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FUJITSU

Fujitsu's Random Access Memory(RAM) for SiP

# FCRAM™

## (Fast Cycle RAM)

2012.2
FUJITSU SEMICONDUCTOR

shaping tomorrow with you

# FCRAM provides great product values and cost solution for digital consumer electronics and mobile applications.

The spread of Social Network Service(SNS) and cloud computing lead to dramatic change of our life style and business style. The data volume of digital media contents has become larger scale. In order to process the large data smoothly, high performance memories are required. On the other hand, low power consumption is a key factor for long battery life. FCRAM(Fast Cycle RAM) has challenged to deliver best balance between performance and power consumption for dedicated applications.

Mobile FCRAM is a high density and low power pseudo SRAM for mobile applications. The FCRAM appeared in 2000 as an alternative memory of low power SRAM which had been used for mobile phones, and at the time the Mobile FCRAM density was the industry's largest for RAM memories used in the mobile phones. It had contributed to the dramatic market expansion.

Consumer FCRAM is a Low Power SDRAM and suitable for digital TVs and digital video cameras that require high-speed data transfer for display and video processing. The FCRAM features low power consumption, high data bandwidth, high temperature of 125˚C operation, and is optimized for SiP(System in Package). Recently market for digital media applications with enriched functions such as High Definition video and 3-D video is spreading rapidly, and the FCRAM is well positioned for that video processing applications.

Not only offering FCRAM products as a pure memory solution, Fujitsu also able to customize FCRAM core-based DRAM, and a SiP solution which containing ASIC/ASSP and FCRAM. Beyond FCRAM, Fujitsu Semiconductors offers a wide range of products to satisfy various requirements and applications.

For more information, please visit:
http://www.fujitsu.com/global/services/microelectronics/product/memory/fcram/

FCRAM Search

* FCRAM is a trademark of Fujitsu Semiconductor Limited.

## What is FCRAM?

- Acronym for Fast Cycle Random Access Memory
- Fujitsu's original DRAM core architecture
- Enable low power consumption and high performance

## FCRAM Product Families

- Consumer FCRAM : Low Power DDR SDRAM for digital consumer applications
- Mobile FCRAM : Pseudo SRAM for mobile applications

## Target Applications of FCRAM

### Digital Consumer Electronics

- Digital TVs (LCD, PDP)
- Digital Still Cameras (DSC)
- Camcoders
- Digital Video Recoders (DVR)
- Portable Games

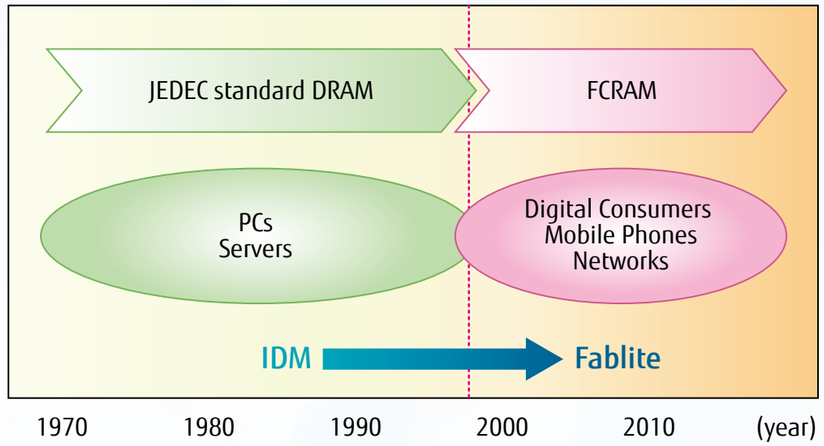
### Mobile Applications

- Cellular Phones
- Smart Phones
- PDAs
- PMPs
- Portable Games

## FCRAM History

### Experience of DRAM development, Innovation to FCRAM

Fujitsu has deep and long experiences of DRAM technology since the 1970's. FCRAM is optimized performance and low power consumption. This contributes to the momentum of expanding new market.



