noise and fine frequency resolution.

DS synthesizers are also used to reduce the number of analog components in a system when used in a direct modulation architecture. Direct modulation allows the baseband digital data to be directly converted to the transmit frequency by having the synthesizer output the modulated frequency. This eliminates many analog components such as mixer stages that would normally be used to upconvert or modulate the transmitted signal.

The fine frequency resolution in Kaben's DS Synthesizers allows the synthesizer to tune to any channel using any crystal frequency, which enables SoC manufacturers to reduce the number of chips in a product family by eliminating the need to fabricate a different version of their chip for their customers' crystal reference frequency. Fine resolution also enables single chip, multiple wireless standards, such as combinations of multi-mode GSM, WCDMA, CDMA2000, WLAN a/b/g, or Bluetooth. Traditional synthesizers cannot be used in multi-mode systems when the channels of two standards are not multiples of a common reference frequency.

The Fractional-N Frequency Synthesizer is available now. The VCO and on-chip loop filter are in development. The next product in this family is a hybrid synthesizer that improves the performance to permit the product to act as the entire transmitter for Bluetooth or GSM systems.

The KR-SDS45-ST6G Delta-Sigma (DS) Fractional-N Synthesizer IP has been fabricated in **STMicroelectronics'** 0.35µm SiGe BiCMOS process. Kaben and **Jazz Semiconductor**, an RF and mixed-signal silicon wafer foundry, have formed an alliance to offer 5GHz Fractional-N Synthesizer and VCO IP for the Jazz SiGe 60 process. **SiGe Semiconductor** has licensed Kaben's DS Fractional-N Synthesizer IP for use in GPS ICs. Kaben's programmable clock generator IP has been designed into **Atsana's** J2210 media processor SoC, which combines Atsana's Array Processor with an embedded ARM9 RISC processor and a clock multiplier DLL using Kaben's architecture. Kaben is also developing a Delta-Sigma Modulator IP cell in **TSMC** 0.18µm CMOS.

Competitors include Parthus and Wipro among others. Kaben is efficient and very specialized. The company claims to have technologies at its disposal that are unique in the industry. Kaben is also cooperating with leading Universities for research on future products.

- Tom Riley, President, CEO, and Co-Founder (An expert in the area of fractional-N frequency synthesis. Has done work with Nortel Semi, Mitel Semi, Gennum, CAL, and Conexant/ Philsar)
- Qinghong Du, Co-Founder (previously a lead designer in the mixed-signal IC area for Conexant)
- Dr. Norm Filiol, VP of Business Development and Co-Founder (previously spent three years at Nortel Semi working on fractional-N frequency synthesis after which he joined Philsar and was a core member of the Bluetooth RF transceiver team)
- Seste Dell'Aera, VP of Sales & Marketing (previously held executive positions for Philsar and OEone)

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