

FRAM (Ferroelectric Random Access Memory)

Non-Volatile : Does not lose data when power is turned off

Typically used to store instructions of your program and constants.

FRAM has power and write speed characteristics that almost matches SRAM (Static RAM) capabilities. FRAM supports dynamic writes (write while the program is running) so it can be mapped to RAM applications.

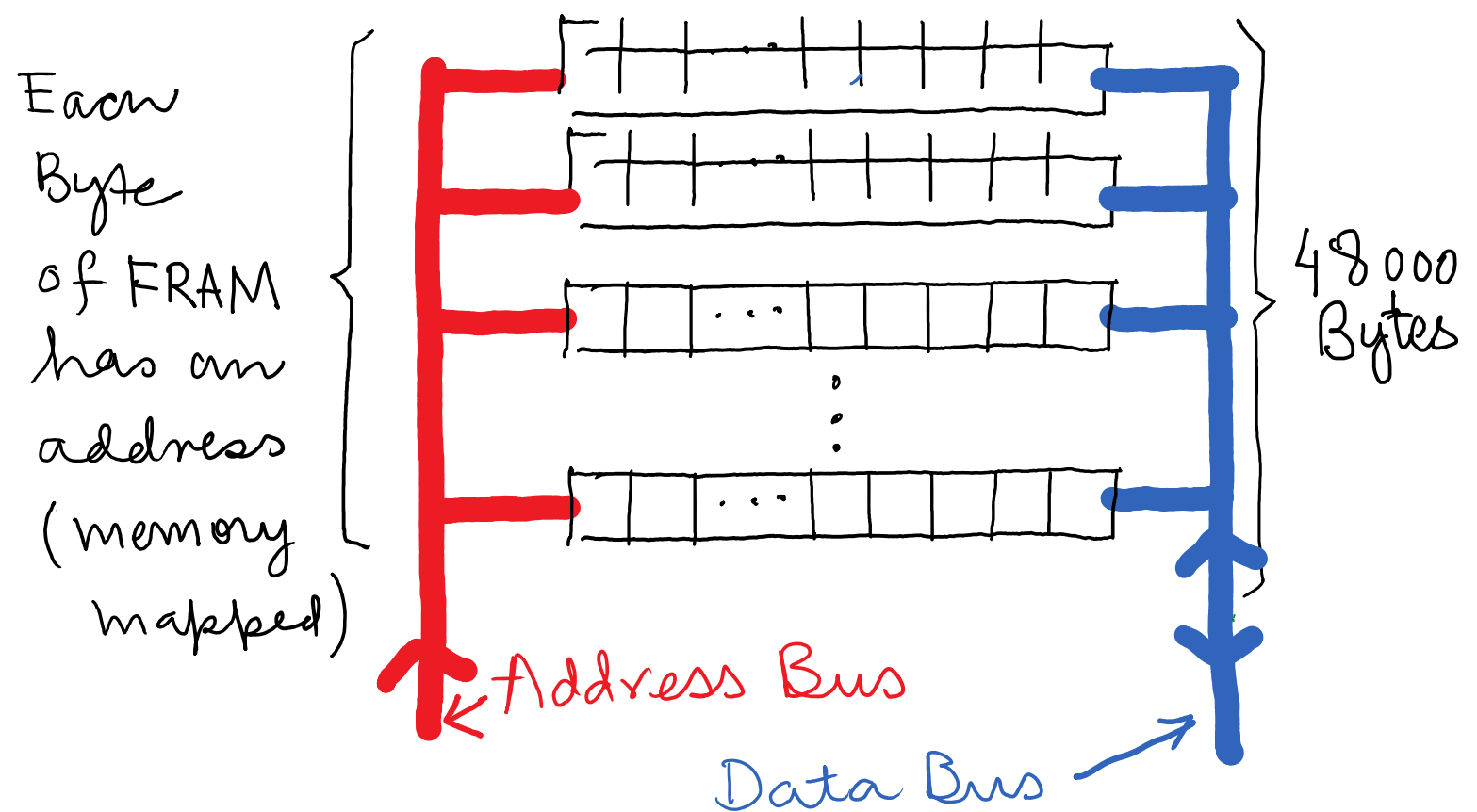
The maximum size of FRAM currently manufactured is 1MB.