# Consumer FCRAM (Low Power SDRAM)

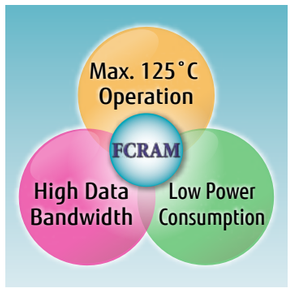
Consumer FCRAM is a Low Power SDRAM suitable for digital consumer electronics that require high-speed processing of large-scale digital data such as video data or computer graphics data, limited power budget. Fujitsu provides Consumer FCRAM products in wafer form allowing FCRAM and SoC to be combined in a single package also known as SiP solution.

## FCRAM Features

Consumer FCRAM with 64-bit I/O features high data bandwidth, low power consumption and the world's first 125˚C operating temperature for standard DRAMs.

### High Temperature Operation up to 125˚C

Maximum operating temperature of standard DDR3 is 85˚C while that of Consumer FCRAM is 125˚C. The extended temperature range allows FCRAM to be used in a SiP together with other high power rating SoC.




### High Data Bandwidth

With 64-bit I/O and operating at 216MHz frequency, an FCRAM delivers 3.46GByte/s data bandwidth that is higher than 3.2GByte/s of a DDR3 with 16-bit I/O at 800MHz.

### Low Power Consumption

Wide data bus width of 64-bit I/O enables higher data bandwidth at a lower operating frequency. FCRAM can reduce power consumption for I/O interface due to no termination resistors and optional 1.2V I/O voltage.

## Feature Comparison between FCRAM and Standard DRAMs

FCRAM with 64-bit I/O operating at 200MHz enables high data bandwidth comparable to that of a DDR3 SDRAM at 800MHz. Lower operating frequency doesn't need termination resistors. FCRAM can reduce power consumption for I/O interface due to no termination resistors and optional 1.2V I/O voltage.

| Memory Type | DDR3 | DDR2 | LPDDR2 | LPDDR | FCRAM |
|---|---|---|---|---|---|
| Bus I/O | x16 | | x32 | | **x64** |
| Core Voltage | 1.5V | 1.8V | 1.8V | 1.8V | **1.8V** |
| I/O Voltage | | | 1.2V | | **1.8V** / **1.2V *** |
| Max Operating Temperature | 85/95˚C | | 85/105˚C | 85˚C | **125˚C** |
| ADD/CMD Input | SDR | | DDR | SDR | **SDR** |
| Operating Frequency (Data Transfer Rate) | 800MHz (1600Mbps) | 400MHz (800Mbps) | 533MHz (1066Mbps) | 200MHz (400Mbps) | **200MHz (400Mbps)** |
| Data Bandwidth | 3.2GByte/s | 1.6GByte/s | 4GByte/s | 1.6GByte/s | **3.2GByte/s** |
| DLL on RAM | Yes | | No | | **No** |
| I/O Interface | SSTL | | CMOS | | **CMOS** |
| Termination | ODT (On Die Termination) | | No | | **No** |

* 1Gbit FCRAM family has a 1.2V I/O voltage products.

## FCRAM Product Lineup

| Item | 512Mbit FCRAM | 1Gbit FCRAM | |
|---|---|---|---|
| Organization | 2Mword x 64bit x 4bank | 4Mword x 64bit x 4bank | |
| Interface | Low Power DDR | Low Power DDR | |
| Supply Voltage | Core Voltage: 1.8V, I/O Voltage: 1.8V | Core Voltage: 1.8V, I/O Voltage: 1.2V | Core Voltage: 1.8V, I/O Voltage: 1.8V |
| Clock Frequency | 216MHz (Tj≦105˚C) 200MHz (Tj≦125˚C) | 216MHz (Tj≦125˚C) | |
| Data Bandwidth | 3.46GByte/s (Tj≦105˚C) 3.2GByte/s (Tj≦125˚C) | 3.46GByte/s (Tj≦125˚C) | |
| Junction Temperature | -10～+125˚C | -10～+125˚C | |



## Benefits of 125˚C-Rated FCRAM

Consumer FCRAM supports operating temperatures up to 125˚C allowing FCRAM to be used in a SiP together with a high power rated SoC. In case of SiP with standard DRAM, constrained by the lower temperature rating of conventional memory, limits its performance and hence applications. By extending the operating temperature up to 125˚C, SiP with 125˚C-rated FCRAM can be used for high performance consumer electronics such as digital television and camcorders.

