## FUJITSU SEMICONDUCTOR LIMITED

Nomura Fudosan Shin-yokohama Bldg. 10-23, Shin-yokohama 2-Chome, Kohoku-ku Yokohama Kanagawa 222-0033, Japan Tel: +81-45-415-5858 http://jp.fujitsu.com/fsl/en/

For further information please contact:

#### North and South America

FUJITSU SEMICONDUCTOR AMERICA, INC. 1250 E. Arques Avenue, M/S 333 Sunnyvale, CA 94085-5401, U.S.A. Tel: +1-408-737-5600 Fax: +1-408-737-5999 http://us.fujitsu.com/micro/

#### Europe

FUJITSU SEMICONDUCTOR EUROPE GmbH Pittlerstrasse 47, 63225 Langen, Germany Tel: +49-6103-690-0 Fax: +49-6103-690-122 http://emea.fujitsu.com/semiconductor/

#### Когеа

FUJITSU SEMICONDUCTOR KOREA LTD. 902 Kosmo Tower Building, 1002 Daechi-Dong, Gangnam-Gu, Seoul 135-280, Republic of Korea Tel: +82-2-3484-7100 Fax: +82-2-3484-7111 http://kr.fujitsu.com/fsk/

Specifications are subject to change without notice. For further information please contact each office.

#### All Rights Reserved.

The contents of this document are subject to change without notice.

Customers are advised to consult with sales representatives before ordering.

The information, such as descriptions of function and application circuit examples, in this document are presented solely for the purpose of reference to show examples of operations and uses of FUJITSU SEMICONDUCTOR device; FUJITSU SEMICONDUCTOR does not warrant proper operation of the device with respect to use based on such information. When you develop equipment incorporating the device based on such information, you must assume any responsibility arising out of such use of the information.

FUJITSU SEMICONDUCTOR assumes no liability for any damages whatsoever arising out of the use of the information.

Any information in this document, including descriptions of function and schematic diagrams, shall not be construed as license of the use or exercise of any intellectual property right, such as patent right or copyright, or any other right of FUJITSU SEMICONDUCTOR or any third party or does FUJITSU SEMICONDUCTOR warrant non-infringement of any third-party's intellectual property right or other right by using such information. FUJITSU SEMICONDUCTOR assumes no liability for any infringement of the intellectual property rights or other rights of third parties which would result from the use of information contained herein.

. The products described in this document are designed, developed and manufactured as contemplated for general use, including without limitation, ordinary industrial use, general office use, personal use, and household use, but are not designed, developed and manufactured as contemplated (1) for use accompanying fatal risks or dangers that, unless extremely high safety is secured, could have a serious effect to the public, and could lead directly to death, personal injury, severe physical damage or other loss (i.e., nuclear reaction control in nuclear facility, aircraft flight control, air traffic control, mass transport control, medical life support system, missile launch control in weapon system), or (2) for use requiring extremely high reliability (i.e., submersible repeater and artificial satellite).

Please note that FUJITSU SEMICONDUCTOR will not be liable against you and/or any third party for any claims or damages arising in connection with above-mentioned uses of the products.

Any semiconductor devices have an inherent chance of failure. You must protect against injury, damage or loss from such failures by incorporating safety design measures into your facility and equipment such as redundancy, fire protection, and prevention of overcurrent levels and other abnormal operating conditions.

Exportation/release of any products described in this document may require necessary procedures in accordance with the regulations of the Foreign Exchange and Foreign Trade Control Law of Japan and/or US export control laws.

The company names and brand names herein are the trademarks or registered trademarks of their respective owners.

© 2007-2012 FUJITSU SEMICONDUCTOR LIMITED Printed in Japan AD05-00029-6E February 2012 **Edited: Sales Promotion Department** 

### Asia Pacific

FUJITSU SEMICONDUCTOR ASIA PTE. LTD. 151 Lorong Chuan, #05-08 New Tech Park 556741 Singapore Tel: +65-6281-0770 Fax: +65-6281-0220 http://sq.fujitsu.com/semiconductor/

FUJITSU SEMICONDUCTOR SHANGHAI CO., LTD. 30F, Kerry Parkside, 1155 Fang Dian Road, Pudong District, Shanghai 201204, China Tel:+86-21-6146-3688 Fax:+86-21-6146-3660 http://cn.fujitsu.com/fss/

FUJITSU SEMICONDUCTOR PACIFIC ASIA LTD. 10/F., World Commerce Centre, 11 Canton Road, Tsimshatsui, Kowloon, Hong Kong Tel:+852-2377-0226 Fax:+852-2376-3269 http://cn.fujitsu.com/fsp/

## Fujitsu's Random Access Memory(RAM) for SiP



# (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/

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

Mobile FCRAM :

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

## **Target Applications of FCRAM**

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

### **FCRAM History**

Experience of DRAM development, Innovation to FCRAM

market.



#### Mobile Applications

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

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

# 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	1.8	.8V
I/O Voltage	1.5V	1.0V	1.2V	1.0V	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	3.2G	Byte/s
DLL on RAM	Yes		No		No	
I/O Interface	SSTL		CMOS		C	NOS
Termination	ODT (On Die Termination)		No		I	No

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

Max. 125°C

Operation

FCRAM

Bandwidth Consumption

Low Power

High Data

### **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, Core Voltage: 1.8V, I/O Voltage: 1.2V 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

- Reduced cost and necessity of heat sink or heat spreader.

#### Case Study of SiP Thermal Design

125°C-rated Consumer FCRAM resolves thermal de

#### 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.

esign issues on SiP shown below.	
SiP with standard DRAM (ex.)	SiP with 125°C-rated FCRAM (ex.)
DDR3 (85°C) SoC (125°C) (a) SiP temperature: 125°C < SiP Not Feasible >	FCRAM (125°C) SoC (125°C) (c) SiP temperature: 125°C < SiP Feasible >
Or, Heat-sink Increased cost DDR3 (85°C) SoC (125°C) (b) SiP temperature: 85°C < SiP Feasible but High Cost >	*: 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
- $\cdot$  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



FCRAM

Resolves thermal design issue and eliminates worry of overheating, high power and high performance SiP become feasible.

\* 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.



#### 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	
128Mbit	8Mx16	1.8V	90ns	

# **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<sub>2</sub> emission.

FCRAM