FRAM is currently inside some micro-controllers as a replacement to built-in SRAM and Flash

	FRAM	SRAM	EEPROM	Flash
Nonvolatile Retains data without power	Yes	No	Yes	Yes
Write speed (13 KB)	10ms	<10ms	2 secs	1 sec
Average active Power [μ A/MHz]	82	<60	Up to 10mA	260
Write endurance	1 million billions (10^{15})	Unlimited	~500,000	10,000
Dynamic Bit-wise programmable	Yes	Yes	No	No
Unified memory Flexible code and data partitioning	Yes	No	No	No

FRAM (Memory Mapping)

Note: $1\text{KB} = 2^{10} \text{ Bytes} = 1024 \text{ Bytes}$



viewed in 8-bit chunks

address 16 bit	FRAM 8 bit
0x4400	0xB1
0x4401	0xFA
0x4402	0x12
0x4403	0xAB
0x4404	
	⋮
0xFFFFE	
0xFFFF	

viewed in 16-bit chunks

address (even) 16 bit	16 bit
0x4400	0xFA B1
0x4402	0xAB 12
0x4404	
	⋮
0x4403	
0xFFFFE	
	0xFFFF

Little Endian Ordering (opposite of big-endian)

16 bit number :

FA | B1
 higher significant byte stored in higher memory | lower significant byte stored in lower memory

viewed as 8-bits

0x4400	0xB1	} number: FAB1
0x4401	0xFA	

viewed as 16-bits

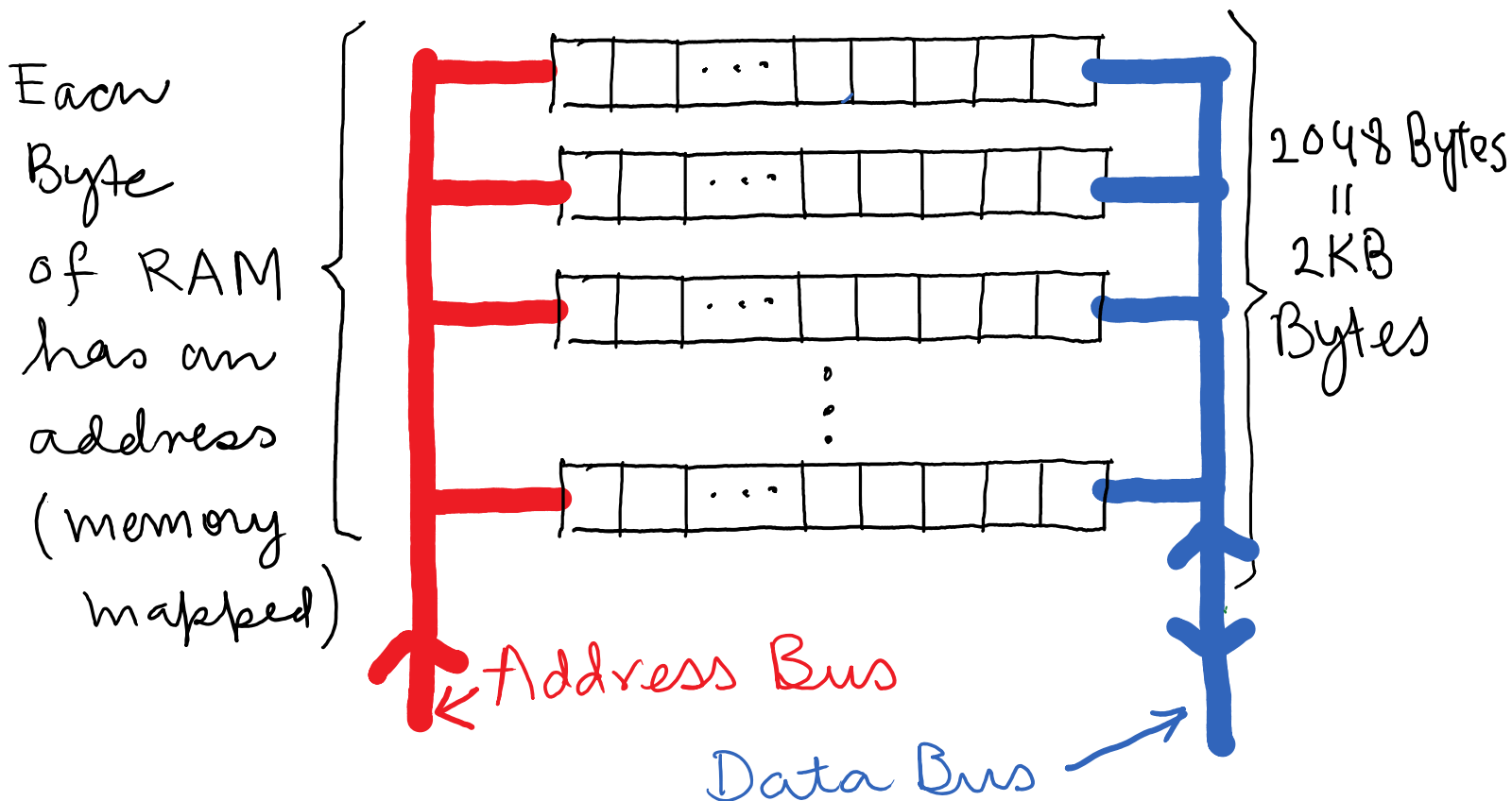
0x4400	0xFA B1	} number: FAB1
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RAM : Random Access Memory