### 125˚C-Rated FCRAM is the Only Solution

- Resolves thermal design issue and eliminates worry of overheating, high power and high performance SiP become feasible.
- Reduced cost and necessity of heat sink or heat spreader.

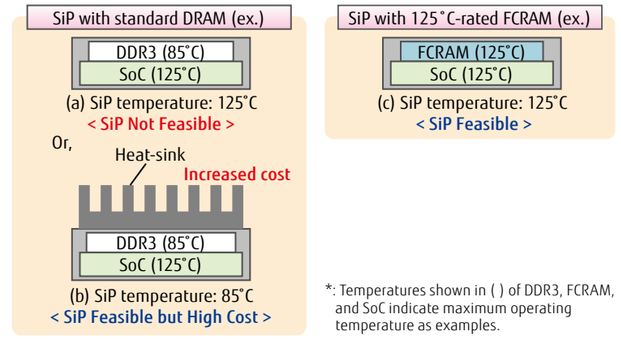
### Case Study of SiP Thermal Design

125˚C-rated Consumer FCRAM resolves thermal design issues on SiP shown below.

Figure (a):
With an SoC of high power consumption, the SiP temperature can rise to 125˚C; however standard DDR3 can only operate up to 85˚C so this configuration is limited only up to 85˚C.

Figure (b):
SiP can operate at 125˚C by dissipating excess heat through costly addition of heat-sink.

Figure (c):
SiP operates up to 125˚C without heat-sink by using 125˚C-rated FCRAM.




*: Temperatures shown in ( ) of DDR3, FCRAM, and SoC indicate maximum operating temperature as examples.

## FCRAM Support Policy

While standard DRAMs are increasing their memory density for PC and smart phone, FCRAM provides the optimal memory density and data bandwidth for digital consumer applications.

### SiP Solutions

- Optimized design for high performance SiP
- SiP solutions possible with ASIC/ASSP and FCRAM

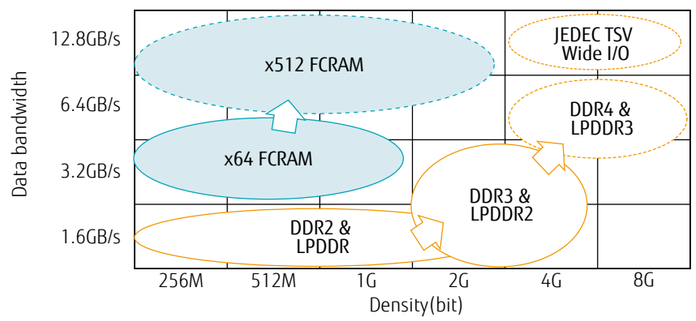
### Wide I/O memory

- Continue development of x64-bit products
- x512-bit products are under study
- Reviewing three-dimensional stack technology such as CoC (Chip on Chip) suited for wide I/O

### Custom FCRAM

- Customization of DRAMs that are optimal for customer applications

### FCRAM Target Area



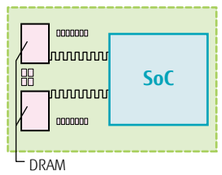
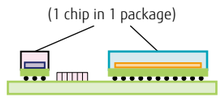
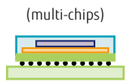

* Please contact our sales department for information on the latest roadmap.

# SiP Solution

Consumer FCRAM featuring 125˚C-rated operation and x64-bit I/O is ideal for SiP. Fujitsu has accumulated a great deal of experience through more than 30 designs with a wide variety of SiP configurations.

## What is SiP?

SiP stands for "System in Package"; a technology and a product containing different semiconductor devices, such as memory devices and SoC (System on Chip) in a single package.
Two cases of memory system configuration mounted on PCB are shown below.

| Configuration (example) | On-board DRAM + SoC | SiP (FCRAM+SoC) |
|---|---|---|
| Top view of devices mounted on PCB |  |  |
| Side view of devices mounted on PCB |  |  |

## Advantages of SiP

SiP resolves the following issues on miniaturization, low design risk with short TAT, and cost reduction.

