

2018 Top 5 Ferroelectric RAM Players in North America, Europe, Asia-Pacific, South America, Middle East and Africa

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Abstracts

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Ferroelectric RAM (FeRAM, F-RAM or FRAM) is a random-access memory similar in construction to DRAM but utilizing a ferroelectric layer instead of a dielectric layer to achieve non-volatility. FeRAM is one of a growing number of alternative non-volatile random-access memory technologies which can offer that same functionality as flash memory.

FeRAM consists of a grid of small capacitors and associated wiring and signaling transistors. Each storage element, a cell, consists of one capacitor and one transistor. Unlike the DRAM use a linear dielectric in its cell capacitor, dielectric structure in the FeRAM cell capacitor usually contains ferroelectric material, typically lead zirconate titanate (PZT).

A ferroelectric material has a nonlinear relationship between the applied electric field and the apparent stored charge. The ferroelectric characteristic has the form of a hysteresis loop, which is very similar in shape to the hysteresis loop of ferromagnetic materials. The dielectric constant of a ferroelectric is typically much higher than that of a linear dielectric because of the effects of semi-permanent electric dipoles formed in the crystal structure of the ferroelectric material. When an external electric field is applied across a dielectric, the dipoles tend to align themselves with the field direction, produced by small shifts in the positions of atoms and shifts in the distributions of electronic charge in the crystal structure. After the charge is removed, the dipoles retain their polarization state. Binary "0"s and "1"s are stored as one of two possible electric polarizations in each data storage cell. For example, in the figure a "1" is encoded using

the negative remnant polarization "-Pr", and a "0" is encoded using the positive remnant polarization "+Pr". In terms of operation, FeRAM is similar to DRAM. Writing is accomplished by applying a field across the ferroelectric layer by charging the plates on either side of it, forcing the atoms inside into the "up" or "down" orientation (depending on the polarity of the charge), thereby storing a "1" or "0". Reading, however, is somewhat different than in DRAM. The transistor forces the cell into a particular state, say "0". If the cell already held a "0", nothing will happen in the output lines. If the cell held a "1", the re-orientation of the atoms in the film will cause a brief pulse of current in the output as they push electrons out of the metal on the "down" side. The presence of this pulse means the cell held a "1". Since this process overwrites the cell, reading FeRAM is a destructive process, and requires the cell to be re-written if it was changed. Ferroelectric RAM was proposed by MIT graduate student Dudley Allen Buck in his master's thesis, *Ferroelectrics for Digital Information Storage and Switching*, published in 1952. Development of FeRAM began in the late 1980s. Work was done in 1991 at NASA's Jet Propulsion Laboratory on improving methods of read out, including a novel method of non-destructive readout using pulses of UV radiation. Much of the current FeRAM technology was developed by Ramtron, a fabless semiconductor company. One major licensee is Fujitsu, who operates what is probably the largest semiconductor foundry production line with FeRAM capability. Since 1999 they have been using this line to produce standalone FeRAMs, as well as specialized chips (e.g. chips for smart cards) with embedded FeRAMs. Fujitsu produced devices for Ramtron until 2010. Since 2010 Ramtron's fabricators have been TI (Texas Instruments) and IBM. Since at least 2001 Texas Instruments has collaborated with Ramtron to develop FeRAM test chips in a modified 130 nm process. In the fall of 2005, Ramtron reported that they were evaluating prototype samples of an 8-megabit FeRAM manufactured using Texas Instruments' FeRAM process. Fujitsu and Seiko-Epson were in 2005 collaborating in the development of a 180 nm FeRAM process. In 2012 Ramtron was acquired by Cypress Semiconductor. FeRAM research projects have also been reported at Samsung, Matsushita, Oki, Toshiba, Infineon, Hynix, Symetrix, Cambridge University, University of Toronto, and the Interuniversity Microelectronics Centre (IMEC, Belgium).

Over the next five years, LPI(LP Information) projects that Ferroelectric RAM will register a 3.7% CAGR in terms of revenue, reach US\$ 300 million by 2023, from US\$ 240 million in 2017.

This report studies the global market, especially in North America, Europe, Asia-Pacific, South America, Middle East and Africa, focuses on the top 5 players in each region, with sales, price, revenue and market share from 2013 to 2018, the top players:

Cypress Semiconductor

Fujitsu

Texas Instruments

IBM

Infineon

Market Segment by Regions, this report splits Global into several key Regions, with sales, revenue, market share of top players in these regions, from 2013 to 2018 (forecast), like

North America (United States, Canada and Mexico)

Asia-Pacific (China, Japan, Southeast Asia, India and Korea)

Europe (Germany, UK, France, Italy and Russia etc.)

South America (Brazil, Chile, Peru and Argentina)

Middle East and Africa (Egypt, South Africa, Saudi Arabia)

Split by Product Types, with sales, revenue, price, market share of each type, can be divided into

Serial Memory

Parallel Memory

Others

Split by applications, this report focuses on sales, market share and growth rate in each application, can be divided into

Smart Meters

Automotive Electronics

Medical Devices

Wearable Devices

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