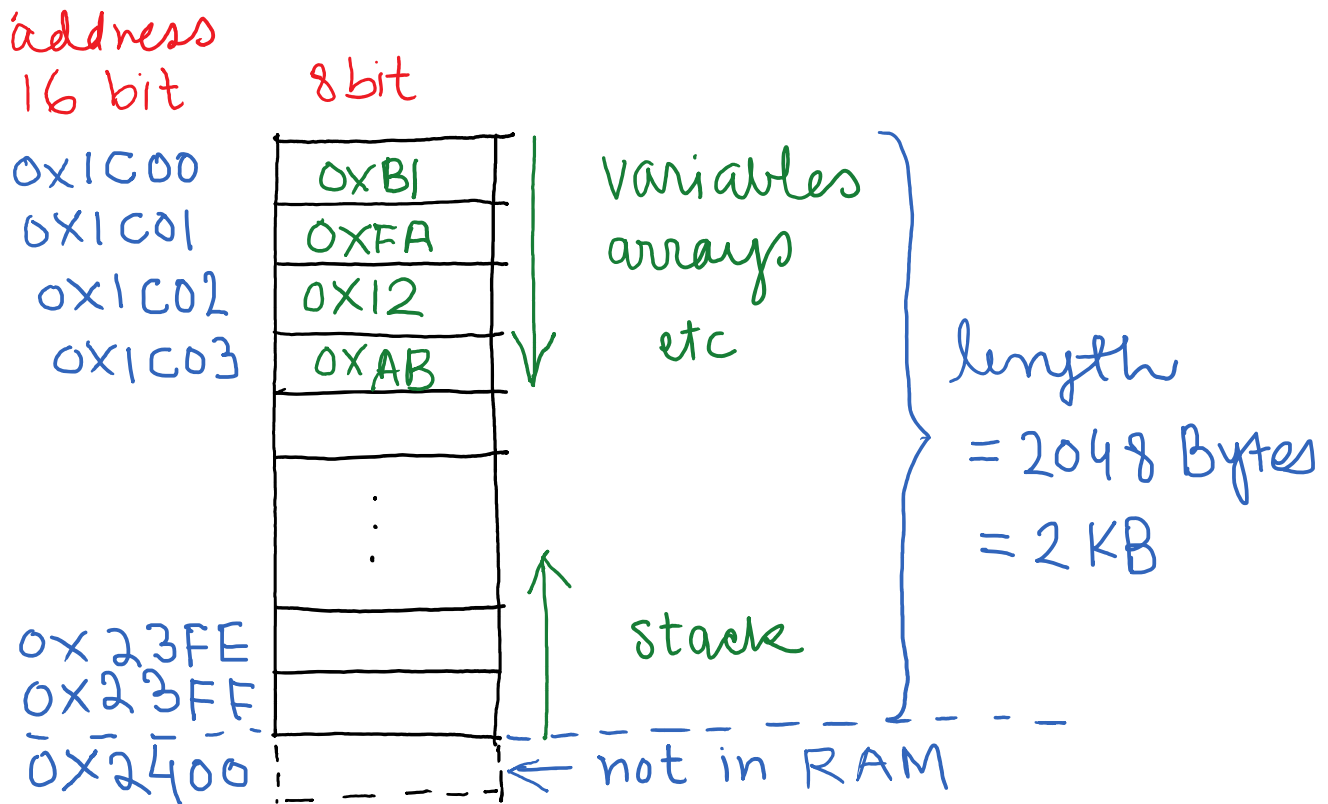
Volatile : Loses data when power is turned off