### Miniaturization

By minimizing of mounting area on PCB, customer's products can be smaller and more compact.

### Low Design Risk and Short TAT

Since PCB design and evaluation for high-speed DRAM interface is not necessary, engineering resources and design risk can be reduced. Design time can be shortened.

### Cost Reduction

Smaller PCB size cost less. In addition, components cost can be reduced since termination resisters are eliminated.

| Factor | On-board DRAM+SoC | | FCRAM+SoC (SiP) | |
|---|---|---|---|---|
| PCB Size | Worse (Larger) | Need space for DRAM, routing of I/F, and passive components on PCB | Better (Smaller) | No DRAMs, routing of I/F on PCB |
| PCB Design | Worse (More difficult) | Need review time of precise SI and EMI design for memory I/F | Better (Easier) | No routing of high-speed memory I/F on PCB |
| Passive Component Cost | Worse (Higher) | Need passive components for noise reduction | Better (Lower) | No passive components for noise reduction |

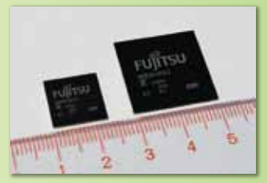


## Fujitsu's SiP Solution Example

Fujitsu offers H.264 1080 60p video processing LSIs with built-in FCRAM.
This SiP solution satisfies the need for high-quality video-processing functions, small size and low power consumption in portable devices such as digital video cameras, AV equipment, and commercial broadcast equipment.

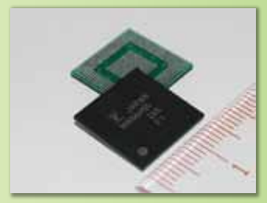
### Full High-Definition(HD) H.264/MPEG-2 Transcoder LSI

The transcoder LSIs can convert between full HD H.264 video data and MPEG-2 video data as well as transcoding between audio formats while featuring a low power consumption. Latest transcoder LSIs with 1Gbit FCRAMs enables higher image quality while reducing the processing burden, resulting in industry-leading low power design consuming just 1.2W for H.264 translating function including the memory.



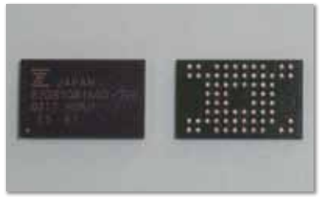
### Full High-Definition(HD) H.264 Codec LSI

The codec LSIs can compress and decompress full HD video in H.264 format in real-time. Codec LSI features compact small-size package of 15mmx15mm, with very low power consumption of less than 500mW during encoding, including the built-in memory.



# Mobile FCRAM (Pseudo SRAM)

Mobile FCRAM is the PSRAM (Pseudo SRAM) developed for cellular phone. Fujitsu, a major PSRAM supplier, has shipped more than 500 million units since year 2000.
Mobile FCRAM interface is based on asynchronous SRAM and supports synchronous burst mode for high-speed read and write operation with low power consumption. Mobile FCRAM is ideal for general mobile applications such as smart phone, PDA, portable media player(PMP), and portable games.



| Density | Configuration | Voltage | Access Time | Burst Mode Frequency | Burst Mode Access Time |
|---|---|---|---|---|---|
| 128Mbit | 8Mx16 | 1.8V | 90ns | 33MHz | 9ns |

# Eco-Friendly Products [Green Products]

Fujitsu thrives to environment-friendly products to contribute to global environmental efforts.
Fujitsu group has established the original regulations called "product environment green assessment" to develop environment-friendly products considering [low energy consumption], [3R design and technology], and [non-use of hazardous substance, materials and technology].
FCRAM products meet the environmental regulation and all new products are approved as "Green Products". The 512Mbit and 1Gbit FCRAM are also qualified as Green Products. FCRAM low power feature contributes to the reduction of $CO_2$ emission.