Can be read from and written to easily at run time while the program is executing

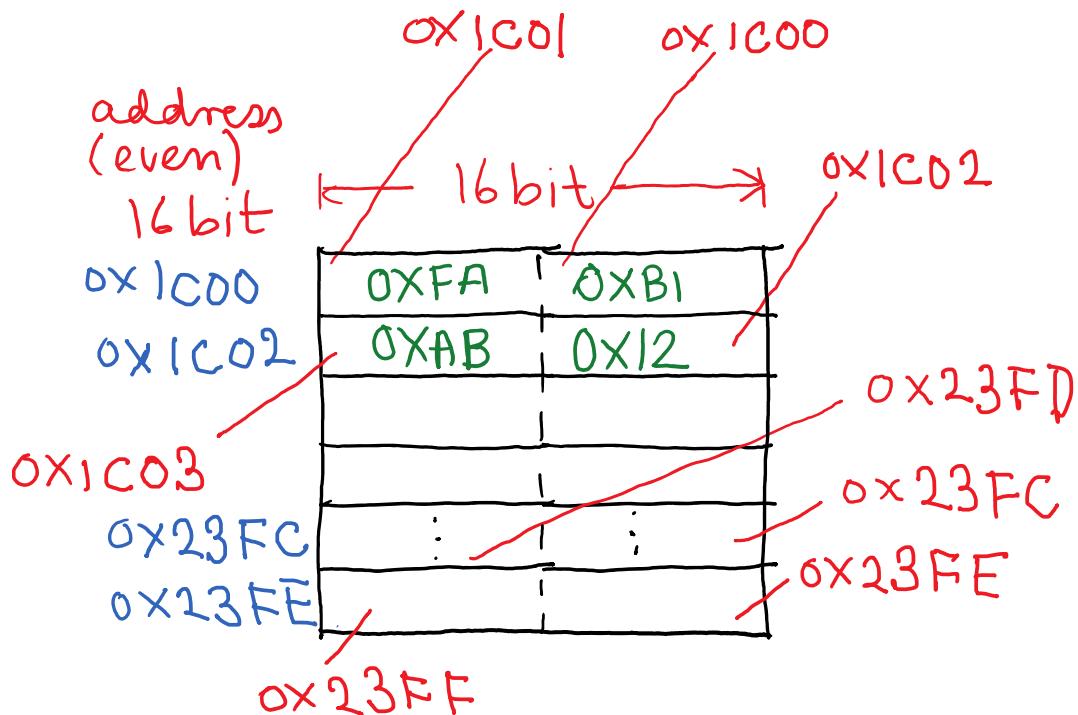
Used to store variables
Used for Stack



viewed in 8-bit chunks



viewed in 16-bit chunks



Ink_msp430fr6989.cmd (File in CCS project)

Memory Mapping of msp430fr6989

... ..

PERIPHERALS_8BIT : origin = 0x0020, length = 0x00E0

PERIPHERALS_16BIT : origin = 0x0100, length = 0x0100

... ..

RAM : origin = 0x1C00, length = 0x0800 (2048 Bytes = 2KB)

FRAM : origin = 0x4400, length = 0xBB80 (48000 Bytes = 46.875 KB)

... ..

INT00 : origin = 0xFF90, length = 0x0002

INT01 : origin = 0xFF92, length = 0x0002

INT02 : origin = 0xFF94, length = 0x0002

... ..

INT53 : origin = 0xFFFA, length = 0x0002

INT54 : origin = 0xFFFC, length = 0x0002

RESET : origin = 0xFFFE, length = 0x0002